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CONTENTS

CONTENTS

1

GENERAL INFORMATION, SAFETY AND TOOLS

HOW TO USE THIS MANUAL

This manual is designed to be a handy reference guide to maintaining and repairing your Johnson or Evinrude Outboard. We strongly believe that regardless of how many or how few year's experience you may have, there is something new waiting here for you.

This manual covers the topics that a factory service manual (designed for factorv trained mechanics) and a manufacturer owner's manual (designed more by lawyers than boat owners these days) covers. It will take you through the basics of maintaining and repairing your outboard, step-by-stea to help you understand what the factory trained mechanics already know by heart. By using the information in this manual, any boat owner should be able to make better informed decisions about what they need to do to maintain and enjoy their outboard.

Even if you never plan on touching a wrench (and if so, we hope that we can change your mind), this manual will still help you understand what a mechanic needs to do in order to maintain your engine.

Can You Do It?

If you are not the type who is prone to taking a wrench to something, NEVER FEAR. The procedures provided here cover topics at a level virtually anyone will be able to handle. And just the fact that you purchased this manual shows your interest in better understanding your outboard.

You may find that maintaining your outboard yourself is preferable in most cases. From a monetary standpoint, it could also be beneficial. The money spent on hauling your boat to a marina and paying a tech to service the engine could buy you fuel for a whole weekend's boating. If you are unsure of your own mechanical abilities, at the very least you should fully understand what a marine mechanic does to your boat. You may decide that anything other than maintenance and adjustments should be performed by a mechanic (and that's your call), but know that every time you board your boat, you are placing faith in the mechanic's work and trusting him or her with your well-being, and maybe your life.

It should also be noted that in most areas a factory-trained mechanic will command a hefty hourly rate for off site service. This hourly rate is often charged from the time they leave their shop to the time that they return home. The cost savings in doing the job yourself might be readily apparent at this point.

Of course, if even you're already a seasoned Do-It-Yourselfer or a Professional Technician, you'll find the procedures, specifications, special tips as well as the schematics and illustrations helpful when tackling a new job on a motor.

■ To help you decide if a task is within your skill level, procedures will often be rated using a wrench symbol in the text. When present, the number of wrenches designates how difficult we feel the procedure to be on a **1** to **4** scale. For more details on the wrench icon rating system, please refer to the information under Skill Levels at the beginning of this manual.

Where to Begin

Before spending any monev on Darts, and before removing any nuts or bolts, read through the entire procedure or topic. This will give you the overall view of what tools and supplies will be required to perform the procedure or what auestions need to be answered before purchasing parts. So read ahead and plan ahead. Each operation should be approached logically and all procedures thoroughly understood before attempting any work.

Avoiding Trouble

Some procedures in this manual may require you to "label and disconnect . . . " a group of lines, hoses or wires. Don't be lulled into thinking you can remember where everything goes — you won't. If you reconnect or install a part incorrectly, the motor may operate poorly, if at all. If you hook up electrical wiring incorrectly, you may instantly learn a very expensive lesson.

A piece of masking tape, for example, placed on a hose and another on its fitting will allow you to assign your own label such as the letter "A, or a short name. As long as you remember your own code, you can reconnect the lines by matching letters or names. Do remember that tape will dissolve when saturated in some fluids (especially cleaning solvents). If a component is to be washed or cleaned, use another method of identification. A permanent felt-tipped marker can be very handy for marking metal parts; but remember that some solvents will remove permanent marker. A scribe can be used to carefully etch a small mark in some metal parts, but be sure NOT to do that on a gasket-making surface.

SAFETY is the most important thing to remember when performing maintenance or repairs. Be sure to read the information on safety in this manual.

Maintenance or Repair?

Proper maintenance is the key to long and trouble-free engine life, and the work can yield its own rewards. A properly maintained engine performs better than one that is neglected. As a conscientious boat owner, set aside a Saturday morning, at least once a month, to perform a thorough check of items that could cause problems. Keep your own personal log to jot down which services you performed, how much the Parts cost you, the date, and the amount of hours on the engine at the time: Keep all receipts for parts purchased, so that they may be referred to in case of related problems or to determine operating expenses. As a do-it-yourselfer, these receipts are the only proof you have that the required maintenance was performed. In the event of a warranty problem (on new motors), these receipts can be invaluable.

It's necessary to mention the difference between maintenance and repair. Maintenance includes routine inspections, adjustments, and replacement of parts that show signs of normal wear. Maintenance compensates for wear or deterioration. Repair implies that something has broken or is not working. A need for repair is often caused by lack of maintenance.

For example: draining and refilling the gearcase oil is maintenance recommended by all manufacturers at specific intervals. Failure to do this can allow internal corrosion or damage and impair the operation of the motor, requiring expensive repairs. While no maintenance program can prevent items from breaking or wearing out, a general rule can be stated: MAINTENANCE IS CHEAPER THAN REPAIR.

Directions and Locations

◆ See Figure 1

Two basic rules should be mentioned here. First, whenever the Port side of the engine (or boat) is referred to, it is meant to specify the left side of the engine when you are sitting at the helm. Conversely, the Starboard means your right side. The Bow is the front of the boat and the Stern or Aft is the rear.

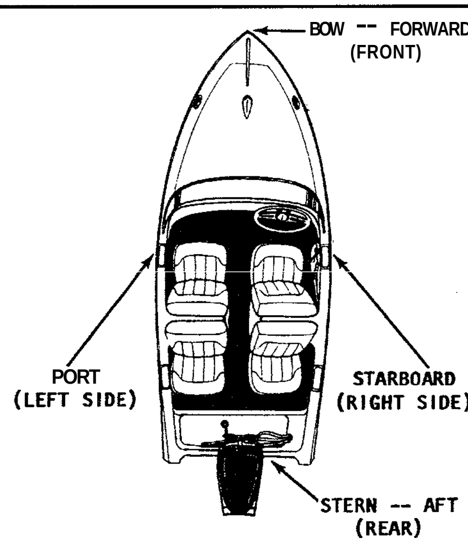


Fig. 1 Common terminology used for reference designation on boats of all size. These terms are used through out the text

Most screws and bolts are removed by turning counterclockwise, and tightened by turning clockwise. An easy way to remember this is: righty-tighty; lefty-loosey. Corny, but effective. And if you are really dense (and we have all been so at one time or another), buy a ratchet that is marked ON and OFF (like Snap-on@ ratchets), or mark your own. This can be especially helpful when you are bent over backwards, upside down or otherwise turned around when working on a boat-mounted component.

Professional Help

Occasionally, there are some things when working on an outboard that are beyond the capabilities or tools of the average Do-It-Yourselfer (DIYer). This shouldn't include most of the topics of this manual, but you will have to be the judge. Some engines require special tools or a selection of special parts, even for some basic maintenance tasks.

Talk to other boaters who use the same model of engine and speak with a trusted marina to find if there is a particular system or component on your engine that is difficult to maintain.

You will have to decide for yourself where basic maintenance ends and where professional service should begin. Take your time and do your research first (starting with the information contained within) and then make your own decision. If you really don't feel comfortable with attempting a procedure, DON'T DO IT. If you've gotten into something that may be over your head, don't panic. Tuck your tail between your legs and call a marine mechanic. Marinas and independent shops will be able to finish a job for you. Your ego may be damaged, but your boat will be properly restored to its full running order. So, as long as you approach jobs slowly and carefully, you really have nothing to lose and everything to gain by doing it yourself.

On the other hand, even the most complicated repair is within the ability of a person who takes their time and follows the steps of a procedure. A rock climber doesn't run up the side of a cliff, he/she takes it one step at a time and in the end, what looked difficult or impossible was conquerable. Worry about one step at a time.

Purchasing Parts

◆ **See Figures 2 and 3**

When purchasing parts there are two things to consider. The first is quality and the second is to be sure to get the correct part for your engine. To get quality parts, always deal directly with a reputable retailer. To get the proper parts always refer to the information tag on your engine prior to calling the parts counter. An incorrect part can adverselv affect vour engine performance and fuel economy, and will cost you more money and aggravation in the end.

Just remember, a tow back to shore will cost plenty. That charge is per hour from the time the towboat leaves their home port, to the time they return to their home port. Get the picture...$$$?

So whom should you call for parts? Well, there are many sources for the parts you will need. Where you shop for parts will be determined by what kind of parts you need, how much you want to pay, and the types of stores in your neighborhood.

Your marina can supply you with many of the common parts you require. Using a marina as your parts supplier may be handy because of location (just walk right down the dock) or because the marina specializes in your particular brand of engine. In addition, it is always a good idea to get to know the marina staff (especially the marine mechanic).

The marine parts jobber, who is usually listed in the yellow pages or whose name can be obtained from the marina, is another excellent source for parts. In addition to supplying local marinas, they also do a sizeable business in over-the-counter parts sales for the do-it-yourselfer.

Almost every boating community has one or more convenient marine chain stores. These stores often offer the best retail prices and the convenience of one-stop shopping for all your needs. Since they cater to the do-it-yourselfer, these stores are almost always open weeknights, Saturdays, and Sundays, when the jobbers are usually closed.

The lowest prices for parts are most often found in discount stores or the auto department of mass merchandisers. Parts sold here are name and private brand parts bought in huge quantities, so they can offer a competitive price. Private brand parts are made by major manufacturers and sold to large chains under a store label. And, of course, more and more large automotive parts retailers are stocking basic marine supplies.

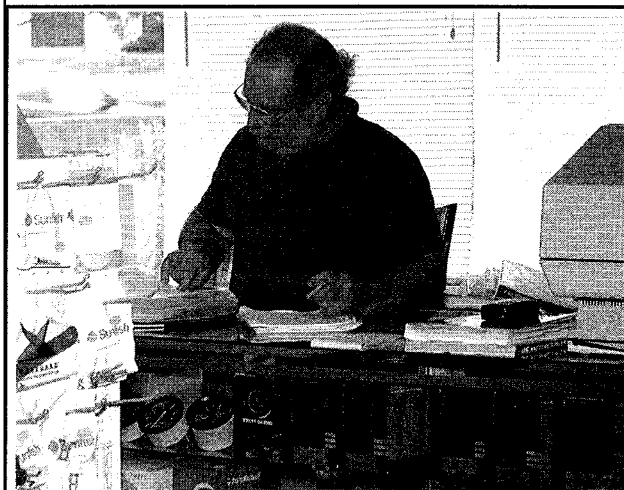


Fig. 2 By far the most important asset in purchasing parts is a knowledgeable and enthusiastic parts person

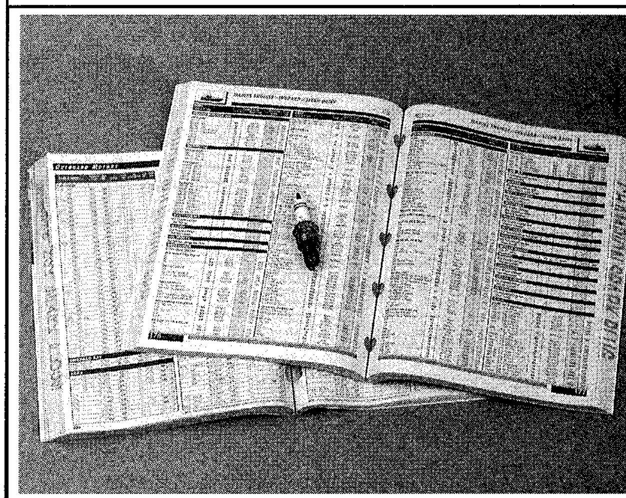


Fig. 3 Parts catalogs, giving application and part number information, are provided by manufacturers for most replacement parts

Avoiding the Most Common Mistakes

There are 3 common mistakes in mechanical work:

1. Following the incorrect order of assembly, disassembly or adjustment. When taking something apart or putting it together, performing steps in the wrong order usually just costs you extra time; however, it CAN break something. Read the entire procedure before beginning disassembly. Perform everything in the order in which the instructions say you should, even if you can't immediately see a reason for it. When you're taking apart something that is very intricate, you might want to draw a picture of how it looks when assembled at one point in order to make sure you get everything back in its proper position. When making adjustments, perform them in the proper order; often, one adjustment affects another, and you cannot expect satisfactory results unless each adjustment is made only when it cannot be changed by subsequent adjustments.

■ **Digital cameras are handy. If you've got access to one, take pictures of intricate assemblies during the disassembly process and refer to them during assembly for tips on part orientation.**

2. Overtorquing (or undertorquing). While it is more common for overtorquing to cause damage, undertorquing may allow a fastener to vibrate loose causing serious damage. Especially when dealing with plastic and aluminum parts, pay attention to torque specifications and utilize a torque wrench in assembly. If a torque figure is not available, remember that if you are using the right tool to perform the job, you will probably not have to strain yourself to get a fastener tight enough. The pitch of most threads is so slight that the tension you put on the wrench will be multiplied many times in actual force on what you are tightening.

3. Cross-threading. This occurs when a part such as a bolt is screwed into a nut or casting at the wrong angle and forced. Crossthreading is more likely to occur if access is difficult. It helps to clean and lubricate fasteners, then to start threading with the part to be installed positioned straight inward. Always start a fastener, etc. with your fingers. If you encounter resistance, unscrew the part and start over again at a different angle until it can be inserted and turned several times without much effort. Keep in mind that some parts may have tapered threads, so that gentle turning will automatically bring the part you're threading to the proper angle, but only if you don't force it or resist a change in angle. Don't put a wrench on the part until it has been tightened a couple of turns by hand. If you suddenly encounter resistance, and the part has not seated fully, don't force it. Pull it back out to make sure it's clean and threading properly.

BOATING SAFETY

In 1971 Congress ordered the U.S. Coast Guard to improve recreational boating safety. In response, the Coast Guard drew up a set of regulations.

Aside from these federal regulations, there are state and local laws you must follow. These sometimes exceed the Coast Guard requirements. This section discusses only the federal laws. State and local laws are available from your local Coast Guard. As with other laws, "Ignorance of the boating laws is no excuse." The rules fall into two groups: regulations for your boat and required safety equipment on your boat.

Regulations For Your Boat

Most boats on waters within Federal jurisdiction must be registered or documented. These waters are those that provide a means of transportation between two or more states or to the sea. They also include the territorial waters of the United States.

DOCUMENTING OF VESSELS

A vessel of five or more net tons may be documented as a yacht. In this process, papers are issued by the U.S. Coast Guard as they are for large ships. Documentation is a form of national registration. The boat must be used solely for pleasure. Its owner must be a citizen of the U.S., a partnership of U.S. citizens, or a corporation controlled by U.S. citizens. The captain and other officers must also be U.S. citizens. The crew need not be.

If you document your yacht, you have the legal authority to fly the yacht ensign. You also may record bills of sale, mortgages, and other papers of title with federal authorities. Doing so gives legal notice that such instruments exist. Documentation also permits preferred status for mortgages. This gives you additional security, and it aids in financing and transfer of title. You must carry the original documentation papers aboard your vessel. Copies will not suffice.

REGISTRATION OF BOATS

If your boat is not documented, registration in the state of its principal use is probably required. If you use it mainly on an ocean, a gulf, or other similar water, register it in the state where you moor it.

If you use your boat solely for racing, it may be exempt from the requirement in your state. Some states may also exclude dinghies, while others require registration of documented vessels and non-power driven boats.

All states, except Alaska, register boats. In Alaska, the U.S. Coast Guard issues the registration numbers. If you move your vessel to a new state of principal use, a valid registration certificate is good for 60 days. You must have the registration certificate (certificate of number) aboard your vessel when it is in use. A copy will not suffice. You may be cited if you do not have the original on board.

NUMBERING OF VESSELS

A registration number is on your registration certificate. You must paint or permanently attach this number to both sides of the forward half of your boat. Do not display any other number there.

The registration number must be clearly visible. It must not be placed on the obscured underside of a flared bow. If you can't place the number on the bow, place it on the forward half of the hull. If that doesn't work, put it on the superstructure. Put the number for an inflatable boat on a bracket or fixture. Then, firmly attach it to the forward half of the boat. The letters and numbers must be plain block characters and must read from left to right. Use a space or a hyphen to separate the prefix and suffix letters from the numerals. The color of the characters must contrast with that of the background, and they must be at least three inches high.

In some states your registration is good for only one year. In others, it is good for as long as three years. Renew your registration before it expires. At that time you will receive a new decal or decals. Place them as required by state law. You should remove old decals before putting on the new ones. Some states require that you show only the current decal or decals. If your vessel is moored, it must have a current decal even if it is not in use.

If your vessel is lost, destroyed, abandoned, stolen, or transferred, you must inform the issuing authority. If you lose your certificate of number or your address changes, notify the issuing authority as soon as possible.

SALES AND TRANSFERS

Your registration number is not transferable to another boat. The number stays with the boat unless its state of principal use is changed.

HULL IDENTIFICATION NUMBER

A Hull Identification Number (HIN) is like the Vehicle Identification Number (VIN) on your car. Boats built between November 1, 1972 and July 31, 1984 have old format HINs. Since August 1, 1984 a new format has been used.

Your boat's HIN must appear in two places. If it has a transom, the primary number is on its starboard side within two inches of its top. If it does not have a transom or if it was not practical to use the transom, the number is on the starboard side. In this case, it must be within one foot of the stern and within two inches of the top of the hull side. On pontoon boats, it is on the aft crossbeam within one foot of the starboard hull attachment. Your boat also has a duplicate number in an unexposed location. This is on the boat's interior or under a fitting or item of hardware.

LENGTH OF BOATS

For some purposes, boats are classed by length. Required equipment, for example, differs with boat size. Manufacturers may measure a boat's length in several ways. Officially, though, your boat is measured along a straight line from its bow to its stern. This line is parallel to its keel.

The length does not include bowsprits, boomkins, or pulpits. Nor does it include rudders, brackets, outboard motors, outdrives, diving platforms, or other attachments.

CAPACITY INFORMATION

◆ **See Figure 4**

Manufacturers must put capacity plates on most recreational boats less than 20 feet long. Sailboats, canoes, kayaks, and inflatable boats are usually exempt. Outboard boats must display the maximum permitted horsepower of their engines. The plates must also show the allowable maximum weights of the people on board. And they must show the allowable maximum combined weights of people, engine(s), and gear. Inboards and stern drives need not show the weight of their engines on their capacity plates. The capacity plate must appear where it is clearly visible to the operator when underway. This information serves to remind you of the capacity of your boat under normal

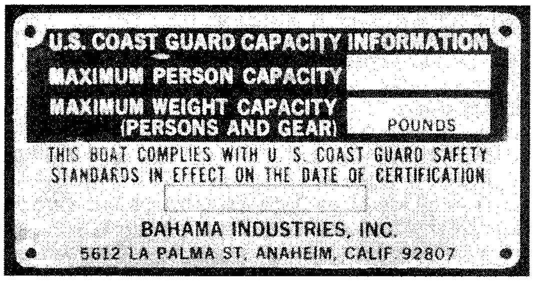


Fig. 4 **A U.S.** Coast Guard certification plate indicates the amount of occupants and gear appropriate for safe operation of the vessel

circumstances. You should ask yourself, "Is my boat loaded above its recommended capacity" and. "Is my boat overloaded for the present sea and wind conditions?" If you are stopped by a legal authority,'you may be cited if you are overloaded.

CERTIFICATE OF COMPLIANCE

◆ See Figure **4**

Manufacturers are required to put compliance plates on motorboats greater than 20 feet in length. The plates must say, "This boat," or "This equipment complies with the U. S. Coast Guard Safety Standards in effect on the date of certification." Letters and numbers can be no less than one-eighth of an inch high. At the manufacturer's option, the capacity and compliance plates may be combined.

VENTILATION

A cup of gasoline spilled in the bilge has the potential explosive power of 15 sticks of dynamite. This statement, commonly quoted over 20 years ago, may be an exaggeration; however, it illustrates a fact. Gasoline fumes in the bilge of a boat are highly explosive and a serious danger. They are heavier than air and will stay in the bilge until they are vented out.

Because of this danger, Coast Guard regulations require ventilation on many powerboats. There are several ways to supply fresh air to engine and gasoline tank compartments and to remove dangerous vapors. Whatever the choice, it must meet Coast Guard standards.

The following is not intended to be a complete discussion of the regulations. **It** is limited to the majority of recreational vessels. Contact your local Coast Guard office for further information.

General Precautions

Ventilation systems will not remove raw gasoline that leaks from tanks or fuel lines. If you smell gasoline fumes, you need immediate repairs. The best device for sensing gasoline fumes is your nose. Use it! If you smell gasoline in an engine compartment or elsewhere, don't start your engine. The smaller the compartment, the less gasoline it takes to make an explosive mixture.

Ventilation for Open Boats

In open boats, gasoline vapors are dispersed by the air that moves through them. So they are exempt from ventilation requirements.

To be "open," a boat must meet certain conditions. Engine and fuel tank compartments and long narrow compartments that join them must be open to the atmosphere." This means they must have at least 15 square inches of open area for each cubic foot of net compartment volume. The open area must be in direct contact with the atmosphere. There must also be no long, unventilated spaces open to engine and fuel tank compartments into which flames could extend.

Ventilation for All Other Boats

Powered and natural ventilation are required in an enclosed compartment with a permanently installed gasoline engine that has a cranking motor. A compartment is exempt if its engine is open to the atmosphere. Diesel powered boats are also exempt.

VENTILATION SYSTEMS

There are two types of ventilation systems. One is "natural ventilation." In it, air circulates through closed spaces due to the boat's motion. The other type is "powered ventilation." In it, air is circulated by a motor-driven fan or fans.

Natural Ventilation System Requirements

A natural ventilation system has an air supply from outside the boat. The air supply may also be from a ventilated compartment or a compartment open to the atmosphere. Intake openings are required. In addition, intake ducts may be required to direct the air to appropriate compartments.

The system must also have an exhaust duct that starts in the lower third of the compartment. The exhaust opening must be into another ventilated compartment or into the atmosphere. Each supply opening and supply duct, if there is one, must be above the usual level of water in the bilge. Exhaust openings and ducts must also be above the bilge water. Openings and ducts must be at least three square inches in area or two inches in diameter. Openings should be placed so exhaust gasses do not enter the fresh air intake. Exhaust fumes must not enter cabins or other enclosed, non-ventilated spaces. The carbon monoxide gas in them is deadly.

Intake and exhaust openings must be covered by cowls or similar devices. These registers keep out rain water and water from breaking seas. Most often, intake registers face forward and exhaust openings aft. This aids the flow of air when the boat is moving or at anchor since most boats face into the wind when properly anchored.

Power Ventilation System Requirements

◆ See Figure 5

Powered ventilation systems must meet the standards of a natural system. They must also have one or more exhaust blowers. The blower duct can serve as the exhaust duct for natural ventilation if fan blades do not obstruct the air flow when not powered. Openings in engine compartment, for carburetion are in addition to ventilation system requirements.

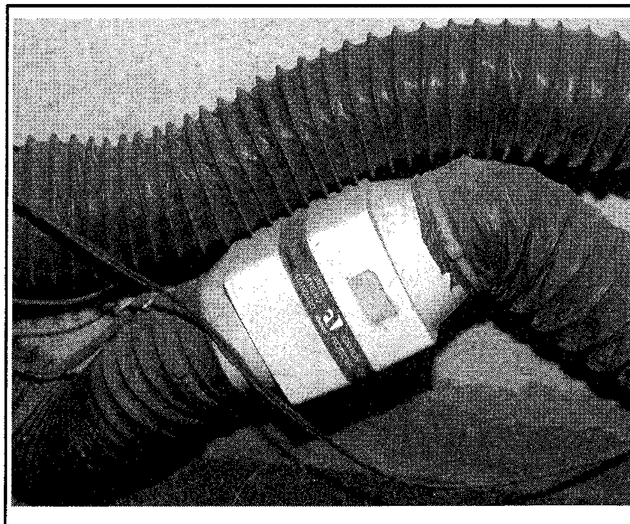


Fig. 5 Typical blower and duct system to vent fumes from the engine compartment

Required Safety Equipment

Coast Guard regulations require that your boat have certain equipment aboard. These requirements are minimums. Exceed them whenever you can.

TYPES OF FIRES

There are four common classes of fires:

- Class A—fires are of ordinary combustible materials such as paper or wood.
- Class B—fires involve gasoline, oil and grease.
- Class C—fires are electrical.
- Class D—fires involve ferrous metals

One of the greatest risks to boaters is fire. This is why it is so important to carry the correct number and type of extinguishers onboard.

The best fire extinguisher for most boats is a Class B extinguisher. Never use water on Class B or Class C fires, as water spreads these types of fires. Additionally, you should never use water on a Class C fire as it may cause you to be electrocuted.

FIRE EXTINGUISHERS

◆ **See Figure 6**

If your boat meets one or more of the following conditions, you must have at least one fire extinguisher aboard. The conditions are:

- Inboard or stern drive engines
- Closed compartments under seats where portable fuel tanks can be stored
- Double bottoms not sealed together or not completely filled with flotation materials
- Closed living spaces
- Closed stowage compartments in which combustible or flammable materials are stored
- Permanently installed fuel tanks
- Boat is 26 feet or more in length.

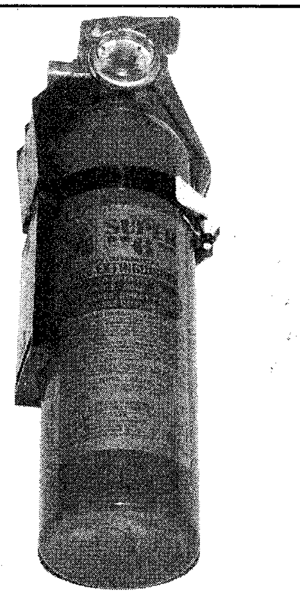


Fig. 6 An approved fire extinguisher should be mounted close to the operator for emergency use

Contents of Extinguishers

Fire extinguishers use a variety of materials. Those used on boats usually contain dry chemicals, Halon, or Carbon Dioxide (CO_2). Dry chemical extinguishers contain chemical powders such as Sodium Bicarbonate—baking soda.

Carbon dioxide is a colorless and odorless gas when released from an extinguisher. It is not poisonous but caution must be used in entering compartments filled with it. It will not support life and keeps oxygen from reaching your lungs. A fire-killing concentration of Carbon Dioxide can be lethal. If you are in a compartment with a high concentration of CO_2, you will have no difficulty breathing. But the air does not contain enough oxygen to support life. Unconsciousness or death can result.

Halon Extinguishers

Some fire extinguishers and 'built-in' or 'fixed' automatic fire extinguishing systems contain a gas called Halon. Like carbon dioxide it is colorless and odorless and will not suooort life. Some Halons may be toxic if inhaled.

To be accepted by the Coast Guard, a fixed Halon system must have an indicator light at the vessel's helm. A green light shows the system is ready. Red means it is being discharged or has been discharged. Warning horns are available to let you know the system has been activated. If your fixed Halon system discharges, ventilate the space thoroughly before you enter it. There are no residues from Halon but it will not support life.

Although Halon has excellent fire fighting properties; it is thought to deplete the earth's ozone layer and has not been manufactured since January 1, 1994. Halon extinguishers can be refilled from existing stocks of the gas until they are used up, but high federal excise taxes are being charged for the service. If you discontinue using your Halon extinguisher, take it to a recovery station rather than releasing the gas into the atmosphere. Compounds such as FE 241, designed to replace Halon, are now available.

Fire Extinguisher Approval

Fire extinguishers must be Coast Guard approved. Look for the approval number on the nameplate. Approved extinguishers have the following on their labels: "Marine Type USCG Approved, Size..., Type..., 162.208/," etc. In addition, to be acceptable by the Coast Guard, an extinguisher must be in serviceable condition and mounted in its bracket. An extinguisher not properly mounted in its bracket will not be considered serviceable during a Coast Guard inspection.

Care and Treatment

Make certain your extinguishers are in their stowage brackets and are not damaged. Replace cracked or broken hoses. Nozzles should be free of obstructions. sometimes, wasps and other insects nest inside nozzles and make them inoperable. Check your extinguishers frequently. If they have pressure gauges, is the pressure within acceptable limits? Do the locking pins and sealing wires show they have not been used since recharging?

Don't try an extinguisher to test it. Its valves will not reseat properly and the remaining gas will leak out. When this happens, the extinguisher is useless.

Weigh and tag carbon dioxide and Halon extinguishers twice a year. If their weight loss exceeds 10 percent of the weight of the charge, recharge them. Check to see that they have not been used. They should have been inspected by a qualified person within the past six months, and they should have tags showing all inspection and service dates. The oroblem is that thev can be partially discharged while appearing to be fully charged.

Some Halon extinguishers have pressure gauges the same as dry chemical extinguishers. Don't rely too heavily on the gauge. The extinguisher can be partially discharged and still show a good gauge reading. Weighing a Halon extinguisher is the only accurate way to assess its contents.

If your dry chemical extinguisher has a pressure indicator, check it frequently. Check the nozzle to see if there is powder in it. If there is, recharge it. Occasionally invert your dry chemical extinguisher and hit the base with the palm of your hand. The chemical in these extinguishers packs and cakes due to the boat's vibration and pounding. There is a difference of opinion about whether hitting the base helps, but it can't hurt. It is known that caking of the chemical powder is a major cause of failure of dry chemical extinguishers. Carry spares in excess of the minimum requirement. If you have guests aboard, make certain they know where the extinguishers are and how to use them.

Using a Fire Extinguisher

A fire extinguisher usually has a device to keep it from being discharged accidentally. This is a metal or plastic pin or loop. If you need to use your extinguisher, take it from its bracket. Remove the pin or the loop and point the nozzle at the base of the flames. Now, squeeze the handle, and discharge the extinguisher's contents while sweeping from side to side. Recharge a used extinguisher as soon as possible.

If you are using a Halon or carbon dioxide extinguisher, keep your hands away from the discharge. The rapidly expanding gas will freeze them. If your fire extinguisher has a horn, hold it by its handle.

Legal Requirements for Extinguishers

You must carry fire extinguishers as defined by Coast Guard regulations. They must be firmly mounted in their brackets and immediately accessible.

A motorboat less than 26 feet long must have at least one approved hand-portable, Type B-1 extinguisher. If the boat has an approved fixed fire extinguishing system, you are not required to have the Type B-1 extinguisher. Also, if your boat is less than 26 feet long, is propelled by an outboard motor, or motors, and does not have any of the first six conditions described at the beginning of this section, it is not required to have an extinguisher. Even so, it's a good idea to have one, especially if a nearby boat catches fire, or if a fire occurs at a fuel dock.

A motorboat 26 feet to less than 40 feet long, must have at least two Type B-1 approved hand-portable extinguishers. It can, instead, have at least one Coast Guard approved Type B-2. If you have an approved fire extinguishing system, only one Type B-1 is required.

A motorboat 40 to 65 feet long must have at least three Type B-1 approved portable extinguishers. It may have, instead, at least one Type B-1 plus a Type B-2. If there is an approved fixed fire extinguishing system, two Type B-1 or one Type B-2 is required.

WARNING SYSTEM

Various devices are available to alert you to danger. These include fire, smoke, gasoline fumes, and carbon monoxide detectors. If your boat has a galley, it should have a smoke detector. Where possible, use wired detectors. Household batteries often corrode rapidly on a boat.

There are many ways in which carbon monoxide (a by-product of the combustion that occurs in an engine) can enter your boat. You can't see, smell, or taste carbon monoxide gas, but it is lethal. As little as one part in 10,000 parts of air can bring on a headache. The symptoms of carbon monoxide poisoning—headaches, dizziness, and nausea—are like seasickness. By the time you realize what is happening to you, it may be too late to take action. If you have enclosed living spaces on your boat, protect yourself with a detector.

PERSONAL FLOTATION DEVICES

Personal Flotation Devices (PFDs) are commonly called life preservers or life jackets. You can get them in a variety of types and sizes. They vary with their intended uses. To be acceptable, PFDs must be Coast Guard approved.

Type I PFDs

A Type I life jacket is also called an offshore life jacket. Type I life jackets will turn most unconscious people from facedown to a vertical or slightly backward position. The adult size gives a minimum of 22 pounds of buoyancy. The child size has at least 11 pounds. Type I jackets provide more protection to their wearers than any other type of life jacket. Type I life jackets are bulkier and less comfortable than other types. Furthermore, there are only two sizes, one for children and one for adults.

Type I life jackets will keep their wearers afloat for extended periods in rough water. They are recommended for offshore cruising where a delayed rescue is probable.

Type II PFDs

◆ **See Figure 7**

A Type II life jacket is also called a near-shore buoyant vest. It is an approved, wearable device. Type II life jackets will turn some unconscious people from facedown to vertical or slightly backward positions. The adult size gives at least 15.5 pounds of buoyancy. The medium child size has a minimum of 11 pounds. And the small child and infant sizes give seven pounds. A Type II life jacket is more comfortable than a Type I but it does not have as much buoyancy. It is not recommended for long hours in rough water. Because of this, Type IIs are recommended for inshore and inland cruising on calm water. Use them only where there is a good chance of fast rescue.

Type III PFDs

Type III life jackets or marine buoyant devices are also known as flotation aids. Like Type IIs, they are designed for calm inland or close offshore water where there is a good chance of fast rescue. Their minimum buoyancy is 15.5 pounds. They will **not** turn their wearers face up.

Type III devices are usually worn where freedom of movement is necessary. Thus, they are used for water skiing, small boat sailing, and fishing among other activities. They are available as vests and flotation coats. Flotation coats are useful in cold weather. Type IIIs come in many sizes from small child through large adult.

Life jackets come in a variety of colors and patterns—red, blue, green, camouflage, and cartoon characters. From purely a safety standpoint, the best color is bright orange. It is easier to see in the water, especially if the water is rough.

Type IV PFDs

◆ **See Figures 8 and 9**

Type IV ring life buoys, buoyant cushions and horseshoe buoys are Coast Guard approved devices called throwables. They are made to be thrown to people in the water, and should not be worn. Type IV cushions are often used as seat cushions. But, keep in mind that cushions are hard to hold onto in the water, thus, they do not afford as much protection as wearable life jackets.

The straps on buoyant cushions are for you to hold onto either in the water or when throwing them, they are **NOT** for your arms. A cushion should never be worn on your back, as it will turn you face down in the water.

Type IV throwables are not designed as personal flotation devices for unconscious people, non-swimmers, or children. Use them only in emergencies. They should not be used for, long periods in rough water.

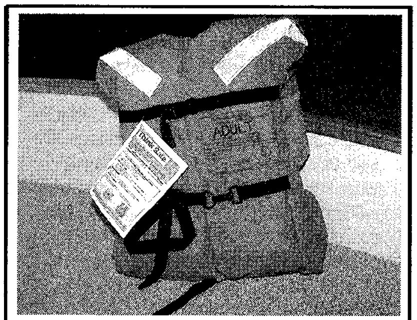


Fig. 7 Type II PFDs are recommended for inshore and inland cruising on calm water (where there is a good chance of fast rescue)

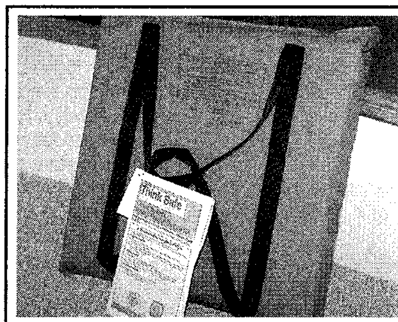


Fig. 8 Type IV buoyant cushions are thrown to people in the water. If you can squeeze air out of the cushion, it should be replaced

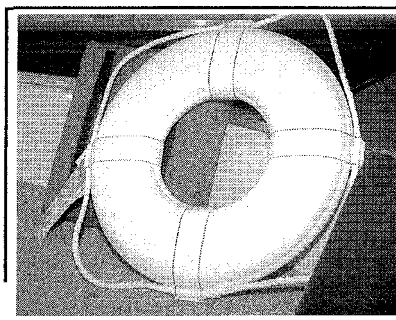


Fig. 9 Type IV throwables, such as this ring life buoy, are not designed for unconscious people, non-swimmers, or children

Ring life buoys come in 18, 20, 24, and 30 in. diameter sizes. They usually have grab lines, but you will need to attach about 60 feet of polypropylene line to the grab rope to aid in retrieving someone in the water. If you throw a ring, be careful not to hit the person. Ring buoys can knock people unconscious

Type V PFDs

Type V PFDs are of two kinds, special use devices and hybrids. Special use devices include boardsailing vests, deck suits, work vests, and others. They are approved only for the special uses or conditions indicated on their labels. Each is designed and intended for the particular application shown on its label. They do not meet legal requirements for general use aboard recreational boats.

Hybrid life jackets are inflatable devices with some built-in buoyancy provided by plastic foam or kapok. They can be inflated orally or by cylinders of compressed gas to give additional buoyancy. In some hybrids the gas is released manually. In others it is released automatically when the life jacket is immersed in water.

The inherent buoyancy of a hybrid may be insufficient to float a person unless it is inflated. The only way to find this out is for the user to try it in the water. Because of its limited buoyancy when deflated, a hybrid is recommended for use by a non-swimmer only if it is worn with enough inflation to float the wearer.

If they are to count against the legal requirement for the number of life jackets you must carry, hybrids manufactured before February 8, 1995 must be worn whenever a boat is underway and the wearer must not go below decks or in an enclosed space. To find out if your Type V hybrid must be worn to satisfy the legal requirement, read its label. If its use is restricted it will say, "REQUIRED TO BE WORN" in capital letters.

Hybrids cost more than other life jackets, but this factor must be weighed against the fact that they are more comfortable than Types I, II or III life jackets. Because of their greater comfort, their owners are more likely to wear them than are the owners of Type I, II or III life jackets.

The Coast Guard has determined that improved, less costly hybrids can save lives since they will be bought and used more frequently. For these reasons, a new federal regulation was adopted effective February 8, 1995. The regulation increases both the deflated and inflated buoyancys of hybrids, makes them available in a greater variety of sizes and types, and reduces their costs by reducing production costs.

Even though it may not be required, the wearing of a hybrid or a life jacket is encouraged whenever a vessel is underway. Like life jackets, hybrids are now available in three types. To meet legal requirements, a Type I hybrid can be substituted for a Type I life jacket. Similarly Type II and III hybrids can be substituted for Type II and Type III life jackets. A Type I hybrid, when inflated, will turn most unconscious people from facedown to vertical or slightly backward positions just like a Type I life jacket. Type II and III hybrids function like Type II and III life jackets. If you purchase a new hybrid, it should have an owner's manual attached that describes its life jacket type and its deflated and inflated buoyancys. It warns you that it may have to be inflated to float you. The manual also tells you how to don the life jacket and how to inflate it. It also tells you how to change its inflation mechanism, recommended testing exercises, and inspection or maintenance procedures. The manual also tells you why you need a life jacket and why you should wear it. A new hybrid must be packaged with at least three gas cartridges. One of these may already be loaded into the inflation mechanism. Likewise, if it has an automatic inflation mechanism, it must be packaged with at least three of these water sensitive elements. One of these elements may be installed.

Legal Requirements

A Coast Guard approved life jacket must show the manufacturer's name and approval number. Most are marked as Type I, II, III, IV or V. All of the newer hybrids are marked for type.

You are required to carry at least one wearable life jacket or hybrid for each person on board your recreational vessel. If your vessel is 16 feet or more in length and is not a canoe or a kayak, you must also have at least one Type IV on board. These requirements apply to all recreational vessels that are propelled or controlled by machinery, sails, oars, paddles, poles, or another vessel. Sailboards are not required to carry life jackets.

You can substitute an older Type V hybrid for any required Type I, II or III life jacket provided:

1. Its approval label shows it is approved for the activity the vessel is engaged in
2. It's approved as a substitute for a life jacket of the type required on the vessel
3. It's used as required on the labels

and

4. It's used in accordance with any requirements in its owner's manual (if the approval label makes reference to such a manual.)

A water skier being towed is considered to be on board the vessel when judging compliance with legal requirements.

You are required to keep your Type I, II or III life jackets or equivalent hybrids readily accessible, which means you must be able to reach out and get them when needed. All life jackets must be in good, serviceable condition.

General Considerations

The proper use of a life jacket requires the wearer to know how it will perform. You can gain this knowledge only through experience. Each person on your boat should be assigned a life jacket. Next, it should be fitted to the person who will wear it. Only then can you be sure that it will be ready for use in an emergency. This advice is good even if the water is calm, and you intend to boat near shore.

Boats can sink fast. There may be no time to look around for a life jacket. Fitting one on you in the water is almost impossible. Most drownings occur in inland waters within a few feet of safety. Most victims had life jackets, but they weren't wearing them.

Keeping life jackets in the plastic covers they came wrapped in, and in a cabin, assure that they will stay clean and unfaded. But this is no way to keep them when you are on the water. When you need a life jacket it must be readily accessible and adjusted to fit you. You can't spend time hunting for it or learning how to fit it.

There is no substitute for the experience of entering the water while wearing a life jacket. Children, especially, need practice. If possible, give your guests this experience. Tell them they should keep their arms to their sides when jumping in to keep the life jacket from riding up. Let them jump in and see how the life jacket responds. Is it adjusted so it does not ride up? Is it the proper size? Are all straps snug? Are children's life jackets the right sizes for them? Are they adjusted properly? If a child's life jacket fits correctly, you can lift the child by the jacket's shoulder straps and the child's chin and ears will not slip through. Non-swimmers, children, handicapped persons, elderly persons and even pets should always wear life jackets when they are aboard. Many states require that everyone aboard wear them in hazardous waters.

Inspect your lifesaving equipment from time to time. Leave any questionable or unsatisfactory equipment on shore. An emergency is no time for you to conduct an inspection.

Indelibly mark your life jackets with your vessel's name, number, and calling port. This can be important in a search and rescue effort. It could help concentrate effort where it will do the most good.

Care of Life Jackets

Given reasonable care, life jackets last many years. Thoroughly dry them before putting them away. Stow them in dry, well-ventilated places. Avoid the bottoms of lockers and deck storage boxes where moisture may collect. Air and dry them frequently.

Life jackets should not be tossed about or used as fenders or cushions. Many contain kapok or fibrous glass material enclosed in plastic bags. The bags can rupture and are then unserviceable. Squeeze your life jacket gently. Does air leak out? If so, water can leak in and it will no longer be safe to use. Cut it up so no one will use it, and throw it away. The covers of some life jackets are made of nylon or polyester. These materials are plastics. Like many plastics, they break down after extended exposure to the ultraviolet light in sunlight. This process may be more rapid when the materials are dyed with bright dyes such as "neon" shades.

Ripped and badly faded fabrics are clues that the covering of your life jacket is deteriorating. A simple test is to pinch the fabric between your thumbs and forefingers. Now try to tear the fabric. If it can be torn, it should definitely be destroyed and discarded. Compare the colors in protected places to those exposed to the sun. If the colors have faded, the materials have been weakened. A life jacket covered in fabric should ordinarily last several boating seasons with normal use. A life jacket used every day in direct sunlight should probably be replaced more often.

SOUND PRODUCING DEVICES

All boats are required to carry some means of making an efficient sound signal, Devices for making the whistle or horn noises required by the Navigation Rules must be capable of a four-second blast. The blast should be audible for at least one-half mile. Athletic whistles are not acceptable on boats 12 meters or longer. Use caution with athletic whistles. When wet, some of them come apart and loose their "pea." When this happens, they are useless.

If your vessel is 12 meters long and less than 20 meters, you must have a power whistle (or power horn) and a bell on board. The bell must be in operating condition and have a minimum diameter of at least 200mm (7.9 in.) at its mouth.

VISUAL DISTRESS SIGNALS

◆ **See Figure 10**

Visual Distress Signals (VDS) attract attention to your vessel if you need help. They also help to guide searchers in search and rescue situations. Be sure you have the right types, and learn how to use them properly.

It is illegal to fire flares improperly. In addition, they cost the Coast Guard and its Auxiliary many wasted hours in fruitless searches. If you signal a distress with flares and then someone helps you, please let the Coast Guard or the appropriate Search And Rescue (SAR) Agency know so the distress report will be canceled

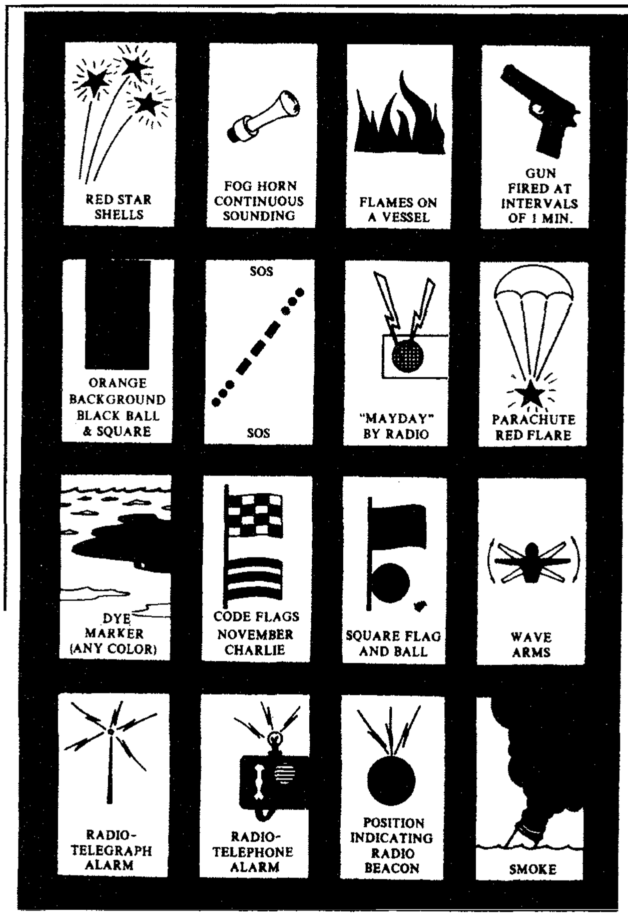


Fig. 10 Internationally accepted distress signals

Recreational boats less than 16 feet long must carry visual distress signals on coastal waters at night. Coastal waters are:

- The ocean (territorial sea)
- The Great Lakes
- Bays or sounds that empty into oceans
- Rivers over two miles across at their mouths upstream to where they narrow to two miles.

Recreational boats 16 feet or longer must carry VDS at all times on coastal waters. The same requirement applies to boats carrying six or fewer passengers for hire. Open sailboats less than 26 feet long without engines are exempt in the daytime as are manually propelled boats. Also exempt are boats in organized races, regattas, parades, etc. Boats owned in the United States and operating on the high seas must be equipped with VDS.

A wide variety of signaling devices meet Coast Guard regulations. For pyrotechnic devices, a minimum of three must be carried. Any combination can be carried as long as it adds up to at least three signals for day use and at least three signals for night use. Three daylnight signals meet both requirements. If possible, carry more than the legal requirement.

The American flag flying upside down is a commonly recognized distress signal. It is not recognized in the Coast Guard regulations, though. In an emergency, your efforts would probably be better used in more effective signaling methods.

Types of VDS

VDS are divided into two groups; daytime and nighttime use. Each of these groups is subdivided into pyrotechnic and non-pyrotechnic devices.

Daytime Non-Pyrotechnic Signals

A bright orange flag with a black square over a black circle is the simplest VDS. It is usable, of course, only in daylight. It has the advantage of being a continuous signal. A mirror can be used to good advantage on sunny days. It can attract the attention of other boaters and of aircraft from great distances. Mirrors are available with holes in their centers to aid in "aiming." In the absence of a mirror, any shiny object can be used. When another boat is in sight, an effective VDS is to extend your arms from your sides and move them up and down. Do it slowly. If you do it too fast the other people may think you are just being friendly. This simple gesture is seldom misunderstood, and requires no equipment.

Daytime Pyrotechnic Devices

Orange smoke is a useful daytime signal. Hand-held or floating smoke flares are very effective in attracting attention from aircraft. Smoke flares don't last long, and are not very effective in high wind or poor visibility. As with other pyrotechnic devices, use them only when you know there is a possibility that someone will see the display.

To be usable, smoke flares must be kept dry. Keep them in airtight containers and store them in dry places. If the "striker" is damp, dry it out before trying to ignite the device. Some pyrotechnic devices require a forceful "strike" to ignite them.

All hand-held pyrotechnic devices may produce hot ashes or slag when burning. Hold them over the side of your boat in such a way that they do not burn your hand or drip into your boat.

Nighttime Non-Pyrotechnic Signals

An electric distress light is available. This light automatically flashes the international morse code SOS distress signal (ooo --- ooo). Flashed four to six times a minute, it is an unmistakable distress signal. It must show that it is approved by the Coast Guard. Be sure the batteries are fresh. Dated batteries give assurance that they are current.

Under the Inland Navigation Rules, a high intensity white light flashing 50—70 times per minute is a distress signal. Therefore, use strobe lights on inland waters only for distress signals.

Nighttime Pyrotechnic Devices

◆ **See Figure 11**

Aerial and hand-held flares can be used at night or in the daytime. Obviously, they are more effective at night.

Currently, the serviceable life of a pyrotechnic device is rated at 42 months from its date of manufacture. Pyrotechnic devices are expensive. Look at their dates before you buy them. Buy them with as much time remaining as possible.

Like smoke flares, aerial and hand-held flares may fail to work if they have been damaged or abused. They will not function if they are or have been wet. Store them in dry, airtight containers in dry places. But store them where they are readily accessible.

Aerial VDSs, depending on their type and the conditions they are used in, may not go very high. Again, use them only when there is a good chance they will be seen.

A serious disadvantage of aerial flares is that they burn for only a short time; most burn for less than 10 seconds. Most parachute flares burn for less than 45 seconds. If you use a VDS in an emergency, do so carefully. Hold hand-held flares over the side of the boat when in use. Never use a road hazard flare on a boat; it can easily start a fire. Marine type flares are specifically designed to lessen risk, but they still must be used carefully.

Aerial flares should be given the same respect as firearms since they are firearms! Never point them at another person. Don't allow children to play with them or around them. When you fire one, face away from the wind. Aim it downwind and upward at an angle of about 60 degrees to the horizon. If there is a strong wind, aim it somewhat more vertically. Never fire it straight up. Before you discharge a flare pistol, check for overhead obstructions that might be damaged by the flare. An obstruction might deflect the flare to where it will cause injury or damage.

Fig. 11 Moisture-protected flares should be carried onboard any vessel for use as a distress signal

Disposal of VDS

Keep outdated flares when you get new ones. They do not meet legal requirements, but you might need them sometime, and they may work. It is illegal to fire a VDS on federal navigable waters unless an emergency exists. Many states have similar laws.

Emergency Position Indicating Radio Beacon (EPIRB)

There is no requirement for recreational boats to have EPIRBs. Some commercial and fishing vessels, though, must have them if they operate beyond the three-mile limit. Vessels carrying six or fewer passengers for hire must have EPIRBs under some circumstances when operating beyond the three-mile limit. If you boat in a remote area or offshore, you should have an EPIRB. An EPIRB is a small (about 6 to 20 in. high), battery-powered, radio transmitting buoy-like device. It is a radio transmitter and requires a license or an endorsement on your radio station license by the Federal Communications Commission (FCC). EPIRBs areeither automatically activated by being immersed in water or manually by a switch.

Equipment Not Required But Recommended

Although not required by law, there are other pieces of equipment that are good to have onboard.

SECOND MEANS OF PROPULSION

All boats less than 16 feet long should carry a second means of propulsion. A paddle or oar can come in handy at times. For most small boats, a spare trolling or outboard motor is an excellent idea. If you carry a spare motor, it should have its own fuel tank and starting power. If you use an electric trolling motor, it should have its own battery.

BAILING DEVICES

All boats should carry at least one effective manual bailing device in addition to any installed electric bilge pump. This can be a bucket, can, scoop, hand-operated pump, etc. If your battery "goes dead" it will not operate your electric pump.

FIRST AID KIT

◆ **See Figure 12**

All boats should carry a first aid kit. It should contain adhesive bandages, gauze, adhesive tape, antiseptic, aspirin, etc. Check your first aid kit from time to time. Replace anything that is outdated. It is to your advantage to know how to use your first aid kit. Another good idea would be to take a Red Cross first aid course.

ANCHORS

+ **See Figure 13**

All boats should have anchors. Choose one of suitable size for your boat. Better still, have two anchors of different sizes. Use the smaller one in calm water or when anchoring for a short time to fish or eat. Use the larger one when the water is rougher or for overnight anchoring.

Carry enough anchor line, of suitable size, for your boat and the waters in which you will operate. If your engine fails you, the first thing you usually should do is lower your anchor. This is good advice in shallow water where you may be driven aground by the wind or water. It is also good advice in windy weather or rough water, as the anchor, when properly affixed, will usually hold your bow into the waves.

VHF-FM RADIO

Your best means of summoning help in an emergency or in case of a breakdown is a VHF-FM radio. You can use it to get advice or assistance from the Coast Guard. In the event of a serious illness or injury aboard your boat, the Coast Guard can have emergency medical equipment meet you ashore.

Fig. 12 Always carry an adequately stocked first aid kit on board for the safety of the crew and guests

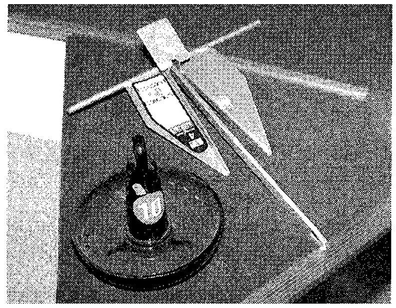


Fig. 13 Choose an anchor of sufficient weight to secure the boat without dragging

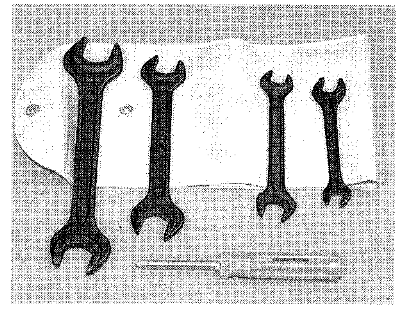


Fig. 14 A few wrenches, a screwdriver and maybe a pair of pliers can be very helpful to make emergency repairs

TOOLS AND SPARE PARTS

◆ **See Figures 14 and 15**

Carry a few tools and some spare parts, and learn how to make minor repairs. Many search and rescue cases are caused by minor breakdowns that boat operators could have repaired. Carry spare parts such as propellers, fuses or basic ignition components (like spark plugs, wires or even ignition coils) and the tools necessary to install them.

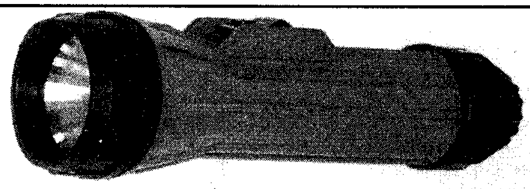


Fig. 15 A flashlight with a fresh set of batteries is handy when repairs are needed at night. It can also double as a signaling device

Courtesy Marine Examinations

One of the roles of the Coast Guard Auxiliary is to promote recreational boating safety. This is why they conduct thousands of Courtesy Marine Examinations each year. The auxiliarists who do these examinations are well-trained and knowledgeable in the field.

These examinations are free and done only at the consent of boat owners. To pass the examination, a vessel must satisfy federal equipment requirements and certain additional requirements of the coast guard auxiliary. If your vessel does not pass the Courtesy Marine Examination, no report of the failure is made. Instead, you will be told what you need to correct the deficiencies. The examiner will return at your convenience to redo the examination.

If your vessel qualifies, you will be awarded a safety decal. The decal does not carry any special privileges, it simply attests to your interest in safe boating.

SAFETY IN SERVICE

It is virtually impossible to anticipate all of the hazards involved with maintenance and service, but care and common sense will prevent most accidents.

The rules of safety for mechanics range from "don't smoke around gasoline," to "use the proper tool(s) for the job." The trick to avoiding injuries is to develop safe work habits and to take every possible precaution. Whenever you are working on your boat, pay attention to what you are doing. The more you pay attention to details and what is going on around you, the less likely you will be to hurt yourself or damage your boat.

Do's

- Do keep a fire extinguisher and first aid kit handy.
- Do wear safety glasses or goggles when cutting, drilling, grinding or prying, even if you have 20--20 vision. If you wear glasses for the sake of vision, wear safety goggles over your regular glasses.
- Do shield your eyes whenever you work around the battery. Batteries contain sulfuric acid. In case of contact with the eyes or skin, flush the area with water or a mixture of water and baking soda; then seek immediate medical attention.
- Do use adequate ventilation when working with any chemicals or hazardous materials.
- Do disconnect the negative battery cable when working on the electrical system. The secondary ignition system contains EXTREMELY HIGH VOLTAGE. In some cases it can even exceed 50,000 volts. Furthermore, an accidental attempt to start the engine could cause the propeller or other components to rotate suddenly causing a potentially dangerous situation.
- Do follow manufacturer's directions whenever working with potentially hazardous materials. Most chemicals and fluids are poisonous if taken internally.
- Do properly maintain your tools. Loose hammerheads, mushroomed punches and chisels, frayed or poorly grounded electrical cords, excessively worn screwdrivers, spread wrenches (open end), cracked sockets, or slipping ratchets can cause accidents,
- Likewise, keep your tools clean; a greasy wrench can slip off a bolt head, ruining the bolt and often harming your knuckles in the process.
- Do use the proper size and type of tool for the job at hand. Do select a wrench or socket that fits the nut or bolt. The wrench or socket should sit straight, not cocked.
- Do, when possible, pull on a wrench handle rather than push on it, and adjust your stance to prevent a fall.
- Do be sure that adjustable wrenches are tightly closed on the nut or bolt and pulled so that the force is on the side of the fixed jaw. Better yet, avoid the use of an adjustable if you have a fixed wrench that will fit.
- Do strike squarely with a hammer; avoid glancing blows.
- Do use common sense whenever you work on your boat or motor. If a situation arises that doesn't seem right, sit back and have a second look. It may save an embarrassing moment or potential damage to your beloved boat.

Don'ts

Don't run the engine in an enclosed area or anywhere else without proper ventilation—EVER! Carbon monoxide is poisonous; it takes a long time to leave the human body and you can build up a deadly supply of it in your system by simply breathing in a little every day. You may not realize you are slowly poisoning yourself.

Don't work around moving parts while wearing loose clothing. Short sleeves are much safer than long, loose sleeves. Hard-toed shoes with neoprene soles protect your toes and give a better grip on slippery surfaces. Jewelry, watches, large belt buckles, or body adornment of any kind is not safe working around any craft or vehicle. Long hair should be tied back under a hat.

- Don't use pockets for toolboxes. A fall or bump can drive a screwdriver deep into your body. Even a rag hanging from your back pocket can wrap around a spinning shaft.
- Don't smoke when working around gasoline, cleaning solvent or other flammable material.
- Don't smoke when working around the battery. When the battery is being charged, it gives off explosive hydrogen gas. Actually, you shouldn't smoke anyway. Save the cigarette money and put it into your boat!
- Don't use gasoline to wash your hands; there are excellent soaps available. Gasoline contains dangerous additives that can enter the body through a cut or through your pores. Gasoline also removes all the natural oils from the skin so that bone dry hands will suck up oil and grease.

Don't use screwdrivers for anything other than driving screws! A screwdriver used as a prying tool can snap when you least expect it, causing injuries. At the very least, you'll ruin a good screwdriver.

TROUBLESHOOTING

Troubleshooting can be defined as a methodical process during which one discovers what is causing a problem with engine operation. Although it is often a feared process to the uninitiated, there is no reason to believe that you cannot figure out what is wrong with a motor, as long as you follow a few basic rules.

To begin with, troubleshooting must be systematic. Haphazard testing one component, then another, **might** uncover the problem, but it will more likely waste a lot of time. True troubleshooting stark by defining the problem and performing systematic tests to eliminate the largest and most likely causes first.

Start all troubleshooting by eliminating the most basic possible causes. Begin with a visual inspection of the boat and motor. If the engine won't crank, make sure that the kill switch or safety lanyard is in the proper position. Make sure there is fuel in the tank and the fuel system is primed before condemning the carburetor or fuel injection system. On electric start motors, make sure there are no blown fuses, the battery is fully charged, and the cable connections (at both ends) are clean and tight before suspecting a bad starter, solenoid or switch.

The majority of problems that occur suddenly can be fixed by simply identifying the one small item that brought them on. A loose wire, a clogged passage or a broken component can cause a lot of trouble and are often the cause of a sudden performance problem.

The next most basic step in troubleshooting is to test systems before components. For example, if the engine doesn't crank on an electric start motor, determine if the battery is in good condition (fully charged and properly connected) before testing the starting system. If the engine cranks, but doesn't start, you know already know the starting system and battery (if it cranks fast enough) are in good condition, now it is time to look at the ignition or fuel systems. Once you've isolated the problem to a particular system, follow the troubleshooting/testing procedures in the section for that system to test either subsystems (if applicable, for example: the starter circuit) or components (starter solenoid).

Basic Operating Principles

◆ See Figures 16 and 17

Before attempting to troubleshoot a problem with your motor, it is important that you understand how it operates. Once normal engine or system operation is understood, it will be easier to determine what might be causing the trouble or irregular operation in the first place. System descriptions are found throughout this manual, but the basic mechanical operating principles for both 2-stroke engines (like your outboard) and 4-stroke engines (like your car) are given here. A basic understanding of both types of engines is useful not only in understanding and troubleshooting your outboard, but also for dealing with other motors in your life.

All motors covered by this manual (and probably MOST of the motors you own) operate according to the Otto cycle principle of engine operation. This means that all motors follow the stages of intake, compression, power and exhaust. But, the difference between a 2- and 4-stroke motor is in how many times the piston moves up and down within the cylinder to accomplish this. On 2-stroke motors (as the name suggests) the four cycles take place in 2 movements (one up and one down) of the piston. Again, as the name suggests, the cycles take place in 4 movements of the piston for 4-stroke motors.

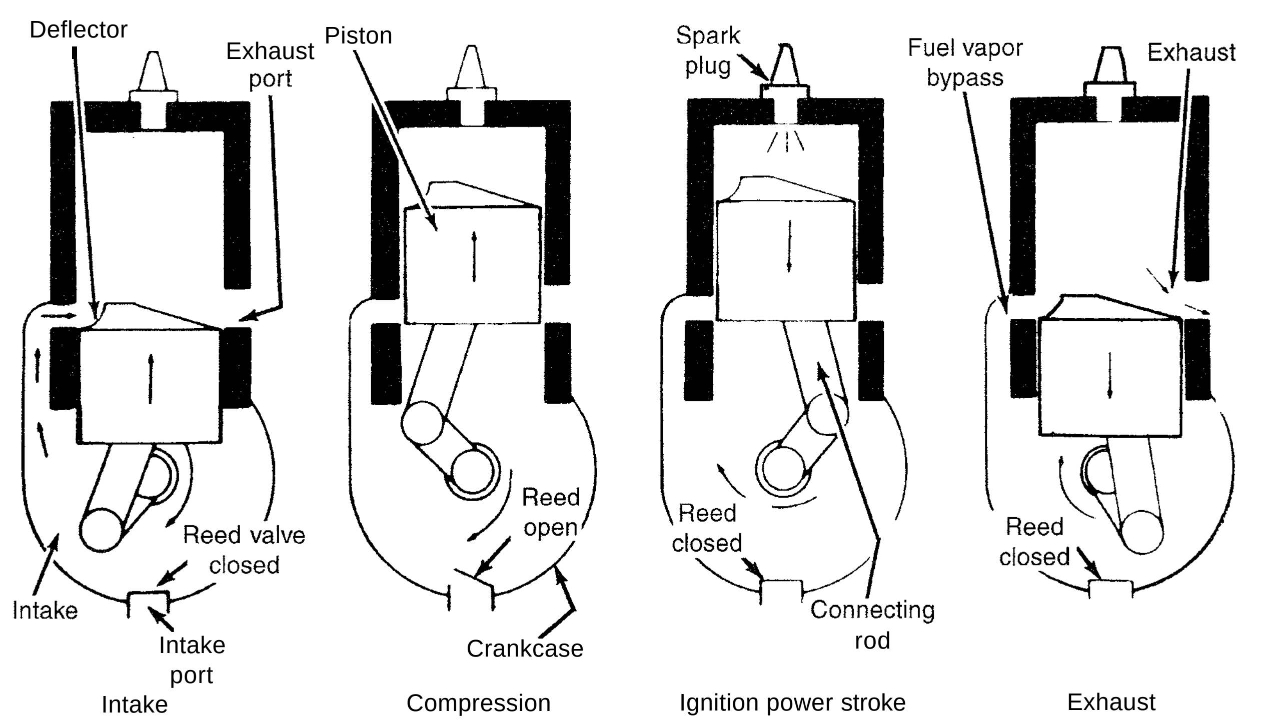


Fig. 16 The complete piston cycle of a 2-stroke motor (intake, compression, power and exhaust)

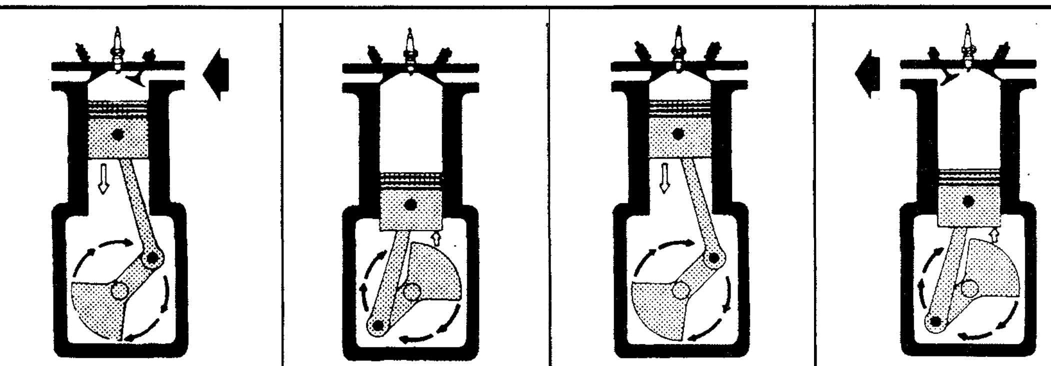


Fig. 17 The complete piston cycle of a 4-stroke motor (intake, compression, power and exhaust)

2-STROKE MOTORS

The 2-stroke engine differs in several ways from a conventional four-stroke (automobile or marine) engine.

1. The intake/exhaust method by which the fuel-air mixture is delivered to the combustion chamber.
2. The complete lubrication system.
3. The frequency of the power stroke.

Let's discuss these differences briefly (and compare 2-stroke engine operation with 4-stroke engine operation.)

Intake/Exhaust

◆ **See Figures 18, 19 and 20**

Two-stroke engines utilize an arrangement of port openings to admit fuel to the combustion chamber and to purge the exhaust gases after burning has been completed. The ports are located in a precise pattern in order for them to be open and closed off at an exact moment by the piston as it moves up and down in the cylinder. The exhaust port is located slightly higher than the fuel intake port. This arrangement opens the exhaust port first as the piston starts downward and therefore, the exhaust phase begins a fraction of a second before the intake phase

Actually, the intake and exhaust ports are spaced so closely together that both open almost simultaneously For this reason, many 2-stroke engrnes utilize deflector-type pistons This design of the prston top serves two purposes very effectively

First, it creates turbulence when the incoming charge of fuel enters the combustion chamber. This turbulence results in a more complete burning of the fuel than if the piston top were flat. The second effect of the deflector-type piston crown is to force the exhaust gases from the cylinder more rapidly. Although this configuration is used in most Johnson/Evinrude outboards, it is generally found on the inline motors. The only "V" configuration motors to use this style of intake with the deflector pistons are the 65 Jet-115 Hp (1632cc) 90CV4 Motors. This form of intake is called, Cross (C) flow "V" or CV motors. The balance of the Johnson/Evinrude "V" configuration motors built from 1992 to present are of the Loop (L) charged or LV configuration.

Loop charged motors, or as they are commonly called "loopers", differ in how the air (FICHT) or air/fuel charge is introduced to the combustion chamber, instead of the charge flowing across the top of the prston from one side of the cylinder to the other (CV) the use a looping action on top of the piston as the charge is forced through irregular shaped openings cut in the piston's skirt. In a LV motor, the charge is forced out from the crankcase by

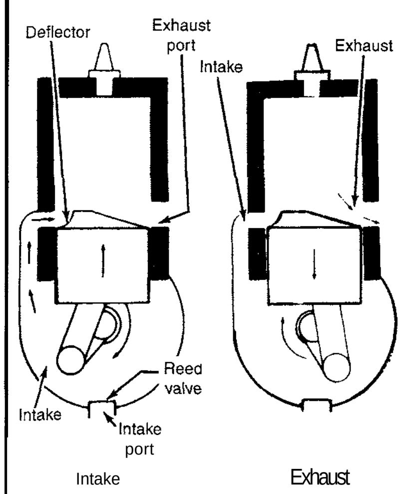


Fig. 18 The intake and exhaust cycles of a two-stroke engine—Cross flow (CV) design shown

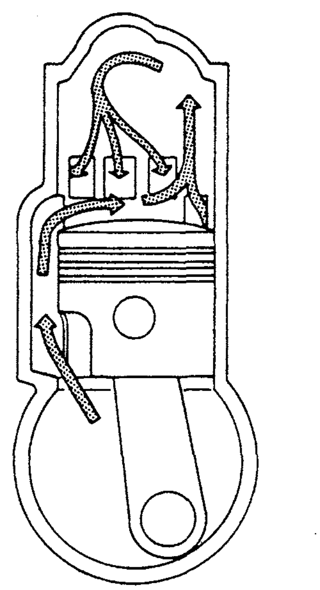


Fig. 19 Cross-sectional view of a typical loop-charged line cylinder, showing charge flow while piston is moving downward

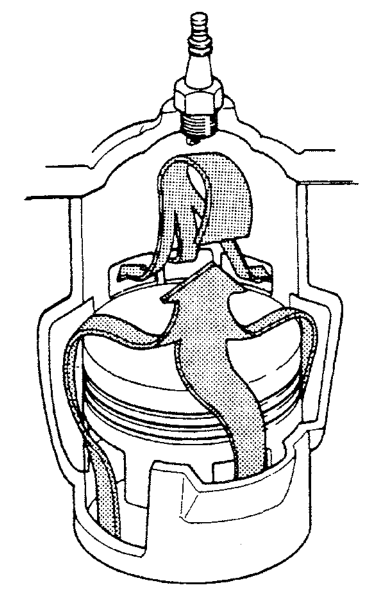


Fig. 20 Cutaway view of a typical loop charged cylinder, depicting exhaust leaving the cylinder as the charge enters through 3 ports in the piston

the downward motion of the piston, through the irregular shaped openings and transferred upward by long, deep grooves in the cylinder wall. The charge completes its looping action by entering the combustion chamber, just above the piston, where the upward motion of the piston traps it in the chamber and compresses it for optimum ignition power.

■ All FICHT motors are of the LV **design. The** major difference between a FICHT motor and a carbureted one, is that on the FICHT motor, ONLY air enters the combustion chamber through the looping action of the passageways. On FICHT motors, the high-pressure fuel injection system INJECTS or SPRAYS the **fuel/oil** charge directly into the top of the chamber, facing the spark plug.

Unlike the knife-edged deflector top pistons used in CV motors, the piston domes on Loop motors are relatively flat.

These systems of intake and exhaust are in marked contrast to individual intake and exhaust valve arrangement employed on four-stroke engines (and the mechanical methods of opening and closing these valves).

It should be noted here that there are some 2-stroke engines that utilize a mechanical valve train, though it is very different **from** the valve train **employed** by most 4-stroke motors. Rotary 2-stroke **engines** use a circular **valve** or **rotating** disc that contains a **port** opening around part of one edge of the disc. As the engine (and disc) turns, the opening aligns with the intake port at and for a predetermined amount of time, closing off the port again as the opening passes by and the solid portion of the disc covers the port.

Lubrication

A 2-stroke engine is lubricated by mixing oil with the fuel. Therefore, various parts are lubricated as the fuel mixture passes through the crankcase and the cylinder. In contrast, four-stroke engines have a crankcase containing oil. This oil is pumped through a circulating system and returned to the crankcase to begin the routing again.

Power Stroke

The combustion cycle of a 2-stroke engine has four distinct phases.

1. Intake
2. Compression
3. Power
4. Exhaust

The four phases of the cycle are accomplished with each up and down stroke of the piston, and the power stroke occurs with each complete revolution of the crankshaft. Compare this system with a four-stroke engine. A separate stroke of the piston is required to accomplish each phase of the cycle and the power stroke occurs only every other revolution of the crankshaft. **Stated** another way, two revolutions of the four-stroke engine crankshaft are required to complete one full cycle, the four phases.

Physical Laws

◆ See Figure 21

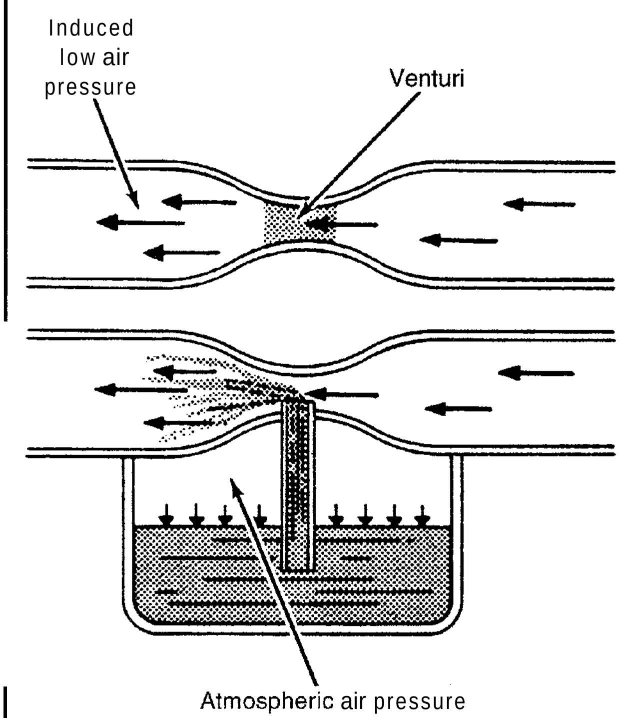


Fig. 21 Air flow principal for a modern carburetor

The **2-stroke** engine is able to function because of two very simple physical laws.

One: Gases will flow from an area of high pressure to an area of lower pressure. A tire blowout is an example of this principle. The high-pressure air escapes rapidly if the tube is punctured.

Two: If a gas is compressed into a smaller area, the pressure increases, and if a gas expands into a larger area, the pressure is decreased.

If these two laws are kept in mind, the operation of the 2-stroke engine will be easier understood.

Actual Operation

◆ See Figure 16

The engine described here is of a carbureted type. FICHT motors operate similarly for intake of the air charge and for exhaust of the unburned gasses. Obviously though, the very nature of FICHT fuel injection changes the actual delivery of the **fuel/oil** charge.

Beginning with the piston approaching top dead center on the compression stroke: the intake and exhaust ports are physically closed (blocked) by the piston. During this stroke, the reed valve is open (because as the piston moves upward, the crankcase volume increases, which reduces the crankcase pressure to less than the outside atmosphere (creates a vacuum under the piston). The spark plug fires; the compressed fuel-air mixture is ignited; and the power stroke begins.

As the piston moves downward on the power stroke, the combustion chamber is filled with burning gases. As the exhaust port is uncovered, the gases, which are under great pressure, escape rapidly through the exhaust ports. The piston continues its downward movement. Pressure within the crankcase (again, under the piston) increases, closing the reed valves against their seats. The crankcase then becomes a sealed chamber so the air-fuel mixture becomes compressed (pressurized) and ready for delivery to the combustion chamber. As the piston continues to move downward, the intake port is uncovered. The fresh fuel mixture rushes through the intake port into the combustion chamber striking the top of the piston where it is deflected along the cylinder wall. The reed valve remains closed until the piston moves upward again.

When the piston begins to move upward on the compression stroke, the reed valve opens because the crankcase volume has been increased, reducing crankcase pressure to less than the outside atmosphere. The intake and exhaust ports are closed and the fresh fuel charge is compressed inside the combustion chamber.

Pressure in the crankcase (beneath the piston) decreases as the piston moves upward and a fresh charge of air flows through the carburetor picking up fuel. As the piston approaches top dead center, the spark plug ignites the air-fuel mixture, the power stroke begins and one complete Otto cycle has been completed.

4-STROKE MOTORS

The 4-stroke motor may be easier to understand for some people either because of its prevalence in automobile and street motorcycle motors today or perhaps because each of the four strokes corresponds to one distinct phase of the Otto cycle. Essentially, a 4-stroke engine completes one Otto cycle of intake, compression, ignition/power and exhaust using two full revolutions of the crankshaft and four distinct movements of the piston (down, up, down and up).

Intake

The intake stroke begins with the piston near the top of its travel. As crankshaft rotation begins to pull the piston downward, the exhaust valve closes and the intake opens. As volume of the combustion chamber increases, a vacuum is created that draws in the airlfuel mixture from the intake manifold.

Compression

Once the piston reaches the bottom of its travel, crankshaft rotation will begin to force it upward. At this point the intake valve closes. As the piston rises in the bore, the volume of the sealed (both intake and exhaust valves are closed) combustion chamber decreases and the airlfuel mixture is compressed. This raises the temperature and pressure of the mixture and increases the amount of force generated by the expanding gases during the Ignition/Power stroke.

Ignition/Power

As the piston approaches top dead center (the highest point of travel in the bore), the spark plug will fire, igniting the airlfuel mixture. The resulting combustion of the airlfuel mixture forces the piston downward, rotating the crankshaft (causing other pistons to move in other phases/strokes of the Otto cycle on multi-cylinder motors).

Exhaust

As the piston approaches the bottom of the Ignition/Power stroke, the exhaust valve opens. When the piston begins its upward path of travel once again, any remaining unburned gasses are forced out through the exhaust valve. This completes one Otto cycle, which begins again as the piston passes top dead center, the intake valve opens and the Intake stroke starts.

COMBUSTION

Whether we are talking about a 2- or 4-stroke engine, all Otto cycle, internal combustion engines require three basic conditions to operate properly,

1. Compression
2. Ignition (Spark)
3. Fuel

A lack of any one of these conditions will prevent the engine from operating. A problem with any one of these will manifest itself in hard-starting or poor performance.

Compression

An engine that has insufficient compression will not draw an adequate supply of airlfuel mixture into the combustion chamber and, subsequently, will not make sufficient power on the power stroke. A lack of compression in just one cylinder of a multi-cylinder motor will cause the motor to stumble or run irregularly.

But, keep in mind that a sudden change in compression is unlikely in 2-stroke motors (unless something major breaks inside the crankcase, but that would usually be accompanied by other symptoms such as a loud noise when it occurred or noises during operation). On 4-stroke motors, a sudden change in compression is also unlikely, but could occur if the timing belt or chain was to suddenly break. Remember that the timing belt/chain is used to synchronize the valve train with the crankshaft. If the valve train suddenly ceases to turn, some intake and some exhaust valves will remain open, relieving compression in that cylinder.

Ignition (Spark)

Traditionally, the ignition system is the weakest link in the chain of conditions necessary for engine operation. Spark plugs may become worn or fouled, wires will deteriorate allowing arcing or misfiring, and poor connections can place an undue load on coils leading to weak spark or even a failed coil. The most common question asked by a technician under a no-start condition is: "do I have spark and fuel" (as they've already determined that they have compression).

A quick visual inspection of the spark plug(s) will answer the question as to whether or not the plug(s) is/art worn or fouled. While the engine is shut OFF a physical check of the connections could show a loose primary or secondary ignition circuit wire. An obviously physically damaged wire may also be an indication of system problems and certainly encourages one to inspect the related system more closely.

If nothing is turned up by the visual inspection, perform the Spark Test provided in the Ignition System section to determine if the problem is a lack of or a weak spark. If the problem is not compression or spark, it's time to look at the fuel system.

Fuel

If compression and spark is present (and within spec), but the engine won't start or won't run properly, the only remaining condition to fulfill is fuel As usual, start with the basics. Is the fuel tank full? Is the fuel stale? If the engine has not been run in some time (a matter of months, not weeks), there is a good chance that the fuel is stale and should be properly disposed of and replaced.

☐ Depending on how stale or contaminated (with moisture) the fuel is, it may be burned in an automobile or in yard equipment, though it would be wise to mix it well with a much larger supply of fresh gasoline to prevent moving your driveability problems to that motor. But it is better to get the lawn tractor stuck on stale gasoline than it would be to have your boat motor quit in the middle of the bay or lake.

For hard starting motors, is the primer system operating properly. Remember that the prime should only be used for **cold** starts. A true cold start is really only the first start of the day, but it may be applicable to subsequent starts on cooler days, if the engine sat for more than a few hours and completely cooled off since the last use. Applying the primer to the motor for a hot start may flood the engine, preventing it from starting properly. One method to clear a flood is to crank the motor while the engine is at wide-open throttle (allowing the maximum amount of air into the motor to compensate for the excess fuel). But, keep in mind that the throttle should be returned to idle immediately upon engine start-up to prevent damage from over-revving.

Fuel delivery and pressure should be checked before delving into the carburetor(s) or fuel injection system. Make sure there are no clogs in the fuel line or vacuum leaks that would starve the motor of fuel.

Make sure that all other possible problems have been eliminated before touching the carburetor. It is rare that a carburetor will suddenly require an adjustment in order for the motor to run properly. It is much more likely that an improperly stored motor (one stored with untreated fuel in the carburetor) would suffer from one or more clogged carburetor passages sometime after shortly returning to service. Fuel will evaporate over time, leaving behind gummy deposits. If untreated fuel is left in the carburetor for some time (again typically months more than weeks), the varnish left behind by evaporating fuel will likely clog the small passages of the carburetor and cause problems with engine performance. If you suspect this, remove and disassemble the carburetor following procedures under Fuel System.

The electronics of the FICHT fuel injection system used on some models will monitor the condition of the circuitry. Don't suspect a fuel injection problem unless the CHECK ENGINE indicator of OMC the System Check gauge rem[illegible] illuminated during engine operation. If so, refer to the information on th[illegible] F[illegible] regarding Trouble Codes and fuel injection diagnostics.

TOOLS AND EQUIPMENT

Safety To

WORK GLOVES

◆ See Figure **22**

Unless you think scars on your hands are cool, enjoy pain and like wearing bandages, get a good pair of work gloves. Canvas or leather gloves are the best. And yes, we realize that there are some jobs involving small parts that can't be done while wearing work gloves. These jobs are not the ones usually associated with hand injuries.

A good pair of rubber gloves (such as those usually associated with dish washing) or vinyl gloves is also a great idea. There are some liquids such as solvents and penetrants that don't belong on your skin. Avoid burns and rashes. Wear these gloves.

And lastly, an option. If you're tired of being greasy and dirty all the time, go to the drug store and buy a box of disposable latex gloves like medical professionals wear. You can handle greasy parts, perform small tasks, wash parts, etc. all without getting dirty! These gloves take a surprising amount of abuse without tearing and aren't expensive. Note however, that it has been reported that some people are allergic to the latex or the powder used inside some gloves, so pay attention to what you buy.

EYE AND EAR PROTECTION

◆ See Figures **23** and **24**

Don't begin any job without a good pair of work goggles or impact resistant glasses! When doing any kind of work, it's all too easy to avoid eye injury through this simple precaution. And don't just buy eye protection and leave it on the shelf. Wear it all the time! Things have a habit of breaking, chipping, splashing, spraying, splintering and flying around. And, for some reason, your eye is always in the way!

If you wear vision-correcting glasses as a matter of routine, get a pair made with polycarbonate lenses. These lenses are impact resistant and are available at any optometrist.

Often overlooked is hearing protection. Engines and power tools are noisy! Loud noises damage your ears. It's as simple as that! The simplest and cheapest form of ear protection is a pair of noise-reducing ear plugs. Cheap insurance for your ears! And, they may even come with their own, cute little carrying case.

More substantial, more protection and more money is a good pair of noise reducing earmuffs. Thev protect from all but the loudest sounds. Hopefully those are sounds that you'll never encounter since they're usually associated with disasters.

WORK CLOTHES

Everyone has "work clothes." Usually these consist of old jeans and a shirt that has seen better days. That's fine. In addition, a denim work apron is a nice accessory. It's rugged, can hold some spare bolts, and you don't feel bad wiping your hands or tools on it. That's what it's for.

When working in cold weather, a one-piece, thermal work outfit is invaluable. Most are rated to below freezing temperatures and are ruggedly constructed. Just look at what local marine mechanics are wearing and that should give you a clue as to what type of clothing is good.

There is a whole range of chemicals that you'll find handy for maintenance and repair work. The most common types are: lubricants, penetrants and sealers. Keep these handy. There are also many chemicals that are used for detailing or cleaning.

When a particular chemical is not being used, keep it capped, upright and in a safe place. These substances may be flammable, may be irritants or might even be caustic and should always be stored properly, used properly and handled with care. Always read and follow all label directions and be sure to wear hand and eye protection!

LUBRICANTS & PENETRANTS

◆ See Figure 25

Anti-seize is used to coat certain fasteners prior to installation. This can be especially helpful when two dissimilar metals are in contact (to help prevent corrosion that might lock the fastener in place). This is a good practice on a lot of different fasteners, BUT, NOT on any fastener that might vibrate loose causing a problem. If anti-seize is used on a fastener, it should be checked periodically for proper tightness.

Lithium grease, chassis lube, silicone grease or a synthetic brake caliper grease can all be used pretty much interchangeably. All can be used for coating rust-prone fasteners and for facilitating the assembly of parts that are a tight fit. Silicone and synthetic greases are the most versatile.

Silicone dielectric grease is a non-conductor that is often used to coat the terminals of wiring connectors before fastening them. It may sound odd to coat metal portions of a terminal with something that won't conduct electricity, but here is it how it works. When the connector is fastened the metal-to-metal contact between the terminals will displace the grease (allowing the circuit to be **completed). The** grease that is displaced will then coat the non-contacted surface and the cavity around the terminals, SEALING them from atmospheric moisture that could cause corrosion.

Silicone spray is a good lubricant for hard-to-reach places and parts that shouldn't be gooped up with grease.

Penetrating oil may turn out to be one of your best friends when taking something apart that has corroded fasteners. Not only can they make a job easier, they can really help to avoid broken and stripped fasteners. The most familiar penetrating oils are Liquid Wrench@ and WD-40®. A newer penetrant, PB Blaster® works very well (and has become a mainstay in our shops). These products have hundreds of uses. For your purposes, they are vital!

Before disassembling any part, check the fasteners. If any appear rusted, soak them thoroughly with the penetrant and let them stand while you do something else (for particularly rusted or frozen parts you may need to soak them a few days in advance). This simple act can save you hours of tedious work trying to extract a broken bolt or stud,

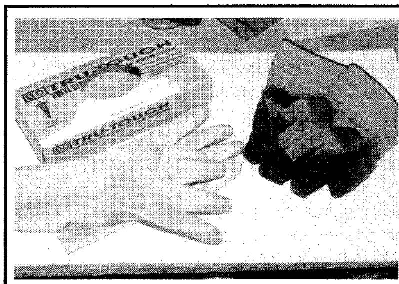


Fig. **22** Three different types of work **gloves. The** box contains latex gloves

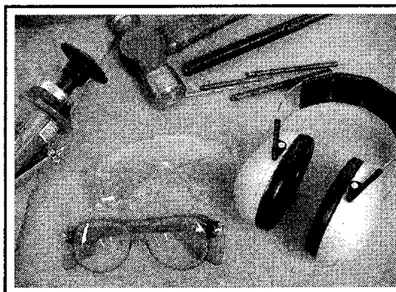


Fig. **23** Don't begin major repairs without a pair of goggles for your eyes and **earmuffs to protect your hearing**

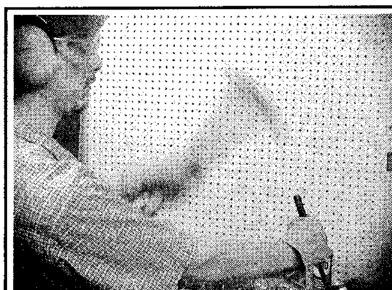


Fig. **24** Things have a habit of, splashing, spraying, splintering and flying around during repairs

Fig. **25** Anti-seize, penetrating oil, lithium grease, electronic cleaner and silicone spray should be a part of your chemical collection

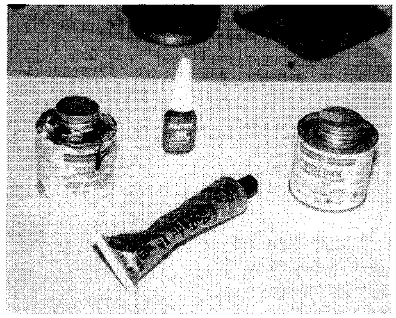


Fig. **26** Sealants are essential for preventing leaks

Fig. **27** On some engines, RTV is used instead of gasket material to seal components

SEALANTS

◆ See Figures **26** and **27**

Sealants are an indispensable part for certain tasks, especially if you are trying to avoid leaks. The purpose of sealants is to establish a leak-proof bond between or around assembled parts. Most sealers are used in conjunction with gaskets, but some are used instead of conventional gasket material.

The most common sealers are the non-hardening types such as Permatex® No.2 or its equivalents. These sealers are applied to the mating surfaces of each part to be joined, then a gasket is put in place and the parts are assembled.

A sometimes overlooked use for sealants like RTV is on the threads of vibration prone fasteners.

One very helpful type of non-hardening sealer is the "high tack type. This type is a very sticky material that holds the gasket in place while the parts are being assembled. This stuff is really a good idea when you don't have enough hands or fingers to keep everything where it should be.

The stand-alone sealers are the Room Temperature Vulcanizing (RTV) silicone gasket makers. On some engines, this material is used instead of a gasket. In those instances, a gasket may not be available or, because of the shape of the mating surfaces, a gasket shouldn't be used. This stuff, when used in conjunction with a conventional |asl pı duces the surest ls.

RTV does have its limitations though. Wh using this terial, you will have a time limit. It starts to set-up within 15 minutes or so, so you have to assemble the parts without delay. In addition, when squeezing the material out of the tube, don't drop any glops into the engine. The stuff will form and set and travel around a cooling passage, possibly blocking it. Also, most types are not fuel-proof. Check the tube for all cautions.

Johnson/Evinrude recommends quite a variety of sealants for their motors, including items like OMC Gasket Sealing Compound, OMC Nut Lock or Screw Lock (with or without OMC Locquic Primer), OMC Gel-Seal **II** and OMC Black Neoprene **Dip. You** probably don't want to stock all of these items, but we'll let you know throughout procedures when they are needed, so always read the procedure thoroughly before starting.

CLEANERS

◆ See Figures 28 and **29**

There are two basic types of cleaners on the market today: parts cleaners and hand cleaners. The parts cleaners are for the parts; the hand cleaners are for you. They are not interchangeable.

There are many good, non-flammable, biodegradable parts cleaners on the market. These cleaning agents are safe for you, the parts and the environment. Therefore, there is no reason to use flammable, caustic or toxic substances to clean your parts or tools.

As far as hand cleaners go; the waterless types are the best. They have always been efficient at cleaning, but they used to all leave a pretty smelly odor. Recently though, most of them have eliminated the odor and added stuff that actually smells good. Make sure that you pick one that contains lanolin or some other moisture-replenishing additive. Cleaners not only remove grease and oil but also skin oil.

■ Most women already know to use a hand lotion when you're all cleaned up. It's okay. Real men DO use hand lotion too! Believe it or not, using hand lotion before your hands are dirty will actually make them easier to clean when you're finished with a dirty job. Lotion seals your hands, and keeps dirt and grease from sticking to your skin.

Fig. 28 Citrus hand cleaners not only work well, but they smell pretty good too. Choose one with pumice for added cleaning power

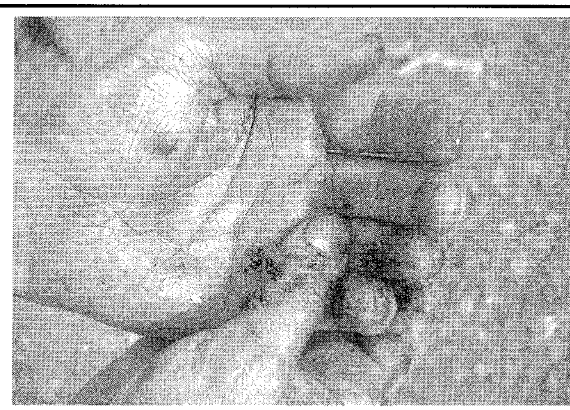


Fig. **29** The use of hand lotion seals your hands and keeps dirt and grease from sticking to your skin

TOOLS

◆ **See Figure 30**

Tools; this subject could fill a completely separate manual. The first thing you will need to ask yourself, is just how involved do you plan to get. If you are serious about maintenance and repair you will want to gather a quality set of tools to make the job easier, and more enjoyable. BESIDES, TOOLS ARE FUN!!!

Almost every do-it-yourselfer loves to accumulate tools. Though most find a way to perform jobs with only a few common tools, they tend to buy more over time, as money allows. So gathering the tools necessary for maintenance or repair does not have to be an expensive, overnight proposition.

When buying tools, the saying "You get what you pay for ..." is absolutely true! Don't go cheap! Any hand tool that you buy should be drop forged and/or chrome vanadium. These two qualities tell you that the tool is strong enough for the job. With any tool, go with a name that you've heard of before, or, that is recommended buy your local professional retailer. Let's go over a list of tools that you'll need.

Most of the world uses the metric system. However, some American-built engines and aftermarket accessories use standard fasteners. So, accumulate your tools accordingly. Any good DIYer should have a decent set of both U.S. and metric measure tools.

Don't be confused by terminology. Most advertising refers to "SAE and metric", or "standard and metric." Both are misnomers. The Society of Automotive Engineers (SAE) did not invent the English system of measurement; the English did. The SAE likes metrics just fine. Both English (U.S.) and metric measurements are SAE approved. Also, the current "standard" measurement IS metric. So, if it's not metric, it's U.S. measurement.

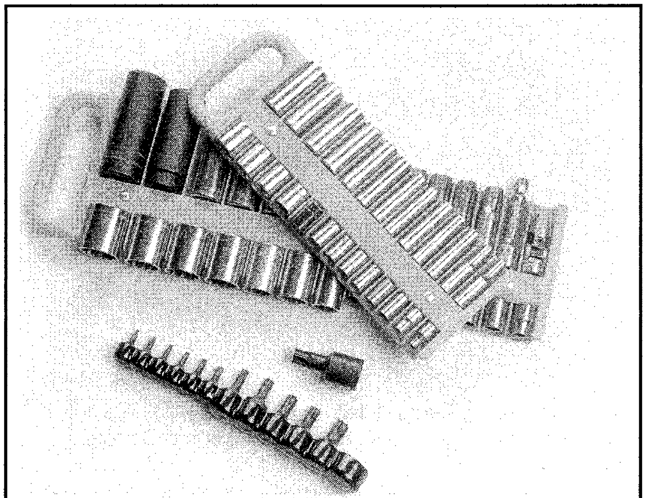


Fig. 30 Socket holders, especially the magnetic type, are handy items to keep tools in order

Hand Tools

SOCKET SETS

◆ **See Figures 31, 32, 33, 34, 35, 36 and 37**

Socket sets are the most basic hand tools necessary for repair and maintenance work. For our purposes, socket sets come in three drive sizes: 114 inch, 318 inch and 112 inch. Drive size refers to the size of the drive lug on the ratchet, breaker bar or speed handle.

A 318 inch set is probably the most versatile set in any mechanic's toolbox. It allows you to get into tight places that the larger drive ratchets can't and gives you a range of larger sockets that are still strong enough for heavy-duty work. The socket set that you'll need should range in sizes from 114 inch through 1 inch for standard fasteners, and a 6mm through 19mm for metric fasteners.

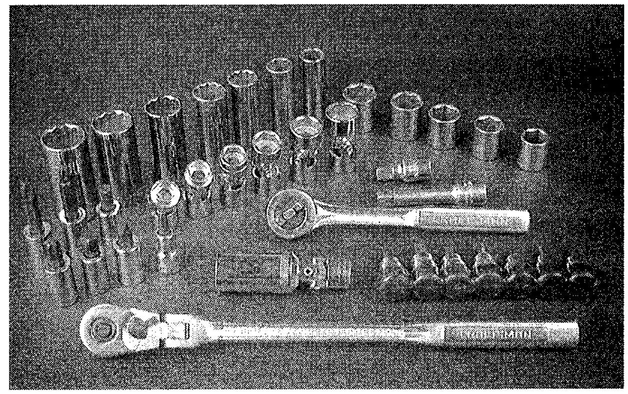


Fig. 31 A 3/8 in. socket set is probably the most versatile tool in any mechanic's tool box

You'll need a good 112 inch set since this size drive lug assures that you won't break a ratchet or socket on large or heavy fasteners. Also, torque wrenches with a torque scale high enough for larger fasteners are usually 112 inch drive.

Plus, 114 inch drive sets can be very handy in tight places. Though they usually duplicate functions of the 318 in. set, 114 in. drive sets are easier to use for smaller bolts and nuts.

As for the sockets themselves, they come in shallow (standard) and deep lengths as well as 6 or 12 point. The 6 and 12 points designation refers to how many sides are in the socket itself. Each has advantages. The 6 point socket is stronger and less prone to slipping which would strip a bolt head or nut. 12 point sockets are more common, usually less expensive and can operate better in tight places where the ratchet handle can't swing far.

Standard length sockets are good for just about all jobs, however, some stud-head bolts, hard-to-reach bolts, nuts on long studs, etc., require the deep sockets.

Most marine manufacturers use recessed hex-head fasteners to retain many of the engine parts. These fasteners require a socket with a hex shaped driver or a large sturdy hex key. To help prevent torn knuckles, we would recommend that you stick to the sockets on any tight fastener and leave the hex keys for lighter applications. Hex driver sockets are available individually or in sets just like conventional sockets.

More and more, manufacturers are using Torx® head fasteners, which were once known as tamper resistant fasteners (because many people did not have tools with the necessary odd driver shape). Since Torx® fasteners have become commonplace in many DIYer tool boxes, manufacturers designed newer tamper resistant fasteners that are essentially Torx® head bolts that contain a small protrusion in the center (requiring the driver to contain a small hole to slide over the protrusion. Tamper resistant fasteners are often used where the manufacturer would prefer only knowledgeable mechanics or advanced Do-It-Yourselfers (DIYers) work.

Torque Wrenches

◆ **See Figure 38**

In most applications, a torque wrench can be used to ensure proper installation of a fastener. Torque wrenches come in various designs and most stores will carry a variety to suit your needs. A torque wrench should be used any time you have a specific torque value for a fastener. Keep in mind that because there is no worldwide standardization of fasteners, so charts or figure found in each repair section refer to the manufacturer's fasteners. Any general guideline charts that you might come across based on fastener size (they are sometimes included in a repair manual or with torque wrench packaging) should be used with caution. Just keep in mind that if you are using the right tool for the job, you should not have to strain to tighten a fastener.

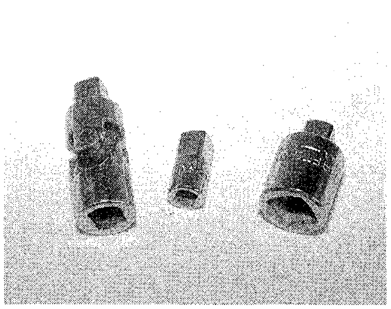


Fig. 32 A swivel **(U-joint)** adapter (left), a 114 in.-to-318 in. adapter (center) and a 318 **in.-to-1/4 in. adapter (right)**

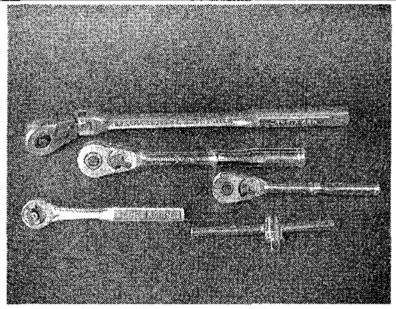


Fig. 33 Ratchets come in all sizes and configurations from rigid to swivel-headed

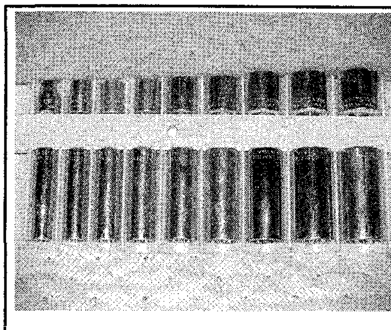


Fig. 34 Shallow sockets (top) are good for most jobs. But, some bolts require deep sockets (bottom)

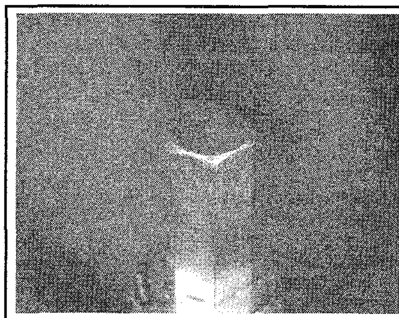


Fig. 35 Hex-head fasteners require a socket with a hex shaped driver

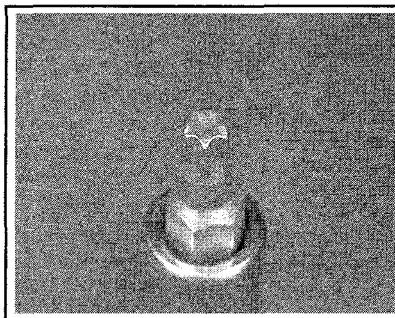


Fig. 36 **Torx®** drivers **. . .**

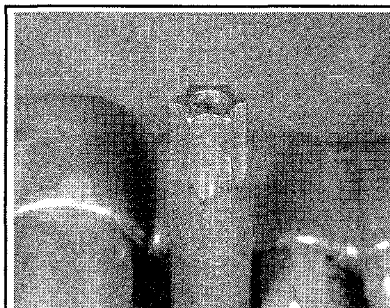


Fig. 37 **. . .** and tamper resistant drivers are required to remove special fasteners

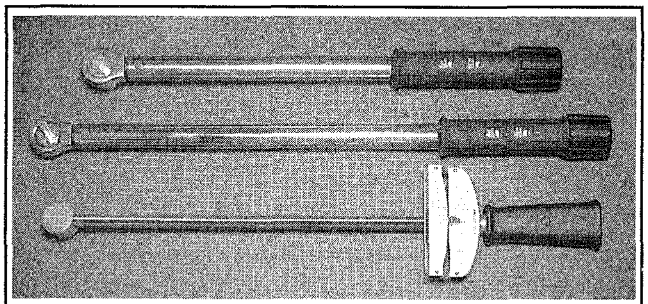


Fig. 38 Three types of torque wrenches. Top to bottom: a 318 in. drive beam type that reads in inch lbs., a 112 in. drive clicker type and a 112 in. drive beam type

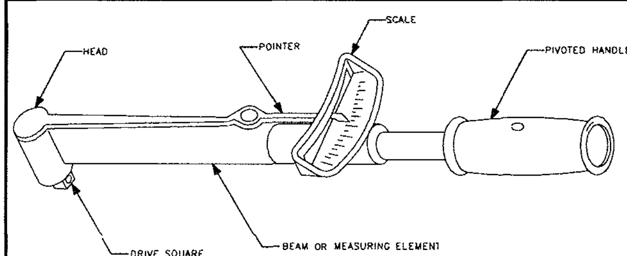


Fig. 39 Parts of a beam type torque wrench

Beam Type

◆ See Figure 39 and 40

The beam type torque wrench is one of the most popular styles in use. If used properly, it can be the most accurate also. It consists of a pointer attached to the head that runs the length of the flexible beam (shaft) to a scale located near the handle. As the wrench is pulled, the beam bends and the pointer indicates the torque using the scale.

Click (Breakaway) Type

◆ See Figures 41 and 42

Another popular torque wrench design is the click type. The clicking mechanism makes achieving the proper torque easy and most use a ratcheting head for ease of bolt installation. To use the click type wrench you pre-adjust it to a torque setting. Once the torque is reached, the wrench has a reflex signaling feature that causes a momentary breakaway of the torque wrench body, sending an impulse to the operator's hand. But be careful, as continuing the turn the wrench after the momentary release will increase torque on the fastener beyond the specified setting.

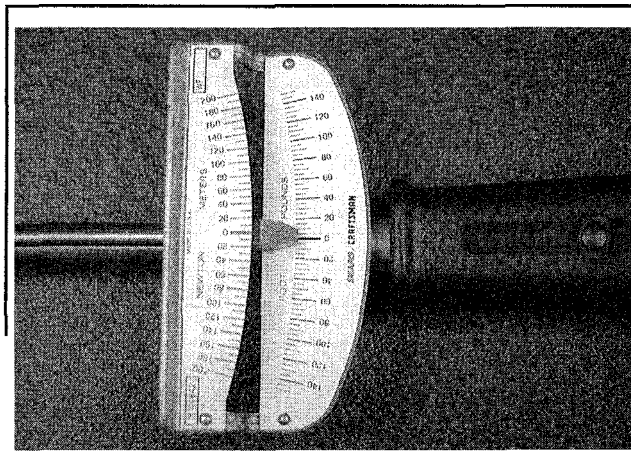


Fig. 40 A beam type torque wrench consists of a pointer attached to the head that runs the length of the flexible beam (shaft) to a scale located near the handle

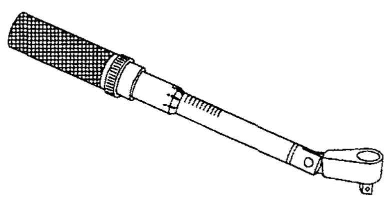


Fig. 41 A click type or breakaway torque wrench—note this one has a pivoting head

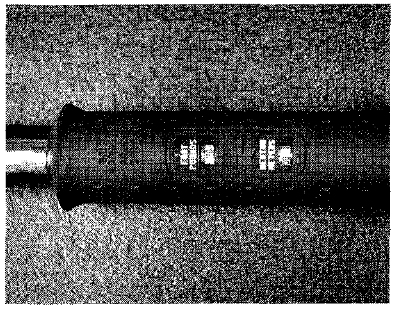


Fig. 42 Setting the torque on a click type wrench involves turning the handle until the specification appears on the dial

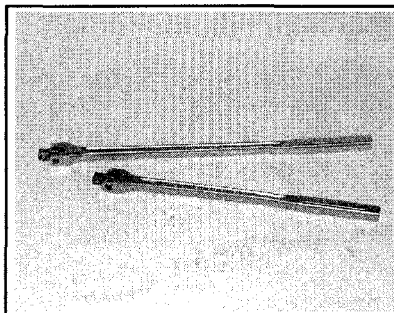


Fig. 43 Breaker bars are great for loosening large or stuck fasteners

Breaker Bars

◆ See Figure 43

Breaker bars are long handles with a drive lug. Their main purpose is to provide extra turning force when breaking loose tight bolts or nuts. They come in all drive sizes and lengths. Always take extra precautions and use the proper technique when using a breaker bar (pull on the bar, don't push, to prevent skinned knuckles).

WRENCHES

◆ See Figures **44, 45, 46, 47** and 48

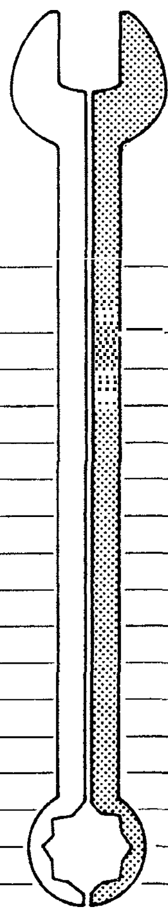
Basically, there are 3 kinds of fixed wrenches: open end, box end, and combination.

Open-end wrenches have 2-jawed openings at each end of the wrench. These wrenches are able to fit onto just about any nut or bolt. They are extremely versatile but have one major drawback. They can slip on a worn or rounded bolt head or nut, causins bleeding knuckles and a useless fastener.

Line wrenches are a special type of open-end wrench designed to fit onto more of the fastener than standard open-end wrenches, thus reducing the chance of rounding the corners of the fastener.

Box-end wrenches have a 360° circular jaw at each end of the wrench. They come in both 6 and 12 point versions just like sockets and each type has some of the same advantages and disadvantages as sockets.

Combination wrenches have the best of both. They have a 2-jawed open end and a box end. These wrenches are probably the most versatile.



INCHES	DECIMAL	DECIMAL	MILLIMETERS
1/8"	.125	.118	3mm
3/16"	.187	.157	4mm
1/4"	.250	.236	6mm
5/16"	.312	.354	9mm
3/8"	.375	.394	10mm
7/16"	.437	.472	12mm
1/2"	.500	.512	13mm
9/16"	.562	.590	15mm
5/8"	.625	.630	16mm
11/16"	.687	.709	18mm
3/4"	.750	.748	19mm
13/16"	.812	.787	20mm
7/8"	.875	.866	22mm
15/16"	.937	.945	24mm
1"	1.00	.984	25mm

Fig. 44 Comparison of **U.S.** measure and metric wrench sizes

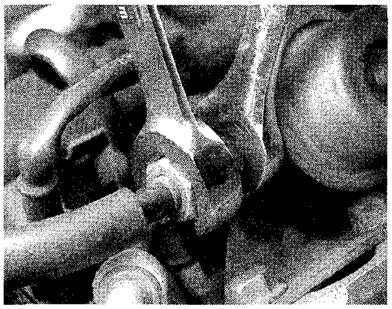


Fig. 45 Always use a backup wrench to prevent rounding flare nut fittings

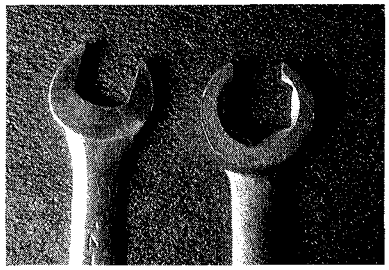


Fig. 46 Note how the flare wrench sides are extended to grip the fitting tighter and prevent rounding

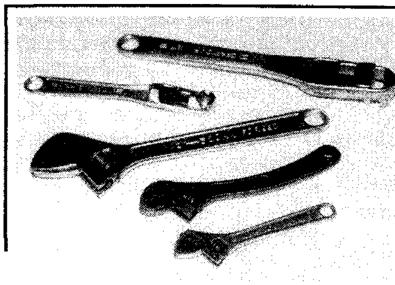


Fig. 47 Several types and sizes of adjustable wrenches

As for sizes, you'll probably need a range similar to that of the sockets, about 114 in. through 1 in. for standard fasteners, or 6mm through 19mm for metric fasteners. As for numbers, you'll need *2* of each size, since, in many instances, one wrench holds the nut while the other turns the bolt. On most fasteners, the nut and bolt are the same size so having two wrenches of the same size comes in handy.

☐ Although you will typically just need the sizes we specified, there are some exceptions. Occasionally you will find a nut that is larger. For these, you will need to buy ONE expensive wrench or a very large adjustable. Or you can always just convince the spouse that we are talking about safety here and buy a whole (read expensive) large wrench set.

One extremely valuable type of wrench is the adjustable wrench. An adjustable wrench has a fixed upper jaw and a moveable lower jaw. The lower jaw is moved by turning a threaded drum. The advantage of an adjustable wrench is its ability to be adjusted to just about any size fastener.

The main drawback of an adjustable wrench is the lower jaw's tendency to move slightly under heavy pressure. This can cause the wrench to slip if it is not facing the right way. Pulling on an adjustable wrench in the proper direction will cause the jaws to lock in place. Adjustable wrenches come in a large range of sizes, measured by the wrench length.

PLIERS

+ See Figure 49

Pliers are simply mechanical fingers. They are, more than anything, an extension of your hand. At least 3 pairs of pliers are an absolute necessity<em dash>standard, needle nose and slip joint.

In addition to standard pliers there are the slip-joint, multi-position pliers such as ChannelLock® pliers and locking pliers, such as Vise Grips@.

Slip joint pliers are extremely valuable in grasping oddly sized parts and fasteners. Just make sure that you don't use them instead of a wrench too often since they can easily round off a bolt head or nut.

Locking pliers are usually used for gripping bolts or studs that can't be removed conventionally. You can get locking pliers in square jawed, needle-nosed and pipe-jawed. Locking pliers can rank right up behind duct tape as the handy-man's best friend.

SCREWDRIVERS

You can't have too many screwdrivers. They come in *2* basic flavors, either standard or Phillips. Standard blades come in various sizes and thickness for all types of slotted fasteners. Phillips screwdrivers come in sizes with number designations from 1 on up, with the lower number designating the smaller size. Screwdrivers can be purchased separately or in sets.

HAMMERS

◆ See Figure **50**

You need a hammer for just about any kind of work. You need a ball-peen hammer for most metal work when using drivers and other like tools. A plastic hammer comes in handy for hitting things safely. A soft-faced dead-blow hammer is used for hitting things safely and hard. Hammers are also VERY useful with non air-powered impact drivers.

[redacted]

There are a lot of other tools that every DIYer will eventually need (though not all for basic maintenance). They include:

- Funnels
- Chisels
- Punches
- Files
- Hacksaw
- Portable Bench Vise
- Tap and Die Set
- Flashlight
- Magnetic Bolt Retriever
- Gasket scraper
- Putty Knife
- Screw/Bolt Extractors
- Prybars

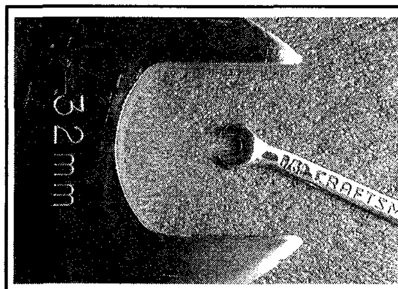


Fig. 48 You may find a nut that requires a particularly large or small wrench (it is usually available at your local tool store

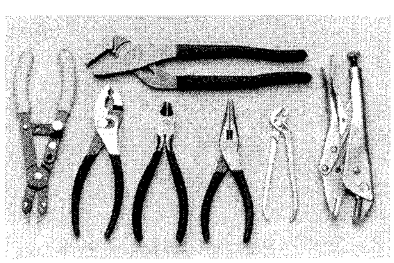


Fig. 49 Pliers and cutters come in many shapes and sizes. You should have an assortment on hand

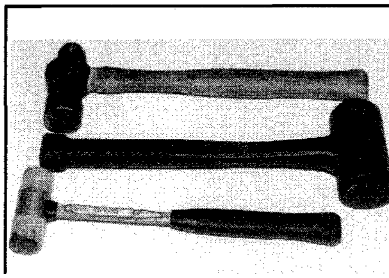


Fig. **50** Three types of **hammers. Top** to bottom: ball peen, rubber dead-blow, and plastic

Hacksaws have just one use—cutting things off. You may wonder why you'd need one for something as simple as maintenance or repair, but you never know. Among other things, guide studs to ease parts installation can be made from old bolts with their heads cut off.

A tap and die set might be something you've never needed, but you will eventually. It's a good rule, when everything is apart, to clean-up all threads, on bolts, screws or threaded holes. Also, you'll likely run across a situation in which you will encounter stripped threads. The tap and die set will handle that for you.

Gasket scrapers are just what you'd think, tools made for scraping old gasket material off of parts. You don't absolutely need one. Old gasket material can be removed with a putty knife or single edge razor blade. However, putty knives may not be sharp enough for some really stubborn gaskets and razor blades have a knack of breaking just when you don't want them to, inevitably slicing the nearest body part! As the old saying goes, "always use the proper tool for the job". If you're going to use a razor to scrape a gasket, be sure to always use a blade holder.

Putty knives really do have a use in a repair shop. Just because you remove all the bolts from a component sealed with a gasket doesn't mean it's going to come off. Most of the time, the gasket and sealer will hold it tightly. Lightly driving a putty knife at various points between the two parts will break the seal without damage to the parts.

A small—8-10 in. (20-25cm) long—prybar is extremely useful for removing stuck parts.

Never use a screwdriver as a prybar! Screwdrivers are not meant for prying. Screwdrivers, used for prying, can break, sending the broken shaft flying!

Screw/bolt extractors are used for removing broken bolts or studs that have broke off flush with the surface of the part.

Special Tools

◆ **See Figure 51**

Almost every marine engine around today requires at least one special tool to perform a certain task. In most cases, these tools are specially designed to overcome some unique problem or to fit on some oddly sized component.

When manufacturers go through the trouble of making a special tool, it is usually necessary to use it to ensure that the job will be done right. A special tool might be designed to make a job easier, or it might be used to keep you from damaging or breaking a part.

Don't worry, MOST maintenance procedures can either be performed without any special tools OR, because the tools must be used for such basic things, they are commonly available for a reasonable price. It is usually just the low production, highly specialized tools (like a super thin 7-point star-shaped socket capable of 150 ft. lbs. (203 Nm) of torque that is used only on the crankshaft nut of the limited production what-dya-callit engine) that tend to be outrageously expensive and hard to find. Hopefully, you will probably never need such a tool.

Special tools can be as inexpensive and simple as an adjustable strap wrench or as complicated as an ignition tester. A few common specialty tools are listed here, but check with your dealer or with other boaters for help in determining if there are any special tools for YOUR particular engine. There is an added advantage in seeking advice from others, chances are they may have already found the special tool you will need, and know how to get it cheaper (or even let you borrow it).

Electronic Tools

BATTERY TESTERS

The best way to test a non-sealed battery is using a hydrometer to check the specific gravity of the acid. Luckily, these are usually inexpensive and are available at most parts stores. Just be careful because the larger testers are usually designed for larger batteries and may require more acid than you will be able to draw from the battery cell. Smaller testers (usually a short, squeeze bulb type) will require less acid and should work on most batteries.

Electronic testers are available and are often necessary to tell if a sealed battery is usable. Luckily, many parts stores have them on hand and are willing to test your battery for you.

BATTERY CHARGERS

◆ **See Figure 52**

If you are a weekend boater and take your boat out every week, then you will most likely want to buy a battery charger to keep your battery fresh. There are many types available, from low amperage trickle chargers to electronically controlled battery maintenance tools that monitor the battery voltage to prevent over or undercharging. This last type is especially useful if you store your boat for any length of time (such as during the severe winter months found in many Northern climates).

Even if you use your boat on a regular basis, you will eventually need a battery charger. The charger should be used anytime the boat is going to be in storage for more than a few weeks or so. Never leave the dock or loading ramp without a battery that is fully charged.

Also, some batteries are shipped dry and in a partial charged state. Before placing a new battery of this type into service it must be filled and properly charged. Failure to properly charge a battery (which was shipped dry) before it is put into service will prevent it from ever reaching a fully charged state.

MULTIMETERS (DVOMs)

◆ **See Figure 53**

Multimeters or Digital Volt Ohmmeter (DVOMs) are an extremely useful tool for troubleshooting electrical problems. They can be purchased in either analog or digital form and have a price range to suit any budget. A multimeter is a voltmeter, ammeter and ohmmeter (along with other features) combined into one instrument. It is often used when testing solid state circuits because of its high input impedance (usually 10 megaohms or more).

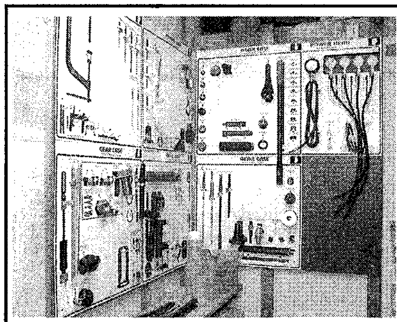


Fig. 51 Almost every marine engine around today requires at least one special tool to perform a certain task

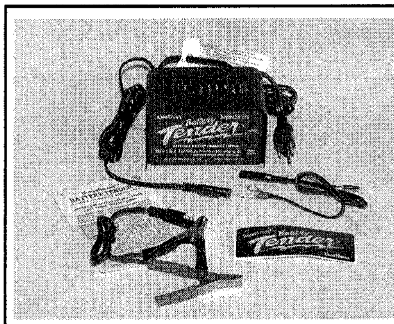


Fig. 52 The Battery Tender@ is more than just a battery charger, when left connected, it keeps your battery fully charged

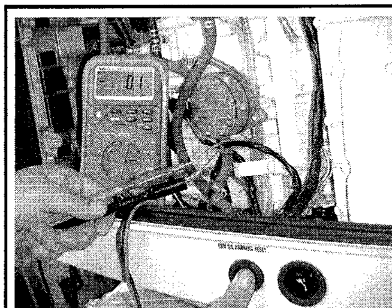


Fig 53 Multimeters, such as this one from UEI, are an extremely useful tool for troubleshooting electrical problems

A brief description of the multimeter main test functions follows:

- Voltmeter—the voltmeter is used to measure voltage at any point in a circuit or to measure the voltage drop across any part of a circuit. Voltmeters usually have various scales and a selector switch to allow the reading of different voltage ranges. The voltmeter has a positive and a negative lead. To avoid the possibility of damage to the meter, whenever possible, connect the negative lead to the negative (-) side of the circuit (to ground or nearest the ground side of the circuit) and connect the positive lead to the positive (t) side of the circuit (to the power source or the nearest power source). Luckily, most quality DVOMs can adjust their own polarity internally and will indicate (without damage) if the leads are reversed. Note that the negative voltmeter lead will always be black and that the positive voltmeter will always be some color other than black (usually red).
- Ohmmeter—the ohmmeter is designed to read resistance (measured in ohms) in a circuit or component. Most ohmmeters will have a selector switch which permits the measurement of different ranges of resistance (usually the selector switch allows the multiplication of the meter reading by 10, 100, 1,000 and 10,000). Some ohmmeters are "auto-ranging" which means the meter itself will determine which scale to use. Since the meters are powered by an internal battery, the ohmmeter can be used like a self-powered test light. When the ohmmeter is connected, current from the ohmmeter flows through the circuit or component being tested. Since the ohmmeter's internal resistance and voltage are known values, the amount of current flow through the meter depends on the resistance of the circuit or component being tested. The ohmmeter can also be used to perform a continuity test for suspected open circuits. In using the meter for making continuity checks, do not be concerned with the actual resistance readings. Zero resistance, or any ohm reading, indicates continuity in the circuit. Infinite resistance indicates an opening in the circuit. A high resistance reading where there should be little or none indicates a problem in the circuit. Checks for short circuits are made in the same manner as checks for open circuits, except that the circuit must be isolated from both power and normal ground. Infinite resistance indicates no continuity, while zero resistance indicates a dead short.

✳✳ WARN

Never use an ohmmeter to check the resistance of a component or wire while there is voltage applied to the circuit.

- Ammeter—an ammeter measures the amount of current flowing through a circuit in units called amperes or amps. At normal operating voltage, most circuits have a characteristic amount of amperes, called "current draw" which can be measured using an ammeter. By referring to a specified current draw rating, then measuring the amperes and comparing the two values; one can determine what is happening within the circuit to aid in diagnosis. An open circuit, for example, will not allow any current to flow, so the ammeter reading will be zero. A damaged component or circuit will have an increased current draw, so the reading will be high. The ammeter is always connected in series with the circuit being tested. All of the current that normally flows through the circuit must also flow through the ammeter; if there is any other path for the current to follow, the ammeter reading will not be accurate. The ammeter itself has very little resistance to current flow and, therefore, will not affect the circuit, but, it will measure current draw only when the circuit is closed and electricity is flowing. Excessive current draw can blow fuses and drain the battery, while a reduced current draw can cause motors to run slowly, lights to dim and other components to not operate properly.

GAUGES

Compression Gauge

◆ **See Figure 54**

An important element in checking the overall condition of your engine is to check compression. This becomes increasingly more important on outboards with high hours. Compression gauges are available as screw-in types and hold-in types. The screw-in type is slower to use, but eliminates the possibility of a faulty reading due to pressure escaping by the seal. A compression reading will uncover many problems that can cause rough running. Normally, these are not the sort of problems that can be cured by a tune-up.

Vacuum Gauge

◆ **See Figure 55 and 56**

Vacuum gauges are handy for discovering air leaks, late ignition or valve timing, and a number of other problems.

Measuring Tools

Eventually, you are going to have to measure something. To do this, you will need at least a few precision tools.

MICROMETERS & CALIPERS

Micrometers and calipers are devices used to make extremely precise measurements. The simple truth is that you really won't have the need for many of these items just for routine maintenance. But, measuring tools, such as an outside caliper can be handy during repairs. And, if you decide to tackle a major overhaul, a micrometer will absolutely be necessary.

Should you decide on becoming more involved in boat engine mechanics, such as repair or rebuilding, then these tools will become very important. The success of any rebuild is dependent, to a great extent on the ability to check the size and fit of components as specified by the manufacturer. These measurements are often made in thousandths and ten-thousandths of an inch.

Micrometers

◆ **See Figure 57**

A micrometer is an instrument made up of a precisely machined spindle that is rotated in a fixed nut, opening and closing the distance between the end of the spindle and a fixed anvil. When measuring using a micrometer, don't overtighten the tool on the part as either the component or tool may be

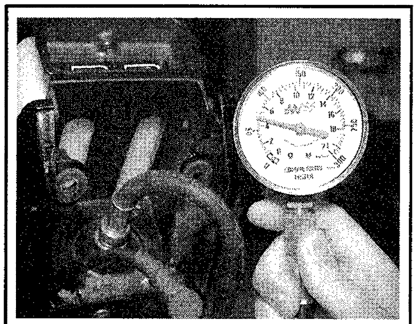


Fig. 54 Cylinder compression test results are extremely valuable indicators of internal engine condition

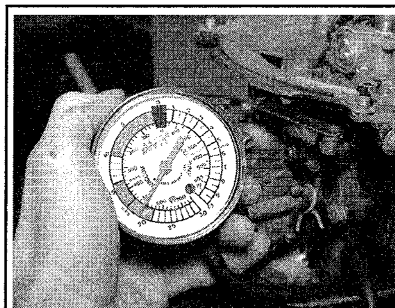


Fig. 55 Vacuum gauges are useful for troubleshooting including testing some fuel pumps

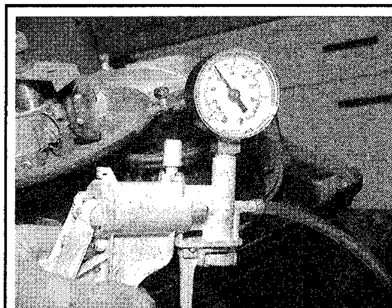


Fig. 56 You can also use the vacuum gauge on a hand-operated vacuum pump for tests

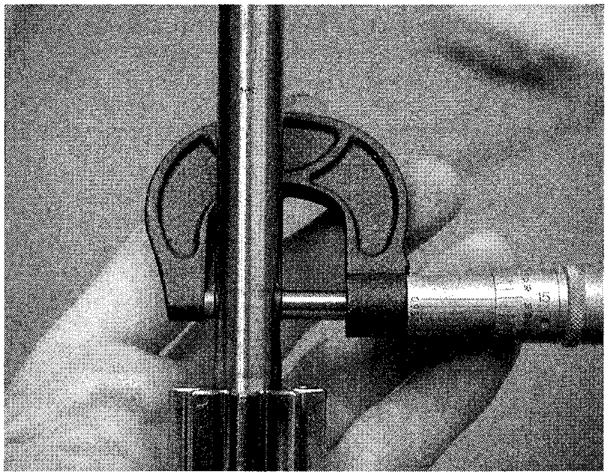


Fig 57 Outside micrometers measure the thickness of parts like shims or the diameter of a shaft

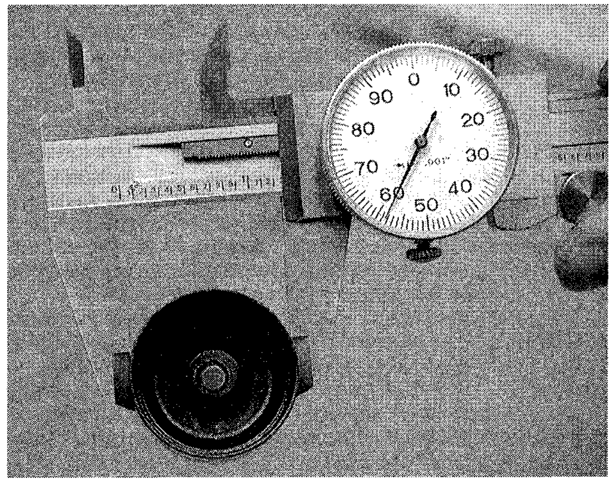


Fig. 58 Calipers are the fast and easy way to make precise measurements

damaged, and either way, an incorrect reading will result. Most micrometers are equipped with some form of thumbwheel on the spindle that is designed to freewheel over a certain light touch (automatically adjusting the spindle and preventing it from overtightening).

Outside micrometers can be used to check the thickness of parts such shims or the outside diameter of components like the crankshaft journals. They are also used during many rebuild and repair procedures to measure the diameter of components such as the pistons. The most common type of micrometer reads in 111000 of an inch. Micrometers that use a vernier scale can estimate to 1110 of an inch.

Inside micrometers are used to measure the distance between two parallel surfaces. For example, in powerhead rebuilding work, the "inside mike" measures cylinder bore wear and taper. Inside mikes are graduated the same way as outside mikes and are read the same way as well.

Remember that an inside mike must be absolutely perpendicular to the work being measured. When you measure with an inside mike, rock the mike gently from side to side and tip it back and forth slightly so that you span the widest part of the bore. Just to be on the safe side, take several readings. It takes a certain amount of experience to work any mike with confidence.

Metric micrometers are read in the same way as inch micrometers, except that the measurements are in millimeters. Each line on the main scale equals Imm. Each fifth line is stamped 5, 10, 15 and so on. Each line on the thimble scale equals 0.01 mm. It will take a little practice, but if you can read an inch mike, you can read a metric mike.

Calipers

◆ **See Figures 58, 59 and 60**

Inside and outside calipers are useful devices to have if you need to measure something quickly and absolute precise measurement is not necessary. Simply take the reading and then hold the calipers on an accurate steel rule. Calipers, like micrometers, will often contain a thumbwheel to help ensure accurate measurement.

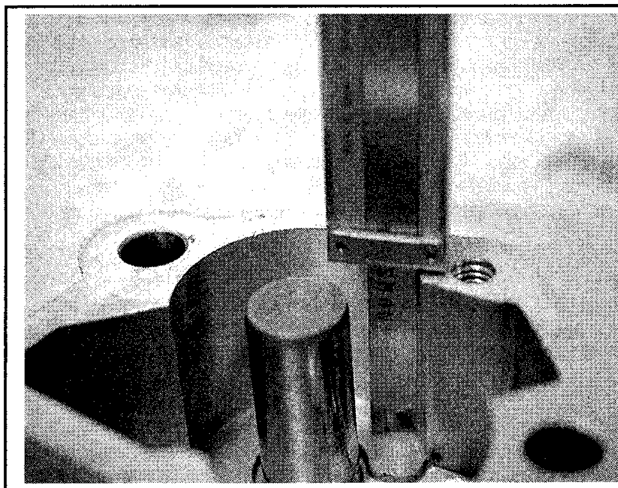


Fig. 59 Calipers can also be used to measure depth

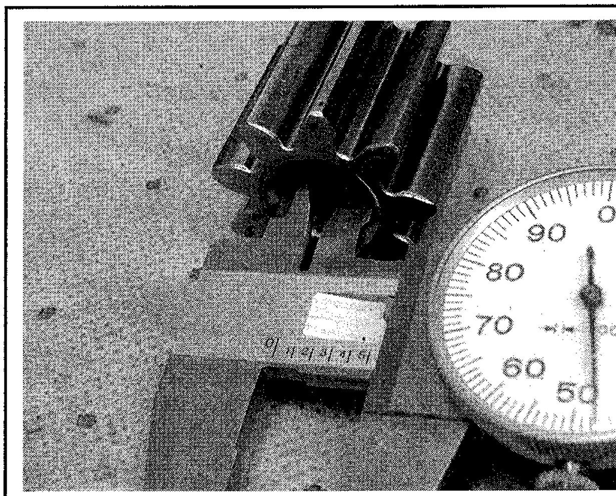


Fig. 60 . . . and inside diameter measurements, usually to 0.001 in. accuracy

DIAL INDICATORS

◆ **See Figure 61**

A dial indicator is a gauge that utilizes a dial face and a needle to register measurements. There is a movable contact arm on the dial indicator. When the arm moves, the needle rotates on the dial. Dial indicators are calibrated to show readings in thousandths of an inch and typically, are used to measure end-play and runout on various shafts and other components.

Dial indicators are quite easy to use, although they are relatively expensive. A variety of mounting devices are available so that the indicator can be used in a number of situations. Make certain that the contact arm is always parallel to the movement of the work being measured.

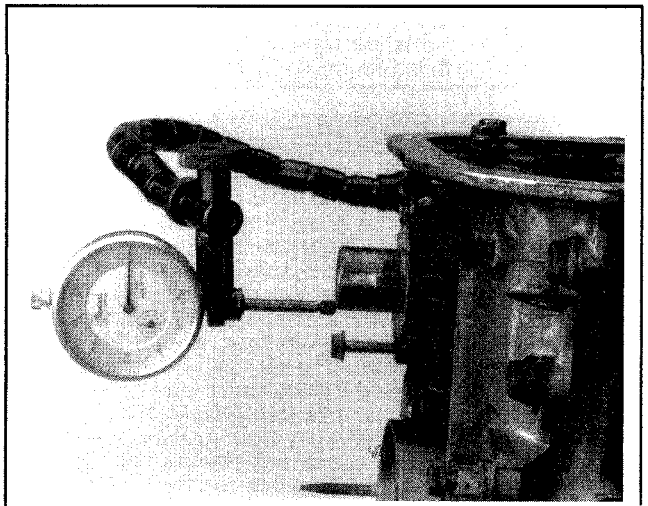


Fig. 61 This dial indicator is measuring the end-play of a crankshaft during a powerhead rebuild

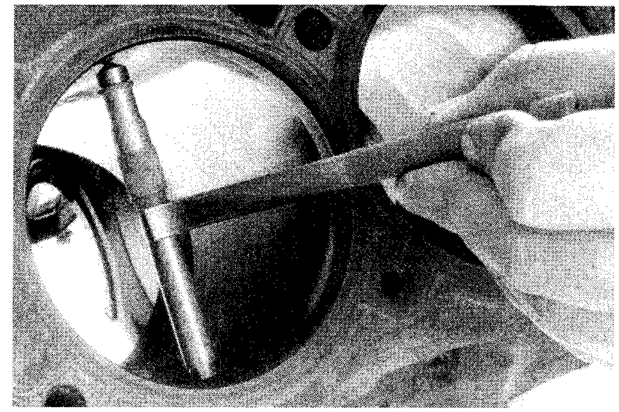


Fig. 62 Telescoping gauges are used during powerhead rebuilding procedures to measure the inside diameter of bores

TELESCOPING GAUGES

◆ **See Figure 62**

A telescope gauge is really only used during rebuilding procedures (NOT during basic maintenance or routine repairs) to measure the inside of bores. It can take the place of an inside mike for some of these jobs. Simply insert the gauge in the hole to be measured and lock the plungers after they have contacted the walls. Remove the tool and measure across the plungers with an outside micrometer.

DEPTH GAUGES

+ **See Figure 63**

A depth gauge can be inserted into a bore or other small hole to determine exactly how deep it is. One common use for a depth gauge is measuring the distance the piston sits below the deck of the block at top dead center. Some outside calipers contain a built-in depth gauge so you can save money and buy just one tool.

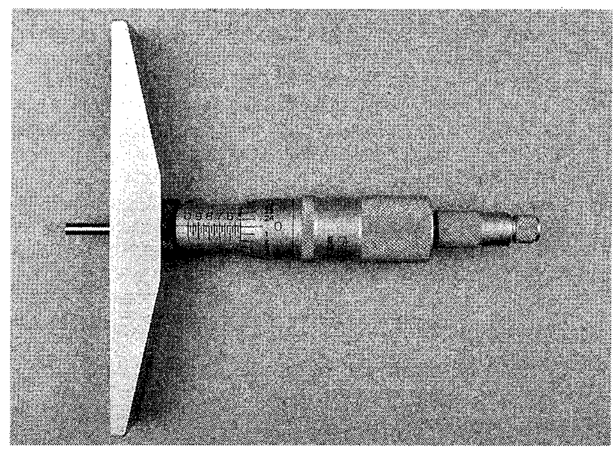


Fig. 63 Depth gauges are used to measure the depth of bore or other small holes

FASTENERS, MEASUREMENTS AND CONVERSIONS

Bolts, Nuts and Other Threaded Retainers

◆ **See Figures 64 and 65**

Although there are a great variety of fasteners found in the modern boat engine, the most commonly used retainer is the threaded fastener (nuts, bolts, screws, studs, etc). Most threaded retainers may be reused, provided that they are not damaged in use or during the repair.

■ **Some retainers (such as stretch bolts or torque prevailing nuts) are designed to deform when tightened or in use and should not be reused.**

Whenever possible, we will note any special retainers which should be replaced during a procedure. But you should always inspect the condition of a retainer when it is removed and you should replace any that show signs of damage. Check all threads for rust or corrosion that can increase the torque necessary to achieve the desired clamp load for which that fastener was originally selected. Additionally, be sure that the driver surface itself (on the fastener) is not compromised from rounding or other damage. In some cases a driver surface may become only partially rounded, allowing the driver to catch in only one direction. In many of these occurrences, a fastener may be installed and tightened, but the driver would not be able to grip and loosen the fastener again. (This could lead to frustration down the line should that component ever need to be disassembled again).

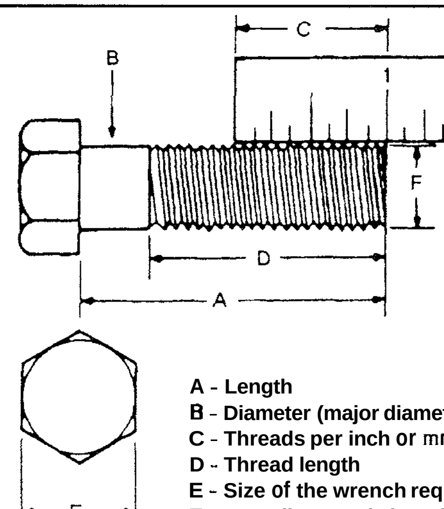


Fig. 64 Threaded retainer sizes are determined using these measurements

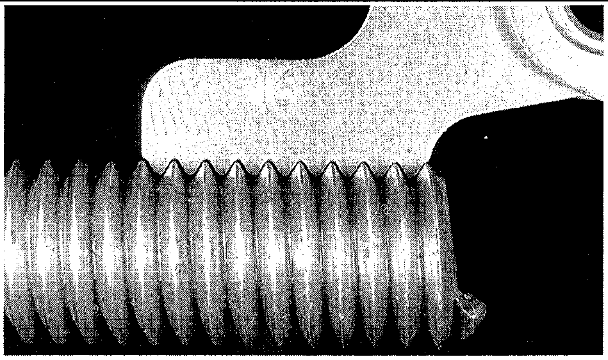


Fig. 65 Thread gauges measure the threads-per-inchand the pitch of a bolt or stud's threads

If you must replace a fastener, whether due to design or damage, you must always be sure to use the proper replacement. In all cases, a retainer of the same design, material and strength should be used. Markings on the heads of most bolts will help determine the proper strength of the fastener. The same material, thread and pitch must be selected to assure proper installation and safe operation of the motor afterwards.

Thread gauges are available to help measure a bolt or stud's thread. Most part or hardware stores keep gauges available to help you select the proper size. In a pinch, you can use another nut or bolt for a thread gauge. If the bolt you are replacing is not too badly damaged, you can select a match by finding another bolt that will thread in its place. If you find a nut that will thread properly onto the damaged bolt, then use that nut as a gauge to help select the replacement bolt. If however, the bolt you are replacing is so badly damaged (broken or drilled out) that its threads cannot be used as a gauge, you might start by looking for another bolt (from the same assembly or a similar location) which will thread into the damaged bolt's mounting. If so, the other bolt can be used to select a nut; the nut can then be used to select the replacement bolt.

In all cases, be absolutely sure you have selected the proper replacement. Don't be shy, you can always ask the store clerk for help.

** WARNING

Be aware that when you find a bolt with damaged threads, you may also find the nut or tapped bore into which it was threaded has also been damaged. If this is the case, you may have to drill and tap the hole, replace the nut or otherwise repair the threads. Never try to force a replacement bolt to fit into the damaged threads.

Torque

Torque is defined as the measurement of resistance to turning or rotating. It tends to twist a body about an axis of rotation. A common example of this would be tightening a threaded retainer such as a nut, bolt or screw. Measuring torque is one of the most common ways to help assure that a threaded retainer has been properly fastened.

When tightening a threaded fastener, torque is applied in three distinct areas, the head, the bearing surface and the clamp load. About 50 percent of the measured torque is used in overcoming bearing friction. This is the friction between the bearing surface of the bolt head, screw head or nut face and the base material or washer (the surface on which the fastener is rotating). Approximately 40 percent of the applied torque is used in overcoming thread friction. This leaves only about 10 percent of the applied torque to develop a useful clamp load (the force that holds a joint together). This means that friction can account for as much as 90 percent of the applied torque on a fastener.

Standard and Metric Measurements

Specifications are often used to help you determine the condition of various components, or to assist you in their installation. Some of the most common measurements include length (in. or cm/mm), torque (ft. lbs., inch lbs. or Nm) and pressure (psi, in. Hg, kPa or mm Hg).

In some cases, that value may not be conveniently measured with what is available in your toolbox. Luckily, many of the measuring devices that are available today will have two scales so U.S. or Metric measurements may easily be taken. If any of the various measuring tools that are available to you do not contain the same scale as listed in your specifications, use the accompanying conversion factors to determine the proper value.

The conversion factor chart is used by taking the given specification and multiplying it by the necessary conversion factor. For instance, looking at the first line, if you have a measurement in inches such as "free-play should be 2 in." but your ruler reads only in millimeters, multiply 2 in. by the conversion factor of 25.4 to get the metric equivalent of 50.8mm. Likewise, if a specification was given only in a Metric measurement, for example in Newton Meters (Nm), then look at the center column first. If the measurement is 100 Nm, multiply it by the conversion factor of 0.738 to get 73.8 ft. lbs.

SPECIFICATIONS

CONVERSION FACTORS

LENGTH–DISTANCE

Inches (in.)	x 25.4	= Millimeters (mm)	x .0394	= Inches
Feet (ft.)	x .305	= Meters (m)	x 3.281	= Feet
Miles	x 1.609	= Kilometers (km)	x .0621	= Miles

VOLUME

Cubic Inches (in3)	x 16.387	= Cubic Centimeters	x .061	= in3
IMP Pints (IMP pt.)	x .568	= Liters (L)	x 1.76	= IMP pt.
IMP Quarts (IMP qt.)	x 1.137	= Liters (L)	x .88	= IMP qt.
IMP Gallons (IMP gal.)	x 4.546	= Liters (L)	x .22	= IMP gal.
IMP Quarts (IMP qt.)	x 1.201	= US Quarts (US qt.)	x .833	= IMP qt.
IMP Gallons (IMP gal.)	x 1.201	= US Gallons (US gal.)	x .833	= IMP gal.
Fl. Ounces	x 29.573	= Milliliters	x .034	= Ounces
US Pints (US pt.)	x .473	= Liters (L)	x 2.113	= Pints
US Quarts (US qt.)	x .946	= Liters (L)	x 1.057	= Quarts
US Gallons (US gal.)	x 3.785	= Liters (L)	x .264	= Gallons

MASS–WEIGHT

Ounces (oz.)	x 28.35	= Grams (g)	x .035	= Ounces
Pounds (lb.)	x .454	= Kilograms (kg)	x 2.205	= Pounds

PRESSURE

Pounds Per Sq. In. (psi)	x 6.895	= Kilopascals (kPa)	x .145	= psi
Inches of Mercury (Hg)	x .4912	= psi	x 2.036	= Hg
Inches of Mercury (Hg)	x 3.377	= Kilopascals (kPa)	x .2961	= Hg
Inches of Water (H_2O)	x .07355	= Inches of Mercury	x 13.783	= H_2O
Inches of Water (H_2O)	x .03613	= psi	x 27.684	= H_2O
Inches of Water (H_2O)	x .248	= Kilopascals (kPa)	x 4.026	= H_2O

TORQUE

Pounds–Force Inches (in–lb)	x .113	= Newton Meters (N·m)	x 8.85	= in–lb
Pounds–Force Feet (ft–lb)	x 1.356	= Newton Meters (N·m)	x .738	= ft–lb

VELOCITY

Miles Per Hour (MPH)	x 1.609	= Kilometers Per Hour (KPH)	x .621	= MPH

POWER

Horsepower (Hp)	x .745	= Kilowatts	x 1.34	= Horsepower

FUEL CONSUMPTION*

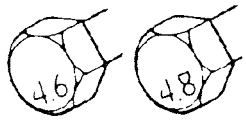
Miles Per Gallon IMP (MPG)	x .354	= Kilometers Per Liter (Km/L)
Kilometers Per Liter (Km/L)	x 2.352	= IMP MPG
Miles Per Gallon US (MPG)	x .425	= Kilometers Per Liter (Km/L)
Kilometers Per Liter (Km/L)	x 2.352	= US MPG

*It is common to covert from miles per gallon (mpg) to liters/100 kilometers (1/100 km), where mpg (IMP) x 1/100 km = 282 and mpg (US) x 1/100 km = 235.

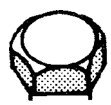
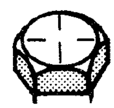
TEMPERATURE

Degree Fahrenheit ("F)	= ("C x 1.8) + 32
Degree Celsius ("C)	= ("F– 32) x .56

Metric Bolts

Relative Strength Marking	4.6, 4.8			8.8		
***Bolt* Markings**						
Usage	Frequent			Infrequent		
Bolt Size	Maximum Torque			Maximum Torque		
Thread Size x Pitch **(mm)**	**Ft-Lb**	**Kgm**	**Nm**	**Ft-Lb**	**Kgm**	**Nm**
6 x 1.0	**2–3**	**.2–.4**	**3–4**	**3–6**	**.4–.8**	**5–8**
8 x 1.25	**6–8**	**.8–1**	**8–12**	**9–14**	**1.2–1.9**	**13–19**
10 x 1.25	**12–17**	**1.5–2.3**	**16–23**	**20–29**	**2.7–4.0**	**27–39**
12 x 1.25	**21–32**	**2.9–4.4**	**29–43**	**35–53**	**4.8–7.3**	**47–72**
14 x 1.5	**35–52**	**4.8–7.1**	**48–70**	**57–85**	**7.8–11.7**	**77–110**
16 x 1.5	**51–77**	**7.0–10.6**	**67–100**	**90–120**	**12.4–16.5**	**130–160**
18 x 1.5	**74–110**	**10.2–15.1**	**100–150**	**130–170**	**17.9–23.4**	**180–230**
20 x 1.5	**110–140**	**15.1–19.3**	**150–190**	**190–240**	**26.2–46.9**	**160–320**
22 x 1.5	**150–190**	**22.0–26.2**	**200–260**	**250–320**	**34.5–44.1**	**340–430**
24 x 1.5	**190–240**	**26.2–46.9**	**260–320**	**310–410**	**42.7–56.5**	**420–550**

SAE Bolts

SAE Grade Number	1 or 2			5			**6 or 7**		
Bolt Markings Manufacturers' marks may vary—number of lines always two less than the grade number.									
Usage	Frequent			Frequent			Infrequent		
Bolt Size **(inches)—(Thread)**	Maximum Torque			Maximum Torque			Maximum Torque		
	Ft-Lb	**kgm**	Nm	Ft-Lb	kgm	Nm	Ft-Lb	kgm	**Nm**
1/4—20	5	0.7	6.8	8	1.1	10.8	10	1.4	13.5
—28	6	0.8	8.1	10	1.4	13.6			
5/16—18	**11**	**1.5**	**14.9**	**17**	**2.3**	**23.0**	**19**	**2.6**	**25.8**
—24	**13**	**1.8**	**17.6**	**19**	**2.6**	**25.7**			
3/8—16	**18**	**2.5**	**24.4**	**31**	**4.3**	**42.0**	**34**	**4.7**	**46.0**
—24	**20**	**2.75**	**27.1**	**35**	**4.8**	**47.5**			
7/16—14	**28**	**3.8**	**37.0**	**49**	**6.8**	**66.4**	**55**	**7.6**	**74.5**
—20	**30**	**4.2**	**40.7**	**55**	**7.6**	**74.5**			
1/2—13	**39**	**5.4**	**52.8**	**75**	**10.4**	**101.7**	**85**	**11.75**	**115.2**
—20	**41**	**5.7**	**55.6**	**85**	**11.7**	**115.2**			
9/16—12	**51**	**7.0**	**69.2**	**110**	**15.2**	**149.1**	**120**	**16.6**	**162.7**
—18	**55**	**7.6**	**74.5**	**120**	**16.6**	**162.7**			
5/8—11	**83**	**11.5**	**112.5**	**150**	**20.7**	**203.3**	**167**	**23.0**	**226.5**
—18	**95**	**13.1**	**128.8**	**170**	**23.5**	**230.5**			
3/4—10	**105**	**14.5**	**142.3**	**270**	**37.3**	**366.0**	**280**	**38.7**	**379.6**
—16	**115**	**15.9**	**155.9**	**295**	**40.8**	**400.0**			
7/8— 9	**160**	**22.1**	**216.9**	**395**	**54.6**	**535.5**	**440**	**60.9**	**596.5**
—14	**175**	**24.2**	**237.2**	**435**	**60.1**	**589.7**			
1— 8	**236**	**32.5**	**318.6**	**590**	**81.6**	**799.9**	**660**	**91.3**	**894.8**
—14	**250**	**34.6**	**338.9**	**660**	**91.3**	**849.8**			

2

MAINTENANCE

GENERAL INFORMATION (WHAT EVERYONE SHOULD KNOW ABOUT MAINTENANCE)

We estimate that 75% of engine repair work can be directly or indirectly attributed to lack of proper care for the engine. This is especially true of care during the off-season. There is no way on this green earth for a mechanical engine, particularly an outboard motor, to be left sitting idle for an extended period of time, say for six months. and then be readv for instant, satisfactory service.

Imagine, if you will, leaving your car or truck for six months, and then expecting to turn the key, having it roar to life, and being able to drive off in the same manner as a daily occurrence. Not likely, eh?

Therefore it is critical for an outboard engine to either be run (at least once a month), preferably, in the water and properly maintained between uses or for it to be specifically prepared for storage and serviced again immediately before the start of the season.

Only through a regular maintenance program can the owner expect to receive long life and satisfactory performance at minimum cost.

Many times, if an outboard is not performing properly, the owner will "nurse" it through the season with good intentions of working on the unit once it is no longer being used. As with many New Year's resolutions, the good intentions are not completed and the outboard may lie for many months before the work is begun or the unit is taken to the marine shop for repair.

Imagine, if you will, the cause of the problem being a blown head gasket. And let us assume water has found its way into a cylinder. This water, allowed to remain over a long period of time, will do considerably more damage than it would have if the unit had been disassembled and the repair work performed immediately. Therefore, if an outboard is not functioning properly, do not stow it away with promises to get at it when you get time, because the work and expense will only get worse, the longer corrective action is postponed. In the example of the blown head gasket, a relatively simple and inexpensive repair job could very well develop into major overhaul and rebuild work.

Maintenance Equals Safety

OK, perhaps no one thing that we do as boaters will protect us from risks involved with enjoying the wind and the water on a powerboat. But, each time we perform maintenance on our boat or motor, we increase the likelihood that we will find a potential hazard before it becomes a problem. Each time we service and inspect our boat and motor, we decrease the possibility that it could leave us stranded on the water.

In this way, performing boat and engine service is one of the most important ways that we, as boaters, can help protect ourselves, our boats, and the friends and family that we bring aboard.

Outboards On Sail Boats

Owners of sailboats pride themselves in their ability to use the wind to clear a harbor or for movement from Port A to Port B, or maybe just for a day sail on a lake. For some, the outboard is carried only as a last resort-in case the wind fails completely, or in an emergency situation or for ease of docking.

Therefore, in some cases, the outboard is stowed below, usually in a very poorly ventilated area, and subjected to moisture and stale air-in short, an excellent environment for "sweating" and corrosion.

If the owner could just take the time at least once every month, to pull out the outboard, clean it up, and give it a short run, not only would helshe have "peace of mind knowing it will start in an emergency, but also maintenance costs will be drastically reduced.

Maintenance Coverage In This Manual

We strongly feel that every boat owner should pay close attention to this section. We also know that it is one of the most frequently used portions of our manuals. The material in this section is divided into sections to help simplify the process of maintenance. Be sure to read and thoroughly understand the various tasks that are necessary to keep your outboard in tip-top shape.

Topics covered in this section include:

1. General Information (What Everyone Should Know About Maintenance)-an introduction to the benefits and need for proper maintenance; a guide to tasks that should be performed before, and after, each use.
2. Lubrication Service-after the basic inspections that you should perform each time the motor is used, the most frequent form of periodic maintenance you will conduct will be the Lubrication Service. This section takes you through each of the various steps you must take to keep corrosion from slowly destroying your motor before your very eyes.
3. Engine Maintenance-the various procedures that must be performed on a regular basis in order to keep the motor and all of its various systems operating properly.
4. Boat Maintenance-the various procedures that must be performed on a regular basis in order to keep the boat hull and its accessories looking and working like new.
5. Tune-Up-also known as the pre-season tune-up, but don't let the name fool you. A complete tune-up is the best way to determine the condition of your outboard while also preparing it for hours and hours of hopefully trouble-free enjoyment.
6. Winter Storage and Spring Commissioning Checklists-use these sections to guide you through the various parts of boat and motor maintenance that protect your valued boat through periods of storage and return it to operating condition when it is time to use it again.
7. Specification Charts-located at the end of the section are quick-reference, easy to read charts that provide you with critical information such as General Engine Specifications, Maintenance Intervals, Lubrication Service (intervals and lubricant types) and Capacities.

Engine Identification

◆ **See Figures 1 and 2**

From 1992-01 Johnson and Evinrude produced an extremely large number of models with regards to horsepower ratings, as well a large number of trim and option variances on each of those models. In this manual, we've included all of the V4, V6 and V8 models (all of which are 2-stroke motors). We chose to do this because of the many similarities these motors have to each other. But, enough differences exist that many procedures will apply only to a sub-set of these motors. When this occurs, we'll either refer to the differences within a procedure or, if the differences are significant, we'll break the motors out and give separate procedures. In order to prevent confusion, we try to sort and name the models in a way that is most easily understood.

In many cases, it is simply not enough to refer to a motor as a 90 or 115 hp model, since in these years Evinrude/Johnson produced two very different 2-cylinder motors with that rating (the 1632cc, 90 degree, cross-charged V4, and the 1726cc, 60 degree, loop-charged V4). To simplify the identification of these motors we'll refer to them either as 1632cc 90CV4 versus 1726cc 60LV4 or we'll use the complete model horsepower range plus the cubic centimeter rating, 65 Jet-115 Hp (1632cc) versus 75-115 Hp (1726cc). To further confuse the issue, many of the 60LV4 models were available either with carburetion or with FICHT Fuel Injection (FFI).

Across that same year span, Evinrude/Johnson sold various Jet models, that although badged with a certain Jet horsepower rating, were built on platforms that, except for the jet drive, were identical to higher horsepower motors. This is because of the difference in the way Jet horsepower ratings are determined. Usually, we'll identify these motors by the ratings found on the engine cases, but let's take a moment to review the platforms from which they are derived, as procedures other than those involving the drive unit should be the same on these models. Two Jet models were produced on the 1632cc 90 CV4 platform, the 65 Jet, which is actually a 90 hp motor and the 80 Jet which is actually a 115 hp motor. One Jet model was produced on the 1726cc 60 LV4 platform, the 80 Jet which is actually a 115 hp motor. And, finally, the 105 Jet is actually a 150 hp (2589cc) 90 LV4 motor.

These sometimes confusing similarities or discrepancies in hp ratings and engine platforms makes proper engine identification important for everything from ordering parts to even just using the procedures in this manual. You'll notice that in all cases, we've chosen to include the cubic centimeter designation, and we'd suggest that you get in the habit on including that designation whenever you are searching for parts or information on your motor. At the end of the day, the combination of the horsepower rating on the casing and the cubic centimeter rating will normally give you the information you need.

Throughout this manual we will make reference to motors the easiest way possible. In some cases procedures will apply to all motors, in other cases, they will apply to all V4 or all V6 motors. When it is necessary to distinguish between different types of motors with the same number of cylinders, we'll differentiate using the Hp rating or, since different motors may have the same rating, we'll use the Hp rating plus the size. In many cases, for motors of a given design, 90 degree loop charged (both V6 and V8), 60 degree loop charged (both V4 and V6), or 90 degree cross-charged (both V4 and V6), the mechanical procedures will be similar or the same across different Hp ratings of the same engine family. So it won't be uncommon to see a title or a procedure refer to a range of horsepower motors, including motors of with a different number of cylinders. In fact, most of the V4 motors are simply V6 models with 2 less cylinders (with the same size pistons, bores and basic crankshaft dimensions). By the same logic, the V8 motors are V6 models with 2 extra cylinders.

To help with proper engine identification, all of the engines covered by this manual are listed in the General Engine and General Engine System Specifications charts at the end of this section. In these charts, the engines are listed with their respective engine families, by horsepower rating, engine configuration (number of cylinders, degree of V and cross- or loop- charged), and years of production and displacement (cubic inches and cubic centimeters or CCs).

But, whether you are trying to tell which version of a particular horsepower rated motor you have in order to follow the correct procedure or are trying to order replacement parts, the absolute best method is to start by referring to the engine serial number tag. For all models covered by this manual an ID tag (1, in the accompanying figure) is located on the port side of the engine clamp or swivel/tilt brackets. Most models are also equipped with an Emissions Control Information label *(2,* in the accompanying figure) as well.

Fig. 1 A model ID tag and an emission control label are found on the port side of most engine **transom/swivel/tilt** brackets

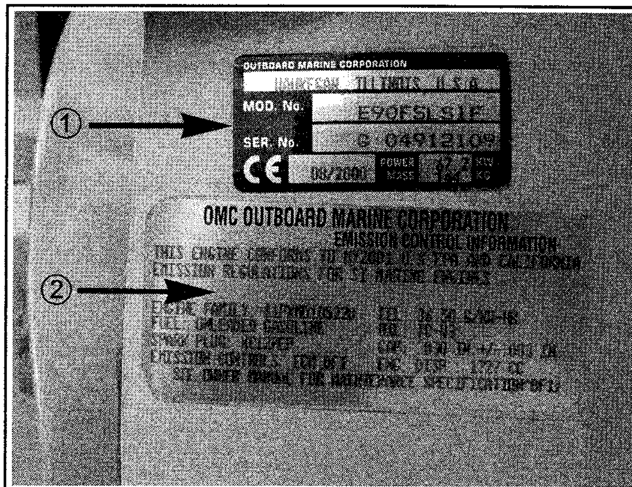


Fig. **2** The model ID tag (1) and emission label (2) provide critical information to identify and service the engine

ENGINE SERIAL NUMBERS

◆ See Figure **2**

The engine serial numbers are the manufacturer's key to engine changes. These alpha-numeric codes identify the year of manufacture, the horsepower rating, lower unit shaft length and various model/option differences (such as tiller electric, remote electric or FICHT or commercial models). If any correspondence or parts are required, the engine serial number must be used for proper identification.

Remember that the serial number establishes the model-year for which the engine was produced, and is often not the year of first installation.

The engine serial number tag contains information such as the plant in which the motor was produced, the model number or code, the serial number (a unique sequential identifier given ONLY to that one motor) as well as other useful information such as weight (mass) in Kilograms (kg).'

☐ We're not quite sure what to tell you about engine weight. If you need to determine how much your engine or rig (boat, motor, trailer) weighs, there's really no substitute for a calibrated truck scale. In working on this text, we've noticed multiple instances when various published weights did not agree, for instance, take a 90 hp FICHT motor we used during the teardown. Published weight for this motor was 349 lbs. **(158kg)** in the factory service information, but it was also listed in a leading boating magazine and in the Evinrude brochure as 362 lbs. **(164kg).** Of course, a close look at the model label in the accompanying figure shows a measurement of **144kg** (318 **lbs.).** One possible explanation for these differences could be dry vs. **w/** fluids. Although we'd normally recommend trusting a label over the printed word, we think you should be conservative when safety is concerned and use the highest published number in this case, until a scale proves it otherwise.

The emissions control information label states that the motor is in compliance with EPA emissions regulations for the model year of that engine. And, more importantly, it gives tune-up specifications that are vital to proper engine performance (that minimize harmful emissions). The specifications on this label may reflect changes that are made during production runs and are often not later reflected in a company's service literature. For this reason, specifications on the label always supercede those of a print manual. Typical specifications that are found on this label will include:

- Spark plug type and gap.

Evinrude/Johnson did NOT publish tune-up specifications such as spark plug type and gap for most FICHT motors, saying even in the factory literature to refer to the emission control label. If you find the label missing on your motor, check with your local parts supplier about ordering a replacement.

- Fuel/2-stroke engine oil recommendations.
- Idle speed settings

Engine ignition timing (such as wide-open throttle and/or idle timing) specification (for carbureted motors only)

- Engine displacement (in Cubic Inches or Cubic Centimeters, as noted on the label)

■ **Most idle and timing functions are handled by the Engine Control Module (ECM) on Direct Fuel Injection (DFI) models, also known as FICHT or FICHT Fuel Injection (FFI) engines. For this reason, the emission control label may just list "Emission Controls: ECM, DFI" instead of idle and timing specs.**

Deciphering The Model Code on 1992-98 Engines

◆ **See Figure 3**

Engines built for the 1992-98 model years (and all Evinrude/Johnson engines built back through 1980) will contain an 8-12 digit code for identification. If the code begins with A, B, C, H, S, T or V, it represents a model variation (a model built for use in certain countries or specifically for a boat-builder to include with their new boat). If one of these alphas is not present, the code should start with **J** (for Johnson) or E (for Evinrude). The next one, two or three digits will be numbers, representing the horsepower rating. The digit following the horsepower rating will be a one, two or three digit alpha code identifying the various trim/model types (such as **TE** for tiller electric or **FS** for FICHT fuel injection, w/ power trim/tilt). Following the model identifier may be a single alpha identifier (L, Y, X or Z) representing lower unit shaft length (a lack of this identifier would represent a 15 in. shaft length). Next, a two-digit, alpha identifier is used for the year. And lastly, the manufacturer internally uses a single check digit to designate the model run.

Refer to the accompanying illustration to interpret the various alpha identifiers found throughout the model code.

Starting in 1980, Evinrude/Johnson began using the word INTRODUCES as an easy way to decipher model years. The 10 letters of that word correspond to the digits 1-9 and 0, in that order. The first letter I represents a 1, the second letter N represents a 2 and so on until S which represents a 0. When deciphering a model code, each of the two alpha identifiers correspond to the last two digits of the model year. A 1998 model would therefore be EC, a 1996 would be ED, and so on. For quick deciphering, right out the word INTRODUCES and then number the letters from 1-9 and then 0. Just remember that the letters of the model code that represent the model year are usually NOT the 2 last letters of the code, since there is normally a model suffix in the code. This means that the model code identifiers are usually the 2nd and 3rd letters from the end of the code.

Deciphering The Model Code on 1999-01 Engines

+ **See Figure 4**

Engines built for the 1999-01 model years contain a simplified version of the model code (when compared with earlier models) containing only 7-8 digits. In all cases, the identifier should start with a single alpha representing Johnson (J) or Evinrude (E). The next one, two or three digits will be numbers, representing the horsepower rating. The digit following the horsepower rating will be a single one or two digit alpha/numeric code identifying design features/model types (such as W for commercial models, **T** for tiller steering or **F** for FICHT fuel injection). Following the design feature/model identifier may be a single alpha identifier (L, Y, X or Z) representing lower unit shaft length (a lack of this identifier would represent a 15 in. shaft length). Next, a two-digit, alpha identifier is used for the year and is deciphered in the same manner as all EvinrudelJohnson models numbers since 1980. Finally, a single check digit, MAY be used internally by the manufacturer to designate the model run.

Refer to the accompanying illustration to interpret the various alpha digits found throughout the model code.

Before/After Each Use

As stated earlier, the best means of extending engine life and helping to protect yourself while on the water is to pay close attention to boat/engine maintenance. This starts with an inspection of systems and components before and after each time you use your boat.

A list of checks, inspections or required maintenance can be found in the Maintenance Intervals Chart at the end of this section. Some of these inspections or tasks are performed before the boat is launched, some only after it is retrieved and the rest, both times.

VISUALLY INSPECTING THE BOAT AND MOTOR

◆ **See Figures 5 and 6**

Before each launch and immediately after each retrieval, visually inspect the boat and motor as follows:

1. **Check the fuel and oil levels** according to the procedures in this manual. Do NOT launch a boat without properly topped off fuel and oil tanks (on oil injected motors). It is not worth the risk of getting stranded or of damage to the motor. Likewise, upon retrieval, check the oil and fuel levels while it is still fresh in your mind. This is a good way to track fuel consumption (one indication of engine performance). Compare the fuel consumption to the oil consumption (a dramatic change in proportional use may be an early sign of trouble).
2. **Check for siqns of fuel or oil leakaqe.** Probablv as important as making sure enough–fuel and oil is onboard, is the need'to make sure that no dangerous conditions might arise due to leaks. Thoroughly check all hoses, fittings and tanks for signs of leakage. Oil leaks may prevent proper oiling of the powerhead and, although all VR02 and FICHT systems have warning systems, reduced oiling could damage the powerhead or, if the system fails completely, could strand the boat. Fuel leaks can cause a fire hazard, or worse, an explosive condition. This check is not only about properly maintaining your boat and motor, but about helping to protect your life.
3. **Inspect the boat hull and engine cases** for signs of corrosion or damage. Don't launch a damaged boat or motor. And don't surprise yourself dockside or at the launch ramp by discovering damage that went unnoticed last time the boat was retrieved. Repair any hull or case damage now.
4. **Check the battery** connections to make sure they are clean and tight. A loose or corroded connection will cause charging problems (damaging the system or preventing charging). There's only one thing worse than a dead battery dockside or on the launch ramp and that's a dead battery in the middle of a bay, river or heavens, the ocean. Whenever possible, make a quick visual check of battery electrolyte levels (keeping an eye on the level will give some warning of overcharging problems). This is especially true if the engine is operated at high speeds for extended periods of time.
5. **Check the propeller (impeller on jet drives) and lower unit.** Make sure the propeller shows no signs of damage. A broken or bent propeller may allow the engine to over-rev and it will certainly waste fuel. The lower unit should be checked before and after each use for signs of leakage. Check the lower unit oil for signs of contamination if any leakage is noted. Also, visually check behind the propeller for signs of entangled rope or fishing lines that could cut through the lower gearcase propeller shaft seal. This is a common cause of lower unit lubricant leakage, and eventually, water contamination that can lead to lower unit failure. Even if no lower unit leakage is noted when the boat is first retrieved, check again next time before launching. A nicked seal might not seep fluid right away when still swollen from heat immediately after use, but might begin seeping over the next day, week or month as it sat, cooled and dried out.
6. **Check all accessible fasteners for tightness.** Make sure all easily accessible fasteners appear to be tight. This is especially true for the propeller nut, any anode retaining bolts, all steering or throttle linkage fasteners and the engine mounting bolts. Don't risk loosing control or becoming stranded due to loose fasteners. Perform these checks before heading out, and immediately after you return (so you'll know if anything needs to be serviced before you want to launch again.)
7. **Check operation of all controls including the throttle/shifter, steering and emergency stop/start switch and/or safety lanyard.** Before launching, make sure that all linkage and steering components operate properly and move smoothly through their range of motion. All electrical switches (such as power trimltilt) and especially the emergency stop system (~i) must be in proper working order. While underway, watch for signs that a system is not working or has become damaged. With the steering, shifter or throttle, keep a watchful eye out for a change in resistance or the start of jerky/notchy movement.
8. **Check the water pump intake grate and water indicator.** The water pump intake qrate should be clean and undamaqed before settinq out. Remember that a damaged grate could allow debris into the system that could destroy the impeller or clog cooling passages. Once underway, make

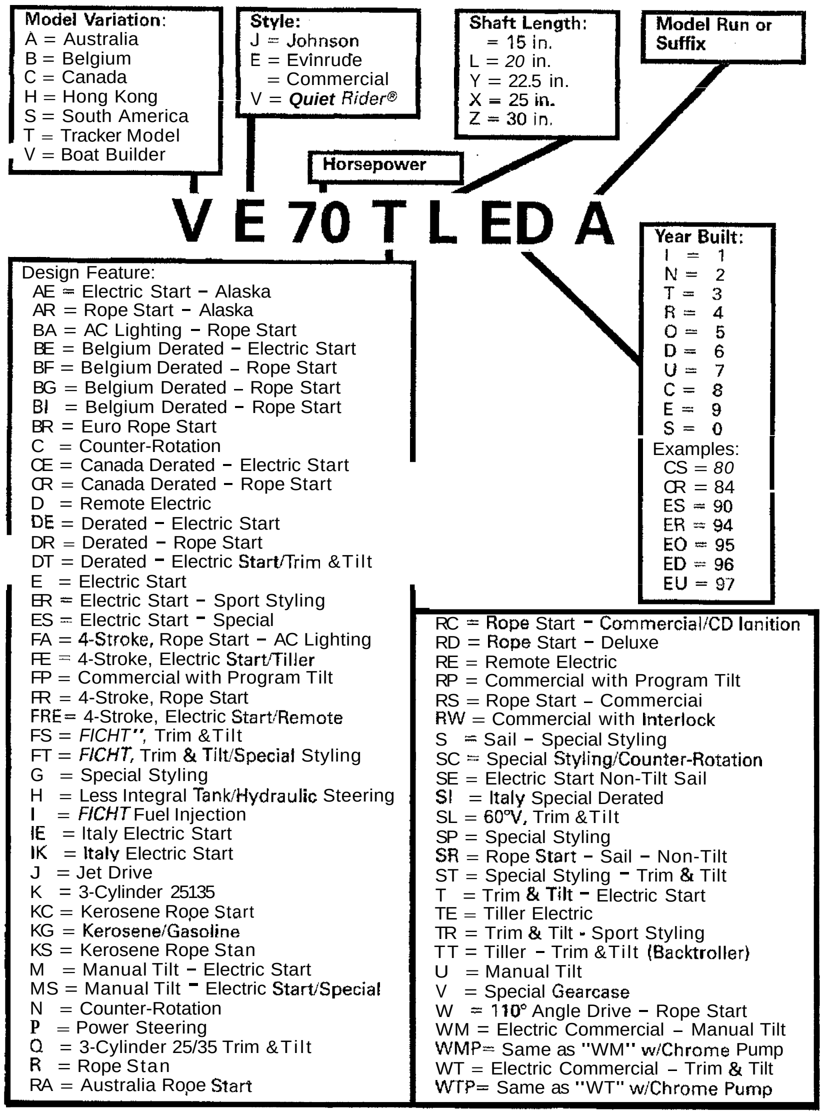


Fig. 3 Model codes-1992-98 models

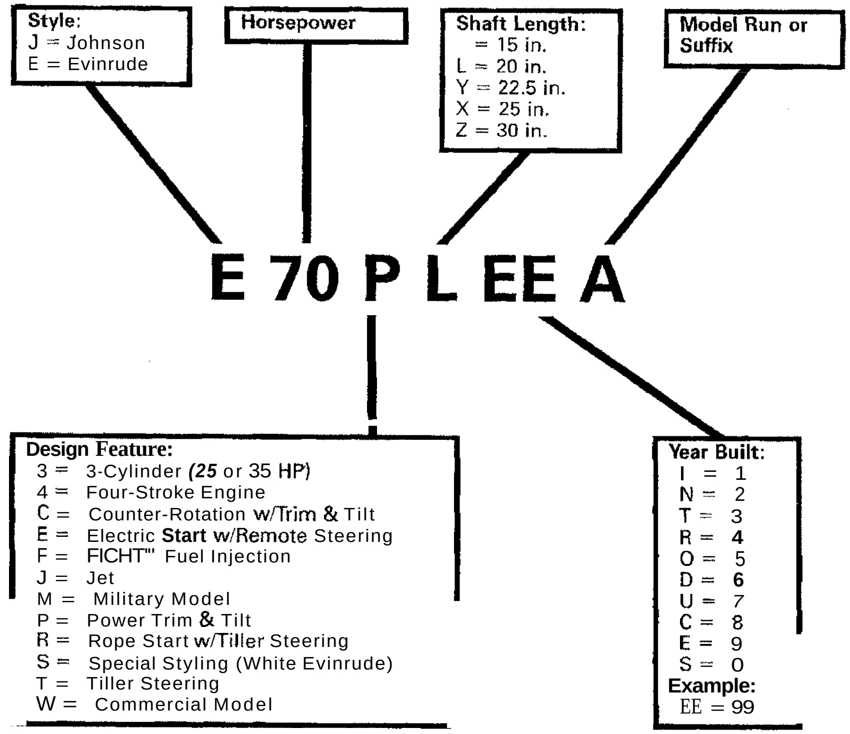


Fig. 4 Model codes-1999-01 models

sure the cooling indicator stream is visible at all times. Make periodic checks, including one final check before the motor is shut down each time. If a cooling indicator stream is not present at any point, troubleshoot the problem before further engine operation.

9. **If equipped, check the power steering belt and fluid level.** A quick visual inspection of the power steering belt and fluid level at the end of each day will warn of oroblems that should be fixed before the next launch.

10. **If used in salt, brackish or polluted waters thoroughly rinse the engine (and hull), then flush the cooling system** according to the procedure in this section.

Even if used in fresh water, it is never a bad idea to flush the system with fresh clean water from a garden hose. Keep in mind that sand, silt or other debris may be picked up by the cooling system during normal motor operation. Removing this debris before it can build-up and clog the engine is wise service.

11. **Inspect all anodes** after each use for signs of wear, damage or to make sure they just plain didn't fall off (especially if you weren't careful about checking all the accessible fasteners the last time you launched).

12. **On FICHT Fuel Injection (FFI) models, be sure to shut the battery switch off** if the engine is not going to be run for a couple of weeks or more. The Engine Management Module (EMM) on FFI motors covered will continue to draw a small amount of current from the battery, even when the motor is shut off. In order to prevent a slow drain of the entire battery, either periodically recharge the battery, or isolate it by disconnecting the cables or shutting off the battery switch when the boat is dockside or on the trailer.

13. **For Pete's sake, make sure the plug is in!** We shouldn't have to say it, but unfortunately we do. If you've been boating for any length of time, you've seen or heard of someone whose backed a trailer down a launch ramp, forgetting to check the transom drain plug before literally submerging the boat. Always make sure the transom plug is installed and tight before a launch.

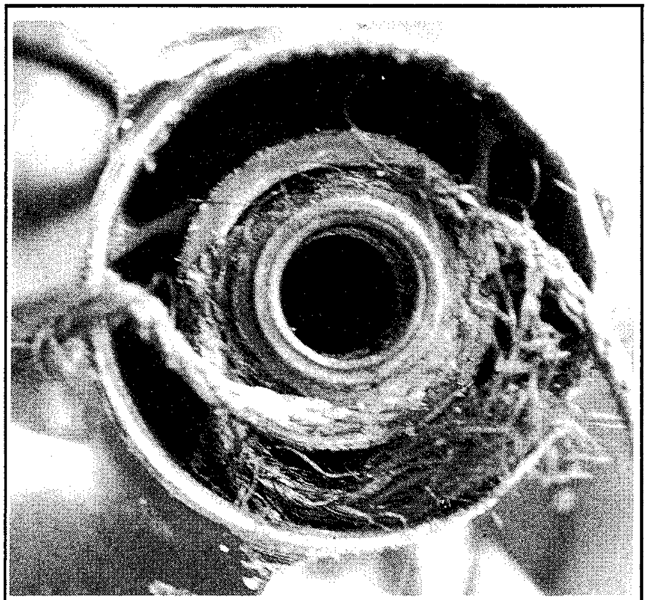


Fig. 5 Rope and fishing line entangled behind the propeller can cut through the seal, allowing water to enter and lubricant to escape

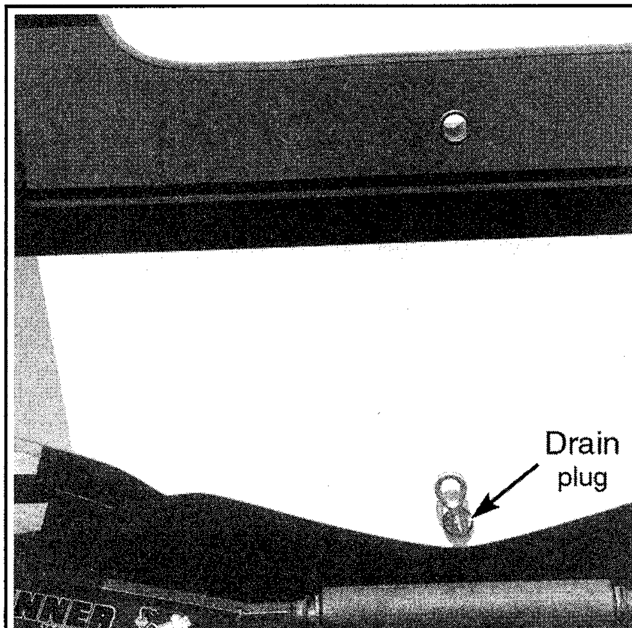


Fig. 6 Always make sure the transom plug is installed and tightened securely before a launch

LUBRICATION SERVICE

An outboard motor's greatest enemy is corrosion. Face it, oil and water just don't mix and, as anyone who has visited a junkyard knows, metal and water aren't the greatest of friends either. To expose an engine to a harsh marine environment of water and wind is to expect that these elements will take their toll over time. But, there is a way to fight back and help prevent the natural process of corrosion that will destroy your beloved boat motor.

Various marine grade lubricants are available that serve two important functions in preserving your motor. Lubricants reduce friction on metal-to-metal contact surfaces and, they also displace air and moisture, therefore slowing or preventing corrosion damage. Periodic lubrication services are your best method of preserving an outboard motor.

Lubrication takes place through various forms. For all engines, internal moving parts are lubricated by 2-stroke engine oil, through oil contained in the fuel/oil mixture. Pay close attention to the oil level in the tank on oil injected models, or to the oil/fuel mixing process on pre-mix motors. Also, the lower unit is filled with gear oil that lubricates the driveshaft, propshaft, gears and other internal gearcase components. The gear oil should be periodically checked and replaced following the appropriate Engine Maintenance procedures. Perform services based on time or engine use, as outlined in the Maintenance Intervals chart at the end of this section.

✳✳ WARNING

If equipped with power trimltilt, maintaining proper fluid level is necessary for the built-in impact protection system. Incorrect fluid level could lead to significant lower unit damage in the event of an impact.

On motors equipped with power trim/tilt, the fluid level and condition in the reservoir should be checked periodically to ensure proper operation. Also, on these motors, correct fluid level is necessary to ensure operation of the motor impact protection system.

Most other forms of lubrication occur through the application of grease (Evinrude/Johnson Triple-Guard, Evinrude/Johnson EP/Wheel bearing grease, Evinrude/Johnson Starter Pinion Lube, or their equivalents) to various points on the motor. These lubricants are either applied by hand (an old toothbrush can be helpful in preventing a mess) or using a grease gun to pump the lubricant into grease fittings (also known as zerk fittings). When using a grease gun, do not pump excessive amounts of grease into the fitting. Unless otherwise directed, pump until either the rubber seal (if used) begins to expand or until the grease just begins to seep from the joints of the component being lubricated (if no seal is used).

To ensure your motor is getting the protection it needs, perform a visual inspection of the various lubrication points at least once a week during regular seasonal operation (this assumes that the motor is being used at least once a week). Follow the recommendations given in the Lubrication Chart at the end of this section and perform the various lubricating services at least every 60 days when the boat is operated in fresh water or every 30 days when the boat is operated in salt, brackish or polluted waters. We said at least meaning you should perform these services more often, as discovered by your weekly inspections.

☐ Jet drive models require one form of lubrication every time that they are **used. The** jet drive bearing should be greased, following the procedure given in this section, after every day of boating. But don't worry, it only takes a minute once you've done it before.

Electric Starter Motor Pi

Periodic lubrication of the starter motor pinion is required on all electric start models, except 60 degree 75-115 Hp (1726cc) V4 and 105 Jet-175 Hp (2589cc) V6 motors.

RECOMMENDED LUBRICANT

Use Evinrude/Johnson Starter Pinion Lube, General Electric Versalube or an equivalent lubricant.

LUBRICATION

4 See Figures **7** and 8

The starter pinion is the gear and slider assembly located on the top of the starter motor as it is mounted to the engine. When power is applied to the starter, the gear on the pinion assembly slides upward to contact and mesh with the gear teeth on the outside of the flywheel. Periodically, apply a small amount of lubricant to the sliding surface of the starter pinion in order to prevent excessive wear or possible binding on the shaft.

■ On models that require periodic lubrication, easy access is normally provided to the starter **pinion. Though,** it is possible that a flywheel cover may need to be removed on a few models.

Engine Cover Latches

For some reason, not all Evinrude/Johnson factory literature mentions the periodic lubrication of the engine cover latches (including one of the author's own motors and owner's manual). But, most motors are equipped with a grease fitting for each cover latch and/or exposed metal-to-metal contact surfaces that will benefit from periodic lubrication).

RECOMMENDED LUBRICANT

Use Evinrude/Johnson Triple-Guard, or equivalent water-resistant marine grease for lubrication.

LUBRICATION

4 See Figures **9** and 10

Although the sliding surfaces of all cover latches can benefit from an application of grease, the design of the latches used on some motors (those equipped with grease fittings) makes periodic greasing necessary to prevent the latches from binding or wearing. Most 65 Jet-115 Hp (1632cc) 90CV4 motors are equipped with 3 grease fittings on the engine case, 2 fittings on the lower outside of one end of the case, and one fitting at the other end. Other models, such as most 75-115 Hp (1726cc) V4 and 105 Jet-175 Hp (2589cc) V6 motors have a single grease fitting on each latch (located facing upward, inside of the engine covers).

Depending on the latch type, either apply a small amount of grease to the metal surfaces using an applicator brush or use a grease gun to pump grease into the zerk fitting facing outward from the latch assembly.

Jet Drive Bearing

4 See Figure 11

Jet drive models covered by this manual require special attention to ensure that the driveshaft bearing remains properly lubricated.

After each day of use, the jet drive bearing should be properly lubricated using a grease gun. Also, after every 30 hours of fresh water operation or every 15 hours of salt/brackish/polluted water operation, the drive bearing grease must be replaced. Follow the appropriate procedure:

RECOMMENDED LUBRICANT

Use Evinrude/Johnson EP/Wheel Bearing grease or equivalent water-resistant NLGI No. 1 lubricant.

DAILY BEARING LUBRICATION

4 See Figures 12 and 13

A grease fitting is located under a vent hose on the lower port side of the jet drive. Disconnect the hose from the fitting, then use a grease gun to apply enough grease to the fitting to just fill the vent hose. Pump grease into the fitting until the old grease just starts to come out from the passages through the hose coupling and then reconnect the hose to the fitting.

☐ Do not attempt to just grasp the vent hose and pull, as it is a tight fit and when it does come off, you'll probably go flying if you didn't prepare for **it. The** easier method of removing the vent hose from the fitting is to deflect the hose to one side and snap it free from the fitting.

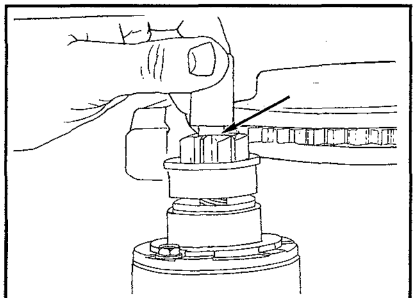


Fig. 7 Apply lubricant to the sliding surface of the electric starter pinion

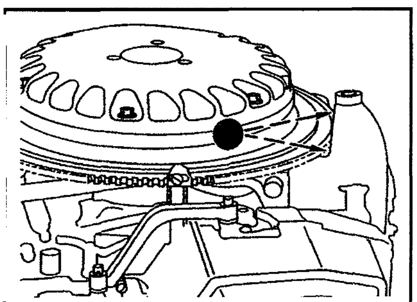


Fig. 8 In most cases, models that require periodic lubrication provide easy access to the starter pinion

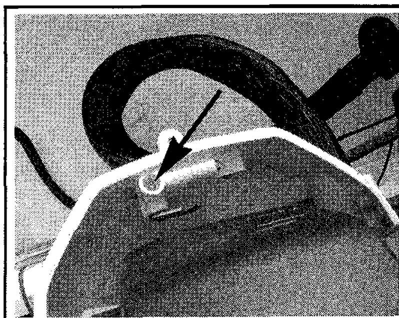


Fig. **9** If equipped, use the grease fittings normally found at the front ...

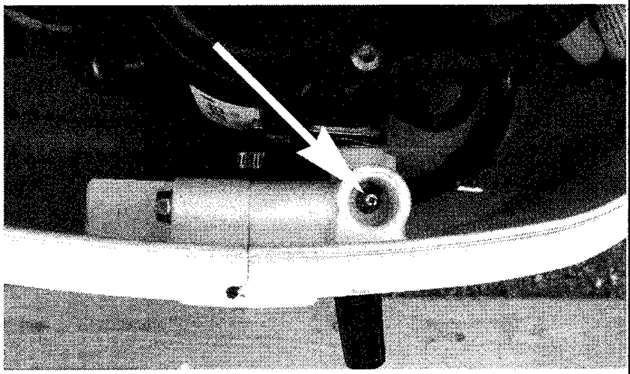


Fig. 10. ... and rear of the engine covers to lubricate the engine cover latches

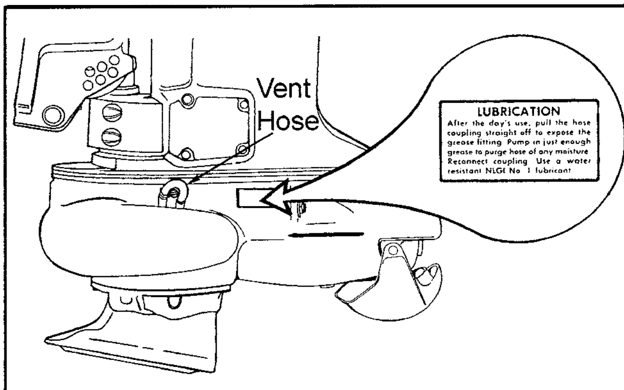


Fig. **11** Jet drive models require lubrication of the bearing after each day of use, a label on the housing usually reminds the owner

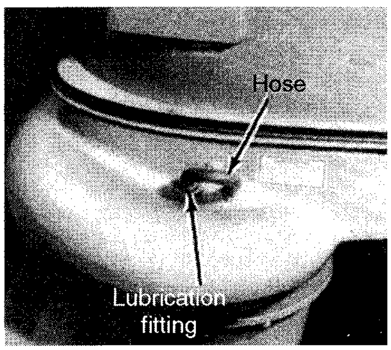


Fig. **12** The jet drive lubrication fitting is found under the vent hose

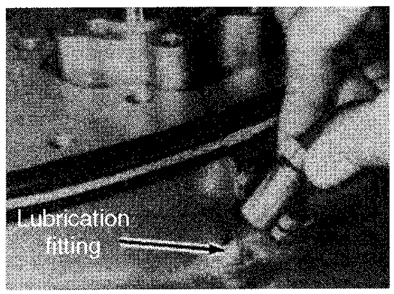


Fig. **13** Attach a grease gun to the fitting for lubrication

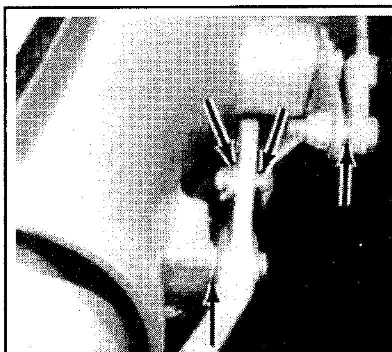


Fig. **14** Coat the pivot points of the jet linkage with grease periodically

GREASE REPLACEMENT

EASY

◆ See Figures **12, 13** and **14**

A grease fitting is located under a vent hose on the lower port side of the jet drive. This grease fitting is utilized at the end of each day's use to add fresh grease to the jet drive bearing. But, every 30 or 15 days (depending if use is in fresh or salt/brackish/polluted waters), the grease should be completely replaced. This is very similar to the daily greasing, except that a lot more grease it used. Disconnect the hose from the fitting (by deflecting it to the side until it snaps free from the fitting), then use a grease gun to apply enough grease to the fitting until grease exiting the assembly fills the vent hose. Then, continue to pump grease into the fitting to force out all of the old grease (you can tell this has been accomplished when fresh grease starts to come out of the vent instead of old grease, which will be slightly darker due to minor contamination from normal use). When nothing but fresh grease comes out of the vent the fresh grease has completely displaced the old grease and you are finished. Be sure to securely connect the vent hose to the fitting.

Each time this is performed, inspect the grease for signs of moisture contamination or discoloration. A gradual increase in moisture content over a few services is a sign of seal wear that is beginning to allow some seepage. Very dark or dirty grease may indicate a worn seal (inspect and/or replace the seal, as necessary to prevent severe engine damage should the seal fail completely).

☐ Keep in mind that some discoloration of the grease is expected when a new seal is **broken-in. The** discoloration should go away gradually after one or two additional grease replacement services.

Whenever the jet drive bearing grease is replaced, take a few minutes to apply some of that same water-resistant marine grease to the pivot points of the jet linkage.

Power Trim/Tilt Reservoir

◆ See Figure **15**

✳✳ WARNING

When equipped with power trimltilt, proper fluid level is necessary for the built-in impact protection system. Incorrect fluid level could lead to significant lower unit damage in the event of an impact.

RECOMMENDED LUBRICANT

The power trimltilt reservoir must be kept full of Evinrude/Johnson Power Trim/Tilt and Power Steering Fluid.

CHECKING FLUID LEVEL/CONDITION

EASY

◆ See Figure **15**

The fluid in the power trim/tilt reservoir should be checked periodically to ensure it is full and is not contaminated.

To check the fluid, tilt the motor upward to the full tilt position and manually engage the tilt support, for safety and to prevent damage.

Remove the filler cap (they are usually threaded in position and equipped with a flat to accept a bladed screwdriver) and make a visual inspection of the fluid. It should seem clear and not milky.

The level is correct if, with the motor at full tilt, the level is even with the bottom of the filler cap hole.

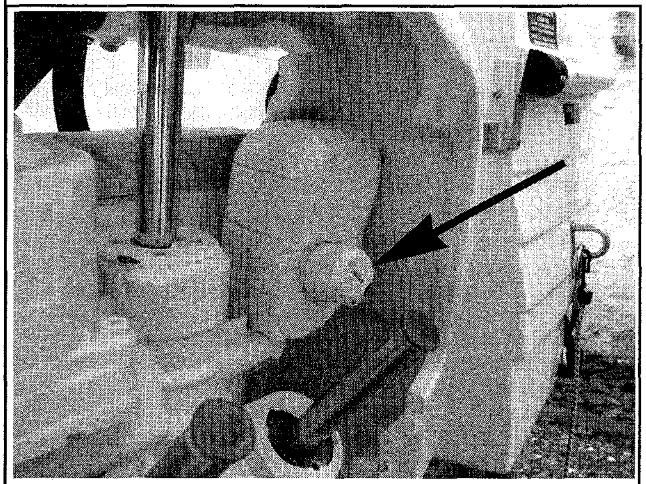


Fig. 15 Maintaining the proper power **trim/tilt** fluid level is critical to protecting the engine in case of an impact

Power Steering Fluid Reservoir

◆ See Figure **16**

Some models are equipped with a power steering system consisting of a belt, pump and reservoir. The fluid level should be checked periodically (ideally with each outing, but at minimum at least every 30 days.

**** CAUTION**

Remember, steering a boat is a matter of safety, don't risk poor performance or failure of the system due to something as silly a low fluid level.

**** WARNING**

Should the pump lose pressure or become inoperative on the water, shut the engine off and cut the drive belt free of the **pulleys. This** will allow normal "non-power" steering operation (which might be a little slow and heavy, but predictable) and will prevent serious and permanent damage which can occur to the pump if it is run low on **fluid/pressure.**

RECOMMENDED LUBRICANT

The power trim/tilt reservoir must be kept full of Evinrude/Johnson Power Trim/Tilt and Power Steering Fluid or with Dexron II (or latest superceding) automatic transmission fluid.

CHECKING FLUID LEVEL/CONDITION

① EASY

◆ See Figure **16**

■ The system should be completely drained (by disconnecting a fluid fitting or line, especially at the filter, if equipped) and the fluid should be completely changed every 500 hours.

The fluid in the power steering reservoir should be checked periodically to ensure it is full and is not contaminated. To check the fluid, the motor must be in the normal, fully vertical position (trimmed level with the ground, NOT the gauge). Remove the engine top case for access to the reservoir (usually located near the top of the motor), then unthread the dipstick. Wipe the dipstick off and insert it back into the reservoir, but DO NOT thread it back into position, instead let it sit for a second on top of the threads, then withdraw the dipstick. Hold the dipstick vertically, with the bottom downward, to prevent a false high reading by fluid running up the stick if it was tilted past vertical. Then read the dipstick by looking at the highest wet line across the surface of the dipstick. Fluid should be kept at the full mark. If not, add just enough fluid to top it off to the full mark, NOT above. While checking the level, also take note of the fluid condition. It should seem clear and not milky.

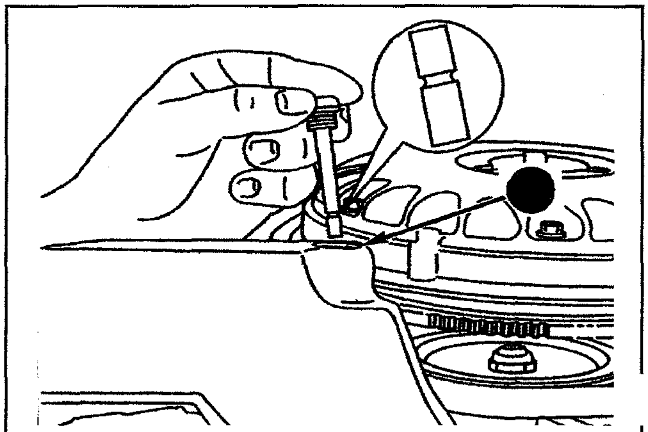


Fig. **16** Check the power steering fluid level periodically to ensure safe, trouble-free system operation

If the fluid level is low, thoroughly inspect the system for signs of leakage and repair, as necessary).

CHANGING FLUID AND FILTER

② MODERATE

◆ See Figure **17**

Every 500 hours of operation or anytime the fluid inspection shows signs of contamination; the system should be completely emptied and refilled using fresh fluid. Most systems are also equipped with an inline power steering fluid filter to help keep the fluid free of particles and contamination. The filter should be changed anytime the fluid is changed. When equipped, the filter is a convenient way of draining the system, as it is normally mounted inline, beneath the reservoir. Once the lines are disconnected they can be pointed downward to ensure thorough system draining. Keep in mind that the bottom filter line must be positioned downward at a point lower than the lowest point in the system in order to ensure draining, this might necessitate placing an additional length of line on it, or following it downward to disconnect it at the other end.

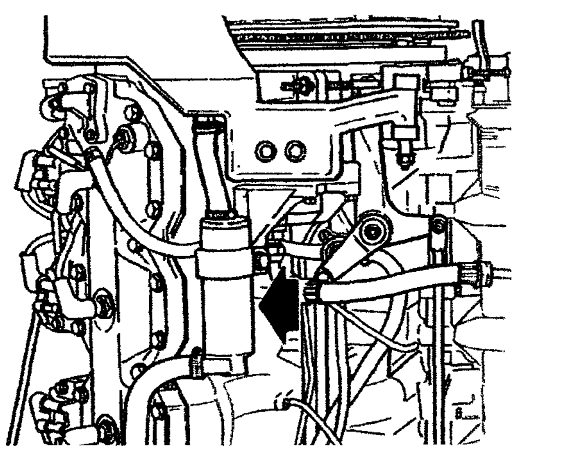


Fig. **17** Most power steering systems utilize an **inline** filter that must be changed whenever the fluid is replaced

Linkage, Cables and Shafts (Shift, Carburetor and/or Throttle Shaft)

RECOMMENDED LUBRICANT

Use Evinrude/Johnson Triple-Guard, or equivalent water-resistant marine grease for lubrication.

LUBRICATION

① EASY

◆ See Figures **18, 19, 20, 21, 22, 23, 24, 25** and 26

Every Johnson and Evinrude outboard uses some combination of cables and/or linkage in order to actuate the throttle plate (of the carburetors or throttle bodies) and the lower unit shifter. Because linkage and cables contain moving parts that work in contact with other moving parts, the contact points can become worn and loose if proper lubrication is not maintained. These small parts are also susceptible to corrosion and breakage if they are not protected from moisture by light coatings of grease. Periodically apply a light coating of suitable water-resistant marine grease on each of these surfaces where either two moving parts meet or where a cable end enters a housing. For more details on grease points refer to the accompanying illustrations.

■ On most models, including the 60 degree 75-115 Hp **(1726cc)** V4 and 105 Jet-175 **Hp (2589cc)** V6 motors, as well as many of the large **90LV6/LV8** motors: the **lower** engine covers must be **removed** for access to some of the **cable/linkage** greasing points. For details, **please** refer to the Engine Covers **(Top** and Lower **Cases) procedure found** in the Engine **Maintenance section.**

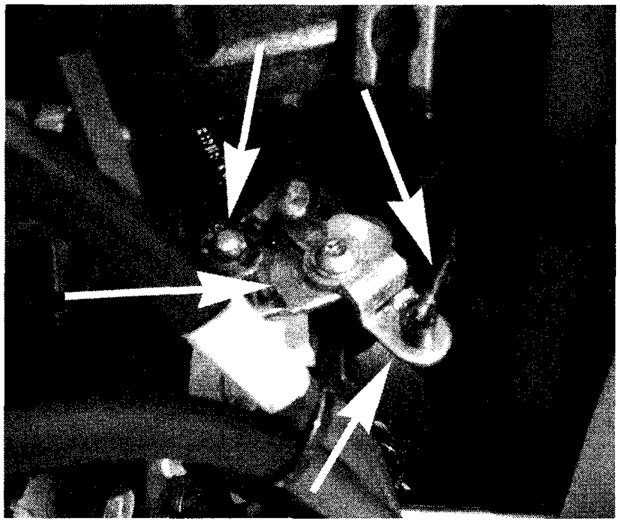


Fig. 18 All engines contain cable throttle and shift linkage...

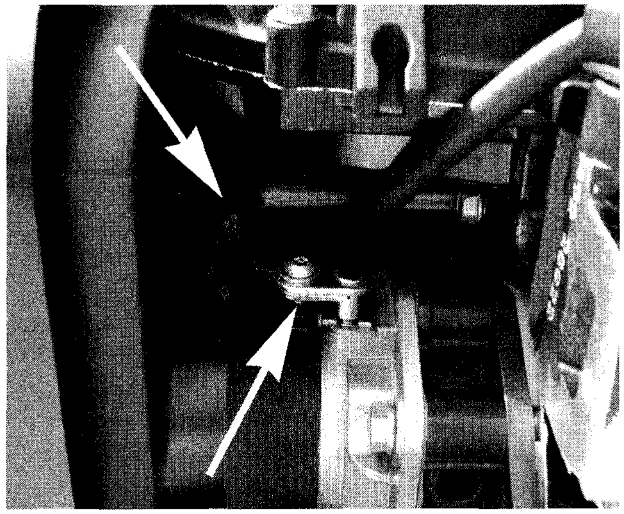


Fig. 19 ... whose metal-to-metal contact points should be periodically coated with grease

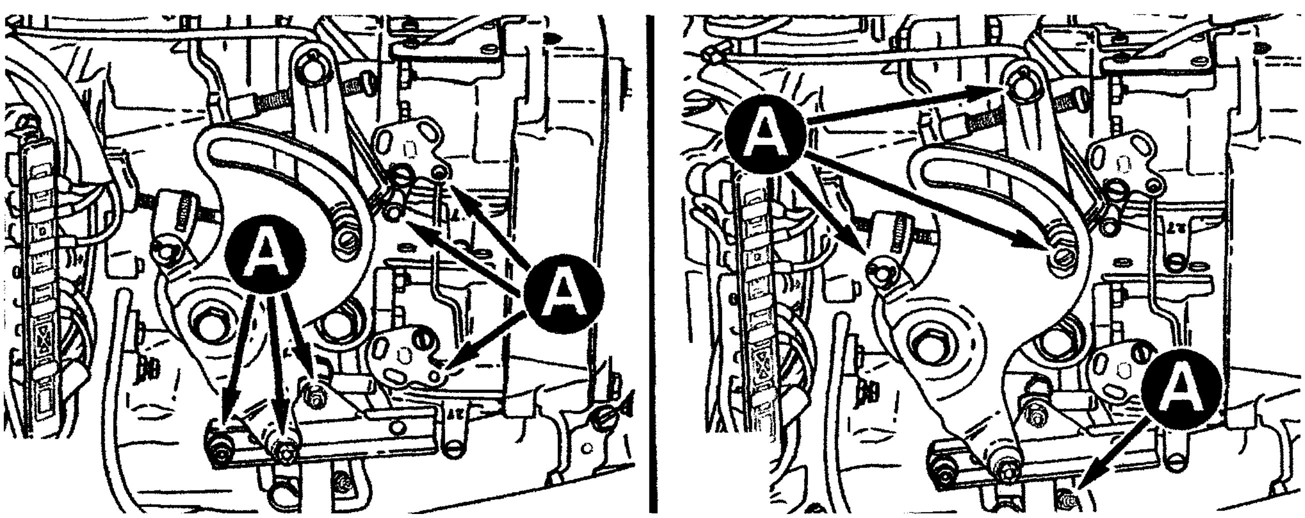


Fig. 20 Carburetor, throttle and shift linkage lubrication points-65 Jet-115 Hp **(1632cc)** V4 motors

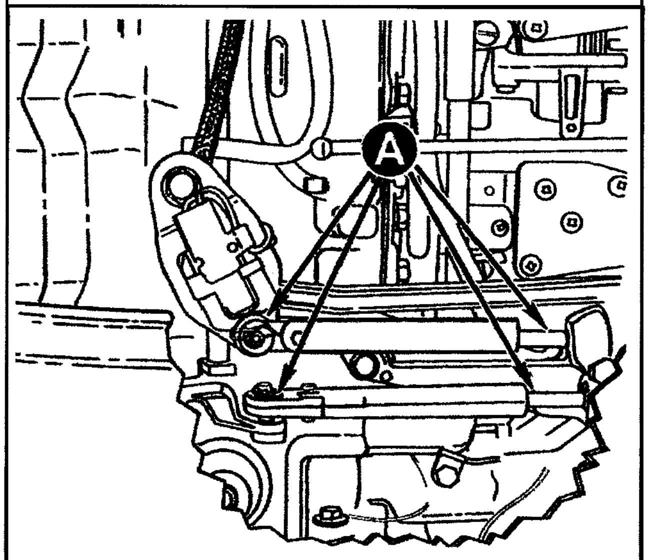


Fig. 21 Throttle and shift linkage lubrication points-75-115 Hp **(1726cc)** V4 and 105 Jet-175 Hp **(2589cc)** V6 motors (carbureted shown, FICHT very similar)

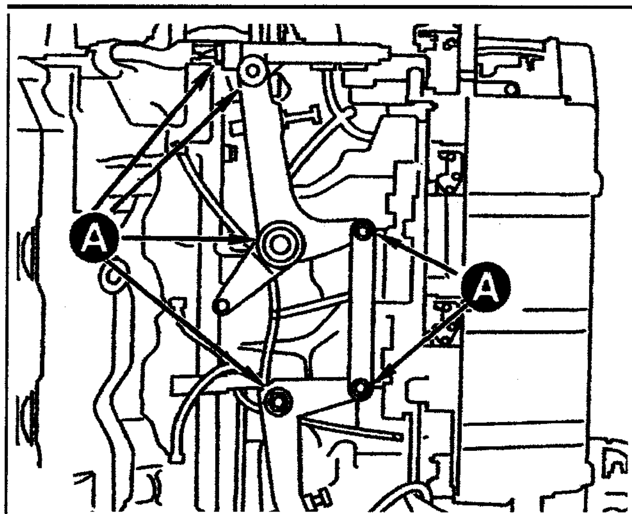


Fig. 22 Throttle and spark advance lubrication points-carbureted **120-300** Hp **(2000/3000/4000cc) V4/V6/V8** Motors

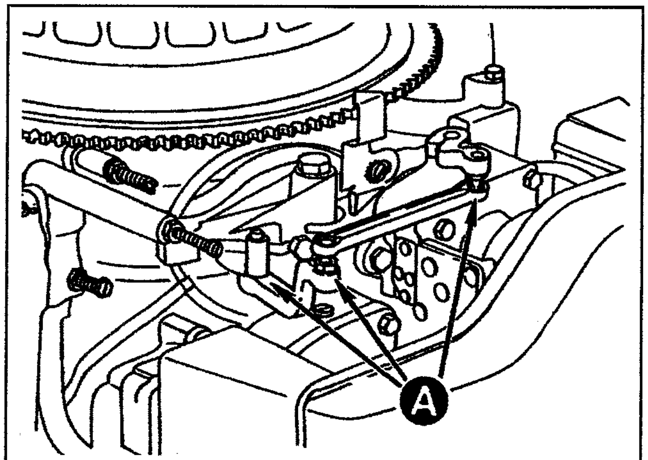


Fig. 23 Carburetor lubrication points-carbureted 120-300 Hp **(2000/3000/4000cc) V4/V6/V8** Motors

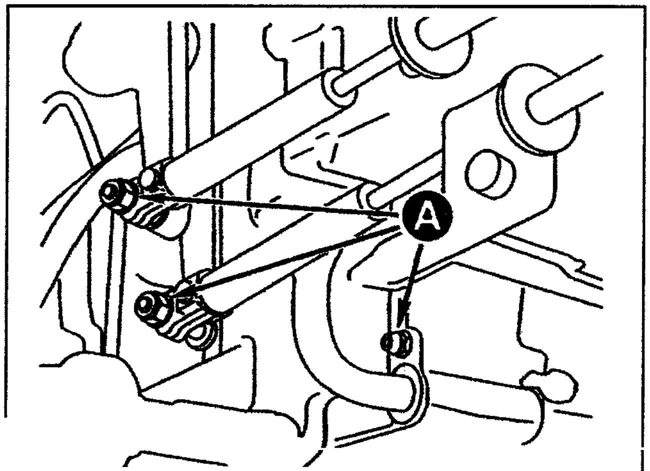


Fig. 24 Control and shift cable lubrication points- carbureted 120-300 Hp **(2000/3000/4000cc) V4/V6/V8** Motors

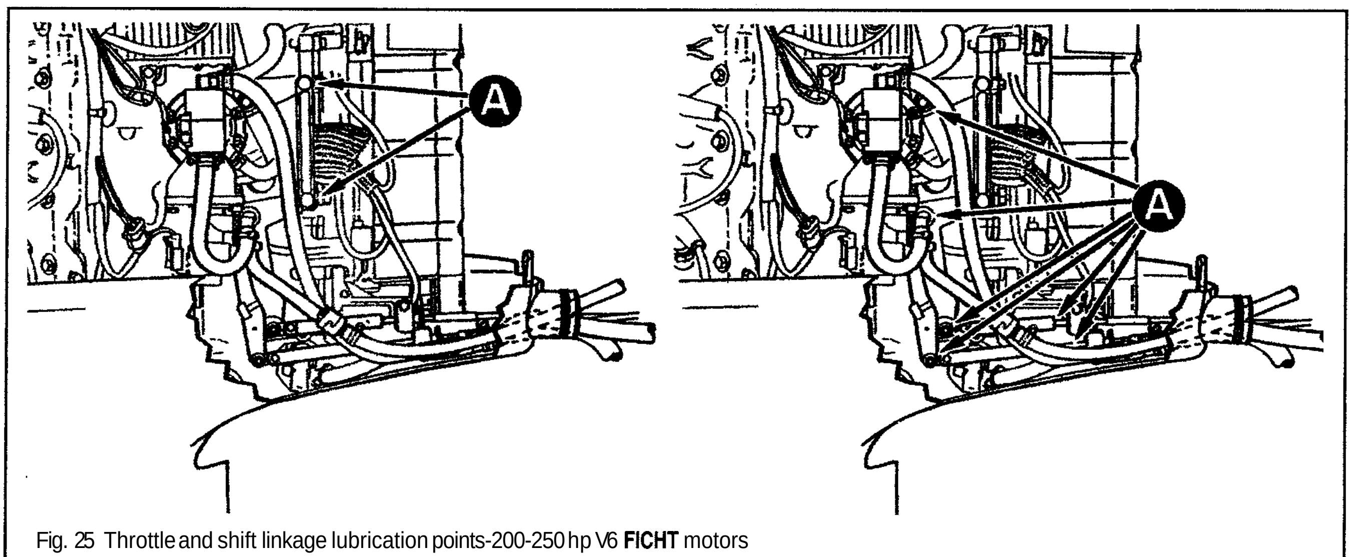


Fig. 25 Throttle and shift linkage lubrication points-200-250 hp V6 **FICHT** motors

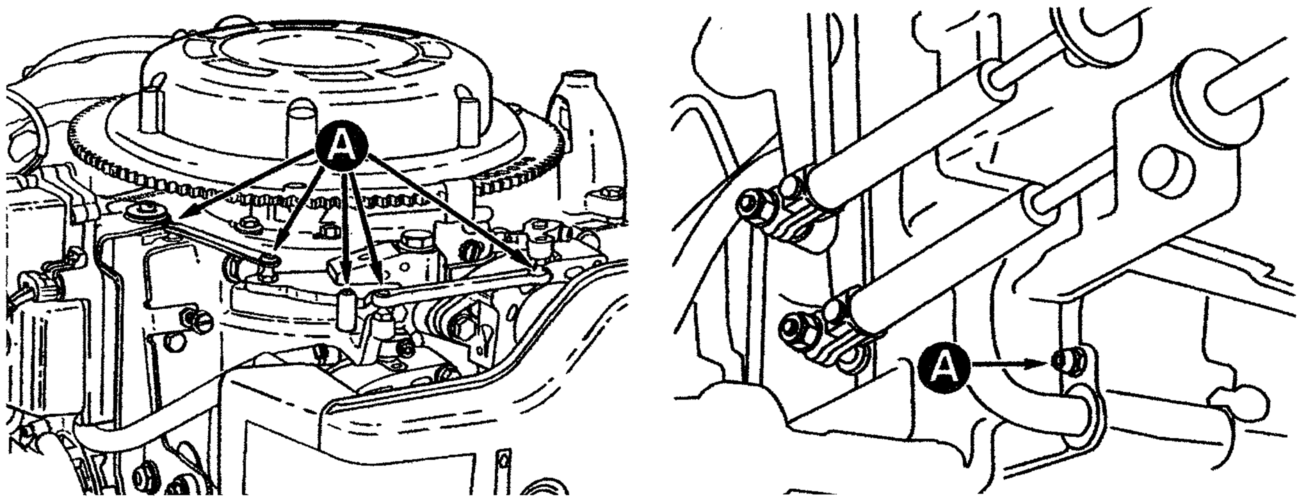


Fig. 26 Throttle and shift linkage lubrication **points-200-250** hp **V6 FICHT** motors

Steering Arm (Cable Ram/Tiller Arm)

◆ See Figures **27** and **28**

RECOMMENDED LUBRICANT

Use EvinrudelJohnson Triple-Guard, or equivalent water-resistant marine grease for lubrication.

LUBRICATION

◆ See Figures 27 and **28**

All motors covered within are equipped with a tiller control and/or a remote control assembly, On models equipped with a tiller, the arm's pivot point (where it attaches to the engine) should be lubricated periodically. On models with remote controls, the steering arm should be given a light coating of fresh lubricant to prevent corrosion or scoring.

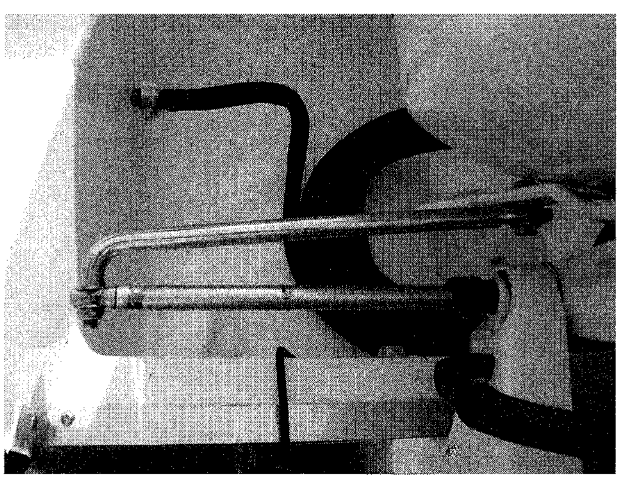


Fig. 27 On remote models, the steering arm (cable ram) must be greased periodically to prevent corrosion and ensure smooth operation

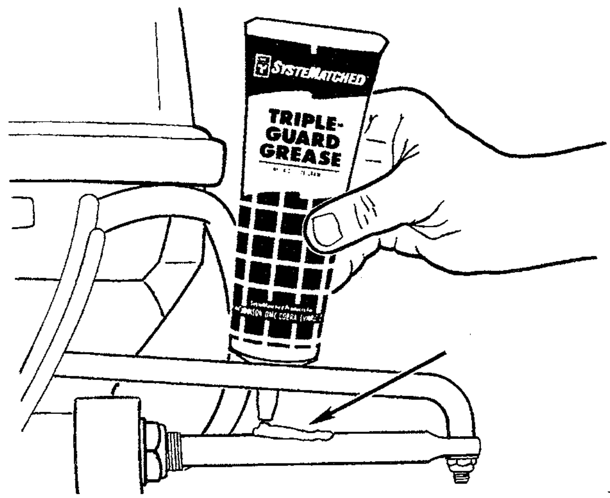


Fig. **28** Apply a light coating of water-resistance marine grease to the steering cable ram

Swivel Bracket and Tilt Support

+ See Figures **29** and 30

RECOMMENDED LUBRICANT

Use Evinrude/Johnson Triple-Guard, or equivalent water-resistant marine grease for lubrication.

LUBRICATION

◆ See Figures 29 and 30

All Evinrude/Johnson V-motors are equipped with a grease fitting on the lower portion of the swivel bracket. Use a grease gun to apply fresh water-resistant marine grease until a small amount of lubricant begins to seep from the swivel bracket. It is important to keep this system corrosion free in order to prevent corrosion that would lead to excessive resistance or even binding that might cause dangerous operational conditions.

■ The grease fitting for the swivel bracket is often located behind the tilt support (trailering) bracket. In these cases, the fitting is normally hidden when the bracket is stowed and accessible when the bracket is engaged to hold the motor in the full tilt position.

The pivot points of the integral support (trailering) bracket should also be lubricated periodically to ensure smooth operation and to prevent corrosion. Since they are normally not equipped with a grease fitting, pump a small amount of grease out of the grease gun and spread it by hand or using an old toothbrush.

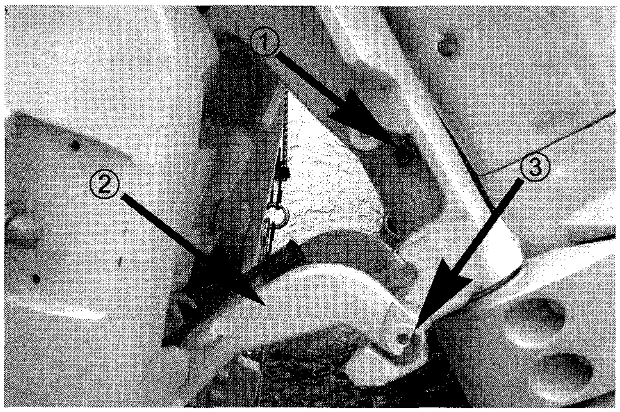


Fig. 29 The swivel bracket grease fitting (1), is usually hidden by the tilt bracket (2). Be sure to grease the pivot points of the tilt bracket (3)...

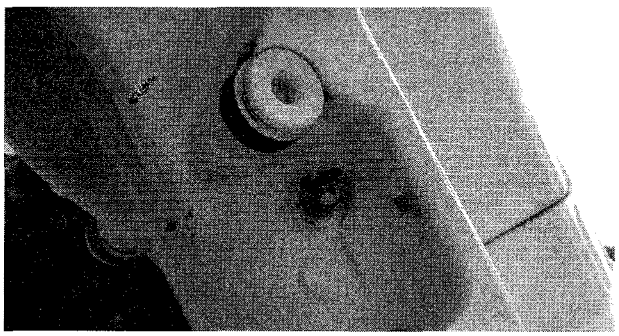


Fig. 30 ... then apply grease to the swivel bracket through the fitting

Tilt Tube Assembly

◆ See Figure 31

The tilt tube assembly must be greased periodically to prevent corrosion or binding, ensuring reliable and trouble-free operation.

RECOMMENDED LUBRICANT

Use Evinrude/Johnson Triple-Guard, or an equivalent water-resistant marine grease for lubrication.

LUBRICATION

◆ See Figure 31

Most Evinrude/Johnson motors have 2 grease fittings on the front of the tilt tube, facing the boat's transom. Apply a water-resistant marine grade grease to the fitting(s) until a small amount of grease seeps from the joints.

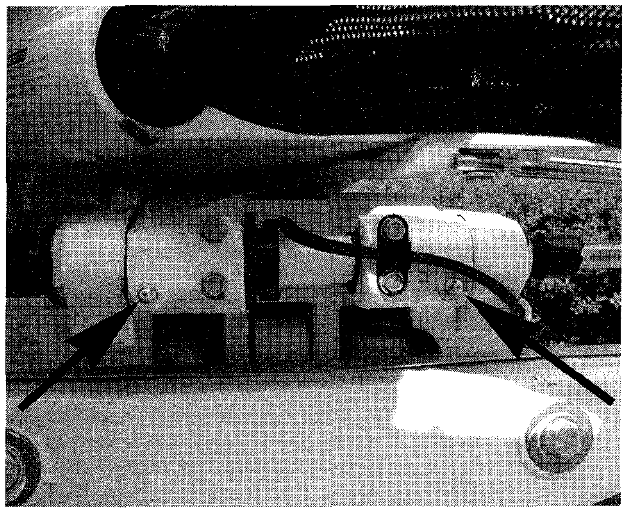


Fig. 31 Using a grease gun, lubricate both tilt tube assembly zerk fittings (normally there are 2 on the tilt tube, facing the transom)

ENGINE MAINTENANCE

Engine Covers (Top and Lower Cases)

REMOVAL & INSTALLATION

◆ See Figures **32, 33** and 34

Removal of the top cover is necessary for the most basic of maintenance and inspection procedures. The cover should come off before and after each use in order to perform these basic safety checks. The lower covers do not need to be removed nearly as often, but on models where they are easily removed, they should be removed at least seasonally for service and inspection procedures, especially linkage/cable lubrication procedures.

On most models, including the 60 degree **75-115** Hp **(1726cc)** V4 and 105 Jet-175 Hp **(2589cc) V6** motors, as well as many of the large **90LV6/LV8** motors, the lower engine covers must be removed for access to some of the cablellinkage greasing points.

On all models, the top cover is attached y s type of lever and latch assembly. I tools re necessary to ove the cove itself. The exact shape and design of the levers vary somewhat from model-to-model, though they are usually located on the engine cover at the front and the aft portions of the split line between the top cover and the lower cases.

For most models, the cover latches must be pulled outward slightly or otherwise removed from a bushing or snap fixture that holds them in the locked position when closed. Once the end of the lever is freed, it is rotated 45-900 from the locked position to a top cover released position. With all of the levers released, most top covers will simply lift straight off the outboard.

No matter what design is used, once installed be certain that the cover is fully seated and mounted tightly to the lower cases in order to prevent the possibility of it coming loose in service. Make sure that the levers are secured once they are returned to the locked position.

Cover screws on most EvinrudelJohnson V outboards are usually retained by various hex-head bolts, but some models may use Phillips, Slotted head, or even star-headed **Torx®** screws. Be sure to use onlv the **proper-sized** socket or driver on fastener heads.

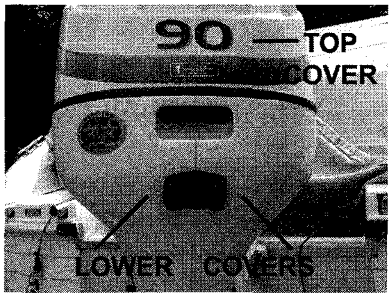


Fig. 32 Outboards are protected by a top and either 1 or 2 lower engine covers

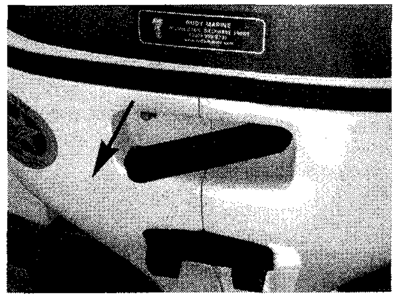


Fig. 33 Release top cover latches by pulling outward on one end...

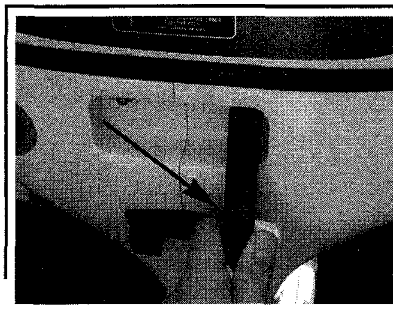


Fig. 34 ...then rotating the lever to release the latch

The lower covers of most motors are screwed or bolted together by fasteners found around the perimeter of one or both sides of the cover. However, the 65 Jet-115 Hp (1632cc) V4 motors are equipped with I-piece covers that are not designed for easy removal. On the other hand, this cover is a low-rise component that should not interfere with service procedures. For this reason, the cover is not usually removed except during a complete overhaul where the powerhead is removed from the lower unit.

In most cases, some of the engine wiring and the fuel or oil lines must be disconnected in order to remove the lower case(s) completely from the outboard. But, some models may be equipped with removable panels or covers that allow most lines and wiring to remain connected and intact. Some lower cover designs utilize cutouts at the cover split-lines through which cables are passed.

✳✳ WARN

It is especially important that you take note how each hose and wire is routed before disconnecting or moving them during service. Unless the person who worked on the motor previously made a mistake (which could cause damage and the need for repairs), all hoses and wires should already be routed in a manner that will prevent interference with and damage from moving components. Unless there are signs of damage from contact with components wires and hoses should be returned to the exact same positions as noted during disassembly. Don't be afraid to grab a digital camera and take pictures as your as disassembling. If you are unsure how a wire or hose was routed, work slowly, checking the positioning as the covers are installed to prevent damage.

75-175 Hp **(1726/2589cc) V4/V6** Motors

Carbureted Motors

◆ See Figures **32, 33, 34** and 35

1. Disconnect the negative battery cable for safety.
2. Release the top cover latches, then carefully lift the cover from the outboard. Make sure the top cover seal remains in the groove on the top cover.

■ Whenever the top cover is removed, be sure to perform a quick visual check of the seal and replace the seal if it is damaged or worn beyond use.

3. For 1995 and later models, loosen and remove the screw fastening the fuel and electric cover to the front side of the port side lower cover. Remove the fuel and electric cover, positioning it aside with the screw so neither are lost or separated.

■ Be sure to take note of the fuel and oil hose positioning before removing them from the bracket.

4. Remove the fuel and oil hoses from the connector, then remove the bolt securing the fuel and oil fitting bracket (retainer) to the lower engine cover. Remove the fitting bracket.
5. If necessary, disconnect the battery cables at the starter solenoid and starter flange.
6. If necessary for access, remove the rubber retainers and the air silencer.
7. Note the harness positioning, then disengage the power trim/tilt wiring connector.
8. Locate and remove the bolts from the perimeter of the starboard lower cover.

There are usually 4 bolts securing the lower cover halves, but, check the covers carefully before attempting to separate them. If the covers seem unwilling to separate, make sure that there are no additional fasteners either around the perimeter or inside the cover.

9. Carefully pull the starboard cover free of the outboard.
10. Note the wire positioning/routing, then tag and disconnect the 3 bullet connectors for the trim/tilt switch and remove the port cover.

□ The lower covers contain various flange seals. Make sure all seals are in good condition or replace them before reinstallation.

11. Installation is essentially the reverse of the removal. During installation, be sure to reconnect all wiring, fuel and oil connectors. Make sure all hoses and wiring are positioned as noted during removal to prevent any pinching or damage by the covers themselves or by other moving parts once the motor is returned to service. Always tighten the retaining bolts securely, but be careful not to overtighten and crack the delicate covers.

FICHT Motors

◆ See Figures 32 thru 40

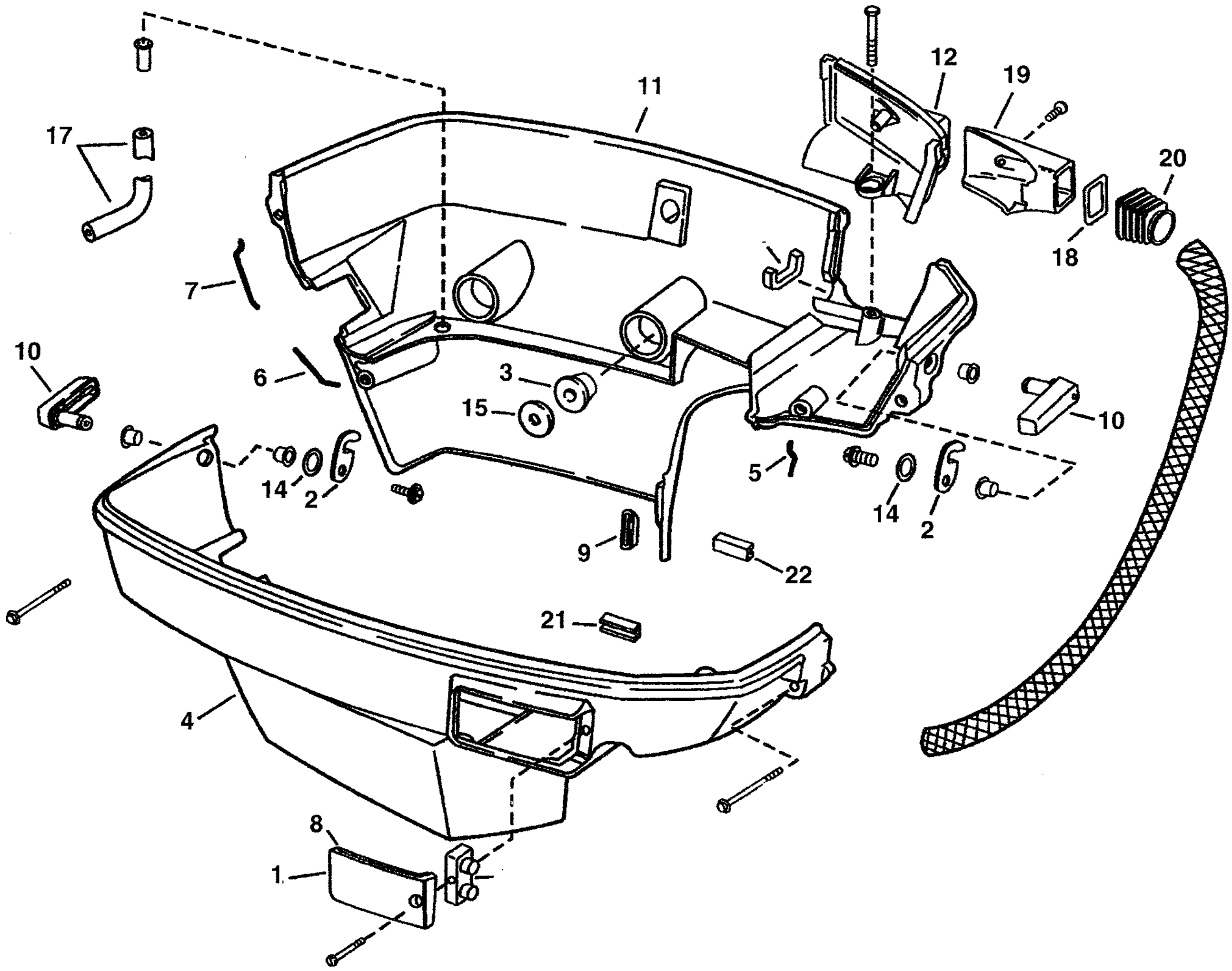
1. Disconnect the negative battery cable for safety.
2. Release the top cover latches, then carefully lift the cover from the outboard. Make sure the top cover seal remains in the groove on the top cover.

■ Whenever the top cover is removed, be sure to perform a quick visual check of the seal and replace the seal if it is damaged or worn beyond use.

3. Loosen and remove the 3 screws fastening the cable entry cover to the front corner of the starboard side lower cover. Remove the cover for access to the fuel and oil hoses.

Be sure to take note of the fuel and oil hose positioning before removing them from the bracket.

4. Remove the fuel and oil hoses from the rubber grommet.
5. Note the harness positioning, then disengage the power trim/tilt wiring connector.



1 Anchor block cover
2 Front and rear hook
3 Lower cover mount
4 Starboard engine cover
5 Engine cover front seal
6 Engine cover rear lower seal
7 Engine cover rear upper seal
8 Anchor block seal
9 Bumper
10 Latch handle
11 Port engine cover
12 Fuel and electric retainer
13 Electric wires **seal**
14 Latch handle spring washer
15 Mount washer
16 Control cables grommet
17 Drain hose
18 Grommet retainer
19 Fuel and electric cover
20 Fuel and electric grommet
21 Starboard seal
22 Port seal

Fig. 35 Exploded view of the lower engine covers and related components-carbureted75-175 Hp **(1726/2589cc)** V4/V6 Motors (1995 and later shown, earlier models similar)

☐ The cover bolts are usually of different lengths, keep the bolts sorted as they are removed in order to prevent difficulty during installation. Also, you'll want smaller, thin walled sockets for access to most of the **bolts. The** 2 bolts found inside the cover can be turned using a wrench or a **U-joint** and wobble adapter on a normal 318 or 114 in, drive ratchet.

6. Locate and remove the bolts from the perimeter of the starboard lower cover and the 2 bolts located inside of the cover flange, one at either top cover latch assembly.

There are usually 6 bolts securing the lower cover halves (4 threaded from the perimeter of the port side cover to the starboard side, and 2 threaded inside the covers, at the latch assemblies), but, check the covers carefully before attempting to separate them. If the covers seem unwilling to separate, make sure that there are no additional fasteners either around the perimeter or inside the cover.

7. Carefully pull the port and starboard covers free of the outboard. Even with the bolts removed, the covers will remain in position by the interference fit of 2 rubber mounts. Slowly pull the covers straight outward to the sides of the motor (while using a hand or foot to keep the motor from turning) in order to free the covers from these mounts.

☐ The lower covers contain various flange seals. Make sure all seals are in good condition or replace them before reinstallation. Also, the starboard cover must be removed slowly, tilting the aft portion of the cover further away from the motor, in order to snake the cutout around the **fuel/oil** hoses. Work slowly and carefully, never forcing anything.

8, Installation is essentially the reverse of the removal. During installation, be sure to reconnect all wiring, fuel and oil connectors. Make sure all hoses and wiring are positioned as noted during removal to prevent any pinching or damage by the covers themselves or by other moving parts once the motor is returned to service. Always tighten the retaining bolts securely, but be careful not to overtighten and crack the delicate covers.

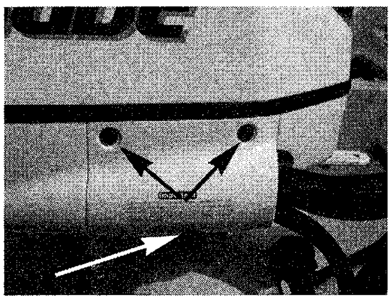


Fig. 36 There are 3 screws holding the cable entry cover to the motor**...**

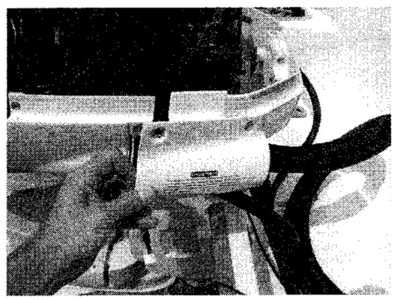


Fig. 36a **...** loosen the screws and remove it to free the **oil/fuel** hoses

Fig. 36b Note the position of the hoses in the grommet

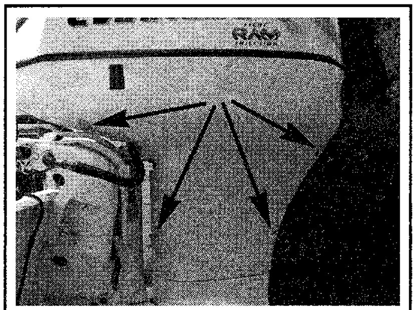


Fig. 37 Once the trimltilt wiring is disconnected, remove the cover bolts**...**

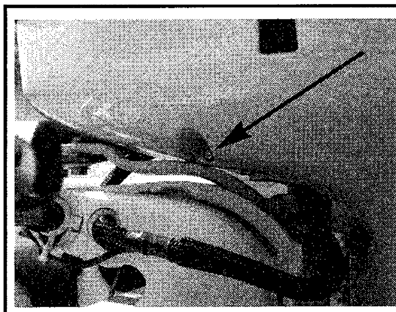


Fig. 38 Don't forget the one tucked under the front of the motor**...**

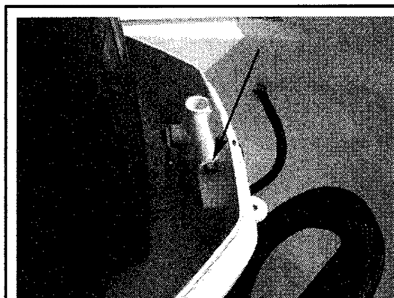


Fig. 39 ...or the bolt found at the front and aft cover latches

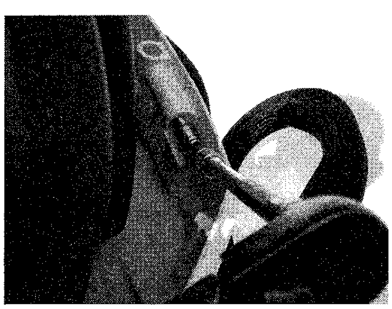


Fig. 39a The inner bolts can be loosened with a **U-joint** and wobble

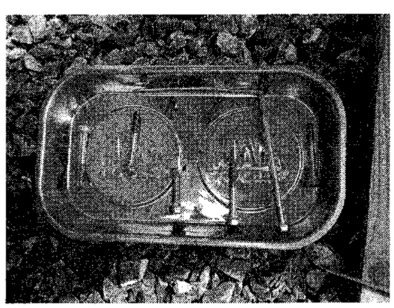


Fig. 39b The cover bolts are different lengths, keep them sorted by position

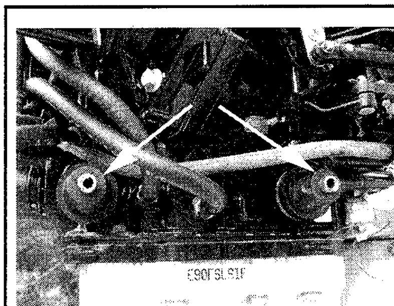
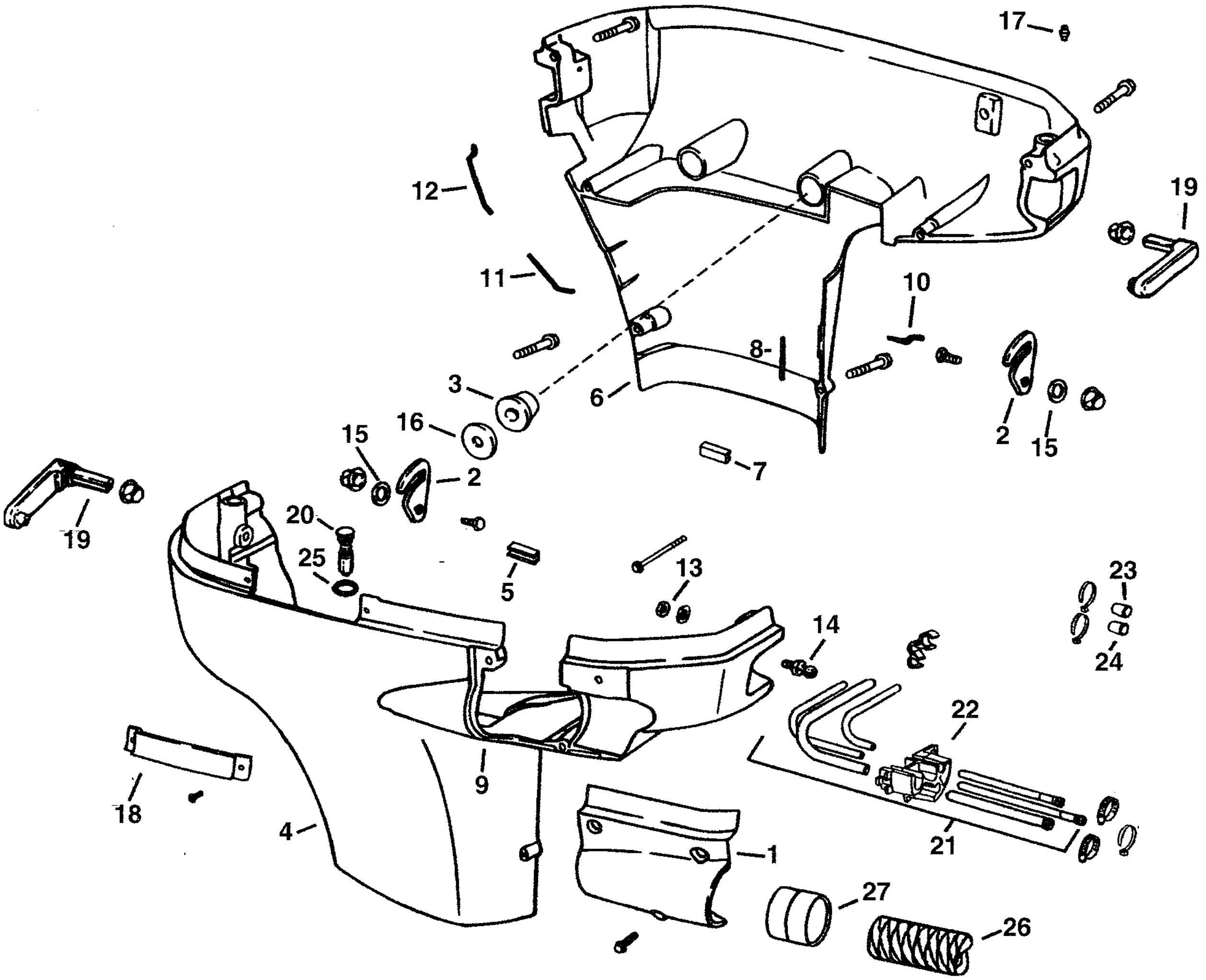


Fig. **39c** The covers are mounted over rubber grommets



1 Cable entry cover
2 Front and rear hook
3 Lower cover mount
4 Starboard engine cover
5 Starboard seal
6 Port engine cover
7 Port seal
8 Engine cover front lower seal
9 Engine cover cable entry seal
10 Engine cover front upper seal
11 Engine cover rear lower seal
12 Engine cover rear upper seal
13 Ball joint screw nut
14 Ball joint screw
15 Latch handle spring washer
16 Mount washer
17 Lubrication fitting
18 Access panel
19 Latch handle
20 Drain check valve assembly
21 Fuel and oil tube assembly
22 Retainer
23 Oil supply and return hoses cap
24 Fuel hose cap
25 O-ring
26 Fuel and electrical sleeve
27 Cable entry grommet

Fig. 40 Exploded view of the lower engine covers and related components-FICHT 75-175 Hp **(1726/2589cc) V4/V6** Motors

120-300 Hp **(2000/3000/3300/4000cc) V4/V6/V8** Motors

◆ See Figures **41, 42, 43** and ***44***

1. Disconnect the negative battery cable for safety.
2. Release the top cover latches, then carefully lift the cover from the outboard. Make sure the top cover seal remains in the groove on the top cover.

☐ Whenever the top cover is removed, be sure to perform a quick **visual** check of the seal and replace the seal if it is damaged or worn beyond use.

3. On 1992-98 carbureted modepower steering hoses at the front, starboard side of the lower cover. You'll need to loosen the screw that is threaded downward through the lower cover while holding the locknut from underneath. Remove the screw, flat washer and locknut.
4. On carbureted models, be sure that a spring clip is installed on the port and starboard lower pan supports.
5. If necessary, remove the cooling indicator hose and grommet.
6. Locate and remove the bolts from the perimeter of the lower cover. On V6 models, the bolts are normally threaded from the starboard side of the motor, on V4 and V6 motors however, the opposite is normally true. The number of bolts used varies slightly by model, so work slowly and make sure you've got them all out before trying to separate the covers.

■ There are USUALLY at least 4 bolts securing the lower cover halves on ***V4*** and V8 models and at least 6 bolts securing the cover halves on ***V6*** models, but, check the covers carefully before attempting to separate them. If the covers seem unwilling to separate, make sure that there are no additional fasteners either around the **perimeter** or inside the cover.

Fig. 41 The lower cover screws are normally found on the starboard side of ***V6*** engines, or the port side of ***V4*** and ***V8*** motors

7. Remove one spring clip and one lower engine cover at a time.

■ The lower covers contain various flange seals. Make sure all seals are in good condition or replace them before reinstallation.

8. Installation is essentially the reverse of the removal. During installation, make sure all hoses and wiring are positioned as noted during removal to prevent any pinching or damage by the covers themselves or by other moving parts once the motor is returned to service. Always tighten the retaining bolts securely, but be careful not to overtighten and crack the delicate covers.

Cooling System

OEM

FLUSHING THE COOLING SYSTEM

① EASY

◆ See Figures **45, 46, 47, 48, 49, 50, 51** and ***52***

The most important service that you can perform on your motor's cooling system is to flush it periodically using fresh, clean water. This should be done immediately following any use in salt, brackish or polluted waters in order to prevent mineral deposits or corrosion from clogging cooling passages. Even if you do not always boat in salt or polluted waters, get used to the flushing procedure and perform it often (ideally, immediately following every outing) to ensure no silt or debris clogs your cooling system over time.

■ Flush the cooling system after any use in which the motor was operated through suspendedlchurned-upsilt, debris or sand.

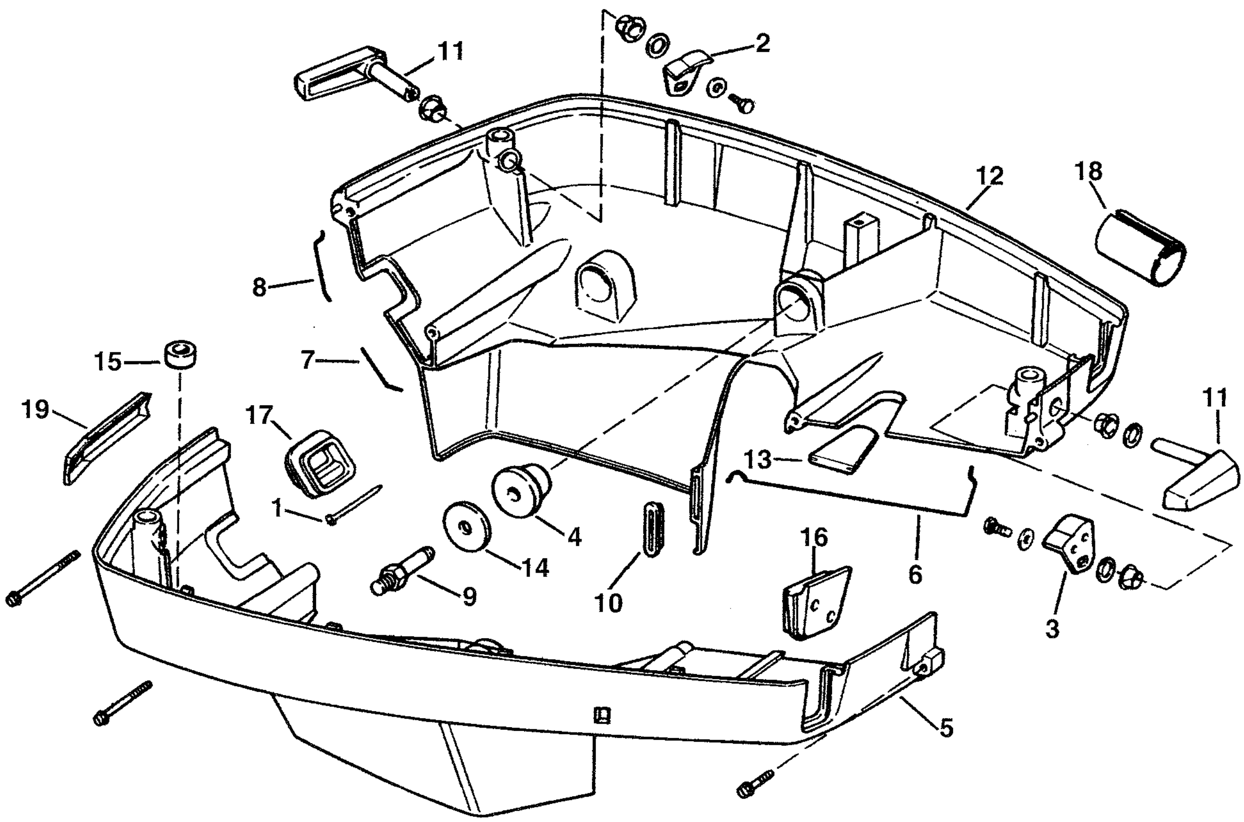
Although the flushing procedure should take place right away (dockside or on the trailer), be sure to protect the motor from damage due to possible thermal shock. If the engine has just been run under high load or at continued high speeds, allow time for it to cool to the point where the powerhead can be touched. Do not pump very cold water through a very hot engine, or you are just asking for trouble. If you trailer your boat short distances, the flushing procedure can probably wait until you arrive home or wherever the boat is stored, but ideally it should occur within an hour of use in salt water. Remember that the corrosion process begins as soon as the motor is removed from the water and exposed to air.

The flushing procedure is not used only for cooling system maintenance, but it is also a tool with which a technician can provide a source of cooling water to protect the engine (and water pump impeller) from damage anytime the motor needs to be run out of the water. Never start or run the engine out of the water, even for a few seconds, for any reason. Water pump impeller damage can occur instantly and damage to the engine from overheating can follow shortly thereafter. If the engine must be run out of the water for tuning or testing, always connect an appropriate flushing device before the engine is started and leave it turned on until after the engine is shut off.

✳✳ WARNING

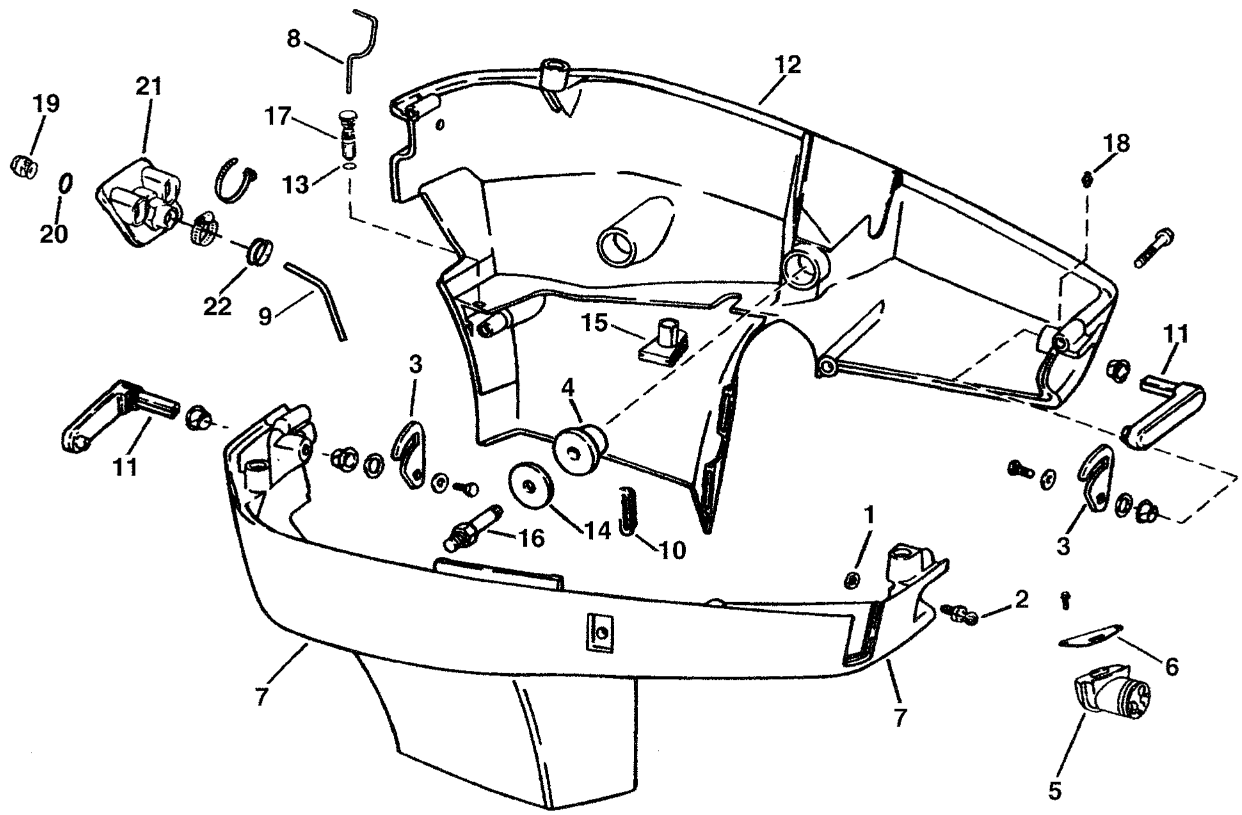
ANYTIME the engine is run, the first thing you should do is check the cooling stream or water indicator. All models covered by this manual are equipped with some form of a cooling stream indicator towards the aft portion of the lower engine cover. Anytime the engine is operating, a steady stream of water should come from the indicator, showing that the pump is supplying water to the engine for cooling. If the stream is ever absent, stop the motor and determine the cause before restarting.

As we stated earlier, flushing the cooling system consists of supplying fresh, clean water to the system in order to clean deposits from the internal passages. If the engine is running, the water does not normally have to be pressurized, as it is delivered through the normal water intake passages and the water pump (the system can self flush if supplied with clean water). If your engine can be placed in a test tank that is filled with fresh, clean water, then in theory, simply running it will self-flush the motor.



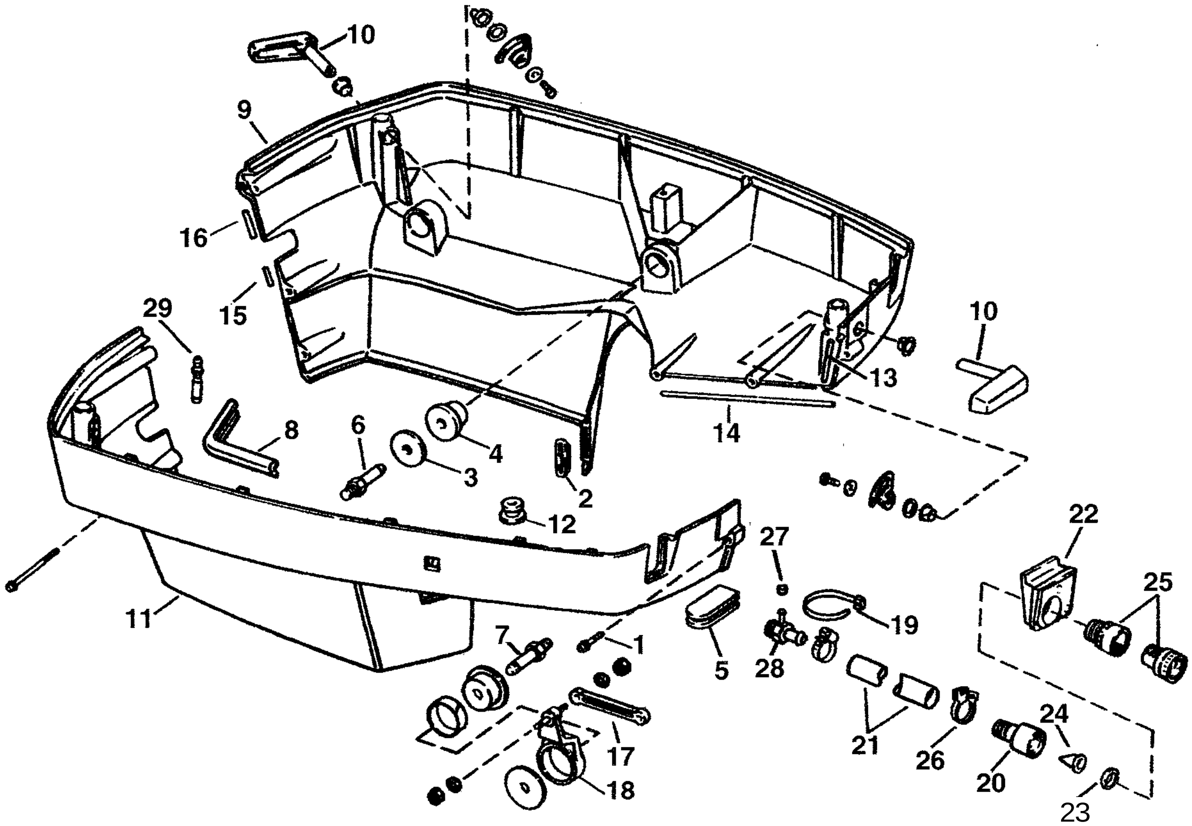
1 Tie strap
2 Port rear hook
3 Front and rear starboard hook
4 Lower cover mount
5 **Starboard** engine cover and seal assy.
6 Starboard front engine cover seal
7 Engine cover rear lower seal
8 Rear upper seal
9 Lower cover stud
10 Lower cover bumper
11 Latch handle
12 Port engine cover
13 Grommet
14 Mount washer
15 Drain indicator grommet
16 Control cables grommet
17 Adapter to cover grommet
18 Battery cable sleeve
19 Applique

Fig. 42 Exploded view of the lower engine covers and related components-120-140 Hp **(2000cc)** V4 motors



1 Ball joint nut	12 Port lower cover
2 Ball joint screw	13 Check valve o-ring
3 Front and rear hook	14 Mount washer
4 Lower cover mount	15 Power trim leads grommet
5 Control cables and fuel hoses grommet	16 Lower cover stud
6 Grommet to cover bracket	17 Check valve assy.
7 Starboard lower cover and seal assy.	18 Fitting
8 Upper seal	19 Overboard indicator plug
9 Lower seal	20 Overboard indicator o-ring
10 Lower cover bumper	21 Grommet assy.
11 Latch handle	22 Clamp liner

Fig. 43 Exploded view of the lower engine covers and related components-carbureted 185-250 Hp **(3000cc) V6** motors (FICHT **3000/3300cc V6** motors, very similar)



1 Engine cover screw
2 Lower cover bumper
3 Mount washer
4 Engine cover mount grommet
5 Steering hoses grommet
5 Engine cover plug **w/o** power steering
6 Mount stud
7 Starboard lower front mount pin
8 Cover seal
9 Port cover assy.
10 Latch handle assy.
11 Starboard engine cover
12 End cover plug **w/o** power steering
13 Engine cover front upper seal
14 Front seal
15 Rear lower seal
16 Top rear seal
17 Transfer lever link
18 Tranfer lever and pin
19 Tie strap
20 Flush nipple
21 Flush hose
22 Cables grommet
23 Check valve retainer
24 Check valve
25 Quick-knec coupler
26 Hose nipple snap clamp
27 Fitting cap
28 Adapter fitting
29 Nipple and valve assy.

Fig. 44 Exploded view of the lower engine covers and related components-2501300Hp **(4000cc)** V8 motors

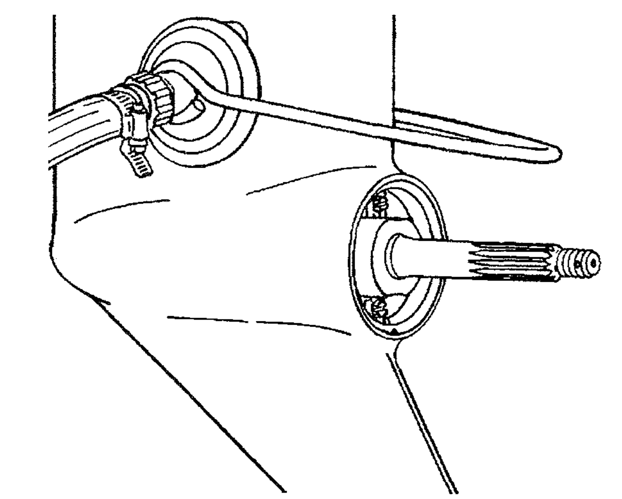


Fig. 45 The easiest way to flush some models is using a clamp-type adapter...

But, V-motors are designed for such high horsepower applications that their great size usually makes this extremely impractical. For this reason, you'll have to come up with another flushing method (i.e. using a garden hose and, in some cases, an adapter, to deliver the fresh water).

All Evinrude/Johnson engines will either accept flush fittings or adapters (though some don't even require an adapter, as the water indicator threads match that of a standard garden hose allowing you to directly attach the hose once the indicator is removed). Most marina's or boat supply shops will carry adapters are of the generic type that are designed to fit over the engine water intakes on the lower unit (and resemble a pair of strange earmuffs with a hose fitting on one side). But, some models (such as jet drives) require special adapters (available from the manufacturer) that thread into special flushing fittings on the powerhead (or drive unit). When using the later type adapter, follow the manufacturer's instructions closely regarding flushing conditions. In some cases, flushing with this type of adapter should occur only with the motor turned off, so as to prevent damage to the water pump impeller or other engine components. This varies with each motor, so be sure to check with your dealer regarding these direct to the powerhead adapters when you purchase one.

Most jet drive models are equipped with a flushing port mounted **under a flat head screw directly above the jet drive bearing grease fitting. Use Evinrude/Johnson adapter** no. **435299** or **equivalent to** attack a garden hose to this port.

When running the engine on a flushing adapter and a garden hose, make sure the hose delivers about 20-40 psi (140-300 **kPa)** of pressure.

✳✳ CAUTION

For safety, the propeller should be removed ANYTIME the motor is run on the trailer or on an engine stand. We realize that this is not always practical when flushing the engine on the trailer, but cannot emphasize enough how much caution must be exercised to prevent injury to you or someone else. Either take the time to remove the propeller or take the time to make sure no one or nothing comes close enough to it to become injured. Serious personal injury or death could result from contact with the **spinning propeller.**

When using a flushing device and a pressurized water source, most motors can be flushed in either a tilted or a vertical position, BUT, the manufacturer specifically warns against flushing most motors in the tilted position with the engine running. Some models can be seriously damaged by attempting to flush them with the engine running in the full tilt position. If the motor must be flushed tilted (dockside) then your best bet it to do so with the engine shut off.

1. Check the engine top case and, if necessary remove it to check the powerhead, to ensure it is cooled enough to flush without causing thermal shock.
2. Prepare the engine for flushing depending on the method you are using as follows:
3. On models that directly accept a garden hose, use a socket to loosen and remove the cooling stream indicator from the rear center of the outboard, then CAREFULLY thread a garden hose into the plastic fitting.

LEARN FROM OUR **MISTAKES. The** truth of the matter is that it is VERY easy to damage the plastic threads for the water pump indicator when threading a metal garden hose into the fitting. Make sure that the hose is completely perpendicular to the indicator fitting threads and NEVER try to force it. If it looks like it is going in at an angle, it probably is, so back it out and start over. We found that it is MUCH easier to obtain a very short length of garden hose (about six inches) with a male fitting on one end and a female fitting on the **other. The** short length of hose can be easily threaded into the fitting on the outboard (without having to fight the length of garden hose while you're doing it). Once attached, the garden hose easily threads to the back of the short hose.

a. If using a flushing adapter of either the generic clamp-type or specific port-type for your model attach the adapter following the instructions that came with the adapter. Then, attach the garden hose to the adapter.

When using a clamp-type adapter, position the suction **cup(s)** over water intake **grate(s)** in such a way that they form tight seals. A little pressure seepage should not be a problem, but look to the water stream indicator once the motor is running to be sure that sufficient water is reaching the powerhead.

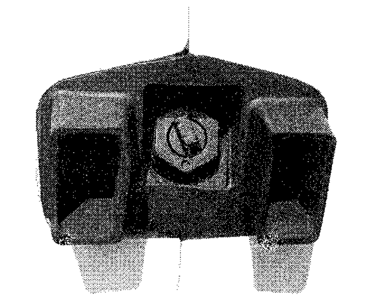


Fig. 46 ...but other models are equipped with a threaded water pump indicator...

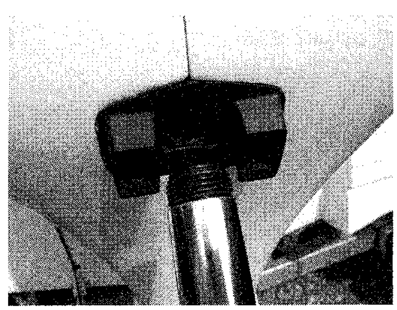


Fig. 47 ...with the indicator removed, the fitting accepts a garden hose

Fig. 48 We recommend using a short length of hose as an adapter...

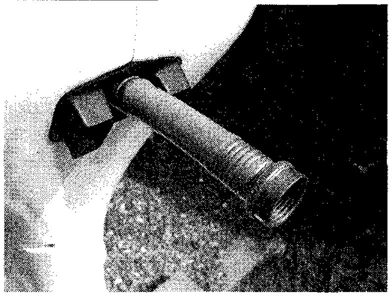


Fig. 49 ...to make threading the hose MUCH easier

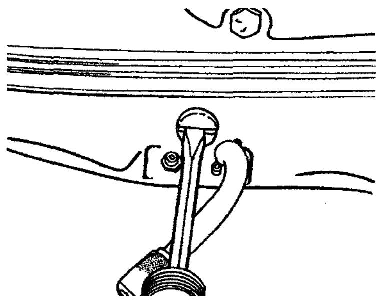


Fig. 50 On some models (such as this jet drive) remove the flushing port fitting...

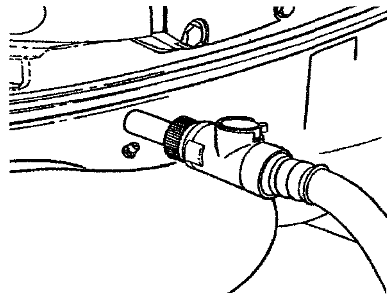


Fig. 51 ...then attach the flushing adapter to the port

4. If the motor is to be run (during flushing or for testing), position the outboard vertically and remove the propeller, for safety. Also, be sure to position the water hose so it will not contact with moving parts (tie the hose out of the way with mechanic's wire or wire ties, as necessary).

5. Unless using a test tank, turn the water on, making sure that pressure does not exceed 45 psi (300 kPa).

6. If the motor must be run for testingltuning procedures, start the engine and run in neutral until the motor reaches operating temperature. For most motors, the motor will continue to run at fast idle until warmed, on fuel injected motors, speed will be automatically regulated by the FICHT system.

✳✳ WARNING

Unless you are flushing a motor through the water indicator fitting, always check the cooling system indicator stream as SOON as the engine is started. It must be present and strong as long as the motor is operated. If not, stop the motor and rectify the problem before proceeding. Common problems could include insufficient water pressure or incorrect flush adapter installation. When you are flushing a motor through the cooling indicator fitting, water should exit through the other **passages** at the bottom of the drive unit.

7. Flush the motor for at least 5-10 minutes or until the water exiting the engine is clear. When flushing while running the motor, check the engine temperature (using a gauge or carefully by touch) and stop the engine immediately if steam or overheating starts to occur. Make sure that carbureted motors slow to low idle for the last few minutes of the flushing procedure.

8. Stop the engine (if running), then shut the water off.

9. Remove the adapter from the engine or the engine from the test tank, as applicable.

10. If flushing did not occur with the motor running (so the motor would already by vertical), be sure to place it in the full vertical position allowing the cooling system to drain. This is especially important if the engine is going to be placed into storage and could be exposed to freezing temperatures. Water left in the motor could freeze and crack the powerhead or lower unit.

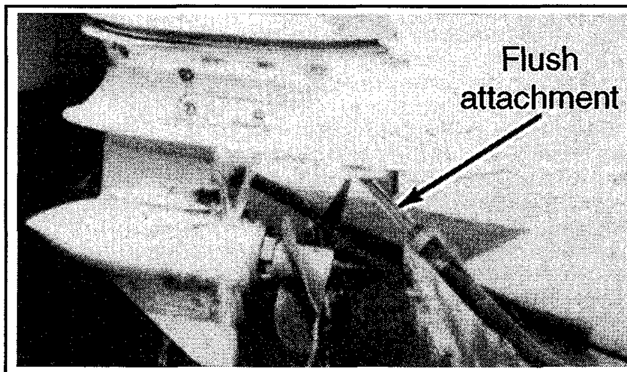


Fig. 52 A water source must be used ANYTIME the engine is started

2-Stroke Engine Oil

OIL RECOMMENDATIONS

◆ See Figure 53

☐ EvinrudelJohnson recommends the use of Carbon Guard fuel additive to help prevent the build-up of harmful carbon deposits in the combustion **chambers. The** manufacturer also recommends decarboning the pistons, twice as often, if Carbon Guard is NOT used.

Use only an NMMA (National Marine Manufacturers Association) certified TC-W3 or equivalent 2-stroke lubricant. Of course, the manufacturer recommends using EvinrudelJohnson brand oils, since they are specially formulated to match the needs of EvinrudelJohnson motors. In all cases, a high quality TC-W3 oils are proprietary lubricants designed to ensure optimal engine performance and to minimize combustion chamber deposits, to avoid detonation and prolong spark plug life. Use only 2-stroke type outboard oil. Never use automotive motor oil.

On FICHT motors, the manufacturer recommends using EvinrudelJohnson brand FICHT RAM Injection Oil with CarbX® combustion chamber cleaner. When FICHT RAM Injection Oil is used exclusively, the use of EvinrudelJohnson Carbon Guard should be unnecessary.

☐ Remember, it is this oil, mixed with the gasoline that lubricates the internal parts of the 2-stroke engine. Lack of lubrication due to the wrong mix or improper type of oil can cause catastrophic powerhead failure.

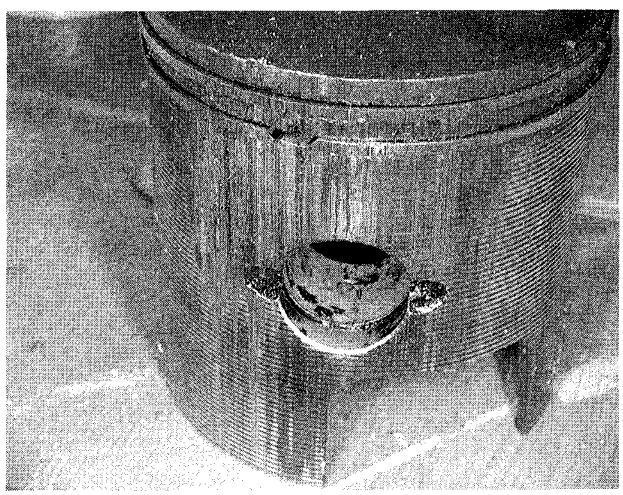


Fig. 53 This scuffed piston is an example of the damage caused by improper 2-stroke oil or mixture

FILLING

There are two methods of adding 2-stroke oil to an outboard. The first is the pre-mix method and is mostly used on low horsepower models and on some commercial outboards. The second, used on most Evinrude/Johnson V motors, is the use of automatic oil injection (a method that automatically injects the correct quantity of oil into the engine based on throttle position and operating conditions). The most common forms of oil injection are the Variable Ratio Oil Injection 2 (VRO2) system for carbureted motors and the FICHT Fuel Injection (FFI) system. In all cases, the fuel ratio should be considered. This is even true on carbureted motors with automatic oiling systems, if the engine is going to be used under certain severe or high performance conditions.

■ The FICHT system automatically adjusts **fuel/oil** ratios for all engine operating conditions. No additional oiling is required.

Fuel:Oil Ratio

The proper fuel:oil ratio will depend upon engine operating conditions. Many of these Evinrude/Johnson engines are be equipped with an automatic oiling system (such as the VR02 or FICHT) that is designed to maintain a 50:1 ratio without adding anything to the fuel tank. But, whether or not an oiling system is used, the proper fuel:oil ratio is 50:1 for normal operating conditions. Most manufacturers define normal as a motor operated under varying conditions from idle to wide open throttle, without excessive amounts of use at either. Unfortunately, no one seems to put a definition to "excessive amount" either, so you'll have to use common sense. We don't think an hour of low speed trolling mixed in with some high speed operation or an hour or two of pulling a skier constitutes "excessive amounts," but you'll have to make your own decision. Also necessary for defining normal operating conditions is the ambient and seawater temperatures. The seawater temperatures should be above 32°F (0°C) and below 68° F (20° C). Ambient air conditions should be above freezing and below the point of extreme discomfort (90-100°F).

□ The fuel/oil ratios listed here are Evinrude/Johnson recommendations given in service literature. Because your engine may differ slightly from service manual specification, refer to your owner's manual or a reputable dealer to be certain that your mixture meets your conditions of use.

If a carbureted outboard is to be used under severe conditions including, long periods of idle, long periods of heavy load, use in severe ambient temperatures (outside the range of normal use) or under high performance (constant wide-open throttle or racing conditions) some adjustment may be necessary to the fuel:oil ratio. Most carbureted outboards require a 25:1 ratio for severe and high performance conditions. But, since of these models are equipped with VR02 this fuel:oil ratio is usually achieved by adding pre-mix to the fuel tank (a mixture of 50:1 in the tank combined with the oil system output will total the correct 25:1 ratio).

□ No additional oiling is necessary for these engines when used in commercial, rental or extended severe service other than high performance applications.

All motors covered by this manual require a 25:1 ratio during some portion of break-in (the first 20 hours of operation). FICHT motors compensate for break-in automatically, by injecting additional oil during certain break-in engine operating conditions. Engines equipped with the VR02 system should run a tank of 50:1 ratio pre-mix IN ADDITION to the VR02 output in order to achieve the 25:1 ratio during break-in.

If equipped with the VR02 oiling system, make sure the system is operating properly (by verifying that the level in the tank dropped during that 20 hours of use) before using untreated gasoline in the fuel tank.

Pre-Mix

◆ See Figure **54**

Mixing the engine lubricant with gasoline before pouring it into the tank is by far the simplest method of lubrication for 2-stroke outboards. However, this method is the messiest and potentially causes the most amount of harm to our environment.

The most important part of filling a pre-mix system is to determine the proper fuel/oil ratio. Most operating conditions require a 50:1 ratio (that is 50 parts of fuel to 1 part of oil). Consult the information in this section on Fuel:Oil Ratio and your owner's manual to determine what the appropriate ratio should be for your engine.

The procedure itself is uncomplicated, but you've got a couple options depending on how the fuel tank is set-up for your boat. To fill an empty portable tank, add the appropriate amount of oil to the tank, then add gasoline and close the cap. Rock the tank from side-to-side to gently agitate the mixture, thereby allowing for a thorough mixture of gasoline and oil. When just topping off built-in or larger portable tanks, it is best to use a separate 3 or 6 gallon (11.4 or 22.7 L) mixing tank in the same manner as the portable tank noted earlier. In this way a more exact measurement of fuel occurs in 3 or 6 gallon increments (rather than just adding fuel directly to the tank and possibly realizing that you've just added 2.67 gallons of gas and need to add, uh, a little less than 8 oz of oil, but exactly how many ounces would that be?) Use of a separate mixture tank will prevent the need for such mathematical equations. Of course, the use of a mixing tank may be inconvenient or impossible under certain circumstances, so the next best method for topping off is to take a good guess (but be a little conservative to prevent an excessively rich oil ratio). Add the oil and gasoline at the same time, or add the oil first, then add the gasoline to ensure proper mixing. For measurement purposes, it would obviously be more exact to add the gasoline first and then add a suitable amount of oil to match it. The problem with adding gasoline first is that unless the tank could be thoroughly agitated afterward (and that would be really difficult on built-in tanks), the oil might not mix properly with the gasoline. Don't take that unnecessary risk.

To determine the proper amount of oil to add to achieve the desired fuel:oil ratio, refer to the Fuel:Oil Ratio chart at the end of this section.

Oil Injection

◆ See Figure 55

Many outboard manufacturers use a mechanically driven oil pump mounted on to the powerhead that is connected to the throttle by way of a linkage arm to supply oil to the oil injection system. The system is thereby powered by the crankshaft, which drives a gear in the pump, creating oil pressure. As the throttle lever is advanced to increase engine speed, the linkage arm also moves, opening a valve that allows more oil to flow into the oil pump. But, we said MOST, not Evinrude/Johnson, which uses a pulse (vacuum) controlled pump assembly for the VR02 assembly. Actually, the VR02 pump is a combination fuel and oil pump that draws both to the mixing unit and then provides the fuel/oil mixture to the carburetors,

Outboards equipped with FICHT, detailed under FICHT Fuel Injection (FFI) in the Fuel System section, uses an electro-mechanical system to mix fuel and oil, then delivering the combination to the combustion chambers.

Both the FICHT and VR02 injection systems incorporate low oil and/or no-oil warning alarms that are also connected to an engine-overheating sensor. Also, these systems have a built in speed limiting system. This sub system is designed to reduce engine speed automatically when oil problems occur. This important feature goes a long way toward preventing severe engine damage in the event of an oil injection problem.

The procedure for filling these systems is simple. Most of these systems use a remote oil tank and a connecting hose. The tank contains a filler cap that is removed in order to add oil to the tank. EVERY time the motor is operated, check the oil level. Whenever oil is added, place a piece of tape on the tank to mark the level and watch how fast it drops in relation to engine usage (hours and fuel consumption). Watch for changes in usage patterns that could indicate under or over oiling. Especially with a system that suddenly begins to deliver less oil, you could save yourself significant engine damage by discovering a problem that could have starved the motor for lubrication.

Should the oil hose become disconnected or suffer a break/leak, the oil prime might be lost. If so, the system should be primed before priming the fuel system and starting the engine. More details on servicing the VR02

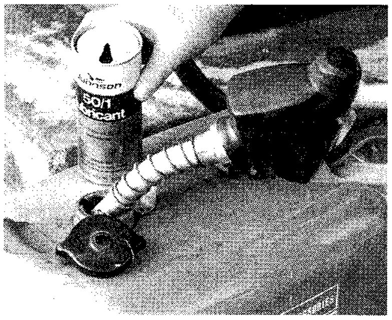


Fig. 54 Add the oil and gasoline at the same time, or add the oil first, then add the gasoline to ensure proper mixing

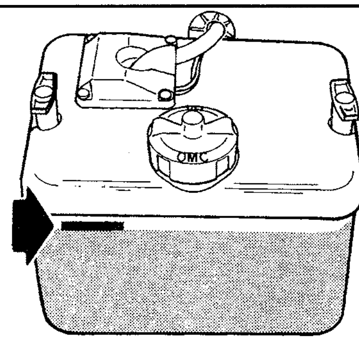


Fig. 55 Mark the oil level with a piece of tape and watch for consumption patterns

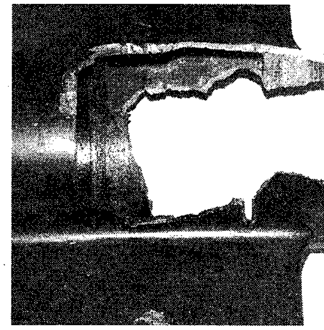


Fig. **56** This lower unit was destroyed because the bearing carrier froze due to lack of lubrication

oiling system are found in the Lubrication section of this manual. More details on servicing the FICHT system are found in the Fuel System section of this manual.

It is highly advisable to carry several spare bottles of 2-stroke oil with you **onboard.** At least for carbureted motors, in the event of an oil system failure, oil can be added to a fuel tank (in the proper ratio) in order to limp the boat and motor safely home.

Lower Unit (Gearcase) Oil

◆ See Figures **56** and **57**

Regular maintenance and inspection of the lower unit is critical for proper operation and reliability. A lower unit can quickly fail if it becomes heavily contaminated with water or excessively low on oil. The most common cause of a lower unit failure is water contamination.

Water in the lower unit is usually caused by fishing line or other foreign material, becoming entangled around the propeller shaft and damaging the seal. If the line is not removed, it will eventually cut the propeller shaft seal and allow water to enter the lower unit. Fishing line has also been known to cut a groove in the propeller shaft if left neglected over time. This area should be checked frequently.

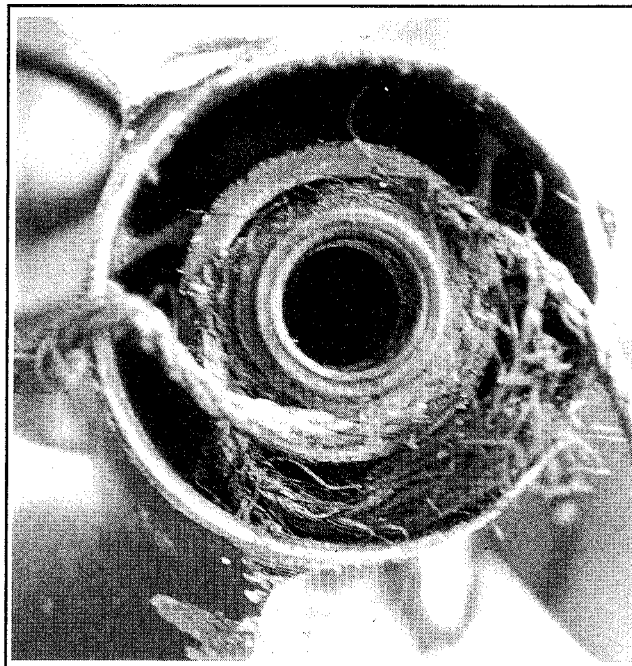


Fig. **57** Fishing line entangled behind the prop can actually cut through the seal

OIL RECOMMENDATIONS

+ See Figure **58**

Use only EvinrudelJohnson Ultra-HPF or an equivalent high quality, marine gearcase lubricant that meets GL5 specifications. EvinrudelJohnson Hi-Vis gearcase lube may be used as a substitute if Ultra-HPF is not available. In both cases, these oils are proprietary lubricants designed to ensure optimal performance and to minimize corrosion in the lower unit.

Remember, it is this lower unit lubricant that prevents corrosion and lubricates the internal parts of the drive gears. Lack of lubrication due to water contamination or the improper type of oil can cause catastrophic lower unit failure.

Fig. **58** Use EvinrudelJohnson **Ultra-HPF,** EvinrudelJohnson Hi-Vis or equivalent marine gear oil

CHECKING LOWER UNIT OIL LEVEL & CONDITION

◆ See Figure **59**

Visually inspect the lower unit before and after each use for signs of leakage. At least monthly, or as needed, remove the lower unit level plug in order to check the lubricant level and condition as follows:

1. Position the engine in the upright position with the motor shut off for at least 1 hour. Whenever possible, check the level overnight cold in order to get the best indication of the level without having to account for heat expansion.
2. Disconnect the negative battery cable and/or remove the propeller for safety.

✳✳ CAUTION

Always observe extreme care when working anywhere near the **propeller. Take** steps to ensure that no accidental attempt to start the engine occurs while work is being performed or remove the propeller completely to be safe.

3. Position a small rag or drain pan under the lower unit, then unthread and remove the ventllevel plug. The level of lubricant should come up just even with the bottom of the threads (if the gearcase was filled properly). If lubricant does not come all the way up, check for signs of leakage. If lubricant leaks out, either the case was overfilled or water has entered the case as well. In all cases, it is best to take a small sample of lubricant from the drain plug in order to examine it further.

■ If a large amount of lubricant escapes when the **vent/level** plug is removed, either the lower unit was seriously overfilled on the last service, the crankcase is still too hot from the last use (and the fluid is expanded) or a large amount of water has entered the lower unit. If the later is true, some water should escape before the oil **and/or** the oil will be a milky white in appearance (showing the moisture contamination).

4. To take small sample, unthread the drainlfill plug at the bottom of the housing and allow a small sample (a teaspoon or less) to drain from the lower unit. Quickly install the drainlfiller plug and tighten securely.

5. Examine the gear oil as follows:

a. Check the oil for obvious signs of water. A small amount of moisture may be present from condensation, especially if a motor has been stored for some time, but a milky appearance indicates that either the fluid has not been changed in ages or the lower unit allowing some water to intrude. If significant water contamination is present, the first suspect is the propeller shaft seal.

b. Dip an otherwise clean finger into the oil and then rub a small amount of the fluid between your finger and your thumb to check for the presence of debris. The lubricant should feel smooth. A very small amount of metallic shavings may be present, but should not really be felt. Large amounts of grit or metallic particles indicate a probable need to overhaul the lower unit looking for damagedlworn gears, shafts, bearings or thrust surfaces.

6. If it is necessary to add fluid, a very small amount of fluid may be added through the level plug, but larger amounts of fluid should be added through the drainlfiller plug opening to make certain that the case is properly filled. If necessary, add gear oil until fluid flows from the level/vent opening. If much more than 1 oz. (29 ml) is reauired to fill the lower unit. check the case carefully for leaks. Install ihe drainlfiller plugs and/or the levellvent plug, tightening both securely.

One trick that makes adding lower unit oil less messy is to install the **vent/level** plug BEFORE removing the pump from the drainlfill opening and threading the drainlfill plug back into **position. This** creates a partial vacuum, which will slow the leakage of **gearcase** oil out of the drainlfill opening while you are attempting to **rethread** the **plug.**

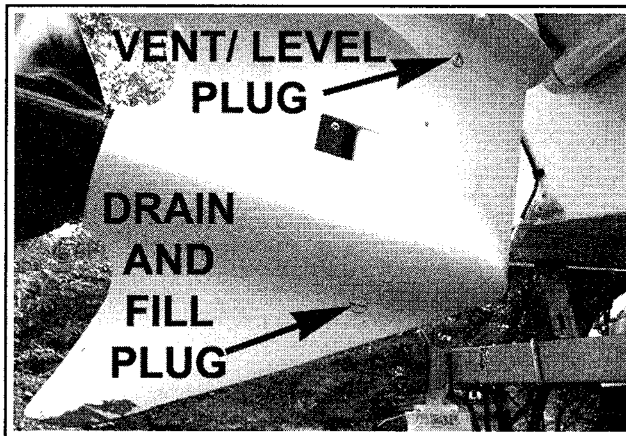


Fig. 59 The venfflevel plug is on top, while the drainlfill plug is at the bottom of the **gearcase**

7. Once fluid is pumped into the lower unit, let the unit sit in a shaded area for at least 1 hour for the fluid to settle. Recheck the fluid level and, if necessary, add more lubricant.

8. Install the propeller and/or connect the negative battery cable, as applicable.

DRAINING AND FILLING

① EASY

◆ See Figure 60

✳✳ CAUTION

The EPA warns that prolonged contact with oils may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap, and water or waterless hand cleaner should be used.

1. Place a suitable container under the lower unit.

2. Loosen the oil ventllevel plug on the lower unit. This step is important! If the oil vent/level cannot be loosened or removed, you will have a VERY difficult time adding oil.

■ Never remove the **vent/level** or drainlfill plugs when the lower unit is hot. Expanded lubricant will be released through the hole.

3. Remove the drainlfill plug from the lower end of the gear housing followed by the oil ventllevel plug.

4. Allow the lubricant to completely drain from the lower unit.

5. If applicable, check the magnet end of the drain screw for metal particles. Some amount of metal is considered normal wear is to be expected but if there are signs of metal chips or excessive metal particles, the lower unit needs to be disassembled and inspected.

6. Inspect the lubricant for the presence of a milky white substance, water or metallic particles. If any of these conditions are present, the lower unit should be serviced immediately.

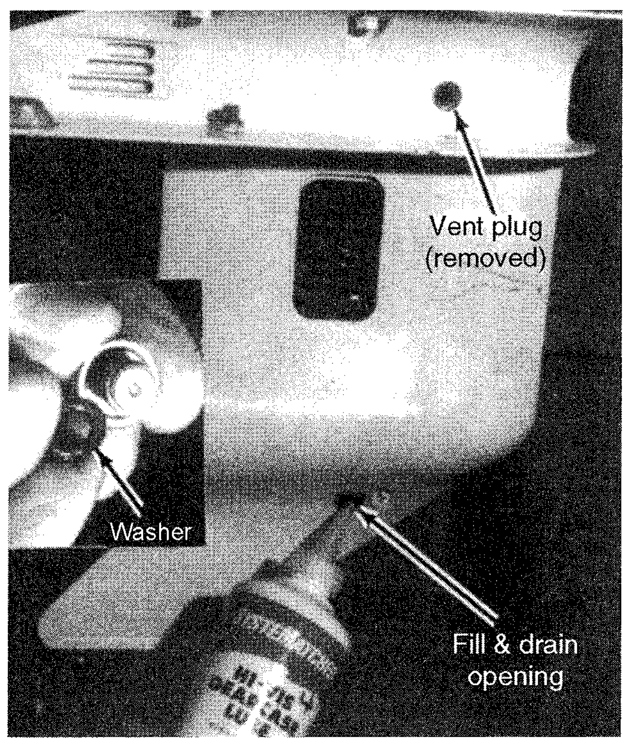


Fig. 60 Lower unit oil is pumped or squeezed into the lower unit through the filler opening, while the vent opening is removed to let air escape

7. Place the outboard in the proper position for filling the lower unit. The lower unit should not list to either port or starboard and should be completely vertical.

8. Insert the lubricant tube into the oil drain hole at the bottom of the lower unit and inject lubricant until the excess begins to come out the oil level hole.

■ The lubricant must be filled from the bottom to prevent air from being trapped in the lower unit. Air could temporarily displace lubricant and causes an improperly full reading that would lead to a lack of lubrication in the lower unit.

9. Oil should be squeezed in using a tube or with the larger quantities, by using a pump kit to fill the lower unit through the drain plug.

One trick that makes adding lower unit oil less messy is to install the **vent/level** plug BEFORE removing the pump from the **drain/fill** opening and threading the **drain/fill** plug back into position.

10. Using new gaskets (washers), install the oil levellvent plug first and then install the oil fill plug.

11. Wipe the excess oil from the lower unit and inspect the unit for leaks.

12. Place the used lubricant in a suitable container for transportation to an authorized recycling facility.

Fuel Filter

A fuel filter is designed to keep particles of dirt and debris from entering the carburetors or the fuel injection system and clogging the tiny internal passages of either. A small speck of dirt or sand can drastically affect the ability of the fuel system to deliver the proper amount of air and fuel/oil to the engine. If a filter becomes clogged, the flow of gasoline will be impeded. This could cause lean fuel mixtures, hesitation and stumbling and idle problems in carburetors. Although a clogged fuel passage in a fuel injected engine could also cause lean symptoms and idle problems, dirt can also prevent a fuel injector from closing properly. A fuel injector that is stuck partially open by debris would likely cause the engine to run rich due to the unregulated fuel constantly spraying from the pressurized injector.

Regular cleaning or replacement of the fuel filter (depending on the type or types used) will decrease the risk of blocking the flow of fuel to the engine, which could leave you stranded on the water. It will also decrease the risk of damage to the small passages of a carburetor or fuel injector that could require more extensive and expensive replacement. Keep in mind that fuel filters are usually pretty inexpensive (at lease when compared to a tow) and replacement is a simple task. Service your fuel filter on a regular basis to avoid fuel delivery problems.

The type of fuel filter used on your engine will vary not only with the year and model, but also with the accessories and rigging. Because of the number of possible variations it is impossible to accurately give instructions based on model. Instead, we will provide instructions for the different types of filters the manufacturer used on various families of motors or systems with which they are equipped. To determine what filter(s) are utilized by your boat and motor rigging, trace the fuel line from the tank to the fuel pump and then from the pump to the carburetors (or premix oiling system, which ever is applicable). The fuel injected motors are listed separately, as their design does not vary in the same way as the carbureted motors.

In addition to the fuel filter mounted on the engine, a filter is usually found inside or near the fuel tank. Because of the large variety of differences in both portable and fixed fuel tanks, it is impossible to give a detailed procedure for removal and installation. Most in-tank filters are simply a screen on the pick-up line inside the fuel tank. Filters of this type usually only need to be cleaned and returned to service (assuming they are not torn or otherwise damaged). Fuel filters on the outside of the tank are typically of the inline type and are replaced by simply removing the clamps, disconnecting the hoses and installing a new filter. When installing the new filter, make sure the arrow on the filter points in the direction of fuel flow.

CARBURETED MOTORS

① EASY

✳✳ CAUTIO

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well-ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Do not smoke while working around gasoline. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

Fuel Pump Filters (Non-VRO2 Equipped Models)

◆ See Figures **61, 62, 63, 64** and **65**

Some of the carbureted models (such as the 88SPL, 112SPL, some 125 Commercial and certain other models including most of the 1632cc CV4 motors) are NOT equipped with the Variable Ratio Oil (VRO2) injection system. When the VR02 system is not used, the outboard will be equipped with only a small, flat, vacuum (pulse) driven fuel pump mounted somewhere on the powerhead. Although the exact shape and design of this pump may vary slightly from model-to-model, for this discussion, they are serviced virtually the same way and we'll refer to them as Type A fuel pumps. The various Type A Evinrude/Johnson mechanical fuel pumps normally contain a serviceable fuel filter screen mounted just underneath the fuel inlet cover. On all versions, the cover is connected to the fuel inlet hose from the fuel tank. Additionally, on all V-models the cover is usually round and is retained by a single bolt at the center.

To service the fuel inlet screen on Type A fuel pumps, remove the inlet cover screw(s), then carefully separate the inlet cover, gasket or O-ring and screen from the fuel pump body. Clean the screen using a suitable solvent and blow dry with low pressure compressed air or allow it to air dry. Once the screen is dry, check it carefully for clogs or tears and replace, if necessary. Depending on the gasket material and condition it may be reused, but it is normally best (and safest) to simply replace the gasket(s).

✳✳ CAUTIC

To prevent the danger of fire of explosion, pressurize the fuel system after service by slowly squeezing the fuel primer bulb until **firm. Then,** once the system is pressurized, inspect it carefully for leaks, especially around the fuel **pump/cover.**

The rest of the EvinrudelJohnson V-configuration, carbureted 2-stroke motors are usually equipped with a larger, more complicated fuel pump that we'll refer to as Type B (it's the combination fuel and oil pump that is used by the VR02 system). We've provided a photo for visual identification. On these pumps an inline filter is normally used somewhere between the tank and the pump, and the shapeldesign of these filters will vary somewhat from model-to-model. Service of the inline filter is sometimes limited to replacement. Inline filters should be serviced annually and anytime fuel deliverylstarvation problems are suspected.

Some Type A fuel pump motors will also be equipped with an **inline** filter. When present be sure to replace all **inline** filters at least annually.

Inline Filters

◆ See Figures **64, 65, 66, 67, 68** and **69**

Most of the carbureted EvinrudelJohnson V motors are equipped with the VR02 system and therefore require an inline filter to protect the system. But, as noted earlier, it is possible for inline filters to also be installed on non-VR02 models (either as an additional line of defense or in lieu of the pump inlet filter on those models).

EvinrudelJohnson has used multiple different types of inline filters on these models. Some of them are sealed and therefore cannot be cleaned and reused. A few of them however utilize 2-piece housings that can be opened to access the filter element.

Generally speaking, the 60° models (80 Jet-175 Hp [1726/2589cc] V4/V6 motors) along with a few of the 1632cc 90° V4s (including the 100WT) are equipped with the serviceable filter design. On all of the 60° models the filter element itself is mounted under a knurled knob that threads onto a cylinder that is incorporated into the fuel component bracket mounted to the engine. The CV motors equipped with a serviceable filter element use a housing that is attached inline, between two fuel supply lines. These can be identified by their design and shape, which varies from the typical inline filter. A typical, disposable inline filter will have a simple round canister on which the fuel lines attach to either end (or a few, with both lines on one end). The serviceable inline filters used on some CV4 motors have one fuel inlet on

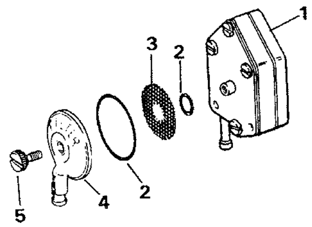


Fig. **61** Versions of **the Type** A fuel pump are found on most carbureted models covered by this manual

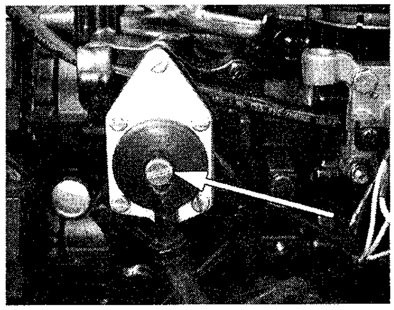


Fig **62** Remove the **bolt(s)** securing the Type A pump cover...

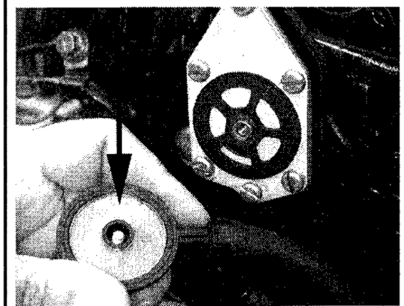


Fig. **63** **...**then remove the inlet cover to access the filter element

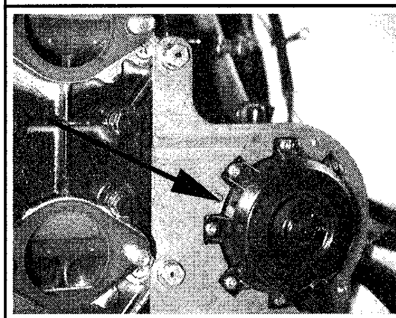


Fig. **64** Models with Type B fuel pumps utilize **inline** filters

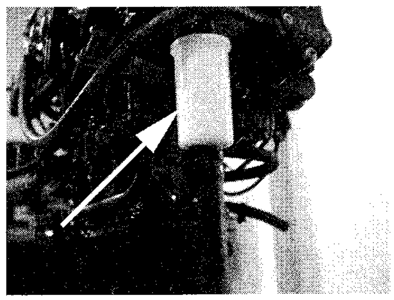


Fig. **65** Type B pump models utilize some form of an **inline** filter

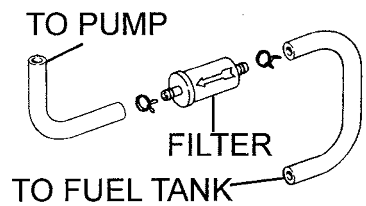


Fig. **66** Disposable **Evinrude/Johnson inline** filter

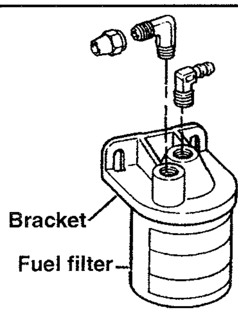


Fig. **67** Disposable spin-on **inline** filter (V8 motors)

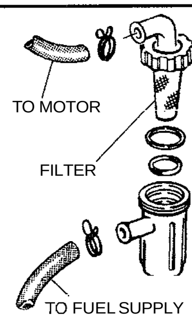


Fig. **68** Typical serviceable **Evinrude/Johnson inline** filter (CV motors)

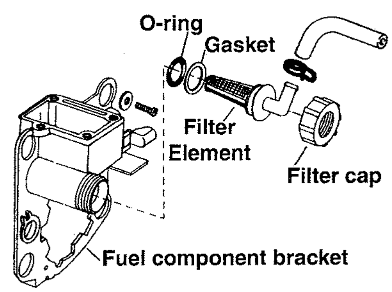


Fig. **69** Serviceable **inline** filter used on **60°** LV4 and LV6 motors

the side and the fuel outlet on the end. Serviceable filters consist of an assembly with a knurled cap that threads onto the filter bowl or base.

The balance of the VR02 equipped V motors either utilize a sealed plastic canister mounted literally inline (with a fuel line attaching to each end similar to how the serviceable filter is mounted on CV motors) or a spin-on type filter that is mounted to a bracket. The spin-on filters are used on most V8 engines and also usually function as a fuel/water separator. The plastic housing inline filters are generally only found on V4 and V6 models.

Because of the relative ease and relatively low expense of an **inline** filter (when compared with the time and hassle of a carburetor overhaul or the expense of a tow) we encourage you to replace the filter at least annually.

Service varies slightly by filter type:

To replace a non-serviceable **inline** filter, release the hose clamps (they are usually equipped with spring-type clamps that are released by squeezing the tabs using a pair of pliers) and slide them back on the hose, past the raised portion of the filter inlet/outlet nipples. Once a clamp is released, position a small drain pan or a shop towel under the filter and carefully pull the hose from the nipple. Allow any fuel remaining in the filter and fuel line to drain into the drain pan or catch fuel with the shop towel. Repeat on the other side, noting which fuel line connects to which portion of the filter (for assembly purposes). Inline filters are usually marked with an arrow indicating fuel flow. The arrow should point towards the fuel line that runs to the motor (not the fuel tank).

Before installation of the new filter, make sure the hoses are in good condition and not brittle, cracking and otherwise in need of replacement. During installation, be sure to fully seat the hoses and then place the clamps over the raised portions of the nipples to secure them. Spring clamps will weaken over time, so replace them if they've lost their tension. If wire ties or adjustable clamps were used, be careful not to overtighten the clamp. If the clamp cuts into the hose, it's too tight; loosen the clamp or cut the wire tie (as applicable) and start again.

To replace a non-serviceable spin-on filter (V8 engines), place a suitable drain pan under the filter in order to catch any escaping fuel, then remove the old filter by unthreading it counterclockwise (when viewed from the bottom). If necessary, use a strap-wrench or oil filter wrench to firmly grasp the filter and apply leverage while turning. Apply a light coating of clean 2-stroke engine oil to the gasket of the new filter and make sure the filter mating surface on the bracket is clean and free of dirt or debris. Then, carefully thread the new filter onto the bracket and tighten it by hand (following the instructions on the filter itself). Generally speaking, the filter should be tightened no more than 1/4-1/2 turn after the gasket contacts the mounting bracket. NEVER use a strap or filter wrench to tighten the filter as overtightening will almost certainly occur.

For models with a serviceable filter element, service will vary slightly by model. For 60° LV4 and LV6 motors, you'll have to remove the air intake silencer for access to the fuel component bracket. For CV motors (or other completely inline mountings), it is best to disconnect the hose from one end, for instance, remove the fuel pump hose from the cap nipple. Once you have access and freedom of movement for the cap, carefully unthread the knurled cap from the base. The filter element is usually removed with the cap. Clean and inspect the element in the same manner as the fuel pump filter screens described under Fuel Pump Filters (Non-VR02 Equipped Models) in this section. Replace any damaged filter element. Check the filter gasket and/or O-ring for damage and replace, as necessary. When reconnecting the hose to the nipple, inspect and replace any damaged hose or clamp as you would with any other inline filter.

✳✳ CAUTION

To prevent the danger of fire of explosion, pressurize the fuel system after service by slowly squeezing the fuel primer bulb until **firm. Then,** once the system is pressurized, inspect it carefully for leaks, especially around the **inline** fuel filter.

FUEL INJECTED MOTORS

✳✳ CAUTION

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well-ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Do not smoke while working around gasoline. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the **possibility** of fire or explosion.

Fuel injected motors covered by this manual are equipped with two interrelated fuel circuits, the high-pressure and low-pressure systems. The low-pressure system is similar to the fuel system that feeds float bowls on carbureted motors. An engine mounted fuel pump (known as the lift pump on these motors) draws fuel from the boat's tank based on vacuum pulses received from the engine. This is pretty much where the similarity ends, as the lift pump is mounted to the front of the powerhead, as opposed to the rear of the powerhead on most carbureted motors. Exact lift pump location varies slightly from model-to-model. The pump is normally found at the lower front of the powerhead on the large V6 motors (3000/3300cc) motors. For other FICHT motors, the pump is normally attached to a related fuel system component, either the fuel/vapor separator on some 150 hp engines or to the fuel component bracket on most other engines. In most cases, the pump is found directly behind the air intake silencer.

The lift pump receives oil from the oil distribution manifold, mixing it with the incoming fuel before delivering the mix to the vapor separator. After passing through the vapor separator, the oil/fuel mixture is drawn by the high-pressure fuel pump to feed the fuel injector circuit.

These motors utilize a spin-on type canister fuel filter/water separator (which looks a lot like an automotive fuel filter or the spin-on fuel filter/water separator used by carbureted V8 engines). Like lift pump location, the fuel filter location varies slightly by model. On the largest V6 FICHT motors (3000/3300cc) it is normally found on the lower front of the powerhead's port side (just behind the lower, port cylinder throttle body). On some of the smaller, FICHT V6 motors, specifically some 150 hp (2589cc), the fuel filter is mounted to a bracket at the REAR of the powerhead. For most other V4 and V6 FICHT motors, the filter should be found at the front of the powerhead, on the fuel system component bracket mounted directly behind the air intake silencer.

Mounted with or to the fuel filter canister is a water sensor that will activate the System Check monitor if water is detected about 3/8 in. (9.5mm) above the bottom of the canister. In order to protect the system, the filter should be replaced at least annually or after every 100 hours of operation, whichever comes first.

Fuel System Pressure

On fuel injected engines, always relieve system pressure prior to disconnecting any high-pressure fuel circuit component, fitting or fuel line. For details, please refer to Fuel System Pressurization under Fuel Injection.

✳✳ CAUTION

Exercise extreme caution whenever relieving fuel system pressure to avoid fuel spray and potential serious bodily injury. Please be advised that fuel under pressure may penetrate the skin or any part of the body it contacts.

To avoid the possibility of fire and personal injury, always disconnect the negative battery cable while servicing the fuel system or fuel system components.

In order to absorb any excess fuel due to spillage, always place a shop towel or cloth around the fitting or connection prior to loosening. Ensure that all fuel spillage is removed from engine surfaces.

The fuel filter is found in the low-pressure fuel circuit, therefore no high-pressure hose or fitting must be disconnected for service. Although this makes fuel pressure relief unnecessary for filter service, it does not take away the need to be cautious when working around fuel and fumes.

Fuel Filter and Water Separator

◆ See Figures **70, 71, 71a, 71b**, **71c** and **71d**

FICHT motors utilize an inline, spin-on fuel filter and water separator canister to protect the fuel injection system from dirt, debris and moisture. The canister is mounted to the fuel component bracket found at the front of the powerhead, directly behind the intake air silencer. Access is possible once the silencer and, in some cases, the lower engine covers are removed. The filter assembly is not serviceable and must be replaced at various intervals to ensure proper function. To protect the system, be sure to replace the filter at least annually, every 100 hours of operation, or if problems are suspected with the low-pressure circuit.

■ It is possible that a second **inline** filter may be installed on the boat itself, and is dependant upon initial boat rigging. Check the fuel lines between the boat and motor to be sure. Remote mounted fuel filter/water separator assemblies are not significantly different from the motor mounted versions. Although access to the filter itself may vary, the actual removal and installation is the same.

1. Disconnect the negative battery cable for safety.

The fuel filter/water separator should not be too hard to find. At the end of the day, it looks like just like an automotive-style, spin-on oil filter (or like most other marine combination filter/water separators). It is mounted somewhere on the powerhead, usually underneath the lower engine cases and sometimes behind the air intake silencer.

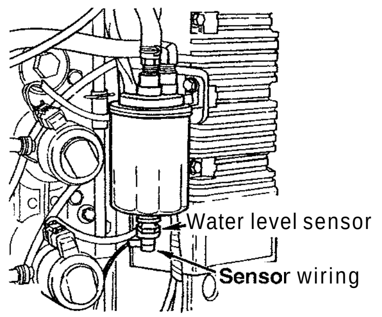


Fig. 70 Some smaller V6 models utilize a filter mounted to the REAR of the powerhead...

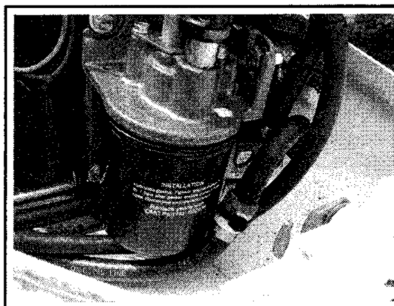


Fig. 71 ... but the filters on most **FICHT** models are mounted to the FRONT of the powerhead

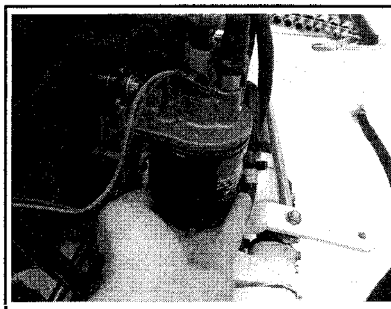


Fig. 71a Access is easier with the lower covers removed

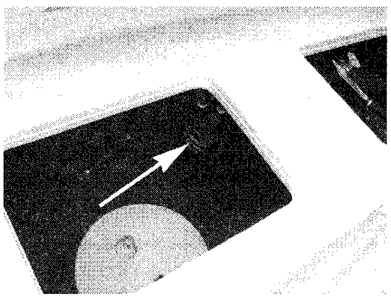


Fig. 71b Some boats may also use a remote mounted filter

Fig. **71c** Remote filters are serviced the same as engine mounted filters

Fig. 71d Be sure to follow any instructions on the replacement part

2. Start by locating the filter assembly, as location varies:

a. On 200 hp and larger (3000/3300cc) V6 models, the filter is normally towards the front, base, port side of the powerhead, behind the lower port cylinder throttle body.

b. On some 150 hp (2589cc) and other smaller V6 models, the filter may be found at the rear of the powerhead. On these motors the water sensor is mounted through the bottom of the filter canister. On these models, disconnect the sensor wiring at this time.

c. On most smaller V4 and V6 engines (including some 150 hp motors), the filter is mounted to the fuel component bracket at the front of the motor (directly behind the air intake silencer).

☐ The lower engine covers often obscure the filter assembly. If you cannot locate the filter with the covers installed, remove them and then verify location. If you still cannot locate the filter after removing the lower cases, check behind the air intake silencer.

3. If necessary for access, remove the air intake silencer assembly.

4. If necessary, remove the lower engine covers, as detailed under Engine Covers (Top and Lower Cases) in this section. On models where the filter is mounted behind the air intake silencer, it may not be absolutely necessary to remove the lower engine covers, but it can make access much easier. Besides, on many of these models, access to one or more of the lower spark plugs is restricted by the cover as well and, you should at least be checking the plugs if you've come this far, right?

5. Position a container or shop rag below the fuel filter. Unthread and remove the fuel filter assembly (keeping in mind that it is probably contains a decent amount of fuel, so try not to tilt and spill it or get it all over the place).

6. On models with the water sensor threaded into the bottom of the sensor, unthread the sensor and install it in the replacement filter.

To install:

7. Place a small amount of clean 2-stroke engine oil on the filter gasket.

8. Carefully thread the filter into position on the mounting bracket and tighten by hand. Follow any instructions that came with or printed on the filter. Generally speaking, the filter should be tightened no more than 1/4-1/2 turn after the gasket contacts the mounting bracket. NEVER use a strap or filter wrench to tighten the filter as overtightening will almost certainly occur.

9. If applicable, reconnect the wiring for the water level sensor.

10. Pressurize the fuel system using the fuel primer bulb from the tank line and check for leaks. Observe the fuel hose fittings for fuel leakage and repair any fuel leaks before starting the motor. Clean up any spilled fuel.

11. If removed, install the air intake silencer assembly.

12. If removed, install the engine covers.

13. Connect the negative battery cable.

Propeller

◆ See Figures **72, 73** and **74**

The propeller is mounted to the lower unit propeller shaft using a nut that is in turned secured either by a cotter pin through the castellations on the nut itself, or through a separate nut keeper. The propeller is driven by a splined connection to the shaft and the rubber drive hub found inside the propeller. The rubber hub provides a cushioning that allows softer shifts, but more importantly, provides some measure of protection for the lower unit components in the event of an impact. The amount of force necessary to break the hub is supposed to be just less than the amount of force necessary to cause lower unit component damage. In this way, the hope is that the propeller and hub will be sacrificed in the event of a collision, but the more expensive lower unit components will survive unharmed. Although these systems do supply a measure of protection, this, unfortunately, is not always the case and lower unit component damage will still occur with the right impact or with a sufficient amount of force.

✻✻ WARNING

Do not use excessive force when removing the propeller from the shaft as excessive force can result in damage to the propeller, shaft and, even other lower unit components. If the propeller cannot be removed by normal means, consider having a reputable marine shop remove it. Using heat or impact wrenches to free the propeller will **likely** lead to damage.

Clean and lubricate the propeller and shaft splines using a high-quality, water-resistant, marine grease every time the propeller is removed from the **shaft. This** will help keep the hub from seizing to the shaft due to corrosion (which would require special tools to remove without damage to the shaft or gearcase.)

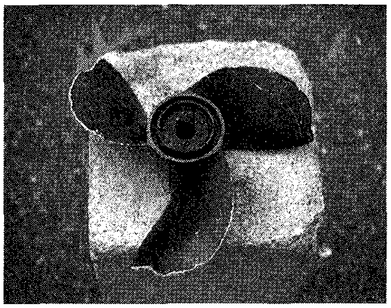


Fig. 72 This propeller is long overdue for repair or replacement

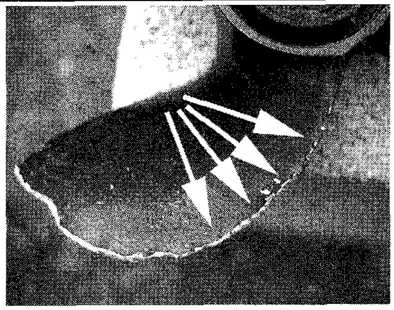


Fig. 73 Although minor damage can be dressed with a file...

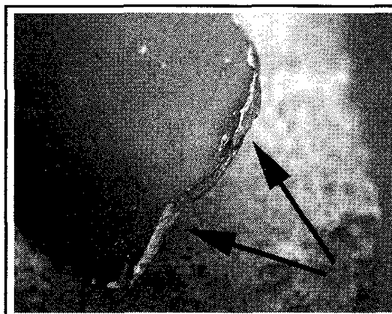


Fig. 74 ... a propeller specialist should repair large nicks or damage

Many outboards are equipped with aftermarket propellers, Because of this, the attaching hardware may differ slightly from what is shown. Contact a reputable propeller shop or marine dealership for parts and information on other brands of propellers.

INSPECTION

1 EASY

◆ See Figures **72, 73** and **74**

The propeller should be inspected before and after each use to be sure the blades are in good condition. If any of the blades become bent or nicked, this condition will set up vibrations in the motor. Remove and inspect the propeller. Use a file to trim nicks and burrs. Take care not to remove any more material than is absolutely necessary.

✳✳ CAUTION

Never run the engine with serious propeller damage, as it can allow for excessive engine speed **and/or** vibration that can damage the motor. Also, a damaged propeller will cause a reduction in boat performance and handling.

Check the rubber and splines inside the propeller hub for damage. If there is damage to either of these, take the propeller to your local marine dealer or a "prop shop." They can evaluate the damaged propeller and determine if it can be saved by rehubbing.

Finally, the propeller should be removed at least every 100 hours of operation or at the end of each season, whichever comes first, for cleaning, greasing and inspection. Whenever the propeller is removed, apply a fresh coating of Evinrude/Johnson Triple-Guard or an equivalent water-resistant, marine grease to the propeller shaft and the inner diameter of the propeller hub. This is necessary to prevent possible propeller seizure onto the shaft that could lead to costly or troublesome repairs. Also, whenever the propeller is removed, any material entangled behind the propeller should be removed before any damage to the shaft and seals can occur. This may seem like a waste of time at first, but the small amount of time involved in removing the propeller is returned many times by reduced maintenance and repair, including the replacement of expensive parts.

☐ Propeller shaft greasing and debris inspection should occur more often depending upon motor usage. Frequent use in salt, brackish or polluted waters would make it advisable to perform greasing more often. Similarly, frequent use in areas with heavy marine vegetation, debris or potential fishing line would necessitate more frequent removal of the propeller to ensure the lower unit seals are not in danger of becoming cut.

REMOVAL & INSTALLATION

1 EASY

◆ See Figures **75, 76, 77, 78** and **79**

There are essentially 2 slightly different ways that propellers are secured to the propshaft on these outboards. Both place a thrust washer over the shaft, followed by the propeller, a spacer and a nut that is tightened to specification. The difference comes in the size of the nut (along with the resulting torque spec) and the method that the nut is secured to keep it from loosening in service. Some of the Evinrude/Johnson V motors use a slotted or castellated nut (so named because, when viewed from the side, it appears similar to the upper walls or tower of a castle.) On these models a cotter pin is placed through the slots in the nut in order to lock it in place. The rest of the models use a larger, standard flat-sided nut and a separate keeper that is fitted in place over the nut and then secured using a cotter pin. The difference is important as the castellated nut is only tightened to 120 inch lbs. (14 Nm), while the standard flat-nut (that utilizes a separate keeper) is tightened to 70-80 ft. lbs. (95-108 Nm).

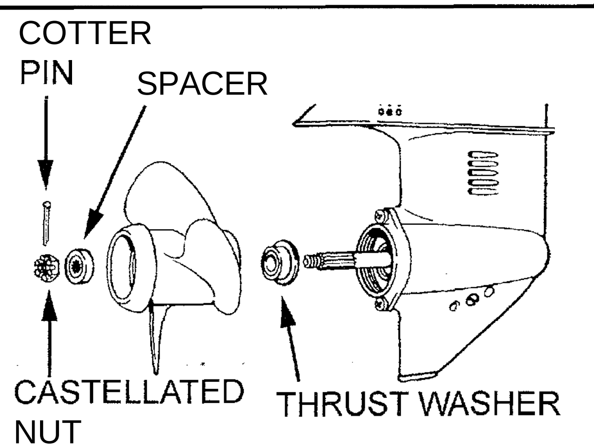


Fig. 75 Typical propeller mounting on models utilizing a castellated nut

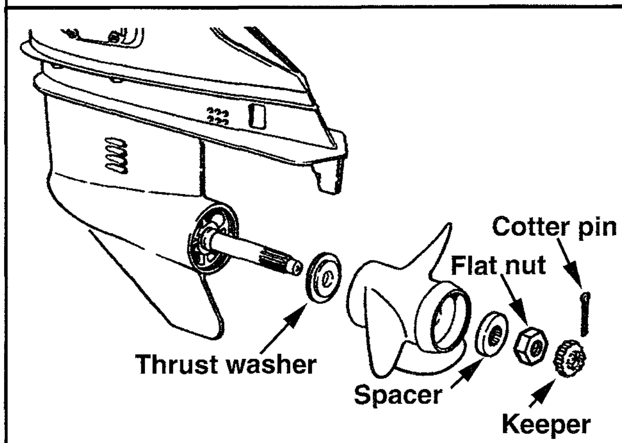


Fig. 76 Typical propeller mounting on models using a flat nut with a separate keeper

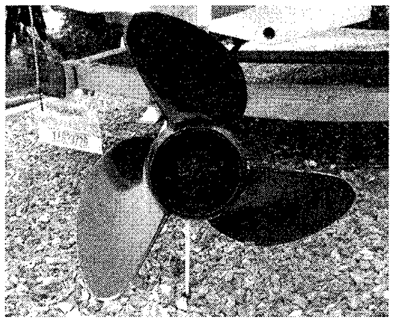


Fig. 77 Although designs vary, propeller nuts are secured with a cotter pin

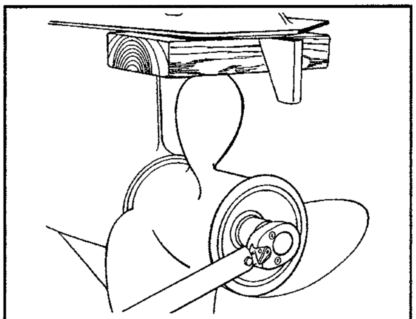


Fig. **78** Use a block of wood to keep the propeller from turning when loosening or tightening the nut

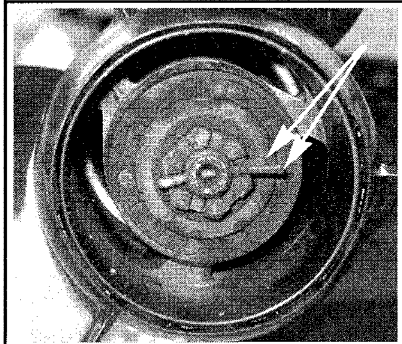


Fig. **79** Notice the cotter pin is gently spread, NOT bent **900** or more

You'll notice that in both cases, the nut is locked in place by a cotter pin to ensure that it cannot loosen while the motor is running. The pin passes through a hole in the propeller shaft, as well as through the notches in the sides of the castellated nut or the keeper. Install a new cotter pin anytime the propeller is removed and, perhaps more importantly, make sure the cotter pin is of the correct size and is made of materials designed for marine use. Make sure that you include the cotter pin in all pre- and post-launch checks.

Whenever working around the propeller, check for the presence of black rubber material in the drive hub and spline grease. presence of this material normally indicates that the hub has turned inside the propeller bore (have the propeller checked by a propeller repair shop). Keep in mind that a spun hub will not allow proper torque transfer from the motor to the propeller and will allow the engine to over-rev in order to produce thrust (or will just over-rev producing little or no thrust). If the propeller has spun on the hub it has been weakened and is more likely to fail completely in use.

1. For safety, disconnect the negative cable (if so equipped) and/or disconnect the spark plug leads from the plugs (ground the leads to prevent possible ignition damage should the motor be cranked at some point before the leads are reconnected to the spark plugs).

✳✳ CAUTION

Don't ever take the risk of working around the propeller if the engine could accidentally be cranked or started. Always take precautions such as disconnecting the spark plug leads and, if equipped, the negative battery cable.

1. Cut the ends off the cotter pin (as that is easier than trying to straighten them in most cases). Next, free the pin by grabbing the head with a pair of needlenose pliers. Either tap on the pliers gently with a hammer to help free the pin from the nut or carefully use the pliers as a lever by prying back against the castellated nut. Discard the cotter pin once it is removed.
2. On models with a separate nut keeper, pull the keeper free and place it aside for installation purposes.
3. Place a block of wood between the propeller and the anti-ventilation housing to lock the propeller and shaft from turning, then loosen and remove the castellated nut. Note the orientation, then remove the splined spacer from the propeller shaft.
4. Slide the propeller from the shaft. If the prop is stuck, use a block of wood to prevent damage and carefully drive the propeller from the shaft.

☐ If the propeller is completely seized on the shaft, have a reputable marine or propeller shop free it. Don't risk damage to the propeller or **gearcase** by applying excessive force.

5. Note the direction in which the thrust washer is facing (the shoulder is normally positioned to the aft, facing the propeller). Remove the thrust washer from the propshaft (if the washer appears stuck, tap lightly to free it from the propeller shaft).
6. Clean the thrust washer, propeller and shaft splines of any old grease. Small amounts of corrosion can be removed carefully using steel wool or fine grit sandpaper.
7. Inspect the shaft for signs of damage including twisted splines or excessively worn surfaces. Rotate the shaft while looking for any deflection. Replace the propeller shaft if these conditions are found. Inspect the thrust washer for signs of excessive wear or cracks and replace, if found.

To Install:

8. Apply a light coat of Evinrude/Johnson Triple-Guard or equivalent high-quality, water-resistant, marine grease to all surfaces of the propeller shaft and to the splines inside the propeller hub.
9. Position the thrust washer over the propshaft in the direction noted during removal. On all models, the shoulder should normally face the propeller.
10. Carefully slide the propeller onto the propshaft, rotating the propeller to align the splines. Push the propeller forward until it seats against the thrust washer.
11. Install the splined spacer onto the propeller shaft, as noted during removal.
12. Place a block of wood between the propeller and housing to hold the prop from turning, then thread the castellated nut onto the shaft with the cotter pin grooves facing outward.
13. Tighten castellated nuts to 120 inch lbs. (14 Nm) or standard flat-nuts (that use a separate keeper) to 70-80 ft. lbs. (95-108 Nm) using a suitable torque wrench.
14. If used, install the keeper over the flat-nut.
15. Install a new cotter pin through the grooves in the nut or the keeper (as applicable) that align with the hole in the propshaft. If the cotter pin hole and the grooves do not align, tighten the nut additionally, just enough to align them (do not loosen the nut to achieve alignment.) Once the cotter pin is inserted, spread the ends sufficiently to lock the pin in place. Do not bend the ends over at 90° or greater angles as the pin will loose tension and rattle in the slot.
16. Connect the spark plug leads and/or the negative battery cable, as applicable.

Jet Drive Impeller

A jet drive motor uses an impeller enclosed in a jet drive housing instead of the propeller used by traditional lower units. Outboard jet drives are designed to permit boating in areas prohibited to a boat equipped with a conventional propeller outboard drive system. The housing of the jet drive barely extends below the hull of the boat allowing passage in ankle deep water, white water rapids, and over sand bars or in shoal water that would foul a propeller drive.

The outboard jet drive provides reliable propulsion with a minimum of moving parts. It operates, simply stated, as water is drawn into the unit through an intake grille by an impeller. The impeller is driven by the driveshaft off the powerhead's crankshaft. Thrust is produced by the water that is expelled under pressure through an outlet nozzle that is directed away from the stern of the boat.

As the speed of the boat increases and reaches planing speed, only the very bottom of the jet drive where the intake grille is mounted facing downward remains in contact with the water.

The jet drive is provided with a reverse-gate arrangement and linkage to permit the boat to be operated in reverse. When the gate is moved downward over the exhaust nozzle, the pressure stream is deflected (reversed) by the gate and the boat moves sternward.

Conventional controls are used for powerhead speed, movement of the boat, shifting and power trim and tilt.

INSPECTION

EASY

◆ See Fig. **80**

The jet impeller is a precisely machined and dynamically balanced aluminum spiral. Close observation will reveal drilled recesses at exact locations used to achieve this delicate balancing. Excessive vibration of the jet drive may be attributed to an out-of-balance condition caused by the jet impeller being struck excessively by rocks, gravel or from damage caused by cavitation "burn."

The term cavitation "burn" is a common expression used throughout the world among people working with pumps, impeller blades, and forceful water movement. These "burns" occur on the jet impeller blades from cavitation air bubbles exploding with considerable force against the impeller blades. The edges of the blades may develop small dime-size areas resembling a porous sponge, as the aluminum is actually "eaten" by the condition just described.

Excessive rounding of the jet impeller edges will reduce efficiency and performance. Therefore, the impeller and intake grate (that protects it from debris) should be inspected at regular intervals.

Before and after each use, make a quick visual inspection of the intake grate and impeller, looking for obvious signs of damage. Always clear any debris such as plastic bags, vegetation or other items that sometimes become entangled in the water intake grate before starting the motor. If the intake grate is damaged, do not operate the motor, or you will risk destroying the impeller if rocks or other debris are drawn upward by the jet drive. If possible, replace a damaged grate before the next launch. This makes inspection after use all that much more important. Imagine the disappointment if you only learn of a damaged grate while inspecting the motor immediately prior to the next launch.

An obviously damaged impeller should be removed and either repaired or replaced depending on the extent of the damage. If rounding is detected, the impeller can be placed on a workbench and the edges restored to as sharp a condition as possible, using a file. Draw the file in only one direction. A back-and-forth motion will not produce a smooth edge. Take care not to nick the smooth surface of the jet impeller. Excessive nicking or pitting will create water turbulence and slow the flow of water through the pump. For more details on impeller replacement or service, please refer to the information on Jet Drives in the Lower Unit section.

CHECKING IMPELLER CLEARANCE

MODERATE

◆ See Figures **81** and **82**

Proper operation of the jet drive depends upon the ability to create maximum thrust. In order for this to occur the clearance between the outer edge of the jet drive impeller and the water intake housing cone wall should be maintained at approximately 0.020-0.030 in. (0.5-0.8mm). This distance can be checked visually by shining a flashlight up through the intake grille and estimating the distance between the impeller and the casing cone, as indicated in the accompanying illustrations. But, it is not humanly possible to accurately measure this clearance by eye. Close observation between outings is fine to maintain a general idea of impeller condition, but, at least annually, the clearance must be measured using a set of feeler gauges. Although some gauges may be long enough to make the measurement with the intake grate installed, removal is advised for access and to allow for a more thorough inspection of the impeller itself. The problem is that on some designs, removal of the intake grate, also results in removal of the intake casing liner to which the clearance must be measured. In these cases, sufficiently long feeler gauges will be necessary.

✳✳ WARNING

Whenever working around the impeller, ALWAYS disconnect the negative battery cable **and/or** disconnect the spark plug leads to make sure the engine cannot be accidentally started during service. Failure to heed this caution could result in serious personal injury or death in the event that the engine is started.

When checking clearance, a feeler gauge larger than the clearance specification should not fit between the tips of the impeller and the housing. A gauge within specification should fit, but with a slight drag. A smaller gauge should fit without any interference whatsoever. Check using the feeler gauge at various points around the housing, while slowly rotating the impeller by hand.

After continued normal use, the clearance will eventually increase. In anticipation of this the manufacturer mounts the tapered impeller deep in its housing, and positions spacers beneath the impeller to hold it in position. The spacers are used to position the impeller along the driveshaft with the desired clearance between the jet impeller and the housing wall. When clearance has increased, spacers are removed from underneath the impeller and repositioned behind it, dropping the impeller slightly in the housing and thereby decreasing the clearance again. Moving 1 spacer will decrease clearance approximately 0.007 in. (0.18mm).

If adjustment is necessary, refer to the Jet Drive procedures under Lower Unit in this manual for impeller removal, shimming and installation procedures.

Anodes (Zincs)

◆ See Figure 83

The idea behind anodes (also known as sacrificial anodes) is simple: When dissimilar metals are dunked in water and a small electrical current is leaked between or amongst them, the less noble metal (galvanically speaking) is sacrificed (corrodes).

The zinc alloy of which the anodes are made is designed to be less noble than the aluminum alloy of which your outboard is constructed. If there's any electrolysis, and there almost always is, the inexpensive zinc anodes are consumed in lieu of the expensive outboard motor.

These zincs require a little attention in order to make sure they are capable of performing their function. Anodes must be solidly attached to a clean mounting site. Also, they must not be covered with any kind of paint, wax or marine growth

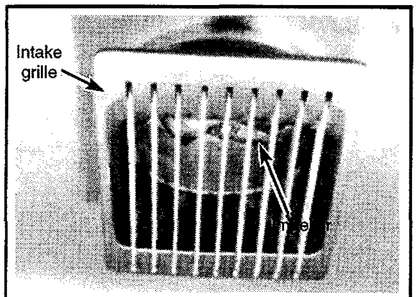


Fig. **80** Visually inspect the intake grate and impeller with each use

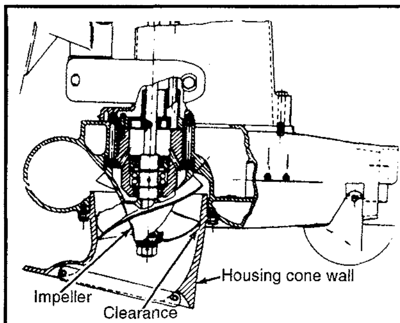


Fig. **81** Jet drive impeller clearance is the gap between the edges of the impeller and its housing

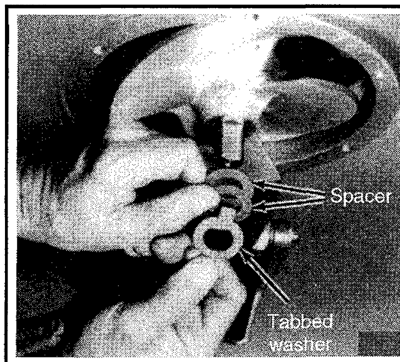


Fig. **82** Impeller clearance is adjusted by moving shims (usually from below to above the impeller)

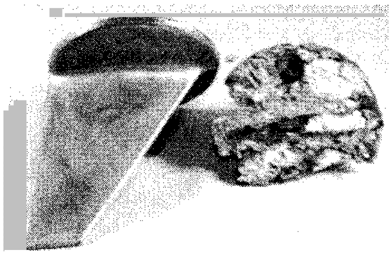


Fig. 83 Extensive corrosion of an anode suggests a problem or a complete disregard for maintenance

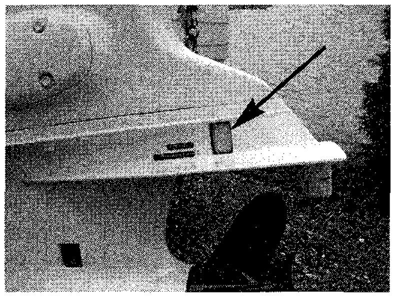


Fig. 84 All motors have at least one (1) anode mounted on the lower unit ...

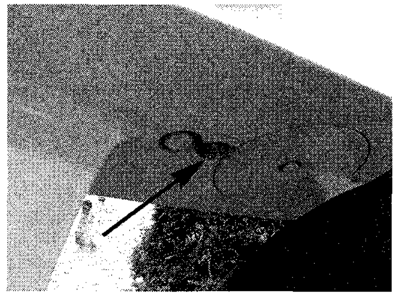


Fig. 85 ...secured by a single bolt from under the anti-ventilation plate

INSPECTION

◆ **See Figures 83, 84, 85, 86, 87 and 88**

Visually inspect the anodes, especially those mounted on the lower unit, before and after each use. You'll want to know right away an anode has become loose or fallen off in service. Periodically inspect anodes closely to make sure they haven't eroded too much. At a certain point in the erosion process, the mounting holes start to enlarge, which is when the zinc might fall off. Obviously, once that happens, your engine no longer has any protection. Generally, a zinc anode is considered worn if it has shrunken to 213 or less than the original size. To help judge this, buy a spare and keep it handy (in the boat or tow vehicle for comparison).

If you use your outboard in salt water or brackish water, and your zincs never seem to wear, inspect them carefully. Paint, wax or marine growth on zincs will insulate them and prevent them from performing their function properly. They must be left bare and must be installed onto bare metal of the motor. If the zincs are installed properly and not painted or waxed, inspect around them for sings of corrosion. If corrosion is found, strip it off immediately and repaint with a rust inhibiting paint. If in doubt, replace the zincs.

On the other hand, if your zinc seems to erode in no time at all, this may be a symptom of the zincs themselves. Each manufacturer uses a specific blend of metals in their zincs. If you are using zincs with the wrong blend of metals, they may erode more quickly or leave you with diminished protection.

At least annually or whenever an anode has been removed or replaced, check the mounting for proper electrical contact using a multimeter. Set the multimeter to check resistance (ohms); connect one meter lead to the anode and the other to a good, unpainted or corroded ground on the motor. Resistance should be very low or zero. If resistance is high or infinite, the anode is insulated and cannot perform its function properly.

You can test anode effectiveness using an ohmmeter. In order for the anode to work it must be in good electrical contact with the motor. Connect one lead of an ohmmeter to a good ground on the powerhead and the other to the anode itself. The meter must show little or no resistance, otherwise the anode and mounting surface must be cleaned of the corrosion, paint or debris that is causing the resistance.

SERVICE

◆ **See Figures 84, 85, 86, 87 and 88**

Depending on your boat, motor and rigging, you may have any number of anodes, but typically these Evinrude/Johnson motors utilize at least 3. First off, an anode is typically mounted just above the anti-ventilation plate on the lower unit. This anode is visible through ports on either side of the gearcase, and accessed from underneath the anti-ventilation plate. This anode is bolted in position from underneath, but be careful not to confuse the unpainted anode retaining bolt with the pained gearcase retaining bolt.

Most motors are also equipped with one or two transom bracket anodes, depending on the design of the transom clamp. Some brackets are designed so it is easier to have a single anode one each of the 2 protrusions sticking down from the bracket assembly, while others utilize a single large anode that spans the entire lower portion of the bracket. The anodes may be bolted from the bottom or the sides, depending on the application.

Most of these outboards are also equipped with a propeller shaft bearing housing anode that is **not** a periodic replacement item, but should be checked anytime the lower unit is opened for overhaul. This anode is typically bolted to the underside of the propeller shaft bearing carrier, mounted inside the gearcase.

Finally, some motors may even be equipped with a powerhead mounted anode. When equipped, these anodes are also expected to give a greater service life than the externally mounted gearcase and transom bracket anodes. But that is not to say they should never be checked. If equipped, be sure to check powerhead mounted anodes at least annually, more often if operated or stored in salty conditions.

Regardless of the number, there are some fundamental rules to follow that will give your boat and motor's sacrificial anodes the ability to do the best job protecting your boat's underwater hardware that they can.

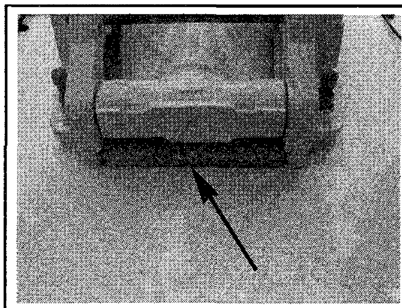


Fig. 86 All motors also use at least one (1) anode on the bottom of the transom bracket...

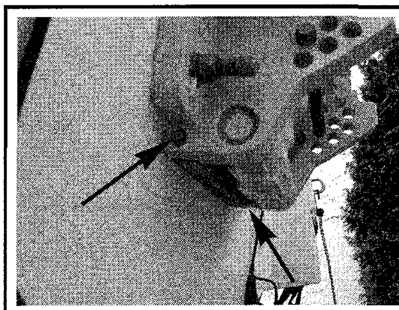


Fig. 87 ...this one is secured by a bolt on either side

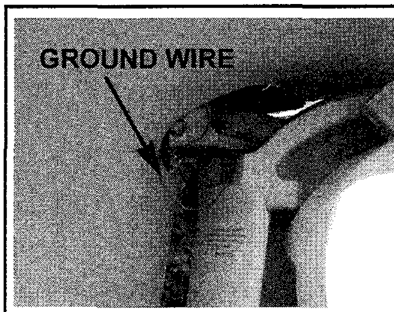


Fig. 88 Though not anodes, ground wires are also used to fight corrosion

Some people replace all zincs annually (not including anodes mounted inside the gearcase such as on the propshaft bearing housing). This may or may not be necessary, depending on the type of waters in which you boat and depending on whether or not the boat is hauled with each use or left in for the season. Either way, it is a good idea to remove zincs at least annually in order to make sure the mounting surfaces are still clean and free of corrosion.

The first thing to remember is that zincs are electrical components and like all electrical components, they require good clean connections. So after you've undone the mounting hardware you want to get the zinc mounting sites clean and shiny.

Get a piece of coarse emery cloth or some 80 grit sandpaper. Thoroughly rough up the areas where the zincs attach (there's often a bit of corrosion residue in these spots). Make sure to remove every trace of corrosion.

Zincs are attached with stainless steel machine screws that thread into the mounting for the zincs. Over the course of a season, this mounting hardware is inclined to loosen. Mount the zincs and tighten the mounting hardware securely. Tap the zincs with a hammer hitting the mounting screws squarely. This process tightens the zincs and allows the mounting hardware to become a bit loose in the process. Now, do the final tightening. This will insure your zincs stay put for the entire season.

Power Steering Belt

◆ See Figure 89

The power steering belt is a long-life component that, under normal circumstances should last up to 500 hours of operation. However, since it is easily accessed (at least for inspection purposes), we recommend inspecting it every time the engine top cover comes off. A quick visual check could prevent having to deal with a problem while you're on the water. Of course, the good news is that, in the event of a failure, you will not completely loose steering, but you will have to deal with greatly increased steering effort.

INSPECTON

① EASY

◆ See Figure 89

Periodically remove the top cover and visually inspect the belt for signs of deterioration or damage. Small cracks across the belt do not constitute a problem, as this is a normal sign of aging for belt materials. But, look for signs of fraying or damage such as missing chunks or belt segments. Also, check the belt for signs of excessive play, as an overly loose belt can damage the pump bearings. Damaged belts should be replaced as soon as possible to avoid a failure in use.

✳✳ WARNING

Should the power steering system loose hydraulic pressure or otherwise become inoperative, shut the engine **OFF,** cut the power steering belt and remove it from the **pulleys. This** is necessary to prevent the possibility of permanent damage to the pump if it is run without proper hydraulic **fluid/pressure.**

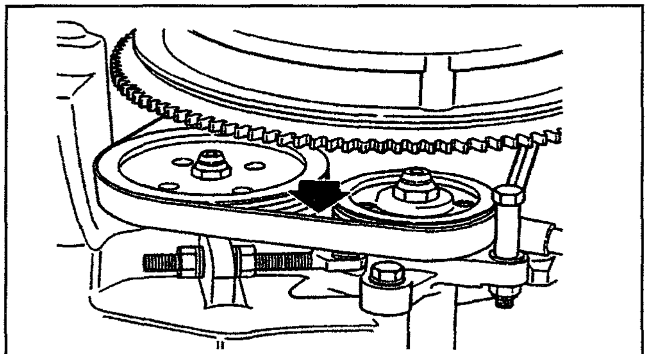


Fig. 89 Check the power steering pump belt frequently-tension is adjusted by the threaded rod visible just underneath the belt in the illustration

An idler pulley controls power steering belt tension. The position of the idler pulley (and therefore the belt tension) is controlled using a threaded adjuster that is inserted through a boss on top of the powerhead. To adjust belt tension, loosen the idler housing pivot screws (just slightly), then loosen the locknuts and washer and turn the adjuster in or out to increase or decrease belt tension. Once tension is correct, tighten the top idler pivot screw, followed by the bottom pivot screw to 108-132 inch lbs. (12-15 Nm). Tighten the adjustment rod locknuts to the same figure.

Belt tension should be checked at least every 50 hours or once a season (during the pre-season tune-up) whichever comes first. The proper way to adjust belt tension is to start and run the engine (using a suitable source of cooling water) at about 800 rpm for 2 minutes. Then, stop the engine and check the tension using a bent tension gauge. Measuring mid-point between the idler and flywheel pulleys, belt tension should be about 25-30 pounds.

REMOVAL & INSTALLATION

② MODERATE

◆ See Figure 89

Belt access is a relatively simple matter on MOST outboards.The belt, pump and idler pulleys are usually visible and accessible once the engine top cover is removed. However, the belt is driven off a pulley on the top of the crankshaft that is UNDER the flywheel. In some cases, the belt can be snaked out without removing the flywheel (though caution must be taken to ensure it is properly seated on the pulley under the flywheel during installation). In order to snake the belt out, some other components may be to be unbolted and repositioned on top of the powerhead, adjacent to the flywheel.

Of course, removing the flywheel may just be the easier option for belt access. Once the flywheel is removed, the belt replacement procedure is very straightforward.

Whenever a belt is replaced, the belt tension should be rechecked and adjusted (as necessary) after 10 hours of operation.

✳✳ WARNING

Use caution when adjusting the belt, as either a belt that is too loose or a belt that is too **tight can permanently** damage the pump.

1. Disconnect the negative battery cable for safety.
2. Loosen the upper and lower idler housing pivot screws, then loosen locknuts and washer on the idler pulley tension adjuster, then turn the adjuster sufficiently to release belt tension.
3. If necessary for access, remove the Flywheel as detailed in the Powerhead section. If the flywheel is not removed, check the perimeter to make sure no other components must be removed in order to snake the belt out from underneath.

Snap-On A-144 flywheel holding fixture or equivalent can be used to hold the flywheel steady on these motors while a 1 7/16 in socket is used to loosen the flywheel retainer.

4. If the flywheel is being removed, loosen and remove the 6 screws securing the pulley to the flywheel. Then, use a universal puller to release the flywheel from the powerhead.
5. Remove the belt from the pulleys.

To install:

6. Route the belt over the pulleys. If necessary, adjust the idler pulley to make this easier.

If the flywheel was not removed, use extreme caution to make sure the belt is properly seated in all pulley grooves before adjusting the belt tension.

7. Clean the crankshaft and flywheel tapers using Evinrude/Johnson Cleaning Solvent, or equivalent, and allow it to air dry. Align the flywheel keyway and install the flywheel, then coat the threads of a NEW retaining nut using Evinrude/Johnson Gasket Sealing Compound. Install the nut and tighten to 140-150 ft. lbs. (190-204 Nm).

8. Install the 6 pulley screws and tighten to 60-84 inch lbs. (7-9 Nm).

☐ The belt must not be loose enough to either slip or chatter on the pulleys, but it should not be so tight as to preload and damage the pump bearings. Gentle thumb pressure at the belt mid-span along the longest stretch between **2** pulleys should produce less than an inch of deflection.

9. Using the threaded adjuster, reposition the idler pulley to tension the belt. Measuring mid-point between the idler and flywheel pulleys, belt tension should be about 25-30 pounds.

10. Once tension is correct, tighten the top idler pivot screw, followed by the bottom pivot screw to 108-132 inch lbs. (12-15 Nm). Tighten the adjustment rod locknuts to the same figure.

■ The motor should be started and run at about **800** rpm for about **2** minutes, then the belt tension rechecked and readjusted, as necessary. Remember, the motor cannot be run, even for a few seconds, without a source of cooling water.

11. Connect the negative battery cable.
12. Recheck the belt after the first 10 hours of operation on a new belt.

BOAT MAINTENANCE

Batteries

◆ See Figures **90** and **91**

Batteries require periodic servicing, so a definite maintenance program will help ensure extended life.
A failure to maintain the battery in good order can prevent it from properly charging or properly performing its job even when fully charged. Low levels of electrolyte in the cells, loose or dirty cable connections at the battery terminals or possibly an excessively dirty battery top can all contribute to an improperly functioning battery. So battery maintenance, first and foremost, involves keeping the battery full of electrolyte, properly charged and keeping the casing/connections clean of corrosion or debris.

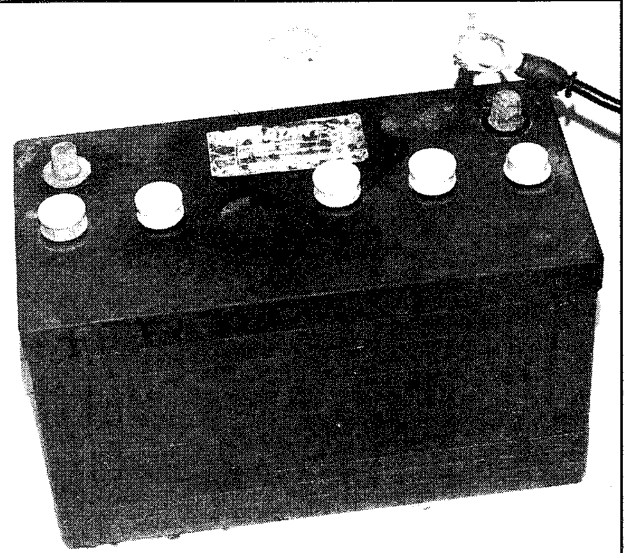


Fig. **90** Explosive hydrogen gas is released from the batteries in a discharged **state. This** one exploded when the gas ignited from someone smoking with a cap. Explosions can also be caused by **a** spark from the battery terminals or jumper cables

If a battery charges and tests satisfactorily but still fails to perform properly in service, one of three problems could be the cause.

1. An accessory left on overnight or for a long period of time can discharge a battery.
2. Using more electrical power than the stator assembly or lighting coil can replace would slowly drain the battery during motor operation, resulting in an undercharged condition.
3. A defect in the charging system. A faulty stator assembly or lighting coil, defective regulator or rectifier or high resistance somewhere in the system could cause the battery to become undercharged.

MAINTENANCE

① EASY

◆ See Figures **91, 92, 93** and **94**

Electrolyte Level

The most common and important procedure in battery maintenance is checking the electrolyte level. On most batteries this is accomplished by removing the cell caps and visually observing the level in the cells. The bottom of each cell has a split vent that will cause the surface of the electrolyte to appear distorted when it makes contact. When the distortion first appears at the bottom of the split vent, the electrolyte level is correct. Smaller marine batteries are sometimes equipped with translucent cases that are printed or embossed with high and low level markings on the side. On some of these, shining a flashlight through the battery case will help make it easier to determine the electrolyte level.

During hot weather and periods of heavy use, the electrolyte level should be checked more often than during normal operation. Add distilled water to bring the level of electrolyte in each cell to the proper level. Take care not to overfill, because adding an excessive amount of water will cause loss of electrolyte and any loss will result in poor performance, short battery life and will contribute quickly to corrosion.

☐ Never add electrolyte from another battery. Use only distilled water. Even **tap** water may contain minerals or additives that will promote **corrosion** on the **battery** plates, so distilled water is **always** the best solution.

Although less common in marine applications than other uses today, sealed maintenance-free batteries also require electrolyte level checks,

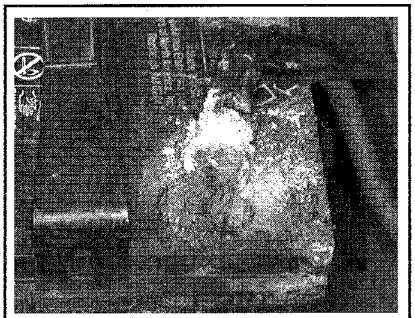


Fig. 91 Ignoring a battery (and corrosion) to this extent is asking for it to fail

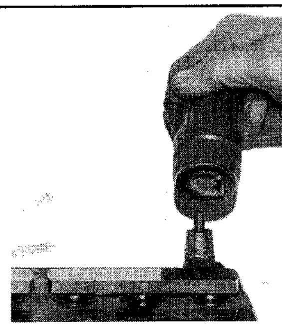


Fig. **92** Place a battery terminal tool over posts, then rotate back and forth **...**

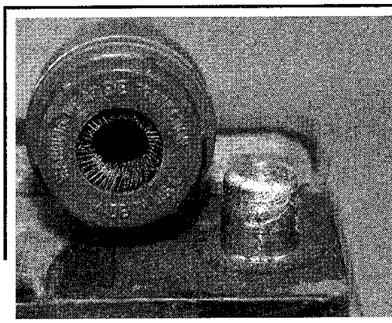


Fig. **93** **...** until the internal brushes expose a fresh, clean surface on the post

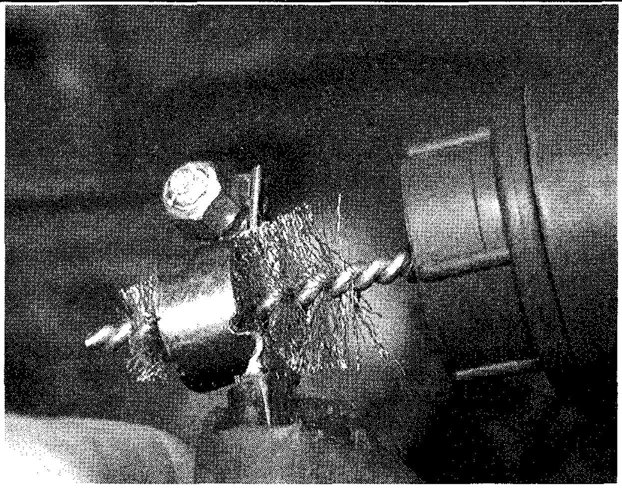


Fig. 94 **Clean the insides of cable ring terminals using the tool's wire brush**

through the window built into the tops of the cases. The problem for marine applications is the tendency for deep cycle use to cause electrolyte evaporation and electrolyte cannot be replenished in a sealed battery.

The second most important procedure in battery maintenance is periodically cleaning the battery terminals and case,

Cleaning

Dirt and corrosion should be cleaned from the battery as soon as it is discovered. Any accumulation of acid film or dirt will permit a small amount of current to flow between the terminals. Such a current flow will drain the battery over a period of time.

Clean the exterior of the battery with a solution of diluted ammonia or a paste made from baking soda and water. This is a base solution to neutralize any acid that may be present. Flush the cleaning solution off with plenty of clean water.

■ **Take care to prevent any of the neutralizing solution from entering the cells as it will quickly neutralize the electrolyte (ruining the battery).**

Poor contact at the terminals will add resistance to the charging circuit. This resistance will cause the voltage regulator to register a fully charged battery and thus cut down on the stator assembly or lighting coil output adding to the low battery charge problem.

At least once a season, the battery terminals and cable clamps should be cleaned. Loosen the clamps and remove the cables, negative cable first. On batteries with top mounted posts, if the terminals appear stuck, use a puller specially made for this purpose to ensure the battery casing is not damaged. NEVER pry a terminal off a battery post. These are inexpensive and available in most parts stores.

Clean the cable clamps and the battery terminal with a wire brush until all corrosion, grease, etc., is removed and the metal is shiny. It is especially important to clean the inside of the clamp thoroughly (a wire brush or brush part of a battery post cleaning tool is useful here), since a small deposit of foreign material or oxidation there will prevent a sound electrical connection and inhibit either starting or charging. It is also a good idea to apply some dielectric grease to the terminal, as this will aid in the prevention of corrosion.

After the clamps and terminals are clean, reinstall the cables, negative cable last, do not hammer the clamps onto battery posts. Tighten the clamps securely but do not distort them. To help slow or prevent corrosion, give the clamps and terminals a thin external coating of grease after installation.

Check the cables at the same time that the terminals are cleaned. If the insulation is cracked or broken or if its end is frayed, that cable should be replaced with a new one of the same length and gauge.

OEM ② MODERATE

TESTING

◆ **See Figure 95**

A quick check of the battery is to place a voltmeter across the terminals. Although this is by no means a clear indication, it gives you a starting point when trying to troubleshoot an electrical problem that could be battery related. Most marine batteries will be of the 12 volt DC variety. They are constructed of 6 cells, each of which is capable of producing slightly more than two volts, wired in series so that total voltage is 12 and a fraction. A fully charged battery will normally show more than 12 and slightly less than 13 volts across its terminals. But keep in mind that just because a battery reads 12.6 or 12.7 volts does NOT mean it is fully charged. It is possible for it to have only a surface charge with very little amperage behind it to maintain that voltage rating for long under load. A discharged battery will read some value less than 12 volts, but can be brought back to 12 volts through recharging. Of course a battery with one or more shorted or un-chargeable cells will also read less than 12, but it cannot be brought back to 12t volts after charging. For this reason, the best method to check battery condition on most marine batteries is through a specific gravity check.

A hydrometer is a device that measures the density of a liquid when compared to water (specific gravity). Hydrometers are used to test batteries by measuring the percentage of sulfuric acid in the battery electrolyte in terms of specific gravity. When the condition of the battery drops from fully charged to discharged, the acid is converted to water as electrons leave the solution and enter the plates, causing the specific gravity of the electrolyte to drop.

It may not be common knowledge but hydrometer floats are calibrated for use at 80°F (27°C). If the hydrometer is used at any other temperature, hotter or colder, a correction factor must be applied.

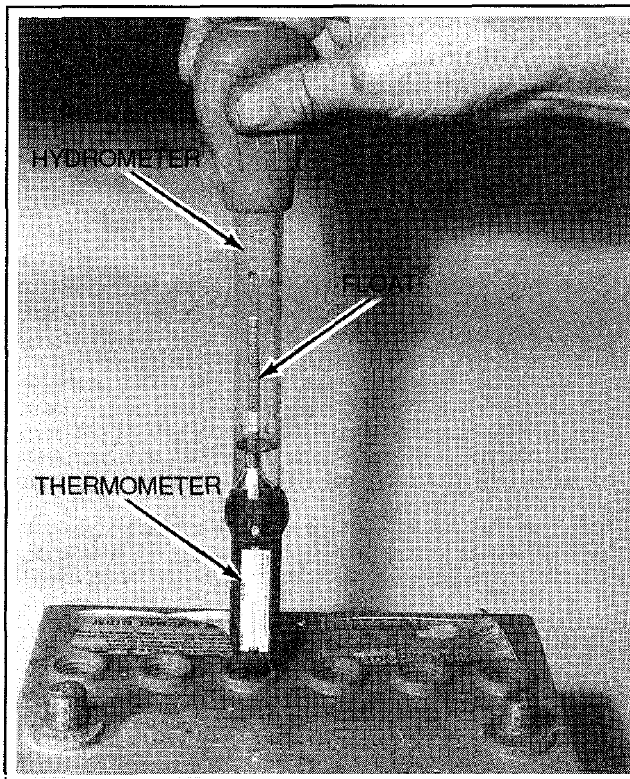


Fig. 95 A hydrometer is the best method for checking battery condition

☐ Remember, a liquid will expand if it is heated and will contract if cooled. Such expansion and contraction will cause a definite change in the specific gravity of the liquid, in this case the electrolyte.

A quality hydrometer will have a thermometerltemperaturecorrection table in the lower aortion. as illustrated in the accompanving illustration. By measuring the'air temperature around the battery and from the table, a correction factor may be applied to the specific gravity reading of the hydrometer float. In this manner, an accurate determination mav be made as to the condition of the battery.

When using a hydrometer, pay careful attention to the following points:

1. Never attempt to take a reading immediately after adding water to the battery. Allow at least 114 hour of charging at a high rate to thoroughly mix the electrolyte with the new water. This time will also allow for the necessary gases to be created.
2. Always be sure the hydrometer is clean inside and out as a precaution against contaminating the electrolyte.
3. If a thermometer is an integral part of the hydrometer, draw liquid into it several times to ensure the correct temperature before taking a reading.
4. Be sure to hold the hydrometer vertically and suck up liquid only until the float is free and floating.
5. Always hold the hydrometer at eye level and take the reading at the surface of the liquid with the float free and floating.
6. Disregard the slight curvature appearing where the liquid rises against the float stem. This phenomenon is due to surface tension.
7. Do not drop any of the battery fluid on the boat or on your clothing, because it is extremely caustic. Use water and baking soda to neutralize any battery liquid that does accidentally drop.
8. After drawing electrolyte from the battery cell until the float is barely free, note the level of the liquid inside the hydrometer, If the level is within the charged (usually green) band range for all cells, the condition of the battery is satisfactory. If the level is within the discharged (usually white) band for all cells, the battery is in fair condition.
9. If the level is within the green or white band for all cells except one, which registers in the red, the cell is shorted internally. No amount of charging will bring the battery back to satisfactory condition.
10. If the level in all cells is about the same, even if it falls in the red band, the battery may be recharged and returned to service. If the level fails to rise above the red band after charging, the only solution is to replace the battery.

STORAGE

If the boat is to be laid up (placed into storage) for the winter or for more than a few weeks, special attention must be given to the battery to prevent complete discharge and/or possible damage to the terminals and wiring. Before putting the boat in storage, disconnect and remove the batteries. Clean them thoroughly of any dirt or corrosion and then charge them to full specific gravity readings. After they are fully charged, store them in a clean cool dry place where they will not be damaged or knocked over, preferably on a couple blocks of wood. Storing the battery up off the deck, will permit air to circulate freely around and under the battery and will help to prevent condensation.

Never store the battery with anything on top of it or cover the battery in such a manner as to prevent air from circulating around the filler caps. All batteries, both new and old, will discharge during periods of storage, more so if they are hot than if they remain cool. Therefore, the electrolyte level and the specific gravity should be checked at regular intervals. A drop in the specific gravity reading is cause to charge them back to a full reading.

In cold climates, care should be exercised in selecting the battery storage area. A fully charged battery will freeze at about 60°F (17°C) below zero. The electrolyte of a discharged battery, almost dead, will begin forming ice at about 19°F (-7°C) above zero.

☐ For more information on batteries and the engine electrical systems, please refer to the **Ignition** and Electrical section of this manual.

Fiberglass Hull

INSPECTION AND CARE

◆ See Figures **96, 97** and **98**

Fiberglass reinforced plastic hulls are tough, durable and highly resistant to impact. However, like any other material they can be damaged. One of the advantages of this type of construction is the relative ease with which it may be repaired.

A fiberglass hull has almost no internal stresses. Therefore, when the hull is broken or stove-in, it retains its true form. It will not dent to take an out-of-shape set. When the hull sustains a severe blow, the impact will be either absorbed by deflection of the laminated panel or the blow will result in a definite, localized break. In addition to hull damage, bulkheads, stringers and other stiffening structures attached to the hull may also be affected and therefore, should be checked. Repairs are usually confined to the general area of the rupture.

The best way to care for a fiberglass hull is to wash it thoroughly, immediately after hauling the boat while the hull is still wet.

A foul bottom can seriously affect boat performance. This is one reason why racers, large and small, both powerboat and sail, are constantly giving attention to the condition of the hull below the waterline.

In areas where marine growth is prevalent, a coating of vinyl, anti-fouling bottom paint should be applied if the boat is going to be left in the water for extended periods of time such as all or a large part of the season. If growth has developed on the bottom, it can be removed with a diluted solution of muriatic acid applied with a brush or swab and then rinsed with clear water. Always use rubber gloves when working with Muriatic acid and take extra care to keep it away from your face and hands. The fumes are toxic. Therefore, work in a well-ventilated area, or if outside, keep your face on the windward side of the work.

If marine growth is not too severe you may avoid the unpleasantness of working with **muriatic** acid by trying a powerwasher instead. Most marine vegetation can be removed with pressurized water and a little bit of scrubbing using a rough sponge (don't use anything that will scratch or damage the surface).

Barnacles have a nasty habit of making their home on the bottom of boats that have not been treated with anti-fouling paint. Actually they will not harm the fiberglass hull but can develop into a major nuisance.

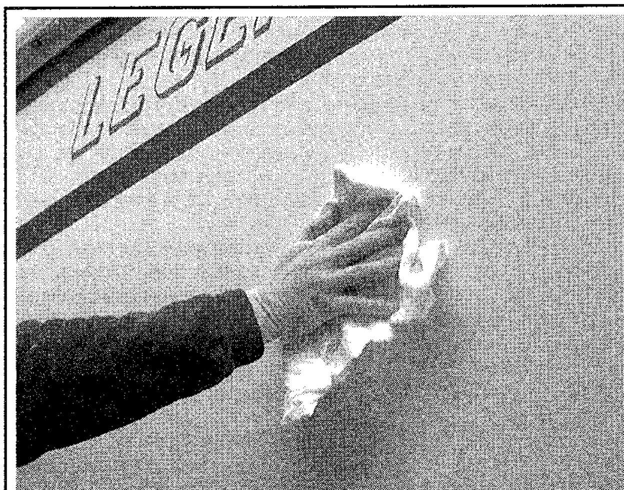


Fig. **96** The best way to care for a fiberglass hull is to wash it thoroughly

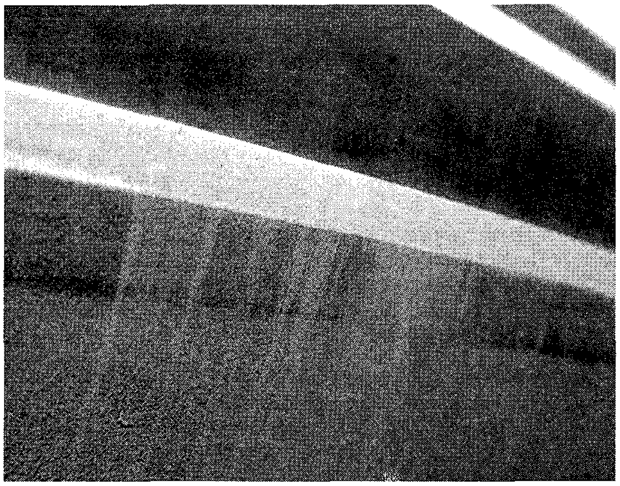


Fig. 97 If marine growth is a problem, apply a coating of anti-foul bottom paint

Fig. 98 Fiberglass, vinyl and rubber care products, like those from Meguiar's protect your boat

If barnacles or other crustaceans have attached themselves to the hull, extra work will be required to bring the bottom back to a satisfactory condition. First, if practical, put the boat into a body of fresh water and allow it to remain for a few days. A large percentage of the growth can be removed in this manner. If this remedy is not possible, wash the bottom thoroughly with a high-pressure sh 'ate source and use a scraper. Small particles of hard shell may still hold fast. These can be removed with sandpaper

TUNE-UP

Introduction

A proper tune-up is the key to long and trouble-free outboard life and the work can yield its own rewards. Studies have shown that a properly tuned and maintained outboard can achieve better fuel economy than an out-of-tune engine. As a conscientious boater, set aside a Saturday morning, say once a month, to check or replace items that could cause major problems later. Keep your own personal log to jot down which services you performed, how much the parts cost you, the date and the number of hours on the engine at the time. Keep all receipts for such items as oil and filters, so that they may be referred to in case of related problems or to determine operating expenses. These receipts are the only proof you have that the required maintenance was performed. In the event of a warranty problem on newer engines, these receipts will be invaluable.

The efficiency, reliability, fuel economy and enjoyment available from boating are all directly dependent on having your outboard tuned properly. The importance of performing service work in the proper sequence cannot be over emphasized. Before making any adjustments, check the specifications. Never rely on memory when making critical adjustments.

Before tuning any outboard, insure it has satisfactory compression. An outboard with worn or broken piston rings, burned pistons or scored cylinder walls, will not perform properly no matter how much time and expense is spent on the tune-up. Poor compression must be corrected or the tune-up will not give the desired results.

The extent of the engine tune-up is usually dependent on the time lapse since the last service. In this section, a logical sequence of tune-up steps will be presented in general terms. If additional information or detailed service work is required, refer to the section of this manual containing the appropriate instructions.

Tune-Up Sequence

A tune-up can be defined as pre-determined series of procedures (adjustments, tests and replacement of worn components) that are performed to bring the engine operating parameters back to original condition (or as near original as possible). The series of steps are important, as the later procedures (especially adjustments) are dependant upon the earlier procedures. In other words, a procedure is performed only when subsequent steps would not change the result of that procedure (this is mostly for adjustments or settings that would be incorrect after changing another part or setting). For instance, fouled or excessively worn spark plugs may affect engine idle. If adjustments were made to the idle speed or mixture **before** these plugs were cleaned or replaced, the idle speed or mixture might be wrong after replacing the plugs. The possibilities of such an effect become much greater when dealing with multiple adjustments such as timing, idle speed and/or idle mixture. Therefore, be sure to follow each of the steps given here. Since many of the steps listed here are full procedures in themselves, refer to the procedures of the same name in this section for details.

A complete pre-season tune-up should be performed at the beginning of each season or anytime a motor is removed from storage. Operating conditions, amount of use and the frequency of maintenance required by your motor may make one or more additional tune-ups necessary during the season. Perform additional tune-ups as use dictates.

Under normal conditions a tune-up is expected about every 100 hours of operation. Excessive idle or wide-open throttle operation, use of poor quality engine oil or fuels, or other variables may necessitate shortening that timeframe.

1. Before starting, inspect the motor thoroughly for signs of obvious leaks, damage and loose or missing components. Make repairs, as necessary.

2. If Evinrude/Johnson Carbon Guard of equivalent is not used consistently with each fill-up, remove carbon from the pistons and combustion chamber after every 50 hours of operation. Refer to the Decarboning the Pistons in this section.

☐ **Although the service literature and owners manuals do not specifically mention it, every dealer we've talked to felt that the use of Carbon Guard was unnecessary when using FICHT RAM oil with CarbX® combustion cleaner.**

3. Perform a compression check to make sure the motor is mechanically ready for a tune-up. An engine with low compression on one or more cylinder should be overhauled, not tuned. A tune-up will not be successful without sufficient engine compression. Refer to the Compression Test in this section.

4. Since the spark plugs must be removed for the compression check, take the opportunity to inspect them thoroughly for signs of oil fouling, carbon fouling, damage due to detonation, etc. Clean and regap the plugs or, better yet, install new plugs, as no amount of cleaning will precisely match the performance and life of new plugs. Refer to Spark Plugs, in this section.

5. Inspect all ignition system components for signs of obvious defects. Look for signs of burnt, cracked or broken insulation. Replace wires or components with obvious defects. If spark plug condition suggests weak or no spark on one or more cylinders, perform ignition system testing to eliminate possible worn or defective components. Refer to the Ignition System Inspection procedures in this section and the Ignition and Electrical System section.

6. Remove and clean (on serviceable filters) or replace the inline filter and/or fuel pump filter, as equipped. Refer to the Fuel Filter procedures in this section. Perform a thorough inspection of the fuel system, hoses and components. Replace any cracked or deteriorating hoses.

7. Perform engine Timing and Synchronization adjustments as described in this section.

Although most of the motors covered by this manual allow for certain ignition timing and carburetor adjustment procedures, none of them require the level of tuning attention that was once the norm. Many of the motors are equipped with electronic ignition systems that limit or eliminate timing adjustments. Most of the carburetors used by these motors are **U.S.** EPA regulated and contain few mixture adjustments (many with fixed low **and/or** high speed jets). FICHT motors are all but completely controlled by the Engine Management Module (EMM) and contain no timing or fuel adjustments (although most include methods for physical timing pointer verification and crankshaft position sensor air gap adjustments).

8. Except for jet drive models, remove the propeller in order to inspect for leaks thoroughly at the shaft seal. Inspect the propeller or rotor condition, look for nicks, cracks or other signs of damage and repair or replace, as necessary. If available, install a test wheel to run the motor in a test tank after completion of the tune-up. If no test wheel is available, lubricate the shaftlsplines, then install the propeller. Refer to the procedure for Propeller, in this section.

9. Change the lower unit oil as directed under the Lower Unit Oil procedures in this section. If you are conducting a pre-season tune-up and the oil was changed immediately prior to storage this is not necessary. But, be sure to check the oil level and condition. Drain the oil anyway if significant contamination is present.

☐ Anytime large amounts of water or debris is present in the lower unit **oil,** be sure to troubleshoot and repair the problem before returning the lower unit to **service. The** presence of water may indicate problems with the seals, while debris could a sign that overhaul is required.

10. Check all accessible bolts and fasteners and tighten any that are loose.

11. Pressurize the fuel system according to the procedures found in the Fuel System section, then check carefully for leaks.

12. Perform a test run of the engine to verify proper operation of the starting, fuel, oil and cooling systems. Although this can be performed using a flush/test adapter, or even on the boat itself (if operating with a normal load/passengers), the preferred method is the use of a test tank. If possible, run the engine, in a test tank using the appropriate test wheel. Monitor the cooling system indicator stream to ensure the water pump is working properly. Once the engine is fully warmed, slowly advance the engine to wide-open throttle, then note and record the maximum engine speed. Refer to the Tune-up Specifications chart to compare engine speeds with the test propeller minimum rpm specifications. If engine speeds are below specifications, yet engine compression was sufficient at the beginning of this procedure, recheck the fuel and ignition system adjustments.

Decarboning the Pistons

A by-product of the normal combustion process; carbon will build-up on the pistons and in the combustion chambers of a motor over time. Engine tuning and condition will affect this process, as a properly tuned engine running high-quality fuels under proper conditions will reduce the amount of build-up, but not stop it completely. Generally speaking an out-of-tune motor, a motor running too rich or a motor run under extended idle conditions will increase the rate at which carbon deposits are formed. Carbon, when its presence becomes significant enough, will increase the compression ratio (by decreasing effective combustion chamber size) and will lead to detonation. Also, over time, carbon may cause piston rings to stick, which would lead to blow-by. For this reason, Johnson/Evinrude recommends the use of Evinrude/Johnson Carbon Guard fuel additive with each fill up in order to help slow this process.

☐ Although the service and owner's literature do not specifically mention the exception, every dealer we've approached feels that Carbon Guard is not necessary on FICHT motors that use **Evinrude/Johnson** FICHT RAM Oil with **CarbX®** combustion chamber cleaner.

The manufacturer also warns that, if this fuel additive is not used, the pistons and combustion chambers should be cleaned of deposits using Evinrude/Johnson Engine Tuner after, at least every 50 hours of engine operation. As noted earlier. variables such as tvoes of fuel used and patterns of usage (wide-open throttle vs. extensive idle) will also have an effect upon how often this procedure should be followed. Let your own experience (and the amount of carbon found on your spark plugs) be your guide,

✳✳ WARNING

Because of the direct fuel injection system used on FICHT motors, spraying **Johnson/Evinrude** EngineTuner into the throttle bodies of a running FICHT outboard will result in an increase of **speed. To** prevent the possibility of dangerous overspeed and resulting powerhead damage on FICHT motors, it is best to perform this operation with the motor running in-gear and the boat attached securely to a dock or the trailer (or alternately to use a test tank and an appropriate test wheel). Your other option for these motors is to remove the spark plugs, tilt the motor fully upward, and spray the tuner directly onto the top of each piston while it is at **TDC. Turn** the motor slowly by hand, in a clockwise direction when viewed from above the flywheel, so each piston is at TDC when spraying. If using this method, be sure to thoroughly coat the inside of the combustion chamber, deflector pin, fuel injector and top of the piston. Perform **the TDC** spray and soak procedure at least **2** times for each cylinder, using the entire can of Engine Tuner.

1. Provide the engine with a cooling water source (either and engine flushing adapter, a test tank, or if necessary, perform this procedure with the boat and motor in the water, attached to a sturdy dock).

2. Start and run the engine at normal idle until it reaches normal operating temperature.

3. Set the engine to fast idle (except on fuel injected motors where the idle speed is controlled by the computer module), For most engines a fast idle of around 1200 rpm is sufficient.

4. For severe cases of carbon build-up, run the engine to normal operating temperature, then shut the engine off and remove the spark plugs. Lay the engine into a horizontal position and peer through the spark plug holes as you slowly turn the motor over by hand (do so by turning the engine clockwise when viewed from above the flywheel). With the pistons leveled so as to best block of the ports, cover the tops of the pistons with engine tuner and let sit for approximately I hour. After at least that amount of time, rotate the engine a couple of revolutions by hand to begin removing the cleaner. Then, proceed with the next step to finish the can of Engine Tuner.

■ **Evinrude/Johnson** service literature gives **2** conflicting recommendations for the amount of time EngineTuner should be left in the motor. Materials published before **1996,** for the **1992-95** model years tell technicians to leave the EngineTuner in for no MORE than **1** hour. But, literature published for **1996** and later model years instructs the technician to allow the engine tuner to soak for **3-16 hours. There** does not appear to be any change in design or materials on these later motors AND, perhaps more importantly, the cans of Engine Tuner available while this text was being written do not give any cautions against letting the motor soak longer than an **hour. You'll** have to make up your own mind, but we can't find the harm in allowing the motor to soak longer.

5. For less severe (typical cases of carbon build-up), spray the entire contents of the EvinrudelJohnson Engine Tuner can with the engine still running from Step 3 above. Spray the Tuner either through the carburetor throats, through the fuel primer solenoid fogging fitting, or through the holes in the throttle plates (inside the throttle body throats) on FICHT motors. When equipped, it is best to use the fogging fitting to ensure even distribution of the Engine Tuner. But, if the engine is not equipped with an electric primer solenoid, move the spray nozzle from carburetor-to-carburetor (or throttle body-to-throttle body), back and forth in sequence until the can is emptied. Once all of the Engine Tuner has been sprayed, shut the engine off and allow the cleaner to penetrate for at least 15 minutes (but more time is permissible).

6. If removed, reconnect the flushing device or place the engine back in the water (test tank or dockside), then start the engine again and warm it to normal operating temperature. When warmed, run the engine above 112 throttle for at least 3-5 minutes.

7. Shut the engine off, then remove and inspect the spark plugs. Shine a small light through each spark plug bore to examine the tops of the pistons and compare the visual evidence of carbon build-up to that before the procedure. If necessary, repeat the procedure using a second can of engine tuner and following the step for severe cases.

■ Some **FICHT** motors are equipped with an Exhaust Pressure (EP) sensor mounted inside the Engine Management Module and a pressure diaphragm mounted near the module. For these motors a sensor tube is mounted in the exhaust (usually on the starboard side). Check the tube for blockage each time the motor is **de-carboned. To** do this, disconnect the hose from the tube side (not the EMM side) of the pressure diaphragm and gently blow through it to make sure there are no obstructions. If it is obviously restricted, or you cannot tell, remove it for cleaning and inspection (by disconnecting the hose from the end of the tube and carefully unthreading the **fitting). You** may be able to clean it by soaking it overnight in **Engine Tuner,** but if not, replace the tube to ensure proper operation. Be careful when disconnecting the hose from the plastic diaphragm housing or from the tube itself.

Compression Check

The quickest (but not necessarily most accurate) way to gauge the condition of an internal combustion engine is through a compression check. In order for an internal combustion engine to work properly, it must be able to generate sufficient compression in the combustion chamber to take advantage of the explosive force generated by the expanding gases after ignition, This is true on all motors whether they are of the 2- or 4-stroke design.

If the combustion chambers or ports (or any mating surfaces like cylinder heads and gaskets) are worn or damaged in some fashion as to allow pressure to escape, the engine cannot develop sufficient horsepower. Under these circumstances, combustion will not occur properly, air/fuel mixtures cannot be set to maximize power and minimize emissions. An engine with poor compression on one or more cylinders cannot be given a proper tune-up, it should be overhauled.

There are two types of compression checks generally conducted by technicians. The first, which is included here, is called a compression check or sometimes a tune-up compression check. It is a quick-test used during a tune-up to determine if you should continue or stop and overhaul the motor. This test is what technicians think of when you say compression check as it measures the ability of a motor to create compression.

A compression check requires a compression gauge and a spark plug port adapter that matches the plug threads of your motor.

Some technicians, during deeper diagnostic work or to verify a rebuild before returning it to service, will perform a second compression check known as a leakage or leak-down check. This test, which uses special gauges, adapters and a pressurized air supply, measures the ability of an engine to hold pressure (as opposed to create it).

OEM

PERFORMING A TUNE-UP COMPRESSION CHECK

② MODERATE

◆ **See** Figure 99

When analyzing the results of a compression check, generally the actual amount of pressure measured during a compression check is not AS important as the variation from cylinder-to-cylinder on the same motor. However, it appears that the manufacturer changed its recommendations to EvinrudelJohnson field technicians over the years. Through 1995, Evinrude/Johnson advised that the variations between cylinders should not exceed 15 psi (100 kPa) or more. However, starting in 1996 (with no apparent change in design or construction), EvinrudelJohnson eased a bit on the compression specifications. Beginning in 1996, the manufacturer instructed technicians that there should be no more than a 20% variation between the lowest and highest cylinders (i.e. that the lowest cylinder reading must be 80% or more of the highest cylinder reading.

■ It does not appear that EvinrudelJohnson changed the motors between 1995 and 1996 leading to different specifications for compression checks. It seems that they instead changed their mind set, adopting a new, and somewhat less strict, set of standards. Which one you decide to follow is your own choice. Following the stricter standard, however, could lead to overhauling a motor that otherwise is performing properly. We'd recommend that a motor, even from 1992. 1995 model years, that is out of the 15 psi (100 **kPa)** spec, but STILL within the **80%** spec, be tuned. If it runs properly, then an overhaul is not necessary**...y**et.

Of course, the MOST important specification when it comes to compression checks is, how much has the spec changed from the last test The first thing you should do with a new motor is to take a compression reading for each cylinder and mark it down. The same should be done with each successive tune-up thereafter. In this way, you can track the internal wear in the motor over time, possibly even predicting at what point an overhaul might be necessary (unless a component failure necessitates one sooner). Even for a used motor, a compression check is the first step in knowing where you stand.

Ok, for the point of argument's sake let's say you bought the engine used and the last owner didn't have any information regarding previous compression checks, or let's say you never checked compression the first season or so, assuming it wasn't something you needed to worry about. You're not alone. Although EvinrudelJohnson does not publish a specification for the exact amount of compression each of their engines should generate, a general rule of thumb that can be applied is that internal combustion engines should generate at least 100 psi (690 kPa).

Another point of comparison for your compression specifications can be one of the tear-down motors we used for this book. A 2001 90 hp (1726cc) 60 degree V4 showed compression readings of 140-145 psi (965-1000 kPa) while we conducted its 20 hour break-in service. Some other brands of marine engines show published specifications of 115-142 psi (800-1000 kPa).

BUT, keep in mind that these are typical specs and not specifications for EvinrudelJohnson motors, so don't put too much credence on your results as compared to these. Again, comparison figures with the other cylinders on the same motor (or readings when the motor was new) are most important.

When taking readings during the compression check, repeat the procedure a few times for each cylinder, recording the highest reading for that cylinder. Then, compare the readings. The compression reading on the lowest cylinder should within 15 psi (100 kPa) or 80% (depending on the year or standard that you wish to apply) of the highest reading.

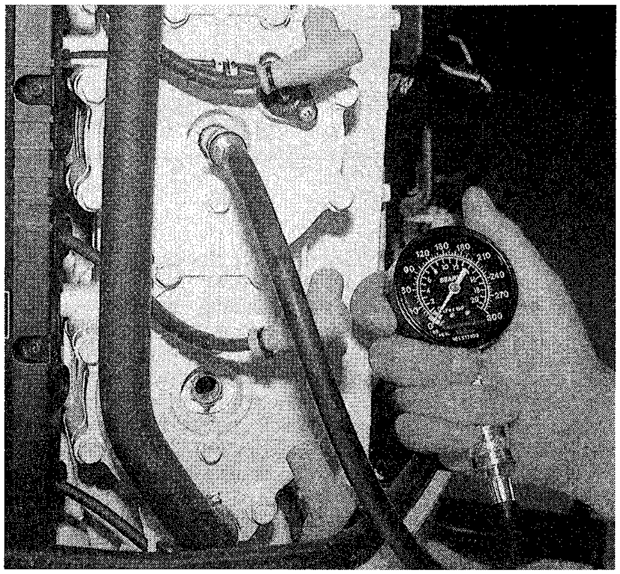


Fig. 99 Compression check on a typical multi-cylinder powerhead

When using the 80% standard, the compression **reading** on the lowest **cylinder reading** should **be equal** to 80% or more **of the** reading from the highest cylinder reading. In other words, the lowest reading should be the equal to or greater than the highest cylinder reading multiplied by 0.8. For example, if the highest reading was 150 psi (1034 **kPa),** then the lowest reading must be equal to or more than 150 psi x 0.8 (1035 **kPa** x 0.8) or 120 psi (827 **kPa).**

☐ If the powerhead has been in storage for an extended period, the piston rings may have **relaxed. This** will often lead to initially low and misleading readings. Always run an engine to normal operating temperature to ensure that the readings are accurate.

☐ If you've never removed the spark plugs from this cylinder head before, break each one loose and retighten them, to make sure they will not seize in the head once it is warmed. Better yet, remove each one and coat the threads very lightly with some fresh anti-seize compound.

1. Using a test tank, flush fitting adapter or other water supply, start and run the engine until it reaches normal operating temperature, then shut the engine off.
2. Disable the ignition system by connecting each spark plug wire to a good engine ground (using a jumper wire from the ground to the wire inside each spark plug boot). Never simply disconnect all the plug wires.

✱✱ CAUTION

Removing all of the spark plugs and cranking the powerhead can lead to an explosion if raw **fuel/oil** sprays out of the plug holes. A plug wire could spark and ignite this mix outside of the combustion chamber if it isn't grounded to the engine. Also, on many of the ignition systems covered, cranking the engine and firing the coil without allowing the coils to discharge through the spark plug leads can lead to severe damage to the ignition system.

3. Remove all the spark plugs and be sure to keep them in order. Carefully inspect the plugs, looking for any inconsistency in coloration and for any sign of water or rust near the tip. Refer to the procedures on Spark Plugs in this section for more details.

☐ On **FICHT** motors, the spark plugs must be indexed during i nstallation (notice the markings that probably appear on the shaft at this time, before you remove **them). The** markings are made during installation to make sure the gap winds up facing the fuel **injector. Take** note of this for installation purposes. For more details, refer to the Spark Plug procedures in this section.

3. Thread the compression gauge into the No. 1 spark-plug hole, taking care to not crossthread the fitting.
4. Open the throttle to the wide open throttle position and hold it there.

Some engines allow only minimal opening if the gearshift is in neutral, to guard against over-revving.

5. Crank over the engine an equal number of times for each cylinder you test, zeroing the gauge for each cylinder.
6. If you have electric start, count the number of seconds you crank. On manual start, pull the starter rope four to five times for each cylinder you are testing. (And, if you have manual start, and are about to try a compression check on one of these monsters, eat your spinach first, because you are going to be ONE TIRED PUPPY when you're finished).

For manual start motors, it really does make sense to remove ALL of the spark plugs before attempting to check compression. Removing the **plugs** on the cylinders not being checked will relieve **compression** on **those cylinders making** it **easier to** turn the motor using the rope.

7. Record your readings from each cylinder. When all cylinders are tested, compare the readings and determine if pressures are within the 15 psi (100 kPa) or 80% criterion, as applicable.

☐ Starting in 1996, **Evinrude/Johnson** also began advising technicians to average the compression readings for each bank (starboard and port) and to make sure that the averages of each bank do not differ by more than 15 psi (100 **kPa).**

8. If compression readings are lower than normal for any cylinders, try a "wet" compression test, which will temporarily seal the piston rings and determine if they are the cause of the low reading. Using a can of fogging oil, fog the cylinder with a circular motion to distribute oil spray all around the perimeter of the piston. Retest the cylinder:
   a. If the compression rises noticeably in a wet test, the piston rings are sticking. You may be able to cure the problem by decarboning the powerhead.
   b. If the dry compression test was really low and no change is evident during the wet test, the cylinder is dead. The piston and/or cylinder are worn beyond specification (possibilities include damaged pistons, broken or stuck pistons rings, scored cylinder walls or a blown head gasket) and a powerhead overhaul or replacement is necessary.
9. If two adjacent cylinders on a multi-cylinder engine give a similarly low reading then the problem may be a faulty head gasket. This should be suspected especially if there is evidence of water or rust on the spark plugs from these cylinders.
10. If the engine has compression within specification on all cylinders, yet is hard to start and runs poorly, there may still be damage to the powerhead, suspect the possibilities of scored cylinder walls, damaged pistons and/or stuck or worn piston rings.

Spark Plugs

The spark plug performs four main functions:

- First and foremost, it provides spark for the combustion process to occur.
- It also removes heat from the combustion chamber.
- Its removal provides access to the combustion chamber (for inspection or testing) through a hole in the cylinder head.
- It acts as a dielectric insulator for the ignition system.

It is important to remember that spark plugs do not create heat, they help remove it. Anything that prevents a spark plug from removing the proper amount of heat can lead to pre-ignition, detonation, premature spark plug failure and even internal engine damage, especially in 2-stroke engines.

In the simplest of terms, the spark plug acts as the thermometer of the engine. Much like a doctor examining a patient, this "thermometer" can be used to effectively diagnose the amount of heat present in each combustion chamber.

Spark plugs are valuable tuning tools, when interpreted correctly. They will show symptoms of other problems and can reveal a great deal about the engine's overall condition. Evaluating the appearance of the spark plug's firing tip, gives visual cues to determine the engine's overall operating condition, in order to get a feel for air/fuel ratios and even diagnose driveability problems.

As spark plugs grow older, they lose their sharp edges and material from the center and ground electrodes slowly erodes away. As the gap between these two points grows, the voltage required to bridge this gap increases proportionately.The ignition system must work harder to compensate for this higher voltage requirement and hence there is a greater rate of misfires or incomplete combustion cycles. Each misfire means lost horsepower, reduced fuel economy and higher emissions. Replacing worn out spark plugs with new ones (that have sharp new edges) effectively restores the ignition system's efficiency and reduces the percentage of misfires, restoring power, economy and reducing emissions.

■ **Although spark plugs can typically be cleaned and regapped if they are not excessively worn, no amount of cleaning or regapping will return most spark plugs to original condition and it is usually best to just go ahead and replace them.**

How long spark plugs last will depend on a variety of factors, including engine compression, fuel used, gap, center/ground electrode material and the conditions in which the outboard is operated.

SPARK PLUG HEAT RANGE

◆ **See Figure 100**

Spark plug heat range is the ability of the plug to dissipate heat from the combustion chamber. The longer the insulator (or the farther it extends into the engine), the hotter the plug will operate; the shorter the insulator (the closer the electrode is to the engine's cooling passages) the cooler it will operate.

Selecting a spark plug with the proper heat range will ensure that the tip maintains a temperature high enough to prevent fouling, yet cool enough to prevent pre-ignition. A plug that absorbs little heat and remains too cool will quickly accumulate deposits of oil and carbon since it won't be able to burn them off. This leads to plug fouling and consequently to misfiring. A plug that absorbs too much heat will have no deposits but, due to the excessive heat. the electrodes will burn away quickly and might also lead to pre-ignition or other ignition problems.

Pre-ignition takes place when plug tips get so hot that they glow sufficiently to ignite the air/fuel mixture before the actual spark occurs. This early ignition will usually cause a pinging during heavy loads and if not corrected, will result in severe engine damage. While there are many other things that can cause pre-ignition, selecting the proper heat range spark plug will ensure that the spark plug itself is not a hot-spot source.

■ **The manufacturer recommended spark plugs for carbureted motors are listed in the Tune-Up Specifications chart. When provided, alternate plugs for extended idle and/or extended wide-open throttle service are also listed. For fuel injected outboards, please refer to Spark Plugs for FICHT Motors.**

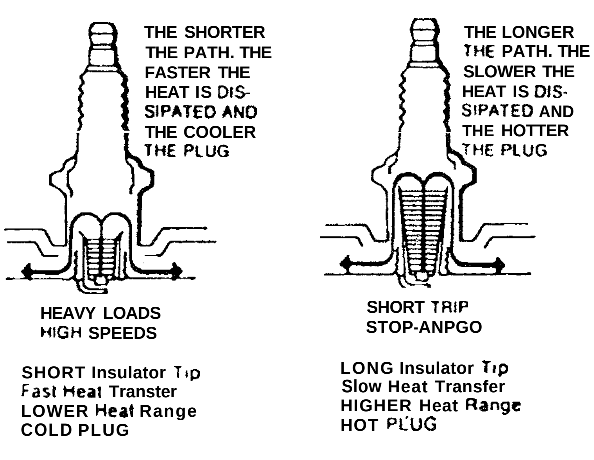


Fig. 100 Spark plug heat range

SPARK PLUGS FOR FICHT MOTORS

When introduced in 1997 FICHT motors went through some growing pains-Mostly due to problems with excessive carbon deposit buildup from extended low-speed operation. Multiple spark plugs were used during this time period and the original Emission Control Information labels early-model FICHT motors may refer you to use almost anything.

In fact, at the time of authoring, the factory service information published by OMC and still sold by Bombardier does not give you spark plug or gap specifications. In almost all cases we were referred to the Emission Control Information label.

However, after speaking with local dealers and researching the subject, we were able to find a couple of recommendations.First of all, most Emission Control labels on FICHT motors will advise the technician to use a spark plug gap within a range, instead of just a fixed number. Most FICHT labels recommend the a spark plug gap of 0.030 in. (0.76mm) give or take 0.003 in. (0.076mm). This translates into a range of 0.027-0.033 in. (0.69-0.84mm). But, FICHT motors use a multi-spark ignition system (that fires multiple times for each power stroke during certain conditions) and are generally very tough on their spark plugs causing accelerated wear. For this reason, we recommend gapping FICHT plugs at the low end of the range, more like 0.027 in (0.69mm) or 0.028 in. (0.71mm) to give the plug more time and gap to wear while in service. By the time the gap starts to exceed specification, there's a good chance the motor will begin showing signs of hard-starting, stumbling or missing, especially at high-speeds.

As for plug types, we normally recommend sticking with what is on the Emission Control Information label, but since some early-model powerheads may have been changed or serviced and we can't be sure the labels were always updated, we've got a few words of advice on the subject.

Some early 90-175 hp 60° V4 and V6 FICHT motors were equipped with non-deflector pin cylinder heads. These models were generally produced only for the 1997-1999 model years. We find most dealers are using Champion 7712 spark plugs on these motors. However, many of these powerheads were replaced if carbon buildup or other mechanical problems were experienced by the original owners (or by the rigging dealer). If you're working on one of these early-model 60° FICHTs, check the cylinder head for a small Allen® head bolt right next to each of the spark plugs (right between the spark plug and the FICHT fuel injector). When present, the powerhead contains updated "pinned" cylinder heads. These heads contain a deflector pin in the combustion chamber (positioned between the fuel injector and the spark plug, retained by the Allen@head bolt). The deflector pin is used to keep fuel from spraying directly on the spark plug, and helps to reduce plug fouling. All 2000 and later 75-175 hp 60° V4 and V6 FICHT motors use the pinned cylinder heads from the factory. On all motors with a pinned cylinder head, use Champion XC12PEP plugs.

For all 200-250 hp 90° V6 FICHT motors, use Champion QC12PEP spark plugs.

Of course, we stated earlier that we NORMALLY recommend sticking with the information on the Emission label, but in this case, we'll advise that we think you should use your heads. If the label, especially on an early-model powerhead, recommends a plug that is no longer available, use what we've suggested here or the superceding part from a dealer. If your FICHT motor is showing signs of plug fouling, and a plug other than what is listed here was used, again, try what we've suggested. Last, we've heard that the 7712 and QC12PEP plugs seem to work best for motors that have been experiencing plug fouling, so again, if you've tried other plugs and not had success, give them a try. Of course, you can always check with a local dealer to see what they recommend. You never know who might have found something that works even better. Just make sure whatever plug you use is a suppression type plug, as the use of non-suppression plugs may lead to performance problems.

■ **Some FICHT motors that show signs of carbon fouling are not the result of excessive low-speed operation, but are instead the victims of leaky oil or fuel diaphragms in the lift pumps. To check this, disconnect the pulse lines from the pumps and look for signs of leakage. The pumps can also be pressure-checked. For details, please refer to FICHT Fuel Injection under Fuel System or FICHT Oil Injection under Lubrication and Cooling.**

Another culprit that may lead to spark plug fouling is problems with the Thermostats. For more details, please refer to the Lubrication and Cooling section.

REMOVAL & INSTALLATION

◆ See Figures 101,102,103,104,105,106 and 107

■ New technologies in spark plug and ignition system design have greatly extended spark plug life over the years. But, spark plug life will still vary greatly with engine tuning, condition and usage. In general, 2-stroke motors are a little tougher on plugs, especially if great care is not taken to maintain proper **oil/fuel** mixtures on pre-mix motors. But, it is not uncommon for plugs to last up to **100** hours of operation.

Typically, spark plugs will require replacement once a season. The electrode on a new spark plug has a sharp edge but with use, this edge becomes rounded by wear, causing the plug gap to increase. As the gap increases, the plug's voltage requirement also increases. It requires a greater voltage to jump the wider gap and about two to three times as much voltage to fire a plug at high speeds then at idle.

Fouled plugs can cause hard-starting, engine mis-firing or other **problems. You** don't want that happening on the **water. Take** time, at least once a month to remove and inspect the spark plugs. Early signs of other tuning or mechanical problems may be found on the plugs that could save you from becoming stranded or even allow you to address a problem before it ruins the motor.

Tools needed for spark plug replacement include: a ratchet, short extension, spark plug socket (there are two types; either 13/16 in. or 518 in., depending upon the type of plug), a combination spark plug gauge and gapping tool and a can of anti-seize type compound.

FICHT motors require the spark plugs to be indexed (marked) in order to ensure that the **gap** is facing the fuel injector once it is installed and tightened. **Be sure** to **follow** the **FICHT s**teps in the accompanying procedures when working on any **FICHT** Fuel Injection (FFI) motors.

1. When removing spark plugs from multi-cylinder motors, work on one at a time. Don't start by removing the plug wires all at once, because unless you number them, they may become mixed up. Take a minute before you begin and number the wires with tape.
2. For safety, disconnect the negative battery cable or turn the battery switch OFF.
3. If the engine has been run recently, allow the engine to thoroughly cool (unless performing a compression check). Attempting to remove plugs from a hot cylinder head could cause the plugs to seize and damage the threads in the cylinder head, especially on aluminum heads!

To ensure an accurate reading during a compression check, the spark plugs must be removed from a hot engine. But, DO NOT force a plug if it feels like it is seized. Instead, wait until the engine has cooled, remove the plug and coat the threads lightly with anti-seize then reinstall and tighten the plug, then back off the tightened position a little less than 114 turn. With the **plug(s)** installed in this manner, re-warm the engine and conduct the compression check.

4. Carefully twist the spark plug wire boot to loosen it, then pull the boot using a twisting motion to remove it from the plug. Be sure to pull on the boot and not on the wire, otherwise the connector located inside the boot may become separated from the high-tension wire.

A spark plug wire removal tool is recommended as it will make removal easier and help prevent damage to the boot and wire assembly. Most tools have a wire loom that fits under the plug boot so the force of pulling upward is transmitted directly **to** the bottom of the boot.

5. Using compressed air (and safety glasses), blow debris from the spark plug area to assure that no harmful contaminants are allowed to enter the combustion chamber when the spark plug is removed. If compressed air is not available, use a rag or a brush'to clean the area. Compressed air is available from both an air comoressor or from compressed air in cans available at photography stores. In a pinch, blow up a balloon by hand and use the escaping air to blow debris from the spark plug port(s).

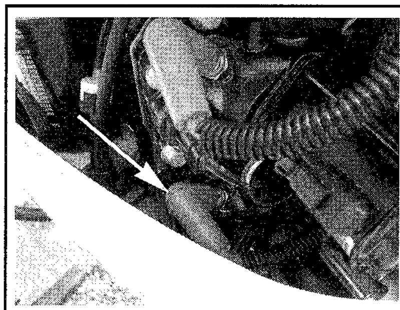


Fig. 101 On some motors, the lower engine cases interfere with access to the plugs

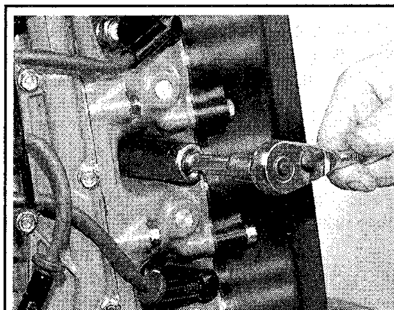


Fig. 102 With the lead removed, loosen the plug using a plug socket...

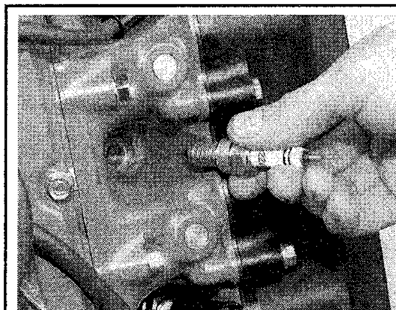


Fig. 103 ... then remove the spark plug from the cylinder head

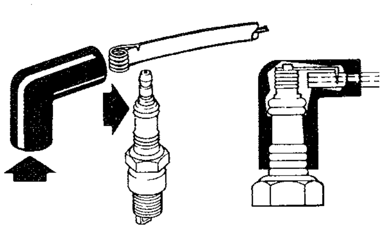


Fig. 104 To prevent corrosion, apply a small amount of grease to the plug and boot during installation

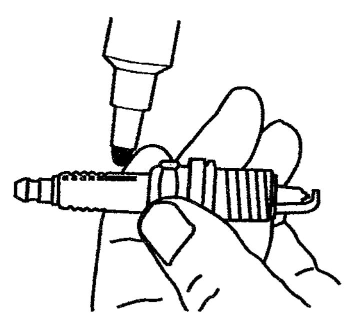


Fig. 105 On **FICHT** motors, place an indexing mark on the plug

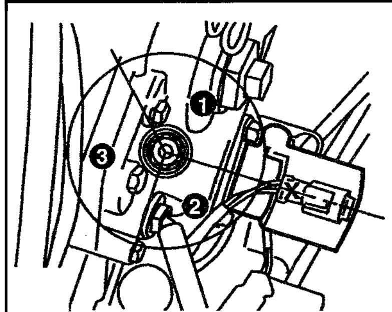


Fig. 106 Use these indexing regions as a guide when tightening the plug (it must roughly align between 1 and 2)

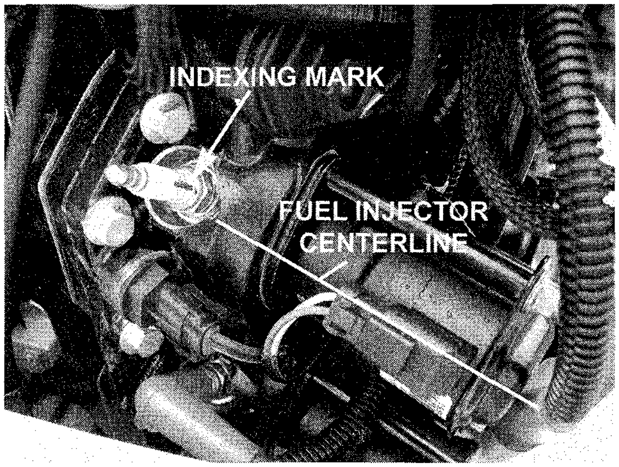


Fig. 107 On FICHT motors, make sure the plug indexing mark roughly faces the centerline of the fuel injector once it is tightened between **15-22 ft.** lbs. **(20-30** Nm)

■ Remove the spark plugs when the engine is cold, if possible, to prevent damage to the threads. If plug removal is difficult, apply a few drops of penetrating oil to the area around the base of the plug and allow it a few minutes to work.

6. Before proceeding any further on FICHT motors, look for the indexing mark on the old plug, it should be facing (roughly speaking) the fuel injector for that cylinder). Note the positioning, it does not have to be matched exactly, but that gives you an idea of what you will have to achieve during installation.
7. Using a spark plug socket that is equipped with a rubber insert to properly hold the plug, turn the spark plug counterclockwise to loosen and remove the spark plug from the bore.

**** WARNING**

Avoid the use of a flexible extension on the socket. Use of a flexible extension may allow a shear force to be applied to the plug. A shear force could break the plug off in the cylinder head, leading to costly **and/or** frustrating repairs. In addition, be sure to support the ratchet with your other hand-this will also help prevent the socket from damaging the plug.

8. Evaluate each cylinder's performance by comparing the spark condition. Check each spark plug to be sure they are from the same plug manufacturer and have the same heat range rating. Inspect the threads in the spark plug opening of the block and clean the threads before installing the plug.
9. When purchasing new spark plugs, always ask the dealer if there has been a spark plug change for the engine being serviced. Sometimes manufacturers will update the type of spark plug used in an engine to offer better efficiency or performance.
10. Inspect the spark plug boot for tears or damage. If a damaged boot is found, the spark plug boot and possibly the entire wire will need replacement.

To install:

11. Check the spark plug gap prior to installing the plug. Most spark plugs do not come gapped to the proper specification.
12. For FICHT motors, place an indexing mark on the ceramic portion of each replacement spark plug. The mark must be made along the length of the plug, directly inline with the electrode gap. The mark will be used once the plugs are threaded to determine whether or not the gap is facing the fuel injector.
13. Apply a thin coating of anti-seize on the thread of the plug. This is extremely important on aluminum head engines to prevent corrosion and heat from seizing the plug in the threads (which could lead to a damaged cylinder head upon removal).
14. Carefully thread the plug into the bore by hand. If resistance is felt before the plug completely bottoms, back the plug out and begin threading again.

**** WARNING**

Do not use the spark plug socket to thread the plugs. Always carefully thread the plug by hand or using an old plug wirelboot to prevent the possibility of crossthreading and damaging the cylinder head bore. An old plug wirelboot can be used to thread the plug if you turn the wire by hand. Should the plug begin to crossthread, the wire will twist before the cylinder head would be **damaged. This** trick is useful when accessories or a deep cylinder head design prevents you from easily keeping fingers on the plug while it is threaded by hand.

15. Carefully tighten the spark plug to specification using a torque wrench as follows:
- Carbureted motors: 18-21 ft. lbs. (24-28 Nm)
- FICHT motors (refer to the accompanying illustration for details): first tighten the plug to 15 ft. lbs. (20 Nm) and check the plug indexing mark. If the indexing mark is in range 2 (approximately 4-7 O'clock, facing roughly toward the fuel injector), do not tighten it any further. If the plug is in range 1 (approximately 11-4 O'clock, tighten the plug additionally until it aligns directly with the center of the injector OR reaching 22 ft. lbs. (30 Nm) whichever happens first. If, at 15 ft. lbs. (20 Nm) the plug is in range 3 (approximately 7-11 O'clock), the plug probably won't work on this bank of cylinders, loosen and rethread it or try it in the other bank.

■ Whenever possible, spark plugs should be tightened to the factory torque specification. If a torque wrench is not available, and the plug you are installing is equipped with a crush washer, tighten the plug until the washer seats, then turn it 114 turn to crush the washer.

16. Apply a small amount of Evinrude/Johnson Triple-Guard or a silicone dielectric grease to the ribbed, ceramic portion of the spark plug lead and inside the spark plug boot to prevent sticking, then install the boot to the spark plug and push until it clicks into place. The click may be felt or heard. Gently pull back on the boot to assure proper contact.
17. Connect the negative battery cable or turn the battery switch ON.
18. Test run the outboard (using a test tank or flush fitting) and insure proper operation.

READING SPARK PLUGS

① EASY

◆ **See** Figures **108, 109, 110, 111, 112** and 113

Reading spark plugs can be a valuable tuning aid. By examining the insulator firing nose color, you can determine much about the engine's overall operating condition.

In general, a light tanlgray color tells you that the spark plug is at the optimum temperature and that the engine is in good operating condition.

Dark coloring, such as heavy black wet or dry deposits usually indicate a fouling problem. Heavy, dry deposits can indicate an overly rich condition, too cold a heat range spark plug, possible vacuum leak, low compression, overly retarded timing or too large a plug gap.

5 Note, carbon fouling can also occur from excessive idling conditions. If you put through a lot of no wake zones, for hours at a time, then you either need a hotter plug, or you need to balance that use by running the motor up at or near wide-open throttle too for periods of time. If you can do this for a while on the way back to the dock or ramp, after those idling conditions, you may alleviate the need to change to a different type of plug.

If the deposits are wet, it can be an indication of a breached head gasket (water) or an extremely rich condition (fuel/oil), depending on what liquid is present at the firing tip.

Also look for signs of detonation, such as silver specs, black specs or melting or breakage at the firing tip.

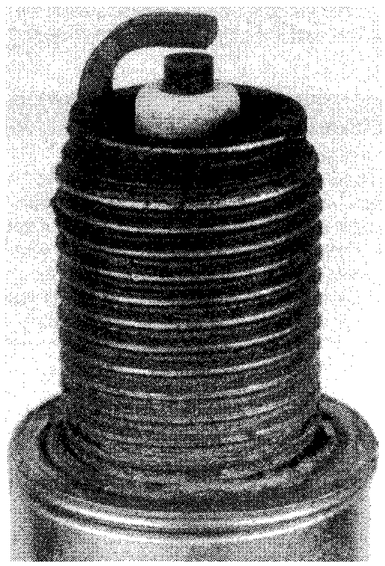


Fig. 108 A normally worn spark plug should have light tan or gray deposits on the firing tip (electrode)

Fig. 109 A carbon-fouled plug, identified by soft, sooty black deposits, may indicate an improperly tuned powerhead

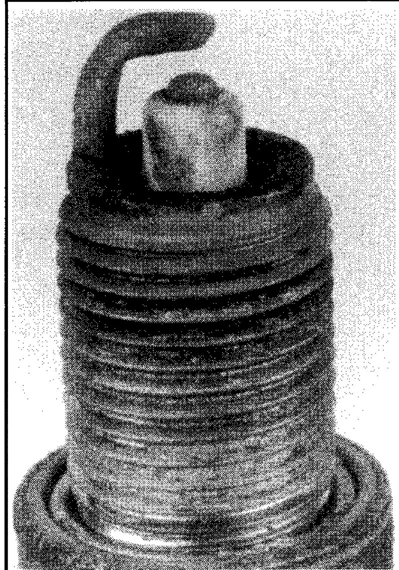


Fig. 110 This spark plug has been left in the powerhead too long, as evidenced by the extreme gap. Plugs with such an extreme gap can cause misfiring and stumbling accompanied by a noticeable lack of power

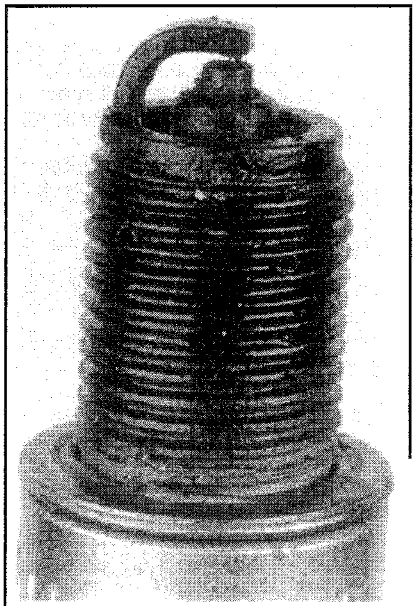


Fig. 111 An oil-fouled spark plug indicates a powerhead with worn piston rings or a malfunctioning oil injection system that allows excessive oil to enter the combustion chamber

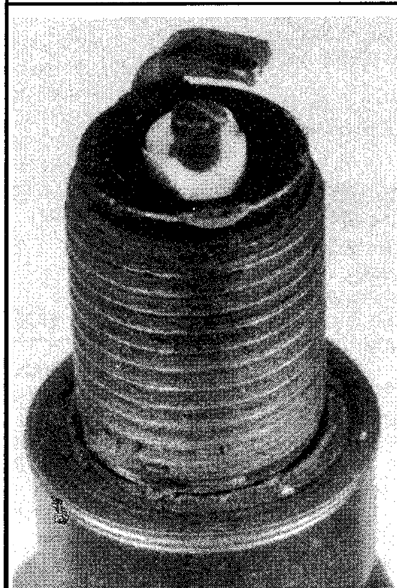


Fig. 112 A physically damaged spark plug may be evidence of severe detonation in that cylinder. Watch the cylinder carefully between services, as a continued detonation will not only damage the plug but will most likely damage the powerhead

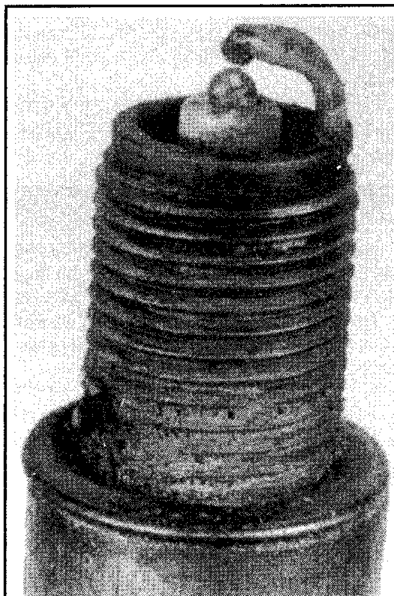


Fig. 113 A bridged or almost bridged spark plug, identified by the build-up between the electrodes caused by excessive carbon or oil build up on the **plug**

Compare your plugs to the illustrations shown to identify the most common plug conditions.

Fouled Spark Plugs

A spark plug is "fouled" when the insulator nose at the firing tip becomes coated with a foreign substance, such as fuel, oil or carbon. This coating makes it easier for the voltage to follow along the insulator nose and leach back down into the metal shell, grounding out, rather than bridging the gap normally.

Fuel, oil and carbon fouling can all be caused by different things but in any case, once a spark plug is fouled, it will not provide voltage tothe firing tip and that cylinder will not fire properly. In many cases, the spark plug cannot be cleaned sufficiently to restore normal operation. It is therefore recommended that fouled plugs be replaced.

Signs of fouling or excessive heat must be traced quickly to prevent further deterioration of performance and to prevent possible engine damage.

Overheated Spark Plugs

When a spark plug tip shows signs of melting or is broken, it usually means that excessive heat and/or detonation was present in that particular combustion chamber or that the spark plug was suffering from thermal shock.

Since spark plugs do not create heat by themselves, one must use this visual clue to track down the root cause of the problem. In any case, damaged firing tips most often indicate that cylinder pressures or temperatures were too high. Left unresolved, this condition usually results in more serious engine damage.

Detonation refers to a type of abnormal combustion that is usually preceded by pre-ignition. It is most often caused by a hot spot formed in the combustion chamber.

As air and fuel is drawn into the combustion chamber during the intake stroke, this hot spot will "pre-ignite" the air fuel mixture without any spark from the spark plugs.

Detonation

Detonation exerts a great deal of downward force on the pistons as they are being forced upward by the mechanical action of the connecting rods. When this occurs, the resulting concussion, shock waves and heat can be severe. Spark plug tips can be broken or melted and other internal engine components such as the pistons or connecting rods themselves can be damaged.

Left unresolved, engine damage is almost certain to occur, with the spark plug usually suffering the first signs of damage.

When signs of detonation or pre-ignition are observed, they are symptom of another problem. You must determine and correct the situation that caused the hot spot to form in the first place.

INSPECTION & GAPPING

1 EASY

◆ **See Figures 114 and 115**

A particular spark plug might fit hundreds of powerheads and although the factory will typically set the gap to a pre-selected setting, this gap may not be the right one for your particular powerhead.

Insufficient spark plug gap can cause pre-ignition, detonation, even engine damage. Too much gap can result in a higher rate of misfires, a noticeable loss of power, plug fouling and poor economy.

☐ **Refer to the Tune-Up Specifications chart or the emission control information label on your motor for spark plug gaps. No specifications are published on FICHT motors. For all FICHT engines, you MUST refer to the label (though the gap on one of our tear-down motors, a 2001 90 hp (1726cc) 60 degree V4, was 0.030 in. (0.8mm) which is the same as the gap specified for MOST carbureted Evinrude/Johnson V-motors).**

Check the spark plug gap before installation. The ground electrode (the L-shaped one connected to the body of the plug) must be parallel to the center electrode and the specified size wire gauge must pass between the electrodes with a slight drag.

Do not use a flat feeler gauge when measuring the gap on a used plug, because the reading may be inaccurate. A round-wire type gapping tool is the best way to check the gap. The correct gauge should pass through the electrode gap with a slight drag. If you're in doubt, try a wire that is one size smaller and one larger; the smaller gauge should go through easily, while the larger one shouldn't go through at all.

Wire gapping tools usually have a bending tool attached. **USE IT!** This tool greatly reduces the chance of breaking off the electrode and is much more accurate. Never attempt to bend or move the center electrode. Also, be careful not to bend the side electrode too far or too often as it may weaken and break off within the engine, requiring removal of the cylinder head to retrieve it.

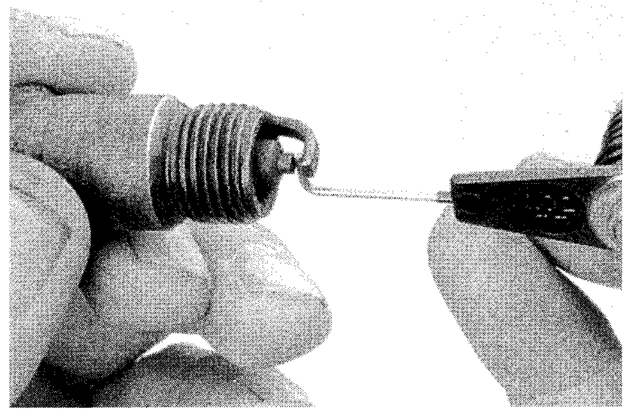


Fig. 114 Use a wire-type spark plug gapping tool to check the distance between center and ground electrodes

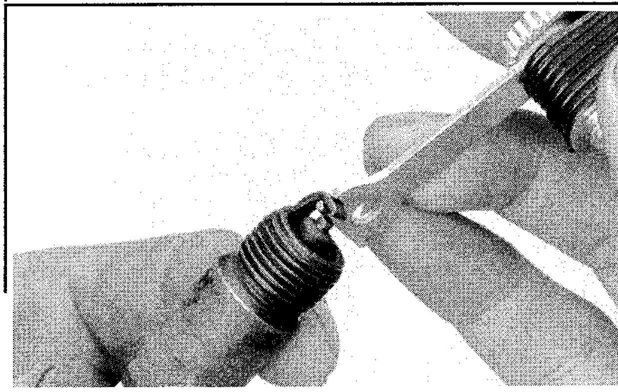


Fig. 115 Most plug gapping tools have an adjusting fitting used to bend the ground electrode

Spark Plug Wires

All **Evinrude/Johnson V-motors are equipped with secondary spark leads or spark plug wires to carry ignition voltage from the coils to the spark plugs. Overtime the insulation on these wires** will **break down, allowing arcing (voltage leakage or shorts to ground) and/or corrosion (causing higher resistance). The wires must be inspected periodically and replaced when worn or damaged in order to ensure optimum ignition performance.**

TESTING

2 MODERATE

◆ **See Figures 116 and 117**

Each time you remove the engine cover, visually inspect the spark plug wires for burns, cuts or breaks in the insulation. Check the boots on the coil and at the spark plug end. Replace any wire that is damaged.

Once a year, this should probably be performed when you change your spark plugs during a pre-season tune-up, check the resistance of the spark plug wires with an ohmmeter. Wires with excessive resistance will cause misfiring and may make the engine difficult to start. In addition worn wires will allow arcing and misfiring in humid conditions.

Remove the spark plug wire from the engine. Test the wires by connecting one lead of an ohmmeter to the coil end of the wire and the other lead to the spark plug end of the wire. Typically resistance for spark plug leads would measure approximately 7000 ohms per foot of wire. However, on carbureted Evinrude/Johnson motors, the manufacturer calls for a reading very close to or equal to zero ohms resistance.

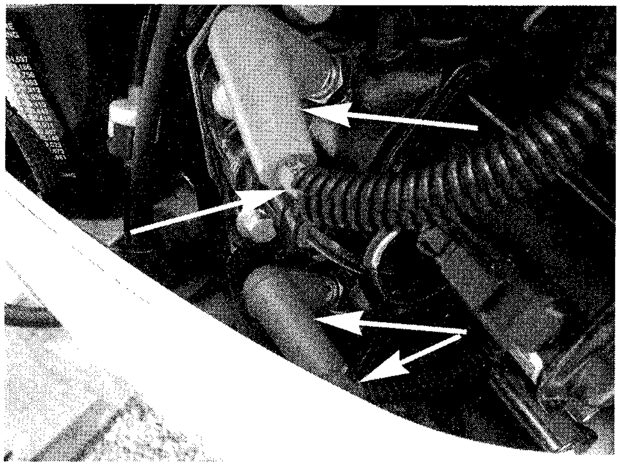


Fig. 116 Visually inspect the spark plug boot and wire (under the protective cover)...

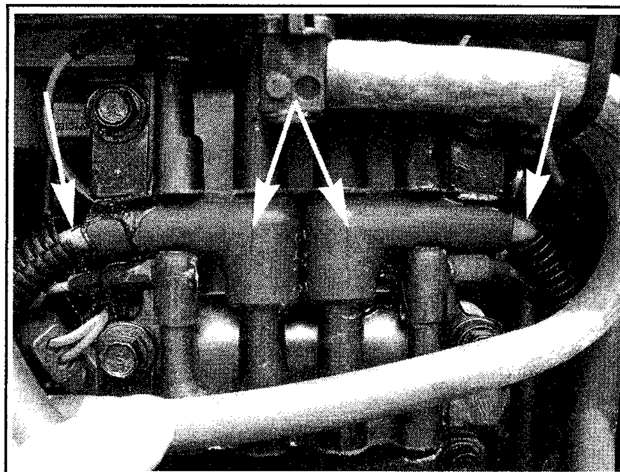


Fig. 117 ...all the way back to the ignition coils for signs of wear or damage

If a spark plug wire is found to have excessive resistance the entire set should be replaced.

■ **Keep in mind that just because a spark plug wire passes a resistance test doesn't mean that it is in good shape. Cracked or deteriorated insulation will allow the circuit to misfire under load, especially when wet. Always visually check wires to cuts, cracks or breaks in the insulation. If found, run the engine in a test tank or on a flush device either at night (looking for a blueish glow from the wires that would indicate arcing) or while spraying water (from a spray bottle, NOT a garden hose) on them while listening for an engine stumble.**

Regardless of resistance tests and visual checks, it is never a bad idea to replace spark plug leads at least every couple of years, and to keep the old ones around for spares. Think of spark plug wires as a relatively low cost item that whose replacement can also be considered maintenance.

REMOVAL & INSTALLATION

① EASY

◆ **See Figure** 104

When installing a new set of spark plug wires, replace the wires one at a time so there will be no confusion. Coat the inside of the boots with Evinrude/Johnson Triple-Guard or dielectric grease to prevent sticking, Install the boot firmly over the spark plug until it clicks into place. The click may be felt or heard. Gently pull back on the boot to assure proper contact. Repeat the process for each wire.

■ **It is important to route the new spark plug wire the same as the original and install it in a similar manner on the powerhead. Improper routing of spark plug wires may cause powerhead performance problems.**

Ignition System Maintenance

INSPECTION

② MODERATE

Modern electronic ignition systems have become one of the most reliable components on an outboard. There is very little maintenance involved in the operation of these ignition systems and even less to repair if they fail. Most systems are sealed and there is no option other than to replace failed components.

Just as a tune-up is pointless on an engine with no compression, a installing new spark plugs will not do much for an engine with a damaged ignition system. At each tune-up, visually inspect all ignition system components for signs of obvious defects. Look for signs of burnt, cracked or broken insulation. Replace wires or components with obvious defects. If spark plug condition suggests weak or no spark on one or more cylinders, perform ignition system testing to eliminate possible worn or defective components.

If trouble is suspected, it is very important to narrow down the problem to the ignition system and replace the correct components rather than just replace parts hoping to solve the problem. Electronic components can be very expensive and are usually not returnable.

Refer to the "Ignition and Electrical" section for more information on troubleshooting and repairing ignition systems.

TIMING AND SYNCHRONIZATION

◆ **See Figures** 118 **and** 119

In simple terms, synchronization is timing the fuel system to the ignition system and the mechanical rotation of the motor. Timing and synchronization ensures that as the throttle is advanced to increase powerhead rpm, the fuel and the ignition systems are both advanced equally and at the same rate.

Various models have unique methods of checking ignition timing. As appropriate, these differences will be explained in detail in the text.

Any time the fuel system or the ignition system on a powerhead is serviced to replace a faulty part or any adjustments are made for any reason, powerhead timing and synchronization must be carefully checked and verified.

Depending on the engine, adjustment of the timing and synchronization can be extremely important to obtain maximum efficiency. The powerhead cannot perform properly and produce its designed horsepower output if the fuel and ignition systems have not been precisely adjusted. We say, depending on the engine because some of the models covered by this manual are equipped with a FICHT Fuel Injection (FFI) system which requires few, if any adjustments once installed.

As a matter of fact, because of the EPA regulated carburetors used on most of the motors covered here, very few adjustments are possible on most carburetors. There are no periodic mixture adjustments necessary on the motors covered. The high-speed jets are fixed units and the low speed mixture screws (when used instead of fixed jets) are sealed to prevent unnecessary tampering. However, any carburetor will require initial set-up and adjustment after disassembly or rebuilding. Also, all carburetors or fuel injection throttle bodies will require synchronization with each other after one or more has been removed or separated.

Although some of the motors covered by this manual utilize fully electronically controlled ignition and timing systems, most of the 2-stroke motors allow for some form of timing adjustment. Care should be taken to ensure settings are correct during each tune-up.

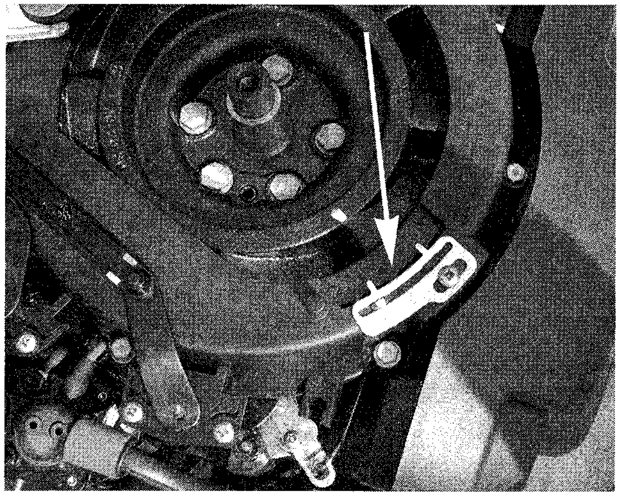


Fig. 118 Most models are equipped with some form of a timing pointer on or near the flywheel cover

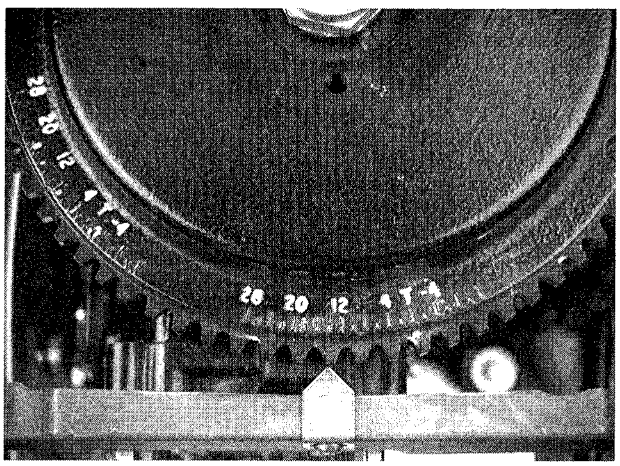


Fig. 119 Flywheel timing marks, aligned with a timing pointer

Most models have timing marks on the flywheel and CDI base. A timing light is normally used to check the ignition timing with the powerhead operating (dynamically). Most of the motors, excluding the FFI units, require idle and/or maximum advance timing adjustments.

☐ Before making any adjustments to the ignition timing or synchronizing the ignition to the fuel system, both systems should be verified to be in good working order.

Timing and synchronizing the ignition and fuel systems on an outboard motor are critical adjustments. The following equipment is essential and is called out repeatedly in this section. This equipment must be used as described, unless otherwise instructed by the equipment manufacturer. Naturally, the equipment is removed following completion of the adjustments.

For many of the adjustments, the manufacturer recommends the use of a test wheel instead of a normal propeller in order to put a load on the engine and propeller shaft. The use of the test wheel both ensures that the proper load is placed on the motor during adjustments while it also prevents the engine from overspeed (excessive rpm).

Timing Light-During many procedures in this section, the timing mark on the flywheel must be aligned with a stationary timing mark on the engine while the powerhead is being cranked or is running. Only through use of a timing light connected to the No. 1 spark plug lead, can the timing mark on the flywheel be observed while the engine is operating

The **60º** motors (75-175 Hp **[1726/2589cc] V4/V6** engines) do not require the use of a timing light, as adjustments are made statically. However, adjustments on these outboards cannot be made without the **Evinrude/Johnson** Ignition Analyzer tool.

- Tachometer-A tachometer connected to the powerhead must be used to accurately determine engine speed during idle and high-speed adjustment. A good tachometer will provide engine speed readings that range from 0-6,000 rpm, in increments of 100 rpm. Choose a tachometer with solid state electronic circuits, eliminating the need for relays or batteries and contribute to their accuracy. For maximum performance, the idle rpm should be adjusted under actual operating conditions. Under such conditions it is necessary to attach a tachometer closer to the powerhead than the one installed on the control panel.
- Flywheel Rotation-The instructions may call for rotating the flywheel until certain marks are aligned with the timing pointer. When the flywheel must be rotated, always move the flywheel in the indicated direction. If the flywheel should be rotated in the opposite direction, the water pump impeller vanes would be twisted. Should the powerhead be started with the pump tangs bent back in the wrong direction, the tangs may not bend in the correct direction before they are damaged. Even the slightest amount of damage to the water pump will affect cooling of the powerhead.

✳✳ CAUTION

Water must circulate through the lower unit to the powerhead anytime the powerhead is operating to prevent damage to the water pump in the lower unit. Just a few seconds without water will damage the water pump impeller.

- Test Tank-Since the engine must be operated at various times and engine speeds during some procedures, a test tank or moving the boat into a body of water, is necessary. If installing the engine in a test tank, outfit the engine with an appropriate test propeller. If using a body of water, make sure it is in a low traffic area and that you have an assistant to navigate the boat.

Remember that some powerheads will not start without the emergency tether in place behind the kill switch knob.

✳✳ CAUTION

Never operate the powerhead above a fast idle with a propeller and a flush attachment connected to the lower unit. Operating the powerhead at a high rpm with no load on the propeller shaft could cause the **powerhead** to runaway causing extensive damage to the unit.

Homemade Synchronization Tool

◆ **See Figures** 120 and 121

When making a synchronization adjustment, it is important to understand exactly what to look for and why. For most motors, the most critical portion of adjustment is finding the spot when the throttle shaft in the carburetors or throttle bodies begin to move. First, realize that the instant the cam follower makes contact with the cam is not the point at which the throttle shaft starts to move. Instead, the critical instant for adjustment is when the follower hits the designated position and the throttle shaft (in the carb or throttle body) itself begins to move.

On most motors, a considerable amount of play exists between the follower at the **top** of the carburetor or throttle body **(through** the linkage) to the **actual** throttle **shaft. Therefore,** the most important consideration is to watch for movement of the throttle shaft, and not the follower. Movement of the shaft can be exaggerated by attaching a short piece of stiff wire (or a drill bit) to an alligator clip; grinding down the teeth on one side of the clip; and then attaching the clip to the throttle shaft, as shown in the illustrations. Movement of the drill bit or a jiggling of the wire will instantly indicate movement of the actual shaft.

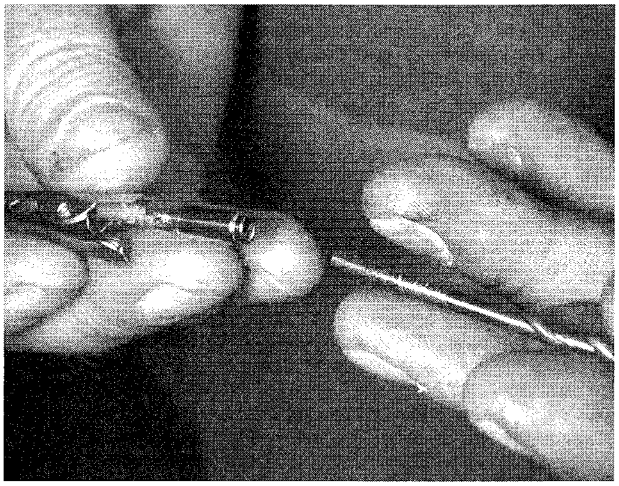


Fig. 120 Use an alligator clip and drill bit (or piece of wire) as a homemade tool

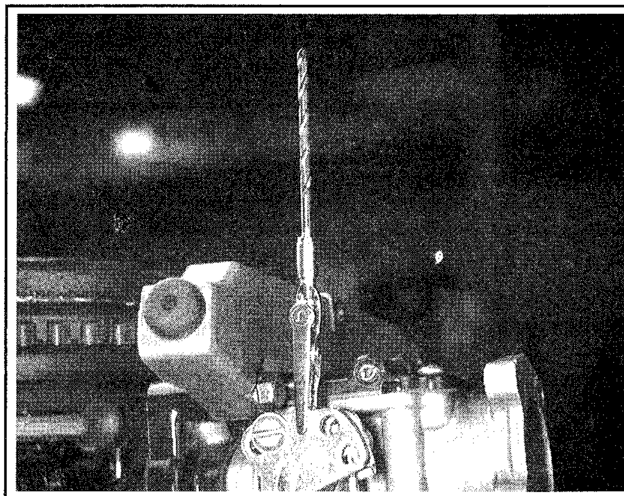


Fig. 121 Attach the clip to the carburetor throttle shaft and watch the bit or wire for movement

65 Jet 115 Hp (1632cc) V4 Motors

ADJUSTMENTS

2 MODERATE

Some of the timing and synchronization procedures for these units require operating the motor at idle rpm under load and at wide-open throttle. Therefore, the outboard must be placed in a test tank or a body of water with the boat well secured to the dock or in a slip (except for the idle timing setting which must be conducted on an unrestrained boat). Never attempt to make the load adjustments or run the engine at wide open throttle with a propeller and a flush attachment connected to the lower unit. The powerhead operating at high rpm with such a device, would likely cause a runaway condition from a lack of load on the propeller, causing extensive damage.

☐ If a test tank must be used for most of the settings, all settings from the idle timing on should be checked and adjusted again once the motor is finally mounted on a boat.

The following procedures provide detailed instructions to set the timing pointer (if the pointer or manifold has been disturbed, or at least verifying proper positioning if you believe that they have not). Then, instructions for adjusting the throttle cable (on TTL models), throttle valve synchronization, cam follower pickup, maximum spark advance, cam follower pickup timing, wide open throttle stop positioning and idle speed. The TTL models also require a shift lever detent adjustment. Since the carburetors are equipped with fixed high and low speed jets, no adjustment procedure is provided. Procedures should be performed exactly as directed and in the order given (or noted) to ensure proper adjustments.

The idle speed portion of the synchronization procedures for these units require that the engine be operated at idle rpm mounted on the boat, under load and unrestrained. For this reason, the adjustments should take place on a low-traffic body of water and only with an assistant to navigate while you make the adjustments.

Removing the air intake silencer may make some of the preliminary adjustments easier. If possible, it is best to have the silencer installed when the engine is running, but it may be left off if access necessitates it.

☐ For remote control models, remove **both** remote control cables from the engine before beginning these procedures.

Setting the Timing Pointer

◆ See Figures 122,123,124 and 125

A timing pointer is mounted to the top of the engine, on or near the flywheel cover. If the timing pointer or intake manifold has been disturbed use this procedure to check and set the pointer positioning (thereby ensuring the accuracy of the cam follower pickup timing and maximum spark advance procedures that later follow).

This procedure describes the use of the Evinrude/Johnson Piston Stop tool, which is basically just an adjustable rod with a locknut, mounted through spark plug threads. A substitute could be fabricated with a little creativity (using the casing of a spark plug or even a plug thread chaser). The key to the tool is that it can be locked in place contacting the piston crown (using the locknut) at some early point in the piston's downstroke. The idea of either tool is to physically measure the exact height of the piston in the cylinder bore at a prescribed distance before and after TDC (on its way up and down in the cylinder bore). The first mark you make on the flywheel translates into this random point. Then, the piston is brought the rest of the way down in its travel and back up again (by rotating the flywheel) until it reaches the very same height in the bore (and contacts the tool again, but this time on the way up). A second mark represents the exact same physical point in the bore, on the exact opposite side of Top Dead Center (TDC) or

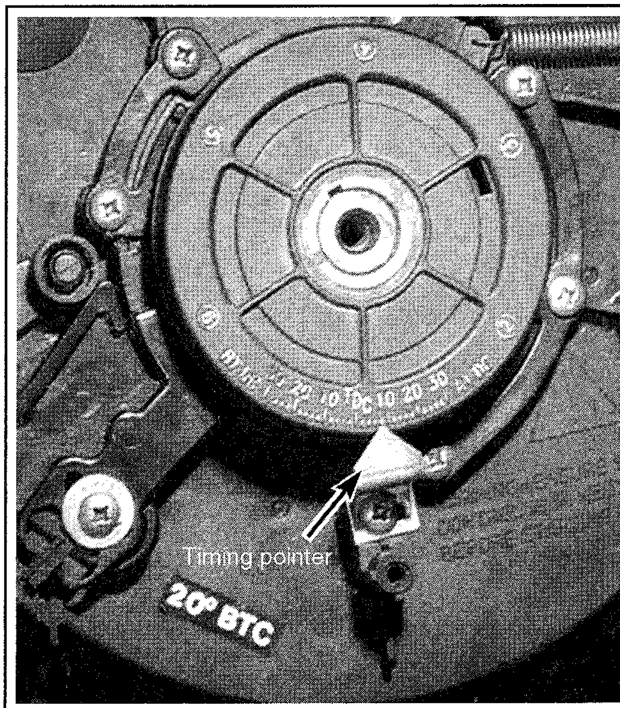


Fig. 122 Timing pointer accuracy should be verified to ensure proper adjustments

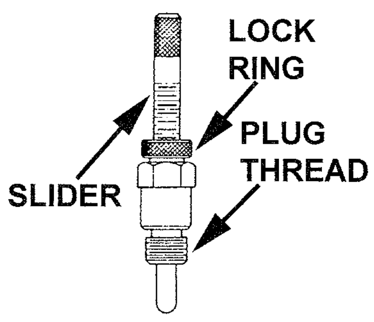


Fig. 123 A piston stop tool...

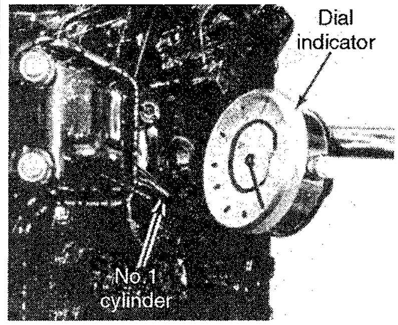


Fig. 124 ...or a dial gauge can be used to measure piston height

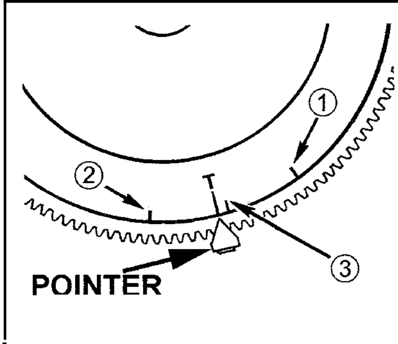


Fig. 125 Timing pointer verification electric start models

the very top of the piston travel. By locating the exact point midway between these to marks, you've found the spot on the flywheel that corresponds perfectly to Top Dead Center with regards to the pointer's current position.

Following the logic of the tool, a dial gauge could also be used instead of the piston stop tool. The gauge could be zeroed at the random downward point of travel. When turning the engine again to bring the piston back upward in the cylinder bore, stop when the gauge zeros again, meaning the piston has once again reached the exact same height.

1. Remove the spark plugs from the cylinder heads using the procedures found under Spark Plugs in this section.

■ The spark plugs are removed in order to relieve engine compression (making the motor easier to turn by hand) and for access to the No. 1 cylinder.

2. Loosen the screw fastening the timing pointer, then center the pointer and retighten the screw to hold it in position.
3. Slowly rotate the flywheel clockwise (when viewed from above) until the cast Top Dead Center (TDC) mark is about 1 112 in. (4cm) past the timing pointer.

WARNING

Under NO circumstances should you EVER rotate the flywheel counterclockwise. If you do there is a good chance that the water **pump impeller vanes will** become **damaged.**

4. Install the Evinrude/Johnson Piston Stop Tool (PIN 384887 or equivalent, or a dial gauge) into the spark plug bore for the top (No.1) cylinder. Adjust the tool using the slider to a point where it makes contact with the piston, then lock the tool in place using the lock ring (or zero the dial gauge, as applicable).
5. Hold the flywheel (and thereby the piston) firmly against the piston stop tool and make a mark on the flywheel directly inline with the timing pointer. Label this mark 1 to distinguish it from the next mark.

■ In the next step you will rotate the flywheel and therefore the engine until the piston goes down in the cylinder bore and comes back up again to the exact same height.

6. Rotate the flywheel in a clockwise direction until the piston contacts the tool again, then make a second mark (label it 2) on the flywheel inline with the timing pointer, then remove the piston stop tool.
7. Using a flexible scale, measure along the flywheel to locate the exact midway point between the first and second marks and place a mark at this location labeled 3. This mark represents TDC to the timing pointer's current setting. If this mark and the cast TDC mark on the flywheel align, then the pointer position is correct.
8. If adjustment is necessary (the 3 mark and the cast TDC do not align), rotate the flywheel clockwise to align this TDC mark with the timing pointer. Then, holding the flywheel in this position, loosen the timing pointer screw again. Slide the pointer away from the center mark and align it with the cast TDC mark on the flywheel itself. Tighten the timing pointer retaining screw securely as it is now set for accurate readings on the flywheel again.
9. Install the spark plugs.

Throttle Cable Adjustment (TTL Models Only)

◆ See Figures 126,127 and 128

1. Turn the idle speed adjustment knob on the tiller handle counter-clockwise (as you face the steering handle) to the full slow position.
2. Check to verify that the throttle cable bracket is secured to the powerhead using the forward mounting hole.
3. Loosen the idle speed screw (threaded horizontally at a slight angle downward against the throttle cam) and the wide-open throttle screw (threaded horizontally into the powerhead, just below the pivot point for the throttle linkage, so the bottom of the linkage will contact the screw head at WOT).
4. Turn the twist grip to the full open and then full closed positions. Check the clearance between the throttle cam roller and the end of the throttle cam slot in each position. The roller should have about a 114 in. (6mm) gap between itself and the respective end in each position.
5. If adjustment is necessary, loosen the locknut on the throttle cable bracket, then rotate the thumbwheel until the correct gaps are achieved. Tighten the locknut after adjustment.

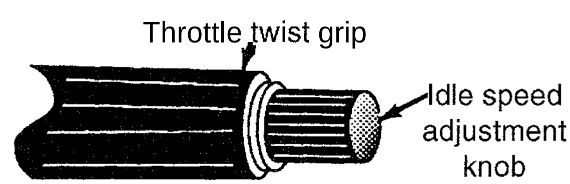


Fig. 126 Turn the idle speed adjustment knob to the slowest idle position

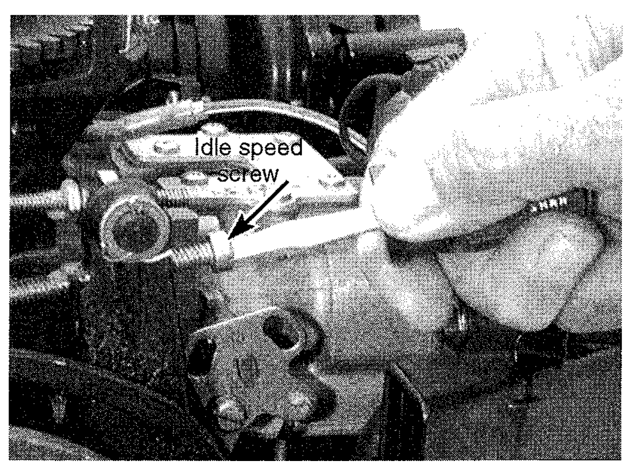


Fig. 127 **Idle** speed screw

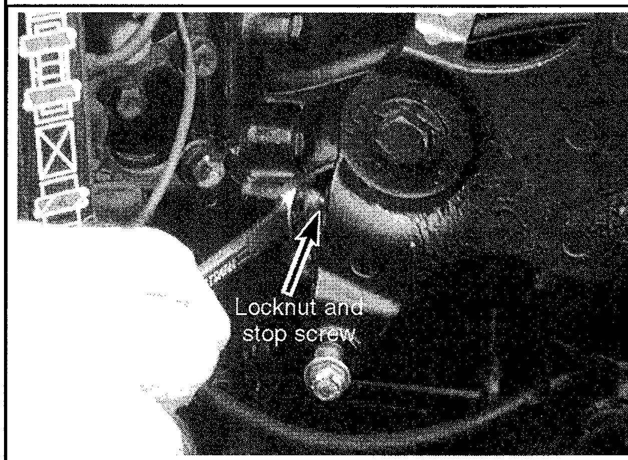


Fig. **128** WOT stop screw

Throttle Valve Synchronization

◆ See Figure **129**

In order for the motor to idle properly, the throttle valves in each of the carburetors must be completely closed. Improper adjustment will often result in the linkage holding one or more of the valves open. If, when the engine is idling with the shifter in neutral, loosening the carburetor lever adjustment screws causes a better idle, there is a good chance that the throttle valves are not properly synchronized. Following this procedure should correct such a problem.

This adjustment is made with the engine not running and the air intake silencer removed so that you can observe the throttle valves.

1. Loosen the cam follower screw, then push the follower away from the throttle cam. The follower cannot touch the cam during this procedure or the adjustment will be incorrect.
2. Loosen the lower carburetor lever adjusting screw, then verify that all throttle plates are closed. Partially open the throttle shafts and allow them to snap closed in order to ensure that the throttle valves are closed,
3. With all throttle plates closed, apply a light downward pressure to the tab of the adiusting link (of the lower carburetor lever) in order to remove all backlash, then tighten the lower lever adjusting screw.
4. Move the cam follower and verify that the throttle shafts start to rotate at the same time.

The cam follower screw can be left loose, as this is part of the starting point for the next adjustment-The Cam Follower Pickup point.

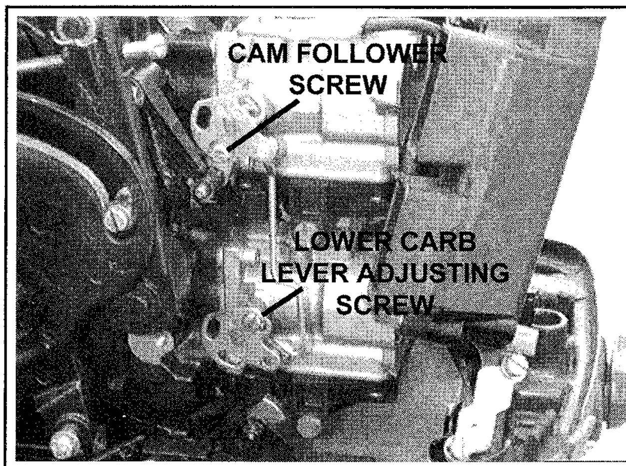


Fig. **129** Both the throttle cam follower and lower carburetor lever adjusting screws must be loosened for throttle valve synchronization

Cam Follower Pickup

◆ See Figure **121** and **130**

1. Connect a homemade synchronizationtool to the throttle plate of the upper carburetor.
2. With the cam follower screw still loose from the previous adjustment procedure, align the embossed mark with the center of the follower. With the throttle valves closed, hold the follower against the cam's embossed mark and tighten the follower screw.
3. Verify the adjustment by advancing the throttle cam and watching the homemade synchronizationtool for movement. The throttle cam mark should align with theroller just as the end of the tool begins to move.

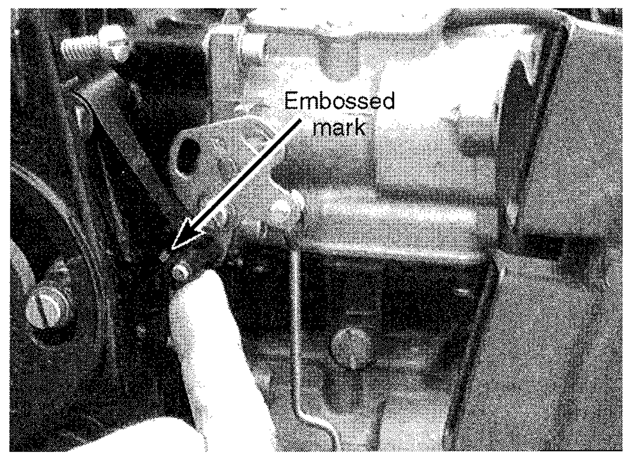


Fig. **130** The embossed mark on the throttle cam must align with the center of the roller just at the throttle shaft begins to move

Maximum Spark Advance

◆ See Figure **131**

■ For the ignition timing maximum spark advance specifications, please refer to **the Tune-Up** Specifications chart.

To check the maximum spark advance, the outboard must be operated with the proper test wheel. Because of the wide variety of propellers available with different sizes and pitches, the manufacturer does not recommend performing this procedure using the propeller. Furthermore, never operate the powerhead with a propeller above idle speeds while using a flush adapter.

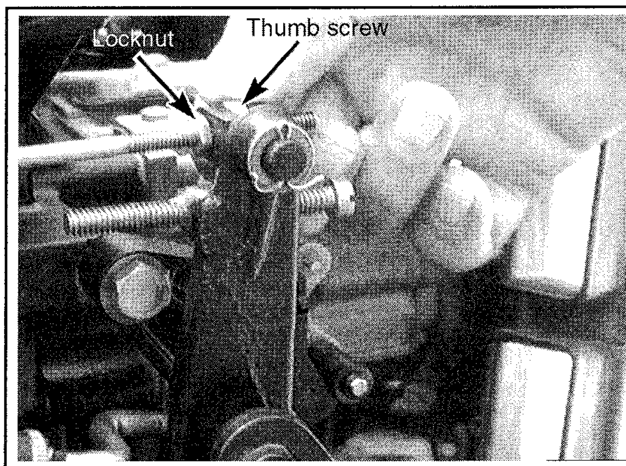


Fig. **131** To adjust maximum spark advance, loosen the advance rod locknut and rotate the thumb screw **to** change rod length

✳✳ WARNING

Water must circulate through the lower unit to the engine any time the engine is run to prevent damage to the water pump in the lower unit. Just a few seconds without water will damage the water **pump.**

1. Install the spark plugs (which were removed for timing pointer verification) and connect the leads.
2. Connect a timing light to the No. 1 cylinder spark plug lead.
3. Start the engine and run it at idle until it reaches operating temperature.
4. Once the motor is fully warmed, run it at full throttle, with the outboard in forward gear (the timer base must be fully advanced). Aim the timing light at the timing marks on the flywheel perimeter. The mark on the timing pointer should align at the correct degree mark on the flywheel (refer to the Tune-up Specifications chart in this section).
5. If the timing requires adjustment, shut down the powerhead for safety and adjust as follows:
   a. Loosen the locknut on the spark advance rod.
   b. Turn the adjustment thumb screw in order to correct the timing. Rotate the top of the thumb screw toward the crankcase to advance timing or away from the crankcase to retard timing.
   c. Tighten the locknut, then restart the engine and check the timing. Repeat until maximum timing is correct.

Cam Follower Pickup Timing

+ See Figures 130,132 and 133

1. With the timing light still connected to the No. 1 spark plug lead (from the previous adjustment) and the warmed and running at idle, point the timing light to the scale while moving the spark advance lever by hand.
2. Once the timing light indicates the 3-50 BTDC, check the embossed mark on the throttle cam to make sure it aligns with the center of the cam follower.
3. If the pickup timing must be adjusted, stop the engine for safety, then loosen the locknut and rotate the top of the thumbwheel away from the crankcase to increase pickup timing or rotate the top of the wheel toward the crankcase to decrease timing.
4. Once adjustment is completed, hold the thumbwheel from turning while you tighten the locknut, then restart the engine and verify proper cam follower pickup timing using the timing light and the spark advance lever.

Wide Open Throttle Stop

◆ See Figures 128 and 134

1. With the engine not running manually advance the throttle lever to the Wide Open Throttle (WOT) position.
2. With the throttle lever at WOT, check each of the roll pins in the carburetor shafts (located behind the linkage tabs, just before the shaft enters the carburetor body). The roll pins should be fully vertical, but NOT over-rotated past vertical.
3. If adjustment is necessary, turn the WOT screw to achieve the proper setting.

Idle Speed

◆ See Figure 127

☐ Always adjust the idle speed with the correct propeller installed.

Here's your excuse, show this page to your better half in case she (or he) doesn't believe you. It's time to take the boat out because that's how the manufacturer wants you to adjust the idle speed. Not in a test tank, not on a trailer or even attached to a dock, but with the motor mounted on a boat, underway. For safety, use an assistant to navigate while you make the adjustment.

On remote motors, the throttle and shift cables must be reconnected at this point to ensure safe operation.

Refer to the Tune-up Specifications chart for idle speed specs.

1. Connect an accurate shop tachometer.
2. Start the engine and allow it to reach normal operating temperature.

✳✳ CAUTION

Water must circulate through the lower unit to the engine any time the engine is run to prevent damage to the water pump in the lower unit. Just a few seconds without water will damage the water pump.

3. Once the engine has fully warmed, operate the engine at idle with the lower unit in the forward position.
4. If adjustment is necessary, either stop the engine for safety or use extreme caution around moving parts. Adjust engine rpm by turning the idle speed screw. Turning the screw inward (clockwise) raises idle speed, while backing the screw out (counterclockwise) lowers idle speed. Restart the engine and recheck idle speed with the lower unit in the forward setting. Repeat this cycle until the proper setting is obtained.

✳✳ CAUTIC

We realize that most people probably don't shut the engine off before playing with the idle speed screw, but the manufacturer does not recommend attempting to adjust the idle speed with the engine running for safety reasons and we cannot disagree. If you choose to ignore this caution, make sure that vou take all possible precautions to **prevent** injury by making sure someone else is **navigating.** Also, keep your hands and clothing away from any hot or moving parts on the outboard.

Remote Throttle Cable Installation and Adjustment

◆ See Figures 135 and 136

On remote motors, the remote throttle cable was disconnected prior to beginning these adjustments, therefore the cable itself must be reconnected and properly adjusted before the engine can be returned to service.

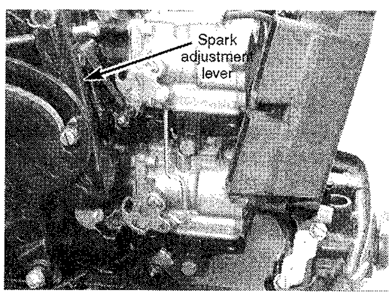


Fig. 132 Check the cam follower pickup timing by moving the spark advance lever by hand while watching the timing light

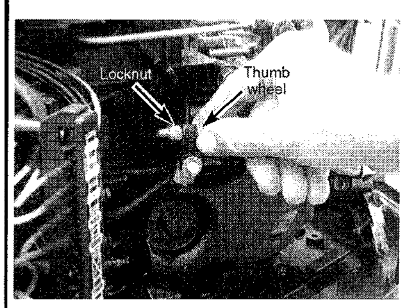


Fig. 133 If the embossed mark on the throttle cam does not align with the center of the cam follower at the correct timing specification, adjust the timing point using the thumbwheel

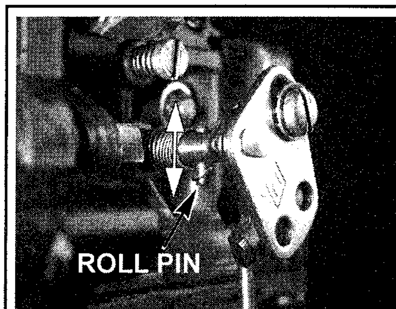


Fig. 134 The roll pins in the carburetor throttle shafts must be completely vertical at WOT

Before reconnecting the cable, make sure the rubber grommet in the front lower engine cover is in good shape and take the opportunity to extend the cable and apply a fresh coating of Evinrude/Johnson Triple-Guard Grease, or equivalent marine grease.

1. Verify that the fast idle lever is down in the Run position.

☐ Rotating the propeller shaft in the next step is only necessary if the shift cable is still or already installed.

2. While an assistant rotates the propeller shaft slowly by hand, move the remote control handle from neutral to the forward detent and then 1/2 the distance back towards neutral again. This places the remote in proper position for throttle cable adjustment.

✳✳ WARNING

Failure to pay close attention to this adjustment may cause accelerated wear and damage to the shift system as well as binding or **high** shift effort.

3. Move the engine throttle lever tightly against the idle stop screw, then attach the cable casing guide to the throttle lever pin using the locknut and washer. Tighten the nut securely.
4. Pull firmly on the throttle cable to remove all backlash, then install the trunnion nut into the anchor pocket (adjusting the trunnion nut, as necessary).
5. Loosely install the cable retaining and screw, then check cable adjustment. If the throttle cable is too loose, idle speed may be high and inconsistent. If the cable is too tight, control effort may be too tight, causing difficult shifting through the operating range. Tighten the cable retaining screw once you are certain adjustment is correct.

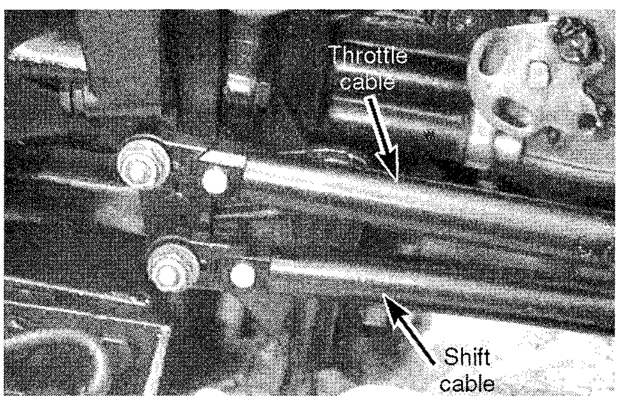


Fig. 135 The remote cables should be adjusted whenever they have been disturbed

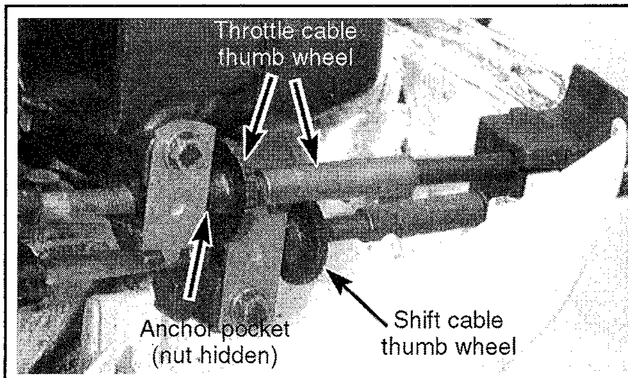


Fig. 136 The shift and throttle cables are adjusted using thumb wheels

Remote Shift Cable Installation and Adjustment

◆ See Figures 135 and 136

On remote motors, if the remote shift cable was disconnected prior to beginning these adjustments, the cable itself must be reconnected and properly adjusted before the engine can be returned to service.

Before reconnecting the cable, take the opportunity to extend the cable and apply a fresh coating of Evinrude/Johnson Triple-Guard Grease, or equivalent marine grease.

1. Verify that the fast idle lever is down in the Run position.
2. Shift the remote control handle to Neutral. Make sure the handle and the neutral lockout plate is in the proper position.
3. Move the remote control handle from Neutral to the fully Forward (WOT) position.
4. While an assistant rotates the propeller shaft slowly by hand, shift the gearcase into Forward.
5. Pull firmly on the shift cable casing to remove all backlash, then install the trunnion nut into the anchor pocket (adjusting the trunnion nut, as necessary).
6. Install the anchor pocket cover and tighten the retainer to 60-84 inch lbs. (7-9 Nm).
7. Shift the remote control handle into neutral.
8. Temporarily remove the shift cable and verify that the gearcase is in the neutral detent.

☐ If there is insufficient threads to allow adjustment, or if the **gearcase** detent does not align with the remote control NEUTRAL positioning, the **gearcase** shift rod height is out of adjustment.

9. Slide the rubber grommet onto the control cables and press it into the lower cover groove.
10. Verify proper installation and operation of the shift and throttle cables. Lift the fast idle lever to the start position and watch, if correctly attached, the throttle cable and throttle lever will move.

Shift Lever Detent Adjustment (TTL only)

1. Check the distance that the shift rod extends through the clevis at the detent bracket. It must extend 1-2 turns through the clevis.
2. Rotate the propeller shaft slowly by hand while moving the shift lever into the Neutral position.
3. Loosen the 2 shift detent bolts, then move the shift lever to the Neutral detent and tighten the 2 shift detent bolts securely.
4. Verify that both the gearcase and shift lever are in the Neutral position.

75-175 Hp (1726/2589cc) V4/V6 Motors

CARBURETED MOTOR ADJUSTMENTS

② MODERATE

There's good news and there's bad news to tell you about these engines. The good news is that the adjustments are relatively straightforward and not particularly difficult in themselves. The bad news is that because all adjustments are to be done statically, a special Evinrude/Johnson Ignition Analyzer (from the Evinrude/Johnson Ignition Test Kit # 434017) is necessary. We've talked to a number of people who've attempted to make the adjustments dynamically or without the analyzer and most attempts have failed. Therefore, we cannot, in good conscience, instruct you to try. It is best to get your hands on the Ignition Analyzer and follow the instructions we've provided here.

The following procedures provide detailed instructions to set the timing pointer (if disturbed). Then instructions are provided to adjust the throttle plate synchronization, idle timing, maximum spark advance, spark/throttle pickup point and finally, either shift lock out adjustment (tiller models) or reinstallation of the throttle cable (remote models) after the adjustments are finished. No periodic carburetor mixture adjustments should be necessary on these motors, so none are provided in this section. For more details on carburetor adjustments refer to the information found under Fuel System. However, adjustment of the carburetor low-speed mixture screws should only be necessary due to carburetor replacement, overhaul or otherwise un-resolvable idle problems after all other adjustments are completed.

The adjustment procedures should be performed exactly as directed and in the order given (or noted) to ensure proper adjustments.

☐ For remote control models, remove the throttle cable from the control arm and the anchor pocket prior to beginning these procedures. The cable ends or trunnion anchor may be accessible on some models through the access cover on the side of the motor, but for other models, you will have to remove the lower engine covers for access. For details, please refer to Engine Cover (Top and Lower Cases) in this section.

Setting the Timing Pointer

◆ See Figures 122,123,124,125 and 136a

A timing pointer is mounted to the top of the engine, on or near the flywheel cover. If the timing pointer or intake manifold has been disturbed use this procedure to check and set the pointer positioning (thereby ensuring the accuracy of the cam follower pickup timing and maximum spark advance procedures that later follow).

This procedure describes the use of the Evinrude/Johnson Piston Stop tool, which is basically just an adjustable rod with a locknut, mounted through spark plug threads. A substitute could be fabricated with a little creativity (using the casing of a spark plug or even a plug thread chaser). The key to the tool is that it can be locked in place contacting the piston crown (using the locknut) at some early point in the piston's downstroke,The idea of either tool is to physically measure the exact height of the piston in the cylinder bore at a prescribed distance before and after TDC (on it's way up and down in the cylinder bore). The first mark you make on the flywheel translates into this random point. Then, the piston is brought the rest of the way down in its travel and back up again (by rotating the flywheel) until it reaches the very same height in the bore (and contacts the tool again, but this time on the way up). A second mark represents the exact same physical point in the bore, on the exact opposite side of Top Dead Center (TDC) or the very top of the piston travel. By locating the exact point midway between these to marks, you've found the spot on the flywheel that corresponds perfectly to Top Dead Center with regards to the pointer's current position.

☐ Following the logic of the tool, a dial gauge could also be used instead of the piston stop tool. The gauge could be zeroed at the random downward point of travel. When turning the engine again to bring the piston back upward in the cylinder bore, stop when the gauge zeros again, meaning the piston has once again reached the exact same height.

1. Remove the spark plugs from the cylinder heads using the procedures found under Spark Plugs in this section.

The spark plugs are removed in order to relieve engine compression (making the motor easier to turn by hand) and for access to the No. 1 cylinder.

2. Remove the timing wheel cover (electric start) or manual starter assembly (rope start) for access, as applicable:

- For electric start models, remove the 3 bolts securing the timing wheel cover, and then remove the cover.

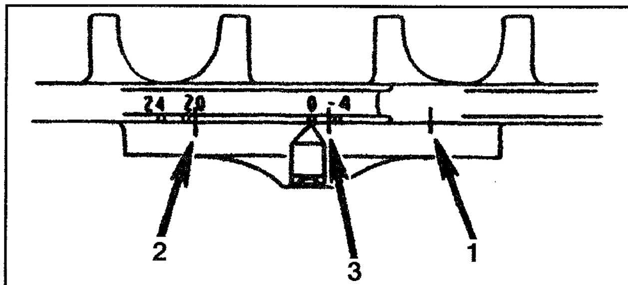


Fig. 136a Timing pointer verification-ropestart models

- For rope start models, if equipped with a starter interlock, remove the bolt securing the lockout cable clamp, then remove the lockout slide from the starter housing. Remove the 4 bolts securing the power pack and reposition for access, then remove the 3 bolts (one in back and two in front) securing the manual starter housing to the powerhead

3. Loosen the screw fastening the timing pointer, then center the pointer and retighten the screw to hold it in position.

4. Slowly rotate the flywheel clockwise (when viewed from above) until the cast Top Dead Center (TDC) mark is about 1 in. (25.4mm) **past** the timing pointer.

✳✳ WARNING

Under NO circumstances should you EVER rotate the flywheel counterclockwise. If you do there is a good chance that the water pump impeller vanes will become damaged.

5. Install the Evinrude/Johnson Piston Stop Tool (PIN 384887 or equivalent, or a dial gauge) into the spark plug bore for the top (No.1) cylinder. Adjust the tool using the slider to a point where it makes contact with the piston, then lock the tool in place using the lock ring (or zero the dial gauge, as applicable).

6. Hold the flywheel (and thereby the piston) firmly against the piston stop tool and make a mark on the flywheel directly inline with the timing pointer. Label this mark **1** to distinguish it from the next mark.

☐ In the next step you will rotate the flywheel and therefore the engine until the piston goes down in the cylinder bore and comes back up again to the exact same height.

7. Rotate the flywheel in a clockwise direction until the piston contacts the tool again, then make a second mark (label it 2) on the flywheel inline with the timing pointer, then remove the piston stop tool.

8. Using a flexible scale, measure along the flywheel to locate the exact midway point between the first and second marks and place a mark at this location labeled 3. This mark represents TDC to the timing pointer's current setting. If this mark and the cast TDC mark on the flywheel align, then the pointer position is correct.

9. If adjustment is necessary (the **3** mark and the cast TDC do not align), rotate the flywheel clockwise to align this TDC mark with the timing pointer. Then, holding the flywheel in this position, loosen the timing pointer screw again. Slide the pointer away from the center mark and align it with the cast TDC mark on the flywheel itself. Tighten the timing pointer retaining screw securely as it is now set for accurate readings on the flywheel again.

10. Install the spark plugs.

Throttle Plate Synchronization

+ See Figures 137,138,139,140 and 141

In order for the motor to operate properly, the throttle plates in each of the carburetors must be open and close at the same time. Through throttle plate synchronization you will ensure that all of the plates close completely at idle, preventing the possible idle problems that could occur if the linkage was to hold one or more of the plates open at idle.

This adjustment is made with the engine **not** running and the air intake silencer removed so that you can observe the throttle valves.

1. Remove the air intake silencer for access.

2. Loosen the spark lever screw, then push the spark lever roller away from the cam.

3. Check to make sure that the throttle cam and cam roller are not touching

4. Next loosen the carburetor link screw. On rope start models, you'll probably have to remove the fuel filter from the bracket for access.

■ There is one throttle shaft connector screw on each side for V4 motors and 2 **connector screws on each side for V6 motors.**

5. Use a 9164 in. hex key or driver to loosen the starboard and port throttle shaft connector screws. Be sure to only **loosen** and not to remove the screws.

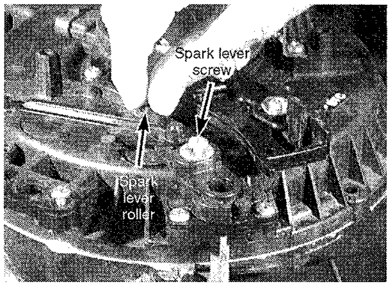


Fig. 137 Loosen the spark lever screw and push the roller away from the cam...

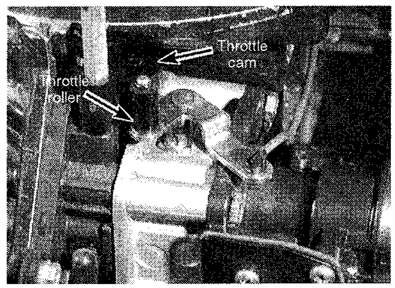


Fig. 138 ...then make sure the throttle cam and cam roller are not touching

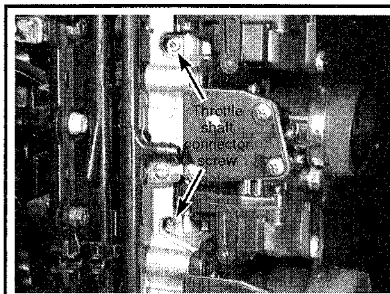


Fig. 139 Throttle shaft connector **screws-** V6 shown (V4 uses one on each side)

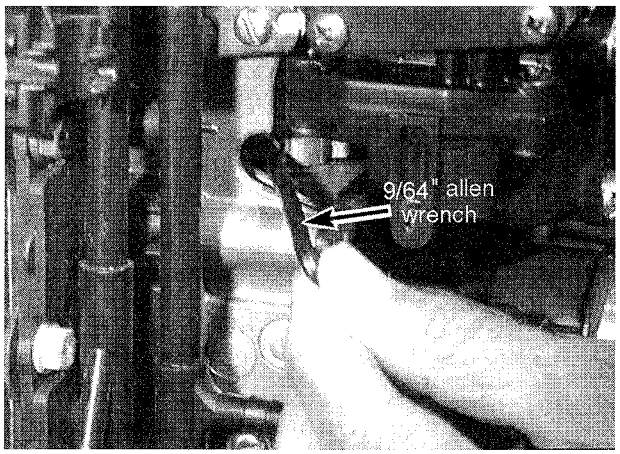


Fig. 140 Use a 9/64 in. hex key or driver to loosenltighten the throttle shaft connector screws

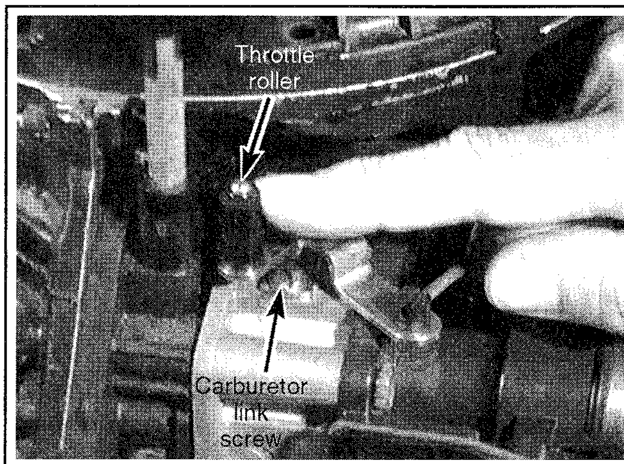


Fig. 141 Light pressure on the roller should hold the throttle **plates/linkage** closed while tightening the shaft connector and link screws

6. Close all carburetor throttle plates and then tighten the throttle shaft screws.

☐ A second set of hands will be helpful to apply light pressure to the throttle plates, ensuring that they remain closed while the connector and link screws are tightened.

7. With all of the throttle plates closed and the shaft screws tightened, carefully tighten the carburetor link screw (still supporting the linkage in position as it is tightened).

8. Leave the spark lever screw loose so the Idle Timing can be properly set. Follow the Idle Timing procedure in this section.

Idle Timing

◆ See Figure 142,143,144,145 and **146**

Idle timing must be performed statically using the special EvinrudelJohnsonIgnition Analyzer (from the EvinrudelJohnsonIgnition Test Kit # 434017) is necessary. We've talked to a number of people who've attempted to make the adjustments dynamically or without the analyzer and most attempts have failed. Therefore, we cannot, in good conscience, instruct you to try. It is best to get your hands on the Ignition Analyzer and follow the instructions we've provided here.

☐ For the idle timing specifications, please refer to **the Tune-Up** Specifications chart.

1. On electric start models, remove the regulatorlrectifier cover for access.
2. Disengage the timing sensor plug from the top of the motor, next to the flywheel. Connect the EvinrudelJohnsonIgnition Analyzer from the Ignition Test Kit No. 434017 to the timing sensor. Connect the Analyzer to a 12-volt power source (such as a well-charged marine or automotive battery).

☐ Set the Ignition Analyzer switch to position B for V4 motors or to position A for V6 motors.

3. Loosen the timer base detent screw, then move both the inner and outer detent tabs completely forward on the detent plate.
4. Verify that the timer base lever is against the stop on the flywheel cover (you'll find the base lever and stop just under the perimeter of the flywheel, next to the base detent screw).
5. Using a socket, slowly rotate the crankshaft (CLOCKWISE when viewed from above) until the timing pointer aligns with the idle timing specification. (Idle timing is generally about 4° ATDC for V4 motors and 6° ATDC for V6 motors, but please refer to the Tune-up Specifications chart to find the spec for your particular motor.)
6. Now, to adjust the idle timing, hold the timing wheel in position and hold the INSIDE detent tab in position against the stop, while you move the detent plate forward until the Ignition Analyzer CYL light goes off.
7. Mark the location of the inside detent tab on the detent plate (in case the plate becomes moved during the next procedure), but leave the timer base detent screw loose for the Maximum Spark Advance adjustment, which should be performed next.

☐ This idle timing procedure should provide optimum idle performance, including the maintenance of an idle speed in the specified range of 600-700 rpm, but will vary somewhat with propeller selection. If idle speed is too high after adjustment, check the intake system for air leaks. If idle speed is too low and all other engine systemslcomponents are operating properly, try decreasing the idle timing by one or two degrees (say from **6°** ATDC on **V6** motors, to **4°** ATDC) in order to increase idle speed. If however, idle speed is inconsistent or the engine runs rough or spits, and no problems can be found, suspect an incorrect carburetor mixture problem, refer to Carburetor **Initial** Low Speed Setting adjustment in the Fuel System section.

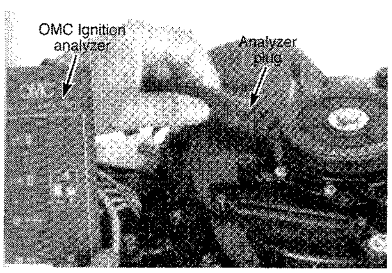


Fig. 142 Connect the Ignition Analyzer to the timing sensor

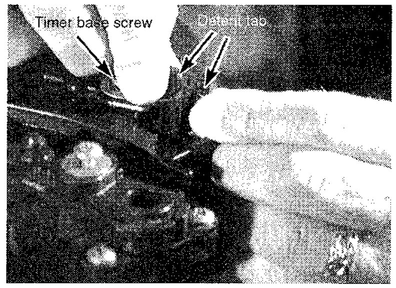


Fig. 143 Loosen the base screw and slide the detent tabs forward...

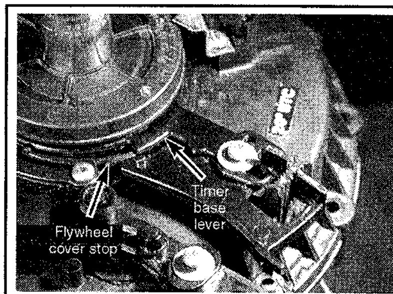


Fig. 144 ...ensure timer base lever is against the cover stop

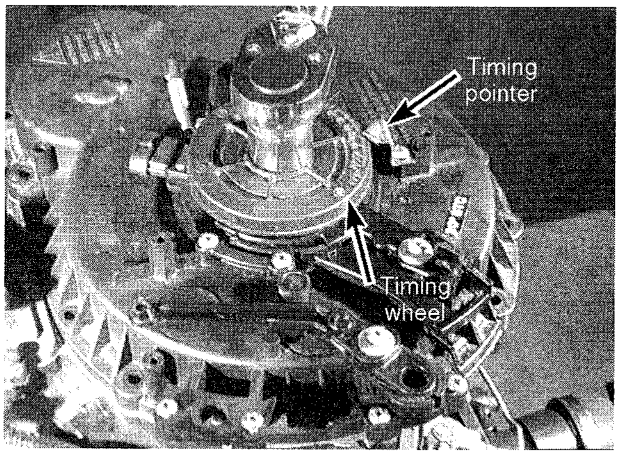


Fig. 145 Rotate the flywheel to align the pointer with the idle timing spec...

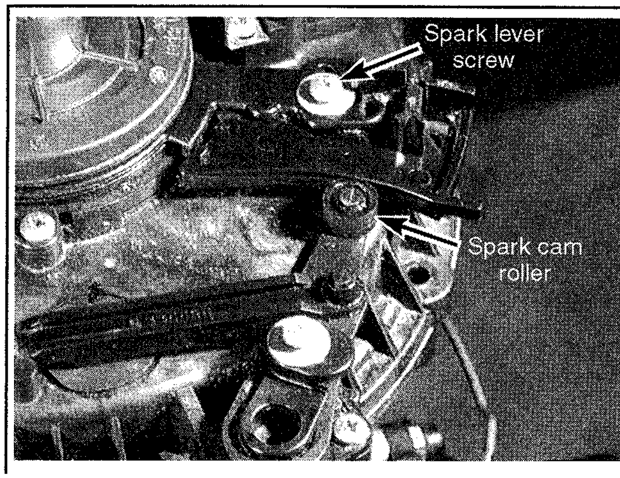


Fig. 147 Use the spark lever to move the spark cam to the WOT position

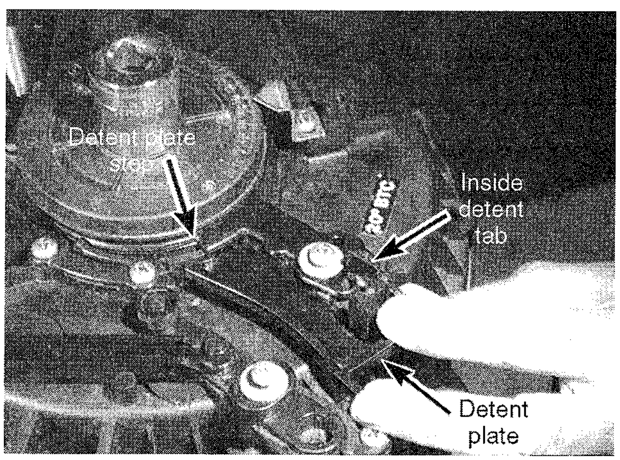


Fig. 146 ...and then slide the detent plate forward until the Analyzer CYL light goes out

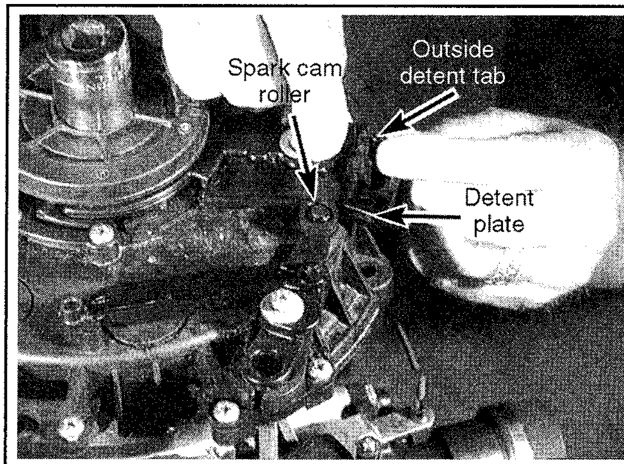


Fig. 148 Adjust max spark advance by moving the OUTSIDE detent tab until the CYL light goes out on the analyzer

Maximum Spark Advance

◆ See Figures 147,148 and 149

Idle timing must be performed statically using the special EvinrudelJohnsonIgnition Analyzer (from the Evinrude/Johnson Ignition Test Kit # 434017) is necessary. We've talked to a number of people who've attempted to make the adjustments dynamically or without the analyzer and most attempts have failed. Therefore, we cannot, in good conscience, instruct you to try. It is best to get your hands on the Ignition Analyzer and follow the instructions we've provided here.

■ For the ignition timing maximum spark advance specifications, please refer to the **Tune-Up** Specifications chart.

1. The spark lever screw should still be loose from the Throttle Plate Synchronizationand Idle Timing adjustment procedures. But, if necessary, re-loosen it.

2. Using the spark lever, manually advance the spark cam to the Wide-Open-Throttle (WOT) position.

3. With the Evinrude/Johnson Ignition Analyzer still connected to the timing sensor and the base detent screw still loosened from the Idle Timing procedure, slowly rotate the crankshaft (CLOCKWISE when viewed from above), until the timing pointer aligns with the maximum ignition timing specification.

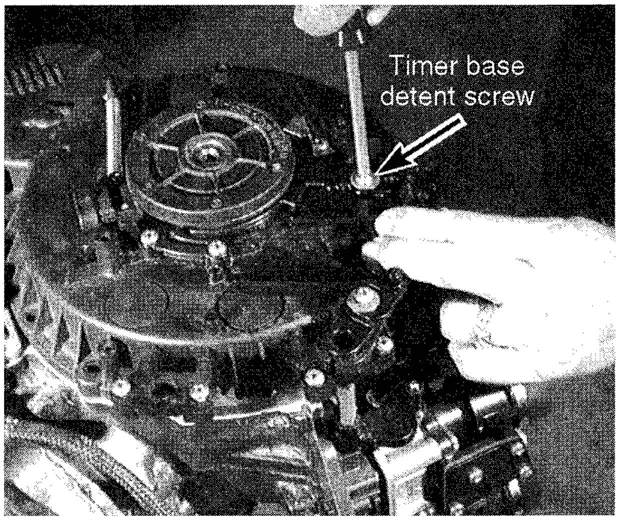


Fig. 149 Verify outer and inner detent tab positioning, then tighten the detent screw

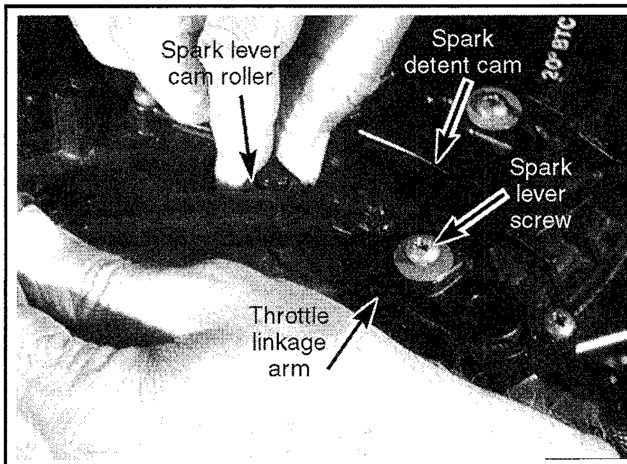


Fig. 150 To adjust **spark/throttle** pickup point, move the spark lever and throttle linkage rearward...

■ Refer to **the Tune-Up** Specifications chart for the maximum ignition timing specification, as it varies slightly by year and model, but generally speaking the spec is about **20°** BTDC.

4. To adjust the maximum spark advance, hold the timing wheel in position, then move the OUTSIDE detent tab rearward on the plate until the Ignition Analyzer CYL light goes off

5. Verify the location of the inside detent tab (using the mark made in the previous procedure), then tighten the timer base detent screw.

6. Move the spark lever rearward and disconnect the Ignition Analyzer. Reconnect the timing sensor wiring, but continue to leave the spark lever screw loose for the next adjustment procedure, Spark/Throttle Pickup Point.

Spark/Throttle Pickup Point

◆ See Figures 150,151,152 and 153

1. On tiller/rope start models, slowly reduce the throttle with the twist grip until the slowest idle position is reached (and the throttle shaft completely closes the throttle plates). Next, remove the anchor block cover screw and remove the cover, then loosen the throttle cable sufficiently to allow cable adjustment. Finally, adjust the throttle cable until there is 0.030 in. (0.7mm) between the carburetor throttle cam and its roller.

2. Make sure the spark lever screw is STILL loose from the previous adjustment procedures. If not, re-loosen it.

3. For electric start models:

a. With the engine off, move the spark lever and throttle linkage rearward, then slowly move the spark lever forward until the roller just touches the spark cam.

b. Hold the spark lever in position and slowly move the throttle linkage forward until the throttle cam just touches the cam roller.

c. Now, verify the adjustment by moving the linkage rearward and then slowly forward while observing the base/linkage. The timer base and carburetor linkage must begin to move at precisely the same time.

4. For tiller/rope start models:

a. With the engine off, move the spark lever and throttle linkage rearward, then slowly move the throttle linkage forward until the throttle cam just touches the cam roller.

b. Hold the throttle linkage in position and slowly move the spark lever forward until the spark cam just touches the lever roller.

5. Carefully tighten the spark lever screw.

6. Once the adjustment is verified, install the timing wheel cover on electric start models or the manual starter and power pack on rope start models (removed initially for Timer Point verification).
Also, install the air intake silencer (removed initially for Throttle Plate Synchronization).

7. If not done already, install and tighten the spark plugs to specification.

8. For rope start models, perform the Shift Lockout Adjustment.

9. Properly reconnect the throttle cable.

Shift Lock Out Adjustment (Tiller Models Only)

1. Move the shift lever to Neutral.

2. Loosen the retaining screw, then reposition the Y-shaped shift detent bracket and the throttle tower shaft until they are parallel and tighten the retaining screw to secure in this position.

3. Check the adjustment by gently pulling on the manual starter while the shifter is in various positions, the starter must only engage when the lever is in Neutral and must not engage when in Forward or Reverse.

4. With the boat launched or the motor equipped with a cooling water supply, start and allow it to reach normal operating temperature. Verify that the motor is running properly after all adjustments.

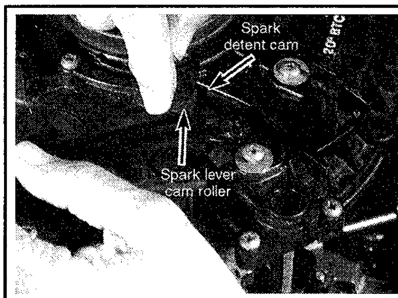


Fig. 151 ...next, move the spark lever forward until the roller JUST touches the spark cam, then...

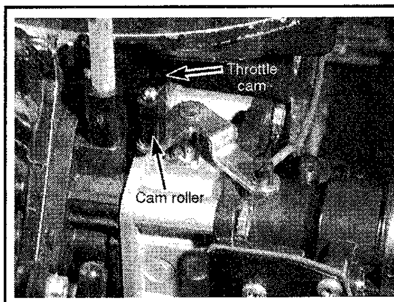


Fig. 152 ...move the throttle linkage forward until the throttle cam JUST touches the cam roller

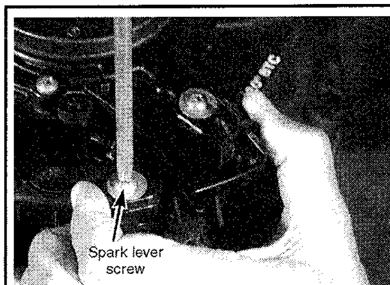


Fig. 153 Finally, tighten the spark lever screw to hold the adjustments

Remote Throttle Cable Installation and Adjustment

◆ See Figures **135** and **136**

On remote motors, the remote throttle cable was disconnected prior to beginning these adjustments, therefore the cable itself must be reconnected and properly adjusted before the engine can be returned to service.

Before reconnecting the cable, make sure any grommets in the front lower engine cover is in good shape. Take the opportunity to extend the cable and apply a fresh coating of Evinrude/Johnson Triple-Guard Grease, or equivalent marine grease.

1. Verify that the fast idle lever is down in the Run position.

Rotating the propeller shaft in the next step is only necessary if the shift cable is still or already installed.

2. While an assistant rotates the propeller shaft slowly by hand, move the remote control handle from Neutral to the Forward detent and then 112 the distance back towards Neutral again. This places the remote in proper position for throttle cable adjustment.

**** WARNING**

Failure to pay close attention to this adjustment may cause accelerated wear and damage to the shift system as well as binding or high shift effort.

3. If not done already, remove the timing sensor cover for access. With the throttle linkage closed, make sure the timer base lever is against the stop on the flywheel cover.
4. Securely attach the cable casing guide to the throttle lever pin using the cotter clip and washer.
5. Pull firmly on the throttle cable to remove all backlash, then install the trunnion nut into the anchor pocket (adjusting the trunnion nut, as necessary).
6. Loosely install the cable retaining and screw, then check cable adjustment. If the throttle cable is too loose, idle speed may be high and inconsistent. If the cable is too tight, control effort may be too tight, causing difficult shifting through the operating range. Tighten the cable retaining screw once you are certain adjustment is correct.

FICHT MOTOR ADJUSTMENTS

② MODERATE

One of the great benefits of a fuel injected motor is that most of the functions that are mechanical on a carbureted motor (and therefore subject to wear and adjustment) are electronically monitored and adjusted to maximize engine performance. The fuel and ignition systems are all but completely controlled by the Engine Management Module (EMM) on these models. The EMM is a computer control module that acceots inout from various sensors mounted around the engine and makes both ignition timing and fuel mapping decisions based on those inputs.

As a matter of fact, none of the timing and synchronization procedures need to be performed periodically, though a well-rounded re-season tune-up can include checking the throttle plate synchronization and crankshaft position sensor air gap. Of course, the timing and synchronization procedures must be performed after related components are serviced or replaced (such as the throttle bodies or crankshaft position sensor).

Ignition timing can only be properly verified using the Evinrude/Johnson Diagnostic Software (designed for use with most IBM compatible laptops) and a suitable interface cable (which should be supplied with the software). Timing verification is not a typical maintenance procedure, but should be performed after any one of the following procedures:

- Powerhead replacement
- Crankshaft replacement
- Flywheel or flywheel cover replacement
- Crankshaft position sensor replacement
- EMM replacement

■ After any updated fuel mapping or other modifications are made to EMM memory

Should it be found out of specification, the electronic engine control system should be checked for problems. Of course, don't get into the trap of assuming every problem that arises is electronic. Although the EMM does an incredible job of regulating engine operation on these motors, it is subject to the same mechanical limitations of anv motor. Mechanical problems will often manifest themselves in symptoms of the electronic engine control system and can lead frustration during troubleshooting if you concentrate only on the electronics.

When it comes to FICHT motors, a good adage applies here, "if it ain't broke, don't fix it." Don't go looking for problems just to have something to adjust, enjoy the fact that your buddies are still working on their tenth adjustment procedure after you install new spark plugs and launch for the first time that season.

Should adjustments be required, the adjustment procedures should be performed exactly as directed and in the order given (or noted) to ensure proper adjustments. Of course, this does not mean that if you replace the crankshaft position sensor, that you would need to go back and adjust the throttle plate synchronization. For what we hope are reasons that make sense, there is no need to perform the throttle plate synchronization procedure if the act of replacing a component such as the crankshaft position sensor did not cause you to disturb the throttle plate linkage.

Throttle Plate Synchronization

◆ See Figures **154,155,156** and **157**

The throttle plate linkage adjusting screws are normally **Torx®** head and require a suitably sized Torx driver. Make sure the driver fits properly, as many **Torx®** head screws are easily stripped if a slightly smaller driver is used.

In order for the motor to operate properly, the throttle plates in each of the throttle bodies must be open and close at the same time. Through throttle plate synchronization you will ensure that all of the plates close completely at idle, preventing the possible idle problems that could occur if the linkage was to hold one or more of the plates open at idle.

This adjustment is made with the engine not running and the air intake silencer removed so that you can observe the throttle valves.

Remove the throttle cable from the control arm and the cable trunnion pocket prior to beginning these **procedures. The** cable trunnion anchor is accessible through the cable entry cover on the side of the motor, but the lower engine covers may need to be removed for access to the throttle arm **connection.** For details, please refer to Engine Cover (Top and Lower Cases) in this section.

1. Loosen the 2 thumbscrews (there is one on either side) and remove the air intake silencer assembly from the outboard.

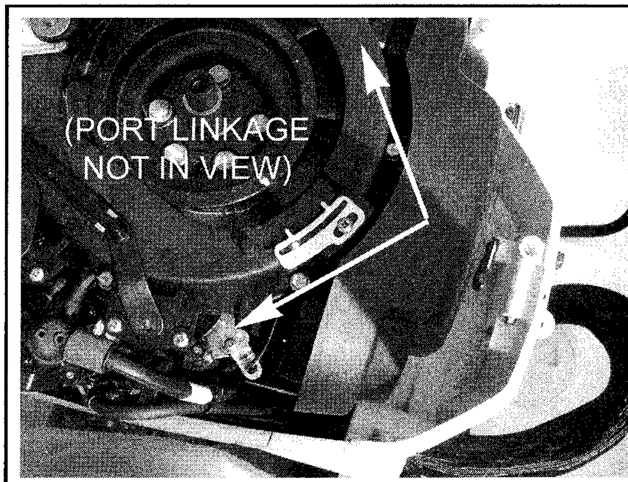


Fig. **154** Throttle plate synchronization takes place at the linkage on top of the throttle bodies on either side of the front of the motor (right behind the air intake silencer)

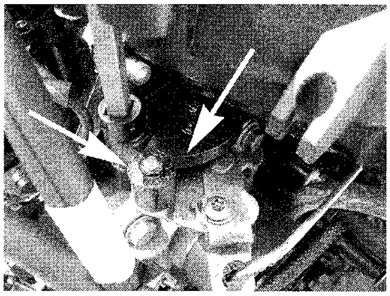


Fig. **155** With the throttle closed there should be clearance between the cam and follower roller

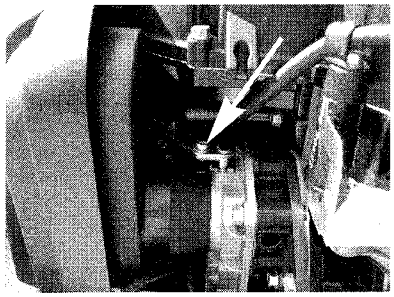


Fig. 156 To adjust the plate linkage, loosen the port side adjusting screw...

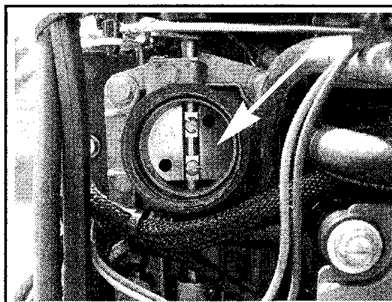


Fig. **157** **...**then make sure all throttle plates are fully, before re-tightening the screw

2. Verify that the throttle cam and cam follower, on top of the starboard side linkage, are not touching. An easy way to do this is to insert a thin bladed tool or piece of paper between the cam and follower roller.

3. Loosen the throttle plate link adjusting screw on top of the port side throttle bodies.

4. Check each of the plates in the throttle body bores to make sure they are all fully seated. If necessary, apply light pressure to the plates while tightening the adjusting screw.

5. Hold the linkage in position (with the throttle plates closed) and tighten the port side adjusting screw.

6. Reconnect the throttle control cable and adjust as detailed in the Control Cable Adjustment procedure in this section.

7. Install the air intake silencer assembly, Make sure the rubber spacers are in position on the thumbscrews. Make sure the thumbscrews are secure, but do not overtighten them and damage the spacers.

Control Cable Adjustment

◆ See Figures 36,155,158,159 and 160

The throttle and or shift control cables must be disconnected before certain procedures (such as throttle plate synchronization) to ensure no preload from the cable interferes with adjustment. Once adjustments are complete or anytime a control cable is removed for service or other reasons, the cable must be properly adjusted to ensure proper motor operation. If no changes were made to the cable or related components, there is a good chance that the setting (if undisturbed) will already be correct, but you'll still want to verify it to be sure.

☐ This procedure covers installation and adjustment of both cables. Furthermore, it assumes that the trunnion anchor bracket was removed, which is not necessary if you are just disconnecting one or more cables from the linkage in order to make adjustments or minor repairs. Follow only the steps that are appropriate for the circumstances under which you are working.

1. Move the remote to the full throttle position, then manually move the engine throttle lever to the full throttle position also. Install the cable guide on the throttle lever, using the washer and clip to secure the guide.

2. Move the control to Neutral. Hold the throttle cable trunnion in the bracket on the side of the motor and check that the throttle closes completely. There MUST be clearance between the throttle cam and the follower roller. If necessary, adjust the throttle cable trunnion (using the thumbwheel) to keep clearance without excessive play.

3. If the shift cable was disconnected, move the remote to Reverse, then move the engine shifter lever to the matching Reverse position. Install the cable guide on the shift lever, using the washer and clip to secure the guide. Move the control to Neutral. Hold the shift cable trunnion in the bracket on the side of the motor, the trunnion must align with the bracket; otherwise, adjust the trunnion as necessary (using the shift cable thumbwheel).

4. Hold the cables in position against the trunnion pocket, then install the trunnion anchor and tighten the mounting screw.

5. If removed, install the lower engine covers.

6. Make sure the rubber grommet is properly positioned over the cables and hoses. The bracket must be seated against the engine cover and the tab should hold it in position.

7. Slide the nylon sleeve forward (we've seen them installed both over and under the rubber grommet, but the factory literature says to place it OVER the grommet), make sure the sleeve and grommet are properly positioned and then install the cablelhose cover to the engine side cover. Make sure no hoses, cables or wires are pinched by the cover, then install and tighten the 3 retaining screws.

Crankshaft Position Sensor Air Gap Adjustment

◆ See Figures 161 and **162**

The Engine Management Module (EMM) controls ignition and fuel injection functions based on signals from various powerhead mounted sensors. One of the most important sensor signals is the Crankshaft Position (CP) sensor, whose signal is used to determine the mechanical positioning of the pistons in relations to the cylinders (using the physical position of the crankshaft). In order to function properly, the crankshaft position sensor must be mounted in precise relation to the raised tooth of the flywheel. Anytime the sensor is removed, the air gap should be adjustedto specification as follows:

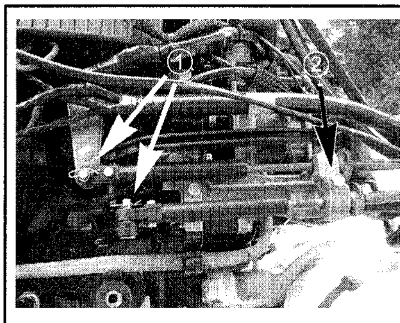


Fig. 158 Control cables are attached at the control levers (1) and the trunnion anchor (2)

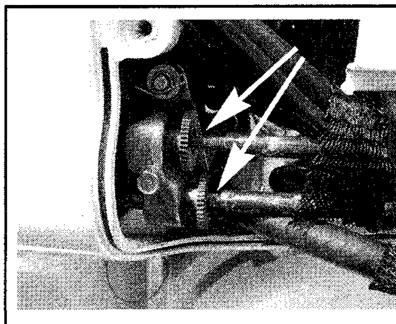


Fig. 159 Adjust the trunnion position (and cable free-play) using the thumbwheels

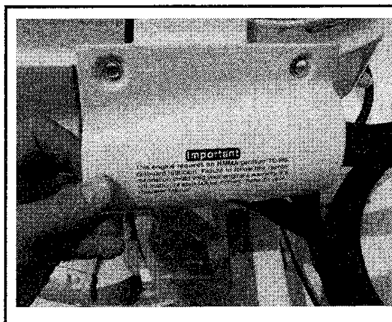


Fig. 160 During installation, don't pinch anything with the **cable/hose** cover

1. If equipped, remove the EMM cover to expose the top of the flywheel, the EMM and the crankshaft position sensor.
2. If order to relieve engine compression and make it easier to rotate the crankshaft, remove the Spark Plugs, as detailed in this section.

A slot (2, in the accompanying illustration) is provided in the flywheel **cover. The** slot can be used to align a flywheel tooth and then, to insert a feeler gauge, checking the gap.

3. Thread a 5/16-18 in. bolt into the top of the crankshaft, then use the bolt and a wrench or socket to slowly turn the crankshaft clockwise when viewed from above, until the crown of a flywheel tooth is aligned with the center of the sensor.
4. Using a feeler gauge set, check the gap between the sensor and the crown of the flywheel tooth. For most models, the gap should be 0.045-0.055 in. (1.1-1.4mm), but on 2000 and later 751901115 V4 or 175 hp V6 models a gap of 0.035-0.055 in. (0.9-1.4mm) is acceptable.

☐ Remember, when using a feeler gauge, the proper sized gauge should pass through the gap with a slight **drag. The** next smaller gauge should pass through the gap with no resistance at all, when conversely the next larger gauge should not fit.

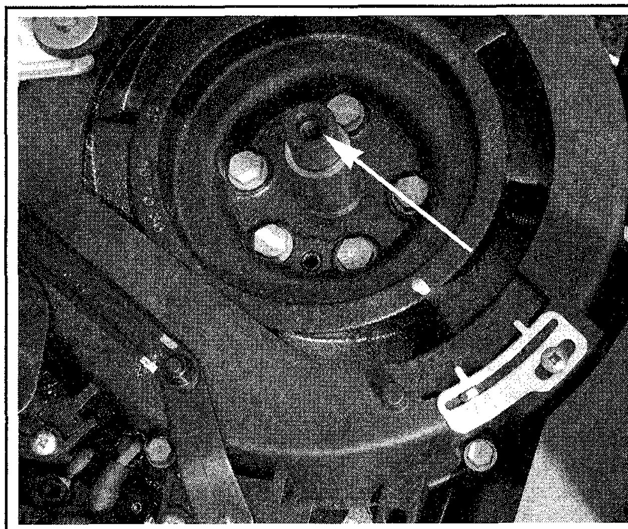


Fig. 161 The easiest method of rotating the crankshaft is to thread a bolt into the top of the shaft, then use a wrench or socket on the bolt head

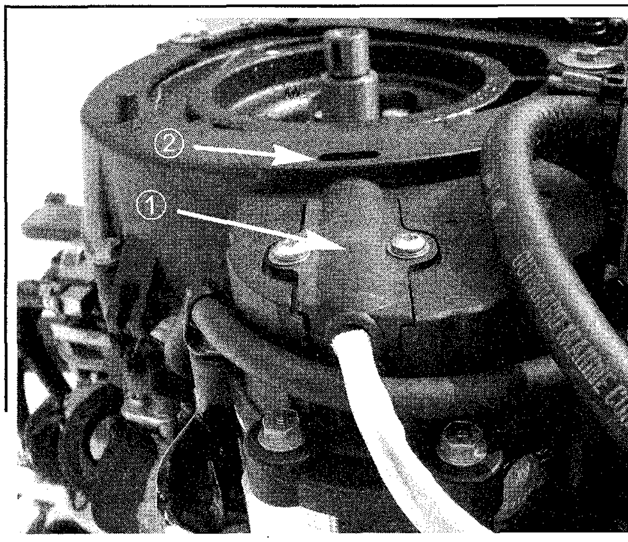


Fig. 162 The crankshaft position sensor (1) air gap is checked using a feeler gauge inserted through the slot (2) provided in the flywheel cover

5. If adjustment is necessary, unplug to 2-pin wiring connector from the back of the sensor and loosen the 2 clamp screws, then rotate the sensor until the proper gap is set.
6. Once the sensor position is properly adjusted, hold it to keep it from moving while tightening the clamp screws, then reconnect the wiring.
7. If possible (if you have access to the EvinrudelJohnson software) follow the Timing Pointer Verification procedure and check ignition timing. Otherwise, check engine performance by running the motor, on the boat, under load, once everything has been reassembled.
8. Index and install the spark plugs.
9. If equipped install the EMM cover.

Setting the Timing Pointer

◆ See Figures **123,124,161** and **163**

A timing pointer is mounted to the top of the flywheel cover on these motors. If the timing pointer has been disturbed use this procedure to check and set the pointer positioning (thereby ensuring the accuracy of the ignition timing verification procedure when using the EvinrudelJohnson Diagnostic Software).

This procedure describes the use of the EvinrudelJohnson Piston Stop tool, which is basically just a fixed rod with, mounted through spark plug threads. A substitute could be fabricated with a little creativity (using the casing of a spark plug or even a plug thread chaser). The key to the tool is that it can be locked in place to physically mark a point early point in the piston's downstroke. The idea of either tool is to physically measure the exact height of the piston in the cylinder bore at a prescribed distance before and after TDC (on its way up and down in the cylinder bore). The first mark you make on the flywheel translates into this point. Then, the piston is brought the rest of the way down in its travel and back up again (by rotating the flywheel) until it reaches the very same height in the bore (and contacts the tool again, but this time on the way up). A second mark represents the exact same physical point in the bore, on the exact opposite side of Top Dead Center (TDC) or the very top of the piston travel. By locating the exact point midway between these to marks, you've found the spot on the flywheel that corresponds perfectly to Top Dead Center with regards to the pointer's current position.

Following the logic of the tool, a dial gauge could also be used instead of the piston stop **tool. The** gauge could be zeroed at the random downward point of travel. When turning the engine again to bring the piston back upward in the cylinder bore, stop when the gauge zeros again, meaning the piston has once again reached the exact same height.

1. If not done already for service or Crankshaft Position Sensor Air Gap Adjustment, remove the spark plugs from the cylinder heads using the procedures found under Spark Plugs in this section.

☐ The spark plugs are removed in order to relieve engine compression (making the motor easier to turn by hand) and for access to the No. 1 cylinder.

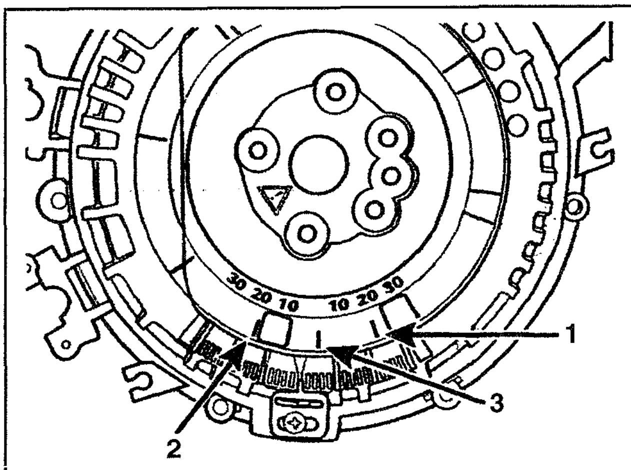


Fig. 163 Timing pointer verification-75-175hp **FICHT** motors

2. Locate the timing pointer (along the edge of the flywheel cover). Some FICHT motors may be equipped with marks on the pointer, one that is to be used for V4 motors and another that is to be used to V6 motors. When equipped, the pointer marks are labeled, but be sure to use the correct one for your motor.

3. Rotate the crankshaft **(clockwise** when viewed from above) until the 30° After Top Dead Center (ATDC) mark is aligned with the pointer.

4. Install the Evinrude/Johnson Piston Stop Tool (PIN 342679 or equivalent, or a dial gauge) into the spark plug bore for the top (No.1) cylinder. Lock the tool in place using the lock ring (or zero the dial gauge, as applicable).

5. Unless you are using a dial gauge, rotate the flywheel, VERY, VERY slowly backwards (yes, **counterclockwise)** until the piston makes contact with the tool.

6. Hold the flywheel (and thereby the piston) firmly against the piston stop tool (or with ihe dial gauge zeroed) and make a mark on the flywheel directly inline with the timing pointer. Label this mark 1 to distinguish it from the next mark.

☐ **In the next step you will rotate the flywheel and therefore the engine until the piston goes down in the cylinder bore and comes back up again to the exact same height.**

7. Rotate the flywheel in a **clockwise** direction until the piston contacts the tool again, then make a second mark (label it 2) on the flywheel inline with the timing pointer, then remove the piston stop tool. It may be necessary to turn the flywheel, very slightly **counterclockwise** to unload the tool before it can be removed.

8. Use the marks that are cast into the flywheel surface to find the spot midway between the first and second marks and place a new mark at this location labeled 3. This mark represents TDC to the timing pointer's current setting. If this mark and the cast TDC mark on the flywheel align, then the pointer position is correct.

9. If adjustment is necessary (the 3 mark and the cast TDC do not align), rotate the flywheel **clockwise** to align this TDC mark with the timing pointer. Then, holding the flywheel in this position, loosen the timing pointer screw again. Slide the pointer away from the center mark and align it with the cast TDC mark on the flywheel itself. Tighten the timing pointer retaining screw securely as it is now set for accurate readings on the flywheel again.

10. Index and install the spark plugs.

Checking Ignition Timing

The Engine Management Module (EMM) controls all ignition and fuel injection function on these motors. No timing adjustment is either necessary or possible, however, using the EvinrudelJohnson Diagnostic Software and an IBM compatible laptop, it is possible to check and verify ignition timing. Follow the instructions included with the software for conducting this check anytime one of the following has occurred:

- Powerhead replacement
- Crankshaft replacement
- Flywheel or flywheel cover replacement
- Crankshaft position sensor replacement
- EMM replacement
- After any updated fuel mapping or other modifications are made to EMM memory

120-300 Hp (2000/3000/3300/4000cc V4/V6/V8 Motors

CARBURETED MOTOR ADJUSTMENTS

② MODERATE

◆ **See Figures 164,165,166,167 and 168**

Some of the timing and synchronization procedures for these units require operating the motor at idle rpm under load and at wide-open throttle. Therefore, the outboard **must** be placed in a test tank or a body of water with the boat well secured to the dock or in a slip (except for the idle speed/timing setting which must be conducted using the test wheel or on an unrestrained boat). Never attempt to make the load adjustments or run the engine at wide open throttle with a propeller and a flush attachment connected to the lower unit. The powerhead operating at high rpm with such a device, would likely cause a runaway condition from a lack of load on the propeller, causing extensive damage.

The following procedures provide detailed instructions to set the timing pointer (if the pointer has been disturbed, or at least verifying proper positioning if you believe that it has not). Then details are provided for throttle plate synchronization, preliminary throttle adjustment (rope/tiller models only), setting the cam pickup point, adjusting the wide open throttle stop, remote throttle and shift cable installation and adjustment, setting maximum spark advance and setting the idle timing.

No periodic carburetor mixture adjustments should be necessary on these motors, so none are provided in this section. For more details on carburetor adjustments refer to the information found under Fuel System. However, adjustment of the carburetor low-speed mixture screws should only be necessary due to carburetor replacement, overhaul or otherwise un-resolvable idle problems after all other adjustments are completed.

The adjustment procedures should be performed exactly as directed and in the order given (or noted) to ensure proper adjustments.

Removing the air intake silencer may make some of the preliminary adjustments easier. If possible, it is best to have the silencer installed when the engine is running, but it may be left off if access necessitates it.

Refer to the accompanying exploded views for help identifying the various linkage components on your outboard. In order to help simplify the procedures components will be referenced in the text using the number used to label the same part in the illustration. But, because some outboards do not use the same linkage components as others, not all illustrations will contain all of the numbers in the keylist.

■ **For remote models, remove throttle cable from the throttle control arm and from the cable trunnion pocket before beginning these procedures.**

Setting the Timing Pointer

◆ **See Figures 122,123,124 and 125**

A timing pointer is mounted to the top of the engine, on or near the flywheel cover. If the timing pointer or mounting has been disturbed use this procedure to check and set the pointer positioning (thereby ensuring the accuracy of the procedures that later follow).

This procedure describes the use of the EvinrudelJohnson Piston Stop tool, which is basically just an adjustable rod with a locknut, mounted through spark plug threads. A substitute could be fabricated with a little creativity (using the casing of a spark plug or even a plug thread chaser). The key to the tool is that it can be locked in place contacting the piston crown (using the locknut) at some early point in the piston's downstroke. The idea of either tool is to physically measure the exact height of the piston in the cylinder bore at a prescribed distance before and after TDC (on its way up and down in the cylinder bore). The first mark you make on the flywheel translates into this random point. Then, the piston is brought the rest of the way down in its travel and back up again (by rotating the flywheel) until it reaches the very same height in the bore (and contacts the tool again, but this time on the way up). A second mark represents the exact same physical point in the bore, on the exact opposite side of Top Dead Center (TDC) or the very top of the piston travel. By locating the exact point midway between these to marks, you've found the spot on the flywheel that corresponds perfectly to Top Dead Center with regards to the pointer's current position.

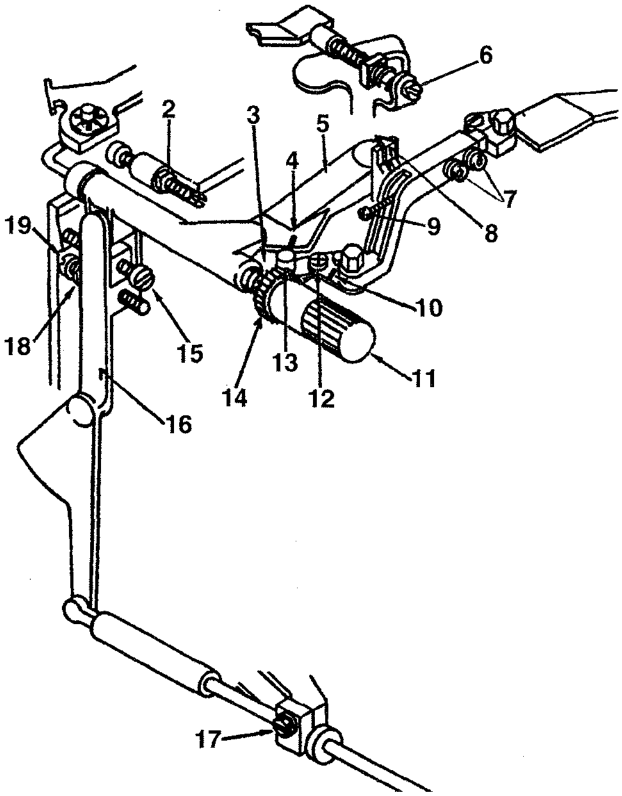
☐ **Following the logic of the tool, a dial gauge could also be used instead of the piston stop tool. The gauge could be zeroed at the random downward point of travel. When turning the engine again to bring the piston back upward in the cylinder bore, stop when the gauge zeros again, meaning the piston has once again reached the exact same height.**

1. Remove the spark plugs from the cylinder heads using the procedures found under Spark Plugs in this section.

☐ **The spark plugs are removed in order to relieve engine compression (making the motor easier to turn by hand) and for access to the NO. 1 cylinder.**

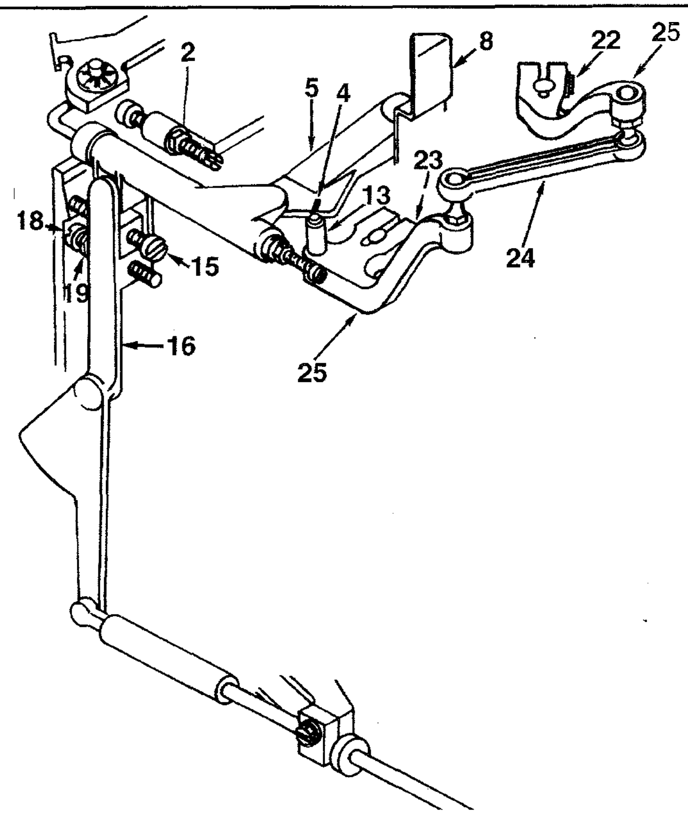
2. Loosen the screw fastening the timing pointer, then center the pointer and retighten the screw to hold it in position.

3. Slowly rotate the flywheel clockwise (when viewed from above) until the cast Top Dead Center (TDC) mark is about 1 112 in. (4cm) **past** the timing pointer,



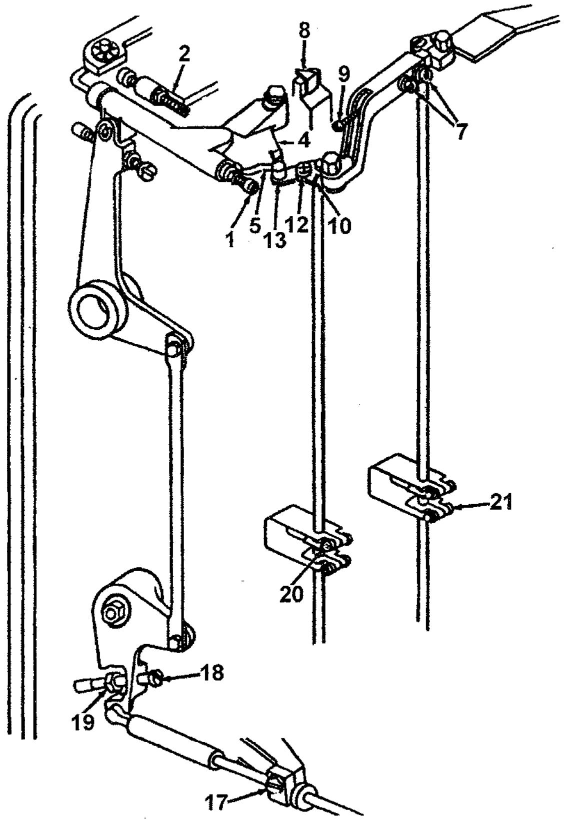
1 Idle speed screw
2 Max spark timing advance screw
3 Throttle cam follower
4 Throttle cam alignment mark
5 Throttle cam
6 Idle timing screw
7 Carb link adjustment screw
8 Timing pointer
9 Carb link stop screw
10 W.O.T. mark
11 **Lockring** and adjustment knoblscrew
12 Cam follower screw
13 Cam **follower/roller**
14 Expansion link **lockring**
15 Throttle arm stop screw
16 Throttle arm
17 Throttle anchor screw
18 WOT stop screw
19 WOT screw locknut
20 Starboard throttle shaft connector
21 Port throttle shaft connector
22 Throttle lever screw (port)
23 Throttle lever screw (starboard)
24 Throttle link
25 Throttle levers

Fig. 164 Linkage adjustment points-1992-96 remote V4 models (except the 125WT) and 1992 V6 models



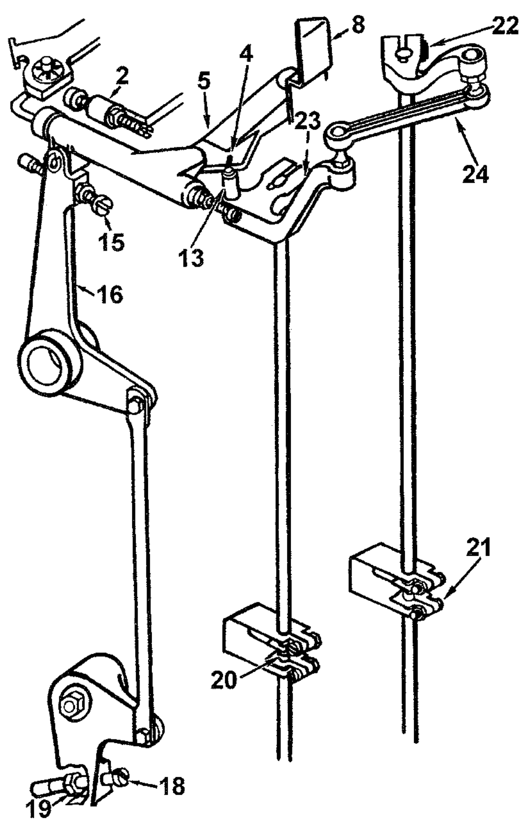
1 Idle speed screw
2 Max spark timing advance screw
3 Throttle cam follower
4 Throttle cam alignment mark
5 Throttle cam
6 **Idle** timing screw
7 Carb link adjustment screw
8 Timing pointer
9 Carb link stop screw
10 W.O.T. mark
11 Lockring and adjustment **knob/screw**
12 Cam follower screw
13 Cam **follower/roller**
14 Expansion link **lockring**
15 Throttle arm stop screw
16 Throttle arm
17 Throttle anchor screw
18 WOT stop screw
19 WOT screw locknut
20 Starboard throttle shaft connector
21 Port throttle shaft connector
22 Throttle lever screw (port)
23 Throttle lever screw (starboard)
24 Throttle link
25 Throttle levers

Fig. 165 Linkage adjustment points-1997 and later remote V4 models



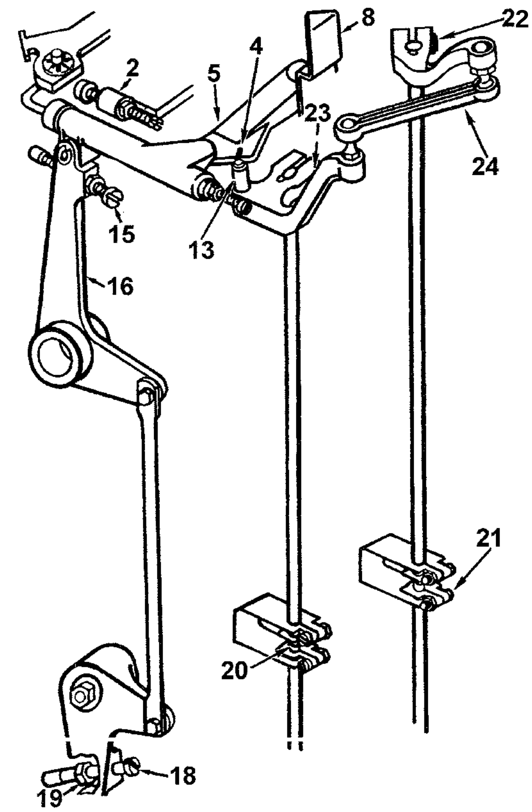
1 Idle speed screw
2 Max **spark** timing advance screw
3 Throttle cam follower
4 Throttle cam alignment mark
5 Throttle cam
6 Idle timing screw
7 Carb link adjustment screw
8 Timing pointer
9 Carb link stop screw
10 W.O.T. mark
11 **Lockring** and adjustment knoblscrew
12 Cam follower screw
13 Cam followerlroller
14 Expansion link **lockring**
15 Throttle arm stop screw
16 Throttle arm
17 Throttle anchor screw
18 WOT stop screw
19 WOT screw locknut
20 Starboard throttle shaft connector
21 Port throttle shaft connector
22 Throttle lever screw (port)
23 Throttle lever screw (starboard)
24 Throttle link
25 Throttle levers

Fig. 166 Linkage adjustment points-1992-96 **125WT V4, 1993-96** remote V6 and, 1992-96 V8 models



1 Idle speed screw
2 Max spark timing advance screw
3 Throttle cam follower
4 Throttle cam alignment mark
5 Throttle cam
6 Idle timing screw
7 Carb link adjustment screw
8 Timing pointer
9 Carb link stop screw
10 W.O.T. mark
11 **Lockring** and adjustment **knob/screw**
12 Cam follower screw
13 Cam **follower/roller**
14 Expansion link **lockring**
15 Throttle arm stop screw
16 Throttle arm
17 Throttle anchor screw
18 WOT stop screw
19 WOT screw locknut
20 Starboard throttle shaft connector
21 Port throttle shaft connector
22 Throttle lever screw (port)
23 Throttle lever screw (starboard)
24 Throttle link
25 Throttle levers

Fig. 167 Linkage adjustment points-1997 and later remote **V6/V8** models



1 Idle speed screw
2 Max spark timing advance screw
3 Throttle cam follower
4 Throttle cam alignment mark
5 Throttle cam
6 Idle timing screw
7 Carb link adjustment screw
8 Timing pointer
9 Carb link stop screw
10 W.O.T. mark
11 Lockring and adjustment knob/screw
12 Cam follower screw
13 Cam follower/roller
14 Expansion link lockring
15 Throttle arm stop screw
16 Throttle arm
17 Throttle anchor screw
18 WOT stop screw
19 WOT screw locknut
20 Starboard throttle shaft connector
21 Port throttle shaft connector
22 Throttle lever screw (port)
23 Throttle lever screw (starboard)
24 Throttle link
25 Throttle levers

Fig. 168 Linkage adjustment points-rope start V4 models

**** WARNING**

Under NO circumstances should you EVER rotate the flywheel counterclockwise. If you do there is a good chance that the water pump impeller vanes will become damaged.

4. Install the Evinrude/Johnson Piston Stop Tool (PIN 384887 or equivalent, or a dial gauge) into the spark plug bore for the top (No.1) cylinder. Adjust the tool using the slider to a point where it makes contact with the piston, then lock the tool in place using the lock ring (or zero the dial gauge, as applicable).
5. Hold the flywheel (and thereby the piston) firmly against the piston stop tool and make a mark on the flywheel directly inline with the timing pointer. Label this mark **1** to distinguish it from the next mark.

■ **In the next step you will rotate the flywheel and therefore the engine until the piston goes down in the cylinder bore and comes back up again to the exact same height.**

6. Rotate the flywheel in a clockwise direction until the piston contacts the tool again, then make a second mark (label it **2)** on the flywheel inline with the timing pointer, then remove the piston stop tool.
7. Using a flexible scale, measure along the flywheel to locate the exact midway point between the first and second marks and place a mark at this location labeled 3. This mark represents TDC to the timing pointer's current setting. If this mark and the cast TDC mark on the flywheel align, then the pointer position is correct.
8. If adjustment is necessary (the 3 mark and the cast TDC do not align), rotate the flywheel clockwise to align this TDC mark with the timing pointer. Then, holding the flywheel in this position, loosen the timing pointer screw again. Slide the pointer away from the center mark and align it with the cast TDC mark on the flywheel itself. Tighten the timing pointer retaining screw securely as it is now set for accurate readings on the flywheel again.
9. Install the spark plugs.

Throttle Plate Synchronization

In order for the motor to operate properly, the throttle plates in each of the carburetors must be open and close at the same time. Through throttle plate synchronization you will ensure that all of the plates close completely at idle, preventing the possible idle problems that could occur if the linkage was to hold one or more of the plates open at idle.

This adjustment is made with the engine **not** running and the air intake silencer removed so that you can observe the throttle valves.

1992-96 Remote Models and all Rope/Tiller Models

◆ **See Figures 164,166 and 168**

☐ **In order to make sure they close completely, be sure to apply light pressure to the throttle plates during this procedure.**

Refer to the accompanying exploded views for help identifying the various linkage components on your outboard. In order to help simplify the procedures components will be referenced in the text using the number used to label the same part in the illustration. But, because some outboards do not use the same linkage components as others, not all illustrations will contain all of the numbers in the keylist.

1. Remove the air intake silencer for visual access to the throttle plates.
2. Check to make sure that the throttle cam (5) and the throttle cam follower (13) are not touching. If necessary, loosen the cam follower screw (12) and move the follower away from the cam.
3. Back out the carb link stop screw (9) four full turns.
4. Loosen both carb link adjustments screws (7), but do not loosen them more than 112 a turn.
5. For V6/V8 motors, loosen (but do NOT remove) the **bottom** screw on the port throttle shaft connector (21) and the **top** screw on the starboard throttle shaft connector (20). Seat all of the throttle plates, then tighten the throttle shaft connector screws, starting with the top on the starboard connector and then moving to the bottom on the port shaft connector.

6. Turn the carb link stop screw (9) slowly back inward until the port carburetors just begin to open, then back out the screw, just enough to fully close the throttle plates again.
7. While holding the ends of the carb link against the stop screw (9), tighten both the carb link adjustment screws (7).
8. Operate the throttle linkage by hand while watching both the port and starboard throttle plates. They must open at **exactly** the same time. If adjustment is necessary, loosen the carb link adjustment screws (7), no more than 112 turn and then turn the carb link stop screw (9) inward or outward as necessary. Then repeat the previous step to tighten the adjustment screws and verify proper throttle synchronization.
9. Leave the cam follower screw (12) loose so the Cam Pickup Point can be properly set. Follow the Cam Pickup Point procedure in this section.

1997 and Later Remote Models

◆ **See Figures 165 and 167**

In order to make sure they close completely, be sure to apply light pressure to the throttle plates during this procedure.

Refer to the accompanying exploded views for help identifying the various linkage components on your outboard. In order to help simplify the procedures components will be referenced in the text using the number used to label the same part in the illustration. But, because some outboards do not use the same linkage components as others, not all illustrations will contain all of the numbers in the keylist.

1. Remove the air intake silencer for visual access to the throttle plates.
2. Loosen, but do not remove, the port and starboard side throttle lever screws (22, 23).

Do NOT remove the throttle link (24) from either throttle lever stud.

3. For V6/V8 motors, loosen (but do NOT remove) the **bottom** screw on the port throttle shaft connector (21) and the **top** screw on the starboard throttle shaft connector (20). Seat all of the throttle plates, tighten the throttle shaft connector screws, starting with the top on the starboard connector and then moving to the bottom on the port shaft connector.
4. Verify that the 2 throttle levers (25) can each rotate freely around their throttle respective shafts.
5. Seat all of the throttle plates and then rotate the starboard throttle lever (25) and the throttle cam (5) until the cam follower (13) just touches the cam at the throttle cam alignment mark (4). The mark is also known as the bisect point, as it aligns with the center of the roller on the cam follower (13).
6. Tighten the starboard throttle lever screw (23), making sure the starboard carburetor throttle plates remain closed.
7. Tigthen the port throttle lever screw (22), making sure the port carburetor throttle plates remain closed.
8. Operate the throttle linkage by hand while watching both the port and starboard throttle plates. They must open at **exactly** the same time. If further adjustment is necessary, repeat the adjustment procedure.

Preliminary Throttle Adjustment (Tiller Control Models Only)

◆ **See Figures 126 and 168**

Refer to the accompanying exploded view for help identifying the various linkage components on your outboard. In order to help simplify the procedures components will be referenced in the text using the number used to label the same part in the illustration. But, because some outboards do not use the same linkage components as others, not all illustrations will contain all of the numbers in the keylist.

1. Turn the idle speed adjustment knob on the tiller handle counter-clockwise (as you face the steering handle) to the full slow position.
2. Turn the throttle arm stop screw (15) and the wide open throttle stop screw (18) until the plastic caps are closest to the throttle arm.
3. Loosen the throttle cable locknut (26) and turn the thumbwheel (27) in order to center the cable travel, then retighten the locknut.

The throttle cable will travel past normal maximum settings in both directions when the thumb wheel is properly adjusted.

4. There should be about 7 threads exposed on the timer base link, also, the rear edge of the spark lever (28) should be flush with the slide (29). If necessary, adjust the spark lever slide screw.
5. Proceed with the Cam Pickup Point adjustment, as detailed in this section.

Cam Pickup Point

1992-96 Remote Models and all Rope/Tiller Models

◆ **See Figures 164,166 and 168**

Refer to the accompanying exploded views for help identifying the various linkage components on your outboard. In order to help simplify the procedures components will be referenced in the text using the number used to label the same part in the illustration. But, because some outboards do not use the same linkage components as others, not all illustrations will contain all of the numbers in the keylist.

☐ **The throttle cam follower screw (12) should still be loose from the proceeding adjustment (Throttle Plate Synchronization). If not, loosen it now.**

1. For V4 models (except the 125WT or all rope/tiller models) and 1992 V6 models, loosen the expansion link lockring (14), then turn the adjustment knob (11) **counterclockwise** until the internal spring tension is relieved.
2. Hold the cam follower (13) against the throttle cam (5) and, at the same time, carefully adjust the throttle arm stop screw (15) until the cam and follower are just touching at the throttle cam alignment mark (4). The alignment mark is also known as the bisect point, as it should align with the center of the cam follower roller (13).
3. Once the throttle arm stop screw (15) is adjusted so the cam (5) and cam follower roller (13) are touching at the bisect point, tighten the cam follower screw (12) to hold the adjustment.

☐ **Do NOT touch the cam follower screw after this step.**

4. After adjustment, proceed as follows, depending on the model:
For the 125WT and all rope/tiller models, 1993 and later V6 models and all V8 models, use a feeler gauge to check the gap between the throttle cam (5) and the cam follower/roller (13). There must be a 0.005 in. (0.13mm) gap to ensure that all throttle plates fully close at idle.
For V4 motors (except the 125WT and all ropeltiller models) and 1992 V6 models, turn the throttle arm stop screw (15) **counterclockwise 1** turn in order to move the throttle cam (5) just slightly away from the cam follower/roller (13).

1997 and Later Remote Models

◆ **See Figures 165 and 167**

Refer to the accompanying exploded views for help identifying the various linkage components on your outboard. In order to help simplify the procedures components will be referenced in the text using the number used to label the same part in the illustration. But, because some outboards do not use the same linkage components as others, not all illustrations will contain all of the numbers in the keylist.

Adjust the throttle arm stop screw (15) until there is a 0.005 in. (0.13mm) gap between the throttle cam (5) and the followerlroller (13). Once the linkage is properly adjusted, both the port and starboard throttle plates must be fully closed and the specified clearance must remain between the cam (5) and roller (13).

Wide Open Throttle Stop

◆ **See Figures 164,165,166,167 and 168**

Refer to the accompanying exploded views for help identifying the various linkage components on your outboard. In order to help simplify the procedures components will be referenced in the text using the number used to label the same part in the illustration. But, because some outboards do not use the same linkage components as others, not all illustrations will contain all of the numbers in the keylist.

1. With the engine not running manually advance the throttle arm (16) and linkage (remote models) or twist the tiller grip (rope/tiller models) to the Wide Open Throttle (WOT) position,
2. Loosen the WOT screw locknut (19), then adjust the WOT stop screw (18) so the carburetor throttle plates approach the wide open position.
3. Next, proceed as follows, depending on the year of the outboard:
- For 1992-96 models and all rope/tiller models, adjust the WOT stop screw (18) until the WOT mark (10) in the cam follower bracket is facing directly forward and perpendicular (at a right angle to) the air intake silencer base.
- For 1997 and later remote models, adjust the WOT stop screw (18) until the throttle plates are wide open as viewed from the front of each carburetor bore. By wide open, we mean at a right angle to the bore (turned 90 degrees from the fully closed position) and not turned past or overcenter.
4. Hold the screw (18) in position and tighten the WOT screw locknut (19)

Remote Throttle Cable Installation and Adjustment

◆ See Figures **135** and **136**

On remote motors, the remote throttle cable was disconnected prior to beginning these adjustments, therefore the cable itself must be reconnected and properly adjusted before the engine can be returned to service.

Before reconnecting the cable, make sure the rubber grommet in the front lower engine cover is in good shape and take the opportunity to extend the cable and apply a fresh coating of Evinrude/Johnson Triple-Guard Grease, or equivalent marine grease.

1. Verify that the fast idle lever is down in the Run position.

Rotating the propeller shaft in the next step is only necessary if the shift cable is still or already installed.

2. While an assistant rotates the propeller shaft slowly by hand, move the remote control handle from Neutral to the Forward detent and then 1/2 the distance back towards Neutral again. This places the remote in proper position for throttle cable adjustment.

✳✳ WARNING

Failure to pay close attention to this adjustment may cause accelerated wear and damage to the shift system as well as binding or high shift effort.

3. Move the engine throttle lever tightly against the idle stop screw, then attach the cable casing guide to the throttle lever pin using the locknut and washer. Tighten the nut securely.
4. Pull firmly on the throttle cable to remove all backlash, then install the trunnion nut into the anchor pocket (adjusting the trunnion nut, as necessary).
5. Loosely install the cable retaining and screw, then check cable adjustment. If the throttle cable is too loose, idle speed may be high and inconsistent. If the cable is too tight, control effort may be too tight, causing difficult shifting through the operating range. Tighten the cable retaining screw once you are certain adjustment is correct.

Remote Shift Cable Installation and Adjustment

◆ See Figures **135** and **136**

On remote motors, if the remote shift cable was disconnected prior to beginning these adjustments, the cable itself must be reconnected and properly adjusted before the engine can be returned to service.

Before reconnecting the cable, take the opportunity to extend the cable and apply a fresh coating of Evinrude/Johnson Triple-Guard Grease, or equivalent marine grease.

1. Verify that the fast idle lever is down in the Run position.
2. Shift the remote control handle to Neutral. Make sure the handle and the neutral lockout plate is in the proper position.
3. Move the remote control handle from Neutral to the fully Forward (WOT) position.
4. While an assistant rotates the propeller shaft slowly by hand, shift the gearcase into Forward.
5. Pull firmly on the shift cable casing to remove all backlash, then install the trunnion nut into the anchor pocket (adjusting the trunnion nut, as necessary).
6. Install the anchor pocket cover and tighten the retainer to 60-84 inch lbs. (7-9 Nm).
7. Shift the remote control handle into Neutral.
8. Temporarily remove the shift cable and verify that the gearcase is in the Neutral detent.

If there is insufficient threads to allow adjustment, or if the **gearcase** detent does not align with the remote control NEUTRAL positioning, the **gearcase** shift rod height is out of adjustment.

9. Slide the rubber grommet onto the control cables and press it into the lower cover groove.
10. Verify proper installation and operation of the shift and throttle cables. Lift the fast idle lever to the start position and watch, if correctly attached, the throttle cable and throttle lever will move.

Maximum Spark Advance

◆ See Figures **164,165,166,167** and **168**

■ For the ignition timing maximum spark advance specifications, please refer to **the Tune-Up** Specifications chart.

To check the maximum spark advance, the outboard must be operated with the proper test wheel. Because of the wide variety of propellers available with different sizes and pitches, the manufacturer does not recommend performing this procedure using the propeller. Furthermore, never operate the powerhead with a propeller above idle speeds while using a flush adapter.

✳✳ CAUTION

Water must circulate through the lower unit to the engine any time the engine is run to prevent damage to the water pump in the lower unit. Just a few seconds without water will damage the water pump.

Refer to the accompanying exploded views for help identifying the various linkage components on your outboard. In order to help simplify the procedures components will be referenced in the text using the number used to label the same part in the illustration. But, because some outboards do not use the same linkage components as others, not all illustrations will contain all of the numbers in the keylist.

1. Install the spark plugs (which were removed for timing pointer verification) and connect the leads.
2. Connect a timing light to the No. 1 cylinder spark plug lead.
3. Start the engine and run it at idle until it reaches operating temperature.
4. Once the motor is fully warmed, run it at full throttle (between 4500-5000 rpm), with the outboard in forward gear. Aim the timing light at the timing marks on the flywheel. The timing pointer should align at the correct degree mark on the flywheel (refer to the Tune-up Specifications chart in this section).
5. If the timing requires adjustment, shut down the powerhead for safety and adjust.
6. For remote models, proceed as follows:
   a. Loosen the locknut on the max spark advance timing screw *(2)*.
   b. Turn the screw (2), as needed, in order to correct the timing. One turn of the screw clockwise retards the timing about 1°, while one turn of the screw counterclockwise advances the timing about 1°.
   c. Tighten the locknut, then restart the engine and check the timing. Repeat until maximum timing is correct.
7. For rope/tiller models, proceed as follows:
   a. Loosen the locknut on spark lever slide screw (30).
   b. Turn the screw (30), as needed, in order to correct the timing. One turn of the screw clockwise advances the timing about 1°, while one turn of the screw counterclockwise retards the timing about 1°.
   c. Tighten the locknut, then restart the engine and check the timing. Repeat until maximum timing is correct.

Idle Speed/Timing

For the ignition idle speedltiming specifications, please refer to the Tune-up Specifications chart.

To check and set the idle speedltiming, the outboard must be operated with the proper test wheel or, preferably, be operated with the engine/boat launched and navigated under normal operating conditions (with the correct propeller installed). This adjustment MUST be made under load. If the adjustment is made using the test wheel, the idle speedltiming should be checked again once the engine is reinstalled and the boat is launched.

✳✳ CAUTION

For safety, don't even THINK about attempting this adjustment unless you have an assistant to help by navigating the craft. In order to make the adjustment properly the boat must be underway, not tied to the dock, anchored or fettered in any way.

1992-96 V4 Models (Except 125WT and all rope/tiller models) and 1992 V6 Models

◆ See Figure 164

Refer to the accompanying exploded views for help identifying the various linkage components on your outboard. In order to help simplify the procedures components will be referenced in the text using the number used to label the same part in the illustration. But, because some outboards do not use the same linkage components as others, not all illustrations will contain all of the numbers in the keylist.

1. If not already done, install the air intake silencer to insure proper idle adjustments.
2. Connect a timing light to the No. 1 cylinder spark plug lead and a shop tachometer to the engine.
3. Loosen the expansion lock ring (14), then turn the lockring and adjustment knob (11) slowly clockwise until they bottom.
4. Start the engine and allow it to idle until it reaches normal operating temperature. The powerhead MUST reach a temperature of at least 96°F (36°C) in order to make the adjustment.
5. Check the idle speed and engine timing with the engine operating at idle in Forward gear, but make sure the throttle arm stop screw (15) is against the crankcase.
6. The idle timing should match what's listed in the Tune-Up Specifications chart. If it does not, stop the engine and adjust the idle timing screw (6) clockwise to advance idle timing or counterclockwise to retard idle timing.

✳✳ CAUTION

We realize that most people probably don't shut the engine off before playing with the idle speed screw, but the manufacturer does not recommend attempting to adjust the idle speed with the engine running for safety reasons and we cannot disagree. If you choose to ignore this caution, make sure that you take all possible precautions to prevent injury by making sure someone else is navigating. Also, keep your hands and clothing away from any hot or moving parts on the outboard.

7. Restart the engine and verify the idle timing. This should allow for idle speeds in the 575-700 rpm range, depending on propeller selection and condition. If the speed is incorrect, check the following:
   a. If the speed it too high, check the induction system for air leaks.
   b. If the speed is too low, and engine components and systems are operating properly, decrease the idle timing by one or two degrees (say from 6 ATDC to 5 or 4 ATDC) to achieve the desired rpm.
   c. If idle speed is inconsistent or the engine runs rough or spits, and no problems can be found, suspect an incorrect carburetor mixture problem, refer to Carburetor Initial Low Speed Setting adjustment in the Fuel System section.
8. Start the motor and shift to the Forward detent, then turn the throttle arm stop screw (15) clockwise until the tachometer reads 950 rpm, then shut the engine off.
9. Without disturbing the throttle arm position, turn the expansion link adjustment knob (11) counterclockwise until the timer base just begins to move away from the idle timing screw (6), then tighten the expansion lock ring (14).

☐ On these models, the throttle cam (5) must not touch the cam follower (13) when the remote control is in NEUTRAL.

10. Gently push back on the throttle arm (16) while turning the throttle arm stop screw (15) counterclockwise until the original cam pickup point is reached. Continue to turn the throttle arm stop screw 1 full turn counterclockwise after the cam pickup point is reached.

All Other Models

◆ See Figures **165, 166, 167** and 168

This idle speedltiming procedure is used for all motors except those listed separately in this section. It should be used for all ropeltiller models, all 125WT models, all 1997 and later V4 motors, 1993 and later V6 motors and all V8 motors.

Refer to the accompanying exploded views for help identifying the various linkage components on your outboard. In order to help simplify the procedures components will be referenced in the text using the number used to label the same part in the illustration. But, because some outboards do not use the same linkage components as others, not all illustrations will contain all of the numbers in the keylist.

1. If not already done, install the air intake silencer to insure proper idle adjustments.
2. Connect a timing light to the No. 1 cylinder spark plug lead and a shop tachometer to the engine.
3. Start the engine and allow it to idle until it reaches normal operating temperature. The powerhead MUST reach a temperature of at least 96°F (36°C) in order to make the adjustment.
4. Check the idle speed and engine timing with the engine operating at idle in Forward gear.
5. The idle speed and timing should match what's listed in the Tune-Up Specifications chart. If it does not, stop the engine for safety, then adjust the idle speed screw (1). For ropeltiller models, loosen the idle speed screw (1) and manually adjust the spark cam.

✳✳ CAUTION

We at realize that most people probably don't shut the engine off before playing with the idle speed screw, but the manufacturer does not recommend attempting to adjust the idle speed with the engine running for safety reasons and we cannot disagree. If you choose to ignore this caution, make sure that you take all possible precautions to prevent injury by making sure someone else is navigating. Also, keep your hands and clothing away from any hot or moving parts on the outboard.

6. If adjustment is necessary on remote models, loosen the locknut, then turn the idle speed screw (1) a full turn clockwise to decrease idle speed or a full turn counterclockwise to increase idle speed.
7. If adjustment is necessary on rope/tiller models, loosen the idle speed screw (1), then manually adjust the spark cam. Move the cam rearward to reduce idle speed or forward to increase it. Retighten the screw (1) once the adjustment is made.
8. Restart the motor and verify idle speedltiming. If the timing is not within range, recheck the linkage adjustments.
9. Once the adjustment is correct on remote models, shut the engine off and hold the idle speed screw (1) steady while tightening the locknut.

☐ If idle speed is inconsistent or the engine runs rough or spits, and no problems can be found, suspect an incorrect carburetor mixture problem, refer to Carburetor Initial Low Speed Setting adjustment in this Fuel System section.

FICHT MOTOR ADJUSTMENTS

2 MODERATE

One of the great benefits of a fuel injected motor is that most of the functions that are mechanical on a carbureted motor (and therefore subject to wear and adjustment) are electronically monitored and adjusted to maximize engine performance. The fuel and ignition systems are all but completely controlled by the Engine Management Module (EMM) on these models. The EMM is a computer control module that accepts input from various sensors mounted around the engine and makes both ignition timing and fuel mapping decisions based on those inputs.

As a matter of fact, none of the timing and synchronization procedures need to be performed periodically, though a well-rounded preseason tune-up can include checking the throttle plate synchronization and crankshaft position sensor air gap. Of course, the timing and synchronization procedures must be performed after related components are serviced or replaced (such as the throttle bodies or crankshaft position sensor).

Ignition timing can only be properly verified using the EvinrudelJohnson Diagnostic Software (designed for use with most IBM compatible laptops) and a suitable interface cable (which should be supplied with the software). Timing verification is not a typical maintenance procedure, but should be performed after any one of the following procedures:

- Powerhead replacement
- Crankshaft replacement
- Flywheel or flywheel cover replacement
- Crankshaft position sensor replacement
- EMM replacement
- After any updated fuel mapping or other modifications are made to EMM memory

Should it be found out of specification, the electronic engine control system should be checked for problems. Of course, don't get into the trap of assuming every problem that arises is electronic. Although the EMM does an incredible job'of regulating engine operation on these motors, it is subject to the same mechanical limitations of any motor. Mechanical problems will often manifest themselves in symptoms of the electronic engine control system and can lead frustration during troubleshooting if you concentrate only on the electronics.

When it comes to FICHT motors, a good adage applies here, "if it ain't broke, don't fix it." Don't go looking for problems just to have something to adjust, enjoy the fact that your buddies are still working on their tenth adjustment procedure after you install new spark plugs and launch for the first time that season.

Should adjustments be required, the adjustment procedures should be performed exactly as directed and in the order given (or noted) to ensure proper adjustments. Of course, this does not mean that if you replace service the throttle bodies and perform a synchronization procedure, that you'd have to go back and check the crankshaft position sensor air gap. For what we hope are reasons that make sense, if the crankshaft position sensor nor they flywheel was touched, there is little or no chance that the air gap changed.

☐ **Remove the throttle cable from the control arm and the anchor pocket prior to beginning these procedures. The cable ends or trunnion anchor may be accessible on some models through the access cover on the side of the motor, but for other models, you will have to remove the lower engine covers for access. For details, please refer to Engine Cover (Top and Lower Cases) in this section.**

Setting the Timing Pointer

◆ **See Figures 122,123,124 and 125**

A timing pointer is mounted to the top of the powerhead on these motors. If the timing pointer has been disturbed use this procedure to check and set the pointer-positioning (thereby ensuring the accuracy of the ignition timing verification procedure when using the EvinrudelJohnson Diagnostic Software).

This procedure describes the use of the EvinrudelJohnson Piston Stop tool, which is basically just a fixed rod with, mounted through spark plug threads. A substitute could be fabricated with a little creativity (using the casing of a spark plug or even a plug thread chaser). The key to the tool is that it can be locked in place to physically mark a point early point in the piston's downstroke. The idea of either tool is to physically measure the exact height of the piston in the cylinder bore at a prescribed distance before and after TDC (on its way up and down in the cylinder bore). The first mark you make on the flywheel translates into this point. Then, the piston is brought the rest of the way down in its travel and back up again (by rotating the flywheel) until it reaches the very same height in the bore (and contacts the tool again, but this time on the way up). A second mark represents the exact same physical point in the bore, on the exact opposite side of Top Dead Center (TDC) or the very top of the piston travel. By locating the exact point midway between these to marks, you've found the spot on the flywheel that corresponds perfectly to Top Dead Center with regards to the pointer's current position.

☐ **Following the logic of the tool, a dial gauge could also be used instead of the piston stop tool. The gauge could be zeroed at the random downward point of travel. When turning the engine again to bring the piston back upward in the cylinder bore, stop when the gauge zeros again, meaning the piston has once again reached the exact same height.**

1. Remove the spark plugs from the cylinder heads using the procedures found under Spark Plugs in this section.

☐ **The spark plugs are removed in order to relieve engine compression (making the motor easier to turn by hand) and for access to the No. 1 cylinder.**

2. Loosen the screw fastening the timing pointer, then center the pointer and retighten the screw to hold it in position.
3. Slowly rotate the flywheel clockwise (when viewed from above) until the cast Top Dead Center (TDC) mark is about 1 112 in. (4cm) **past** the timing pointer.
4. Install the Evinrude/Johnson Piston Stop Tool (PIN 342679 or equivalent, or a dial gauge) into the spark plug bore for the top (No.1) cylinder. Lock the tool in place using the lock ring (or zero the dial gauge, as applicable).
5. Unless you are using a dial gauge, rotate the flywheel, VERY, VERY slowly backwards (yes, **counterclockwise)** until the piston makes contact with the tool.
6. Hold the flywheel (and thereby the piston) firmly against the piston stop tool (or with the dial gauge zeroed) and make a mark on the flywheel directly inline with the timing pointer. Label this mark 1 to distinguish it from the next mark.

☐ **In the next step you will rotate the flywheel and therefore the engine until the piston goes down in the cylinder bore and comes back up again to the exact same height.**

7. Rotate the flywheel in a **clockwise** direction until the piston contacts the tool again, then make a second mark (label it 2) on the flywheel inline with the timing pointer, then remove the piston stop tool. It may be necessary to turn the flywheel, very slightly **counterclockwise** to unload the tool before it can be removed.
8. Use the marks that are cast into the flywheel surface to find the spot midway between the first and second marks and place a new mark at this location labeled 3. This mark represents TDC to the timing pointer's current setting. If this mark and the cast TDC mark on the flywheel align, then the pointer position is correct.
9. If adjustment is necessary (the **3** mark and the cast TDC do not align), rotate the flywheel **clockwise** to align this TDC mark with the timing pointer. Then, holding the flywheel in this position, loosen the timing pointer screw again. Slide the pointer away from the center mark and align it with the cast TDC mark on the flywheel itself. Tighten the timing pointer retaining screw securely as it is now set for accurate readings on the flywheel again.
10. Index and install the spark plugs.

Crankshaft Position Sensor Air Gap Adjustment

The Engine Management Module (EMM) controls ignition and fuel injection functions based on signals from various powerhead mounted sensors, One of the most important sensor signals is the Crankshaft Position (CP) sensor, whose signal is used to determine the mechanical positioning of the pistons in relations to the cylinders (using the physical position of the crankshaft). In order to function properly, the crankshaft position sensor must be mounted in precise relation to the raised tooth of the flywheel. Anytime the sensor is removed, the air gap should be adjusted to specification as follows:

The crankshaft position sensor is located on the starboard side of the powerhead, mounted directly underneath the flywheel.

1. Using a feeler gauge set, check the gap between the sensor and the flywheel. The gap should be 0.040-0.080 in. (1.0-2.0mm).

☐ Remember, when using a feeler gauge, the proper sized gauge should pass through the gap with a slight drag. The next smaller gauge should pass through the gap with no resistance at all, when conversely the next larger gauge should not fit.

2. If adjustment is necessary, loosen the sensor retaining bolt, then install or remove shims between the sensor and the spacer in order to bring the gap into spec.
3. Once the sensor position is properly adjusted, tighten the retaining bolt and recheck the gap.

Throttle Plate Synchronization

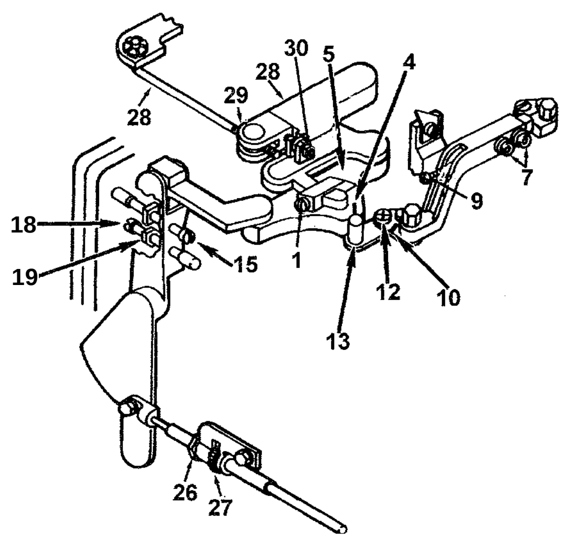
◆ **See Figure 169**

In order for the motor to operate properly, the throttle olates in each of the throttle bodies must be open and close at the same time. Through throttle plate synchronization you will ensure that all of the plates close completely at idle, preventing the possible idle problems that could occur if the linkage was to hold one or more of the plates open at idle.

This adjustment is made with the engine **not** running and the air intake silencer removed so that you can observe the throttle valves.

☐ Apply light pressure to the throttle plates during this procedure to make sure they close completely.

1. Remove the air intake silencer assembly.
2. Loosen, but do NOT remove, the port (1) and starboard (2) throttle lever screws. Do NOT remove the links (3).
3. Loosen, but do NOT remove, the **bottom** screw for the port throttle shaft connector (4) and the **top** screw for the starboard shaft connector.
4. Seat all of the throttle plates and then tighten the starboard shaft connector screw, followed by the port screw.
5. Make sure that the throttle levers (6 and 7) can rotate freely around their throttle shaft.
6. Seat all of the throttle plates, then adjust the idle stop (10) so that the cam follower roller (8) JUST touches the throttle cam at the bisect point (9).
7. Tighten the starboard throttle lever screw (2), making sure that the starboard throttle plates remain fully closed.
8. Tighten the port throttle lever screw (1), making sure that the port throttle plates remain fully closed.
9. Observe the throttle plates as you actuate the linkage, both the port and starboard throttle plates must open at precisely the same time. If necessary, repeat the adjustment procedure until the plates operate simultaneously.
10. Push the throttle lever (12) to the Wide Open Throttle (WOT) position and adiust the throttle stoo screw (11) until the plates are wide open.
11. 'Return the throttle lever (12) to the idle position, then back out the idle stop screw (10) 1 1/2 turns. Hold the screw in that position and tighten the locknut. Make sure that the roller turns freely after tightening.
12. Reattach the throttle control cable.



1 Idle speed screw
2 Max spark timing advance screw
3 Throttle cam follower
4 Throttle cam alignment mark
5 Throttle cam
6 Idle timing screw
7 Carb link adjustment screw
8 Timing pointer
9 Carb link stop screw
10 W.O.T. mark
11 Lockring and adjustment knob/screw
12 Cam follower screw
13 Cam followerlroller
14 Expansion link lockring
15 Throttle arm stop screw
16 Throttle arm
17 Throttle anchor screw
18 WOT stop screw
19 WOT screw locknut
20 Starboard throttle shaft connector
21 Port throttle shaft connector
22 Throttle lever screw (port)
23 Throttle lever screw (starboard)
24 Throttle link
25 Throttle levers
26 Throttle cable locknut
27 Thumbwheel
28 Spark lever
29 Slide
30 Slide screw

Fig. 169 Throttle plate synchronization adjustment points

Control Cable Adjustment

◆ See Figures 159 and **169**

The throttle and or shift control cables must be disconnected before certain procedures (such as throttle plate synchronization) to ensure no preload from the cable interferes with adjustment. Once adjustments are complete or anytime a control cable is removed for service or other reasons, the cable must be properly adjusted to ensure proper motor operation. If no changes were made to the cable or related components, there is a good chance that the setting (if undisturbed) will already be correct, but you'll still want to verify it to be sure.

This procedure covers installation and adjustment of both cables. Furthermore, it assumes that the trunnion anchor bracket was removed, which is not necessary if you are just disconnecting one or more cables from the linkage in order to make adjustments or minor repairs. Follow only the steps that are appropriate for the circumstances under which you are working.

1. If the shift cable was disconnected, move the remote to Reverse, then move the engine shifter lever to the matching Reverse position. Install the cable guide on the shift lever, using the washer and nut to secure the guide. Move the control to Neutral . Hold the shift cable trunnion in the bracket on the side of the motor, the trunnion must align with the bracket; otherwise, adjust the trunnion as necessary (using the shift cable thumbwheel).
2. Move the remote to the full throttle position, then manually move the engine throttle lever to the full throttle position also. Install the cable guide on the throttle lever, using the washer and nut to secure the guide.
3. Move the control to Neutral and make sure the fast idle lever is in the down position, then pull back lightly on the trunnion to remove any freeplay from the cable. Adjust the trunnion (using the thumbwheel) to fit in the pocket and hold slight tension against the idle stop screw. This adjustment should apply a slight drag on a piece of paper inserted between the idle stop screw and the powerhead.
4. Hold the cables in position against the trunnion pocket, install the trunnion anchors and tighten the mounting screws.
5. If removed, install the lower engine covers.

Checking Ignition Timing

The Engine Management Module (EMM) controls all ignition and fuel injection function on these motors. No timing adjustment is either necessarv or possible, however, using the Evinrude/Johnson Diagnostic Software and' an IBM compatible laptop, it is possible to check and verify ignition timing. Follow the instructions included with the software for conducting this check anytime one of the following has occurred:

- Powerhead replacement
- Crankshaft replacement
- Flywheel or flywheel cover replacement
- Crankshaft position sensor replacement
- EMM replacement
- After any updated fuel mapping or other modifications are made to EMM memory

STORAGE (WHAT TO DO BEFORE AND AFTER)

Winterization

◆ See Figure **170**

Taking extra time to store the boat and motor properly at the end of each season or before any extended period of storage will greatly increase the chances of satisfactory service at the next season. Remember, that next to hard use on the water, the time spent in storage can be the greatest enemy of an outboard motor. Ideally, outboards should be used regularly. If weather in your area allows it, don't store the motor, enjoy it. Use it, at least on a monthly basis. It's best to enjoy and service the boat's steering and shifting mechanism several times each month. If a small amount of time is spent in such maintenance, the reward will be satisfactory performance, increased longevity and greatly reduced maintenance expenses.

But, in many cases, weather or other factors will interfere with time for enjoying a boat and motor. If you must place them in storage, take time to properly winterize the boat and outboard. This will be your best shot at making time stand still for them.

For many years there was a widespread belief that simply shutting off the fuel at the tank and then running the powerhead until it stops constituted prepping the motor for storage. Right? Well, WRONG!

First, it is not possible to remove all fuel in the carburetor or fuel injection svstem bv operatinq the powerhead until it stoes. Considerable fuel will remain trapped in the float chamber and other passages, especially in the lines leading to carburetors. The only guaranteed method of removing all fuel is to take the physically drain the carburetors from the float bowls. On FFI systems, disassembling the fuel injection components to drain the fuel is impractical so properly mixing fuel stabilizer becomes that much more important. Actually, the manufacturer recommends prepping all of the motors using fuel stabilizer as opposed to draining the fuel system, but on carbureted motors, you always have the option.

■ On **VRO2** equipped motors, disconnecting the fuel line to run the engine out of **mav** cause the **consumption** of excessive amounts of oil. **This** can lead to hard starting **problems** later, from deposits formed in the combustion chamber.

Proper storage involves adequate protection of the unit from physical damage, rust, corrosion and dirt. The following steps provide an adequate maintenance program for storing the unit at the end of a season.

Fig. **170** Add fuel stabilizer to the system anytime it will be stored without being completely drained

PREPPING FOR STORAGE

EASY

Where to Store Your Boat and Motor

Ok, a well lit, locked, heated garage and work area is the best place to store you precious boat and motor, right? Well, we're probably not the only ones who wish we had access to a place like that, but if you're like most of us, we place our boat and motor wherever we can.

Of course, no matter what storage limitations are placed by where you live or how much space you have available, there are ways to maximize the storage site.

If possible, select an area that is dry. Covered is great, even if it is under a carport or sturdy portable structure designed for off-season storage. Many people utilize canvas and metal frame structures for such purposes. If you've got room in a garage or shed, that's even better. If you've got a heated garage, God bless you, when can we come over? If you do have a garage or shed that's not heated, an insulated area will help minimize the more extreme temperature variations and an attached garage is usually better than a detached for this reason. Just take extra care to make sure you've properly inspected the fuel system before leaving your boat in an attached garage for any amount of time.

If a storage area contains large windows, mask them to keep sunlight off the boat and motor otherwise, use a high-quality, canvas cover over the boat, motor and if possible, the trailer too. A breathable cover is best to avoid the possible build-up of mold or mildew, but a heavy duty, non-breathable cover will work too. If using a non-breathable cover, place wooden blocks or length's of 2 x 4 under various reinforced spots in the cover to hold it up off the boat's surface. This should provide enough room for air to circulate under the cover, allowing for moisture to evaporate and escape.

☐ Marine supply stores normally sell various types of desiccant (water absorbent) **products. These** mesh bags or small plastic pails are filled with a material that tends to draw moisture from the air and hold it in **suspension. They** can be very helpful in the prevention of mildew when insufficient airflow is present to naturally remove moisture from underneath a cover (or shrink wrapping). Follow the product instructions closely when using such products (and keep them away from small children).

Whenever possible, avoid storing your boat in industrial buildings or parks areas where corrosive emissions may be present. The same goes for storing your boat too close to large bodies of saltwater. Hey, on the other hand, if you live in the Florida Keys, we're jealous again, just enjoy it and service the boat often to prevent corrosion from causing damage.

Finally, when picking a place to store your motor, consider the risk or damage from fire, vandalism or even theft. Check with your insurance agent regarding coverage while the boat and motor is stored.

Storage Checklist (Preparing the Boat and Motor)

◆ See Figure 171

The amount of time spent and number of steps followed in the storage procedure will vary with factors such as the length of planed storage time, the conditions under which boat and motor are to be stored and your personal decisions regarding storage.

But, even considering the variables, plans can change, so be careful if you decide to perform only the minimal amount of preparation. A boat and motor that has been thoroughly prepared for storage can remain so with minimum adverse affects for as short or long a time as is reasonably necessary. The same cannot be said for a boat or motor on which important winterization steps were skipped.

☐ Always store an **Evinrude/Johnson** motor vertically on the boat or on a suitable engine stand.

1. Thoroughly wash the boat motor and hull. Be sure to remove all traces of dirt, debris or marine life. Check the water stream fitting, water inlet(s) and, on jet models, the impeller grate for debris. If equipped, inspect the speedometer opening at the leading edge of the lower unit or any other lower unit drains for debris (clean debris with a compressed air or a piece of thin wire).

☐ The manufacturer recommends the use of EvinrudelJohnson **2+4** Fuel Conditioner when treating the fuel svstems on **Evinrude/Johnson** motors. In the past, **Evinrude/Johnson** recommended using **2+4** in a ratio of 1.0 oz. (30 ml) for every gallon (3.8 L), but products may change, so be sure to follow the directions on the bottle if they differ. On carbureted motors, you always have the work intensive option of draining the **fuel** system instead, either using the float bowl drains on the **carburetor(s)** or by removing the **carburetor(s)** completely from the motor. For more details on carburetor service, please refer to the Fuel System section, but keep in mind that the manufacturer recommends using the fuel conditioner method. Of course, if the engine is to be **stored** for an undetermined amount of time (more **than 1** or 2 seasons), removing and completely draining the carburetors is probably the best option.

2. Stabilize the engine's fuel supply and fog the motor using a high quality fuel stabilizer and storage fogging oil. At the same time, take this opportunity to thoroughly flush the engine cooling system as well:

For FFI motors (or carbureted motors if you wish to spray some fogging oil down the carburetor throttle bodies while the motor is running), remove the air intake silencer for access.

a. Add an appropriate amount of fuel stabilizer to the fuel tank and top off to minimize the formation of moisture through condensation in the fuel tank.

b. Next, prepare a fuel storage mixture as directed. Use a portable 6.0 gal. (23L) gas tank to mix:

5.0 gal. (19L) of gas

2.0 qt. (1.9L) of EvinrudelJohnson Storage Fogging Oil

For carbureted motors also add 1 pt. (0.47L) of EvinrudelJohnson 2-stroke engine oil.

• Add 2.5 oz. (74ml) of EvinrudelJohnson 2+4 Fuel Conditioner or equivalent storage fluids.

■ Through 1994 **Evinrude/Johnson** recommended adding **1** pt. **(0.47L)** of **2+4, but beginning** in 1995 they changed the **recommendation** to 2.5' oz. **(74ml).** Although we cannot confirm, we believe the change was not **due to differing requirements by** the **motors** themselves, **but to** either a change in **thinking or** a change-in the formulation of **2+4.** If you're working on a 1994 or earlier motor, the choice is yours, but we'd go with the updated specification of **2.5oz (74ml).**

c. Connect this tank to the engine in order to provide a treated fuel mixture to the engine for storage.

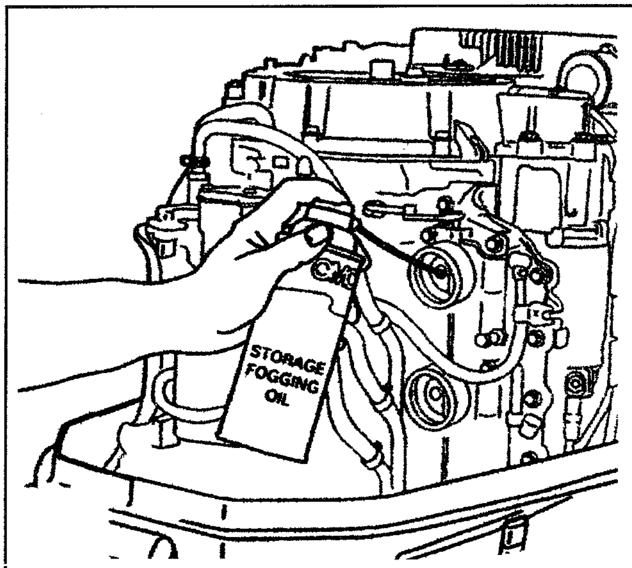


Fig. 171 Fogging oil can be sprayed down the throats of the throttle bodies (or carburetors), but it should still be added directly to the cylinders through the spark plug ports

d. Attach a flushing attachment as a cooling waterflushing source. For details, please refer to the information on Flushing the Cooling System, in this section.

e. Start and run the engine at about 1500 rpm for approximately 5 minutes on carbureted models or 10 minutes on FFI models. This will ensure the entire fuel supply system contains the appropriate storage mixtures.

f. On FFI models (or carbureted models too, if you wish to spray fogging oil down the throats of the carburetors while the motor is running), follow the instructions provided on the can of fogging oil and spray the oil into the mouth of each throttle body (or carburetor).

g. Stop the engine and remove the flushing source, keeping the outboard perfectly vertical. Allow the cooling system to drain completely, especially if the outboard might be exposed to freezing temperatures during storage.

**** WARNING**

NEVER keep the outboard tilted when storing in below-freezing temperatures as water could remain trapped in the cooling system. Any water left in cooling passages might freeze and could cause severe engine damage by cracking the powerhead or lower unit.

h. Finish the fogging procedure by removing all of the spark plugs, and placing the engine is the fully-tilted position then spraying a generous amount of fogging oil directly into each of the cylinders.

☐ On models equipped with power steering, allow the engine to sit in the fully-tilted position for at LEAST 5 minutes in order to completely drain the oil cooler. But, the engine must be returned to a fully-vertical position for long term storage.

i. Turn the crankshaft slowly (by hand) in a clockwise direction a few complete turns to evenly distribute the fogging oil throughout the cylinders.

j. Spray a small amount of additional fogging lubricant into each of the cylinders, then reinstall and torque the Spark Plugs (as detailed in this section).

k. To prevent accidental starting, leave the spark plug wires tagged and disconnected. To prevent potential damage to the ignition system, make sure the motor is not cranked with the wires disconnected. The best thing to do is to ground the spark plug wires to the powerhead. But, alternately, you could secure a reminder note to the ignition switch (a wire tie and a note in a plastic bag has infinitely better chance of lasting than a piece of paper and some tape. May we suggest the following text for the note "LISTEN DUMMY, DON'T CRANK THE MOTOR, THE SPARK PLUG WIRES ARE DISCONNECTED."

3. Drain and refill the engine gearcase while the oil is still warm (for details, refer to the Lower Unit Oil procedures in this section). Take the opportunity to inspect for problems now, as storage time should allow you the opportunity to replace damaged or defective seals. More importantly, remove the old, contaminated gear oil now and place the motor into storage with fresh oil to help prevent internal corrosion.

4. For models equipped with portable fuel tanks, disconnect and relocate them to a safe, well-ventilated, storage area, away from the motor. Drain any fuel lines that remain attached to the tank.

☐ On VRO or FFI motors, DO NOT disconnect the oil tank **lines. Top** off the tanks and leave the lines connected to help protect the system from moisture.

5. Remove the battery or batteries from the boat and store in a cool dry place. If possible, place the battery on a smart charger or Battery Tender®, otherwise, trickle charge the battery once a month to maintain proper charge.

**** WARNING**

Remember that the electrolyte in a discharged battery has a much lower freezing point and is more likely to freeze **(cracking/destroying** the battery case) when stored for long periods in areas exposed to freezing temperatures. Although keeping the battery charged offers one level or protection against freezing; the other is to store the battery in a heated or protected storage area.

6. For models equipped with a boat mounted fuel filter or filter/water canister, clean or replace the boat mounted fuel filter at this time. The engine mounted fuel filters should be left intact, so the sealed system remains filled with treated fuel during the storage period.

7. For motors with external oil tanks, if possible, leave the oil supply line connected to the motor. This is the best way to seal moisture out of the system. If the line must be disconnected for any reason (such as to remove the motor or oil tank from the boat), seal the line by sliding a snug fitting cap over the end. Most motors equipped with remote oil tanks are equipped with a cap, mounted somewhere on the engine, such as on the fuel line, near the fuel pump. Top off the oil tank to displace moisture-laden air and help prevent contamination of the oil in storage. Also, clean and inspect the VRO2 reservoir and pickup filter at this time. Replace the filter if it is damaged in any way.

8. For FFI motors or motors equipped-with a lower unit speedometer pickup, disconnect the speedometer hose from the upper most connector and blow all water from the lower unit speedometer pickup. If compressed air is available, use less than 25 psi (167 kPa) of air pressure in order to prevent damage to the system.

9. Perform a complete lubrication service following the procedures in this section.

10. Remove the propeller and check thoroughly for damage. Clean the propeller shaft and apply a protective coating of grease. On Jet models, thoroughly inspect the impeller and check the impeller clearance. Refer to the procedures in this section.

11. Check the motor for loose, broken or missing fasteners. Tighten fasteners and, again, use the storage time to make any necessary repairs.

☐ If the motor is to be removed from the boat for storage, carefully examine all mounting fasteners as well as the steering, throttle and shift systems. Replace any damaged or missing components. Also, **keep** close track of the fasteners, during installation NEVER substitute **the mounting** hardware from a smaller **motor** (especially on V8 motors) since a mounting failure during service could cause loss of control (or loss of the motor).

12. Inspect and repair all electrical wiring and connections at this time. Make sure nothing was damaged during the season's use. Repair any loose connectors or any wires with broken, cracked or otherwise damaged insulation.

13. Clean all components under the engine cover and apply a corrosion preventative spray.

14. Too many people forget the boat and trailer, don't be one of them.

a. Take the opportunity to touch-up any damaged paint on the motor cases or trailer (if you're using a painted trailer).

b. Coat the boat and all outside painted surfaces of the motor with a fresh coating of wax then cover it with a breathable cover

c. If possible place the trailer on stands or blocks so the wheels are supported off the ground.

d. Check the air pressure in the trailer tires. If it hasn't been done in a while, remove the wheels to clean and repack the wheel bearings.

15. Sleep well, since you know that your baby will be ready for you come next season.

Recommissioning

REMOVAL FROM STORAGE

① EASY

The amount of service required when recommissioning the boat and motor after storage depends on the length of non-use, the thoroughness of the storage procedures and the storage conditions.

At minimum, a thorough spring or pre-season tune-up and a full lubrication service is essential to getting the most out of your engine. If the engine has been properly winterized, it is usually no problem to get it in top running condition again in the springtime. If the engine has just been put in the garage and forgotten for the winter, then it is doubly important to perform a complete tune-up before putting the engine back into service. If you have ever been stranded on the water because your engine has died and you had to suffer the embarrassment of having to be towed back to the marina you know how it can be a miserable experience. Now is the time to prevent that from occurring.

Take the opportunity to perform any annual maintenance procedures that were not conducted immediately prior to placing the motor into storage. If the motor was stored for more than one off-season, pay special attention to inspection procedures, especially those regarding hoses and fittings. Check the engine gear oil for excessive moisture contamination. The same goes for oil tanks on oil or fuel injected motors. if necessary, change the lower unit or drain and refill the injection tank oil to be certain no bad or contaminated fluids are used.

■ Although not absolutely necessary, it is a good idea to ensure optimum cooling system operation by replacing the water pump impeller at this time. In the old days, seasonal replacement was a regular thing. To be honest, the impellers and pumps are usually made of better materials now and can easily last a couple of seasons, but it is cheap insurance.

Other items that require attention include:

1. Install the battery (or batteries) if so equipped.
2. Inspect all wiring and electrical connections. Rodents have a knack for feasting on wiring harness insulation over the winter. If any signs of rodent life are found, check the wiring carefully for damage, do not start the motor until damaged wiring has been fixed or replaced.
3. For models with a remote oil tank, if the line was disconnected, remove the cover and reconnect the line, then prime the system to ensure proper operation once the motor is started.
4. if not done when placing the motor into storage clean and/or replace the boat fuel filters at this time. Also, clean or replace the engine mounted filters (which should have been neglected during winterization so the fuel system would remain sealed with treated fuel.
5. If the fuel tank was emptied, or if it must be emptied because the fuel is stale fill the tank with fresh fuel. Keep in mind that even fuel that was treated with stabilizer will eventually become stale, especially if the tank is stored for more than one off-season. Pump the orimer bulb and check for fuel leakage or flooding at the carburetor or vapbr separator tank. For FFI motors, pressurize the high pressure fuel circuit turning the ignition on (and listening to verify that the fuel pump runs for a few seconds). Inspect the fuel rail and fittings under the engine top case for leaks.
6. Attach a flush device or place the outboard in a test tank and start the engine. Run the engine at idle speed and warm it to normal operating temperature. Check for proper operation of the cooling, electrical and warning systems.

**** CAUTION**

Before putting the boat in the water, take time to verify the drain plug is installed. Countless number of spring boating excursions have had a very sad beginning because the boat was eased into the water only to have the boat begin to fill with it.

CLEARING A SUBMERGED MOTOR

The good news is that motors of this size are rarely lost overboard (unless there is serious neglect of the mounting fasteners or unless there is a catastrophic failure to the boat, transom or motor). It is rare enough that Evinrude/Johnson does not even discuss the possibility in literature for many of the motors covered in this guide. On the other hand, accidents do occur, and if you're reading this for some other reason than morbid curiosity then you've obviously got a situation with which you must deal. Should a large V outboard become submerged, it is usually possible to salvage, service and enjoy the motor again.

In order to prevent severe damage, be sure to recover an engine that is dropped overboard or otherwise completely submerged as soon as possible. It is really best to recover it immediately. But, keep in mind that once a submerged motor is recovered exposure to the atmosphere will allow corrosion to begin etching highly polished bearing surfaces of the crankshaft, connecting rods and bearings. For this reason, not only do you have to recover it right away, but you should service it right away too. Make sure the motor is serviced within 3 hours of initial submersion.

OK, maybe now you're saying "3 hours, it will take me that long to get it to a shop or to my own garage." Well, if the engine cannot be serviced immediately (or sufficiently serviced so it can be started), re-submerge it in a tank of fresh water to minimize exposure to the atmosphere and slow the corrosion process. Even if you do this, do not delay any more than absolutely necessary, service the engine as soon as possible. This is especially important if the engine was submerged in salt, brackish or polluted water as even submersion in fresh water will not preserve the engine indefinitely. Service the engine, at the MOST within a few days of protective submersion.

**** WARNING**

Keep in mind that even fresh water will cause etching on the highly polished bearing surfaces of the crankshaft, connecting rods and bearings. We simply cannot over-emphasize the need to purge the motor of moisture once submersion has occurred.

After the engine is recovered, vigorously wash all debris from the engine using pressurized freshwater.

■ If the engine was submerged while still running, there is a good chance of internal damage (such as a bent connecting rod). Under these circumstances, don't start the motor, follow the beginning of this procedure to try turning it over slowly by hand, feeling for mechanical problems. If necessary, refer to Powerhead Overhaul for complete disassembly and repair instructions.

**** WARNING**

NEVER try to start a recovered motor until at least the first few steps (the ones dealing with draining the motor and checking to see it if is hydro-locked or damaged) are performed. Keep in mind that attempting to start a hydro-locked motor could cause major damage to the **powerhead,** including bending or breaking a **connecting** rod.

If the motor was submerged for any length of time it should be horoughly disassembled and cleaned. Of course, this depends on whether or not water intruded into the motor itself. To help determine this check the lower unit oil for signs of contamination. Also, be sure to remove the spark plugs and visually check for signs of moisture.

The extent of cleaning and disassembly that must take place depends also on the type of water in which the engine was submerged. Engines totally submerged, for even a short length of time, in salt, brackish or polluted water will require more thorough servicing than ones submerged in fresh water for the same length of time. But, as the total length of submerged time or time before service increases, even engines submerged in fresh water will require more attention. Complete powerhead disassembly and inspection is required when sand, silt or other gritty material is found inside the engine cover.

Many engine components suffer the corrosive effects of submersion in salt, brackish or polluted water. The symptoms may not occur for some time after the event. Salt crystals will form in areas of the engine and promote significant corrosion.

Electrical components should be dried and cleaned or replaced, as necessary. If the motor was submerged in salt water, the wire harness and connections are usually affected in a shorter amount of time. Since it is difficult (or nearly impossible) to remove the salt crystals from the wiring connectors, it is best to replace the wire harness and clean ail electrical component connections. The starter motor, relays and switches on the engine usually fail if not thoroughly cleaned or replaced.

To ensure a through cleaning and inspection:

1. Remove the engine cover and wash all material from the engine using pressurized freshwater. If sand, silt or gritty material is present inside the engine cover, completely disassemble and inspect the powerhead.
2. Tag and disconnect the spark plugs leads. Be sure to grasp the spark plug cap and not the wire, then twist the cap while pulling upward to free it from the plug. Remove the spark plugs. For more details, refer to the Spark Plug procedure in this section.

3. Disconnect the fuel supply line from the engine, then drain and clean all fuel lines. Depending on the circumstances surrounding the submersion, inspect the fuel tank for contamination and drain, if necessary.

4. On oil or fuel injected models, drain and clean the oil supply system. On carbureted models, be sure to drain and clean the VR02 oil reservoir. Purge any potentially contaminated oil from the supply lines. Properly prime the oil system before attempting to start and run the motor.

**** WARNING**

When attempting to turn the flywheel for the first time after the submersion, be sure to turn it SLOWLY, feeling for sticking or binding that could indicate internal damage from hydro-lock. This is a concern, especially if the engine was cranked before the spark plug(s) were removed to drain water or if the engine was submerged while still running.

5. Support the engine horizontally with the spark plug port(s) facing downward, allowing water, if present, to drain. Force any remaining the water out by slowly rotating the flywheel by hand about 20 times or until there are no signs of water. If there signs of water are present, spray some fogging oil into the spark plug ports before turning the flywheel. This will help dislodge moisture and lubricate the cylinder walls.

6. On carbureted models, drain the carburetor(s). The best method to thoroughly drainlclean the carburetor is to remove and disassemble it. For details refer to the Carburetor procedures under Fuel System.

7. Support the engine in the normal upright position. Check the engine lower unit oil for contamination. Refer to the procedures for Lower Unit Oil in this section. The lower unit is sealed and, if the seals are in good condition, should have survived the submersion without contamination. But, if contamination is found, look for possible leaks in the seals, then drain the lower unit and make the necessary repairs before refilling it. For more details, refer to the section on Lower Units.

8. Remove all external electrical components for disassembly and cleaning. Spray all connectors with electrical contact cleaner and then apply a small amount of dielectric grease prior to reconnection to help prevent corrosion. For electric start models, remove, disassemble and clean the starter components. For details on the electrical system components, refer to the Ignition and Electrical section.

9. Reassemble the motor and mount the engine or place it in a test tank. Start and run the engine for 112 hour using a break-in fuel/oil mixture. If the engine won't start, remove the spark plugs again and check for signs of moisture on the tips. If necessary, use compressed air to clean moisture from the electrodes or replace the plugs.

10. Stop the engine and recheck the lower unit oil.

11. Perform all other lubrication services.

12. Try not to let it get away from you (or anyone else) again!

SPECIFICATIONS

General Engine Specifications

Model (Hp)	No. of Cyl	Engine Type Degree	Year	Displacement cu. in. (cc)	Bore and Stroke in. (mm)	Gear Ratio	Appx Weight lb. (kg)
65 Jet	4	90 CV	1992-95	100 (1632)	3.50 x 2.59 (89 x 66)	na	288-314 (131-142)
80 Jet	4	90 CV	1992-97	100 (1632)	3.50 x 2.59 (89 x 66)	na	288-314 (131-142)
85	4	90 CV	1992-95	100 (1632)	3.50 x 2.59 (89 x 66)	13:26 (0.50)	288-314 (131-142)
88	4	90 CV	1992-96	100 (1632)	3.50 x 2.59 (89 x 66)	13:26 (0.50)	288-314 (131-142)
90	4	90 CV	1992-98	100 (1632)	3.50 x 2.59 (89 x 66)	13:26 (0.50)	288-314 (131-142)
100	4	90 CV	1992-97	100 (1632)	3.50 x 2.59 (89 x 66)	13:26 (0.50) ①	288-314 (131-142)
112 SPL	4	90 CV	1994-96	100 (1632)	3.50 x 2.59 (89 x 66)	13:26 (0.50)	288-314 (131-142)
115	4	90 CV	1992-98	100 (1632)	3.50 x 2.59 (89 x 66)	13:26 (0.50)	288-314 (131-142)
75	4	60 LV	2001	105 (1726)	3.60 x 2.59 (91 x 66)	13:26 (0.50)	349-366 (158-166)
80 Jet	4	60 LV	1998-01	105 (1726)	3.60 x 2.59 (91 x 66)	na	319-336 (145-152)
90	4	60 LV	1995-01	105 (1726)	3.60 x 2.59 (91 x 66)	②	③
100	4	60 LV	1998-01	105 (1726)	3.60 x 2.59 (91 x 66)	②	319-336 (145-152)
105 Com	4	60 LV	1997-01	105 (1726)	3.60 x 2.59 (91 x 66)	12:27 (0.44)	311-332 (141-150)
115	4	60 LV	1995-01	105 (1726)	3.60 x 2.59 (91 x 66)	②	③
120	4	90 LV	1992-94	122 (2000)	3.69 x 2.86 (94 x 73)	13:26 (0.50) ④	365-378 (166-172)
125 Com	4	90 LV	1992-98	122 (2000)	3.69 x 2.86 (94 x 73)	12:27 (0.44) ⑤	365-369 (166-172)
130	4	90 LV	1994-00	122 (2000)	3.69 x 2.86 (94 x 73)	12:27 (0.44) ⑥	365-368 (166-172)
135	4	90 LV	2001	122 (2000)	3.69 x 2.86 (94 x 73)	12:27 (0.44)	365 (166)
140	4	90 LV	1992-94	122 (2000)	3.69 x 2.86 (94 x 73)	12:27 (0.44) ⑦	368-378 (168-172)
105 Jet	6	60 LV	1992-01	158 (2589)	3.60-2.59 (91 x 66)	na	⑧
135	6	60 LV	2001	158 (2589)	3.60-2.59 (91 x 66)	14:26 (0.54)	⑧
150	6	60 LV	1992-01	158 (2589)	3.60-2.59 (91 x 66)	14:26 (0.54)	⑧
175	6	60 LV	1992-01	158 (2589)	3.60-2.59 (91 x 66)	14:26 (0.54)	⑧
185	6	90 LV	1992-94	183 (3000)	3.69 x 2.86 (94 x 73)	14:26 (0.54)	450-471 (204-214)
200	6	90 LV	1992-01	183 (3000)	3.69 x 2.86 (94 x 73)	14:26 (0.54)	450-471 (204-214)
225	6	90 LV	1992-01	183 (3000)	3.69 x 2.86 (94 x 73)	14:26 (0.54)	450-471 (204-214)
250	6	90 LV	1999-01	183 (3000)	3.69 x 2.86 (94 x 73)	14:26 (0.54)	450-471 (204-214)
200	6	90 LV	2001	200 (3300)	3.85 x 2.86 (98 x 73)	14:26 (0.54)	498-512 (226-232)
225	6	90 LV	2001	200 (3300)	3.85 x 2.86 (98 x 73)	14:26 (0.54)	512-518 (232-235)
250	6	90 LV	2001	200 (3300)	3.85 x 2.86 (98 x 73)	14:26 (0.54)	512-518 (232-235)
250	8	90 LV	1992-98	244 (4000)	3.69 x 2.86 (94 x 73)	17:30 (0.57)	555-611 (252-277)
300	8	90 LV	1992-95	244 (4000)	3.69 x 2.86 (94 x 73)	17:30 (0.57)	555-611 (252-277)

CV - Cross flow-charged "V" cylinder LV - Loop-charged "V" cylinder configuration motor

① Gear ratio listed is for all models except the 100WTL and 100WTX which are 12:27 (0.44)

② Determine gear ratio by measuring outer diameter of the propshaft housing - 4 1/8 in. (105mm) housings contain 13:26 (0.50) gearing, while 4 5/8 in. (117mm) housings contain 12:27 (0.44) gearing

③ Carbureted models 319-336 lbs. (145-152kg), FICHT motors 345366 lbs. (158-166kg)

④ Specification is for all models, except TX, TXETF and TXATF which use a 12:27 (0.44) ratio gearcase

⑤ Specification is for all models, except ES which uses a 13:26 (0.50) ratio gearcase

⑥ Specification is for all models, except 1994 TL ONLY, which uses a 13:26 (0.50) ratio gearcase

⑦ Specification is for all models, except TL which uses a 13:26 (0.50) ratio gearcase

⑧ Carbureted models 370-375 lbs. (168-170kg), FICHT motors 405-410 lbs. (183-186kg)

General Engine System Specifications

Model (Hp)	No. of Cyl	Engine Type	Year	Displace cu. in. (cc)	Oil Injection System ①	Ignition System	Starting System	Cooling System	Fuel System	Charging System ②	Battery ③ cca (mca)
65 Jet	4	90 CV	1992-95	100 (1632)	VR02	Mag CD	RE, EP	IMP / UG / TC	2 - 2BC ④	9-amp FR ⑤	360 (465) ⑥
80 Jet	4	90 CV	1992-97	100 (1632)	VR02	Mag CD	ROTE, EP	IMP / UG / TC	2 - 2BC ④	9-amp FR ⑤	360 (465) 8
85	4	90 CV	1992-95	100 (1632)	VR02	Mag CD	TE, EP	IMP / UG / TC	2 - 2BC ④	10-amp FR	360 (465) ⑥
88	4	90 CV	1992-96	100 (1632)	VR02 Optional	Mag CD	RE, EP	IMP / UG / TC	2 - 2BC ④	9- am^ FR ⑤	360 (465) 8
90	4	90 CV	1992-98	100 (1632)	VR02 Optional	Mag CD	RE, EP	IMP / UG / TC	2 - 2BC ④	9-amp FR ⑤	360 (465) ⑥
100	4	90 CV	1992-97	100 (1632)	VR02	Mag CD	ROTE, EP	IMP / UG / TC	2 - 2BC ④	9-amp FR ⑤	360 (465) 8
112 SPL	4	90 CV	1994-96	100 (1632)	VR02 Optional	Mag CD	RE, EP	IMP / UG / TC	2 - 2BC ④	9- am^ FR ⑤	360 (465) 8
115	4	90 CV	1992-98	100 (1632)	VR02 Optional	Mag CD	RE, EP	IMP / UG / TC	2 - 2BC ④	9-amp FR ⑤	360 (465) ⑥
75	4	60 LV	2001	105 (1726)	FICHT	EMM CD	RE, FICHT	IMP / UG / TC	FICHT	135-amp FR	500 (620) ⑦
80 Jet	4	60 LV	1998-01	105 (1726)	VR02	Mag CD	RE, EP	IMP / UG / TC	2 - 2BC	120-amp FR	360 (465) 8
90	4	60 LV	1995-01	105 (1726)	VR02 or FICHT	⑧	RE, EP or FICHT	IMP / UG / TC	2 - 2BC or FICHT	⑨	⑩
100	4	60 LV	1998-01	105 (1726)	VR02	Mag CD	RE, EP	IMP / UG / TC	2 - 2BC	20-amp FR	360 (465) 8
105 Com	4	60 LV	1997-01	105 (1726)	VR02	Mag CD	WMP or ROTE, EP	IMP / UG / TC	2 - 2BC	⑪	360 (465) 8
115	4	60 LV	1995-01	105 (1726)	VR02 or FICHT	⑧	RE, EP or FICHT	IMP / UG / TC	2 - 2BC or FICHT	⑨	⑩
120	4	90 LV	1992-94	122 (2000)	VR02	Mag CD	RE, EP	IMP / UG / TC	2 - 2BC	9-amp FR	360 (465) ⑥
125 Com	4	90 LV	1992-98	122 (2000)	VR02 Optional	Mag CD	R/MP or RE/EP	IMP / UG / TC	2 - 2BC	9-amp FR ⑫	360 (465) ⑥
130	4	90 LV	1994-00	122 (2000)	VR02	Mag CD	RE, EP	IMP / UG / TC	2 - 2BC	9-amw FR	360 (465) 8
135	4	90 LV	2001	122 (2000)	VR02	Mag CD	RE, EP	IMP / UG / TC	2 - 2BC	9-amp FR	360 (465) ⑥
140	4	90 LV	1992-94	122 (2000)	VR02	Mag CD	RE, EP	IMP / UG / TC	2 - 2BC	9-amv FR	360 (465) 8
105 Jet	6	60 LV	1992-01	158 (2589)	VR02	Mag CD	RE, EP	IMP / UG / TC	2 - 3BC	35-amp FR	500 (620)
135	6	60 LV	2001	158 (2589)	VR02 or FICHT	⑧	RE, EP w FICHT	IMP / UG / TC	2 - 3BC or FICHT	⑬	8
150	6	60 LV	1992-01	158 (2589)	VR02 or FICHT	⑧	RE, EP or FICHT	IMP / UG / TC	2 - 3BC or FICHT	⑬	⑭
175	6	60 LV	1992-01	158 (2589)	VR02 or FICHT	⑧	RE, EP or FICHT	IMP / UG / TC	2 - 3BC or FICHT	⑬	⑭
185	6	90 LV	1992-94	183 (3000)	VR02	Mag CD	RE, EP	IMP / UG / TC	8	35-amp FR	500 (620)
200	6	90 LV	1992-01	183 (3000)	VR02 or FICHT	⑧	RE, EP or FICHT	IMP / UG / TC	8	35-amp FR	⑭
225	6	90 LV	1992-01	183 (3000)	VR02 or FICHT	⑧	RE, EP or FICHT	IMP / UG / TC	⑮	35-amw FR	⑭
250	6	90 LV	1999-01	183 (3000)	VR02 or FICHT	⑧	RE, EP or FICHT	IMP / UG / TC	⑮	135-amp FR	8
200	6	90 LV	2001	200 (3300)	FICHT	EMM CD	FICHT	IMP / UG / TC	FICHT	35-amp FR	8
225	6	90 LV	2001	200 (3300)	FICHT	EMM CD	FICHT	IMP / UG / TC	FICHT	35-amp FR	8
250	6	90 LV	2001	200 (3300)	FICHT	EMM CD	FICHT	IMP / UG / TC	FICHT	35-amp FR	8

General Engine System Specifications

Model (Hp)	No. of Cyl	Engine Type	Year	Displace cu. in. (cc)	Oil Injection System ①	Ignition System	Starting System	Cooling System	Fuel System	Charging System ②	Battery ③ cca (mca)
250	8	90 LV	1992-98	244 (4000)	VRO2	Mag CD	RE, EP	IMP / UG / TC	4 - 2BC	35-amp FR	500 (620)
300	8	90 LV	1992-95	244 (4000)	VRO2	Mag CD	RE, EP	IMP / UG / TC	4 - 2BC	35-amp FR	500 (620)

① Most common oiling system installed. Note that oiling systems could be installed or removed during boat rigging

② The referenced charging system is optional on some models

③ Minimum recommended cca (mca) ratings when motor/cables are new. Replacements must meet or exceed specification

④ Unlike other models covered here, these motors use a true 2-barrel carburetor w/ integral throttle body

⑤ Most models equipped with a 9-amp fully regulated charging system, but some versions may be equipped with a 6-amp non-regulated system

⑥ Minimum recommended battery: 360 cca (465 mca) w/ 90 min reserve (50 ah)

⑦ Specification is for FICHT motors under normal operating conditions, when operating FICHT in ambient temperatures below 32 degrees F (0 degrees C) use a 675 cca (845 mca) with at least a 107 amp-hour rating

⑧ Carbureted models utilize a conventional MAG CD ignition system, while FICHT motors use a electronic module controlled CD ignition

⑨ Carbureted models utilize a 20-amp fully-regulated charging system, while FICHT models are equipped with a 35-amp fully-regulated system

⑩ Carbureted models should be equipped with a 360 cca (465 mca) battery w/ 90 min reserve (50 ah), while FICHT motors require a 500 cca (620 mca) battery w/ a 60 amp-hour rating for normal opearting conditions (for severe conditions on FICHT motors, refer to footnote ⑦)

⑪ Most models equipped w/ a 20-amp fully-regulated charging system, but an AC model is available whose output is 81 watts @ idle and 117 at WOT

⑫ Most models equipped w/ a 9-amp fully-regulated charging system, but a 100 watt AC model is available

⑬ Carbureted models are equipped with a 35-amp fully-regulated charging system, while FICHT motors either utiize a 35-amp fully-regulated system or a 40-amp fully-regulated system (the 40-amp system is found on models with hard fuel rails)

⑭ Equip carbureted models w/ a 500 cca (620 mca) battery of 90 min reserve (60 ah). Equip FICHT motors w/ a 675 cca (845 mca) battery of at least a 107 ah rating for normal operating conditions or a 750 cca (940 mca) battery when operating in ambient temperatures below freezing

⑮ Carbureted models are equipped with 2 - 2BC and 2 - 1BC (for a total of 6 barrels), but FICHT models were also available for all but the 185 hp motor

#bc: Number of barrels or throats in each carburetor/throttle body assembly
EMM CD: Electronic Management Module, Capacitor Discharge
EP: Electric Primer
FICHT: FICHT Fuel Injection system
FR: Fully-Regulated (equipped with regulator/rectifier)
IMP: Impeller pump
Mag CD: Magneto Powered Capacitor Discharge
MP: Manual Primer
NA: Not applicable
NR: Non-Regulated (equipped with rectifier)
R: Rope
RE: Remote Electric Start
TC: Thermostatically controlled
TE: Tiller Electric Start
UG: Upper gearcase mounted
VRO2: OMC's VRO automatic oiling system (VRO pump and external oil tank)

Maintenance Intervals Chart

Component	Each Use	Monthly or As Needed	First 20-Hour Check	Every 12mths/100hrs ①	Off Season ①
2-Stroke engine oil (except pre-mix systems)	I (top off tank as, as needed)	I (top off tank as, as needed)			
Anode(s)	I	I		I	I
Battery condition and connections (if equipped)*	I (condition/connections)	I (charge / fluid level) / T		I	I
Boat hull*	I			I	I
Bolts and nuts (all accessible fasteners)*	I		I	I	I
Case finish (wash and wax)	C (salt / brackish / polluted water)	C		C	C
Cylinder head bolts			T	T	
Electrical wiring and connectors*			I	I	I
Emergency stop switch, clip &/or lanyard*	I	I	I	I	I
Engine mounting bolts	I	I	I	I	I
Flush cooling system	if in salt / brackish / polluted water	P		P	P
Fuel filter (clean or replace, as applicable)			P	P	P
Fuel hose and system components*	I	I	I	I	I
Gear oil	I (for signs of leakage)	I (level and condition)	R	R	R
Impeller clearance/intake grate (jet models)	I (intake grate for debris or damage)	I (visually inspect impeller)	I	I	I
Jet drive bearing lubrication	L (fill vent hose after each day)	I (L every 10 hours)	L	L	L
Lubrication points	I	②	②	②	②
Oil system hose and components*	I	I	I	I	I
Pistons (Decarbon)				③	
Power steering belt, fluid, filter (if equipped)	I (quick-check of belt/fluid)		I	R (500 hours)	I
Power trim and tilt (if equipped)		I (check fluid level monthly)	I	I	I
Propeller	I	I	I	I	I
Propeller shaft and nut	I		I	I, L / T	I, L / T
Remote control*	I	I	I	I	I
Spark plugs		R (as needed)	I	I	I
Steering cable*	I	L (as needed)	I	I	I
Steering friction	I	A (as needed)		I	I
Tune-up		A (as needed)		I (annually)	Perform pre-season tune-up
Water pump intake grate and indicator	I				

A-Adjust I-Inspect and Clean, Adjust, Lubricate or Replace, as necessary R-Replace

C-Clean L-Lubricate T-Tighten

* Denotes possible safety item (although, all maintenance inspections/service can be considered safety related when it means not being stranded on the water should a component fail.)

① Many items are listed for both every 100 hours and off season. Since most boaters use their crafts less than 100 hours a year, these items should most often be performed annually. If you find yourself right around 100 hours per season, try to time the service so it occurs immediately prior to placing the motor in storage, as some items must be reperformed if the engine is used again (even once) before storage.

② Varies with use, generally every 30 days when used in salt, brackish or polluted water and every 60 days when used in fresh water (refer to Lubrication Chart for more details)

③ Every 50 hours is OMC Carbon Guard additive is NOT used consistently with fuel.

Lubrication Chart

Component	Applicable Models	Recommended Lubricant	Minimum Frequency Fresh Water	Salt, Polluted or Brackish Water
Electric starter motor pinion	except 60 degree ①	OMC Starter pinion lube or General Electric Versalube	every 60 days ②	every 30 days ②
Engine cover latches	Most ③	OMC Triple-Guard or equivalent marine grease	every 60 days ②	every 30 days ②
Jet drive bearing, lubrication	Jet drive models	OMC EP/Wheel Bearing or equivalent water-resistant NLGi No. 1 grease	after every use	after every use
Jet drive bearing. grease replacement	Jet drive models	OMC EP/Wheel Bearing or equivalent water-resistant NLGI No. 1 grease	every 30 hours	every 15 hours
Power trim/tilt reservoir	If equipped (most except a few manual tilt motors)	OMC Power trim/tilt and power steering fluid	Check at least every 30 days	Be sure to check at least every 30 days
Power steering fluid	if equipped	OMC Power trim/tilt and power steering fluid or Dexron II automatic transmission Ruid	Check at least every 30 days	Be sure to check at least every 30 days
throttle shafts, cables and/or linkage	All	OMC Triple-Guard or equivalent marine grease	every 60 days ②	every 30 days ②
Steering cable ram	If equipped (most except a few 1632cc motors)	OMC Triple-Guard or equivalent marine grease	every 60 days@	every 30 days 6
Swivel & trailering brackets	All	OMC Triiie-Guard or equivalent manne grease	every 60 days ②	every 30 days ②
Tilt tube (normally equipped with one or more grease fittings)	All	OMC Triple-Guard or equivalent marine grease	every 60 days ②	every 30 days ②

① Starter motor pinion lubrication is specifically recommended for all motors, except the 75-115 HP (1726cc) 60 degree V4s and the 105Jet-175 HP (2589cc) 60 degree V6 engines

② Lubrication points should be checked weekly or with each use, whichever is LESS frequent. Based upon individual motor/use needs frequency of actual lubrication should occur at recommended intervals or more oflen during season. Perform all lubrication procedures immediately prior to extended motor storage

③ Although engine cover latch lubrication is not specifically mentioned in the service literature for most Johnson/Evinrude V motors, most covers are equipped with grease fiings or have exposed metal-to-metal contact surfaces that would benefit from attention

TWO-STROKE MOTOR FUEL:OIL RATIO CHART

Desired Fuel:Oil Ratio	Amount of oil needed when mixed with: 3 G (11.4 L) of Gas	6 G (22.7 L) of Gas	18 G (68.1 L) of Gas	30 G (114 L) of Gas	45 G (171 L) of Gas
100:1 (1%oil)	4 fl. oz. (118 mL)	8 fl. oz. (236 mL)	24 fl. oz. (708 mL)	40 fl. oz. (1180 mL)	60 fl. oz. (1770 mL)
50:1 (2% oil)	8 fl. oz. (236 mL)	16 fl. oz. (473 mL)	48 fl. oz. (1419 mL)	80 fl. oz. (2360 mL)	120 fl. oz. (3.54 L)
25:1 (4% oil)	16 fl. oz. (473 mL)	32 fl. oz. (946 mL)	96 fl. oz. (2838 mL)	160 fl. oz. (4.73 L)	240 fl. oz. (7.1 L)

NOTE: Fuel:Oil ratios listed here are for caicuation purposes. Refer to the fuel:oil recommendations for your engine before mixing. Remember that a pre-mix system designed to produce a 50:1 ratio will produce a 25:1 ratio if a 50:1 ratio is already in the fuel tank feeding the motor.

Capacities

Model (Hp)	No. of Cyl	Engine Type	Year	Displace cu. in. (cc)	Gear Oil Oz (mL)	Injection Oil Ratio ①
65 Jet	4	90 CV	1992-95	100 (1632)	na	50:1
80 Jet	4	90 CV	1992-97	100 (1632)	na	50:1
85	4	90 CV	1992-95	100 (1632)	26 (800)	50:1
88	4	90 CV	1992-96	100 (1632)	26 (800)	50:1
90	4	90 CV	1992-98	100 (1632)	26 (800)	50:1
100	4	90 CV	1992-97	100 (1632)	②	50:1
112 SPL	4	90 CV	1994-96	100 (1632)	26 (800)	50:1
115	4	90 CV	1992-98	100 (1632)	26 (800)	50:1
75	4	60 LV	2001	105 (1726)	26 (770)	50:1
80 Jet	4	60 LV	1998-01	105 (1726)	na	50:1
90	4	60 LV	1995-01	105 (1726)	③	50:1
100	4	60 LV	1998-01	105 (1726)	③	50:1
105 Com	4	60 LV	1997-01	105 (1726)	33 (980)	50:1
115	4	60 LV	1995-01	105 (1726)	③	50:1
120	4	90 LV	1992-94	122 (2000)	26 (800) ④	50:1
125 Com	4	90 LV	1992-98	122 (2000)	33 (980) ⑤	50:1
130	4	90 LV	1994-00	122 (2000)	33 (980) ⑥	50:1
135	4	90 LV	2001	122 (2000)	33 (980)	50:1
140	4	90 LV	1992-94	122 (2000)	33 (980) ⑦	50:1
105 Jet	6	60 LV	1992-01	158 (2589)	na	50:1
135	6	60 LV	2001	158 (2589)	33 (980)	50:1
150	6	60 LV	1992-01	158 (2589)	33 (980)	50:1
175	6	60 LV	1992-01	158 (2589)	33 (980)	50:1
185	6	90 LV	1992-94	183 (3000)	33 (980)	50:1
200	6	90 LV	1992-01	183 (3000)	33 (980)	50:1
225	6	90 LV	1992-01	183 (3000)	33 (980)	50:1
250	6	90 LV	1999-01	183 (3000)	33 (980)	50:1
200	6	90 LV	2001	200 (3300)	33 (980)	50:1
225	6	90 LV	2001	200 (3300)	33 (980)	50:1
250	6	90 LV	2001	200 (3300)	33 (980)	50:1
250	8	90 LV	1992-98	244 (4000)	71 (2100)	50:1
300	8	90 LV	1992-95	244 (4000)	71 (2100)	50:1

NOTE - **FICHT** systems perform all engine oiling functions including break-in, no pre-mix is necessary

na - not applicable

① Injection oil ratio based on normal operating **conditions,** some severe or **high** performance applications may need higher ratio, refer to information on Fuel Recommendations under Maintenance

② 26 **fl. oz. (800ml)** for all except the **100WTL** and **100WTX** which is 33 fl. oz. **(980ml)**

③ **Determine gearcase** capacity by measuring outer diameter of the **propshaft** housing - 4 1/8 in. **(105mm)** housings contain 26 **fl.** oz. **(770ml),** while 4 5/8 **in. (117mm)** housings contain 33 **fl. oz. (980ml)**

④ **Specification** is for all models, except TX . TXETF and TXATF which use 33 fl. **oz. (980ml)**

⑤ **Specification** is for all models, except ES which use 26 **fl.** oz. **(800ml)**

⑥ **Specification** is for all models, except the 1994 TL ONLY, which uses 26 fl. **oz. (800ml)**

⑦ **Specification** is for all models, except TL which uses 26 **fl. oz. (800ml)**

Tune-Up Specifications

Model (Hp)	No. of Cyl	Engine Type	Year	Displace cu. in. (cc)	Spark Plug Make	Spark Plug Type	Spark Plug Gap In. (mm)	Ignition Timing Degrees Idle	Ignition Timing Degrees Max	Idle Speed RPM (In Gear)	OMC Test Prop*	Min. Test RPM*
65 Jet	4	90 CV	1992-95	100 (1632)	Champion	QL77JC4 or L77JC4 ①	0.030 (08)	③	27-29 BTDC	600-700	not app	not app
80 Jet	4	90 CV	1992-95	100 (1632)	Champion	QL77JC4 or L77JC4 ①	0.030 (0.8)	③	27-29 BTDC	600-700	not app	not app
	4	90 CV	1996	100 (1632)	Champion	QL82C	0.030 (0.8)	③	27-29 BTDC	600-700	not app	not app
	4	90 CV	1997	100 (1632)	Champion	QL82C	0.030 (0.8)	8	25-27 BTDC	600-700	not app	not app
85	4	90 CV	1992-95	100 (1632)	Champion	QL77JC4 or L77JC4 ①	0.030 (0.8)	③	27-29 BTDC	600-700	382861	4800
88	4	90 CV	1992-95	100 (1632)	Champion	QL77JC4 or L77JC4 ①	0.030 (0.8)	8	27-29 BTDC	600-700	382861	4800
	4	90 CV	1996	100 (1632)	Champion	QL82C	0.030 (0.8)	8	27-29 BTDC	600-700	382861	4800
90	4	90 CV	1992-95	100 (1632)	Champion	QL77JC4 or L77JC4 ①	0.030 (0.8)	③	27-29 BTDC	600-700	382861	4800
	4	90 CV	1996	100 (1632)	Champion	QL82C	0.030 (0.8)	③	27-29 BTDC	600-700	382861	4800
	4	90 CV	1997-98	100 (1632)	Champion	QL82C	0.030 (0.8)	8	25-27 BTDC	600-700	382861	4800
I@	4	90 CV	1992-95	100 (1632)	Champion	QL16V or L16V ②	fixed gap plug	③	27-29 BTDC	600-700	④	4800
	4	90 CV	1996	100 (1632)	Champion	QL82C	0.030 (0.8)	③	27-29 BTDC	600-700	④	4800
	4	90 CV	1997	100 (1632)	Champion	QL16V	fixed gap plug	③	25-27 BTDC	600-700	④	4800
112 SPL	4	90 CV	1994-95	100 (1632)	Champion	QL77JC4 or L77JC4 ①	0.030 (0.8)	8	27-29 BTDC	600-700	382861	4800
	4	90 CV	1996	100 (1632)	Champion	QL82C	0.030 (0.8)	③	27-29 BTDC	600-700	382861	4800
115	4	90 CV	1992-95	100 (1632)	Champion	QL77JC4 or L77JC4 ①	0.030 (0.8)	③	27-29 BTDC	600-700	382861	4800
	4	90 CV	1996	100 (1632)	Champion	QL82C	0.030 (0.8)	8	27-29 BTDC	600-700	382861	4800
	4	90 CV	1997-98	100 (1632)	Champion	QL82C	0.030 (0.8)	③	25-27 BTDC	600-700	382861	4800
75	4	60 LV	2001	105 (1726)	Champion	XC12PEP ⑤ ⑥	0.028 (0.71) ⑤	㉑	㉑	600-700	382861	4650
80 Jet	4	60 LV	1998	105 (1726)	Champion	QL78YC ⑥	0.030 (0.8)	4 ATDC	20 BTDC	600-700	not app	not app
	4	60 LV	1999-01	105 (1726)	Champion	QL78YC ⑥	0.030 (0.8)	4 ATDC	22 BTDC	600-700	not app	not app
90	4	60 LV	1995	105 (1726)	Charnoion	QL77JC4 ⑦ ⑥	0.030 (0.8)	3-5 ATDC	19-21 BTDC	600-700	382861	4500
	4	60 LV	1996	105 (1726)	Champion	QL82YC ⑧ ⑥	0.030 (0.8)	3-5 ATDC	19-21 BTDC	600-700	382861	4500
	4	60 LV	1997	105 (1726)	Champion	QL78YC ⑥	0.030 (0.8)	3-5 ATDC	19-21 BTDC	600-700	382861	4500
	4	60 LV	1998-01	105 (1726)	Champion	QL78YC ⑨ ⑥	0.030 (0.8) ⑨	4 ATDC ⑨	20 BTDC ⑨	600-700	382861	4500 ⑩
100	4	60 LV	1998	105 (1726)	Champion	QL78YC ⑥	0.030 (0.8)	4 ATDC	22 BTDC	600-700	382861	4500
	4	60 LV	1999-01	105 (1726)	Champion	QL78YC ⑥	0.030 (0.8)	4 ATDC	22 BTDC	600-700	387388	5250
105 Com	4	60 LV	1997	105 (1726)	Champion	QL78YC ⑥	0.030 (0.8)	3-5 ATDC	13-21 BTDC	600-700	387388	5250
	4	60 LV	1998-01	105 (1726)	Champion	QL78YC ⑥	0.030 (0.8)	4 ATDC	22 BTDC	600-700	387388	5250 ⑪
115	4	60 LV	1995	105 (1726)	Champion	QL77JC4 ⑦ ⑥	0.030 (0.8)	3-5 ATDC	13-21 BTDC	600-700	382861	4800
	4	60 LV	1996	105 (1726)	Champion	QL82YC ⑧ ⑥	0.030 (0.8)	3-5 ATDC	19-21 BTDC	600-700	382861 ⑫	4800
	4	60 LV	1997	105 (1726)	Champion	QL78YC ⑥	0.030 (0.8)	3-5 ATDC	13-21 BTDC	600-700	382861 ⑫	4800
	4	60 LV	1998-01	105 (1726)	Champion	QL78YC ⑨ ⑥	0.030 (0.8) ⑨	4 ATDC ⑨	20 BTDC ⑨	600-700	382861 ⑫	4800 ⑩

Tune-Up Specifications

Model (Hp)	No. of Cyl	Engine Type	Year	Displace cu. in. (cc)	Spark Plug Make	Spark Plug Type	Spark Plug Gap In. (mm)	Ignition Timing Degrees Idle	Ignition Timing Degrees Max	Idle Speed RPM (In Gear)	OMC Test Prop*	Min. Test RPM*
120	4	90 LV	1992	122 (2000)	Champion	QL77JC4 or L77JC4 ②	0.030 (0.8)	8 ATDC	17-19 BTDC	575-700	386246	5300
	4	90 LV	1993-94	122 (2000)	Champion	QL77JC4 or L77JC4 ①	0.030 (0.8)	8 ATDC	17-19 BTDC	575-700	433068 ⑭	5200
125 Com	4	90 LV	1992-94	122 (2000)	Chamoion	QL77JC4 or L77JC4 ⑬	0.030 (0.8) ⑬	4-8 ATDC ⑮	15-17 BTDC	600-700 ⑯	387388 ⑮	5000 ⑮
	4	90 LV	1995	122 (2000)	Champion	QL16V or L16V	fixed gap plug	4-8 ATDC ⑮	15-17 BTDC	600-700 ⑯	387388	5000
	4	90 LV	1996	122 (2000)	Champion	QL82YC ⑥	0.030 (0.8)	4-8 ATDC ⑮	15-17 BTDC	600-700 ⑯	387388	5000
	4	90 LV	1997-93	122 (2000)	Champion	QL78YC	0.030 (0.8)	4-8 ATDC ⑮	15-17 BTDC	600-700 ⑯	387388	5000
130	4	90 LV	1994	122 (2000)	Champion	QL77JC4 or L77JC4 ⑬	0.030 (0.8) ⑬	8 ATDC	17-19 BTDC	575-700	1433068 ⑭	5300
	4	90 LV	1995	122 (2000)	Champion	QL16V or L16V	fixed gap plug	6-10 ATDC	17-19 BTDC	575-700	387388 ⑭	5300
	4	90 LV	1996	122 (2000)	Champion	QL82YC ⑥	0.030 (0.8)	2-6 ATDC	17-19 BTDC	600-700	387388 ⑭	5300
	4	90 LV	1997-00	122 (2000)	Champion	QL78YC	0.030 (0.8)	2-6 ATDC	18 BTDC	600-700	387388 ⑰	5300
135	4	90 LV	2001	122 (2000)	Champion	QL78YC	0.030 (0.8)	2-6 ATDC	18 BTDC	600-700	387388	5300
140	4	90 LV	1992	122 (2000)	Champion	QL77JC4 or L77JC4 ②	0.030 (0.8)	8 ATDC	17-19 BTDC	575-700	433068 ⑭	5300
	4	90 LV	1993-94	122 (2000)	Champion	QL77JC4 or L77JC4 ①	0.030 (0.8)	8 ATDC	17-19 BTDC	575700	433068 ⑭	5300
105 Jet	6	60 LV	1992-95	158 (2589)	Champion	QL77JC4 ⑦ ⑥	0.030 (0.8)	5-7 ATDC	19-21 BTDC	600-700	not app	not app
	6	60 LV	1996	158 (2589)	Champion	QL82YC ⑧ ⑥	0.030 (0.8)	5-7 ATDC	19-21 BTDC	600-700	not app	not app
	6	60 LV	1997	158 (2589)	Champion	QL78YC ⑥	0.030 (0.8)	5-7 ATDC	19-21 BTDC	600-700	not app	not app
	6	60 LV	1998	158 (2589)	Champion	QL78YC ⑥	0.030 (0.8)	6 ATDC	20 BTDC	600-700	not app	not app
	6	60 LV	1999-01	158 (2589)	Champion	QL78YC ⑥	0.030 (0.8)	6 ATDC	22 BTDC	600-700	not app	not app
135	6	60 LV	2001	158 (2589)	Champion	QL78YC ⑨ ⑥	0.030 (0.8) ⑨	6 ATDC ⑨	20 BTDC ⑨	600-700	387388 ⑱	4500
150	6	60 LV	1992-95	158 (2589)	Champion	QL77JC4 ⑦ ⑥	0.030 (0.8)	5-7 ATDC	19-21 BTDC	600-700	387388 ⑱	4500
	6	60 LV	1996	158 (2589)	Champion	QL82YC ⑧ ⑥	0.030 (0.8)	5-7 ATDC	19-21 BTDC	600-700	387388 ⑱	4500
	6	60LV	1997	158 (2589)	Champion	QL78YC ⑥	0.030 (0.8)	5-7 ATDC	19-21 BTDC	600-700	387388 ⑱	4500
	6	60 LV	1998-01	158 (2589)	Champion	QL78YC ⑨ ⑥	0.030 (0.8) ⑨	6 ATDC ⑨	20 BTDC ⑨	600-700	387388 ⑱	4500 ⑲
175	6	60 LV	1992-55	158 (2589)	Champion	QL77JC4 ⑦ ⑥	0.030 (0.8)	5-7 ATDC	19-21 BTDC	600-700	387388 ⑱	4800
	6	60 LV	1996	158 (2589)	Champion	QL82YC ⑧ ⑥	0.030 (0.8)	5-7 ATDC	19-21 BTDC	600-700	387388 ⑱	4800
	6	60 LV	1997	158 (2589)	Champion	QL78YC ⑥	0.030 (0.8)	5-7 ATDC	19-21 BTDC	600-700	387388 ⑱	4800
	6	60 LV	1998-01	158 (2589)	Champion	QL78YC ⑨ ⑥	0.030 (0.8) ⑨	6 ATDC ⑨	20 BTDC ⑨	600-700	387388 ⑱	4800 ⑳
185	6	90 LV	1992	183 (3000)	Champion	QL77JC4 or L77JC4 ①	0.030 (0.8)	6 ATDC	17-19 BTDC	575-700	387388	5500
	6	90 LV	1993-94	183 (3000)	Champion	QL77JC4 or L77JC4 ①	0.030 (0.8)	4-8 ATDC	17-19 BTDC	650-750	436080	5500
200	6	90 LV	1992	183 (3000)	Champion	QL77JC4 or L77JC4 ①	0.030 (0.8)	6 ATDC	17-19 BTDC	575-700	387388 ⑰	5500 ㉑
	6	90 LV	1993-94	183 (3000)	Champion	QL77JC4 or L77JC4 ①	0.030 (0.8)	4-8 ATDC	17-19 BTDC	650-750	436080 ㉒	5500 8

Tune-Up Specifications

Model (Hp)	No. of Cyl	Engine Type	Year	Displace cu. in. (cc)	Spark Plug Make	Spark Plug Type	Spark Plug Gap In. (mm)	Ignition Timing Degrees Idle	Ignition Timing Degrees Max	Idle Speed RPM (In Gear)	OMC Test Prop*	Min. Test RPM*
	6	90 LV	1995	183 (3000)	Champion	QL77JC4 or L77JC4 ①	0.030 (0.8)	2-6 ATDC	17-19 BTDC	600-700	436080 ㉒	5500 ㉑
	6	90 LV	1996	183 (3000)	Champion	QL82YC	0.030 (0.8)	2-6 ATDC	17-19 BTDC	600-700	436080 ㉒	5500 ㉑
	6	90 LV	1997-99	183 (3000)	Champion	QL78YC ⑨ ⑥	0.030 (0.8) ⑨	2-6 ATDC ⑨	18 BTDC ⑨	600-700 ⑨	436080 ㉒	5000
	6	90 LV	2000-01	183 (3000)	Champion	QL78YC ⑨ ⑥	0.030 (0.8) ⑨	2-5 ATDC ⑨	18 BTDC ⑨	625-725 ⑨	436080 ㉒	5000
225	6	90 LV	1992	183 (3000)	Champion	QL77JC4 or L77JC4 ①	0.030 (0.8)	6 ATDC	17-19 BTDC	575-700	387388 ⑰	5700
	6	90 LV	1993-94	183 (3000)	Champion	QL77JC4 or L77JC4 ①	0.030 (0.8)	4-8 ATDC	17-19 BTDC	650-750	436080 ㉒	5700
	6	90 LV	1995	183 (3000)	Champion	QL77JC4 or L77JC4 ①	0.030 (0.8)	2-6 ATDC	17-19 BTDC	600-700	436080 ㉒	5700
	6	90 LV	1996	183 (3000)	Champion	QL82YC	0.030 (0.8)	2-6 ATDC	17-19 BTDC	600-700	436080 ㉒	5700
	6	90 LV	1997-99	183 (3000)	Champion	QL78YC ⑨ ⑥	0.030 (0.8) ⑨	2-6 ATDC ⑨	18 BTDC ⑨	600-700 ⑨	436080 ㉒	5000
	6	90 LV	2000-01	183 (3000)	Champion	QL78YC ⑨ ⑥	0.030 (0.8) ⑨	2-5 ATDC ⑨	18 BTDC ⑨	625-725 ⑨	436080 ㉒	5000
250	6	90 LV	1999	183 (3000)	Champion	QL78YC ⑨ ⑥	0.030 (0.8) ⑨	2-6 ATDC ⑨	18 BTDC ⑨	600-700 ⑨	436080 ㉒	5000
	6	90 LV	2000-01	183 (3000)	Champion	QL78YC ⑨ ⑥	0.030 (0.8) ⑨	2-5 ATDC ⑨	18 BTDC ⑨	625-725 ⑨	436080 ㉒	5000
200	6	90 LV	2001	200 (3300)	Champion	QC12PEP ⑤ ⑥	0.028 (0.71) ⑤	㉔	㉔	㉔	n/a	n/a
225	6	90 LV	2001	200 (3300)	Champion	QC12PEP ⑤ ⑥	0.028 (0.71) ⑤	㉔	㉔	㉔	n/a	n/a
250	6	90 LV	2001	200 (3300)	Champion	QC12PEP ⑤ ⑥	0.028 (0.71) ⑤	㉔	㉔	㉔	n/a	n/a
250	8	90 LV	1992-94	248 (4000)	Champion	QL77JC4 or L77JC4 ①	0.030 (0.8)	2 B - 2 ATDC	17-19 BTDC	550-650	396277 ㉓	5500
	8	90 LV	1995	244 (4000)	Champion	QL77JC4 or L77JC4 ①	0.030 (0.8)	0-4 ATDC	17-19 BTDC	600-700	396277 ㉓	5500
	8	90 LV	1996	244 (4000)	Champion	QL82YC ⑧	0.030 (0.8)	0-4 ATDC	17-19 BTDC	600-700	396277 ㉓	5500
	8	90 LV	1997	244 (4000)	Champion	QL78YC	0.030 (0.8)	0-4 ATDC	17-19 BTDC	600-700	396277 ㉓	5500
	8	90 LV	1998	244 (4000)	Champion	QL82YC	0.030 (0.8)	1-5 ATDC	18 BTDC	500-700	396277 ㉓	5500
300	8	90 LV	1992-95	244 (4000)	Champion	QL77JC4 or L77JC4 ①	0.030 (0.8)	6-10 ATDC	15-17 BTDC	650-750	396277 ㉓	5500

* Note: Test propeller and **rpm** not applicable to Jet models   **n/a:** not available   not app: not applicable

① For sustained high speed **operation,** use Champion **QL16V** or **L16V** fixed gap spark plug

② For sustained high speed operation, substitute **QL78V** or **L78V fixed** gap plugs

③ Throttle pickup timing 3-5 degrees BTDC

④ Use test prop 382861 for all models, except the **100WTL** and **100WTX** which use 387388

⑤ Refer to emission control **label** on motor or appropriate **section** of text for more details

⑥ Use of noksuppression spark plugs **WILL** cause ignition problems

⑦ For sustained high-speed, use Champion fixed-gap plugs **QL16V**

⑧ For extended idle use Champion **QL87YC**

⑨ Specification is for carbureted motors, on **FICHT** motors, refer to the emission control label (NOTE **timing** and idle speed is EMM controlled on **FICHT** motors)

⑩ Specification is carbureted motors, min test RPM on **FICHT** motors is 5100

Tune-Up Specifications

Model (Hp)	No. of Cyl	Engine Type	Year	Displace cu. in. (cc)	Spark Plug Make	Spark Plug Type	Spark Plug Gap In. (mm)	Ignition Timing Degrees Idle	Ignition Timing Degrees Max	Idle Speed RPM (In Gear)	OMC Test Prop*	Min. Test RPM*

@Specification is for all except the 1998 non-RW models, on which the min. test speed is 4800

⑫ Part number is for all except SX, PX and FPX models, which should use test propeller 387388

⑬ Specification is for ES models **only**, other models use **QL16V or L16V fixed** gap plugs. For sustained high speed operation on ALL models, substitute **QL78V** or **L78V fixed** gap **plugs**

⑭ Part number is for all except TX, TXETF and TXATF models, which should use test propeller 396277 or CX models which should use 398673

⑮ Specification is for all except RW models, on which idle **timing/spark** screw should be set to achieve 650 **rpm** at idle

⑯ Part number and specification is for all except ES models, on which part number 386246 should be used **with** a min speed of 5300 rpm

⑰ **Specification** is for all except CX models, **which** use lest propeller 398673

⑱ Part number is for all except CX, FCX and NX models, which should use test **propeller** 398673

⑲ Specification is for carbureted and FICHT motors, except the 1999 150 FICHT, on which min test speed is 4700

⑳ **Specification** is for carbureted motors, for the 175 FICHT, min test speed is 4500 for **all** years except 1999 which is 5200

㉑ Specification is for all except STL models, on which min test speed is 5700

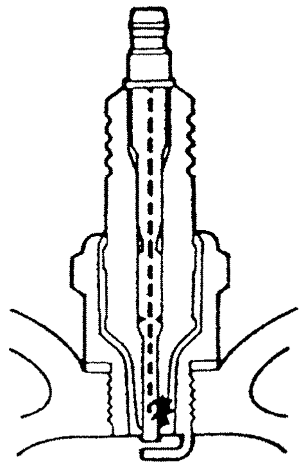
㉒ **Part** number listed or 396277 can be used for all except CX models, which should use 436081 or 398674

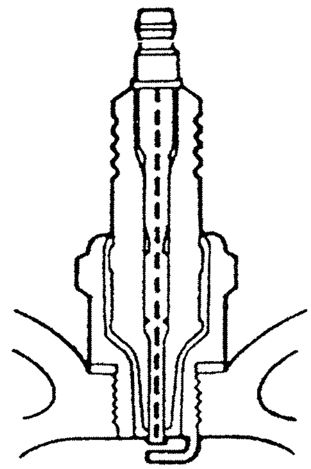
㉓ Part number listed can be used for all except CX models, which should use 398674

㉔ Timing and idle speed is EMM controlled on FICHT motors, use the diagnostic soflware to **verify**

SPARK PLUG DIAGNOSIS

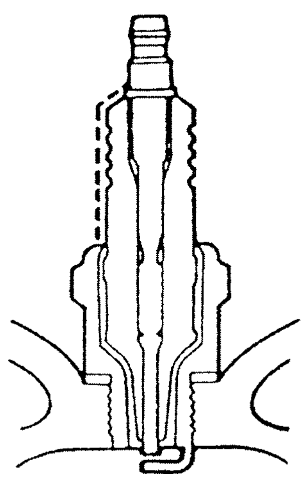
Tracking Arc
High voltage arcs between a fouling deposit on the insulator tip and spark plug shell. This ignites the fuel/air mixture at some point along the insulator tip. retarding the ignition timing which causes a power and fuel loss.

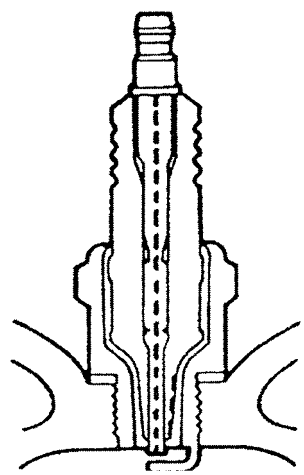




Wide Gap
Spark plug electrodes are warn so that the high voltage charge cannot arc across the electrodes. Improper gapping of electrodes on new or "cleaned" spark plugs could cause a similar condition. Fuel remains unburned and a power loss results

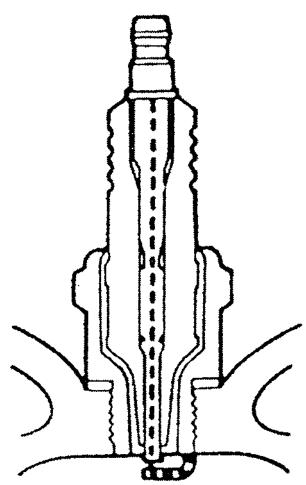
Flashover
A damaged spark plug boot. along with dirt and moisture. could permit the high voltage charge to short over the insulator to the spark plug shell or the engine. A buttress insulator design helps prevent high voltage flashover.

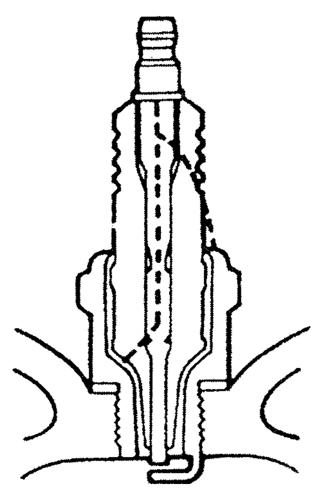




Fouled Spark **Plug**
Deposits that have formed on the insulator tip may become conductive and provide a "shunt" path to the shell. This prevents the high voltage from arcing between the electrodes. A power and fuel loss is the result.

Bridged Electrodes
Fouling deposits between the electrodes 'ground out" the high voltage needed to fire the spark plug. The arc between the electrodes does not occur and the fuel air mixture is not ignited. This causes a power loss and exhausting of raw fuel.





Cracked **Insulator**
A crack in the spark plug insulator could cause the high voltage charge to "ground out." Here, the spark does nor jump the electrode gap and the fuel air mixture is not ignited. This causes a power loss and raw fuel is exhausted.

3

FUEL SYSTEM

FUEL SYSTEM BASICS

**** CAUTION**

If equipped, disconnect the negative battery cable ANYTIME work is performed on the engine, especially when working on the fuel system. This will help prevent the possibility of sparks during service (from accidentally grounding a hot lead or powered component). Sparks could ignite vapors or exposed fuel. Disconnecting the cable on electric start motors will also help prevent the possibility fuel spillage if an attempt is made to crank the engine while the fuel system is **open.**

**** CAUTION**

Fuel leaking from a loose, damaged or incorrectly installed hose or fitting may cause a fire or an explosion. ALWAYS pressurize the fuel system and run the motor while inspecting for leaks after servicing any component of the fuel system.

The carburetion or fuel injection, and the ignition principles of engine operation must be understood in order to troubleshoot and repair an outboard motor's fuel system or to perform a proper tune-up on carbureted motors.

If you have any doubts concerning your understanding of engine operation, it would be best to study The Basic Operating Principles of an engine as detailed under Troubleshooting in Section 1, before tackling any work on the fuel system.

The fuel systems used on engines covered by this manual include multiple carburetors and electronic fuel injection. For the most part, the carbureted motors covered here utilize fuel-enrichment for quicker cold starting in the form of an electric primer solenoid (though a few models are equipped with a manual primer). Similarly, although a few motors may be rigged to require pre-mixing of the fuel and oil, the majority of Evinrude/Johnson V-motors utilize the Variable Rate Oiling (VRO2) automatic oiling system. Refer to the General Engine System Specifications chart in Section 2 for more details as to what systems were commonly used on what motors, but keep in mind that during boaffmotor rigging, systems such as VR02 or an electric fuel primer solenoid could have been added (or even deleted). For details on the VR02 oiling system, please refer to the section on Lubrication and Cooling.

Fuel System Service Cautions

There is no way around it. Working with gasoline can provide for many different safety hazards and requires that extra caution be used during all steps of service. To protect yourself and others, you must take all necessary precautions against igniting the fuel or vapors (which will cause a fire at best or an explosion at worst).

**** CAUTION**

Take extreme care when working with the fuel system. NEVER smoke (it's bad for you anyhow, but smoking during fuel system service could kill you much faster!) or allow flames or sparks in the work area. Flames or sparks can ignite fuel, especially vapors, resulting in a fire at best or an explosion at worst.

For starters, disconnect the negative battery cable EVERY time a fuel system hose or fitting is going to be disconnected. It takes only one moment of forgetfulness for someone to crank the motor, possibly causing a dangerous spray of fuel from the opening. This is especially true on the high-pressure fuel circuit of Ficht Fuel Injection (FFI) motors, where just turning the key to on will energize the fuel pump.

Gasoline contains harmful additives and is quickly absorbed by exposed skin. As an additional precaution, always wear gloves and some form of eye protection (regular glasses help, but only safety glasses offer any significant protection for your eyes).

☐ Throughout service, pay attention to ensure that all components, hoses **and fittings** are **installed** them in the correct location and orientation to prevent the **possibility** of leakage. Matchmark components before they are removed as **necessary.**

Because of the dangerous conditions that result from working with aasoline and fuel vapors alwavs take extra care and be sure to follow these guidelines for safety:

- Keep a Coast Guard approved fire extinguisher handy when working.

Allow the engine to cool completely before opening a fuel fitting. Don't all gasoline to drip on a hot engine.

- The first thing you must do after removing the engine cover is to check for the presence of gasoline fumes. If strong fumes are present, look for leaking or damage hoses, fittings or other fuel system components and repair.

Do not repair the motor or any fuel system component near any sources of ignition, including sparks, open flames, or anyone smoking.

- Clean up spilled gasoline right away using clean rags. Keep all fuel soaked rags in a metal container until they can be properly disposed of or cleaned. NEVER leave solvent, gasoline or oil soaked rags in the hull.

Don't use electric powered tools in the hull or near the boat during fuel system service or after service, until the system is pressurized and checked for leaks.

Fuel leaking from a loose, damaged or incorrectly installed hose or fitting may cause a fire or an explosion. ALWAYS pressurize the fuel system and run the motor while inspecting for leaks after servicing any component of the fuel system.

Fuel

◆ See Figure 1

Fuel recommendations have become more complex as the chemistry of modern gasoline changes. The major driving force behind many of the changes in gasoline chemistry was the search for additives to replace lead as an octane booster and lubricant, these additives are governed by the types of emissions they produce in the combustion process. Also, the replacement additives do not always provide the same level of combustion stability, making a fuel's octane rating less meaningful.

In the 1960's and 1970's, leaded fuel was common. The lead served two functions. First, it served as an octane booster (combustion stabilizer) and second, in Cstroke engines, it served as a valve seat lubricant. For 2-stroke engines, the primary benefit of lead was to serve as a combustion stabilizer. Lead served very well for this purpose, even in high heat applications.

For decades now, all lead has been removed from the refining process. This means that the benefit of lead as an octane booster has been eliminated. Several substitute octane boosters have been introduced in the place of lead. While many are adequate in automobile engines, most do not perform nearly as well as lead did, even though the octane rating of the fuel is the same.

OCTANE RATING

◆ See Figure 1

A fuel's octane rating is a measurement of how stable the fuel is when heat is introduced. Octane rating is a major consideration when deciding whether a fuel is suitable for a particular application. For example, in an engine, we want the fuel to ignite when the spark plug fires and not before, even under high pressure and temperatures. Once the fuel is ignited, it must burn slowly and smoothly, even though heat and pressure are building up while the burn occurs. The unburned fuel should be ignited by the traveling flame front, not by some other source of ignition, such as carbon deposits or the heat from the expanding gasses. A fuel's octane rating is known as a measurement of the'fuel's anti-knock properties (ability to burn without exploding). Essentially, the octane rating is a measure of a fuel's stability.

Usually a fuel with a higher octane rating can be subjected to a more severe combustion environment before spontaneous or abnormal combustion occurs. To understand how two gasoline samples can be different, even though they have the same octane rating, we need to know how octane rating is determined.

The American Society of Testing and Materials (ASTM) has developed a universal method of determining the octane rating of a fuel sample. The octane rating you see on the pump at a gasoline station is known as the pump octane number. Look at the small print on the pump.

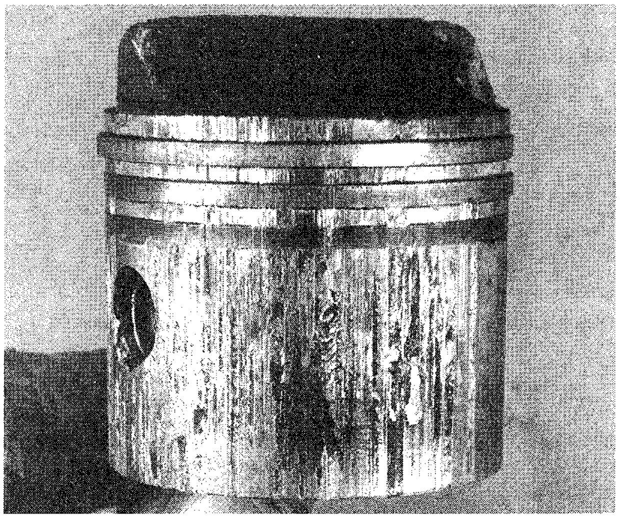


Fig. 1 Damaged piston, possibly caused by; using too-low an octane fuel; using fuel that had "soured" or by insufficient oil

The rating has a formula. The rating is determined by the R+M/2 method. This number is the average of the research octane reading and the motor octane rating.

The Research Octane Rating is a measure of a fuel's anti-knock properties under a light load or part throttle conditions. During this test, combustion heat is easily dissipated.

- The Motor Octane Rating is a measure of a fuel's anti-knock properties under a heavy load or full throttle conditions, when heat buildup is at maximum.

In general, 2-stroke engines tend to respond more to the motor octane rating than the research octane rating, because a 2-stroke engine has a power stroke (with heat buildup) every revolution. Therefore, in a 2-stroke outboard motor, the motor octane rating of the fuel is one of the best indications of how it will perform.

VAPOR PRESSURE

Fuel vapor pressure is a measure of how easily a fuel sample evaporates. Many additives used in gasoline contain aromatics. Aromatics are light hydrocarbons distilled off the top of a crude oil sample. They are effective at increasing the research octane of a fuel sample but can cause vapor lock (bubbles in the fuel line) on a very hot day. If you have an inconsistent running engine and you suspect vapor lock, use a piece of clear fuel line to look for bubbles, indicating that the fuel is vaporizing.

One negative side effect of aromatics is that they create additional combustion products such as carbon and varnish. If your engine requires high-octane fuel to prevent detonation, de-carbon the engine more freauently with an internal engine cleaner to prevent ring sticking due to excessive varnish buildup.

ALCOHOL-BLENDED FUELS

When the Environmental Protection Agency mandated a phase-out of the leaded fuels in January of 1986; fuel suppliers needed an additive to improve the octane rating of their fuels. Although there are multiple methods currently employed, the addition of alcohol to gasoline seems to be favored because of its favorable results and low cost. Two types of alcohol are used in fuel today as octane boosters, methanol (wood alcohol) or ethanol (grain alcohol).

When used as a fuel additive, alcohol tends to raise the research octane of the fuel, so these additives will have limited benefit in an outboard motor. There are, however, some special considerations due to the effects of alcohol in fuel.

- Since alcohol contains oxygen, it replaces gasoline without oxygen content and tends to cause the airlfuel mixture to become leaner.

On older outboards, the leaching affect of alcohol will, in time, cause fuel lines and plastic components to become brittle to the point of cracking. Unless replaced, these cracked lines could leak fuel, increasing the potential for hazardous situations.

- When alcohol blended fuels become contaminated with water, the water combines with the alcohol then settles to the bottom of the tank. This leaves the gasoline (and the oil for 2-stroke models using premix) on a top layer.

Modern outboard fuel lines and plastic fuel system components have been specially formulated to resist alcohol-leaching effects.

HIGH ALTITUDE OPERATION

At elevated altitudes there is less oxygen in the atmosphere than at sea level. Less oxygen means lower combustion efficiency and less power output. As a general rule, power output is reduced three percent for every thousand feet above sea level.

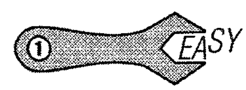
On carbureted engines, re-jetting for high altitude does not restore lost power, it simply corrects the air-fuel ratio for the reduced air density and makes the most of the remaining available power. The most important thing to remember when re-jetting for high altitude is to reverse the jetting when return to sea level. If the jetting is left lean when you return to sea level conditions, the correct airlfuel ratio will not be achieved (the motor will run very lean) and possible powerhead damage may occur.

RECOMMENDATIONS

According to the fuel recommendations that come with your outboard, there is no engine in the product line that requires more than 87 octane when rated by the R+M/2 method (the method used throughout the U.S.). The same 87 RON rating normally translates into a 90 RON rating (most often displayed and used outside the U.S.). An 89 or higher octane rating generally means middle to premium grade unleaded. Premium unleaded is more stable under severe conditions but also produces more combustion products. Therefore, when using premium unleaded, more frequent de-carboning is necessary.

Check the emissions label found on your motor as it will normally list the minimum required fuel octane rating for your specific model. However, some emission labels only display the fuel requirement of "unleaded."

CHECKING FOR STALE/CONTAMINATED FUEL



◆ **See Figures 2, 3, 4 and 5**

Outboard motors often sit weeks at a time making them the perfect candidate for fuel oroblems. Gasoline has a short life, as combustibles beain evaporating almost immediately. Even when stored properly, fuel starts to-deteriorate within a few months, leaving behind a stale fuel mixture that can cause hard-starting, poor engine performance and even lead to possible engine damage.

Further more, as gasoline evaporates it leaves behind gum deposits that can clog filters, lines and small passages. Although the sealed high-pressure fuel system of an FFI motor is less susceptible to fuel evaporation, the low-pressure fuel systems of all engines can easily suffer the affects. Carburetors, due to their tiny passages and naturally vented designs are the most susceptible components on non-FFI motors.

As mentioned under Alcohol-Blended Fuels, many modern fuels contain alcohol, which is hydroscopic (meaning it absorbs water). And, over time, fuel stored in a partially filled tank or a tank that is vented to the atmosphere will absorb water. The waterlalcohol settles to the bottom of the tank, promoting rust (in metal tanks) and leaving a non-combustible mixture at the bottom of a tank that could leave a boater stranded.

One of the first steps to fuel system troubleshooting is to make sure the fuel source is not at fault for engine performance problems. Check the fuel if the engine will not start and there is no ignition problem.

Stale or contaminated fuels will often exhibit an unusual or even unpleasant unusual odor.

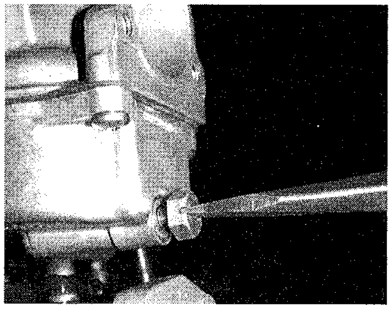


Fig. 2 Carburetor float bowls are normally equipped with a drain screw...

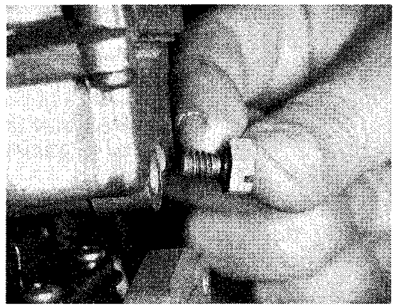


Fig. 3 ...to drain the carburetor, remove the drain screw

Fig. 4 Commercial additives, such as Sta-bil, may be used to help prevent "souring"

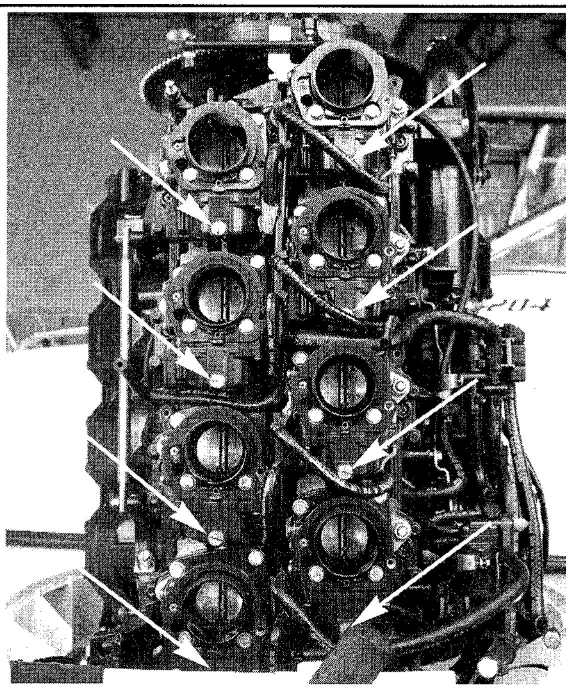


Fig. 5 There are a LOT of float bowls and screws on this **V8,** but at least they were all pretty easily accessed (once the air intake was removed)

■ The best method of disposing stale fuel is through a local waste pickup service, automotive repair facility or marine dealership. But, this can be a hassle. If fuel is not too stale or too badly contaminated, it may be mixed with greater amounts of fresh fuel and used to power **lawn/yard** equipment or even an automobile (if greatly diluted so as to prevent misfiring, unstable idle or damage to the automotive engine). But we feel that it is much less of a risk to have a lawn mower stop running because of the fuel problem than it is to have your boat motor quit or refuse to start.

Carburetors are normally equipped with a float bowl drain screw that can be used to drain fuel from the carburetor for long-term storage or for inspection. On FFI motors, there is not usually a dedicated drain for the high-pressure system. However, FFI motors are normally equipped with one or more high-pressure fuel circuit test ports (found on top of the vapor separator and/or inline on the high-pressure fuel lines). To obtain a sample of fuel from the high-pressure circuit, attach a fuel pressure gauge (equipped with a pressure bleed line) to the test fitting, then use the pressure bleed to drain a small amount of the fuel from the lines. If necessary, cycle the ignition key to run the fuel pump (with the pressure bleed closed) in order to rebuild system pressure and obtain a larger sample. On all motors, fuel samples can be taken from the low-pressure circuit, by simply disconnecting the fuel pump inlet hose and using the primer bulb to push out a sample.

For some motors, it may be easier to drain a fuel sample from the hoses leading to or from the low-pressure fuel filter or fuel pump. Removal and installation instructions for the fuel filters are provided in the Maintenance Section, while fuel pump procedures are found in this section. To check for stale or contaminated fuel:

1. Disconnect the negative battery cable for safety. Secure it or place tape over the end so that it cannot accidentally contact the terminal and complete the circuit.

**** CAUTION**

Throughout this procedure, clean up any spilled fuel to prevent a fire hazard.

2. For carbureted motors, remove the float bowl drain screw (and orifice plug, if equipped), then allow a small amount of fuel to drain into a glass container.

■ If there is no fuel present in the carburetor, disconnect the inlet line from the fuel pump and use the fuel primer bulb to obtain a sample.

3. For FFI motors, if a fuel sample is desired from the high-pressure circuit, attach a fuel pressure gauge (equipped with a bleed hose) to the pressure test fitting, then use the pressure bleed to drain a small fuel sample. If there is insufficient fuel/pressure present to obtain the sample, close the pressure bleed and cycle the ignition keyswitch to on, wait for 10 seconds and turn the keyswitch off again. Repeat as necessary to build system pressure and obtain a sufficient sample.
4. On either carbureted or FFI motors, obtain a sample from the low pressure circuit by disconnecting the fuel supply hose from the pump or low pressure fuel filter (as desired), then squeezing the fuel primer bulb to obtain a small sample of fuel. Place the sample in a clear glass container and reconnect the hose.

■ If a sample cannot be obtained from the fuel filter or pump supply hose, there is a problem with the fuel tank-to-motor fuel circuit. Check the tank, primer bulb, fuel hose, fuel pump, fitting or inlet needle on carbureted models.

5. Check the appearance and odor of the fuel. An unusual smell, signs of visible debris or a cloudy appearance (or even the obvious presence of water) points to a fuel that should be replaced.
6. If contaminated fuel is found, drain the fuel system and dispose of the fuel in a responsible manner, then clean the entire fuel system. On FFI models, properly drain the high-pressure fuel system by relieving pressure from the high-pressure circuit.

■ If debris is found in the fuel system, clean **and/or** replace all fuel filters.

7. When finished, reconnect the negative battery cable, then properly pressurize the fuel system and check for leaks.

Fuel System Pressurization

When it comes to safety and outboards, the condition of the fuel system is of the utmost importance. The system must be checked for signs of damage or leakage with every use and checked, especially carefully when portions of the system have been opened for service.

The best method to check the fuel system is to visually inspect the lines, hoses and fittings once the system has been properly pressurized.

Furthermore, FFI motors are equipped with two inter-related fuel circuits, a low pressure circuit that is similar to the circuit that feeds carburetors on other motors and a high pressure circuit that feeds the fuel injection system. As its name implies, the high-pressure circuit contains fuel under pressure that, if given the chance, will spray from a damaged/loose hose or fitting. When servicing components of the high pressure system, the fuel pressure must first be relieved in a safe and controlled manner to help avoid the potential explosive and dangerous conditions that would result from simply opening a fitting and allowing fuel to spray uncontrolled into the work area.

RELIEVING FUEL SYSTEM PRESSURE FFI MOTORS ONLY

OEM — 2 MODERATE

◆ See Figure 6

Before servicing the high-pressure fuel circuit or related components, including the vapor separator tank, high-pressure fuel pump, fuel injectors and/or related high-pressure lines, the pressure must be released. Failure to do so in a proper manner could lead to high pressure fuel spray, excessive concentrations of vapors and an extremely dangerous, potentially explosive condition.

FFI motors are equipped with a high-pressure fuel circuit test port. The port is normally located either on top of the vapor separator tank or is found in one of the high-pressure circuit fuel lines. The test port is useful when checking fuel system performance and pump operating pressures, but it is also used to provide a means of controlled pressure release prior to servicing the system. In order to do this, you'll need a fuel pressure gauge equipped with a bleed valve. Attach the gauge to the port and, if the gauge is not already equipped, a drain hose to the gauge bleed valve. Carefully bleed system pressure through the drain hose into a suitable container.

1. Disconnect the negative battery cable for safety during service.

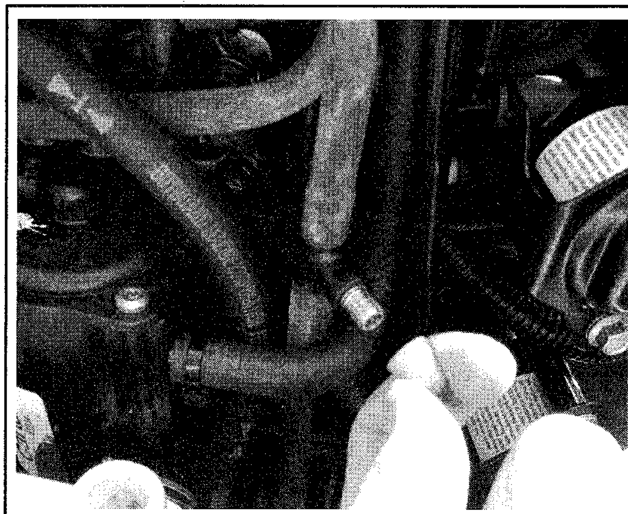


Fig. 6 The high-pressure fuel circuit test port can be used to carefully release system pressure and to connect a pressure gauge for system tests

✱✱ WARNING

Disconnecting the negative battery cable serves 2 important safety purposes. The first is that it prevents the electric fuel pump from activating during service. This could occur is someone was to turn the ignition keyswitch to the ON position for any reason (which would result in the pump running for 10 seconds, possibly spewing high-pressure fuel spray from any open fittings). The second is to prevent an accidental grounding of a hot lead during service (which would result in sparks that could ignite fuel vapors in the work area). It only takes a couple of seconds to protect yourself and your boat, so always disconnect the negative battery cable when working on fuel system components.

2. Connect a fuel pressure gauge (equipped with a pressure bleed valve and a drain hose) to the high-pressure fuel circuit test port. Place the drain hose into a suitable container and slowly open the bleed valve to release system pressure.

Even after most or all of the pressure has been dissipated, there may still be some liquid fuel left in the lines. Always wrap a shop rag around fittings before they are disconnected to catch any escaping fuel.

3. After maintenance or repairs are finished, fully pressurize the high- and low-pressure fuel circuits, then thoroughly check the system for leakage.

PRESSURIZING THE FUEL SYSTEM CHECKING FOR LEAKS

1 EASY

✱✱ CAUTION

Fuel leaking from a loose, damaged or incorrectly installed hose or fitting may cause a fire or an explosion. ALWAYS pressurize the fuel system and run the motor while inspecting for leaks after servicing any component of the fuel system.

Carbureted Models

Carbureted engines covered by this manual are equipped only with a low-pressure fuel system, making pressure release before service a non-issue. But, even a low-pressure fuel system should be checked following repairs to make sure that no leaks are present. Only by checking a fuel system under normal operating pressures can you be sure of the system's integrity.

Carbureted engines should be equipped with a fuel primer bulb mounted inline between the fuel tank and engine. The bulb can be used to pressurize that portion of the fuel system. Squeeze the bulb until it and the fuel lines feel firm with gasoline. At this point check all fittings between the tank and motor for signs of leakage and correct, as necessary.

Once fuel reaches the engine it is the job of the fuel pump to distribute it to the carburetors. On pre-mix 2-stroke motors the fuel is pumped directly from the pump to the carburetor. When equipped with the VRO2 system (as are most Evinrude/Johnson V-motors), VRO pump (consisting of a fuel and oil pump, as well as a fuel/oil-mixing unit) is responsible for feeding a fuel/oil mixture to the carburetors.

No matter what system you are inspecting, start and run the motor with the engine top case removed, then check each of the system hoses, fittings and gasket-sealed components to be sure there is no leakage after service.

FFI Models

Ficht Fuel Injection (FFI) models covered by this manual utilize 2 fuel circuits. A low-pressure circuit consisting of a fuel tank, primer bulb, mechanical fuel pump (also known as the lift pump), one or more low-pressure filters and the low-pressure fuel line to the vapor separator tank all operate in the same manner as the low-pressure fuel system of a carbureted motor. The high-pressure circuit consists of the electric fuel pump, vapor separator tank, fuel injectors and the high-pressure lines.

Although it is necessary to pressurize and inspect both systems after repairs have been performed on the motor, it is especially important to properly check the high-pressure circuit. Leaks from the high- pressure circuit will, as you might expect, be under much greater pressures leading to potentially more hazardous conditions than a low-pressure leak. That's not to say that a low-pressure leak isn't dangerous, but a high-pressure leak can be even more so.

1. Pressurize and check the low-pressure circuit as follows: Make sure the fuel tank is sufficiently full to provide an uninterrupted fuel source, then squeeze the bulb until it begins to feel firm. Check the low- pressure lines, fittings and components for signs of leakage before continuing.

2. Pressurize the high-pressure fuel circuit as follows: Make sure the negative battery cable is connected (if removed for service), then turn the key switch to ON for 10 seconds and then OFF again for about 3-5 seconds. Repeat the key switch cycle 3-4 times, while listening at the fuel pump to hear the electric high-pressure pump run each time the key is turned to the ON position. If the pump does not run, check the fuel pump and circuit as described in this section. Once pressurized, check the high-pressure lines, fittings and components for signs of leakage.

3. Start the engine, then allow it to idle it for a few seconds, while continuing to scan all fuel system components for signs of leakage.

4. Stop the motor and recheck the fittings.

5. Repair any leakage and then recheck the fuel system integrity.

FUEL TANK AND LINES

◆ See Figure 7

** CAUTION

If equipped, disconnect the negative battery cable ANYTIME work is **performed** on the engine, especially when working on the fuel system. **This** will help **prevent** the **possibility** of sparks **during** service **(from** accidentally'grounding a hot lead or powered component). **Sparks** could ignite vaoors or exoosed fuel. Disconnecting the cable on **electric start** motors will also help prevent the **possibility** fuel spillage if an attempt is made to crank the engine while the fuel system is open.

** CAUTION

Fuel leaking from a loose, damaged or incorrectly installed hose or fitting may cause a fire or an explosion. ALWAYS pressurize the fuel system and run the motor while inspecting for leaks after servicing any component of the fuel system.

If a problem is suspected in the fuel supply, tank and/or lines, by far the easiest test to eliminate these components as possible culprits is to substitute a known good fuel supply. This is known as running a motor on a test tank (as opposed to running a motor IN a test tank, which is an entirely different concept). If possible, borrow a portable tank, fill it with fresh gasoline (or gas and oil for pre-mix models) and connect it to the motor.

■ When using a test fuel tank, make sure the inside diameter of the fuel hose and fuel fittings is at least 5/16 in. **(8mm)** or larger for V4 models or 3/8 in. **(9.5mm)** or larger on **V6/V8** motors. Also, please note that although a 5/16 in. **(8mm) line/fitting** is acceptable for V4 motors, a **3/8** in. **(9.5mm)** or larger **line/fitting** is preferred. All models should utilize a pickup tube filter of stainless steel No. 304 wire cloth, 100 mesh with a wire diameter of 0.0045 **in. The** pickup tube filter should a cvlindrical screen of the same outer diameter of the pickup tube and at least 1 in. **(25.4mm)** in length.

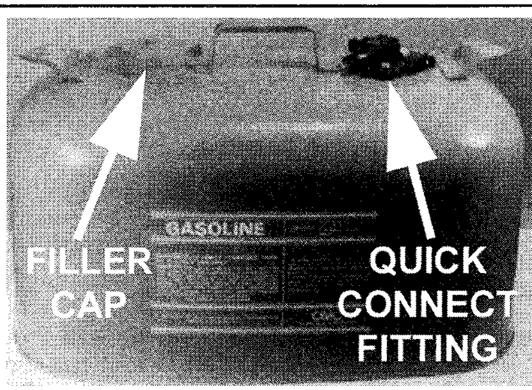


Fig. 7 Although most V-motors are not rigged with portable tanks, they are useful to keep around as shop or test tanks

□ A **6-gallon** shop tank is needed for the factory recommended **winterization procedure** (for details, see the **information** on Winterization in the Maintenance And Tune-Uo section). So, it's probably not a bad idea to obtain a shop or test tank **if you need** to diagnose fuel system problems.

Fuel Tank

◆ See Figure **8**

There are 2 different types of fuel tanks that might be used along with these Evinrude/Johnson motors. Some commercial or specially rigged boats might choose to use portable fuel tanks. But, the majority of V-motors will use a permanently mounted, integral (boat mounted) fuel tank. In both cases, a tank that is not mounted to the engine itself (as occurs with some tiny, portable outboards) is commonly called a remote tank.

Although many **Evinrude/Johnson** dealers rig boats using **Evinrude/Johnson** fuel tanks, there are many other tank manufacturers and tank designs may vary **greatly. Your** outboard might be equipped with a tank from the engine manufacturer or more likely, the boat manufacturer. Although components used, as well as the techniques for cleaning and repairing tanks are similar for almost all fuel tanks, be sure to use caution and common sense. If the design varies from the instructions included here, stop and assess the situation instead of following the instructions blindly. If we reference 2 or 4 screws for something and the component is still tight after removing that many, look for another or for another means of securing the component, don't force it. Refer to a reputable marine repair shop or marine dealership when parts are needed for aftermarket fuel tanks.

Whether or not your boat is equipped with a boat mounted, built-in tank depends mostly on the boat builder and partially on the initial engine installer. Boat mounted tanks can be hard to access (sometimes even a little hard to find if parts of the deck must be removed. When dealing with boat mounted tanks, look for access panels (as most manufacturers are smart or kind enough to install them for tough to reach tanks). At the very least, all manufacturers must provide access to fuel line fittings and, usually, the fuel level sender assembly.

No matter what type of tank is used, all must be equipped with a vent (either a manual vent or an automatic one-way check valve) that allows air in (but should prevent vapors from escaping). An inoperable vent (one that is blocked in some fashion) would allow the formation of a vacuum that could prevent the fuel pump from drawing fuel from the tank. A blocked vent could cause fuel starvation problems. Whenever filling the tank, check to make sure air does not rush into the tank each time the cap is loosened (which could be an early warning sign of a blocked vent).

If fuel delivery problems are encountered, first try running the motor with the fuel tank cap removed to ensure that no vacuum lock will occur in the tank or lines due to vent problems. If the motor runs properly with the cap removed but stall, hesitates or misses with the cap installed, you know the problem is with the tank vent system.

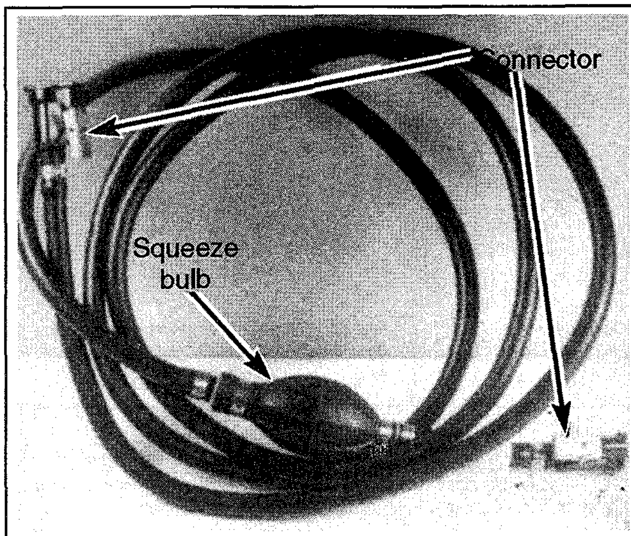


Fig. 8 Remote tanks are connected to the motor using a fuel line with a primer bulb

SERVICE

② MODERATE

Portable Fuel Tanks

◆ See Figures **9, 10, 11, 12** and **13**

Because of a V-motor's size and power, portable fuel tanks are the exception and not the norm. But, because unique rigging and applications, especially for some of the commercial models, could make multiple portable fuel tanks preferable to a boat mounted unit, we've chosen to include information on portable tanks as well.

Modern fuel tanks are vented to prevent vapor lock of the fuel supply system, but are normally vented by a one-way valve to prevent pollution through the evaporation of vapors. A squeeze bulb is used to prime the system until the powerhead is operating. Once the engine starts, the fuel pump, mounted on the powerhead pulls fuel from the tank and feeds the carburetors, or FFI high-pressure fuel circuit, as applicable. The pickup unit in the tank is usually sold as a complete unit, but without the gauge and float.

To disassemble and inspect or replace tank components, proceed as follows:

1. For safety, remove the filler cap and drain the tank into a suitable container.
2. Disconnect the fuel supply line from the tank fitting.
3. To replace the pickup unit, first remove the screws (normally 4) securing the unit in the tank. Next, lift the pickup unit up out of the tank.
4. Remove the Phillips screws (usually 2) securing the fuel gauge to the bottom of the pickup unit and set the gauge aside for installation onto the new pickup unit.

■ If the pickup unit is not being replaced, clean and check the screen for damage. It is possible to bend a new piece of screen material around the pickup and solder it in place without purchasing a complete new unit.

5. If equipped with a level gauge assembly, check for smooth, non-binding movement of the float arm and replace if binding is found. Check the float itself for physical damage or saturation and replace, if found.
6. Check the fuel tank for dirt or moisture contamination. If any is found use a small amount of gasoline or solvent to clean the tank. Pour the solvent in and slosh it around to loosen and wash away deposits, then pour out the solvent and recheck. Allow the tank to air dry, or help it along with the use of an air hose from a compressor.

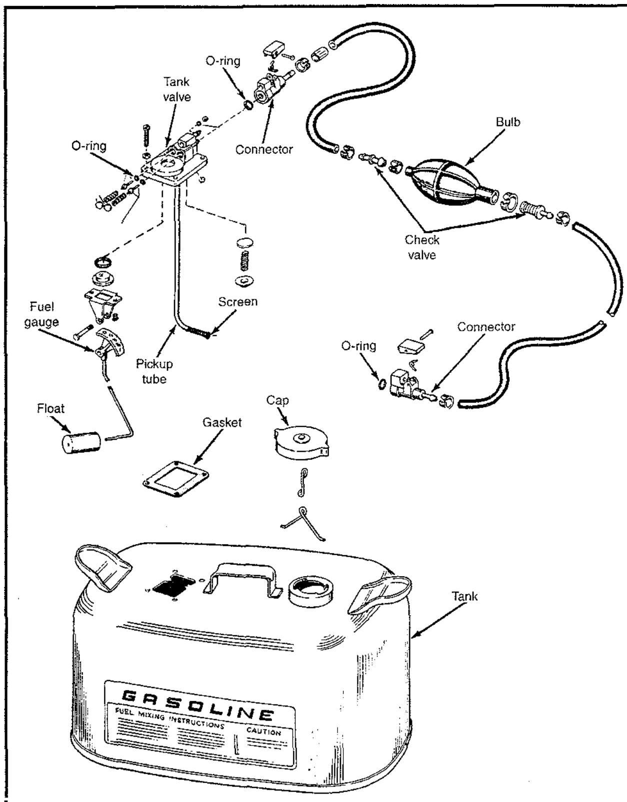


Fig. 9 Exploded view of a typical **Evinrude/Johnson** portable fuel tank

✳✳ WARNING

Use extreme care when working with solvents or fuel. Remember that both are even more dangerous when their vapors are concentrated in a small area. No source of ignition from flames to sparks can be allowed in the **workplace** for even an instant.

To install:

7. Attach the fuel gauge to the new pickup unit and secure it in place with the Phillips screws.
8. Clean the old gasket material from fuel tank and, if being used, the old pickup unit. Position a new gasket/seal, then work the float arm down through the fuel tank opening, and at the same time the fuel pickup tube into the tank. It will probably be necessary to exert a little force on the float arm in order to feed it all into the hole. The fuel pickup arm should spring into place once it is through the hole.
9. Secure the pickup and float unit in place with the attaching screws.
10. If removed, connect the fuel tank, then pressurize the fuel system and check for leaks.

Boat Mounted Fuel Tanks

The other type of remote fuel tank usually used on these models is a boat mounted, built-in tank. Depending on the boat manufacturer, built-in tanks may vary greatly in actual shape/design and access. All should be of a one-way vented to prevent a vacuum lock, but capped to prevent evaporation design.

Most boat manufacturers are kind enough to incorporate some means of access to the tank should fuel lines, fuel pickup or floats require servicing. But, the means of access will vary greatly from boat-to-boat. Some might contain simple access panels, while others might require the removal of one or more minor or even major components for access. If you encounter difficulty, seek the advice of a local dealer for that boat builder. The dealer or his/her techs should be able to set you in the right direction.

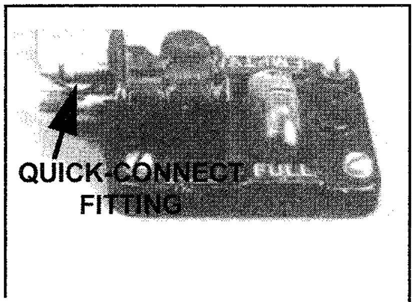


Fig. 10 To service the tank, disconnect the fuel line from the quick-connect fitting...

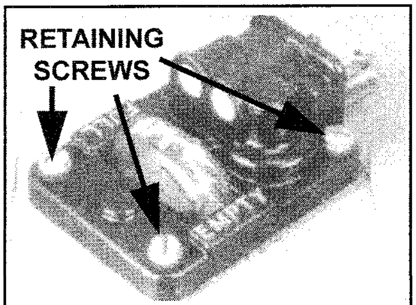


Fig. 11 ... then remove the screws holding the pickup and float assembly to the tank

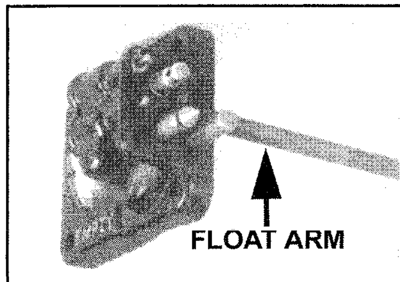


Fig. 12 When removing the pickup and float, be careful not to damage the float arm

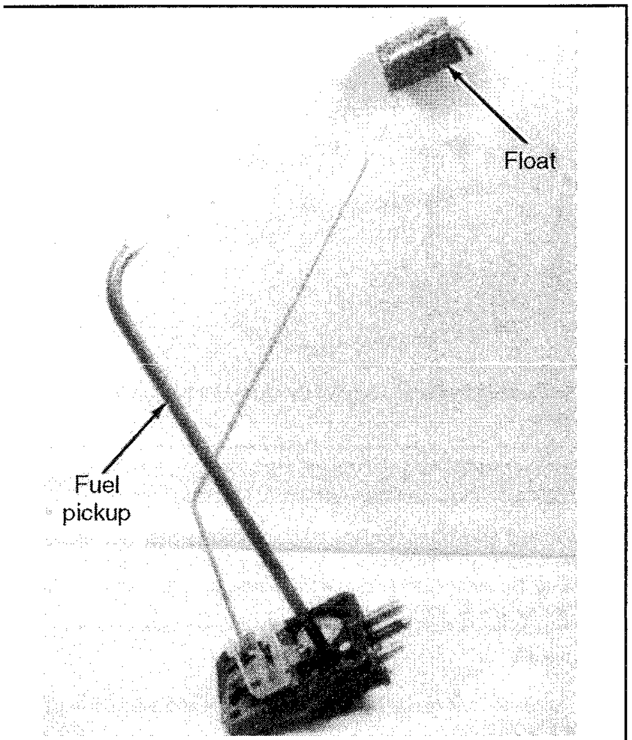


Fig. 13 The assembly must be tilted to remove the float arm from the tank

✳✳ CAUTION

Observe all fuel system cautions, especially when working in recessed portions of a hull. Fuel vapors tend to gather in enclosed areas causing an even more dangerous possibility of explosion.

Anti-Siphon Valve

On many boats with built-in fuel tanks, the fuel system is provided with an anti-siphon valve to prevent fuel from being siphoned from the tank in the event the fuel line is broken or disconnected. The valve is mounted on top of the tank. It should be removed periodically and checked to verify adequate fuel flow under normal conditions and no fuel flow when the valve is closed.

Fuel Lines and Fittings

◆ See Figure 8

In order for an engine to run properly it must receive an uninterrupted and unrestricted flow of fuel. This cannot occur if improper fuel lines are used or if any of the lineslfittings are damaged. Too small a fuel line could cause hesitation or missing at higher engine rpm. Worn or damaged lines or fittings could cause similar problems (also including stalling, poorlrough idle) as air might be drawn into the system instead of fuel. Similarly, a clogged fuel line, fuel filter or dirty fuel pickup or vacuum lock (from a clogged tank vent as mentioned under Fuel Tank) could cause these symptoms by starving the motor for fuel.

If fuel delivery problems are suspected, check the tank first to make sure it is properly vented, then turn your attention to the fuel lines. First check the lines and valves for obvious signs of leakage and then check for collapsed hoses that could cause restrictions.

If there is a restriction between the primer bulb and the fuel tank, vacuum from the fuel pump may cause the primer bulb to collapse. Watch for this sign when troubleshootingfuel delivery problems.

✳✳ CAUTION

Only use the proper fuel lines containing suitable Coast Guard ratings on a boat. Failure to do so may cause an extremely dangerous condition should fuel lines fail during adverse operating conditions.

TESTING

② MODERATE

Fuel Line Quick Check

◆ See Figure 8

Stalling, hesitation, rough idle, misses at high rpm are all possible results of problems with the fuel lines. A quick visual check of the lines for leaks, kinked or collapsed lengths or other obvious damage may uncover the problem. If no obvious cause is found, the problem may be due to a restriction in the line or a problem with the fuel pump.

If a fuel delivery problem due to a restriction or lack of proper fuel flow is suspected, operate the engine while attempting to duplicate the miss or hesitation. While the condition is present, squeeze the primer bulb rapidly to manually pump fuel from the tank to (and through) the fuel pump to the carburetors (or FFI vapor separator tank). If the engine then runs properly while under these conditions, suspect a problem with a clogged restricted fuel line, a clogged fuel filter or a problem with the fuel pump.

Checking Fuel Flow at Motor

◆ See Figures 8, 14 and 15

To perform a more thorough check of the fuel lines and isolate or eliminate the possibility of a restriction, proceed as follows:

1. For safety, disconnect the spark plug leads, then ground each of them to the powerhead to prevent sparks and to protect the ignition system.
2. Disconnect the fuel line from the engine. Place a suitable container over the end of the fuel line to catch the fuel discharged. If using a quick-connector, insert a small screwdriver into the end of the line to hold the valve open.

3. Squeeze the primer bulb and observe if there is satisfactory fuel flow from the line. If there is no fuel discharged from the line, the check valve in the squeeze bulb may be defective, or there may be a break or obstruction in the fuel line.

4. If there is a good fuel flow, reconnect the tank-to-motor fuel supply line and disconnect the fuel line from the carburetors or FFI vapor separator, directing that line into a suitable container. Crank the powerhead. If the fuel pump is operating properly, a healthy stream of fuel should pulse out of the line. If sufficient fuel does not pulse from the line, compare flow at either side of the inline fuel filter (if equipped) or check the fuel pump.

5. Continue cranking the powerhead and catching the fuel for about 15 pulses to determine if the amount of fuel decreases with each pulse or maintains a constant amount. A decrease in the discharge indicates a restriction in the line. If the fuel line is plugged, the fuel stream may stop. If there is fuel in the fuel tank but no fuel flows out the fuel line while the powerhead is being cranked, the problem may be in one of several areas:

6. Plugged fuel line from the fuel pump to the carburetor(s).
7. Defective O-ring or seal in fuel line connector into the fuel tank.
8. Defective O-ring or seal in fuel line connector into the engine.
9. Defective fuel pump.
10. The line from the fuel tank to the fuel pump may be plugged; the line may be leaking air; or the squeeze bulb may be defective.
11. Defective fuel tank.
12. If the engine does not start even though there is adequate fuel flow from the fuel line, the fuel inlet needle valve and the seat may be gummed together and prevent adequate fuel flow into the float bowl or FFI vapor separator tank.

Checking the Primer Bulb

◆ See Figures **8, 14** and **16**

The way most outboards are rigged, fuel will evaporate from the system during periods of non-use. Also, anytime quick-connect fittings on portable tanks are removed, there is a chance that small amounts of fuel will escape and some air will make it into the fuel lines. For this reason, outboards are normally rigged with some method of priming the fuel system through a hand-operated pump (primer bulb).

When squeezed, the bulb forces fuel from inside the bulb, through the one-way check valve toward the motor filling the carburetor float bowls or FFI vapor separator tank with the fuel necessary to start the motor. When the bulb is released, the one-way check valve on the opposite end (tank side of the bulb) opens under vacuum to draw fuel from the tank and refill the bulb.

When using the bulb, squeeze it gently as repetitive or forceful pumping may flood the carburetor (or overfill the FFI vapor separator tank. The bulb is operating normally if a few squeezes will cause it to become firm, meaning the float bowl/tank is full, and the float valve is closed. If the bulb collapses and does not regain its shape, the bulb must be replaced.

For the bulb to operate properly, both check valves must operate properly and the fuel lines from the check valves back to the tank or forward to the motor must be in good condition (properly sealed). To check the bulb and check valves use hand operated vacuum/pressure pump (available from most marine or automotive parts stores):

1. Remove the fuel hose from the tank and the motor. If equipped, remove the clamps for the quick-connect valves at the ends of the hose and carefully remove the quick-connect valve from the motor side of the fuel line.

Most quick-connect valves are secured to the fuel supply hose using disposable plastic ties that must be cut and discarded for removal. If equipped, spring-type or threaded metal clamps may be reused, but be sure they are in good condition first. Do not overtighten threaded clamps and crack the valve or cut the hose.

2. Place the end of the line into the filler opening of the fuel tank. Gently pump the primer bulb to empty the hose into the fuel tank.

☐ Be careful when removing the quick-connect valve from the fuel line as fuel will likely still be present in the hose and will escape (drain or splash) if the valve is jerked from the line. Also, make sure the primer bulb is empty of fuel before proceeding.

3. If equipped, remove the quick-connect valve from the tank side of the fuel line, draining any residual fuel into the tank.

☐ For proper orientation during testing or installation, the primer bulb is marked with an arrow that faces the engine side check valve.

4. Securely connect the pressure pump to the hose on the tank side of the primer bulb. Using the pump, slowly apply pressure while listening for air escaping from the end of the hose that connects to the motor. If air escapes, both one-way check valves on the tank side and motor side of the prime bulb are opening.

5. If air escapes prior to the motor end of the hose, hold the bulb, check valve and hose connections under water (in a small bucket or tank). Apply additional air pressure using the pump and watch for escaping bubbles to determine what component or fitting is at fault. Repair the fitting or replace the defective hose/bulb component.

6. If no air escapes, attempt to draw a vacuum form the tank side of the primer bulb. The pump should draw and hold a vacuum without collapsing the primer bulb, indicating that the tank side check valve remained closed.

7. Securely connect the pressure pump to the hose on the motor side of the primer bulb. Using the pump, slowly apply pressure while listening for air escaping from the end of the hose that connects to the motor. This time, the check valve on the tank side of the primer bulb should remain closed, preventing air from escaping or from pressurizing the bulb. If the bulb pressurizes, the motor side check valve is allowing pressure back into the bulb, but the tank side valve is operating properly.

8. Replace the bulb and/or check valves if they operate improperly.

SERVICE

1 EASY

◆ See Figures **15, 16, 17** and **18**

Whenever work is performed on the fuel system, check all hoses for wear or damage. Replace hoses that are soft and spongy or ones that are hard and brittle. Fuel hoses should be smooth and free of surface cracks, and they should definitely not have split ends (there's a bad hair joke in there, but we won't sink that low). Do not cut the split ends of a hose and attempt to reuse it, whatever caused the split (most likely time and deterioration) will cause the new end to follow soon.

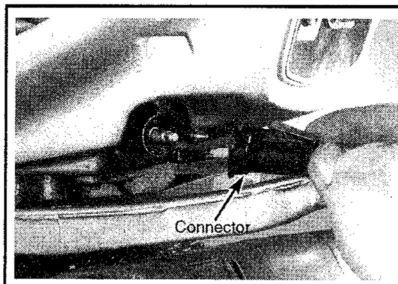


Fig. 14 Remove the fuel supply line from the motor, usually only portable tanks will utilize a quick-disconnect fitting such as pictured here

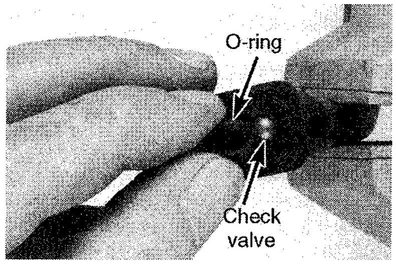


Fig. **15** When used, make sure the **quick-**connector O-ring and check valve are in good condition

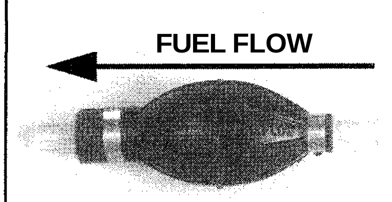


Fig. 16 The primer bulb contains an arrow that indicates the direction of fuel flow (points toward the motor)

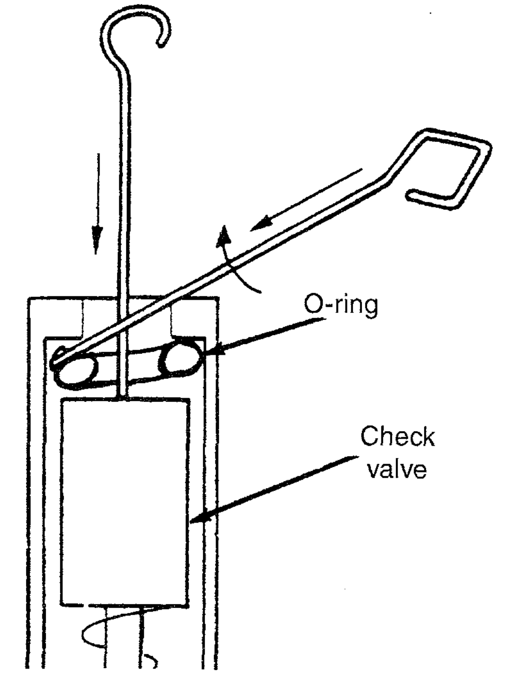


Fig. 17 Use two picks, punches or other small tool to replace quick-connect O-rings. One to push the valve and the other work the O-ring free

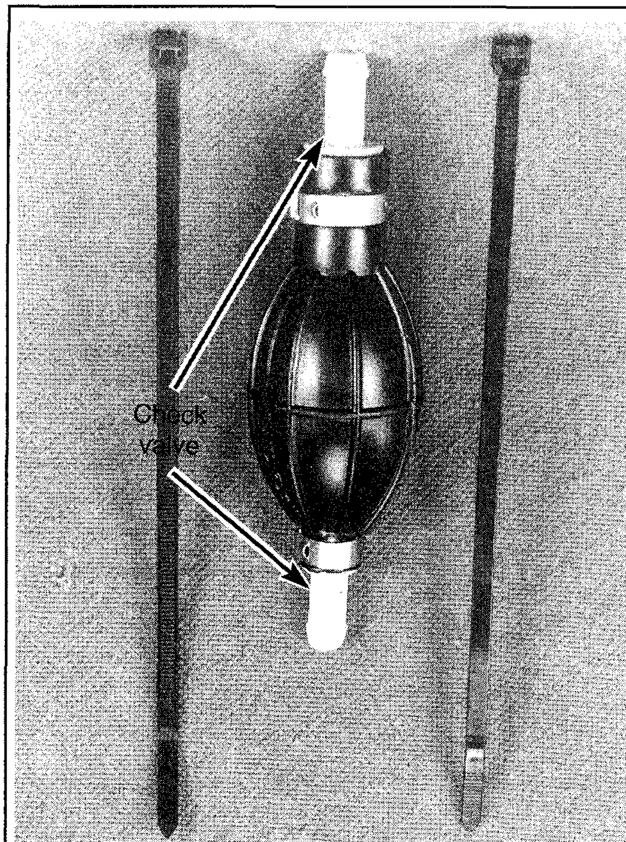


Fig. 18 A squeeze bulb kit usually includes the bulb, 2 check valves, and two tie straps

Fuel hoses are safety items, don't scrimp on them, instead, replace them when necessary. If one hose is too old, check the rest, as they are likely also in need of replacement.

When replacing fuel lines, make sure the inside diameter of the fuel hose and fuel fittings is at least 5/16 in. **(8mm)** or larger for V4 models or 318 in. **(9.5mm)** or larger on **V6/V8** motors. Also, please note that although a 5/16 in. **(8mm) line/fitting** is acceptable for V4 motors, a 318 in. **(9.5mm)** or larger **line/fitting** is preferred. Lastly, be certain to use only marine fuel line the meets or exceeds United States Coast Guard (USCG) **A1** or **B1** guidelines.

When replacing fuel lines only use Evinrude/Johnson replacement hoses or other marine fuel supply lines that meet United States Coast Guard (USCG) requirements A1 or B1 for marine applications. All lines must be of the same inner diameter as the original to prevent leakage and maintain the proper seal that is necessary for fuel system operation.

Using a smaller fuel hose than specified could cause fuel starvation problems leading to misfiring, hesitation, rough idling and possibly even engine damage.

The USCG ratings for fuel supply lines have to do with whether or not the lines have been testing regarding length of time it might take for them to succumb to flame (burn through) in an emergency situation. A line is " A rated if it passes specific requirements regarding burn-through times, while "B" rated lines are not tested in this fashion. The A1 and B1 lines (normally recommended on EvinrudelJohnson applications) are capable of containing liquid fuel at all times. The A2 and B2 rated lines are designed to contain fuel vapor, but not liquid.

**** CAUTION**

To help prevent the possibility of significant personal injury or death, do not substitute "**B**" rated lines when "A" rated lines are required. Similarly, do not use "**A2**" or "**B2**" lines when "AI" or "**A2**" lines are specified.

Various styles of fuel line clamps may be found on these motors. Many applications will simply secure lines with plastic wire ties or special plastic locking clamps. Although some of the plastic locking clamps may be released and reconnected, it is usually a good idea to replace them. Obviously wire ties are cut for removal, which requires that they be replaced.

Some applications use metal spring-type clamps that contain tabs which are squeezed, releasing pressure and allowing the clamp to slid up the hose and over the end of the fitting so the hose can be pulled from the fitting. Threaded metal clamps are nice since they are very secure and can be reused, but do not overtighten threaded clamps as they will start to cut into the hose and they can even damage some fittings underneath the hose. Metal clamps should be replaced anytime they've lost tension (spring type clamps), are corroded, bent or otherwise damaged.

The best way to ensure proper fuel fitting connection is to use the same size and style clamp that was originally installed (unless of course the "original" clamp never worked correctly, but in those cases, someone probably replaced it with the wrong type before you ever saw it).

To avoid leaks, replace all displaced or disturbed gaskets, O-rings or seals whenever a fuel system component is removed.

On most installations with portable tanks, the fuel line is provided with quick-disconnect fittings at the tank and at the powerhead. If there is reason to believe the problem is at the quick-disconnects, the hose ends can be replaced as an assembly, or new O-rings may be installed. A supply of new O-rings should be carried on board for use in isolated areas where a marine store is not available (like dockside, or worse, should you need one while on the water). For a small additional expense, the entire fuel line can be replaced and eliminate this entire area as a problem source for many future seasons. (If the fuel line is replaced, keep the old one around as a spare, just in case).

If a quick-connect O-ring must be replaced, use two small punches, picks or similar tools, one to push down the check valve of the connector and the other to work the O-ring out of the hole. Apply just a drop of oil into the hole of the connector, Apply a thin coating of oil to the surface of the O-ring. Pinch the O-ring together and work it into the hole while simultaneously using a punch to depress the check valve inside the connector.

The primer squeeze bulb can be replaced in a short time. A squeeze bulb assembly kit, complete with the check valves installed, may be obtained from vour local Evinrude/Johnson dealer. The replacement kit will usuallv include two tie straps to secure the bulb properly in the line.

An arrow is clearly visible on the squeeze bulb to indicate the direction of fuel flow. The squeeze bulb must be installed correctly in the line because the check valves in each end of the bulb will allow fuel to flow in only one direction. Therefore, if the squeeze bulb should be installed backwards, in a moment of haste to get the job done, fuel will not reach the carburetors or FFI vapor separator tank.

To replace the bulb, first unsnap the clamps on the hose at each end of the bulb. Next, pull the hose out of the check valves at each end of the bulb. New clamps are included with a new squeeze bulb.

If the fuel line has been exposed to considerable sunlight, it may have become hardened, causing difficulty in working it over the check valve. To remedy this situation, simply immerse the ends of the hose in boiling water for a few minutes to soften the rubber. The hose will then slip onto the check valve without further problems, After the lines on both sides have been installed, snap the clamps in place to secure the line. Check a second time to be sure the arrow is pointing in the fuel flow direction, towards the powerhead,

CARBURETED FUEL SYSTEM

** WARNING

If equipped, disconnect the negative battery cable ANYTIME work is performed on the engine, especially when working on the fuel system. This will help prevent the possibility of sparks during service (from accidentally grounding a hot lead or powered component). Sparks could ignite vapors or exposed fuel. Disconnecting the cable on electric start motors will also help prevent the possibility fuel spillage if an attempt is made to crank the engine while the fuel system is open.

** WARNING

Fuel leaking from a loose, damaged or incorrectly installed hose or fitting may cause a fire or an explosion. ALWAYS pressurize the fuel system and run the motor while inspecting for leaks after servicing any component of the fuel system.

Carbureted motors covered by this manual are equipped with one carburetor barrel or throat per cylinder. The 65 Jet-115 Hp (1632cc) 90CV4 motors are the only Evinrude/Johnson V-motors which utilize true 2 barrel carburetors (a single carburetorlthrottle body assembly with a dual-throated body). The rest of the carbureted V-motors utilize a single throttle body on which two or three carburetor throats (carburetor bodies) are mounted. This method allows for the same basic carburetor and throttle body assembly to be used on multiple applications. One type of carburetor body is used on the 600, 80 Jet-175 Hp (1726/2589cc) V4 and V6 models. The carburetor body is mounted to either a 2 (V4) or 3 (V6) bore throttle body assembly. One throttle/carburetor body assembly is then used on each bank of cylinders. The modular style carburetorlthrottle body assembly is taken a step further on the 900 looper models. For the 120-300 Hp (2000/3000/4000cc) V4/V6/V8 motors a dual throat throttle body is mounted for each pair of cylinders on each bank. This means 2 of these units are mounted on V4 motors, while 4 of them are used on V8 motors. Each unit then contains 2 carburetor bodies, resulting in 4 barrels on V4 motors or 8 barrels on V8 motors, For V6 motors, a single throat throttle body is attached to the dual throat unit on each side. The additional throttle body also uses an additional carburetor body, for a total of 6 barrels on these V6 motors. Although on initial inspection some these carbureted motors may look somewhat complicated, they're actually very basic, especially when compared with other modern fuel svstems (such as an automotive or marine fuel iniection system).

The entire system essentially consists of a fuel tank, a fuel supply line, and a mechanical fuel pumo assembly mounted to the powerhead (and for most motors, the oil/fuel mixing system that uses a unique fuel/oil pump). These components are all designed to feed the carburetors with the fuelloil mixture necessary to power the motor.

Cold starting is enhanced by the use a manual primer (on a few, mostly commercial/tiller models) or an electric fuel primer solenoid (generally all remote models).

For information on fuels, tanks and lines please refer to the sections on Fuel System Basics and Fuel Tanks and Lines. For more information on the VR02 oil/fuel mixing system, please refer to the Lubrication and Cooling section.

The most important fuel system maintenance that a boat owner can perform is to provide and to stabilize fuel supplies before allowing the system to sit idle for any length of time more than a few weeks. The next most important item is to provide the system with fresh gasoline if the system has stood idle for any length of time, especially if it was without fuel system stabilizer during that time.

If a sudden increase in gas consumption is noticed, or if the engine does not perform properly, a carburetor overhaul, including cleaning or replacement of the fuel pump may be required.

Description and Operation

BASIC FUNCTIONS

The Role of a Carburetor

+ **See Figures 19 and 20**

The carburetor is merely a metering device for mixing fuel and air in the proper proportions for efficient engine operation. At idle speed, an outboard engine requires a mixture of about 8 parts air to 1 part fuel. At high speed or under heavy load, the mixture may change to as much as 12 parts air to 1 part fuel.

Carburetors are wonderful devices that succeed in precise air/fuel mixture ratios based on tiny passages, needle jets or orifices and the variable vacuum that occurs as engine rpm and operating conditions vary,

Because of the tiny passages and small moving parts in a carburetor (and the need for them to work precisely to achieve exact air/fuel mixture ratios) it is important to retain fuel system integrity. Introduction of water (that might lead to corrosion), debris (that could clog passages) or even the presence of unstabilized fuel that could evaporate over time can cause big problems for a carburetor. Keep in mind that when fuel evaporates it leaves behind a gummy deposit that can clog those tiny passages, preventing the carburetor (and therefore preventing the engine) from operating properly.

Float Systems

◆ **See Figures 19 and 20**

Ever lift the tank lid off the back of your toilet? Pretty simple stuff once you realize what's going on in there. A supply line keeps the tank full until a valve opens allowing all or some of the liquid in the tank to be drawn out through a passage. The dropping level in the tank causes a float to change position, and, as it lowers in the tank it opens a valve allowing more pressurized liquid back into the tank to raise levels again. OK, we were talking about a toilet right, well yes and no, we're also talking about the float bowl on a carburetor. The carburetor uses a more precise level control, uses vacuum to draw out fuel from the bowl through a metered passage and, most importantly, stores gasoline instead of water, but otherwise, they basically work in the same way.

A small chamber in the bottom of the carburetor serves as a fuel reservoir. A float valve admits fuel into the reservoir to replace the fuel consumed by the engine.

Fuel level in each chamber is extremely critical and must be maintained accurately. Accuracy is obtained through proper adjustment of the float. This adjustment will provide a balanced metering of fuel to each cylinder at all speeds. Improper levels will lead to engine operating problems. Too high a level can promote rich running and spark plug fouling, while excessively low float bowl fuel levels can cause lean conditions, possibly leading to engine damage.

Following the fuel through its course from carburetor float bowl to the cylinder combustion chamber, will provide an appreciation of exactly what is taking place. At the carburetor, fuel from the pump or, more likely, the fuelloil mixing unit, passes through the inlet passage to the needle and seat, and then into the float chamber (reservoir). A float in the chamber rides up and down on the surface of the fuel. After fuel enters the chamber and the level

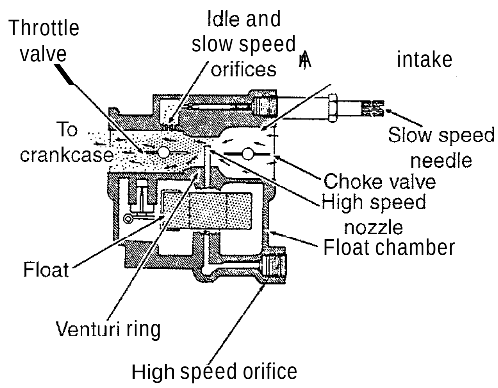


Fig. **19** Fuel flow through the venturi, showing principal and related Darts controlling intake and outflow (carburetor with manual'choke circuit **shown)**

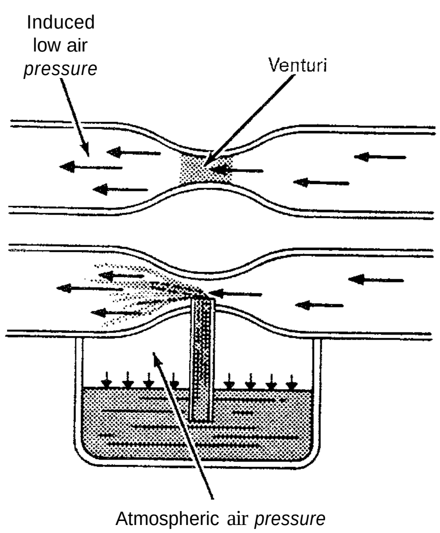


Fig. **20** Air flow principal sf a modern carburetor, demonstrates how the low pressure induced behind the venturi draws fuel through the high speed nozzle

rises to a predetermined point, a tang on the float closes the inlet needle and additional fuel is cutoff from entering the chamber. When fuel leaves the chamber as the powerhead operates, the fuel level drops and the float tang allows the inlet needle to move off its seat and fuel enters the chamber once again. In this manner a constant reservoir of fuel is maintained in the chamber to satisfy the demands of the engine at all speeds.

A fuel chamber vent hole is located near the top of the carburetor body to permit atmospheric pressure to act against the fuel in each chamber. This pressure assures an adequate fuel supply to the various operating systems of the engine.

Air/Fuel Mixture

+ See Figures **19** and **20**

A suction effect is created each time the piston moves upward in the cylinder of a 2-stroke motor. This suction draws air through the throat of the carburetor. A restriction in the throat, called a venturi, controls air velocity and has the effect of reducing air pressure at this point.

The difference in air pressures at the throat and in the fuel chamber, causes the fuel to be pushed out metering jets extending down into the fuel chamber. When the fuel leaves the jets, it mixes with the air passing through the venturi. This airlfuel mixture should then be in the proper proportion for burning in the cylinder for maximum engine performance.

In order to obtain the proper airlfuel mixture for all engine speeds, high- and low-speed orifices or needle valves are installed. On most modern powerheads the high-speed needle valve (and on a few the low speed needle valve as well) has been replaced with a fixed high-speed orifice (to discourage tampering and to help maintain proper emissions under load). There is no adjustment with the orifice type (other than replacing the orifice with one that uses a larger or smaller opening). The needle valves are used to compensate for changing atmospheric conditions.

On the other hand, most motors (excluding the cross-flow models and a few of the loopers) utilize low-speed needles, so that idle airlfuel mixture can be precisely adjusted for conditions other than what occurs at atmospheric sea-level. Although the low speed needle should not normally require periodic adjustment, it can be adjusted to compensate for high-altitude (riverllake) operation or to adjust for component wear within the fuel system. Powerhead operation at sea level compared with performance at high altitudes is quite noticeable.

A throttle valve controls the volume of airlfuel mixture drawn into the powerhead. A cold engine requires a richer fuel mixture to start and during the brief period it is warming to normal operating temperature. On these models, an enrichment system is used to provide extra fuel through additional passages. When the enrichment system is actuated, a rich fuel mixture is drawn into the engine. This mixture will help wake-up a cold motor, but will quickly foul the plugs on a warm engine so it should only be used for cold starts.

The throat of the carburetor is usually referred to as the "barrel." As detailed earlier, carburetors installed on these engines are equipped with a single throat or barrel per cylinder. Each barrel or throat will incorporate an individual metering jet and throttle (except the true 2 barrel or dual-throat carburetors used by the cross-flow motors, that use 2 throttle plates mounted on a single throttle shaft for each carburetor assembly). Single barrel or throat carburetors are fed by one float and chamber.

So, as far as carburetors go, these are relatively easy carburetors to understand, rebuild or adjust. The real key to proper operation of these carburetors comes with the throttle plate or valve synchronization procedures found in the Timing and Synchronization section. In order for these carburetors/outboards to operate properly, ALL of the throttle valves must open simultaneously when the throttle is activated and must close completely when released.

Troubleshooting the Carbureted Fuel System

② MODERATE

COMMON PROBLEMS

The last step fuel system troubleshooting is to adjust or rebuild and then adjust the carburetor. We say it is the last step, because it is the most involved repair procedures on the fuel system and should only be performed after all other possible causes of fuel system trouble have been eliminated.

Fuel Delivery

◆ See Figures **21, 22** and **23**

Many times fuel system troubles are caused by a plugged fuel filter, a defective fuel pump, or by a leak in the line from the fuel tank to the fuel pump. Aged fuel left in the carburetor and the formation of varnish could cause the needle to stick in its seat and prevent fuel flow into the bowl. A defective choke may also cause problems. Would you beiieve, a majority of starting troubles, which are traced to the fuel system, are the result of an empty fuel tank or aged fuel.

If fuel delivery problems are suspected, refer to the testing procedures in Fuel Tank and Lines to make sure the tank vent is working properly and that there are no leaks or restrictions that would prevent fuel from getting to the pump and/or carburetors.

A blocked fuel filter causes hard starting, stalling, misfire or poor performance. Typically the engine malfunction worsens with increased engine speed. This filter prevents contaminants from reaching the fuel pump. Most models are equipped with a form of an inline filter, though the non-VR02 equipped motors are usually equipped with a fuel filter screen under the pump inlet cover. Refer to the Fuel Filter in the section on Maintenance and Tune-up for more details on checking, cleaning or replacing fuel filters.

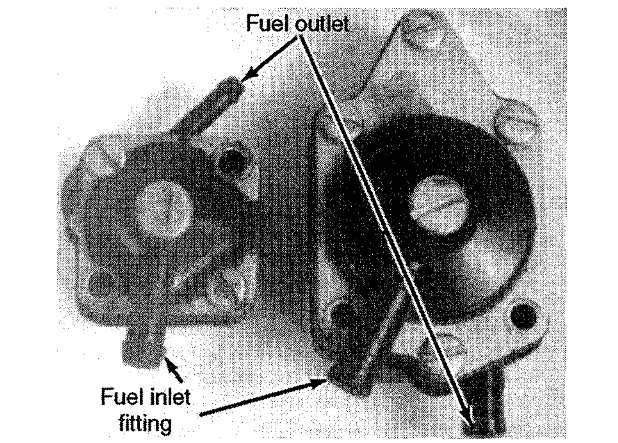


Fig. 21 Typical Evinrude/Johnson fuel pumps from non-VRO2 equipped motors...

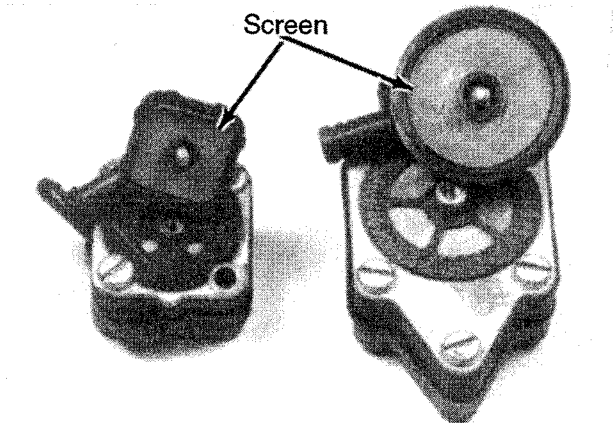


Fig. 22 **...** most non-VR02 pumps are equipped with filter elements under the pump inlet covers

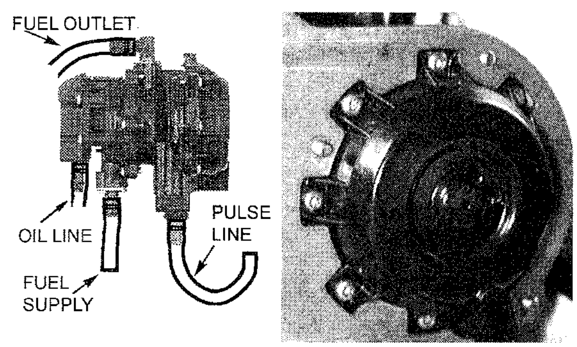


Fig. 23 Most V-motors are equipped with the VR02 **fuel/oil** pump assembly

Sour Fuel

Fuel will begin to sour in a matter of weeks, and within a couple of months, will cause engine starting problems. Therefore, leaving the motor setting idle with fuel in the carburetor, lines, or tank during the off-season, usually results in very serious problems. A fuel additive such as Sta-Bil® may be used to prevent gum from forming during storage or prolonged idle periods.

Refer to the information on Fuel System Basics in this section, specifically the procedure under Fuel entitled checking For Stale/Contaminated Fuel for information on how to determine if stale fuel is present in the system. If draining the system of stalelcontaminated fuel and refilling it wit6 fresh fuel does not make a difference in the problem, look for restrictions or other problems with the fuel delivery system. If stale fuel was left in the tank/system for a long period of time and evaporation occurred, there is a good chance that the carburetors are gummed (tiny passages are clogged by deposits left behind when the fuel evaporated). If no fuel delivery problems are found, the carburetor(s) should be removed for disassembly and cleaning.

Although there are some commercially available fuel system cleaning products that are either added to the fuel mixture or sprayed into the carburetor throttle bores, the truth is that although they can provide some measure of improvement, there is no substitute for a thorough disassembly and **cleaning. The** more fuel that was allowed to evaporate, the more gum or varnish that may have been **left** behind and the more likely that only a disassembly will be able to restore proper performance.

Enrichment Problems

◆ See Figure 24

When the engine is hot, the fuel system can cause starting problems. After a hot engine is shut down, the temperature inside the fuel bowl may rise to 200°F (94°C) and cause the fuel to actually boil. Carburetors are normally vented to allow this pressure to escape to the atmosphere. However, some of the fuel may percolate over the main nozzle.

If the enrichment circuit (manual or electric) fail to operate, while the engine is cold, it will be hard to start. Likewise, if the enrichment circuit remains activated during normal engine operating temperatures, the engine will flood making it very difficult to start or, once started, making it buck or hesitate, especially at lower speeds.

In order for this raw fuel to vaporize enough to burn, considerable air must be added to lean out the mixture. Therefore, one remedy is to make sure the enrichment circuit is off and open the throttle to the fully open position (to allow in maximum air) and hold it there while the engine is cranked. If this doesn't work, the only remedy remaining is to remove the spark plugs and ground the leads, then crank the powerhead through about ten revolutions to blow out raw fumes. Then, clean the plugs; install the plugs again; and start the engine.

If the needle valve and seat assembly is leaking, an excessive amount of fuel may enter the intake manifold in the following manner: After the powerhead is shut down, the pressure left in the fuel line will force fuel past the leaking needle valve. This extra fuel will raise the level in the fuel bowl and cause fuel to overflow into the intake manifold.

A continuous overflow of fuel into the intake manifold may be due a defective float or overpriming the system using the primer bulb which would cause an extra high level of fuel in the bowl and overflow into the intake manifold.

Rough Engine **Idle**

If a powerhead does not idle smoothly, the most reasonable approach to the problem is to perform a tune-up to eliminate such areas as faulty spark plugs and timing or synchronization out of adjustment.

Other problems that can prevent an engine from running smoothly include an air leak in the intake manifold; uneven compression between the cylinders; and sticky or broken reed valves.

Of course any problem in the carburetors affecting the airlfuel mixture will also prevent the engine from operating smoothly at idle speed. These problems usually include too high a fuel level in the bowl; a heavy float; leaking needle valve and seat; defective enrichment circuit; and improper idle (low-speed) needle valve adjustments or the installation of an improperly size'd idle orifice.

"Sour" fuel (fuel left in a tank without a preservative additive) will cause an engine to run rough and idle with great difficulty. Remember that fuel enriched with alcohol is hydroscopic and could accumulate/absorb water over time.

As with all troubleshooting procedures, start with the easiest items to check/fix and work towards the more complicated ones.

Recirculation Hoses and Check Valves

The recirculation hoses and check valves remove any excess fuel/oil build-up from the low point in each of the cylinders and lower bearing cavity. The build-up is scavenged and returned to the intake manifold where it is mixed with a fresh airlfuel charge from the carburetor.

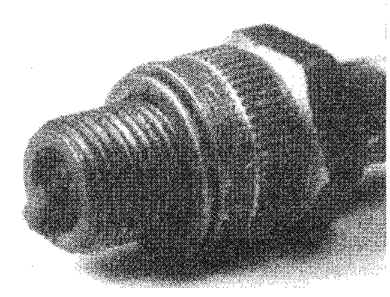


Fig. 24 Fouled spark plug, possibly caused by over-choking or a malfunctioning enrichment circuit

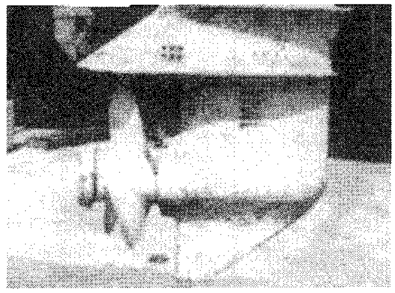


Fig. 25 Marine growth on the lower unit will create "drag" and seriously hamper boat performance

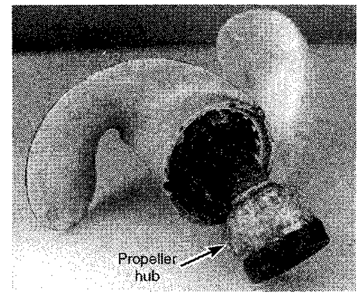


Fig. 26 A corroded hub on a small engine propeller. Hub and propeller damage will also cause poor performance

If one of the hoses or fittings become plugged, or the check valve malfunctions, the fuel/oil mixture will build up in the cylinder and eventually cause the cylinder to misfire, foul the spark plug or cause excessive smoke during acceleration after an extended idling period.

Excessive Fuel Consumption

◆ See Figures 25 and **26**

Excessive fuel consumption can result from a variety of conditions, including excessively rich carburetors and wrong size and pitch propeller for the boat and user application. The most common and over looked conditions are as follows:

1. Inefficient engine operation.
2. Damaged hull, outdrive or propeller, including excessive marine growth.
3. Poor operator boating habits.

If the fuel consumption suddenly increases over what could be considered normal, then the cause can probably be attributed to the engine or boat and not the operator (unless he/she just drastically changed the manner in which the boat is operated).

Marine growth on the hull can have a very marked effect on boat performance. This is why racing sailboats always try to have a haul-out as close to race time as possible. While you are checking the bottom take note of the propeller condition. A bent blade or other damage will definitely cause poor boat performance.

If the hull and propeller are in good shape, check the fuel system for possible leaks. For pre-mix motors, check the line between the fuel pump and the carburetors. For oil injected motors, check the fuel distribution manifold and hoses between the VR02 pump(s) and the carburetors while the powerhead is running and the fuel supply hose between the fuel tank and the VR02 pump when the powerhead is not operating. Many times, a fuel leak between the tank and the fuel pump will not appear when the powerhead is operating, because the suction created by the pump drawing fuel will not allow the fuel to escape. Once the powerhead is turned off and the suction no longer exists, fuel may begin to leak slowly from the supply hose or fittings.

If no other problems are found, a minor tune-up has been performed and the spark plugs and engine timing/synchronization are properly adjusted, then the problem most likely is in the carburetors, indicatina an overhaul is in order. Check for damage to the needle valve and seat, which will cause an internal leak. Use extra care when making any adjustment or bleed air orifice and high speed jet changes.

✳✳ WARNING

A powerhead running too lean may be severely damaged by operation. Check with a local dealer for the proper size orifices and jets for the specific size powerhead and application.

Engine Surge

If the engine operates as if the load on the boat is being constantly increased and decreased, even if there is no change to the throttle, the problem can most likely be attributed to the fuel pump. Refer to Fuel Tank and Lines in this section for information on checking the lines for restrictions and checking fuel flow. Also, refer to Fuel Pump under Carbureted Fuel System for more information on fuel pump operation and service.

FUEL SYSTEM TROUBLESHOOTING—BY SYMPTOM

Powerhead Fails to Start
- Poort quality or old "sour" fuel.
- Fuel supply restricted to the fuel pump and carburetors.
- Fuel primer valve leaking, flooding the powerhead.
- Out of fuel.

Powerhead Fails to Idle
- Fuel supply restricted to the powerhead.
- Fuel primer valve is leaking.
- VR02 or fuel pump is sucking air.
- Throttle linkage misadjusted.
- Carburetors gummed or dirty.
- Recirculation hoses and fittings plugged or disconnected.
- Intake manifold air leaks.
- Reed valves bent or broken.

Powerhead Fails to Idle Slowly
- Fuel supply anti-siphon valve or filter restricted. Fuel primer valve is leaking.
- VR02 or fuel pump malfunction.
- Throttle linkage misadjusted.
- Internal carburetor leakage.

Powerhead **Coughs/Spits** at Idle
- Fuel system leaks air.
- Throttle linkage misadjusted.
- Carburetor leaking air.
- Recirculation fittings plugged or hoses misrouted.
- Intake manifold leaking air.

Powerhead Operates Rich at Idle
- Fuel primer valve leaks.
- VR02 pump is damaged.
- Carburetor malfunction.
- Recirculation system hoses loose.

Excessive Oil Use **(VRO2** Motors Only)
- Restricted fuel supply.
- VR02 pump malfunction.

Powerhead Stalls During Acceleration
- Restricted fuel supply.
- VR02 or fuel pump malfunction.
- Throttle linkage misadjusted.
- Carburetor malfunction.
- Intake manifold leaking air.
- Reed plates bent or broken.

Powerhead Surges at High RPM
- Restricted fuel supply.
- VR02 or fuel pump malfunction.
- Carburetors gummed or dirty.
- Air silencerlbaffle missing.

Runs Rich at High Speed
- Fuel primer valve leaks.
- Internal carburetor leakage.

Powerhead Fails to Obtain WOT RPM
- Fuel supply restricted to the powerhead.
- VR02 or fuel pump malfunction.
- Carburetors gummed or dirty.
- Reed valves bent or broken.

Fuel Spits From Carburetor(s)
- Reed valves bent, broken.
- Manifold seal is leaking air.

VR02 FUEL SYSTEM TEST PROCEDURES

On models equipped with the Variable Ratio Oil (VRO2) injection system, please refer to the System Verification and Troubleshooting procedures found for the VR02 System in the Lubrication and Cooling system section. We've placed all VR02 service in one section, separate from the Fuel System section to prevent confusing those people working on non oil-injected motors.

Carburetor—65 Jet-115 Hp (1632cc) 90CV4 Motors

◆ **See Figure 27**

This section provides complete detailed procedures for removal and installation and overhaul (disassemblylcleaning & inspection/assembly), for the carburetors normally found on 65 Jet-115 Hp (1632cc) 900, cross-flow V4 motors.

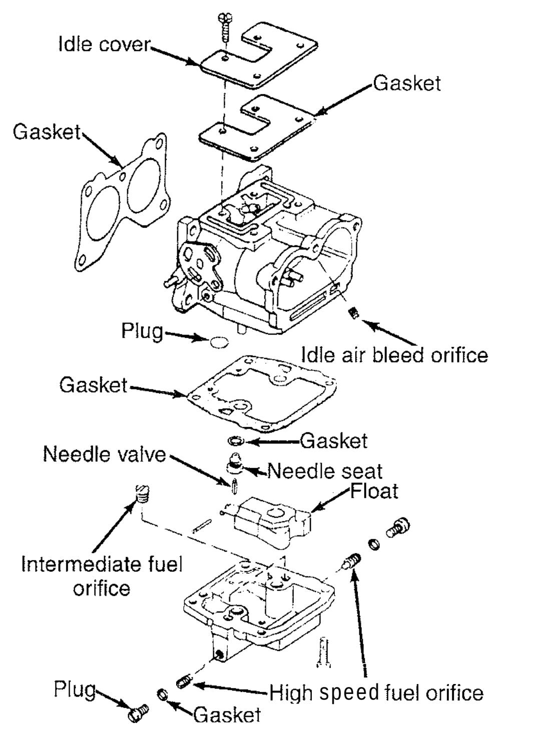


Fig. 27 Exploded view of the carburetor used on 65 Jet-115 Hp (1632cc) 90°, cross-flow V4 motors

DESCRIPTION

◆ **See Figure 27**

This, more conventionally designed 2 barrel or throat carburetor is normally used on 65 Jet-115 Hp (1632cc) 900, cross-flow V4 motors. In most cases, one dual throat carburetor will service a pair of cylinders. This dual throat carburetor contains two High Speed fixed orifices, two Idle Air Bleed orifices, and two Intermediate Fuel orifices. The single float chamber maintains the proper fuel level in the carburetor for both throats. One carburetor provides the fuel/air mixture for two cylinders. Therefore two dual throat carburetors are installed on a V4 powerhead.

REMOVAL & INSTALLATION

② MODERATE

◆ **See Figure 27**

☐ **The fuel hose fittings are delicate on these models. To protect the fittings, gently push the hoses from them instead of grasping and pulling on the hose itself. If pushing won't free the hose, use a utility knife to carefully slit the hose from the end to a point at or near the fitting flange, then peel the hose from the fitting and replace it upon reinstallation.**

1. Remove the spark plug leads and/or disconnect the negative battery cable (if equipped) to prevent accidental starting of the engine.

☐ **Remember, half of the point of disconnecting the negative battery cable is to prevent the possibility of sparks that could ignite fuel vapors. The other half of the point is to prevent someone from cranking the motor while fuel lines or fittings are open.**

2. Loosen the intake air silencer cover retaining bolts (usually 9), then remove the air silencer cover and discard the gasket.
3. Loosen the intake air silencer base retaining bolts (usually 4), then remove the VR02 pump retaining bolts. Disconnect the drain hose and then remove the intake air silencer base.
4. Disconnect the carburetor throttle linkage.
5. Loosen and remove the Allen head retaining bolts and pull the carburetor(s) from the intake manifold. Support the carburetor(s) while removing the primer hoses. Then, cut the wire tie(s) and carefully remove the fuel supply line(s). Set the carburetor(s) aside.
6. Remove and discard the carburetor gasket. Carefully clean the gasket mating surfaces of any remaining material.

To install:

7. Inspect the carburetor base gasket(s) to make sure there is a hole to match the primer fitting. Position a new base gasket on the carburetor, using the Allen head screws to hold it in position on the carburetor.

Install the carburetor gasket dry. Do not use sealer.

8. Attach the fuel supply and primer hoses and secure using new wire ties.
9. Position the carburetor and gasket to the intake manifold. Make sure the gasket is positioned properly, thread the screws and tighten securely.
10. Reconnect the carburetor throttle linkage. Refer to the information under Timing and Synchronization for throttle adjustments.
11. Apply a light coating of Evinrude/Johnson Screw Lock, or equivalent threadlock to the intake air silencer base retaining screws. Place the screws aside for use in a couple of steps.
12. Install the VR02 pump to the back of the air silencer base and tighten the screws to 18-24 inch lbs. (2-3 Nm).
13. Connect the drain hose to the air silencer base, then install the silencer base to the carburetors using a new gasket. Install the gasket dry, using NO sealer, then install the silencer base screws (coated with threadlock) and tighten to 35-60 inch lbs. (4-6.8 Nm).
14. Pressurize the fuel system using the primer bulb and check the fuel system for leaks. For more details, please refer to Fuel System Pressurization for details.
15. Install the air intake silencer cover using a new gasket and tighten the bolts securely.
16. Reconnect the negative battery cable and/or install the spark plugs, as applicable.

OVERHAUL

OEM ② MODERATE

◆ See Figure 27

☐ Good shop practice dictates a carburetor repair kit be purchased and new parts be installed any time the carburetor is disassembled.

Make an attempt to keep the work area clean and organized. Be sure to cover parts after they have been cleaned. This practice will prevent foreign matter from entering passageways or adhering to critical parts.

Be sure to have a rag handy to catch spilled fuel, as some fuel is bound to still be present in the lines and the float bowl. Take this opportunity to closely inspect the fuel lines and replace any that are damaged or deteriorated.

During removal or overhaul procedures, always matchmark hoses or connections prior to removal to ensure proper assembly and installation. Following a complete rebuild and the initial bench settings, perform the complete Timing and Synchronization procedure as detailed in the Maintenance and Tune-Up section.

☐ To avoid leaks, replace all displaced or disturbed gaskets, O-rings or seals whenever a fuel system component is **removed. This** is especially true when rebuilding a carburetor.

Disassembly

◆ See Figures **27, 28, 29, 30, 31, 32** and 33

The following procedures pickup the work after the carburetor has been removed from the intake manifold on the powerhead. If both carburetors are to be serviced, repeat all given steps for the other carburetor. It is recommended to perform all the steps on one carburetor before beginning work on another. Such a procedure will prevent possible mix-up of internal components.

1. Invert the carburetor and drain any gasoline remaining in the float bowl through the vent.
2. Remove the four screws securing the float bowl assembly to the carburetor. Lift off the float bowl assembly and gasket. Discard the gasket.
3. Loosen and remove the two float bowl drain plugs on each side of the float bowl. Discard the gasket on each plug.

■ The bleed air orifices and jets are made of a soft brass material. A slot on the end of the orifice is provided to insert a common flat blade screwdriver. However, the manufacturer has a specially designed tool **P/N** 317002 driver, which fits the slotted opening nicely and will not slip. If multiple carburetors are to be serviced, the cost of this tool justifies the modest expenditure compared with the price of a couple bleed air orifices.

✳✳ WARNING

Use extreme caution when a common screwdriver is used. If the end of the orifice is damaged, it must be replaced with a new orifice.

4. Using the EvinrudelJohnson Orifice Plug Screwdriver PIN 317002, or equivalent, remove the two high speed jets from the float bowl drain plug bores—one on each side of the float bowl. Note the size and location as each jet is removed.

✳✳ CAUTION

The bleed air orifices and jets appear identical in size, but have different drill size **openings and thread** sized. A number is stamped on the end of each orifice and jet for size. Note the size number and location prior to removal. **Installation** of the wrong size orifice could cause **poor** performance and severe powerhead damage.

5. Using EvinrudelJohnson Orifice Plug Screwdriver P/N 317002, or equivalent, remove the two intermediate fuel orifices from the interior of the float bowl. Note the size and location as each orifice is removed.
6. Pull the pin from the float hinges. Lift out the float assembly and needle valve from the carburetor body.
7. Using a wide flat blade screwdriver, remove the needle valve seat and gasket from the carburetor body. Discard the gasket. If the carburetor being serviced is a late model unit, a cover plate and gasket covering the idle circuit passages is located on top of the carburetor. Remove the four screws securing the cover and gasket. Discard the gasket.
8. Using the EvinrudelJohnson Orifice Plug Screwdriver PIN 317002, or equivalent, remove the two idle air bleed orifices from the throat of the carburetor. Note the size and location of each orifice removed.
9. Clean and inspect the carburetor, as detailed in this section.

Cleaning and Inspection

◆ See Figures **27, 34** and 35

Never submerge the carburetor or any of its components into a strong carburetor cleaner or a hot soaking tank. Strong chemicals or hot tank may damage certain parts and sealing compounds.

Use EvinrudelJohnson Carburetor and Choke cleaner or an equivalent product in a spray can. Flush all passages, tubes and orifices with the spray carburetor cleaner or a syringe filled with isopropyl alcohol. Use a clean bristle brush to remove any gum or varnish deposits. Blow out all passages with low pressure compressed air at approximately 25 psi (172 kPa). Never use a piece of wire or any type of pointed instrument to clean drilled passages or calibrated holes in the carburetor.

Inspect the carburetor body and float bowl gasket sealing surfaces for nicks, gouges or irregularities that could cause a leak. Check all nozzle and pickup tubes for security and cleanliness.

Inspect the nylon tip of the needle valve for wear, distortion or damage. Replace the needle valve and seat if damaged or worn. Good shop practice dictates to always replace the needle valve and needle seat when the carburetor is fully disassembled.

Check the throttle plate and shaft for excessive wear. Move the throttle shaft back-and-forth to check for wear. If the shaft appears to be loose, replace the complete throttle body because individual replacement parts are not available. Verify the throttle plate retaining screws are tight, and check alignment of the throttle plate to the throttle body bore.

This carburetor has two calibration pockets in the top of the fuel chamber which are covered with soft plugs.

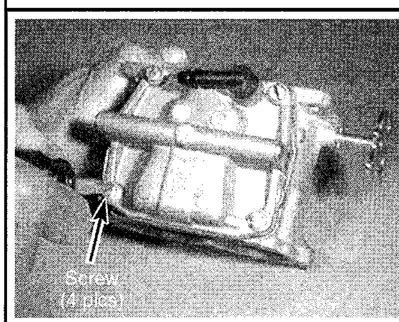


Fig. 28 Remove the four screws securing the float bowl

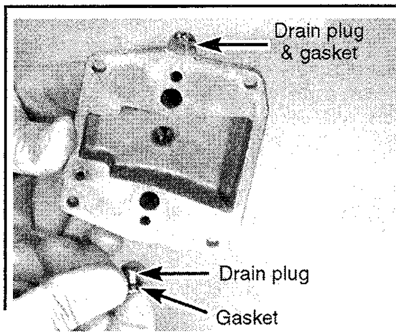


Fig. 29 Remove the 2 float bowl **drain-**plugs and discard the gaskets (O-rings)

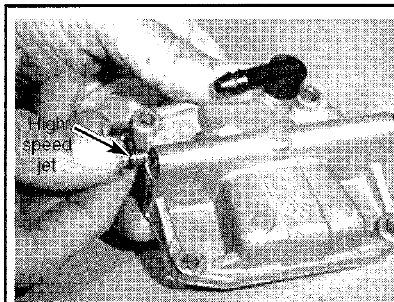


Fig. 30 Remove the 2 high speed jets from the bowl drain plug bores

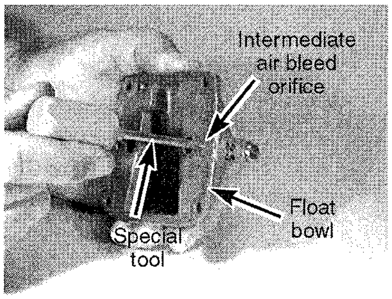


Fig. 31 Remove the 2 intermediate fuel orfices from the float bowl

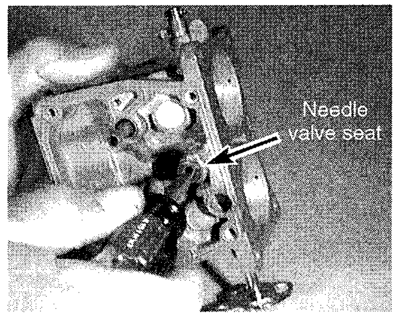


Fig. 32 Remove the needle valve seat and gasket

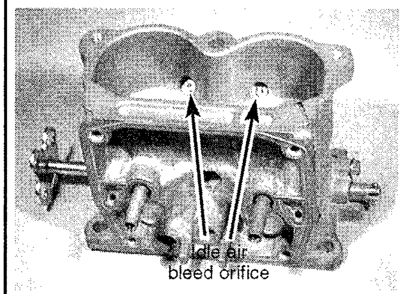


Fig. 33 Remove the 2 idle air bleed orfices from the carburetor throat

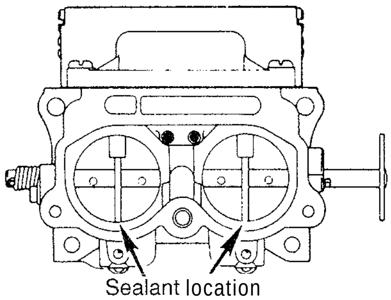


Fig. 34 If the emulsion tubes are leaking, apply a drop of Ultra Lock as shown

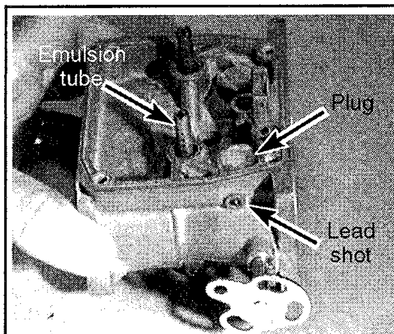


Fig. 35 Locations of the lead shot and plug covering the idle and intermediate circuit passages

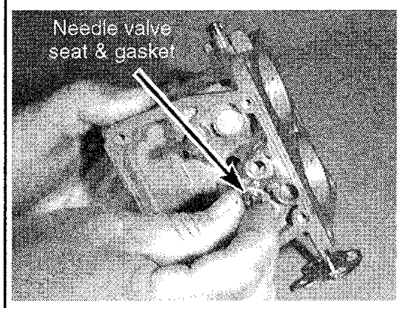


Fig. 36 Install needle valve seat and a new gasket

Do not remove these soft plugs unless absolutely necessary for cleaning, or if they are known to be leaking. When it is necessary to remove these plugs, drill a small hole in the center of the plug. Take care not to damage the throttle body. Pry the plug out with a small punch. After cleaning, install a new soft plug with the convex side up. Seat the soft plug using the flat end of a drift punch. Apply a fuel resistant sealer such as Evinrude/Johnson Gasoila sealant to the edges of the soft plug.

The side of the carburetor main body contains a lead shot covering drilled passages. If the carburetor is extremely gummed and varnished, the lead shot may be removed for cleaning these passages. Pry up on the lead shot with a knife or other sharp instrument. Clean the passage free of all debris and gum. Place a new lead shot over the opening and flatten it using a hammer and blunt end punch.

Invert the carburetor main body. Fill the idle circuit with isopropyl alcohol. Check for leaks around the emulsion tube where it joins the carburetor body. If a leak is discovered, drain the isopropyl alcohol and blow dry with compressed air. Apply a drop of Evinrude/Johnson Ultra Lock or equivalent high-strength threadlocking compound at the points indicated in the illustration:

Assemblv

◆ **See Figures 27, 36, 37, 38, 39, 40, 41, 42, 43, 44 and 45**

Install a new float bowl gasket making sure all holes in the gasket are aligned with carb body passages

1. Place a new gasket on the needle valve seat and install the seat in the carburetor body. If the carburetor being serviced is a late model unit, a cover plate and gasket covering the idle circuit passages is located on top of the carburetor. Place a new gasket and cover in position. Secure the cover with four screws.
2. Place a new needle valve onto the float tab. Lower the float and needle valve onto the carburetor, and at the same time, guide the needle valve into the seat. Align the float hinge between the float supports and insert the hinge pin.
3. Invert the carburetor and hold it level. Check the float closed height, with the needle valve fully closed. The leading edge of the float should be approximately level with the gasket. Carefully bend the float arm to adjust for the proper height.

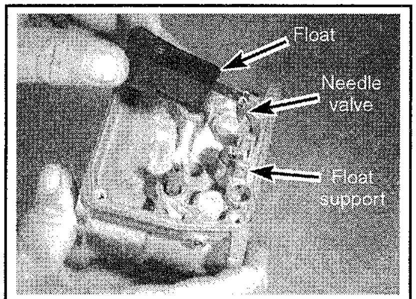


Fig. 37 Install a new needle valve along with the float assembly

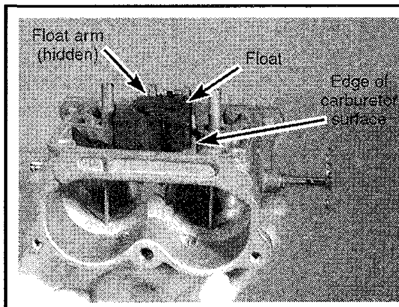


Fig. 38 Check the float closed height (the float leading edge should be about level with the gasket)

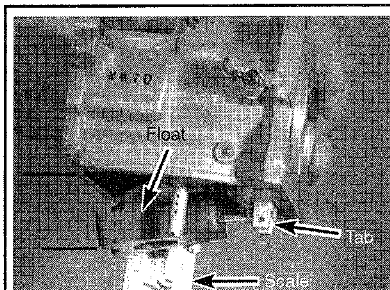


Fig. 39 Hold the carburetor upright and level to measure the float drop height

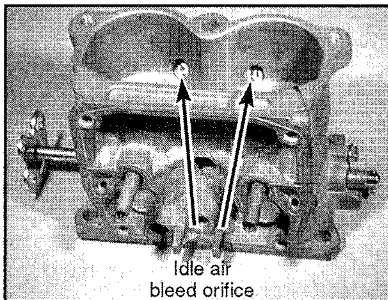


Fig. **40** Install the **2** idle air bleed orifices **to** the throat

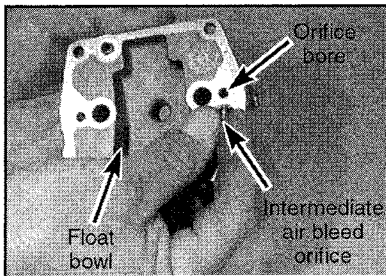


Fig. **41** Install the **2** intermediate fuel orifices into the bores

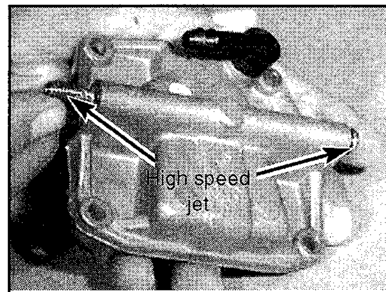


Fig. **42** Install the **2** high speed jet orifices into the bores

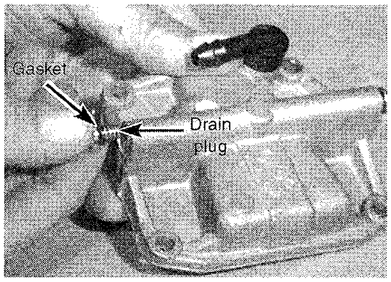


Fig. **43** Install the **2** float bowl drain plugs using new gaskets

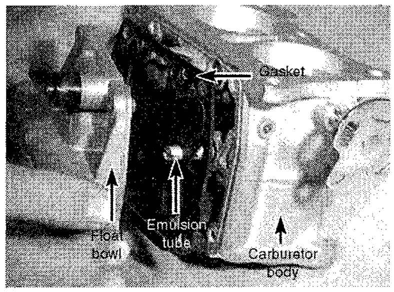


Fig. **44** Install a new float bowl gasket making sure all holes in the gasket are **aligned with carb body passages**

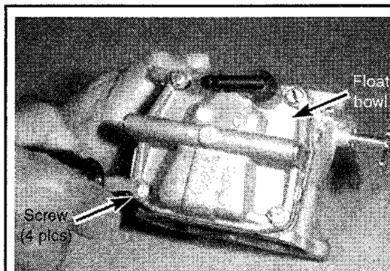


Fig. 45 Install the float bowl onto the carburetor

4 Hold the carburetor upright and level Measure the float drop height with a scale or ruler The float drop height should be 1 in (25 4mm) give or take 1/8 an inch (3 18mm) or stated another way, float drop height should be 7/8-1 7/8 in (22 3-28 6mm) Carefully bend the tab on the float to set the drop height

5 Install the 2 idle air bleed orifices into the carburetor throat Tighten the orifices using Evinrude/Johnson Orifice Plug Screwdr~vePIN 317002, or equivalent

6 Insert one of the Intermediate fuel orifices into the bore on the float bowl Using Evinrude/Johnson Orifice Plug Screwdriver PIN 317002, or equivalent, tighten the orifice securely Repeat this step for the opposite intermediate fuel orifice

7 Start one of the high speed jet orifices into the bore Screw the jet down into the bore until it is seated and then tighten it using Evinrude/Johnson Orifice Plug Screwdr~vePIN 317002, or equivalent Repeat this step on the opposite side of the float bowl for the other high speed jet orifice

8 Place a new gasket onto the float bowl fuel drain plugs Install one drain plug on each side of the float bowl and tighten

9 Slide a new float bowl gasket over the emulsion tubes and against the carburetor body Check to be sure all holes in the gasket are aligned with the passages in the carburetor body

10 Place the float bowl onto the carburetor Apply Evinrude/Johnson Screw Lock or equivalent threadlocking compound to the screw threads Install the 4 screws and tighten in a crossing pattern to 24-36 inch lbs (3-4 Nm)

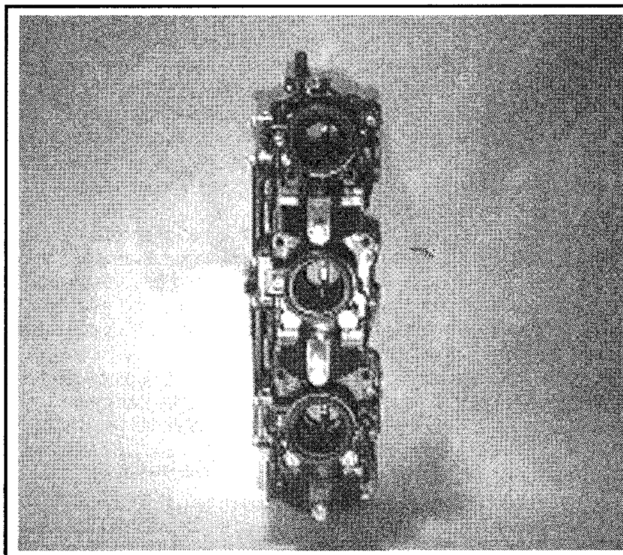


Fig. **46** Clear view of the triple throat carburetor assembly used by **80 Jet—175hp 60° V6 powerheads. This** arrangement consists of 3 single throat carburetors mounted on a single throttle plate

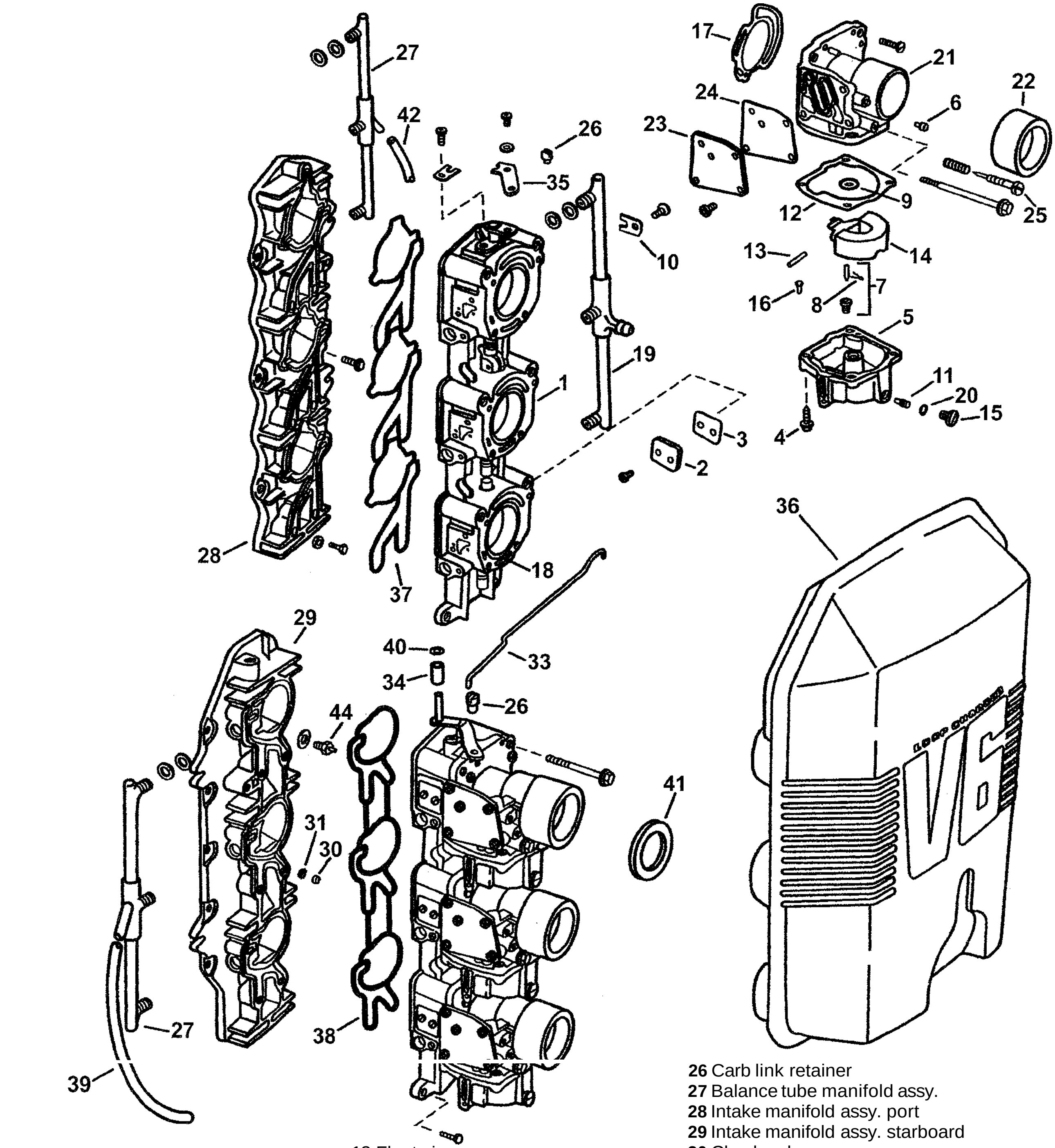
Carburetor—80 Jet-175 Hp (1726/2589cc) 60LV4/V6 Motors

◆ See Figures **46** and 47

This section provides complete detailed procedures for removal and installation and overhaul (disassembly/cleaning & inspectionlassembly)and mixture adjustment, for the carburetors normally found on 80 Jet-175 Hp (1726/2589cc) 600, loop charged V4/V6 motors.

DESCRIPTION

The 60° loop charged V4 and V6 motors, 80 Jet-175 Hp (1726/2589cc) powerheads utilize a unique modular carburetor assembly in which 2 (V4) or 3 (V6) single throat carburetor bodies are mounted on a single throttle plate. In this fashion, each individual carburetor provides the air/fuel mixture for just 1 cylinder (making carburetor tuningltroubleshootinga relatively straight-forward matter on these motors).



1 Throttle bodylcarb. assy.
2 Calibration pocket cover
3 Cover gasket
4 Bowl to body screw
5 Float chamber assy.
6 Intermediate or **airbleed** orfice
7 Float valve assy.
8 Spring clip
9 Nozzle well gasket
10 Manifold to throttle body clip
11 High speed orfice
12 Float bowl gasket
13 Float pin
14 Manifold to throttle body clip
15 High speed orfice
16 Float bowl gasket
17 Carb body seal
18 Throttle body screen
19 Fuel manifold port **&** starboard
20 Screw plug o-ring
21 Carb body assy.
22 Air silencer seal
23 Cover plate
24 Cover plate gasket
25 Needle valve
26 Carb link retainer
27 Balance tube manifold assy.
28 Intake manifold assy. port
29 Intake manifold assy. starboard
30 Check valve
31 Screen
32 Primer nipple
33 Port to starboard carb. link
34 Cam follower roller
35 Linkage adjustment lever
36 Air silencer assy.
37 Port manifold to carb seal
38 Starboard manifold to carb seal
39 Balance tube drain seal
40 Roller and sleeve o-ring
41 Air silencer seal
42 Port balance tube to air silencer drain

Fig. 47 Exploded view of the triple throat carburetor assembly used by **80 Jet—175hp 60º V6** powerheads **(V4** powerheads very similar, but with only 2 single throat carburetors mounted to the throttle plate)

This mounting arrangement is referred to as a duel or triple throat carburetor assembly. Two carburetor assemblies, one on the port and one on the starboard side of the intake manifold account for the term "Dual," Some refer to these motors are containing dual 2-barrel (2 throat) or 3-barrel (triple throat) carburetors—when actually you could consider it to be 4 (V4) or 6 (V6) carburetors total mounted to the powerhead.

Each individual carburetor body contains either an adjustable idle mixture screw or a fixed orifice, depending on the year and serial number of the powerhead. A fixed air bleed orifice, found immediately above the idle mixture screw or orifice, controls the intermediate mixture. A fixed orifice in the fuel float chamber controls the high-speed mixture. The single float fuel chamber maintains the proper fuel level in the carburetor bowl for all power settings.

REMOVAL & INSTALLATION

② MODERATE

◆ See Figures **47, 48, 49** and **50**

Carburetor mixture adjustments (via screw adjustment or orifice replacement) can normally occur without removing the carburetor body or entire carburetor assembly from the motor. Also, if necessary, an individual carburetor body can be removed without disturbing the entire throttle body assembly.

The carburetor metering bodies and the throttle plate are separate units. The metering body is made of a plastic nylon material and the throttle plate is cast aluminum. If only one or two carburetors are to be serviced, each carburetor metering body may be removed from the throttle plate.

If all carburetors are to be serviced then it is advisable to remove the throttle plate from the intake manifold with the carburetors still attached. If removal of the throttle plate with the carburetors attached is preferred, follow the instructions given in Step 4, otherwise, when it comes time, skip it and move on to Step 5 for individual carburetor removal.

The fuel hose fittings are delicate on these models, To protect the fittings, gently push the hoses from them instead of grasping and pulling on the hose itself. If pushing won't free the hose, use a utility knife to carefully slit the hose from the end to a point at or near the fitting flange, then peel the hose from the fitting and replace it upon reinstallation.

1. Remove the spark plug leads and/or disconnect the negative battery cable (if equipped) to prevent accidental starting of the engine.

■ Remember, half of the point of disconnecting the negative battery cable is to prevent the possibility of sparks that could ignite fuel **vapors. The** other half of the point is to prevent someone from cranking the motor while fuel lines or fittings are open.

2. Remove the engine cover for access. If necessary, disconnect both the fuel and, if applicable, the oil supply hoses from the fittings on the lower cowling. Cap the hoses and fittings to minimize fuel and oil leaks. Unlatch and remove the cowling from the powerhead and set it aside.

3. Disconnect the fuel vapor hose from the air silencer box. Disconnect the rubber strap retainers for the air silencer cover and lift off the cover.

4. If you are removing the entire carburetorlthrottle body assembly, proceed as follows:

a. Cut the wire tie securing the main fuel supply hose to the carburetor fuel manifold, then carefully push the hose from the manifold.

b. Carefully push the valance tube hose off the tube manifold.

c. Remove the primer hose from the intake manifold.

d. On the port carburetor assembly, remove the screw securing the linkage arm to the top carburetor.

e. On the starboard carburetor assembly, pull the linkage arm from the nylon insert on the top carburetor assembly.

f. Remove the short bolts (usually 8) securing the throttle plate assembly to the intake manifold. Lift off the throttle plate—with carburetors still attached—from the intake manifold. Discard the preformed seal between the throttle plate and the intake manifold.

5. To remove a carburetor body from the carburetorlthrottle plate assembly, remove the bolts, and 2 Phillips head screws securing the carburetor metering body to the throttle plate. Lift the carburetor free of the throttle plate. Remove and discard the preformed gasket from the carburetor main body.

If all carburetors are to be serviced, but the throttle plate is to remain on the intake manifold, after each carburetor is removed, insert the two short carburetor bolts through the throttle plate and tighten. This will prevent the throttle plate from moving and disturbing the preformed gasket seal underneath.

6. Remove and check the condition of the throttle plate base seal. Although the manufacturer advises that it can be reused, it is usually a good idea to discard the carburetor base seal if it has been in service for some length of time.

To install:

7. Install the carburetors to the throttle plate, as follows:

a. If the throttle plate was left attached to the powerhead, remove the 2 bolts securing the throttle plate to the intake manifold.

If the throttle plate was left attached to the powerhead and more than 1 carburetor body was removed, install one carburetor at a time. Meaning, don't remove ALL of the bolts securing the throttle plate, remove only the 2 which are in the way of the carburetor body about to be installed). In this way the throttle bodv will remain secure as each carburetor is installed.

b. Carefully place the carburetor onto the throttle plate using a new preformed seal. Take care not to disturb the preformed seal. Secure the carburetor to the throttle plate with four bolts and two Phillips head screws.

c. Tighten the bolts in a crossing pattern until snug.

8. If the throttle body assembly was removed from the intake manifold, install the preformed seal (we really do recommend using a new one), then position the throttle plate and carburetor assembly. Install the bolts.

9. Using a crossing pattern, tighten the carburetor body and throttle plate bolts to 45-55 inch lbs. (5-6 Nm).

10. Reconnect any hoses that were removed. When applicable, secure using new wire ties.

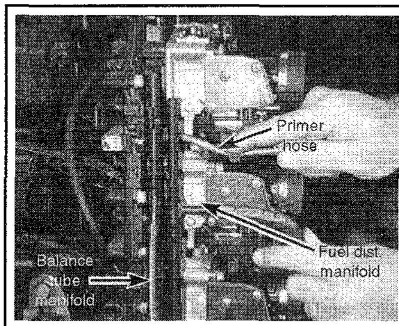


Fig. 48 If the entire throttle **body/carburetor** assembly is being removed, disconnect all of the hoses

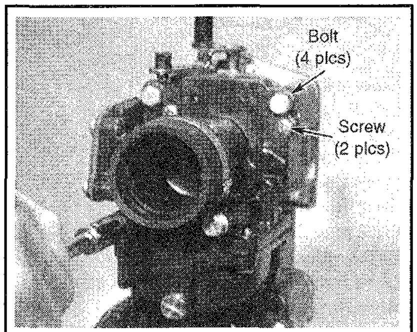


Fig. 49 To remove a carburetor from the throttle body, loosen the bolts and Phillips screws

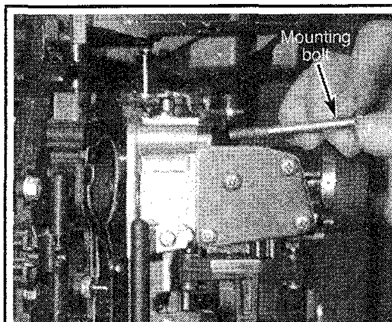


Fig. **50** When installing carb bodies onto the throttle plate, take care not to disturb the preformed seal

11. Connect the throttle link rod into the top of the starboard carburetor throttle shaft. Connect the throttle link on top of the port carburetor and secure it with the link screw.

12. Pressurize the fuel system using the primer bulb and check the fuel system for leaks. For more details, please refer to Fuel System Pressurization for details.

13. Install the spark plugs and/or connect the battery cables.

14. Perform the Timing and Synchronization adjustments detailed in the Maintenance and Tune-UDsection. On models with adjustable low speed screws, perform the carburetor Mixture Adjustment procedure detaiied in this section.

OVERHAUL

◆ See Figure 47

☐ Good shop practice dictates a carburetor repair kit be purchased and new parts be installed any time the carburetor is disassembled.

Make an attempt to keep the work area clean and organized. Be sure to cover parts after they have been cleaned. This practice will prevent foreign matter from entering passageways or adhering to critical parts.

Be sure to have a rag handy to catch spilled fuel, as some fuel is bound to still be present in the lines and the float bowl. Take this opportunity to closely inspect the fuel lines and replace any that are damaged or deteriorated.

During removal or overhaul procedures, always matchmark hoses or connections prior to removal to ensure proper assembly and installation. Following a complete rebuild and the initial bench settings, perform the complete Timing and Synchronization procedure as detailed in the Maintenance and Tune-Up section. Also, be sure to perform a Carburetor Mixture Adjustment procedure on carburetor bodies'that are overhauled or replaced (when equipped with adjustable low-speed screws).

To avoid leaks, replace all displaced or disturbed gaskets, O-rings or seals whenever a fuel system component is **removed. This** is especially true when rebuilding a carburetor.

Disassembly

◆ See Figures 47, 51, 52, 53, 54, 55, 56, 57, 58 and 59

The following procedures pickup the work after the carburetor body or carburetorlthrottle plate assembly has been removed from the powerhead. If more than one carburetor is to be serviced, repeat all given steps for the other carburetor(s). It is recommended to perform all the steps on one carburetor before beginning work on another. Such a procedure will prevent possible mix-up of internal components.

Only one carburetor will be serviced in the following procedures. Servicing each of the remaining units is to be performed in the same manner.

1. If not done already, remove the carburetor from the throttle plate. Discard the O-ring seal between the carburetor body and the throttle body.

2. Using a small screwdriver, lift out the fuel bowl screen from the throttle plate. Clean the screen with a choke and carburetor spray cleaner and blow dry with compressed air. Insert the screen back into the cavity in the throttle plate.

3. Remove the 4 Phillips head screws securing the float bowl to the carburetor body. Lift off the float bowl and rubber gasket. Discard the gasket.

4. Remove the Phillips head screw securing the float assembly and hinge pin. Lift off the float, hinge pin and needle valve. Slide the retaining spring and needle valve free of the float assembly.

5. Using a large blade screwdriver. Remove the needle valve seat from the carburetor base.

6. Slide the nozzle well rubber gasket off the tube in the carburetor base. Discard the gasket.

7. Remove the 4 Phillips head screws securing the side cover plate to the carburetor base. Lift off the cover and rubber gasket. Discard the rubber gasket under the plate.

The intermediate and (on some early-models) idle bleed air orifices have identical physical appearances. These orifices have a number stamped on the slotted end of the **orifice. This** number identifies the size of the orifice. Note the location—Intermediate or **Idle** position—and the size of the orifice prior to removing it. Installation of the wrong size orifice will cause rough idle, poor performance and possible damage to the powerhead.

8. Note the size number and location of the idle and intermediate bleed air orifices. Remove the orifices from the carburetor base.

9. If equipped with an idle speed screw instead of an idle orifice, loosen and remove the low speed (idle mixture) needle and spring. Visually inspect the needle for damage or nicks.

10. Remove the plug and O-ring from the float bowl to gain access to the high-speed orifice. Discard the O-ring.

11. Using a narrow blade screwdriver, slide the blade of the screwdriver through the float bowl plug opening and up into the slots of the high-speed orifice. Use caution when removing this orifice as the narrow blade of the screwdriver could damage the orifice slots. Remove the high-speed orifice from the float bowl. Note the size of the orifice and its location to ensure correct assembling.

There are no more serviceable components to remove from the carburetor assembly. All passages, vent tubes and orifice openings should be exposed to facilitate proper cleaning and inspection of the carburetor. Follow the instructions listed in the next section for Cleaning and Inspecting.

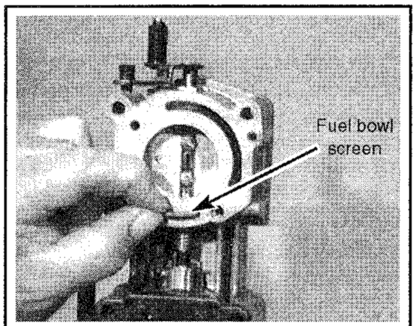


Fig. **51** Remove the fuel bowl screen from the throttle plate

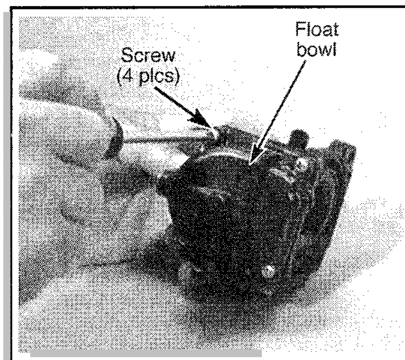


Fig. **52** Remove the Phillips screws securing the float bowl to the carburetor body

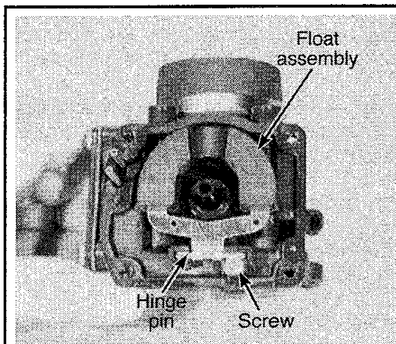


Fig. **53** Remove the Phillips screw securing the float and hinge pin

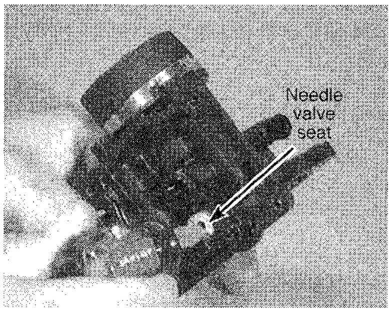


Fig. 54 Remove the needle valve seat from the carburetor base

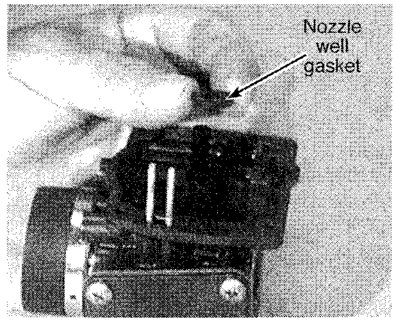


Fig. 55 Slide the nozzle well rubber gasket off the tube in the carburetor base

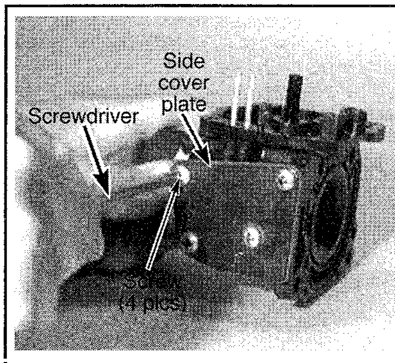


Fig. 56 Remove the Phillips head screws securing the side cover plate

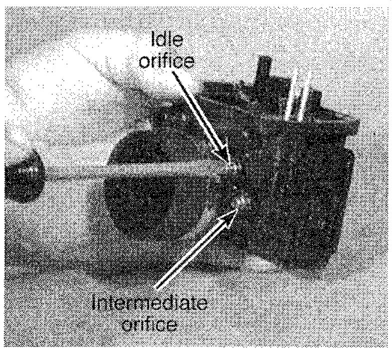


Fig. 57 Remove the orifices from the carburetor base

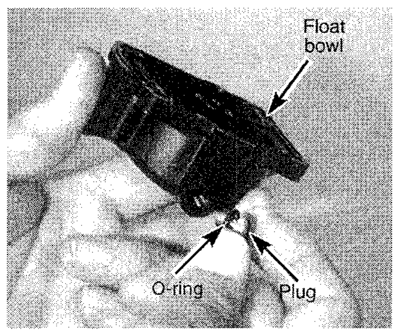


Fig. 58 Remove the plug and O-ring from the float bowl for access to the high speed orifice

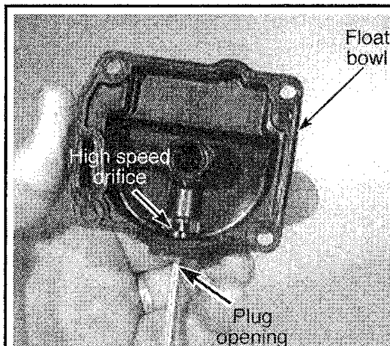


Fig. 59 Remove the high speed orifice from the float bowl

Cleaning and Inspection

◆ **See Figures 47, 60, 61, 62, 63 and 64**

Never submerge the carburetor or any of its components into a strong carburetor cleaner or a hot soaking tank. Strong chemicals or hot tank may damage certain parts and sealing compounds.

Use Evinrude/Johnson Carburetor and Choke cleaner or an equivalent product in a spray can. Flush all passages, tubes and orifices with the spray carburetor cleaner or a syringe filled with isopropyl alcohol. Use a clean bristle brush to remove any gum or varnish deposits. Blow out all passages with low-pressure compressed air at approximately 25 psi (172 kPa). Never use a piece of wire or any type of pointed instrument to clean drilled passages or calibrated holes in the carburetor.

Inspect the carburetor body and float bowl gasket sealing surfaces for nicks, gouges or irregularities, which could cause a leak. Check all nozzle and pickup tubes for security and cleanliness.

Inspect the nylon tip of the needle valve for wear, distortion or damage. Replace the needle valve and seat if damaged or worn. Good shop practice dictates to always replace the needle valve and needle seat when the carburetor is fully disassembled.

Check the throttle plate and shaft for excessive wear. Move the throttle shaft back-and-forth to check for wear. If the shaft appears to be loose, replace the complete throttle body because individual replacement parts are not available. Verify the throttle plate retaining screws are tight, and check alignment of the throttle plate to the throttle body bore. Maximum throttle plate clearance is 0.002 in. (0.05 mm).

Early model throttle bodies (1992-93) have two soft plugs on the side for the calibration pockets. Do not remove these soft plugs unless absolutely necessary for cleaning, or if they are known to be leaking. When it is necessary to remove these plugs, drill a small hole in the center of the plug. Take care not to damage the throttle body. Pry the plug out with a small punch. After cleaning, install a new soft plug with the convex side up. Seat the soft plug using the flat end of a drift punch. Apply a fuel resistant sealer such as Evinrude/Johnson Gasoila sealant to the edges of the soft plug.

Late model throttle bodies (1994 & later) have a cover plate and gasket over the calibration pockets, secured with 2 screws. Remove the two screws, cover plate, and gasket. Discard the gasket. After cleaning, install a new gasket, cover plate and secure it with the screws.

✳✳ WARNING

Tightening a needle valve against the valve seat will result in damage to the valve or seat and require replacement of damaged components. Use great care when threading and seating the idle speed mixture screw prior to backing it out for initial adjustment.

If the unit being serviced has an adjustable idle speed needle valve, remove the needle valve and spring from the throttle plate. Inspect the needle valve tip for distortion or damage. Replace the needle valve if damaged. Clean the idle speed passages with spray carburetor cleaner and blow dry with compressed air. Install the spring and needle into the throttle body orifice. Screw the needle in until it just makes **light** contact with the seat. Now, back the needle out the appropriate number of turns for the Initial Low Speed Setting (as detailed in the Carburetor Set-Up Specifications chart in this section).

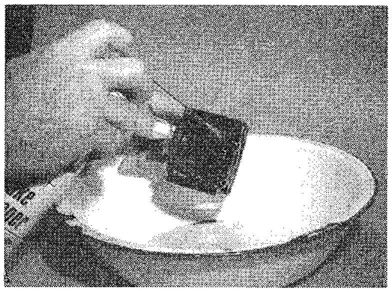


Fig. 60 Clean the carburetor body using spray Carburetor and Choke cleaner

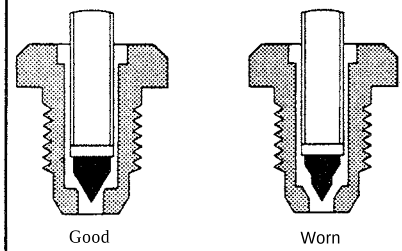


Fig. 61 Inspect the float needle (and, idle speed screw, if equipped)...

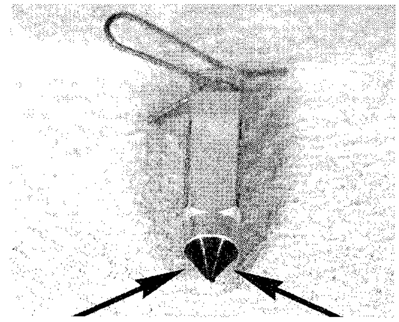


Fig. 62 ...most needle wear or damage occurs at the tip

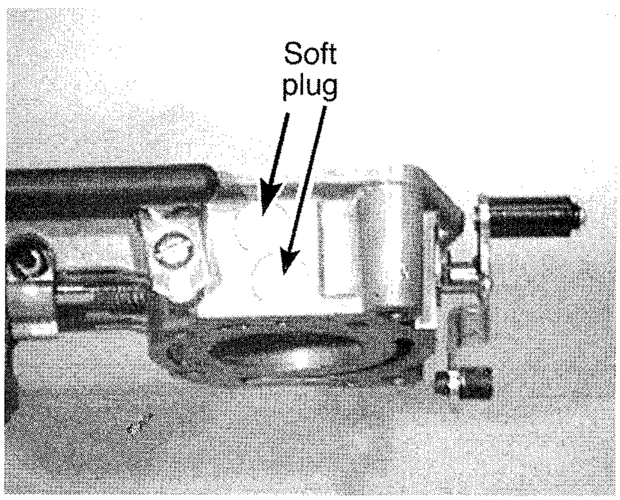


Fig. 63 Remove the soft plugs only if passages in the throttle plate are plugged or if the plugs show evidence of fuel leakage

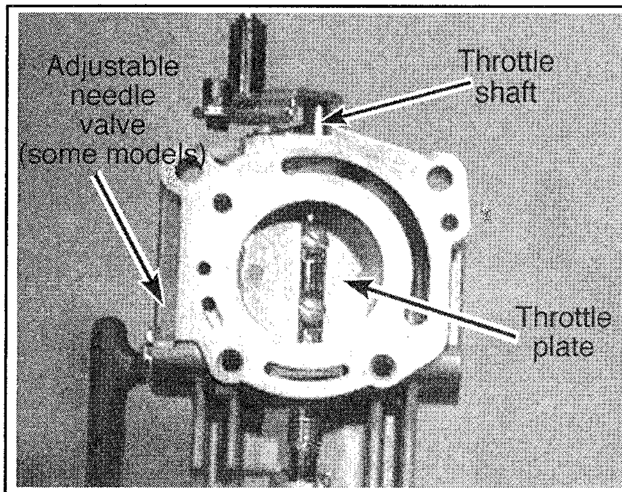


Fig. 64 Check the throttle shaft for excessive wear

Assembly

◆ See Figures **47, 65,thru** 75

✳✳ WARNING

During the assembly procedures several components are secured with self-tapping **screws. These** screws have cut their own threads into the components during factory assembly. When installing these screws in pre-tapped holes, turn the screw 1-1 **1/2** turns counterclockwise before turning them in the clockwise—tightening **direction. This** action will cause the screw to drop into the existing thread and ensure that it starts into the existing threads, thereby keeping it from cross-threading or attempting to cut new threads. If the screw is hard to turn on the first attempt, back the screw out and attempt to locate the existing thread pattern again. Cross-threaded screws will distort the housing and cannot be tightened securely, contributing to possible fuel or air **leaks. They** will also be weaker than properly threaded screws so they are more likely to fail (pull out) or loosen (back out) during service.

1. Place the proper size high-speed orifice onto the end of a flat blade screwdriver. Insert the screwdriver tip with the orifice through the float bowl opening. Thread the orifice into the float bowl and tighten.
2. Place a new O-ring on the float bowl plug. Thread the plug into the float bowl and tighten it to a torque value of 30-35 inch lbs. (3-4 Nm).
3. Select the correct size Idle and Intermediate air bleed orifices, Install the orifices into their respective locations on the carburetor main body and tighten them. Installation of the wrong size orifice in the wrong location could cause rough idle, poor performance and possible damage to the powerhead.
4. Place a new side cover gasket into position on the cover plate. Align the cover plate and gasket with the carburetor and secure with four self apping Phillips head screws. Tighten the screws in a crossing pattern to 18-24 inch lbs. (2-3 Nm) for 1992-94 models or to 24-30 inch lbs. (3-4 Nm) for 1995 and later models.
5. Thread the needle valve seat into the carburetor main body and tighten the seat securely.
6. Slide a new rubber nozzle gasket down the nozzle well on the carburetor main body.
7. Slip the needle valve with spring onto the float assembly metal plate. Slide the float hinge pin onto the float arm. Lower the float, pin and needle valve into the carburetor main body. Align the needle valve with the seat and the hinge pin with the groove in the carburetor main body. Install the retaining screw for the float hinge pin and tighten it.
8. Invert the carburetor and place a new float bowl gasket onto the carburetor main body. With the carburetor inverted, check the float closed height. The top of the float must be level with the bowl gasket give or take 1132 in. (0.08 mm). Do not exert pressure on the needle valve when making adjustments. Bend the float arm to make closed height adjustments.
9. Turn the carburetor upright and check the float drop. Measure from the bowl gasket to the bottom of the float assembly with a machinist scale or ruler; the float drop should be between 11/16-1 1/8 in. (17-28 mm). Bend the tab on the float next to the needle seat for drop height adjustment.
10. Lower the float bowl over the float and onto the carburetor main body. Note the float bowl does not fit flush on the carburetor main body at this time. The rubber gasket on the nozzle well has to be slightly compressed by squeezing the float bowl and carburetor base together. Install the 4 self-tapping Phillips head screws. Tighten the 4 screws in a crossing pattern to 18-24 inch lbs. (2-3 Nm).
11. Rub a very small amount of petroleum jelly onto a new preformed seal. Place the seal on the carburetor mounting flange and press the seal into the grooves. The petroleum jelly will help hold the seal in place during installation.

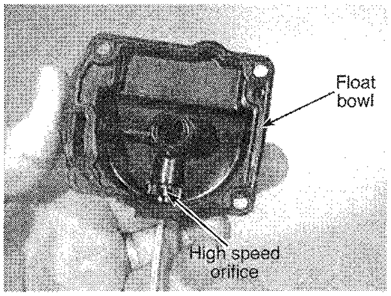


Fig. **65** Install the high speed orifice using a flat bladed screwdriver

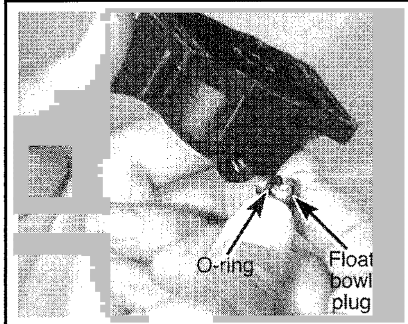


Fig. 66 Install the float bowl plug using a new O-ring

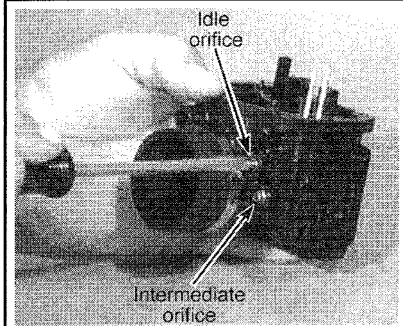


Fig. **67** Install the Intermediate, and if applicable, idle air bleed orifices

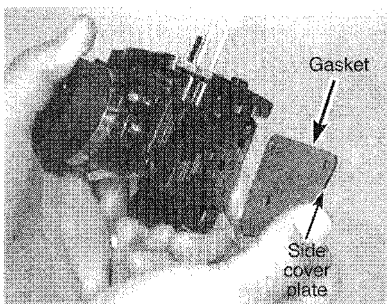


Fig. **68** Install the cover plate using a new side cover gasket

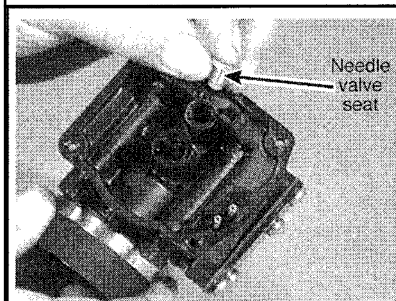


Fig. 69 Thread the needle valve seat into the carburetor main body

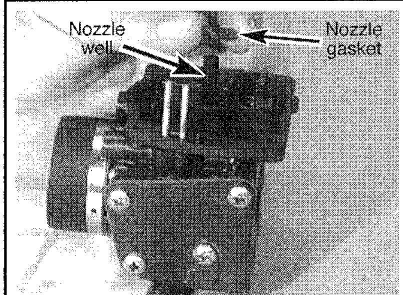


Fig. 70 Slide a new rubber nozzle gasket down the nozzle well

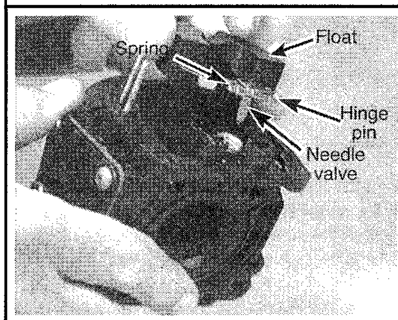


Fig. **71** Install the float and needle valve assembly

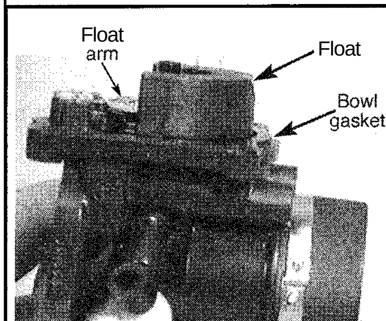


Fig. **72** Check the float closed height with the carburetor inverted

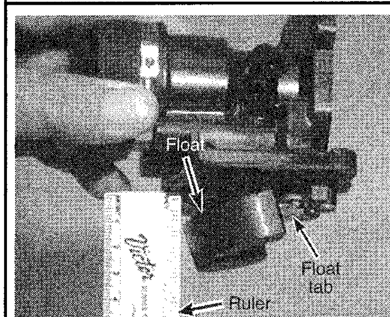


Fig. **73** Measure the float drop with the carburetor upright

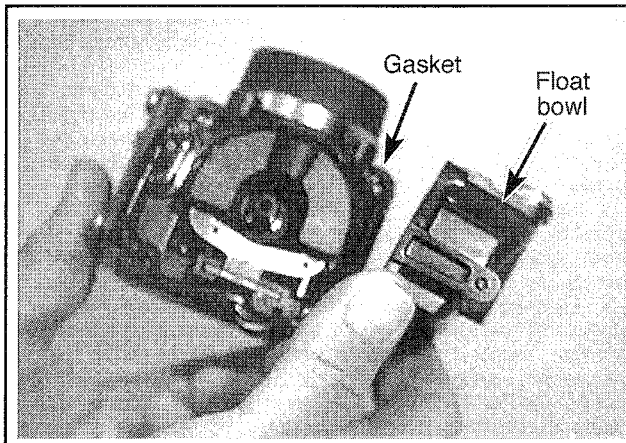


Fig. 74 Install the float bowl over the float and onto the carburetor main body

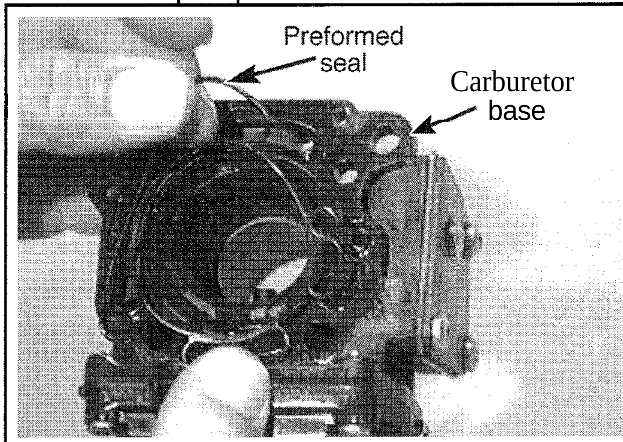


Fig. **75** Install a new preformed seal on the back of the carb body

CARBURETOR MIXTURE ADJUSTMENT

+ See Figure **47**

Each individual carburetor body contains either an adjustable idle mixture screw or a fixed orifice, depending on the year and serial number of the powerhead. A fixed air bleed orifice, found immediately above the idle mixture screw or orifice, controls the intermediate mixture. A fixed orifice in the fuel float chamber controls the high-speed mixture. The single float fuel chamber maintains the proper fuel level in the carburetor bowl for all power settings.

■ For models not equipped with any mixture screws, see a knowledgeable **Evinrude/Johnson** parts counterperson for information on alternate orifices to compensate for high-altitude operation.

On models equipped with an idle (low speed) mixture screw, the carburetor idle mixture can be adjusted to compensate for changes in the fuel system due to carburetor rebuild or replacement or changes in operating conditions such as moving from sea-level to high-altitude. In order for the adjustments to occur properly the motor must mounted on a launched boat that is operating and unrestrained. You'll need an assistant to safely navigate the craft while the adjustment is being made.

If the engine is not operating under normal exhaust back-pressure (which occurs from the aearcase **ooerating** under normal conditions. submerged below the transom), mdunted **at** a normal trim angle, with the correct propeller installed and the boat unrestrained, proper mixture adjustment will not occur.

This adjustment is NOT a periodic maintenance item and should not be touched unless all other attempts to resolve an idle speed operation problem have failed. The ignition and fuel system components must all be in good condition and operating properly. The carburetor linkage must be properly adjusted before attempting this procedure, for details please refer to Timing and Synchronization in the Maintenance and Tune-Up section.

1. With the engine top cover removed for access (and, on most models, the air intake silencer as well), make a matchmark between the carburetor body and idle mixture screw.
2. Start the engine and allow it to idle until normal operating temperature is reached.
3. Once warmed, shift the engine in forward and run at idle speed for 3 minutes.
4. If the adjustment is too lean, the engine will sneeze and backfire; to correct this, note the reference mark, then rotate the idle mixture needle (low speed screw) 118 turn counterclockwise. Wait 15 seconds for the engine soeed to stabilize before turning the screw again. Turn the screw until you reach the highest steady engine speed.
5. If the adjustment is too rich, the engine will be rough an unsteady; to correct this, note the reference mark, then rotate the idle mixture needle (low speed screw) 118 turn clockwise. Wait 15 seconds for the engine speed to stabilize before turning the screw again. Turn the screw until you reach the highest steady engine speed.
6. Allow the engine to run at idle in gear for 3 minutes, then move to the next mixture screw. Repeat until all carburetor body screws have been adjusted.
7. Run the engine at or near Wide Open Throttle (WOT) for 3 minutes and then reduce speed to idle, leaving the motor in gear. The motor should not stumble, spit or backfire. If any of these problems are found, repeat the adjustment procedure, making small adjustments only, until the engine operates normally.

Carburetor—120-300 Hp (2000/3000/4000cc) 90LV4/V6/V8 Motors

◆ See Figures **76** and **77**

This section provides complete detailed procedures for removal and installation and overhaul (disassembly/cleaning & inspectionlassembly) and mixture adjustment, for the carburetors normally found on 120-300 Hp (2000/3000/4000cc) 90°, loop charged V4/V6/V8 motors.

Because of the similarities between the carburetors found on different Evinrude/Johnson motors, common Carburetor Cleanina and Insoection procedures are found later in this section.

DESCRIPTION

◆ See Figure **76**

The modular carburetor assembly used on 120-300 Hp (2000/3000/4000cc) 900, loop charged V4/V6/V8 motors consists of two individual carburetors mounted on a double butterfly throttle plate. The throttle plate is then bolted to the intake manifold. Two of these carburetor assemblies (1 port and 1 starboard) are used on V4 models. Four of these assemblies (2 port and 2 starboard are used on V8 models). Two of these assemblies (1 port and 1 starboard) are used along with 2 smaller single carburetorlthrottle plate assemblies (1 port and 1 starboard) are used on V6 models.

☐ Although the actual carburetor bodies and throttle plates differ, the concept behind the modular carburetor used on the **900** looper engines is very similar to the concept behind the carburetors used on **60°** looper engines. In both cases, the same basic carburetor body is used throughout a line of multi-cylinder engines with one carburetor body feeding each cylinder.

One carburetor supplies and controls the fuel/air mixture to one cylinder. Each carburetor is identical, therefore the procedures are to be repeated for each carburetor.

Early versions of this carburetor—1992-93—contain only an air bleed orifice for the idle circuit. Later versions, 1994 and on, contain both an adjustable needle valve and an air bleed orifice for the idle circuit. A fixed air bleed orifice controls the intermediate mixture for all units. Similarly, a fixed jet located in the fuel float bowl controls the high-speed mixture for each carburetor body. A single float chamber on each carburetor body maintains the proper fuel level in the carburetor bowl for all power ranges.

REMOVAL & INSTALLATION

◆ See Figure **76**

Carburetor mixture adjustments (via screw adjustment or orifice reolacement) can normally occur without removina the carburetor bodv or entire carburetor assembly from the motor. Also, if necessary, an individual carburetor body can be removed without disturbing the entire throttle body assembly.

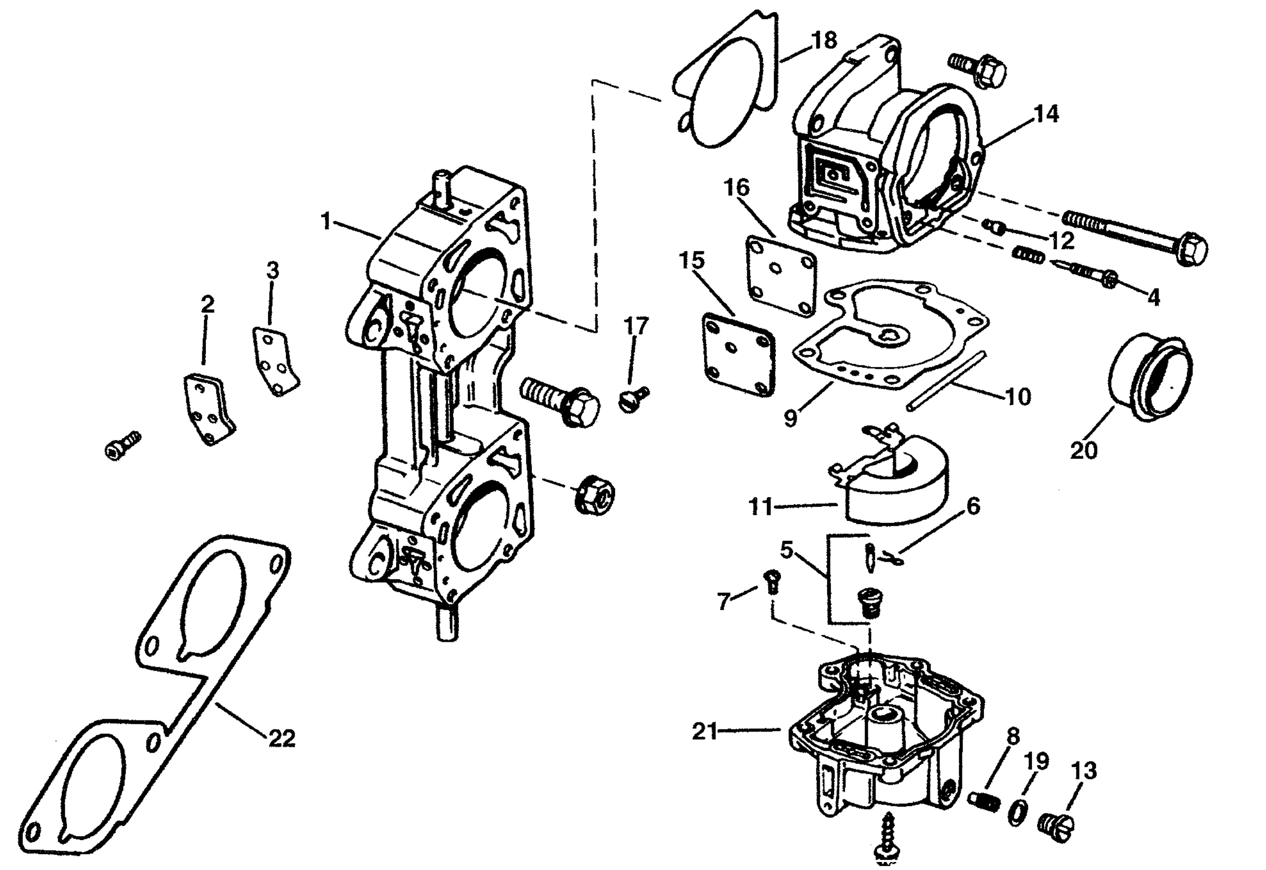
☐ The carburetor metering bodies and the throttle plate are separate **units. The** metering bodv is made of a **plastic** nylon material and the throttle plate is **cast** aluminum. If only bne **carburetor** is to be serviced, a single carburetor metering body may be removed from the throttle plate.

If all carburetors are to be serviced then it is advisable to remove the throttle plate from the intake manifold with the carburetors still attached. If removal of the throttle plate with the carburetors attached is preferred, follow the instructions to disconnect all fuel lines. If only one carburetor is being removed, only disconnect the fuel line for that carburetor body.

■ The fuel hose fittings are delicate on these **models. To** protect the fittings, gently push the hoses from them instead of grasping and pulling on the hose itself. If pushing won't free the hose, use a utility knife to carefully slit the hose from the end to a point at or near the fitting flange, then peel the hose from the fitting and replace it upon reinstallation.

1. Remove the spark plug leads and/or disconnect the negative battery cable (if equipped) to prevent accidental starting of the engine.

☐ Remember, half the point of disconnecting the negative battery cable is to prevent the possibility of sparks that could ignite fuel **vapors. The** other half of the point is to prevent someone from cranking the motor while fuel lines or fittings are open.



1 Throttle body assembly	**12 Intermediate orfice**
2 Cal ocket cover	**13 Plug screw**
3 Cal pocket gasket	**14 Carburetor body**
4 Needle valve	**15 Cover plate**
5 Float valve assembly	**16 Cover plate gasket**
6 Spring clip	**17 Cover plate screw**
7 Hinge pin screw	**18 Carburetor body seal**
8 High speed orfice	**19 O-ring**
9 Float bowl gasket	**20 Air silencer sleeve**
10 Float pin	**21 Float chamber assembly**
11 Float assembly	**22 Carburetor mounting gasket**

Fig. **76** Exploded view of the modular carburetor assembly used on 120-300 Hp **(2000/3000/4000cc) 90°,** loop charged **V4/V6/V8** motors (note ***V6*** motors use an additional carburetor assembly on each side that contains a single carburetor body)

2. If equipped, remove the power steering hose support bracket.
3. Remove the engine covers access. Please refer't'o Engine Cover (Top and Lower Cases) in the Maintenance and Tune-Up Section for details.
4. Remove the air intake silencer assembly.

■ Depending on the year and model fuel lines may be secured using a wire tie or using a plastic ratcheting fuel line clamp. When equipped with ratcheting clamps, the same **type/style** clamps should be used during assembly. Although these ratcheting clamps may be reused if removed properly, it is usually a good idea to replace them in order to prevent the possibility of fuel leaks.

5. Disconnect the fuel line(s) from the individual carburetor body being removed, or from the entire carburetor assembly as applicable. Most fuel lines are secured using wire ties that must be cut before removal, be sure to use new wire ties during installation.

☐ If more than one fuel line is being disconnected ALWAYS tag them lines and the fittings to ensure proper installation.

6. If just a single carburetor is being removed, loosen and remove the bolts (usually 2 long on the bottom of the body and 2 short on top of the body) securing the carburetor body to the throttle plate assembly. Remove and discard the preformed seal located between the carburetor and throttle plate.
7. If you are removing a carburetor body, loosen the throttle shaft links at one or both ends.
8. To remove the throttle body or the carburetor/throttle body assembly, remove the 2 bolts and 2 nuts securing the assembly to the manifold. Remove and discard the carburetor assembly to intake manifold gasket. Remove all traces of gasket from the mating surfaces.

To install:

9. Install a new preformed seal to the back of the carburetor body. Position the carburetor body to the throttle plate, making sure the seal remains in position during installation, then install and tighten the carburetor body mounting screw using a crossing pattern to 45-55 inch lbs. (5-6 Nm).

■ If both carburetors were removed from the throttle plate assembly, repeat the previous step for the remaining carburetor body.

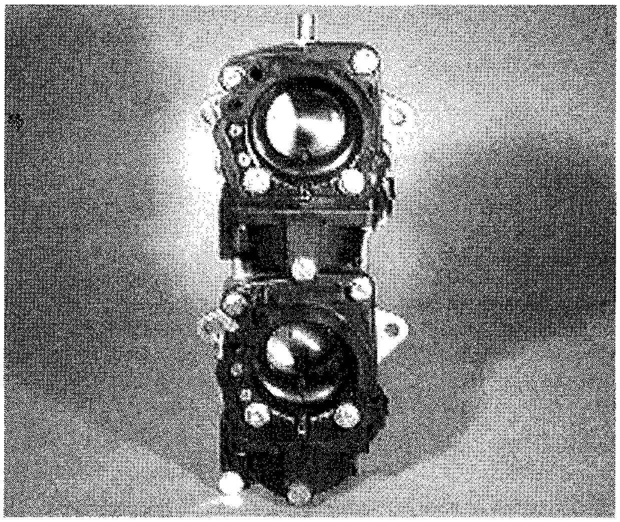


Fig. 77 View of the double throat Carburetor used on **V4/V6/V8 90°** loop charged powerheads

10. If removed, position the throttle body on the intake manifold using a new gasket, and at the same time engage the throttle shaft connector. Secure the throttle body/carburetor assembly to the intake manifold using the two bolts and two nuts. Tighten the bolts and nuts in a crossing pattern to 120-144 inch lbs. (14-16 Nm). Tighten the throttle shaft connectors.

Install the carburetor gasket dry. Do not use sealer.

11. Attach the fuel supply and primer hoses and secure using new wire ties or using plastic ratcheting clamps, as applicable.
12. Pressurize the fuel system using the primer bulb and check the fuel system for leaks. For more details, please refer to Fuel System Pressurization for details.
13. Install the spark plugs and/or connect the battery cables.
14. Perform the Timing and Synchronization adjustments detailed in the Maintenance and Tune-Up section. On models with adjustable low speed screws, perform the Carburetor Mixture Adjustment procedure detailed in this section.

When access is no longer necessary during the Timing and Synchronization procedures, install the lower engine covers and the air intake silencer.

OVERHAUL

OEM ② MODERATE

◆ See Figures 76

Good shop practice dictates a carburetor repair kit be purchased and new parts be installed any time the carburetor is disassembled.

Make an attempt to keep the work area clean and organized. Be sure to cover parts after they have been cleaned. This practice will prevent foreign matter from entering passageways or adhering to critical parts.

Be sure to have a rag handy to catch spilled fuel, as some fuel is bound to still be present in the lines and the float bowl. Take this opportunity to closely inspect the fuel lines and replace any that are damaged or deteriorated.

During removal or overhaul procedures, always matchmark hoses or connections prior to removal to ensure proper assembly and installation. Following a rebuild a complete and the initial bench settings, perform the complete Timing and Synchronization procedure as detailed in the Maintenance and Tune-up section.

To avoid leaks, replace all displaced or disturbed gaskets, O-rings or seals whenever a fuel system component is **removed. This** is especially true when rebuilding a carburetor.

Disassembly

+ See Figures **76, 78, 79, 80, 81, 82, 83, 84** and **85**

The following procedures pickup the work after the carburetor body or carburetor/throttle plate assembly has been removed from the powerhead. If more than one carburetor is to be serviced, repeat all given steps for the other carburetors. It is recommended to perform all the steps on one carburetor before beginning work on another. Such a procedure will prevent possible mix-up of internal components.

Only one carburetor will be serviced in the following procedures. Servicing each of the remaining units is to be performed in the same manner.

The bleed air orifices and jets are made of a soft brass material. **A** slot on the end of the orifice is provided to insert a common flat blade screwdriver. However, the manufacturer has a specially designed tool **Evinrude/Johnson** PIN 317002 driver, which fits the slotted opening nicely and will not slip. If multiple carburetors are to be serviced, the cost of this tool justifies the modest expenditure compared with the price of a couple air bleed orifices.

1. If the entire carburetor/throttle body assembly was removed from the powerhead, loosen and remove the two long and two short bolts securing the carburetor to the throttle body, then carefully lift the carburetor from the throttle body and discard the preformed seal.
2. Remove Phillips head screws (usually 5) securing the float bowl assembly to the carburetor body. Lift off the float bowl and gasket. Discard the gasket.

**** WARNING**

Use extreme caution when a common screwdriver is used. If the end of the orifice is damaged, it must be replaced with a new orifice.

3. Note the size number and location of the orifices. Remove the intermediate and, if equipped, idle orifices from the carburetor main body.

**** WARNING**

The air bleed orifices appear identical in size, but have different drill size openings and thread sizes. **A** number is stamped on the end of each orifice and jet for size. Note the size number and location prior to removal. Installation of the **wrong** size orifice could cause poor performance and severe powerhead damage.

4. Remove the Phillips head screws (usually 4 or 5) securing the side cover plate to the carburetor main body. Lift the plate off and discard the gasket.
5. Remove the Phillips head screw securing the float hinge pin to the float bowl. Lift out the float, hinge pin, and needle valve.
6. Using a large flat blade screwdriver, carefully remove the needle seat from the float bowl. Discard the gasket under the seat.
7. Remove the float bowl drain plug and discard the O-ring. Insert the special tool or a screwdriver up through the drain plug opening and remove the high-speed orifice jet. Note the size number of the orifice jet.
8. If equipped with an idle speed screw instead of an idle orifice, loosen and remove the low speed (idle mixture) needle and spring. Visually inspect the needle for damage or nicks.

Cleaning and **Inspection**

◆ See Figures **60, 61, 62, 63, 64** and 76

Never submerge the carburetor or any of its components in a strong carburetor cleaner or a hot soaking tank. Strong chemicals or hot tank may damage certain parts and sealing compounds.

Use Evinrude/Johnson Carburetor and Choke cleaner or an equivalent product in a spray can. Flush all passages, tubes and orifices with the spray carburetor cleaner or a syringe filled with isopropyl alcohol. Blow out all passages with low-pressure compressed air at approximately 25 psi (172 kPa). Never use a piece of wire or any type of pointed instrument to clean drilled passages or calibrated holes in the carburetor.

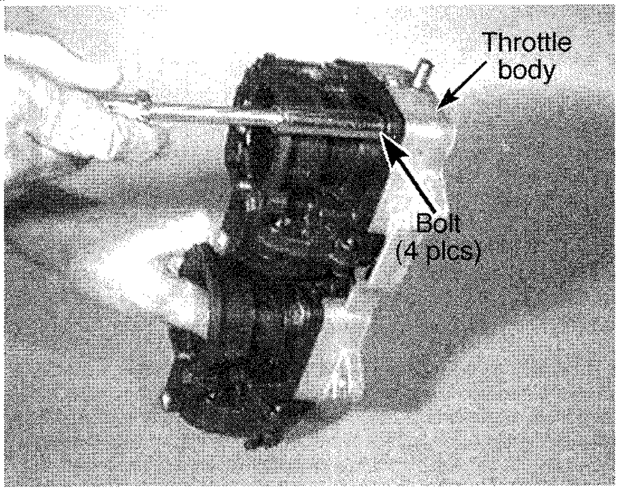


Fig. 78 If note done already, remove the carburetor-to-throttle body bolts...

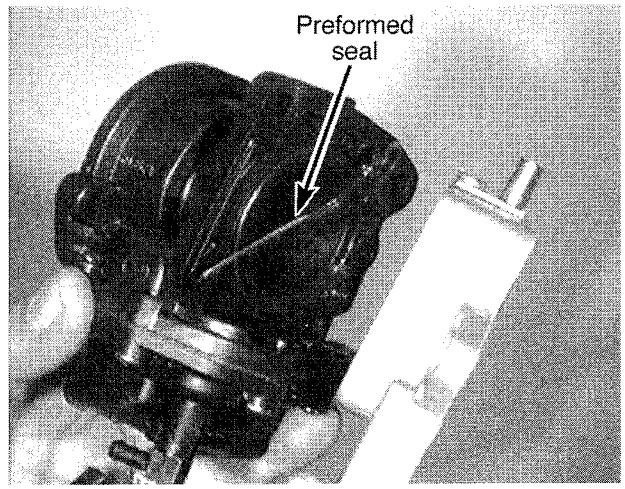


Fig. 79 ...then remove the carburetor and discard the preformed seal

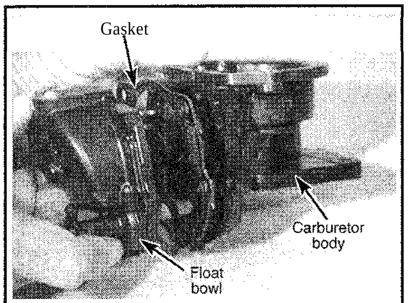


Fig. 80 Remove the float bowl assembly

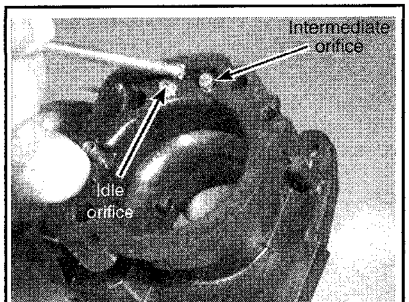


Fig. 81 Remove the orifices from the carb body

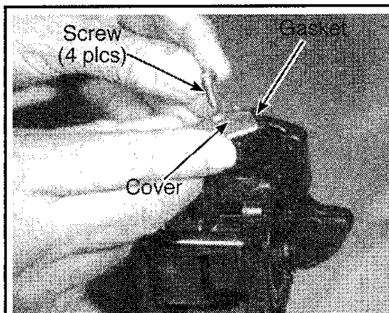


Fig. 82 Remove the Phillips screws and side cover plate

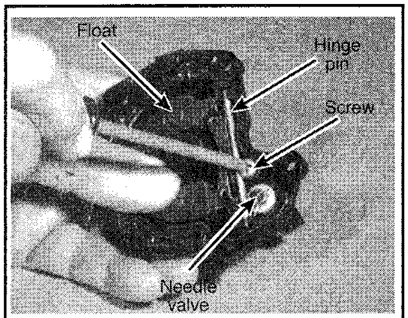


Fig. 83 Remove the Phillips screw and the float assembly

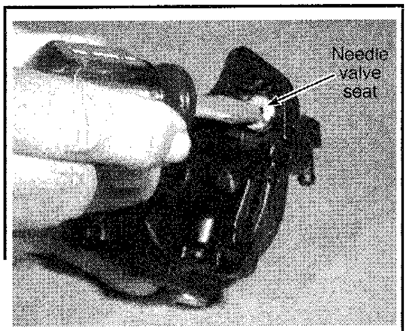


Fig. 84 Remove the needle seat from the float bowl

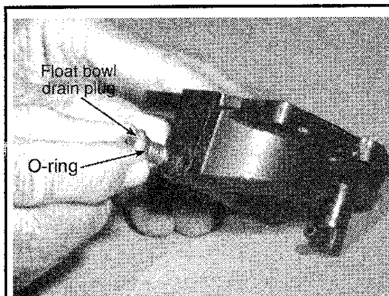


Fig. 85 Remove the float bowl drain plug and discard the O-ring

Inspect the carburetor body and float bowl gasket sealing surfaces for nicks, gouges or irregularities, which could cause a leak. Check all nozzle and pickup tubes for security and cleanliness.

Inspect the nylon tip of the needle valve for wear, distortion or damage. Replace the needle valve and seat if damaged or worn. Good shop practice dictates to always replace the needle valve and needle seat when the carburetor is fully disassembled.

Check the throttle plate and shaft for excessive wear. Move the throttle shaft back-and-forth to check for wear. If the shaft appears to be loose, replace the complete throttle body because individual replacement parts are not available. Verify that the throttle plate retaining screws are tight and properly aligned with the throttle plate to the throttle body bore. Maximum throttle plate clearance is 0.002 in. (0.05mm).

The throttle body has a single soft plug on the side for the calibration pockets. Do not remove the soft plug unless absolutely necessary for cleaning, or if it is known to be leaking. When it is necessary to remove the plug, drill a small hole in the center of the plug. Take care not to damage the throttle body. Pry the plug out with a small punch. After cleaning, install a new soft plug with the convex side up. Seat the soft plug using the flat end of a drift punch. Apply a fuel resistant sealer such as Evinrude/Johnson Gasoila sealant to the edges of the soft plug.

✳✳ WARNING

Tightening a needle valve against the valve seat will result in damage to the valve or seat and **require** replacement of damaged components. Use great care when threading and seating the idle speed mixture screw **prior** to backing it out for initial adjustment.

If the unit being serviced has an adjustable idle speed needle valve, remove the needle valve and spring from the throttle plate, Inspect the needle valve tip for distortion or damage. Replace the needle valve if damaged. Clean the idle speed passages with spray carburetor cleaner and blow dry with compressed air. Install the spring and needle into the throttle body orifice. Screw the needle in until it just makes light contact with the seat. Now, back the needle out the appropriate number of turns for the Initial Low Speed Setting (as detailed in the Carburetor Set-Up Specifications chart in this section).

Assembly

◆ See Figures **76, 86, 87, 88, 89, 90, 91, 92, 93** and 94

**** WARNING**

During the assembly procedures several components are secured with self-tapping **screws. These** screws have cut their own threads into the components during factory assembly. When installing these screws in pre-tapped holes, turn the screw 1-1 **1/2** turns counterclockwise before turning them in the clockwise—tightening **direction. This** action will cause the screw to drop into the existing thread and ensure that it starts into the existing threads, thereby keeping it from cross-threading or attempting to cut new threads. if the screw is hard to turn on the first attempt, back the screw out and attempt to locate the existing thread pattern again. Cross-threaded screws will distort the housing and cannot be tightened securely, contributing to possible fuel or air **leaks. They** will also be weaker than properly threaded screws so they are more likely to fail (pull out) or loosen (back out) during service.

1. Insert the correct size high-speed jet through the drain plug opening on the float bowl. Screw the jet into the bore and tighten it just snug.

2. Slip a new O-ring on the float bowl drain plug. Install the drain plug and tighten it to a torque value of 30-35 inch lbs. (3-4 Nm).

3. Place a new gasket on the needle seat, Install the needle seat into the float bowl and tighten it securely.

■ When attaching the clip to the needle valve on these models, the clip must face the port side of the chamber.

4. Clip the needle valve retaining spring over the end of a new needle valve. Slip the needle valve spring over the tab on the float assembly, Insert the float hinge pin through the float hinges. Lower the float and needle valve into the float bowl. Guide the needle valve into the needle seat, and hinge pin into the pocket in the float bowl. Secure the float assembly with a Phillips head screw and tighten it securely.

5. Place a new gasket on the side cover plate. Position the cover on the side of the carburetor and secure it with the Phillips head screws. Tighten the screws to a torque value of 18-24 inch lbs. (2-3 Nm) for 1992-94 models or to 24-30 inch lbs. (2.7-3.4 Nm) for 1995 and later models.

6. Invert the carburetor and place a new float bowl gasket onto the carburetor main body. With the carburetor inverted, check the float closed height. The top of the float must be level with the bowl gasket give or take 1132 in. (0.08 mm). Adjust the float closed height by carefully bending the tab over the needle valve. Do not pry the float tab against the needle valve, because such action will damage the needle tip.

7. Place a new gasket on the float bowl. Position the float bowl against the carburetor body and align the screw holes. Install the Phillips head screws, backing them counterclockwise slightly before threading to make sure they find the original threads, then tighten them in a crossing pattern to a torque value of 18-24 inch lbs. (2-3 Nm).

8. Install the correct size intermediate (and idle, if applicable) bleed air orifices into the main body. Note the size of each orifice and the location identified during removal. Tighten the orifices securely.

9. Place a new preformed seal on the main body of the carburetor. The use of a light grease will aid in holding the seal in position.

10. Lower the carburetor into position on the throttle body. Take care not to dislodge the preformed seal. Secure the carburetor to the throttle body with the two long and two short bolts. Tighten the bolts in a cross pattern to a torque value of 45-55 inch lbs. (5-6 Nm).

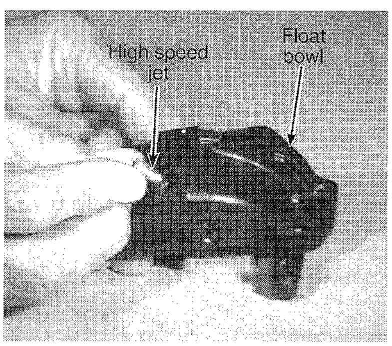


Fig. 86 **Install** the high-speed jet through the float bowl drain plug opening

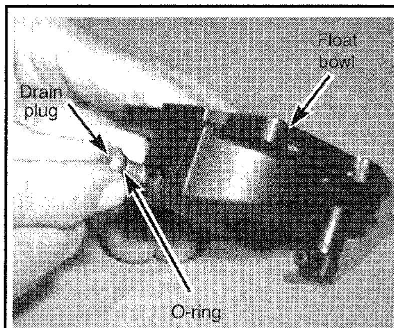


Fig. 87 Install the drain plug using a new O-ring

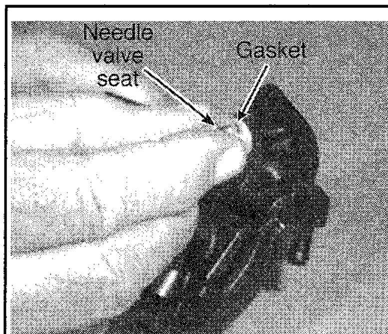


Fig. 88 Install the needle seat using a new gasket

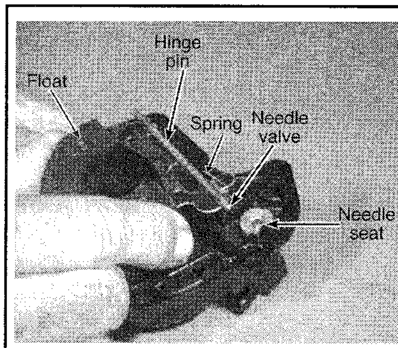


Fig. 89 Install the float assembly and secure using the screw

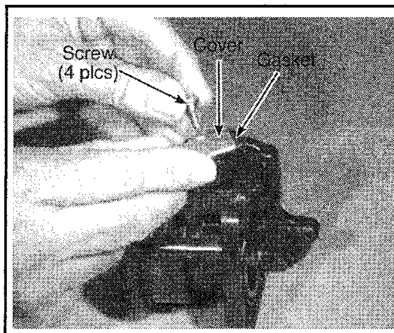


Fig. 90 Install the cover plate using a new gasket

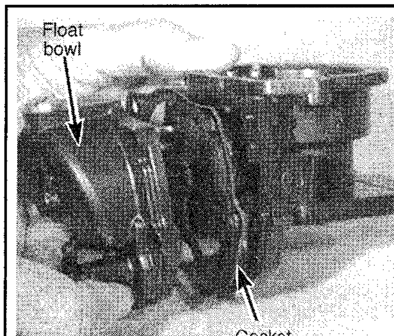


Fig. 91 Invert the float bowl and check the float closed height

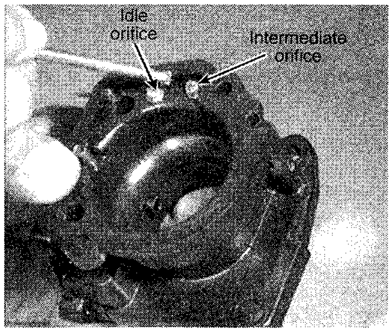


Fig. **92** Install the intermediate, and if applicable, idle orifices

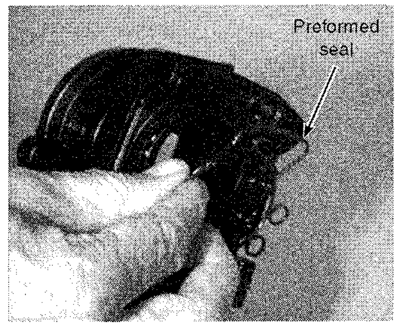


Fig. **93** Install a new preformed seal in the groove on the carb body

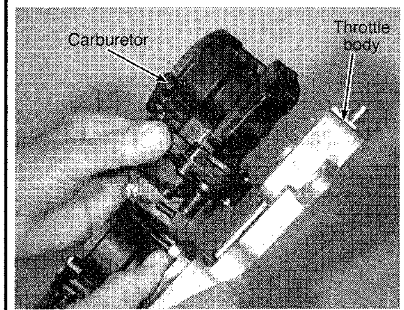


Fig. **94** Install the carb to the throttle body, taking care not to disturb the seal

CARBURETOR MIXTURE ADJUSTMENT

② MODERATE

◆ See Figure **76**

Each individual carburetor body contains either an adjustable idle mixture screw or a fixed orifice, depending on the year and serial number of the powerhead. A fixed air bleed orifice, found immediately above the idle mixture screw or orifice, controls the intermediate mixture. A fixed orifice in the fuel float chamber controls the high-speed mixture. The single float fuel chamber maintains the proper fuel level in the carburetor bowl for all power settings.

■ For models not equipped with any mixture screws, see a knowledgeable EvinrudelJohnson parts counterperson for information on alternate orifices to compensate for high-altitude operation.

On models equipped with an idle (low speed) mixture screw, the carburetor idle mixture can be adjusted to compensate for changes in the fuel system due to carburetor rebuild or replacement or changes in operating conditions such as moving from sea-level to high-altitude. In order for the adjustments to occur properly the motor must mounted on a launched boat that is operating and unrestrained. You'll need an assistant to safely navigate the craft while the adjustment is being made.

■ If the engine is not operating under normal exhaust back-pressure (which occurs from the **gearcase** operating under normal conditions, submerged below the transom), mounted at a normal trim angle, with the correct propeller installed and the boat unrestrained, proper mixture adjustment will not occur.

This adjustment is NOT a periodic maintenance item and should not be touched unless all other attempts to resolve an idle speed operation problem have failed. The ignition and fuel system components must all be in good condition and operating properly. The carburetor linkage must be properly adjusted before attempting this procedure, for details please refer to Timing and Synchronization in the Maintenance and Tune-Up section.

1. With the engine top cover removed for access (and, on most models, the air intake silencer as well), make a matchmark between the carburetor body and idle mixture screw.
2. Start the engine and allow it to idle until normal operating temperature is reached.
3. Once warmed, shift the engine in forward and run at idle speed for 3 minutes.
4. If the adjustment is too lean, the engine will sneeze and backfire; to correct this, note the reference mark, then rotate the idle mixture needle (low speed screw) 118 turn counterclockwise. Wait 15 seconds for the engine speed to stabilize before turning the screw again. Turn the screw until you reach the highest steady engine speed.
5. If the adjustment is too rich, the engine will be rough an unsteady; to correct this, note the reference mark, then rotate the idle mixture needle (low speed screw) 118 turn clockwise. Wait 15 seconds for the engine speed to stabilize before turning the screw again. Turn the screw until you reach the highest steady engine speed.
6. Allow the engine to run at idle in gear for 3 minutes, then move to the next mixture screw. Repeat until all carburetor body screws have been adjusted.
7. Run the engine at or near Wide Open Throttle (WOT) for 3 minutes and then reduce speed to idle, leaving the motor in gear. The motor should not stumble, spit or backfire. If any of these problems are found, repeat the adjustment procedure, making small adjustments only, until the engine operates normally.

Fuel Pump

◆ Figure **95**

Most EvinrudelJohnson V configuration outboards are equipped with the Variable Oil Ratio (VRO2) oil injection system. The VR02 system uses a combination fuel and oil pump assembly that is covered in the Lubrication and Cooling section. For details information on the fuel pump for these models, please refer to the VR02 System Verification and Troubleshooting or to the VRO2 System Component Servicing procedures in that section.

However, some EvinrudelJohnson V configuration outboards (mostly commercial, but some recreational models as well) may be rigged for pre-mix operation. The outboards are equipped with a simple diaphragm-displacement type fuel pump. The pump is normally mounted somewhere on the side or end of the powerhead (usually on or near an intake manifold). The diaphragm is actuated by the cycle of crankcase pressure alternately receiving pressure and vacuum.

■ Have a shop towel and a suitable container handy when testing or servicing a fuel pump as fuel will likely spill from hoses disconnected during these procedures. To ensure correct assembly and hose routing, mark the orientation of the fuel pump and hoses before removal.

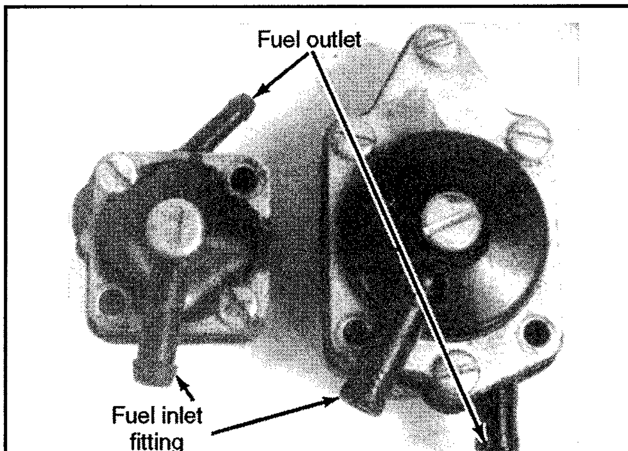


Fig. **95** Typical diaphragm-displacement fuel pumps used on EvinrudelJohnson outboards

TESTING

2 MODERATE

◆ **See Figure 96**

The problem most often seen with diaphragm-displacement fuel pumps is fuel starvation. hesitation or missing due to inadequate fuel pressure/delivery. In extreme cases, this might lead to a no start condition as all but total failure of the pump prevents fuel from reaching the carburetor(s). More likely, pump failures are not total, and the motor will start and run fine at idle, only to miss, hesitate or stall at speed when pump performance falls short of the greater demand for fuel at high rpm.

Before replacing a suspect fuel pump, be absolutely certain the problem is the pump and NOT with fuel tank, lines or filter. A plugged tank vent could create vacuum in the tank that will overpower the pump's ability to create vacuum and draw fuel through the lines. An obstructed line or fuel filter could also keep fuel from reaching the pump. Any of these conditions could partially restrict fuel flow, allowing the pump to deliver fuel, but at a lower pressure/rate. A pump delivery or pressure test under these circumstances would give a low reading that might be mistaken for a faulty pump. Before testing the fuel pump, refer to the testing procedures found under Fuel Lines and Fitting to ensure there are no problems with the tank, lines or filter.

If inadequate fuel delivery is suspected and no problems are found with the tank, lines or filters, a conduct a quick-check to see how the pump affects performance. Use the primer bulb to supplement fuel pump. This is done by operating the motor under load and otherwise under normal operating conditions to recreate the problem. Once the motor begins to hesitate, stumble or stall, pump the primer bulb quickly and repeatedly while listening for motor response. Pumping the bulb by hand like this will force fuel through the lines to the carburetor, regardless of the fuel pump's ability to deliver fuel. If the engine performance problem goes away while pumping the bulb, and returns when you stop, there is a good chance you've isolated the fuel pump as the culprit. Perform a pressure test to be certain, then repair or replace the pump assembly.

Keep in mind that low vacuum supply from the crankcase or insufficient vacuum at the pump itself due to bad seals can also be the culprit for poor fuel delivery.

✳✳ WARNIN

Never run a motor without cooling water. Use a test tank, a flush/test device or launch the craft. Also, never run a motor at speed without load, so for tests running over idle speed, make sure the motor is either in a test tank with a test wheel or on a launched craft with the normal propeller installed.

Pump Pressure Test

◆ **See Figure 96**

By far the most accurate way to test the fuel pump is using a low-pressure fuel gauge while running the engine at various speeds, under load. To prevent the possibility of severe engine damage from over-speed, the test must be conducted under load, either in a test tank (with a proper test propeller) or mounted on the boat with a suitable propeller.

1. Test the Fuel Lines and Fittings as detailed in this section to be sure there are no vacuum/fuel leaks and no restrictions that could give a false low reading.
2. Make sure the fuel filter(s) is(are) clean and serviceable.
3. Start and run the engine in forward gear, at idle, until normal operating temperature is reached. Then shut the motor down to prepare for the test.
4. Remove the fuel tank cap to make sure there is no pressure in the tank (the fuel tank vent must also be clear to ensure there is no vacuum). Check the tank location, for best results, make sure the tank is not mounted any more than 30 in. (76mm) below the fuel pump mounting point. On portable tanks, reposition them, as necessary to ensure accurate readings.

The fuel outlet line from the fuel pump may be disconnected at either the pump or the carburetor whichever provides easier access. If you disconnect it from the pump itself you might have to provide a length of fuel line (depending on whether or not the gauge contains a length of line to connect to the pump fitting).

5. Disconnect the fuel output hose from the carburetor or fuel pump, as desired.
6. Connect a fuel pressure gauge inline between the pump and the carburetor(s).
7. Run the engine at or around each of the following speeds and observe the pressure on the gauge:
   a. For 65 Jet-115 Hp (1632cc) 90CV4 motors:
   - At 600 rpm, the gauge should read about 1 psi (7 kPa).
   - At 2500-3000 rpm, the gauge should read about 1.5 psi (10 kPa).
   - At 4500 rpm, the gauge should read about 2.5 psi (17 kPa).

   b. Except 65 Jet-115 Hp (1632cc) 90CV4 motors:
   - At 1000 rpm, the gauge should read about 4 psi (27 kPa).
   - At 5000 rpm, the gauge should read about 5 psi (34 kPa).
8. If readings are below specification and other causes such as fuel line or filter restrictions have been eliminated, repair or replace the pump.

Pump Leak Test

Pressurize the fuel system using the primer bulb. Squeeze repeatedly, but slowly, until the bulb is firm, then check the pump body and connections for leaks. Remove the pump from the powerhead, leaving the fuel lines connected. Observe the vacuum port at the rear of the pump (where is connects to the port on the powerhead). The leakage of any fuel at this point indicates a damaged diaphragm.

Repair or replace any pump that shows signs of leakage.

REMOVAL & INSTALLATION

1 EASY

◆ **See Figures 97 and 98**

1. For safety, either disconnect the negative battery cable (if so equipped) and/or disconnect the spark plug lead(s) and ground them to the powerhead.

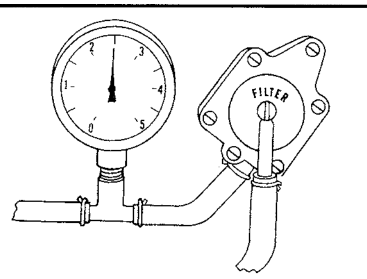
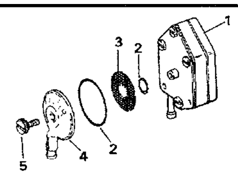


Fig. 96 Use a fuel pressure gauge connected in the pump outlet line to check operating pressure—typical Evinrude/Johnson pump shown



① FUEL PUMP BODY
② O-RING or GASKET
③ FILTER ELEMENT
④ INLET COVER
⑤ SCREW

Fig. 97 Diaphragm-displacement fuel pump used on some V outboards

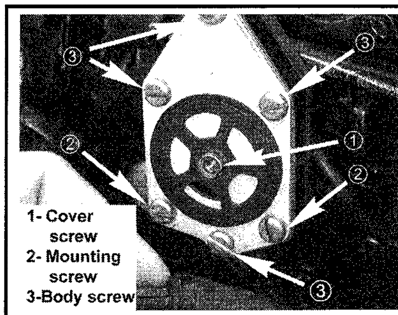


Fig. 98 Typical Evinrude/Johnson fuel pump screw identification

2. Locate the fuel pump on the powerhead and determine if it will be easier to remove the lower engine covers. On some models equipped with split (2-piece) lower covers, it is easier to access the pump if the lower engine covers are removed. For details, refer to the Engine Cover procedure under the Engine Maintenance section.

On most models, fuel hoses are retained by a plastic wire tie (which must be cut to remove the hose). Use a pair or dikes or cutters to carefully remove the wire tie. Be sure not to cut, nick or otherwise damage the fuel hose or it will have to be replaced.

3. Place a small drain basin or a shop rag under the fuel line fittings (to catch escaping fuel), then tag and disconnect the fuel hoses from the pump.

The fuel pumps used on these motors are equipped with 2 or 3 sets of bolts visible on the surface of the pump. On most models, a round inlet cover is mounted to the center of the pump with a single **bolt. Then,** of the remaining bolts, 2 are usually used to secure the pump to the powerhead and the balance of the bolts are used to secure the halves of the body together around the diaphragm.

4. Loosen the pump mounting bolts (the bolts that thread not just through the inlet cover, but all the way through the body of the pump and into the powerhead). If in doubt as to which bolts secure the pump, look at the back of the pump (as can be seen at the pump-to-powerhead seam line) to see which bolts continue through the pump assembly and into the powerhead. These are the only bolts that should be loosened for pump removal.

On the 5 sided pumps used by most **Evinrude/Johnson** 2-stroke models, there are 2 mounting bolts at the bottom of the pump assembly.

5. If necessary, remove the cover screw or screws and disassemble the fuel pump for inspection or overhaul, as applicable. For details, refer to the Fuel Pump, Overhaul procedure in this section.
6. Clean the mating surface of the pump and powerhead of any remaining gasket material, dirt, or debris. Be careful not to damage the surface as that could lead to vacuum leaks.

To install:

7. Apply a coating of Evinrude/Johnson nut lock to the fuel pump retaining screws.
8. Position a new gasket and install the pump to the powerhead using the retaining screws. Tighten the screws to 24-36 inch lbs. (2.8-4.0 Nm).
9. Connect the fuel lines as noted during removal and secure using the clamp or new wire ties, as applicable.
10. Gently squeeze the primer bulb while checking for fuel leakage. Correct any fuel leaks before returning the engine to service.
11. Connect the negative battery cable and/or spark plug lead(s).

OVERHAUL

② MODERATE

◆ See Figures 97 and 99

Most of the displacement-diaphragm fuel pumps used on Evinrude/Johnson outboards may be disassembled for overhaul. These pumps are of a fairly simple design with relatively few moving parts. Check with your local parts supplier to make sure that an overhaul kit containing the necessary parts are available for your model. In most cases, the parts are limited to the diaphragm(s), gasket(s) and a fuel inlet screen (if equipped).

If overhaul is required due to damage from contamination or debris (as opposed to simple deterioration) disassemble and clean the rest of the fuel supply system prior to the fuel pump. Failure to replace filters and clean or replace the lines and fuel tank could result in damage to the overhauled pump after it is placed back into service.

All diaphragms and seals should be replaced during assembly, regardless of their condition. Check for fuel leakage after completing the repair and verify proper operating pressures before returning the motor to service.

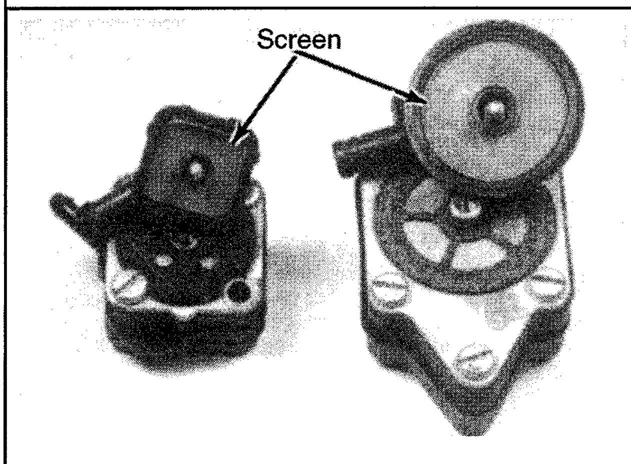


Fig. 99 Many of the pumps used on these motors are equipped **with** a filter screen under the cover

✳✳ WARNING

No sealant should be used on fuel pump components unless otherwise specifically directed. If small amounts of a dried sealant were to break free and travel through the fuel supply system it could easily clog passages (especially the small, metered orifices and needle valves of the carburetor).

1. Remove the fuel pump from the powerhead as detailed in this section.
2. Matchmark the fuel pump cover, housing and base to ensure proper assembly.

To ease inspection and assembly, lay out each piece of the fuel pump as it is removed. In this way, keep track of each component's orientation in relation to the entire assembly.

3. Remove the center cover screw, then remove the fuel inlet cover, filter element (screen) and gasket or O-rings (as applicable).
4. Remove the pump housing-to-base screws (usually 4 flat-head screws) and carefully separate the housing from the base, removing the diaphragm(s) from the center.
5. Clean the metallic components thoroughly using solvent and carefully remove all traces of gasket material.
6. Inspect the diaphragm closely for cracks or tears.

It is advisable to replace the diaphragm ANYTIME the fuel pump is disassembled to ensure reliability and proper performance.

7. Inspect the fuel pump body for cracks. Check gasket surfaces for nicks, scratches, or irregularities. Inspect the mating surfaces of the fuel cover, body and base using a straight edge to ensure that they are not warped from heat or other damage Replace warped or damaged components.

To assemble:

8. Assemble the components of the fuel pump housing, base and diaphragm noting the following:
   a. Use new gaskets. Make sure each gasket and the components it seals are aligned properly.
   b. Align the matchmarks made during disassembly to ensure proper component mounting.
9. Apply a coating of Evinrude/Johnson Nut Lock, or an equivalent threadlocking compound to the pump housing and base screws, then install and tighten them to 24-36 inch lbs. (2.8-4.0 Nm).
10. If equipped, install the fuel pump cover and filter screen using a new gasket or O-ring(s), then tighten the center screw securely.
11. Install the fuel pump and then check for leaks and for proper operation.

Manual Fuel Primer

◆ See Figure 100

A few Evinrude/Johnson V configuration motors (such as some 105 hp commercial models) are equipped with a manual fuel primer system to aid with cold starts. The basic design of the manual primer is that of a small, hand-operated plunger-type pump. The primer works by drawing fuel into the pump housing through a fuel line with a one-way check valve when the shaft is withdrawn. The fuel is then forced out, toward the motor, through a second one-way check valve when the shaft is pushed back inward.

The primer performs the same function of a choke (aiding cold starting by making sure the engine receives a richer fuel mixture), but by opposite means. Whereas a choke reduces the amount of air provided to the combustion chamber (thus increasing the fuel portion of the air/fuel ratio), a primer works on the fuel side of the ratio by manually increasing the amount of fuel. The extra fuel provided by the manual primer enriches the air/fuel mixture for cold start purposes only. Use of the primer on an engine that is at or near operating temperature can flood the motor preventing starting.

TESTING

2 MODERATE

◆ See Figure 100

An inoperable manual primer will cause hard start or possibly even a no start condition during attempts to start a cold motor. The colder the ambient temperature, the more trouble an inoperable primer will cause. A primer with internal leakage (allowing fuel to bypass the air/fuel metering system) will cause rich running conditions that could include hesitation, stumbling, rough running, especially at idle and lead to spark plug fouling.

Function Test

If the motor is operable, but trouble is suspected with the primer system, perform a function test with the engine running. Although this test can be conducted on a flush-fitting, engine speed will reach 2000 rpm and it is much safer to conduct the test in a test tank or with the boat launched.

1. Start and run the engine until it reaches normal operating temperature.
2. Once the engine warms, set the throttle so it runs at 2000 rpm.
3. Pump the manual primer knob and observe engine operation. If the primer is operating correctly, the engine should run rich and speed should drop to about 1000 rpm.
4. If the primer seems ineffective, stop the engine, then remove the primer hose from its fitting(s). Check each fitting for clogs using a syringe filled with isopropyl and a clear vinyl 118 in. inner diameter hose. Attach the hose to the fitting being checked and press lightly on the syringe, Fluid will move through the fitting unless it is clogged.
5. If any clogs are found, use a thin pick to carefully clean the fitting. Evinrude/Johnson makes a cleaning tool for this purpose, No. 326623.
6. Be sure to check the primer hose T-fitting for clogs as well.
7. If no clogs are found, perform the Primer Check procedure to see if the problem lies within the primer assembly itself.

Primer Check

If you suspect the manual primer system is not functioning correctly (and no clogs were found in the lines or fittings), check the primer as follows:

1. Remove the fuel line from the primer fitting at the carburetor.
2. Place the end of the fuel line just removed into a suitable container. Squeeze the fuel tank primer bulb to make sure the carburetor bowls are full of fuel.
3. Operate the primer choke lever twice. If fuel squirts from the disconnected fuel line into the container, the manual primer system is functioning correctly. If not, a kinked or restricted fuel line may be the problem, or if no kinks/clogs are found, the primer is at fault. Check the primer nipple to ensure the nipple is free of obstructions.

The most probable cause of a malfunctioning primer system is internal leakage past the O-rings. Therefore if the primer itself is still suspected, proceed to Servicing the Manual Primer.

SERVICING THE MANUAL PRIMER

2 MODERATE

Removal/Disassembly

+ See Figures 100,101 and 102

1. Disconnect and plug the inlet and outlet fuel lines to prevent loss of fuel and contamination. Remove the primer assembly from the engine.
2. Carefully pull or pry the retaining clip from the primer body housing. Pull out the end cap, plunger, and spool valve assembly. Slide the end cap from the plunger. Remove and discard the O-ring around the end cap.

Observe the small O-rings, there are usually 2 on the spool valve and 1 around the plunger shaft. These O-rings are made from a special material and must be replaced with a genuine EvinrudelJohnson replacement part. Just matching O-ring sizes will not work!

3. Remove and discard the O-rings.
4. Remove the large washer and spring from the plunger shaft

Cleaning and Inspection

◆ See Figures 100,101 and 102

1. Inspect the grooves of the spool valve and the shaft of the plunger for any scratches or burrs. Polish away any imperfections using crocus cloth. If a smooth finish cannot be obtained without removing excessive material, replace the spool valve and plunger assembly.

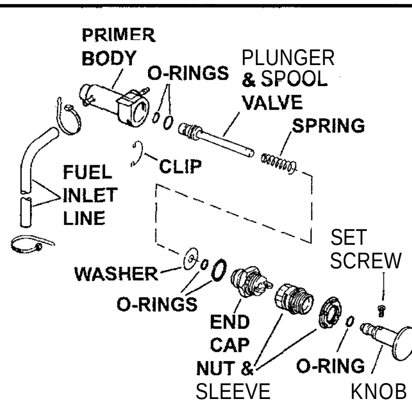


Fig. 100 Exploded view of a manual primer assembly

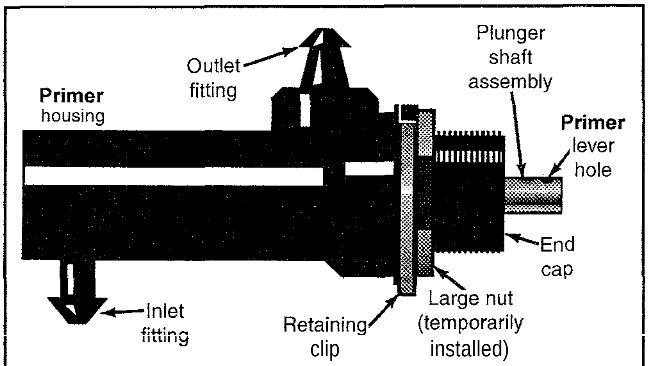


Fig. 101 The primer choke valve removed from the powerhead. The large nut is temporarily installed onto the threads of the end cap for safe keeping

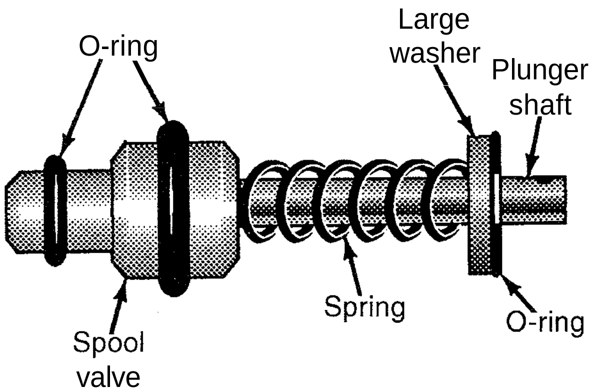


Fig. 102 Plunger shaft assembly removed from the choke housing with major parts identified

2. Check the plunger where the cross hole meets the inside hole. The slightest burrs around the cross hole will cause rapid O-ring wear. Remove any burrs and polish using crocus cloth.
3. Inspect the condition of the plunger spring, replace as required.
4. Test each of the one-way valves (there is-1 at'each fuel fitting) by blowing through them in turn. Each valve is functioning correctly if it allows air to pass one direction, but not in the other direction. If a valve allows air to be drawn both in and out, the valve is defective. Individual valves are not serviceable. The primer body must be replaced.

The valves can also be checked using a syringe filled with isopropyl alcohol and a length of tube. Squeeze the syringe lightly to force alcohol through the hose, although it is permissible for a drop or two to pass through the wrong direction of a check valve, a steady stream indicates the valve has failed and must be replaced.

Assembly/Installation

◆ **See Figures 100,101 and 102**

1. Install the two new O-rings around the spool valve. Slide the spring, followed by the large washer and the third O-ring, over the plunger.
2. Install a new O-ring over the end cap and place the end cap over the plunger end.
3. If desired, bench test the assembly before installation, as follows:
 a. Connect a 5 in. (127mm) long piece of hose to the large nipple on the primer assembly, then place the other end of the hose in a container of alcohol.
 b. Connect a length of hose to the small primer nipple and place the other end in a small container (preferable a graduated cylinder or measuring cup).
 c. Hold the primer horizontally (the same way it would be installed on the motor) and pump the plunger 10 times. The primer should deliver approximately 10cc of alcohol to the graduated cylinder total as a result of the 10 strokes.
 d. If the pump does not deliver sufficient volume, disassemble it again and check for torn, missing or dislodged O-rings.
4. Insert the assembly into the primer housing and install the retaining clip to secure everything together.
5. Slide the assembled primer into the opening in the lower cowling and thread the large nut over the protruding threads. Tighten the nut securely.
6. Install the fuel lines to the appropriate fittings and snap the choke lever into the vertical hole in the plunger.
7. Pressurize the fuel system using the fuel tank supply line primer bulb and thoroughly inspect for leaks.

Electric Fuel Primer

◆ **See Figure 103**

Most Evinrude/Johnson V-motors are equipped with an electric fuel primer "choke" system to aid with cold starts.

The primer performs the same function of a choke (aiding cold starting by making sure the engine receives a richer fuel mixture), but by opposite means. Whereas a choke reduces the amount of air provided to the combustion chamber (thus increasing the fuel portion of the air/fuel ratio), a primer works on the fuel side of the ratio by increasing the amount of fuel. The extra fuel provided by the primer enriches the air/fuel mixture for cold start purposes only. Activation of the primer on an engine that is at or near operating temperature can flood the motor preventing starting.

The primer system consists of a solenoid valve, distribution lines, and injection nozzles. The nozzles are normally tapped into the intake manifolds. During normal powerhead cranking and with the key switch pressed in, a portion of the pump (usually the VR02 system) fuel output is routed through the primer solenoid valve to the injection nozzles on the manifolds. This metered amount of fuel enriches the fuel charge to the cylinders for easier cold starting.

The basic design of the electric primer is that of a solenoid valve and, as such, does not pump fuel, but instead opens or closes a passage that allows fuel from a pressurized supply to flow. The circuit is designed to receive pressurized fuel from the fuel pump or the primer bulb. When power is applied to the circuit, the solenoid energizes, opening the valve. Once the circuit is deactivated, an internal spring closes the valve once again.

The system is controlled by the "push-in" type key switch on the remote control box or from a separate switch on the control panel. When the key is pushed in, the primer solenoid is activated, moving a small plunger—which acts as a small pump—injecting fuel through the nozzles directly into the intake manifold.

The fuel is atomized in the crankcase by the spraying action of the injection nozzles. The enriched fuel charge is then drawn into the cylinders where a richer fuel mixture is required for cold starting.

The electric primer is equipped with a manual lever that can be used in the event of battery or solenoid failure. When the lever is rotated by hand it will physically move the solenoid valve to the open position, allowing fuel from the pump or primer bulb to flow through the priming system. When used, the valve must be manually closed immediately following engine start-up to prevent spark plug fouling.

✳✳ CAUTIC

If the fuel tank has been exposed to direct sunlight, pressure may have developed inside the tank. Therefore, when the solenoid lever is moved to the manual position, an excessive amount of fuel may be forced into the cylinders. As a safety precaution, under possible fuel tank pressure conditions, the fuel tank cap should be opened slightly to allow the pressure to escape before attempting to start the engine.

The electric primer assembly is usually equipped with a maintenance or fogging fitting. Under a removable plastic cap on one end or side of the valve is a schrader valve. The valve is provided as an easy way to add fogging oil or Evinrude/Johnson Engine Tuner to the combustion chambers.

PRIMER TESTING

② MODERATE

◆ **See Figure 103**

An inoperable electric primer will cause hard start or possibly even a no start condition during attempts to start a cold motor. The colder the ambient temperature, the more trouble an inoperable primer will cause. A primer with internal leakage (weak spring and/or stuck open valve allowing a constant supply of additional fuel) will cause rich running conditions that could include hesitation, stumbling, rough running, especially at idle and lead spark plug fouling.

Function Test

◆ **See Figure 103 and 104**

If the motor is operable, but trouble is suspected with the primer system, perform a function test with the engine running. Although this test can be conducted on a flush-fitting, engine speed will reach 2000 rpm and it is much safer to conduct the test in a test tank or with the boat launched.

1. Start and run the engine until it reaches normal operating temperature.
2. Once the engine warms, set place the unit in gear and advance the throttle so it runs at 2000 rpm.
3. Push inward on the keyswitch momentarily; if the primer is operating

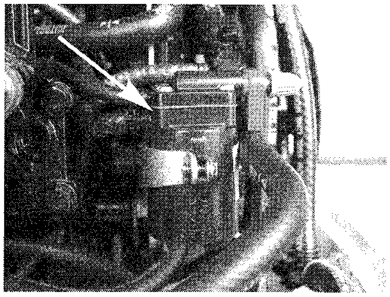


Fig. 103 Typical **Evinrude/Johnson** electric fuel primer assembly

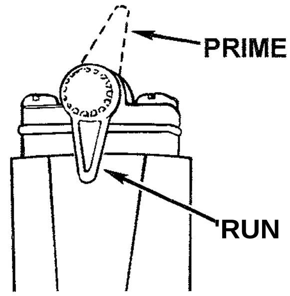


Fig. 104 The electric primer is also equipped with a manual override valve

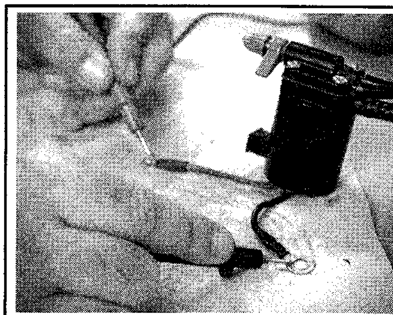


Fig. 105 Use a **DVOM** or ohmmeter to probe across the primer solenoid terminals

correctly, the engine should run rich and speed should drop to about 1000 rpm and then return to normal.

4. If the keyswitch makes no difference in operation, move the manual lever on the solenoid housing to the open or prime position. The engine should now run rich and speed should drop to about 1000 rpm. If it does not respond, suspect a clog in the system. If it responds this time, but not when the switch was depressed, suspect a problem with the activation circuit. Refer to the Solenoid Test to decide if the problem is the solenoid motor or the activation circuit. Refer to the wiring diagrams to help troubleshoot the circuit, as necessary.

5. If a clog is suspected, stop the engine, then remove the primer hose from its fitting(s). Check each fitting for clogs using a syringe filled with isopropyl and a clear vinyl 118 in. inner diameter hose. Attach the hose to the fitting being checked and press lightly on the syringe, Fluid will move through the fitting unless it is clogged.

6. If any clogs are found, use a thin pick to carefully clean the fitting. Evinrude/Johnson makes a cleaning tool for this purpose, No. 326623.

7. If no clogs are found, perform the Solenoid and Circuit Check procedure to see if the problem lies within the solenoid motor itself or the circuit.

**** CAUTION**

When checking the fuel lines of the primer system, pay particular attention to any evidence of a crack in a fuel line that may permit fuel to escape and cause a very hazardous condition.

SOLENOID AND CIRCUIT CHECK

2 MODERATE

◆ See Figures **103, 105** and **106**

Use an ohmmeter and voltmeter (or a DVOM) to check condition of the solenoid to determine if a system fault is localized to the solenoid motor or if you must instead troubleshoot the balance of the activation circuit. Refer to the wiring diagrams to assist with circuit troubleshooting, as necessary.

1. Disconnect the primer solenoid wiring, then connect an ohmmeter to the solenoid between the purple/white stripe wire and the black ground wire. The ohmmeter should indicate 5.5 +/- 1.5 ohms (4.0-7.0 ohms). If the reading is not within the prescribed range, the solenoid is defective and must be replaced. If the solenoid valve tests within spec, but is not operating properly (and there are no clogs in the system) suspect the circuit, but verify in the next step.

Remember that ohmmeter readings will vary with temperature and test specifications are designed for **ambient/component** temperatures around **68°F (20°F).**

2. Set a voltmeter or DVOM to read on the 0-15 vdc setting. Connect the Red meter lead to the Purple/White connector on the engine harness connector and the meter Black lead to a good powerhead ground. Set the key switch to the on position and press in with the key switch. If meter indicates 10-14 vdc the circuit is operating properly (repair or replace the defective primer solenoid valve). If the meter indication is less, troubleshoot the wiring harness, key switch and connectors for possible open circuit, or corroded connector pins.

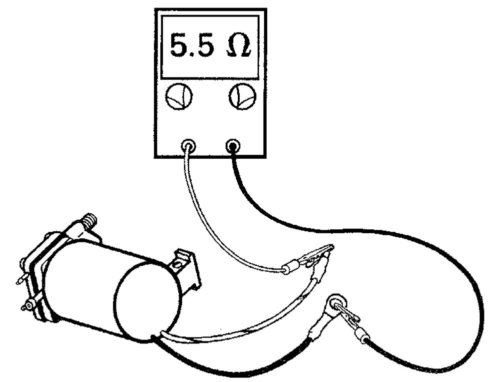


Fig. 106 Checking the primer solenoid winding resistance

3. Use a syringe filled with isopropyl alcohol to lightly pressurize the fuel inlet fitting. With the no power applied to the circuit and the lever in the run position (facing the primer body) no fluid should pass through the inlet valve.

4. Move the lever to the prime position (facing away from the primer body) or apply power to the circuit, fluid should come out of the outlet fitting(s).

5. If necessary disassemble the primer for component inspection or replacement.

REMOVAL

◆ See Figures **103, 107, 108, 109, 110** and **111**

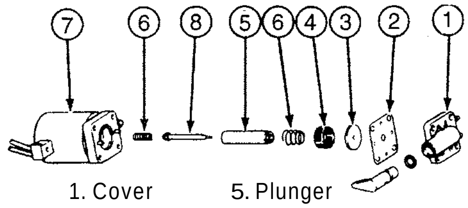
The primer valve is normally located next to the VR02 pump. On some models the valve is secured to the powerhead by a bracket and 2 screws. On other models, the valve is secured to the fuel component bracket. The following procedures may not show the exact mounting for the model being serviced, but they are valid for all primer valves.

1. Disconnect the negative battery cable for safety.

2. As necessary, remove the lower engine cases and/or air silencer covers from the powerhead for access.

3. Separate the Purple/White lead and Black leads from the primer valve at the bullet connectors. Some models may have terminal screws for these leads. Remove the terminal screws from the leads.

4. Loosen the retainers (usually 2 bolts or screws) securing the primer to the fuel component bracket or powerhead.



1. Cover
2. Gasket
3. Seal
4. Filter
5. Plunger
6. Spring
7. Solenoid body
8. Plunger valve

Fig. 107 Exploded view of an electric fuel primer assembly used on 65 Jet-115 Hp **(1632cc)** 900 CV4 motors

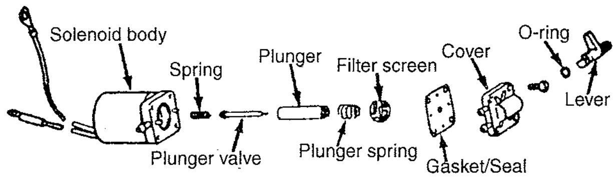


Fig. 108 Exploded view of an electric fuel primer assembly used on **V4/V6/V8** loop charged motors

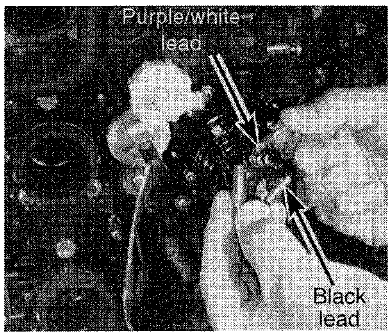


Fig. 109 To remove the primer, disconnect the wiring**...**

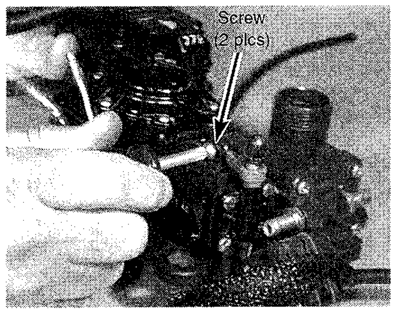


Fig. 110 **...** then remove the retainers securing it to the fuel component bracket or powerhead

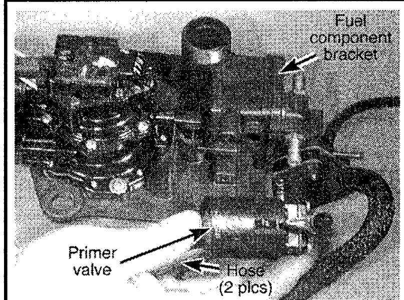


Fig. 111 Primer valve mounting will vary, so be sure to tag all hoses

☐ Wrap the end of each fuel line using a shop rag to catch any remaining spray when the line is removed from the fitting.

5. Lift the valve clear of the powerhead or the component bracket. Note the fuel line routing, then tag and disconnect the 2 or 3 lines from the primer valve fittings.
6. If necessary, disassemble the primer for component inspection or replacement.

DISASSEMBLY

◆ **See Figures 103, 107, 108, 112, 113, 114, 115, 116 and 117**

1. If equipped, remove the 2 O-rings from the valve inlet (large fitting). Discard the O-rings.
2. Matchmark the cover to the solenoid body, prior to removal, in order to ensure proper positioning during installation. Remove the 4 screws securing the cover to the solenoid and lift off the cover.
3. Lift off the gasket and slide out the plunger spring, plunger, and plunger valve from the solenoid body. Slide the plunger valve free from the center of the plunger.
4. Lift out the filter screen. Clean the filter with a spray carburetor cleaner and blow dry with low-pressure compressed air.
5. Turn the solenoid over and catch the small plunger valve spring as it falls free of the solenoid body.
6. Grasp the cover with a firm grip in one hand. Pull the primer lever from the cover with the other hand. Remove the O-ring from the lever and discard the O-ring.
7. Clean all components in a mild solvent or carburetor cleaner.
8. Blow through all passages with low-pressure air.

A repair kit from **Evinrude/Johnson** contains all the replaceable components for the solenoid valve. If any parts are damaged which do not come in the kit, replace the entire solenoid primer valve.

ASSEMBLY

◆ See Figures 103,107,108,118,119 and 120

1 Slide the plunger valve into the plunger with the small tip going in first. Insert the small plunger valve spring into the center of the plunger. Slip the large plunger spring over the opposite end of the plunger valve.

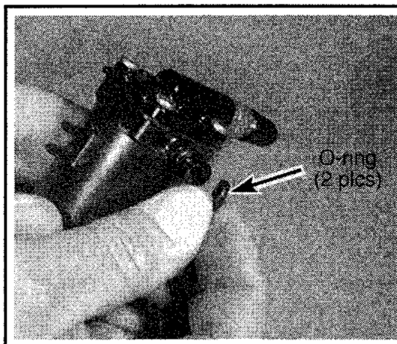


Fig. 112 If equipped remove the O-rings from the valve inlet fitting

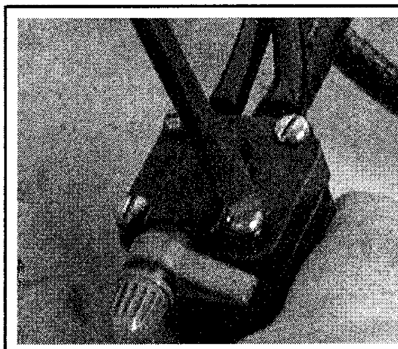


Fig. 113 If overhaul is necessary, remove the 4 solenoid cover screws...

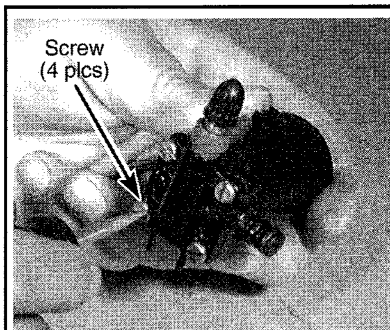


Fig. 114 **...** but be sure to matchmark or note the cover orientation

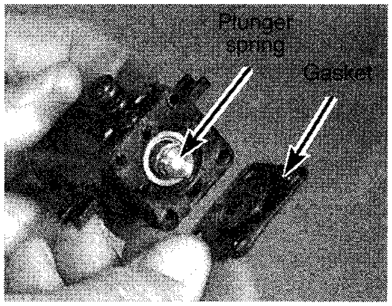


Fig. **115** Remove the cover, gasket, plunger spring, plunger valve

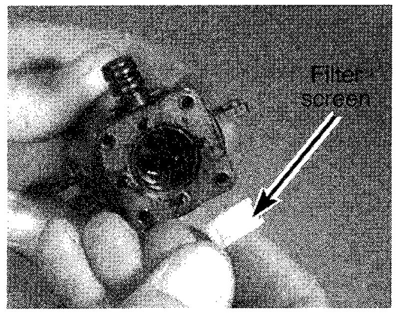


Fig. **116** Remove the filter screen

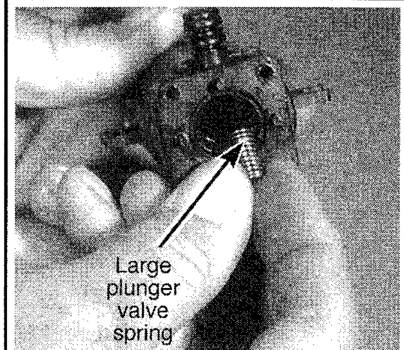


Fig. **117** Invert the solenoid so the small plunger valve falls free

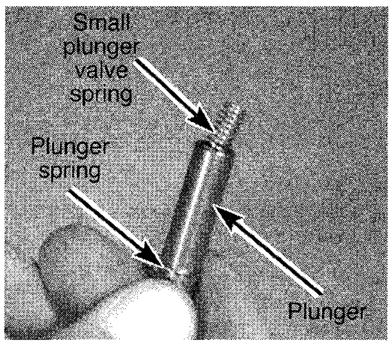


Fig. **118** Assemble the plunger with the small and large springs**...**

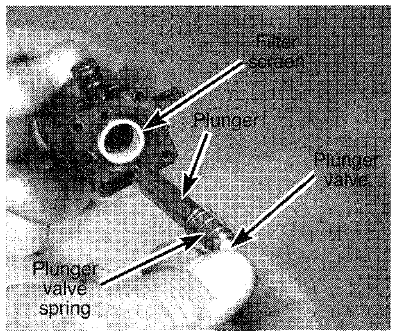


Fig. **119** **...**then install the assembly into the valve

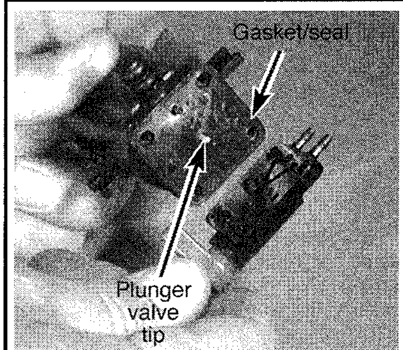


Fig. **120** Install the cover using a new gasket, properly locating it over the valve tip

2 Insert a new or clean filter screen into the solenoid body. Insert the plunger and valve assembly—small spring end going in first—into the solenoid body.

3 Place a new O-ring on the lever and lubricate it with a light coating of Evinrude/Johnson lubricant, petroleum jelly or equivalent. Insert the lever into the cover while rotating the lever clockwise.

Place a new gasket/seal over the end of the solenoid body with the raised side or the seal pointing towards the plunger. Be sure to align the gasket/seal with the small studs and press the gasket firmly into place. The end of the plunger valve tip must protrude through the gasket/seal.

4 Align the marks on the cover and solenoid body. Set the cover onto the solenoid body and secure it with the 4 screws.

5 On models with the primer valve fastened to the fuel component bracket, place two new O-rings on the inlet fitting of the primer valve.

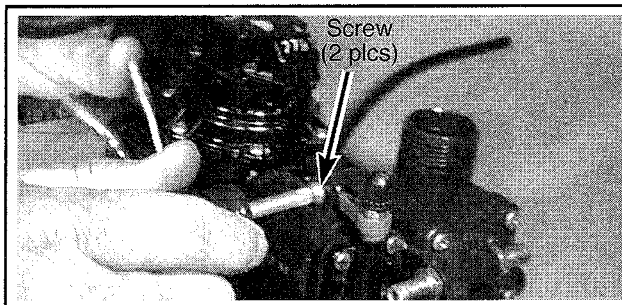


Fig. **121** During installation, position the valve into the clamp or the fuel component bracket and secure using the retainers

INSTALLATION

① EASY

◆ See Figures **103,107,108,121** and **122**

1. Position the valve next to the powerhead, then reconnect the fuel lines as tagged during removal. (Connect the fuel supply hose to the large fitting and secure it and secure with a tie strap or clamp, as applicable, then connect the smaller discharge hoses to the discharge fittings).
2. Slide the primer valve into the clamp or the fuel component bracket and secure it with retainers (usually 2 self-tapping screws, which must be just started in the opposite direction until they drop into the old threads to ensure they do not strip the threads).
3. Connect the primer valve wiring (Purple/White lead and Black lead) to the primer valve at the bullet connectors and/or terminals.
4. Pressurize the fuel system and check for leaks.
5. Reconnect the negative battery cable.
6. Perform the Function Test given earlier in this section to verify proper operation. Make sure the valve is operating properly and that there are no fuel leaks.
7. As applicable, install the air intake silencer and engine cover(s).

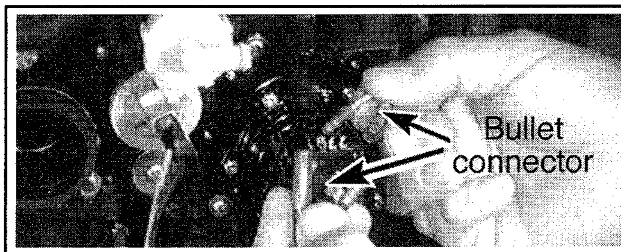


Fig. **122** Be sure to properly reconnect the primer wiring

Fuel Component Bracket

All 80 Jet-175 Hp (1726/2589cc) V4/V6 motors (the 60º loopers), utilize a fuel component bracket to centrally hose most of the fuel related components. The bracket consists of a reservoir tank/float valve assembly, internal fuel passages, and mounting surfaces for other related components. The fuel primer valve, fuel filter, VR02 pump, vacuum pump and fuel vacuum warning switch are all mounted to the bracket. A series of internal passages within the bracket and hoses connect the components together.

REMOVAL

◆ See Figures **123,124,125,126** and **127**

1. Disconnect the negative battery cable for safety.
2. Remove the engine top cover, then, if necessary for access, remove the lower cases. For details, please refer to the Engine Covers (Top and Lower Cases) procedure found in the Engine Maintenance section.
3. Remove the ratchet clamps or wire ties (as applicable) from the oil supply hose to the VR02 pump, the fuel supply hose to the fuel filter inlet, and the distribution hoses to the carburetors. Push on the hoses to slip them off the fittings, do not pull. If the hoses are difficult to remove, cut the hose on the side and peel it away from the fitting.
4. Disconnect the 4-wire connector to the VR02 pump from the main powerhead harness.
5. Tag and disconnect the primer valve Purple/White bullet connectors and vacuum switch Tan and Black bullet or terminal connectors.
6. Remove the ratchet clamps or wire ties (as applicable) from the vacuum pulse hose, recirculation hose, and vacuum pump hose. Push on the hoses to slip them off the fittings, do not pull. If the hoses are difficult to remove, cut the hose on the side and peel it away from the fitting.
7. Remove the screws (usually 4) and large washers securing the fuel components bracket to the powerhead. Tilt the bracket assembly forward and remove the two primer valve discharge hoses from the rear. Lift the fuel component bracket free of the powerhead.

DISASSEMBLY

◆ See Figures **128,129,130,131** and **132**

1. Remove the retaining clip from the rear side of the vacuum switch. Lift the switch out of the component bracket. Cut the tie strap and remove the hose from the vacuum switch.
2. Remove the Phillips head screws (usually 2) securing the primer valve to the bracket. Pull the primer valve straight out from the fuel separator reservoir. Discard the two O-rings on the stem of the valve.
3. Remove the Phillips head screws (usually 4) and lift off the vapor separator cover and float assembly. Lift off and discard the preformed seal.
4. The vapor pump is normally secured to the reservoir cover with 2 Phillips head screws. Two additional screws hold the pump assembly together. Remove the two screws that secure the vapor pump to the cover and lift off the vapor pump.
5. Remove the Phillips head screws (usually 3) and washers from the VR02 pump. Lift the pump straight off the bracket to prevent damaging the fuel inlet fitting on the pump.

Vapor Separator Float

◆ See Figures **133** and **134**

1. Remove the screw securing the vapor separator float hinge pin to the reservoir cover.
2. Lift out the float, hinge pin, and needle valve.
3. Loosen and remove the needle valve seat from the cover. Discard the gasket under the seat (if equipped).

Vapor Pump

◆ See Figures **135,136** and **137**

1. Grasp the vapor pump between the fingers, as shown. Keep a firm clamping pressure on the pump because the spring under the diaphragm

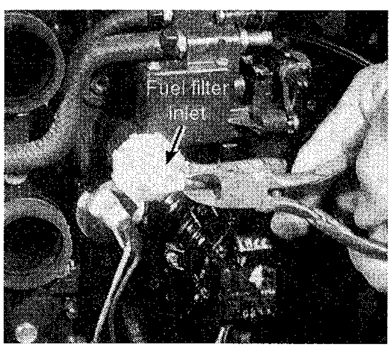


Fig. **123** When used, wire ties must be cut carefully cut free off the fuel hoses

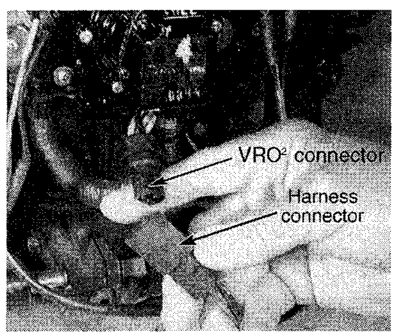


Fig. **124** Disconnect the wiring, starting with the **VR02** pump harness**...**

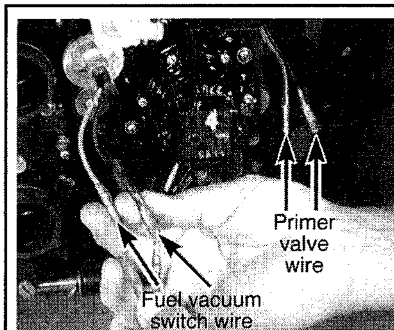


Fig. **125** **...** then tag and disconnect the primer valve wiring

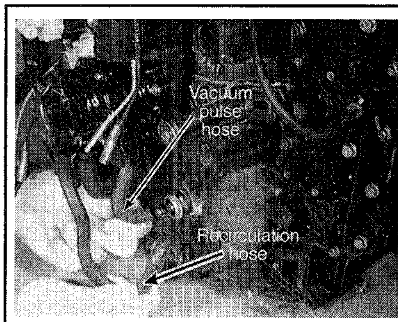


Fig. **126** Tag and disconnect all accessible hoses from the fuel component bracket

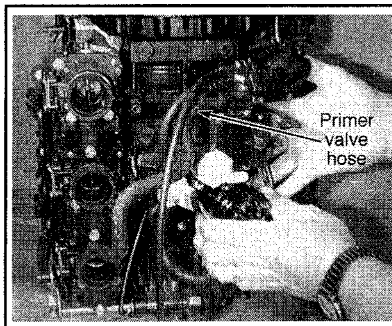


Fig. **127** Remove the screws and then tilt the bracket assembly for access to the rear primer valve discharge hoses

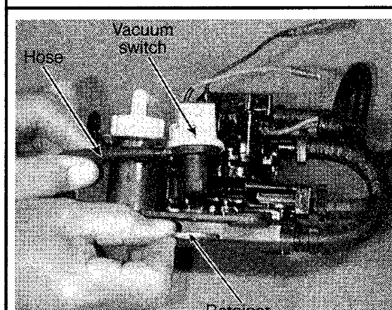


Fig. **128** Remove the retainer and then remove the vacuum switch

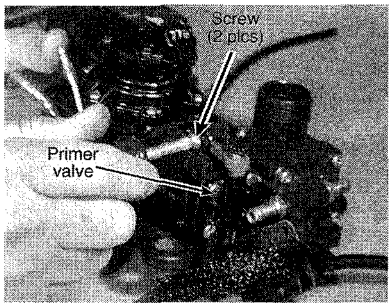


Fig. **129** Remove the **2** screws securing the primer valve to the bracket

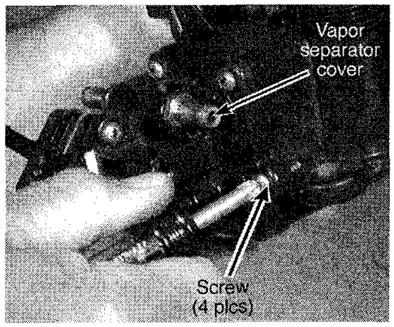


Fig. **130** Remove the cover screws, then lift off the vapor separator cover and float assembly

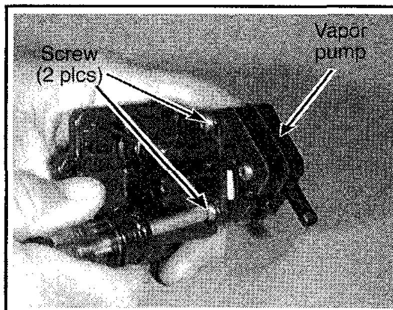


Fig. **131** Remove the **2** screws securing the vapor pump

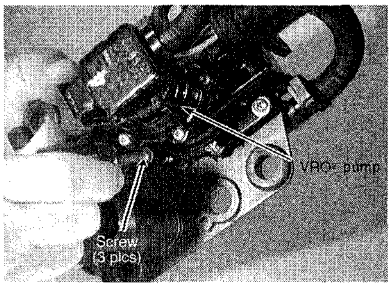


Fig. **132** Remove the screws from the **VR02** pump

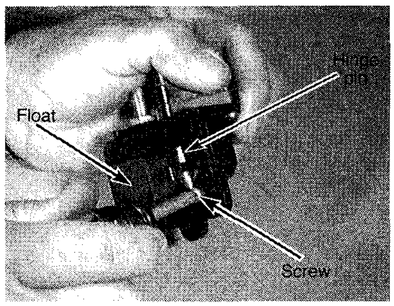


Fig. 133 Loosen the screw and then remove the float, hinge pin, and needle valve assembly

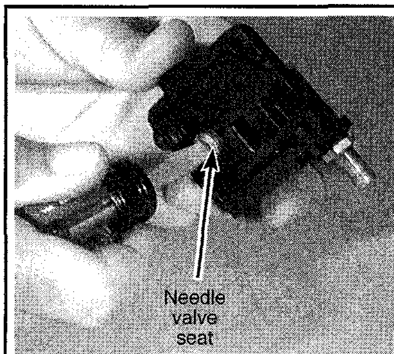


Fig. **134** Loosen and remove the needle valve seat **from** the cover

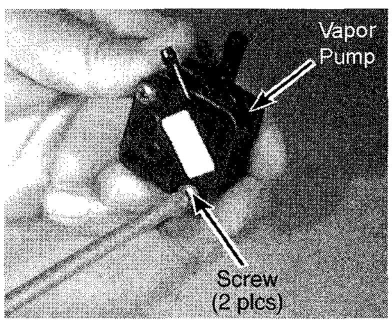


Fig. **135** Grasp the vapor pump firmly and squeeze while loosening the screws

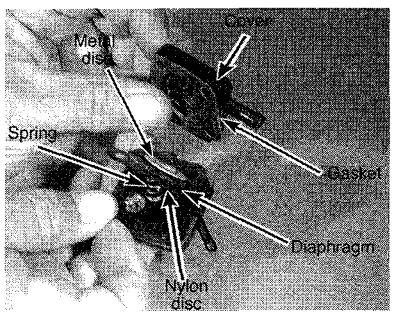


Fig. **136** Carefully lift the cover, easing spring pressure

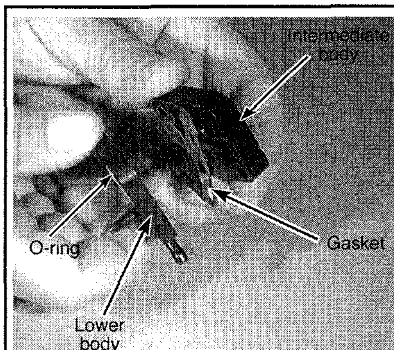


Fig. **137** Remove the intermediate body

will attempt to separate the pump halves. Remove the two screws securing the vapor pump together.

2. Slowly lift off the cover and remove the gasket, metal disc, diaphragm, nylon disc, and spring. Discard the gasket and diaphragm.

3. Lift off the intermediate body and gasket from the lower body. Remove the O-ring on the lower body. Discard the gasket and O-ring.

CLEANING AND INSPECTING

Inspect the fuel filter and clean it with Evinrude/Johnson Carburetor and Choke spray cleaner or equivalent. Inspect the float needle and seat for wear and distortion. If the needle valve is worn, the needle and seat both must be replaced. Check the float for contamination and build-up. Check the mating surfaces of the vapor pump and separator cover for distortion and damage. Verify all brass fittings are tight and secure. Replace any damaged or excessively worn parts.

ASSEMBLY

Vapor Separator Float

◆ See Figures **138,139** and **140**

1. Place a new gasket over the float needle valve seat (if equipped). Install the needle valve seat in the reservoir cover and tighten it securely.

2. Place a new needle valve onto the float tab by sliding the retainer spring over the tab. Insert the hinge pin through the float hinges and center it. Lower the float assembly onto the separator cover and at the same time,

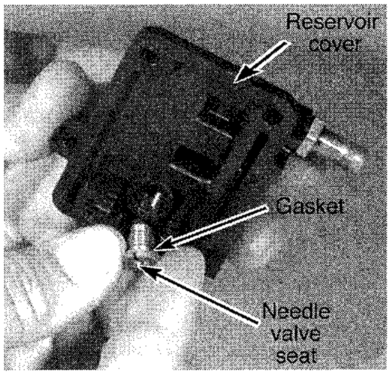


Fig. 138 Install the needle valve (using a new gasket, if equipped)

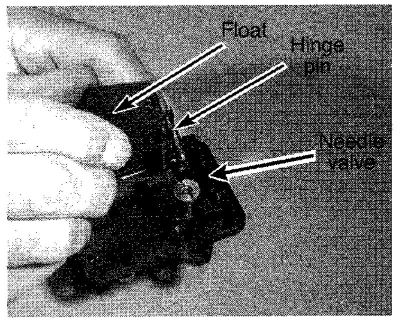


Fig. 139 Install a **NEW** needle valve with the float assembly

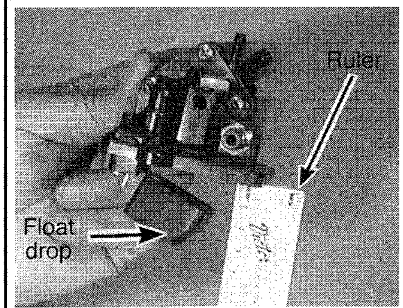


Fig. 140 Turn the cover right-side-up and check the float drop

guide the needle valve into the seat. Secure the float to the cover with a Phillips head screw.

3. Invert the cover with the float in the closed position. The bottom of the float should be parallel with the surface of the cover. Adjust the float closed height by carefully bending the float tab.

4. Invert the cover again (so it is right-side-up) and check the float drop height. Place a scale against the cover and measure the distance from the bottom of the float to the cover. The correct measurement should be 1 1/4-1 11132 in. (32-34mm) float drop.

Vapor Pump

◆ See Figures 141,142,143,144,145,146,147 and 148

1. Place a NEW gasket between the intermediate and lower bodies of the vapor pump. Verify the mounting holes are aligned properly.

2. Place the spring into the cavity on the intermediate body. Set the nylon disc on top of the spring. Place a NEW gasket on the cover, followed by the metal disc with the convex, raised side towards the diaphragm. Set the diaphragm over the cover. A small amount of grease may be applied to the edges of the gasket and diaphragm to hold them in place. Squeeze the cover and body together against the pressure of the spring. Hold the cover and body together and at the same time, insert two Phillips head screws through the lower body and tighten them to a torque value of 18-24 inch lbs. (2-3 Nm).

3. Install a new O-ring in the lower body. Place the vapor pump onto the fuel separator and secure it with two Phillips head screws. Tighten the screws to a torque value of 18-24 inch lbs. (2-3 Nm).

4. Place a new preformed seal on the components bracket. Be sure the seal is fully seated in the groove. Guide the float of the separator into the reservoir and align the separator cover with the bracket. Install the five Phillips head screws and tighten in a cross pattern to a torque value of 18-24 inch lbs. (2-3 Nm).

5. Install two new O-rings on the VR02 pump fuelloil outlet fitting. Place the VR02 pump in position on the bracket and at the same time, guide the fuel/oil outiet fitting 'into the cavity on the bracket. Secure the pump in place with three Phillips head screws and washers. Tighten the screws to a torque value of 18-24 inch lbs. (2-3 Nm). Connect the fuel inlet hose between the bracket and the VR02 pump.

6. Install two O-rings on the primer valve fuel inlet. Lubricate the O-rings with outboard motor oil. Insert the primer valve fuel inlet into the opening on the fuel reservoir. Secure the primer valve to the bracket with two Phillips head screws.

7 Place a new gasket and O-ring on the fuel filter. Be sure the filter element is clean or replace the entire filter, Install the filter on the bracket and tighten just hand tight.

8. Insert the fuel vacuum switch through the bracket and secure it with the retainer ring.

INSTALLATION

◆ See Figures 149,150,151 and 152

1. Place the component bracket against the powerhead while reconnecting the fuel primer hoses to the primer valve on the rear side of the bracket. Rotate the bracket against the powerhead and secure the bracket in place with four Phillips head screws and flat washers. Tighten the 4 screws to a torque value of 18-24 inch lbs. (2-3 Nm). Connect the fuel hose to the carburetor fuel distribution manifold, or carburetors—depending on the model being serviced.

2. As tagged during removal, connect the recirculation hose to the fitting on the crankcase and the pulse limiter hose to the pulse limiter valve. If used originally, secure the hoses with ratchet type clamps.

3. Connect the primer valve wiring (Purple/White bullet connectors (or terminal wires) and vacuum switch Tan and Black bullet connectors to the same color wires.

4. Engage the 4 wire connector from the VR02 pump to the main powerhead harness.

5. Connect the oil supply hose to the VR02 pump; the fuel supply hose to the fuel filter inlet; and the distribution hoses to the carburetors. Secure the hoses with clamps (wire tie or ratchet types, depending on what was used originally).

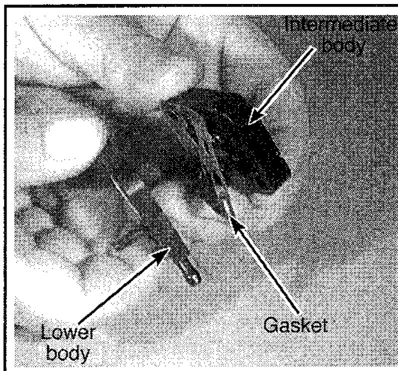


Fig. 141 During installation make sure the gasket aligns properly

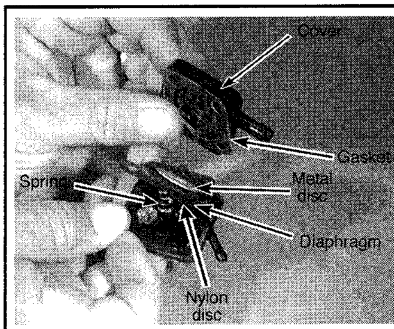


Fig. 142 Install the spring and diaphragm components

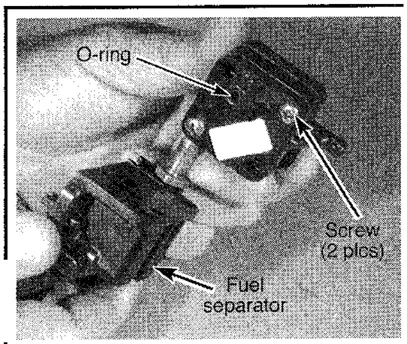


Fig. 143 Install the lower body using a new O-ring

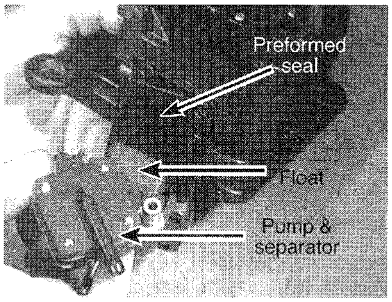


Fig. 144 Install the pump and separator using a new preformed seal

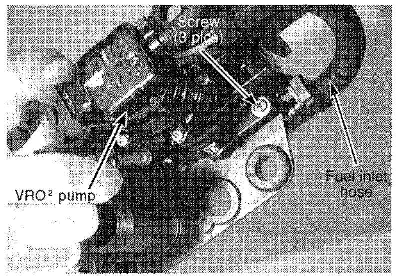


Fig. 145 Install **the VRO2** pump using new O-rings on the fitting

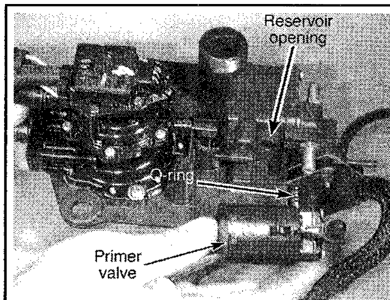


Fig. 146 Install the primer valve using new O-rings on the fitting

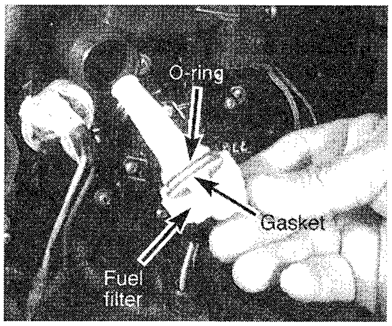


Fig. 147 Install the fuel filter using a new gasket and O-ring

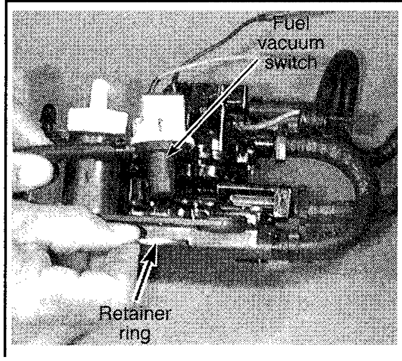


Fig. 148 Install the vacuum switch and secure with the retainer ring

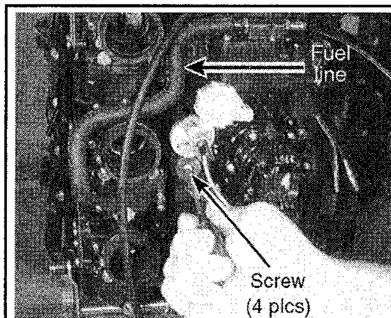


Fig. 149 Install the component bracket to the powerhead

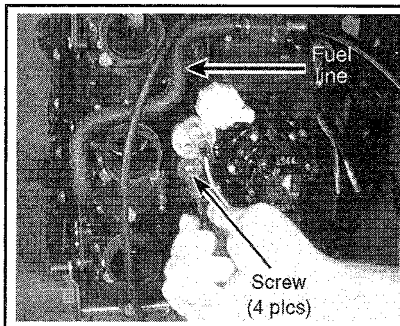


Fig. 150 Connect the hoses, as tagged during removal...

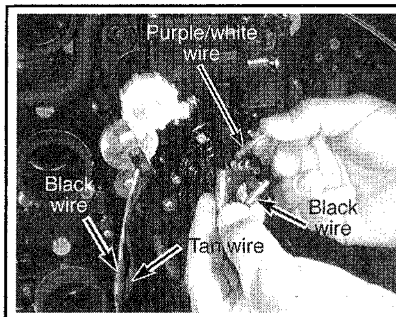


Fig. 151 **...** then reconnect the wiring

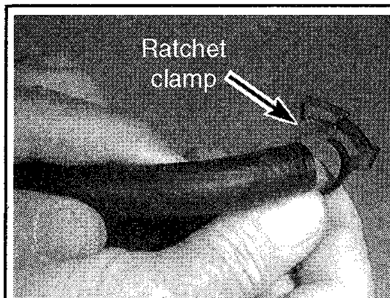


Fig. 152 If used, secure hoses using ratchet type clamps

6. Pressurize the fuel system and check for leaks.
7. Install the engine covers (leaving the top cover until after the engine has been RUN and inspected again for leaks).
8. Reconnect the negative battery cable.

Recirculation System

Loop charged Evinrude/Johnson outboards are equipped with a recirculation system designed, primarily, to drain excessive fuelloil build-up in the powerhead crankcase and route it back to the intake manifold. From the manifold this excess or build-up it is drawn into the crankcase and eventually burned in the cylinders. The system consists mainly of a series of hoses, fittings and check valves, If a fitting, hose or check valve is left plugged or inoperative, the affected cylinder could possibly misfire, the spark plug become fouled--causing excessive smoke when accelerating from idle or even burn a piston—resulting in severe damage to the powerhead.

A syringe, a 1/8 in. Inner Diameter (ID) piece of clear tubing and some lsopropyl Alcohol are required to make these simple tests. These items may also be used to test idle and air bleed passages in the carburetor.

✳✳ CAUTION

After checking or servicing any part of the recirculation system you should observe all system hoseslfittings while the engine operates to ensure there are no fuel leaks. Remember that even a small fuelloil leak can lead to a fire or explosion. Don't take any risks.

CHECKING THE RECIRCULATION SYSTEM

◆ See Figures ***153*** and ***154***

Functional **Check—60° V4/V6** Models

■ This check assumes that one or more of the operational symptoms for trouble with the recirculation system are **present. These** symptoms include poor or erratic idle, fouled spark plugs in the LOWER cylinders only, excessive smoke when accelerated after an extended idle or idle quality that is unusually sensitive to trim angle. If one or more of these symptoms are NOT present, start your search elsewhere in the the fuelloil **system(s).**

On 80 Jet-175 Hp (1726/2589cc) V4/V6 motors, also known as the 60° loopers, the recirculation system is plumbed in a manner that allows functional diagnosis to start at the after end of the No. 1 cylinder recirculation hose. Unfortunately, the functional check only tells you what fittings or check valves you should check next (when a problem is already present), and the additional checks involve the removal of the carburetors and intake manifold for access to the valveslfittings.

Provide the engine a source of cooling water, then start the motor and allow it to idle until it reaches normal operating temperature. Disconnect the aft end of the No. 1 cylinder recirculation hose from the fitting on the cylinder block. Submerge the end of the hose in a cup of water and observe.

- If bubbles appear, refer to Checking Cylinder Block Fittings. On these models, the carburetors and intake manifold assembly must usually be removed in order to access the cylinder block fitting and cylinder check valve.
- If no bubbles appear, inspect the 2 check valves for each cylinder by injecting them with isopropyl alcohol from the rear of the intake manifold (yes, the carburetors and intake manifold must be removed for this check as well). The valve should allow flow only in one direction, from the block side of the manifold toward the carburetor side of the manifold. If a valve allows flow in the opposite direction, in both directions or resists flow in both directions, replace the valve.

Before re-installing the intake, make sure all recirculation system passages are clean and free of deposits or debris.

Checking Cylinder Block Fittings—All Models

Connect a piece of clear tubing to the syringe and fill the syringe and tubing with Isopropyl Alcohol. Remove the recirculation hose from one of the crankcase fittings and connect the clear tubing to the fitting.

Press gently on the end of the syringe plunger. If the fluid flows easily, the fitting is clear. If there is no fluid flow, the fitting is plugged and must be cleaned with a wire gauge. Insert a wire gauge (such as Evinrude/Johnson Nipple Cleaning Tool # 326623 or equivalent) through the center of the fitting. Connect the syringe tubing to the fitting again, and verify the fitting is clear.

Repeat this test on all remaining recirculation fittings on the crankcase.

In-Line Check Valve Test

☐ **In-line check valves are used on the recirculation system for 120-300 Hp (2000/3000/4000cc) V4/V6/V8 motors, also known as 90° loopers.**

90° V4 (1992-1996) and V8 Only

◆ **See Figure 154**

Disconnect the in-line check valve from the recirculation hose. Connect the syringe filled with Isopropyl Alcohol and 1/8 in. clear tubing to fitting " A on the check valve. Press on the syringe plunger, fluid should flow easily out fitting "C" only.

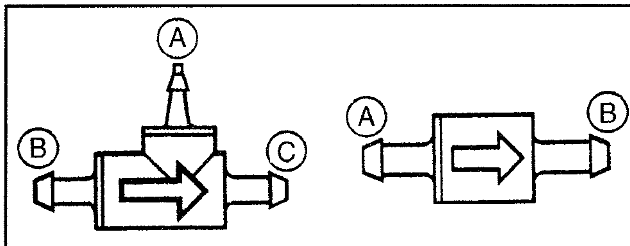


Fig. 154 Simple line drawing of the in-line check valve used on 90° looper outboards. Pictured on the left is a valve from a V4 power powerhead through 1996 and all V8 powerheads, while the valve used on 1997 and later V4 powerheads, as well as all V6 motors is on the right. The text makes reference to the letters called out on the drawings.

Move the tubing to fitting "B" and again press on the syringe plunger. Fluid should flow easily out fitting "C" only.

If the fluid flow was restricted through fitting "C", replace the check valve. If there was leakage from fittings " A or "B" during this test, replace the check valve.

Connect the tubing to fitting "C" on the check valve and press on the syringe plunger. Fluid should NOT flow from any fitting on the valve. If fluid flows from a fitting, replace the defective check valve.

90° V4 (1997 and later) and V6 Only

+ **See Figure 154**

Disconnect the in-line check valve from the recirculation hose. Connect the syringe filled with Isopropyl Alcohol and 1/8 in. clear tubing to fitting " A on the check valve. Press on the syringe plunger. Fluid should flow out through fitting "B". Move the tubing to fitting "B" and again press on the syringe plunger. Fluid should Not flow out through fitting " A.

If the fluid flow was restricted through fitting "B", replace the check valve. If there was leakage from fitting " A, replace the check valve.

Check Valve Test at Crankcase—All 900 Models

Use this check valve test for 120-300 Hp (2000/3000/4000cc) V4/V6/V8 motors, also known as 900 loopers.

Disconnect the hose from one of the fittings on the base of the intake manifold. Connect a syringe filled with Isopropyl Alcohol to the fitting. Press lightly on the syringe plunger. Fluid should NOT flow through the fitting. If fluid flows through, replace the check valve.

Now, pull out lightly on the syringe plunger, air should be drawn into the syringe through the valve. Some dark fluid may be drawn into the syringe—this is acceptable. If no air or fluid is drawn out with the syringe, replace the defective check valve.

Intake Manifold Internal Check Valve Tests—90° V6 Only

The recirculation system for 185-250 Hp (3000cc) V6 motors, also known as 90° looper V6s, utilizes an internal intake manifold check valve. Use this test to check that valve, but only after all other system component checks have been made.

Access to the internal check valves requires the carburetors and intake manifolds be removed first. Using a piece of wire, slip the check valve out from the recess in the crankcase. Place the small end of the check valve into a piece of clear vinyl tubing about 6 in. (15.24cm) in length. Be sure not to cover the holes in the center of the check valve.

Now, gently blow air through the tubing. Air should pass through the check valve. If no air passes through, the valve is defective and MUST be replaced.

Using a hand held vacuum pump (or your lungs, but be careful not to suck in anything too nasty), attach the tubing to the pump and attempt to draw air through the check valve. No air should pass through the valve and a vacuum should be indicated on the gauge. If air passes through, the valve is defective and MUST be replaced.

Test the remaining check valves in the same manner. Replace any defective valves. Insert the valves into the crankcase. Install the intake manifolds and carburetors.

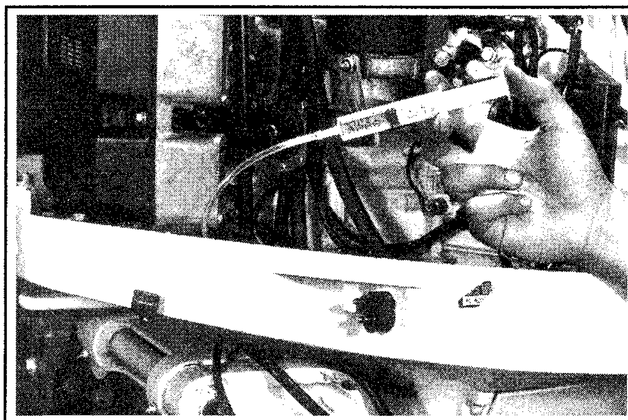


Fig. 153 Pushing on the syringe when making a test of the cylinder block fittings, as described in detail in the procedure

Recirculation Hose Routing

◆ See Figures 155,156 and 157

The recirculation hoses should be inspected at least once a season for condition and security. If any hose is damaged, cracked or hard from age, it must be replaced in order to draw a vacuum and scavenge any fuel/oil residue from the crankcase.

■ **The illustrations given here are for the 120-300 Hp (2000/3000/4000cc) V4/V6/V8 motors, also known as 90° loopers. For** 80 Jet-175 Hp **(1726/2589cc) V4/V6** motors (the **60°** loopers); there are no **inline Ts** or check valves. On 600 motors, the lines run from fittings on the cylinders to fittings on the intake manifold **only. The** lower cylinder on each bank is plumbed to the carburetor for the highest cylinder on each bank and vice-versa. On V6 motors, the lowest is plumbed to the highest, then the middle cylinder is plumbed **to** the lowest carburetor and the highest cylinder is plumbed to the middle carburetor.

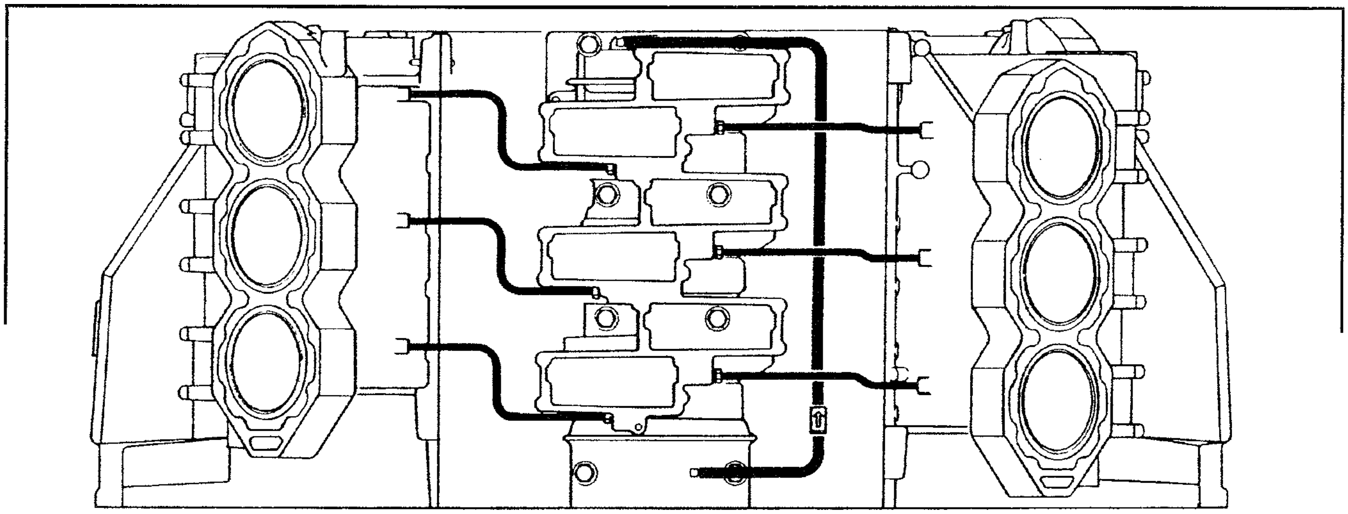


Fig. **155 Line drawing to depict typical recirculation hose routing on a 90° V6 powerhead**

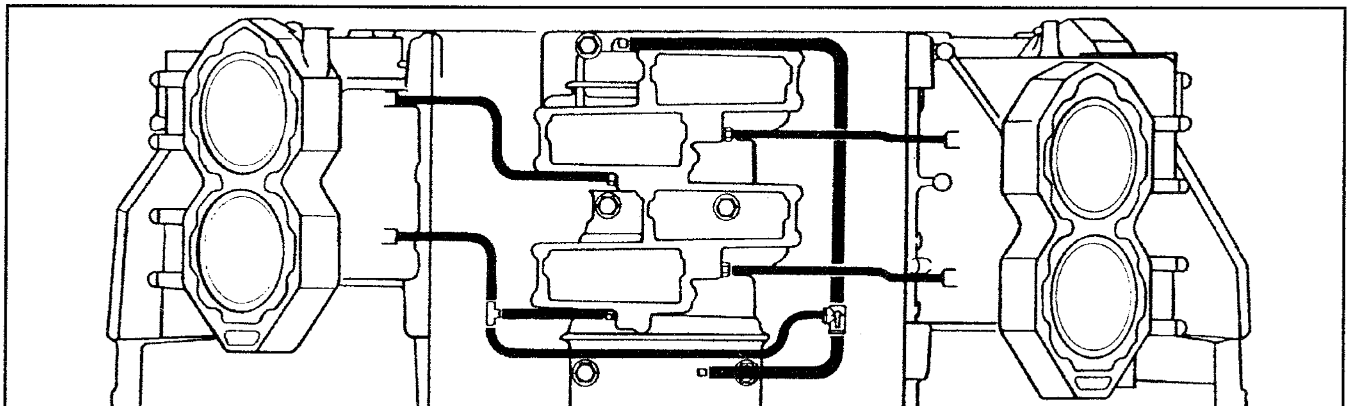


Fig. 156 Line drawing depicting typical recirculation hose routing on **90°** V4 (1992-96) and V8 powerheads

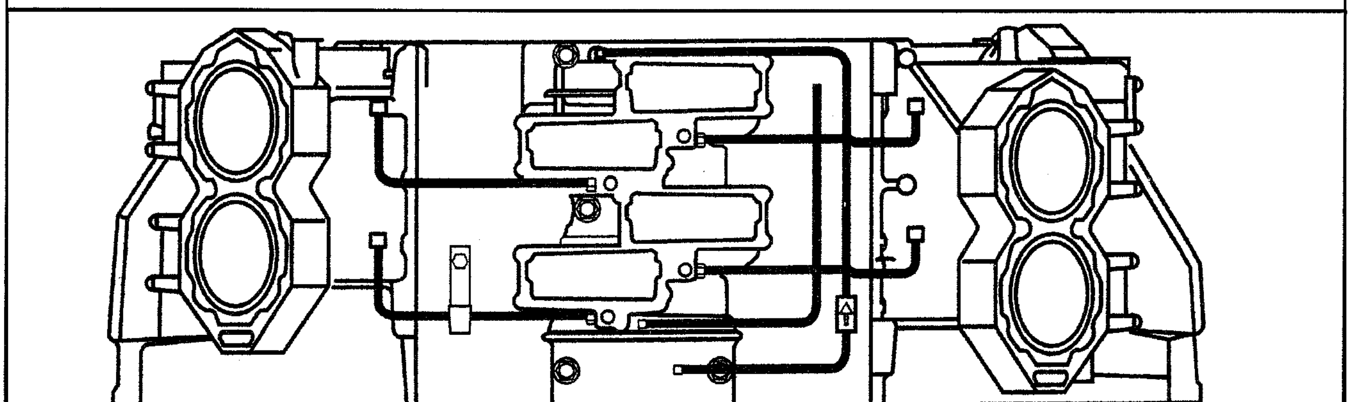


Fig. 157 Line drawing depicting typical recirculation hose routing on 1997 and later **90° V4** powerheads

FICHT FUEL INJECTION (FFI)

✳✳ CAUTION

Disconnect the negative battery cable ANYTIME work is performed on the engine, especially when working on the fuel **system. This** will help prevent the possibility of sparks during service (from accidentally grounding a hot lead or powered component). Sparks could ignite vapors or exposed fuel. Disconnecting the cable on FFI motors will also help prevent the possibility fuel spillage if the key is turned to start while the high-pressure fuel system is open.

✳✳ CAUTION

Fuel leaking from a loose, damaged or incorrectly installed hose or fitting may cause a fire or an explosion. ALWAYS pressurize the fuel system and run the motor while inspecting for leaks after servicing any **component** of the fuel system.

Although not absolutely necessary for troubleshooting and service, some operations require, while other are simply made easier by, the EvinrudelJohnson Diagnostic **Software. The** manufacturer sells various versions software, one for use in IBM compatible laptop computers and another for Palm Pilots or other Personal Data Assistants **(PDAs)** that utilize the Palm Operating System. Prices vary, though at time of authoring, the laptop software was cheapest, around $40.00 **U.S.** while the PDA CD-Rom was much more expensive, around $300.00 U.S.

Description and Operation

◆ See Figures **158,159,160,161,162** and **163**

EvinrudelJohnson,working with the FICHT Engineering company of Kirchseeson, Germany began producing Direct Fuel Injection (DFI) outboards, known as FICHT Fuel Injected (FFI) or just "FICHT" motors in the late 1990s. Because of the revolutionary design of the FICHT fuel injector, these motors differed greatly from the fuel injection used on other 2-stroke engines (and from the fuel injection systems used on most other modern outboard or automobile 4-stroke engines).

If you have a passing familiarity with other fuel injection systems, let us set the FICHT motors apart by explaining first the differences. But, don't worry, because even if you're new to fuel injection, we'll go ahead and paint the whole picture for you.

Most modern fuel injection systems utilize fuel injectors that are little more than solenoid valves (electronically actuated valves). This type of fuel injector simply opens against spring pressure when actuated allowing pre-pressurized fuel to spray through the opening. On these typical systems, the amount of fuel sprayed into the cylinder is a function of the amount of time the injector remains energized during the intake phase of the Otto cycle. (For details on mechanical engine operation and the Otto cycle, please refer to Basic Operating Principles in the General Information section.)

The fuel injection systems found on many 2-stroke outboards is a little more complicated, in that they use extreme high pressure fuel or airlfuel spray that is often achieved through the use of a compressor. For instance, the Orbital Engineering Company@from Australia produces a system used in many 2-stroke applications (such as some Sea-Doo® personal watercraft) which requires the use of an air compressor and drive system along with a combination airlfuel manifold and direct injectors.

Although EvinrudelJohnson worked with the Orbital Engineering Company in the early 1990s to investigate that technology and actually developed prototype Orbital Injected outboards, in the end, they felt that FICHT offered a better alternative to the use of so many additional components. The centerpiece of the FICHT design is the use of an electromagnetic piston valve direct injector that is capable of generating its own pressure through the hammering motion of the piston. Although the high-pressure fuel circuit of a FICHT motor is generally regulated to about 20-30 psi (138-207 kPa), the FICHT fuel injector itself is capable of forcing the fuel into the cylinder at over 250 psi (1724 kPa). In most other respects, FICHT operates in a similar manner to most other fuel injection systems.

For starters the FFI system itself can be segmented into 4 inter-related sub-systems:

- Low-pressure fuel circuit
- Oil delivery circuit
- High-pressure fuel circuit
- Electronic engine controls

■ For more information on the FICHT Oil delivery circuit, please refer to the Lubrication and Cooling section.

The low-pressure circuit delivers a fuelloil mixture fuel through a filterlwater separator canister to the vapor separator that serves as a fuel reservoir for the high-pressure circuit. The key component of the low-pressure fuel circuit is the fuel pump, which the manufacturer normally refers to as the lift pump (since it lifts fuel from the tank and provides it to the FICHT system). The lift pump is a diaphragm-displacement fuel pump actuated by crankcase pules in a way VERY similar in form and function to the pumps used on non-oil injected 2-stroke EvinrudelJohnson carbureted motors. The pump itself receives fuel from the boat's fuel tank and oil from the oil delivery circuit. Although it is conceivable that the low-pressure circuit may be rigged with a portable or built-in fuel tank, the size of FICHT motors makes it likely that they will be rigged with larger boat-mounted tanks. The system is often rigged with a boat-mounted filter canister/water separator, in addition to the engine-mounted canister. This makes the engine-mounted canister more of a backup, or second line of defense in keeping the system safe from moisture or debris.

The role of the low-pressure circuit is to keep the electric pump of the high-pressure circuit supplied with sufficient fuelloil mixture to meet engine operating demands.

The high-pressure circuit ensures proper operation of the FICHT fuel injectors (that require a constant supply of pressurized fuel in order to function properly). The circuit uses a high-pressure pump mounted next to the vapor separator tank to build system pressure and maintain it through a fuel pressure regulator that vents excess fuellpressure back into the vapor separator tank. A single FICHT fuel injector is mounted directly to each cylinder. Each fuel injector contains a high-speed piston assembly that is operated by an electromagnet. The injector piston is used to force a fuel mixture out the injector nozzle at extreme high pressure, creating a highly combustible fuel mist. Spray is directed toward a central "splash port" at the center of each piston that redirects the spray/mist upward in the combustion chamber, again improving combustibility. The high-speed injector is capable of pulsing at a cyclic rate of up to 100 times per second, hammer pulsing proper amounts of fuelloil spray into the combustion chamber for varied engine operating conditions.

One of the keys to smoke-free and low emission operation for FICHT motors is the fact that the fuel injection can be so precisely controlled that the fuel charge does not reach the exhaust port before it is covered by the piston. Another important element is the use of a multi-strike ignition system that is capable of firing more than once during a single combustion event within the cylinder, helping to ensure more complete combustion.

Additionally, the FICHT motor employs 2 basic fuel strategies:

- Stratified injection
- Homogeneous injection.

During idle and trolling conditions, fuel is injected using Stratified injection strategy. Due to fuel/air density that occurs with low RPM operation and fuel spraying near the spark plug itself, the system employs multiple plugs firing to ensure proper combustion. The multi-strike ignition pattern also helps to keep the spark plug tip clean and free of deposits. During stratified injection, spark is timed to begin just as the fuel reaches the plug tip.

During engine startup and high RPM operation, fuel is injected using the homogeneous injection strategy. For these operating conditions, fuel is injected while the piston is lower in the cylinder allowing turbulence to better mix the air and fuel. During start-up, multiple plugs firing are used to ensure quick-starting, but during high RPM conditions only a single plug firing is necessary per combustion event.

The electronic engine control system monitors and controls engine operation in order to properly meter fuelloil delivery to match operating conditions. The role of the Electronic Management Module (EMM) and the fuel injectors is to do electronically what the carburetor does mechanically on other motors. The precise control made possible by the EMM's

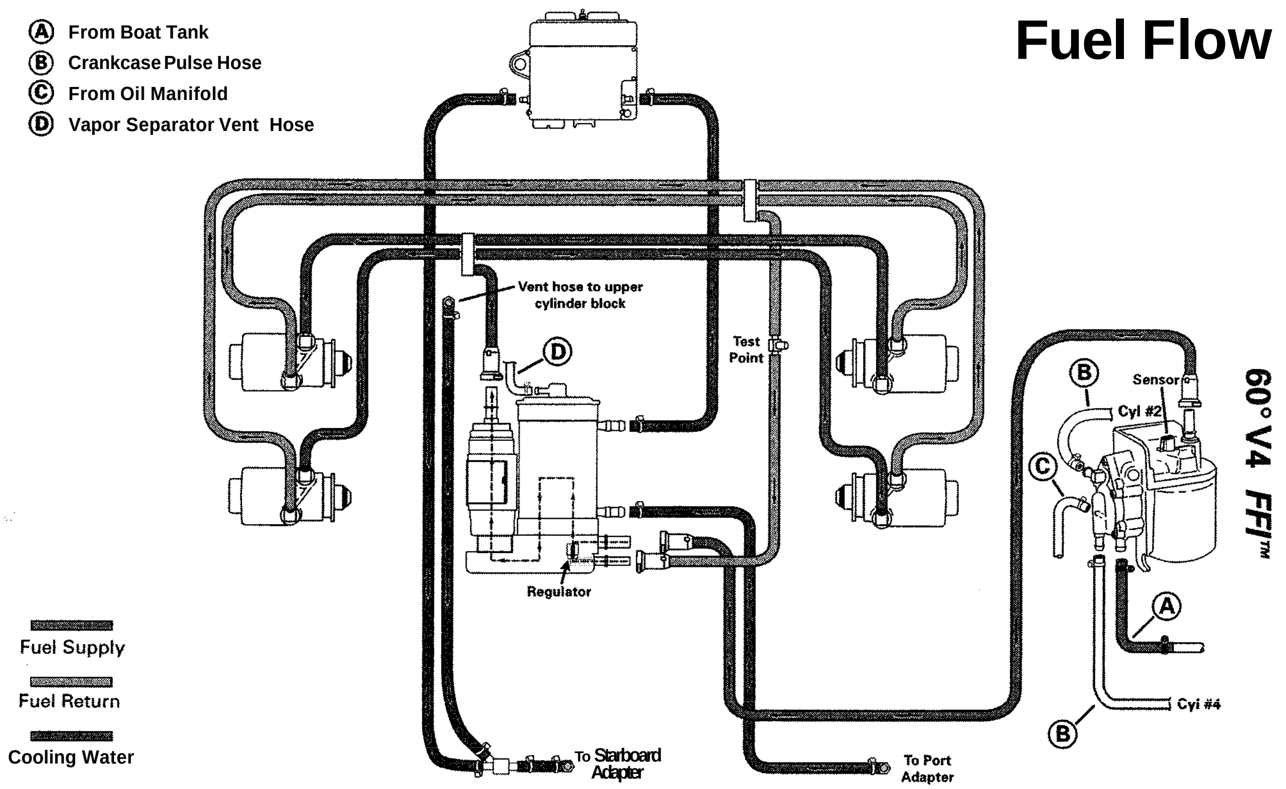


Fig. 158 Fuel and cooling water flow diagram—751901115 Hp V4 FICHT motors

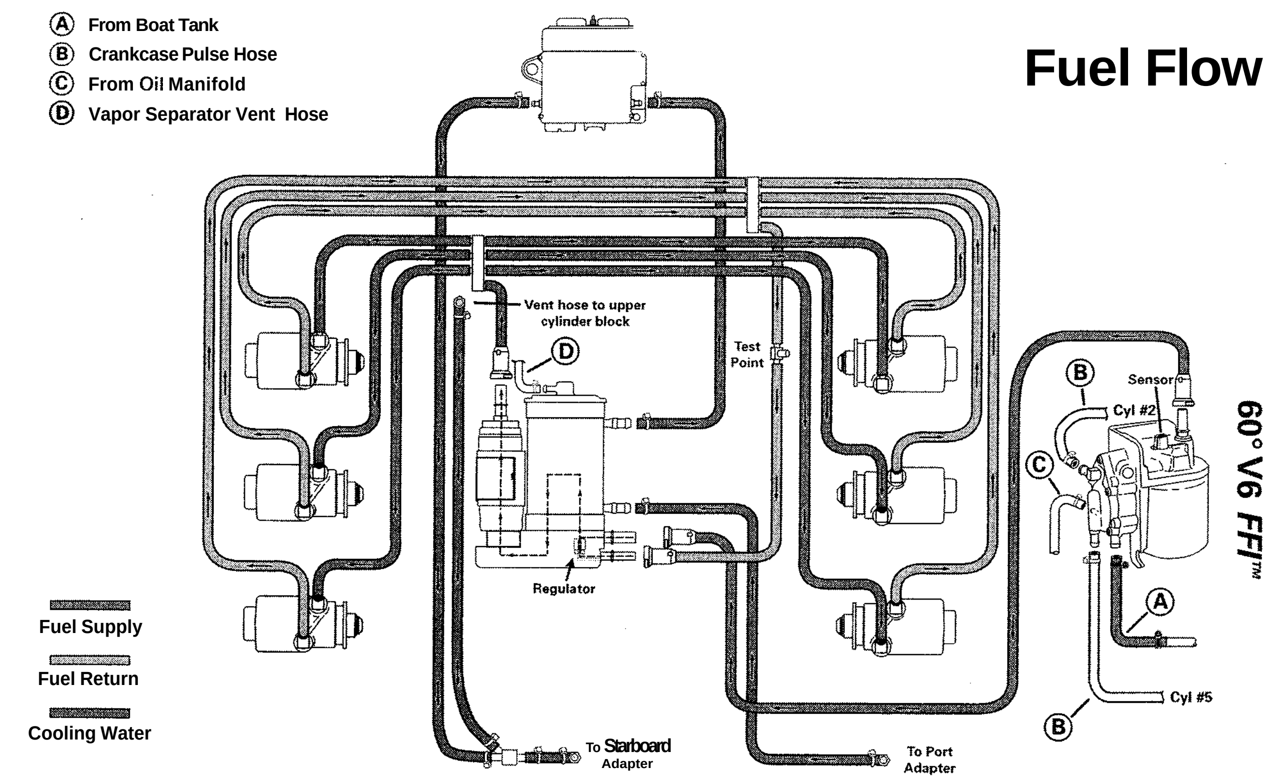


Fig. 159 Fuel and cooling water flow diagram—1501175 Hp 60° V6 FICHT motors without fuel rails

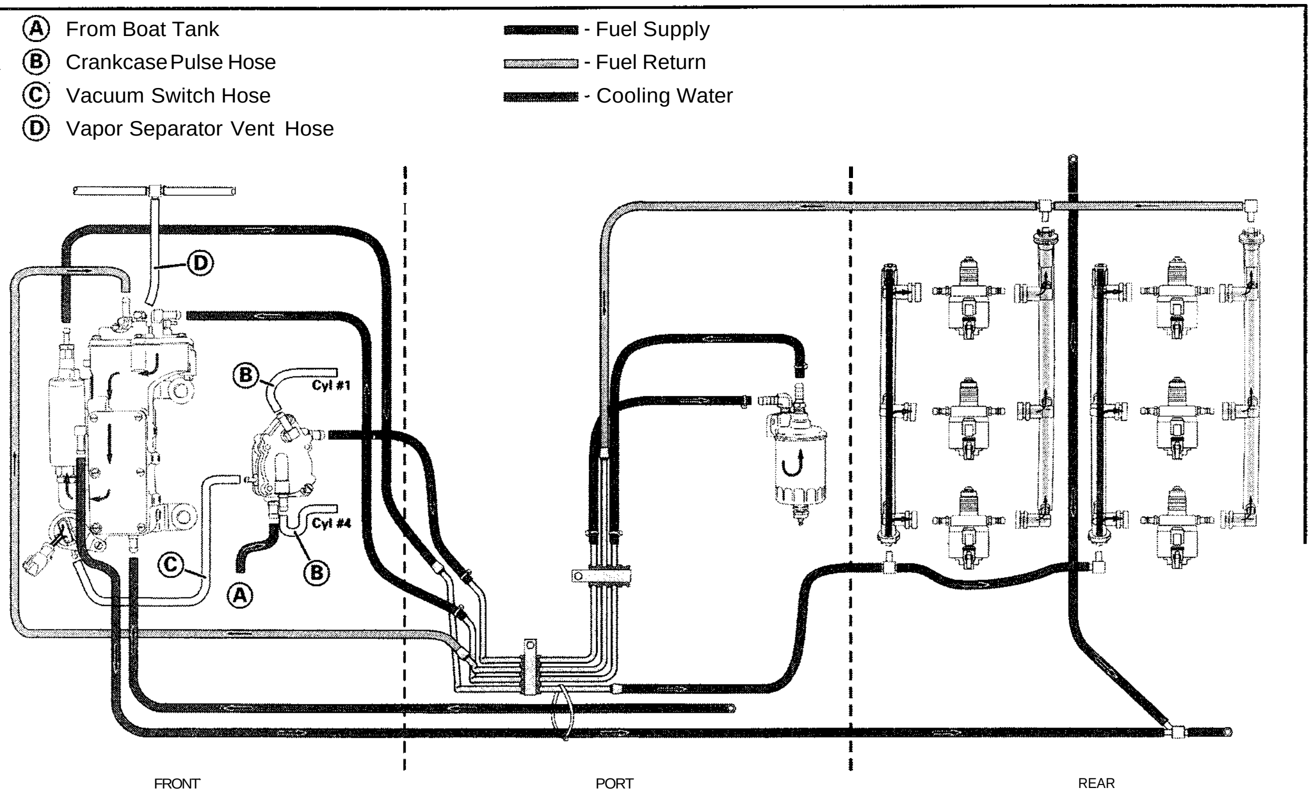


Fig. 160 Fuel and cooling water flow diagram—1501175 Hp **60° V6 FICHT** motors with fuel rails

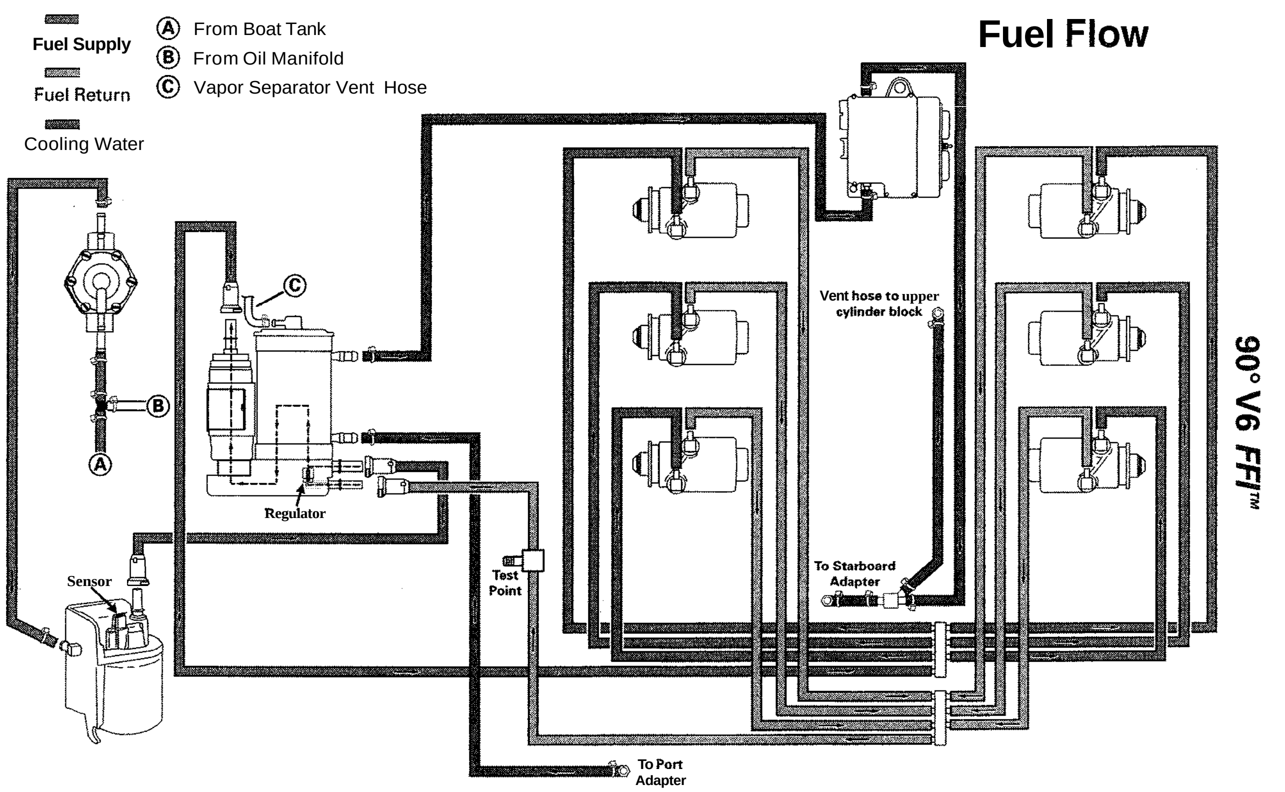


Fig. 161 Fuel and cooling water flow diagram—20012251250 Hp **90° V6 FICHT** motors

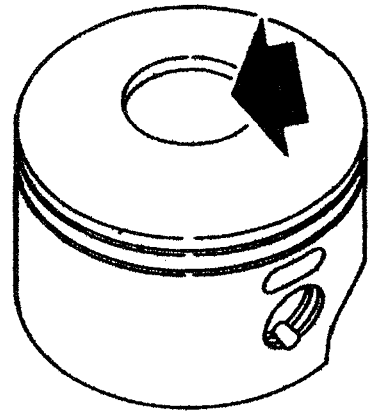


Fig. 162 The pistons on FICHT motors contain a "splash port" in the dome used to deflect oillfuel mixture spray to achieve better atomization

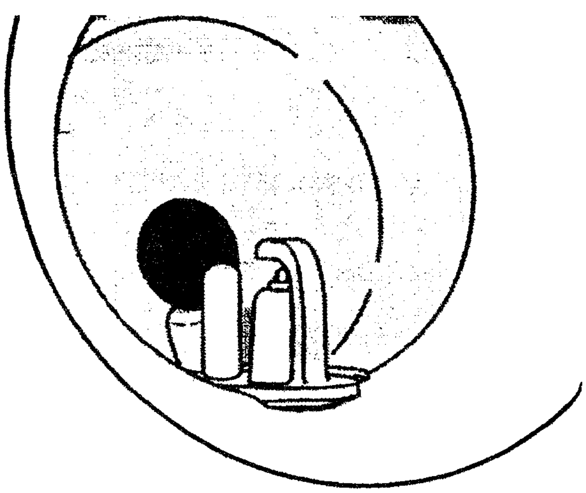


Fig. 163 Some FICHT motors contain a deflector pin between the fuel injector nozzle and the spark plug to prevent the plug from being hit directly with **oil/fuel** spray

microprocessors allows an FICHT motor to increase both reliability and performance while simultaneously decreasing harmful emissions. And, those are all good things, right?

The electronic engine control system monitors engine operation through a number of electronic switches and sensors mounted to both the powerhead and mounted inside the EMM itself. The role of the sensors and switches is to translate mechanical information such as throttle position or even the exact position of the pistons (on what portion of each stroke, each piston is as determined by crankshaft position) into electronic data for use by the EMM. The system is equipped with the following external sensors:

- Air temperature (AT) sensor
- Water temperature (WT) sensor
- Water temperature switch
- Shift interrupt switch (V6 models only)
- Throttle position (TP) sensor
- Crankshaft position (CP) sensor

The FICHT system is also equipped with the following internal sensorslswitches (which are integral with the EMM) and control circuitry:

- Exhaust and/or Barometric pressure sensor
- EMM temperature sensor
- 40-volt (most models) or 26-volt (certain 90-175 hp models) circuit sensor
- RPM limiter
- Idle governor
- 12-volt circuit sensor
- ROM verification (self-diagnostic) circuitry

Based upon input from the various sensors, the EMM makes all decisions regarding fuel mapping (the amount of fuel iniected in relation to engine speed and load), ignition timing and oil injector operation.

Many system components are cooled by water, fuel, or oil, in order to ensure reliable and predictable operation. A small amount of fuel constantly passes through each fuel injector, cooling the solenoid before exiting the injector and returning to the vapor separator tank through the return line. Similarly, a small passage in the oil injector allows a portion of the oil flow to pass through the injector, cooling the coil and armature, before returning to the boat's oil tank. Other components of the system, including the vapor separator tank and the EMM contain water passages to aid in cooling the components. The water flow through the EMM housing helps to keep the circuitry from becoming too hot, while the cooling circuit of the vapor separator tank is provided to prevent the possibility of vapor lock or hot soak conditions.

SYSTEM IDENTIFICATION

FICHT was introduced in the late 1990's to a mixed review from people who did not want to embrace new technology. Perception of the technology was not helped by troubles (mostly from buildup of excessive carbon deposits in combustion chambers) that included premature powerhead failure on some early models. The 150 hp V6 was the first motor on which the technology was used and, as such, the early production units suffered most of the problems. As of this writing, most of the problems seem to have been attributed to poor quality control in the late years of OMC, prior to the bankruptcy. The new parent company of Evinrude/Johnson (Bombardier) has embraced the FICHT technology and holds to the claim that the problem was not with the system but with quality control, which they claim to have fixed on their versions of the Evinrude/Johnson motors.

For the pre-Bombardier units covered here, there appear to be 3 possible permutations of the FICHT Fuel Injection (FFI) system, all of which are VERY similar, but which may differ slightly in individual component placement and some specifications. A slightly different version of the system is used on each of the following groups of motors:

- All 75-115 hp (1726cc) V4 motors and 135-175 Hp (2589cc) V6 motors (EXCEPT, those motors equipped with fuel rails)
- 1501175 Hp (2589cc) V6 motors equipped with fuel rails
- 200-250 hp (3000/3300cc) V6 motors

The earliest system produced seems to have remained in production on some 1501175 hp motors and is most easily identified by the fact that it contains automotive style hard fuel rails (as opposed to the soft fuel distribution lines found on all other FICHT motors). Although this is the version of the system whose earliest models suffered most problems, there is no evidence that suggests the system itself is to blame. If you're working on one that's been in service, don't loose any sleep over it, as the faulty units/components have, most likely, been found and replaced already. This system is the most different from other FICHT systems in both component location and function. The fuel filter, fuel component bracket, charging system, ignition system and EMM all contain subtle changes. These differences will be referred to throughout the procedures in this section when we refer to "1501175 hp motors with fuel rails."

The other 2 systems used on V4 and V6 motors are more similar to each other than dis-similar, but some differences occur between the version used on the 60° V4/V6 (1726/2859cc) models and the one found on 90° V6 (3000/3300cc) models. We will refer to those differences in text, by hp and/or cc.

Troubleshooting Electronic Fuel Injection

On carbureted outboards fuel is metered through needles and valves that react to changes in engine vacuum as the amount of air drawn into the motor increases or decreases. The amount of air drawn into carbureted motors is controlled through throttle plates that effectively increase or decrease the size of the carburetor throat (as they are rotated open or closed).

In contrast, fuel injected engines use a computer control module to regulate the amount of fuel introduced to the motor. The control unit or Electronic Management Module (EMM) monitors input from various engine sensors in order to receive precise data on items like engine position (where each piston is on its 2-stroke cycle), overall engine speed, air or water temperatures, exhaust and/or barometric pressure and throttle oosition. Analyzing the data from these sensors tells the EMM exactly how much air is drawn into the motor at any given moment and allows it to determine how much fuel is required (as well as how much oil and what ignition timing curves to use).

The EMM will hammer pulse the fuel injectors (activating them repeatedly up to 100 times per combustion cycle for a single cylinder) to spray metered amounts of the oil/fuel mixture needed for optimum performance with minimum emissions. This electronically controlled, precisely metered fuel spray or "fuel injection" is the heart of the FICHT fuel injection system and the main difference between a fuel injected and carburetor motor.

Troubleshooting a fuel injected motor contains similarities to carbureted motors. Mechanicallv, the powerhead of a 2-stroke fuel injected motor operates in the same way as a carbureted 2-stroke. There still must be good engine compression for either engine to operate properly. Wear or physical damage will have virtually the same affect upon either motor. Furthermore, the low-pressure fuel system that supplies fuel to the reservoir in the vapor separator tank operates in the same manner as the fuel circuit that supplies gasoline to the carburetor float bowl (on non-oil injected models).

The major difference in troubleshooting engine performance on FICHT motors is the presence of the EMM and electronic engine controls. The complex interrelation of the sensors used to monitor engine operation and the EMM used to control the fuel, oil injection, and ignition svstems makes logical troubleshooting all that much more important.

Before beginning troubleshooting on a FICHT motor, make sure the basics are all true. Make sure the engine mechanically has good compression (refer to the Compression check procedure that is a part of a regular Tune-Up). Make sure the fuel is not stale. Check for leaks or restrictions in the Lines and Fittings of the low-pressure fuel circuit, as directed in this section under Fuel Tank and Lines. FICHT systems cannot operate properly unless the circuits are complete and a sufficient voltage is available from the battery and charging systems. A quick-check of the battery state of charge and alternator output with the engine running will help determine if these conditions are adversely affecting FICHT operation.

Loose/corroded connections or problems with the wiring harness cause a large percentage of the problems with FICHT systems. Before getting too far into engine diagnostics, check each connector to make sure they are clean and tight. Visually inspect the wiring harness for visible breaks in the insulation, burn spots or other obvious damage.

In order to help find electronic problems with the FICHT system, the EMM contains a self-diagnostic system that constantly monitors and compares each of the signals from the various sensors. Should a value received by the EMM from one or more sensors fall outside certain pre-determined ranges the module will determine there is a problem with that sensor's circuit. Basically the EMM compares signals received from different sensors to each other and to real world possible values and makes a decision if it thinks one must be lying. For instance, if the EMM receives a ridiculous signal, let's say the air temperature sensor suddenly provides a signal of 338°F (170°C), the EMM will know there is something wrong with that signal. Depending on the severity of the fault or faults, the engine will continue to run, substituting fixed values for the sensors that are considered out of range. Under these circumstances, engine performance and economy may become drastically reduced. In many instances, the module will reduce the motor to idle speed, but allow it to keep running so the boat can reach port.

■ **The EMM utilizes an Electronically Erasable Programmable Read Only Memory (EEPROM) which will maintain trouble codes, even if the battery is disconnected. Codes will remain in memory, until either the codes are manually erased or the motor is operated for 15 hours after the condition that originally caused the code to set is corrected. Once the basics are checked on FICHT motors, the next step for troubleshooting is to check, record and clear codes. If codes are not present, yet problems persist, use the symptom charts to help determine what further components or systems to check.**

When a fault is present the EMM will store a diagnostic code in memory. The EMM will usually illuminate the Check Engine light in the gauge package and sound the warning horn to alert the operator. Codes can be retrieved by following specific procedures and then used to help determine what components and circuits should be checked for trouble.

Remember that a fault code doesn't automatically mean that a component (such as a sensor) is bad, it means that the signal received from the sensor circuit is missing or out of range. This can be caused by loose or corroded connections, problems with the wiring harness, problems with mechanical components (that are actually causing this condition to be true), or a faulty sensor.

In addition, troubleshooting charts are provided based on symptoms that should be used to help narrow down problems in engine performance. If no diagnostic codes are present, refer to these charts (after performing the basic checks mentioned earlier) to help determine what further components or systems to check.

Once components or circuits that require testing have been identified, use the testing procedures found in this section (for other sections, as applicable) and the wiring diagrams to test components and circuits until the fault is determined.

Keep in mind that although a haphazard approach might find the cause of problems, only a systematic approach will prevent wasted time and the possibility of unnecessary component replacement. In some cases, installing an electronic component into a faulty circuit that damaged or destroyed the previous component will instantly destroy the replacement. For various reasons, including this possibility, most parts suppliers do not accept returns on electrical components.

ISOLATING PROBLEMS WITH THE FICHT SYSTEM

◆ **See Figures 164 and 165**

✳✳ CAUTION

The FICHT ignition system operates a primary circuit of 250 volts and a secondary circuit with voltage exceeding 35,000 volts. This represents a serious shock hazard. To prevent serious or fatal injury, NEVER handle ignition system components with the engine running or cranking.

On FICHT motors the fuel, oil, ignition and electrical systems are integrated in such a manner that a problem with one may manifest itself as a symptom in another. For this reason, logical troubleshooting procedures are essential. Use this steo-by-step procedure along with the Symptom Charts and the trouble codes of the Self-Diagnostic System to properly isolate and correct problems.

1. Check ALL ground wires and wire connections for clean and tight connections that are undamaged and free of corrosion. Poor grounds may cause symptoms including failure to start and misfiring. Any questionable ground connection should be disassembled, inspected and cleaned or replaced.
2. Check ALL fuses in the power distribution panel (positions 1-7). For all except 1501175 hp motors equipped with fuel rails, check the 20-amp inline switched battery positive to EMM fuse. Replace any fuses that have failed.
3. Remove and examine the spark plugs, one-by-one for indications of rich or lean cylinders, fouling or signs of internal engine damage. For details, please refer to Spark Plugs in the Maintenance and Tune-up section.
4. Check and retrieve any stored trouble codes from the Self-Diagnostic System, as detailed in this section.
5. If the engine won't crank, check the following:
   - Filter module (except 1501175 hp motors with fuel rails)
   - Main battery switch (if used)
   - Battery condition and connections
   - Fuse in position No. 7 (if not already done in the 2nd Step)
   - Start delay relay (except 1501175 hp motors with fuel rails)
   - 20-amp inline fuse (except 150/175 hp motors with fuel rails)
   - Emergency stop switch and other related boat wiring (except 1501175 hp motors with fuel rails)

✳✳ CAUTION

To prevent injury or damage, all spark plug leads must remain connected to a spark tester that has been adjusted to a 7/16 in. (11mm) gap during cranking tests. DO NOT connect the spark tester to the EMM or its brackets and be certain that the tester and its leads are at least 2 in. (51mm) away from all wires or sensor leads.

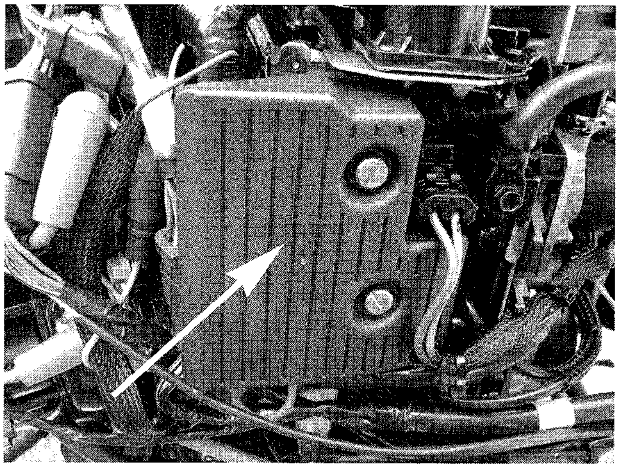


Fig. 164 One of the first FICHT troubleshooting steps is to check the power distribution panel (fuse box)...

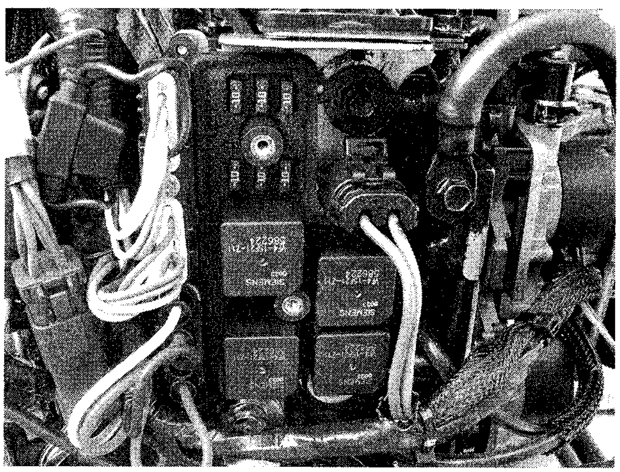


Fig. 165 ... once the cover is removed, visually check the panel for blown, damaged or missing fuses

6. If the engine will crank, but will not start. perform a cranking spark test using a spark tester whose gaps are adjusted to 7/16 in. (11mm). If there is steady spark on ALL ignition leads, proceed with the next step. If there is no spark at some or all leads, refer to the Symptoms Charts for further diagnosis.

☐ Make sure that all parts of the cranking circuit are connected and working properly. On 1501175 hp models equipped with fuel rails, the engine should crank as long as the fuse in position No. 7 is good (even if the 6 remaining fuses are blown or missing). For all other models, check pin 11 **(white/red** wire of the forward EMM connector) and pin 4 (purplelwhite wire of the rear EMM connector) for battery voltage with the key ON and the other side of the meter connected to a good engine ground.

7. If the engine will run, perform the following tests (preferably while recreating the symptoms):

The **Evinrude/Johnson** diagnostic software is capable of performing cylinder drop tests in addition to providing real-time engine data. If possible, the software and an **IBM** compatible computer should be used during the engine running tests to help isolate FICHT problems.

a. Use a timing light to monitor each spark plug lead. Look for a consistent spark, and only 1 spark per engine revolution (homogenous injection strategy occurs above 15% throttle). If all show a steady flash, the fault is fuel or electrical, proceed with Step B. If there is intermittent output or multiple fire on some, note the problem cylinders and proceed to the Symptom Charts for further diagnosis.

b. Use a timing light to monitor each fuel injector signal (be sure that you only clip the inductive pickup to **1** wire at a time). If all injectors show a steady flash, suspect faulty fuel delivery system, low injector driver system output or a failed injector. If there are intermittent problems on one or more injectors, note the problem cylinders. In both cases, proceed to the Symptom Charts for further diagnosis.

If an engine running problem occurs above 1800 RPM, the engine may be running with the Speed Limiting Operational Warning (S.L.O.W.) mode **activated. Trouble** codes should be present in this mode, refer to the Self-Diagnostic system for more information and to the appropriate symptom in the Symptom Charts for further diagnosis.

Self Diagnostic System

◆ See Figure **166** and Chart **2** Trouble **Codes—FICHT** Motors

READING CODES

② MODERATE

Certain electrical equipment such as stereos and communication radios can interfere with the electronic FICHT Fuel Injection **(FFI)** system. To be certain there is no interference, shut **these** devices off when troubleshooting. If a check engine light illuminates immediately after installing or re-rigging an existing accessory, reroute the accessory wiring to prevent interference.

When the electronic engine control system detects a problem with one of its circuits, the EMM will activate the Check Engine light found in the gauge pack and sound the warning horn. As a result of most faults, the EMM will ignore the circuit signal and enter a fail-safe mode designed to keeps the boat and motor from becoming stranded. During fail-safe operation the EMM will provide a fixed substitute value for the faulty circuit. During fail-safe operation the engine will run, but usually with reduced performance (power and economy).

In most cases, once a malfunction ceases (has been fixed or the circuit signal returns to something within the anticipated normal range), the warning system and engine operation will return to normal. Though in some cases engine speed may have to be reduced to idle or the motor-must be shut off and restarted for normal operation to occur.

The gauge Check Engine light is not only used as a warning, but it can also used to read the diagnostic trouble codes.

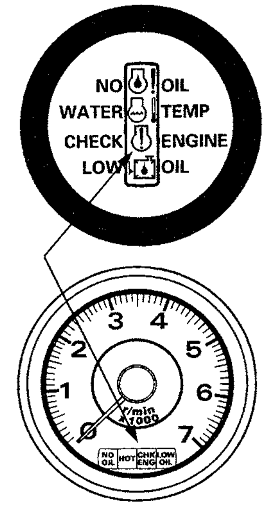


Fig. 166 The Check Engine light in the various **Evinrude/Johnson** gauge packages is used to alert the operator if the EMM detects an electronic fault

TROUBLE CODES

Code	Fault	Activates S.L.O.W.	Activates Gauge Light
Priority A			
11	System OK - no fault	no	none
12	TP sensor circuit malfunction	no	Check engine
13	TP sensor circuit below expected range	no	Check engine
14	TP sensor circuit above expected range	no	Check engine
15	ROM "check sum" verification	no	Check engine
16	Crank sensor misadjusted or damaged	no	Check engine
17	Alternator voltage below expected range	yes ①	Check engine
18	Alternator voltage above expected range	yes	Check engine
22	Water temperature switch activation	yes	Water Temp
23	EMM temperature sensor circuit malfunction	no	Check engine
24	EMM temperature sensor circuit below expected range	no	Check engine
25	EMM temperature sensor circuit above expected range	yes	Check engine
34	Oil injector circuit open	yes	No oil
35	Oil pressure loss, switch/circuit malfunction	yes	No oil
37	*Water-in-fuel sensor circuit activation*	no	Check engine
Priority B			
26	Battery voltage below expected range	no	Check engine
27	Battery voltage above expected range	no	Check engine
41	WT sensor circuit malfunction	no	Check engine
42	WT sensor circuit below expected range	no	Check engine
43	WT sensor circuit above expected range	yes	Water Temp
44	BP sensor circuit malfunction	no	Check engine
45	BP sensor circuit below expected range	no	Check engine
46	BP sensor circuit above expected range	no	Check engine
51	Injector #1 open load	no	Check engine
52	Injector #2 open load	no	Check engine
53	Injector #3 open load	no	Check engine
54	Injector #4 open load	no	Check engine
55	Injector #5 open load (V6 only)	no	Check engine
56	Injector #6 open load (V6 only)	no	Check engine
Priority C			
28	Shift assist circuit malfunction	no	Check engine
47	AT sensor circuit malfunction	no	Check engine
48	AT sensor circuit below expected range	no	Check engine
49	AT sensor circuit above expected range	no	Check engine
81	Ignition coil #1 open primary ②	no	Check engine
82	Ignition coil #2 open primary ②	no	Check engine
83	Ignition coil #3 open primary ②	no	Check engine
84	Ignition coil #4 open primary ②	no	Check engine
85	Ignition coil #5 open primary (V6 only) ②	no	Check engine
86	Ignition coil #6 open primary (V6 only) ②	no	Check engine

NOTE: Trouble codes are sorted into Priority levels to assist in troubleshooting. Fix A's first, as this may eliminate related B or C codes (similarly, fix B's before C's).

① YES on the 2001225 hp motors only, NO on all others

② Not used on 1501175 hp motors equipped with fuel rails

A code is normally displayed by using short flashes of the check engine light. The manufacturer has diagnostic software for FICHT engines that can also be used to retrieve codes and other stored EMM operational data. If available, a diagnostic connector is located in the engine harness to allow the connection with the computer cable adapter that is used with the diagnostic software. Follow the instructions that come with the software pack to use the diagnostic connector.

Once diagnostic mode is entered, the engine cannot be started.

Proceed as follows to display stored codes using the Check Engine light:

1. If the engine is running, shut the engine off using the ignition key switch.
2. Remove the top engine cover for access.
3. For 150/175 hp motors equipped with fuel rails, you have to make sure the EMM is fully powered down (discharged all capacitors) before proceeding, to accomplish this perform one of the following:
   - Disconnect the negative battery cable for 2 seconds
   - Shut off the battery switch (if equipped) for 2 seconds
   - Remove the EMM fuse from position No. 7 in the power distribution panel for 2 seconds
   - Turn the ignition keyswitch off and wait 10 minutes

On 150/175 hp motors, after waiting the appropriate amount of time (depending on the action), you'll then have to reconnect the cable, turn the switch on or reinstall the fuse (as applicable).

4. For 200/225/250 hp V6 motors, disconnect the starboard throttle link from the throttle cam, then manually move the throttle cam to its fullest limit of travel simulating Wide-Open-Throttle (WOT). Moving the throttle cam in this manner manually moves the TP sensor to the WOT position.

☐ DO NOT attempt to use the boat's remote control to activate the throttle cam or throttle position sensor, as damage could occur to the shift system if this is done without the motor running. In THEORY, you could have an assistant spin the propeller shaft by hand while gently moving the remote handle into the WOT position. But, if binding seems to occur, don't force the remote and **BE** SURE to remove the propeller first (we just don't like the idea of an assistant anywhere near the propeller during this procedure).

5. For 75-175 hp V4 and V6 motors, unbolt and remove the Throttle Position (TP) sensor from the flywheel cover. Manually move the TP sensor to the fullest limit of high-end travel in order to simulate WOT operation.
6. On ALL motors, use a rubber band, clip or piece of wire to hold the throttle cam or the TP sensor in the WOT position.
7. Turn the ignition switch to on in order to power up the EMM (the switch must remain on throughout the test with the emergency stop clip (if used) in position. Wait at least 10 seconds and watch for the codes to display on the Check Engine light.

☐ If **the TP** sensor or throttle cam is moved from the maximum limit before 10 seconds have passed, the **EMM** will NOT go into diagnostic mode and you'll have to start over from the beginning.

8. Any trouble codes present will begin flashing on the Check Engine LED. Count the flashing to determine the code(s). If more than one is present, each code will flash until all stored codes have displayed, then there will be long pause (several seconds), during which the Check Engine light will remain lit, After the pause, the codes will loop and being displaying again. This will continue until you exit the diagnostic mode or erase the trouble codes.

Interpret codes by counting the **flashes. There** will be a short pause between digits of the 2-digit code. **A** longer pause indicates the start of a different number.

9. Once the codes are counted/recorded, you should manually erase the codes and run the engine to see verify if any were hard codes (meaning the faults are still present) or to see if they were all soft (meaning stored for faults that occurred but are no longer present).
10. After the engine is run to normal operating temperature, shut the engine off and repeat the diagnostic trouble code reading procedure to see if any codes are present. Codes found again at this time should be considered hard codes or codes that represent a problem whose symptoms are still present.
11. Compare the codes with the accompanying code table to determine the defective circuit. Remember that a code does NOT necessarily mean a given component is at fault, it means that the EMM sees signal that is out of the normal, predetermined operating range. The problem may also lie with the wiring, another system or component that would make a circuit read out of specification.

Make sure all connections for that circuit and related components of the electrical system are clean and tight before troubleshooting the circuit. Bad wiring or connections can cause out of range signals and set trouble codes.

12. Test the sensor or system components as described in this section. When troubleshooting, always start with the easiest checks/fixes and work toward the more complicated.
13. Once the problem has been corrected, connect a source of cooling water to the flushing system, then start and run the engine to clear the codes and verify proper operation. If the problems are gone, all LEDs should extinguish after starting the motor.

MANUALLY CLEARING CODES

◆ See Figure **166**

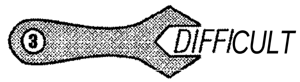
The Evinrude/Johnson diagnostic software can be also used to manually clear codes, but if the software is not available, a manual procedure can be conducted to erase all codes.

1. Enter diagnostic mode and allow the codes to begin displaying. For details, please refer to Reading Codes, in this section.
2. While in diagnostic move, return the TP sensor or the throttle cam to the low-end limit of its travel, simulating idle operation. The Check Engine light should come on and remain lit, wait 5 seconds or more, then move the sensor or cam again to the WOT throttle position (the Check Engine light should extinguish). Return the sensor or throttle cam AGAIN to the idle position (the Check Engine light should come on again). Repeat this step 4 more times, cycling the sensor or cam completely from stop-to-stop (from WOT to IDLE) and waiting at least 5 seconds at idle each time.
3. After returning the sensor or throttle cam to the low-end limit for the 5th time, the Check Engine light should remain on until the sensor is reattached to the engine or the throttle link is reattached. At that time, the light should go OUT if there are no hard codes present. If there are hard codes, the light will turn back on (but keep in mind that some hard codes will not show until the motor is run again).
4. Turn the ignition keyswitch off, erasing all service codes.

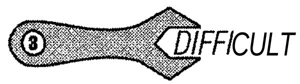
The manual codes erase procedure CANNOT be performed using the remote control handle as it will NOT move the sensor through its full range of travel.

Engine Symptom Diagnostic Charts

ALL 75-250 HP MOTORS
EXCEPT 1501175 HP
WITH FUEL RAILS



150/175 HP
WITH FUEL RAILS



Engine Won't Crank

SYSTEM/COMPONENT	CAUSES	ACTIONS
Battery and cables	Dead or low battery	Charge and test battery
	Loose or corroded connections	Check voltage drop across suspected problem connection
	Battery switch not ON	
Boat Electrical	Broken, loose or corroded wire in harness	Clean and repair as necessary
	Failed key switch	Test key switch
	Failed neutral switch in control	Test neutral switch or start circuit
	Emergency stop switch	Test neutral switch
Engine	Broken, loose or corroded wire or connection	Repair as necessary - remember to look for bad ground connections
	Blown 10A fuse position 7	Replace - Test RED circuit for excessive current draw
	Failed darter solenoid	Test solenoid
	Failed start delay relay	Test delay relay
	Failed filter module	Test filter module
	Failed starter or bendix	Test starter
	Seized powerhead or gearcase	Visually inspect
	Blown 20-amp iniine fuse	Replace
	Incomplete connection of white/red wire (pin 11) at EMM	Test voltage - Repair as necessary
	Incomplete connection of purple/white wire (pin 4) at EMM	Test voltage - Repair as necessary
	Failed main power relay	See Ignition System
	Failed stop circuit relay - position 8 no switched B+ to EMM	See Ignition System to test stop circuit
	Failed capacitor or bad connection	See Ignition System

CHART 1 ENGINE WON'T CRANK

Engine Cranks But Won't Start

SYSTEMICOMPONENT	CAUSES	ACTIONS
Fuel System	Water in fuel	Check fuel filter for water CODE 37
	Restricted or leaking fuel delivery system	Check for damaged primer bulb, antisiphon valve or poor connections that leak air
	Old/stale fuel	Substitute known good fuel
	Blown circulation pump fuse - position 4	Fuel pump should run for 10 seconds when key switch is turned ON = Replace fuse and retry
	Failed pump relay	See - Fuel System - Check Circulation Pump
	Failed circulation pump	See - Fuel System - Check Circulation Pump
	EMM – No signal to injectors	Monitor Injector wires while cranking or use FFI Diagnostic Software to activate Injectors. See - Fuel System. See also Failed start assist circuit (below)
Ignition System	EMM – No output to coils	Use a PRV to measure voltage at coils – 180V minimum
Electrical System	Blown fuse – position 5 No. 40V to EMM	Replace and retry - repeated failure may indicate a failed EMM
	Blown fuse – position 4 No switched B+ to fuel pump	See - Fuel System - Check Circulation Pump
	Failed or disconnected capacitor	See - Ignition System
	No voltage on purple wire	Check key switch, instrument harness or diode in engine harness
	Low cranking voltage	Low or inadequate battery, loose connection, etc.
	Failed start assist circuit	Low voltage on 40V circuit while cranking. See - Fuel System
	Crank position sensor – no output, no synchronization – incorrect output	***FFI* Diagnostics** Software should indicate at least 200 RPM while cranking. Adjust or test component.
Mechanical	Scored cylinders	

PRV: Peak reading voltmeter

CHART 2 ENGINE CRANKS BUT WON'T START

Engine Starts and Dies

SYSTEM/COMPONENT	CAUSES	ACTIONS
Fuel Svstem	Poor quality or spoiled fuel or water in fuel	Check fuel filter for water Substitute known good fuel Possible CODE 37
	Restricted or leaking fuel delivery system	Check for damaged primer bulb, antisiphon valve or poor connections that leak air
	Vapor separator float stuck closed	See - Fuel System
	Blown circulation pump fuse	Fuel pump should run for 10 seconds when key switch is turned ON – Replace fuse and retry
	Failed circulation pump or relay	See - Fuel System - Check Circulation Pump
	Failed lift pump	See - Fuel System
	EMM - intermittent signal to injectors(s)	Monitor injector signal using timing light while cranking or use ***FFI* Diagnostics Software** to activate Injectors.
Ignition System	Worn or fouled spark plugs	Replace as necessary
	Poor system grounds	A tight connection doesn't mean a good connection – check using an ohmmeter or o sassemble ana nspect
	Failed EMM – no output to coils	Use a PRV to measure voltage at coils – 180V minimum Possible CODE 81. 82, 83, 84, 85, 86
	Failed EMM – mis-timed	Mis-timed will cause engine to die as it accelerates – verify using timing light
	Incorrect timing	Use FFI Diagnostic Software to verify
Electrical System	Faulty key switch – intermittent B+ purple/white EMM pin connection	Troubleshoot harness, PDP or intermittent kill to ground
	Failed main power relay – intermittent connections	See - Ignition System
Mechanical	Damaged powerhead	See - Powerhead
Charging System Alternator Side	8-pin Deutsch from stator not fully engaged	Ensure wire connector is properly engaged Possible CODE 17
	Poor system grounds	Check ground, 2 black wires going to common ¼ in. ring terminal Possible CODE 17
	Open circuit on starter	Perform ohm check to verify Possible CODE 17

CHART 3 ENGINE STARTS BUT **DIES**

Engine Surges/Runs Rough

SYSTEMICOMPONENT	CAUSES	ACTIONS
Fuel System	Contaminated fuel or old stale fuel	Substitute known good fuel
	Restricted or leaking fuel delivery system	Check for damaged primer bulb, antisiphon valve, dirty filter or poor connections that leak air
	Failed pressure regulator - low or unsteady pressure	Upper cylinders may run lean. See - Fuel System
	Damaged fuel pump(s) - low pressure	See - Fuel System
	Failed fuel injector(s) or intermittent connection	See Fuel System - Fuel Injection System Possible CODE 51, 52, 53, 54, 55, 56
	Faulty vapor separator	Leaking or stuck closed. See - Fuel System
	Erratic EMM signal to injector(s)	Check for loose connection or ground, correct spark plugs and wires (RFI). Possible CODE 16, 51, 52. 53, 54. 55, 56
Ignition System	Damaged, worn, fouled or incorrect spark plugs	Replace with correct type. Possible CODE 16
	Crank position sensor - out of adjustment - erratic ignition and fuel	Inspect for damage and adjust as necessary Possible CODE 16
	Erratic output from EMM (misfire or multiple fire)	Check for loose connection or ground, correct spark plugs and wires Possible CODE 16
	Loose or broken wire or connection	Repair or replace as necessary
	Damaged or loose coil or primary lead	Be sure grounds are clean and tight. Repair or replace as necessary. CODES 81, 82, 83, 84, 85, 86
Electrical System	Loose battery connections	Clean and tighten
	Loose or damaged wire connection or ground	A tight connection doesn't mean a good connection. Check using an ohmmeter or disassemble and inspect.
	Failed stop circuit relay or intermittent connection	Monitor voltage at purple/white wire. See - Ignition System to test stop circuit.
	Failed main power relay or intermittent connection	Monitor voltage at fuse 4.
	Failed or disconnected capacitor	See - Ignition System
	Low 40V output - low voltage on white/green and whiteired wires	Monitor alternator voltage using *FFI* Diagnostic Software. CODE 17
Mechanical	Damaged powerhead	See - Powerhead for test procedures
S.L.O.W. (affects only fuel)	Engine overheat. oiling problems or high or low voltage on 40V system, EMM overheat	See items related to CODES 17, 18. 22, 25, 34, 35

CHART 4 ENGINE **SURGES/RUNS** ROUGH

Low Maximum RPM

SYSTEMICOMPONENT	CAUSES	ACTIONS
Fuel System	Faulty fuel pump(s) low fuel pressure	Monitor fuel system pressure See - Fuel System
Ignition System	Spark plug secondary open	No code
	Bad coil	No code
	Primary open	No code
Electrical System	Loss of throttle position sensor signal - Engine will stay at idle regardless of throttle position	Verify connections - use *FFI* Diagnostic Software to verify CODES 12, 13 or 14
	Blown injector fuse Fused in pairs	injectors are fused in pairs - this would affect 2 injectors. See - Fuel System
	Faulty EMM or incorrect software version	Verify using FFI Diagnostic Software Possible CODE 15
Mechanical System	Damaged powerhead	See - Powerhead -for test procedures
	Incorrect propeller - over propped	Water test and install correct pitch prop
	Throttle plates not opening enough	Check operation.
	Damaged gearcase	Inspect gearcase lube for debris
	Incorrect engine height	Check installation

CHART 5 LOW MAXIMUM RPM

Engine Won't Shut Off

SYSTEM/COMPONENT	CAUSES	ACTIONS
Boat Electrical System	Faulty key switch	Test key switch
	Faulty emergency stop switch	Test stop switch
	Broken wire or connection in stop circuit	See - Ignition System
Engine Electrical System	Broken wire or connection in stop circuit	See - Ignition System
	Stop circuit relay won't energize	See - Ignition System

CHART 6 ENGINE WON'T SHUT OFF

Excessive Smoking

SYSTEMICOMPONENT	CAUSES	ACTIONS
Fuel Svstem	Poor quality fuel	Substitute know good fuel
	Hole in lift pump diaphragm	Fuel present in lift pump pulse lines. See - Fuel System
	Vapor separator float stuck open	Fuel would flow from vapor vent hose. See - Fuel System
	Injector(s) stuck open	See - Fuel System
	Incorrectly connected fuel and oil hoses at engine	Engine may start with fuel and oil hoses swapped, but fuel system will be filled with oil
EMM	"Break-in" mode	Use *FFI* **Diagnostic** Software to verify
Oil System	Oil injector stuck open	Perform leakdown test See - Oil System
	Restricted or pinched oil return hose regulator check valves	System is operating in excess of 43 PSI causing continuous oil flow into bores. Visually inspect oil lines at nozzles.
Mechanical	Engine mounted too low on boat	Check installation

CHART 7 EXCESSIVE SMOKING

False Warning Light

SYSTEM/COMPONENT	CAUSES	ACTIONS
Boat Electrical System	Faulty System Check Gauge	Perform self-diagnostic test
	Damaged/shorted wire or connection	**System Check** Tester, P/N 437274, can be used to verify gauge function
Engine Electrical System	Faulty sender or circuit	Use ***FFI* Diagnostic Software** to verify EMM inputs and check for service codes
	Faulty EMM	Eliminate possibility of actual problem first

CHART 8 FALSE WARNING LIGHT

Engine Won't Crank

SYSTEMICOMPONENT	CAUSES	ACTIONS
Battery and Cables	Dead or Low Battery	Charge and test battery
	Loose/Corroded Connections	Perform start system Volt Drop test Clean and repair as necessary
	Battery Switch Not ON	
Boat Electrical	Broken, Loose or Corroded Wire in Harness	Clean and repair as necessary
	Failed Key Switch	Test Key Switch
	Failed Neutral Start Switch	Test Start Circuit
Engine	Broken, Loose or Corroded Wire or Ground	Clean and repair as necessary
	Blown 10A Fuse Position 7	Replace - Test Red/Pur circuit for excessive load
	Failed Starter Solenoid	Perform operational test
	Failed Starter or Bendix	Repair or replace
	Seized Powerhead or Gearcase	Visual inspection

CHART 9 ENGINE WON'T CRANK

Engine Cranks But Won't Start

SYSTEM/COMPONENT	CAUSES	ACTIONS
Fuel System	Water in Fuel	Check fuel filter for water - Code 37
	Old/Stale Fuel	Substitute known good fuel
	Restricted or Broken Lines, Fittings, or Filters	Repair or replace as necessary
	Blown Circulation Pump Fuse - Position 4	Fuel pump should run for 10 seconds when Key Switch is turned ON -Replace fuse and retry
	Failed Pump Relay	Fuel pump should run for 10 seconds when Key Switch is turned On. See Fuel System - Check Circulation Pump
	Failed Circulation Pump	Fuel pump should run for 10 seconds when Key Switch is turned ON - verify voltage supply and signal from ECU See Fuel System - Check Circulation Pump
	ECU - No Signal to Injectors	Monitor injector signal wires while cranking or use *FFI* Diagnostic Software to activate injectors. See - Fuel System
Ignition System	Emergency Stop Circuit - No Switched B+ to ECU or Ignition	Test Emergency Stop Circuit See - Ignition System
	Crank Position Sensor - No Output	*FFI* Diagnostic Software should indicate at least 200 RPM while cranking. Adjust or test Crank Position Sensor
	Ignition Module - No output to Coils	Measure voltage at ign, coils using a PRV while cranking - 180V min.
	ECU - No Signal to Ignition Module	Monitor ignition system signal wires while cranking or use FFI Diagnostic **Software** to activate ignition. See - Ignition System
	Incorrect Input from a Sensor (water temp, air temp)	i.e. ECU thinks it is starting a warm engine when it is actually cold. Use *FFI* **Diagnostic** Software to verify

CHART 10 ENGINE CRANKS BUT WON'T START

Engine Cranks But Won't Start (Cont.)

SYSTEM/COMPONENT	CAUSES	ACTIONS
Electrical System	Blown Fuse - Position 5 No 26V to Ignition Module	Replace and Retry - repeated failures indicated probable failed Ignition Module
	Blown Fuse - Position 4 No Switched B+ to Fuel Pump Relay	Fuel pump should run for 10 seconds when Key Switch is turned ON See - Fuel System - Check Circulation Pump
	Failed Stop Circuit Relay - Position 8 No Switched B+ to Ignition and ECU	Verify Circuit operation or test resistance of Relay Coil See - Ignition System
	Failed Main Power Relay	Perform Functional Test See - Ignition System
	Failed or Disconnected Capacitor	Verify Capacitor operation See - Ignition System
	No Voltage on Purple Wire	Check Key Switch, Instrument Harness or Diode in engine harness
	Low Cranking Voltage	Perform Volt Drop Test Low battery, loose connection, weak starter, failing solenoid, inadequate battery cables, etc.
Mechanical	Scored Cvlinders	Perform Compression Test or Visual Inspection

CHART 11 ENGINE CRANKS BUT WON'T START (CONT.)

Engine Starts and Dies

SYSTEM/COMPONENT	CAUSES	ACTIONS
Fuel System	Broken, Restricted Lines, Fittings, Filters	Repair or replace as necessary
	Poor Quality or Spoiled Fuel or Water in Fuel	Substitute known good fuel
	Vapor Separator Float Stuck Closed	See - **Fuel System**
	Damaged or Inoperable Fuel Pumps(s) - Low or No Pressure	Fuel pump should run for 10 seconds when Key Switch is turned ON - Perform Fuel Pressure Test and/or test pumps See - **Fuel System**
	Loss of ECU Signals to Injector(s)	Verify using timing light while running or use ***FFI* Diagnostic Software** to activate injectors See - **Fuel System**
Ignition System	Worn Spark Plugs	
	Poor Ground Connections	A tight connection doesn't mean a good connection - check using an ohmmeter or disassemble and inspect
	Loss of ECU Signals to Ignition Module	Monitor signal leads at Ignition Module See - **Ignition System**
	Failed Ignition Module	Multiple firing of cylinder can cause engine to die as it accelerates - verify using timing light
	Failed Ignition Module	Loss of output to coils See - **Ignition System**
	Incorrect Timing	Use ***FFI* Diagnostic Software** See **Software Users Guide**
Electrical System	Faulty Key Switch	Intermittent switched B+ - Test Key Switch
	Main Power Relay - Intermittent Connections	Perform functional test
Mechanical	Damaged Powerhead	Perform Compression Test and/or Visual Inspection

CHART 12 ENGINE STARTS BUT DIES

Engine Surges/Runs Rough

SYSTEM/COMPONENT	CAUSES	ACTIONS
Fuel System	Broken or Restricted Fuel Lines, Fittings, Filter	Repair or replace as necessary
	Contaminated Fuel	Substitute known good fuel
	Damaged Fuel Pump(s) - Low Pressure	Perform Fuel System pressure test See - **Fuel System**
	Pressure Regulator Stuck Open Low or Unsteady Pressure - Upper Cylinders may be Lean	Fuel System Pressure Test See - **Fuel System**
	Failed Injector(s)	Perform cylinder drop test to isolate using ***FFI* Diagnostic Software** and verify signal from ECU using timing light See - **Fuel System**
	Faulty Vapor Separator	Leaking or stuck - look for fuel at PORT vapor hose fitting See - **Fuel System**
	Erratic ECU Signal to Injector(s)	Monitor using timing light See - **Fuel System** ECU affected by RFI - verify correct spark plugs and wires
Ignition System	Damaged, Worn, Fouled or Incorrect Spark Plugs	Replace with correct type Can also set CODE 16 due to RFI
	Damaged or Loose Coil or Lead	Repair or replace as necessary
	Loose/Broken Wire or Connection	Repair or replace as necessary
	Erratic Output from Ignition Module (Misfire or Multiple Fire)	Isolate cylinder using timing light See - **Ignition System**
	Misadjusted or Damaged Crank Position Sensor - Erratic Ignition and Fuel	Check adjustment - possible code 16 Perform Visual Inspection

CHART 13 ENGINE SURGES/RUNS ROUGH

Engine Surges/Runs Rough (Cont.)

SYSTEMICOMPONENT	CAUSES	ACTIONS
Electrical System	Loose Battery Connections	Clean and tighten
	Loose or Damaged Wire Connection or Ground	Measure ground with an ohmmeter or disassemble and inspect - repair or replace as necessary
	Main Power Relay - Intermittent Connection	Monitor voltage at fuse 4 -Test Relay Circuit See - Ignition System
	Stop Circuit Relay (Position 8) - Intermittent Contact	Monitor voltage at Purple/White wire - test Stop Relay Circuit See - Ignition System
	Low 26V Output - Low Voltage at Injectors and Ignition Module	Monitor voltage using FFI Diagnostic Software while running engine. 12V system can affext 26V output - See Charging System Tests. Code 17
	Faulty or Disconnected Capacitor	Test See - Ignition System
Mechanical	Damaged Powerhead	Perform compression test Do visual inspection
S.L.O.W. (affects only fuel)	Engine Overheat	Blocked water intakes, damaged water pump, thermostats or outboard installation (too high on transom). Code 22
	ECU Overheat	Lack of cooling air - check for blockage. Code 25
	Oil Injector Open Circuit	Injector coil is open or disconnected Code 34
	No Oil Pressure	Perform oil pressure test See - Oil System Code 35
	High Voltage on 26V System	Test 26V system - See Code 18

CHART 14 ENGINE **SURGES/RUNS** ROUGH (CONT.)

Low Maximum RPM

SYSTEMICOMPONENT	CAUSES	ACTIONS
Fuel System	Broken, Restricted Lines, Fittings, Filter	Repair or replace
	Poor Quality/Spoil Fuel	Substitute known good fuel
	Faulty Injector or Injector Signal - Possible Lean or Rich Cylinder	isolate using cylinder drop test in ***FFI* Diagnostic** Software and/or timing light See - Fuel System - Pressure Test Injector
	Faulty Fuel Pump(s) Low Fuel Pressure	Monitor Fuel System pressure See - Fuel System
	Pressure Regulator Stuck Open or Missing. Low Pressure - Possible Lean Top Cylinders	Monitor Fuel System pressure See - Fuel System
	Leaking or Restricted Vapor Separator Inlet Valve	Possible presence of fuel at PORT intake manifold - See - Fuel System
Ignition System	Faulty or Incorrect Spark Plugs	Replace with correct type and number
	Faulty Coil or Lead	Use timing light to isolate Visual Inspection and test suspect Coil
	Faulty Ignition Module - No Output to Some Cylinders	Monitor output to coil primary leads using Timing Light See - Ignition System
	Incorrect Timing	Use FFI Diagnostic Software
	Loss of Throttle Position Sensor Signal - Engine Stays at Idle RPM	Check service codes See Service Code Chart
	Loss of ECU Signals to Ignition Module	Perform Ignition Module Elimination Test - See - Ignition System

CHART 15 LOW MAXIMUM RPM

Low Maximum RPM (Cont.)

SYSTEM/COMPONENT	CAUSES	ACTIONS
Electrical System	Blown Fuse to Injector Fused in pairs	Check fuses - repeated failure might be due to grounded injector signal leads or shorted Injector Coil
	Low Output from 26V Regulator Affects Fuel and Ignition	Monitor Voltage rating using ***FFI*** Diagnostic Software - Possible Code 17. See - Fuel or Ignition Systems
	Faulty ECU Software	Possible Code 15 - reprogram or replace ECU
Mechanical Svstem	Incorrect Propeller - Over propped	Check Prop Pitch
	Damaged Powerhead	Perform Compression test Do visual inspection
	Throttle Plates not Opening Enough	Check operation
	Gearcase Damage	Inspect sample of gear lubricant
	Incorrect Outboard Height	Check installation

CHART 16 LOW MAXIMUM RPM (CONT.)

Engine Won't Shut Off

SYSTEMICOMPONENT	CAUSES	ACTIONS
Boat Electrical System	Faulty Key Switch	Test Key Switch
	Faulty Emergency Stop Switch	Test Stop Circuit See - **Ignition** System
	Broken Wire or Connection in Stop Circuit	Test Stop Circuit See - **Ignition System**
Engine Electrical System	Broken Wire or Connection in Stop Circuit	Test Stop Circuit See - **Ignition System**
	Stop Circuit Relay (Position 8) Won't Energize	Test Stop Circuit See - **Ignition System**

CHART 17 ENGINE WON'T SHUT OFF

Excessive Smoking

SYSTEMICOMPONENT	CAUSES	ACTIONS
Fuel System	Hole in Lift Pump Diaphragm	Fuel present in lift pump pulse lines See - **Fuel System**
	Vapor Separator Vent Valve Stuck Open	Fuel flows from PORT Vapor Hose
	Poor Quality Fuel	Substitute known good fuel
	Injector(s) Stuck Open	Isolate using ***FFI*** Diagnostic Software and/or pressure test See - Fuel System
	Improperly Connected Fuel/Oil Hoses at Fittings	Engine may start if fuel and oil hoses are swapped, but fuel system will be filled with oil
ECU	Failed Sensor Input	Use ***FFI* Diagnostic Software** to extract codes
	Firing Oil Injector too often - ECU may be in "Break-in" Mode	Monitor using voltmeter or timing light See - **Oil System** Check programming using ***FFI* Diagnostic Software**
	Firing Fuel Injector too often	Monitor using timing light See -Fuel System -check for loose connections or damaged crank position sensor Possible Code 15 - replace ECU
Oil System	Oil Injector Stuck Open	Perform Oil System Leak - Down Test
	Oil Return Line Restricted or Pinched	System is operating in excess of 43 PSI causing constant flow of oil into throttle bores
Mechanical	Engine Mounted too Low on Boat	Check installation

CHART 18 EXCESSIVE SMOKING

Engine Overheats

SYSTEMICOMPONENT	CAUSES	ACTIONS
Water Supply System	Blocked Intake Screens	Visual inspection - clean
	Engine too High on Transom	Verify installation
	Damaged/Worn Water Pump Impeller	Check water pressure
	Poorly Sealed Water Pump Components	Look for air in cooling system discharge
	Plugged Vent Hole on Water Pump Housing	
Powerhead	Damaged Thermostat	Test Thermostat operation
	Blocked or Restricted Cooling Passage	Do visual inspection
	Blown Cylinder Head Seal Ring	Perform compression test/visual inspection
	False Indication from Defective Temperature Sensor/Switch or Pinched Wire	Test temperature sensor and switch

CHART 19 ENGINE OVERHEATS

False Warning Light

SYSTEMICOMPONENT	CAUSES	ACTIONS
Boat Electrical System	Faulty System Check Gauge	Perform Self Diagnostic
	Damaged/Shorted Wire or Connection	System Check Tester P/N 437274 can be used to verify Repair or replace
Engine Electrical System	Faulty Sensor or Sender or Circuit	Test appropriate circuit and components Check service codes
	Faulty ECU	Check service codes and eliminate possibility of being a genuine problem
	ECU Affected by Electronic Noise	Verify all Spark Plugs and Wires are of the correct type

CHART 20 FALSE WARNING LIGHT

ECM Pinouts/Circuit Checks

◆ See Figures 167 thru 177

Because the Engine Management Module (EMM) is the mind of the FICHT Fuel Injection (FFI) system most circuits begin or end at the module itself. For this reason, various testing procedures for the fuel injection, ignition and oil injection systems may require you to access those circuits in order to take readings using a multi-meter. Many voltage checks must be made with the circuit complete, and therefore a connector must either be backprobed or a jumper harness must be fashioned to allow the circuits to complete while providing a test point. Backprobing is the act of inserting a test lead through the back of the connector, although this is common in many troubleshooting applications, it is not usually the BEST method on marine engines, as moisture resistant or sealed connectors are of even greater importance in a marine environment. When necessary, backprobing will either at the EMM connector (not usually the preferred method, as it could damage the large weatherproof connector) or at the component itself (usually a better solution as you're only placing one component's connector at risk).

Evinrude/Johnson sells a test probe (part No. 342677) designed to be inserted through the back of a connector and prevent damage. When using a test probe, lubricate it lightly and use extreme care not to damage the connector seal.

Other tests might involve checking resistance of a component (such as an injector or ignition coil winding) or just of the circuit itself. When tests like this occur, the harness connector must almost ALWAYS be removed from the EMM, as the voltage provided by the Digital Volt/Ohm Meter (DVOM) or multimeter can damage certain EMM circuits. For this reason, NEVER connect an ohmmeter to an EMM connector or circuit that is complete with the EMM unless specifically instructed to do so by the test procedure.

Unlike many of automotive and recreational product manufacturers Evinrude/Johnson took some time to think about the technician or the DIYer when they built the FICHT motors. Specifically, for most wiring applications, the FICHT harness contains connector PIN ID Numbers molded right into the connectors themselves. Use the numbers, along with the diagrams/wire colors provided here to make sure you are checking the proper circuit.

A few more things to keep in mind when testing the FICHT circuitry, before conducting resistance or voltage checks on a componenffcircuit, make sure all electrical connections in the system are clean and tight. Visually check the wiring for obvious breaks, defects or other problems.

Keep in mind that although a haphazard approach might find the cause of problems, only a systematic approach will prevent wasted time and the possibility of unnecessary component replacement. In some cases, installing an electronic component into a faulty circuit that damaged or destroyed the previous component, will instantly destroy the replacement.

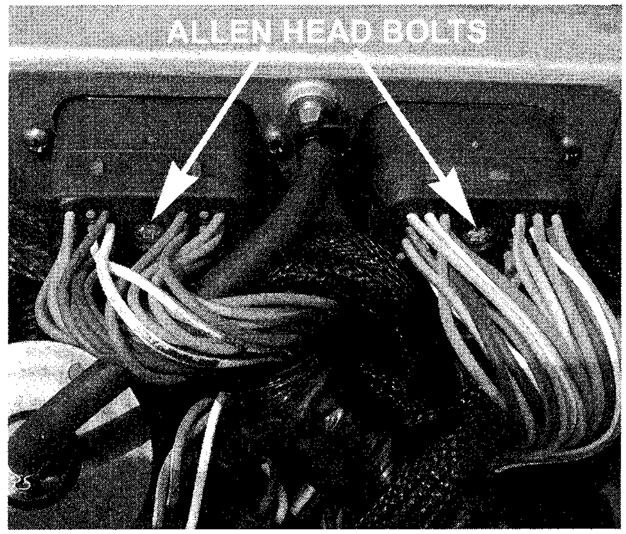


Fig. 168 To test circuits, free the connectors by removing the retaining bolts...

For various reasons, including this possibility, most parts suppliers do not accept returns on electrical components.

Make sure you perform each test procedure and especially, make all test connections as described. If a component tests out of range (faulty), but the reading is close to the service limit, bring the component to your marine dealer so they can verify your result before purchasing the replacement. In some cases, your dealer may be willing to check a sensor against the reading on a new one to verify whether or not your sensor is actually faulty.

Although resistance checks are relatively easy to conduct, their results can be difficult to interpret. Remember that resistance in any electrical component or circuit will vary with temperature. Also, ohmmeters will vary with quality, meaning that readings can vary on the same component between different meters. The specifications provided in this manual are based upon the use of a high-quality digital multimeter applied to a component that is currently at about 68°F (20°).

■ More information on electrical test equipment is can be found in the General Information section, while additional information on basic electrical theory and electrical troubleshooting can be found in the Electrical section.

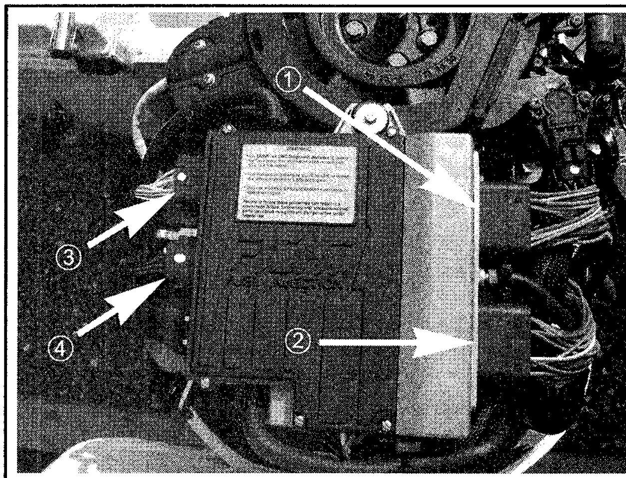


Fig. 167 Most **EMMs** will contain 4 major connectors (1) the Forward EMM, (2) **Aft** EMM, (3) Battery and (4) Injector harness connectors

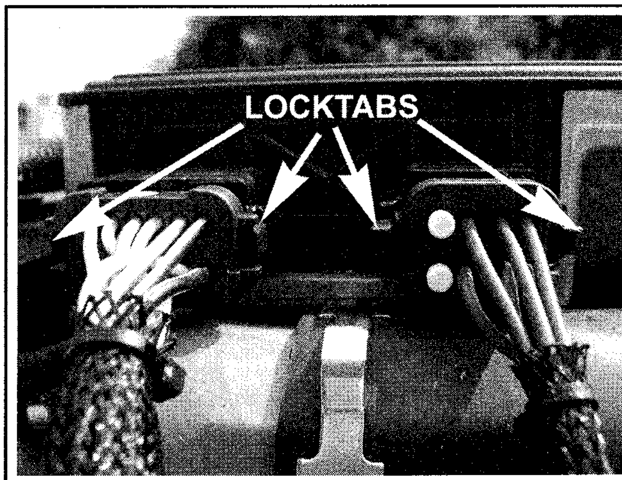


Fig. 169 **...**or squeezing the **locktabs** and gently pulling the connector free

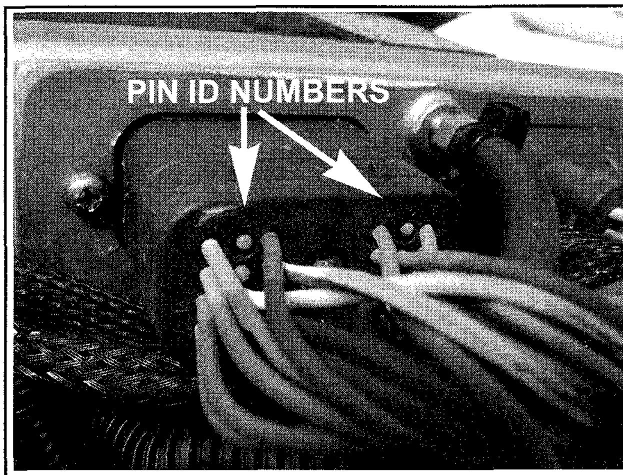


Fig. 170 The wire terminal PIN ID numbers are usually molded into the connectors on FICHT motors

As a general rule, the resistance of a circuit or component will increase (rise) as temperature increases. Although this is true for most resistor and windings, some manufacturers use negative temperature coefficient sensors for certain functions. A negative temperature coefficient sensor reacts in an opposite manner, meaning that its resistance decreases (lowers) as temperature increases (rises) and vice-versa.

Most components of the FFI system are checked using resisiance or voltages checks. This means that a voltmeter or ohmmeter is connected to the component or circuit under the proper circumstances.

For resistance checks, no voltage must be applied to the circuit (except that as provided by the meter to perform the check). Typically, the circuit or component wiring is isolated, by disconnecting the wiring from the component itself or somewhere else in the circuit, then applying the meter probes across 2 terminals that connect through the component. When conducting resistance checks, you **must** isolate the EMM from the meter in order to prevent the possibility of damage to the control module. By identifying the proper circuit you can conduct tests of the entire component circuit right from the harness connectors that attach to the EMM. Otherwise, use the wiring diagrams and the test procedures to determine other points to disconnect the wiring and test the circuit/component.

We recommend you work in one of two directions. Either test the component first, then work your way back through the component wiring toward the EMM, or disconnect the harness connectors from the EMM, testing the entire circuit first, then working your way toward the component. A bad test reading at the EMM harness connector must be verified by making sure it is not the result of a bad wiring harness or connection along the way to the component. Likewise, a good reading at a component (when there is a bad reading on the circuit as noted by the presence of a trouble code or by a reading at the EMM harness) must be verified by checking the circuit wiring for trouble.

When checking the circuit wiring, isolate the harness by disconnecting it from both the component and the EMM, then using an ohmmeter to check resistance from one connector to the next on each wire. Wiggle the wire and connectors while conducting the test to see if reading fluctuate. Although specifications are usually not provided for wiring resistance, all sensorlswitch wiring for these motors should have very little resistance. Also, be sure to check wiring for shorts to ground (by checking resistance between one terminal and a good engine ground), and for shorts to power (by checking a terminal using a voltmeter and connecting the other probe to a good engine ground or the negative battery cable).

FICHT Component Testing

If the preliminary troubleshooting procedure, Isolating Problems With The FICHT System, Self-Diagnostic system trouble codes and/or the Symptom Charts (all found earlier in this section) lead you to component testing, use the procedures provided here. When checking a system such as the Fuel Delivery or Fuel Injection systems, follow each of the procedures in the order they are provided (unless a chart, code or other test has sent you to a specific test). Each of the system tests have been designed to lead you step-by-step, based upon results from each check through a total sub-system verification process.

CHECKING THE FUEL DELIVERY SYSTEM

③ DIFFICULT

Unless otherwise instructed by a trouble code, symptom chart or other test, follow each of the test procedures in the order provided to ensure a complete verification of the fuel delivery system.

✳✳ CAUTION

The FICHT ignition system operates a primary circuit of 250 volts and a secondary circuit with voltage exceeding 35,000 volts. This represents a serious shock hazard. To prevent serious or fatal injury, NEVER handle ignition system components with the engine running or cranking.

☐ **Be sure to check for any trouble codes before starting these test procedures. If possible, make repairs and clear all codes before proceeding.**

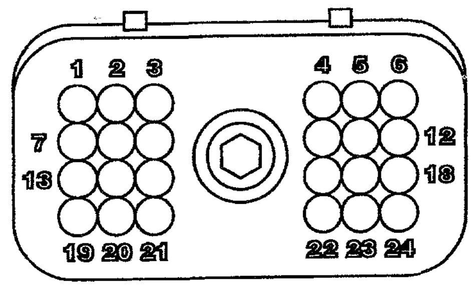


Fig. 171 Wire terminal PIN identification for Forward and Aft EMM harness connectors

Forward EMM Connector

Pin No.	Circuit Description	Wire Color
1	Tach Signal/Start Delay Relay	Gray
2	Oil Pressure Switch	Tan/White
3	Crank Position Sensor Voltage	Orange
4	*System Check* "Check Engine" Light	Tan/Orange
5	Water Temperature Sensor Voltage	Pink/Black
6	Throttle Position Sensor Signal Return	Green
7	Download Activation Pin	Black/Orange
8	*System Check* "No Oil" Light	Tan/Yellow
9	Diagnostic Connector	Red
10	*System Check* "Water Temperature" Light	Tan
11	EMM 40 Volts	White/Red
12	Throttle Position Sensor Voltage	Red
13	Water Temperature Switch	Tan/Black
14	Diagnostic Connector	White
15	Crank Sensor Ground	Black
16	Water Temperature Sensor Ground	Black
17	Air Temperature Sensor Ground	Black
18	Throttle Position Sensor Ground	Black
19	Vacant (V4); Shift Interrupter Switch (V6)	None (V4); Blk/Yel (V6)
20	Vacant	–
21	Diagnostic Connector/EMM Ground	Black
22	Start Assist Circuit Activation	Pink/White
23	Water-in-Fuel Sensor Voltage	Pink/Green
24	Air Temperature Sensor Voltage	Pink/Blue

Fig. 172 Forward EMM harness connector pin, circuit and wire color IDs—75-250 hp FICHT Motors (except 1501175 hp motors with fuel rails)

Forward ECU Connector

Pin No.	Circuit Description	Wire Color
1	Tach Signal	Gray
2	Oil Pressure Switch	Tan/White
3	Crank Position Sensor	Orange
4	System Check "Check Engine" Light	Tan/Orange
5	Water Temperature Sensor Voltage	Pink/Black
6	Throttle Position Sensor Signal Return	Green
7	Vacant	
8	System Check "No Oil" Light	Tan/Yellow
9	Diagnostic Connector	Red
10	System Check 'Water Temperature" Light	Tan
11	Regulator 26 Volts	White/Red
12	Throttle Position Sensor Voltage	Red
13	Water Temperature Switch	Tan/Purple
14	Diagnostic Connector	White
15	Vacant	
16	Water Temperature Sensor Ground	Black
17	Air Temperature Sensor Ground	Black
18	Throttle Position Sensor Ground	Black
19	Shift Interrupter Switch	Black/Yellow
20	Vacant	-
21	Vacant	-
22	Diagnostic Connector Ground	Black
23	Water-in-Fuel Sensor	Pink/Green
24	Air Temperature Sensor Voltage	Pink/Blue

Fig. 173 Forward EMM harness connector pin, circuit and wire color IDs—1501175 hp FICHT motors with fuel rails

Rear ECU Connector

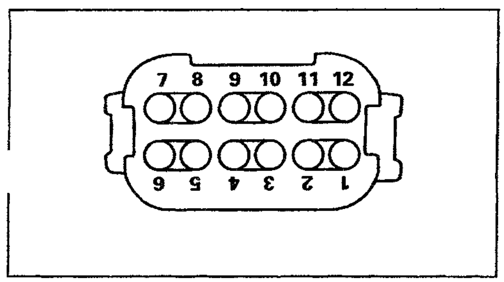
tin No.	Circuit Description	Wire Color
1	Injector No. 4	Purple
2	Injector No. 6	Green
3	Electric Fuel Pump Relay	Brown
4	Battery 12 Volts	Red/Purple
5	Ignition No. 5	Orange/Green
6	Ignition No. 1	Orange/Blue
7	Injector No. 3	Purple
8	Injector No. 5	Green
9	Vacant	-
10	Oil Injector	Blue
11	Ignition No. 6	Orange/Red
12	Ignition No. 2	Orange
13	Injector No. 2	Blue
14	Injector Ground	Black
15	Injector Ground	Black
16	Vacant	
17	vacant	-
18	Ignition No. 3	Orange/Purple
19	Injector No. 1	Blue
20	Injector Ground	Black
21	injector Ground	Black
22	ECU Ground	Black
23	Switched 12 Volts	Purple/White
24	Ignition No. 4	Orange/Black

Fig. 175 Aft EMM harness connector pin, circuit and wire color IDs—1501175 hp FICHT motors with fuel rails

Rear EMM Connector

Pin No.	Circuit Description	Wire Color
1	Injector No. 4	Green (V4); Purple (V6)
2	Vacant (V4); Injector No. 6 (V6)	None (V4); Green (V6)
3	Elec. Fuel Pump Relay/Start Delay Relay	Brown
4	Ignition Switched 12 Volts	Purple/White
5	Vacant (V4); Ignition No. 5 (V6)	None (V4); Or/Grn (V6)
6	Ignition No. 1	Orange/Blue
7	Injector No. 3	Green (V4); Purple (V6)
8	Vacant (V4); Injector No. 5 (V6)	None (V4); Green (V6)
9	40 Volts From PDP	White/Green
10	Oil Injector	Blue
11	Vacant (V4); Ignition No. 6 (V6)	None (V4); Or/Grn (V6)
12	Ignition No. 2	Orange/Blue
13	Injector No. 2	Blue
14	40 Volts From PDP	White/Green
15	Injector Ground	Black
16	EMM Ground	Black
17	EMM Ground	Black
18	Ignition No. 3	Or/Grn (V4); Or/Pur (V6)
19	Injector No. 1	Blue
20	Injector Ground	Black
21	Injector Ground	Black
22	EMM Ground	Black
23	Ignition Switched 12 Volts	Purple/White
24	Ignition No. 4	Or/Grn (V4); Or/Pur (V6)

Fig. 174 Aft EMM harness connector pin, circuit and wire color IDs—75-250 hp FICHT Motors (except 1501175 hp motors with fuel rails)

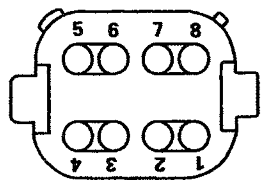


Pin No's.	Wire Color
1 & 12	Yellow/Black
2 & 11	Yellow/Purple
3 & 10	Yellow
4 & 9	Yellow/Blue
5 & 8	Yellow/Gray
6 & 7	Yellow/Green

Fig. 176 EMM battery harness connector pin, circuit and wire color IDs

Verifying Fuel Delivery to the Engine

1. Check all fuel hoses and connections for kinks, obvious restrictions or damage.
2. Check the boat (if equipped) and motor water separator canister(s) for signs of contamination. Remove the canister and check for the presence of water.
3. Check for fuel at the port intake manifold vapor vent hose (if necessary, locate the hose by tracing it from the vapor separator canister to the manifold). If there is little or no fuel, the vapor separator is ok. If fuel is present, the vapor separator vent valve is likely stuck. Refer to the information in this section on the Vapor Separator Tank assembly.
4. To verify fuel flow from the tank to the engine, use a T fitting to install a fuel gauge inline between the lift pump and the vapor separator tank, then watch the gauge while cranking or running the engine. If the gauge shows 2-10 psi (14-69 kPa) then there are no fuel delivery problems to the engine,



Pin No.	Wire Color
1	Brown/Black
2	Brown/Orange
3	Brown/White
4	None
5	None
6	Brown
7	Brown/Green
8	Brown/Yellow

Fig. 177 EMM Injector harness connector pin, circuit and wire color **IDs**

Verify Fuel Delivery to the Injectors, as detailed in this section. If there is little or no pressure, refer to Checking the Lift (Low Pressure) Fuel Pump, as detailed in this section to see if the problem is the pump, the lines or the vacuum pulse.

Verifying Fuel Delivery to the **Injectors**

◆ See Figure **6**

If fuel delivery to the engine is OK, verify fuel delivery to the injectors as follows:

1. Connect a 100 psi (690 kPa) fuel pressure gauge to the test port. The test port location varies slightly from motor-to-motor, it is normally found on one of the fuel supply lines between the pump and the injectors, but on some motors it may also be located on the vapor separator tank itself). Refer to the fuel and cooling water flow diagrams supplied in the Description & Operation portion of this section for more details.
2. Slowly pump the primer bulb to fill the vapor separator tank. Continue to pump until a firm bulb is felt.
3. Turn the ignition keyswitch on and listen, the pump should run for about 10 seconds. Watch the gauge and proceed as follows, depending upon the result:

- If the gauge shows 20-30 psi (138-207 kPa) of pressure, the high-oressure circuit of the fuel system is operating correctlv to deliver fuel to the injectors. If there is a fuel delivery problem, either there is a problem with the fuel injection system itself, or the low-pressure circuit is not operating properly. Either check the Lift Pump as detailed in this section or proceed to Checking The Fuel Injection System, as applicable.

If the gauge shows low or no pressure suspect a damaged pressure regulator or circulation pump. On models not equipped with a separate fuel pressure regulator, you'll have to replace the vapor separator tank assembly. But, the manufacturer advises replacing the separator tank assembly if either component is faulty.

If the gauge shows excessive pressure there is either a damaqedlkinkedlrestrictedfuel line or pressure regulator. Repair or replace, as necessary.

- If the pump won't run, proceed to Checking the Circulation (High Pressure) Fuel Pump, in this section.

■ Cranking or running the engine should show the same results on pressure tests.

Checking the Lift (Low Pressure) Fuel Pump

If a problem is suspected with the low-pressure, lift pump, proceed as follows:

1. Remove the Low Pressure Fuel Pump (Lift Pump) from the front of the motor, as detailed in this section.

■ Most **FICHT** lift pumps contain 2 **vacuum/pressure** pulse nipples one toward the top and the other toward the bottom of the cover. Do not confuse this with the oil or fuel supply line nipples.

2. Connect a hand pressure pump or regulated compressed air source to one of the pulse nipples (the nipples that connect to the crankcase vacuum/pressure pulse lines). Apply 15 psi (103 kPa) of pressure to the pulse nipple in order to test the diaphragm for leaks. Proceed as follows, depending upon the results:

If the diaphragm holds pressure for at least 30 seconds, but a fuel delivery problem is suspected, proceed with Checking the Circulation (High Pressure) Fuel Pump, in this section.

If the lift pump will not hold pressure, repair or replace the pump, as detailed in this section.

3. Repeat the test on the other pulse nipple.

Checking the Circulation (High Pressure) Fuel Pump

◆ See Figures **6,178** and 179

If all other components of the fuel delivery system test OK, but you still suspect there is a problem supplying the fuel injection system with the appropriate amount of fuel, test the high-pressure, circulation pump as follows:

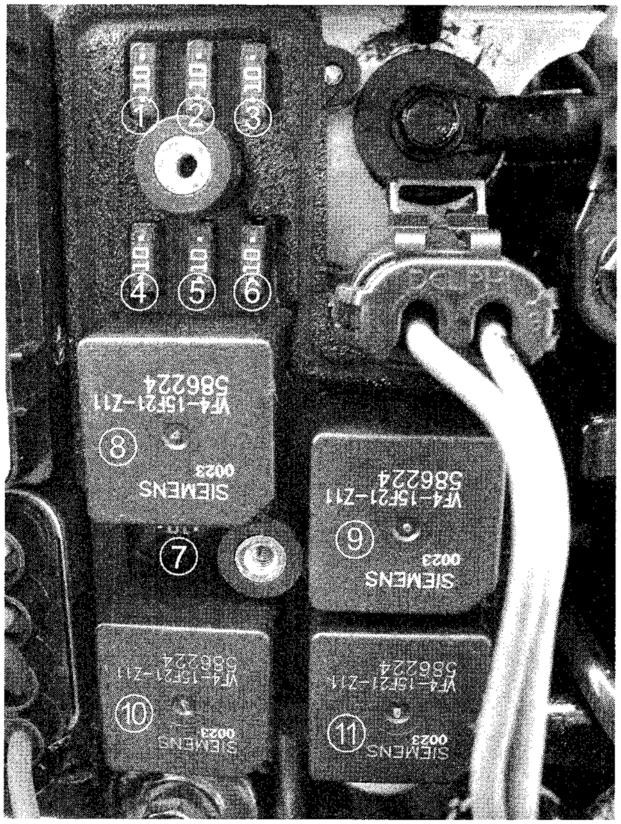
■ Although the FFI diagnostic software is required for parts of this test, it is used as a convenient way to supply battery voltage to the electric pump circuit during testing. If the software is not available, jumper wires can be used to carefully supply voltage to the various points of the circuit during testing. Be sure to refer to the wiring diagrams for your motor when in doubt about any connections.

1. Connect a 100 psi (690 kPa) fuel pressure gauge to the test port. The test port location varies slightly from motor-to-motor, it is normally found on one of the fuel supply lines between the pump and the injectors, but on some motors it may also be located on the vapor separator tank itself). Refer to the fuel and cooiing water flow diagrams supplied in the Description & Ooeration portion of this section for more details.
2. Slowly pump the primer bulb to fill the vapor separator tank, Continue to pump until a firm bulb is felt.
3. If the FFI diagnostic software is available, initiate the "Fuel Pump Test" while monitoring the pump pressure (the pump should run for 10 seconds). If the software is not available, turn the ignition keyswitch on and listen, the pump should run for about 10 seconds. Watch the gauge and proceed as follows, depending upon the result:

If the gauge shows 20-30 psi (138-207 kPa) of pressure, the high-pressure circuit of the fuel system is operating correctly to deliver fuel to the injectors. Proceed to Checking The Fuel Injection System, as detailed in this section.

If the pump does NOT run, check the fuse in position No. 4 of the power distribution center (fuse box), and check the fuel pump ground using a DVOM.

4. With the fuel pump circuit energized (using the keyswitch or the FFI software as detailed in the previous step), battery voltage should be present when probing with a DVOM between the fuel pump connector (purple/black wire) and a good engine ground. If voltage is present, but the pump did not run, replace the pump.
5. If battery voltage was not available at the pump connector, go back through the circuit and check at fuse position No. 4. Again, once the circuit is energized, battery voltage should occur between one side of the fuse terminal and a good engine ground. If there is no voltage at the fuse, refer to Checking the Ignition System, Main Power Relay Circuit Testing.
6. If battery voltage was present at the fuse, remove the relay in position No. 10 of the power distribution center (fuse box). This is the relay at the lower left corner when facing the panel. Now check for battery voltage at relay terminals 30 and 86 in the panel (86 is the terminal on the top while 30 is the terminal on the right). If there is no voltage, repair or replace the power distribution panel.



Fig, 178 Use the power distribution panel (fuse box) fuse positions 1-7 and relay positions 8-11 for testing procedures as noted in the accompanying text

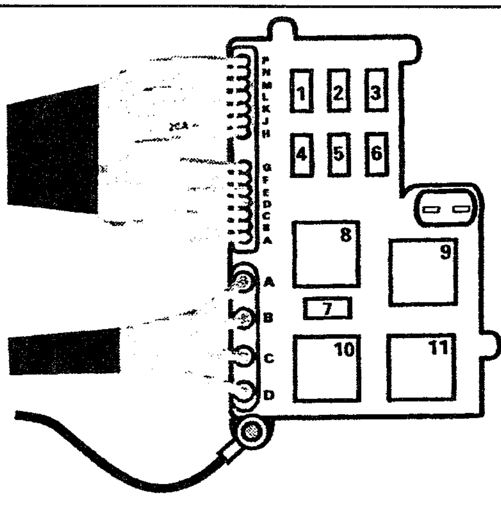


Fig. 179 The wire colors and terminal IDs for the 14-pin and 4-pin connectors attached to the left side of the power distribution panel are used widely in FICHT test procedures

7. If there is battery voltage at terminals 30 and 86, substitute another relav for the one that was mounted in oositron 10

8. If the pump STILL doesn't run with the new relav, check continuity between relay terminal 85 and terminal C (3rd pin from'bottom) on the 14-pin connector attached to the upper left portion of the power distribution box. Relay terminal 85 is the bottom relay terminal in the power distribution box for relay position No. 10. If there is no continuity, repair or replace the power distribution box.

9. If there is continuity between terminal 85 (No. 10 relay) and terminal C of the 14-pin connector, check continuity of the brown wire leading to the EMM (remember to disconnect the wire from the EMM before using an ohmmeter). If there is no continuity, replace the wire. If there is continuity, verify that the EMM has power. To do this, refer to the Stop Circuit Testing, under Checking the Ignition System. If voltage is present at terminal J (purple/white wire of the 14-pin connector for the power distribution box) and you are certain of all other test procedures, replace the EMM. Terminal J is the second terminal from the bottom of the upper group of 7 wires in the 14-pin power distribution box connector.

CHECKING THE FUEL INJECTION SYSTEM

3 DIFFICULT

Unless otherwise instructed by a trouble code, symptom chart or other test, follow each of the test procedures in the order provided to ensure a complete verification of the fuel injection system.

**** CAUTION**

The FICHT ignition system operates a primary circuit of 250 volts and a secondary circuit with voltage exceeding 35,000 volts. This represents a serious shock hazard. To prevent serious or fatal injury, NEVER handle ignition system components with the engine running or cranking.

Be sure to check for any trouble codes before starting these test procedures. If possible, make repairs and clear all codes before proceeding.

Many of the tests for the fuel injection system are designed for the use of the FFI diagnostic software. Although the software makes most tests easier, it is not ABSOLUTELY necessary except the Injector Static Test,

At the conclusion of these tests, you may determine that the electrical portion of the fuel injection system is determined working properly. If so, BUT one or more cylinders are still running lean or rich (as evidenced by spark plug conditions), look for crankcase air leaks, ignition problems or test individual components (such as the injectors).

Injector Static Test

◆ **See Figure 178**

This test is designed as a quick verification of injector signal and operation WITHOUT running &cranking the engine. The only real way to perform this test is using the FFI diagnostic software.

1. Connect an IBM compatible computer loaded with the FFI diagnostic software to the motor diagnostic connector using the cable provided with the software. Using the software menu actuate the injectors while listening for an audible click at each individual injector.
2. If no injectors fire, troubleshoot the injector driver circuits by following the Voltage Supply Tests provided in this section.
3. If all injector fire correctly, perform the Injector Dynamic Test, as detailed in this section to verify proper operation under normal operating conditions.
4. If SOME of the injectors do not operate, check the fuses in positions No. 2, 3 and 6. Also, repeat the test while monitoring the each of the injector signal wires using an inductive timing light (be sure to attach the pickup to only one wire at a time).

Some timing lights may not flash consistently during cranking. Timing light pickup orientation may affect results, and should be tried both ways. Any flashes likely indicate that the circuit is working, but the Injector Dynamic Test should still be used to verify proper operation.

5. If the timing light flashes, indicating a proper signal, but the injector does not actuate, replace the injector.
6. If the timing light does not flash, suspect an open circuit either in the injector coil or signal lead. If neither are at fault, the EMM is probably damaged.

Injector Dynamic Test

◆ See Figure **178**

If the FFI diagnostic software is available, use it to monitor voltages as the engine is run. If voltages drop as engine RPM is increased, suspect the charging system. Refer to the Ignition and Electrical Svstem for information and testing procedures on the Charging System.

1. Recreate the problem while running or cranking the motor (use a source of cooling water to prevent damage to the water pump and powerhead). While the problem is occurring, check each EMM signal lead at the injector using an inductive timing light (be sure to attach the pickup to only one wire at a time).

■ Some timing lights may not flash consistently during cranking. Timing light pickup orientation may affect results, and should be tried both ways. Any flashes likely indicate that the circuit is working, but the Injector **Dynamic Test** should still be used to verify proper operation.

2. If the timing light flashes properly or remains steadily on, the fuel injection system is working properly. If one or more cylinders are still running lean or rich (as evidenced by spark plug conditions), look for crankcase air leaks, ignition problems or test individual components (such as the injectors).
3. If the timing light indicates irregular firing or a lack of firing on SOME injectors, suspect the fuses in positions 2, 3 and 6, the crankshaft position sensor adjustment, low voltage available to the injectors, damaged injectors, an intermittently open circuit or a faulty EMM.
4. If the timing light does not flash, suspect an open circuit either in the injector coil or signal lead. If neither of these is at fault, the EMM is probably damaged. Proceed with the Voltage Supply Tests in this section to help narrow down the problem.
5. If no injectors fire, suspect the crankshaft position sensor signal, the 40-volt (or 26-volt) charging system (which should also adversely affect the ignition system), the main power relay or the EMM. Proceed with the Voltage Supply Tests in this section to help narrow down the problem.

Voltage Supply Tests

+ See Figures **178** and **179**

In order to ensure proper results during the voltage supply tests you must be sure that the battery is in good condition and is fully charged at the outset of the test. Excessive cranking could begin to drain the battery to a point that will adversely affect test results.

1. Check the condition of the fuses in positions 2, 3, 6 and 7, as well as the 20-amp inline fuse used on all models (except 1501175 hp motors equipped with fuel rails).
2. If equipped, install the emergency stop clip.
3. Verify that the switched battery positive voltage is available at terminal J (purplelwhite wire) of the power distribution panel (fuse box). Terminal J is par! of the 14-pin connector's top group of 7 wires, second terminal from the bottom of that group. There should be more than 9.5 volts while cranking and more than 13 volts when running. Proceed as follows, depending on the result:

If voltage is good, verify the 40-volt (or 26-volt) charging system, proceed with the next step.

- If there is NO voltage, test the stop circuit, refer to Stop Circuit Testing under Checking the Ignition System.

If there is low voltage, check the battery conditionlconnectionsand state of charge. If the battery is not at fault, test the starter motor current draw to see if it is excessive.

4. Test the 40-volt (or 26-volt) charging system output using a DVOM lead between a good powerhead ground and fuse positions 2, 3 and 6. Check for any of the following:

- With the keyswitch on, but the engine NOT running, voltage should be about 1 volt less than battery voltage at the fuse positions.

With the motor cranking, voltage should be GREATER than the keyswitch on reading.

- With the motor running, voltage should be 39-volts or greater (except on 1501175 hp motors equipped with fuel rails, on which voltage should be 25 volts or more).

■ On 200-250 hp motors, the 40-volt system should show at least 20 volts when cranking, more than 24 volts and steady with the motor running at idle, and more the 39 volts when running above 1500 rpm.

5. If any voltages are less than specified, test the charging system (and the start assist circuit except for 1501175 hp motors with fuel rails). For details, refer to the Ignition and Electrical System section. If voltages are as specified, check the injector supply voltage at the white or white-striped lead on each injector connector. Voltages at each injector connector should be the same as the previous step when testing keyswitch on, engine cranking and engine running at each of the fuses.

■ If the FFI diagnostic software is available, voltage can also be monitored using the software.

6. If voltages at one or more injector vary from the voltage when tested at the fuse positions, check voltage at terminal M (white wire), terminal P (whiteltan wire) and terminal K (whitelblack wire) at the 14-pin connector for the power distribution panel (fuse block). Terminals M, P and K are in the upper group of 7 wires on the 14-pin connector. Terminal P is the top wire, terminal M is the 3rd one down, and terminal K is 3rd from the bottom (but still in the top group). If there are no voltages at ALL wires, when there was at the fuse terminals, the power distribution panel must be repaired or replaced.

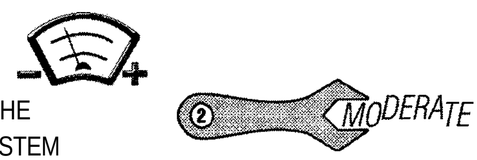
Checking the Start Assist Circuit

◆ See Figure **179**

Only 40-volt injector driver models are equipped with a start assist circuit.

1. Check the 20-amp fuse in the purplelwhite-to-black wire from the power distribution panel (fuse box). Terminal J is part of the 14-pin connector at the top left of the distribution panel, it is the 2nd wire from the bottom in the top group of 7 wires. Repeated failures of the 20-amp fuse indicate either a failed Starter Assist Circuit inside the EMM or a short somewhere inside the 40-volt circuit.
2. Check for positive battery voltage at the EMM pink/white wire while cranking. If there is no voltage, replace the faulty wire or starter solenoid, as applicable.

CHECKING THE IGNITION SYSTEM



Because the ignition system is an integral part of the FICHT Fuel Injection (FFI) system, overall system test procedures are provided here. For individual component testing (such as the ignition coil) not covered here or for component replacement procedures, please refer to the Ignition and Electrical System section.

Unless otherwise instructed by a trouble code, symptom chart or other test, follow each of the test procedures in the order provided to ensure a complete verification of the ignition system.

✳✳ CAUTION

The **FICHT** ignition system operates a primary circuit of 250 volts and a secondary circuit with voltage exceeding 35,000 volts. This represents a serious shock hazard. To prevent serious or fatal injury, NEVER handle ignition system components with the engine running or **cranking.**

■ Be sure to check for any trouble codes before starting these test procedures. If possible, make repairs and clear all codes before proceeding.

Visually Inspecting the Ignition System

1. Check all connections and grounds for the ignition system to make sure they are clean and tight.

2. Check all grounds using an ohmmeter. Probe between a good powerhead ground and the ground wire itself, resistance must be zero ohms. If necessary, remove the ground then clean the terminal and connection point, then reinstall, tighten and re-test.

Performing a Cranking Spark Test

✳✳ CAUTION

The FICHT ignition system operates a primary circuit of 250 volts and a secondary circuit with voltage exceeding 35,000 volts. This represents a serious shock hazard. To prevent serious or fatal injury, NEVER handle ignition system components with the engine running or cranking.

A spark tester can be used to make a quick check of the ignition system. It can also be used during other test procedures to provide a safe path for ignition voltage when cranking the motor is required but spark plugs may be removed. Remember, that is the engine is cranked with the spark plug wires disconnected, you've GOT to ground the electrodes to prevent creating a very serious shock hazard. Furthermore, if the spark plugs are removed or if fuel fitting are open, there is a strong possibility of fuel vapors being present in the work area, which could easily be ignited by arcing voltage from a stray spark plug lead.

Relatively inexpensive spark testers should be available from most marine and automotive part stores. The typical, inexpensive tester usually looks a lot like a spark plug with a ground lead and/or a clip (sometimes the clip serves the grounding function as well). Most will contain a threaded gap adjuster so the gap can be set to the specific requirements of the ignition system being tested. In some cases a spark testing tool can be fashioned from an old spark plug with a ground wire and/or grounding clip spot welded to it.

✳✳ CAUTION

To prevent injury or damage, all spark plug leads must remain connected to a spark tester that has been adjusted to a 7/16 in. (llmm) gap during cranking tests. DO NOT connect the spark tester to the EMM or its brackets and be certain that the tester and its leads are at least 2 in. (51mm) away from all wires or sensor leads.

1. Tag and remove the spark plug wire(s) from the plug(s) and connect to an adjustable-gap type spark tester. Set the spark tester gap(s) to 7116 in. (l1mm).
2. Make sure the battery is fully charged and the emergency stop clip (if used) is in place.
3. Crank the motor and observe the spark tester(s).
4. If there is steady spark on ALL ignition leads, the system appears to be operating correctly, perform the Ignition System Running Test, as detailed in this section, to verify.
5. If there is no spark at some or all leads, note the problem cylinder(s) and proceed with the next test (Checking the Crankshaft Position Sensor).

Checking the Crankshaft Position Sensor

1. In order to operated properly the crankshaft position sensor must be positioned a specific distance from the flywheel and no closer or further away. This distance is determined by air gap. To check and adjust the sensor air gap, refer to the Timing and Synchronization procedures in the Maintenance and Tune-Up section.
2. If the gap is within spec, make a quick check of the sensor functionality by disconnecting the wiring and probing across the 2 sensor leads (normally black and orange wires) using an ohmmeter. Resistance, at normal room temperature varies by engine:

For 75-175 hp V4 and V6 motors (EXCEPT those with fuel rails), resistance should be about 120-160 ohms.

For 1501175 hp V6 with fuel rails, resistance should be about 800-1000 ohms.

For 200-250 hp V6 motors, resistance should be about 1000-1200 ohms.

3. If the sensor tests within spec, but the circuit is suspect, use the wiring diagrams provided in the Ignition and Electrical System section, trace the crankshaft position sensor wiring. Disconnect it at both ends and use an ohmmeter to check continuity. Check for shorts to ground by checking between one end of the wire and a good powerhead ground. Similarly, use a voltmeter to check for shorts to power using the same method.
4. If the sensor and circuit tests good, but problems are still suspected, proceed with the next text (Checking Primary Circuit Voltage).

Checking Primary Circuit Voltage

This test requires the use of a terminal extender, which is essentially a short, rigid wire that is placed inline between the primary terminal of the ignition coil and primary coil wire from the EMM. The extender is used to provide an unprotected point to which the DVOM probe may be connected. Alternatively, a short length of jumper wire with a suitable connector on each end, and a length of bare wire in between (where the insulation has been removed for access) can be substituted. Also, in order to obtain an accurate reading, a high-quality Peak Reading Voltmeter (PRV) or DVOM with PRV function must be used.

1. While cranking, check the primary voltage at the ignition coil for each spark plug, compare the results to the following:

If the meter shows 180 volts or higher for one or more cylinders, suspect a defective coil or spark plug lead (that is drawing too much current).

If the meter shows little or no voltage on any, substitute a known good coil (this is really the best way to check a coil, as it approximates actual use conditions). One method is, if there is little or no voltage on only one coil, swap the 2 like coils on the motor and see if the problem follows the coil or stays behind. If voltage is ok after the substitution, you've found a bad coil. If voltage is STILL no good, the EMM must be replaced (and that can be expensive, so you see why we want you to substitute another coil first).

If there is NO voltage at all, perform the Voltage Supply Tests, as detailed in this section.

Voltage Supply Tests

◆ **See Figures 178 and 179**

Sufficient voltage must be present at the ignition system components in order for the system to operate properly. If symptoms or test lead you to suspect the possibility of insufficient voltage, use these checks to verify the circuitry and power supply.

For best results, these tests should be conducted while the symptoms or problems are occurring.

■ **The battery must be in good condition and fully charged for these tests. Make sure that all connections are clean and tight.**

1. If not already done, make sure that the emergency stop clip (if equipped) is in position.
2. Verify that the switched battery positive voltage is available at terminal J (purplelwhite wire) of the power distribution panel (fuse box). Terminal J is part of the 14-pin connector's top group of 7 wires, second terminal from the bottom of that group. There should be more than 9.5 volts while cranking and more than 13 volts when running. Proceed as follows, depending on the result:

- If voltage is good, verify output voltage to the EMM (all except 1501175 hp motors with fuel rails) or the separate ignition module on 1501175 hp motors with fuel rails, proceed with the next step.

If there is NO voltage, test the stop circuit, refer to Stop Circuit Testing, detailed in this section.

- If there is low voltage while cranking, check the battery conditionlconnections and state of charge. If the battery is not at fault, check for a voltage drop across the battery cables and starter solenoid or test the starter motor current draw to see if it is excessive.

Also, on all except 1501175 hp motors equipped with fuel rails, check the condition of the 20-amp inline fuse.

3. To verify output voltage to the EMM or separate ignition module (as applicable), connect a DVOM between the fuse in position No. 5 (of the power distribution panel) and a good powerhead ground. With the key **on,** but the engine not running there should be about 1 volt less than battery voltage. With the engine cranking there should be more than the key **on** voltage. Proceed as follows, depending upon the result:

If results are within specification, check continuity of the whitelgreen wire between power distribution panel (fuse box) and the EMM.

If the wire is in good condition and all other tests show properly operational circuits, the EMM is faulty and must be replaced.

- If output voltage to the EMM is less than specified, check the 40-volt or 26-volt charging system as applicable.
- If there is no voltage, recheck the fuse in position No. 5 and check voltage on terminal A (whiteired wire) of the 4-pin connector at the lower left of the power distribution panel. Terminal A is the top wire on the 4-pin connector. If results are now as specified (showing intermittent problems) the power distribution panel itself is likely at fault. If there is still no voltage, check the EMM voltage regulator.

Repeated failures of the fuse in position No. 5 are normally caused by a failed EMM.

Ignition System Running Test

The only safe and accurate way of conducting this test is through the FFI diagnostic software.

Connect a source of cooling water so the engine can be run. Use the FFI diagnostic software to monitor system voltages while also checking each spark plug lead using a timing light. There should be one consistent flash and only one flash per revolution while observing steady voltages via the software.

- If spark plugs are firing properly and system voltages are within specification, but a problem still exists, suspect worn or fouled spark plugs, fuel system problems or internal problems.
- If voltages are low or decrease with rpm, check the charging system.
- If voltages are steady but the engine misfires, check the crankshaft position sensor air gap and resistance as detailed under Checking the Crankshaft Position Sensor, in this section.
- If voltages fluctuate and engine misfires, suspect a loose battery connection or a damaged capacitor. To check the capacitor, refer to the Capacitor Verification procedure in this section.

Capacitor Verification

+ **See Figure 178**

1. Turn the ignition keyswitch **on.**
2. Connect a DVOM between the fuse in position No. 5 (of the power distribution panel) and a good powerhead ground and monitor voltage while physically turning the keyswitch **off.**

- If the capacitor is good, the voltage will quickly bleed to near 0 volts.
- If voltage drops immediately to 0, the capacitor is faulty and must be replaced.
- If voltage does NOT drop, verify the stop circuit. Please refer to Stop Circuit Testing, in this section.

Stop Circuit Testing

◆ **See Figures 178 and 179**

All tests are performed with the keyswitch ON and the engine NOT running.

1. If equipped, install the emergency stop switch.
2. Check the condition of the fuses in position No. 1, 5 and 7. Replace any damaged or questionable fuses.
3. Verify that the switched battery positive voltage is available at terminal J (purple/white wire) of the power distribution panel (fuse box). Terminal J is part of the 14-pin connector's top group of 7 wires, second terminal from the bottom of that group. Proceed as follows, depending on the result:

- If there is battery voltage, leave the probe connected and proceed with the next step, removing the emergency stop clip and checking the result.
- If there is NO voltage, skip the next step and check voltage at terminal N.
- If there is low voltage, replace the relay in position No. 8, then proceed with the next step, removing the emergency stop clip and checking the result.

Also, on all except 1501175 hp motors equipped with fuel rails, check the condition of the 20-amp inline fuse if voltage readings are incorrect.

4. If voltage at terminal J was within spec, continue to probe terminal J using the DVOM and remove the emergency stop clip. If the stop circuit is working properly, voltage should drop to 0 and the stop relay in position No. 8 should audibly click. If voltage remains present at terminal **J,** use a jumper to ground terminal **F** (black/yellow wire) of the 14-pin connector, while continuing to watch voltage on terminal **J.** Terminal **F** is the second wire from the top on the bottom group of 7 wires. Proceed as follows, depending on what happens:

- **If** there is no voltage now, then there is likely a faulty instrument harness or emergency stop clip. Repair or replace, as necessary.
- If voltage is STILL present, check voltage as fuse position No. 5. If voltage IS present, skip the next 2 steps and check for voltage at fuse box terminal 86 for relay No. 8. If voltage is NOT present at fuse No. 5, check for voltage at terminal A (white/red wire), the top terminal of the 4-pin connector at the lower left of the fuse box). If there is about 1 volt less than battery voltage at terminal **A,** but no voltage at fuse No. 5, repair or replace the power distribution box. If there is no voltage at terminal **A** either, check the charging system.

5. Check for battery voltage at terminal **N** (red wire) of the 14-pin connector of the power distribution panel. Terminal **N** is the second wire from the top of the top group of 7-wires for the 14-pin connector. If there is battery voltage, go to the next step (and test voltage at terminal 30 for the relay No. 8 in the fuse box). If there was no voltage at terminal **N,** perform the Main Power Relay Circuit Testing procedure in this section.
6. Remove the relay from position No. 8 in the power distribution panel. Check for battery voltage at terminal 30 (the right most terminal for relay No. 8, when facing the panel) of the relay socket. If there is NO voltage, verify the condition and connection of the 14-pin connector and/or repair/replace the power distribution panel. If there IS battery voltage here, substitute a known good relay and verify proper operation.
7. If not done already, remove the relay from position No. 8 in the power distribution panel, check for approximate battery voltage at terminal 86 (the top most terminal for relay No. 8, when facing the panel). If there is approximate battery voltage, but the tests 2 steps ago failed, substitute a known good relay and verify proper operation. If there is NO voltage at the terminal socket, repaidreplace the power distribution panel.

Main Power Relay Circuit Testing

◆ **See Figures 178 and 179**

1. Check the condition of the fuse in position No. 7 of the power distribution panel (fuse box).
2. With the ignition keyswitch **on,** check for approximate battery voltage as fuse position No. 4. If there is power at position No. 4, the main power relay is working properly.
3. If there was NO voltage at position No. 4, check for the presence of switch battery voltage at terminal L (purple wire) of the 14-pin connector. Terminal L is the center wire (4 from the top or the bottom) of the top group of 7 wires for the 14-pin connector. Proceed as follows, depending upon the result:

- If readings are slightly less than battery voltage, go the next step.
- If there is NO voltage, make a diode check between terminal L of the 14-pin connector and terminal 4 (purple wire) of the 6-pin instrument harness connector. If OK, check the instrument harness and keyswitch. If not OK, replace the diode in the engine harness purple wire.

4. If there was slightly less than battery voltage at terminal L during the previous step, check for switched battery voltage at the relay socket purple wire. And proceed as follows, depending upon the result:

- If there is NO voltage there with the keyswitch **on,** repair the purple wire or replace the engine harness.
- If there is slightly less than battery voltage, check the relay socket red wire (from the starter solenoid) for proper battery voltage. If OK, suspect a faulty relay. If there is NO voltage, repair the red wire or replace the engine harness.

Air Intake Silencer/Flame Arrester

The air intake silenceriflame arrester mounts over the throttle bodies at the front of the powerhead. As the name implies, it is designed to reduce mechanical noise emitted from the engine while protecting the engine cases and external components from the possibility of a backfire through the manifolds and throttle bodies

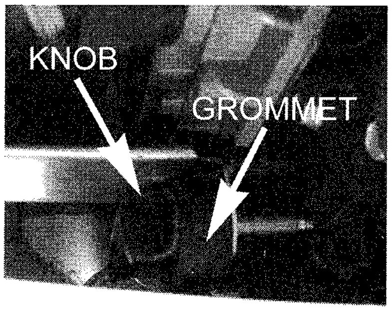


Fig. 180 The intake silencer is secured by a knobs and grommets...

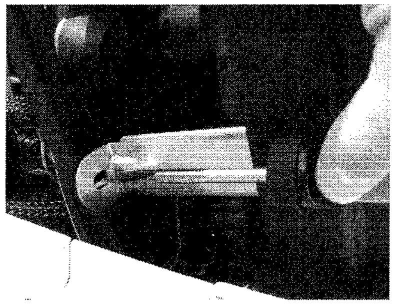


Fig. 181 ...that must be unthreaded to free the housing

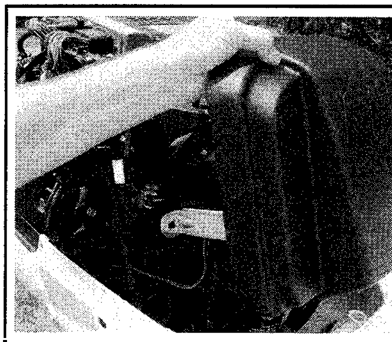


Fig. 182 Carefully lift the housing for access to the sensor wire

REMOVAL & INSTALLATION

◆ **See Figures 180,181,182,183,184 and 185**

The air intake silencer housing is secured over the throttle bodies and to the powerhead by large rubber mounted knobs (usually one on either side of the assembly). Removal is normally a relatively straightforward procedure of loosening and unthreading the knobs and carefully pulling the housing free of the throttle bodies. BUT, be careful as the intake silencer normally houses the air temperature sensor (which must be freed from the housing to prevent damage to the mounting or the wiring harness). Also, be sure that no air silencer seals are dislodged or damaged (replace any which are damaged during installation).

1. Remove the engine top case for access. On most models, the air intake silencer is easily removed without having to disturb the lower covers.
2. Locate the threaded knob assemblies securing the metal legs of the air intake silencer housing to the powerhead. There are usually 2 (one on each side), but models will vary slightly).
3. Loosen and unthread the knobs by hand. If however a "torque monster" was there before you, a pair of pliers covered with a sturdy rag (to help prevent damaging the composite material of the knobs) may be used to loosen the knob, but turn it by hand as soon as it is loose enough to do so.

☐ **Keep track of the rubber grommet(s) normally mounted between the knob and the metallic intake housing leg.**

4. Carefully pull the silencer housing away from the throttle bodies in order to gain access to the sensor mounted at the rear of the housing. Gently release the sensor locktabs and withdraw the sensor from the housing.

☐ **Be sure to keep track of the sensor seal. It must not be lost or damaged.**

5. Clean the insides of the silencer-to-throttle body bores using a rag and a small amount of suitable solvent.

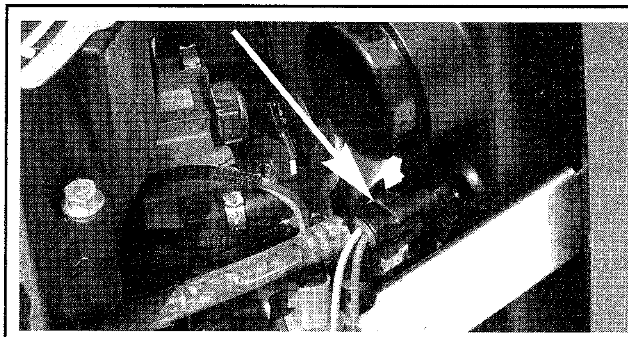


Fig. 183 Release the locktabs and carefully withdraw the sensor from the rear of the intake silencer

To install:

6. Position the air intake silencer assembly just in front of the throttle bodies, then carefully install the air temperature sensor. Make sure the rubber seal is in position and the locktabs engage to hold the sensor securely in place.
7. Carefully align the housing with the throttle bodies and push gently back to seat the housing.
8. Install the cover retaining knobs and rubber grommets and tighten securely. We mean, tighten them so that they won't loosen in service from vibration, but not so tight as to damage the grommets, deform the housing leg or to require a pair of pliers to loosen them again next time.
9. Install the engine top case.

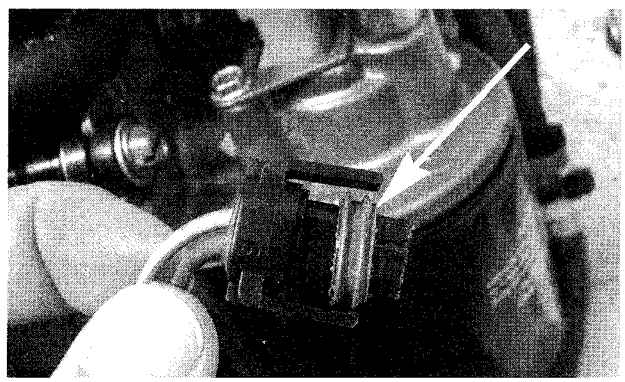
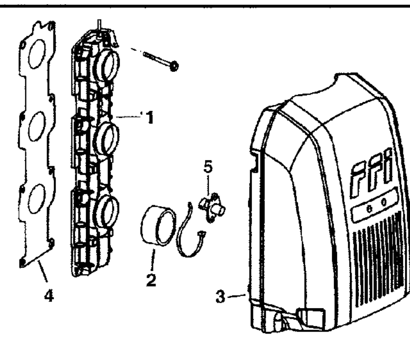


Fig. 184 Make sure the sensor's rubber grommet is not lost or damaged



1 Throttle body assembly
2 Air silencer seal
3 Air silencer assembly
4 Manifold to throttle body assy. gasket
5 Air temperature sensor assembly

Fig. 185 Exploded view of a typical FICHT air intake silencer and throttle body mounting—1501175 hp V6 shown

Throttle Body

◆ See Figure 185

Like the throttle bore of a carburetor, the throttle body assembly controls engine speed by mechanically controlling the amount of air allowed to enter the engine. For all FFI models, there is one throttle bore per cylinder. The 75-175 hp motors utilize a one piece 2 (V4) or 3 (V6) throat assembly mounted on each cylinder bank. The larger V6 motors (200-250 hp models) utilize a 3 throat assembly on each cylinder bank consisting of a 2 throat upper throttle body and a single throat lower throttle body. In all cases, the throttle bodies are bolted to the front of the intake manifolds, directly behind the air intake silencer.

REMOVAL & INSTALLATION

② MODERATE

◆ See Figures 185 and 186

There are no serviceable parts to the throttle body assemblies. Removal and installation is a relatively straightforward proposition where the linkage is disconnected, hoses are repositioned slightly and the assembly is unbolted from the manifold. During assembly, be sure to ALWAYS use a new gasket and to carefully tighten the retainers to the proper torque using a crossing sequence. This will help prevent the possibility of air leaks that could cause rough running and lean operating conditions.

1. Disconnect the negative battery cable for safety.
2. Remove the air intake silencerlflame arrester, as described in this section.
3. Disconnect the throttle linkage from the top of the throttle body assembly.

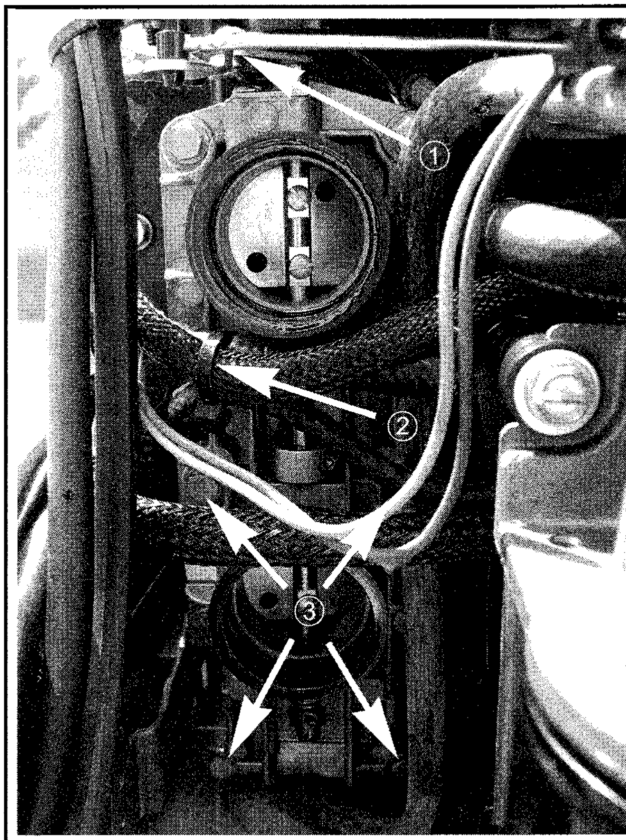


Fig. 186 Throttle body removal is a basic matter of (1) disconnecting the linkage, (2) cutting any tie straps and relocating interfering **hoses/wires** and . . _ the _ bolts around the **i ter of the assembly (number of bolts varies with model)**

4. If necessary, cut any wire ties and reposition hoses or wiring that interfere with throttle body removal. Take note of all wire/hose and wire tie positioning for installation purposes.
5. If necessary, tag and disconnect the vent hoses.
6. Slowly loosen and remove the throttle body retaining nuts and/or bolts, then carefully pull the assembly from the intake manifold.
7. Remove and discard the gasket, then carefully clean the mating surfaces of all debris.

To install:

On some applications, the replacement gaskets come with an adhesive side. If applicable, peel the backing from the gasket and carefully apply it to the throttle bodies. If the replacement gasket is not self-adhesive, DO NOT use sealant in an attempt to hold the gasket in position during installation, the gasket must be installed dry, instead use a few of the throttle body retaining bolts (inserted through the throttle body) to hold the gasket in position.

8. Install the throttle bodes using a new gasket, then carefully thread the retaining nuts and/or bolts. Tighten the retainers using several passes of a crossing pattern that starts at the center and works outward until the specification is reached. Tighten the retainers to 40-50 inch lbs. (4.5-5.6 Nm) for 75-175 hp motors or to 120-144 inch lbs. (14-16 Nm) for 200-250 hp motors.

Be sure to route all wiring as noted during removal to avoid interference.

9. Reposition any hoses or wires that were disconnected and/or moved for access to the throttle bodies. Secure using new wire ties as noted during removal.
10. If removed, reconnect the vent hoses as tagged during removal.
11. Apply a light coating of grease to any pivot points, then reconnect the throttle linkage.

☐ Grease all pivot points, even any pivot point not disconnected.

12. Install the air intake silencerlflame arrester, as described in this section.
13. Reconnect the negative battery cable.

Low Pressure Fuel Pump (Lift Pump)

The lift pump operates in the same basic fashion as the pump that is found on 2-stroke carbureted engines. It draws a steady fuel supply from the tank and feeds a fuel reservoir (but instead of the feeding carburetor float bowls, it feeds the fuel vapor separator assembly, supplying fuel to the high-pressure circulation pump).

Mounting varies slightly with the 3 permutations of the FICHT system, but in all cases, the lift pump is found on the fuel component bracket.

TESTING

② MODERATE

☐ In order to isolate problems with the FICHT **system, VERY** specific diagnostic procedures are set forth by the manufacturer and we've provided them under FICHT Component Testing, in this **section. The** portions relating most directly to the lift pump are **the Verifying** Fuel Delivery to the Engine and Checking the Lift (Low Pressure) Fuel Pump procedures. If desired, the quick-check provided here can be used to help see of the lift pump may be in question, but it is no substitute for the proper diagnostic procedure found earlier in this section.

The problem most often seen with fuel pumps is fuel starvation, hesitation or missing due to inadequate fuel pressure/delivery. In extreme cases, this might lead to a no start condition as all but total failure of the pump prevents fuel from reaching and filling the vapor separator tank). More likely, pump failures are not total, and the motor will start and run fine at idle, only to miss, hesitate or stall at speed when pump performance falls short of the greater demand for fuel at high rpm.

Before replacing a suspect fuel pump, be absolutely certain the problem is the pump and NOT with fuel tank, lines or filter. A plugged tank vent could create vacuum in the tank that will overpower the pump's ability to create vacuum and draw fuel through the lines. An obstructed line or fuel filter could also keep fuel from reaching the pump. Any of these conditions could partially restrict fuel flow, allowing the pump to deliver fuel, but at a lower pressureirate. A pump delivery or pressure test under these circumstances would give a low reading that might be mistaken for a faulty pump

If inadequate fuel delivery is suspected and no problems are found with the tank, lines or filters, a conduct a quick-check to see how the pump affects performance. Use the primer bulb to supplement fuel pump. This is done by operating the motor under load and otherwise under normal operating conditions to recreate the problem. Once the motor begins to hesitate, stumble or stall, pump the primer bulb quickly and repeatedly while listening for motor response. Pumping the bulb by hand like this will force fuel through the lines to the vapor separator tank, regardless of the fuel pump's ability to draw and deliver fuel. If the engine performance problem goes away while pumping the bulb, and returns when you stop, there is a good chance you've isolated the low-pressure fuel pump as the culprit. Perform a pressure test to be certain, then repair or replace the pump assembly.

**** WARNING**

Never run a motor without cooling water. Use a test tank, a **flush/test** device or launch the craft. Also, never run a motor at speed without load, so for tests running over idle speed, make sure the motor is either in a test tank with a test wheel or on a launched craft with the normal propeller installed.

REMOVAL & INSTALLATION

② MODERATE

Exact location of the lift pump varies slightly from model-to-model, but in all cases, the FICHT fuel pump is mounted to the front of the powerhead, either between or right below the throttle body assemblies. On most of the motors it is mounted to or with a Fuel Component Bracket assembly and often removed with the assembly.

If hoses are removed completely or replaced, be sure to make a note of hose routing for installation purposes. Hoses must be carefully positioned to prevent interference with other components, as interference could wear away at hoses over time, eventually causing a hazardous fuel leak.

Most hoses are installed using a threaded clamp that is loosened by turning the clamp screw using a socket or a screwdriver. On these hoses, loosen the clamp and slide it well up the hose, past the raised portion of the fitting. Some hoses (usually vacuum pulse hoses only) are retained using wire ties that must be carefully cut free.

**** WARNING**

Once it comes time to remove the hose from the fitting, push on the hose (rather than pull on it) in order to help prevent damage to the fittings. If a hose is too stuck on a fitting, make a thin slit in the side of the hose from the end, back past the end of the fitting and carefully peel the hose off. Be careful not to damage the fitting with the blade. Obviously, if this is done, the hose must be replaced using one of the same length and materials during installation.

In all cases, have a small shop rag or drain pan handy to catch any escaping fuel or oil that may be present in the end of the lines. Cap or plug the fuel and oil supply lines to help prevent system contamination and excessive leakage.

**** WARNING**

Always replace hoses that are worn (spongy, hard or brittle).

75-175 Hp *(1726/2859cc)* V4/V6 Motors (Except Models with Fuel Rails)

◆ See Figures *187,188* and *189*

On 75-175 hp motors (except 1501175 hp motors equipped with fuel rails), the pump is assembled to the REAR of the fuel component bracket, right behind the fuel/water separator, requiring removal (or at least repositioning) of the bracket for access. Actually, on these models, the bracket itself is a functional part of the pump, acting as the rear cover of the pump body. The pump itself is mounted to the bracket using a gasket. For this reason, although you could reposition the bracket and unbolt the pump cover and body, it would be relatively awkward and we recommend completely removing the component bracket. Besides, unbolting the pump from the bracket opens the assembly up for a rebuild that should include a careful cleaning and component inspection.

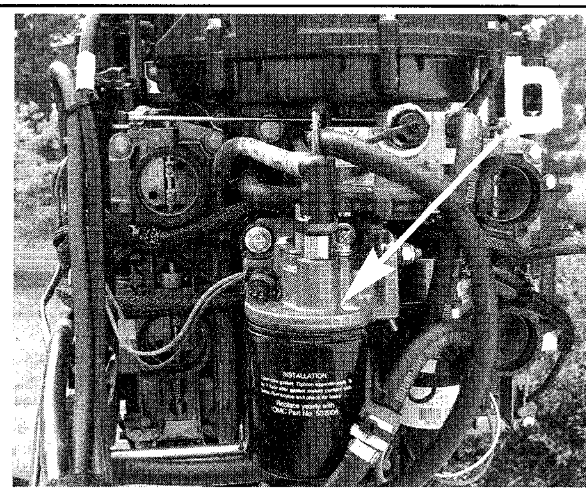


Fig. *187* A fuel component bracket, consisting of the lift pump and filter assembly, is found at the front of the motor on most *75-175* hp motors (except those with fuel rails)

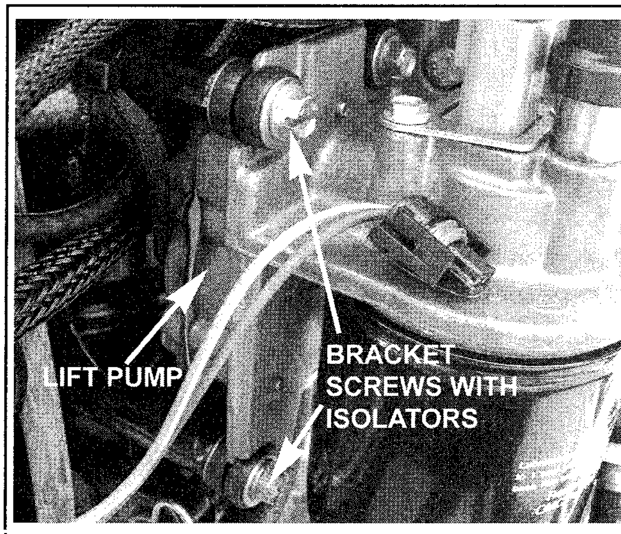
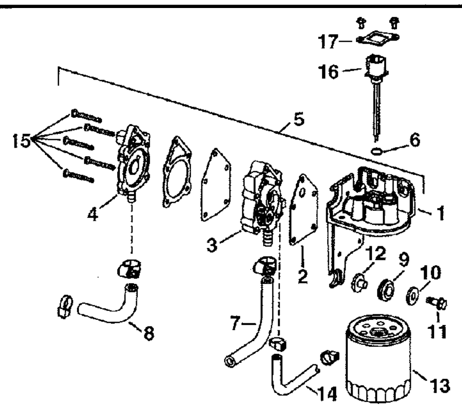


Fig. *188* The lift pump itself is mounted to the rear of the bracket. The bracket itself is secured to the powerhead using bolts and isolator grommets

■ To ensure proper assembly and hose routing, mark the fuel pump relative to the powerhead or bracket and tag all hoses be before removal.

1. Disconnect the negative battery cable for safety.
2. Remove the engine covers. For details, please refer to Engine Cover (Top and Lower Cases) in the Maintenance and Tune-Up Section.
3. Remove the Air Intake Silencer/Flame Arrester, as detailed in this section.
4. Remove any oil system components necessary to access the fuel components. In most cases, the oil system components can simply be unbolted and positioned aside. For details on oil system component removal refer to the Lubrication and Cooling Section.
5. Tag and carefully disconnect the fuel lift pump pulse hoses at the crankcase. These hoses are usually retained on the pulse nipples using wire ties that must be cut free and replaced with new ties during installation. If the hoses are to be disconnected from the pump, they may be secured using wire ties or threaded clamps.
6. Tag and disconnect the fuel tank-to-lift pump hose. This line is normally secured using a threaded clamp.
7. Disconnect the ground wire, the fuel filter electrical connector and the filter-to-vapor separator fuel line.
8. Loosen the pump/bracket mounting screws with isolator enough to remove the lift pump, filter and bracket assembly from the motor.
9. Inspect clamps for corrosion or damage and replace questionable clamps.
10. Replace hoses that are worn (spongy, hard or brittle).
11. If overhaul is necessary, tag and remove the hoses from the lift pump itself, then remove the screws securing the pump to the bracket and remove the pump. In most cases, the 5 cover screws are threaded through the pump cover and body into the back of the bracket. Carefully separate the pump cover from the body in order to access the individual pump components. Clean the components using a mild solvent and allow to air drv (or blow dry with low-pressure compressed air).



1 Housing assembly
2 Gasket
3 Lift pump housing assembly
4 Lift pump cover
5 Fuel lift pump assembly
6 Water sensor O-ring
7 Inlet tube to lift pump hose
8 Lower hose lift pump pulse
9 Bracket mounting isolator
10 Washer
11 Screw
12 Spacer
13 Fuel filter
14 Upper hose lift pump pulse
15 Screws
16 Water sensor unit
17 Sensor retainer

Fig. 189 Exploded view of the fuel pump and filter component bracket assembly—75-175 Hp **(1726/2859cc) V4/V6** motors (except models with fuel rails)

To install:

12. If removed for overhaul, assemble the lift pump components, replacing all gaskets and diaphragms to ensure proper operation. Install the lift pump to the bracket assembly using a new gasket and tighten the mounting screws to 40-50 inch lbs. (4.5-5.6 Nm).
13. Apply a light coating of Evinrude/Johnson Nut Lock, or equivalent threadlock to the pump, filter and bracket assembly retaining screws.
14. Position the lift pump, filter and bracket assembly to the front of the powerhead using the isolators, then tighten the retaining screws to 60-80 inch lbs. (7-9 Nm).
15. Connect the filter-to-vapor separator line, the fuel filter wire connector and the ground wire. Tighten the screw to 60-80 inch lbs. (7-9 Nm).
16. Reconnect the lift pump pulse and fuel lines, as tagged during removal. The pulse lines on these motors are usually secured using wire ties while the fuel line is normally secured using a threaded clamp.
17 Connect the negative battery cable, then properly pressurize the fuel system and check for leakage. Pump the primer bulb until it becomes firm, then check of the fuel fittings and lines that were disconnected for any signs of weepage.
18. Install and oil system components that were removed or relocated for access.
19. Correct any fuel leaks before starting or running the engine, then run the motor using a source of cooling water and recheck.
20. Install the air intake silencer assembly and the engine covers.

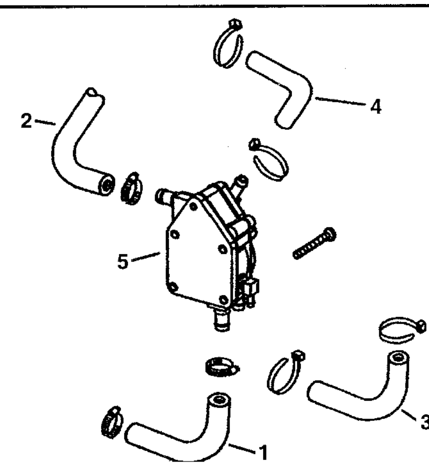
150-175 Hp **(2589cc) V6** Motors (Models with Fuel Rails)

◆ See Figures 190,191,192,193 and 194

On 1501175 hp motors equipped with fuel rails, the lift pump mounted to the side of the fuel vapor separator tank, at the center, front of the motor, smack dab between the throttle bodies. The lift pump can be removed along with circulation pump/vapor separator assembly or it can be unbolted and removed separately. In all cases, tagging the hose connections and noting the hose routing is of utmost importance.

To ensure proper assembly and hose routing, mark the fuel pump relative to the powerhead or bracket and tag all hoses be before removal.

1. Disconnect the negative battery cable for safety.
2. Remove the engine covers. For details, please refer to Engine Cover (Top and Lower Cases) in the Maintenance and Tune-up Section.



1 Inlet tube to lift pump hose
2 Lift pump outlet to tube hose
3 Pulse nipple to lift pump lower hose
4 Pulse nipple to lift pump port upper hose
5 Lift pump assembly

Fig. 190 Exploded view of the lift pump mounting and hose connections (viewed from side of pump which faces the vapor **separator)<em dash>150-175** Hp **(2589cc)** V6 motors (with fuel rails)

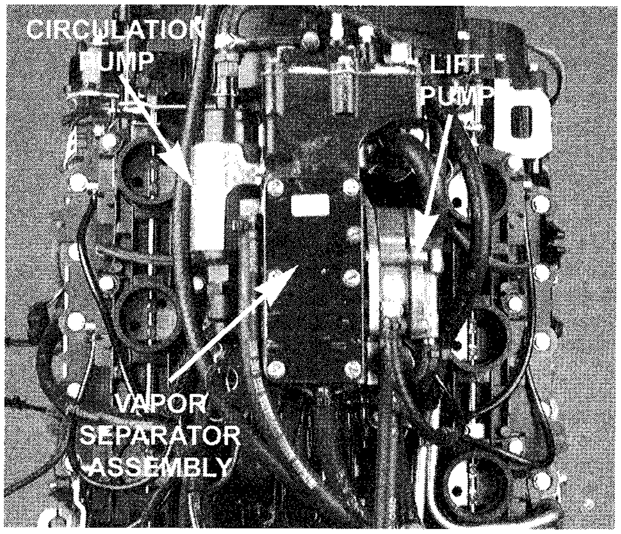


Fig. 191 The fuel component assembly for 1501175 Hp **(2589cc)** motors with fuel rails consists of the lift pump, vapor separator **tank/fuel** reservoir and the circulation pump

3. Remove the Air Intake Silencer/Flame Arrester, as detailed in this section.
4. Tag the vacuum pulse hoses and fuel/oil supply hoses for the pump nipples. On these models that includes the lift pump-to-filter hose, the tank-to-lift pump hose and the pulse hoses.

If hoses are removed completely or replaced, be sure to make a note of hose routing for installation purposes. Hoses must be carefully positioned to prevent interference with other components, as interference could wear away at hoses over time, eventually causing a hazardous fuel leak.

5. Loosen and reposition or remove the clamps securing the hoses. Most fuel/oil hoses are installed using a threaded clamp that is loosened by turning the clamp screw using a socket or a screwdriver. On these hoses, loosen the clamp and slide it well up the hose, past the raised portion of the fitting. Some hoses (usually the vacuum pulse hoses) are retained using wire ties that must be carefully cut free.

If a hose is stuck on the fitting, use a small blade to carefully cut and peel it free of the fitting. Be careful not to damage the fittings with the blade.

6. Once the clamps are loosened and repositioned or removed, carefully push the hoses off the fittings. In all cases, have a small shop rag or drain pan handy to catch any escaping fuel or oil that may be present in the end of the lines. Cap or plug the fuel/oil lines to help prevent system contamination and excessive leakage.

. WARNING**

Use extreme care when disconnecting the hoses to prevent damaging or breaking the fittings on the fuel pump assembly. Replace hoses that are worn (spongy, hard or brittle).

7. Loosen the 2 pump mounting screws and then carefully remove the pump from the vapor separatorlmountingbracket.

Two of the **5** visible cover screws are threaded completely through the body and into the vapor separatorlmounting bracket. When facing the pump the mounting screws are at the lower left and upper right positions, the rest of the screws attach the cover to the body only and should not be removed unless the pump is being overhauled.

8. Inspect clamps for corrosion or damage and replace questionable clamps.
9. Replace hoses that are worn (spongy, hard or brittle).
10. If overhaul is necessary, proceed as follows:
a. Matchmark the cover-to-pump body for ease of assembly (even though the shape of the pump makes it unlikely that you will mix this up).
b. Remove the 3 remaining pump cover screws, then carefully remove the pump cover and gasket exposing the light spring and cap on the diaphragm. Remove the spring and cap.
c. Slowly remove the remaining components, laying each one out on a clean worksurface to ensure proper orientation during assembly.

☐ Even if a component is being replaced, always place the old component on the worksurface in a manner that will show you the proper orientation for the replacement.

d. Discard the old gaskets and diaphragm.
e. Remove the heavy spring and cap from the pump body for cleaning and inspection.
f. Carefully press the check valve retainer pin downward in order to free the valve, then carefully remove the valves from the body and inspect for wear or damage.
g. Clean the components using a mild solvent and allow to air dry (or blow dry with low-pressure compressed air).
h. Discard and replace any worn or damaged components.

To install:

11. If the pump was disassembled for inspection or overhaul, proceed as follows:
a. Install the check valves into the pump and secure in place by carefully pressing the pin into the retainer.
b. Install the heavy spring with cap into the lift pump body.
c. Position the light spring with cap around the internal end of the nipple in cover and install a new diaphragm gasket on the body.
d. Assemble the lift pump cover to the body and finger-tighten the screws to hold all of the components in position.
12. Install the lift pump to the side of the vapor separator housing and finger-tighten the retaining bolts.

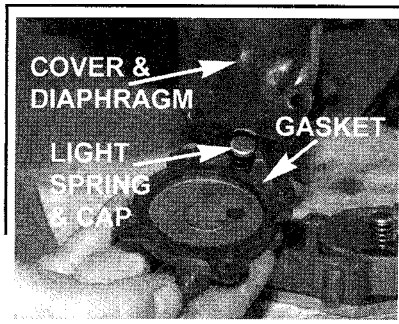


Fig. 192 To overhaul the lift pump, carefully remove the covers...

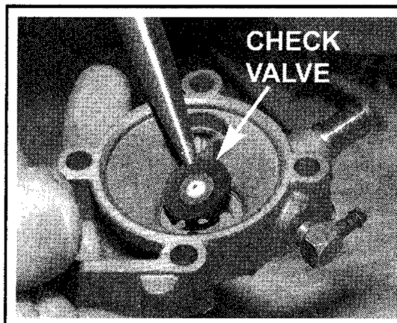


Fig. 193 ... and disassemble the pump components

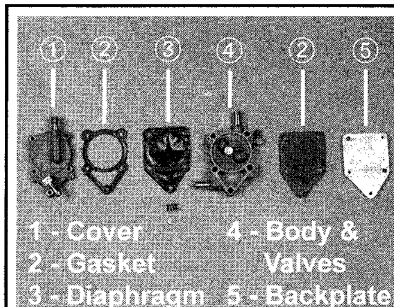


Fig. 194 Arrange all parts to ensure ease of assembly

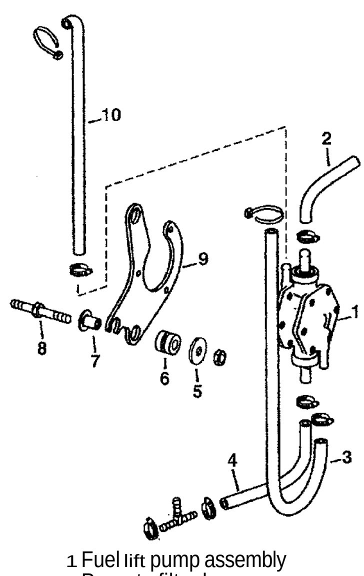
13. Securely tighten the pump screws. If the pump itself was disassembled, tighten all 5 screws using one or two passes of a crossing sequence. The sequence should start at the upper left screw (when facing the pump), then move to the lower right screw, next to the upper right screw, then the lower left screw and finally to the top, center screw.
14. If the pump was disassembled or replaced, pressure test it as detailed in this section under FICHT Component Testing, specifically, the Checking the Lift (Low Pressure) Fuel Pump procedure.
15. Reconnect the hoses to the pump as tagged during removal and secure using the threaded clamps and new wire ties, as applicable.
16. Connect the negative battery cable, then properly pressurize the fuel system and check for leakage. Pump the primer bulb until it becomes firm, then check of the fuel fittings and lines that were disconnected for any signs of weepage.
17. Correct any fuel leaks before starting or running the engine, then run the motor using a source of cooling water and recheck.
18. Install the air intake silencer assembly and the engine covers.

200-250 Hp (3000/3300cc) V6 Motors

◆ **See Figure 195**

The lift pump on 200 hp and larger V6 motors is located on a bracket that mounts on the front of the motor, directly below the port side throttle bodies. Ironically although the pump body itself is readily accessible, the hoses and mounting bolts are not. In fact, the mounting bolts are threaded from behind the bracket to which it is mounted (the heads are facing the powerhead), so the bracket itself must be removed with the pump for access.

The manufacturer recommends removing the pump with the hoses attached, but this can lead to extra steps involving removal of other interfering components (like the starter motor). Of course, the reason they recommend this is that access to the pump hoses can be difficult with the pump installed. We suggest you make up your own mind, possibly leaving some of the hoses attached until the bracket can be repositioned slightly; otherwise, we've given you all the steps necessary to completely remove the pump and bracket with the hoses still attached.



1 Fuel lift pump assembly
2 Pump to filter hose
3 Lift pump pulse lower hose
4 Tee to pump hose
5 Washer
6 Mounting bracket isolator
7 Fuel bracket spacer
8 Bracket to crankcase stud
9 Lift pump bracket
10 Lift pump pulse upper hose

Fig. 195 Exploded view of the lift pump mounting and hose connections—200-250 Hp (3000/3300cc) V6 motors

■ **To ensure proper assembly and hose routing, mark the fuel pump relative to the powerhead or bracket and tag all hoses be before removal.**

1. Disconnect the negative battery cable for safety.
2. Remove the engine covers. For details, please refer to Engine Cover (Top and Lower Cases) in the Maintenance and Tune-Up Section.
3. Remove the Air Intake Silencer/Flame Arrester, as detailed in this section.

■ **OK, it's time to make a decision. Either, you'll need to tag and disconnect the hoses that you can access (mostly at the pump), then pull the pump forward for access to the vacuum pulse hoses once the bracket is unbolted (if you can get at the bolts). OR, you'll have to disassemble additional components for access.**

4. If you have decided to remove additional components for access and remove the pump complete with the hoses attached, proceed as follows:
   a. Remove the starter motor and bracket. For details, please refer to Starter in the Ignition and Electrical System section.
   b. Disengage the electrical connector and the fuel line from the filter assembly.
   c. Tag and remove the fuel lift pump-to-filter hose.
   d. Remove the screws and spacers retaining the filter bracket, now remove the assembly.

■ **If hoses are removed completely or replaced, be sure to make a note of hose routing for installation purposes. Hoses must be carefully positioned to prevent interference with other components, as interference could wear away at hoses over time, eventually causing a hazardous fuel leak.**

5. Tag the vacuum pulse hoses and fuel/oil supply hoses at the fittings from which they are to be disconnected. At this point in the procedure, that means the fuel tank-to-pump hose and oil manifold-to-pump hose at the T-fitting. Of course, if you've chosen not to follow the previous step, that also includes the pump-to-filter hose.

■ **Remember, access to the lift pump pulse hoses requires repositioning of the starter and filter bracket (for the crankcase end of the hose) or repositioning of the pump/bracket (for pump end of the hoses). Tag and disconnect the appropriate ends when accessible, depending on how you've decided to proceed.**

6. Loosen and reposition or remove the clamps securing the hoses. Most hoses are installed using a threaded clamp that is loosened by turning the clamp screw using a socket or a screwdriver. On these hoses, loosen the clamp and slide it well up the hose, past the raised portion of the fitting. Some hoses (usually vacuum pulse hoses only and even then, usually only at the crankcase ends) are retained using wire ties that must be carefully cut free.

■ **If a hose is stuck on the fitting, use a small blade to carefully cut and peel it free of the fitting. Be careful not to damage the fittings with the blade.**

7. Once the clamps are loosened and repositioned or removed, carefully push the hoses off the fittings. In all cases, have a small shop rag or drain pan handy to catch any escaping fuel/oil that may be present in the end of the lines. Cap or plug the fuel/oil supply lines to help prevent system contamination and excessive leakage.

✳✳ WARNING

Use extreme care when disconnecting the hoses to prevent damaging or breaking the fittings on the fuel pump assembly. Replace hoses that are worn (spongy, hard or brittle).

8. Remove the locknuts retaining the lift pump and bracket assembly to the front of the powerhead.
9. If the pulse hoses have not been disconnected yet, pull the assembly gently forward for access, then tag and carefully remove them from the fittings.
10. Remove the pump and bracket assembly completely from the motor, then remove the locknuts and screws securing the pump to the bracket and separate the pump.

11. Inspect clamps for corrosion or damage and replace questionable clamps.
12. Replace hoses that are worn (spongy, hard or brittle).
13. If the pump was not functioning properly, see your local parts dealer to discuss the availability of an overhaul kit. If one is available, tag and remove the hoses from the lift pump itself (if removed with the pump as an assembly), then matchmark the pump cover to the body to ensure proper assembly. Remove the cover screws threaded through the pump cover and body. Carefullv seoarate the pump cover from the body in order to access the individual pump components. Clean the components using a mild solvent and allow to air dry (or blow dry with low-pressure compressed air).

To install:

14. If disassembled, be sure to replace all gaskets and diaphragms to ensure proper operation. Carefully assemble the pump cover and body, aligning the matchmarks made during removal and tighten the screws securely.
15. Install the pump to the bracket and tighten the screws/locknuts to 40-50 inch lbs. (4.5-5.6 Nm).
16. If the hoses were removed with the pump, install them now as tagged during removal.
17. Position the pump and bracket assembly to the powerhead. If the hoses were NOT removed with the pump, be sure to connect and secure the pulse hoses as tagged before fully seating the assembly.
18. Secure the pump and bracket to the powerhead and tighten the locknuts to 60-80 inch lbs. (7-9 Nm).
19. Connect the remaining hoses as tagged during removal. This includes the tank-to-pump and oil manifold-to-pump hoses at the T-fitting. If the pulse hoses were removed from the crankcase, attach them now and secure using new wire ties.
20. If the filter bracket and starter were removed for access, proceed as follows:
    a. Apply a light coating of Evinrude/Johnson Nut Lock, or equivalent threadlock to the filter bracket and start motor bracket retainers.
    b. Install the filter bracket and spacers, then install and tighten the retaining screws to 60-80 inch lbs. (7-9 Nm).
    c. Connect the fuel line and engage the electrical connector to the fuel filter/water separator.
    d. Install the starter motor and bracket, then tighten the retaining screws to 14-16 ft. lbs. (19-22 Nm).
21. Connect the negative battery cable, then properly pressurize the fuel system and check for leakage. Pump the primer bulb until it becomes firm, then check of the fuel fittings and lines that were disconnected for any signs of weepage.
22. Correct any fuel leaks before starting or running the engine, then run the motor using a source of cooling water and recheck.
23. Install the air intake silencer assembly and the engine covers.

OVERHAUL

MODERATE

Overhaul components may not be available for all **FICHT** motors, see your local parts dealer for availability.

If overhaul is required due to damage from contamination or debris (as opposed to simple deterioration) disassemble and clean the rest of the fuel supply system prior to the fuel pump. Failure to replace filters and clean or replace the lines and fuel tank, could result in damage to the overhauled pump after it is placed back into service.

All diaphragms and seals should be replaced during assembly, regardless of their condition. Check for fuel leakage after completing the repair and verify proper operating pressures before returning the motor to service.

**** WARI**

No sealant should be used on fuel pump components unless otherwise specifically directed. If small amounts of a dried sealant were to break free and travel through the fuel supply system it could easily clog passages (especially the small, metered orifices and needle valves of the fuel injectors).

1. Remove the Low Pressure Fuel Pump (Lift Pump) from the powerhead as detailed in this section.

When available, specific steps concerning internal components and lift pump overhaul are covered in the removal and installation procedure.

2. Matchmark the fuel pump cover, housing and base to ensure proper assembly.

To ease inspection and assembly, lay out each piece of the fuel pump as it is removed. In this way, keep track of each component's orientation in relation to the entire assembly.

3. Remove the cover screws from the fuel pump and carefullv lift the outer cover from the pump body. If necessary, pry gently using a small prytool covered with tape to avoid damaging the gasket surface.

**** WARNING**

In most cases, you should NOT disturb the diaphragm that is attached to the pump cover unless the diaphragm is going to be replaced. During installation the diaphragm surface molded into the shape of the cover, and, if it is removed for any reason it must be installed EXACTLY in the same position (which is pretty darn tough and not worth the **effort).**

4. Remove the internal pump components, carefully noting the orientation of each piece for assembly purposes.
5. Clean the fuel pump using a suitable solvent, then dry all components with compressed air.
6. Inspect the fuel pump cover, body and base using a straight edge. Inspect their gasket surfaces for scratches, voids or any irregularities. Replace warped or damaged components.
7. Inspect the fuel pump body for cracks. Replace damaged components.
8. Inspect the pump check valves for bent, cracked or corroded surfaces. The check valves are not normally replaceable, if damage or defects are found, replace the pump body.

To assemble:

9. Install all internal pump components in the positions and orientations noted during removal. Take extra care to make sure no gasket or diaphragm is pinched during assembly.

When assembling, use the screw holes in the gaskets and diaphragms to ensure proper orientation.

10. Install new gaskets and, if disturbed, worn or in anyway damaged, install a new diaphragm.
11. Align the matchmarks made before disassembly, then install the outer cover and secure using the covers screws.

When available, specific torque requirements including specifications and **sequences,** depending upon the **model, are** available in the lift pump installation procedure.

12. Install the Low Pressure Fuel Pump (Lift Pump), as described in this section.

High Pressure Fuel Pump (Circulation Pump) and Fuel Vapor Separator

One maior difference between an FFI and carbureted system (as far as fuel delivery is concerned) comes at the high-pressure circulation pump and fuel vapor separator tank. The design and location of the pump and vapor separator vary slightly from motor-to-motor, but the function is essentially the same. The vapor separator assembly serves 2 major roles, the first is to act at a fuel reservoir for the high-pressure fuel circuit driven by the circulation pump. The separator housing receives fuel from the lift pump, as well as excess fuel from the return lines (routed through the pressure regulator). The second role the separator plays should be obvious from the name. It gathers fuel vapors and routes them to the intake system for combustion. The separator tank is water cooled in order to help prevent the possibility of vapor lock or hot soak problems. The high-pressure circulation pump is either mounted to the vapor separator (so that it can be removed and serviced individually) or is incorporated into the assembly and cannot be replaced or serviced without replacing the entire pump and separator unit.

The fuel pressure regulator mounted in the bottom of the separator tank. On most applications and the fuel pressure regulator may be removed from within the tank should the regulator require replacement.

The reservoir is normally drained by removing a fuel line from the bottom of the tank, but the cooling water circuit will self-drain whenever the engine is shut off and left in a perfectly vertical position.

Removal, disassembly (when applicable) and installation procedures are provided for each of the 3 basic FICHT system permutations.

TESTING

3 DIFFICULT

■ In order to isolate problems with the FICHT **system, VERY** specific diagnostic procedures are set forth by the manufacturer and we've provided them under FICHT Component Testing, in this section. The portions relating most directly to the circulation pump are found under Checking the Fuel Delivery System, specifically Checking the Circulation (High Pressure) Fuel Pump procedure. Please refer to FICHT Component Testing for further information.

Regulated fuel system pressure in the high-pressure circuit should be 20-30 psi (138-207 kPa) with the key on and pump running. This should be true whether or not the engine is running.

REMOVAL & INSTALLATION

75-175 Hp **(1726/2859cc) V4/V6** Motors (Except Models with Fuel Rails)

◆ See Figures 196 and 197

The high-pressure circulation pump and fuel vapor separator assembly is mounted at the center rear of the motor, directly between the fuel injectors and right below the ignition coils. The unit contains an internal pressure regulator, fuel reservoir/vapor separator tank and high-pressure fuel pump, all of which must be serviced as an assembly and replaced found defective.

1. Disconnect the negative battery cable for safety.
2. Remove the engine covers. For details, please refer to Engine Cover (Top and Lower Cases) in the Maintenance and Tune-up Section.
3. Relieve the fuel system pressure, as detailed in this section.
4. Tag and disconnect the fuel line from the circulation pump. If necessary, loosen the rear EMM retaining screws for better access.
5. Tag and disconnect the fuel supply and return connectors at the vapor separator.
6. Remove the fuel supply and return manifold lines.

□ The water and vent hoses are normally retained using wire ties that must be carefully cut away for hose removal. Be careful not to nick or damage the hoses themselves.

7. Tag and disconnect the water inlet, water outlet and vent hoses from the vapor separator, then disengage the high-pressure fuel pump connector.
8. Loosen the retaining bolt and remove the clip retaining the high-pressure circulation pump/fuel vapor separator bracket to the powerhead stud, then remove the assembly from the motor.

To install:

9. Position the high-pressure circulation pump/fuel vapor separator to the powerhead using the isolators, then secure using the retaining clip and the retaining bolt.
10. Reconnect the water inlet, water outlet and vent hoses to the vapor separator as tagged during removal. Secure them using new wire ties.
11. Engage the high-pressure circulation pump connector.
12. Install the filter-to-vapor separator tube, along with the fuel supply and return manifold lines.
13. Engage the fuel supply and return connectors to the vapor separator as tagged during removal.
14. Reconnect the high-pressure fuel pump line. If loosened for access, tighten the rear EMM retaining screws to 60-80 inch lbs. (7-9 Nm).
15. Connect the negative battery cable, then properly pressurize the fuel system, as detailed in this section and check for leaks.

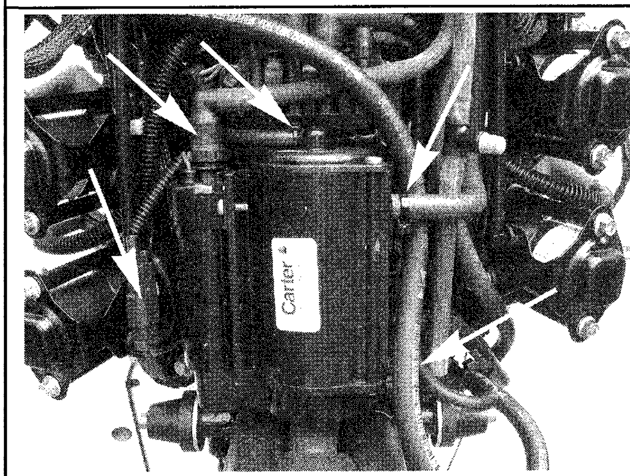


Fig. 196 Tag and disconnect the wiring and hoses from the circulation pump and vapor separator tank before removal

16. Correct any fuel leaks before startina or runninq the enăine, then run the motor using a source of cooling water and recheck.
17. Install the engine covers.

150-175 Hp **(2589cc)** V6 Motors (Models with Fuel Rails)

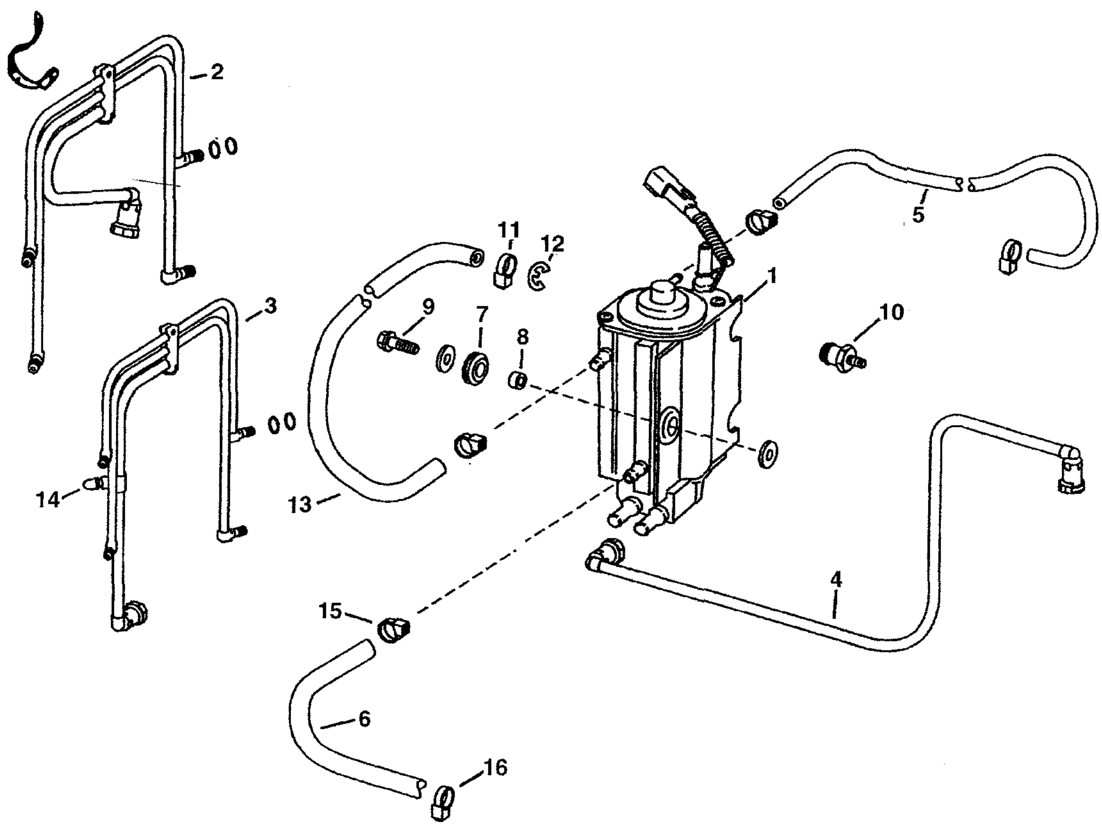
◆ See Figures 191 and 198 thru 216

The high-pressure circulation pump, fuel vapor separator and low-pressure lift pump assembly is mounted at the center front of the motor, directly between the throttle bodies. The unit contains a vapor separator float/valve assembly, pressure regulator, external low- and high-pressure fuel pump components, most of which can be serviced individually (unlike the other FICHT systems). A complete removal, disassembly, assembly and installation procedure is included.

1. Disconnect the negative battery cable for safety.
2. Remove the engine covers. For details, please refer to Engine Cover (Top and Lower Cases) in the Maintenance and Tune-Up Section.
3. Remove the Air Intake Silencer/Flame Arrester, as detailed in this section.
4. Relieve the fuel system pressure, as detailed in this section.
5. Remove the EMM cover for access.
6. Tag and disengage the connector for the vacuum switch (located under the electric pump) and the connector for the electric fuel pump (located at the top of the pump).
7. Tag and disconnect the hoses from the top of the fuel vapor separator assembly. This includes the vent hose, oil injection hose, electric fuel pump hose, injectors-to-vapor separator hose and filter-to-separator hose.

Most hoses are secured by threaded clamps that must be loosened and repositioned up the hose, away from the fitting for removal. But, some hoses are secured using wire ties that must be carefully cut away and replaced using new ties during installation.

8. Tag and disconnect the water inlet and outlet hoses from the vapor separator tank. The inlet hose is connected to the bottom of the separator, while the outlet hose is connected toward the top of the separator tank, on the left side next to the circulation pump.
9 Tag and disconnect the lift pump hoses, including the lift pump-to-filter hose, the tank-to-lift pump hose and the lift pump pulse hoses.
10. Remove the 4 retainer clips securing the assembly bracket to the powerhead studs, then remove the fuel pump component bracket assembly (the circulation pump, lift pump and vapor separator assembly). Retain the 4 washers for use during assembly.
11. Remove the vacuum switch and hose, along with the lift pump pulse hose from the assembly.
12. To service the electric circulation pump, proceed as follows:



1 Vapor **Separator/Fuel** Pump
2 Supply fuel manifold assy.
3 Return fuel manifold assy.
4 Filter to vapor separator fuel supply tube assy.
5 Vapor separator to intake hose
6 Block to vapor separator water hose
7 Vapor separator mounting grommet
8 Vapor separator mounting spacer
9 Vapor separator to block mounting screw
10 Vapor separator to block mounting stud
11 Tie strap
12 Retaining ring
13 Vapor separator to ECU water hose
14 Cap
15 Tie strap
16 Tie strap

Fig. 197 Exploded view of the high-pressure circulation pumplfuel vapor separator tank and related fuel lines 75-175 Hp **(1726/2859cc) V4/V6** motors (except models with fuel rails)

a. Remove the 3 screws securing the electric circulation pump clamp and then remove the clamp.

b. Pull the elbow at the base of the circulation pump free of the tank in order to remove the pump with the sleeve from the housing.

c. If necessary, remove the fittings from the top and/or bottom of the pump using one wrench to loosen a fitting and using another to hold the housing from turning. Remove and discard any O-rings used on the fittings.

13. If necessary, loosen the 2 lift pump mounting screws, then carefully remove the pump from the vapor separator/mounting bracket. If the lift pump requires overhaul, please refer to the Removal & Installation procedure for the Low Pressure Fuel Pump (Lift Pump) in this section. A specific overhaul sub-procedure is included in the Removal & Installation procedure.

☐ Two of the 5 visible cover screws are threaded completely through the body and into the vapor separatorlmounting bracket. When facing the pump the mounting screws are at the lower left and upper right positions, the rest of the screws attach the cover to the body only and should not be removed unless the pump is being overhauled.

14. If the vapor separator assembly requires overhaul, proceed as follows:

a. Remove the 4 screws securing the bracket to the housing and then remove the bracket.

b. Remove the 6 vapor separator cover screws, then carefully lift the cover from the reservoir and discard the gasket.

c. Remove the 2 screws securing the injector-to-vapor separator nipple and pressure tap to the top of the cover. Remove the nipple and related components (o-ring, check ball, valve and spring). Inspect the components for wear or damage and replace as necessary. Either way, discard the O-ring.

d. Remove the float valve assembly components from the cover and inspect for wear or damage. Again, replace, as necessary.

e. Inspect the float needle and seat for wear, damage or distortion and replace both components if wear or damage is found on either.

f. Remove the 6 bolts securing the water reservoir cover to the side of the housing, then remove the cover and gasket. Visually inspect the reservoir and passages for corrosion, restrictions or damage and repairireplace, as necessary.

g. If necessary, remove the plug from the bottom of the reservoir, then remove and discard the O-ring.

h. Clean vapor separator tank, cover and any parts which were removed that are not being replaced (such as components of the float/valve assembly) using a suitable solvent. Use low-pressure compressed air to carefully blow out each of the passages.

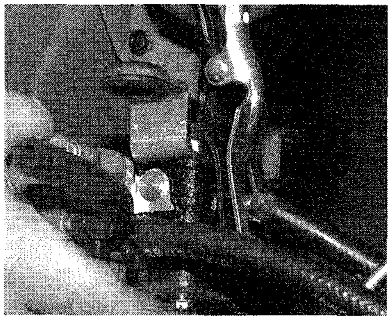


Fig. **198** Be sure to PUSH (not pull) hoses off fittings

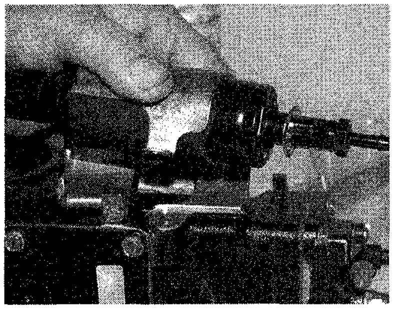


Fig. **199** Removing the circulation pump

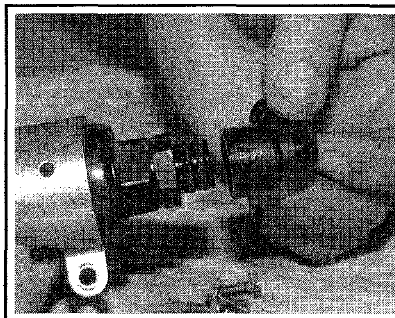


Fig. **200** Pull the elbow off to access the lower fitting

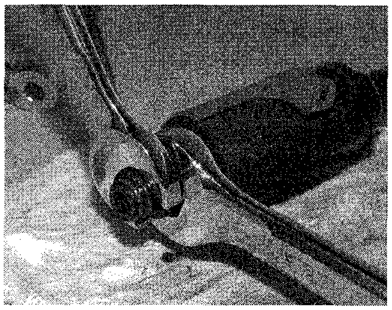


Fig. **201** The fittings are threaded into position

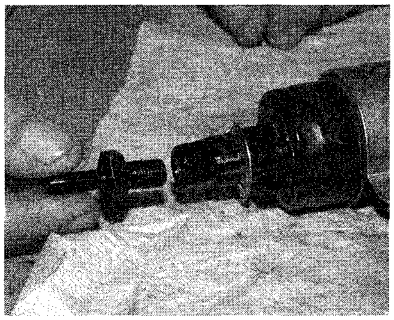


Fig. **202** Top fining unthreaded from the pump

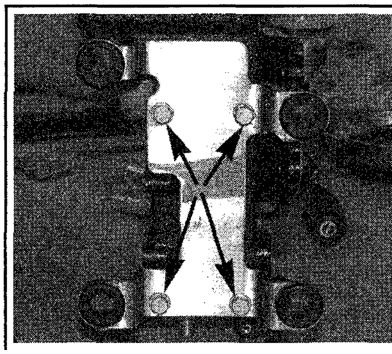


Fig. **203** Loosen the bolts and remove the bracket

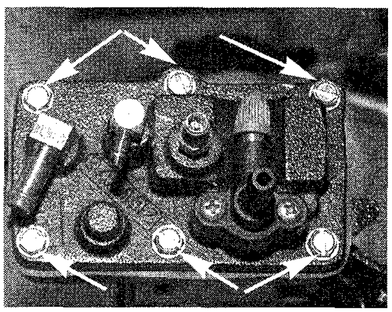


Fig. **204** Loosen the **6** cover bolts**...**

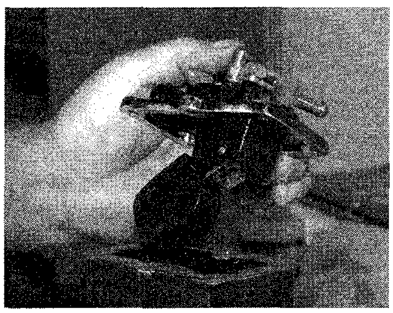


Fig. **205** **...then** carefully **lift** the cover

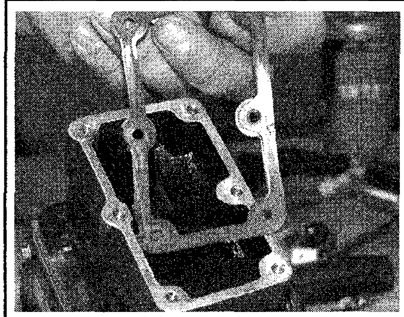


Fig. **206** **...**and the gasket from the **body**

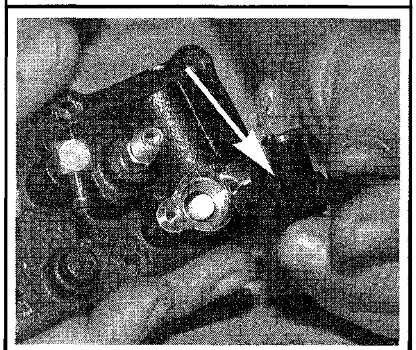


Fig. **207** Remove the injectors-to-separator nipple**...**

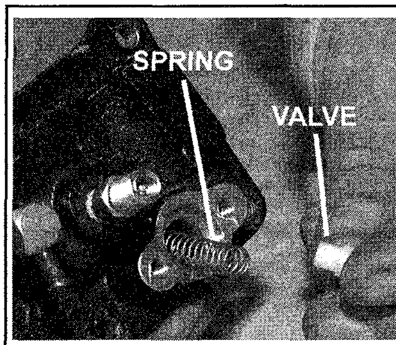


Fig. **208** **...**and related components

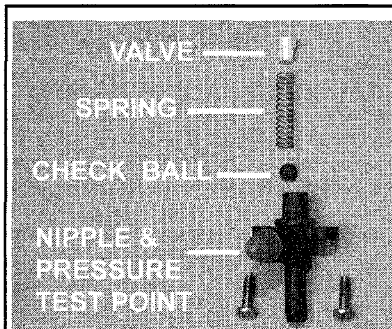


Fig. **209** arrange components for ease of assembly

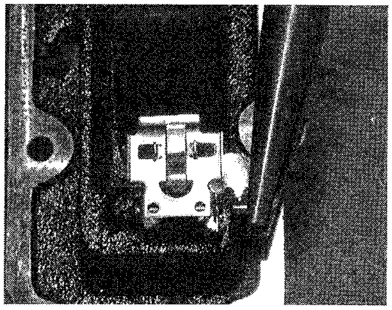


Fig. **210** Use a pair of needle-nose pliers...

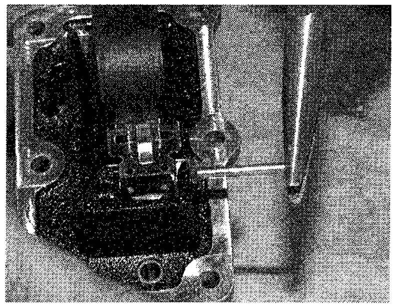


Fig. **211** ...to grasp and remove the hinge pin

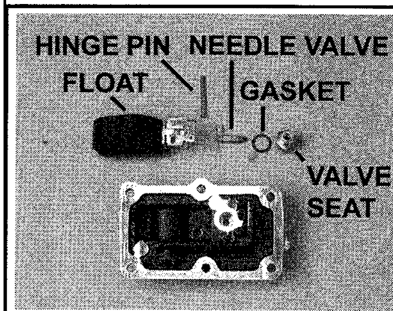


Fig. **212** Inspect all of the float components

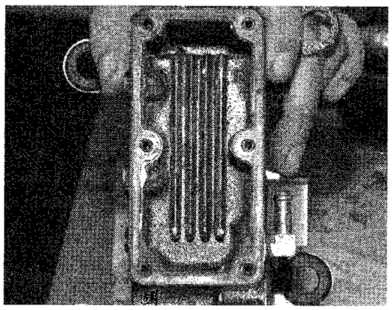


Fig. **213** Check the water reservoir for **corrosion/damage**

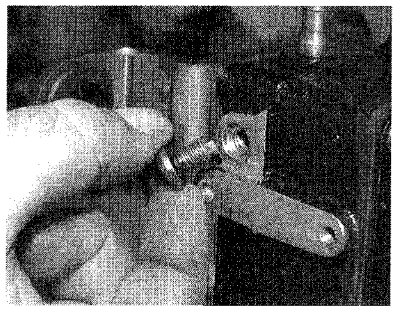


Fig. **214** If necessary remove the reservoir plug

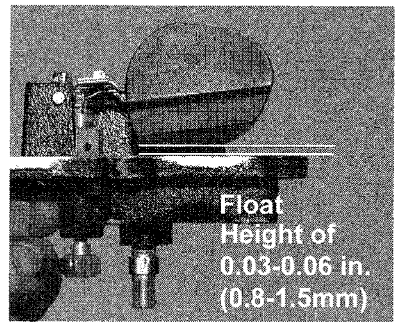


Fig. **215** Check the height at the float's lowest point

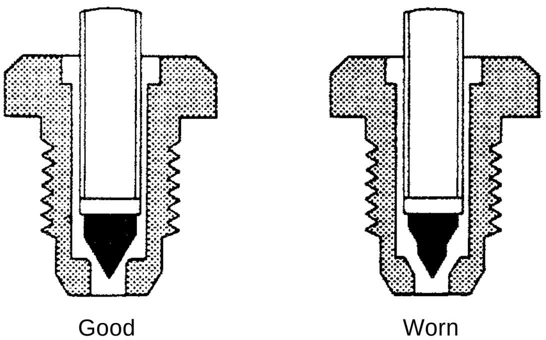


Fig. **216** Inspect the float needle valve and seat for wear or damage. Replace both if either component is not serviceable

To install:

15. If disassembled for overhaul, assemble the vapor separator reservoir as follows:

a. If removed, install the plug to the bottom of the reservoir using a NEW O-ring.

b. Apply a light coating of EvinrudelJohnson Nut Lock, or equivalent threadlock to the threads of the water reservoir cover retaining screws, then install the cover using a new gasket and tighten the screws to 60-80 inch Ibs. (7-9 Nm).

c. Install the float valve components, then invert the housing cover and check the float positioning. At its lowest point, the float should be still be 0.03-0.06 in. (0.8-1.5mm) above the gasket mating surface of the cover. If necessary, carefully bend the float tab to reposition (when bending the tab, be sure NOT to force the needle down into the seat which could damage one or both components.

d. Lubricate and install a NEW O-ring on the injector-to-vapor separator nippleltest point, then install the nipple and components (spring, valve, check ball) to the separator cover. Tighten the 2 screws securely.

e. Using a new gasket, install the vapor separator cover to the reservoir tank and tighten the retaining screws to 18-24 inch Ibs. (2-3 Nm) using multiple passes of a criss-cross sequence to ensure it seats fully without warping or cracking.

f. Apply a light coating of EvinrudelJohnson Nut Lock, or equivalent threadlock to the threads of the bracket-to-housing retaining screws, then install the bracket to the housing and tighten the screws to 60-80 inch Ibs. (7-9 Nm).

16. If the lift pump was removed and disassembled, follow the procedures found under Low Pressure Fuel Pump (Lift Pump), Removal & Installation, in this section to assemble the pump and secure it to the vapor separatorlmounting bracket.

17. If the circulation pump was removed from the assembly for service or replacement, install it to the vapor separator, as follows:

a. If removed, install the fitting(s) to the top and bottom of the pump.

b. Install NEW O-rings to the bottom fitting and elbow, the carefully push the elbow into the housing.

c. Apply a light coating of Evinrude/Johnson Nut Lock, or equivalent threadlock to the threads of the of the circulation pump clamp screw, then install the clamp and tighten the screws to 60-80 inch lbs. (7-9 Nm).

18. Install the vacuum switch and bracket to the assembly and secure using the retaining screws. Install the vacuum hose with clamps and the lift pump pulse hoses using tie straps.

19. Install the fuel pumplcomponent bracket assembly (lift pump, circulation pump and vapor separator) to the powerhead with washers underneath the retainer clamps.

20. Connect the lift pump hoses, including the tank-to-lift pump hose and the lift pump-to-filter hose. Secure using new wire ties.

21. Connect the reservoir water inlet and outlet hoses, then secure using new wire ties.

22. Secure the filter-to-vapor separator hose, the injectors-to-separator hose, the circulation pump hose, oil injection hose and separator vent hose. Secure using threaded clamps or new wire ties, as applicable per hose.

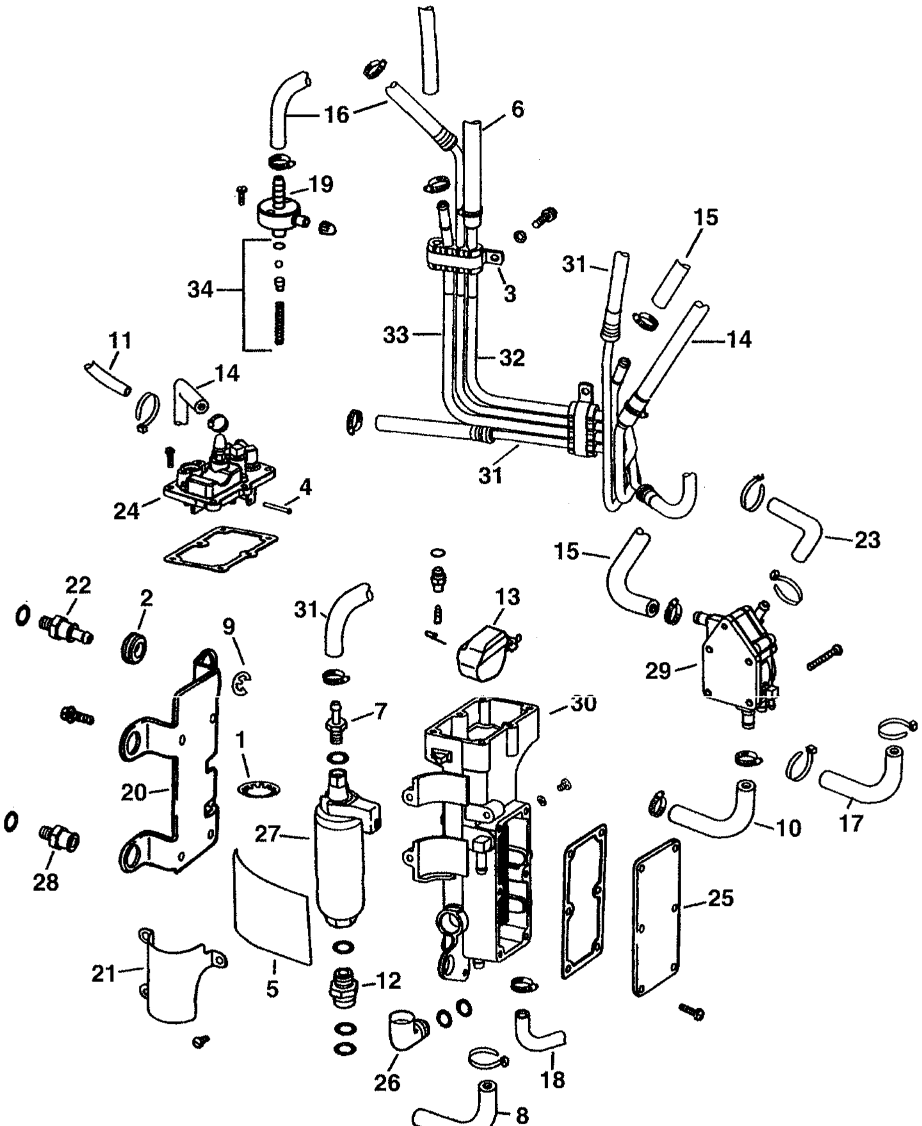
23. Reconnect the wiring for the circulation pump and the vacuum switch.

24. Install the EMM cover.

25. Connect the negative battery cable, then properly pressurize the fuel system, as detailed in this section and check for leaks.

26. Correct any fuel leaks before starting or running the engine, then run the motor using a source of cooling water and recheck.

27. Install the air intake silencer assembly and the engine covers.



1 Fuel pump retaining ring
2 Bracket to crankcase grommet
3 Fuel lines grommet clamp
4 Float hinge pin
5 Fule pump sleeve
6 Tube to filler inlet hose
7 Fuel outlet nipple
8 Reservoir to tee water hose
9 Fuel bracket retaining ring
10 Inlet tube to lift pump hose
11 Vapor separator to port intake manifold nipple hose
12 Fuel pump nipple kit
13 Float
14 Tube to vapor separator hose
15 Lift pump outlet to tube hose
16 Injector return to pressure regulator tube and hose assy
17 Pulse nipple to lift pump lower hose
18 Cylinder block to reservoir inlet hose
19 Nipple assembly
20 Vapor separator bracket
21 Fule pump clamp
22 Pulse hose and fuel bracket nipple port mount
23 Pulse nipple to lift pump port upper hose
24 Vapor separator cover assembly
25 Water chamber cover
26 Fuel reservoir elbow
27 High pressure fuel pump
28 Starboard mount nipple
29 Lift pump assembly
30 Fuel reservoir
31 Fuel pump to injectors tube and hose assembly
32 Lift pump to filter inlet tube
33 Fuel outlet to vapor separator tube
34 Fuel pressure regulator repair kit

Fig. 217 Exploded view of the fuel pump components bracket (fuel pumps and vapor separator assembly)
150-175 Hp **(2589cc)** V6 motors equipped with fuel rails

200-250 Hp (3000/3300cc) V6 Motors

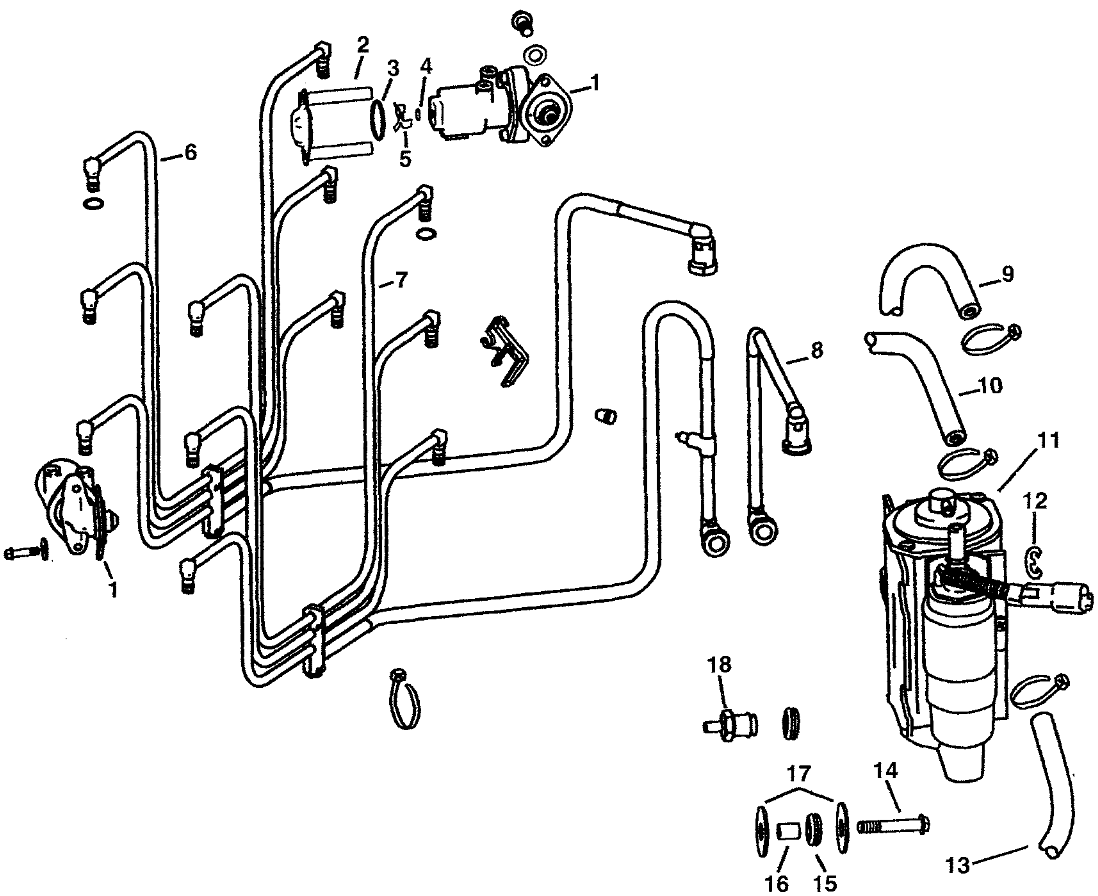
◆ See Figure 218

The high-pressure circulation pump and fuel vapor separator assembly is mounted toward the center of the port side of the motor, directly behind the fuel/water separator and below/behind the starter motor. The unit contains an internal pressure regulator, fuel reservoir/vapor separator tank and high-pressure fuel pump, all of which must be serviced as an assembly and replaced if defective.

1. Disconnect the negative battery cable for safety.
2. Remove the engine covers. For details, please refer to Engine Cover (Top and Lower Cases) in the Maintenance and Tune-Up Section.
3. Relieve the fuel system pressure, as detailed in this section.
4. Tag and disconnect both the fuel line and the electrical connector from the high-pressure circulation pump.
5. Tag and disconnect the vapor separator vent hose.
6. Tag and disconnect the water inlet and outlet hoses, followed by the fuel supply and return lines from the vapor separator.
7. Loosen the retaining bolt and remove the clip retaining the high-pressure circulation pump/fuel vapor separator bracket to the powerhead stud, then remove the assembly from the motor.

To install:

8. Position the high-pressure circulation pump/fuel vapor separator to the powerhead using the isolators, then secure using the retaining clip and the retaining bolt.
9. Reconnect the water inlet and water hoses along with the fuel supply and return lines to the vapor separator as tagged during removal. Secure them using new wire ties.
10. Engage the high-pressure circulation pump electrical connector.
11. Reconnect the fuel line to the circulation pump.
12. Install the vapor separator vent hose and secure using a new wire tie.
13. Connect the negative battery cable, then properly pressurize the fuel system, as detailed in this section and check for leaks.
14. Correct any fuel leaks before starting or running the engine, then run the motor using a source of cooling water and recheck.
15. Install the engine covers.



1 Injector assembly
2 Cap and sleeve assembly
3 O-ring
4 O-ring
5 Spring and button assembly
6 Fuel feed manifold assembly
7 Fuel return manifold assembly
8 Filter to vapor separator connector and tube assembly
9 Adaptor to vapor separator water hose
10 Vapor separator to EMM water hose
11 Reservoir and pump
12 Retaining ring
13 Vapor separator to intake hose
14 Mounting screw
15 Mounting grommet
16 Spacer
17 Spacer retainer
18 Vapor separator to block stud

Fig. 218 Exploded view of the high-pressure circulation pump/fuel vapor separator tank and related fuel lines/injectors 200-250 Hp (3000/3300cc) V6 motors

Fuel Injectors

◆ See Figure 219

On most automotive and marine electronic fuel injection systems, the fuel injector itself is a small, solenoid valve that is designed to open against spring pressure when power is applied to the circuit. An internal'spring snaps the valve closed the instant that Dower is removed from the circuit. On such systems, the injectors receive a cbnstant supply of high-pressure fuel and the amount of fuel that is injected is a function of the amount of time the injector is actuated.

The major difference in a FICHT fuel injection system is the use of an electromagnetic piston valve direct injector that is capable of generating its own pressure through the hammering motion of the piston. Although the high-pressure fuel circuit of a FICHT motor is generally regulated to about 20-30 psi (138-207 kPa), the FICHT fuel injector itself is capable of forcing the fuel into the cylinder at over 250 psi (1724 kPa). In most other respects, FICHT operates in a similar manner to most other fuel injection systems. In the end, the amount of fuel sprayed is still a function of time, the total amount of times that the injector is hammer pulsed (actuated repeatedly producing a hammering motion of the piston) to inject fuel into the cylinder for a single combustion event.

In all any injection system, it is the exact fuel metering made possible by such precise fuel metering that is responsible for a fuel injected engine's ability to maximize both engine performance and fuel economy. The advantage in a FICHT system lies in its relative simplicity coupled with the ability to inject fuel at an extremely high pressure (much higher than most automotive fuel injection systems) for better atomization, which leads to more complete combustion.

Like any other fuel injection system, the most important system maintenance is a combination of periodic filter/water separator changes and the use of fuel stabilizer if the motor is stored for any amount of time (more than a few weeks). This is true because the passages inside a fuel injector are very small, and are easily clogged by dirt or debris in the fuel system.

A separate fuel injector is mounted to the cylinder head for each cylinder combustion chamber. There are 2 different designs for injector mounting. On 1501175 hp motors equipped with fuel rails the injectors themselves are threaded into place and secured with a locknut, On all other motors the injector is bolted to the cylinder head using a flange and 2 retaining bolts.

The style injector used with fuel rails may be disassembled for overhaul, while the flange-retained unit is not serviceable. However, because of the similarity in operation, testing procedures are similar for all permutations of the system.

TESTING

MODERATE

The injectors are mounted on the cylinder heads at the rear of the motor. There is one injector for each cylinder.

☐ In order to isolate problems with the FICHT **system, VERY** specific diagnostic procedures are set forth by the manufacturer and we've provided them under FICHT Component Testing, in this section. The portions relating most directly to the fuel injectors are found under checking the Fuel **Injection System, specifically the** Injector **Static Test** and the Injector Dynamic Test. Iniector diagnosis should start with these **procedures. However,** subject to **their** results, you can perform pressure and resistance checks to individual injectors as detailed here.

Injector Pressure Test

◆ See Figure 219

On models equipped with fuel rails the rails themselves must be disconnected from the injector and removed in order to conduct this test. The injector itself on these models can be tested while either installed or removed from the cylinder head. On all models NOT equipped with fuel rails, the injector must remain installed in the cylinder head (with the fuel lines disconnected) and you will need inlet/outlet fittings (part #'s 5000911 and 5000912, along with outlet elbow cap # 315391, which is secured using a wire tie).

To pressure test an injector, cap the outlet nippielfitting so no pressure can escape. Attach a regulated source of air pressure to the inlet nipple (such as a hand pump with gauge) and apply 30 psi (207 kPa) of pressure. The injector must hold the pressure for AT LEAST 5 minutes or it must be overhauled (models with fuel rails) or replaced (models without fuel rails).

Injector Resistance Test

◆ See Figure 219

Another quick-check of a fuel injector is made using an ohmmeter to measure the resistance of the winding inside the injector itself. It is important to remember that a correct reading does not mean the injector is operating. Mechanical damage or clogs within the injector could prevent it from opening or closing properly which would lead to engine performance problems. Similarly, the injector cannot operate properly unless both the low- and high-pressure fuel delivery circuits are functioning and supplying it with an appropriate amount of fuel. Lastly, the injector driver circuit of the EMM must function within specification.

The injector does not need to be removed from the engine to check its resistance.

1. In order to protect the test equipment, disconnect the negative battery cable.
2. Disengage the wire harness connector from the injector.
3. Set the DVOM to the resistance scale, then apply the meter probes across the 2 wire terminals on the injector. The meter should read 0.85-0.95 ohms for 1501175 hp models equipped with fuel rails or 0.90-1.10 ohms for models NOT equipped with fuel rails. Replace the injector if resistance exceeds specification.

■ It is important to keep in mind that resistance readings will vary slightly with temperature (most specs are determined at room temperature and a component that is significantly hotter or colder may test out of spec even if in good condition). Readings will also vary somewhat with test equipment (again, specs are determined using a high quality DVOM). If in doubt, compare the readings from one injector to another or from the injectors on that motor to a potential replacement.

4. If the injector is inoperable, but resistance is within specification. Refer back to the procedures for Checking the Fuel Injection System, in this section.
5. When finished, reconnect the wiring harness to the injector.

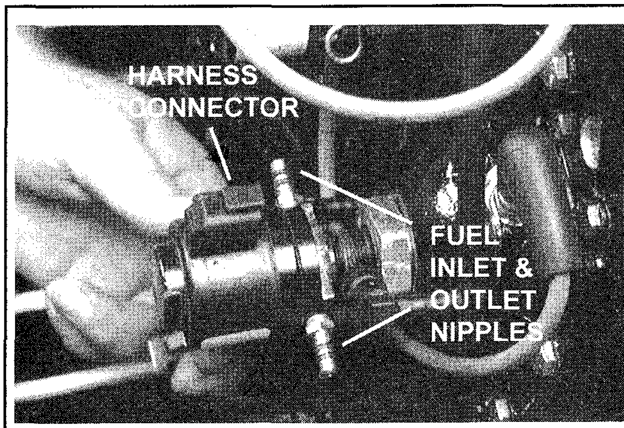


Fig. 219 One fuel injector is mounted to each cylinder—1501175 hp motors with fuel rails shown (others similar, but are equipped with internal fittings instead of external fuel nipples)

REMOVAL & INSTALLATION

MODERATE

All Models Except 1501175 Hp Motors with Fuel Rails

◆ See Figures 218,220,221 and 222

On 75-175 hp V4 and V6 motors the fuel injector flange bolts are mounted through an injector retainer (bridge) that partially covers the injector body. On 200-250 hp V6 motors, the injector retaining bolts are only mounted directly through the flange itself. Other than this slight design difference which was made to accommodate the differences in mounting to the 60° cylinder bank as opposed to the 90° cylinder bank, the injectors are virtually identical.

The iniectors on these models MUST **always** be returned to use in their original cylinders. Do not move **injectors from** one cylinder to another once they have been in service.

1. Relieve the fuel system pressure as detailed in this section and disconnect the negative battery cable for safety.
2. Remove the lower engine covers for additional access. For details, please refer to Engine Cover (Top and Lower Cases) in the Maintenance and Tune-up Section.

■ If no compressed air is available, use a soft brush or some spray engine degreaser and rag to clean debris from the area around the injector mounting.

3. Use compressed air (from a compressor or hand pump) to blow debris from the injectors and cylinder head.

The elbows of the fuel manifold lines are secured to the injectors using small retainer clips. Note the clip orientation before removal.

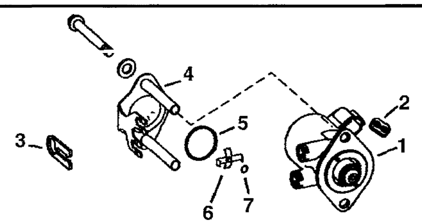
4. Tag and remove the retainers from the fuel manifold line inlet and outlet elbows, then carefully separate the elbows from the injectors. Have a rag handy to catch any fuel that may escape from the injector or fuel line.

The injector inlet ports are slightly larger than the outlet ports.

5. Disengage the fuel injector harness connector (if more than one injector is going to be removed at a time, tag the connector AND mark the injector to ensure it is returned to the same cylinder).
6. Remove the injector flange bolts and then carefully withdraw the injector from the cylinder head.

To install:

7. Injectors must be completely clean before installation, if necessary clean all dirt or debris from the injectors using solvent and lint free towels.
8. Insert the injector into the cylinder head opening, aligning the flange bolt holes with the bores in the cylinder head. Install the retaining bolts and tighten them to 144-168 inch lbs. (16-19 Nm), while alternating back and forth between the 2 bolts in order to properly seat the injector.



1 Fuel injector
2 Vibration dampener
3 Manifold to injector retainer (R models)
4 Fuel injector retainer (H **models)**
5 O-ring
6 Spring and button (H models)
7 O-ring (H **models)**

Fig. **220** Exploded view of a fuel injector used on **75-175** hp **V4** and **V6** motors without fuel rails

✻✻ WARNING

Carefully inspect the O-rings for the elbows on the fuel manifold line. Although they do not NEED to be replaced every time the injector is removed, they SHOULD be replaced if the powerhead has been in service for some time. Keep in mind that fuel leaks in the **high-pressure** system could cause a **potentially explosive** condition.

9. Connect the fuel inlet and outlet elbows to the injector as tagged during removal, then secure using the retainer clips (making sure to position them as noted during removal).
10. Connect the negative battery cable, then properly pressurize the fuel system, as detailed in this section and check for leaks.
11. Correct any fuel leaks before starting or running the engine, then run the motor using a source of cooling water and recheck-
12. Install the engine covers.

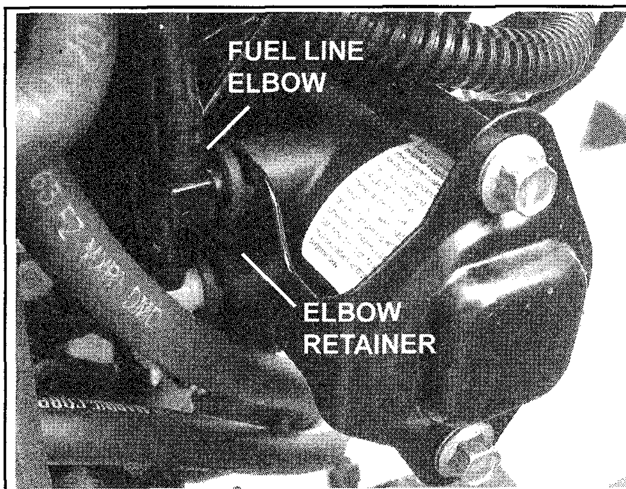


Fig. **221** To remove the fuel injector, first disconnect the fuel inlet and outlet lines**...**

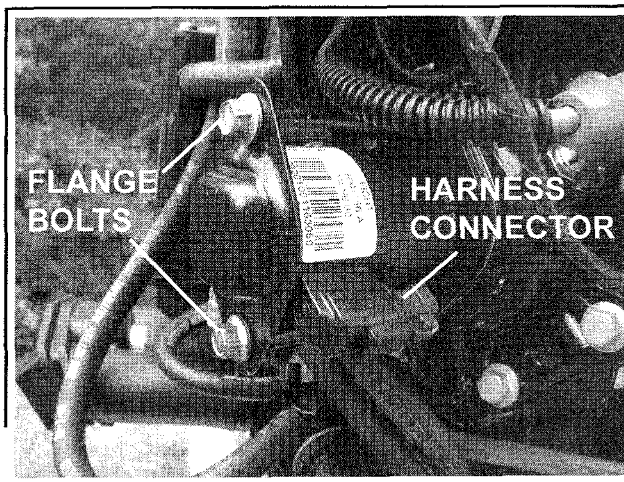
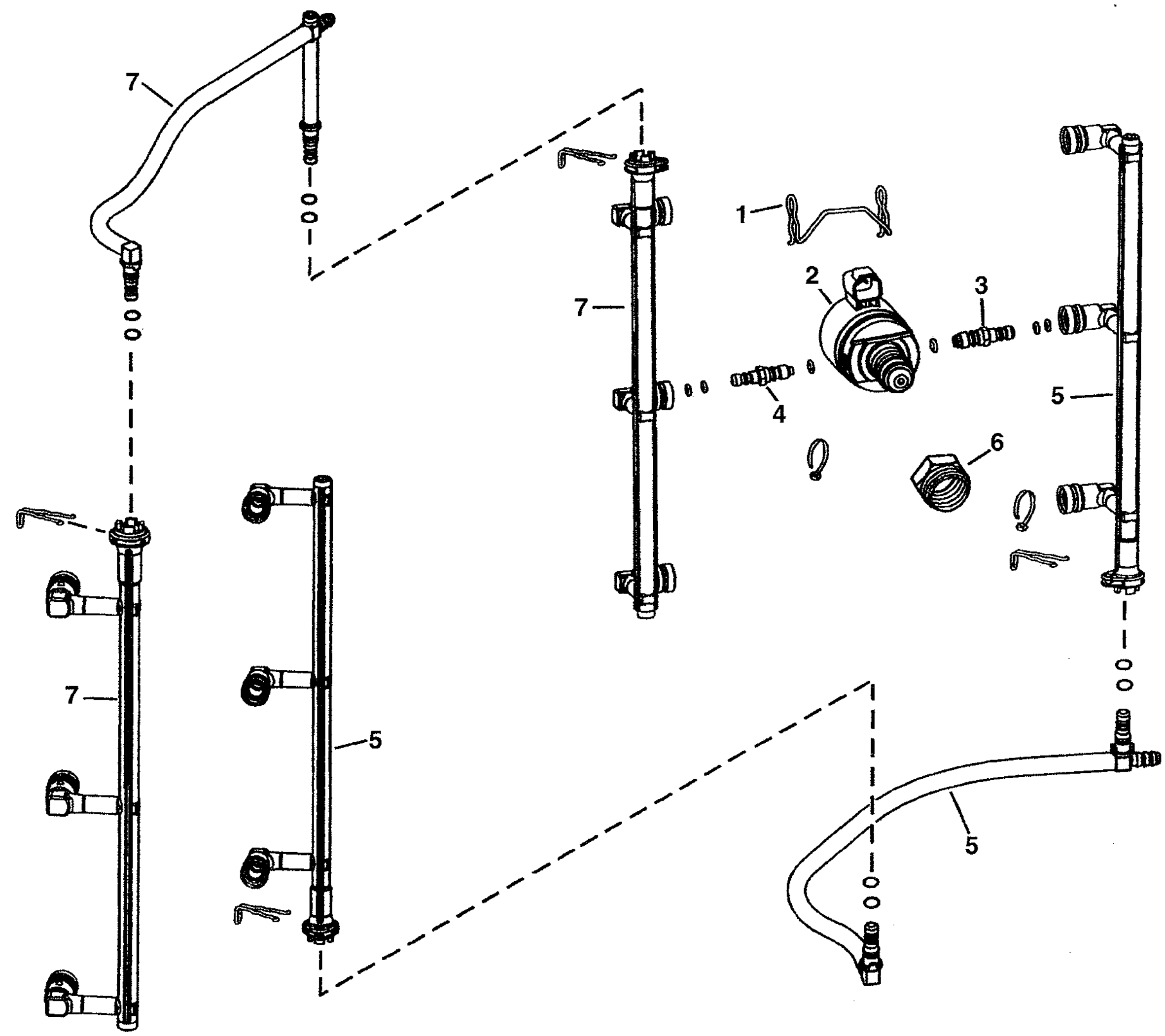


Fig. **222** **...**then disengage the wiring and remove the retaining flange bolts

1501175 Hp Motors with Fuel Rails

◆ See Figures 223 thru **241**

Because the fuel rails are mounted next to (as opposed to on top off) the fuel injectors, it is not necessary to completely remove the fuel rails from the motor in order to remove the injectors. However, the rails must be repositioned slightly for clearance when removing and installing the injectors.



1 Fuel manifold to injector retainer
2 Fuel injector assembly
3 Fuel inlet nipple
4 Fuel return nipple
5 Fuel feed tube assembly
6 Injector to cylinder head holder
7 Fuel return tube assembly

Fig. 223 Exploded view of the fuel rails and injector assembly used on some 1501175 hp V6 motors

The rails themselves are primarily secured using retaining clips and removal is easy. You may decide that it is easier to just get them out of the way completely. If you decide to completely remove the rails, be sure to tag them to ensure proper installation.

1. Relieve the fuel system pressure as detailed in this section and disconnect the negative battery cable for safety.
2. Remove the lower engine covers for additional access. For details, please refer to Engine Cover (Top and Lower Cases) in the Maintenance and Tune-Up Section.

■ **The fuel rails may be completely removed from the engine or they may pulled back for access to the injectors with the fuel lines still attached.**

3. If the fuel rails are being completely removed from the motor:
   a. Position a rag to catch any remaining fuel in the lines.
   b. Remove the wire ties and retainer clips from the fuel rails-to-injectors on the port side.
   c. Loosen the threaded clamp, then remove the hose from the bottom of the fuel inlet rail at the T-fitting. Remove the wire tie from the retainer, then push in on the retainer and pull the lower cross-tube from the rail. Remove the port side fuel rail from the injector inlet nipples and from the powerhead.
   d. Loosen the threaded clamp, then remove the hose from the port side outlet fuel rail T-fitting. Remove the tie strap from the retainer and push the retainer in, then remove the upper cross-tube from the port outlet fuel rail. Remove the port side outlet fuel rail from the injector outlet nipples and from the powerhead.
   e. Remove the wire ties and retainer clips from the fuel rails-to-injector on the starboard side.
   f. Remove the wire tie and pull the retainer back in order to remove the lower cross-tube from the starboard inlet fuel rail. Remove the starboard inlet fuel rail from the injector inlet nipples and from the powerhead.

g. Remove the wire tie and push in on the retainer in order to remove the cross-tube from the starboard outlet fuel rail. Remove the starboard outlet fuel rail from the injector outlet nipples and from the powerhead.

■ **The EMM cover will have to be removed if the upper-cross tube is being removed completely from the powerhead.**

h. If the upper cross-tube is to be removed, loosen the EMM retaining bolts and lift the EMM slightly for additional access.
i. While wearing safety glasses to protect your eyes, use low-pressure compressed air (regulated to no more than 25 psi/1772 kPa) to make sure there is no debris in the fuel lines.
j. Inspect the fuel rails and lines for damage and remove/discard all O-rings.
4. If the fuel rails are not being completely removed from the powerhead, cut the wire ties and remove the retainer clips from the inlet and outlet nipples on each injector that is being removed.
5. Use compressed air (from a compressor or hand pump) to blow debris from the injectors and cylinder head.

■ **If no compressed air is available, use a soft brush or some spray engine degreaser and rag to clean debris from the area around the injector mounting.**

6. Disengage the injector electrical connector.
7. Use a wrench to loosen the locknut, then remove the injector and locknut from the cylinder head.
8. If injector disassembly for overhaul or inspection is required, proceed as follows:
a. Loosen and remove the nut from the injector and then unthread the nozzle.
b. Using Evinrude/Johnson Injector Check Valve Removerllnstaller No. 342678 (which is essentially a dual-pin spanner which can be inserted into the injector nozzle bore) remove the outlet check valve. Place the tool in the housing while aligning the pins with the holes in the check valve, then using a socket or wrench on the tool flats, carefully loosen the valve from the housing.
c. Remove the check valve, with the O-ring, from the injector housing. Remove and discard the old O-ring.
d. Remove the check ball and spring from the housing (beneath the check valve).
e. Remove the O-rings from the inlet and outlet nipples, then loosen and remove the nipples from the housing using a wrench or socket. Remove the O-rings from the threaded ends of the nipples. Discard the old O-rings.
f. Using a wrench on the top rear of the housing, loosen and remove the coil, then remove the O-ring from inside the coil. Discard the old O-ring.
g. Remove the bushing and stop from the end of the armature, then remove the armature and large spring from the housing.

✳✳ WARNING

DO NOT compress or stretch the large spring or flow rate will be altered.

h. Thoroughly clean the injector components using Evinrude/Johnson Carburetor and Choke Cleaner.

✳✳ WARNING

DO NOT attempt to clean components by submerging them in a strong carburetor cleaning solvent or hot soaking tank. Those cleaners might damage components and remove sealing compounds.

i. Inspect all injector components for wear or damage, replace any that show signs. Some parts are available either individually or in the service kit, but note that ALL parts are not available and if some components are damaged the only resort is to replace the injector.

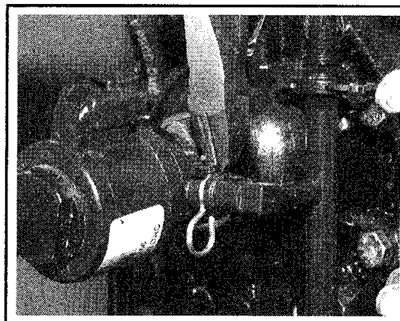


Fig. 224 Disconnect the fuel rails by cutting the ties...

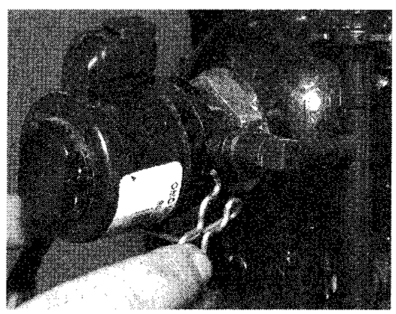


Fig. 225 ...removing the retainer clip...

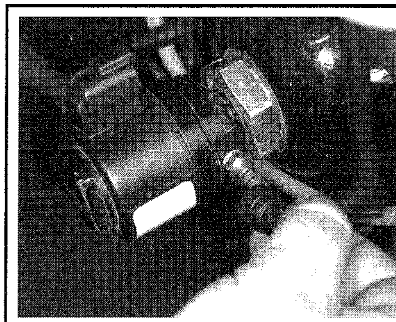


Fig. 226 ...and pulling them off the injector nipples

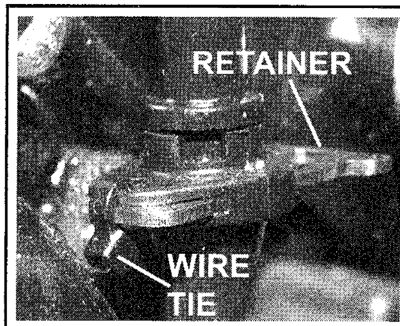


Fig. 227 Fuel line-to-fuel rail connector

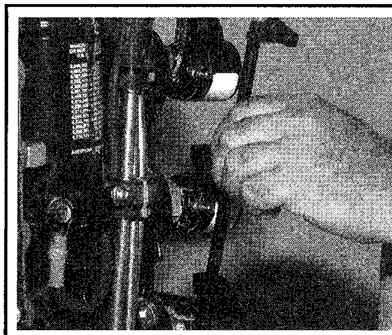


Fig. 228 If necessary, remove the fuel rails for access

Fig. 229 Disengage the injector wiring connector

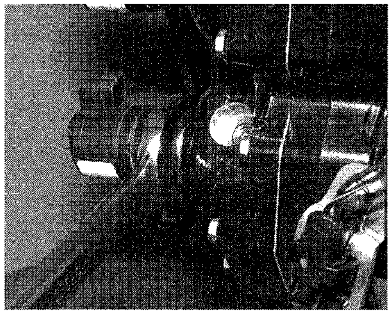


Fig. **230** Loosen the locknut using a **1 112** in. wrench**...**

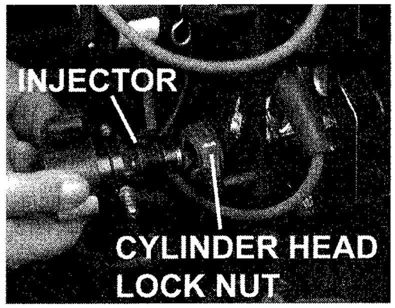


Fig. **231** **...**then unthread the injector from the nut and cylinder head

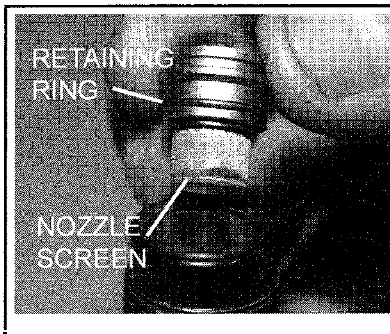


Fig. **232** Carefully disassemble the injector**...**

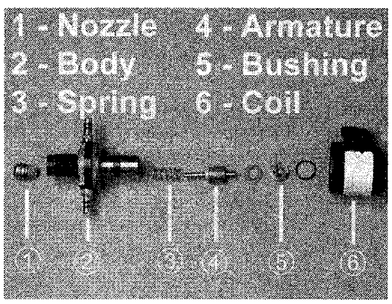


Fig. **233** **...**laying out the components for inspection

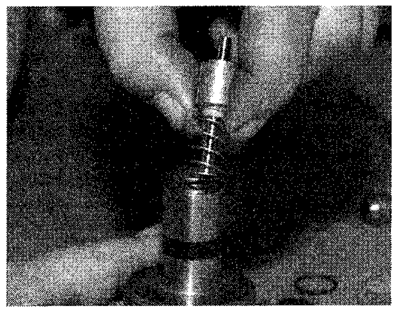


Fig. **234** To assemble, insert the large spring and armature**...**

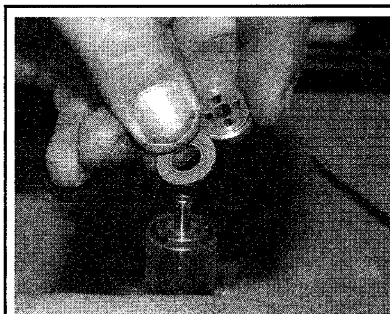


Fig. **235** **...**then position the stop and bushing on top**...**

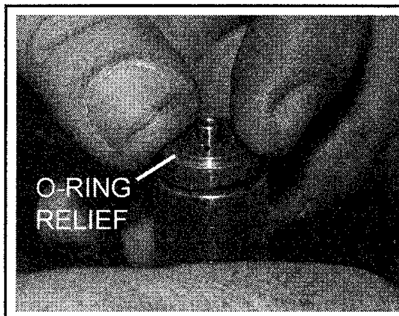


Fig. **236** **...**with the O-ring relief facing **up**

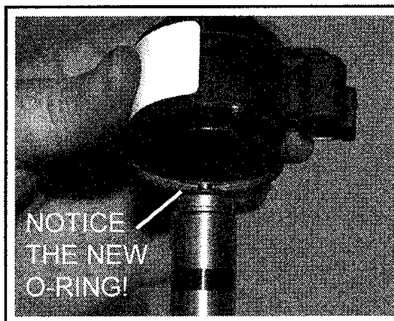


Fig. **237** Position the coil over the armature and housing

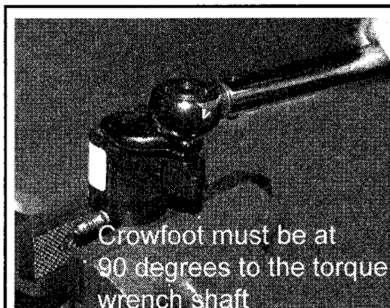


Fig. **238** Then tighten using crowfoot adapter and torque wrench

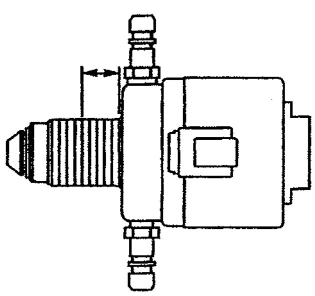


Fig. **239** Apply high-strength threadlock to the thread closest to the injector

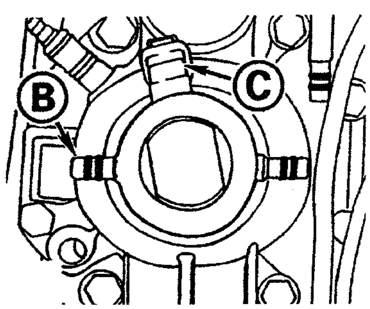


Fig. **240** Upon installation, the injector inlet nipple must face the port side**...**

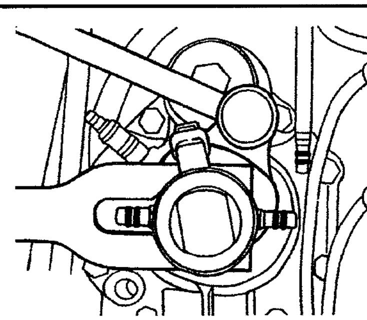


Fig. **241** **...**hold the injector in this position while tightening the locknut

To install:

9. If the injector was disassembled for inspectionloverhaul,proceed as follows to assemble it:

a. Install the large spring and armature into the housing, then place the stop and bushing (with the O-ring relief facing upwards) on the shaft.

b. Apply a light coating of EvinrudelJohnson Triple-Guard or equivalent marine grease to a NEW O-ring, then install it on the bushing and install the coil onto the housing.

■ Apply a light coating of **Evinrude/Johnson** Triple-Guard or equivalent marine grease to all of the O-rings as they are installed. If the injector has been in service for any length of time, ALL of the old O-rings should be discarded and replaced with new ones.

c. Using a crowfoot wrench positioned 90º to the torque wrench, tighten the coil to 20-30 ft. lbs. (27-40.5 Nm).

d. Grease and install NEW O-rings on the threaded ends of the inlet and outlet nipples, then install the nipples and tighten to 60-72 inch lbs. (6.5-8 Nm). Grease and install new O-rings on the exposed ends of the nipples.

□ Good news, the replacement O-rings from the manufacturer are color-coded. Brown is for use on the inlet nipple and black for the outlet nipple.

e. Insert the check ball and small spring into the injector housing, then grease and install a NEW O-ring to the outlet check valve. Install the check valve and tighten to 80-100 inch lbs. (9-11 Nm).

f. Position the nozzle on the housing, then push on the retaining ring and seat the nozzle in the housing. It is usually necessary to use a small tool, like a flat-bladed screwdriver to press on the retaining ring, BUT, be very careful not to scratch the beveled surfaces of the housing or the nozzle.

10. Verify that the injector threads (and the threads of the nut and the cylinder head) are all completely clean and free of debris. The threads MUST be clean and in good condition. If necessary clean all dirt or debris from the injectors using solvent and lint free towels.

11. Apply a light coating of EvinrudelJohnsonUltra Lock, or equivalent high-strength threadlock to the external threads of the nut and the threads of the injector (the threads starting at the injector body going about halfway down to the nozzle). Thread the nut into the cylinder head until seated. Back the nut out ONE FULL TURN from the seated position.

■ REMEMBER that the fuel inlet nipple is larger than the outlet nipple.

12. Hold the nut from turning, then thread the injector counterclockwise into the nut until the injector is seated. THEN turn the injector clockwise slightly JUST until the inlet and outlet nipples are properly positioned (with the nipples precisely horizontal, the INLET nipple facing port and the electrical connector facing upward).

■ **Evinrude/Johnson** has a positioning tool, No. **342673,** designed to hold the injector in place (keep it from turning) while the nut is tightened.

13. Using a tool on the injector body only (NOT the coil), hold the injector to keep it from turning and tighten the injector locknut. Use a 1 112 in. crowfoot adapter mounted at a 90º angle to the torque wrench and tighten the nut to 50-60 ft. lbs. (68-81 Nm).

14. Engage the wiring harness connector(s) to the injector(s).

15. Reconnect the inlet and outlet fuel rails to the injector nipples and secure using the retaining clips and new wire ties. If the entire fuel rail assembly was removed, install the rails and cross-tubes in the reverse of the removal procedure. Again, use new wires ties at each location where one was cut during removal.

16. Connect the negative battery cable, then properly pressurize the fuel system, as detailed in this section and check for leaks.

17. Correct any fuel leaks before starting or running the engine, then run the motor using a source of cooling water and recheck.

18. Install the engine covers.

Crankshaft Position (CP) Sensor

◆ See Figures **242** and **243**

The CP sensors converts changes in an electromagnetic field to a voltage signal that is then used by the EMM to help control engine operation. The sensor itself generates a magnetic field which is interrupted as encoder ribs of the flywheel passes through it, producing an AC voltage that directly relates to flywheel rpm. A change in the encoder spacing changes the signal, alerting the engine control module to crankshaft Top Dead Center (TDC).

Based on these signals the EMM calculates engine speed and crankshaft position at each instant of engine operation. In turn, the EMM generates a tachometer signal and uses the information to control all fuel injector and ignition operation.

■ Unlike some fuel injection systems, there appears to be no r edundancy of function in other sensors to cover for a failure in the **CP** circuit. An improper gap adjustment will cause the outboard to run erratically (if at all), but a complete circuit or sensor failure will cause the engine to cease functioning. Without this sensor's signal the engine simply cannot determine when to inject fuel or when to fire the spark plugs.

For obvious reasons, on all FICHT motors, the CP sensor is mounted near the flywheel. For all 75-175 hp V4 and V6 motors, it is mounted to the port side of the flywheel cover, slightly in front of the starter motor. For all 200-250 hp V6 motors, it is mounted to the starboard side of the powerhead, underneath the flywheel.

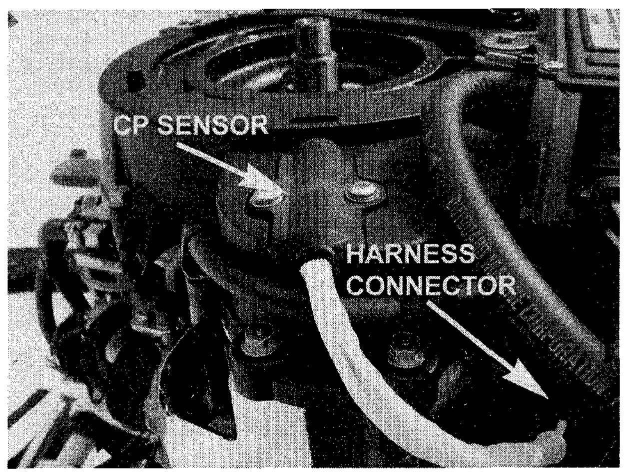


Fig. **242** For function purposes, the **CP** sensor must be mounted near the flywheel—75—175 hp models without fuel rails shown

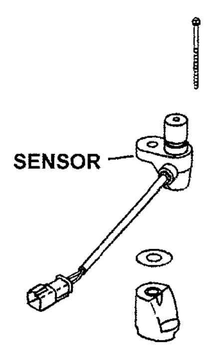


Fig. **243** The **CP** sensor is mounted UNDER the flywheel on **200-250** hp **V6** motors

TESTING

DIFFICULT

◆ **See Figures 242 and 243**

As with all resistance readings, keep in mind that test results will vary with temperature. The specifications for this test were determined at an ambient temperature of about 68°F (20°C).

A sensor that becomes damaged or is out of adjustment will cause the EMM to illuminate the Check Engine light and store a trouble code. BUT, this will happen only if the failure occurs with the engine running.

Crankshaft sensor operation is normally verified using the Engine Monitoring function of the Evinrude/Johnson diagnostic software. Should a no start occur due to a suspected failure of the sensor circuit, check rpm on the screen vs. rpm on a shop tachometer. If the circuit is functioning properly it screen rpm should reflect engine rpm during cranking.

As with all resistance readings, keep in mind that test results will vary with temperature and with the ohmmeter used for testing. The specifications for this test were determined using a high-quality DVOM ai an ambient temperature of about 68°F (20°C).

It is not necessary to remove the CP sensor for testing. However, because the sensor is mounted UNDER the flywheel on 200-250 hp V6 motors, the flywheel may need to be removed on some models for access to the wiring harness. Sensor testing is a relatively simple matter of locating and disconnecting the wiring harness (normally black and orange wires), then applying a DVOM (set to read resistance) across the 2 sensor wires (NOT the engine harness wires, but the wires leading back to the sensor itself). Resistance should be as follows:

- 75-175 Hp (1726/2859cc) V4/V6 motors (except models with fuel rails): 120-160 ohms.
- 150-175 Hp (2589cc) V6 motors (models with fuel rails): 800-1000 ohms.
- 200-250 Hp (3000/3300cc) V6 motors: 1000-1200 ohms.

■ **If in doubt about the CP sensor wiring, please refer to the Wiring Diagrams found in the Ignition and Electrical System section to confirm the proper wire colors.**

REMOVAL & INSTALLATION

MODERATE

◆ **See Figures 242,243 and 244**

Removal and installation of the sensor is a simple matter of accessing it. Of course, on 200 hp and larger V6 motors, because the sensor is mounted under the flywheel, this necessitates removal of the flywheel for access. On all other motors, the sensor is mounted to the flywheel cover, under a small composite sensor cover that is secured by 2 retaining bolts.

The other important point of sensor removal and installation is setting the proper air gap once the sensor is installed. And, the Evinrude/Diagnostic software should be used to verify settings once this has occurred. For more details, please refer to Timing and Synchronization procedures in the Maintenance and Tune-Up section.

Temperature Sensor/Switches (AT, WT and EMMT)

◆ **See Figures 245,246 and 247**

Temperature signals are used by the EMM for various functions including engine operation and for engine protection. Each FICHT motor is equipped with 3 temperature sensors and a temperature switch. Signals from the Air Temperature (AT) sensor are used to help adjust airlfuel ratios in relation to changes in ambient air temperature (which affects the density of the air being pulled into the motor). The Water Temperature (WT) sensor signal is also used to help determine airlfuel ratios, including changes in fuel mapping strategies that occur once the engine is fully warmed vs. cold start operation. The EMM will also use information from this sensor to limit engine speed during engine warm-up or to initiate the Speed Limiting Operational Warning (S.L.O.W.) system in the event of a potentially overheating signal. Similarly, the Water Temperature (WT) switch is only used only to protect the engine from a possible overheat condition. Activation of the switch will result in activation of the S.L.O.W. system. Lastly, the EMM Temperature (EMMT) sensor, is an internal component of the EMM that is used to protect the brain of the FICHT system against an overheat condition. Signals from the EMMT can also be used to activate the S.L.O.W. system.

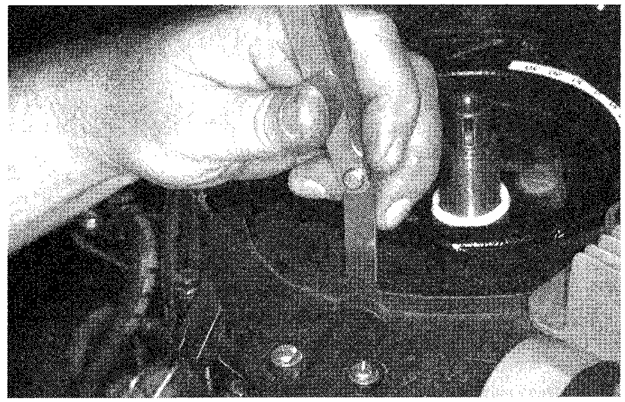


Fig. 244 Checking the crankshaft position sensor air gap on 75-175 hp V4 and V6 motors

Temperature sensors for modern fuel injection systems are normally thermistors, meaning that they are variable resistors or electrical components that change their resistance value with changes in temperature. The Evinrude/Johnson temperature sensors are Negative Temperature Coefficient (NTC) thermistors. Whereas the resistance of most'thermistors (and most electrical circuits) increases with temperature increases (or lowers as the temperature goes down), an NTC sensor operates in an opposite manner. The resistance of an NTC thermistor goes down as temperature rises (or goes up when temperature goes down).

The WT switch however, is named so because output is not variable like that of a sensor. The switch is exactly that, it has 2 positions, ON and OFF. The switch remains OFF (or open) until its temperature rises above a predetermined point. Once the switch gets hot enough, it turns ON (closes the circuit) in order to complete a circuit with the voltage signal from the EMM.

Sensor locations are as follows:

- AT: the air temperature sensor is located in the air intake silencer. For most models it is mounted into a grommet at the rear of the silencer housing, towards the starboard side of the motor.

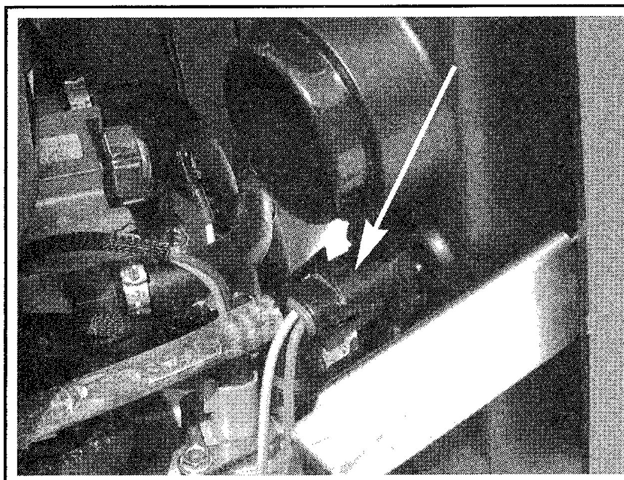


Fig. 245 The AT sensor is normally mounted in the rear of the air intake silencer housing

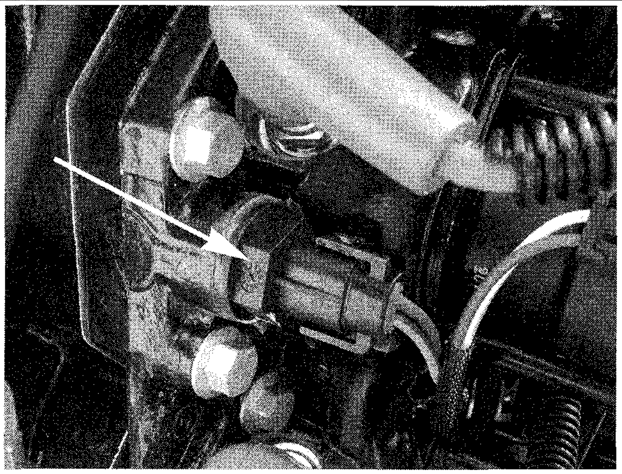


Fig. 246 A WT sensor or switch threaded into each cylinder head

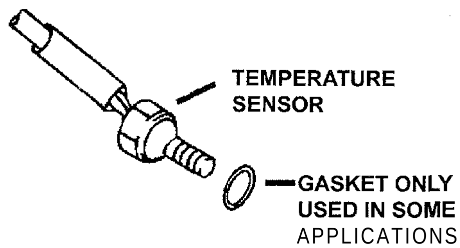


Fig. 247 Exploded view of a typical WT sensor or switch

- WT Sensor: To keep things interesting OMC decided to move these around a little. The water temperature sensor is located in the port cylinder head for all models except the 1501175 hp motors equipped with fuel rails. On the fuel rail equipped V6 motors, the sensor is found in the starboard cylinder head. What keeps things interesting is that the opposite cylinder head on ALL FICHT motors contains the water temperature switch.
- WT Switch: Well, if you've just finished reading about the location of the sensor, you already know the location of the switch (it's the OTHER cylinder head). But to be a little more specific, the water temperature switch is located in the starboard cylinder head for all models except the 1501175 hp motors equipped with fuel rails. On the fuel rail equipped V6 motors, the switch is found in the port cylinder head. Again, since the sensor is on the opposite side, you'll want to be sure that you're working on the correct component. If in doubt, refer to the Wiring Diagrams provided in the Ignition and Electrical System section to help confirm sensor identity.
- EMMT: You're not really going to make me write this, are you. Well, yes, as might be suspected, the EMM temperature sensor is located inside the EMM. The bad news is that it is an integral part of the EMM and is not serviceable separately.

Because fuel mapping decisions are made using input from the AT and WT sensors, incorrect operation can result in excessive exhaust smoke, spark plug fouling or other poor engine performance can result from an incorrect air/fuel mixture caused by a defective signal. Problems with the WT circuit can also lead to hard starting or problems during warm-up operation or improper activation of the S.L.O.W. system, which will greatly limit engine performance in attempts to prevent engine damage from an EMM perceived overheating condition.

Shoud the AT sensor signal falls out of range, or the sensor/circuit fails, the EMM will illuminate the Check Engine light and store a trouble code. The engine should continue to operate, but performance and efficiency will be compromised.

If the WT sensor signal rises ABOVE predetermined limits, the EMM will assume an engine overheat condition is occurring and will actuate the S.L.O.W. system, store a trouble code and illuminate the Water Temp light. The same thing will occur should the WT switch close, except the code will be different.

If the EMMT sensor values are out of limits, or the sensor/circuit fails, the EMM will illuminate the Check Engine light and store a trouble code. The EMM will also actuate the S.L.O.W. mode, but only if the failure or sensor value appears to be in the excessive temperature range.

TESTING

② MODERATE

◆ **See Figures 248 and 249**

Temperature sensors are among the easiest components of the FFI system to check for proper operation. That is because the operation of an NTC thermistor is basically straightforward. In general terms, raise the temperature of the sensor and resistance should go down. Lower the temperature of the sensor and resistance should go up. The only real concern during testing is to make clean test connections with the probe and to use accurate (high quality) testing devices including a DVOM and a relatively accurate thermometer or thermosensor.

A quick check of the circuit and/or sensor can be made by disconnecting the sensor wiring and checking resistance (comparing specifications to the ambient temperature of the motor and sensor at the time of the test). Keep in mind that this test can be misleading as it could mask a sensor that reads incorrectly at other temperatures. Of course, a cold engine can be warmed and checked again in this manner.

More detailed testing involves removing the sensor and suspending it in a container of liquid (either water or oil, as desired), then slowly heating the liquid (without using a flame if the liquid of choice is oil) while watching sensor resistance changes on a DVOM. This method allows you to check for problems in the sensor as it heats across its entire operating range. This method is really only recommended for water temperature sensors and switches. For the AT sensor, a better method is to place the sensor in a controlled heated environment (like a toaster oven) and watching for a

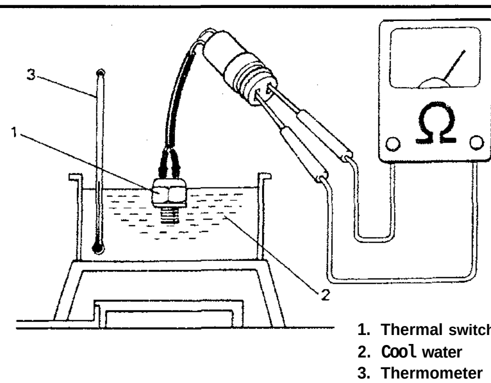


Fig. 248 Resistance of these temperature sensors should be high when the temperature is low...

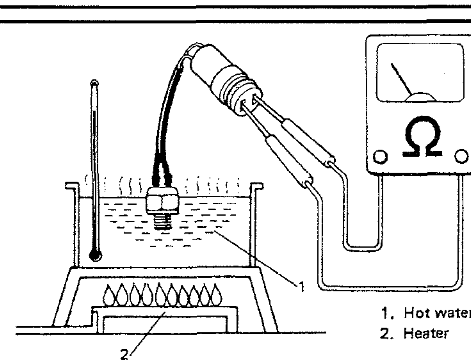


Fig. 249 ... temperature sensor resistance will lower as temperature rises

change in resistance. Unfortunately, Evinrude/Johnson does not supply any sensor specifications other than for ambient temperatures. Of course, knowing that it is a negative temperature coefficient sensor we know that resistance should change with temperature (and we know that resistance should go DOWN, as temperature goes UP), so we can use that knowledge to better test the sensor.

☐ **Bad news, there are no specifications provided by the manufacturer or any information on how you could access the EMMT sensor for testing even if they were provided. If an EMMT sensor or circuit fault has occurred, the only fix is to replace the entire EMM.**

Quick Test

A quick check of the AT and WT temperature sensor's/switches can be made using a DVOM set to the resistance scale and applied across the sensor terminals. The DVOM can be connected to directly to the sensor (AT) or the sensor/switch pigtail (WT). Use a thermometer or a thermosensor to determine ambient enginelsensor temperature before checking resistance.

■ **Isolate the EMM from the sensor harness by disconnecting sensor or EMM harness connector before attempting to check resistance. Even the small voltage provided by a DVOM in order to check a circuit's resistance can damage an EMM.**

Even if the sensor tests ok cold, the sensor might read incorrectly hot (or anywhere in between). If trouble is suspected, reconnect the circuit, then start and run the engine to normal operating temperature. After the engine is fully warmed, shut the engine **OFF** and recheck the sensor hot. If the sensor checks within specification hot, it is still possible that another point during warm-up could be causing a problem, but not likely. The sensor can be removed and checked using the Comprehensive Test in this section or other causes for the symptoms can be checked. If the sensor was checked directly, be sure to check the wiring harness between the EMM and the sensor for continuity. Excessive resistance due to loose connections or damage in the wiring harness can cause the sensor to read out of range.

☐ **If in doubt about the temperature sensor wiring, please refer to the Wiring Diagrams found in the Ignition and Electrical System section to confirm the proper wire colors.**

When checking the sensor be sure to make the correct connections as follows:

- AT: Connect the meter directly the sensor terminals (there is normally no pigtail on these sensors) or to the sensor side of the appropriate EMM harness wires, as desired.
- WT (sensor or switch): Connect the meter to sensor pigtail or the sensor/switch side of the appropriate EMM harness wires. Make sure you've got the correct sensor or switch, since testing the switch using the sensor specifications would likely lead to the replacement of a switch, even if there was no trouble (and vice-versa).

Resistance specifications for the temperature sensors are as follows:

- AT (all except models with fuel rails): 9,000-11,000 ohms @ 77°F (25°C)
- AT (1501175 hp models with fuel rails): 990-1010 ohms @ 77°F (25°C)
- WT Sensor (all except models with fuel rails): 9,000-11,000 ohms @ 77°F (25°C)
- WT Sensor (1501175 hp models with fuel rails): 985-1015 ohms @ 77°F (25°C)

When testing the switch, keep in mind that a quick-test in not as easy as the comprehensive test. The switch is normally OPEN, meaning the circuit is not complete (there should be no continuity across the 2 switch pigtail leads). The switch must remain open from ambient (room) temperatures, to slightly above normal engine operating range, when the switch should CLOSE (meaning there would be continuity across the 2 leads). During the quick-test, this means the switch should remain OPEN. During the comprehensive test, you should heat the switch and note the point at which the contacts close. Almost as important, is the temperature at which the switch contacts OPEN again, because this is the temperature to which the engine would have to cool in order for the S.L.O.W. system to deactivate.

- WT Switch (75-115 V4 motors) switch should remain open until it reaches 234-246°F (112-120°C). After closing, the switch contacts should open again once it cools to 192-222°F (90-104°C).
- WT Switch (V6 motors, except models with fuel rails) switch should remain open until it reaches 206-218°F (96-104°C). After closing, the switch contacts should open again once it cools to 155-185°F (69-83°C).
- WT Switch (1501175 hp motors with fuel rails) switch should remain open until it reaches 271-283°F (133-139°C). After closing, the switch contacts should open again once it cools to 221-251°F (107-119°C).

Comprehensive Test

◆ **See Figures 248 and 249**

It is important to FFI operation that the temperature sensors (especially the AT and WT) provide accurate signals across the entire operating range and not just when fully hot or fully cold. For this reason, it is best to test the sensor by watching output or resistance constantly as the sensor is heated from a cold temperature to the upper end of the engine's operating range. The easiest way to do this is to use the Evinrude/Johnson Diagnostic Software installed in a suitable IBM compatible laptop. If the software is not available, the next best (and most often used solution) is to suspend the sensor in a container of water or oil, connect a DVOM and slowly heat the liquid while watching resistance on the meter.

As noted earlier, submerging the AT sensor in oil or water is probably not the best way to go, we'd recommend slowly cooling it in a fridge and then heating it in a toaster over. Keep in mind that the AT sensor operating range does not normally require it to be heated much above the range of ambient temperatures it would normally encounter. Unlike the WT sensor, the AT sensor should never need to be exposed to the extreme temperatures that occur inside a motor.

Because the WT switch is designed to actuate at temperatures above the normal engine operating range, the BEST method for testing the switch is to remove it and submerge it in a container of water; watch continuity across the switch contacts while it is slowly heated and then cooled.

To perform this check, you will need a high quality (accurate) DVOM, a thermometer (or thermosensor, some multimeters are available with thermosensor adapters), a length of wire, a metal or laboratory grade glass container and a heat source. Again, a hot plate or camp stove is preferred for the WT sensor/switch, but a toaster oven is best for the AT sensor). A DVOM with alligator clip style probes will make this test a lot easier, otherwise alligator clip adapters can be used, but check before testing to make sure they do not add significant additional resistance to the circuit. This check is performed by connecting the two alligator clips together and checking for a very low or 0 resistance reading. If readings are higher than 0, record the value to subtract from the sensor resistance readings compensating for the use of the alligator clips.

✳✳ CAUTION

When using a camp stove or source of open flame to heat the container oil should not be used as the suspension liquid to protect against the possibility of an oil fire. Use water when flame is involved.

1. Remove the WT temperature sensor/switch from as cylinder head or the AT switch from the air intake silencer, as detailed in this section.
2. Suspend the WT switch/sensor and the thermometer or thermosensor probe in a container of cool water or four-stroke engine oil. Or place the AT sensor in a refrigerator.

☐ **To ensure accurate readings make sure the WT temperature switchlsensor and the thermometer are suspended in the liquid and are not touching the bottom or sides of the container.**

3. Set the DVOM to the resistance scale, then attach the probes to the sensor or sensor pigtail terminals, as applicable.
4. Allow the temperature of the switchlsensor and thermometer to stabilize, then note the temperature and the resistance reading.
5. Use the hot plate or camp stove (or a toaster oven on AT switches) to slowly raise the temperature. Continue to note resistance readings as the temperature rises to 77°F (25°C) and then above that reading. Look for the following:

- For sensor testing, the meter should show a steady decrease in resistance that is proportional to the rate at which the liquid is heated. Extreme peaks or valleys in the sensor signal should be rechecked to see if they are results of sudden temperature increases or a possible problem with the sensor.

- For switch testing, note the temperature at which the switch contacts CLOSE (completing the circuit across the 2 switch leads). Then, allow the switch to slowly cool, again, note the temperature at which the switch contacts OPEN again.

6. Compare the readings to the following specifications:

- AT (all except models with fuel rails): 9,000-11,000 ohms @ 77ºF (25ºC)
- AT (1501175 hp models with fuel rails): 990-1010 ohms @ 77ºF (25ºC)
- WT Sensor (all except models with fuel rails): 9,000-11,000 ohms @ 77ºF (25ºC)
- WT Sensor (1501175 hp models with fuel rails): 985-1015 ohms @ 77ºF (25ºC)
- WT Switch (75-115 V4 motors) switch should remain open until it reaches 234-246ºF (112-120ºC). After closing, the switch contacts should open again once it cools to 192-222ºF (90-104ºC).
- WT Switch (V6 motors, except models with fuel rails) switch should remain open until it reaches 206-218ºF (96-104ºC). After closing, the switch contacts should open again once it cools to 155-185ºF (69-83ºC).
- WT Switch (1501175 hp motors with fuel rails) switch should remain open until it reaches 271-283ºF (133-139ºC). After closing, the switch contacts should open again once it cools to 221-251ºF (107-119ºC).

7. Sensors that read well outside specifications (more than about a 5% variance in reading) should be replaced to ensure proper engine operation. Switches that do not close until temoeratures above specification could put the powerhead at risk of damage from overheating. Similarly, switches that close too early or do not open again until too late, may cause inconvenience with unnecessary activation of the S.L.O.W. system.

REMOVAL & INSTALLATION

(2) MODERATE

Air Temperature (AT) Sensor

◆ See Figure 245

The air temperature sensor is located in the air intake silencer. For most models it is mounted into a grommet at the rear of the silencer housing, towards the starboard side of the motor.

1. Disconnect the negative battery cable for safety.
2. Remove the Air Intake Silencer/Flame Arrester assembly, as detailed in this section. The AT sensor wiring must be disconnected for this. The sensor will then be found in a grommet at the back of the housing.
3. Carefully remove the sensor from the air intake silencer housing.
4. Installation is the reverse of removal. Be sure the sensor is fully seated in the housing and that the wiring connector locktabs are properly engaged to secure the harness.

Water Temperature (WT) Sensor or Switch

◆ See Figures 246 and 247

As we warned you earlier, the OMC decided to move the WT sensors and switches around a little. In all cases, they are threaded into the cylinder head, usually near the top of the head, adjacent to the thermostat ssemblies. The challenge comes in determining which cylinder bank contains the sensor and which contains the switch.

The water temperature sensor is located in the port cylinder head for all models except the 1501175 hp motors equipped with fuel rails. On the fuel rail equipped V6 motors, the sensor is found in the starboard cylinder head.

The water temperature switch is located on the OPPOSITE cylinder bank. The WT switch is located in the starboard cylinder head for all models except the 1501175 hp motors equipped with fuel rails. On the fuel rail equipped V6 motors, the switch is found in the port cylinder head.

If in doubt, refer to the Wiring Diagrams provided in the Ignition and Electrical System section to help confirm sensor identity.

1. Disconnect the negative battery cable for safety.
2. Locate the WT sensor or switch towards the top of the cylinder head assembly. If necessary, refer to the wiring diagrams to help trace the wires from the EMM harness.
3. Disengage the wiring harness connector from the sensor or switch pigtail. Note the wire routing for installation purposes. Make sure the terminals on the sensor and in the wiring harness are clean and free of corrosion.
4. Unthread and remove the sensor from the manifold. Be sure to clean the sensor threads and the threads in the manifold before installation.

**** WARNING**

Repeated heating and cooling cycles of the motor during normal service will often seize components in the cylinder head, sometimes even including this sensor. If it is difficult to remove, DO NOT force it or it could break off in the manifold. Instead, apply a few drops of penetrating oil such as PB Blaster or WD-40 and give it a few minutes to work before attempting to loosen the sensor again. If the sensor still won't budge, warm the engine to normal operating temperature and loosen the sensor as it cools (using GREAT care to prevent burning yourself).

5. If equipped, remove and discard the gasket or seal.
6. Installation is the reverse of removal, but take care not to overtighten and damage the sensor or the mounting threads in the manifold. Push the wiring connector until the retaining tab snaps in place, then pull back gently to ensure proper connection.

EMM Temperature (IAT) Sensor

Unfortunately, the EMM temperature sensor is located inside the EMM. As an integral part of the engine management module, it cannot be serviced or replaced separately.

Throttle Position (TP) Sensor

● See Figure 250

The TP sensor (don't you just think that's hilarious, we think that's why most OTHER manufacturers call it the TPS, so as not to have adults walking around laughing at bathroom humor... What? You didn't get it. Sorry. Let us spell it out for you "T" "P" sensor ... the TP sensor... HELLO... wouldn't that be useful, a sensor that warned you when you were almost out of TP. Sorry.) Anyway, the TP sensor is a rotary potentiometer, meaning it sends a variable signal to the EMM based on physical throttle (and therefore sensor) positioning.

The sensor itself receives a reference voltage from the EMM, as the throttle lever is rotated, the EMM receives a return voltage signal through a second wire. This signal will change with throttle position. As the throttle shaft opens the voltage increases, as the shaft closes voltage decreases. A third wire is used to complete the ground circuit back to the EMM.

Should the EMM detect values that our out of range for sensor operation, it will illuminate the Check Engine light, store a trouble code and reduce the engine speed to idle. The EMM will not allow engine speed above idle again until the fault goes away and the engine is stoppedlrestarted.

Sensor location varies slightly from model-to-model. On all motors, the TP sensor is located on top of the vertical throttle shaft (for what we hope are obvious reasons), so it is found at or near the top of the powerhead. For 75-175 hp V4 and V6 motors, it is on the starboard side, near the flywheel cover. For 200-250 hp V6 motors, it is on the port side, near or slightly under the flywheel.

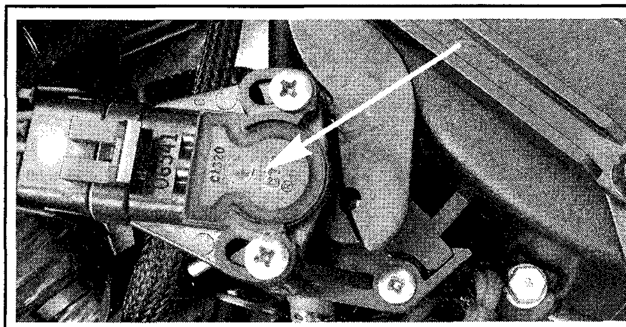


Fig. 250 Typical TP sensor—75-175 hp motors shown, others similar

TESTING

DIFFICULT

+ **See Figure 250**

For 200-250 hp V6 motors, all or part of the sensor may be covered by the flywheel. If necessary for access to the wiring connector and sensor terminals, remove the flywheel from the powerhead. For details. please refer to the Powerhead section.

1. Disconnect the negative battery cable.
2. Locate the sensor connector by tracing the wires from the EMM harness, or by locating the sensor itself on top of the throttle shaft. For 75-175 hp V4 and V6 motors, it is on the starboard side, near the flywheel cover. For 200-250 hp V6 motors, it is on the port side, near or slightly under the flywheel.
3. Disengage the wiring harness connector from the sensor. Note the wire routing for installation purposes. Make sure the terminals on the sensor and in the wiring harness are clean and free of corrosion.
4. Set a DVOM to the resistance scale, then connector the meter leads to the connector pins for the red and black wires. The meter should show more than 3000 ohms resistance.
5. Move one of the 2 meter leads to the pin for the green wire, then watch the meter while slowly and smoothly moving the throttle arm through the full range of movement. The meter reading must change slowly and smoothly in relation to the movement.
6. Keep the meter lead on the green pin, but move the OTHER lead to the open wire pin. Again, watch the meter while slowly and smoothly moving the throttle arm through the full range of movement. The meter reading must change slowly and smoothly in relation to the movement.
7. If the readings are not as specified, the sensor must be replaced. Recheck your findings before removing and discarding the old sensor.

REMOVAL & INSTALLATION

MODERATE

◆ **See Figure 250**

Removal and installation of the sensor should be a relatively straightforward proposition. Of course, on 200-250 hp V6 motors, the sensor may be partially or completely covered by the flywheel, necessitating flywheel removal in order to access the sensor. For details, please refer to the Powerhead section.

Once the sensor is accessed, disconnect the wiring, remove the bolts and remove the sensor. Unfortunately, the Evinrude/Johnson does not publish any other information regarding the sensor. The design of the sensor makes it look like some adjustment is possible. If there are slotted retainers for the sensor screw, matchmark the position of the retainers to the old sensor before loosening them. Transfer these marks to the new sensor before installation in an attempt to duplicate the sensor positioning. If problems result after replacement, check with a local Evinrude/Johnson dealer to see if any information regarding switch adjustment was subsequently made available by the manufacturer.

Shift Interrupt Switch (V6 Motors)

The FICHT V6 motors are equipped with a shift interrupt switch mounted in contact with the shift lever, toward the bottom on the starboard side of the motor. The switch is used to monitor for excessive shift loads.

As a switch, it electrically works in 2 positions, open (off) or closed (on). The switch, is normally open, but will close when the button is actuated. This occurs when the shift lever depresses the button due to excessive shift loads. Once the switch closes, providing the ground circuit for the EMM signal, the EMM will, if engine speed is below 2500 rpm, shut of fuel and spark to 3 cylinders to momentarily reduce drivetrain loads and ease shifting. On 1501175 hp motors equipped with fuel rails, the EMM will cut fuelispark from cylinder Nos. 2, 4 and 6 for a total of six revolutions (about 3 seconds). On all other models (not equipped with fuel rails), the EMM will cut fuel/spark from 3 cylinders on either bank for a total of 4 revolutions or about 1 second. In either case, the EMM will automatically restore normal engine operation after the completion of the appropriate number of revolutions.

The EMM will not respond to the switch signal if engine speed is above 2500 rpm. Similarly, the signal must be reset before the EMM will respond again. I.E. the switch button must be fully released to its normal open (circuit off) position and then reactivated before the EMM will respond to the signal again.

Should the switch or circuit fail, the EMM will store a trouble code and illuminate the Check Engine light. Engine operation, with the exception of the shift interrupt function, should be otherwise unaffected.

TESTING

MODERATE

Testing the shift interrupt switch is accomplished using a DVOM set to read resistance or a continuity checker. In either case, disconnect the wiring from the switch, then connect the tester to the switch terminals. The switch is a normally open unit, meaning that with the button released, there should be no continuity. Once the button is depressed, the switch contacts must close and the tester should shown continuity. Once the button is released, the switch contacts must open again. Replace the switch if the contacts stick and do not open or close properly or if there is an internal fault leaving the switch permanently open or closed.

Pressure (EP or BP) Sensors

◆ **See Figure 251**

One of the important EMM inputs for determining airlfuel ratios is the Exhaust Pressure (EP) or Barometric Pressure (BP) sensors. This internal EMM sensor, which is strictly a BP sensor on models with fuel rails but as EP that functions as both on all other models, provides the EMM with data regarding ambient air density.

On all FICHT motors, the BP or EP sensor provides a signal to the EMM prior to startup in order for the EMM to compensate for weather and altitude conditions (including changes in air density up to 14,000 ft/4267m).

On 150/175 hp motors equipped with fuel rails, the internal component is a silicon pressure sensor that contains a diaphragm-sealedair passage. It senses ambient air pressure through a screened passage that remains open to the atmosphere. On these motors the sensor is referred to as a BP sensor as it strictly measures barometric (ambient) pressure.

On all models that are not equipped with fuel rails, the internal sensor works in conjunction with an external pressure diaphragm. Although the component on these motors is referred to as an EP sensor, it functions as a BP sensor immediatelv prior to engine startup. Once the engine starts, the EMM receives exhaust pressure readings to more finely adjust the air/fuel mapping strategies.

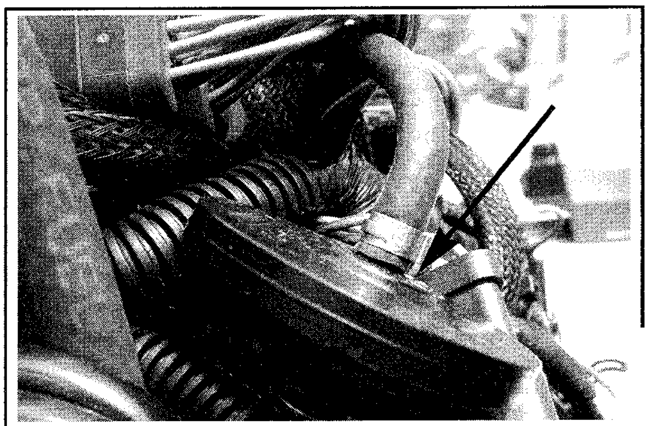


Fig. 251 The EP sensor used on most FICHT motors (except those with fuel rails) works in conjunction with an external pressure diaphragm, pictured here

On all systems, sensor or circuit failure will cause the EMM to illuminate the Check Engine light and store a trouble code. Engine performance and efficiency can obviously be affected.

■ Because this is an internal EMM sensor, it cannot be serviced or replaced individually. But, before replacing an EMM, make sure the problem is the sensor and NOT the external pressure **diaphragm,** the exhaust sensor tube or the hoses between them. **To** check **the sensor** tube and hose, carefully disconnect it from the pressure diaphragm and blow **gently** through them to check for restrictions. **Replace** any damaged **hoses** and **clean** or replace a restricted tube. A tube clogged with carbon buildup MIGHT clean up suitably for use if soaked over night in **Evinrude/Johnson** Engine Tuner.

Engine Management Module (EMM)

◆ See Figure **252**

The Engine Management Module (EMM) controls all functions of the FFI, ianition and oil systems. Problems with the EMM are relatively rare, but when they occur can cause a no-start, stumbling, misfire, hesitation, rough idle or incorrect speed limiting through improper control of the ignition and/or fuel injection systems.

To make matters more interesting, the FICHT EMM is a unique component when compared to the computer control modules found on many other modern fuel injection systems. Unlike many other systems, the EMM is not just a computer module that receives signals from outside sensor and that contains drivers to operate solenoids and other components. On FICHT motors, the EMM also contains a number of integrated sensors, none of which can be serviced separately. The EMM contains the following internal sensorslswitches(which are integral with the EMM) and control circuitry:

- Exhaust and/or Barometric aressure sensor
- EMM temperature sensor
- 40-volt (most models) or 26-volt (certain 90-175 hp models) circuit sensor
- RPM limiter
- Idle governor
- 12-volt circuit sensor
- ROM verification (self-diagnostic) circuitry

Unfortunately, solid state components like the EMM cannot be directly tested in many ways. In most cases, EMM testing involves a process of elimination, testing all other possible causes of a symptom. Condemn the EMM only if all other components and wires/circuits that could cause a problem have been eliminated. Remember that many of the circuits used by the EMM for information or for direct control of the motor are sensitive to changes in resistance. Simple problems such as loose, dirty or corroded connectors, even pinched wires or interference caused by marine radios or other electronic accessories can cause symptoms making an otherwise good EMM seem bad.

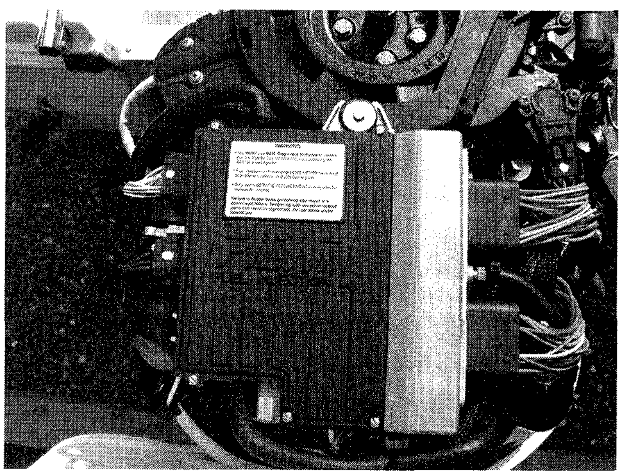


Fig. **252** The EMM is mounted to the top or rear of the powerhead, with a myriad of wiring and hose connections

■ Another unique feature of the EMM is that it is water cooled in order to protect the internal circuitry and sensors from the temperatures that they could **otherwise** experience, not only from circuitry operation but from being mounted to the top of an outboard powerhead,

REMOVAL & INSTALLATION

2 MODERATE

◆ See Figures **252,253,254** and **255**

The EMM is mounted horizontally on top of the powerhead for all 75-175 hp V4 and V6 motors (though it is under a cover on models equipped with fuel rails). The EMM is mounted vertically, on the rear of the powerhead on 200-250 hp motors.

Make sure all other possible causes of improper operation have been eliminated before replacing this component. The EMM tends to be expensive and is normally non-returnable. Also, make sure that no other problems exist in the FFI system and wiring harnesses, because circuit problems could exist that destroy or damage an EMM could also instantly destroy or damage the replacement.

1. Disconnect the negative battery cable to prevent the possibility of damage to the EMM.

**** WARNING**

Static electricity can instantly damage or destroy the solid state control modules. In order to prevent this possibility, ground yourself by touching a metallic component on the motor immediately prior to touching the EMM. If you feel a small static shock, you may have prevented damage to the control unit.

2. If equipped, remove the EMM cover.
3. Tag and disconnect the wiring harness connectors fastened to either side of the EMM. Carefully release each of the locktabs and/or remove the fasteners, as applicable.

■ Note all wire connector and harness positioning for installation **purposes. This** is not onlv important to prevent interference with and **damage** from moving components, but electrical signal interference can also occur from improperly routed wires.

4. The EMM may contain it's own pigtail that is engaged to a connector in the engine harness and, most also contain at least one or two ring terminals/ground straps. Tag and disconnect all wires coming from the EMM to the engine harness or powerhead.
5. Since the EMM is water-cooled, there should be one or more cooling hoses, secured to nipple fittings on the side of the housing. Cut the wire ties and carefully disconnect the hoses. Note the hose positioning for installation purposes.

On all but the models equipped with fuel rails, there should be an EP sensor hose connected to a fitting on the EMM as well.

6. Remove the EMM or bracket retainers and isolators (as equipped), then carefully remove the EMM from the powerhead.

■ Note any ground wires connected at the retaining **bolts. To** prevent problems with the unit (including failures due to poor grounding) make sure ground wires are connected during installation.

To install:

7. Clean dirt and corrosion from the mounting location.

Make sure any ground wires that are used are installed properly. Take care when routing all ground or harness wiring to prevent interference with other components.

8. Position the EMM to the powerhead, then install any fasteners and tighten securely.

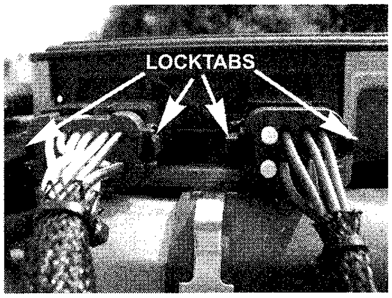


Fig. 253 Tag and disconnect all of the EMM wiring, some use locktabs...

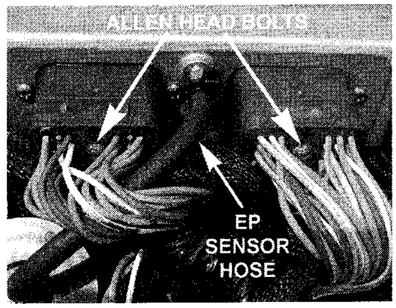


Fig. 254 ...and some use fasteners (shown) or ring terminals...

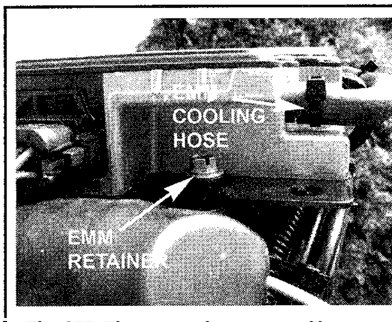


Fig. 255 Then complete removal by disconnecting all hoses and removing the EMM mounting fasteners

9. Reposition and connect the cooling hoses, as noted during removal. Secure using new wire ties.
10. On models NOT equipped with fuel rails, connect the EP sensor hose to the fitting and secure using a new wire tie.
11. Reconnect all wiring including ground straps, pigtails and harness connectors as tagged during removal.
12. If equipped, install the EMM cover.
13. Connect the negative battery cable and check for proper operation.

Fuel Pressure Regulator

Like the circulation pump, the fuel pressure regulator is part of the vapor separator tank assembly. The regulator itself is mounted inside the tank on most models (except the 1501175 hp motors equipped with fuel rails) and cannot be replaced separately.

■ **In order to isolate problems with the FICHT system, VERY specific diagnostic procedures are set forth by the manufacturer and we've provided them under FICHT Component Testing, in this section. The portions relating most directly to the pressure regulator include the sections on Checking the Fuel Delivery System and Checking the Fuel Injection System.**

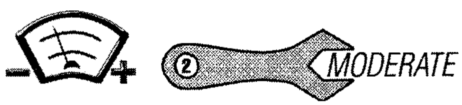
Fuel Filter Water Sensor

◆ **See Figures 256,257 and 258**

The fuel filter water sensor is located at the top of the fuel filter on all models except the 1501175 hp motors equipped with fuel rails (on which it is found at the bottom of the fuel filter). For ALL models, the sensor is designed to complete a ground circuit if water is present in the filter about 318 in. (9.5mm) above the bottom of the filter canister.

When the ground circuit is triggered, the EMM will illuminate the Check Engine light and store a trouble code.

TESTING



◆ **See Figures 256,257 and 258**

Testing the fuel filter water sensor is a relatively simple matter of \removing it from the filter assembly and submerging the tip of the sensor in water. Then, use a DVOM or a continuity meter to check for continuity. On models equipped with fuel rails, connect on meter lead to the sensor and the other to the water itself, there should be continuity. On all models NOT equipped with fuel rails, connect the 2 meter leads across the sensor terminals, again, with the tip of the sensor in water there should be continuity.

■ **When reinstalling the sensor on models NOT equipped with fuel rails, be sure to position it with the connector tab facing the powerhead, then tighten the retaining screws to 25-35 inch lbs. (3-4 Nm).**

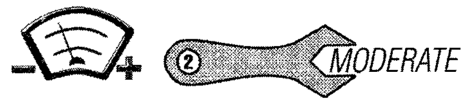
Filter Module

◆ **See Figure 259**

All FICHT motors NOT equipped with fuel rails ARE equipped with a filter module, attached to the wiring harness (located near the thermostat on the 200 hp and larger V6 motors). The module is used to filter out electrical spikes on the accessory wires and to correct erroneous tachometer or other accessory readings.

Filter module failure will normally manifest itself by blowing the accessory fuse and/or through higher than normal (higher than accurate) tachometer readings.

TESTING



◆ **See Figure 259**

1. Using a DVOM set to read resistance, check for proper continuity between the filter ground terminal and a good powerhead ground.
2. Set the DVOM to read DC voltage and move the lead from the filter ground terminal to check for battery voltage at the filters connection to the power distribution terminal (fuse box) wire at terminal B. Refer to the accompanying diagram to help identify the wire. The meter should show approximately 12 volts (battery voltage). If the meter shows 0 volts, repair or replace the fuse in position No. 7 of the power distribution panel. If the problem is not the fuse, check and replace the wire or the module.

■ **Remember to keep one meter lead connected to the good powerhead ground or you won't get ANY voltage readings, even if the circuit is good.**

3. Move the same DVOM lead to the engine harness connector terminal No. 5 (follow the other wire from the filter to that terminal if necessary, again, refer to the accompanying diagram). Again, the meter should 12 volts (battery voltage). If the meter shows 0 volts, repair or replace the wire or the module.

Capacitor

A voltage limiting capacitor is used on all FICHT motors to prevent fluctuations in voltage that might lead to erratic injector operation (and thereby, undesired changes in air/fuel ratio an erratic combustion). On 75-175 hp V4 and V6 motors, this component is a large, cylindrical housing mounted adjacent to the EMM. On 200-250 hp V6 motors, the capacitor is in a small, squarish housing, just behind the upper aft corner of the power distribution box (fuse box) cover.

FFI Main System Relay

A main system relay is normally located at the starboard rear of the powerhead. The main relay provides power to power distribution panel

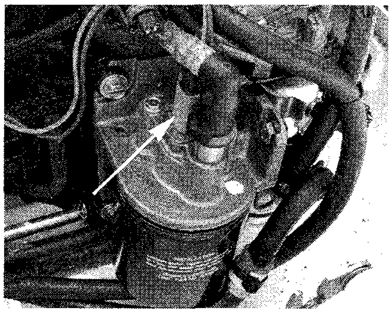


Fig. 256 The fuel filter water sensor is mounted on top of the filter on all models NOT equipped with fuel rails

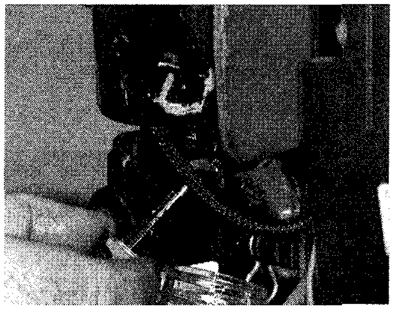


Fig. 257 The sensor is mounted to the bottom of the fuel filter on models **WITH** fuel rails

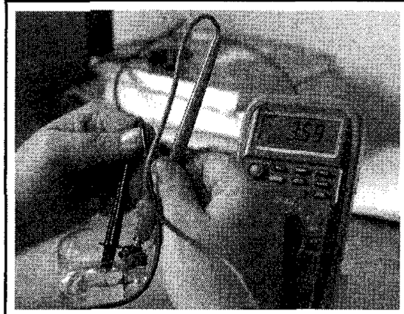


Fig. 258 To test all sensors, they should be removed and their tips submerged in water while checking for continuity (model with fuel rail shown)

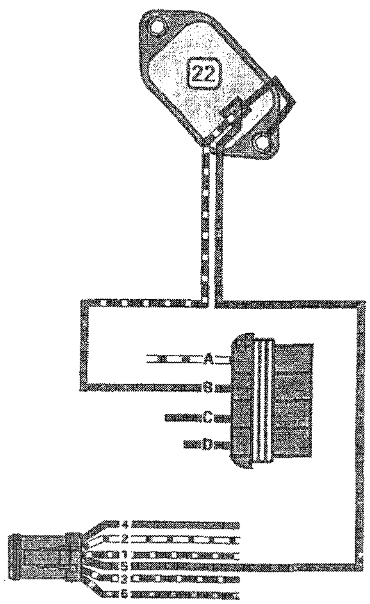


Fig. 259 **FICHT** filter module testing (the module is only used on models NOT equipped with fuel rails)

(fuse box) and maintains the circuit used to charge the battery. Power is applied only when the ignition keyswitch is turned to the ON position.

All models, except the 1501175 hp motors with fuel rails, utilize a 70-amp main power relay.

TESTING & SERVICE

◆ See Figure 260

Problems with the system relay will normally keep the engine from starting, but intermittent problems (that come and go) could cause the engine to stall periodically. Intermittent faults are often caused by heat related conditions, so if the engine stalls with no other symptoms, but restarts only after it has cooled, check the system relay.

The easiest and safest test is to remove the relay (which helps protect test equipment during testing) and check the terminals as directed. To properly test the relay in this fashion you will need a DVOM, jumper wires with alligator clips and fresh (charged) 12-volt battery.

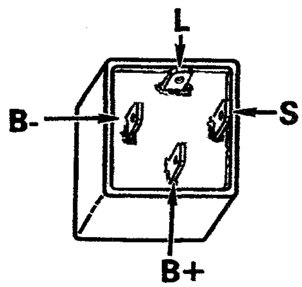


Fig. 260 FFI main system relay terminal identification

The main system relay is always connected to the main wiring harness as follows:

- Terminal S: purple wire (switch)
- Terminal Bt: red wire (positive 12-volts from the starter solenoid)
- Terminal B-: black wire (battery ground)
- Terminal L: red wire (load, 12-volts to EMM)

1. Disconnect the negative battery cable for safety, then locate and remove the main relay from the powerhead, disconnecting it from the wiring harness.
2. Position the relay on the workbench as shown with the L (load) terminal on top. The load terminal is the one terminal pin on the relay that faces a different direction than the others. Use the accompanying illustration to help identify the relay terminals as follows:
   - L Top terminal (the terminal facing a different direction from the others)
   - Bt Lower terminal (when L is on top)
   - B- Left terminal (when L is on top)
   - S Right terminal (when L is on top)
3. With the DVOM set to the resistance scale, connect the positive meter test lead to the **Bt** terminal, then connect the negative meter test lead to the L terminal. No continuity should be noted on the DVOM.
4. Move the meter leads to the B- and S terminals. The meter must now read 60-85 ohms resistance for all models NOT equipped with fuel rails. For the 1501175 hp motors that are equipped with fuel rails, the resistance should read 2-3 ohms.
5. Remove the meter leads; now connect relay terminal S to the positive terminal of a fully charged 12-volt battery. Using another jumper lead, connect relay terminal B- to the negative terminal of the battery.
6. Connect the DVOM (still set to check resistance) to the Bt and L terminals again. With the meter connected 12-volt battery power applied to S and B-, the internal switch in the relay should close causing B+ and L to show continuity.
7. Replace the system relay if B+ and L fail to show continuity when power is applied to the other 2 terminals or if they continue to show continuity when power is removed.
8. Clean the relay and harness connector terminals, then plug the relay back into the harness connector.
9. Connect the negative battery cable and verify proper relay operation.

Carburetor Set-Up Specifications

Model (Hp)	No. of Cyl	Engine Type	Year	Displace cu. in. (cc)	Initial Low Speed Setting	Float Drop Setting In. (mm)	OMC Float Guage
65 Jet	4	90 CV	1992-95	100 (1632)	Fixed low and high Jets	7/8-1 1/8 (22-28)	324891
80 Jet	4	90 CV	1992-97	100 (1632)	Fixed low and high Jets	7/8-1 1/8 (22-28)	324891
85	4	90 CV	1992-95	100 (1632)	Fixed low and high Jets	7/8-1 1/8 (22-28)	324891
88	4	90 CV	1992-96	100 (1632)	Fixed low and high Jets	7/8-1 1/8 (22-28)	324891
90	4	90 CV	1992-98	100 (1632)	Fixed low and high Jets	7/8-1 1/8 (22-28)	324891
100	4	90 CV	1992-97	100 (1632)	Fixed low and high Jets	7/8-1 1/8 (22-28)	324891
112 SPL	4	90 CV	1994-96	100 (1632)	Fixed low and high Jets	7/8-1 1/8 (22-28)	324891
115	4	90 CV	1992-98	100 (1632)	Fixed low and high Jets	7/8-1 1/8 (22-28)	324891
80 Jet	4	60 LV	1998-01	105 (1726)	4 1/2 turns	11/16-1 1/8 (17-28)	na ①
90	4	60 LV	1995	105 (1726)	3 turns	11/16-1 1/8 (17-28)	na ①
	4	60 LV	1996-01	105 (1726)	5 3/4 turns	11/16-1 1/8 (17-28)	na ①
100	4	60 LV	1998-01	105 (1726)	5 turns	11/16-1 1/8 (17-28)	na ①
105 Com	4	60 LV	1997-01	105 (1726)	5 turns	na	na ①
115	4	60 LV	1995	105 (1726)	3 turns	11/16-1 1/8 (17-28)	na ①
	4	60 LV	1996-01	105 (1726)	5 3/4 turns	11/16-1 1/8 (17-28)	na ①
120	4	90 LV	1992-94	122 (2000)	2 1/2 turns ②	No specification ③	na ①
125 Com	4	90 LV	1992-98	122 (2000)	2 1/2 turns ②	No specification ③	na ①
130	4	90 LV	1994-95	122 (2000)	2 1/2 turns	No specification ③	na ①
	4	90 LV	1996-00	122 (2000)	3 1/2 turns	No specification ③	na ①
135	4	90 LV	2001	122 (2000)	3 1/2 turns	No specification ③	na ①
140	4	90 LV	1992-94	122 (2000)	2 1/2 turns ②	No specification ③	na ①
105 Jet	6	60 LV	1992-95	158 (2589)	3 turns	11/16-1 1/8 (17-28)	na ①
		60 LV	1996-01	158 (2589)	4 turns	11/16-1 1/8 (17-28)	na ①
135	6	60 LV	2001	158 (2589)	5 turns	11/16-1 1/8 (17-28)	na ①
150	6	60 LV	1992-95	158 (2589)	3 turns	11/16-1 1/8 (17-28)	na ①
		60 LV	1996-01	158 (2589)	4 turns ④	11/16-1 1/8 (17-28)	na ①
175	6	60 LV	1992-95	158 (2589)	3 turns	11/16-1 1/8 (17-28)	na ①
	6	60 LV	1996-01	158 (2589)	4 turns	11/16-1 1/8 (17-28)	na ①
185	6	90 LV	1992-94	183 (3000)	2 1/2 turns ②	No specification ③	na ①
200	6	90 LV	1992-95	183 (3000)	2 1/2 turns ②	No specification ③	na ①
	6	90 LV	1996-01	183 (3000)	5 turns	No specification ③	na ①
225	6	90 LV	1992-01	183 (3000)	2 1/2 turns ②	No specification ③	na ①
	6	90 LV	1996-01	183 (3000)	5 turns	No specification ③	na ①
250	6	90 LV	1999-01	183 (3000)	5 turns	No specification ③	na ①
250	8	90 LV	1992-96	244 (4000)	2 1/2 turns ②	No specification ③	na ①
	8	90 LV	1997-98	244 (4000)	5 turns	No specification ③	na ①
300	8	90 LV	1992-95	244 (4000)	2 1/2 turns ②	No specification ③	na ①

n/a: not applicable **Initial low speed setting turn(s): back (counterclockwise) from a *lightly* seated position**

① No float gauge is available, instead float should be level with gasket surface (plus or minus 1/32 in. / 0.8mm) with carbureter inverted

② All 1992 and most 1993 models were equipped with fixed low speed jets

③ No float drop specification is given, adjustment is made by checking float height, see footnote ①

④ Specification is for all 150 models, except J, WT and WP which are 4 turns

4 IGNITION AND ELECTRICAL SYSTEMS

UNDERSTANDING AND TROUBLESHOOTING ELECTRICAL SYSTEMS

Basic Electrical Theory

◆ **See Figure 1**

For any 12-volt, negative ground, electrical system to operate, the electricity must travel in a complete circuit. This simply means that current (power) from the positive terminal (+) of the battery must eventually return to the negative terminal (-) of the battery. Along the way, this current will travel through wires, fuses, switches and components. If, for any reason, the flow of current through the circuit is interrupted, the component fed by that circuit would cease to function properly.

Perhaps the easiest way to visualize a circuit is to think of connecting a light bulb (with two wires attached to it) to the battery-one wire attached to the negative (-) terminal of the battery and the other wire to the positive (+) terminal. With the two wires touching the battery terminals, the circuit would be complete and the light bulb would illuminate. Electricity would follow a path from the battery to the bulb and back to the battery. It's easy to see that with wires of sufficient length, our light bulb could be mounted nearly anywhere on the boat. Further, one wire could be fitted with a switch inline so that the light could be turned on and off without having to physically remove the wire(s) from the battery.

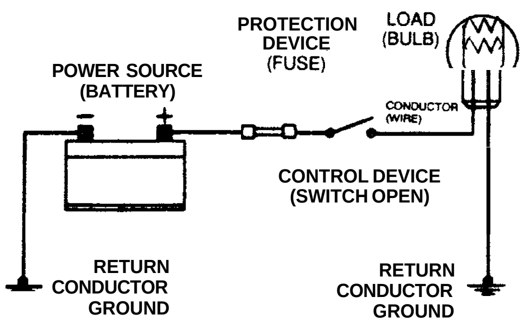


Fig. 1 This example illustrates a simple circuit. When the switch is closed, power from the positive (+) battery terminal flows through the fuse and the switch, and then to the light bulb. The electricity illuminates the bulb and the circuit is completed through the ground wire back to the negative (-) battery terminal.

The normal marine circuit differs from this simple example in two ways. First, instead of having a return wire from each bulb to the battery, the current travels through a single ground wire that handles all the grounds for a specific circuit. Secondly, most marine circuits contain multiple components that receive power from a single circuit. This lessens the overall amount of wire needed to power components.

HOW DOES ELECTRICITY WORK: THE WATER ANALOGY

Electricity is the flow of electrons-the sub-atomic particles that constitute the outer shell of an atom. Electrons spin in an orbit around the center core of an atom. The center core is comprised of protons (positive charge) and neutrons (neutral charge). Electrons have a negative charge and balance out the positive charge of the protons. When an outside force causes the number of electrons to unbalance the charge of the protons, the electrons will split off the atom and look for another atom to balance out. If this imbalance is kept up, electrons will continue to move and an electrical flow will exist.

Many people find electrical theory easier to understand when using an analogy with water. In a comparison with water flowing through a pipe, the electrons would be the water and the wire is the pipe.

The flow of electricity can be measured much like the flow of water through a pipe. The unit of measurement used is amperes, frequently abbreviated as amp (a). You can compare amperage to the volume of water flowing through a pipe (for water that would mean a measurement of mass usually measured in units delivered over a set amount of time such as gallons or liters per minute). When connected to a circuit, an ammeter will measure the actual amount of current flowing through the circuit. When relatively few electrons flow through a circuit, the amperage is low. When many electrons flow, the amperage is high.

Water pressure is measured in units such as pounds per square inch (psi). The electrical pressure is measured in units called volt (v). When a voltmeter is connected to a circuit, it is measuring the electrical pressure.

The actual flow of electricity depends not only on voltage and amperage, but also on the resistance of the circuit. The higher the resistance, the higher the force necessary to push the current through the circuit. The standard unit for measuring resistance is an ohm . Resistance in a circuit varies depending on the amount and type of components used in the circuit. The main factors that determine resistance are:

- Material-some materials have more resistance than others. Those with high resistance are said to be insulators. Rubber materials (or rubber-like plastics) are some of the most common insulators used, as they have a very high resistance to electricity. Very low resistance materials are said to be conductors. Copper wire is among the best conductors. Silver is actually a superior conducior to copper and is used in some relay contacts, but its high cost prohibits its use as common wiring. Most marine wiring is made of copper.
- Size-the larger the wire size being used, the less resistance the wire will have (just as a large diameter pipe will allow small amounts of water to just trickle through). This is why components that use large amounts of electricity usually have large wires supplying current to them.
- Length-for a given thickness of wire, the longer the wire, the greater the resistance. The shorter the wire, the less the resistance. When determining the proper wire for a circuit, both size and length must be considered to design a circuit that can handle the current needs of the component.
- Temperature-withmany materials, the higher the temperature, the greater the resistance (positive temperature coefficient). Some materials exhibit the opposite trait of lower resistance with higher temperatures (these are said to have a negative temperature coefficient). These principles are used in many engine control sensors (especially those found on EFI systems).

OHM'S LAW

There is a direct relationship between current, voltage and resistance. The relationship between current, voltage and resistance can be summed up by a statement known as Ohm's law.

Voltage (E) is equal to amperage (I) times resistance (R): $E=I \times R$

Other forms of the formula are $R=E/I$ and $I=E/R$

In each of these formulas, E is the voltage in volts, I is the current in amps and R is the resistance in ohms. The basic point to remember is that if the voltage of a circuit remains the same, as the resistance of that circuit goes up, the amount of current that flows in the circuit will go down.

The amount of work that electricity can perform is expressed as Dower. The unit of power is the watt (w). The relationship between power, voltage and current is expressed as:

Power (W) is equal to amperage (I) times voltage (E): $W=I \times E$

This is only true for direct current (DC) circuits; the alternating current formula is a tad different, but since the electrical circuits in most vessels are DC type, we need not get into AC circuit theory.

Electrical Components

POWER SOURCE

+ **See Figure 2**

Typically, power is supplied to a vessel by two devices: The battery and the stator (or battery charge coil). The stator supplies electrical current anytime the engine is running in order to recharge the battery and in order to operate electrical devices of the vessel. The battery supplies electrical power during starting or during periods when the current demand of the vessel's electrical system exceeds stator output capacity (which includes times when the motor is shut off and stator output is zero).

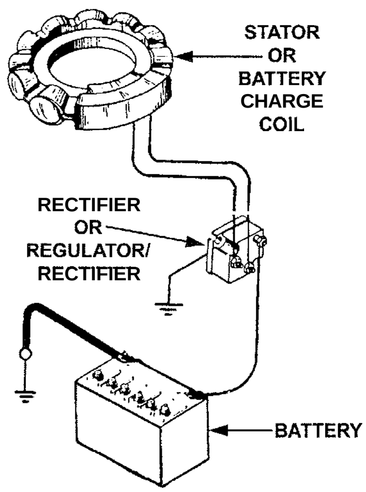


Fig. 2 Functional diagram of a typical charging circuit showing the relationship between the stator (battery charge coil), rectifier (or **regulator/rectifier)** and battery

The Battery

In most modern vessels, the battery is a lead/acid electrochemical device consisting of six 2-volt subsections (cells) connected in series, so that the unit is capable of producing approximately 12 volts of electrical pressure. Each subsection consists of a series of positive and negative plates held a short distance apart in a solution of sulfuric acid and water.

The two types of plates in each battery cell are of dissimilar metals. This sets up a chemical reaction, and it is this reaction which produces current flow from the battery when its positive and negative terminals are connected to an electrical load. Power removed from the battery in use is replaced by current from the stator and restores the battery to its original chemical state.

The Stator

Alternators and generators are devices that consist of coils of wires wound together making big electromagnets. The coil is normally referred to as a stator or battery charge coil. Either, one group of coils spins within another set (or a set of permanently charged magnets, usually attached to the flywheel, are spun around a set of coils) and the interaction of the magnetic fields generates an electrical current.. This current is then drawn off the coils and fed into the vessel's electrical system.

Some vessels utilize **a** generator instead of an alternator. Although the terms are often misused and interchanged, the main difference is that an alternator supplies alternating current that is changed to direct current for use on the vessel, while a generator produces direct current. Alternators tend to be more efficient and that is why they are used on almost all modern engines.

GROUND

Two types of grounds are used in marine electric circuits. Direct ground components are grounded to the electrically conductive metal through their mounting points. All other components use some sort of ground wire that leads back to the battery. The electrical current runs through the ground wire and returns to the battery through the ground or negative (-) cable; if you look, you'll see that the battery ground cable connects between the battery and a heavy gauge ground wire.

■ A large percentage of electrical problems can be traced to bad grounds.

If you refer back to the basic explanation of a circuit, you'll see that the ground portion of the circuit is just as important as the power feed. The wires delivering power to a component can have perfectly good, clean connections, but the circuit would fail to operate if there was a damaged ground connection. Since many components ground through their mounting or through wires that are connected to an engine surface, contamination from dirt or corrosion can raise resistance in a circuit to a point where it cannot operate.

PROTECTIVE DEVICES

◆ See Figure 3

Problems can occur in the electrical system that will cause large surges of current to pass through the electrical system of your vessel. These problems can be the fault of the charging circuit, but more likely would be a problem with the operating electrical components that causes an excessively high load. An unusually high load can occur in a circuit from problems such as a seized electric motor (like a damaged starter) or the excessive resistance caused by a bad ground (from loose or damaged wires or connections). A short to ground that bypasses the load and allows the battery to quickly discharge through a wire can also cause current surges.

If this surge of current were to reach the load in the circuit, the surge could burn it out or severely damage it. It can also overload the wiring, causing the harness to get hot and melt the insulation. To prevent this, fuses, circuit breakers and/or fusible links are connected into the supply wires of the electrical system. These items are nothing more than a built-in weak spot in the system. When an abnormal amount of current flows through the system, these protective devices work as follows to protect the circuit:

- Fuse-when an excessive electrical current passes through a fuse, the fuse blows (the conductor melts) and opens the circuit, preventing current flow.
- Circuit Breaker-a circuit breaker is basically a self-repairing fuse. It will open the circuit in the same fashion as a fuse. but when the surge subsides. the circuit breaker can be reset and does not need replacement. Most circuit breakers on marine engine applications are self-resetting, but some that operate accessories (such as on larger vessels with a circuit breaker panel) must be reset manually (just like the circuit breaker panels in most homes).
- Fusible Link-a fusible link (fuse link or main link) is a short length of special, high temperature insulated wire that acts as a fuse. When an excessive electrical current passes through a fusible link, the thin gauge wire inside the link melts, creating an intentional open to protect the circuit. To repair the circuit, the link must be replaced. Some newer type fusible links are housed in plug-in modules, which are simply replaced like a fuse, while older type fusible links must be cut and spliced if they melt. Since this link is very early in the electrical path, it's the first place to look if nothing on the vessel works, yet the battery seems to be charged and is otherwise properly connected.

✳✳ CAUTION

Always replace fuses, circuit breakers and fusible links with identically rated components. Under no circumstances should a component of higher or lower amperage rating be substituted. A lower rated component will disable the circuit sooner than necessary (possibly during normal operation), while a higher rated component can allow dangerous amounts of current that could damage the circuit or **component** (or even melt insulation causing **sparks** or a fire).

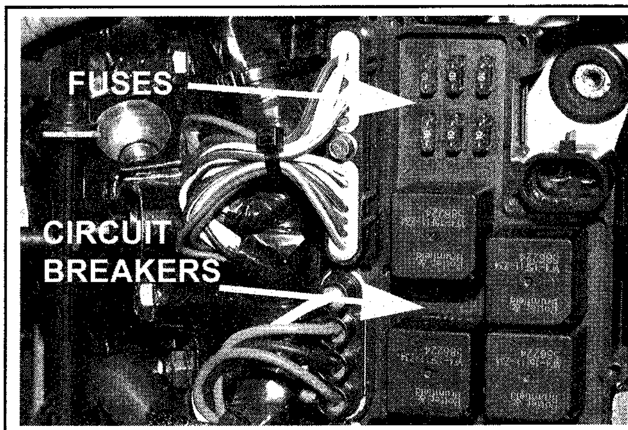


Fig. 3 Fuses and circuit breakers may be found in a central location, or mounted to individual holders in the wiring harness

SWITCHES & RELAYS

◆ **See Figure 4**

Switches are used in electrical circuits to control the passage of current. The most common use is to open and close circuits between the battery and the various electric devices in the system. Switches are rated according to the amount of amperage they can handle. If a sufficient amperage rated switch is not used in a circuit, the switch could overload and cause damage.

Some electrical components that require a large amount of current to operate use a special switch called a relay. Since these circuits carry a large amount of current, the thickness of the wire in the circuit is also greater. If this large wire were connected from the load to the control switch, the switch would have to carry the high amperage load and the space needed for wiring in the vessel would be twice as big to accommodate the increased size of the wiring harness. A relay is used to prevent these problems.

Think of relays as essentially "remote controlled switches." They allow a smaller current to throw the switch that operates higher amperages devices. Relays are composed of a coil and a set of contacts. When current is passed through the coil, a magnetic field is formed that causes the contacts to move together, closing the circuit. Most relays are normally open, preventing current from passing through the main circuit until power is applied to the coil. But, relays can take various electrical forms depending on the job for which they are intended. Some common circuits that may use relays are horns, lights, starters, electric fuel pumps and other potentially high draw circuits.

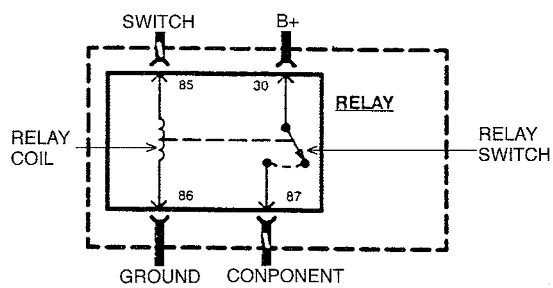


Fig. 4 Relays are composed of a coil and a switch. These two components are linked together so that when one is operated it actuates the other. The large wires in the circuit are connected from the battery to one side of the relay switch (B+) and from the opposite side of the relay switch to the load (component). Smaller wires are connected from the relay coil to the control switch for the circuit and from the opposite side of the relay coil to ground

LOAD

Every electrical circuit must include a load (something to use the electricity coming from the source). Without this load, the battery would attempt to deliver its entire power supply from one pole to another. This is called a short circuit. All this electricity would take a short cut to ground and cause a great amount of damage to other components in the circuit (including the battery) by developing a tremendous amount of heat. This condition could develop sufficient heat to melt the insulation on all the surrounding wires and reduce a multiple wire cable to a lump of plastic and copper. A short can allow sparks that could ignite fuel vapors or other combustible materials in the vessel, causing an extremely hazardous condition.

WIRING & HARNESSES

The average vessel contains miles of wiring, with hundreds of individual connections. To protect the many wires from damage and to keep them from becoming a confusing tangle, they are organized into bundles, enclosed in plastic or taped together and called wiring harnesses. Different harnesses serve different parts of the vessel. Individual wires are color coded to help trace them through a harness where sections are hidden from view.

Marine wiring or circuit conductors can be either single strand wire, multi-strand wire or printed circuitry. Single strand wire has a solid metal core and is usually used inside such components as stator coil windings, motors, relays and other devices. Multi-strand wire has a core made of many small strands of wire twisted together into a single conductor. Most of the wiring in a marine electrical system is made up of multi-strand wire, either as a single conductor or grouped together in a harness. All wiring is color coded on the insulator, either as a solid color or as a colored wire with an identification stripe. A printed circuit is a thin film of copper or other conductor that is printed on an insulator backing. Occasionally, a printed circuit is sandwiched between two sheets of plastic for more protection and flexibility. A complete printed circuit, consisting of conductors,' insulating material and connectors is called a printed circuit board. Printed circuitry is used in place of individual wires or harnesses in places where space is limited, such as behind 1-piece instrument clusters.

Since marine electrical systems are very sensitive to changes in resistance, the selection of properly sized wires is critical when systems are repaired. A loose or corroded connection or a replacement wire that is too small for the circuit will add extra resistance and an additional voltage drop to the circuit.

The wire gauge number is an expression of the cross-section area of the conductor. Vessels from countries that use the metric system will typically describe the wire size as its cross-sectional area in square millimeters. In this method, the larger the wire, the greater the number. Another common system for expressing wire size is the American Wire Gauge (AWG) system. As gauge number increases, area decreases and the wire becomes smaller. Using the AWG system, an 18 gauge wire is smaller than a 4 gauge wire. A wire with a higher gauge number will carry less current than a wire with a lower gauge number. Gauge wire size refers to the size of the strands of the conductor, not the size of the complete wire with insulator. It is possible, therefore, to have two wires of the same gauge with different diameters because one may have thicker insulation than the other.

It is essential to understand how a circuit works before trying to figure out why it doesn't. An electrical schematic shows the electrical current paths when a circuit is operating properly. Schematics break the entire electrical system down into individual circuits. In most schematics no attempt is made to represent wiring and components as they physically appear on the vessel; switches and other components are shown as simply as possible. But, this is usually **not** the case on Evinrude/Johnson schematics and some of the wiring diagrams provided here. So, when using a Evinrude/Johnson schematic if the component in question is represented by something more than a small square or rectangle with a label, it is likely a true representation of the component. On most schematics, the face views of harness connectors show the cavity or terminal locations in all multi-pin connectors to help locate test points.

Test Equipment

Pinpointing the exact cause of trouble in an electrical circuit is usually accomplished by the use of special test equipment, but the equipment does not always have to be expensive. The following sections describe different types of commonly used test equipment and briefly explains how to use them in diagnosis. In addition to the information covered below, be sure to read and understand the tool manufacturer's instruction manual (provided with most tools) before attempting any test procedures.

JUMPER WIRES

◆ **See Figure 5**

✳✳ CAUTION

Never use jumper wires made from a thinner gauge wire than the circuit being tested. If the jumper wire is of too small a gauge, it may overheat and possibly melt. Never use jumpers to bypass high resistance loads in a circuit. Bypassing resistances, in effect, creates a short circuit. This may, in turn, cause damage and fire. Jumper wires should only be used to bypass lengths of wire or to simulate switches.

Jumper wires are simple, yet extremely valuable, pieces of test equipment. They are basically test wires that are used to bypass sections of a circuit. Although jumper wires can be purchased, they are usually fabricated from lengths of standard marine wire and whatever type of connector (alligator clip, spade connector or pin connector) that is required for the particular application being tested. In cramped, hard-to-reach areas, it is advisable to have insulated boots over the jumper wire terminals in order to prevent accidental grounding.

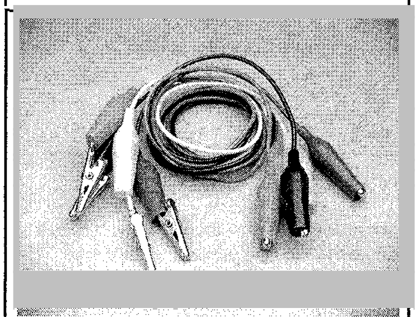


Fig. **5** Jumper wires are simple, but valuable pieces of test equipment

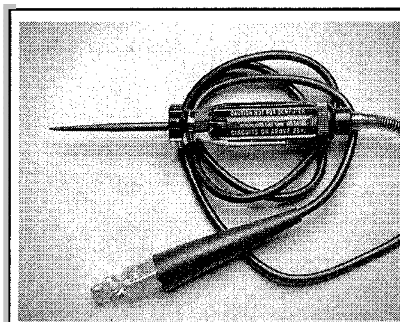


Fig. **6** A 12-volt test light is used to detect the presence of voltage in a circuit

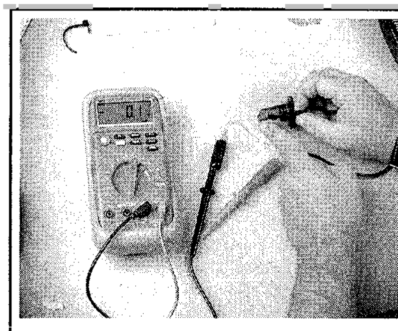


Fig. **7** Multimeters are probably the most versatile and handy tools for diagnosing faulty electrical components or circuits

It is also advisable to include a standard marine fuse in any jumper wire. This is commonly referred to as a fused jumper. By inserting an in-line fuse holder between a set of test leads, a fused jumper wire is created for bypassing open circuits. Use a 5-amp fuse to provide protection against voltage spikes.

Jumper wires are used primarily to locate open electrical circuits, on either the ground (-) side of the circuit or on the power (+) side. If an electrical component fails to operate, connect the jumper wire between the component and a good ground. If the component operates only with the jumper installed, the ground circuit is open. If the ground circuit is good, but the component does not operate, the circuit between the power feed and component may be open. By moving the jumper wire successively back from the component toward the power source, you can isolate the area of the circuit where the open is located. When the component stops functioning, or the power is cut off, the open is in the segment of wire between the jumper and the point previously tested.

You can sometimes connect the jumper wire directly from the battery to the hot terminal of the component, but first make sure the component uses a full 12 volts in operation. Some electrical components, such as fuel injectors or sensors, are designed to operate on smaller voltages like 4 or 5 volts, and runninq 12 volts directlv to these comoonents can damaae or destroy them.

TEST LIGHTS

● See Figure *6*

The test light is used to check circuits and components while electrical current is flowing through them. It is used for voltage and ground tests. To use a 12-volt test light, connect the ground clip to a good ground and probe connectors the pick where you are wondering if voltage is present. The test light will illuminate when voltage is detected. This does not necessarily mean that 12 volts (or any particular amount of voltage) is present; it only means that some voltage is present. It is advisable before using the test light to touch its ground clip and probe across the battery posts or terminals to make sure the light is operating properly and to note how brightly the light glows when 12 volts is present.

✳✳ WARNING

Do not use a test light to probe electronic ignition, spark plug or coil wires, as the circuit is much, much higher than 12 volts. Also, never use a pick-type test light to probe wiring on electronically controlled systems unless specifically instructed to do so. Whenever possible, avoid piercing insulation with the test light pick, as you are inviting shorts or corrosion and excessive resistance. But, any wire insulation that is pierced by necessity, must be sealed with silicone and taped after testing.

Like the jumper wire, the 12-volt test light is used to isolate opens in circuits. But, whereas the jumper wire is used to bypass the open to operate the load, the 12-volt test light is used to locate the presence or lack of voltage in a circuit. If the test light illuminates, there is power up to that point in the circuit; if the test light does not illuminate, there is an open circuit (no power). Move the test light in successive steps back toward the power source until the light in the handle illuminates. The open is between the probe and the point that was previously probed.

The self-powered test light is similar in design to the 12-volt test light, but contains a 1.5 volt penlight battery in the handle. It is most often used in place of a multimeter to check for open or short circuits when power is isolated from the circuit (thereby performing a continuity test).

The battery in a self-powered test light does not provide much current. A weak battery may not provide enough power to illuminate the test light even when a complete circuit is made (especially if there is high resistance in the circuit). Always make sure that the test battery is strong. To check the battery, briefly touch the ground clip to the probe; if the light glows brightly, the battery is strong enough for testing.

■ A self-powered test light should not be used on any electronically controlled system or component. Even the small amount of electricity transmitted by the test light is enough to damage many electronic components.

MULTIMETERS

◆ See Figure **7**

Multimeters are extremely useful for troubleshooting electrical problems. They can be purchased in either analog or digital form and have a price range to suit nearly any budget. A multimeter is a voltmeter, ammeter and ohmmeter (along with other features) combined into one instrument. It is often used when testing solid state circuits because of its high input impedance (usually 10 megaohms or more). A high-quality digital multimeter or Digital Volt Ohm 1 t (DVOM) ps to ensure the most accurate test results and, although not absolutely necessary for electronic components such as EFI systems and charging systems, is highly recommended. A brief description of the main test functions of a multimeter follows:

- Voltmeter-the voltmeter is used to measure voltage at any point in a circuit, or to measure the voltage drop across any part of a circuit. Voltmeters usually have various scales and a selector switch to allow metering and display of different voltage ranges. The voltmeter has a positive and a negative lead. To avoid damage to the meter, connect the negative lead to the negative (-) side of the circuit (to ground or nearest the ground side of the circuit) and connect the positive lead to the positive (t) side of the circuit (to the power source or the nearest power source). This is mostly a concern on analog meters, as DVOMs are not normally adversely affected (as they are usually designed to take readings even with reverse polarity and display accordingly). Note that the negative voltmeter lead will always be black and that the positive voltmeter will always be some color other than black (usually red).
- Ohmmeter-the ohmmeter is designed to read resistance (measured in ohms) in a circuit or component. Most ohmmeters will have a selector switch which permits the measurement of different ranges of resistance (usually the selector switch allows the multiplication of the meter reading by 10, 100, 1,000 and 10,000). Most modern ohmmeters (especially DVOMs) are auto-ranging which means the meter itself will determine which scale to use. Since ohmmeters are powered by an internal battery, the ohmmeter can be used like a self-powered test light.

When the ohmmeter is connected, current from the ohmmeter flows through the circuit or component being tested. Since the ohmmeter's internal resistance and voltage are known values, the amount of current flow through the meter depends on the resistance of the circuit or component being tested. The ohmmeter can also be used to perform a continuity test for suspected open circuits. When using the meter for continuity checks, do not be concerned with the actual resistance readings. Zero resistance, or any ohm reading, indicates continuity in the circuit. Infinite resistance indicates an opening in the circuit. A high resistance reading where there should be none indicates a problem in the circuit. Checks for short circuits are made in the same manner as checks for open circuits, except that the circuit must be isolated from both power and normal ground. Infinite resistance indicates no continuity, while zero resistance indicates a dead short.

✳✳ WARNING

Never use an ohmmeter to check the resistance of a component or wire while there is voltage applied to the circuit. Voltage in the circuit can damage or destroy the meter.

Ammeter-an ammeter measures the amount of current flowing through a circuit in units called amperes or amps. At normal operating voltage, most circuits have a characteristic amount of amperes, called current draw that can be measured using an ammeter. By referring to a specified current draw rating, then measuring the amperes and comparing the two values, you can determine what is happening within the circuit to aid in diagnosis. An open circuit, for example, will not allow any current to flow, so the ammeter reading will be zero. A damaged component or circuit will have an increased current draw, so the reading will be high. The ammeter is always connected in series with the tested circuit. All of the current that normally flows through the circuit must also flow through the ammeter; if there is any other path for the current to follow, the ammeter reading will not be accurate. The ammeter itself has very little resistance to current flow and, therefore, will not affect the circuit, but it will measure current draw only when the circuit is closed and electricity is flowing. Excessive current draw can blow fuses and drain the battery, while a reduced current draw can cause motors to run slowly, lights to dim and other components to not operate properly.

Troubleshooting Electrical Systems

When diagnosing a specific problem, organized troubleshooting is a must. The complexity of a modern marine vessel demands that you approach any problem in a logical, organized manner. There are certain troubleshooting techniques, however, which are standard:

- **Establish when the problem occurs.** Does the problem appear only under certain conditions? Were there any noises, odors or other unusual symptoms? Isolate the problem area. To do this, make some simple tests and observations, then eliminate the systems that are working properly. Check for obvious problems, such as broken wires and loose or dirty connections. Always check the obvious before assuming something complicated is the cause.
- **Test for problems systematically to determine the cause once the problem area is isolated.** Are all the components functioning properly? Is there power going to electrical switches and motors? Performing careful, systematic checks will often turn up most causes on the first inspection, without wasting time checking components that have little or no relationship to the problem.
- **Test all repairs after the work is done to make sure that the problem is fixed.** Some causes can be traced to more than one component, so a careful verification of repair work is important in order to pick up additional malfunctions that may cause a problem to reappear or a different problem to arise. A blown fuse, for example, is a simple problem that may require more than another fuse to repair. If you don't look for a problem that caused a fuse to blow, a shorted wire (for example) may go undetected and cause the new fuse to blow right away (if the short is still present) or during subsequent operation (as soon as the short returns if it is intermittent).

Experience shows that most problems tend to be the result of a fairly simple and obvious cause, such as loose or corroded connectors, bad grounds or damaged wire insulation that causes a short. This makes careful visual inspection of components during testing essential to quick and accurate troubleshooting.

Electrical Testing

VOLTAGE

◆ **See Figure 8**

This test determines the voltage available from the battery and should be the first step in any electrical troubleshooting procedure after visual inspection. Many electrical problems, especially on electronically controlled systems, can be caused by a low state of charge in the battery. Many circuits cannot function correctly if the battery voltage drops below normal operating levels.

Loose or corroded battery cable terminals can cause poor contact that will prevent proper charging and full battery current flow.

1. Set the voltmeter selector switch to the 20V position.
2. Connect the meter negative lead to the battery's negative (-) post or terminal and the positive lead to the battery's positive (+) post or terminal.
3. Turn the ignition switch **ON** to provide a small load.
4. A well charged battery should register over 12 volts. If the meter reads below 11.5 volts, the battery power may be insufficient to operate the electrical system properly. Check and charge or replace the battery as detailed under Engine Maintenance before further tests are conducted on the electrical system.

VOLTAGE DROP

◆ **See Figure 9**

When current flows through a load, the voltage beyond the load drops. This voltage drop, is due to the resistance created by the load and also by small resistances created by corrosion at the connectors (or by damaged insulation on the wires). Since all voltage drops are cumulative, the maximum allowable voltage drop under load is critical, especially if there is more than one load in the circuit.

1. Set the voltmeter selector switch to the 20 volts position.
2. Connect the multimeter negative lead to a good ground.
3. Operate the circuit and check the voltage prior to the first component (load).
4. There should be little or no voltage drop in the circuit prior to the first component. If a voltage drop exists, the wire or connectors in the circuit are suspect.
5. While operating the first component in the circuit, probe the ground side of the component with the positive meter lead and observe the voltage readings. A small voltage drop should be noticed. This voltage drop is caused by the resistance of the component.
6. Repeat the test for each component (load) down the circuit.
7. If an excessively large voltage drop is noticed, the preceding component, wire or connector is suspect.

RESISTANCE

◆ **See Figure 10**

✳✳ WARNING

Never use an ohmmeter with power applied to the circuit. The ohmmeter is designed to operate on its own power supply. The normal 12-volt electrical system voltage will damage or destroy many meters!

1. Isolate the circuit from the vessel's power source.
2. Ensure that the ignition key is **OFF** when disconnecting any components or the battery.
3. Where necessary, also isolate at least one side of the circuit to be checked, in order to avoid reading parallel resistances. Parallel circuit resistances will always give a lower reading than the actual resistance of either of the branches.
4. Connect the meter leads to both sides of the circuit (wire or component) and read the actual measured ohms on the meter scale.

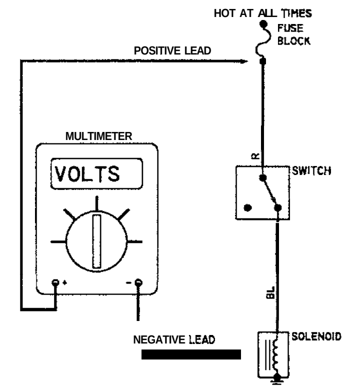


Fig. 8 A voltage check determines the amount of battery voltage available and, as such, should be the first step in any troubleshooting procedure

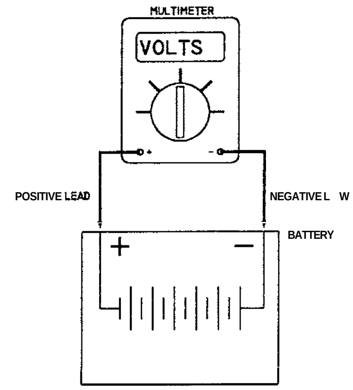


Fig. 9 Voltage drops are due to resistance in the circuit, from the load or from problems with the wiring

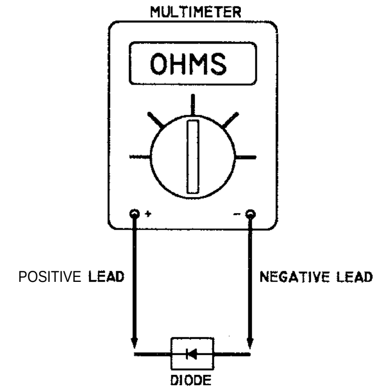


Fig. 10 Resistance tests must be conducted on portions of the circuit, isolated from battery power

Make sure the selector switch is set to the proper ohm scale for the circuit being tested, to avoid misreading the ohmmeter test value.

The resistance reading of most electrical components will vary with temperature. Unless otherwise noted, specifications given are for testing under ambient conditions of **68°F (20°C).** If the **component** is tested at higher or lower temperatures, expect the readings to vary slightly. When testing engine control sensors or coil windings with smaller resistance specifications (less than **1000** ohms) it is best to use a high quality DVOM and be especially careful of your test results. Whenever possible, double-check your results against a known good part before purchasing the replacement. If necessary, bring the old part to the marine parts dealer and have them compare the readings to prevent possibly replacing a good component.

OPEN CIRCUITS

◆ See Figure 11

This test already assumes the existence of an open in the circuit and it is used to help locate position of the open.

1. Isolate the circuit from power and ground.
2. Connect the self-powered test light or ohmmeter ground clip to the ground side of the circuit and probe sections of the circuit sequentially.
3. If the light is out or there is infinite resistance, the open is between the probe and the circuit ground.
4. If the light is on or the meter shows continuity, the open is between the probe and the end of the circuit toward the power source.

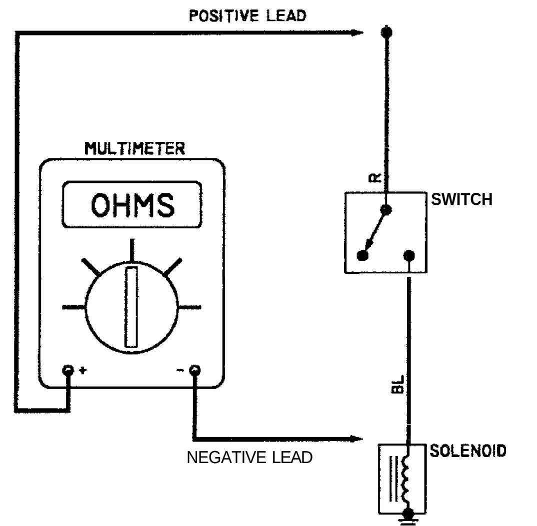


Fig. **11** The easiest way to illustrate an open circuit is to picture a circuit in which the switch is turned OFF (creating an opening in the circuit) that prevents power from reaching the load

SHORT CIRCUITS

◆ See Figure **12**

Never use a self-powered test light to perform checks for opens or shorts when power is applied to the circuit under **test. The** test light can be damaged by outside power.

1. Isolate the circuit from power and ground.
2. Connect the self-powered test light or ohmmeter ground clip to a good ground and probe any easy-to-reach point in the circuit.
3. If the light comes on or there is continuity, there is a short somewhere in the circuit.
4. To isolate the short, probe a test point at either end of the isolated circuit (the light should be on or the meter should indicate continuity).
5. Leave the test light probe engaged and sequentially open connectors or switches, remove parts, etc. until the light goes out or continuity is broken.
6. When the light goes out, the short is between the last two circuit components that were opened.

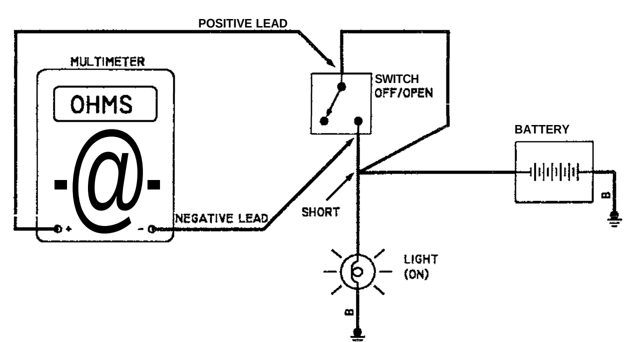


Fig. **12** In this illustration a load (the light) is powered when it should not be (since the switch should be creating an open condition), but a short to power (battery) is powering the circuit. Shorts like this can be caused by chaffed wires with worn or broken insulation

Wire and Connector Repair

Almost anyone can replace damaged wires, as long as the proper tools and parts are available. Wire and terminals are available to fit almost any need. Even the specialized weatherproof, molded and hard shell connectors used on EvinrudelJohnson enaines are usuallv available for ourchase individually.

Be sure the ends of all the wires are fitted with the proper terminal hardware and connectors. Wrapping a wire around a stud is not a permanent solution and will only cause trouble later. Replace wires one at a time to avoid confusion. Always route wires in the same manner of the manufacturer.

When replacing connections, make absolutely certain that the connectors are certified for marine use. Automotive wire connectors may not meet United States Coast Guard (USCG) specifications.

If connector repair is necessary, only attempt it if you have the proper tools. Weatherproof and hard shell connectors require special tools to release the pins inside the connector. Attempting to repair these connectors with conventional hand tools will damage them. See a EvinrudelJohnson dealer about the proper connector terminal tools available from the manufacturer for these engines.

Electrical System Precautions

Wear safety glasses when working on or near the battery.

Don't wear a watch with a metal band when servicing the battery or starter. Serious burns can result if the band completes the circuit between the positive battery terminal (or a hot wire) and ground.

- Be absolutely sure of the polarity of a booster battery before making connections. Remember that even momentary connection of a booster battery with the polarity reversed will damage charging system diodes. Connect the cables positive-to-positive, and negative (of the good battery)-to-a good ground on the engine (away from the battery to prevent the possibility of an explosion if hydrogen vapors are present from the electrolyte in the discharged battery). Connect positive cables first (starting with the discharged battery), and then make the last connection to ground on the body of the booster vessel so that arcing cannot ignite hydrogen gas that may have accumulated near the battery.

Disconnect both vessel battery cables before attempting to charge a battery.

Never ground the alternator or generator output or battery terminal. Be cautious when using metal tools around a battery to avoid creating a short circuit between the terminals.

When installing a battery, make sure that the positive and negative cables are not reversed.

- Always disconnect the battery (negative cable first) when charging.
- Never smoke or expose an open flame around the battery. Hydrogen gas is released from battery electrolyte during use and accumulates near the battery. Hydrogen gas is highly explosive.

IGNITION SYSTEMS CARBURETED ENGINES

All motors covered here utilize an electronic ignition system; a version of the magneto powered Capacitor Discharge Ignition (CDI) system. Individual components will vary slightly from model-to-model. But, even with slight variances in the system's source of power and trigger signals, the basic theories of system operation and service are virtually the same for all models. Differences are noted under suitable headings or substeps.

The ignition system's main purpose is to provide the spark necessary for engine combustion, and to do so at the proper time. It does so by converting a low voltage power source (such as the low voltage alternating current produced by the stator's charge coil) into a high voltage DC current. This is accomplished in the primary circuit of the ignition coil. Power is then conducted from the primary circuit, through the ignition coil's secondary circuit (spark plug wires) to the spark plugs.

This section provides information for troubleshooting and repairing the ignition system.

Description and Operation

◆ See Figures **13, 14, 15** and 16

In its simplest form, a Magneto CDI ignition system is composed of the following elements:

- Power Source (Magneto stator charge coil)
- Ignition coil (to transfer low voltage signals to the high voltage current necessary for proper spark)
- Spark plugs

Other components such as main switches, stop switches, or computer systems may be included, though, these items are not necessary for basic CDI operation.

To understand basic CDI operation, it is important to understand the basic theory of induction. Induction theory states that if we move a magnet (magnetic field) past a coil of wire (or the coil by the magnet), it will generate AC current in the coil. This current is used to feed the ignition system.

The amount of current produced depends on several factors:

- How fast the magnet moves past the coil
- The size of the magnet (strength)
- How close the magnet is to the coil
- Number of turns of wire and the size of the windings

Current for the ignition system is provided to the power pack (ignition module) and stored in a capacitor located inside the box. As a charge coil produces current, a capacitor stores it.

At a specific time in the magneto's revolution, the magnets go past the sensor or trigger coil. A sensor coil is essentially a smaller version of a charge coil that produces a smaller current. The current from the sensor coil is used by the power pack to fire the capacitor (that explains why the sensor coil is often referred to as a trigger coil). The current from the capacitor flows out to the ignition coil and spark plug. The sensor acts much like the points found on ignitions systems in days gone by.

The ignition coil is a step-up transformer. It turns the relatively low voltage entering the primary windings into high voltage at the secondary windings. This occurs due to a phenomenon known as induction.

The high voltage generated in the secondary windings leaves the ignition coil and goes to the spark plug. The spark in turn ignites the air-fuel charge in the combustion chamber.

Once the complete cycle has occurred, the spinning magneto repeats the process again and again.

Most EvinrudelJohnson engines contain additional components to enhance functionality of the ignition system. Although the primary power for the ignition system comes from the charge coil, most motors (except the 65 Jet-115 Hp (1632cc) 90CV4 motors) also contain another set of windings called the power coil. When equipped with power coil is usually used to supply current for additional features such as the Speed Limiting Operator Warning (S.L.O.W.) and QuikStart circuits integrated into the power pack. On all of the EvinrudelJohnson V-motors, the power and/or charge coils are combined with the charging system's battery charge coil and mounted in a one-piece stator assembly.

The spark advance is handled electronically and is controlled via the power pack. However, base timing is adjustable on most motors through a sensor coil that is mounted to a moveable sensor base. For more details on adjustments, please refer to the Timing and Synchronization procedures in the Maintenance and Tune-up section.

Main switches, engine stop switches, and the like are usually connected to the wiring in between the power pack box and the ignition coil. When the main switch or stop switch is turned to the OFF position, the switch is closed. This closed switch short-circuits the charge coil current to ground rather than sending it through the power pack. With no charge coil current through the power pack, there is no spark and the engine stops or, if the engine is not running, no spark is produced preventing it from starting.

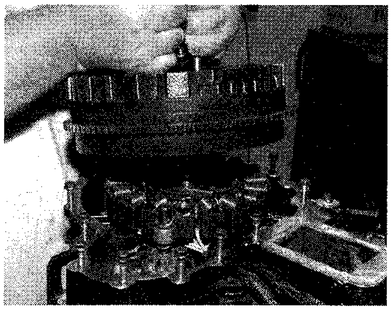


Fig. **13** Power for ignition operation comes from the magneto comprised of the flywheel-mounted magnets and **...**

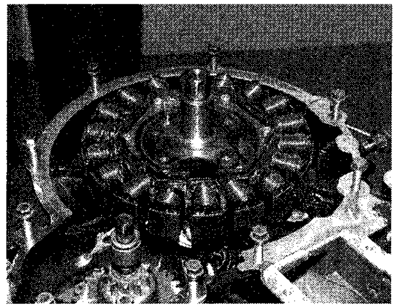


Fig. **14** **...** the stator coil windings mounted under the flywheel

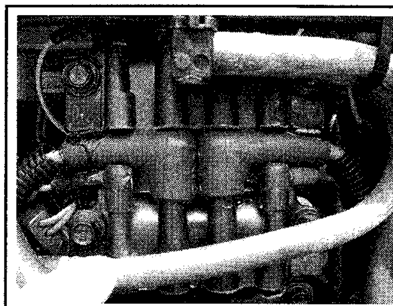


Fig. **15** The ignition coil uses the low voltage from the charge coil to induct high voltage that fires the spark plugs

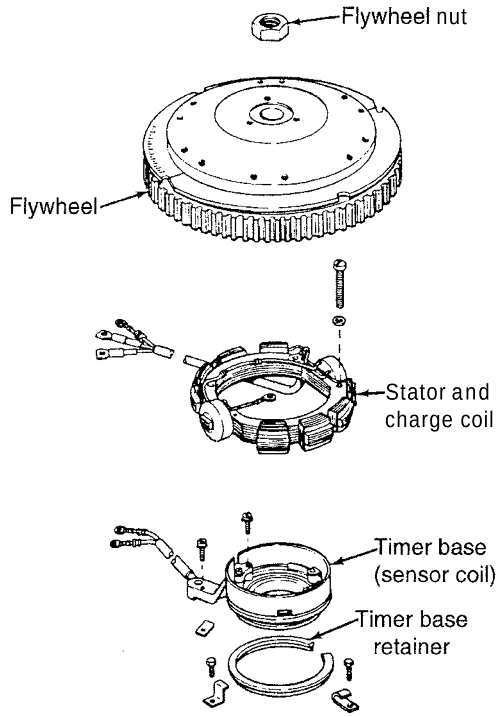


Fig. **16** Exploded view of a typical flywheel, stator, timer base (sensor or trigger coil) and retainer. Note that on **60°** motors a timing wheel is instead mounted ABOVE the flywheel

Troubleshooting

◆ See Figures **19, 20, 21** and **22**

Don't waste your time with haphazard testing. The only way to ensure success (and the only way to avoid the possibility of accidentally replacing a good part) is to perform ignition system testing in a logical and systematic manner.

An engine must have 3 things to run properly, Compression, Fuel and Spark. If compression is not an issue, then fuel system and ignition system checks are normally next.

☐ To check engine compression, please refer to the Compression Check procedure found under Tune-up, in the Maintenance and Tune-Up section.

Begin all electronic troubleshooting procedures by ensuring that wiring and connections are in good condition.

Before conducting any tests, double-check all wire colors and locations with the Wiring Diagrams provided in this section.

The quickest and most important check after the basic condition of the wiring harness has been verified is to perform a Spark Check, as detailed in this section to determine if further ignition system troubleshooting is warranted, or if problems are instead fuel or compression related.

Weak or no spark conditions found during the Spark Check will lead you to additional circuit or component testing procedures, depending on the results and the specific systems utilized on the motor being tested.

✳✳ CAUTION

During ignition system testing, ALWAYS follow the steps of our procedures and any tool manufacturer's instructions closely to avoid injury or possible damage to the engine's ignition system. Make sure that spark tests are only conducted with spark plugs installed in the engine to prevent the possible combustion of fuel vapors leaking out of the cylinders.

✳✳ WARNING

If, during testing, the engine is to be run at speeds over **2000** rpm, it must be mounted in a test tank using a suitable test wheel or placed in the water. Running the engine on a flushing device at speeds above **2000** rpm could allow the motor to run overspeed and possibly suffer severe mechanical damage.

② MODERATE

SPARK EVALUATION TEST

◆ See Figures **19, 20, 21, 22** and **23**

The first question normally asked when an engine does not run properly, or at all "Is there spark and fuel?" should be answered before in depth troubleshooting is conducted on any system. Since engine mechanical problems that might cause a lack of compression do not usually happen without warning or without an accompanying noise or other symptom, compression is usually taken for granted. If you are unsure of engine compression, refer to the Compression Test provided under Tune-up, in the Maintenance and Tune-Up section to ensure there is no mechanical problem before proceeding.

If there is no problem with engine compression, then this Spark Evaluation Test is the quickest way to determine whether or not the ignition system requires further attention. Depending on the results of this test, follow the instructions (or the accompanying charts) to determine your next course of action. In most cases, this test will lead to specific component tests that can be conducted to narrow system problems.

Because modern ignition systems are capable of extremely high voltages (30,000-50,000 and sometimes even higher voltage outputs) we must insist that you abandon the spark test you might have witnessed as a child. It is no longer advisable to simply remove a spark plug and hold it against the powerhead (even using an insulated tool) while the motor is cranked to see

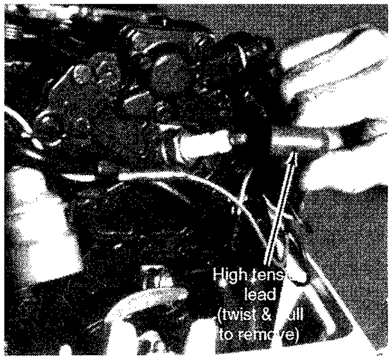


Fig. 19 Twist and disconnect the spark plug **lead(s)** from the spark **plug(s) ...**

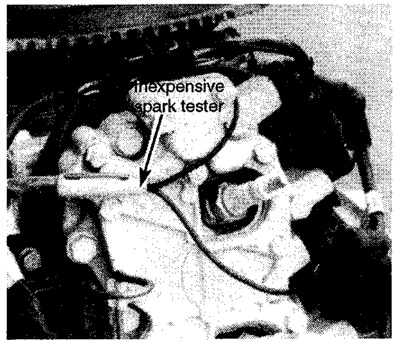


Fig. **20 ...** in order to connect a spark tester to the leads **...**

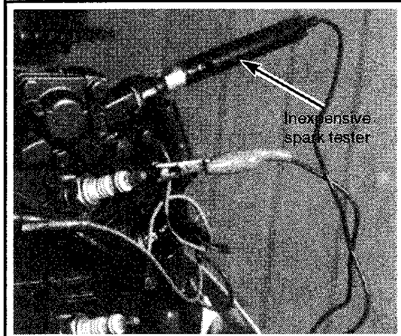


Fig. 21 **...** or to the coil, as directed by the tool manufacturer

if a spark jumps the gap. Besides being dangerous to the person holding the spark plug, this form of testing also jeopardizes the solid state components of the ignition system that can be destroyed by excessively high or infinite resistance in output circuits. Never operate the ignition system on these motors unless the spark plugs are properly attached or their leads are properly grounded to the powerhead.

With all that said, a spark gap tester is required for this test. There are many types of spark testers available from both marine and automotive parts outlets. The most basic (and least expensive) consists of what looks somewhat like a spark plug and a large alligator clip that is used to fasten the device to an engine ground or a jumper with an alligator clip for the same reason. Most spark testers will be equipped with some form of an adjustable gap (often a threaded, screw-type adjuster is built into the tester) so either the spark plug gap or a test gap for your motor can be used to simulate the proper electrical load on the system. The most convenient type of a tester for these multi-cylinder motors is a unit in a self-contained housing that allows the connection of all spark plug leaks at the same time. Of course, you also have the option of buying one small, inexpensive tester per cylinder too. If you only have one tester connection, remove and ground the spark plug leads for the other cvlinders, then move the tester from lead to lead for each test.

✳✳ CAUTION

The extremely high voltages generated by the secondary ignition circuit (for spark) can cause serious injury or even death from electric shock. Never touch bare wires or wire connections during testing or while the engine is running. Also, for additional safety, never perform tests while you or the powerhead is wet (sure a water supply or test tank must be used when cranking or running the motor, just keep it off you and the outside of the powerhead, and DO NOT stand in puddles). Finally, we know you're not reading the fuel system section right now, but spark and fuel don't mix, unless it's inside the combustion chamber, so NEVER perform tests on the ignition system if you can smell fuel vapors. Ventilate the area thoroughly before proceeding.

1. Except for jet drive models, remove the propeller for safety. Refer to the procedures found for Propeller under Engine Maintenance.
2. Tag and disconnect the spark plug wires to ensure proper connection after the test is finished. Be sure to note the wiring routing as well as the final connection point.

✳✳ CAUTION

Leave all spark plugs installed and tightened in the powerhead to ensure that no raw fuel or fuel vapors are expelled from the spark plug bores and ignited by the testing procedure. Spark plug leads not connected to a tester (if you are using a single connection tester) must be grounded to prevent damage to the ignition system (for safety, ground them as far away from the spark plug bores as possible).

3. Connect the spark tester alligator clip or ground lead to a good grounding point on the powerhead, such as a cylinder head bolt.
4. Connect the spark plug wire lead to the spark tester.

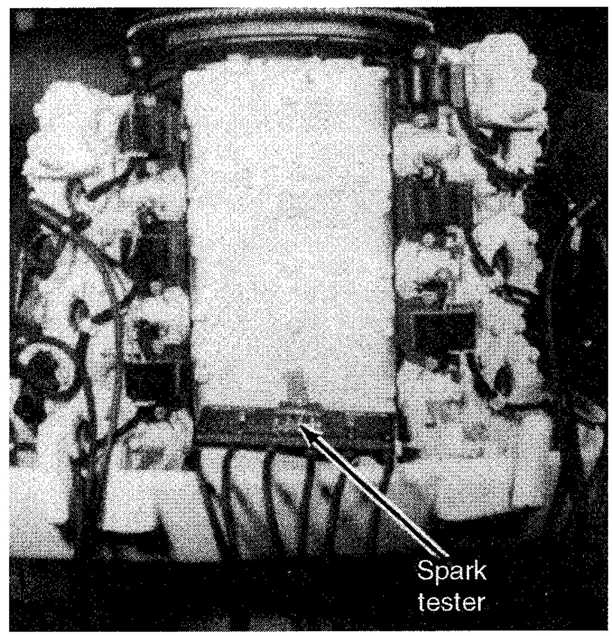


Fig. 22 A tester that will allow you to check all cylinders simultaneously is best these motors (V6 shown)

5. Set the spark tester gap to 7116 in. (11mm) for all looper outboards, the 80 Jet-175 hp (1726/2589cc) V4/V6 and the 120-300 hp (2000/3000/4000cc) V4/V6/V8 motors. When testing a cross-flow (CV) outboard, such as the 65 Jet-115 Hp (1632cc) V4 motors, set the tester gap to 1/2 in. (12mm).

■ To prevent the possibility of high voltage arcing, try to route tester wiring at least 2 in. **(51mm)** away from any metallic surface.

6. Make sure the shifter is in Neutral and the emergency stop clip (if equipped) is properly installed, then operate the starter and observe the spark tester. Display on testers will vary slightly, so refer to the instructions that came with the tester. On simple mechanical gap testers, watch make sure the ignition produces a strong blue spark from each of the spark leads (coils).
7. If using a single test connection, repeat the procedure for each of the remaining cylinders. Results must be good on all cylinders or further testing is required.

Various components of the ignition system should be checked, when interpreting the results of the Spark Evaluation Test. Refer to the accompanying chart to help determine what additional components or systems should be tested depending on the observed results of the Spark Evaluation Test.

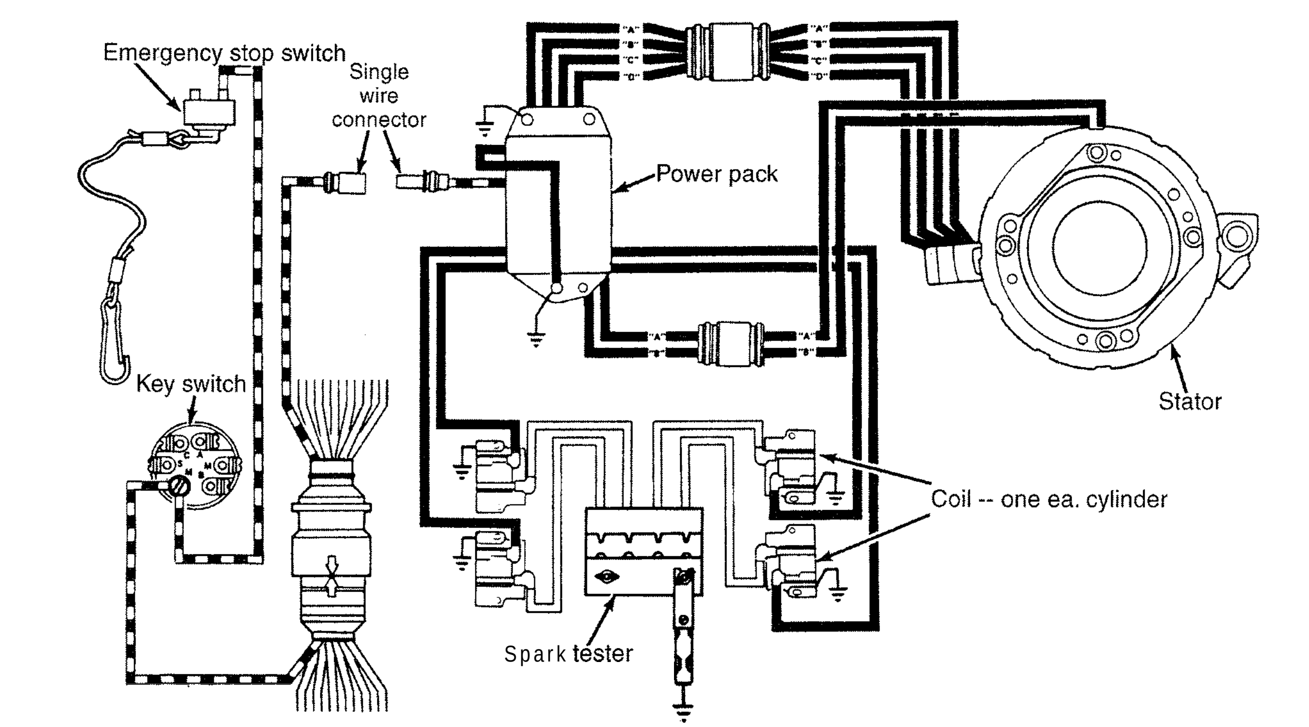


Fig. 23 Spark evaluation and stop circuit test functional diagram-V4 shown, but V6 and V8 similar, just using additional secondary ignition coil connections (also note, stop circuit connector varies on 60° models)

If the tester shows good results, but problems are still suspected, other systems should be checked to help decide whether or not the ignition system is actually at fault for a performance problem.

If the tester showed proper output on all cylinders, perform the Power Pack, Running Output Test to ensure that a problem does not appear under load that is absent under cranking.

If the tester showed no output on one bank of cylinders for V6 or V8 motors (specifically cylinders 1, 3 and 5 for V6 models or 5, 6, 7 and 8 for V8 models), perform the Shift Switch test.

If the tester showed proper output on at least one of the cylinders, but improper output on another, proceed as follows, depending on the model:

- On 65 Jet-115 hp (1632cc) 90° V4 motors, perform the Sensor Coil test.

On 80 Jet-175 hp (1726/2589cc) 60° V4/V6 motors, perform the Power Pack, Cranking Output test.

- On 120-300 hp (2000/3000/4000cc) 90° V4/V6/V8 motors, perform the Charge Coil test.

If the tester shows NO output on any cylinders, check the Stop Circuit.

■ It is possible for the ignition to show good output on the spark test and still have problems. If the engine spits, pops or backfires during startup, the ignition system may be out of time. Check the following:

- Coil primary wire routing
- Spark plug secondary wire routing
- Flywheel condition
- Flywheel TDC positioning (900 motors only)
- Tming wheel, key and optical sensor assembly (600 motors only)
- Synchronization and linkage adjustments

DIFFICULT

STOP CIRCUIT TEST

◆ See Figures 22.23 and 24

■ Refer to the schematics found in the Wiring Diagram section for more details on the stop circuit.

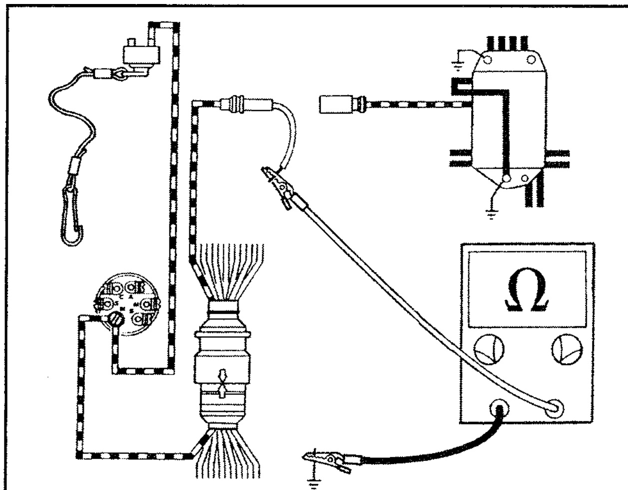
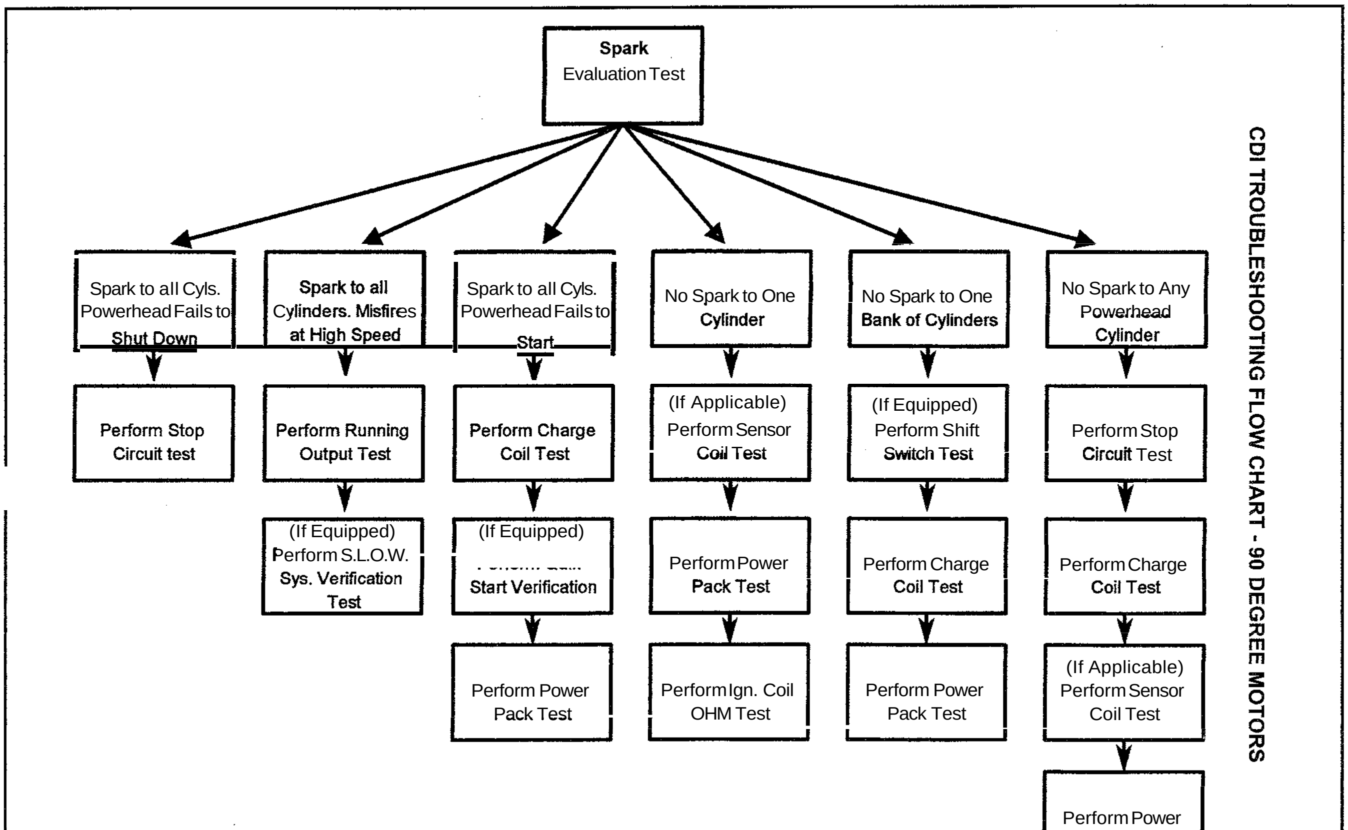


Fig. 24 Stop circuit testing using an ohmmeter-90° powerheads shown, 60° similar

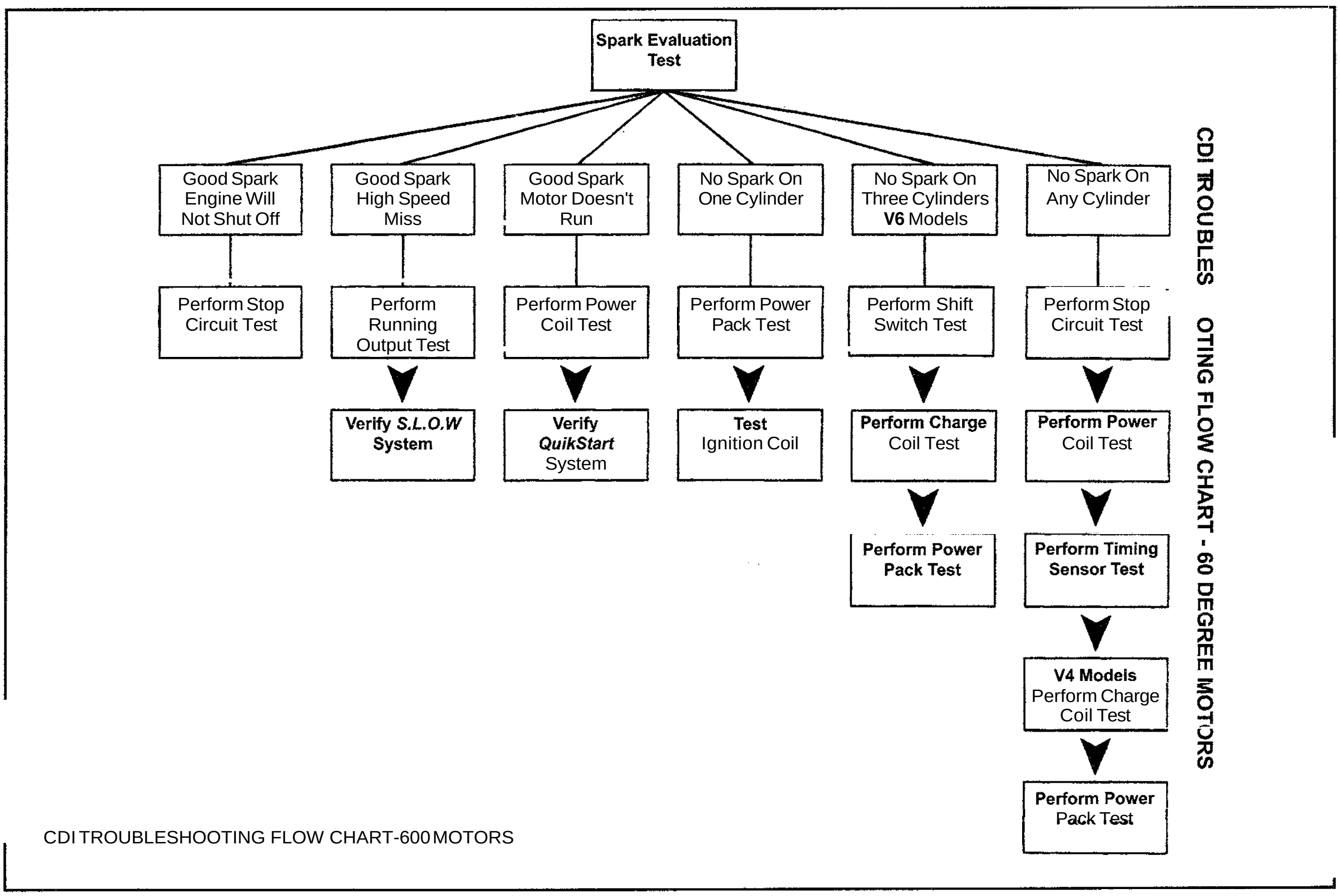
The Stoo Circuit Test is used to determine if an ignition fault is caused by the ignition'or stop switch side of the circuit, or if the problem comes from the stator (charge coil), power pack, and ignition coil side of the circuit. Problems with the stop circuit usually cause a no start fault, but intermittent faults may occur that cause the engine to cut out.

The Spark Evaluation Test is normally performed before checking the stop circuit in order to determine if spark is occurring at all. If there is spark at one or more cylinders of a multi-cylinder motor it is not likely that the stop circuit is the culprit. Of course, checking it is a relatively fast and easy way to eliminate any concern over it.

■ Leave the spark tester installed as detailed in the Spark Evaluation Test in this section.



CDI TROUBLESHOOTING FLOW CHART-90° MOTORS



CDI TROUBLESHOOTING FLOW CHART-60° MOTORS

1. On 185-300 hp (3000/4000cc) 90° V6/V8 motors (which are equipped with a shift switch), disconnect the 1-pin Amphenol style connector between the engine harness and the shift switch. Crank the motor and watch the spark tester. If spark now appears alternately at each gap, the problem is with the shift switch circuit, perform the Shift Switch test.

2. Disconnect the wiring between the power pack (ignition module) and the ignition keyswitch. For most models this is a 1-pin Amphenol style connector containing a blackiyellow lead. But, for 80 Jet-175 hp (1726/2589cc) 60°V4/V6 motors, it is the port side Packard style connector on the power pack containing the blackiyellow wire. It is usually (but not always) a multi-pin connector containing 4 or 5 wires). And, on 185-300 hp (3000/4000cc) 90° V6/V8 motors equipped with a shift switch, the stop circuit wiring is a 2-pin Amphenol style connector.

3. Crank the motor and watch the spark tester. If spark now appears alternately on all cylinders, but only with the blackiyellow lead disconnected, it appears the problem is with the stop circuit. Test the stop button and/or the keyswitch, as equipped. If there are still spark problems, proceed as follows, depending on the outboard:

- On V4 90° motors, if there is still no spark, perform the Power Coil test. If there is spark at some cylinders, perform the Sensor Coil test.
- On V6/V8 90° motors, if there is still no spark, perform the Charge Coil test.
- On 60° motors, if there no spark present on one cylinder, perform the Power Pack, Cranking Output test. If there is no spark present on one bank of cylinders, perform the Shift Switch test for V6 models, or the Charge Coil test for V4 models. If there is no spark present on any cylinder, perform the Power Coil test.

4. On tiller control models, check the stop button/safety lanyard switch with the engine not running or cranking as follows:

a. Connect the ohmmeter probes between the stop button side of the blackiyellow lead and a good engine ground.

b. With the safety lanyard clip installed and the switch in the run position, the meter must show high or infinite resistance.

c. Press the stop button and/or remove the safety lanyard while observing the meter reading, it should show low or zero resistance with the button held in the down position or the safety lanyard removed.

d. Replace the stop button if the circuit does not perform as noted.

5. For remote models, check the keyswitch with the engine not running or cranking, as follows:

a. Connect the ohmmeter probes between terminal (switch side) of the blackiyellow lead and a good engine ground.

b. If equipped, make sure the safety lanyard is installed.

c. The meter must show a low reading with the keyswitch OFF and a high or infinite reading with the keyswitch ON.

d. With the keyswitch ON, disconnect the blacklyellow lead from the keyswitch harness (terminal M). If the meter now shows a high reading, replace the keyswitch. If the meter now shows a low reading, proceed with the next step to test the wiring harness.

e. Disconnect the 6-pin connector for the keyswitch. If the meter NOW shows a high reading, repair or replace the keyswitch harness. If the meter still shows a low reading, proceed with the next step.

f. Disconnect the 6-pin connector from the instrument harness that contains the blackiyellow lead. If the meter NOW shows a high reading, repair or replace the instrument harness. If the meter still shows a low reading, repair or replace the engine harness.

■ If the engine fails to shut off during normal operation, check for an open **black/yellow** lead, open **black/white** lead, damaged keyswitch or damaged power pack. On **60° V6** models, if only the starboard cylinders fail to shut down, the problem could be with the shift interrupter diode.

6. Reconnect all wiring as removed for testing.

Shift Switch

Most carbureted V6 and V8 models are equipped with a shift switch that is capable of cutting spark to one or both banks of cylinders in order to ease load on the driveshaft while shifting. A malfunctioning switch can cause a no spark condition on one bank of cylinders.

The first check (the Elimination Test) isolates the shift switch from the ignition system to determine if the switch or charae coils are the cause of spark loss to one side of the powerhead. The second and third checks (the Switch Resistance Test along with the Diode & Connector Test) will determine if the shift switch, drop-out diode, or the harness wiring is defective.

Refer to the schematics found in the Wiring Diagram section for more details on the shift switch circuit.

ELIMINATION TEST

3 DIFFICULT

◆ See Figure **25**

Leave the spark tester installed as detailed in the Spark Evaluation Test in this section.

1. Disconnect the single pin connector for the blackiyellow wire connector between the powerhead harness and the shift switch.

2. Crank the powerhead with the cranking motor and observe the spark output at the spark tester.

If cylinders 1, 3, and 5, on V6 powerheads or cylinders 5, 6, 7, and 8, on V8 powerheads now have an adequate spark, perform the shift switch resistance test.

If no spark is still observed at the spark tester, perform the Charge Coil test

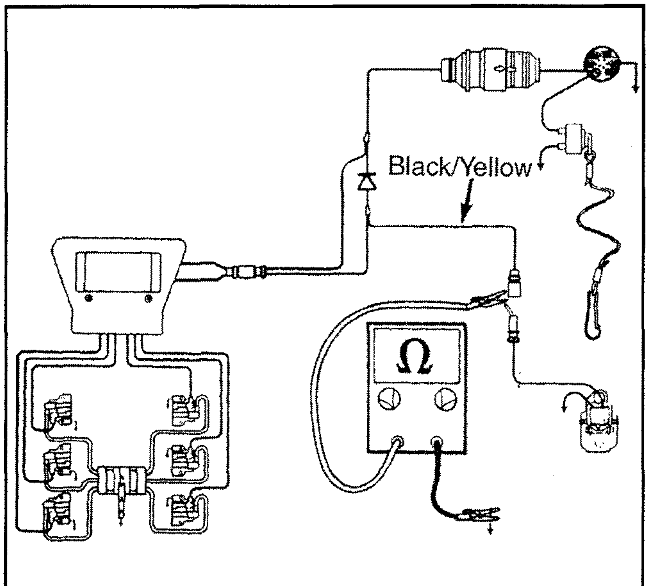


Fig. 25 Shift Switch hookup for testing on a **90° V6 powerhead-** naturally a **V8** powerhead has two additional coils

SWITCH RESISTANCE TEST

3 DIFFICULT

✳✳ WARNING

Ohmmeter tests must be conducted with the engine **NOT** running.

1. Obtain an ohmmeter and set the switches for a high and low ohm reading. Connect the Red meter lead to the shift switch connector terminal and the Black meter lead to a good powerhead ground.

If the meter indicates low ohms, the switch has malfunctioned in the closed position and must be replaced.

2. Press down on the shift cable pin to manually close the switch contacts.

If the meter indicates high ohms, the switch or harness is defective and must be replaced. If the meter indicates low ohms, perform the following diode and connector test.

DIFFICULT

DIODE & CONNECTOR TEST

✳✳ WARNING

Ohmmeter tests must be conducted with the engine NOT running.

900 V6/V8 Powerheads

◆ **See Figure 26**

1. Follow the wiring back from the shift switch. If not already done, first disconnect the 1-pin Amphenol style connector in the black/yellow wire. Next, disconnect the wiring between the power pack and the keyswitch (the multi-pin connector at the engine harness AND the 2-wire connector at the power pack.)

2. Connect the red meter lead to the black/yellow pin on the engine harness connector. Connect the black meter lead to the black/orange pin on the 2-pin harness connector (between the shift switch and power pack). Observe the meter reading. If the ohmmeter is equipped with a polarity button, press and hold the polarity button, note the meter reading. If the meter does not have a polarity button, reverse the meter lead connections and again observe the meter indication.

If the meter indicates a high reading in one direction and a low reading in the other, both the diode and wiring harness are okay.

If the meter reading is the same in both directions, the wiring harness and diode must be replaced

3. Connect the red meter lead to the blackiyellow pin on the engine harness connector. Connect the black meter lead to the black/yellow 2-pin connector for the power pack. Observe the reading on the ohmmeter.

If the meter indicates low ohms, continue with the test. If the meter indicates high ohms, replace the wiring harness.

4. Connect the red meter lead to the black/yellow pin on the engine harness connector. Connect the black meter lead to the 1-pin connector of the shift switch connector. Observe the reading on the ohmmeter.

If the meter indicates a high reading in one direction and a low reading in the other, both the diode and wirina harness are good.

If the'meter reading is the same in both directions, the wiring harness must be replaced.

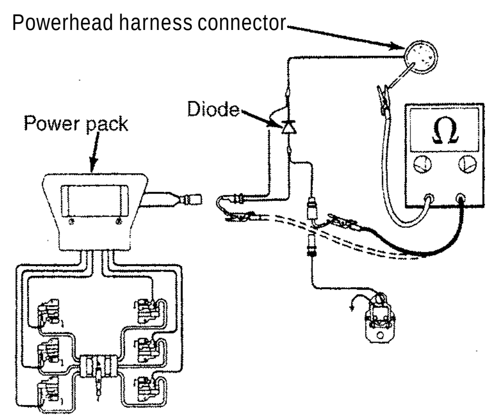


Fig. 26 Blocking diode test hookup on a 90° V6 or V8 powerhead

60° V6 Powerheads

◆ **See Figure 27**

1. Follow the wiring back from the shift switch. If not already done, first disconnect the 1-pin Amphenol style connector in the blackiyellow wire. Next, disconnect the wiring between the power pack and the keyswitch (the multi-pin connector in the engine harness.)

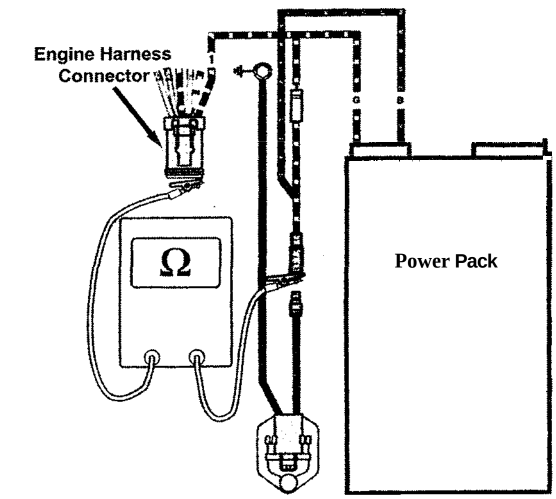


Fig. 27 Blocking diode test hookup on a 60° V6 powerhead

2. Connect the red meter lead to the black/yellow pin on the engine harness connector. Connect the black meter lead to the black/yellow pin on the 1-pin harness connector for the switch (with the black/yellow wirej. Observe the meter reading. If the ohmmeter is equipped with a polarity button, press and hold the polarity button, note the meter reading. If the meter does not have a polarity button, reverse the meter lead connections and again observe the meter indication.

If the meter indicates a high reading in one direction and a low reading in the other, both the diode and wiring harness are okay.

If the meter reading is the same in both directions, the wiring harness and diode must be replaced

Charge Coil

◆ **See Figures 13 and** 14

All carbureted Evinrude/Johnson motors are equipped with an ignition system charge coil that is used to generate voltage to power the ignition system. The coil windings are part of the stator assembly that is centered and mounted directly under the flywheel to interact with permanent magnets attached to the underside of the flywheel assembly. As the flywheel rotates, the magnetic force cuts through the coil assembly, generating an electric current that is utilized by the ignition system.

Although the coil windings can be tested separately on carbureted motors, damage to any charge, power or stator coil winding requires replacement of the entire stator assembly.

DIFFICULT

TESTING

◆ **See Figures 28 and 29**

Charge coil testing typically encompasses making sure the wiring is in good condition, then verifying coil output (using a peak-reading DVOM) while cranking the motor and/or checking resistance (using an ohmmeter) across the coil windings when the motor is not turning. The charge coil and wiring can also be checked for shorts to ground either using the peak-reading DVOM while the motor is cranking or the ohmmeter when the motor is at rest.

Problems with the ignition charge coil usually cause a no start condition. But, a partial short of the coil winding can cause hard starting and/or an ignition misfire. The most reliable tests for the charge coil are to dynamically check the output with the engine cranking (or in some cases, running). Of course, dynamic tests require a digital multi-meter capable of reading and displaying peak voltage values (also known as a peak-reading voltmeter). If one is not available, specifications are usually available to statically check

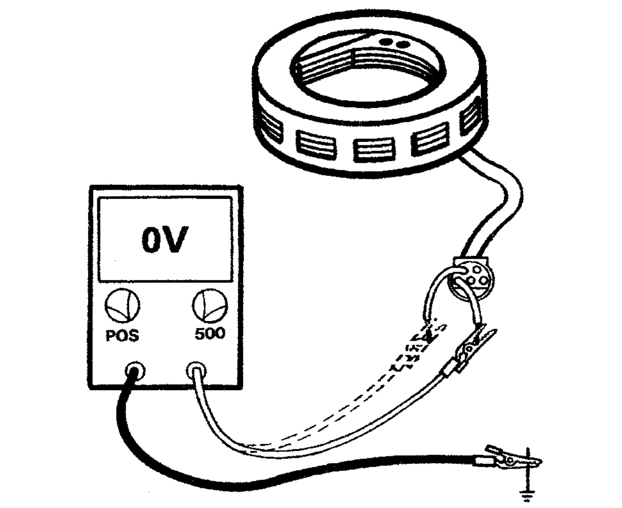


Fig. **28** Charge or power coil testing involves checking between the appropriate harness terminals and a **good** engine ground to make sure there are no shorts to **ground. This test can be** conducted with a voltmeter (engine cranking) **and/or** an ohmmeter (engine static)

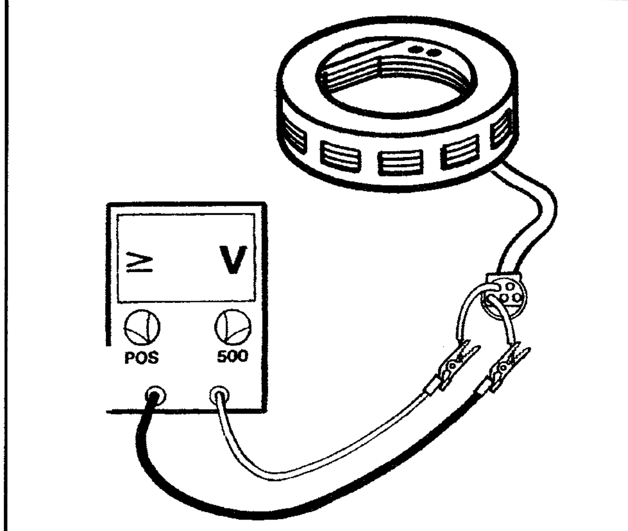


Fig. **29** Charge or power coil testing also involves checking voltage output while the motor is cranking **and/or** checking resistance across coil windings while the motor is at rest-cranking test on a typical stator shown

the coil winding using an ohmmeter. But, before replacing the coil based only on static test that shows borderline readings, remember that resistance readings will vary with temperature and the specifications provided here are based on a component temperature of about 68°F (20°C). Also, remember that a coil may test within specification statically, but show intermittent faults under engine operating conditions, especially at normal operating temperature.

■ The charge coil wiring varies slightly from motor-to-motor, but they are always brown or brown with a tracer color wires on **Evinrude/Johnson** motors. The tracer colors may be yellow, white or black. Refer to the schematics found in the Wiring Diagram section for more details on the charge coil circuit.

1. Set a peak-reading DVOM to read positive in the 500 volts scale, then check for a grounded charge coil as follows:

a. Disengage the charge coil wiring between the stator and the power pack. On all motors, this harness contains brown and, brown w/ a tracer color, wires from the stator's charge coil windings. But, the connector(s) and location(s) vary slightly by model:

- On 65 Jet-115 hp (1632cc) 900 V4 motors, disengage the single 2-pin connector located in the harness between the stator and power pack.
- On 80 Jet-175 hp (1726/2589cc) 60° V4/V6 motors, disengage the multi-pin (usually 4- or 6-pin) connector from the power pack itself.
- On 120-300 hp (2000/3000/4000cc) 90° V4/V6/V8 motors, disengage the 2-pin connector(s) located inline between the stator and the power pack. The V4 motors contain one connector, while the V6 and V8 motors utilize a separate connector for each group of cylinders. For these motors the forward connector is for cylinder Nos. 1, 3 and 5 (V6) or 5, 6, 7 and 8 (V8), while the rear connector is for cylinder Nos. 2, 4 and 6 (V6) or 1, 2, 3 and 4 (V8).

b. Connect the black meter probe to a good engine ground and the red probe either to one of the brown charge coil leads (on the stator side of the harness). Crank the engine and observe, then note the reading.

c. Move the red meter probe to the other brown (or brown with tracer) charge coil lead, then crank the engine and observe the meter again.

■ If you don't have access to a peak reading DVOM, you can perform a static test, checking each of these brown leads to ground using an ohmmeter. Any continuity indicates a short to ground. BUT, keep in mind, high resistance doesn't mean that an intermittent short to ground cannot occur at operating temperatures or under load. This is why a cranking test is a better indication of charge coil condition.

d. Any voltage reading from either test connection indicates a short in the charge coil or harness. Either, locate and repair the problem with the harness, or replace the charae coil. For 90° V6 and V8 models, repeat the test at the other 2-pin connector.

2. Check the charge coil cranking output using the peak-reading voltmeter, set to the same scale. Connect the meter probes to the two brown leads from the charge coil and crank the engine. Note the meter reading and compare it to the specifications provided in the Ignition Testing Specifications-Carbureted Motors, chart in this section. For 900 V6 and V8 models, repeat the test at the other 2-pin connector.

- If the cranking voltage is within spec, but ignition problems still exist, perform the Sensor Coil test on 90° motors or the Power Pack, Cranking Output test, on 600 motors.
- If the cranking voltage is below the specification, check the wiring/connectors, then, if the wiring appears to be in good shape, check coil resistance.

3. With the engine not running or cranking, connect the probes from a DVOM set to read resistance across the two brown (or brown w/ tracer) leads from the charge coil. Note the meter reading and compare it to the specifications provided in the Ignition Testing Specifications-Carbureted Motors, chart in this section. Remember that these specifications are for a temperature of about 68°F (20°C).

4. Verify test results and connections, then replace the charge coil, if any reading is well out of specification.

5. Reconnect all wiring as removed for testing.

OEM ② MODERATE

REMOVAL & INSTALLATION

◆ See Figures **16, 30, 31** and 32

The charge coil windings are integrated into the l-piece stator assembly mounted directly under the flywheel. Once the flywheel is removed for access; removal and installation is a relatively simple matter of tagging and disconnecting the wiring and unbolting the stator itself.

✻✻ WARNING

Refer to Flywheel in the Powerhead section for details on removal and installation. Do not risk damage to the flywheel itself by using an improper holding tool **(i.e.** a **prybar** on one of the ring gear teeth) or using an improper puller (a jawed instead of a threaded puller, for instance). Handle the flywheel with care, never strike or jar the flywheel for fear of breakinglcracking the housing or damaging the permanent magnets used by the stator to generate current.

Prior to removal, make a quick sketch or take a photograph (aren't digital cameras great?) of the wire harness routing. During installation, be sure to position all wires as noted before removal so as to prevent possible interference with moving parts. Remember that contact with a component such as the flywheel could break wear through the insulation or the wires themselves. An exposed portion of wire could short damaging the coil windings or other components in the system.

1. Disconnect the negative battery cable for safety.
2. Remove the Flywheel, as detailed in the Powerhead section.
3. On 60° motors, remove the regulator cover for access.

On most models you will have to cut one or more wire ties securing the harness in **position. Take** close note of the wire tie locations for installation purposes. Also, for some models, like ***600*** powerheads, you'll have to carefully remove the harness grommet to free the harness from the cylinder block.

4. Tag and disengage the stator wiring.
- On 60° motors, disengage the multi-pin connector at the power pack and the 2-pin connector for the voltage regulator or, for rope start models, the leads from the terminal board.
- On 90° motors, disengage the inline engine harness connectors (there may be 2,3 or 4 connectors depending on the model) and the brown and/or yellow stator leads at the terminal board. Keep in mind that the sensor coil wiring is also coming out of this general area, but it is NOT necessary to disconnect it, unless the sensor coil is also being serviced. Generally speaking the stator (power and/or charge coil wiring is orange, yellow and brown with various tracer colors).

☐ We said to TAG and disconnect the wiring and we meant it. It is one thing if you only have 2 wiring connectors of different sizes and shapes (as on some **60°** powerheads), but if you've got multiple connectors of the same size as **and/or** ring terminals attached to a terminal board, proper installation is CRITICAL to powerhead operation. Don't take any chances, take a photo, write and note and tag them before removal.

5. Loosen the screws retaining the stator coil to the powerhead, then remove the stator assembly.

To install:

6. Carefully inspect the stator mounting surface and retaining screw holes for signs of corrosion or varnish. For proper operation, the stator MUST have a clean, metal-to-metal contact with the powerhead and retaining screws.
7. Place the stator coil in position on the powerhead, and position the wiring harnesses as noted during removal. MAKE SURE that each wire is positioned so to ensure it will not contact moving components. If used, reseat any grommets in the powerhead.
8. Throughly clean the stator retaining screw threads. Be sure to remove all traces of corrosion or sealant. Apply a light coating of EvinrudelJohnson Locquic Primer or equivalent to the screw threads and allow it to dry then apply a light coating of EvinrudelJohnson Nut Lock, or equivalent threadlock.
9. Install the stator retaining screws and tighten to 120-144 inch lbs. (14-16 Nm).
10. Reconnect the stator wiring as tagged and noted during removal. If any wires are attached to a terminal strip, coat the ends lightly using EvinrudelJohnson Neoprene Dip or equivalent sealant to protect them from moisture and keep them from loosening. Secure the harnesses using new wire ties in the original tie locations, again, as noted during removal.

☐ Double check the positioning of all wires that were disturbed during service. Make sure the wires are routed properly and, any wire ties that were removed, are replaced with new ties.

11. On 60° motors, install the regulator cover.
12. Install the Flywheel, as detailed under Powerhead.
13. Connect the negative battery cable.

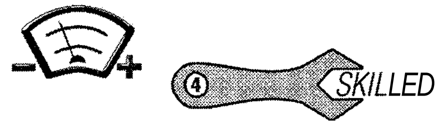
Power Coil

Some carbureted EvinrudelJohnson motors are equipped with an ignition system power coil that is used to generate voltage for various ignition system functions. On most motors equipped with a power coil, the voltage generated from the coil windings is provided to the power pack (ignition module) in order to operate ignition system functions such as the Speed Limiting Operator Warning (S.L.O.W.) and/or QuikStart systems.

Like the charge coil, the power coil windings are part of the stator assembly that is centered and mounted directly under the flywheel to interact with permanent magnets attached to the underside of the flywheel assembly. As the flywheel rotates, the magnetic force cuts through the coil assembly, generating an electric current that is utilized by the ignition system.

Although the factory technical information for the 900 loopers mentions the use of a power coil (and the orange leads in the wiring diagrams for these models would tend to agree) no separate specifications or test procedures are provided. Testing procedures and specifications are however provided for the carbureted 600 motors. If you are working on an 80 Jet-175 hp (1726/2589cc) V4/V6 motors, the following procedure can be used to check the power coil windings.

Keep in mind that although the coil windings can be tested separately on some motors, damage to any charge, power or stator coil winding requires replacement of the entire stator assembly.



TESTING

◆ **See** Figures 28 and **29**

Power coil testing typically encompasses making sure the wiring is in good condition, then verifying coil output and/or checkinq resistance across the coil windings.

Problems with the ignition power coil can result in a no-spark condition, but can also account for hard starting and/or an ignition misfire.
The most reliable tests for the power coil are to dynamically check the output with the engine cranking (or in some cases, running). Of course, dynamic tests require a digital multi-meter capable of reading and displaying

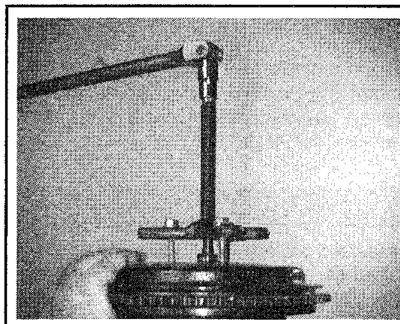


Fig. 30 In some cases a puller is necessary to help free the flywheel

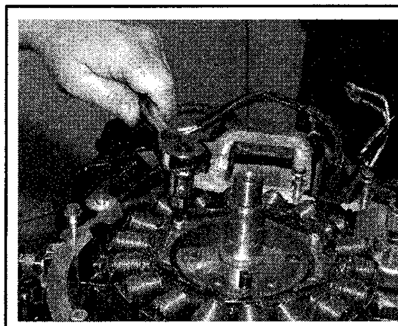


Fig. 31 Remove the stator retaining bolts...

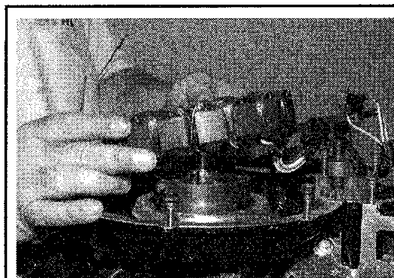


Fig. 32 ... then lift the stator assembly from the mounting plate

peak voltage values (also known as a peak-reading voltmeter). If one is not available, specifications are usually available to statically check the coil winding using an ohmmeter. But, before replacing the coil based only on static test that shows borderline readings, remember that resistance readings will vary with temperature and the specifications provided here are based on a component temperature of about 68ºF (20ºC). Also, remember that a coil may test within specification statically, but show intermittent faults under engine operating conditions, especially at normal operating temperature.

☐ Refer to the schematics found in the Wiring Diagram section for more details on the power coil circuit.

1. Set a peak-reading DVOM to read positive in the 500 volts scale, then check for a grounded power coil as follows:
   a. Disengage the power coil wiring between the stator and the power pack. On these motors, this means removing the multi-pin (usually 4- or 6-pin) connector from the power pack itself.
   b. Connect the black meter probe to a good engine ground and the red probe either to one of the orange or orange/black power coil leads (on the stator side of the harness). Crank the engine and observe, then note the reading.
   c. Move the red meter probe to the other orange (or orange with tracer) power coil lead, then crank the engine and observe the meter again.

If you don't have access to a peak reading DVOM, you can perform a static test, checking each of these brown leads to ground using an ohmmeter. Any continuity indicates a short to ground. BUT, keep in mind, high resistance doesn't mean that an intermittent short to ground cannot occur at operating temperatures or under **load. This** is why a cranking test is a better indication of charge coil condition.

   d. Any voltage reading from either test connection indicates a short in the power coil or harness. Either, locate and repair the problem with the harness, or replace the power coil.
2. Check the power coil cranking output using the peak-reading voltmeter, set to the same scale. Connect the meter probes to the two orange leads from the power coil and crank the engine. Note the meter reading and compare it to the specifications provided in the Ignition Testing Specifications-Carbureted Motors, chart in this section.
   - If the cranking voltage is within spec, but ignition problems still exist, either perform the Sensor Coil test (if there is no spark on any cylinder) or check the QuikStart system (if there is good spark but the motor still doesn't run).
   - If the cranking voltage is below the specification, check the wiring/connectors, then, if the wiring appears to be in good shape, check coil resistance.
3. With the engine not running or cranking, connect the probes from a DVOM set to read resistance across the two orange (or orange w/ tracer) leads from the power coil. Note the meter reading and compare it to the specifications provided in the Ignition Testing Specifications-Carbureted Motors, chart in this section. Remember that these specifications are for a temperature of about 68ºF (20ºC).
4. Verify test results and connections, then replace the power coil, if any reading is well out of specification.
5. Reconnect all wiring as removed for testing.

REMOVAL & INSTALLATION

◆ See Figures **16, 30, 31** and 32

When equipped, the power coil windings are part of the l-piece stator coil assembly. For removal and installation procedures, please refer to Charge Coil, in this section.

Sensor/Trigger Coil

◆ See Figure 33

All modern Evinrude/Johnson engines are equipped with some form of a sensor or trigger coil. Various forms of the sensor exist, and not all can be accurately described as a coil (such as the optical sensors used on 80 Jet-175 Hp [1726/2589cc] 60º V4/V6 motors). But on most carbureted motors some form of sensor is used to generate a voltage based on the rotating

Fig. 33 The sensor coil used on all 900 powerheads is also referred to as the sensor base assembly, as it is mounted under the flywheel and stator

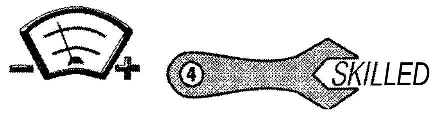
magnets in the flywheel. This signal is used by the power pack to fire the ignition coils at the appropriate times. The nickname Trigger Coil comes from this function.

The sensor coil is therefore normally mounted near the flywheel. On all motors, except the 80 Jet-175 Hp (1726/2589cc) V4/V6 outboards, the sensor coil is mounted under the dead center of the flywheel. On these motors, the sensor coil is referred to as a timer base, because it is mounted under other ignition system components, like the stator. However, the optical sensor used on 60º outboards is mounted, along with the timing wheel, ABOVE the flywheel.

The manufacturer provides only limited information for testing the optical sensors used on 600 motors, and even that is limited unless you use the manufacturer's Ignition **Analyzer** tool. They also warn that because of the way in which **optical** sensor's function., you must make sure the sensors **are** kept **clean** and free of dirt or **debris** to ensure proper function.

Signals from the sensor coil are generated at certain points in flywheel revolution, thus alerting the power pack to exact engine (crankshafffpiston) positioning. In turn, the power pack uses the signal to determine proper spark timing. In this manner, a spark at the plug may be accurately timed by the timing marks on the flywheel relative to the magnets in the flywheel and to provide as many as 100 sparks per second for a powerhead operating at 6000 rpm.

TESTING



Most carbureted motors, except the 80 Jet-175 Hp (1726/2589cc) 600 V4/V6 outboards, are equipped with a sensor coil that operates in the same manner as a charge, power or battery charge coil. Therefore, except on 60º motors, the sensor coil generates a voltage using the electromagnetic force created by magnets attached to the flywheel. On these motors, testing is therefore conducted in the same manner as the charge, power or battery charge coils. A voltmeter is used to perform dynamic checks (watching for voltage while cranking the motor checking for shorts to ground and/or for proper output), while an ohmmeter is used for static checks (testing the windings for proper resistance and checking for shorts to ground).

☐ The only testing information provided by the manufacturer for the optical sensors used on **60º** motors is the use of the manufacturer's Ignition Analyzer tool. However, because of the manner in which optical sensors function, remember that they must be kept clean and free of dirt or debris to ensure proper function. Many sensor malfunctions can be traced to a dirty sensor lens.

■ Refer to the schematics found in the Wiring Diagram section for more details on the sensor coil circuit.

65 Jet-115 hp (1632cc) 90° V4

◆ **See Figure 34**

This is a 3-part test to determine the condition and serviceability of the sensor coil. The first-a ground test, checks the sensor coil and wiring for a short to ground. The second part-an output test, checks the sensor coil voltage while cranking the powerhead. The third part-a resistance check, will determine if the coil or windings have an internal open or short to ground.

☐ **A peak-reading DVOM like the Stevens CD-77 is necessary for this test.**

1. Set the peak reading voltmeter to provide positive sensor readings on the 5 volts scale (on the Stevens meter that is accomplished by setting POS and 5, or SEN and 5).
2. Disengage the 5-pin Amphenol connector located between the power pack (ignition module) and the sensor coil mounted under the flywheel.
3. Check for a grounded sensor coil by connecting the meter red lead alternately to each of the sensor terminals and the black meter lead to ground, then cranking the engine and observing the reading. Any voltage reading indicates that the sensor coil or wiring harness is shorted to ground. Either repair the harness or replace the sensor coil assembly.
4. Next, check the sensor coil output. Attach the black meter probe to the sensor lead for terminal **E** (white wire) and the red meter probe to one of the remaining terminals **A, B, C,** or **D** (colored wires). Crank the engine and note the meter reading, then move the red meter probe to the next colored wire terminal and repeat until all combinations with terminal **E** and each of the colored wire terminals have been checked:
   - If the meter reads 0.3 volts or higher, sensor output it probably good. If further ignition troubleshooting is necessary, test the Power Pack output while cranking, as detailed in this section.
   - If the meter shows less than 0.3 volts, first check the wiring and connectors. If the wiring and connectors appear in good condition, proceed with the ohmmeter test in the next step.
5. With the engine not running or cranking, check the sensor coil windings using an ohmmeter. Attach the black meter probe to the sensor lead for terminal **E** (white wire) and the red meter probe to one of the remaining terminals **A, B, C,** or **D** (colored wires). Note the meter reading, then move the red meter probe to the next colored wire terminal and repeat until all combinations with terminal **E** and each of the colored wire terminals have been checked. Resistance across each combination must be 30-50 ohms. Remember the specifications are for a component at a temperature of about 68°F (20°C).

☐ **The sensor coil can also be checked for a possible short to ground by probing between a good engine ground and each of the sensor coil leads. If the meter shows continuity between any lead and ground, the wiring or the sensor coil itself is grounded. Repair the harness or replace the sensor coil, as necessary.**

6. Verify test results and connections, then replace the sensor coil, if the reading is well out of specification.
7. Reconnect all wiring as removed for testing.

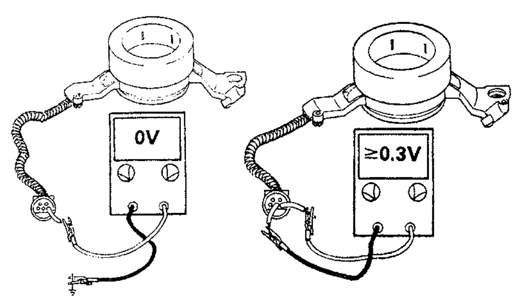


Fig. 34 Sensor coil ground test (left) and output test (right) hookup on a the 90° CV motors (65 jet-115 hp V4)

80 Jet-175 hp (1726/2589cc) 60° V4/V6

The optical sensor used on 60° outboards is mounted to the top, center of the flywheel cover assembly and used, in conjunction with the timing wheel to determine crankshaft positioning. Because the sensor functions by creating an optical signal, it can be thrown off by sources of intense light, causing ignition misfiring. If possible, avoid running the motor with the engine in bright sunlight if the timing wheel cover is removed, And, during service or operation, never point a timing light directly at the sensor.

☐ **The manufacturer provides no information for sensor testing, OTHER than to use the Evinrude/Johnson Ignition Analyzer.**

1. Remove the regulatorlrectifier cover for access.
2. Disengage the timing sensor electrical connector, then attach the Evinrude/Johnson Ignition Analyzer to the sensor and to a 12-volt power source (such as a properly charged marine battery).
3. Set the analyzer switch to position **B** for V4 motors or **A** for V6 motors, then press the analyzer **reset** button.
4. Crank the engine for a minimum of 3 complete revolutions using the starter and while observing the meter. If the **GOOD** indicator flashes while cranking, the problem is NOT with the timing sensor. Proceed with Charge Coil testing, or the next appropriate step of the Ignition Troubleshootingchart for 600 outboards. If the **BAD** indicator flashes, or the **GOOD** and **BAD** indicator lights flash alternately, first double-check the condition of the timing wheel and if no dirt or damage is found, replace the timing sensor.
5. Remove the analyzer tool and reconnect the wiring once the test and repairs are complete.

120-140 hp (2000cc) 90° V4

◆ **See Figure 35**

This is a 3-part test to determine the condition and serviceability of the sensor coils. The ground test checks the sensor coils and wiring for a short to ground. The output test checks the sensor coil voltage while cranking the powerhead. The resistance check will determine if the coils or windings have an internal open or short to ground.

On all models, except the 125RW, there are 2 sets of sensor coil windings, the normal and advance coils. They are testing in the same manner, except that the resistance specifications vary. The 5-pin connector, found on the port side, is for the normal coil while the 4-pin connector on the starboard side is for the advance coil.

☐ **A peak-reading DVOM like the Stevens CD-77 is necessary for this test.**

1. Set the peak reading voltmeter to provide positive sensor readings on the 5 volts scale (on the Stevens meter that is accomplished by setting POS and 5, or SEN and 5).

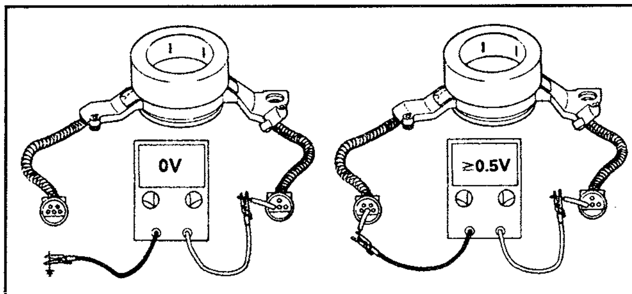


Fig. 35 Sensor coil ground test (left) and output test (right) hookup on V4 120-140 hp powerheads (note specifications and wiring are for all models except the 125WR which uses a single connector)

These models are equipped with 2 separate connectors between the power pack and the sensor coil mounted under the flywheel. One is a **4-pin,** while the other is a 5-pin connector. Other connectors coming out from underneath the flywheel are for the **stator. The** connectors with orange and brown wires are for the powerlcharge coil windings in the stator, while the connectors with the blue, purple and green wires are for the sensorltrigger coil windings.

2. Disengage the 4- and 5-pin Amphenol connectors for the sensorltrigger coil assembly.

☐ The sensor coil used on **125RW** models only contains the 5-pin connector.

3. Check for a grounded sensor coil or wire at each terminal of the sensor connectors by attaching the meter red probe to the terminal and black probe to ground, then cranking the motor while watching the meter. Repeat this for each of the terminals of both connectors. Any voltage reading from one of the connections indicates that the sensor coil or wiring harness is shorted to ground. Either repair the harness or replace the sensor coil assembly.

4. Check the sensor coil output as follows:

a. Attach the black meter probe to the sensor lead for terminal E (white wire) of the 5-pin connector and the red meter probe to terminal to one of the other wires on the 5-pin connector, then crank the engine and note the meter reading. Repeat this step for each of the 4 terminals on the 5-pin connector and then for the 4 terminals on the 4-pin connector.

- If the meter reads 0.5 volts or higher for all models except the 125RW which must be 0.3 volts or greater, but ignition system trouble is still suspected, perform the cranking output test for the Power Pack, as detailed in this section.
- If the meter shows less than 0.5 volts (or 0.3 volts on the 125RW), first check the wiring and connectors, and then perform the resistance checks in the next step. If the wiring and connectors appear in good condition, but the coil continues to test out of specification, replace the sensor coil.

5. With the engine not running or cranking, connect the DVOM black lead to terminal E (white wire). Then connect the red meter probe alternately to each of the remaining terminals in the port, 5-pin connector, noting the resistance readings across terminal E and each of the other terminals. This will give you the resistance for the normal coil windings. Resistance across each combination must be 35-55 ohms. Remember the specifications are for a component at a temperature of about 68°F (20°C).

6. Except for 125RW models (since they do not use the advance coil), probe each of the terminals for the 4-pin connector to check the advance coil windings in the same manner as the previous step when checking the normal coil windings. Note the resistance reading across terminal E of the 5-pin connector and each of the 4-pin connector terminals, it should be 100-160 ohms at a temperature of about 68°F (20°C).

7. If the resistance readings are out of specification either repair or replace the damaged harness or replace the sensor coil assembly, as applicable.

8. The sensor coil can also be checked for a possible short to ground by probing between a good engine ground and each of the sensor coil leads. If the meter shows continuity between any lead and ground the wiring or the sensor coil itself is grounded. Repair the harness or replace the sensor coil, as necessary.

9. Verify test results and connections, then replace the sensor coil, if any reading is well out of specification.

10. Reconnect all wiring as removed for testing.

185-300 hp (3000/4000cc) 90° V6/V8

◆ See Figures 36 and **37**

This is a 3-part test to determine the condition and serviceability of the sensor coils. The V6 powerhead is equipped with two four-pin connectors on the timer base where the V8 unit is equipped with two five-pin connectors. This is a combined test for the V6 and V8 sensor coil. Where differences exist between the V6 and V8 powerheads-appropriate notations are made in the text.

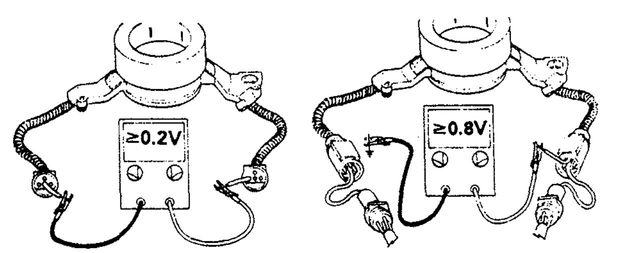


Fig. **36** Sensor coil output test hookup-normal coil testing (left)-involves connecting the white wire sequentially to each of the colored wires in both connectors. Advance coil testing (right) involves reconnecting the white and blacklwhite wires with jumpers, then checking between each colored wire and ground

The first part-the ground test-checks the sensor coils and wiring for a short to ground. The next part-an output test, checks the sensor coil voltage while cranking the powerhead. The third portion-the resistance check, will determine if the coils or windings have an internal open or short to ground.

On all models, there are 2 sets of sensor coil windings, the normal and advance coils. They are testing in the same manner, except that the resistance specifications varv. The connector, found on the port side, is for the normal coil while the connector on the starboard side is for the advance coil. The two connectors can also be identified by the final terminal **(D** on the 4-pin connectors or E on the 5-pin connectors) wire colors. The final terminal contains a white lead on the port connector and a blacklwhite wire on the starboard or connector.

■ A peak-reading **DVOM** like the Stevens **CD-77** is necessary for this test.

1. Set the peak reading voltmeter to provide positive sensor readings on the 5 volts scale (on the Stevens meter that is accomplished by setting POS and 5, or SEN and 5).

■ These models are equipped with 2 separate connectors between the power pack and the sensor coil mounted under the flywheel. Other connectors coming out from underneath the flywheel are for the stator. The connectors with orange and brown wires are for the powerlcharge coil windings in the stator, while the connectors with the blue, purple and green wires are for the sensorltrigger coil windings.

2. Disengage the two 4-pin (V6) or two 5-pin (V8) Amphenol connectors for the sensor/trigger coil assembly.

3. Check for a grounded sensor coil or wire at each terminal of the sensor connectors by attaching the meter red probe to the terminal and black probe to ground, then cranking the motor while watching the meter. Repeat this for each of the terminals of both connectors. Any voltage reading from one of the connections indicates that the sensor coil or wiring harness is shorted to ground. Either repair the harness or replace the sensor coil assembly.

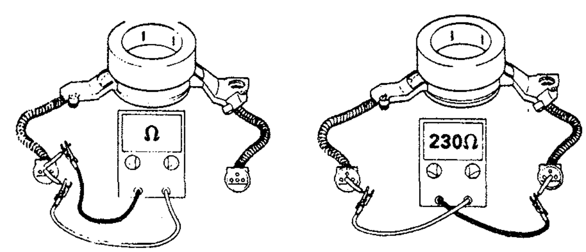


Fig. **37** Sensor coil resistance testing-involves checking each terminal to the white wire in the port side connector (left)-then checking the white wire (port side) to the blacklwhite wire in the starboard connector

4. Check the sensor coil output as follows:

a. Attach the black meter probe to the sensor lead for the white wire terminal **D** (V6) or **E** V8 of the normal coil winding (port) connector. Connect the red meter probe to one of the other wires on the same connector, then crank the engine and note the meter reading. Repeat this step for each of the remaining terminals on the port connector. Next, leave the black meter probe on the white wire of the port connector and move the red meter probe to each of the colored wires on the starboard connector. Again, crank the engine and note the meter readings across each terminal.

- If the meter reads 0.2 volts or higher, the normal coil winding is checking within specification, proceed to Step B in order to check the advance coil winding.
- If the meter shows less than 0.2 volts, first check the wiring and connectors, then check the normal coil winding resistance as detailed later in this procedure. If the wiring and connectors appear in good condition, but any coil winding continues to test out of specification, replace the sensor coil.

b. Use 2 jumper wires to attach the white and whitelblack leads of the disengaged sensor coil connectors (wire terminals D (V6) or E V8 of both the port and starboard coil windings). Then attach the black meter probe to a good engine ground and the red meter probe to one of the colored wires on starboard connector. Crank the engine and note the meter reading, then repeat for each of the remaining colored wire terminals on both the starboard and port connectors.

- If the meter reads 1.2 volts or higher for 1992-94 models or 0.8 volts or higher for 1995 and later models, the advance coil winding is checking in specification. Perform the cranking output test for the Power Pack, as detailed in this section if ignition system problems are still suspected.
- If the meter shows less than 1.2 volts for 1992-94 models or 0.8 volts for 1995 and later models, check the wiring and connectors and perform the resistance check in the next step. If the wiring and connectors appear in good condition, replace the sensor coil assembly.

5. With the engine not running or cranking, connect the DVOM red lead to the final terminal (white wire) on the port connector. Then connect the black meter probe alternately to each of the remaining terminals in the port connector, noting the resistance readings across terminal **D** (V6), or **E** (V8) and each of the other terminals. Keep the red lead on the white wire in the port connector, but next move the black lead to each of the colored wire terminals on the starboard connector. Resistance readings will vary slightly depending on the meter used, but in all cases a high-quality DVOM is necessary. Some examples of readings on different meters include:

- Stevens AT-101: 330-390 ohms.
- Merc-O-Tronic M-700: 870-1070 ohms.
- Fluke 29 Series II: no specification provided for models through 1994 or 875-1075 ohms for 1995 and later models. Of course, since the other test specifications are the same for early models, there is no reason to believe that this spec shouldn't apply to earlier models as well. In all cases, if using a Fluke 29 Series II, make sure the meter is set to the low resistance (40 ohms) scale.

ll r h sistance specifications are for a component at a temperature of about 68°F (20°C).

6. Connect the meter red probe to the final terminal **(D** for V6 motors or E for V8 motors) white wire for the port connector and the black lead to the black/white wire of the same terminal on the starboard connector. Resistance across the final terminals should be 200-260 ohms for V6 outboards or 140-180 ohms for V8 outboards. In both cases, specifications are for a temperature of about 68°F (20°C).

7. If the resistance readings are out of specification either repair or replace the damaged harness or replace the sensor coil assembly, as applicable.

8. The sensor coil windings can also be checked for a possible short to ground by probing between a good engine ground and each of the sensor coil leads. If the meter shows continuity between any lead and ground the wiring or the sensor coil itself is grounded. Repair the harness or replace the sensor coil, as necessary.

9. Verify test results and connections, then replace the sensor coil, if any reading is well out of specification.

10. Reconnect all wiring as removed for testing.

REMOVAL & INSTALLATION

② MODERATE

The sensor coil mounted near the flywheel. On all motors, except the 80 Jet-175 Hp (1726/2589cc) V4/V6 outboards, the sensor coil is mounted under the dead center of the flywheel. On these, 900 outboards, the sensor coil is referred to as a timer base, because it is mounted under other ignition system components, like the stator. However, the optical sensor used on 60° outboards is mounted, along with the timing wheel, ABOVE the flywheel. Two very different procedures are therefore provided. On for all 90° CV and LV motors from the 65 Jet through the 300 hp V8 and another for the 60° 80 Jet-175 hp LV outboards.

All 90° Outboards

◆ **See Figures 38, 39, 40, 41, 42 and 43**

The 65 Jet-115 Hp (1632cc) CV4 motors, along with the 120-300 hp (2000/3000/4000cc) LV4/V6/V8 motors all use a sensor coil assembly that is mounted centrally beneath the flywheel and stator. Because of the coils positioning on these models, it is often referred to as the timer base assembly.

On all 90° models, the sensor coil is accessible once the flywheel and I-piece stator assembly is removed.

A brash bushing is in integral part of the coil, which has a very close tolerance with the upper bearing and seal assembly. The bushing rotates as the spark is retarded or advanced. Once the coil is removed, be sure to thoroughly check for dirt, debris, chips or damage that might prevent the timer base from rotating freely.

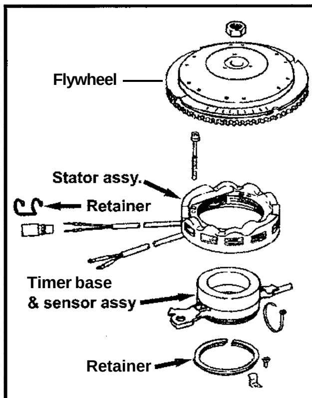


Fig. 38 Exploded view of the flywheel, stator and sensor coil-65 Jet-115 hp (1632cc) 90CV4 motors

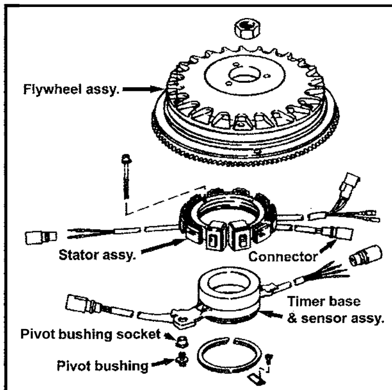


Fig. 39 Exploded view of the flywheel, stator and sensor coil-120-300 hp (2000/3000/4000cc) 90° looper V4/V6/V8 motors (V6/V8 shown, V4 very similar)

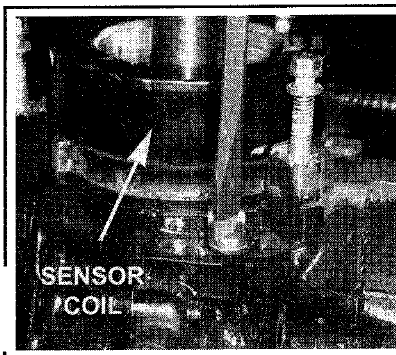


Fig. 40 Disconnect the wiring and loosen the retainers...

Fig. 41 **...**then **lift** the sensor coil from the powerhead

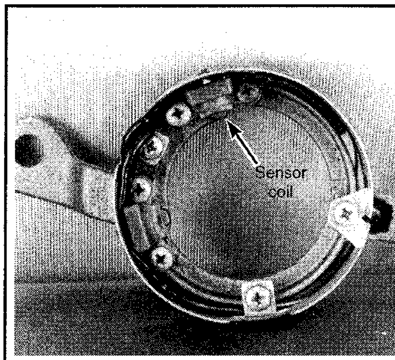


Fig. 42 Thoroughly inspect the sensor coil**...**

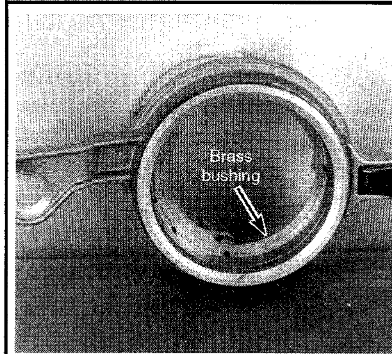


Fig. 43 **...**and bushing for wear or damage

1. Remove the Flywheel, as detailed under Powerhead.
2. Remove the Charge Coil, as detailed earlier in this section.
3. Tag and disconnect the sensor coil wiring.

☐ As with all outboard wiring, take careful note of how the coil wires are routed to ensure they will not be damaged by moving components (such as the flywheel).

4. Remove the screws securing the sensor coil/timer base retaining clips and then carefully lift the coil from the powerhead.
5. Thoroughly inspect the coil's integral brass bushing for dirt, debris, chips or other damage that might prevent it from rotating freely once installed. Replace the coil assembly, as necessary.
6. Check bushing's mating surface on the powerhead for dirt, debris, chips or damage and clean or repair, as necessary.

To install:

7. Apply a light coating of EvinrudelJohnson Moly Lube, or equivalent assembly lubricant to the bearing surface on the powerhead and to the sensor coil bushing.
8. Apply a light coating of EvinrudelJohnson Outboard Lubricant, or equivalent 2-stroke engine oil to the sensor coil retainer ring groove.
9. Gently compress the retainer ring and install the sensor coil, properly routing the wiring as noted during removal.
10. Install the retaining clips and screws, then tighten to 25-35 inch lbs. (3-4 Nm).
11. Install the Charge Coil.
12. Install the Flywheel.

All **60°** Outboards

◆ See Figures **44, 45, 46, 47, 48** and 49

On the 80 Jet-175 hp (1726/2589cc) 60° V4/V6 motors, the optical timing sensor is mounted to the flywheel cover and works in conjunction with a timing wheel. One advantage of this setup is the relative ease of serviceability that comes from mounting the sensor on TOP of the flywheel (instead of underneath as on the 90° motors).

The following procedure may be performed with the flywheel cover in place on the powerhead, or removed from the powerhead (if this was necessary for some other service or repair).

1. Disconnect the negative battery cable for safety.
2. Remove the timing wheel/sensor cover for access.
3. Tag and disconnect the timing sensor plug from the sensor itself.
4. Lift the sensor support return spring free of the post on the flywheel cover.
5. Remove the 2 screws from the small sensor support retainer and lift off the retainer.
6. Remove the 3 screws from the larger sensor support retainer and lift off the retainer.
7. Lift the sensor support free of the flywheel cover. Turn the support over and remove the two screws securing the sensor to the support.

To install:

8. Insert the timing sensor onto the support from the back side. Secure the sensor to the support ring with the two screws. Tighten the screws to 10-14 inch lbs. (1.1-1.6 Nm).
9. Apply a light coating of EvinrudelJohnson Triple-Guard, or equivalent marine grease to the sliding surfaces of the support ring.
10. Position the sensor support onto the flvwheel cover. Place the large and small sensor support retainers on the flywheel cover and secure the retainers with five screws. Rotate the sensor support from stop-to-stop, checking for binding or rough spots. If binding occurs, check for adequate lubrication or replace the sensor support.
11. Connect one end of the sensor return spring to the sensor support and the opposite end to the post on the flywheel cover.

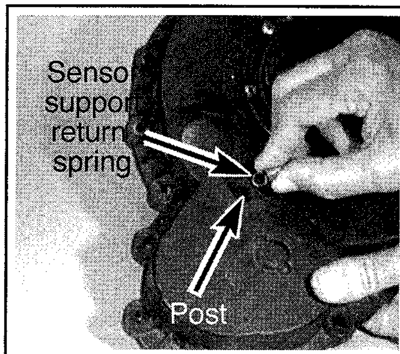


Fig. 44 Free the sensor coil return spring

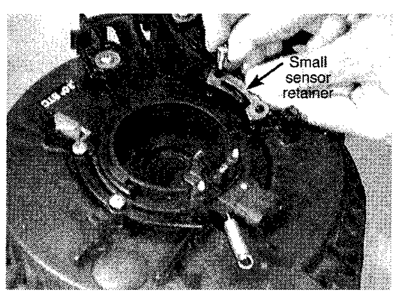


Fig. 45 Loosen the screws for the small and**...**

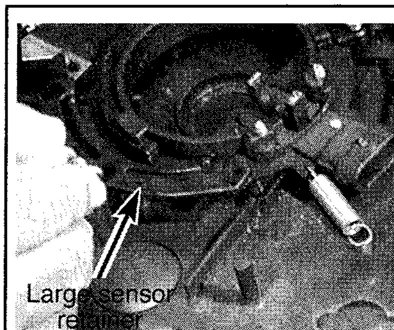


Fig. 46 **...**and large retainers**...**

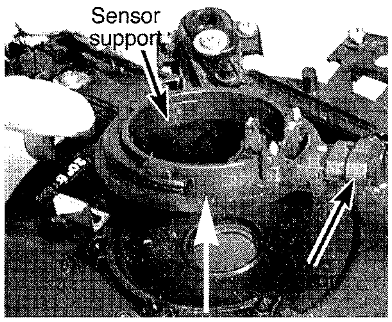


Fig. 47 ...then lift the sensor straight off the flywheel cover

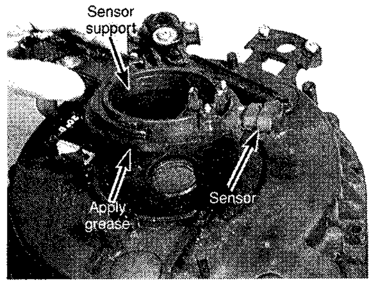


Fig. 48 Lubricate the sliding surfaces of the sensor before installation

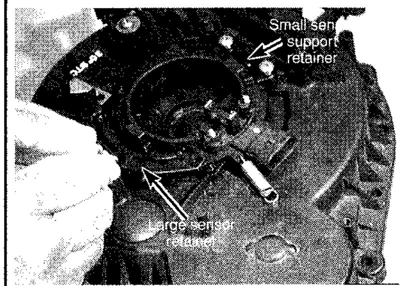


Fig. 49 Then position the sensor and tighten the retainer screws

Power Pack (Ignition Module)

On carbureted motors, current from the power coil and/or charge coils used to run the ignition, is controlled by a solid-state Power Pack or Ignition Module. When equipped with the Speed Limiting Operator Warning (S.L.O.W.) system, additional circuits are provided for warning system control and speed limiting operation.

All ignition timing functions are controlled by the power pack electronically based on input signals from the sensor (timing) coils (or optical sensors). Also, some models are equipped with the QuikStart timing advance system that is used to improve engine startup and cold engine performance by advancing the engine timing. When equipped, the QuikStart circuitry is also incorporated in the power pack.

On all motors, the power pack is mounted at the rear of the powerhead. For 900 motors it is a separate unit mounted to the rear top of the powerhead, but on 60° motors the power pack and ignition coil assembly is mounted under a cover, between the cylinder banks. Regardless, the testing and service of all power packs (and ignition coils) is similar.

If you have trouble locating the power pack, either trace the **charge/power** coil wires from the stator to the power pack or the primary ignition wires from the ignition coils back to the power pack assembly. For more details, please refer to the Wiring Diagrams found in this section.

OEM ③ DIFFICULT

TESTING

◆ See Figures 50 and 51

A peak-reading voltmeter must be used to check the power pack output with the engine cranking or running. The power pack (ignition module) is a solid state component; for this reason, there area no static methods to check it (such as a resistance check using an ohmmeter).

The cranking test for most motors requires the use of a special test load adapter. The manufacturer recommends an adapter produced by the Stevens Test Equipment Company, No. PL-88. If this special adapter is not available, you can make one using a 10-ohm, 10-watt resistor from an electronics store (at the time of publication this was available from Radio Shack@as part No. 271-132.)

The engine running test requires a terminal adapter on the primary side of the ignition coil so you can connect the meter without disrupting the circuit. If a terminal extender is not available, you can make one out of an old primary side ignition wire (the wire that is normally connected between the power pack and ignition coil). Cut a small section of the insulation away from an old wire, taking great care not to damage or break any strands of the wire under the insulation (as this would raise resistance in the circuit, possibly rendering false results). Install the wire in place of the one that is currently installed between the power pack and coil. During testing, connect the voltmeter probe to the exposed portion of the wire, using great care to make sure neither shorts to ground on the powerhead.

1. On 60° motors, remove the regulatorlrectifier and ignition system cover from the rear of the powerhead for access to the power pack and ignition coils. Disconnect the timing sensor plug.

2. Check the power pack cranking output first as follows:

a. Set the peak reading voltmeter to read positive on the 500 volts scale.

b. Twist and pull the primary lead from the power pack off the ignition coil. Install the Stevens PL-88 load adapter connecting the red end of the adapter to the primary wire lead and the black end of the adapter to a good engine ground.

c. Connect the black DVOM lead to a good engine ground also, then connect the red meter lead to the red end of the test adapter (where it connects to the primary wire).

d. Crank the engine and observe meter reading, it should be 100 volts or higher on all V6 and V8 powerheads, 150 volts or higher on 90° V4 powerheads or 200 volts or higher on 60° powerheads. Note the results, remove the test adapter and reconnect the wiring. Repeat the cranking output test for each of the remaining ignition coil outputs from the power pack.

e. Interpret the meter readings as follows:

- If the meter reads at or higher than specification, but the ignition is not performing properly for the spark test, check the Ignition Coil as detailed in this section.
- If one primary lead has no output, and all other components have tested good, replace the power pack.

3. To check the power pack under load, at engine speeds where intermittent problems are noted, proceed as follows:

a. Connect a source of cooling water to the engine, as detailed under Flushing the Cooling System in the Engine Maintenance section.

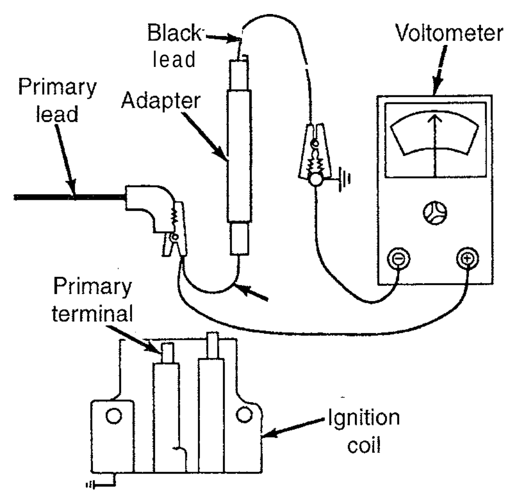


Fig. 50 Checking the power pack output while cranking usually involves connecting an adapter (Stevens PL-88 or equivalent) and a voltmeter to the primary lead from the power pack

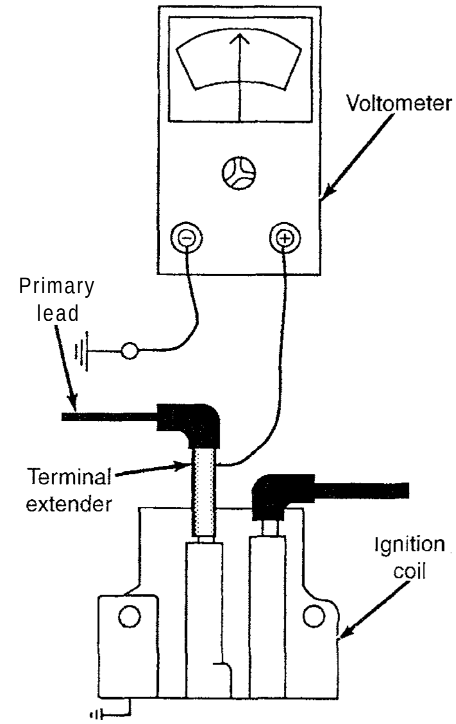


Fig. 51 The running output test requires that the circuit is completed so a terminal extender (or modified primary wire that allows signal probing) is necessary to get a voltage reading

✳✳ WARNING

If the engine is to be run at speeds over 2000 rpm, it must be mounted in a test tank using a suitable test wheel or placed in the water to prevent possible overspeed and damage which could occur if the engine was run on a flushing device.

b. Install a terminal extender to the primary terminal of the ignition coil whose power pack signal is being tested.

c. Set the peak-reading DVOM to read positive 500 volts scale, then connect the black meter lead to a good engine ground and the red meter lead to the metal portion of the terminal extender.

d. Double-check to make sure the test leads are routed so they will not be damaged by rotating parts, then start and run the engine. If the engine is to be run above high-idle, allow it lo warm before advancing the throttle.

e. With the engine running, power pack output should remain steady at a constant engine speed. Power pack output should be at least 130 volts for most outboards, except the 90° V4s, which should be at least 180 volts for looper (2000cc) motors or 230 volts for cross-flow (1632cc) motors. If a problem has been noted at a particular engine speed, attempt to duplicate the symptom while observing the meter. Output must not dip below the specified voltage for all operating conditions. Repeat the running output test on the power pack signals for the remaining engine coils.

f. If the meter reads less than specified on one or more ignition coils, test the Charge Coil (if not done already), as detailed in this section. If all other components test within specification, but output remains low, the power pack must be replaced.

g. If one or more cylinders shows no output, check the sensor coil. If the sensor coil is good and the power pack failed the cranking test as well, it must be replaced.

4. Reconnect all wiring as removed for testing.

5. On 60° motors, install the regulatorlrectifier and ignition cover to the rear of the powerhead and reconnect the timing sensor wiring.

REMOVAL & INSTALLATION

② MODERATE

◆ See Figures **52, 53, 54, 55, 56, 57** and 58

On most models, power pack removal and installation is pretty straightforward. You simply disconnect the wiring and unbolt the module. But, pay close attention to wiring harness position, especially any ground straps that may be present. Failure to reattach a ground strap properly could cause ignition system problems at best or module damage at worst.

On all motors, the power pack is mounted at the rear of the powerhead. On 90° motors it is a separate unit mounted to the rear top of the powerhead, but on 60° motors the power pack and ignition coil assembly is mounted under a cover, between the cylinder banks. The ignition coils on 60° motors can be removed from the power pack and serviced individually.

If you have trouble locating the power pack, either trace the **charge/power** coil wires from the stator to the power pack or the primary ignition wires from the ignition coils back to the power pack assembly. For more details, please refer to the Wiring Diagrams found in this section.

✳✳ WARNING

The quickest way to trash your powerhead is to improperly connect the power pack wiring, which could destroy ignition system components or, if the **primary** leads are improperly connected, cause mechanical damage to the powerhead when **it is** started. Be sure to carefully tag ALL wires before removal. For more details **(or** to bail **yourself out if** wires were disconnected without tagging) **refer** to the Wiring Diagrams in this section.

1. Disconnect the negative battery cable for safety and to protect components during service.

2. On 60° motors, remove the regulatorlrectifier and ignition system cover from the rear of the powerhead for access to the power pack and ignition coils. Disconnect the timing sensor plug.

■ The power packs on some motors are equipped with a ground strap secured by a star washer and retaining bolt. Pay close attention whenever this strap is removed to make sure the ground strap and star washer is retained and positioned properly during installation.

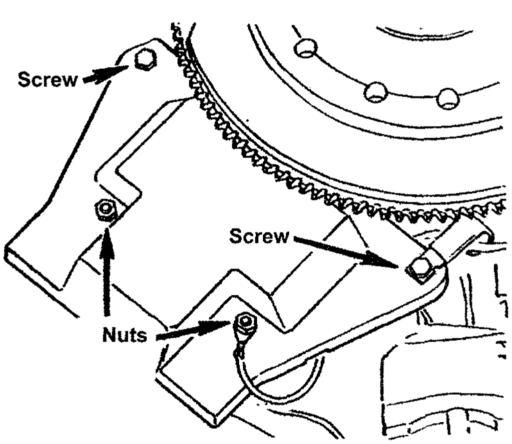


Fig. 52 Power packs are secured using various bolts, screws or nuts-typical 900 looper shown

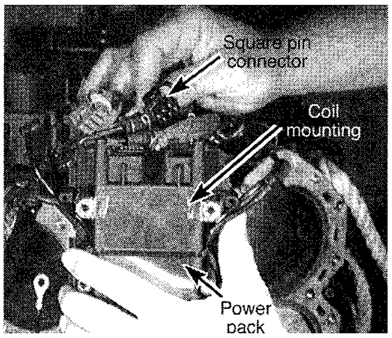


Fig. 53 Be sure to note and tag all power pack wiring (**60°** models shown)

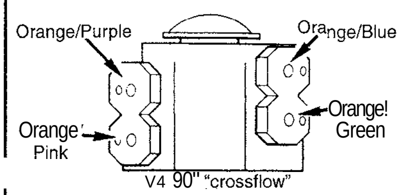


Fig. 54 Primary coil **wiring-1632cc V4s**

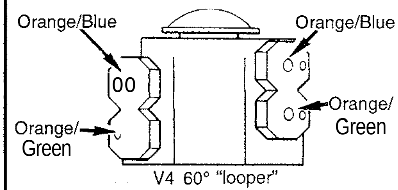


Fig. 55 Primary coil **wiring-1726cc V4s**

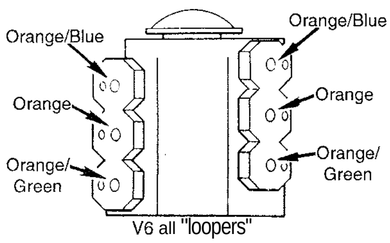


Fig. 56 Primary coil wiring-V6 motors

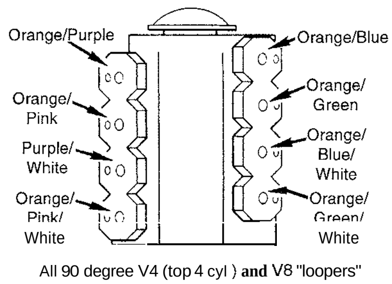


Fig. 57 Primary coil wiring-all **90°** V4 and **V8** loopers

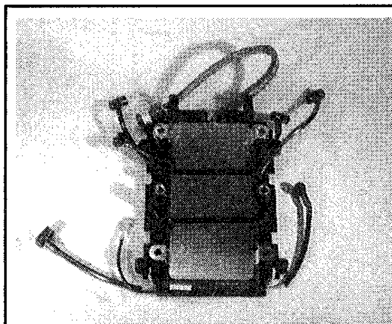


Fig. 58 Typical power pack (600 shown)

3. Tag and disconnect the power pack/ignition module wiring. This is especially important with regards to the various primary leads, as they must be reconnected to the proper terminals on the power pack assembly during installation.

Note the routing of all wiring harnesses, especially if wire ties must be cut so that wires can be repositioned. During installation, the wiring must be routed in an identical manner to make sure no contact occurs with moving components (which could rub through the insulation, shorting or cutting out ignition circuits).

4. Loosen the power pack mounting bolt/screws, then remove the power pack/ignition module from the motor. 2 screws and 2 nuts secure the power pack on most 90° looper motors.

On 600 motors, remove the top ignition coil mounting screws first, then work towards the bottom ignition coil.

5. Clean the mounting area of the power pack and powerhead of any dirt, debris, oil or corrosion. Be especially sure that the mounting point(s) and ring terminal(s) for any ground strap is clean and free of dirt, debris or corrosion to ensure to electrical contact.

To install:

6. Position the power pack to the powerhead. Make sure any ground straps attached to the module itself are in position with their appropriate washers (usually star washers).

On **60°** motors, position the power pack along with the lower ignition coil first, then install the power pack ground lead followed by the flat washer and lockwasher for the port coil **screw. The** starboard coil screw is also mounted with a flat washer on the bottom and a lockwasher on top (but with no ground strap).

7. Tighten the retaining bolts/screws to specification, as follows:

- 65 Jet-115 hp (1632cc) 90° V4 motors: 60-84 inch lbs. (7-9 Nm).
- 80 Jet-175 hp (1726/2589cc) 60° V4/V6 motors: 50-95 inch lbs. (5.6-10.7 Nm).
- 120-300 hp (2000/3000/4000cc) 90° V4/V6/V8 motors: 48-60 inch lbs (5-7 Nm).

8. Apply a light coating of dielectric grease to the terminal(s) for the primary ignition circuit (the terminal for the wire running to the ignition coil).

9. Connect the power pack wiring as tagged during removal. Be certain that wires, if disturbed, are routed properly to prevent interference with and damage from other components.

10. On 600 motors, install the regulator/rectifier and ignition cover to the rear of the powerhead and reconnect the timing sensor wiring.

11. Connect the negative battery cable.

12. Verify the correct Maximum Spark Advance setting using the Timing and Synchronization procedure found in the Maintenance and Tune-up section.

DESCRIPTION & OPERATION

◆ **See** Figure 59

Besides the spark plugs and wires, the ignition coil is the last major link in the chain that produces spark for ignition. Coils of various size, shape and design are used on Evinrude/Johnson engines. Some are equipped with a 1 primary input and a 1 secondary output terminal, but most are equipped with 2 primary and 2 secondary terminals.

The primary circuit of an ignition coil is connected to the Power Pack. Low voltage power is fed and cut from the primary circuit in a manner that induces a high voltage discharge in the secondary winding. When power is cut to the primary circuit, the secondary winding discharges a burst of high voltage through the secondary lead. The voltage then travels through the spark plug and jumps the gap at the plug's tip. The actual voltage jump is the spark referred to when discussing ignition system operation. This spark is what ignites the air/fuel mixture in the combustion chamber and causes the engine to produce power.

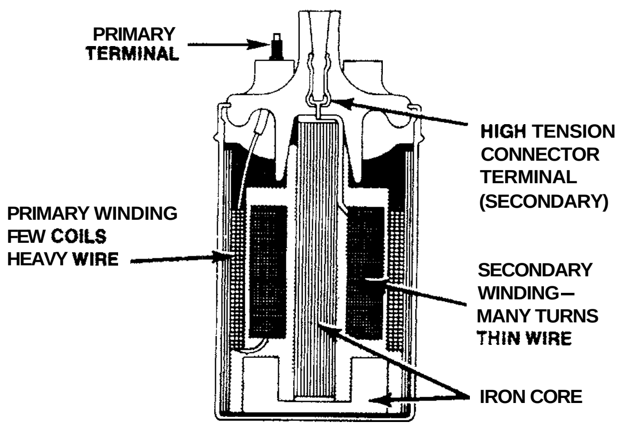


Fig. **59** Conventional ignition coil. All coils work on the same principal: power is transformed from low voltage on the primary side to high voltage on the secondary side

TESTING

◆ **See** Figures **60, 61, 62, 63** and 64

The best way to check an ignition coil is to use a dynamic ignition coil tester (which will show problems that might occur under load and might not be revealed by static tests). Unfortunately the simple fact that not everyone has access to a coil tester makes resistance checks useful.

If you do have access to an ignition coil tester, follow the manufacturer's instructions closely in order to prevent damage to the test equipment or the coil assembly. For all Evinrude/Johnson carbureted engines, be sure not to exceed the maximum test amperage ratings. These ratings will vary slightly with test equipment, but two representative values would be 1.1 amps for a Stevens ignition coil tester or 1.5 amps for the Merc-O-Tronic ignition coil tester.

When checking ignition coils, keep in mind that there are two circuits, the primary winding circuit and the secondary winding circuit. Both need to be checked.

The tester connection procedure for a continuity check will depend on how the coil is constructed. Generally, the primary circuit is the small gauge wire, while the secondary circuit contains the high tension or plug lead. The primary circuit is connected to the Power Pack, while the secondary circuit is connected to the spark plug,

Problems with an ignition coil usually cause a no spark condition for the connected spark plug(s). But, a partial internal short or a cracked/damaged coil case that allows voltage leakage could cause an ignition misfire that appears only under certain conditions. If this is the case, the best test for the coil is to use a dynamic ignition tester and try to recreate those conditions.

An ignition coil with an internal or external short will prevent the creation of a strong, blue spark at the plug. If this is suspected, listen closely to the coil during operation for audible clicking noises that may be an indication of a short. External shorts are often visible at night as they cause a blue arc from the coil body to short.

To ensure the best possible results with resistance testing, remember that specifications will change with temperature and with meters. Whenever possible, use a high quality DVOM for coil resistance testing. The specifications provided are for ignition coils tested when they are 68°F (20°C). That means you can't simply stop a motor that has been operating for 1/2 hour and take a resistance test just because it is 68°F (20°C) outside that day. You'd have to wait for the coil to cool off first.

In most cases the ignition coil does not have to be removed from the powerhead for testing, as long as the wiring can be disconnected for access to the terminals. As a matter of fact, the primary test is generally designed not only to test the coil, but the coil mounting (ground), so it is best conducted with the coil still on the powerhead. If the primary test is conducted with the coil not installed, make sure the coil mounting area is clean and free of debris and double-check the result once it is bolted in position.

Remember that on the carbureted 600 motors, you'll have to remove the regulator/rectifier and ignition cover for access to the coil. Remove the cover carefully while disconnecting the timing sensor harness. Be sure to reconnect the harness when repositioning the cover after testing or service.

If there is any question as to the location of a coil, find a spark plug in the powerhead and trace the secondary ignition wire (spark plug lead) back to the coil.

Primary Coil Winding

◆ See Figure 60

1. Disconnect the negative battery cable to protect the test equipment and for safety.

2. On 60° motors, remove the regulator/rectifier and ignition system cover from the rear of the powerhead for access to the power pack and ignition coils. Disconnect the timing sensor plug.

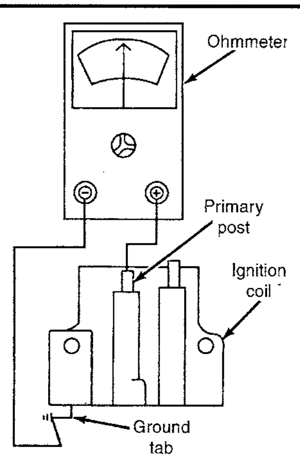


Fig. 60 Checking primary resistance for a coil on a typical motor with one primary and one secondary terminal

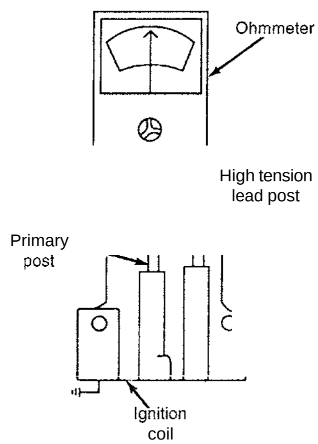


Fig. 61 Checking secondary resistance for a coil on a typical motor with one primary and one secondary terminal

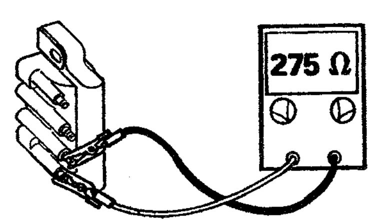


Fig. 62 Checking secondary resistance on a motor that uses 2 primary and 2 secondary leads for a single coil

3. Note the routing and connection points then disconnect the primary wire or wires from the ignition coil.

■ **When testing multiple ignition coils on the same motor, it is a good idea to only disconnect and test one coil at a time, this will help prevent confusion when reconnecting the wiring.**

4. Select the resistance scale on the DVOM.
5. Connect the black meter probe to a good ground (on the engine if the coil is installed or to a tab on the coil itself if it is removed from the motor).
6. Connect the red meter probe to the primary terminal (the small terminal on which the wire coming from the power pack normally connects).
7. Resistance should be 0.05-0.15 ohms for all motors.
8. If tests are out of specification, make sure that test connections were good. When checking with a ground on the motor, make sure the ground was good (painted and insulated surfaces will prevent you from getting a good ground).
9. Replace the coil(s) if readings are out of specification and no other causes can be located.
10. Reconnect the wiring when testing and/or repairs are complete.
11. On 60° motors, install the regulator/rectifier and ignition cover to the rear of the powerhead and reconnect the timing sensor wiring.
12. Connect the negative battery cable and verify proper system operation.

Secondary Coil Winding

◆ **See Figures 61, 62, 63 and 64**

On all models it is best to remove the spark plug leads before checking the ignition coils, but not absolutely necessary on carbureted models, whose secondary wires should have little or no resistance. Even so, age, deterioration, or problems with the connectors may cause high readings that could make an otherwise good coil test out of range.

1. Disconnect the negative battery cable to protect the test equipment and for safety.
2. On 60° motors, remove the regulator/rectifier and ignition system cover from the rear of the powerhead for access to the power pack and ignition coils. Disconnect the timing sensor plug.
3. Select the resistance scale on the DVOM.

■ **When testing multiple ignition coils on the same motor, it is a good idea to only disconnect and test one coil at a time, this will help prevent confusion when reconnecting the wiring.**

4. Tag and disconnect the primary and secondary wiring from the coil being tested, then connect the DVOM probes to the primary terminal and the adjacent secondary terminal (on multi-terminal coils). If there is a second spark plug tower (for coils that fire 2 spark plugs), note the reading, then move both meter leads to the primary and secondary tower pair for the other spark plug. In all cases, resistance should be 225-325 ohms.
5. Confirm all connections and readings, especially if the coils test out of specification. Replace the ignition coil(s) if the Primary or Secondary readings are well out of specification and all test connections/conditions were conducted properly.
6. Reconnect the wiring after testing and/or repairs. Be sure to route the wires carefully so as to prevent contact with moving components.
7. On 600 motors, install the regulator/rectifier and ignition cover to the rear of the powerhead and reconnect the timing sensor wiring.
8. Connect the negative battery cable.

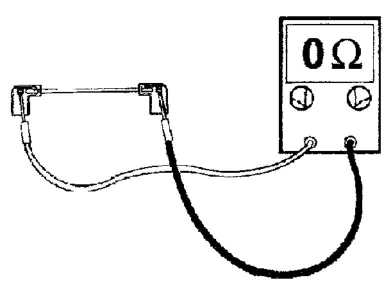


Fig. 63 Spark plug lead resistance should be very low, close to zero

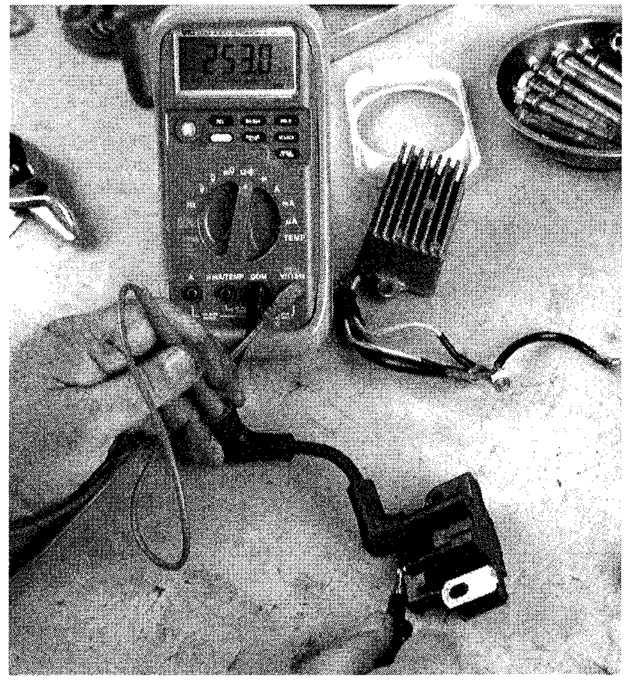


Fig. 64 Since the secondary lead resistance on carbureted motors should be at or near zero, the spark plug end of the lead may be probed instead of the tower itself-note this coil tests in spec for 2-stroke motors

REMOVAL & INSTALLATION

1 EASY

◆ **See Figures 65, 66, 67, 68 and 69**

On all Evinrude/Johnson V-motors the ignition coils are found on the rear of the motor, between the cylinder banks. The 90° motors USUALLY are equipped with one ignition coil per cylinder (found immediately adjacent to that cylinder's spark plug), while the 600 motors use 2 (V4) or 3 (V6) ignition coils mounted centrally on the power pack.

If coil location is not readily apparent, locate a spark plug wire and trace the wire back to the coil. If necessary, refer to the schematics under Wiring Diagrams to help identify the primary wiring.

Be sure to tag the wiring before disconnecting it from the ignition coil(s) in order to ensure proper installation and operation.

1. Disconnect the negative battery cable for safety.
2. On 600 motors, remove the regulator/rectifier and ignition system cover from the rear of the powerhead for access to the power pack and ignition coils. Disconnect the timing sensor plug.
3. Tag and disconnect the wiring (spark plug leads and primary leads) from the ignition coils.

☐ If more than one coil is being removed, either replace them one at a time to avoid confusion or tag all wiring before removal. Failure to reconnect the primary and secondary wiring in the same order as originally installed will usually cause incorrect timing and minor-to-severe performance problems including backfiring, stumbling or even a **no**-start.

4. Check the coil mounting bolts for spacers, ground wires and flat, fiber or star washers. Note the location of each on a piece of paper. The washers, spacers and, most importantly the ground straps, must be installed in the proper orderlorientation during installation.
5. Carefully remove the ignition coil mounting bolts (usually 2 on most coils), keeping each of the washers and ground straps in order as they are removed. If necessary, reposition the bolt back into the powerhead through the various washers and straps (marking at what point the coil is installed) or spread them out on a secure work surface to remind you of their proper order.
6. Remove the coil from the powerhead.

To install:

7. Carefully clean any traces of dirt, debris or corrosion from the mating surfaces of the coil and powerhead. This is especially important to ensure proper electrical contact for the ground strap.
8. Position the ignition coil to the powerhead with the washers and ground strap(s) in the order noted during removal. Make sure the ground strap has good electrical contact with the powerhead. (This can be quickly checked using an ohmmeter if there is any concern).

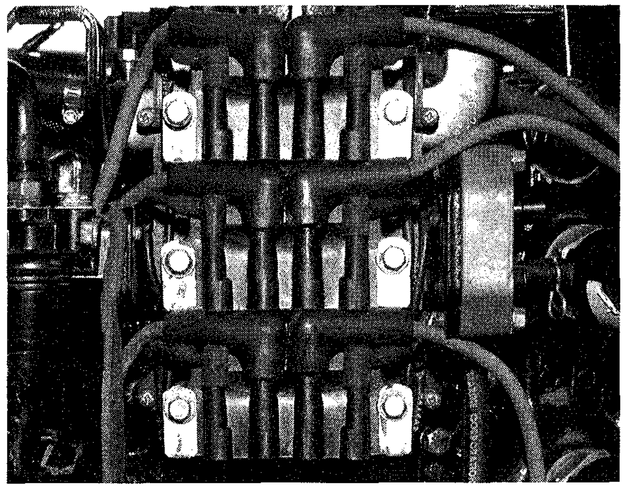


Fig. 65 On all motors, the ignition coils are mounted on the rear of the powerhead either together (as shown for **60°** motors) or individually, adjacent to each cylinder **(90°** motors)

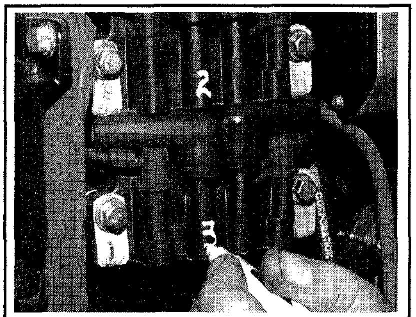


Fig. 66 In all cases, tag the coils and wires...

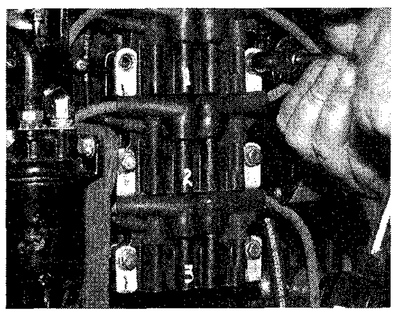


Fig. 67 ...then remove the retainers...

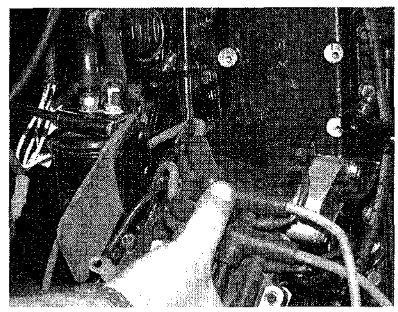


Fig. 68 ... and free the coil from the powerhead

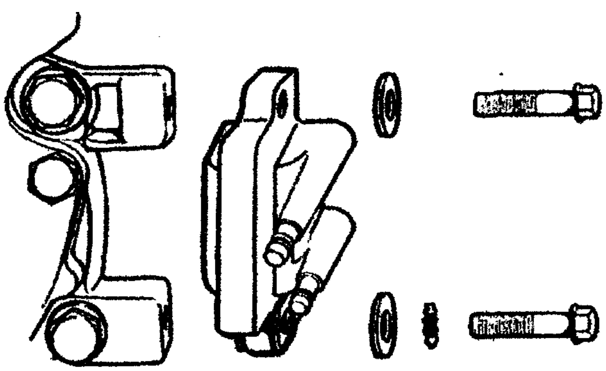


Fig. 69 Exploded view of the coil mounting for most **90°** motors

☐ On 600 motors, position the lower ignition coil first, then install the power pack ground lead followed by the flat washer and lockwasher for the port coil screw. The starboard coil screw is also mounted with a flat washer on the bottom and a lockwasher on top (but with no ground strap).

9. Tighten the retaining boltslscrews to 50-95 inch lbs. (5.6-10.7 Nm).
10. Apply a light coating Evinrude/Johnson electrical grease or other suitable dielectric grease to the primary and secondary terminals, then reconnect the wiring as noted during removal.
11. On 60° motors, install the regulatorlrectifier and ignition cover to the rear of the powerhead and reconnect the timing sensor wiring.

QuikStart System Verification

The ignition system on most carbureted looper models is equipped with the Evinrude/Johnson QuikStart feature. As the name implies, the system is designed to improve start-up function, especially during cold starts.

The system functions by automatically advancing the ignition timing when the powerhead temperature is below 96° F (36° C) for 90° powerheads or 105°F (41°C) for 60° powerheads. The timing is advanced for approximately five seconds each time the powerhead is started and independent of the powerhead temperature. Once the QuikStart electronic starting has been canceled by the powerhead temperature, the powerhead must be shut down before the ignition advance cycle may be repeated.

The QuikStart electronic starting also monitors the rpm and cancels the ignition advance when the powerhead speed exceeds approximately 1100 rpm.

FUNCTIONAL CHECK

◆ See Figures **14, 15, 16, 70, 71, 72** and 73

✻✻ CAUTION

Water must circulate through the lower unit to the powerhead any time the powerhead is operating to prevent damage to the water pump impeller in the lower unit. Just five seconds without water will damage the impeller.

Never operate the powerhead above idle rpm with only a flush attachment connected. Without a load on the propeller, the powerhead could exceed the maximum limit-"Runaway"-severely damaging the powerhead.

1. Check the flywheel for cast in marks corresponding to Top Dead Center (TDC) for each cylinder. The 60° powerheads usually have them, the 90° powerheads usually do not. If there are no cast in marks, remove the spark plugs and, using a dial gauge to determine piston position, make a mark on the flywheel facing the timing pointer when each cylinder is at TDC.

■ If no dial gauge is available, you can also use a pencil to determine TDC. Remove the spark plug from the cylinder. Insert a pencil, eraser end first into the cylinder bore approximately 1-2 inches. Have an assistant **slowly** rotate the flvwheel. As the cvlinder comes **up to TDC** the pencil will **be** pushed almost completely but of the **cylinder. When** the pencil begins to drop back into the cylinder, stop rotating the flywheel. Now, rotate the flywheel in the opposite direction approximately until the pencil returns to the highest point, then stop rotating the flywheel and place a mark directly across the pointer from that cylinder.

2. Place the powerhead in a test tank or secure the boat to a dock in a body of water. Start the powerhead and allow it to warm (it must be above the QuikStart activation temperature range for the powerhead being serviced). Be sure the synchronization and linkage adjustments are correct before proceeding. If adjustments are necessary, refer to the Timing and Synchronization procedures in the Maintenance and Tune-Up section.

3. On the port cylinder head temperature switch, disconnect the white/black wire lead from the temperature switch to the power pack. On 60° models, you may need to remove the engine cable bracket for access.

4. Connect a timing light to the No. 1 cylinder spark plug lead for all except 60° V4 models, on which you should connect the timing light to the No. 2 cvlinder spark plug lead.

5. Restart ihe powerhead and verify the idle speed is set at no more than 900 rpm in forward gear. Adjust the idle speed, as necessary.

6. Aim the timing light at the pointer on the flywheel. Proceed from here, depending upon the model:

7. On 80 Jet-115 Hp (1726cc) 60LV4 motors:

a. When a warm engine is restarted and allowed to idle below 900 rpm, the cast No. 2 mark must be to one sides (advanced) of the timing pointer for about 5 seconds. This demonstrates that the QuikStart circuit has advanced engine timing for startup. If this does not occur, check the timing wheel and the power pack.

b. Reconnect the white/black temperature switch wire while watching the timing mark. It must now move to the other side (retarded/normal) of the timing pointer demonstrating that the system has released control of the advance. If the system fails to release, check the temperature switch, associated wiring and finally, the power pack.

8. On 105 Jet-175 Hp (2589cc) 60LV6 motors:

a. When a warm engine is restarted and allowed to idle below 900 rpm, the timing light should show about 4-6° of advance (BTDC) for about 5 seconds. This demonstrates that the QuikStart circuit has advanced engine timing for startup. If this does not occur, check the timing wheel and the power pack.

b. Reconnect the white/black temperature switch wire while watching the timing light. It must now show 4-6° of timing retard (ATDC) demonstrating that the system has released control of the advance. If the system fails to release, check the temperature switch, associated wiring and finally, the power pack.

9. On 120-300 hp (2000/3000/4000cc) 90LV4/V6/V8 motors:

a. When a warm engine is restarted and allowed to idle below 900 rpm, the timing light should show the mark for the cylinder being tested at or about aligned with the timing pointer for about 5 seconds.

b. Reconnect the white/black temperature switch wire while watching the timing light. The mark should now shift to the left of the timing pointer showing a normal specified idle timing (ATDC) demonstrating that the system has released control of the advance.

c. Stop the engine, disconnect the temperature switch wire again, move the timing light to the next cylinder and repeat the test. The engine must be stopped and the temperature switch wire disconnected again before each cylinder is tested, otherwise the system will not reset. If some cylinder coils do not react properly, replace the sensor coil (timer base assembly).

d. If NO coil reacts properly, there is a complete loss of the QuikStart system.

10. If the QuikStart system remains activated constantly, even when the engine is operated above 1100 rpm, the power pack must be replaced. If the svstem remains activated below 1100 rpm, reqardless of the amount of time that has passed, check the following:

- Check for trace amounts of battery voltage on the power pack yellow/red lead demonstrating a damaged starter solenoid.
- Check for a damaged port temperature switch (or wiring).
- Check for an open power pack white/black lead or damaged connectors.
- Check engine for overcooling (thermostat's remaining wide open).
- If no other causes can be found, replace the power pack.

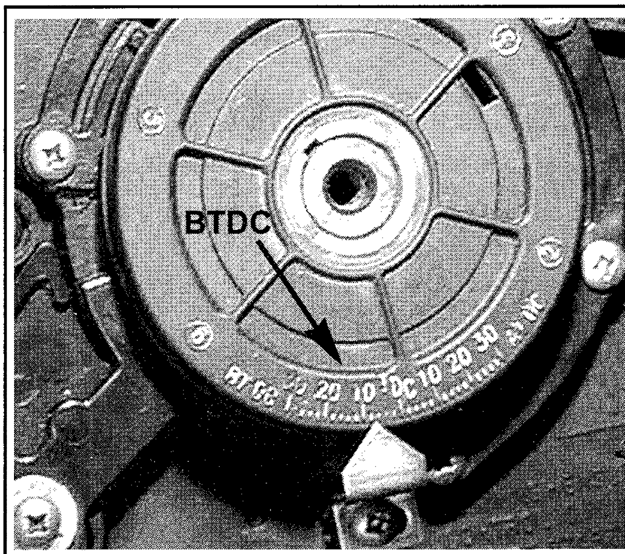


Fig. 70 If the QuikStart function is operating properly it will advance timing during startup...

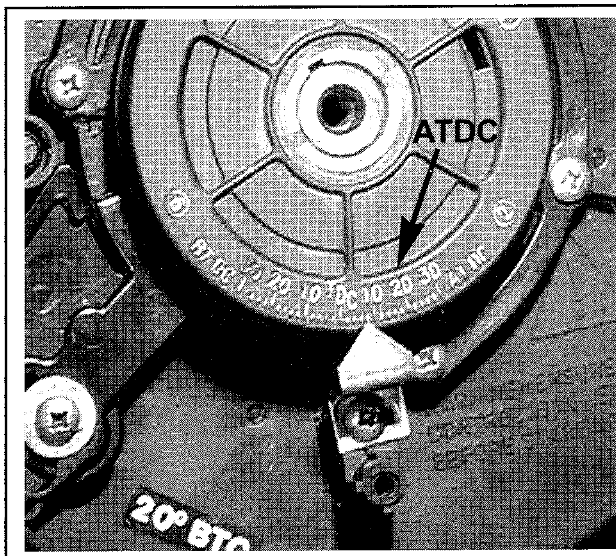


Fig. 71 ...and retard timing above idle or after 5 seconds (if the engine is **warm)-60°** timing wheel shown

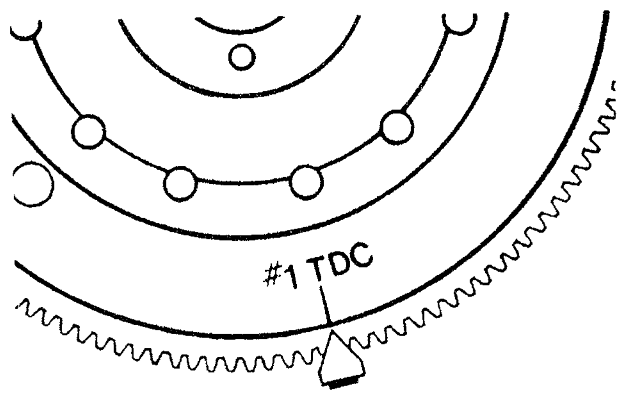


Fig. 72 On 90° loopers, the timing mark will approximately align during QuikStart operation (this position is advanced from normal idle timing, which is ATDC)...

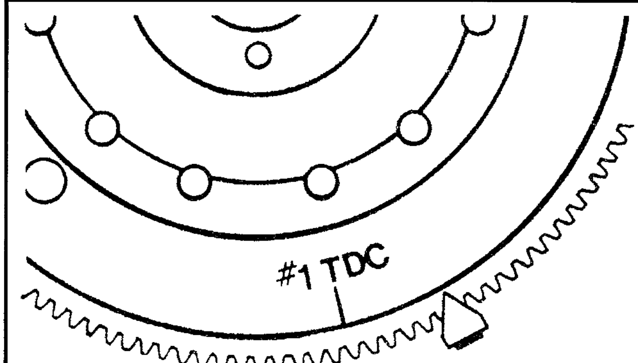


Fig. 73 ... timing will advance on these motors as well, once the QuikStart function releases control

Complete Loss of QuikStart (900 Loopers Only)

If there is a complete loss of the QuikStart system on 90° V4/V6/V8 looper motors, proceed as follows:

1. Allow the engine to cool below 89°F (32°C).
2. Disconnect the white/black lead between the power pack and port temperature switch.
3. Check the switch and wiring using an ohmmeter between the temperature switch white/black lead and a good engine ground. If the meter shows a low reading (continuity), then check the switch itself (refer to the information on temperature switches found under Warning Systems, in this section. If resistance is high (no continuity), proceed as follows, depending upon the model:
4. On V6/V8 models:
   a. Loosen the power pack and install a junction box at the sensor coil (timer base) starboard Amphenol connectors. Provide an external ground for the power pack.

☐ A junction box is used to allow access to a connector's circuits while they are complete as if the wiring harness was not disconnected. An alternate method would be to use jumper wires to reconnect each of the terminals, and carefully probe the jumper wire or exposed terminal pins in order to get the necessary voltage readings. But, use caution not to allow any jumpers to touch and short.

   b. Set a peak-reading DVOM to read "POS" on the "50" volt scale, then connect the black meter lead to a good engine ground and the red lead the sensor coil Terminal D in the junction box.

✻✻ WARNING

DO NOT run the engine with any sensor coil (timer base) leads disconnected. If using a junction box, make sure that all box switches are in the ON **position.**

   c. With the engine mounted in a test tank using the correct test wheel or propeller, start and run the engine in gear at about 900 rpm. If the power pack is good, the meter should show 8-12 volts. If not, replace the sensor coil (timer base). If results vary, proceed with the next step:

5. Disconnect the power coil orange and orange black/leads; alternately probe between each power coil lead and a good engine ground using a DVOM set to read resistance. There must be no continuity.
6. Connect the DVOM across the orange and orangeiblack leads. The power coil must show 86-106 ohms resistance. If results vary, replace the stator.

✻✻ WARNING

NEVER run these motors with the power coil leads disconnected.

IGNITION SYSTEMS—FICHT ENGINES

■ All motors covered here utilize an electronic ignition system; a multi-strike capacitor discharge system (CDI) that is fully controlled by the Engine Management Module **(EMM).** Individual components will vary slightly from **model-to-model.** But, even with slight variances in the system's source of power and trigger signals, the basic theories of system operation and service are virtually the same for all models. Differences are noted under suitable headings or sub-steps.

The ignition system's main purpose is to provide the spark necessary for engine combustion, and to do so at the proper time. It does so by converting a low voltage power source (such as the low voltage alternating current produced by the stator's charge coil) into a high voltage DC current. This is accomplished in the primary circuit of the ignition coil. Power is then conducted from the primary circuit, through the ignition coil's secondary circuit (spark plug wires) to the spark plugs.

This section provides information for troubleshooting and repairing the ignition system.

Description and Operation

◆ See Figures **73a, 73b, 73c,** 73d and 73e

The EMM controlled Capacitor Discharge (CD) ignition system used on FICHT operates on the same basic theory as the Magneto CDI system, found on carbureted engines. A magneto and stator assembly generates power for the ignition system. This power is rectified and regulated using an internal EMM regulator, and then provided to the power distribution panel (fuse box) for use by the various motor systems.

The EMM itself controls the primary circuit, based on signals from the Crankshaft Position (CP) sensor. In this manner, the EMM is free to set and adjusts ignition timing based on engine operating conditions to achieve maximum efficiency and reliability. No end user adjustments are necessary or possible on this system, which only requires periodic cleaning, inspection and replacement of ihe spark plugs for service. Problems that can occur with the system are usually traced to poor wire connections or a defective stop circuit.

Anytime the ignition switch is turned to the OFF position the system relay will de-energize, removing power from the EMM.

The major difference in the EMM controlled system comes in its interrelation with the FICHT fuel injection system and how the ignition system is thereby used to help achieve lower emissions along with better performance. One of the keys to smoke free and low emission operation for FICHT motors is the fact that the fuel injection can be so precisely controlled that the fuel charge does not reach exhaust port before it is covered by the piston. Another important element is the use of the multi-strike ignition system that is capable of firing more than once during a single combustion event within the cylinder, helping to ensure more complete combustion. FICHT motors employ 2 basic fuel and spark strategies:

Stratified injectionispark
Homogeneous injectionispark.

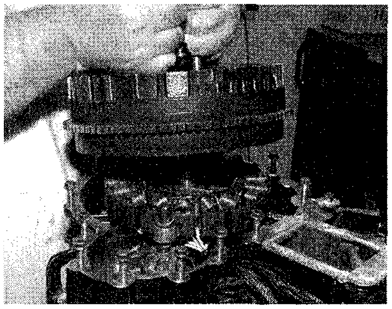


Fig. 73a Power for ignition operation comes from the magneto comprised of the flywheel-mounted magnets and ...

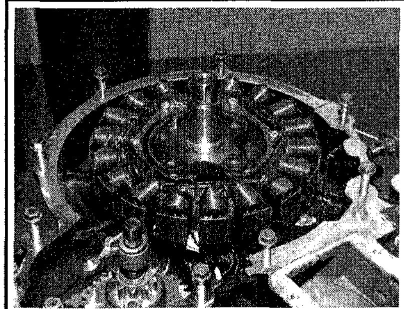


Fig. 73b ... the stator coil windings mounted under the flywheel

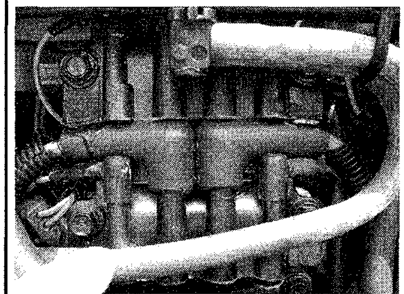


Fig. **73c** The ignition coil uses the low voltage from the charge coil to induct **high voltage that fires the spark plugs**

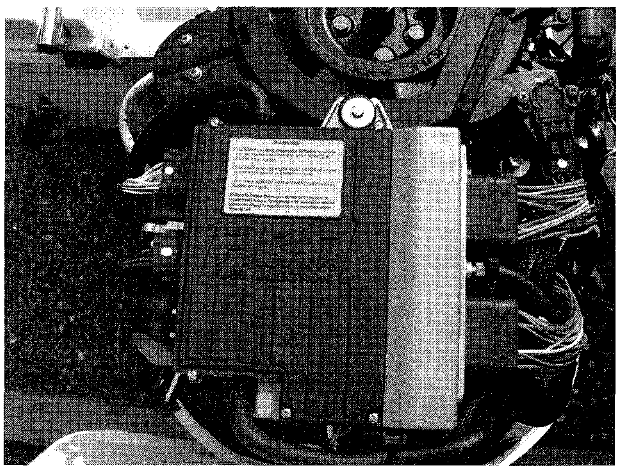


Fig. 73d All FICHT ignition functions are controlled by the **EMM...**

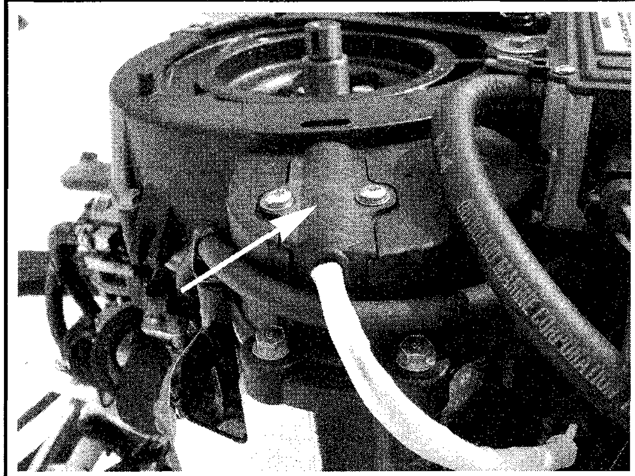


Fig. 73e ...based on signals from the CP sensor

During idle and trolling conditions, fuel and spark is controlled using the Stratified injection/spark strategy. Due to fuel/air density that occurs with low RPM operation and fuel spraying near the spark plug itself, the system employs multiple plug firings to ensure proper combustion. The multi-strike ignition pattern also helps to keep the spark plug tip clean and free of deposits. During stratified injection, spark is timed to begin just as the fuel reaches the plug tip.

During engine startup and high RPM operation, fuel and spark is controlled using the homogeneous injection/spark strategy. For these operating conditions, fuel is injected while the piston is lower in the cylinder allowing turbulence to better mix the air and fuel. During start-up, multiple plug firings are used to ensure quick-starting, but during high RPM conditions only a single plug firing is necessary per combustion event.

Because the ignition system is such an integral part of the fuel injection system on these motors, all troubleshooting must include FICHT system analysis. Before performing any tests on the FICHT ignition system, refer to the information for Troubleshooting Electronic Fuel Injection under FICHT Fuel Injection in the Fuel System section. The FICHT system troubleshooting procedures, self-diagnostic system, Symptom Charts, and FICHT Component Testing, including the Checking the Ignition System procedures should be followed in proper order before conducting any of the component tests in this section.

Troubleshooting

Because the ignition system is such an integral part of the fuel injection system on these motors, all troubleshooting must include complete FICHT system analysis. Before performing any tests on the FICHT ignition system, refer to the information for Troubleshooting Electronic Fuel Injection under FICHT Fuel Injection in the Fuel System section. The FICHT system troubleshooting procedures, self-diagnostic system, Symptom Charts, and FICHT Component Testing, including the Checking the Ignition System procedures should be followed in proper order before conducting any of the component tests in this section.

Ignition Coils

DESCRIPTION & OPERATION

◆ See Figure *73f*

Besides the spark plugs and wires, the ignition coil is the last major link in the chain that produces spark for ignition. Coils of various size, shape and design are used on Evinrude/Johnson engines. Some are equipped with a 1 primary input and a 1 secondary output terminal, but most are equipped with 2 primary and 2 secondary terminals.

The primary circuit of an ignition coil is connected to the Electronic Management Module (EMM) on FFI models. Low voltage power is fed and cut from the primary circuit in a manner that induces a high voltage discharge in the secondary winding. When power is cut to the primary circuit, the secondary winding discharges a burst of high voltage through the secondary lead. The voltage then travels through the spark plug and jumps the gap at the plug's tip. The actual voltage jump is the spark referred to when discussing ignition system operation. This spark is what ignites the airlfuel mixture in the combustion chamber and causes the engine to produce power.

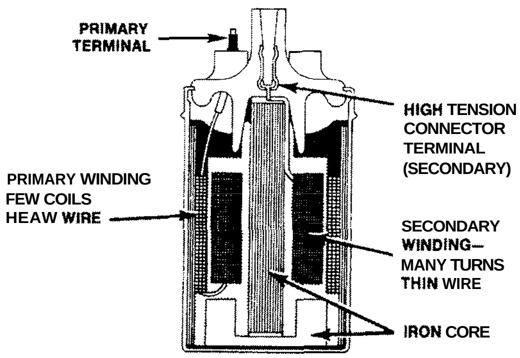


Fig. 73f Conventional ignition coil. All coils work on the same principal: power is transformed from low voltage on the primary side to high voltage on the secondary side

TESTING

◆ **See Figures 73g, 73h, 73i and 73j**

The best way to check an ignition coil is to use a dynamic ignition coil tester (which will show problems that might occur under load and might not be revealed by static tests). Unfortunately the simple fact that not everyone has access to a coil tester makes resistance checks useful.

If you do have access to an ignition coil tester, follow the manufacturer's instructions closely in order to prevent damage to the test equipment or the coil assembly.

When checking ignition coils, keep in mind that there are two circuits, the primary winding circuit and the secondary winding circuit. Both need to be checked.

The tester connection procedure for a continuity check will depend on how the coil is constructed. Generally, the primary circuit is the small gauge wire, while the secondary circuit contains the high tension or plug lead. The primary circuit is connected to the EMM, while the secondary circuit is connected to the spark plug.

Problems with an ignition coil usually cause a no spark condition for the connected spark plug(s). But, a partial internal short or a cracked/damaged coil case that allows voltage leakage could cause an ignition misfire that appears only under certain conditions. If this is the case, the best test for the coil is to use a dynamic ignition tester and try to recreate those conditions.

An ignition coil with an internal or external short will prevent the creation of a strong, blue spark at the plug. If this is suspected, listen closely to the coil during operation for audible clicking noises that may be an indication of a short. External shorts are often visible at night as they cause a blue arc from the coil body to short.

To ensure the best possible results with resistance testing, remember that specifications will change with temperature and with meters. Whenever possible, use a high quality DVOM for coil resistance testing. The specifications provided are for ignition coils tested when they are 68°F (20°C). That means you can't simply stop a motor that has been operating for 1/2 hour and take a resistance test just because it is 68°F (20°C) outside that day. You'd have to wait for the coil to cool off first.

In most cases the ignition coil does not have to be removed from the powerhead for testing, as long as the wiring can be disconnected for access to the terminals. As a matter of fact, the primary test is generally designed not only to test the coil, but the coil mounting (ground), so it is best conducted with the coil still on the powerhead. If the primary test is conducted with the coil not installed, make sure the coil mounting area is clean and free of debris and double-check the result once it is bolted in position.

If there is any question as to the location of a coil, find a spark plug in the powerhead and trace the secondary ignition wire (spark plug lead) back to the coil.

Primary Coil Winding

◆ **See Figure 73g**

1. Disconnect the negative battery cable to protect the test equipment and for safety.
2. Note the routing and connection points then disconnect the primary wire or wires from the ignition coil.

When testing multiple ignition coils on the same motor, it is a good idea to only disconnect and test one coil at a time, this will help prevent confusion when reconnecting the wiring.

3. Select the resistance scale on the DVOM.
4. Connect the black meter probe to a good ground (on the engine if the coil is installed or to a tab on the coil itself if it is removed from the motor).
5. Connect the red meter probe to the primary terminal (the small terminal on which the wire coming from the power pack normally connects).
6. Resistance should be 0.05-0.15 ohms.
7. If tests are out of specification, make sure that test connections were good. When checking with a ground on the motor, make sure the ground was good (painted and insulated surfaces will prevent you from getting a good ground).
8. Replace the coil(s) if readings are out of specification and no other causes can be located.
9. Reconnect the wiring when testing and/or repairs are complete.
10. Connect the negative battery cable and verify proper system operation.

Secondary Coil Winding

◆ **See Figures 73h, 73i and 73j**

On all models it is best to remove the spark plug leads before checking the ignition coils. All FFI motors are equipped with resistor leads, which can be individually checked for proper resistance. Resistance will vary slightly with length, so it is important that only the proper parts be used when replacing spark plug wires on these motors. The 17 in. (432mm) wires used on the 200 and larger hp V6 FICHT motors should have 650-850 ohms resistance, while the 20 3/4 in. (527mm) wires used on all other FICHT motors should have about 760-960 ohms resistance. These resistor leads make it critical that they be removed before taking readings on the coil, otherwise the additional resistance of the leads will make the coil test out of specification.

1. Disconnect the negative battery cable to protect the test equipment and for safety.
2. Select the resistance scale on the DVOM.

When testing multiple ignition coils on the same motor, it is a good idea to only disconnect and test one coil at a time, this will help prevent confusion when reconnecting the wiring.

3. Tag and disconnect the primary and secondary wiring from the coil being tested, then connect the DVOM probes to the primary terminal and the adjacent secondary terminal (on multi-terminal coils). If there is a second spark plug tower (for coils that fire 2 spark plugs), note the reading, then move both meter leads to the primary and secondary tower pair for the other spark plug. In all cases, resistance should be 225-325 ohms.
4. Confirm all connections and readings, especially if the coils test out of specification. Replace the ignition coil(s) if the Primary or Secondary readings are well out of specification and all test connections/conditions were conducted properly.
5. Reconnect the wiring after testing and/or repairs. Be sure to route the wires carefully so as to prevent contact with moving components.
6. Connect the negative battery cable.

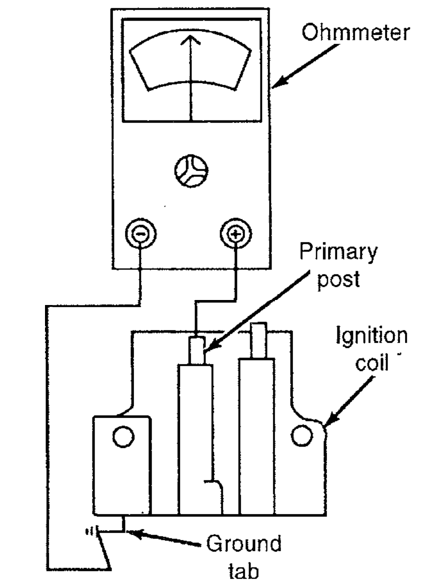


Fig. 73g Checking primary resistance for a coil on a typical motor with one primary and one secondary terminal

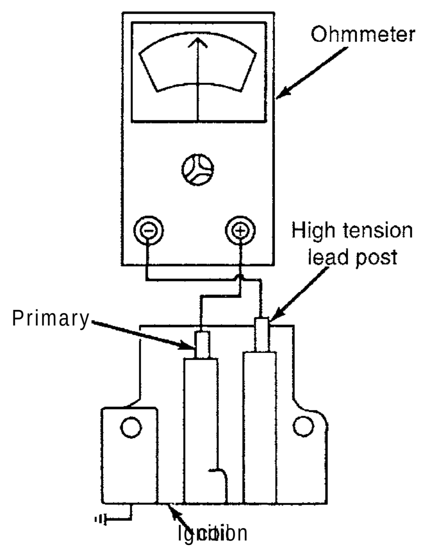


Fig. 73h Checking secondary resistance for a coil on a typical motor with one primary and one secondary terminal

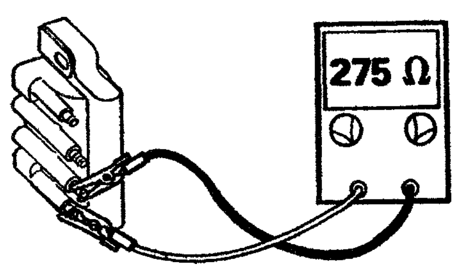


Fig. 73i Checking secondary resistance on a motor that uses 2 primary and 2 secondary leads for a single coil

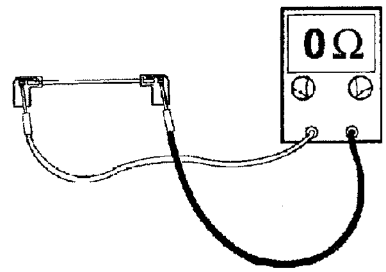


Fig. 73j On FFI motors, the leads should produce a specified amount of resistance

EASY

REMOVAL & INSTALLATION

◆ See Figures **73l, 73m, 73n,** 730 and **73p**

On all Evinrude/Johnson V-motors, the ignition coils are found on the rear of the motor, between the cylinder banks. The 900 motors USUALLY are equippe with [illegible] ignition **coil per** cylinder (f[illegible] to **that cylinder**s **spark** plug), while the **60°** [illegible] USUALLY use 2 (V4) or 3 (V6) ignition coils mounted centrally on the power pack.

If coil location is not readily apparent, locate a spark plug wire and trace the wire back to the coil. If necessary, refer to the schematics under Wiring Diagrams to help identify the primary wiring.

Be sure to tag the wiring before disconnecting it from the ignition **coil(s)** in order to ensure proper installation and operation.

1. Disconnect the negative battery cable for safety.
2. Tag and disconnect the wiring (spark plug leads and primary leads) from the ignition coils.

If more than one coil is being removed, either replace them one at a time to avoid confusion or tag all wiring before removal. Failure to reconnect the primary and secondary wiring in the same order as originally installed will usually cause incorrect timing and **minor-to-severe** performance problems including backfiring, stumbling or even a no-start.

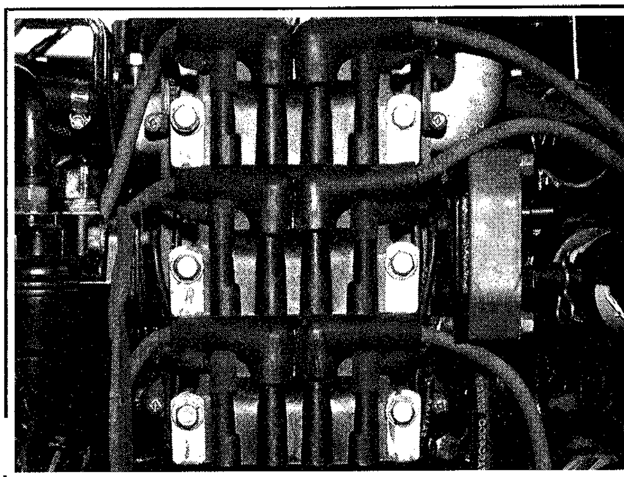


Fig. 73l On all motors, the ignition coils are mounted on the rear of the Powerhead, either together (as shown for **60°** motors) or individually, adjacent to each cylinder

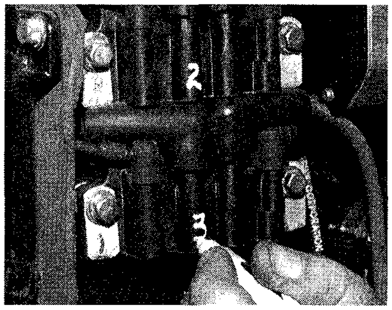


Fig. **73m** In all cases, tag the coils and wires**...**

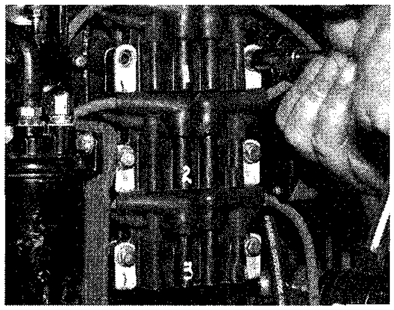


Fig. 73n **...**then remove the retainers**...**

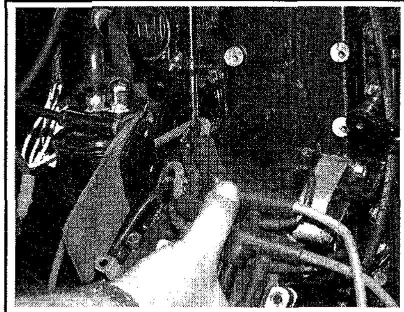


Fig.73o ... and free the coil from the powerhead

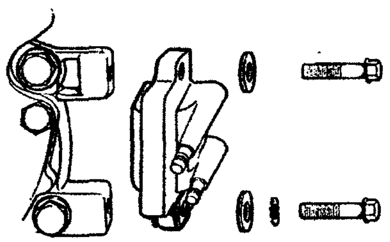


Fig. **73p** Exploded view of the coil mounting for most **90°** motors

3. Check the coil mounting bolts for spacers, ground wires and flat, fiber or star washers. Note the location of each on a piece of paper. The washers, spacers and, most importantly the ground straps, must be installed in the proper order/orientation during installation.

4. Carefully remove the ignition coil mounting bolts (usually 2 on most coils), keeping each of the washers and ground straps in order as they are removed. If necessary, reposition the bolt back into the powerhead through the various washers and straps (marking at what point the coil is installed) or spread them out on a secure work surface to remind you of their proper order.

5. Remove the coil from the powerhead.

To install:

6. Carefully clean any traces of dirt, debris or corrosion from the mating surfaces of the coil and powerhead. This is especially important to ensure proper electrical contact for the ground strap.

7. Position the ignition coil to the powerhead with the washers and ground strap(s) in the order noted during removal. Make sure the ground strap has good electrical contact with the powerhead. (This can be quickly checked using an ohmmeter if there is any concern).

8. Tighten the retaining boltslscrews to 50-95 inch lbs. (5.6-10.7 Nm).

9. Apply a light coating Evinrude/Johnson electrical grease or other suitable dielectric grease to the primary and secondary terminals, then reconnect the wiring as noted during removal.

CHARGING CIRCUIT

General Information

◆ See Figures **74** and 75

A charging system is standard on almost all of the models covered here, with the exception of a few rope start, mostly commercial, models. Even if not standard, a charging system could have been added at the time of engine rigging or even as a later accessory. When equipped, the charging system provides current to maintain the battery and to operate other enginelboat mounted electric components.

The charging systems used on these outboards have various outputs (9-amp, 10-amp, 20-amp, 35-amp) matched to appropriate load capacities for the motor and loads from accessories due to anticipated boat size. The systems can be broken down into two basic types, unregulated and regulated (the difference being that regulated systems protect the battery from overcharging and boiling away electrolyte or possibly even overheating and cracking). An AC lighting coil is standard on a handful of rope start models. However, because the voltage produced by this system is Alternating Current (AC), and not Direct Current (DC, which is necessary for 12-volt DC marine batteries), models equipped only with AC lighting coils cannot charge marine batteries.

Regardless of the system used, all types start by generating an AC current in the same fashion. A battery charge coil or AC lighting coil is incorporated in the stator mounted directly under the flywheel in order to utilize its mechanical spinning motion when the engine is operating. Permanent magnets attached to the flywheel generate a spinning magnetic field that cuts through the coil windings producing an alternating current. The coil wiring (yellow and/or yellow with various tracer colors on all models), delivers current (through a ring-terminal board or directly through the harness) to charging system components or to the AC lighting system.

On charging systems (as opposed to AC lighting systems), current is then passed through a series of diodes (electrical components that only passcurrent in one direction) contained in the rectifier or rectifier/regulator. The diodes convert the current to DC in order to charge the battery and operate DC voltage accessories. On non-regulated systems, charging rates are controlled only by engine speed, as a rectifier only contains circuitry to convert the current, not control it. For this reason, the total output on a non-regulated system is normally lower than a regulated system in order to help prevent the possibility of battery overcharging. However, extended high-speed operation will risk overcharging on some models, so be diligent with battery maintenance (checking and topping-off cell fluid levels) on these models. A non-regulated system can be identified easily by the cylindrical rectifier mounted on a small, triangular bracket.

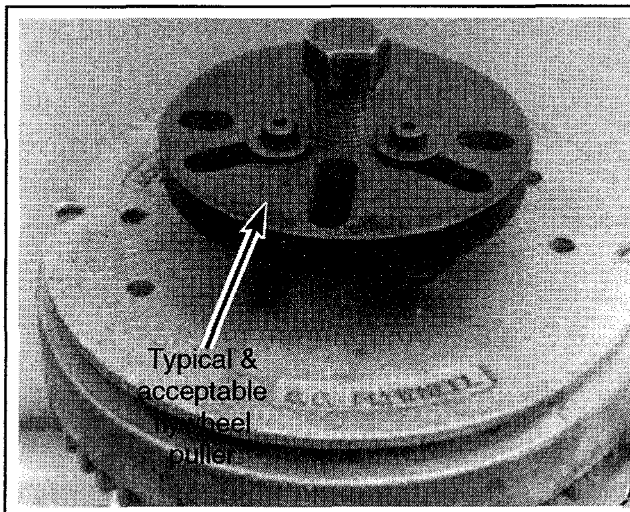


Fig. 74 **A** universal puller tool can be used to access the charging coil (stator, battery charge or **AC** lighting)

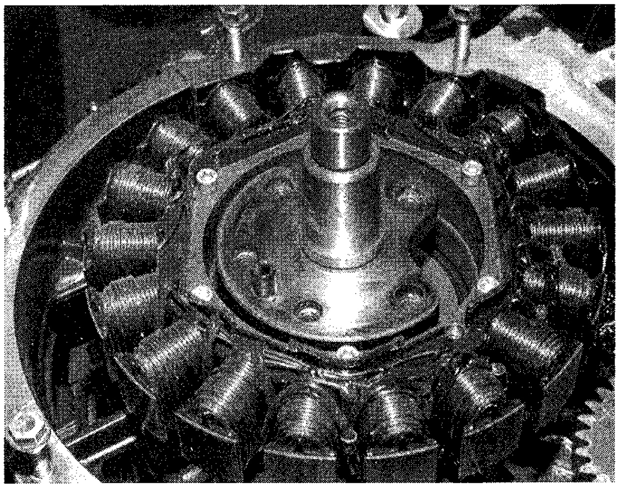


Fig. 75 All **Evinrude/Johnson V** motors are equipped with a 1-piece stator whose windings incorporate the battery charge or AC lighting coil and ignition charge coils (or only the battery charge coils on FFI motors)

Regulated charging systems utilize a rectifierlregulator that not only converts current to DC, but limits charging system output to about 14.6 volts maximum output to prevent battery overcharging. Visually, the rectifier is identified easily by tracing the yellow (or yellow with tracers) wires from the stator coil (through the terminal bar on some models) to the rectangular, finned regulator assembly.

Servicing charging systems is not difficult if you follow a few basic rules. Always start by verifying the problem. If the complaint is that the battery will not stay charged do not automatically assume that the charging system is at fault. Something as simple as an accessory that draws current with the key off will convince anyone they have a bad charging system. Another culprit is the battery. Remember to clean and service your battery regularly. Battery abuse is the number one charging system problem. The second most common cause of charging system complaints comes from loose or corroded wiring connections, mostly at the battery, but problems can be caused at any charging system harness connection.

On regulated systems, the regulatorlrectifier is the brains of the charging system. This assembly controls current flow in the charging system. If battery voltage is low the regulator sends the available current from the rectifier to the battery. If the battery is fully charged the regulator diverts most of the current from the rectifier back to the lighting coil through ground.

Do not expect the regulatorirectifier to send current to a fully charged battery. You may find that you must pull down the battery voltage below 12.5 volts to test charging system output. Running the power trim and tilt will reduce the battery voltage, or running other accessories, especially a spot light or other high-power accessory load will reduce the battery voltage quickly.

When equipped, the regulatorlrectifier is the most complex item to troubleshoot. You can avoid troubleshooting the regulatorlrectifier by checking around it. Check the battery and charge or replace it as needed. Check the amp output of the stator coil. If amperage is low check the stator coil for proper resistance and insulation to ground. If all tests and wiring are good, the regulator is likely the culprit, but this can be verified using a variable load tester, if available.

FICHT motors contain two separate and distinct functioning sets of stator windings. The first, a 12-volt circuit, can be considered the equivalent of the battery charge circuit on carbureted outboards. The injector driver circuit is powered by a second 40-volt or 26-volt (depending on the model) set of windings. All 200 hp and larger motors, as well as all 2000 and later 75-175 hp motors (that are NOT equipped with fuel rails) use a 40-volt charging circuit. All 1501175 hp motors equipped with fuel rails, as well as all 1999 and earlier FICHT motors of 175 hp or less are equipped with a 26-volt charging circuit. The difference becomes important when testing the stator.

SERVICE PRECAUTIONS

For safety and to prevent damage to the EMM on FFI motors or Power Pack and, when equipped, regulatorirectifier on carbureted motors the following precautionary measures must be taken when working with the electrical system:

- Wear safety glasses when working on or near the battery.
- Don't wear a watch with a metal band when servicing the battery. Serious burns can result if the band completes the circuit between the positive battery terminal and ground.
- When installing a battery, make sure that the positive and negative cables are not reversed. Making the wrong connections in this fashion, even for a split second, can destroy the charging system diodes in the rectifier or regulatorlrectifier.
- Be absolutely sure of the polarity of a booster battery before making connections. Connect the cables positive-to-positive, and negative-to-negative. Connect positive cables first, and then make the last connection to ground on the body of the booster vehicle so that arcing cannot ignite hydrogen gas that may have accumulated near the battery. Even momentary connection of a booster battery with the polarity reversed will damage alternator diodes. This also applies to using a battery charger. Reversed polarity will burn out the alternator and regulator in a matter of seconds.
- Always disconnect the battery ground cable before disconnecting the alternator lead.
- Always disconnect the battery (negative cable first) when charging it.
- Never ground the alternator or generator output or battery terminal. Be cautious when using metal tools around a battery to avoid creating a short circuit between the terminals. Be just as careful when working around a hot wire (a circuit to which current is currently applied). Because terminal grounding can occur with any hot wire, not just the battery cable, the negative battery cable should be disconnected before servicing any part of the electrical system.
- Never run or crank the engine without the stator coil wiring and battery properly connected. Doing so will damage the diodes or the voltage regulator instantly. For this reason, it is crucial that you check the battery connections periodically, because a terminal that comes loose during service will do more than cause the engine to stop, it may damage the charging system as that occurs.

Charging System Identification

◆ See Figure **76**

One of three basic systems can be found on these motors.

1. AC lighting system
2. Unregulated charging system
3. Regulated charging system

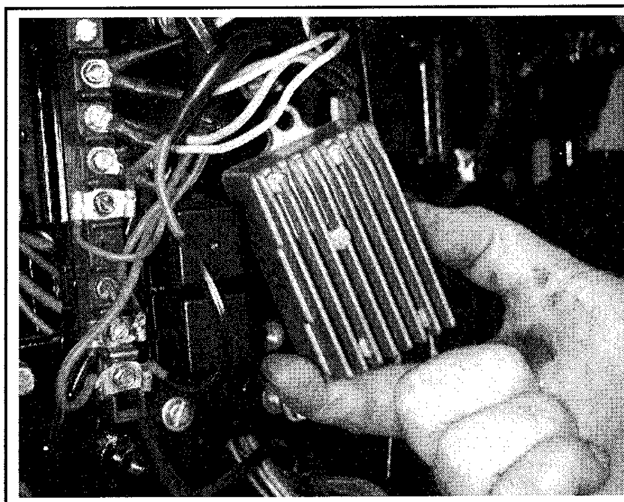


Fig. **76** The most obvious sign of a motor's charging system is the presence of a regulatorlrectifier (which indicates the motor has a fully-regulated system)

Most motors may be equipped with 2 or more of these systems depending on the model. For the most part, the handful of large rope start models in service should at least be equipped with an AC lighting coil. However, all electric start models are normally equipped either with an unregulated (the minority) or a regulated (the vast majority of V motors) charging system. The difference comes in the amperage output, which will vary with model or options.

The most common motor and system combinations are listed in the General Engine System specifications chart found in the Maintenance and Tune-Up section. But keep in mind that systems can vary. If in doubt, trace the yellow (or yellow with tracer) wires coming from the stator coil (battery charge or AC lighting coil) under the flywheel. Follow the wires back to their first connection (unless it is ring terminal board, in which case, you should continue to follow them to the first component).

If the wires run only to a boat connection or electrical accessory on rope start models, you've got an AC lighting coil. If the wires run to a smooth cylindrical shaped component mounted to a small triangular bracket on the powerhead (it's a rectifier), you've got an unregulated charging system. If the wires run to a finned, rectangular box (a regulatorlrectifier) mounted to the powerhead, you've got a regulated charging system.

For more details on charging system components and model identification information, refer to the schematic located in the Wiring Diagram section.

Troubleshooting the Charging System

◆ **See Figure 77**

Don't waste your time with haphazard testing. The only way to ensure success (and the only way to avoid the possibility of accidentally replacing a good part) is to perform charging system testing in a logical and systematic manner.

Begin all electronic troubleshooting procedures by ensuring that wiring and connections are in good condition. Check battery condition and connections to make sure there is sufficient voltage to operate the system at start-up.

Before conducting any tests, double-check all wire colors and locations with the Wiring Diagrams provided in this section.

**** CAUTION**

During system testing, ALWAYS follow the steps of our procedures and any tool manufacturer's instructions closely to avoid injury or possible damage to the engine's charging system.

**** WARNING**

If, during testing, the engine is to be run at speeds over 2000 rpm, it must be mounted in a test tank using a suitable test wheel or placed in the water. Running the engine on a flushing device at speeds above 2000 rpm could allow the motor to run overspeed and possibly suffer severe mechanical damage.

Servicing charging systems is not difficult if you follow a few basic rules. Always start by verifying the problem.

- Do not automatically assume that the charging system is at fault.

A small draw with the key off, a battery with a low electrolyte level, or an overdrawn system can cause the same symptoms.

It has become common practice on outboard engines to overload the electrical system with accessories.

Where to Look	Cause	Procedure
Battery	1. Battery defective or worn out 2. Low electrolyte level 3. Terminal connections loose or corroded 4. Excessive electrical load	1. Check condition and charge 2. Add water and recharge 3. Clean and tighten 4. Evaluate accessory loads
Wiring	1. Connections loose or corroded 2. Stator leads shorted or grounded 3. Circuit wiring grounded	1. Clean and tighten 2. Perform ohmmeter tests 3. Perform ohmmeter tests
Coil (Stator, Battery charge, or AC Lighting)	1. Damaged stator windings 2. Weak flywheel magnets 3. Damaged stator leads	1. Perform ohmmeter tests 2. Perform running output tests 3. Perform ohmmeter tests
Rectifier	1. Damaged wiring or diodes	1. Perform rectifier ohmmeter tests
Rectifier/regulator	1. Inoperative rectifier/regulator	1. Perform variable load tests

Fig. 77 When inspecting and troubleshooting the charging system, check each of the components, as applicable. Charging systems are equipped with either a rectifier or a regulatorlrectifier. AC lighting coil models are not equipped with either, nor are they equipped with a battery

This places an excessive demand on the charging system. If the system is "overdrawn at the amp bank" then no amount of parts changing will fix it.

The charging system should be inspected if:

- The battery is undercharged (there is insufficient power to crank the starter)
- The battery is overcharged (electrolyte level is low and/or boiling out)
- The voltmeter on the instrument panel (if equipped) indicates improper charging (either high or low) voltage

A thorough, systematic approach to troubleshooting will pay big rewards. Build your troubleshooting check list with the most likely offenders at the top. Do not be tempted to throw parts at a problem without systematically troubleshooting the system first.

The starting point for all charging system problems begins with the inspection of the battery and related wiring. The battery must be in good condition and fully charged before system testing. Perform a visual check of the battery, wiring and fuses. Are there any new additions to the wiring? An excellent clue might be, "Everything was working OK until I added that live well pump." With a comment like this you would know where to check first (is the pump operating properly or did it increase total draw on the system past capacity).

1. Test the battery thoroughly. Check the electrolyte level, the wiring connections and perform a load test to verify condition.
2. Perform a fuse and Red wire (positive battery cable) check with the voltmeter. Verify the ground at the rectifier or regulatorlrectifier, Do you have 12 volts and a good fuse? While you are at the Red wire, check alternator output with an ammeter. Be sure the battery is down around 12 volts.
3. Do a draw test if it fits the symptoms. Many times a battery that will not charge overnight or week-to-week has a constant electrical draw applied that is always sapping a small amount of power. Put a test lamp or ammeter in the line with everything off and look for a draw.
4. A similar problem can be a system that is simply overdrawn. The electrical system cannot keep up with the demand. Do a consumption survey. More amps out than the alternator can return will require a different strategy.
5. Next, go to the source. Check the stator (battery charge) coil for correct resistance and/or shorts to ground.
6. If all these tests fail to pinpoint the problem and you have verified low or no output to the battery then replace the rectifier or regulator/rectifier.

On fully-regulated systems there is really only one cause for undercharging (unless the stator or wiring is damaged/corroded or the battery cannot accept a charge). If other components are in good shape, the only cause for undercharging on a regulated system is that the regulatorlrectifier is not working. Refer to the information under regulatorlrectifier for more testing hints.

**** WARNING**

Never operate a marine motor without providing a source of cooling water such as a test tank or flush fitting. It takes less than a minute to damage the water pump impeller that could lead to much more expensive powerhead failures later during normal motor usage. Use a **suitable** test wheel whenever possible, **but** remember that **for safety** the **propeller** should not be installed on motors when running on a flush **fitting.**

TESTING

**** WARNING**

To protect the motor and test equipment, perform voltage tests with the leads connected and the terminals exposed to accommodate test lead connection (unless specifically directed otherwise by our instructions). All electrical components must be securely grounded to the powerhead any time the engine is cranked or started or certain components could be damaged.

2 MODERATE

Quick Test

You can use a DVOM and a tachometer to get a quick idea whether or not the charging system is doing its job. For part of this test, the engine is run while a suitable source of water is supplied to the cooling system (such as a test tank or a flush fitting).

Fully regulated charging systems are designed to keep system voltage output around 14.5 volts in order to charge the battery to a point near 13 volts, Any regulated charging system that is putting out less than 12 volts or more than 15 volts indicates a problem. Undercharging could be a problem with a coil winding/wiring or the regulator/rectifier, while overcharging is usually the fault of the regulator/rectifier, but perform additional component tests as directed in this section to be sure.

☐ Remember that charging system problems are often caused by problems with the wiring harness. Loose and corroded connections can cause excessive resistance in the charging circuit. Similarly damaged wiring such as insulation that exposes the wire core because of burning, melting or wear from interference with moving components like the flywheel can cause shorts to ground preventing voltage from reaching the rectifier or **regulator/rectifier.**

**** WARNING**

Never operate a marine motor without providing a source of cooling water such as a test tank or flush fitting. It takes less than a minute to damage the water pump impeller that could lead to much more expensive powerhead failures later during normal motor usage. Use a suitable test wheel whenever possible, but remember that for safety the propeller should not be installed on motors when running on a flush fitting.

1. Make sure the ignition switch and all electrical boatlmotor accessories are turned OFF.
2. Connect a shop tachometer to the engine, following the instructions provided from the tool manufacturer.
3. With the engine not running, connect the red DVOM lead to the positive battery terminal and the black lead to a good engine ground. Read and record the voltage. If the battery is fully charged (reads more than 12.6 volts) apply a load to draw the system down slightly for testing purposes. Use boatlmotor mounted accessories for a few minutes such as search lights, trolling motors, power trim/tilt to drain the battery slightly, but not below 11.0 volts, then note the reading.
4. Start and run the engine until it warms, then allow it to run at slow idle. Again, check the DVOM and record the voltage produced by the charging system at idle.
5. Advance the throttle until the engine is running at or above 2000 rpm. Check the DVOM and record the voltage produced by the charging system above idle.
6. If the charging system is working at all, the voltage readings taken with the motor running at idle and above 2000 rpm should show an increase of at least 0.3 volt over the static reading of the battery prior to running the motor. If no voltage increase is noted, test statorlbattery charge coil and the rectifier or regulator/rectifier as detailed in this section.
7. If the charging system performed properly, but battery the battery is discharging (and the battery tests ok), take additional voltage readings, with the engine running above 2000 rpm, running at idle and engine stopped, but this time, turn on ALL boat and motor accessories. Again, the voltage must be at least 0.3 volt higher with the engine running than stopped or the stator/charge coil and the rectifier or regulator/rectifier should be tested. If component tests show that there is no problem, the system is being overtaxed by accessories (more amps are being withdrawn from the system than are available at the proverbial amp bank, don't use all those accessories at once).

3 DIFFICULT

Running Output Test

Except 26V Or 40V FICHT Systems

◆ See Figure 78

Using an ammeter and a tachometer you can determine if the charging system is operating to specification (generating sufficient amperage). This test requires running the engine across a wide portion of its powerband and is really best conducted with the motor in a test tank or attached to a boat that is firmly secured to a dock or navigated by an assistant.

We don't recommend running an engine above idle (and especially not, anywhere near wide open throttle) on a flush fitting as damage will likely occur as the engine is run overspeed.

1. Determine proper amperage output for the motor being tested. Refer to the information on Charging System Identification in this section and the General Engine System Specifications chart in the Maintenance and Tune-Up section.
2. Make sure the ignition switch and all electrical boatimotor accessories are turned **OFF.**
3. Connect a shop tachometer to the engine, following the instructions provided from the tool manufacturer.
4. With the engine not running, connect the red DVOM lead to the positive battery terminal and the black lead to a good engine ground.

Read and record the voltage. If the battery is fully charged (reads more than 12.6 volts) apply a load to draw the system down slightly for testing purposes. Use boatimotor mounted accessories for a few minutes such as search lights, trolling motors, power trim/tilt to drain the battery slightly, but not below 11.0 volts, then note the reading.

5. Connect an ammeter with at least 0-40 amp capacity in series with the battery, as follows:

On unregulated motors, disconnect the red rectifier lead from the terminal board, then insert the ammeter wiring between the terminal board and the rectifier.

- On regulated motors equipped with carburetors, disconnect the red regulatorlrectifier lead from the battery side of the starter solenoid, then connect the ammeter in series between the regulatorlrectifier red lead and the wiring harness red lead.

- On FICHT motors, disconnect the red lead on the battery side of the starter solenoid that feeds the main power relay. Connect the ammeter in series between the red wire for the relay and the appropriate terminal of the starter solenoid.

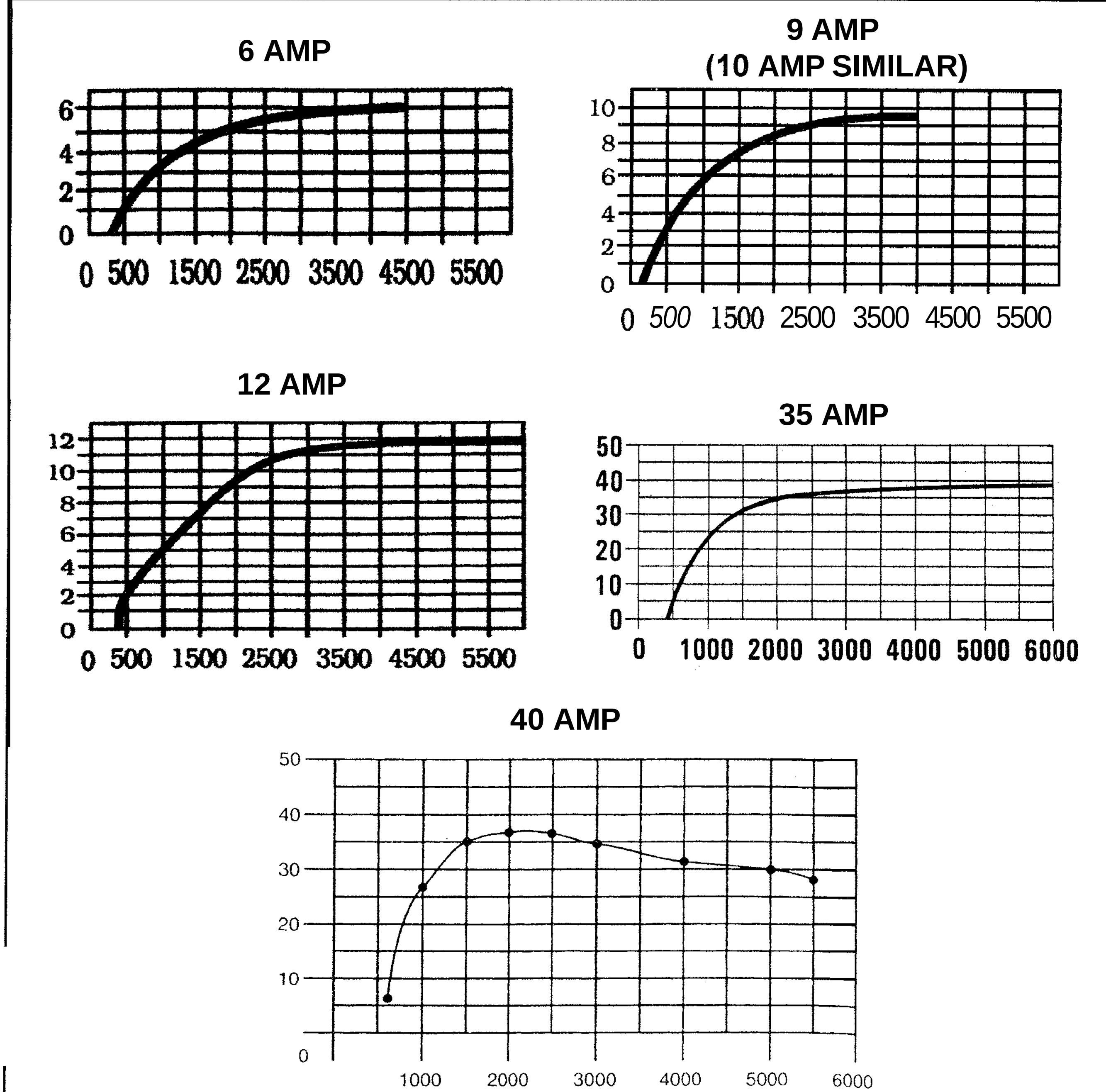


Fig. 78 Charging system amperage output at engine rpm-be sure to refer to the correct charge based on amperage rating for your charging system

✳✳ WARNING

Make sure no portion of the wiring (red lead, harness or ammeter leads) contacts engine ground while the engine is running or arcing will likely occur.

6. Start and run the engine until it warms, then allow it to run at slow idle. While the engine is running at idle compare the reading on the ammeter with the specified amperage output for that engine rpm on the accompanying charts.

This test is essentially the same as the variable-load test that is used to verify proper operation of the voltage **regulator. The** difference is that during the variable load test, you place **a** load on the battery using a variable load tester in order to draw power down and see how the regulator responds to the increase in load. **A** tester such as the Steven LB-85 or the Snap-On **MT540D** can be used to continue to place a load on the battery, prompting the charging system to keep maximum output during the test. Absent a tester, operate all boat mounted accessories (bait wells, bilge pumps, radios, lights etc) to keep a load on the system during testing.

7. Once the engine has warmed fully, slowly advance the throttle noting the ammeter readings at each 500 or 1000 rpm increase in speed. Generally speaking, output should increase in a linear fashion according to the output chart for the system being tested. However, note that output chart on some FICHT models (specifically the 40-amp charging system models equipped with fuel rails) actually peaks by 2000 rpm and declines slightly at higher speeds. If there is no output or output is incorrect, perform the statorlbattery charge coil and rectifier or regulator/rectifier tests in this section, as applicable.

DIFFICULT

FICHT Systems

FICHT motors contain two separate and distinct functioning sets of stator windings. The first, a 12-volt circuit, can be considered the equivalent of the battery charge circuit on carbureted outboards. The 12-volt charging circuit is checked using the Charging System Running Output Check, much in the same way as the 12-volt charging system is verified on carbureted motors.

However, the injector driver circuit is powered by a second 40-volt or 26-volt (depending on the model) set of windings. All 200 hp and larger motors, as well as all 2000 and later 75-175 hp motors (that are NOT equipped with fuel rails) use a 40-volt charging circuit. All 1501175 hp motors equipped with fuel rails, as well as all 1999 and earlier FICHT motors of 175 hp or less are equipped with a 26-volt charging circuit. The difference becomes important when testing the stator.

A voltmeter can be used to verify proper voltage output on the 26- or 40-volt charging circuit. This test is made with the engine running at 1000 rpm, so it can be done on a flush fitting, but a test tank or dockside is still a more convenient way to perform the check. In all cases, just make sure a source of cooling water is used.

1. Make sure the ignition switch and all electrical boat/motor accessories are turned OFF.
2. Connect a shop tachometer to the engine, following the instructions provided from the tool manufacturer.
3. With the engine not running, connect the red DVOM lead to fuse position No. 5 in the power distribution block (fuse box). Connect the black lead to the battery ground cable or a good ground on the engine block. Voltage should be 0.5-1.0 volts less than current battery readings.

On the 40-volt system used on 200 hp and large motors, voltage output must be at least 24 volts at idle and **39** volts or more by 1500 rpm.

4. Start and run the engine at 1000 rprn (1500 rpm for 200 hp and larger motors), recheck the voltage at fuse position No. 5, it should now be 26-28 volts (on 26-volt models) or 40-42 volts (on 40-volt models).

If not, check the wiring harness and stator 26- or 40-volt windings. If no problems are found in the harness or stator windings, suspect the regulator (which is internal to the EMM on some 40-volt models).

DIFFICULT

Electric System Current Draw Test

Using an ammeter you can determine if the total load of all electrical accessories on the boat/motor exceed the total capability of the charging system to produce power. The ammeter should be rated for at least 3-5 amps more than the charging system rating, meaning a minimum of 9 amps on the smallest, unregulated charging systems or as much as 45 amps for the most powerful systems (which are found on some FFI motors).

To help determine the rated output for the charging system of the motor being tested, please refer to the information on Charging System Identification in this section.

1. Install an ammeter as follows:
   a. Unless an inductive ammeter is being used, disconnect the negative cable, followed by the positive cable from the battery. Install the ammeter between the positive battery post and cable then reconnect the negative battery cable.
   b. If using an inductive ammeter, attach the inductive pickup clamp to the positive battery cable following any instructions provided by the tool manufacturer.

2. Turn the ignition keyswitch ON to the RUN position, but do not start the engine. Turn on all boatimotor accessories (radios, spot lights, trolling motors etc) and note the reading on the ammeter.

3. If the reading exceeds charging system output, turn off accessories one at a time (noting the difference in the reading each time) to determine the individual loads provided by each accessory. This will tell you what accessories can be used together in order to prevent discharging the battery while the motor is running.

Stator/Battery Charge Coil

◆ **See** Figure **75**

All models equipped with a marine battery and charging system are equipped a 1-piece stator. that incoroorates the windinqs of the battery charge and, on carbureted motors, the ignition charge coils. The battery charge coils of the stator can be tested (independently of the power and/or charge coils on carbureted motors) using the proper winding leads.

The statorlbattery charge coil consists of a series of metal windings that are used generate Alternating Current (AC) voltage current that is then converted to Direct Current (DC) by a rectifier or, more commonly, a regulator/rectifier. Current is generated with the help a magnetic field generated by permanent magnets that are attached to the flywheel and which rotate past the coil winding repeatedly during engine operation. The rectified DC current is used to recharge the marine battery and supply voltage to the boat and motor electrical accessories whenever the engine is running.

FICHT motors contain two separate and distinct functioning sets of stator windings. The first, a 12-volt circuit, can be considered the equivalent of the battery charge circuit on carbureted outboards. The injector driver circuit is powered by a second 40-volt or 26-volt (depending on the model) set of windings. All 200 hp and larger motors, as well as all 2000 and later 75-175 hp motors (that are NOT equipped with fuel rails) use a 40-volt charging circuit. All 1501175 hp motors equipped with fuel rails, as well as all 1999 and earlier FICHT motors of 175 hp or less are equipped with a 26-volt charging circuit. The difference becomes important when testing the stator.

In all cases the statorlbattery charge coil is mounted directly underneath the flywheel. Testing occurs through the wiring harness, but removal and replacement of the coil requires removal of the flywheel for access.

TESTING

DIFFICULT

◆ See Figure 79

Before testing, make sure all connections and mounting bolts are clean and tight. Many charging system problems are related to loose and corroded terminals or bad grounds. Don't overlook the engine ground connection to the body.

Since most stator/battery charge coil test values are near or below 1 ohm, testing requires the use of a high quality Digital Volt Ohmmeter (DVOM). As with all resistance testing, care must be taken as specifications are determined by testing components that are precisely 68°F (20°C) and readings taken on components at other temperatures will vary. Also, keep in mind that certain intermittent problems (such as certain internal shorts) might only appear when the coil is put under a load during normal operation or at certain operating temperatures. Therefore, dynamic checks such as those provided under the Charging System Running Output Test and Charging System Quick Test may show problems that do not surface when only conducting a resistance check.

During testing the coil winding resistance is checked across various combinations of the stator coil wiring (yellow or yellow with trace color wires) in order to see if the circuit contains the proper amount of resistance and is therefore complete, yet containing no internal shorts between coils. On FICHT motors, both the 12-volt and the 26- or 40-volt windings of the stator must be checked separately. On these motors the 12-volt leads are yellow or yellow with trace colors while the 26- or 40-volt leads are usually brown or brown with trace colors (or they are yellow wires of different lengths, depending on the model). In all cases, each stator lead is then checked between the coil and a good engine ground to make sure no coil winding is shorted to ground. If opens or shorts are found. the wiring harness should be checked for damage (when present, visible signs of broken or worn insulation are usually the cause of the problem) before deciding to replace the coil itself,

Carbureted Motors

+ See Figure 79

1. Disconnect the negative battery cable for safety and to protect the test equipment.
2. Locate the yellow (and yellow with a trace color) wiring for the stator. Trace the wiring from under the edge of the flywheel to the harness or terminal board connectors, as applicable.
3. Disconnect the stator battery charge circuit wiring from the terminal board or disengage the harness connector, as applicable, for access while testing with the DVOM. Inspect the terminals for corrosion or damage and clean or replace them, as necessary.

■ **As usual on outboards, take note of wire routing before disconnecting them. Wires must always be returned to the original position/routing in order to prevent interference with and damage from moving components.**

4. Using the DVOM set to its lowest resistance scale, connect one meter probe to the yellow and the other meter probe to the yellowlgray wire and compare the readings to specification, as follows:
 - **6-amp charging systems** resistance should be 1.2-1.7 ohms.
 - **9 or 10-amp charging systems** resistance should be 0.65-0.75 ohms.
 - **20-amp charging systems** resistance should be 0.175-0.195 ohms.
 - **35-amp charging systems on 60° powerheads** resistance should be 0.05-0.19 ohms.
 - **35-amp charging systems on 90° powerheads** resistance should be 0.11-0.21 ohms.

Check the information under Charging System Identification in this section and the General Systems Specifications Chart from the Maintenance and Tune-Up section for details on charging system capacities.

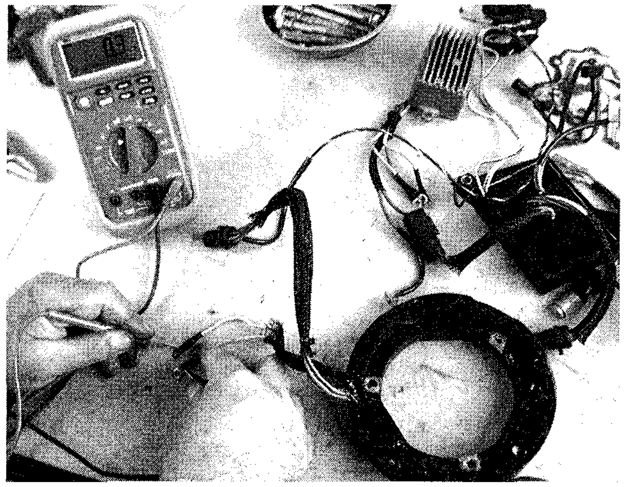


Fig. 79 Testing the statorlbattery charge coil involves using an ohmmeter to check resistance across various terminals-note removal is NOT necessary (or even preferred) for testing

5. If resistance readings are out of specification, recheck connections to ensure proper testing readings (and make sure the components are being tested at the proper temperature). Double-check the wiring harness for any problems and, if none are found, replace the stator.
6. Check the stator/battery charge coil winding and harness for shorts to ground as follows. Connect one meter probe to a good engine ground, then probe each of the statoribattery charge coil wires (yellow or yellow with tracer) in turn using the other probe. Resistance should be high or infinite in all cases, or there is a short to ground. If a short is present either repair the wiring harness or replace the stator, as applicable.
7. Once the tests and/or repairs are completed, be sure to route the wires as noted before removal to ensure there is no interference with moving components (such as the flywheel).
8. Connect the negative battery cable.

Fuel Injected Motors

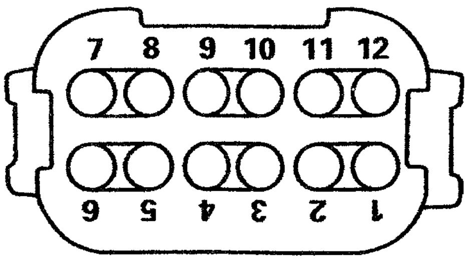
◆ See Figures 80 and 81

For some reason Evinrude/Johnson decided to make the wire colors the same for the 12-volt battery charging circuit and the 26-volt injector driver voltage supply circuit on the 26-volt FICHT motors. They also did this to the 40-volt, 200 hp and larger motors, prior to 2000. So, how do you tell what wires to test? Easy really, the 12-volt wires are the LONGER set of yellow wires connecting to the starboard side of the regulator. The harness for the 26-volt windings (or the 40-volt windings on pre-2000 model year 200 hp and larger motors) is the shorter set of wires connected to the port side of the regulator.

On all 2000 and later 40-volt models, it is a lot easier to tell the difference. The 12-volt battery charge harness contains the yellow wires routed into the 12-pin battery connector for the EMM. The 40-volt injector driver voltage supply harness contains the brown wires routed into the 8-pin injector connector for the EMM.

1. Disconnect the negative battery cable for safety and to protect the test equipment.
2. Locate the yellow (and yellow with a trace color) wiring for the stator as follows:
 - On 26-volt models (or pre-2000 40-volt models), trace the longer set of yellow wires from underneath the flywheel to the starboard side of the regulator/rectifier.
 - On 2000 and later 40-volt models, locate the yellow stator wires at the EMM, in the 12-pin battery connector.

☐ **Even though we are using the injector driver circuit capacity (26- or 40-volt) to tell the difference between FICHT motors in the previous step, we are still only testing the 12-volt windings of battery charging circuit at this point in the procedure. The 26- or 40-volt windings for the injector driver circuit are tested later in this procedure.**



BATTERY

Fig. 80 Terminal location and identification(pin-outs) for the EMM battery harness connector-2000 and later FICHT motors with 40-volt systems (12-volt winding tested through this harness)

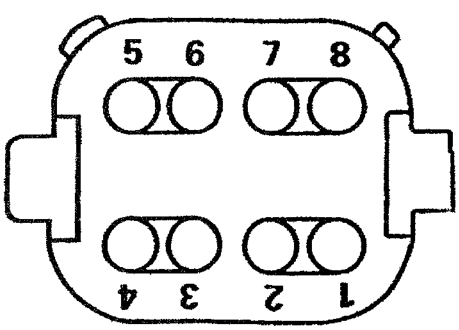
3. Disconnect the stator battery charge circuit wiring from the regulator (26-volt models) or EMM (40-volt models), as applicable, for access while testing with the DVOM. Inspect the terminals for corrosion or damage and clean or replace them, as necessary.

■ **As usual on outboards, take note of wire routing before disconnecting them. Wires must always be returned to the original positionlrouting in order to prevent interference with and damage from moving components.**

4. Using the DVOM set to its lowest resistance scale, probe across the appropriate pairs of wires and compare the readings to specification, as follows:

26-volt models (or pre-2000 40-volt models) connect one probe to any of the 3 stator harness wires (yellow, yellowlblue or yellowlgray) and the other probe to one of the 2 remaining wire. Note the reading, then move one probe to the 3rd wire and note the reading. Finally relocate the probe that was not moved in the second check to the other wire from the first check and note the reading (in this way you will have checked across all possible combinations of the 3 terminals). In all cases, the meter should show 0.1-0.3 ohms (if the wires show 0.3-0.5 ohms, make sure you haven't probed the 26-volt winding by accident).

2000 and later 40-volt models use the EMM harness connector to probe back through the wiring harness across the across the appropriate combinations of the yellow stator wires. First connect the probes to terminals 1 and 2 (yellowlblack and yellow/purple). Then connect the probes to terminals 3 and 4 (yellow and yellowlblue wires). Continue to probe the connector pairs, terminals 5 and 6 (yellow/gray and yellow/green), terminals 7 and 8 (yellow/green and yellow/gray), terminals 9 and 10 (yellow/blue and yellow) and finally terminals 11 and 12 (yellowlpurple and yellowlblack). Note the reading on each pair of terminals and compare them all to specification. In all cases, the meter should show 0.190-0.240 ohms.



INJECTOR

Fig. 81 Terminal location and identification(pin-outs) for the EMM injector harness connector-2000 and later FICHT motors with 40-volt systems (40-volt winding tested through this harness)

5. If resistance readings across any pair of the appropriate terminals are out of specification, recheck connections to ensure proper testing readings (and make sure the components are being tested at the proper temperature). Double-check the wiring harness for any problems and, if none are found, replace the stator.

6. Check the stator/12-volt battery charge coil windings and harnesses for shorts to ground as follows. Connect one meter probe to a good engine ground, then probe each of the EMM battery terminals of the harness connector in turn using the other probe. Resistance should be high or infinite in all cases, or there is a short to ground. If a short is present either repair the wiring harness or replace the stator, as applicable.

7. If tests are within specification, reconnect the 12-volt wiring and locate the injector driver voltage supply circuit (26- or 40-volt) wiring for testing as follows:

On 26-volt models (or pre-2000 40-volt models), trace the **shorter** set of yellow wires from underneath the flywheel to the **port** side of the regulator/rectifier.

- On 2000 and later 40-volt models, locate the brown stator wires at the EMM, in the 8-pin injector connector.

8. Disconnect the stator injector driver voltage supply circuit wiring from the regulator (26-volt models or pre-2000 40-volt models) or EMM (2000 and later 40-volt models), as applicable, for access while testing with the DVOM. Inspect the terminals for corrosion or damage and clean or replace them, as necessary.

Once again, take note of wire routing before disconnecting them. Wires must always be returned to the original position/routing in order to prevent interference with and damage from moving components.

9. Using the DVOM set to its lowest resistance scale, probe across the appropriate pairs of wires and compare the readings to specification, as follows:

26-volt models (or pre-2000 40-volt models) connect one probe to any of the 3 stator harness wires (yellow, yellow/blue or yellowlgray) and the other probe to one of the 2 remaining wire. Note the reading, then move one probe to the 3rd wire and note the reading. Finally relocate the probe that was not moved in the second check to the other wire from the first check and note the reading (in this way you will have checked across all possible combinations of the 3 terminals). In all cases, the meter should show 0.3-0.5 ohms (if the wires show 0.1-0.3 ohms, make sure you haven't probed the longer 12-volt winding harness by accident).

- **2000 and later 40-volt models** use the EMM injector harness connector to probe back through the wiring harness across the across the appropriate combinations of the brown stator wires. First connect the probes to terminals **8** and ▮ (brownlyellow and brownlblack). Then connect the probes to terminals 7 and **2** (brownlgreen and brownlorange wires). Finally, probe terminals **6** and 3 (brown and brown/white). Note the reading on each pair of terminals and compare them all to specification. In all cases, the meter should show 0.180-0.285 ohms.

10. If resistance readings across any pair of the appropriate terminals are out of specification, recheck connections to ensure proper testing readings (and make sure the components are being tested at the proper temperature). Double-check the wiring harness for any problems and, if none are found, replace the stator.

11. Check the stator 26- or 40-volt injector driver supply coil windings and harnesses for shorts to ground as follows. Connect one meter probe to a good engine ground, then probe each of the EMM injector harness terminals or stator wire leads checked in the previous step in turn using the other probe. Resistance should be high or infinite in all cases, or there is a short to ground. If a short is present either repair the wiring harness or replace the stator, as applicable.

12. Once the tests and/or repairs are completed, be sure to route and connect the wires as noted before removal to ensure there is no interference with moving components (such as the flywheel).

13. Connect the negative battery cable.

■ **Remember that static tests will often hide problems that occur when the engine or system is operating under a load. A stator that tests within specification during resistance testing, may still contain an intermittent short under load and not generate the appropriate amount of voltage. For this reason, we recommend that a performing cranking voltage or running tests before deciding that the stator is good. A cranking test is available for 2000 and later motors equipped with 40-volt systems. For running output tests, please refer to Charging System Running Output Test and 26- or 40-Volt FICHT Charging System Running Output Test, located earlier in this section.**

14. To check the cranking stator voltages on 2000 and later 40-volt models, disconnect the crankshaft position sensor, then proceed as follows:

a. If reconnected, disengage the 12-pin battery connector from the EMM. Using a DVOM set to read AC volts, probe each of the terminal pairs checked earlier for resistance. In turn probe terminals **1** and **2**, **3** and **4**, **5** and **6**, **7** and **8**, **9** and **10**, and finally **11** and **12**. Each time, crank the motor using a fully charged battery and making sure that powerhead speed is at least 150-225 rpm. Each time, the meter should show 3.0-4.7 volts.

b. If reconnected, disengage the 8-pin injector connector from the EMM. Using a DVOM set to read AC volts, probe each of the terminal pairs checked earlier for resistance. In turn probe terminals **8** and **1**, **6** and **3**, and finally **7** and **2**. Each time, crank the motor using a fully charged battery and making sure that powerhead speed is at least 150-225 rpm. The meter should show 3.7-5.7 volts across terminals **8** and **1**, as well as terminals **6** and **3**, but should only show 2.6-4.1 volts across terminals **7** and **2**.

c. If readings are below specification, suspect the stator.

d. Reconnect all wiring.

OEM ② MODERATE

REMOVING & INSTALLATION

◆ See Figures **82** and **83**

Carbureted Motors

The charge coil windings are integrated into the I-piece stator assembly mounted directly under the flywheel. Once the flywheel is removed for access; removal and installation is a relatively simple matter of tagging and disconnecting the wiring and unbolting the stator itself.

✳✳ WARNING

Refer to Flywheel in the Powerhead section for details on removal and installation. Do not risk damage to the flywheel itself by using an improper holding tool (**i.e.** a **prybar** on one of the ring gear teeth) or using an improper puller (a jawed instead of a threaded puller, for instance). Handle the flywheel with care, never strike or jar the flywheel for fear of **breaking/cracking** the housing or damaging the permanent magnets used **by** the stator to generate current.

■ Prior to removal, make a quick sketch or take a photograph (aren't digital cameras great?) of the wire harness routing. During installation, be sure to position all wires as noted before removal so as to prevent possible interference with moving parts. Remember that contact with a component such as the flywheel could break wear through the insulation or the wires themselves. An exposed portion of wire could short damaging the coil windings or other components in the system.

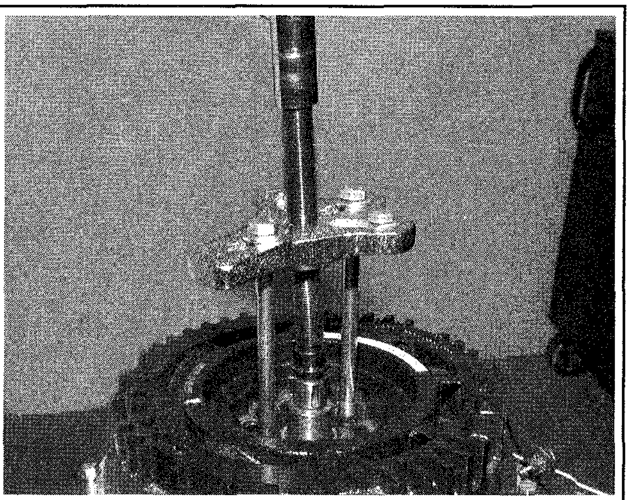


Fig. **82** A universal puller usually makes flywheel removal much easier

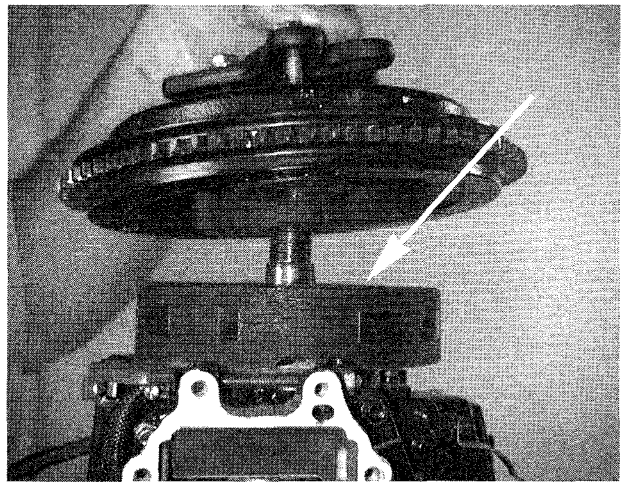


Fig. **83** The statorlbattery charge coil is mounted directly underneath the flywheel

1. Disconnect the negative battery cable for safety.
2. Remove the Flywheel, as detailed in the Powerhead section
3. On 60° motors, remove the regulator cover for access.

■ On most models you will have to cut one or more wire ties securing the harness in **position. Take** close note of the wire tie locations for installation purposes. Also, for some models, like **60°** powerheads, you'll have to carefully remove the harness grommet to free the harness from the cylinder block.

4. Tag and disengage the stator wiring.

■ On 600 motors, disengage the multi-pin connector at the power pack and the 2-pin connector for the voltage regulator or, for rope start models, the leads from the terminal board.

■ On 900 motors, disengage the inline engine harness connectors (there may be 2, 3 or 4 connectors depending on the model) and the brown and/or yellow stator leads at the terminal board. Keep in mind that the sensor coil wiring is also coming out of this general area, but it is NOT necessary to disconnect it, unless the sensor coil is also being serviced. Generally speaking the stator (power and/or charge coil wiring is orange, yellow and brown with various tracer colors).

■ We said **to TAG** and disconnect the wiring and we meant it. It is one thing if you only have **2** wiring connectors of different sizes and shapes (as on some **60°** powerheads), but if you've got multiple connectors of the same size as **and/or** ring terminals attached to a terminal board, proper installation is CRITICAL to powerhead operation. Don't take any chances, take a photo, write and note and tag them before removal.

5. Loosen the screws retaining the stator coil to the powerhead, then remove the stator assembly.

To install:

6. Carefully inspect the stator mounting surface and retaining screw holes for signs of corrosion or varnish. For proper operation, the stator MUST have a clean, metal-to-metal contact with the powerhead and retaining screws.
7. Place the stator coil in position on the powerhead, and position the wiring harnesses as noted during removal. MAKE SURE that each wire is positioned so to ensure it will not contact moving components. If used, reseat any grommets in the powerhead.
8. Throughly clean the stator retaining screw threads. Be sure to remove all traces of corrosion or sealant. Apply a light coating of Evinrude/Johnson Locquic Primer or equivalent to the screw threads and allow it to dry then apply a light coating of Evinrude/Johnson Nut Lock, or equivalent threadlock.
9. Install the stator retaining screws and tighten to 120-144 inch lbs. (14-16 Nm).

10. Reconnect the stator wiring as tagged and noted during removal. If any wires are attached to a terminal strip, coat the ends lightly using Evinrude/Johnson Neoprene Dip or equivalent sealant to protect them from moisture and keep them from loosening. Secure the harnesses usina new wire ties in the original tie locations, again, as noted during removal–

Double-check the positioning of all wires that were disturbed during service. Make sure the wires are routed properly and, any wire ties that were removed, are replaced with new ties.

11. On 60º motors, install the regulator cover.
12. Install the Flywheel, as detailed under Powerhead.
13. Connect the negative battery cable.

Fuel Injected Motors

◆ See Figures **82** and **83**

On FFI motors, the stator coil is more than just an ignition component, as it also contains 26- or 40-volt windings that provide power to the fuel injector drivers. The I-piece stator used on all FFI motors however is removed and installed in essentially the same manner. For what we hope are obvious reasons, the flywheel must be removed for access.

**** WARNING**

Refer to Flywheel in the Powerhead section for details on removal and installation. Do not risk damage to the flywheel itself by using an improper holding tool **(i.e.** a **prybar** on one of the ring gear teeth) or using an improper puller (a jawed instead of a threaded puller, for instance). Handle the flywheel with care, never strike or jar the flywheel for fear of **breaking/cracking** the housing or damaging the permanent magnets used by the stator to generate current.

☐ Prior to removal, make a quick sketch or take a photograph (aren't digital cameras great?) of the wire harness routing. During installation, be sure to position all wires as noted before removal so as to prevent possible interference with moving parts. Remember that contact with a component such as the flywheel could break wear through the insulation or the wires themselves. An exposed portion of wire could short damaging the coil windings or other components in the system.

1. Disconnect the negative battery cable for safety.
2. Remove the Flywheel, as detailed in the Powerhead section.

☐ On most models you will have to cut one or more wire ties **securing** the harness in **position. Take** close note of the wire tie **locations** for installation'purposes. Also, for some models, you may have to carefully remove a harness grommet to free the harness from the powerhead.

3. Tag and disengage the stator wiring.

On all pre-2000 motors and 2000 and later 1501175 hp motors equipped with fuel rails, tag and disconnect the various yellow wire leads from the starboard and port side of the voltage regulator. Be VERY careful not to mix these leads up as the longer length wires (which attach to the starboard side) are for the 12-volt windings while the shorter length wires (which attach to the port side) are for the 26- or 40-volt windings.

On all 2000 and later models not equipped with fuel rails, disconnect the 12-pin battery harness connector (containing yellow wires) and the 8-pin injector harness connector (containing brown wires) from the side of the EMM.

☐ We said to TAG and disconnect the wiring and we meant it. OK, if you're working on a **2000** or later 40-volt model (with the **12-** and 8- pin wiring connectors, it would be really difficult to mess it up). But, if you're working on a model that contains a separate voltage regulator, the fact that both sets of wires use the same colors (even if the harnesses are separate lengths) only invites trouble. Don't take any chances, take a photo, write and note and tag them before removal.

4. Loosen the screws retaining the stator coil to the powerhead, then remove the stator assembly.

To install:

5. Carefully inspect the stator mounting surface and retaining screw holes for signs of corrosion or varnish. For proper operation, the stator MUST have a clean, metal-to-metal contact with the powerhead and retaining screws.
6. Place the stator coil in position on the powerhead, and position the wiring harnesses as noted during removal. MAKE SURE that each wire is positioned so to ensure it will not contact moving components. If used, reseat any grommets in the powerhead.
7. Apply a coating of EvinrudelJohnson Nut Lock or equivalent thread-locking compound to the threads of the stator retaining screws, then install. Tighten the screws to 25-35 inch lbs. (2.8-4 Nm) for all models, except 2000 and later 1501175 hp motors equipped with fuel rails, on which the stator screws must be tightened to 120-144 inch lbs. (14-16 Nm).
8. Route the stator wiring as noted during removal to prevent damage and reconnect the wiring harness. For models using an external regulator, attach the wires and securely tighten the wire nuts.

☐ Double-check the positioning of all wires that were disturbed during service. Make sure the wires are routed properly and, any wire ties that were removed, are replaced with new ties.

9. install the Flywheel, as detailed under Powerhead.
10. Connect the negative battery cable.

Rectifier

◆ See Figure **84**

The battery charging system found on carbureted models is either non-regulated (the vast minority) or fully-regulated (the vast majority) depending on model design parameters. Generally speaking, EvinrudelJohnson V-motors were equipped with a fully-regulated system. However, some of the 65 Jet-115 Hp (1632cc) 90º CV4 motors may have been equipped with a non-regulated 6-amp charging system. These systems are equipped with a rectifier whose purpose is to convert the Alternating Current (AC) voltage produced by the battery charge coil windings into Direct Current (DC) voltage for use in charging the battery.

These systems are known as non-regulated because there is no electronic control for the amount of current put out. Whenever the engine is running, voltage is produced to charge the battery. These systems have a much lower amperage output (6-amps, as opposed to 9-40 amps on other models) in order to help reduce the possibility of overcharging the battery during engine operation. Of course, extended full-throttle operation on a boat with an otherwise fully-charged battery and no other electrical accessories could lead to overcharging and boiling away of electrolyte. This makes periodic battery maintenance even more important on these models to prevent the possibility of premature battery failure.

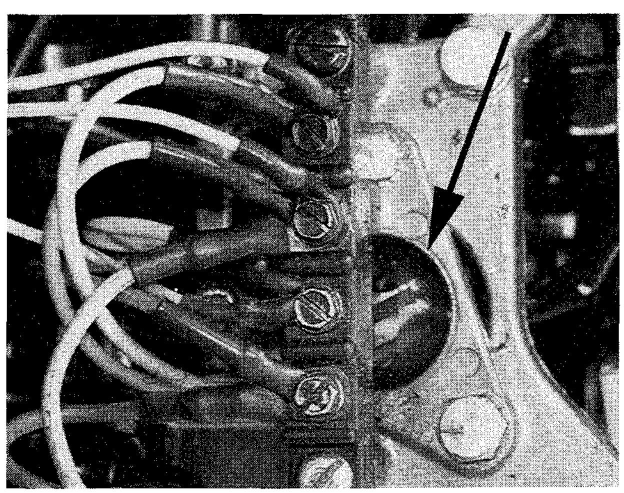


Fig. 84 When equipped, the voltage rectifier is normally mounted immediately adjacent to the wire terminal strip on these models

■ The rectifier can be visually identified by following the yellow (and yellow with tracer) wiring for the battery charge coil from **underneath** the flywheel (through the **terminal board)** to a smooth, round **component** mounted to a small triangular base (the rectifier) mounted immediately adjacent to the **terminal** board. **If** these wire's instead are connected to a roughly rectangular (and sometimes finned for cooling) box, the motor is equipped with a regulated system and uses a **regulator/rectifier** instead of the rectifier we discuss here.

TESTING

DIFFICULT

◆ See Figures **84, 85** and **86**

Rectifiers use diodes to act as one-way electrical check valves, thereby converting Alternating Current (AC) to Direct Current (DC). Therefore you. may test a rectifier bv using an ohmmeter to see if the rectifier will only pass current in one directibn. Essentially the test is conducted by connecting the ohmmeter probes, one to a common ground and one to a lead (terminal) coming from the rectifier. Using the high ohm scale, look for a reading, then reverse the leads. There should be no reading (infinity) in one direction, but continuity in the other. This means the diode is good. Repeat the test on the other leads. Also test between the red lead and the other two leads (terminals). A normal diode will show a reading. For step-by-step instructions, proceed as follows:

1. Disconnect the negative battery cable for safety and to protect the test equipment.

■ The rectifier on these models uses 3 leads, red, yellow and **yellow/gray.** The wiring is usually connected to a ring terminal board.

2. To ensure proper installation, note the wire harness routing and connection points. Of course, the wiring is usually very short on these models so the routing shouldn't be as critical an issue as it is on some outboards. Then, disconnect the rectifier lead ring terminals from the terminal board.

■ If necessary, refer to the schematics found under Wiring Diagrams in this section for more details on wire colors and connections.

3. Connect the black probe of a DVOM set to read resistance to a good engine ground, then connect the red probe to the yellowlgray lead. Note the reading on the meter, then reverse the leads (or, if the DVOM is equipped, press the reverse polarity button on the meter) and note the reading. The readings must be high in one direction and low in the other, indicating the diode inside the rectifier is good. If readings are the same (high or low) in both directions, the diode is damaged and the rectifier must be replaced.
4. Repeat the previous step for the yellow lead.

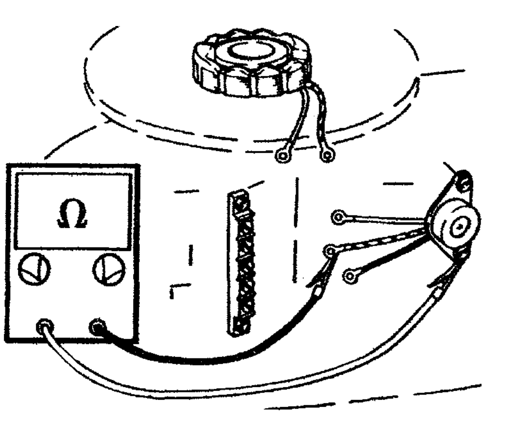


Fig. **85** Rectifier testing involves checking between various yellow leads and ground for continuity in only one direction**...**

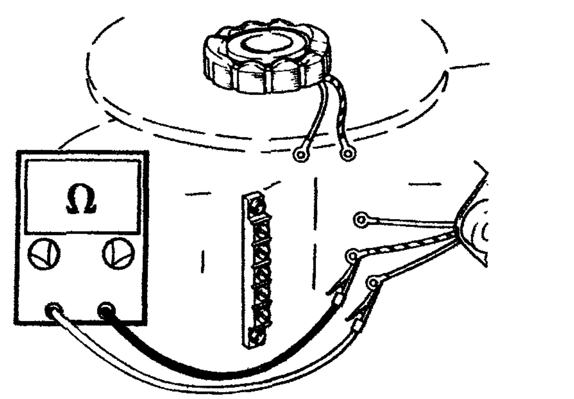


Fig. **86** **...**then checking between the red rectifier lead and the various yellow leads for continuity in only one direction

5. Connect the black DVOM probe to the red rectifier lead, then connect the red probe to the rectifier yellowlgray lead. Reverse the leads or press the polarity button and compare the results. The readings must be high in one direction and low in the other, indicating the diode inside the rectifier is good. If readings are the same (high or low) in both directions, the diode is damaged and the rectifier must be replaced.
6. Repeat the previous step connecting the red probe to the yellow lead.
7. If test results vary, verify all test connections and results, then replace the rectifier.
8. After testing and/or repairs, route the wiring and secure it to the terminal board or connectors as noted during removal.
9. Reconnect the negative battery cable.

REMOVAL & INSTALLATION

EASY

◆ See Figure **84**

To help locate the smooth round metal cased rectifier (mounted to a triangular bracket), trace the yellow (and yellow with tracer) wires from under the flywheel through the terminal board to the rectifier.

1. Disconnect the negative battery cable for safety.

The rectifier used on these motors uses 3 leads, red, yellow and **yellow/gray. They** are normally connected directly to the adjacent terminal strip.

2. To ensure proper installation, note the wire harness routing and all of the connection points, then disconnect the rectifier lead ring terminals from the terminal board.

■ If necessary, refer to the schematics found under Wiring Diagrams in this section for more details on wire colors and connections.

3. Remove the mounting screws from the triangular bracket and then remove the rectifier from the powerhead.

■ The rectifier mounting screws on some models require the use of an appropriate sized **Torx®** bit.

To install:

4. Clean the rectifier mounting area, along with the powerhead and screw threads of any dirt, corrosion or debris.
5. Inspect the rectifier terminal wiring and connectors for damage or corrosion and repair, clean or replace, as necessary.
6. Position the rectifier and tighten the mounting bolts securely.
7. Properly route and reconnect the rectifier wiring as noted during removal.
8. Reconnect the negative battery cable.

Regulator/Rectifier

Although there are a few carbureted models that are equipped with either a non-regulated battery charge system or an AC lighting coil, the vast majority of Evinrude/Johnson V motors are equipped with a fully-regulated battery charging system.

These systems are equipped with a regulatorlrectifierthat serves a dual purpose. Just like a rectifier, the regulator/rectifier first and foremost converts the Alternating Current (AC) voltage produced by the battery charge coil windings of the stator into Direct Current (DC) voltage for use in charging the battery. Then, the regulator portion of the circuitry is used to control the amount of voltagelcurrentthat is supplied to the battery, in order to prevent overcharging. This type of a charging system works on the same principles and in the same basic manner as the charging system in your car or truck.

These systems tend to have higher amperage output (9-40-amps depending on the model) in order to meet the larger demands of boat and motor electrical accessories that come with larger motors and boats. Also, the fact that the charging circuit is regulated or controlled to protect the battery allows the system to generate more power without the worry that the battery will be damaged.

5 The **regulator/rectifier** can be visually identified by following the yellow (and yellow with tracer) wiring for the stator battery charge coil from underneath the flywheel (through the terminal board when used) to a finned, rectangular or semi-rectangular box (the **regulator/rectifier).** If these wires instead are connected a smooth, round component mounted to a small triangular base (the rectifier), the motor is equipped with a non-regulated system and uses a rectifier instead of the **regulator/rectifier** we discuss here.

Although the location and appearance of the **regulator/rectifier** varies slightly by model, it can be easily found by tracing the yellow stator battery charge coil wires from underneath the flywheel (and through the terminal board on some models) to the **regulator/rectifier** assembly.

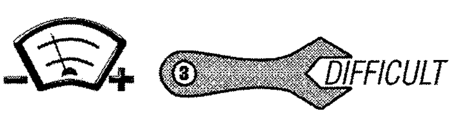
Although **many** FICHT models are **equipped** with an external regulator, **all 2000 and** later models that are NOT equipped with hard fuel rails utilize an Engine Management Module (EMM) that contains built-in **regulator/rectifier** circuitry.

On carbureted engines the regulator/rectifier is normally mounted on the too rear of the side of the powerhead. In many cases it is located under a cover. For 65 Jet-115 Hp (1632cc) 90CV4 motors, the regulator may be partially obscured by the flywheel and stator. For 80 Jet-175 Hp (1726/2589cc) 60LV4/V6 motors, the regulator is located under the regulator/ignition cover assembly. For 120-300 Hp (2000/3000/4000cc) 90LV4/V6/V8 motors the regulator is normally found under the electrical component bracket (which must be swung aside for access).

On FICHT motors the regulator is either integrated into the EMM or it is mounted separately either under the flywheel or EMM. All 2000 and later motors that are NOT equipped with fuel rails utilize an EMM with integral regulator/rectifier circuitry. For 200 and larger horsepower motors before the 2000 model year the regulator/rectifier is mounted under the flywheel. On 175 hp and smaller motors before the 2000 model year and all 1501175 hp motors equipped with hard fuel rails, the regulator/rectifier is mounted under the EMM. Whenever the regulator/rectifier is mounted separately on FICHT motors, it is mounted in a water-cooled passage to help prevent the possibility of overheating and burning out the unit.

■ If necessary, refer to the schematics provided under Wiring Diagrams in this section to help locate the **regulator/rectifier** and wiring necessary for these procedures.

TESTING



◆ See Figures **87** and **88**

The only reliable way to test the regulator/rectifier is observe its affect on charging system output when a battery is fully charged as opposed to when a battery is discharged. The safest and easiest method to perform this test is using a ammeter to monitor charging system output in amps while a carbon pile load tester (such as the Stevens LB-85 or the Snap-On MT540D) is used to draw down power from the battery.

■ It may be possible to simulate the affect of the carbon pile load tester by performing the test using different batteries, one fully or near fully charged and the other near fully **discharged. The** only problem is how to start the motor with the near fully discharged **battery. The** best method would be to use a battery switch and **start** the motor on the charged battery, then switch over to the discharged unit in order to full **field the regulator** (in order to see how the **regulator** reacts when it gets a signal that the battery is discharged). It might also be possible to jump-start the motor, as connecting a booster battery just long enough to get the motor running should not appreciably charge the "discharged" battery so test readings would still likely be valid. Of course, both methods are really not performing the test the proper way, so to be sure of your results, beg or borrow a carbon pile load tester.

✳✳ WARNING

We do not recommend using a dual-battery switch to change between the charged and the discharged battery while the motor is running on FFI units as voltage spikes could damage solid state electronic modules like the EMM on FFI motors. Of course, a similar, but lesser danger exists to the power pack on carbureted engines as well. Do you see a pattern here, obtain a carbon pile load tester.

Perform these tests with the motor in a test tank or with the motor properly mounted on a boat that is either firmly secured to a dock, or underway and under navigation by an assistant. The test will involve running the engine under load at speeds of 3000-5000 rpm depending on the model. Running the engine at these speeds using a flush fitting could allow the motor to become damaged from overspeed operation.

✳✳ WARNING

Never operate a marine motor without providing a source of cooling water such as a test tank or flush fitting. It takes less than a minute to damage the water pump impeller that could lead to much more expensive powerhead failures later during normal motor usage. Use a suitable test wheel whenever possible, but remember that for safety the propeller should not be installed on motors when running on a flush fitting.

OK, we've got one LAST out for you. If you are testing a CARBURETED motor only and do NOT have a carbon pile load tester, you can instead perform the Cranking Discharge Test instead of the Variable Load Test.

Variable Load Test

◆ See Figures **78, 87** and **88**

1. Determine proper amperage output for the motor being tested. Refer to the information on Charging System Identification in this section and the General Engine System Specifications chart in the Maintenance and Tune-Up section.
2. Make sure the ignition switch and all electrical boat/motor accessories are turned OFF.
3. Connect a shop tachometer to the engine, following the instructions provided from the tool manufacturer.
4. The regulation circuit of the charging system cannot work properly unless it receives a signal of battery voltage during operation. Before proceeding, use a DVOM to check the battery power signal to the regulator is working. The test should be performed between the appropriate terminal and a good engine ground by checking for battery power with the key on, engine not running at the proper wire connector as follows:
   - Carbureted motors, check the purple lead bullet connector for the regulator.
   - FICHT motors, check the regulator red wire.
5. Disconnect the cables from the battery, then connect an ammeter (with a minimum capacity of 0-40 amps) in series as follows:

On carbureted motors, use a jumper wire to install the ammeter in series between the red regulator wire and the battery side of the starter solenoid/relay.

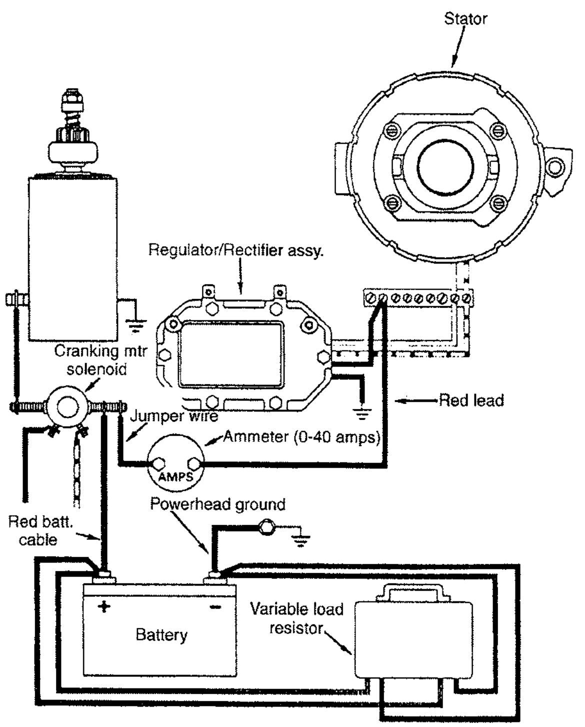


Fig. **87** Regulatorlrectifier testing using an ammeter and carbon pile load tester-typical **90°** looper shown, others similar (note that terminal locations and regulator shape varies with model, also **60°** models are not wired through the terminal strip)

On FICHT motors, disconnect the red lead on the battery side of the starter solenoid that feeds the main power relay. Connect the ammeter in series between the red wire for the relay and the appropriate terminal of the starter solenoid.

✳✳ WARNING

Make sure no portion of the wiring (red lead, harness or ammeter leads) contacts engine ground while the engine is running or arcing will **likely** occur.

6. Reconnect the battery cables and then install a carbon pile load tester to the battery terminals. Be sure to follow the tool manufacturer's instructions when connecting the carbon pile load tester.

✳✳ CAUTION

Excessive battery discharge rates could overheat the battery, releasing highly explosive hydrogen gas from the battery electrolyte and creating a dangerous explosive condition. Regardless, be especially sure to keep sparks, open flame, or any possible source of ignition away from the test area to prevent severe personal injury or even death should the battery **explode.**

7. Start and run the engine at idle speed until it reaches normal operating temperature

8. Once the engine has fully warmed, run it at the specified rpm while using the variable carbon pile load tester to draw the battery down at a rate equivalent to the stator's full output, then watch charging system output on the ammeter:

On carbureted motors, run the engine at about 4500 rpm, watching the ammeter for full or near full charging system output.

On FICHT motors (except 1501175 hp models equipped with fuel rails), run the engine at about 2000 rpm watching the ammeter for full or near full charging system output.

- 1501175 hp FICHT motors equipped with hard fuel rails, run the engine at about 3000 rpm watching the ammeter for full or near full charging system output.

On FICHT motors, especially the 1501175 hp units equipped with fuel rails (which have 40-amp charging systems), be careful not to run the motor at too excessive a speed as power output actually peaks around 2000 rpm and begins to drop off after that.

9. Using the carbon pile load tester, slowly decrease the battery load toward zero amps while watching the ammeter. The meter should show a decrease in output from the charging system as the draw decreases. Check the battery voltage; it should stabilize at approximately 14.5 volts as the voltage decreases.

10. If output is too high or if output is too low and the stator has already passed a static ohmmeter check, perform a final inspection of all other system wiring/connections and, if no problems are found, replace the regulator/rectifier assembly as detailed in this section.

Cranking Discharge Test (Carbureted Models Only)

The cranking discharge test is basically a simplified version of the variable load test, minus the variable load. If a carbon pile (variable resistor) tester is not available, this test can be used as another quick-verification of the charging system and regulator/rectifier. No specifications are provided for using this test on FICHT motors, possibly because of concerns over attempting to start the FICHT unit with low battery voltage and possibly because of the significantly higher charging system output on FICHT motors.

1. Check the battery using a voltmeter across the 2 terminals. If it is at or above 12.5 volts, you've got 2 choices. For one, you could install a battery that is below 12.5 volts. Otherwise either tag and disconnect the ignition charge coil connectors (90° motors) or tag, disconnect, and ground the spark plug wires (60° motors). With the wiring disconnected as noted, use short bursts of the starter motor (allowing pauses between each burst so the motor can cool down) to drain the battery to a point below 12.5 volts,

2. The regulation circuit of the charging system cannot work properly unless it receives a signal of battery voltage during operation. Before proceeding, use a DVOM to check the battery power signal to the regulator is working. The test should be performed between the purple lead bullet connector for the regulator and a good engine ground by checking for battery power with the key on, engine not running.

3. Disconnect the battery cables, then connect a 0-40 amp ammeter in series between the rectifier/regulator red lead and the battery side of the starter solenoid.

4. Connect the battery cables, then reconnect the ignition charge coil or spark plug wiring, as applicable.

5. Start the engine and run it at approximately 4500 rpm. The ammeter should indicate nearly full charging system output, but as you continue to allow the engine to run at 4500 rpm the battery voltage will eventually stabilize at 14.5 volts. At this point alternator output should begin to decrease.

6. If output is incorrect, check the stator condition before replacing the regulator/rectifier.

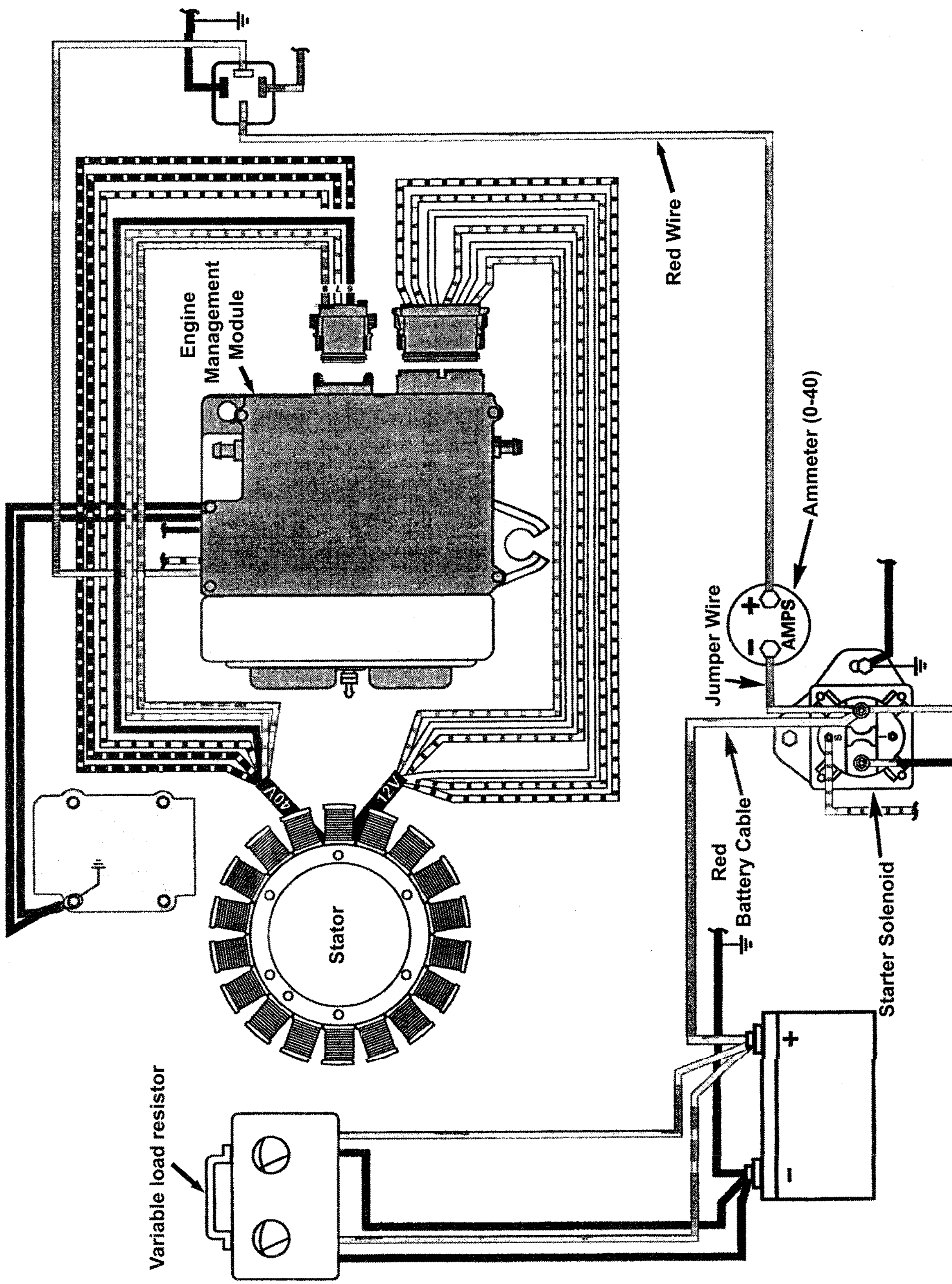


Fig. 88 Regulator/rectifier testing on FICHT motors-typical 2000 or later model shown using EMM with internal regulator instead of external regulator used on most earlier models and on 150/175 hp motors with hard fuel rails (note starter solenoid terminal positions vary on 200 hp and larger motors)

REMOVAL & INSTALLATION

EASY

◆ See Figures 89 and 90

■ If necessary, refer to the schematics provided under Wiring Diagrams in this section to help locate the regulatorlrectifier and wiring necessary for these procedures.

On carbureted engines the regulatorlrectifier is normally mounted on the top rear of the side of the powerhead. In many cases it is located under a cover. On 65 Jet-115 hp (1632cc) 90CV4 motors, the regulator may be partially obscured by the flywheel and stator. On 80 Jet-175 hp (1726/2589cc) 60º V4/V6 motors, the regulator is located under the regulatorlignition cover assembly. On 120-300 hp (2000/3000/4000cc) 90º V4/V6/V8 motors the regulator is normally found under the electrical component bracket (which must be swung aside for access).

On FICHT motors the regulator is either integrated into the EMM or it is mounted separately either under the flywheel or EMM. All 2000 and later motors that are NOT equipped with fuel rails utilize an EMM with integral regulatorlrectifier circuitry. On 200 and larger horsepower motors before the 2000 model year the regulatorlrectifier is mounted under the flywheel. On 175 hp and smaller motors before the 2000 model year and all 1501175 hp motors equipped with hard fuel rails, the regulatorirectifier is mounted under the EMM. Whenever the regulatorlrectifier is mounted separately on FICHT motors, it is mounted in a water-cooled passage to help prevent the possibility of overheating and burning out the unit.

On 2000 and later FICHT motors (except the 1501175 hp motors with fuel rails), the regulator is part of the internal EMM circuitry. **Please** refer to the FICHT Fuel Injection section for removal and installation instructions.

1. Disconnect the battery cables for safety.
2. On carbureted motors, access the regulatorlrectifier as necessary, according to the model:

- On 65 Jet-I 15 hp (1632cc) 90º V4 motors, it may be necessary to remove the flywheel and, in some cases, the stator for access. Refer to the Powerhead section for the Flywheel and Stator/Battery Charge Coil later in this section for the stator.
- On 80 Jet-175 hp (1726/2589cc) 60º V4/V6 motors, remove the ignitionlregulator cover from the rear of the powerhead for access.

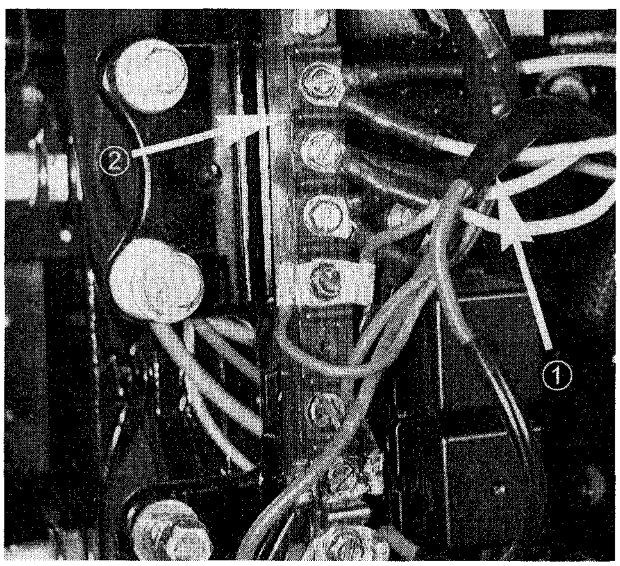


Fig. 89 To remove the regulator on most models, first disconnect the wiring (1) from the terminal strip (2) or harness connections (as applicable)...

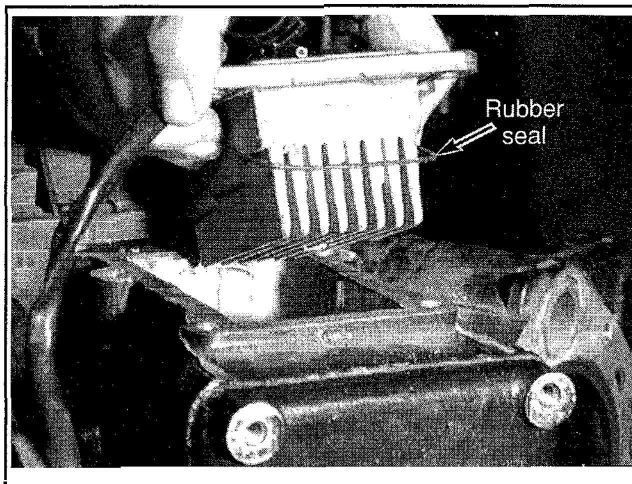


Fig. 90 ... then unbolt and remove the regulatorlrectifier from the powerhead (noting the gasket or rubber seal)

- On 120-300 hp (2000/3000/4000cc) 90º V4/V6/V8 motors, remove the power pack, then swing the electrical component bracket away from the powerhead for access to the regulatorlrectifier.

3. On FICHT motors, remove the flywheel (200 hp and larger only), EMM and regulatorlrectifier covers for access to the regulatorlrectifier.

Note wire routing before disconnecting any ring terminals or wiring connectors. Noting the routing at this stage will help during installation to make sure wires are properly positioned to prevent interference with any moving components.

4. Tag and disconnect the regulatorlrectifier leads at the terminal board (90º carburetor motors), at the regulator terminals (FICHT motors) or tag and disengage the wiring connectors (60º carbureted motors) from the wiring harnesses.

If necessary, refer to the schematics found under Wiring Diagrams in this section to assist with wire terminallconnector identification. **Regulator/Rectifier** assemblies are normally connected to two or more yellow (or yellow **w/** some tracer color) wires from the statorlterminal **strip. They** are also connected to a red power **and/or** a purple battery signal wire, and possibly a ground **wire. The** separate regulators used on some FICHT motors are normally connected to various ground wires.

5. Remove the mounting bolts (usually 2, 4 or 6 but models may vary), then remove the regulatorlrectifier from the powerhead. If the regulator is mounted to a cooling jacket, you'll have to carefully remove all traces of gasket material from the mating surfaces.

Most FICHT motors utilize a rubber O-ring, always remove and discard the old ring when servicing the regulatorlrectifier assembly.

To install:

6. Clean the regulatorlrectifier mounting area, along with the powerhead and screw threads of any dirt, corrosion or debris.
7. Inspect the ring terminal or wiring connectors for damage or corrosion and repair, clean or replace, as necessary.

□ The O-ring on FICHT motors and the retaining screws and normally installed without any gasket sealant.

8. On models where the regulator is mounted to a cooling jacket a new gasket (or O-ring for FICHT models) must be used for installation. The gasket on some carbureted models is self-adhesive. If so, install the gasket with the adhesive side facing the powerhead. On models that do not use a self-adhesive gasket, apply a light coating of Evinrude/Johnson Gasket Sealing Compound to BOTH sides of the replacement gasket.

■ To be honest, the factory seemed to go back and forth on the sealant for the bolt threads. Sometimes they said to do it, sometimes they didn't (although they never seemed to recommend it on 600 motors or on **FICHT** motors). We can't see why it would be harmful, unless the retaining bolt was used for a ground strap, in which case it COULD isolate the bolt from the powerhead.

9. On all models, except FICHT or 600 carbureted powerheads, apply a light coating of Evinrude/Johnson Gasket Sealing Compound to the regulator screw threads.
10. Position the regulatorlrectifier, then install and tighten the mounting bolts to 60-84 inch lbs. (7-9 Nm) for carbureted motors or to 96-120 inch lbs. (11-14 Nm).
11. Properly route and reconnect the regulator/rectifier wiring as noted during removal. For carbureted models that utilize ring terminal connections, apply a coating of Evinrude/Johnson Black Neoprene Dip or equivalent terminal sealant to the ring terminal connections (this will help keep them securely connected and help to protect them from corrosion).
12. Install any covers or components, which were removed for access.
13. Reconnect the battery cables.

Battery

The battery is one of the most important parts of the electrical system. In addition to providing electrical power to start the engine, it also provides power for operation of the running lights, radio, and electrical accessories.

Because of its job and the consequences (failure to perform in an emergency), the best advice is to purchase a well-known brand, with an extended warranty period, from a reputable dealer.

The usual warranty covers a pro-rated replacement policy, which means the purchaser would be entitled to a consideration for the time left on the warranty period if the battery should prove defective before its time.

Do not consider a battery of less Cold Cranking Amperage (CCA) or Amp Hour (AH) rating than the battery that was originally installed for your motor. In fact, due to the increased resistance that will occur in circuits over time (from things like corrosion or internal wire strands that wear and break inside the insulation), it is advisable to buy a replacement battery with higher capacity than the original (but do not go overboard, pun intended).

□ Original minimum battery CCA ratings are provided in the General Engine System Specifications chart found in the General Information and Maintenance section.

MARINE BATTERIES

◆ See Figure 91

Because marine batteries are required to perform under much more rigorous conditions than automotive batteries, they are constructed differently than those used in automobiles or trucks. Therefore, a marine battery should always be the No. 1 unit for the boat and other types of batteries used only in an emergency (or possibly as a second battery).

Marine batteries have a much heavier exterior case to withstand the violent pounding and shocks imposed on it as the boat moves through rough water and in extremely tight turns. The plates are thicker and each plate is securely anchored within the battery case to ensure extended life. The caps are spill proof to prevent acid from spilling into the bilge when the boat heels to one side in a tight turn, or is moving through rough water. Because of these features, the marine battery will recover from a low charge condition and give satisfactory service over a much longer period of time than any type intended for automotive use.

✳✳ WARNING

Never use a maintenance-free battery with an outboard engine that is not voltage regulated. The charging system will continue to charge as long as the engine is running and it is possible that the electrolyte could boil out **rendering** the battery useless.

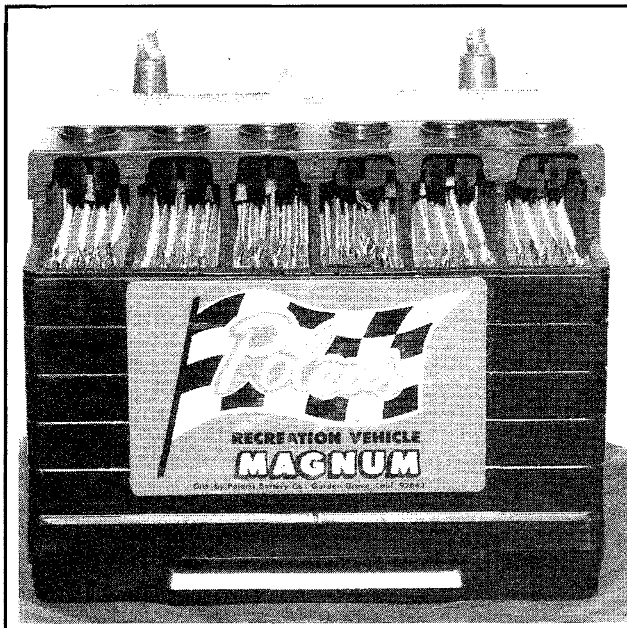


Fig. 91 A fully charged battery, filled to the proper level with electrolyte, is the heart of the ignition and electrical systems. Engine cranking and efficient performance of electrical items depend on a full rated battery

BATTERY CONSTRUCTION

◆ See Figure 92

A battery consists of a number of positive and negative plates immersed in a solution of diluted sulfuric acid. The plates contain dissimilar active materials and are kept apart by separators. The plates are grouped into elements. Plate straps on top of each element connect all of the positive plates and all of the negative plates into groups.

The battery is divided into cells holding a number of the elements apart from the others. The entire arrangement is contained within a hard plastic case. The top is a one-piece cover and contains the filler caps for each cell. The terminal posts protrude through the top where the battery connections for the boat are made. Each of the cells is connected to its neighbor in a positive-to-negative manner with a heavy strap called the cell connector.

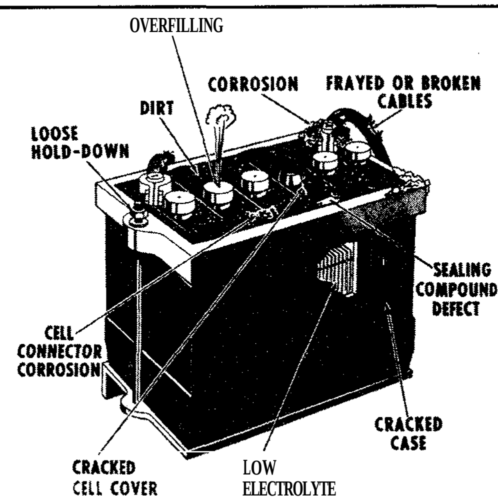


Fig. 92 A visual inspection of the battery should be made each time the boat is used. Such a quick check may reveal a potential problem in its early stages. A dead battery in a busy waterway or far from assistance could have serious consequences

BATTERY RATINGS

◆ **See Figure 93**

Three different methods are used to measure and indicate battery electrical capacity:

- Amp/hour (AH) rating
- Cold Cranking Amp (CCA) performance
- Reserve capacity

The AH rating of a battery refers to the battery's ability to provide a set amount of amps for a given amount of time under test conditions at a constant temperature. Therefore, if the battery is capable of supplying 4 amps of current for 20 consecutive hours, the battery is rated as an 80 amplhour battery. The amplhour rating is useful for some service operations, such as slow charging or battery testing.

CCA performance is measured by cooling a fully charged battery to 0°F (-17°C) and then testing it for 30 seconds to determine the maximum current flow. In this manner the cold cranking amp rating is the number of amps available to be drawn from the battery before the voltage drops below 7.2 volts.

The illustration depicts the amount of power in watts available from a battery at different temperatures and the amount of power in watts required of the engine at the same temperature. It becomes quite obvious-the colder the climate, the more necessary for the battery to be fully charged.

Reserve capacity of a battery is considered the length of time, in minutes, at 80°F (27°C), a 25 amp current can be maintained before the voltage drops below 10.5 volts. This test is intended to provide an approximation of how long the engine, including electrical accessories, could operate satisfactorily if the stator assembly or lighting coil did not produce sufficient current. A typical rating is 100 minutes.

If possible, the new battery should have a power rating equal to or higher than the unit it is replacing.

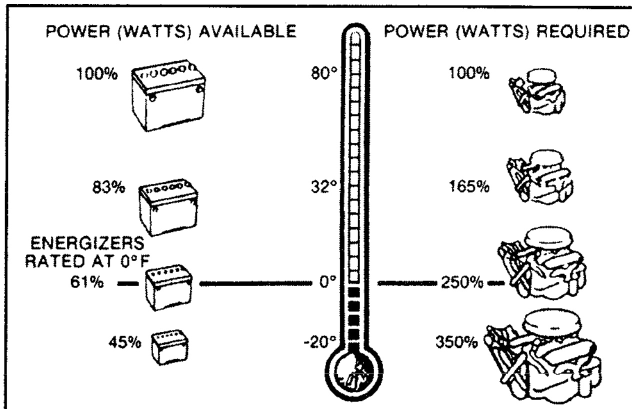


Fig. 93 Comparison of battery efficiency and engine demands at various temperatures

BATTERY LOCATION

Every battery installed in a boat must be secured in a well protected, ventilated area. If the battery area lacks adequate ventilation, hydrogen gas, which is given off during charging may gather in a concentrated quantity, and could cause a hazardous condition as it is very explosive.

BATTERY SERVICE

Details regarding cleaning the battery, checking fluid level and testing it and maintaining a proper charge while the battery is in storage can be found under Batteries in the Boat Maintenance section.

STARTING CIRCUIT

Description and Operation

◆ **See Figures 94, 95, 96 and 97**

In the old days (when everyone walked barefoot to school, uphill, both ways), all outboards were started by pulling on a rope wrapped around the flywheel. As time passed and owners were reluctant to use muscle power (or came up short especially as larger and larger outboards were built), it was necessary to replace the rope starter with some form of power cranking system. Today, only the smaller outboards are normally equipped with a starting rope, but many smaller almost all large engines are also equipped with an electric starter system.

The system used to ep the rope starter is an t starter t coupled with a al r nesh e e the starter motor and the powerhead flywheel, similar to the method used to crank an automobile engine.

As the name implies, the sole purpose of the starter circuit is to control operation of the starter motor causing it to crank the powerhead until the engine catches and runs. The circuit usually includes a solenoid or magnetic switch that connects the motor to the battery when the circuit is actuated and disconnects the motor from the battery when the circuit is deactivated. The operator controls the solenoid switch with a key switch or starter button, depending on the model.

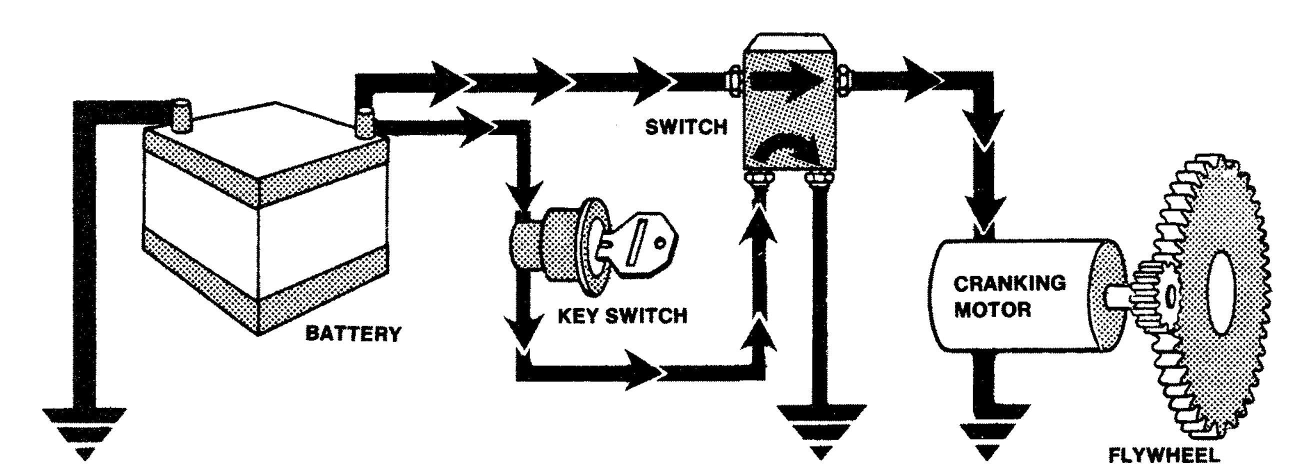
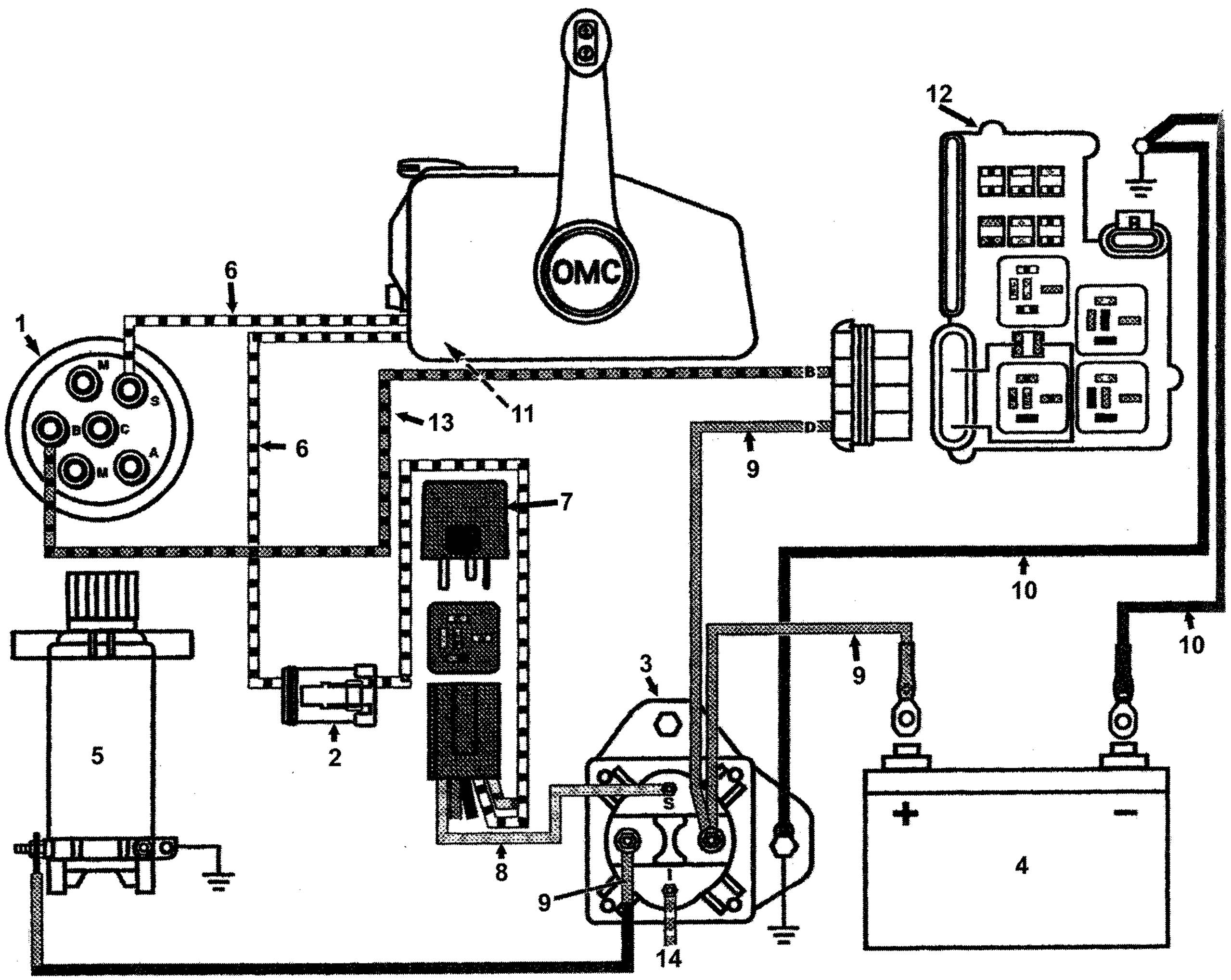


Fig. 94 A typical starting system converts electrical energy into mechanical energy to turn the engine. The basic components are: Battery, to provide electricity to operate the starter; Ignition switch, to control the energizing of the starter relay or solenoid; Starter relay or solenoid switch, to make and break the circuit between the battery and starter; Starter, to convert electrical energy into mechanical energy to rotate the engine; Starter drive gear, to transmit the starter rotation to the engine flywheel



1 Key Switch
2 6-Way Connector
3 Starter Solenoid
4 Battery
5 Starter Motor
6 Yellow/Red
7 Start Delay Relay/Some 2000 and later models
8 Yellow/Blue
9 Red
10 Black
11 Neutral Start Switch
12 Power Distribution Panel
13 Red/Purple
14 Pink/White to SAC

Fig. **95** Even the most complicated starting circuit used on these outboards still contains the same basic elements of the typical cranking circuit, it just includes a few more components, like the start delay relay-typical **FICHT** system shown (not all wiring used on all models)

A neutral safety switch is installed to permit operation of the starter motor only if the shift control lever is in neutral. When used, the switch is a safety device that prevents accidental engine starts when the motor is in gear.

The starter motor itself is an electric component consisting of a wound coil that draws a heavy current from the battery. It is designed for short periods of usage when cranking the engine for startup. To prevent overheating the motor, cranking should not be continued for more than 30-seconds without allowing the motor to cool for at least three minutes. Actually, this time can be spent in making preliminary checks to determine why the engine fails to start.

On most models, power is transmitted from the starter motor to the powerhead flywheel through a Bendix drive. This drive has a pinion gear mounted on screw threads. When the motor is operated, the pinion gear moves upward and meshes with the teeth on the flywheel ring gear.

When the powerhead starts, the pinion gear is driven faster than the shaft, and as a result, it screws out of mesh with the flywheel. A rubber cushion is built into the Bendix drive to absorb the shock when the pinion meshes with the flywheel ring gear. The parts of the drive must be properly assembled for efficient operation. If the drive is removed for cleaning, take care to assemble the parts as noted during removal (and shown in accompanying illustrations). If the screw shaft assembly is reversed, it will strike the splines and the rubber cushion will not absorb the shock.

However, some models are equipped with a gear reduction unit, on which the cranking motor gear is in constant mesh with a gear several times larger. This larger gear increases the torque necessary to rotate the flywheel at the required speed to start the powerhead. The large reduction gear drives a shaft with the Bendix. Therefore, rotation of the reduction drive causes the Bendix gear to rise and mesh with the flywheel ring gear, in the same manner as the standard cranking motor Bendix drive.

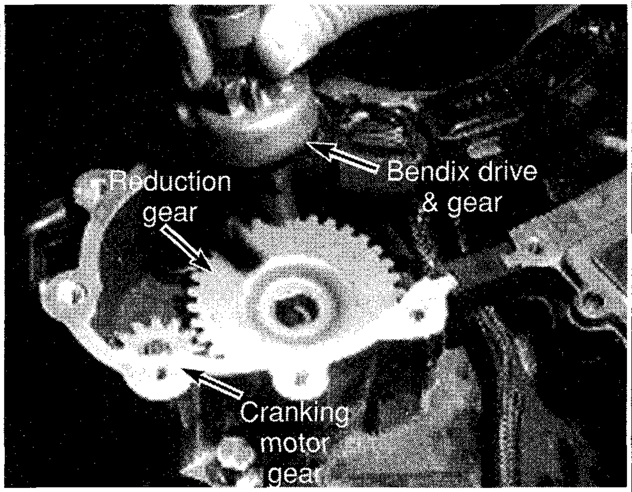


Fig. 96 Typical mounting of a cranking motor-with gear reduction drive-used on large **V6** or V8 powerheads. In this case, the gear reduction is housed in an integral part of the crankcase casting. Another gear reduction model has the gear reduction housed in a separate casting bolted to the cranking motor

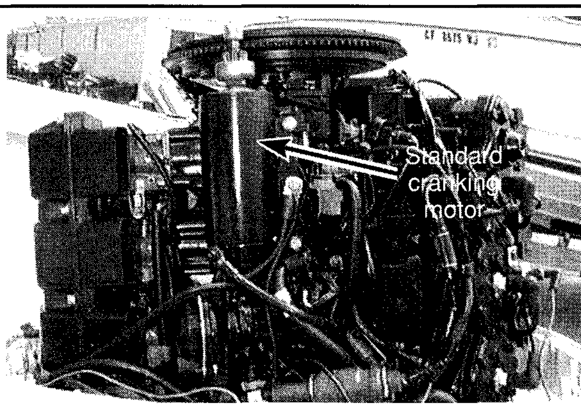


Fig. 97 Typical mounting of a standard cranking motor-without a gear reduction drive. Some of the electrical connections are clearly **visible. The** motor is attached to the powerhead with three bolts. One bolt is very near the carburetor and the other two are on the side. This cranking motor arrangement is used on most V4 and small horsepower V6 powerheads covered in this manual

The sound of the motor during cranking is a good indication of whether the starter motor is operating properly or not. Naturally, temperature conditions will affect the speed at which the starter motor is able to crank the engine. The speed of cranking a cold engine will be much slower than when cranking a warm engine. An experienced operator will learn to recognize the favorable sounds of the powerhead cranking under various conditions.

Troubleshooting

If the starter motor spins, but fails to crank the engine, the cause is usually a corroded or gummy Bendix drive. The drive should be at least lubricated or it should be removed, cleaned, and given an inspection.

If the starter motor cranks the engine too slowly, the following are possible causes and the corrective actions that may be taken:

- Battery charge is low. Charge the battery to full capacity.
- High resistance connections at the battery, solenoid, or motor. Clean and tighten all connections.
- Undersize battery cables. Replace cables with sufficient size.
- Battery cables too long (which creates too high a resistance in the circuit). Relocate the battery to shorten the run to the solenoid.
- Binding mechanical problem with the powerhead or gearcase.

If the starter does not crank the motor ai all, before wasting too much time troubleshooting the starter motor circuit, the following checks should be made. Many times, the problem will be corrected. Make sure the:

- Battery is fully charged.
- Shift control lever is in neutral.
- Main fuse (if used in the starter circuit, refer to Starter Circuit Testing or Wiring Diagrams, in this section for more information) is good (not blown).
- All electrical connections are clean and tight.
- Wiring in good condition, insulation not worn or frayed.

Also, keep in mind that mechanical problems could exist that would cause the powerhead to freeze or crank slowly even though the starter motor circuit is in excellent condition

- A tight or frozen powerhead
- Hydrolocked motor (see Clearing a Submerged Motor, in the Maintenance and General Information section).
- Water in the lower unit.

If no obvious cause has been found and the starter motor does not operate, test the circuit and/or components as detailed in this section.

TESTING-CARBURETED MODELS

④ SKILLED

Voltage Drop Test (Starter Turns Slowly)

◆ See Figures **98, 99, 100** and **101**

If the preliminary checks covered under Troubleshooting the Starting System do not reveal the problem, either perform the voltage drop test covered here or the No Load Current Draw Test covered under Starter Motor.

■ For more details on the theory behind Voltage **Drop Testing,** please refer to the information found in Understanding and Troubleshooting Electrical Systems, found in this section.

Excessively high resistance within the starter circuit (from problems with battery cables, the starter solenoid or any of the wiring/grounds) can impede the amount of voltage available to the starter. This may cause the starter to turn slowly or even not at all. In addition, a slow cranking speed will keep the ignition charge coil from reaching full output, thereby weakening spark during attempts to start the motor. This might cause the ignition system to appear faulty when diagnosing a hard or no-start condition.

A voltage drop test is used to check the amount of voltage consumed by the circuit. Remember also that intermittent problems from internally broken or frayed cables to loose or corroded connections can cause slow cranking. If readings vary when testing a portion of the circuit, grasp and flex cables attached to the point of testing to make sure no intermittent connections are adversely affecting the test or circuit operation.

1. Disconnect and ground the spark plug leads to the powerhead for safety (to keep the engine from starting during testing) and to protect the ignition system.
2. If not done already, perform all preliminary checks as listed under Troubleshooting the Starting System. The battery must be fully charged, all connections must be clean and tight. All wiring and electrical components must at least appear to be in good condition.
3. Using a DVOM set to read voltage, connect the red probe to the positive battery post and the black probe to positive post of the starter solenoid terminal (the point at which the red cable from the battery connects to the starter solenoid). Then crank the starter while watching the DVOM. A reading of more than 0.3 volt indicates high resistance in the positive battery cable (meaning it should be cleaned and tightened or replaced, as necessary to test within specification).
4. Connect the DVOM black probe to the starter side of the solenoid terminal (the terminal whose wiring runs to the starter motor itself). With the engine cranking, touch the red DVOM probe to the positive post of the starter solenoid terminal (again, the point at which the red cable from the battery connects to the solenoid). In order to prevent damage to the DVOM,

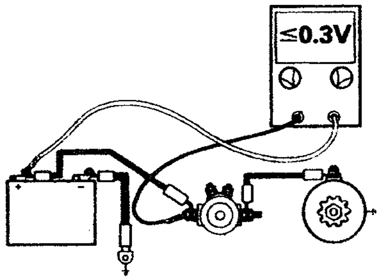


Fig. 98 Checking voltage drop between the positive battery terminal and positive connection on the starter solenoid tests the positive battery cable

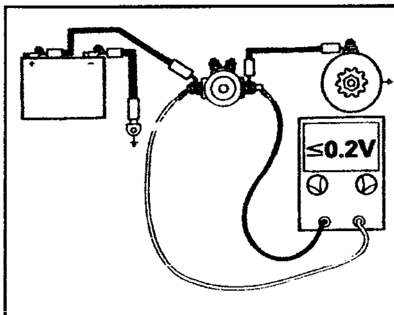


Fig. 99 Test the solenoid itself for high resistance by checking drop on either side of it (solenoid positive terminal and solenoid starter terminal)-NEVER make this connection unless the motor is cranking

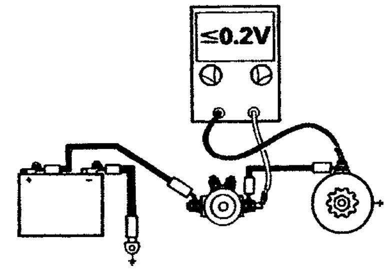


Fig. 100 Probing at both ends of the solenoid-to-starter cable and cranking the motor will check for excessive resistance in this cablelconnection

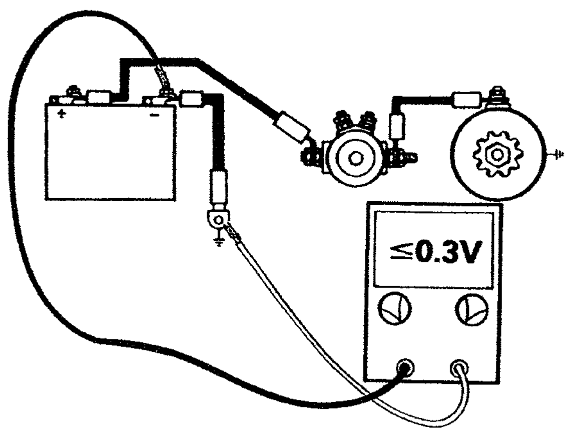


Fig. 101 Checking voltage drop between the negative battery terminal and the powerhead ground connection tests the negative battery cable

do not allow the red probe to make contact with the post **unless** the motor is cranking (otherwise, voltage may try to short around the solenoid, through the meter). A reading of more than 0.2 volt indicates high resistance in the starter solenoid itself. If such a reading is noted on the meter, replace the starter solenoid.

5. Connect the DVOM red probe to the starter side of the solenoid terminal (again, the terminal whose wiring runs to the starter motor itself). Connect the black probe directly to the terminal on the starter motor (the other end of the wire where the red probe is connected). Actuate the starter while watching the DVOM. A readina of more than 0.2 volt indicates high resistance in the solenoid-to-motor cable (meaning it should be cleaned and tightened or replaced, as necessary to test within specification).

6. Connect the DVOM red probe to the negative battery cable, where it connects to the powerhead, then connect the black probe to the negative battery post. Actuate the starter while watching the DVOM. A reading of more than 0.3 volt, indicates high resistance in the negative battery cable (meaning it should be cleaned and tightened or replaced, as necessary to test within specification).

DIFFICULT

Starter Circuit Testing (Starter Does Not Turn)

◆ **See Figures 102,103,104,105,106 and 107**

If the starter does not operate at all, check the starter circuit using a DVOM (or a test light if one if not available) to check for voltage at points throughout the circuit.

The accompanying charts will take you step-by-step through each starter circuit in the most logical sequence for that circuit. On these models Evinrude/Johnson suggests checking for power starting at the solenoid, then the keyswitch and finally the starter itself, working your way through the circuit in a logical manner until power is found (meaning the problem in the circuit is between that point and the previously tested point). Illustrations accompany each chart that can be used to help determine proper testing points.

Testing Starter Switches (Isolating Wiring Problems)

MODERATE

Starter Button

Although the wire colors and mounting positions vary slightly, all EvinrudelJohnson starter buttons operate in the same basic fashion. The button is a spring-loaded, continuity switch that completes the circuit (has continuity) when held down (depressed) and breaks the circuit (has no continuity) when released.

Refer to the schematics in the Wiring Diagrams section for details.

1. Disconnect the negative battery cable for safety (and to prevent accidental starting when testing or if switch leads are accidentally connected when they are removed from the switch or harness).
2. Locate the starter button and trace the wiring looking for the easiest disconnectionltesting point. Disconnect the harness for access to the switch wires.
3. Connect a DVOM set to read resistance across the two switch terminals or wires leading to the switch. Switch harness wires are normally yellowlred and purple.
4. Observe the meter with the button depressed and the button released. The DVOM should show no continuity (infinite resistance) when the button is released, then must show continuity (low resistance) when the button is held down.
5. Reconnect the wiring once the testing and/or repairs are completed.
6. Connect the negative battery cable.

DIFFICULT

Keyswitch Circuit Test

◆ **See Figures 108,109,110 and 111**

This test checks function of factory EvinrudelJohnson rigged keyswitch assemblies through the Modular Wiring System (MWS). Carbureted and FICHT motors may be equipped with this rigging system.

For more details on terminal locations and wiring colors refer to the accompanyingillustrationsor the schematics for the MWS remote control and harness found in the Wiring Diagram section.

Note Battery must be fully charged

step	Procedure	Result
A. Check voltage between ground and ①. ⚠ Steps **A thru F** - Remove **starter** to **solenoid** cable **from** ⑦ to prevent starter engagement while **making** checks.	Remove black lead from ground at ①. Connect voltmeter between @ and common engine ground. Turn key to START position. Voltmeter should show battery voltage.	a. If no reading, go to Step **B** b. If meter reads banery voltage, reconnectblack lead to ground and go to Step **F**
B. Check voltage between ground and ②. **Note** **Steps B** thru **F** - Turn key OFF **before** connecting **and disconnecting** meter. Turn key to START position after connecting.	Connect meter at ②. Turn key to START position.	a. If meter reads battery voltage, lead is open between ① and ②. b. If no reading, go to Step **C**
C. Check voltage between **ground** and ③.	Connect meter at ③. Turn key to START position.	a. If meter reads battery voltage, solenoid is faulty. b. If no **reading,** go to **Step D**
D. Check voltage between ground and ④.	Connect meter at ④. Turn key to START position.	a. If meter reads battery voltage, lead is open between ③ and ④ or neutral **start** switch Ⓐ is open or improperly adjusted. b. If no reading, go to Step **E**
E. Check voltage between ground and ⑤.	**Connect meter at ⑤. Turn key to OFF position.**	a. If meter reads battery voltage. check key switch. b. If no reading at ⑤, check for open lead or open fuse between @ and @. c. Connect meter at ⑧. If no reading, check for open **lead** between @ and battery "+" terminal. If meter reads banery voltage, go to Step **G**

Fig. 102 Starter circuit **testing-60°V4** and V6 models

F. Check voltage between ground and ⑦.	Connect voltmeter at ⑦. Turn key to START position.	a. If no reading, solenoid is faulty. b. If solenoid clicks and meter reads battery voltage, go to **Step G**
G. Check voltage between ground and ⑧.	Reconnect starter to **solenoid cable** at ⑦. Connect meter at ⑧. Turn key to START position.	a. If meter reads battery voltage and starter motor does not turn, check starter motor. b. If no reading, check for broken cable or poor connection.

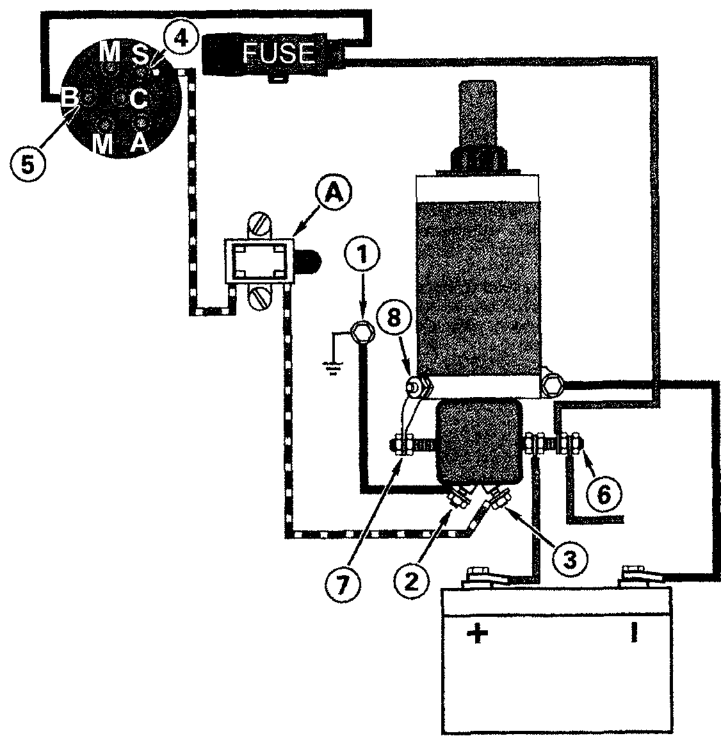


Fig. 103 Starter circuit **testing-60° V4** and V6 models

Note Battery must be fully charged.

Step	Procedure	Result
A. Check voltage between ground and ①. ⚠ Steps **A** thru **F** - Remove starter to solenoid cable from ⑦ to prevent starter engage. ment while making checks.	Remove black lead from ground at ①. Connect voltmeter between @ and common engine ground. Turn key to START position. Voltmeter should show battery voltage.	a. If no reading, go to Step **B** b. If meter reads battery voltage, reconnect black lead to ground and go to Step **G**
B. Check voltage between ground and ②. **Note** Steps **B** thru **F** - Turn key OFF before connectina and disconnecting meter. Turn key to START position after connecting.	Connect meter at ②. Turn key to START position.	a. If meter reads battery voltage, lead is open between ① and ⊙. b. If no reading, go to Step **C**
C. Check voltage between ground and ③.	Connect meter at ③. Turn key to START position.	a. If meter reads battery voltage, solenoid is faulty. b. If no reading, go to Step **D**
D. Check voltage between ground and@.	Connect meter at ④. Turn key to START position.	a. If meter reads battery voltage, lead is open between ③ and ④ or neutral start switch Ⓐ is open or improperly adjusted. b. If no reading, go to Step **E**
E. Check voltage between ground and ⑤.	Connect meter at ⑤. Turn key to OFF position.	a. If meter reads battery voitage, check key switch. b. If no reading at ⑤, check for open lead or open fuse between @ and @. c. Connect meter at ⑥. If no reading, check for open lead between ⑥ and battery "+" terminal. If meter reads battery voltage, go to Step **H**

Fig. 104 Starter circuit **testing-90° V4/V6/V8** models (except TTL)

Step	Procedure	Result
F. Check voltage between ground and ⑦.	Connect voltmeter at ⑦. Turn key to START position.	a. If no reading, solenoid is faulty. b. If solenoid clicks and meter reads battery voltage, go to Step **G**
G. Check voltage between ground and ⑧.	Reconnect starter to solenoid cable at ⑦. Connect meter at ⑧. Turn key to START position.	a. If meter reads battery voitage and starter motor does not turn, check starter motor. b. If no reading, check for broken cable or poor connection.

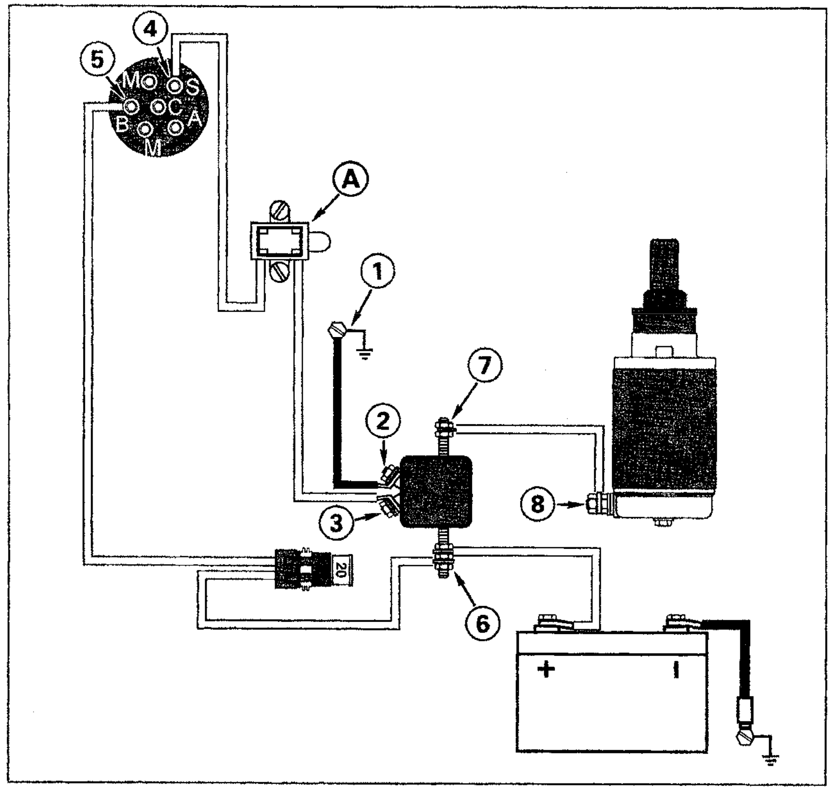


Fig. 105 Starter circuit testing-90° V4N6N8models (exceptTTL)

⚠ To avoid accidental starting of engine, disconnect starter cable at ①.

Note Engine must be in NEUTRAL throughout test procedure. Battery must be fully charged.

Step	Procedure	Results
A. Check voltage to cable at ①.	Connect voltmeter between cable at ① and ground. Turn key switch to ON position. Press start button Ⓐ.	• If meter shows 12 volts, test starter. • If meter shows **0** volts, go to Step **B**
B. Check voltage at ②.	Connect voltmeter between ② and ground.	• If meter shows 12 volts, go to **Step C** • If meter shows **0** volts, test battery and cables.
C. Check voltage at ③.	Connect voltmeter between ③ and ground. Press start button.	• If meter shows 12 volts, go to **Step D** • If meter **shows 0** volts, test start button, key switch, and wiring.
D. Check voltage at ④.	Disconnect solenoid ground lead ④ from engine ground. Connect voltmeter between lead ④ and engine ground. Press start **button** Ⓐ.	• If meter shows 12 volts, proceed to Step **E** • If meter shows 0 volts, replace solenoid or lead.
E. Check voltage at ⑤.	Reconnect solenoid ground lead ④ Connect voltmeter between ⑤ and ground. Press start button Ⓐ.	• If meter shows **0** volts, replace solenoid. • If meter shows 12 volts, replace starter cable.

Fig. 106 Starter circuit testing-90° V4 TTL models

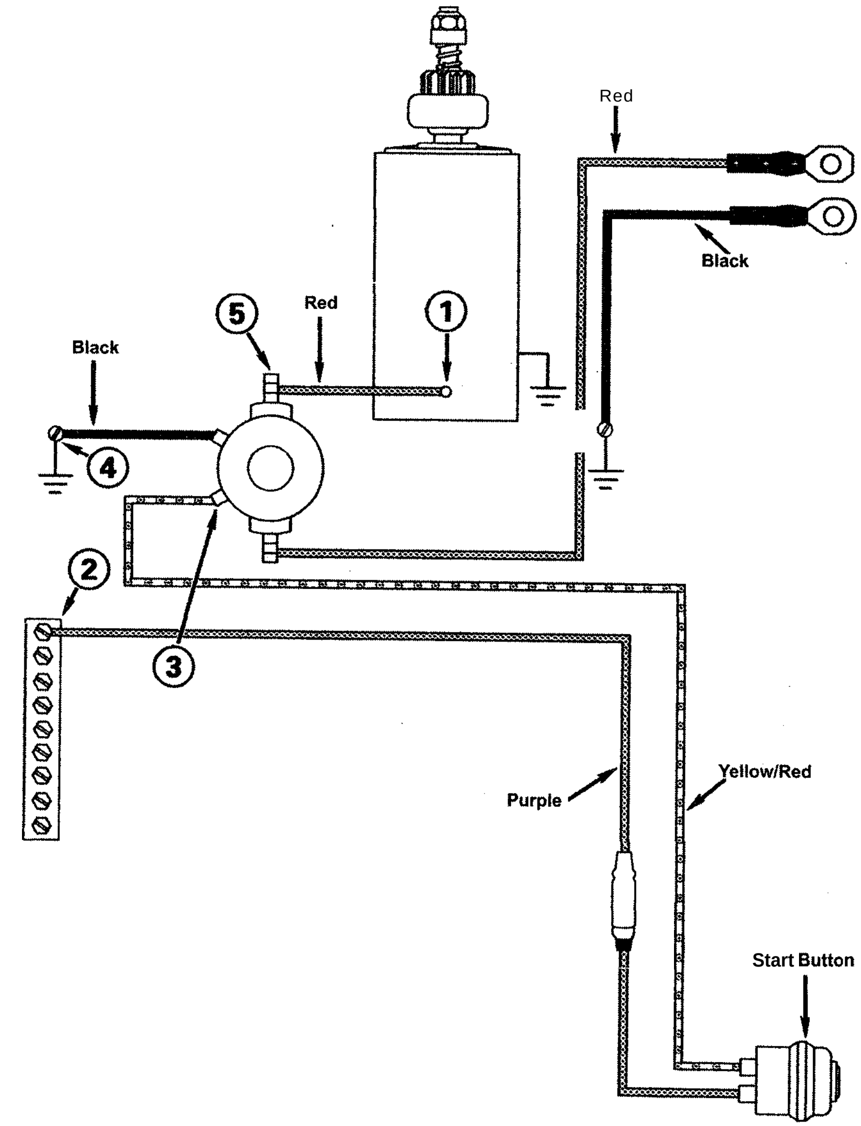


Fig. 107 Starter circuit testing-90° V4 TTL models

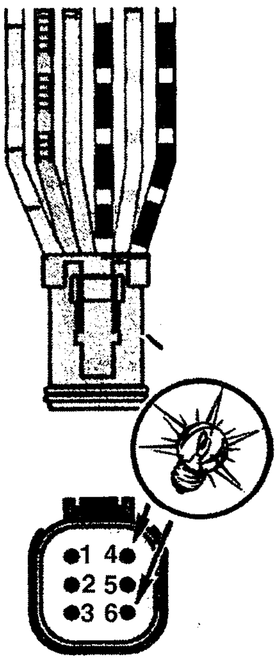


Fig. 108 There should be continuity across terminals 4 and ***6*** with the keyswitch ***OFF***

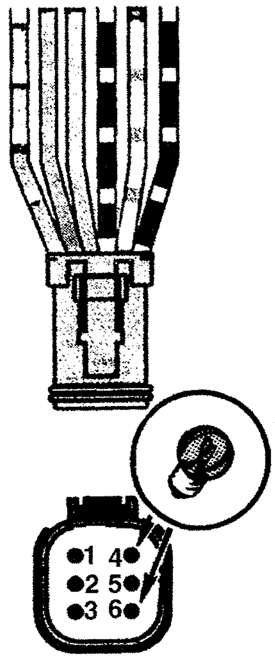


Fig. 109 There should be no continuity across terminals 4 and ***6*** with the keyswitch ***ON***

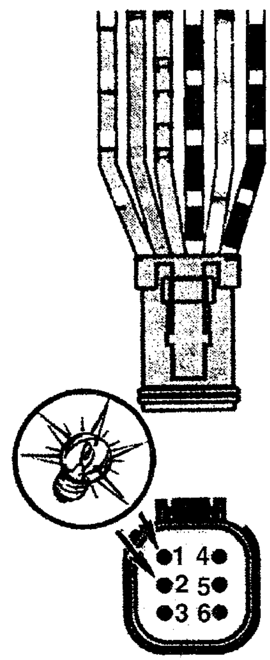


Fig. 110 There should be continuity across terminals 1 and 2 with the keyswitch pushed inward while it is in the ***ON*** or ***START*** position

A DVOM set to read resistance is used by this test to check continuity, though a self-powered test light could also be used.

1. Disconnect the negative battery cable from the battery for safety.
2. Install the stop switch clip and safety lanyard.
3. Locate and disengage the MWS 6-pin remote harness connector inline between the remote and the engine (the harness contains yellowlred, blackfwhite, black. red, purple and purple/white wires).
4. Make sure the keyswitch is turned to OFF.

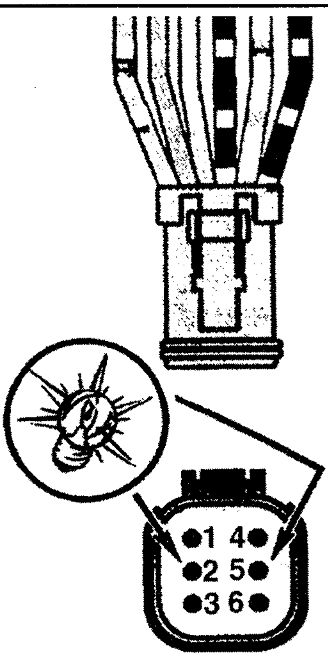
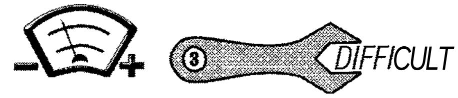


Fig. 111 There should be continuity across terminals **2** and **5** with the keyswitch turned to START and the remote lever in the ***NEUTRAL*** position

5. Probe the remote control side of the harness terminals 4 and ***6*** (blackfyellowand black wires) as identified in the accompanying illustration, there should be continuity.
6. Turn the keyswitch to ON, while continuing to probe terminals 4 and 6. There should now be no continuity with the keyswitch ON.
7. Connect the probes across terminals **1** and **2** (purple/yellow and redlpurple wires), there should be no continuity until the keyswitch is pushed inward while in the ON and START positions.
8. Move the control handle into NEUTRAL.
9. Connect the probes across terminals **2** and *5* (redlpurple and yellow/red wires), there should be no continuity if the key is released, but there should be continuity when the key is turned to the START position.
10. If the circuit does not test properly, check for problems with the harness wires or connectors. If no problems are found with the harness, test the keyswitch directly, as detailed in this section, before replacing the switch. If the switch is not faulty, recheck the harness and test connections.



Keyswitch Test

◆ See Figures 112,113,114 and 115

This test directly checks function of factory Evinrude/Johnson rigged keyswitch assemblies that is used with the Modular Wiring System (MWS). Carbureted and FICHT motors may be equipped with this rigging system. For more details on terminal locations and associated wiring colors refer to the accompanying illustrations or the schematics for the MWS remote control and harness found in the Wiring Diagram section.

A DVOM set to read resistance is used by this test to check continuity, though a self-powered test light could also be used.

1. Disconnect the negative battery cable from the battery for safety.
2. Disassemble the remote control as necessary for access to the keyswitch terminals. Tag (for proper installation) and disconnect the wiring from the terminals.
3. Install the stop switch clip and safety lanyard.
4. Make sure the keyswitch is turned to OFF.
5. Probe across terminals A and B (purple and redlpurple wires), there should be no continuity.

6. Turn the keyswitch to **ON,** there should now be continuity across terminals **A** and B.
7. Turn the keyswitch to **START,** there should still be continuity across terminals **A** and B.
8. With the keyswitch held in **START,** move one probe from terminal **A** to terminal **S** (yellowlred wire), there should still be continuity.
9. Move both probes to the M terminals (black and black/yellow). There should be NO continuity with the keyswitch in the **START** or **ON** positions.
10. Turn the keyswitch OFF, there should no be continuity across the M terminals.
11. Move the probes to terminals B and **C** (redlpurple and purple/white), then turn the keyswitch to **ON** and push inward. There should be continuity once the switch is pushed inward in this position.
12. With the probes still connected across terminals B and **C,** turn the keyswitch to **START** and push inward. There should be continuity once the switch is pushed inward in this position as well.
13. Recheck connections and test conditions if the switch fails any part of the test, then replace the switch if found defective. If the switch is not faulty, recheck the harness or look for other problems.
14. When tests or repairs are completed, assembly the remote control assembly.
15. Connect the negative battery cable.

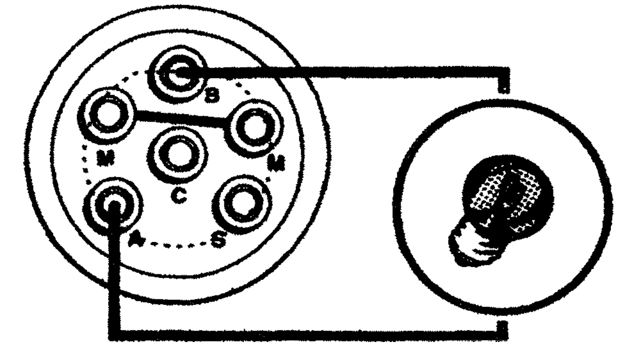


Fig. 112 Ignition keyswitch testing and terminal identification-with the keyswitch ***OFF* the** M terminals are connected, but **A** and B should show no continuity

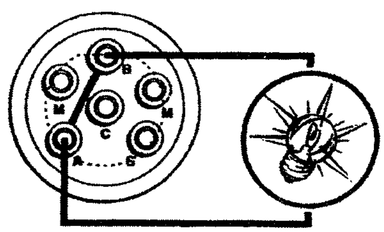


Fig. 113 With the keyswitch ON the M terminals are disconnected, while **A** and B should be continuous

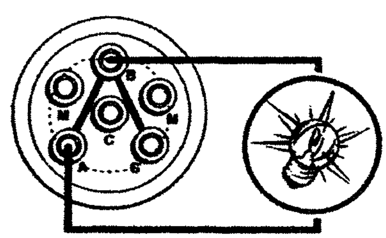


Fig. 114 With the keyswitch held in the START position, terminals **A** and B, as well as B and **S** should show continuity

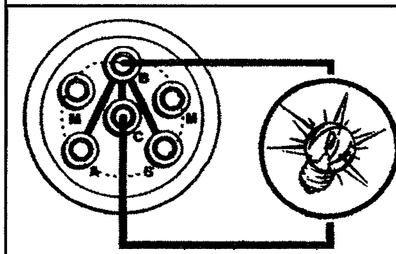
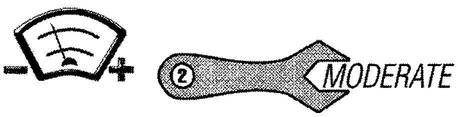


Fig. 115 Pressing inward on the keyswitch when it is in ON or, as shown in START, while allow for continuity between B and ***C*** (applying power to the electric primer, when equipped)



Neutral Safety Switch And Circuit Test

◆ See Figure **116**

Thrs test checks function of remote control mounted neutral safety swrtch assembly through the Modular Wiring System (MWS) harness Carbureted and FICHT motors may be equipped with this rıggıng system For details on terminal locations and wırıng colors refer to the accompanyıng illustrations or the schematrcs for the MWS remote control and harness found ın the Wiring Diagram section

A DVOM set to read resistance is used by this test to check continuity, though a self-powered test light could also be used.

The swrtch itself can also be tested directly, by checking continuity across the swrtch contacts whrle the plunger ıs released and while the plunger ıs depressed Continuity should only exist when the plunger ıs held downward

On models equipped with an engine mounted switch, test the switch directly following the final step of this test procedure.

Keep in mind that the function of the neutral safety switch is to prevent the motor from being started (to keep the starter circuit open) unless the gearcase is in **NEUTRAL.** This is a safety feature that is meant to prevent injury on land during testingltune-ups or on the water (to keep the boat from lurching suddenly when the motor is started).

✳✳ WARNING

The gearbox should not be forced into gear without propshaft rotation. **If** necessary, have an assistant slowly turn the shaft by hand when shifting into FORWARD or ***REVERSE* gear.**

✳✳ CAUTION

Be sure to disconnect the negative battery cable and to **remove/ground** the spark plug leads to prevent accidental starting which could lead to serious injury or death, especially for your assistant.

1. Disconnect the negative battery cable from the battery for safety.
2. Make sure the keyswitch is turned to OFF.
3. Locate and disengage the MWS 6-pin remote harness connector inline between the remote and the engine (the harness contains yellow/red, black/white, black, red, purple and purplelwhite wires).
4. Probe the remote control side of the harness terminals 2 and 5 (red/purple and yellowlred wires) as identified in the accompanying illustration, there should be continuity only with the shifter in **NEUTRAL** and the keyswitch held in the **START** position.
5. Shift into **FORWARD** while an assistant rotates the propshaft slowly by hand to prevent damage, then turn and hold the keyswitch in the **START** position. The DVOM must now show no continuity. Repeat this step, moving the shifter into **REVERSE,** the meter must still show no continuity.
6. If readings vary, check the wiring harness and switch itself.
7. To check the neutral safety switch directly (mounted in the remote assembly or on the motor, depending on the application):
   a. Locate the switch (by removing the engine cover or disassembling the remote control unit for access).

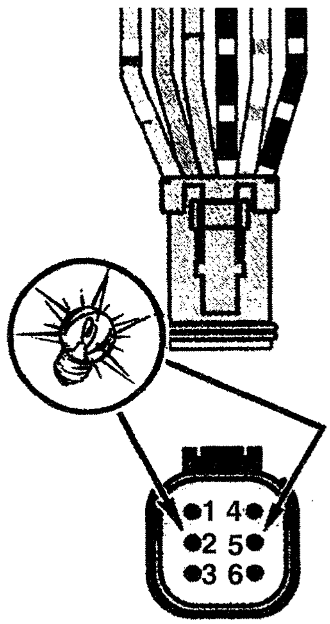


Fig. **116** Testing the remote mounted neutral safety switch through the MWS harness

b. Disconnect the wiring from the switch (usually 2 yellowlred leads), then probe across the 2 switch terminals using a DVOM.

c. Depress and release the switch while watching the meter. The switch must shown continuity only when the plunger is depressed and should show no continuity as soon as the plunger is released.

d. The switch should be replaced if it does not function properly.

■ In some applications the switch mounting is adjustable. If so, when installed, make sure the switch plunger is only held down when in **NEUTRAL. The** plunger must be extended when in gear (either FORWARD or REVERSE).

8. Once testing and/or repairs are finished, reconnect the wiring.
9. Connect the negative battery cable.

STARTING SYSTEM TESTING (FFI MODELS)

Perform all preliminary checks as noted under Troubleshootingthe Starting System. Also, refer to the engine troubleshooting charts found in the FICHT Fuel Injection (FFI) section, specifically ENGINE WON'T CRANK for troubleshooting hints. If you find no obvious causes of a no or slow cranking condition, check for voltage in the circuit working from the starter motor, back to the switch. Don't forget the start/delay relay used on some 2000 and later models.

- Test the voltage at the starter motor, then the starter solenoid relay, the start delay relay (if equipped) and finally the keyswitch.
- If voltage readings are good, check the function of the neutral safety switch, then the starter solenoid relay and finally the keyswitch.

The ignition keyswitch provides battery voltage to operate dash gauges, the starting circuit and engine control circuits on FFI models. Access to the switch leads is required for testing, which will require partial disassembly of the remote control or accessory tiller control bracket on most motors.

These motors are normally rigged using the standard Evinrude/Johnson keyswitch assembly and, on remote models, the Modular Wiring System (MWS). Testing is conducted in the same manner as keyswitch and circuit testing for carbureted models. For this reason, please refer to the Keyswitch Circuit Test and the Keyswitch test under Testing Starter Switches (Isolating Wiring Problems) in the Starting System Troubleshooting (Carbureted Models) section for details.

Individual component test procedures for the starter motor and solenoid are test provided under the appropriate components in this section.

Starter Motor

◆ **See** Figures **117** and **118**

As the name implies, the sole purpose of the cranking motor circuit is to control operation of the electric starter motor to crank (turn) the powerhead flywheel and crankshaft until the engine is operating. The circuit includes a solenoid relay (magnetic switch) to connect or disconnect the motor from the battery, which the operator normally controls using a keyswitch, but TTL models may be equipped with a starter button.

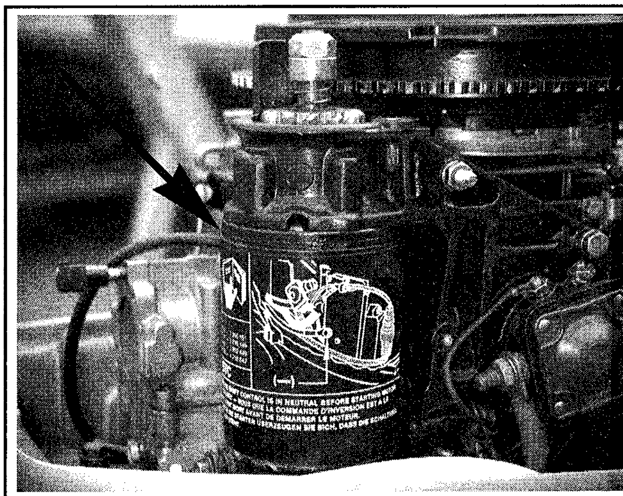


Fig. **117** The electric starter motor is mounted vertically to the powerhead, next to the flywheel (though the pinion drive assembly is not exposed on some V-motors)

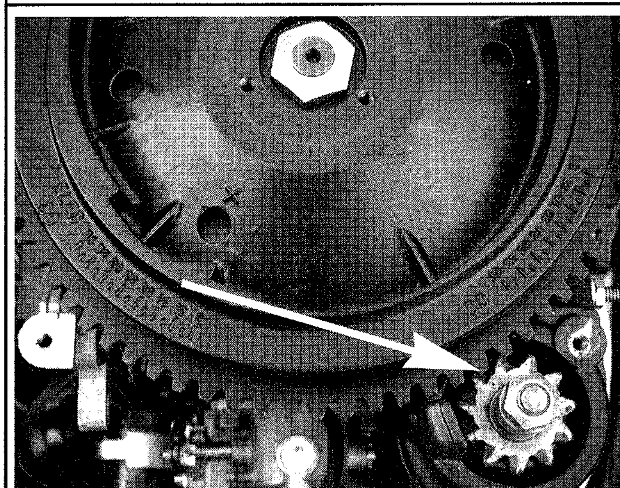


Fig. **118** When actuated, the starter pinion gear meshes with the flywheel ring gear teeth in order to turn the flywheel

A neutral safety switch is installed into the circuit to permit operation of the cranking motor only if the shift control lever is in neutral. This switch is a safety device to prevent accidental engine startup when the motor is in gear.

The starter is an electric motor consisting of a series of windings that draw a heavy current from the battery. It is designed to be used only for short periods of time. To prevent overheating the motor, cranking should not be continued for more than 30-seconds without allowing the motor to cool for at least three minutes. Actually, this time can be spent in making preliminary checks to determine why the engine fails to start.

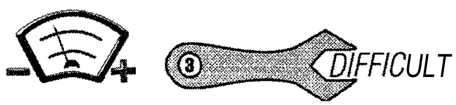
On most models, power is transmitted from the starter motor to the powerhead flywheel through a Bendix drive. This drive has a pinion gear mounted on screw threads. When the motor is operated, the pinion gear moves upward and meshes with the teeth on the flywheel ring gear.

When the powerhead starts, the pinion gear is driven faster than the shaft, and as a result, it screws out of mesh with the flywheel. A rubber cushion is built into the Bendix drive to absorb the shock when the pinion meshes with the flywheel ring gear. The parts of the drive must be properly assembled for efficient operation. If the drive is removed for cleaning, take care to assemble the parts as noted during removal (and shown in accompanying illustrations). If the screw shaft assembly is reversed, it will strike the splines and the rubber cushion will not absorb the shock.

However, some models are equipped with a gear reduction unit, on which the cranking motor gear is in constant mesh with a gear several times larger. This larger gear increases the torque necessary to rotate the flywheel at the required speed to start the powerhead. The large reduction gear drives a shaft with the Bendix. Therefore, rotation of the reduction drive causes the Bendix gear to rise and mesh with the flywheel ring gear, in the same manner as the standard cranking motor Bendix drive.

The sound of the motor during cranking is a good indication of whether the starter motor is operating properly or not. Naturally, temperature conditions will affect the speed at which the starter motor is able to crank the engine. The speed of cranking a cold engine will be much slower than when cranking a warm engine. An experienced operator will learn to recognize the favorable sounds of the powerhead cranking under various conditions.

TESTING



Starter No Load Current Draw Test

◆ See Figure 119

Although the starting circuit itself may vary, the electric starter motor used on carbureted or fuel injected versions of the same powerhead are virtually identical. In both cases, if a starter motor is suspect (failed to operate properly even though sufficient voltage is available at the motor wiring and no ground problem was located), the motor can be removed and checked using a no-load current draw test. To perform this check you will need an ammeter of 0-100 amp capacity (you can usually get away with a 0-50 amp unit on smaller motors, such as the cross-flow V4s). You will also need a vibration tachometer (such as a Frahm Reed tachometer) and a fully-charged battery of suitable capacity. On the cross-flow V4s (the 65 Jet-115 hp [1632cc] models), a battery of 350 CCA (70 amp-hour) should be sufficient, but for all looper (both 60° and 900 models, including all FICHTS, the manufacturer recommends using a 500 CCA (60 amp-hour) battery.

For safety, you should also use a bench vise mounted to a suitable working surface to hold the motor securely in place during testing. Although people have been known to simply place the starter on the floor and hold it securely underfoot, this can get pretty awkward when trying to read the various meters used during testing.

☐ An inductive (clamp-on type) ammeter is easiest to use for this test.

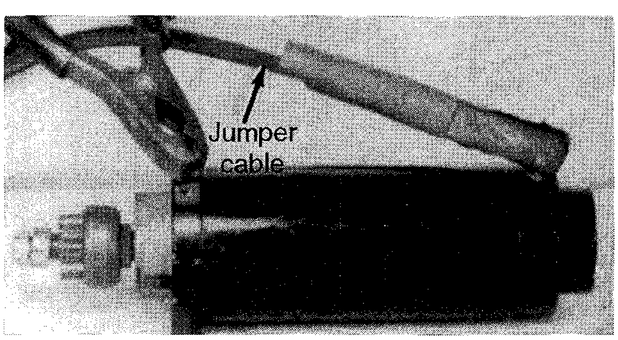


Fig. 119 Starters can be tested for operation using a fully-charged 12-volt battery and a set of jumper cables

To use a Frahm Reed or other suitable vibration tachometer, simply hold it against the starter housing while the motor is running. If one if not available, a stroboscopic tachometer may be used, provided a reference mark is placed on the drive gear (pinion).

Most hobby shops will sell tachometers designed for use on model plane engines that would be held against the drive unit to measure rotational speed.

1. Remove the starter from the engine as detailed in this chapter.
2. On V6 and V8 models, remove the driven gear and pinion assembly before testing.
3. Mount the starter motor in a suitable bench vise (or a mounting fixture to which the motor can be bolted to hold it securely during testing).

✳✳ WARNING

If possible, use a soft-jawed vise or some form of rubber padding to protect the starter housing. Be careful not to overtighten and damage the housing by crushing it in the vise.

4. Connect a voltmeter across the battery terminals to monitor voltage.

✳✳ WARNING

Make sure the cables used to connect the starter motor are of sufficient gauge (at least as thick as the battery cables normally connected to the starter motor, in fact those cables can be used). Also, make sure the cables are not too long. Use of cables with insufficient gauge or of too great a length will increase resistance in the circuit leading to false readings and possibly overheating the components used in the test.

☐ If jumper cables of some sort are used to connect the battery to the starter motor, make sure that sufficient electrical connections are provided. Cables held loosely against the starter will increase resistance in the test circuit, and could lead to false results.

5. Connect the positive terminal of the battery to the positive wiring terminal on the starter motor itself (the point where the red cable normally attaches to the motor when installed). If using a conventional ammeter you'll have to place the meter inline between the 2 points (connect the positive battery terminal to the ammeter positive probe, then wire the negative meter orobe to the starter motor oositive terminal). If using an inductive meter, connect the positive terminal of the battery directly to the positive terminal on the starter, then clamp the meter pickup somewhere on the cable that was used.

✳✳ CAUTION

Use great care when connecting the cable from the negative terminal of the battery to the starter motor. Make sure there are NO sparks created anywhere near the battery (that could ignite the explosive vapors emitted by battery electrolyte).

6. Connect a suitable jumper cable to the negative terminal of the battery, then make sure the voltmeter, ammeter and tachometer are all ready to conduct the test.
7. Connect the jumper from the negative battery terminal to the starter motor casing, then check each of the meters.

☐ Voltage must not drop below 12 volts DC or the battery is either insufficiently charged for this test or defective.

8. With voltage maintained between 12.0-12.4 VDC make sure the starter motor reaches the proper cranking RPM without exceeding amperage rating for the engine model being tested, as follows:
   - On V4 outboards the starter must rotate above 5350 rpm while drawing no more than 36 amps for 90° models (both CV and looper) or above 6500 rpm while drawing no more than 30 amps on 60° models.
   - On all V6 and V8 outboards the starter must rotate above 10500 rpm while drawing no more than 30 amps.
9. If the motor exceeds current draw and/or fails to achieve proper speed, the motor must be overhauled or replaced. Refer to the procedures found in this section.

REMOVAL & INSTALLATION

② MODERATE

**** WARNING**

Be careful when servicing the starter motor assembly not to drop or strike the housing as this could crack or damage the permanent magnets contained with the motor.

All Except 75-175 Hp (1726/2589cc) 60° V4/V6 Motors

See Figures 120,121,122,123,124 and 125

Although the motor may differ slightly between the V4 and V6/V8 models (resulting in differences for overhaul), the method of removal and installation is virtually the same on all 900 powerheads.

1. Disconnect the negative battery cable, followed by the positive cable at the battery for safety.
2. On 65 Jet-115 hp (1632cc) V4 motors, remove the screws securing the air intake silencer, then reposition or remove the silencer for additional access.
3. Disconnect the solenoid-to-starter cable and the negative cable or ground strap from the starter. On some models this will require removal of one or more of the bracket bolts. On the 1632cc CV4 motors, this will require removal and repositioning of the solenoid bracket.

The **90° V4** models are normally equipped with 3 retainers, one at the top front, one at the top rear and one at the bottom rear of the starter. Similarly, the starter motor on **90° V4** and V6 powerheads is normally secured using 4 retainers, 2 at the top and 2 at the bottom.

4. To free the starter from the outboard, loosen and remove the remaining bolts. Although bolt location and count varies, most models use 3 or 4 bolts. Support the starter as the last bolt is unthreaded and remove the assembly.

On the **90°** V4 and V6 models, the starter motor consists of the cranking motor frame housing and a reduction gear housing. Although it is possible to leave the reduction gear housing behind (by leaving the top 2 bolts installed, but instead-unthreading the 3 vertically mounted bolts from the reduction gear housing to the starter **frame)**, both are usually removed as an **assembly. This makes** cleaning, inspection and service of the assembly easier and gives you **a chance** to inspect the upper mounting area for the reduction gear housing.

5. Using a suitable solvent, clean all dirt, debris or corrosion from the starter mounting surfaces of the starter housing and powerhead. Clean all bolt/stud threads of any dirt, debris or corrosion.
6. If used, inspect rubber insulators for wear, damage or decay and replace as necessary.

To install:

7. On V6 and V8 models, apply a light coating of Evinrude/Johnson Locquic Primer to the threads of the mounting bolts according to the instructions that come with the primer.
8. On all models, apply a light coating of Evinrude/Johnson Nut Lock or an equivalent threadlock to the threads of the retaining bolts.
9. Position the starter to the powerhead and tighten the retaining bolts to 14-16 ft. lbs. (19-22 Nm). For V6 and V8 motors, tighten the top 2 bolts first, followed by the bottom 2 bolts.
10. On 65 Jet-115 hp (1632cc) V4 motors, apply a light coating of Evinrude/Johnson Nut Lock or an equivalent threadlock to the threads of the solenoid bracket retaining screws. Reposition and secure the bracket, along with the ground strap. Tighten the retaining screws to 60-84 inch lbs. (7-9 Nm).
11. Connect the starter wiring including the ground wire or negative cable (if applicable and not done in the previous step) to the starter. Connect the red positive cable to the starter. Tighten the retaining nut securely.
12. Apply a light coating of Evinrude/Johnson Black Neoprene Dip or a weather-strip sealant over all wiring terminals to protect them from moisture and corrosion.
13. On 65 Jet-115 hp (1632cc) V4 motors, remove position and secure the air intake silencer.
14. Connect the positive battery cable, followed by the negative.

75-175 Hp (1726/2589cc) 60° V4/V6 Motors

See Figures 122,123,124,125,126 and **127**

On carbureted 60° engines the starter solenoid is mounted to the bottom of the starter motor and they are removed as an assembly. For this reason, starter removal on carbureted models is a little more involved, as you must tag and disconnect additional wiring.

1. Disconnect the negative battery cable, followed by the positive cable at the battery for safety.
2. On V4 models (and when necessary on V6 models for access) remove the port side lower engine cover. For details, please refer to the Engine Covers (Top and Lower Cases) procedure found in the Engine Maintenance section.
3. Disconnect the positive battery cable (red) from the starter (FICHT) or the large post on the solenoid (carbureted), as applicable.
4. On some FICHT models, there is a hose clamp bolted to the bottom of the starter assembly. When equipped the bolt and clamp must be removed for access to the lower starter mounting bolt.
5. On carbureted models, proceed as follows:
   a. Disconnect the negative battery cable from the starter flange.
   b. On V4 models, remove the 2 screw retaining the electrical cable cover to the powerhead (immediately adjacent to the starter and solenoid), then remove the cover.
   c. Tag and disconnect the power trim cable and VR02 connector ground wires from the starter flange.
   d. Tag and disconnect the regulator/rectifier, engine cable and power trim cable red wires from the large (positive battery) post on the starter solenoid.

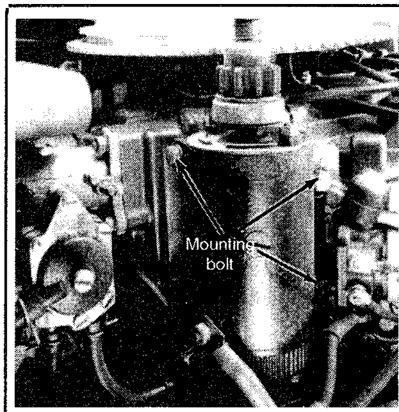


Fig. 120 Starters, such as this one from a **90°** V4, are secured using **3...**

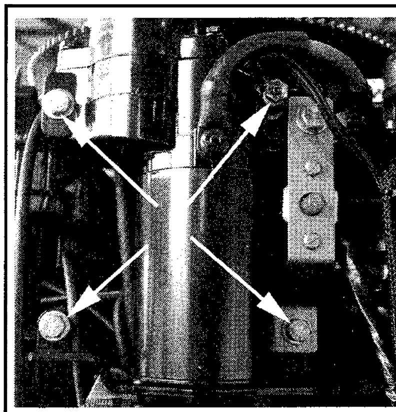


Fig. 121 **...**or 4 retaining bolts, such as this from a **90° V6** or **V8**

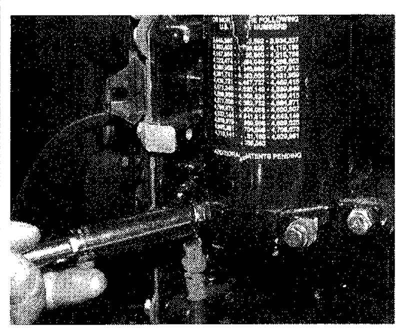


Fig. 122 To remove, first disconnect the wiring**...**

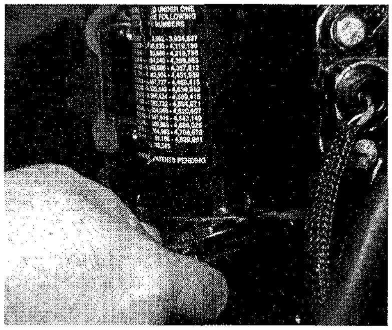


Fig. 123 ...then loosen the lower and...

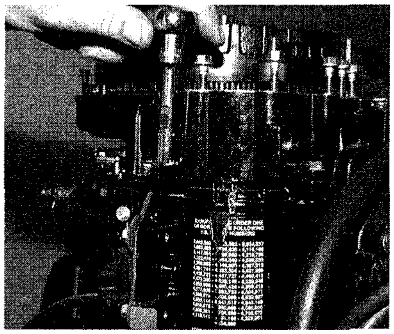


Fig. 124 ... upper retaining bolts (600 powerhead shown)

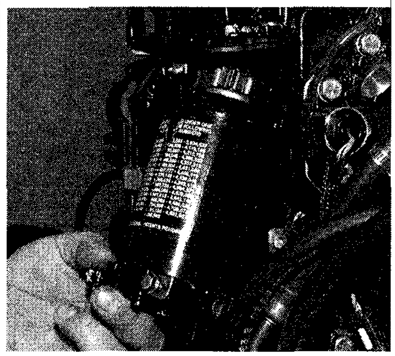


Fig. 125 Finally, carefully remove the starter

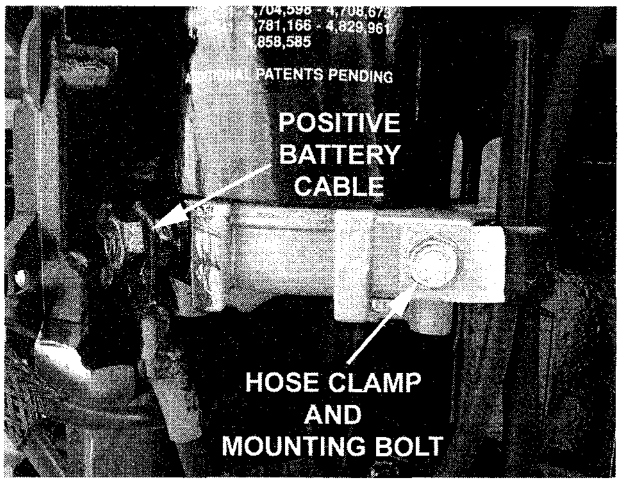


Fig. 126 Starter motors on FICHT models use a single electrical connection (and sometimes as hose clamp), while carbureted models have the solenoid attached at the base of the starter

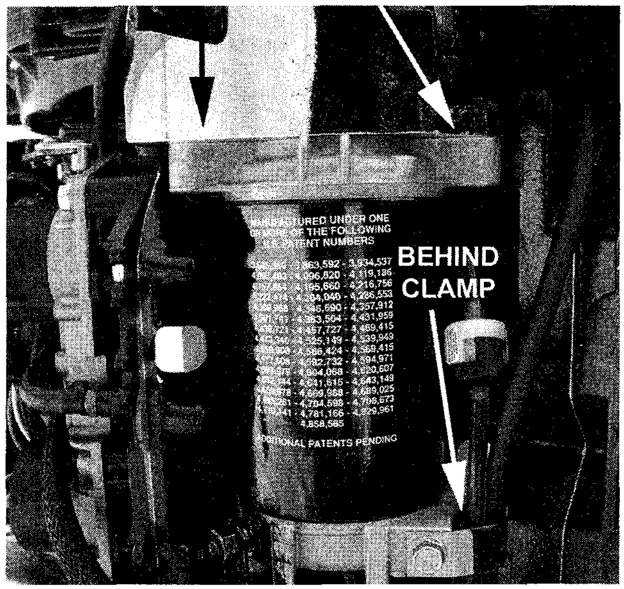


Fig. 127 Both carbureted and FICHT models are secured using 3 retaining bolts, but on the carbureted model, the lower one also retains the negative battery cable

e. Disconnect the yellowlred neutral safety switch wire from the bottom solenoid post.

f. Disconnect the ground wire from the bottom post on the solenoid.

6. Support the starter and remove the 2 (carbureted) or 3 retaining bolts, then carefully remove the starter motor from the powerhead.

On **carbureted models the 3rd starter retaining bolt was already removed when the negative battery cable was disconnected from the starter.**

7. Using a suitable solvent, clean all dirt, debris or corrosion from the starter mounting surfaces of the starter housing and powerhead. Clean all bolt/stud threads of any dirt, debris or corrosion.

8. If used, inspect rubber insulators for wear, damage or decay and replace as necessary.

To install:

9. Apply a light coating of Evinrude/Johnson Locquic Primer to the threads of the starter mounting bolts (including the one used to secure the negative battery cable on carbureted motors) according to the instructions that come with the primer. Then apply a light coating of EvinrudelJohnson Nut Lock or an equivalent threadlock to the threads of the retaining bolts.

10. Position the starter to the powerhead and tighten the retaining bolts to 14-16 ft. lbs. (19-22 Nm). On carbureted motors, be sure to position the negative battery cable and secure it using the bottom starter retaining bolt.

11. On carbureted models, proceed as follows:

a. Connect the ground wire and the yellowlred wire for the neutral safety switch to the small posts on the bottom of the solenoid and tighten securely.

b. Connect the red regulator/rectifier, engine cable and power trim cable wires to the large (battery positive) post on the starter solenoid, then tighten the nut securely.

c. Connect the power trim and VR02 connector ground wires to the starter flange and tighten the screw securely.

d. Apply a light coating of EvinrudelJohnson Black Neoprene Dip or a weather-strip sealant over all wiring terminals to protect them from moisture and corrosion.

e. On V4 models, install the electrical cable cover and secure using the retaining screws.

12. Connect the positive battery cable to the large solenoid post (carbureted) or to the starter post (FICHT) using the lockwasher and nut. Apply a light coating of EvinrudelJohnson Black Neoprene Dip or a weather-strip sealant over the connection to protect it from moisture and corrosion.

13. If equipped on FICHT models, position the hose clamp to the bottom of the starter flange and secure using the retaining bolt.

14. If removed, install the port side lower engine cover.

15. Connect the positive battery cable, followed by the negative.

OVERHAUL

DIFFICULT

◆ See Figures 128 thru 143

Although the working internal components of all Evinrude/Johnson starter motors are virtually the same, slight differences in housings, end-caps and mounting brackets used on different motors makes for subtle differences in the most logical order of disassembly/assembly. For this reason, we've provided a few different overhaul procedures, based on engine models. When it comes to cleaning and inspection however, a starter motor is a starter motor, except that specifications will again vary slightly with engine model. A single cleaning and inspection procedure is provided.

65 Jet-115 Hp (1632cc) 900 CV4 and 120-140 Hp (2000cc) 900 LV4 Motors

Two similar starter motor designs were used on the 90° V4 motors. The main difference really comes in the design of the inertia bendix and how it is serviced. On 1992-94 models the inertia bendix assembly is secured using a locknut on the top of the armature shaft. However by 1995 the design was changed to a snapring retained assembly (also used on most of the smaller Evinrude/Johnson outboards). Overhaul procedures obviously differ, at least in the steps regarding the drive assemblies.

1992-94 Models

◆ See Figures 131 thru 156

■ If the only motor repair necessary is replacement of the brushes, the drive gear does not have to be removed. All cranking motors have thru-bolts securing the upper and lower cap to the field frame assembly. In all cases both caps have some type of mark or boss. These marks are used to properly align the caps with the field frame assembly.

As a matter of fact, **DON'T** remove the drive gear unless service or inspection is necessary, as the locknut used to retain the inertia bendix drive looses the locking feature once it is **loosened. This** means anytime the locknut is removed, it must be replaced.

1. Remove the starter from the powerhead as detailed in this section.

2. Mount the starter with the pinion gear sideways in a soft-jawed vise to ease disassembly. Do not overtighten the vise and damage the starter motor housing.

3. Observe the caps and find the identifying mark or boss on each. If the marks are not visible, make an identifying mark prior to removing the thru-bolts as an essential aid during assembling. Remove the thru-bolts from the bracket and the starter motor.

4. Use a small hammer (preferably a rubber, plastic or brass mallet) and carefully tap the lower (commutator) cap free of the starter motor. The brushes are mounted in the end cap. Take care not to lose the four springs and four brushes when the end cap is removed and the brushes pop out.

Be sure to note the brush positions, as reversing the positive and negative brushes during installation will cause the motor to run backwards!

5. Both the positive and negative brushes are mounted in the lower cap. The positive brushes are attached to the positive terminal and are sold as an assembled set. The negative brushes are attached to the lower cap with a bolt. To remove the positive brushes, slip the terminal out of the slot in the cap. The negative brushes are removed by simply removing the two bolts attaching the brush lead to the lower cap.

6. Pull outward on the armature shaft from the drive gear end and remove it from the field frame (housing) assembly.

The permanent magnets in the starter field frame (housing) will resist armature **removal. You** should pull carefully, but hard enough to overpower the magnetic force.

Fig. 128 The typical **snapring** retained drive unit used on some models utilizes a protective cap...

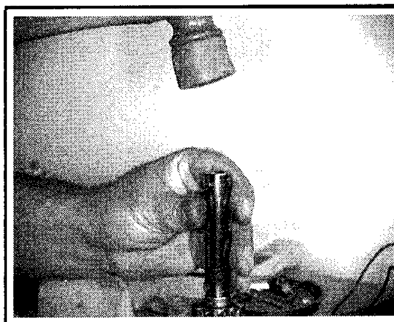


Fig. **129** ... once removed, use a driver to push the cup and spring down **revealing the snapring**

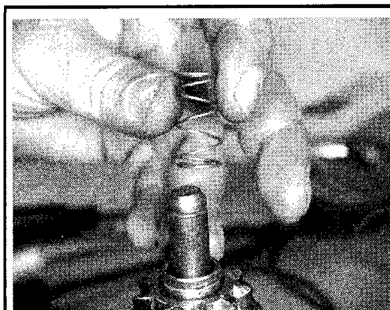


Fig. 130 With the **snapring** and cup removed, lift the spring and lower **cup/spacer** from the armature shaft

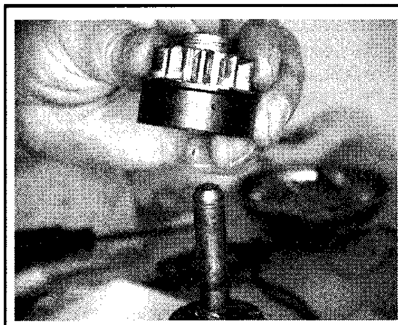


Fig. **131** Remove the pinion gear and...

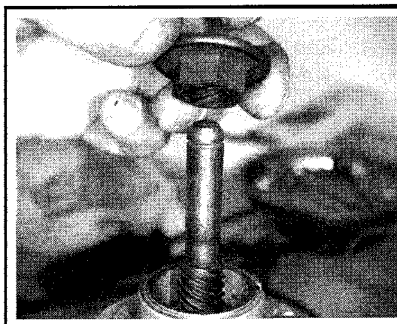


Fig. 132 ... if equipped, remove pinion gear base from the helical coils on the armature shaft

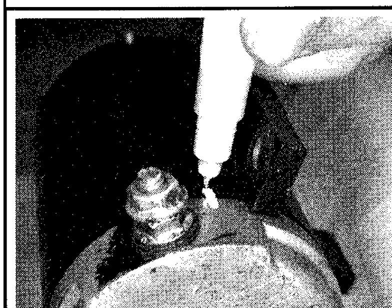


Fig. 133 If not already done, matchmark the end caps (commutator and drive) to the starter housing for assembly **purposes**

7. If pinion removal is necessary, hold the armature from turning by holding it with the proper size wrench on the hex nut provided for this purpose (on the opposite end from the shaft nut). Or, if the hex nut is not provided, hold the drive assembly with a suitable strap wrench placed across the armature shaft. Carefully loosen and remove the shaft locknut, spring retainer (spacer), anti-drift spring, and then the drive assembly (pinion, drive end cap, thrust washer). The shaft nut should be replaced and not used a second time.

8. Clean and inspect all components as detailed in this section under Cleaning and Inspection.

9. Replace any worn or unserviceable components.

To assemble:

■ Remember to install the new brushes as noted during removal since reversing the positive and negative brushes would cause the motor to run backwards!

10. Install the new brushes to the commutator end cap. The new positive brushes are installed by sliding the new positive terminal into the slot of the end cap. The negative brushes are positioned in place in the lower cap, and then the leads should be secured using the attaching bolts.

□ Read ahead and decide whether you are going to install the brushes using the special tool (a modified putty knife) or whether you'd prefer to use the armature to hold the brushes in place. If you decide to use the second method (the armature to hold the brushing in place), skip ahead to that portion of the procedure, then come back to install the pinion gear and drive assembly.

11. Apply a single drop of SAE No. 10 oil on the armature shaft bearing surface, then apply a light coating of Evinrude/Johnson Starter Pinion Lube to the helical threads on the armature shaft.

12. If removed, install the retaining ring, thrust washer and the drive end cap to the top of the armature shaft. Next, install the pinion gear, spring and spring retainer (spacer), and secure using a new locknut. Hold the armature shaft from turning while you tighten the locknut to 240-300 inch lbs. or 20-25 ft. lbs. (27-34 Nm).

13. If you are going to use the special installation tool (modified putty knife) to install the brushes, you've already followed the 2 previous steps, now:

a. Fasten a tool as shown in the accompanying illustration to prevent the brushes from being damaged during installation of the commutator end cap. If the tool cannot be easily fashioned, the same result can be achieved by cutting a slot down the center of a putty knife (the difference being that you'll have to physically hold the putty knife down against spring pressure, when the special tool would hold itself in position).

b. Slide the brush springs into the brush holders, and then install the positive and negative leads. Position the special tool over the cap and brushes, to hold the brushes in place.

c. Clamp the drive gear in a vise equipped with soft jaws and with the drive gear down. Lower the frame assembly over the armature. Align the marks on the frame assembly with the marks on the upper end cap.

d. Position the lower end cap onto the frame assembly. Lower the cap as far as it will go, and then remove the special tool. Now, align the mark on the cap with the mark on the frame.

e. Place a single drop of oil on each thru-bolt before installing it. Tighten the bolts to 95-110 inch lbs. (11-12 Nm), then seal the bolts using Evinrude/Johnson Black Neoprene Dip or an equivalent weatherstrip sealant around the end caps.

14. If you've removed the drive gear assembly and you cannot (or do not wish to) obtainlfabricate the brush holding tool, proceed as follows:

■ The drive gear assembly must have been removed in order to assemble the starter using this method.

a. Install the brush springs into the brush holder, and then place each brush on top of the springs. Lay the lower cap on the bench with the brush facing up. Pickup the armature and place the commutator on top of the brushes. Lower the armature and at the same time, work each brush into its holder. Continue to lower the armature until the full weight of the armature is on the brushes.

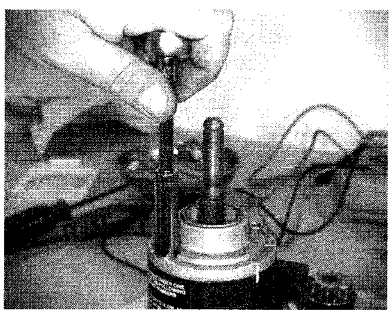


Fig. ***134*** Remove the starter housing through-bolts (usually 2) ...

Fig. ***135*** ... then remove the end caps (commutator and drive, the drive end cap is shown)

Fig. ***136*** The brush assemblies are normally located in the commutator end cap (except on the largest **V6/V8** motors), if removed, note the wire routing

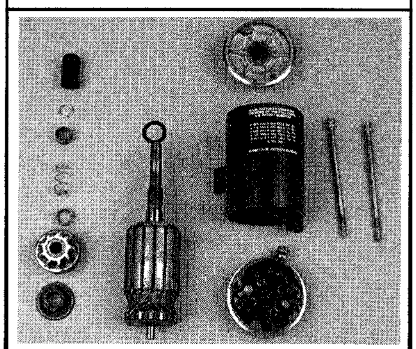


Fig. ***137*** Exploded view of a typical starter. Lay out each of your starter's components in such a manner to ease assembly

Fig. ***138*** Take care when inserting the armature in the starter housing, as permanent magnets will pull it inward strongly

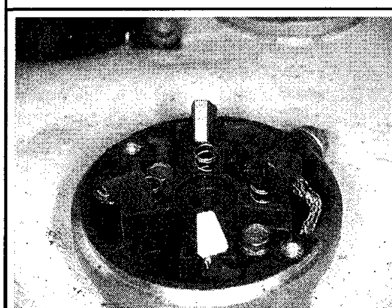


Fig. ***139*** During assembly, position the brushes as noted during removal, and place the brush springs under each contact...

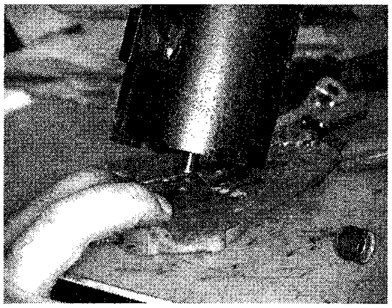


Fig. **140** ... then use a modified putty knife to hold the brushes in position as the armature and starter housing are lowered onto the commutator cap

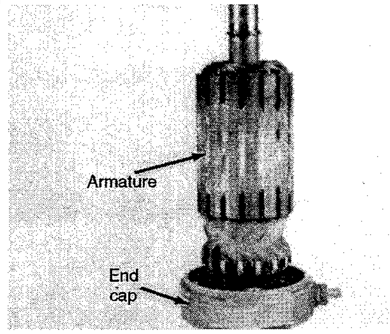


Fig. **141** An alternative procedure for holding the brushes that will work on most starters is to position the armature over the commutator...

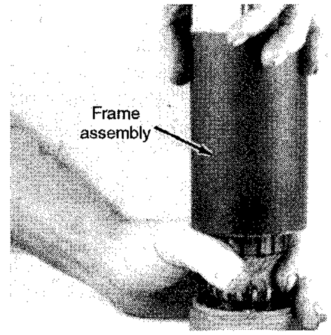


Fig. **142** ...then carefully slide the starter housing over the assembly (remember the magnets will pull strongly)

b. Now, very carefully lower the frame assembly down over the armature. Take care because the magnets in the frame assembly will tend to pull against the armature.

c. When the frame makes contact with the lower cap, align the marks on the cap and the frame.

d. Slide the upper cap washer onto the shaft.

e. Install the upper cap with the mark on the cap aligned with the mark on the frame.

15. Install the thru-bolts and tighten them securely. Clamp the cranking motor in a vise equipped with soft jaws or a couple blocks of wood. To test the assembled cranking motor, proceed directly to the next section.

a. Place a single drop of oil on each thru-bolt before installing it. Tighten the bolts to 95-110 inch lbs. (11-12 Nm), then seal the bolts using Evinrude/Johnson Black Neoprene Dip or an equivalent weatherstrip sealant around the end caps.

b. Now, go back up to the beginning of the installation portion of this procedure. Follow the 2 steps for pinion gear and drive end assembly.

16. Clamp the starter motor in a vise equipped with soft jaws and test its operation. For details, refer to the Starter No Load Current Draw Test, as detailed earlier in this section under Starter Motor, Testing.

17. Install the starter to the powerhead, as detailed in this section.

1995 and Later Models

◆ See Figures 128 thru 143 and 157

☐ If the only motor repair necessary is replacement of the brushes, the drive gear does not have to be removed. **All** cranking motors have thru-bolts securing the upper and lower cap to the field frame assembly. In all cases both caps have some type of mark or boss. These marks are used to properly align the caps with the field frame assembly.

1. Remove the starter from the powerhead as detailed in this section.
2. Mount the starter with the pinion gear facing upward (in the same direction the starter motor is normally installed on the powerhead) in a soft-jawed vise to ease disassembly. Do not overtighten the vise and damage the starter motor housing.
3. Carefully pry the protective cap from the groove in the spacer.
4. Gently push the cupped spacer down on the armature shaft until the snapring is exposed, then carefully remove the retaining ring with a pair of snapring pliers.
5. Pull the cup, spring and spacer off the armature shaft.
6. Unthread the pinion gear and base from the armature shaft.
7. Matchmark the 2 end caps (drive cap on top and the commutator cap on the bottom) to the starter housing.
8. Remove the 2 starter housing through-bolts (they are normally threaded from the top/drive end on these motors).
9. Separate the end caps from the housing and carefully withdraw the armature assembly.
10. The brush kits (brush and terminal sets) are mounted to the commutator cap. They can be removed for inspection, cleaning or replacement, but first take note of the correction orientation of each brush set and wire terminal.
11. Clean and inspect all components as detailed in this section under Cleaning and Inspection.
12. Replace any worn or unserviceable components.

To assemble:

13. Apply a single drop of SAE No. 10 oil on the armature shaft bearing surface, then apply a light coating of Evinrude/Johnson Starter Pinion Lube to the helical threads of the armature shaft.

If a brush holder is not available, install the armature to the commutator cap BEFORE assembling the drive cap components. In this alternative method of **assembly,** the armature is held in position on top of the brushes while the **starter** housing is lowered **over** the **assembly, THEN** the drive cap and components are installed.

14. If removed, install the thrust washer over the top of the armature shaft, then place the drive cap over top of the armature shaft.
15. Insert the armature into the starter housing while aligning the matchmarks made on the drive cap and housing during removal. Put the assembly down and prepare the commutator cap.
16. If removed, install the brush plate assembly to the commutator cap with the long lead in the slot. Be sure to position the brush sets as noted during removal (as reversing the positive and negative brushes will cause the motor to run backwards). Place each brush spring into the bore in the brush plate, position each brush just above its spring.

■ A brush holder can be fabricated by cutting a slot in putty knife. Make the slot just thick enough so that the knife can be slid around the bottom of the armature shaft, or more correctly, the armature shaft can be positioned over the knife and commutator cap, then the knife can be withdrawn from between the **2 components. This** will hold the brushes down against spring pressure until armature is in place.

Fig. **143** Align the matchmarks as the housing is placed in position

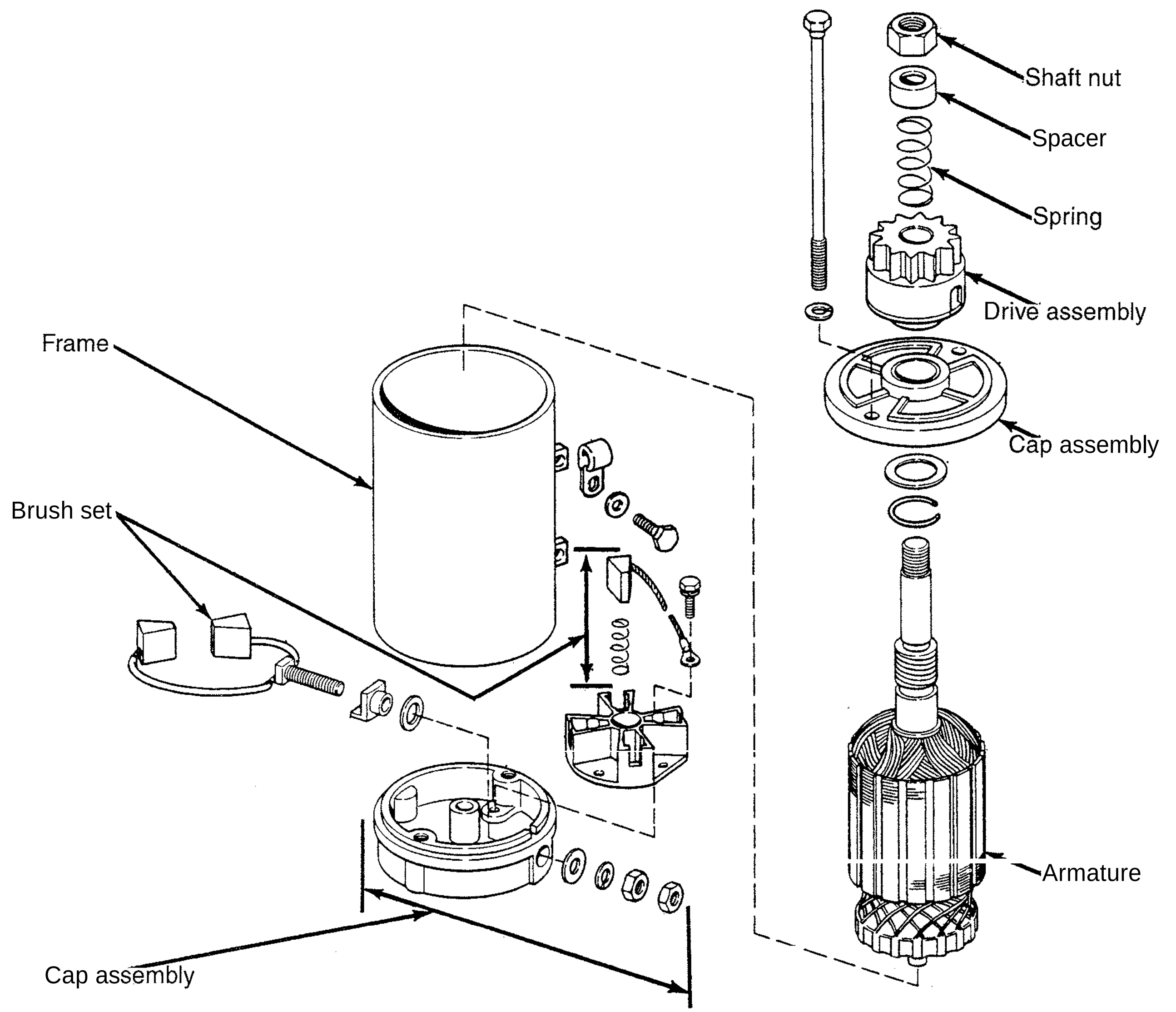


Fig. 144 Exploded view of the starter motor assembly used on 90° V4 motors through 1994

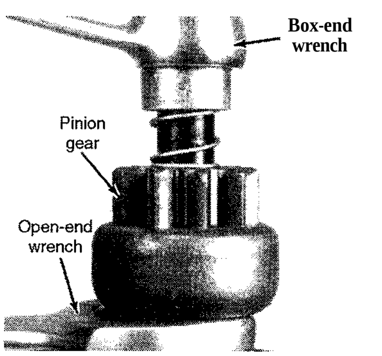


Fig. 145 On these models, some method must be used to hold the armature shaft...

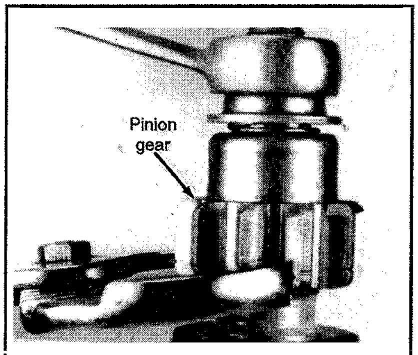


Fig. 146 ...while loosening the locknut (but take GREAT care not to damage the shaft or pinion gear)

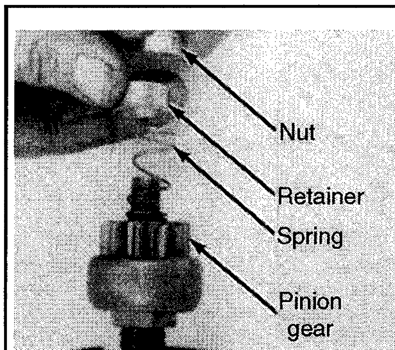


Fig. 147 Pinion gear drive assembly for locknut retained models-through 1994

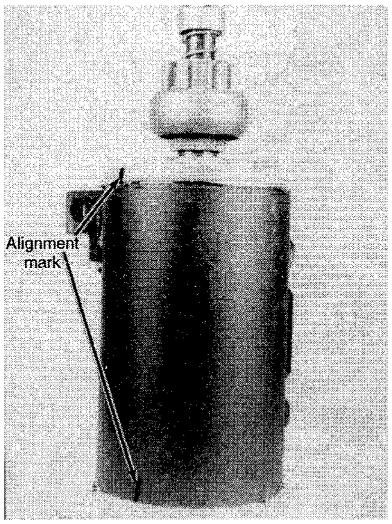


Fig. 148 Make sure the caps are matchmarked to the starter frame (housing)

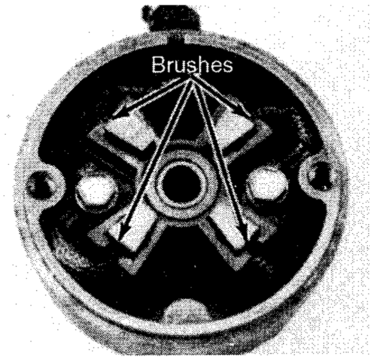


Fig. 149 The brushes are mounted in the lower end cap for these motors

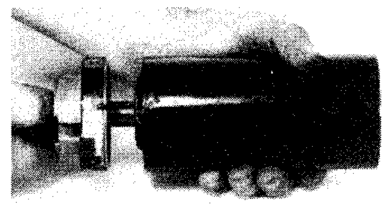


Fig. 150 Pull on the armature shaft (and drive gear assembly) to remove them from the starter frame (housing)

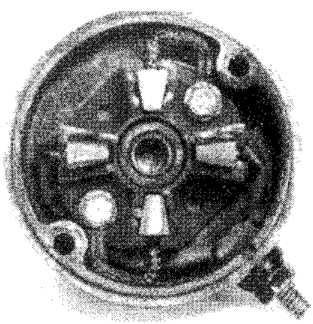


Fig. 151 During installation, make sure the positive and negative brushes are properly positioned in the lower cap...

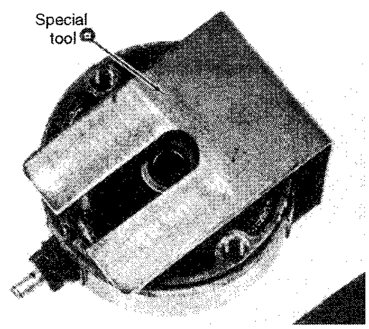


Fig. 152 ...then use the special tool (or a modified putty knife to hold the **brushes against spring pressure)**

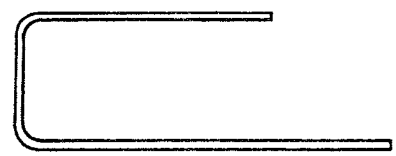


Fig. 153 **Side-view** of the special tool used to hold the brushes in position

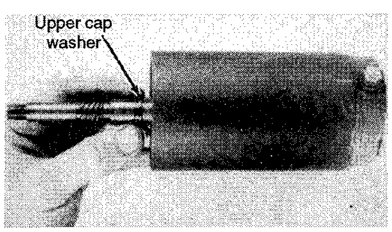


Fig. 154 If removed, slide the upper cap thrust washer onto the shaft...

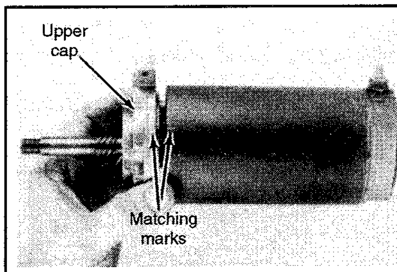


Fig. 155 ...then install the upper cap while aligning the matchmark

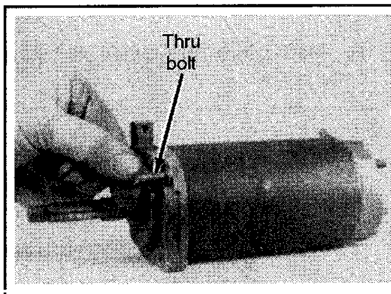


Fig. 156 Install the thru-bolts and tighten them securely

17. Position a brush holder tool (modified putty knife) over the brushes to hold them down into the commutator cap, then carefully lower the armature (with the drive cap and starter housing assembly) onto the commutator cat, while aligning the matchmarks. As the armature is seated. slowly withdraw the putty knife from between the cap and armature.

18. Apply a single drop of oil to each of the 2 starter through-bolts, then gently insert them through the end cap.

19. Tighten the starter housing through-bolts to 95-100 inch lbs. (11-12 Nm), then seal the bolts using Evinrude/Johnson Black Neoprene Dip or an equivalent weatherstrip sealant.

20. Thread the base and pinion gear over the armature shaft, then slide the spacer, spring and cup over the shaft.

21. Push downward on the cup in order to expose the snapring groove in the armature shaft, then install the snapring. Pull the cup upward over the snapring to verify that the ring seats in both the shaft and cup grooves to allow proper Bendix travel. If there is interference, use a small prytool to gently compress and seat the ring.

22. Gently snap the protective cap into place.

23. Perform the Starter No-Load Current Draw Test in order to check starter operation.

24. Install the starter motor, as detailed in this section.

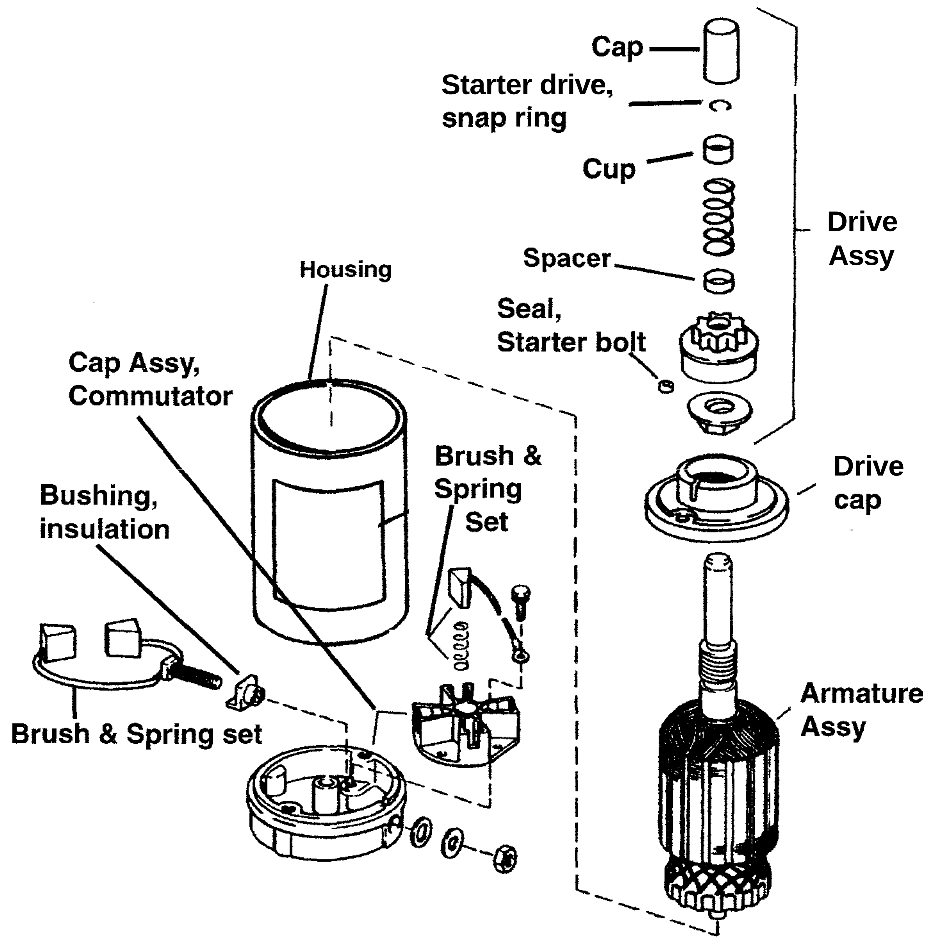


Fig. 157 Exploded view of the starter motor assembly used on 1995 and later 900 V4 motors

75-175 Hp **(1726/2859cc) 60° LV4/V6** Motors

◆ See Figures 133 thru 143 and 158

☐ If the only motor repair necessary is replacement of the brushes, the drive gear does not have to be removed. All cranking motors have thru-bolts securing the upper and lower cap to the field frame assembly. In all cases both caps have some type of mark or boss. These marks are used to properly align the caps with the field frame assembly.

1. Remove the starter from the powerhead as detailed in this section.
2. From the center of the pinion gear at the drive end of the starter motor, use a pair of external snapring pliers to carefully remove the ring securing the pinion to the armature shaft. Remove the pinion gear.
3. On carbureted models, remove the solenoid from the base of the starter as follows:

a. Remove the nut securing the solenoid strap to the starter post, then disconnect the strap from the post.
b. Remove the 2 screws on either side of the solenoid, securing the bracket (clamp) to the starter. Remove the solenoid from the base of the starter assembly.

4. Matchmark the 2 end caps (drive cap on top and the commutator cap on the bottom) to the starter housing.
5. Remove the 2 starter housing through-bolts from the bottom (commutator) cap.
6. Separate the bottom (commutator) end cap from the housing, taking care not to lose the brush springs.
7. Remove the drive end cap from the armature and housing, being careful not to loose the thrust washer.
8. The brush kits (brush and terminal sets) are mounted to the commutator cap. They can be removed for inspection, cleaning or replacement, but first take note of the correction orientation of each brush set and wire terminal.
9. Clean and inspect all components as detailed in this section under Cleaning and Inspection.
10. Replace any worn or unserviceable components.

To assemble:

11. If removed, apply a light coating of Evinrude/Johnson Locquic Primer or equivalent, followed by a light coating of Evinrude/Johnson Screw Lock, or equivalent threadlock to the brush card screws before installation.

■ If a brush holder is not available, install the armature to the commutator cap BEFORE assembling the drive cap components. In this alternative method of assembly, the armature is held in position on top of the brushes while the starter housing is lowered over the assembly, THEN the drive cap and components are installed.

12. Install the armature into the starter frame (housing).
13. Apply a light coating of Evinrude/Johnson Extreme Pressure or equivalent grease to the brush holder cap armature bearing.
14. If removed, carefully route the brush leads and install the brush springs and sets as noted during removal (as reversing the positive and negative brushes will cause the motor to run backwards). Place each brush spring into the bore in the brush plate, position each brush just above its spring.

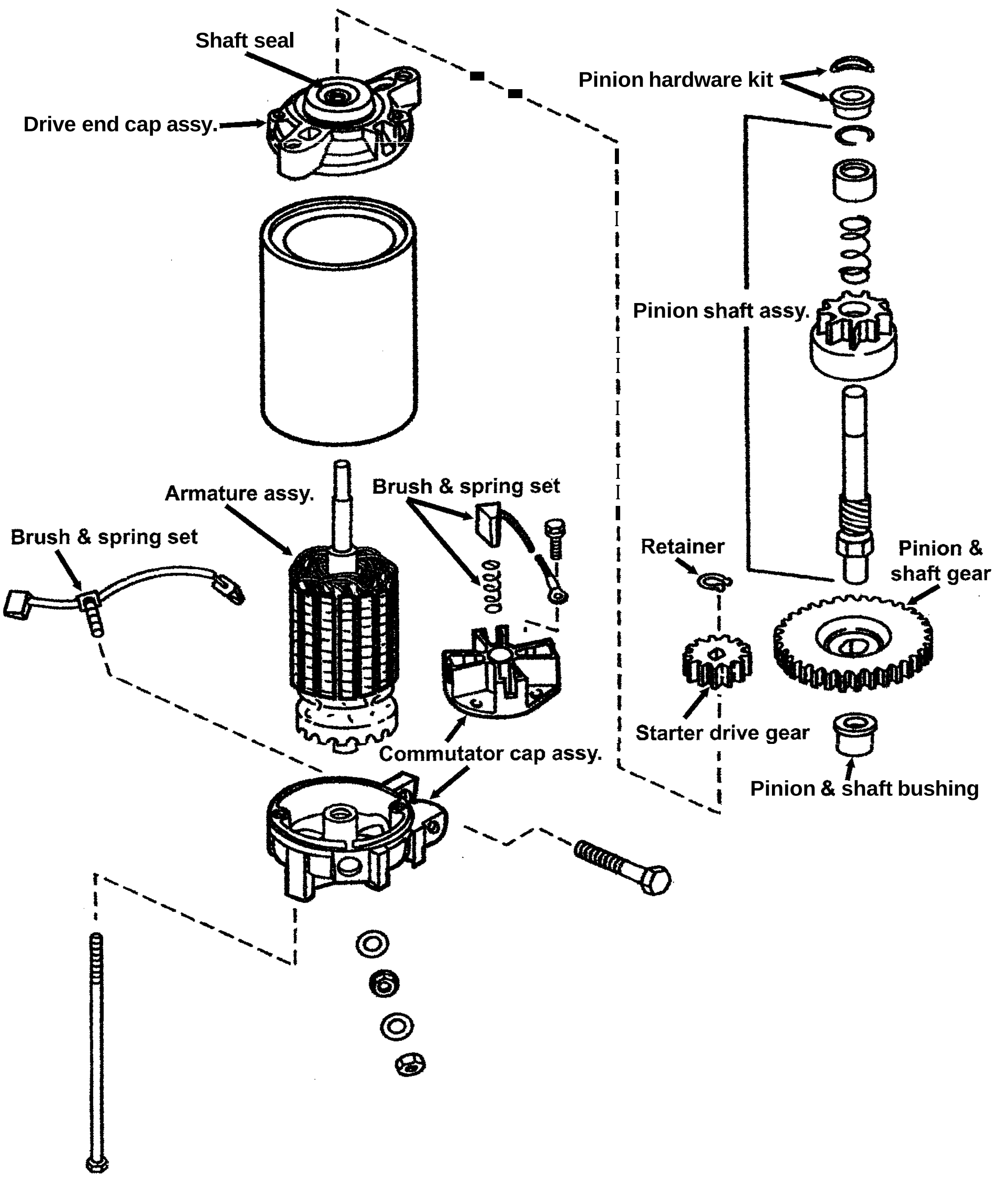


Fig. 158 Exploded view of the starter motor assembly used all **60º V4** and **V6** powerheads

A brush holder can be fabricated by cutting a slot in putty knife. Make the slot just thick enough so that the knife can be slid around the bottom of the armature shaft, or more correctly, the armature shaft can be positioned over the knife and commutator cap, then the knife can be withdrawn from between the 2 **components. This** will hold the brushes down against spring pressure until armature is in place.

15. Position a brush holder tool (modified putty knife) over the brushes to hold them down into the commutator cap, then carefully lower the armature (with the drive cap and starter housing assembly) onto the commutator cap while aligning the matchmarks. As the armature is seated, slowly withdraw the putty knife from between the cap and armature.

16. If removed, install the thrust washer over the top of the armature shaft, then place the drive cap over top of the armature shaft, aligning the matchmarks on the drive cap and the starter frame (housing).

17. Apply a light coating of Evinrude/Johnson Locquic Primer or equivalent, followed by a light coating of Evinrude/Johnson Screw Lock, or equivalent threadlock to the threaded portion of the thru-bolts.

18. Install the starter housing through-bolts and tighten to 50-60 inch lbs. (5.6-9 Nm).

19. Apply a light coating of EvinrudelJohnson Triple-Guard or equivalent marine grease to the pinion, then position it over the armature shaft. Secure the pinion gear using the snapring.
20. On carbureted models, connect the solenoid to the starter using the bracket (clamp) and the strap to the starter post, Tighten the retainers securely, then apply a light coating of EvinrudelJohnson Black Neoprene Dip or a weather-strip sealant over the strap, post and nut to protect them from moisture and corrosion.
21. Perform the Starter No-Load Current Draw Test in order to check starter operation.
22. Install the starter motor, as detailed in this section.

185-300 Hp (3000/3300/4000cc) 900 LV6/V8 Motors

◆ **See Figures 159,160,161,162,163 and 164**

There are 2 major differences between the starter motor used on all 3000cc and larger powerheads and the starters used by all smaller EvinrudelJohnson outboards. For one thing, the commutator end cao and brush assemblies are mounted towards the top of the starter on these motors instead of the bottom. The other major difference comes in the mounting, design and function of the drive unit, a reduction gear assembly that allows the starter motor to crank these large V6 and V8 engines. With all that said, the internal components of the motor itself do not differ greatly from the other starters and overhaul is not dramatically different or more difficult.

1. Remove the starter from the powerhead as detailed in this section.
2. Loosen the nuts and remove the starter mounting bracket from the thru-bolts at the bottom of the starter motor.
3. Loosen the 3 pinion (reduction gear) housing bolts and lockwashers, then separate the housing from the top of the starter motor.
4. Remove the wave washer and bushing from the top of the pinion gear shaft.
5. Position a suitably sized deep socket (to be used as a driver) over the end of the pinion gear shaft and in contact with the spacer. Tap on the socket using a mallet in order to expose the retaining ring found under the spacer itself.
6. Remove the retaining ring, spacer and spring from the pinion gear shaft.
7. Remove the pinion gear and plastic weather cover from the pinion gear shaft.
8. Remove the driven (reduction) gear and thrust washer.
9. Locate the drive gear on the armature shaft (in the small, semi-circular pocket to the side of the opening in the top of the assembly, but directly under the armature housing). Use a pair of external snapring pliers to carefully remove the retaining ring and drive gear from the armature shaft.
10. Using a deep socket or open-end wrench loosen and remove the 2 thru-bolts from the bottom of the starter housing.
11. Matchmark the upper and lower end caps (note the upper cap is a combination drive/commutator cap, it may already contain a matchmark aligned with the positive terminal stud, if not make one now).
12. Remove the lower end cap, if necessary, using a rubber mallet to gently tap on the housing to help free it. Once the lower cap is removed, check for an insulator cap located inside the lower cap or possibly on the shaft. Inspect and replace the cap, if damaged.
13. Position the starter with the gear end facing downward on a worksurface or in a soft-jawed vise. Hold the armature in place while grasping the starter frame and carefully pulling it away from the armature and gear housing.
14. Now, SLOWLY remove the armature and thrust washer, taking care not to loose the brush springs.
15. If possible compare the brush sets to a new set and replace, if they are more than 112 worn. Note the brush locations and wire routing for assembly purposes.
16. Inspect the locating ring found about 112 way down the gear end of the armature shaft and replace if it is worn or damaged.
17. Clean and inspect all components as detailed in this section under Cleaning and Inspection.
18. Replace any worn or unserviceable components.

To assemble:

19. If removed, apply a light coating of EvinrudelJohnson Locquic Primer or equivalent, followed by a light coating of EvinrudelJohnson Screw Lock, or equivalent threadlock to the brush card screws before installation.

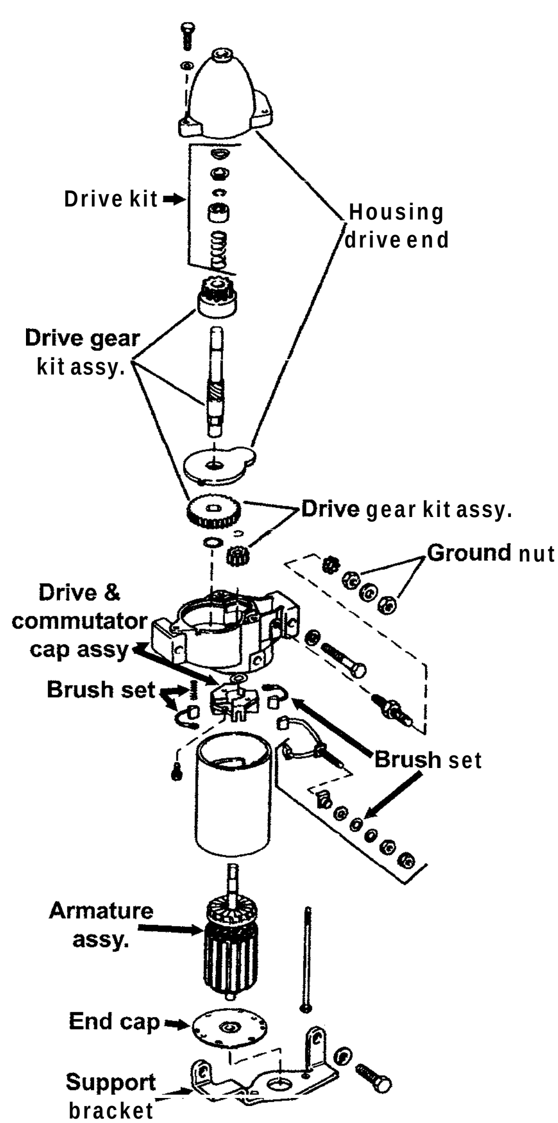


Fig. 159 Exploded view of the reduction gear starter motor used on 3000cc and larger V4 and V6 motors

20. If removed, carefully route the brush leads and install the brush springs and sets as noted during removal (as reversing the positive and negative brushes will cause the motor to run backwards). Place each brush spring into the bore in the brush plate, position each brush just above its spring.

A brush holder can be fabricated by cutting a slot in a putty knife. Make the slot just thick enough so that the knife can be slid around the bottom of the armature shaft, or more correctly, the armature shaft can be positioned over the knife and commutatorldrive cap, then the knife can be withdrawn from between the 2 components. This will hold the brushes down against spring pressure until armature is seated.

21. Apply a light coating of EvinrudelJohnson Extreme Pressure or equivalent grease to the armature bearing in the bottom of the gear housing. Position the thrust washer on the armature shaft.
22. Position a brush holder tool (modified putty knife) over the brushes to hold them down into the commutatorldrive cap, then carefully lower the armature (taking care not to dislodge the thrust washer) onto the commutatorldrive cap. As the armature is seated, slowly withdraw the putty knife from between the cap and armature.

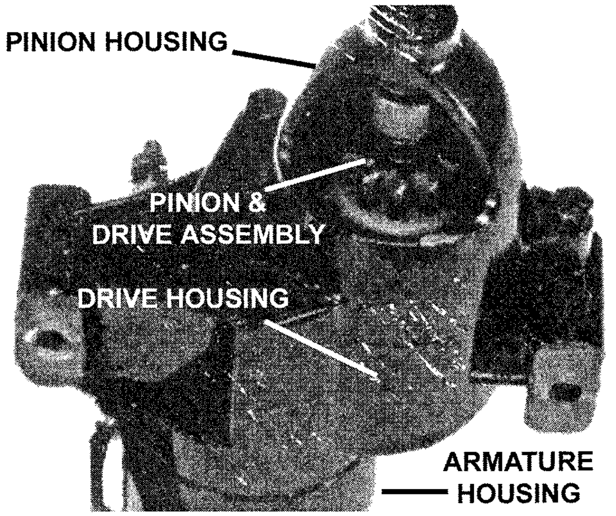


Fig. 160 Major components of the reduction gear starter motor

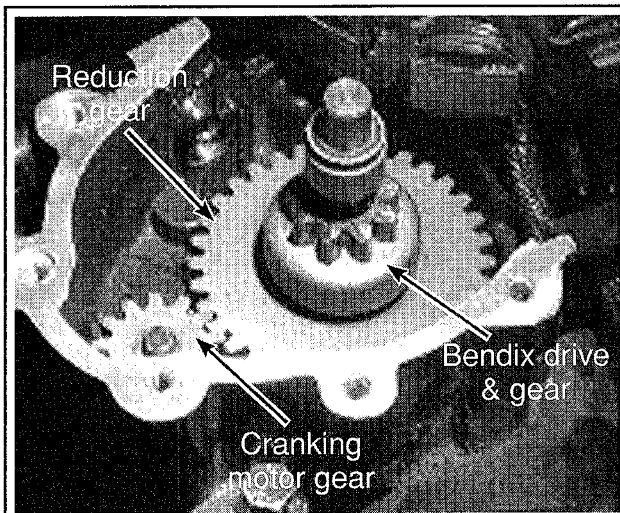


Fig. 161 Pinion and driven (reduction) gear assembly

23. Position the starter frame so the matchmark will align with the positive terminal stud, then CAREFULLY lower it into position over the armature. Here's the challenge; the permanent magnets in the frame are either going to want to pull the frame down into position very quickly (and with some force, so WATCH your fingers), or it is going to try and pull the armature up and off the brushed (don't let this happen). Slide the frame into position while keeping pressure down on the armature. The notches in the gear housing and frame should align when properly installed.
24. Install the insulator cap on the bottom end of the armature shaft. Apply a light coating of EvinrudelJohnson Extreme Pressure or equivalent grease to the armature shaft end cap bearing and install the bottom end cap to the starter.
25. Install the starter housing through-bolts and tighten to 50-65 inch Ibs. (5.6-7.3 Nm).
26. Apply a light coating of EvinrudelJohnson Triple-Guard or equivalent marine grease to the armature drive gear, then install it over the armature shaft. Install the retaining ring with the flat side facing upward to secure the drive gear.
27. Apply a light coating of EvinrudelJohnson Extreme Pressure or equivalent grease to the gear housing bearing. Apply a light coating of EvinrudelJohnson Triple-Guard or equivalent marine grease to the driven (reduction) gear, Install the thrust washer and the driven (reduction) gear.
28. Install the weather cover.
29. Install the spring and spacer (with the large diameter facing upward) onto the pinion shaft. Secure using the retaining ring, then install the bushing and wave washer (positioned with the convex side down).
30. Apply a light coating of EvinrudelJohnson Starter Pinion Lube or equivalent to the pinion shaft splines and to the pinion hosing bearing. Lower the pinion gear and shaft assembly into position without disturbing the driven (reduction) gear and the thrust washer.
31. Install the pinion housing to the top of the starter motor assembly, then secure using the bolts andlockwashers. Tighten the bolts to 60-84 inch lbs. (7-9 Nm).
32. Apply a light coating of EvinrudelJohnson Nut Lock, or equivalent threadlock to the threads of the thru-bolt studs, then install the starter mounting bracket and secure using the retaining nuts. Tighten the nuts to 50-65 inch lbs. (5.6-7.3 Nm).
33. Perform the Starter No-Load Current Draw Test in order to check starter operation.
34. Install the starter motor, as detailed in this section.

CLEANING AND INSPECTION

3 DIFFICULT

◆ **See Figures 165,166,167,168,169 and 170**

NEVER attempt to clean the starter drive assembly with solvent while the components are installed. Solvent could wash dirt into the bearings and commutator that would eventually lead to starter failure.

1. Remove the starter motor from the powerhead, as detailed in this section.
2. Disassemble the starter motor, laying out each of the components in a logical order to ease inspection and assembly, as detailed in this section.

Work on only one component at a time, then place it back into your logical layout on the worksurface.

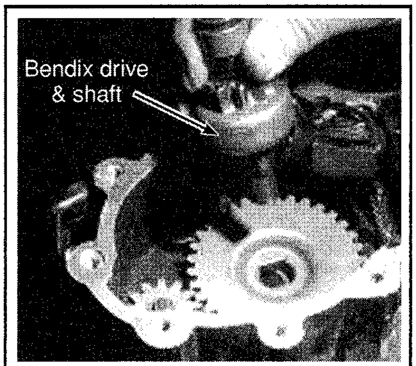


Fig. 162 Remove the bendix drive and shaft (pinion gear assembly)...

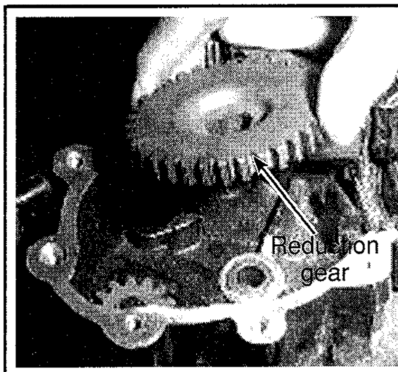


Fig. 163 ... followed by the driven (reduction) gear...

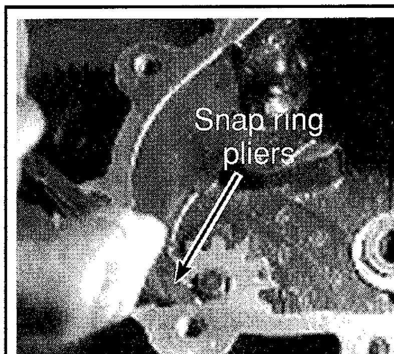


Fig. 164 .. and armature drive gear

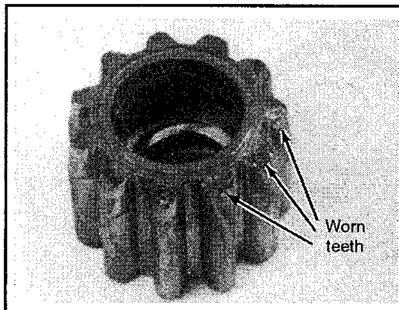


Fig. **165** Check the pinion gear for damaged or worn teeth and replace, if **necessary**

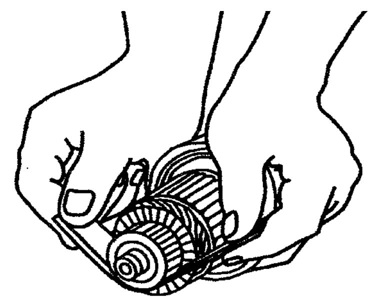


Fig. **166** Use **300** grit emery cloth to carefully polish the commutator surface

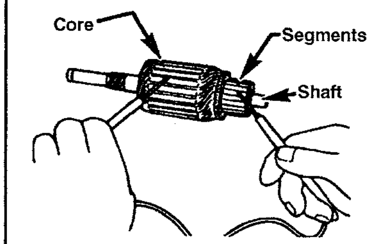


Fig. **167** Use an ohmmeter to check the commutator for shorts between the commutator and core or shaft...

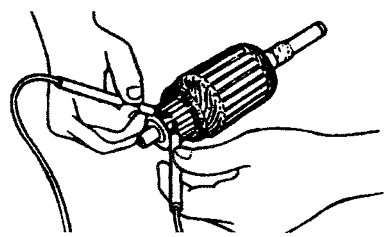


Fig. **168** **...**and for opens between segments

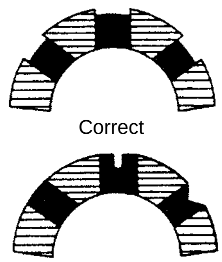


Fig. **169** If undercutting is necessary, make sure the cuts are square and not triangular

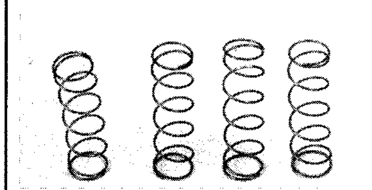


Fig. **170** Compare the color and length of the brush springs. Replace the set if any are stretched or bluish in color

3. Use compressed air to remove brush material or debris from the armature and commutator cover.

4. Use a mild solvent to clean all starter motor components, except the brush plate and brushes.

5. Clean the brush plate and brushes using an electrical contact cleaner.

6. Visually check the pinion drive for damaged (chipped, cracked or worn) teeth and replace it if needed.

7. Inspect the helical splines at the base of the armature shaft (where the armature shaft meets the body) for damage or corrosion. Thread the pinion drive on and off of the shaft splines. Reolace the pinion drive and/or armature if the pinion drive does move smoothly on the threads.

8. Inspect the entire armature assembly for damage, wear or corrosion and, replace, if necessary.

9. Carefully secure the armature in a vise with soft jaws (otherwise, use wooden blocks or rubber pads to protect the armature in the vise). Tighten the vise just sufficiently to secure the armature, but not so tight as to damage it.

10. With the armature in the vise, carefully polish the commutator using 300-grit emery cloth. Rotate the armature often in the vise to polish it evenly around the circumference.

**** WARNING**

It is best to polish the commutator by hand as power tools would likely remove too much material making it unserviceable. Proceed slowly and evenly removing only a minimal amount of material. However, if the commutator surface is pitted or unevenly worn, you may turn it using a lathe. In all cases, be sure to remove all traces of oil or metal dust from the commutator.

11. Check the commutator for shorts or open windings using a DVOM or ohmmeter:

a. Probe between the commutator segments and the core (laminated section) of the armature. There should be no continuity between any commutator segment and any laminated section (if continuity is present, there is a shorted winding and the commutator must be replaced).

b. Probe between the armature shaft and each commutator segment. There should be no continuity should between any commutator segment and the armature shaft (if continuity is present, there is a shorted winding and the commutator must be replaced).

c. Probe between the between each commutator segment (place one meter probe on a segment and the other probe against an adjacent segment, then move the probes sequentially around the segments until all are checked). There must be continuity between segment pairs (if continuity is not present, there is an open winding and the armature must be replaced).

12. Use a small file to carefully undercut the insulation (lengthwise cuts that are located between the commutator segments) between the mica. Remove all metal particles using compressed air. The insulation must be about 1132 in. lower than the segments. The cuts must be squared, not triangular.

13. Visually inspect the brushes, springs and brush plate for damage (chipped or broken surfaces), dirt or corrosion. If any brush springs are weak, lack tension, or are discolored, replace all the springs as a set. Brushes or brush plates that show damage must be replaced.

14. Check the permanent magnets in the starter housing for dirt, debris or corrosion and clean, as necessary. Make sure none of the magnets are loose or damaged (cracked or visibly deformed). The starter housing must be replaced if it or the magnets have been damaged.

Two things to check for on the housing magnets would be the present of metal particles (since the magnets would attract any loose particles in the **housing)** and if the starter failed the No Load Test, weak magnets. **Excessive** RPM in the No Load Test is usually theresult of weak magnets.

15. Check the bearing surfaces on the armature and inside the bushing (commutator and drive caps) for discoloration and/or excessive or uneven wear. Replace any questionable bearingslbushings using a suitable puller and driver. Replace the armature its bearing surfaces are rough or uneven.

16. Assemble the starter and install it to the powerhead as detailed in the procedures in this section.

Starter Motor Solenoid/Relay Switch

◆ **See Figure 171**

A solenoid is a remote controlled switch. It works by using a smaller current circuit as an actuator or signal circuit to throw the internal switch that completes a larger circuit.

When the ignition keyswitch (or starter button on a few models) is actuated, current flows to and energizes the starter solenoidlrelay coil. The energized coil closes a set of contacts that allows high current from the battery terminal of the solenoid to connect with the power output (starter motor) terminal of the solenoid and reach the starter motor.

The solenoidlrelay is normally mounted to the powerhead in the immediate vicinity of the starter motor. If its location is not immediately apparent, remember that the solenoid is essentially a remote controlled switch that must be wired inline between the battery and starter. Follow either the positive battery cable from the battery to the solenoid or the red, positive cable, from the starter back to the solenoid.

On carbureted versions of the 60° powerheads (80 Jet-175 hp 1726/2589cc outboards), the solenoid is actually mounted to the bottom of the starter motor itself.

TESTING THE SOLENOID

◆ **See Figures 171,172 and 173**

On all models, a DVOM can be used to check the coil winding (the battery-to-starter motor circuit) of the starter solenoid for continuity only under specific conditions. To perform this functional check of the solenoid, a fully-charged 12-volt battery and a set of jumper leads will also be necessary. The test essentially involves checking to make sure the main switch (battery power-to-starter power terminal) is closed when the solenoid signal circuit is not activated, then manually activating the circuit using the battery and jumpers to make sure the main switch closes. The actual method of actuation varies slightly on carbureted and FICHT motors (simply because of the physical differences in appearance and differences in wiring between the two types of solenoids).

For safety and to ensure proper results, be sure to tag and disconnect all wiring from the starter solenoid/relay before performing this test.

1. Disconnect the negative battery cable for safety.
2. Tag and disconnect the wiring from the solenoid. If desired, remove the solenoid completely from the powerhead.

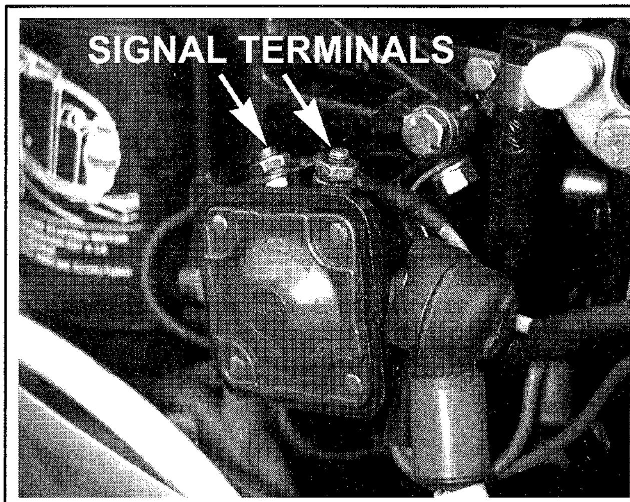


Fig. 171 Typical Evinrude/Johnson starter solenoid with signal terminal identification-used on all carbureted motors

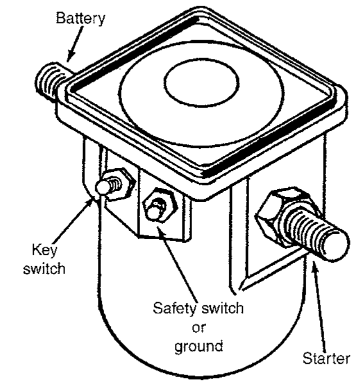


Fig. 172 On all Evinrude/Johnson solenoids, the larger terminals are for the battery and starter motor cables, while the smaller terminals connect to the signal wires-typical carbureted solenoid shown, FICHT solenoids are shaped differently

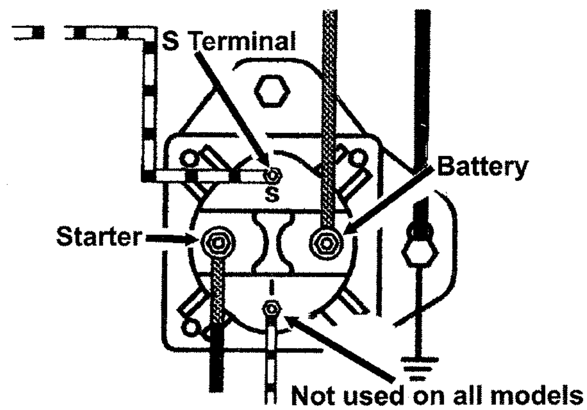


Fig. 173 Terminal identification for solenoids used on FICHT motors

■ **On FICHT motors, removing the solenoid from the powerhead will require you to use a second jumper to provide a ground to the solenoid body. Carbureted motors already require the second jumper as that is how the circuit is wired to the signal terminals utilizing both a power and ground signal.**

3. Set the DVOM to read resistance, then connect the probes across the 2 large terminals on either end or either side of the solenoid. These are the main switch terminals to which the positive battery cable and the red starter cable normally attach. The meter should show no continuity. If the switch is closed with no power applied to the signal terminals, the solenoid is stuck closed and must be replaced.
4. Using the set of jumper'wires, apply battery voltage to the solenoid signal circuit as follows (depending on the model):
   - On carbureted motors, apply voltage across the 2 signal terminals. Use one jumper wire to connect from the positive battery cable to one signal terminal (the small terminals to which the ignition switch and ground wiring normally connect) and the other jumper wire to connect the negative battery cable to the other terminal.
   - On FICHT motors, apply voltage to the terminal **S** in the accompanying illustration. This terminal is easily identified as it normally has a yellowlred or yellow/green wire connected to it. The terminal opposite the **S** terminal is not used on all FICHT models. Use one jumper wire to connect the positive battery cable to the **S** terminal and the other jumper wire to connect the negative battery cable to the solenoid body (near one of the mounting tabs where the ground strap is normally attached).

Listen as the battery connections are made to the signal terminals of the solenoid. An audible click should be heard as the main power switch closes.

5. With the battery power applied to the signal switch circuit, recheck the meter for continuity between the 2 large terminals. The meter must now show very little or no resistance at all, as the main switch must be closed (which would normally allow battery power to reach the starter motor). If the solenoidlrelayswitch does not close, it must be replaced.
6. On some FICHT motors there is one additional test step. If there is a wire attached to the other signal switch terminal (the one on the bottom of the solenoid, opposite terminal **S),** then you need to check for continuity between that terminal and one of the two main circuit towers. With power applied to the signal circuit, same as in the previous step, there must be continuity between that additional wire's terminal and either the power output terminal (attached to the starter) for all 2000 and later models, or to the battery power input terminal (all 1992-99 models). If there is no continuity with power applied, the solenoid should be replaced.
7. After testing or repairs, reconnect the wiring as tagged. Apply a light coating of Evinrude/Johnson Black Neoprene Dip or a weather-strip sealant over all wiring terminals to protect them from moisture and corrosion.
8. Reconnect the negative battery cable.

REMOVAL & INSTALLATION

2 *MODERATE*

◆ See Figures 172,173,174 and 175

Removal and installation of the solenoid itself is a relatively simple matter of disconnecting the wiring and unbolting the solenoid. Sounds easy right? Well, it is, as long as you remember to tag the wiring before disconnecting it. Look, we all do this, we go, I'll remember it, then the phone rings or someone walks in or you bang your big toe on the trailer, whatever. Point is, take a few pieces of tape and a few seconds to tag the wiring before you start and you'll have no problem installing the solenoid, whenever you finish.

On carbureted versions of the **60º** powerheads (80 Jet-175 hp **1726/2589cc** outboards), the solenoid is actually mounted to the bottom of the starter motor itself. Although solenoid replacement is normally possible (and relatively easy) to accomplish with the starter attached to the powerhead, more details regarding solenoid mounting on these models are included in the Starter Motor, Overhaul procedure located earlier in this section.

1. Disconnect the negative battery cable, followed by the positive battery cable for safety.
2. Locate the starter solenoid by following the red positive cable back from the starter or forward from the battery.
3. Tag the wiring to ensure proper and easy installation. If necessary, sketch a quick diagram of each wire color and terminal location. Disconnect the wiring and move it gently aside for clearance.

■ Although mounting will vary slightly from model-to-model, solenoids on carbureted engines are normally held in place by a band clamp that passes across the rounded portion of the solenoid body and bolts on either side to the powerhead (or starter motor on **60º** models). In contrast, the solenoid used on FICHT motors is normally held by **2** mounting bolts that pass directly through **2** integral mounting flanges in the solenoid body.

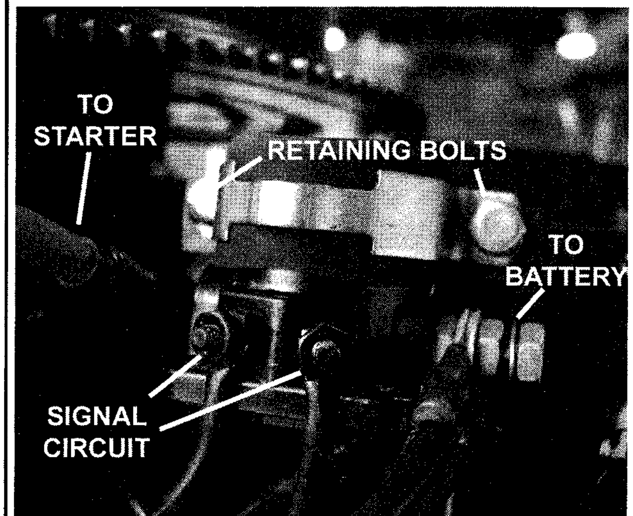


Fig. 174 Typical solenoid mounting for carbureted motors V8 shown

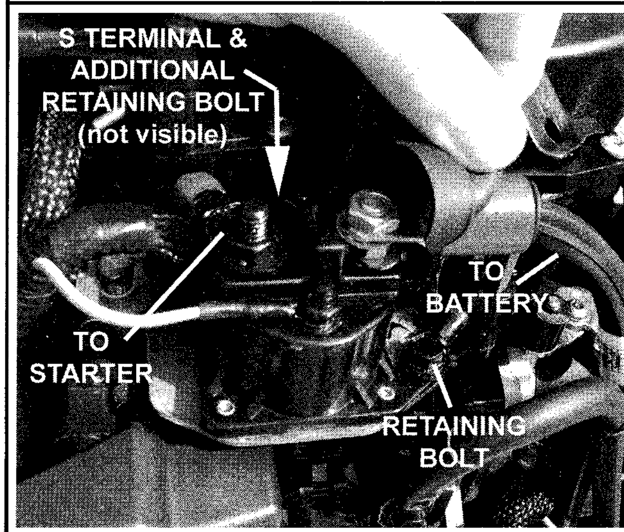


Fig. 175 Typical solenoid mounting for FICHT motors-V4 shown

4. Remove the solenoid or solenoid bracket retaining screws and then remove the solenoid from the powerhead or mounting bracket.
5. Installation is the reverse of the removal procedure. Tighten the screws and wiring terminal nuts securely. If the wiring is not equipped with a plasticlrubber protective cover, apply a light coating of Evinrude/Johnson Black Neoprene or equivalent weather-stripping adhesive over the wires to protect them from moisture and corrosion.

WARNING SYSTEM

Description and Operation

◆ See Figures 176 and 177

✳✳ WARNING

Read and follow all warnings/cautions in your owner's manual regarding engine warning system operation. The warning system is meant to protect both your engine (by protecting it from potentially severe engine damage) and you (by protecting you from becoming stranded on the water).

Almost all Evinrude/Johnson [illegible] a few rope start/tiller control models) are equipped with one or more warning systems designed to alert the boater should a malfunction occur in various engine operating systems [illegible] engine [illegible] oil delivery).

Most Evinrude/Johnson engines (except for the 90º cross-flow V4s) are equipped with some version of the Speed Limiting Operational Warning (S L O W) system This system monitors one or more parameters, depending on the model On most models it monitors engine temperature and oil level in the oil tank (for oil injected 2-strokes) The system is used to warn the boater of trouble before damage to the engine can occur

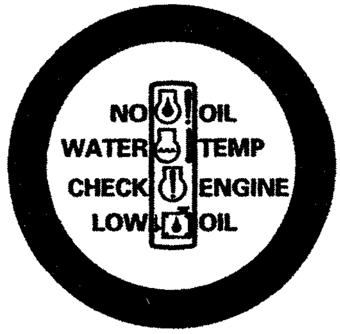


Fig. 176 The System Check monitor in normally installed in the boat dash as a stand-alone gauge...

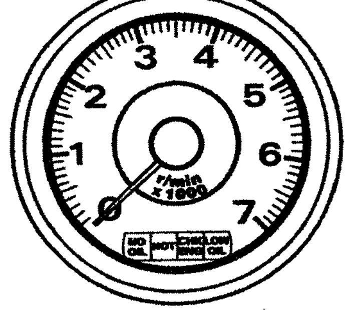


Fig. 177 ... or as part of a tachometer

The warning system will normally trigger if it detects a high temperature or low oil level (2-stroke), depending on the model. But the speed limiting function of the system is limited to engine temperature faults on carbureted models. A much more comprehensive version of the system is incorporated into the Electronic Management Module (EMM) on FFI engines. For fuel injected engines, the system monitors charging system output and EMM temperature as well as oil delivery (oil injector circuit operation and oil pressure loss) and cooling water temperatures.

All FFI and most remote control carbureted engines are equipped with either a stand-alone Evinrude/Johnson System Check engine'monitor gauge or a tachometer housing that contains the same 4 trouble-lights at the base. The System Check monitor acts as a dash mounted gauge/horn to alert the operator in the event of certain potentially damaging operating conditions.

Gauge circuits monitor conditions such as a lack of oil, excessive water temperature, electronic fault detection (check engine light condition) or low oil (meaning low oil in a reservoir that feeds the FFI oil injection circuit). On FFI motors, in addition to the information on oil pressure and water temperature provided by powerhead mounted sensors, the Check Engine light is connected to a warning circuit for the EMM designed to alert the boat operator should a malfunction occur in the electronic engine control system.

CARBURETED MODELS

◆ **See Figures 176 and 177**

All carbureted outboards are equipped with a water pump indicator stream. Always be sure that a strong stream of water exits the fitting at the lower rear area of the motor cover while the engine is operating. If the stream of water is ever absent or weak, shut the motor down immediately and inspect the cooling system. Check the stream more frequently anytime engine is operated in water clouded with sand or debris.

On all carbureted looper powerheads, if the S.L.O.W. system is activated, the ignition module will gradually reduce and limit the engine speed to 2500 rpm. This will occur if the engine temperature exceeds specification as follows:

- 60° loopers: approximately 240°F (116°C)
- 90° loopers: approximately 203°F (95°C)

In order for normal operation to resume, the engine must cool below about 207°F (97°C) for 60° motors or below 170°F (77°C) for 90° motors. Also, the engine must be shut off and restarted before the power pack will reset the S.L.O.W. system.

FFI MODELS

◆ **See Figures 176 and 177**

On FFI models, the EMM monitors input from multiple sensors to determine if the S.L.O.W. system mode should be actuated. It will automatically trigger the operation in this mode if various codes are recorded in the self-diagnostic system including certain signals from the charging circuit, water temperature switch, water temperature sensor, EMM temperature sensor, oil injector circuit and oil pressure loss switch/circuit.

When activated the S.L.O.W. system operates in a more sophisticated manner on FICHT motors. Whereas on carbureted motors spark is controlled to limit engine rpm, on FICHT motors, the EMM will actually interrupt the fuel iniection circuit. But the EMM won't just cut fuel to the motor, it will gradually'interrupt injection to one cylinder at a time until 3-5 cylinders are affected, depending on the motor, gradually slowing engine speed to 1800 rpm. To recover from the system 2 things must occur. First, whatever sensor signal caused activation must return to normal parameters. And second, engine speed must have returned completely to idle. At this point, the EMM will reset the system and return normal fuel mapping.

A warning buzzer is normally located within the remote control unit (but also may be located with the tiller control housing or behind the dash). The buzzer is actuated by the EMM, which provides a ground circuit. When the ignition switch is first turned on, battery voltage is applied to the buzzer and if the circuit is completed through the EMM at any time, the buzzer sounds.

☐ **More details about the Temperature Sensors/Switches can be found in the FICHT Fuel Injection Section.**

If the Check Engine warning light illuminates, first check the battery condition as detailed under Batteries in the General Information and Maintenance section. If the battery is good, the EMM may have detected a fault within the electronic engine control system (and stored a diagnostic trouble code). If the EMM detects a fuel injection or electronic engine control fault, it will siore a Service Code, sound the horn for 10 seconds and illuminate the gauge LED for a minimum of 30 seconds. The light will go out if the fault does not remain present, otherwise the LED will remain illuminated until the fault goes away or the key is turned off (whichever comes first). If the fault is still present the next time the engine is started, the LED will illuminate once again to alert the operator that problem is still present. The Check Engine light can also be used to output the Service Code. For more information, please refer to Reading Codes in the Self-Diagnostic System portion of the FICHT Fuel Injection (FFI) section.

Troubleshooting

TESTING WARNING CIRCUITS

System Check Gauge

◆ **See Figures 176 and 177**

2 MODERATE

Self Test Mode

◆ **See Figures 176 and 177**

The System Check gauge enters a self-test mode each time the key is turned to the ON or RUN position. When power is first applied, the internal gauge electronics gauge (or the circuits in the EMM) will sound the warning horn for a 1/2 second and illuminate all four gauge LEDs. Then, the electronics will turn off each LED in sequence. Each self test helps the operator be sure that the warning horn and all LEDs are functioning, as well as reassuring that the electronic control circuits for the system are operating correctly.

Should battery voltage drop below 7 VDC anytime during engine operation or if the ignition switch is simply left in the ON or RUN position, the gauge may automatically re-enter the self-test mode.

If the self test mode does not occur normally, check the following:

- If 1-3 of the LEDS do not illuminate, the control circuits may be at fault and, if so the gauge or EMM, must be replaced. Make sure the control circuits are at fault by checking the related circuits/components.
- If all 4 LEDs do not illuminate, test the power to the gauge as follows:

1. Locate and disconnect the system gauge 8-pin connector, then use a voltmeter to check for power on the purple lead (using the black lead to provide ground) with the ignition keyswitch turned to ON or RUN, If battery voltage is not supplied under these conditions, recheck connecting the black lead directly to ground (if power is now present, repair/replace the open in the black lead). If voltage is not available under either condition, check the purple lead, 20-amp fuse and/or ignition keyswitch and repair or replace components, as necessary.
2. If the purple lead indicates battery voltage and the black lead is continuous with ground, but not LEDs illuminate when the harness is reconnected, replace the system check gauge or the EMM.

☐ The high cost of an EMM would make us seek a second opinion if we were not completely sure of our test procedures and that nothing was overlooked in making harness connections.

- If the warning horn does not sound for 1/2 second when the keyswitch is first turned to ON or RUN

3. If available, substitute a known good horn. If the replacement horn beeps, the problem is found. More likely, if a known good horn is not available, disconnect the 8 pin connector at the system check gauge. Turn the ignition switch to ON or RUN and use a suitable jumper lead to ground the connector's tanlblue lead to the black lead. If the warning horn now sounds, replace the system check gauge.
4. If the warning still does not sound, leave the gauge disconnected and now disengage the warning horn from its 2 pin connector. Test the tanlblue lead for continuity between the warning horn (2-pin) and gauge (8 pin) connectors. If no continuity is found, repair or replace the tanlblue lead (and/or connectors) whichever is necessary.
5. Next, test the purple lead in the 2 pin connector (on the wiring harness side) for battery voltage whenever the ignition switch is turned to ON or RUN. Repair or replace the purple lead, 20-amp fuse and/or ignition switch as necessary. Reconnect the 2 pin connector when finished.
6. If the circuits check out, but the horn will still not sound you can check the horn using jumpers to connect it directly to a 12-volt battery, then replace the horn if it will not sound.

Operational Mode

4 **See** Figures **176** and **177**

The System Check gauge (or EMM) circuitry enters operational mode each time the self test mode is complete and the engine is started. When in the operational mode, anytime a sensor activates (the switch closes providing a ground signal) or anytime the EMM detects certain faults in a monitored signal for FFI motors, the corresponding LED will illuminate and the warning horn will sound for ten seconds. The LED will remain illuminated for a minimum of 30 seconds, even if the problem only occurred momentarily and then disappeared. This gives the operator time to react to the horn and check what LED circuit was illuminated. If the problem remains, the LED will remain illuminated until the condition goes away or the keyswitch is turned OFF.

When the sensor deactivates (opens from ground on the switch type sensors used by carbureted motors), the LED will remain illuminated for an additional 30 seconds, then go out.

Should additional sensors activate while an **LED** is already illuminated (say an overheating engine, suddenly reaches the point of no oil (low pressure or low level in the remote tank), the warning horn will sound again for ten seconds and the second LED will illuminate.

If the warning system activates immediately take steps to identify and rectify the problem and/or protect the motor:

- If the NO OIL LED illuminates, this indicates that an oil delivery problem has occurred with the VR02 system or a problem has occurred with either the oil injector circuit or the oil pressure loss switchlcircuit on FFI systems. Stop the engine and check oil level in the tank, check for kinked oil delivery hoses or problems with the oil line (leaks or blockages). Also, check the VR02 pump for proper operation. If necessary, determine how much fuel is left in your tank and how much oil is on hand, it may be possible to mix the oil directly into the fuel tank in order to limp the engine home without damaging the powerhead. Refer to the information on 2-Stroke Engine Oil and Pre-Mixing under General Information and Maintenance in order to help determine proper ratios.

✳✳ WARNING

Operating an engine with insufficient oiling can result in SEVERE powerhead damage requiring a total **overhaul** or replacement.

- If the WATER TEMP LED illuminates, reduce the engine speed to idle and immediately check the cooling water indicator stream. If present, carefully check to see if the water from the stream is hotter than usual (you've of course checked it before during normal operation, ok if you haven't take a guess, if it's steaming, it's too hot). Stop the motor and allow it to cool, then limp home at idle. If the stream is absent, check for clogging at the water intake, and if not found, start signaling for a tow. Remember that even if you let the motor cool thoroughly for an hour or so, overheating will occur again quickly (possibly warping or damaging the powerhead beyond repair) in no time at all without cooling water. When back at port, inspect the water pump impeller.
- If the CHECK ENGINE LED illuminates on FFI motors, the EMM has detected an out-of-range sensor signal in the engine control system and stored a diagnostic trouble code. For most faults, the engine will continue to run, but with diminished performance until the circuit is repaired and the proper signal restored. For more details on troubleshooting please refer to the information in the FICHT Fuel Injection (FFI) section.
- If the LOW OIL LED illuminates, immediately check the level in the oil tank. This LED is designed to illuminate when the tank reaches 1/4 capacity. But keep in mind that a stuck float may have kept the signal from illuminating until it was jarred loose by action of the boat and the level could be lower. Of course, as a responsible boater you **ALWAYS** check the level in the oil tank visually before setting out, so it is not likely that you've used THAT much oil today right?

Diagnostic Mode (Carbureted Models)

4 See Figures **176** and **177**

The System Check gauge electronics on carbureted models feature a gauge diagnostic mode which is entered automatically by turning the ignition switch to the ON or RUN position without starting the motor. When this is done, the gauge will go through the usual self test mode, then enter the diagnostic mode automatically. In this mode the warning horn circuits are disabled so a technician can manually activate a circuit to manually check it's LED.

If a switch is activated in this mode (by simulating sensor fault conditions or by manually connecting the sensor lead to ground), the appropriate LED will illuminate as long as the sensor is activated.

Keep in mind that the diagnostic mode does not operate unless the self-test mode has satisfactorily completed.

To test various LEDs of the System Check gauge, turn the ignition keyswitch to **ON** or **RUN** and wait for it to complete the self-check mode, then proceed as follows:

- To check the NO OIL LED, remove the 4 screws securing the pickup assembly to the oil tank, then carefully lift the assembly out of the tank and hold it upright. As the float drops the LOW OIL led must illuminate and remain so as long as float is toward the bottom of its travel. If the LED does not illuminate, disengage the 2-pin harness connector at the pickup and connect the 2 wires of the harness together using a jumper. If the LED now illuminates, replace the pickup. If the LED still does not illuminate, trace the wiring and repair the problem with the tan/black and black wires.

To check the WATER TEMP LED, disconnect the tan lead from the temperature switch harness connector, then use a jumper wire to ground the lead (connect it to a good engine ground). The WATER TEMP led must illuminate and remain so as long as the tan lead is jumped to ground. Otherwise, trace and repair the tan lead.

To check the LOW OIL LED, disengage the 4-pin connector for the VR02 pump. Connect the tanlyellow and black wires of the harness together using a jumper. if the LED now illuminates, check the VR02 pump warning circuit, as detailed under the VR02 Oil System section. If the LED still does not illuminate, trace the wiring and repair the problem with the tan/yellow and black wires.

Diagnostic Mode (FFI Models)

If the CHECK ENGINE LED illuminates on FFI motors, the EMM has detected an out-of-range sensor signal in the engine control system and stored a diagnostic trouble code. For most faults, the engine will continue to run, but with diminished performance until the circuit is repaired and the proper signal restored. For more details on troubleshooting, including information on how to read and interpret stored diagnostic trouble codes please refer to the information in the FICHT Fuel Injection (FFI) section.

Engine Temperature Sensors/Switches

FICHT ENGINES ONLY

The engine temperature sensors and switches used on FFI motors are an integral part of the FICHT Fuel Injection (FFI) system. As such, details on testing, as well as removal and installation instructions can be found in that section.

Functional S.L.O.W. System Verification

CARBURETED ENGINES ONLY

On carbureted motors the speed limiting function of the S.L.O.W. system is limited to engine overheat conditions. As such, a functional verification is relatively easy, just fool the power pack into thinking that the engine is overheating. The easiest way to do this is to simply disconnect and ground the appropriate wire for the temperature switch (a normally open switch that completes a circuit to ground once a certain temperature is reached).

If ignition system testing or engine performance leads you to question S.L.O.W. system function or activation, verify the system as follows:

✳✳ WARNING

Since this test requires the motor to be run under load it cannot occur on a flushing device or damage from overspeed would likely occur. Either mount the motor in a test tank using a suitable test wheel or place the boat in the water (tied to a sturdy pier or still on the trailer is fine, as long as the boat is secure),

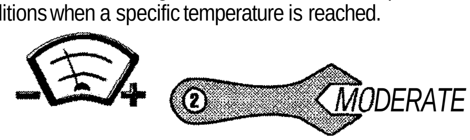
1. Disconnect the port and starboard temperature switch leads (there's one in each cylinder head). The leads are normally tan or tan/blue.
2. Start the engine and allow it to come to normal operating temperature, then run the motor at about 3500 rpm.
3. Touch the tan lead from the port engine harness to a good ground. The engine must slow to 2500 rpm.
4. Stop the engine.
5. Restart the engine, then touch the tan lead from the starboard engine harness to a good ground. The engine must slow to 2500 rpm.
6. If the engine slows both times, system function is normal, but the switch should still be verified (refer to the Engine Temperature Switches procedure in this section). If only ONE of the 2 checks was normal, verify the harness and connectors for the check to which the engine did not respond. If the engine did not respond to BOTH of the checks, first verify that you were using a good ground, then check and verify that the Power Coil is within specification. Lastly, suspect the Ignition Module/Power Pack.

Engine Temperature Switches

CARBURETED ENGINES ONLY

A temperature switch is mounted to each cylinder head of all nearly all carbureted motors (except a couple rope start/tiller control powerheads). The switch is used to activate the warning horn or buzzer to warn of potential overheating conditions when a specific temperature is reached.

TESTING



◆ See Figure 178

A DVOM (or ohmmeter or even a self-powered test light), a thermometer (pyrometer or even a thermosensor adapter for the DVOM), a metal or laboratory grade glass container and a length of mechanic's wire are necessary for this test. Also, you will need a heat source, but for safety (since oil is used), you should not use an open flame, instead make sure you have access to an electric burner (your stove?) or a hot plate. To prevent the possibility of burns (and to ease testing), use probes that can be attached (clipped) to the test points.

The temperature switch used on carbureted motors differs slightly from the sensors found on FFI motors in the way that it operates. Whereas the sensor (on FFI motors) is a thermistor or variable resistor that changes its resistance value based on temperature, and thereby is capable of sending different electrical signals across a range of temperatures, the switch (on carbureted motors) is simply an on/off type. The temperature switch is used only by the warning system and only to turn on the LED and/or warning horn.

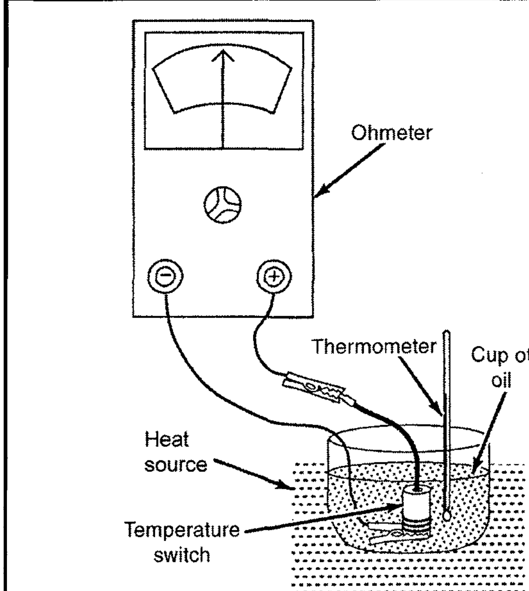


Fig. 178 Temperature switches are tested by suspending them in an oil bath, heating the oil and watching when the switch closes

■ Another type of temperature switch is used on some motors, it is called a warm-up switch. It is also used to ground a circuit at a specific temperature, but it does not activate the warning system. Instead, it alerts the power pack that normal operating temperature has been reached and the power pack may make timing adjustments in response. Warm-up temperature switches normally use a **white/black** lead.

All temperature switches on these motors are designed to remain open until a specific temperature (that varies with model) is reached. When the switch is open, the'circuit that is fed power anytime the engine is running cannot complete. Once a specific temperature is reached, the switch closes, grounding and completing the circuit, and activating the LED and/or warning horn.

Temperature switches are tested in the same basic fashion as the sensors and switches on FFI motors, only the specifications observed during the test differ. The best method to test the switch is to remove it from the powerhead, suspend it in a warm liquid (oil) and to use an ohmmeter and a temperature probe to determine at what temperature the circuit closes.

** WARNING

When testing the switch avoid the use of an open flame to heat the container as it will be filled with oil. If possible, use an electric stove or a hot plate.

If the switch may has been removed/replaced previously, make sure of the proper switch for your motor. Evinrude/Johnson OE switches will have different lead wire colors based on switch calibration:

- 65 Jet-115 hp (1632cc) 90° V4 motors use either a switch with a tan or a white/black lead, depending upon the modellcalibration.
- 80 Jet-175 hp (1726/2589cc) 60° V4/V6 motors use either a switch with a tan/blue or a white/black lead, depending upon the model/calibration.
- 120-300 hp (2000/3000/4000cc) 90° V4/V6/V8 motors use a switch with a tan, tan/black or a white/black lead, depending upon the model/calibration.

1. Remove the temperature switch from the powerhead, as detailed in this section.
2. Connect a DVOM set to read resistance or check continuity with one lead on the switch terminal and the other to the metallic switch body. There should be no continuity with a switch that is cold or at ambient temperatures.

■ If there is continuity at ambient temperatures, the switch is shorted or stuck closed and must be replaced, in these cases, the **horn/buzzer** would normally not shut off or otherwise there is a problem with the circuit or your test method.

3. Using a small wooden dowel across the container, suspend the switch in a container of cool automotive oil. To ensure the switch remains at the same temperature as the liquid (and not the temperature of the container) it must onlv touch the oil (and not touch the bottom or sides of the container).
4. Suspend the thermometer or the thermosensor in the same fashion as the switch. Again, to ensure accurate reading it cannot touch the bottoms or sides of the container. When using a thermometer give it a few minutes to stabilize at the oil's temperature.
5. Using the heat source, slowly raise the temperature of the liquid.
6. Watch the DVOM (or listen to the continuity checker) for the point at which the circuit closes, then check the thermometerlthermosensor reading and compare with the specification for your switch (as listed below by the switch wiring lead colors). The switch must close at the specified temperature for its motor to ensure proper operation of the warning system (or warm-up system if testing warm-up switches):
   - Tan lead switch: 197-209°F (92-98°C)
   - Tan/black lead switch: 206-218°F (97-103°C)
   - Tan/blue lead switch: 234-246°F (112-120°C)
   - Whitelblack lead (warm-up) switch: either 102-108°F (39-43°C) for 60° powerheads or 93-99°F (34-38°C) for 90° powerheads
7. Remove the heat source, and allow the switch to cool, watch the DVOM (or listen to the continuity checker) for the point at which the circuit opens, then check the thermometerlthermosensor reading and compare with the specification for your motor. The switch must open at approximately the specified temperature for its motor to ensure proper operation of the warning system (or warm-up system if testing warm-up switches):
   - Tan or tan/black lead switch: 155-185°F (70-84°C)
   - Tanlblue lead switch: 192-222°F (91-103°C)
   - Whitelblack lead (warm-up) switch: 86-93°F (30-34°C)
8. A switch that does not close until well after the specified temperature MUST be replaced to prevent the potential of powerhead damage should an overheating condition occur (or to ensure proper operation of the warm-up circuit when testing warm-up switches). A switch that closes a little early can still be used, unless it is so early that the horn or buzzer never shuts off (that would get old real fast, wouldn't it?). Similarly, a switch that remains closed too lona after the motor has cooled can cause false overheating signals or, woke, on warm-up switches might prevent the motor from operating properly.
9. After testing or repairs, install the switch and reconnect the wiring.

REMOVAL & INSTALLATION

1 EASY

A temperature switch is mounted to each cylinder head on nearly ALL carbureted motors (except a few rope start/tiller control models). The switch is used to activate the warning horn or buzzer to warn of potential overheating conditions when a specific temperature is reached. The switch is also used as a signal to the power pack to activate the S.L.O.W. system operation (limiting engine speed until the problem is corrected) on all but the 90° cross-flow motors.

In addition, some powerheads are equipped with an additional warm-up temperature switch. The function of the warm-up switch is to monitor at what point the motor has reached normal operating temperature. This is used by the power pack on these models to control spark advance functions.

Temperature switches are normally mounted somewhere on the powerhead, but exact location varies slightly from model-to-model. The best method is to trace the lead (usually tan or tan with a tracer, except warm-up switches which are always whitelblack) from the power pack to the switch itself. For more details, please refer to the schematics provided in the Wiring Diagrams section.

1. Disengage the temperature sensor harness connector.
2. Using an open-end wrench or sensor socket (a socket that is made or modified to prevent damage to the sensor terminals or wiring), carefully unthread the sensor from the powerhead.
3. Clean the sensor and powerhead threads.

To install:

4. Carefully thread the sensor into the opening by hand making sure not to crossthread it.
5. Tighten the sensor securely, but take care not to overtighten and damage the sensor or the mounting threads.
6. Connect the sensor wiring harness, making sure all wires are routed to prevent interference with moving components.
7. Connect the motor to a source of cooling water, then start and run the engine. If the sensor was threaded into a water jacket, make sure there is no leakage.

Oil Level Switch

Evinrude/Johnson 2-stroke motors that are equipped with oil reservoir tanks and oil injection systems use one or more sensors to ensure that the motor is always receiving a supply of 2-stroke oil. Two sensors are normally used for this circuit, one in the reservoir tank that is used to signal when the reservoir reaches approximately 114 or less capacity and one in the VR02 pump or FICHT fuel injection system that signals if the oil feed line should loose pressure.

For models equipped with the VR02 or FFI system, please refer to the information on Oil Injection Systems for details on the VR02 or FFI warning circuits.

To test the oil level switch warning circuits, refer to the Diagnostic Mode (Carbureted Models) section found under Testing Warning Circuits.

Warning Horn or Buzzer

Testing the warning horn or buzzer is a relatively simple matter of using two sets of jumper leads to temporarily connect a fully-charged 12-volt battery across the horn/buzzer terminals. For safety, always connect jumpers to the battery first and THEN to the horn or buzzer. This prevents the possibility of sparks/arcing near the battery (which could ignite explosive gases released by batteries).

Location of the warning horn or buzzer may vary with the boat and motor rigging, but it is normally found within the control box or behind the dash on remote control models.

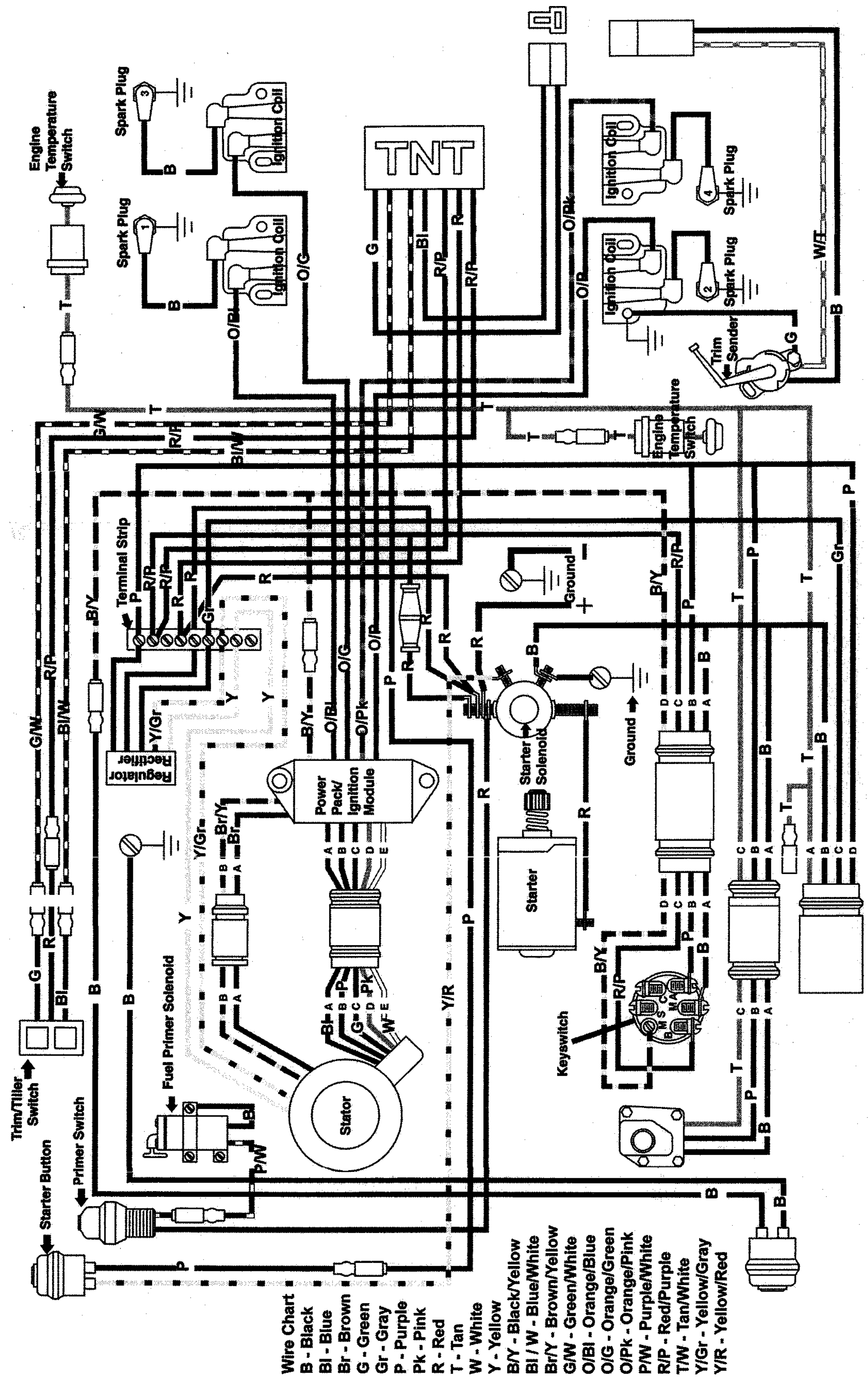
For tiller models, the horn or buzzer is normally found within the tiller control housing or under the engine cover.

Since access to the wire terminals is required for testing, you may need to partially disassembly the remote or tiller control housings.

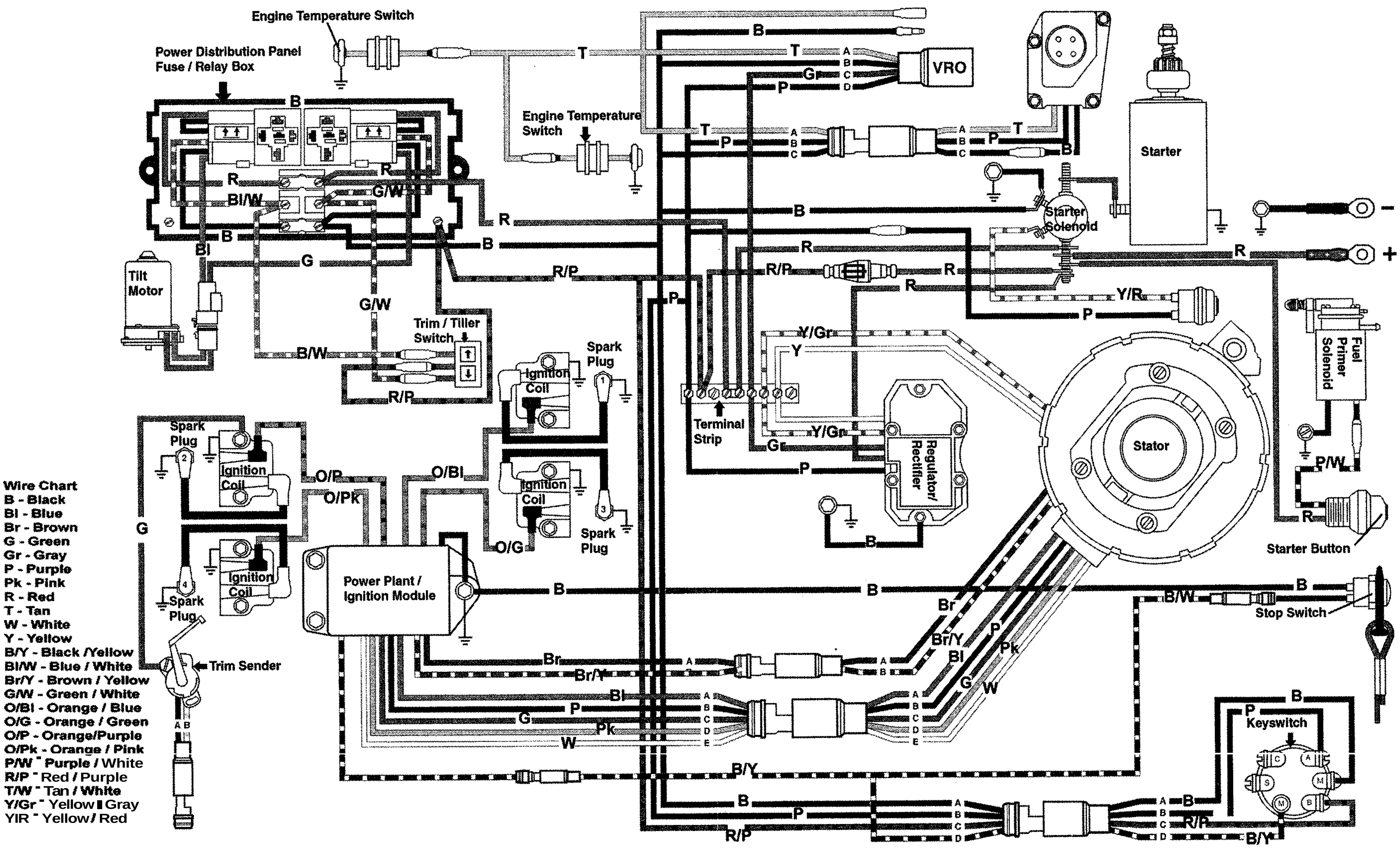
To test the horn or buzzer, use the jumper wires to apply 12-volts across the hornlbuzzer terminals. Replace the unit if it fails to emit a suitable warning tone.

Wiring Schematic Index

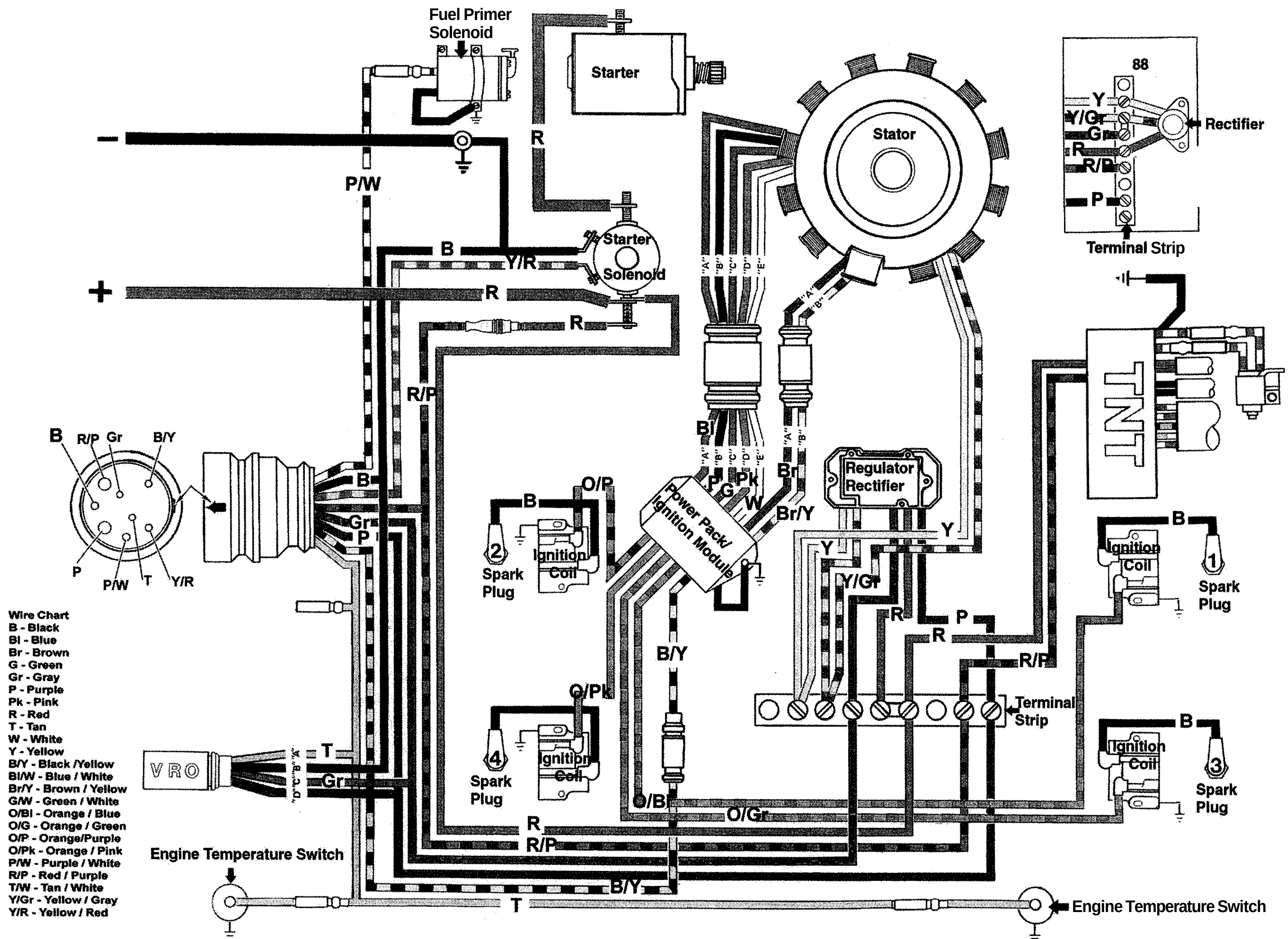
WIRING DIAGRAMS-V4 CARBURETED ENGINES



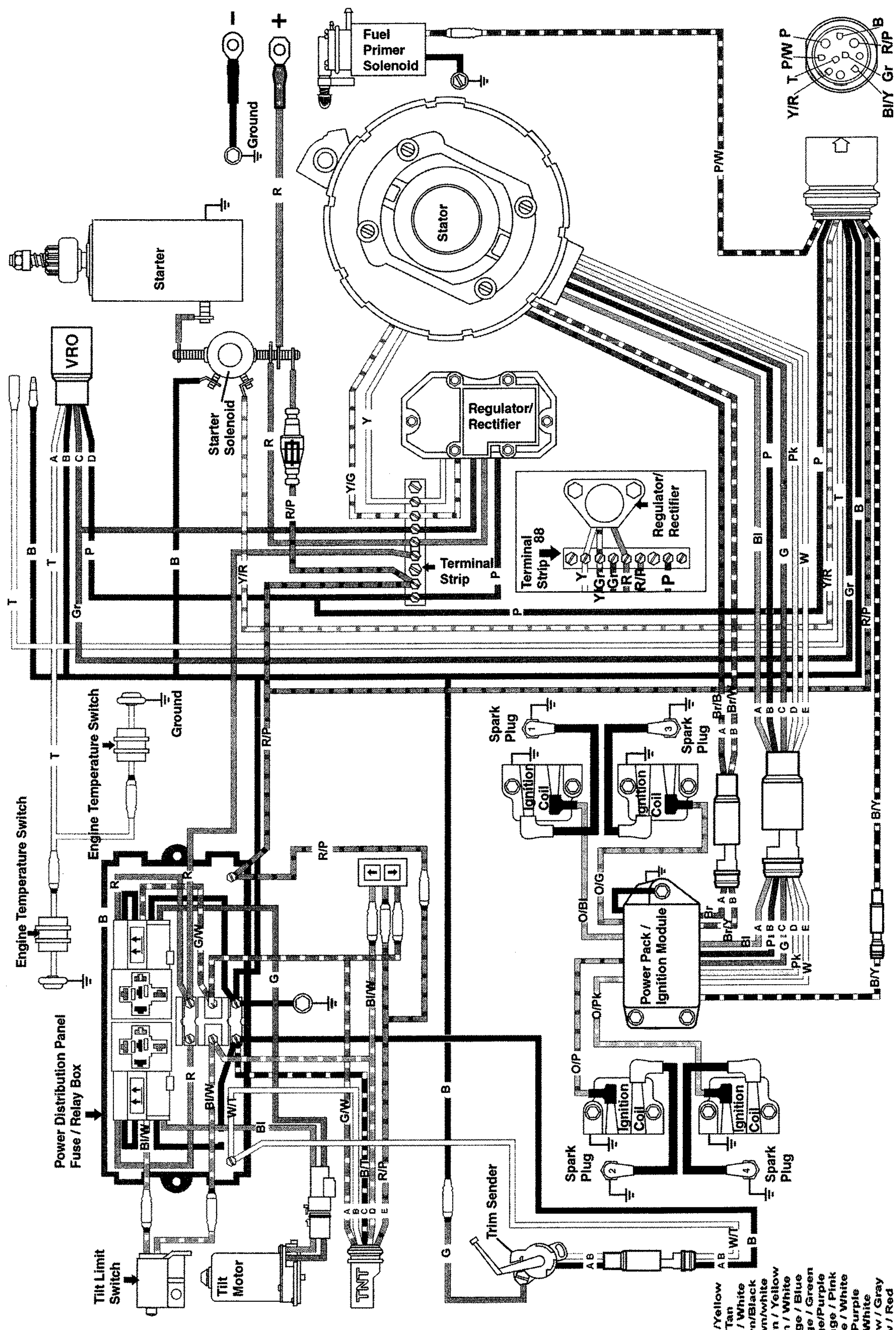
Wiring Diagram-1992-93 65 Jet-115 hp (1632cc) Tiller Control 90° Cross-Flow V4 motors, including the 85TTL



Wiring Diagram-1994-95 65 Jet-115 hp **(1632cc)** Tiller Control 900 Cross-Flow V4 motors, including the **85TTL**

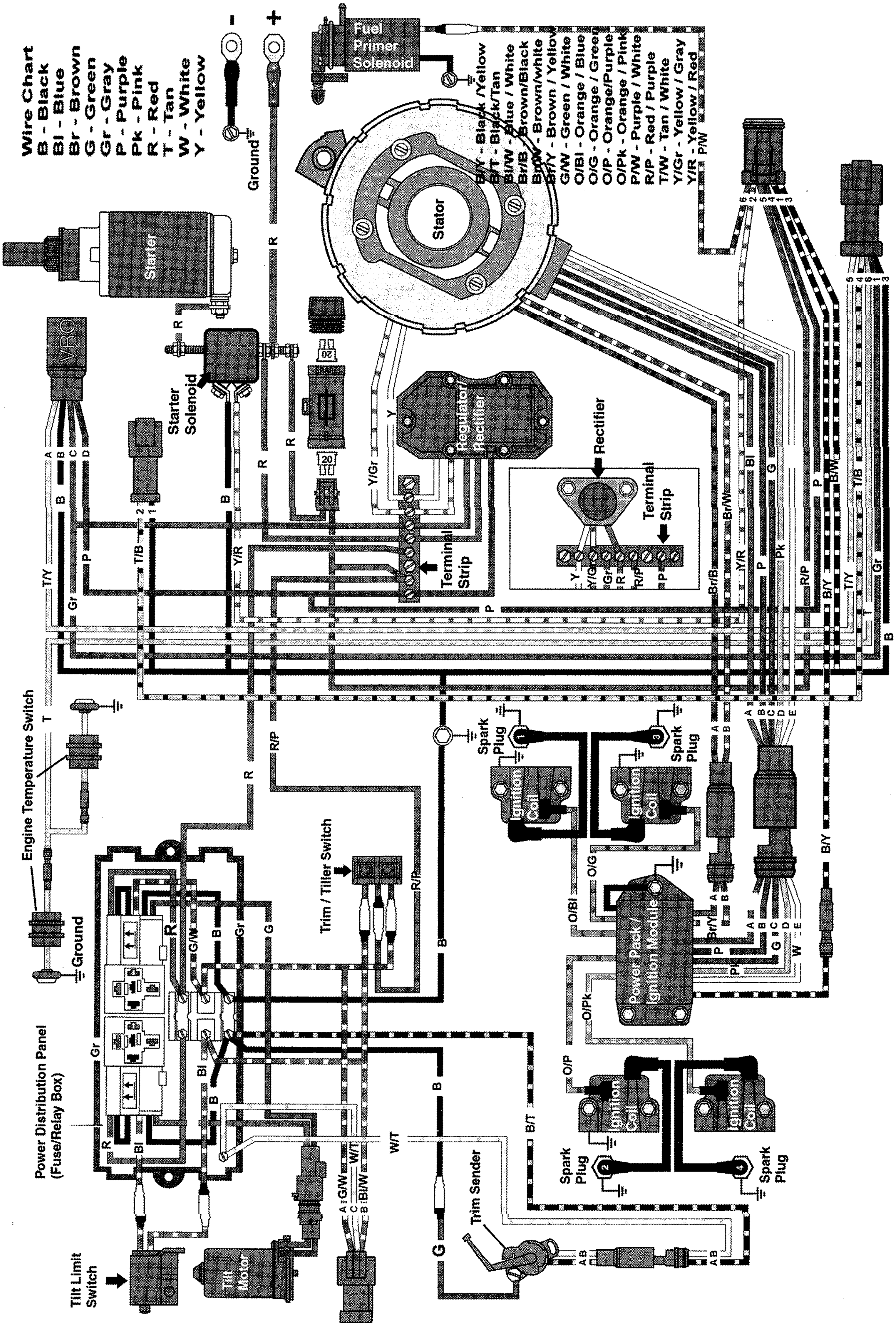


Wiring Diagram-1992-93 65 Jet-115 hp (1632cc) Remote Control 90º Cross-Flow V4 motors

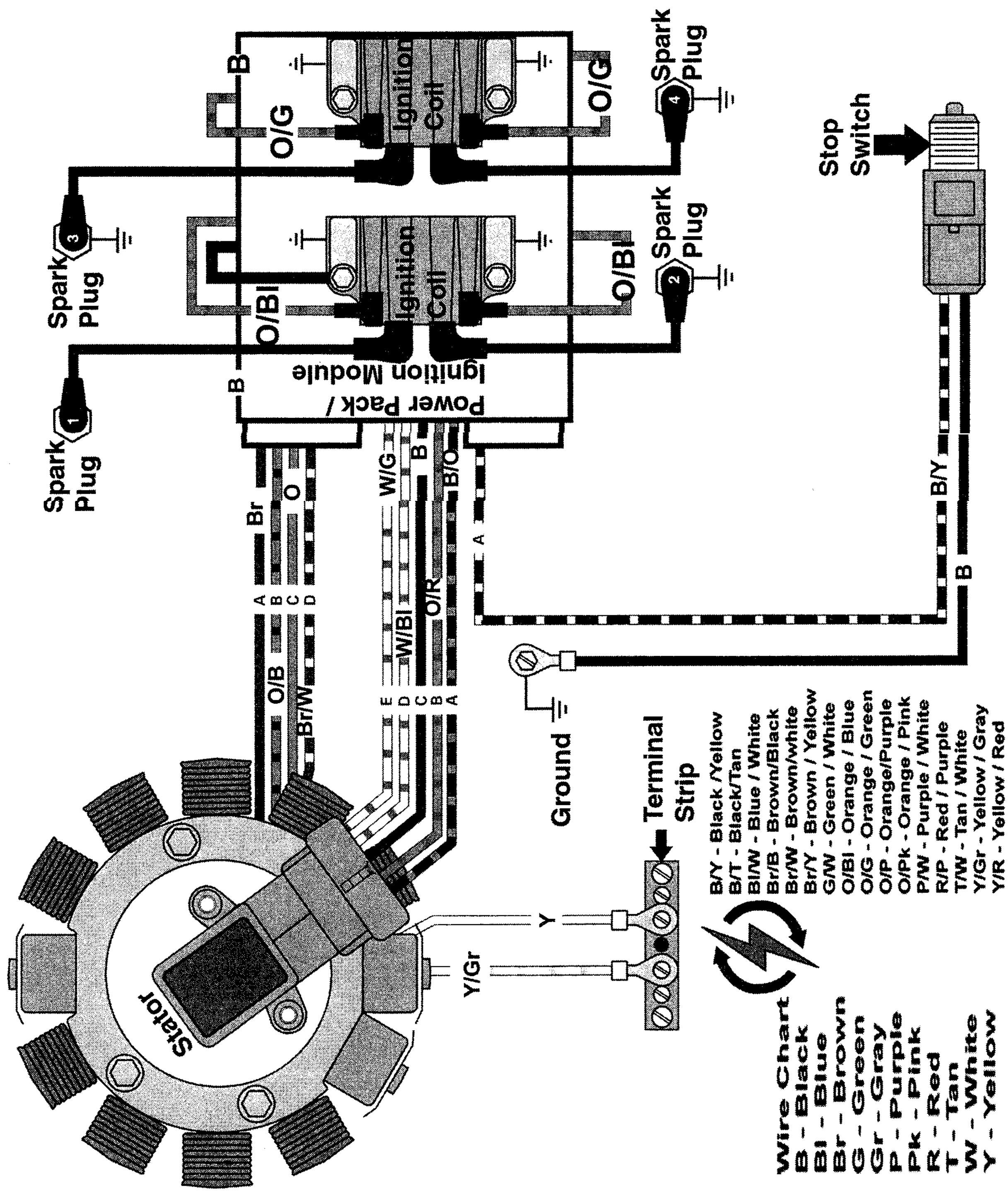


Wire Chart
B - Black
Bl - Blue
Br - Brown
G - Green
Gr - Gray
P - Purple
Pk - Pink
R - Red
T - Tan
W - White
Y - Yellow
B/Y - Black /Yellow
B/T - Black/Tan
Bl/W - Blue / White
Br/B - Brown/Black
Br/W - Brown/white
Br/Y - Brown / Yellow
G/W - Green / White
O/Bl - Orange / Blue
O/G - Orange / Green
O/P - Orange/Purple
O/Pk - Orange / Pink
P/W - Purple / White
R/P - Red / Purple
T/W - Tan / White
Y/Gr - Yellow / Gray
Y/R - Yellow / Red

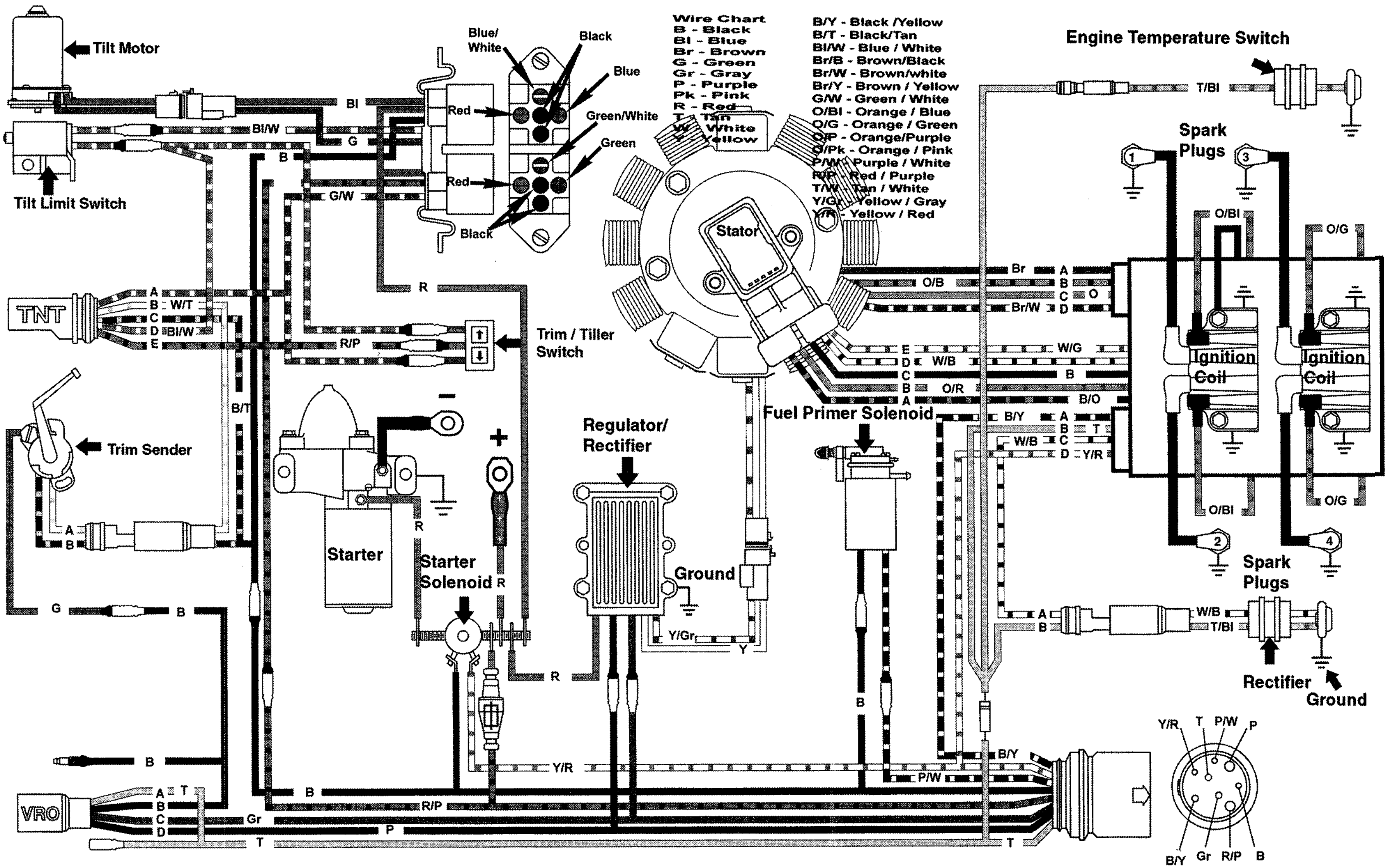
Wiring Diagram-1994-95 65 Jet-115 hp (1632cc) Remote Control 90° Cross-Flow V4 motors



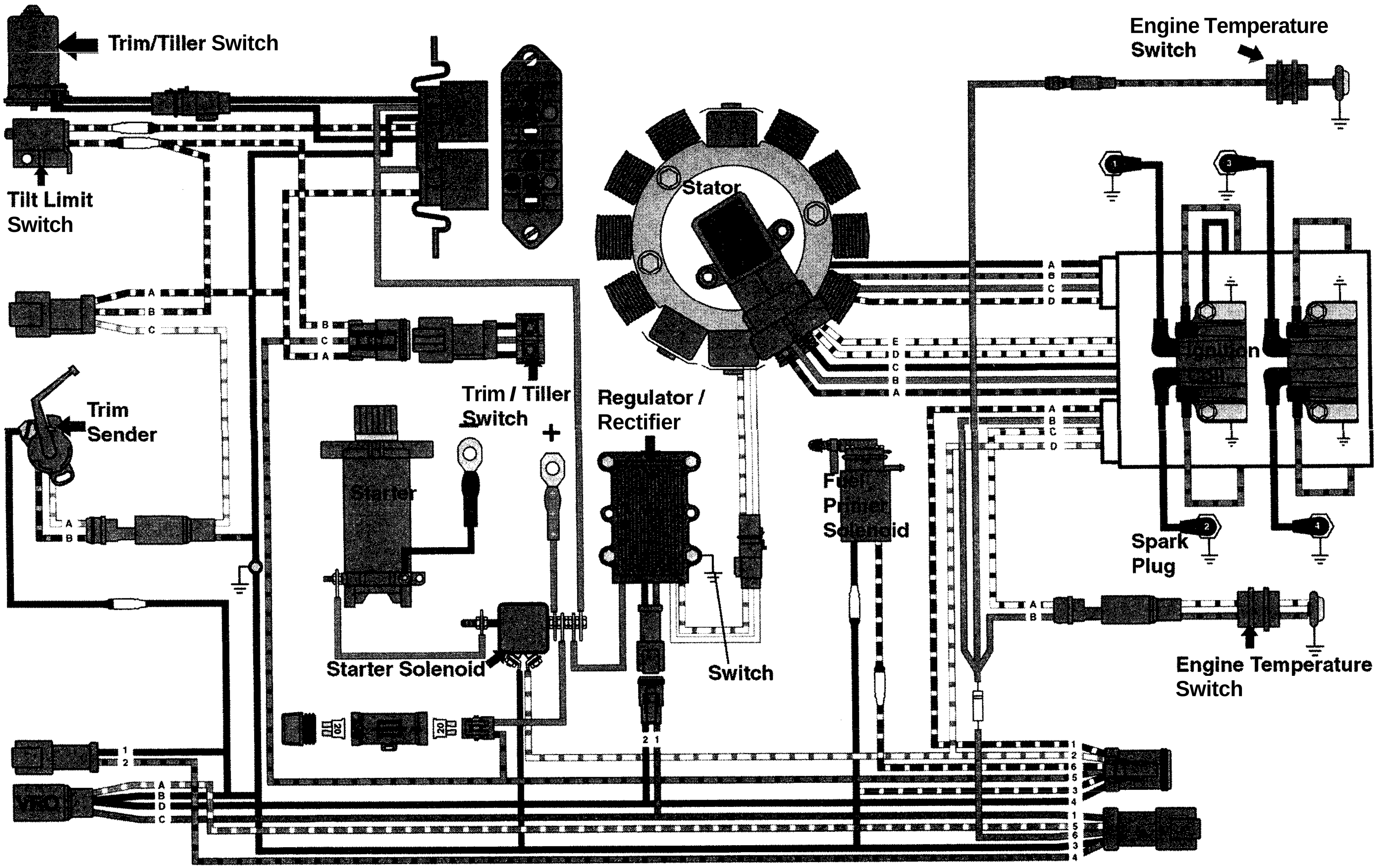
Wiring Diagram-1996-98 80 Jet-115 hp (1632cc) Remote Control 90° Cross-Flow V4 motors



Wiring Diagram-1996-01 Tiller Control 80 Jet-115 hp (1726cc) 60° Looper V4 Motors, including the 105RW and WR



Wiring Diagram-1995 Remote Control 90-115 hp (1726cc) 60° Looper V4 Motors



Wiring Diagram-1996-01Remote Control 80 Jet-I15 hp **(1726cc)** 600 Looper V4 Motors

Wire Chart
B - Black
Bl - Blue
Br - Brown
G - **Green**
Gr - Gray
O - Orange
P - Purple
Pk - Pink
R - Red
T - Tan
W - White
Y - Yellow
B/Y - Black **/Yellow**
B/T - Black/Tan
Bl/W - Blue / White
Br/B - Brown/Black
Br/W - Brown/white
Br/Y - Brown / Yellow
G/W - Green / White
O/Bl - Orange / Blue
O/G - Orange / Green
O/P - Orange/Purple
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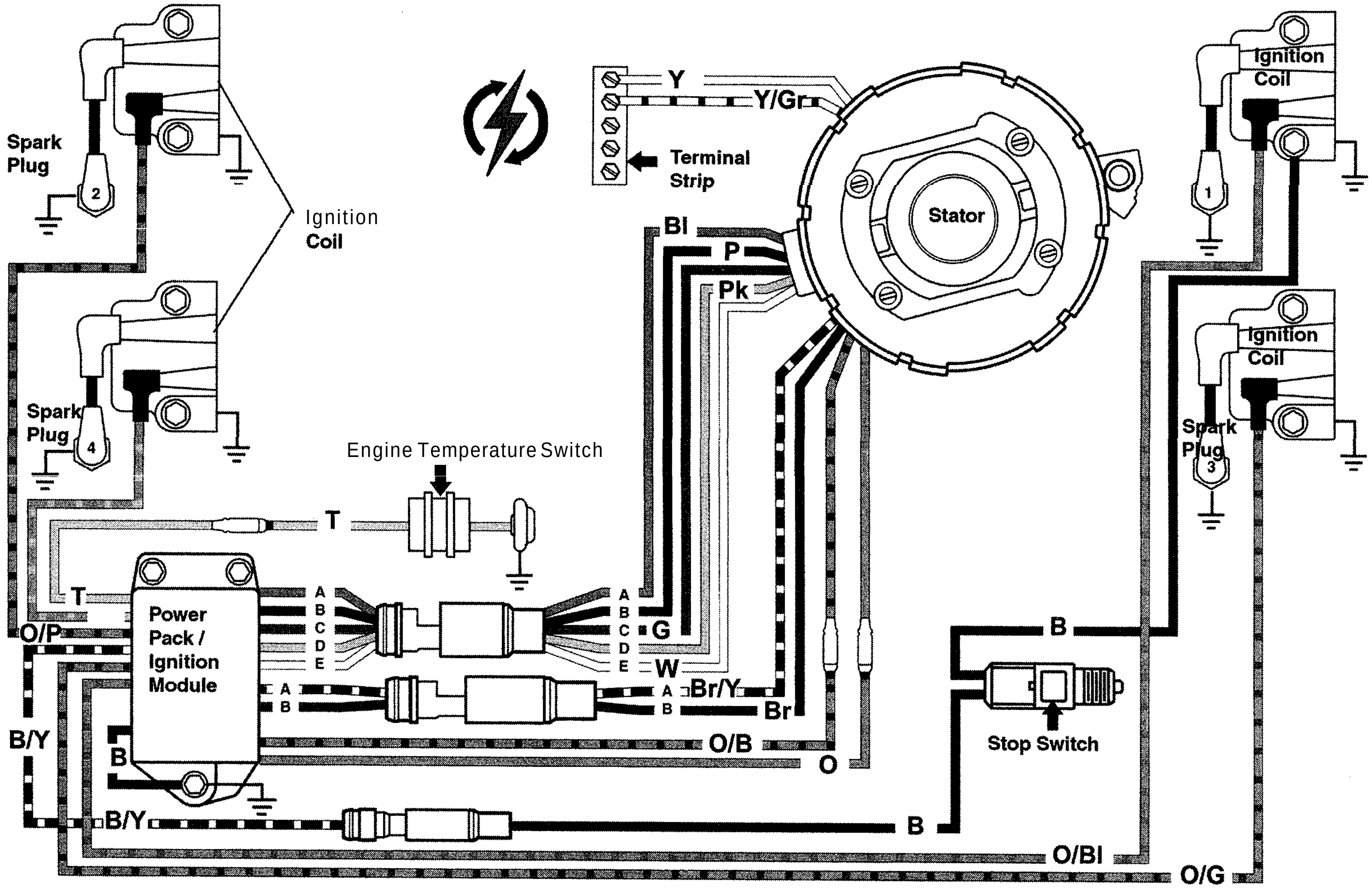
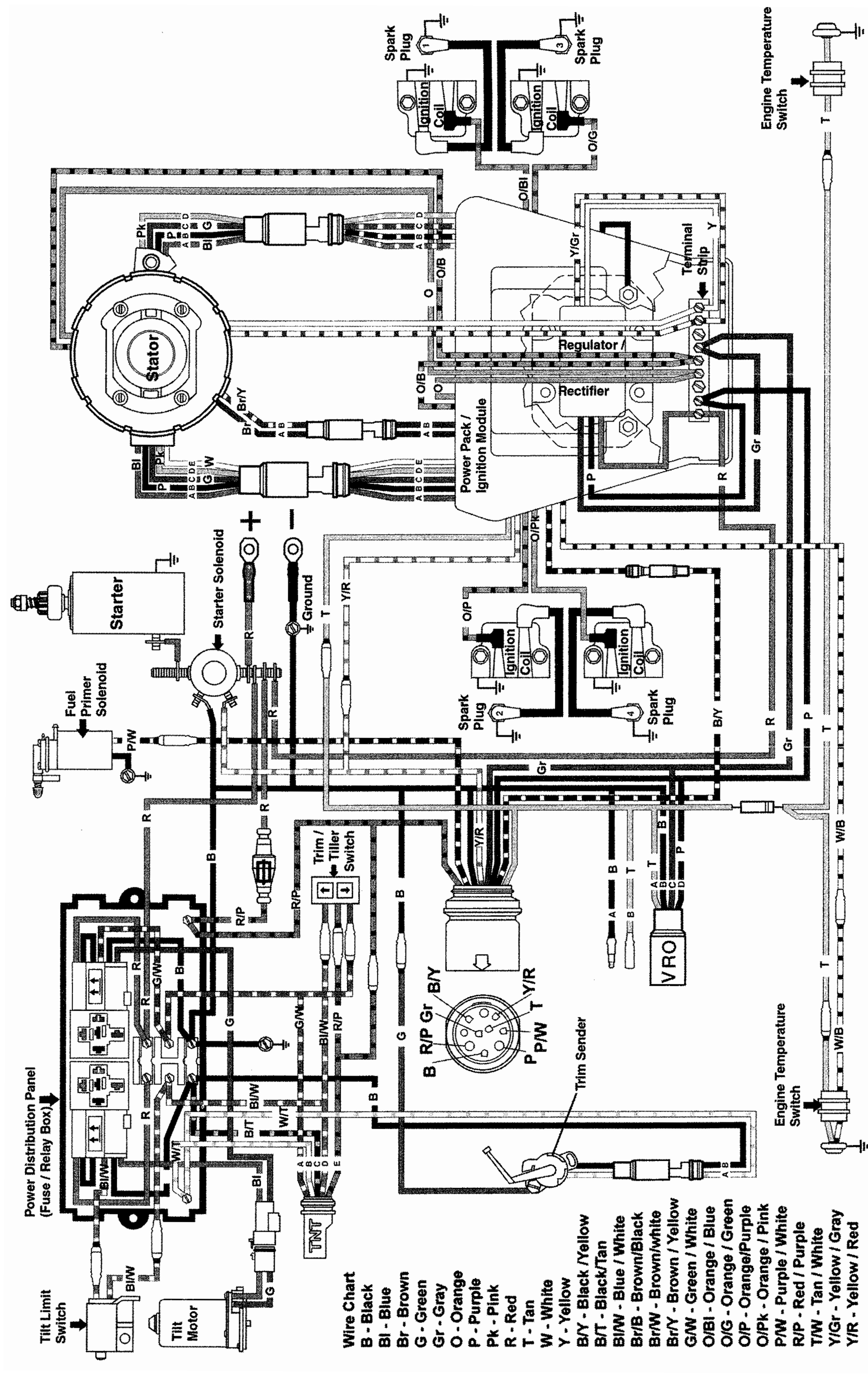
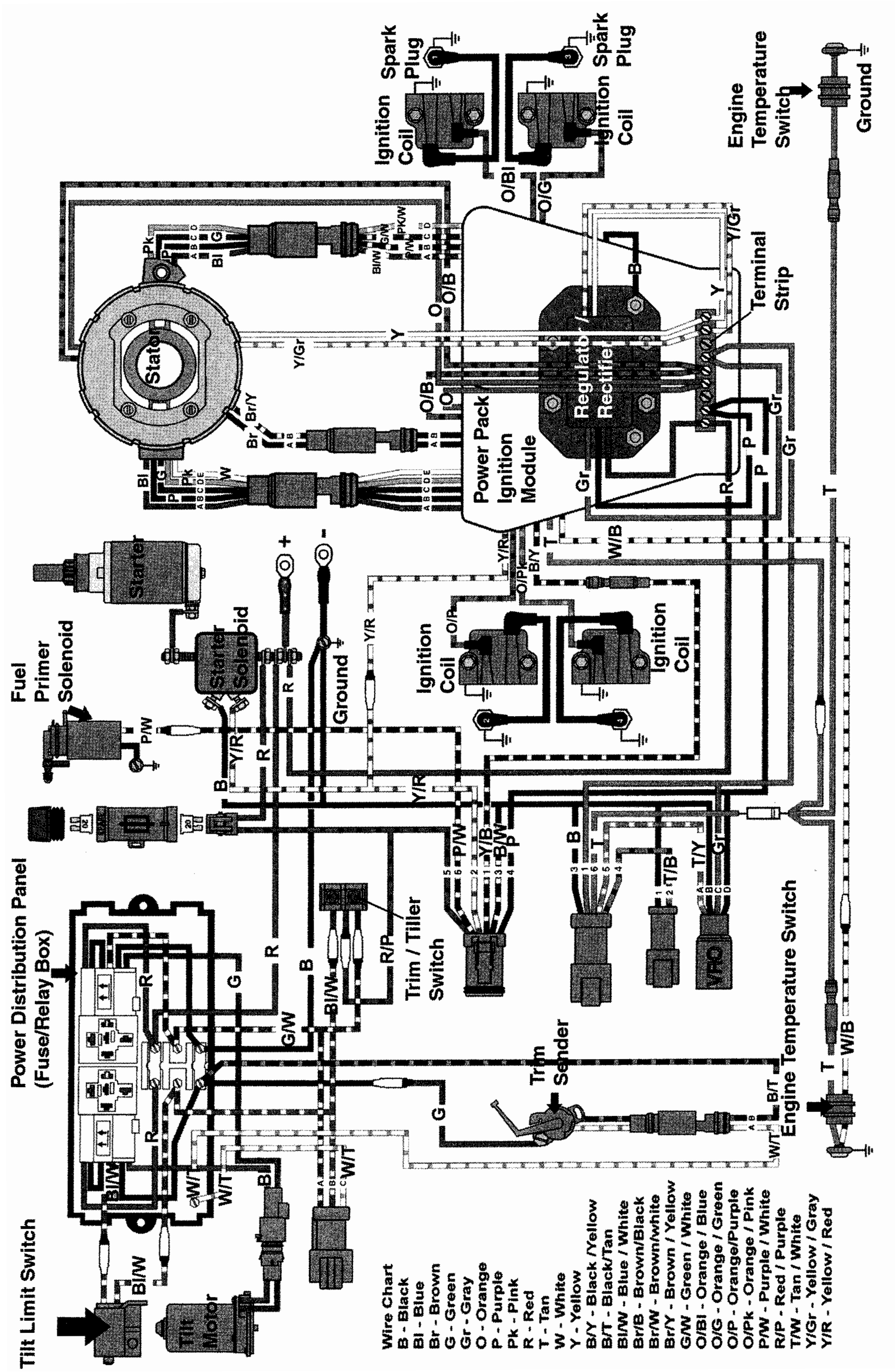
R/P - Red / Purple
T/W - Tan / White
Y/Gr - Yellow / Gray
Y/R - Yellow / Red



Wiring Diagram-1992-98 Tiller Control with AC Power 120-140 hp **(2000cc) 90°** Looper V4 Motors, including the 125 RW

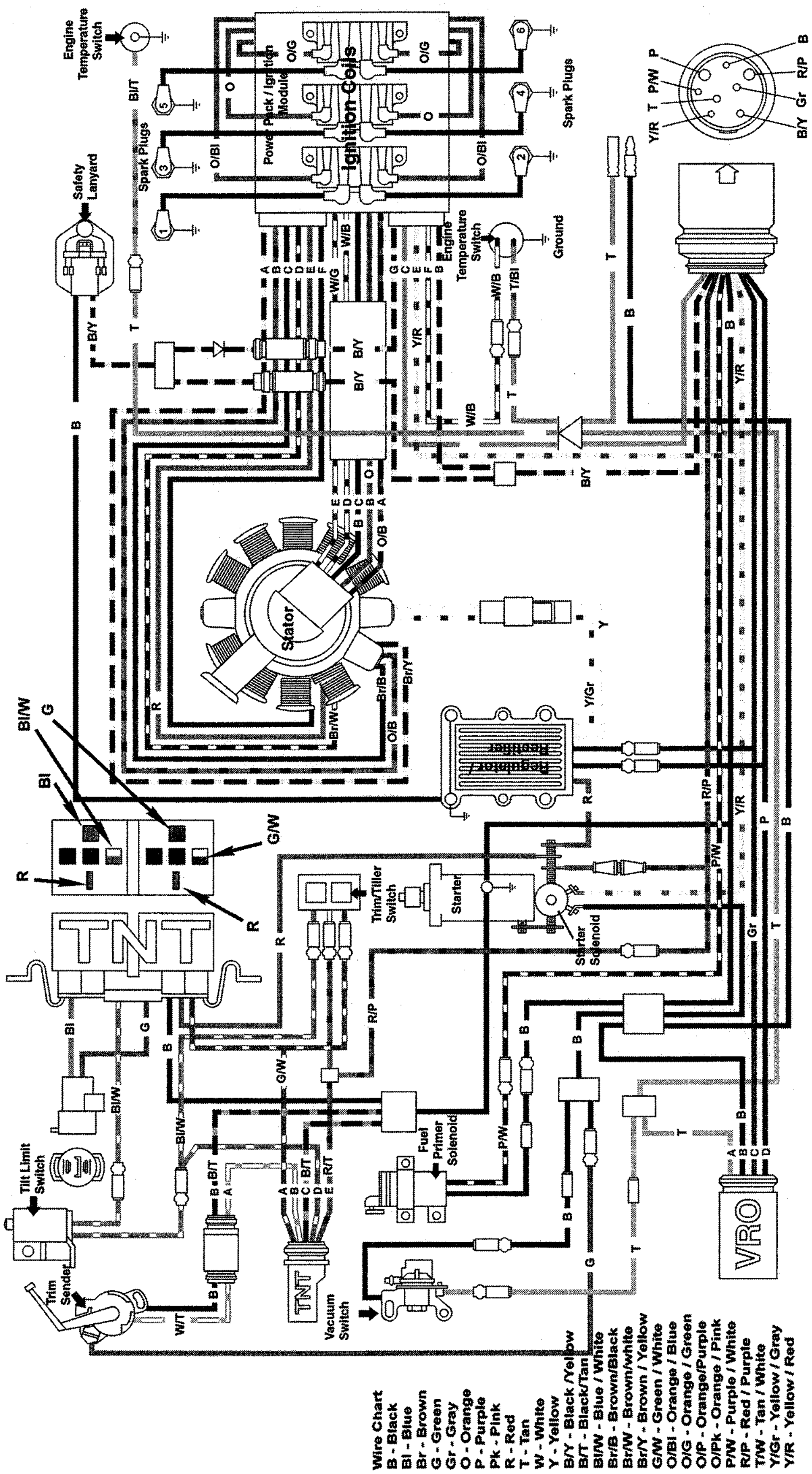


Wiring Diagram-1992-95 Remote Control 120-140 hp (2000cc) 90° Looper V4 Motors

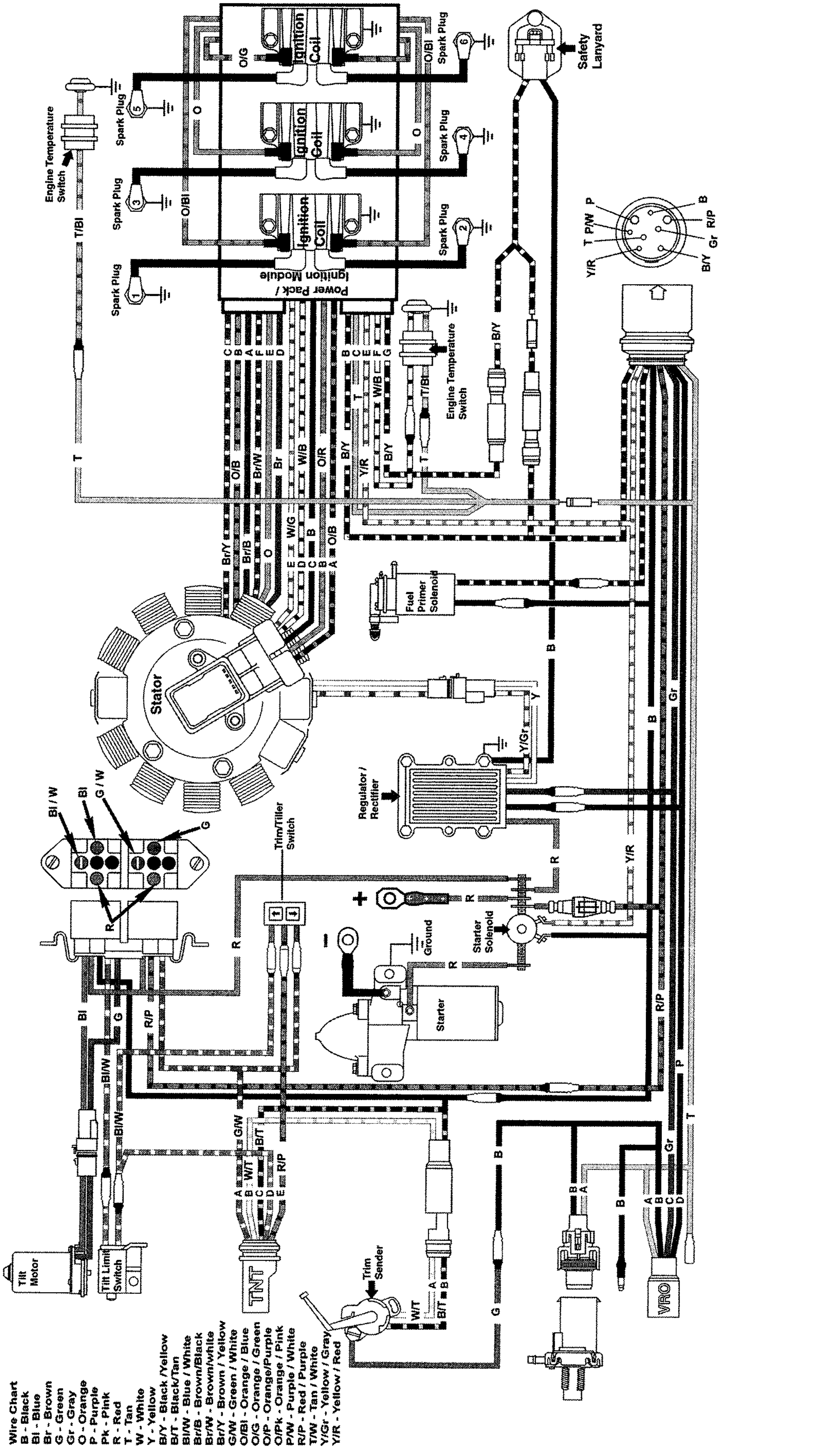


Wiring Diagram-1996-01 Remote Control 125-135 hp (2000cc) 90° Looper V4 Motors

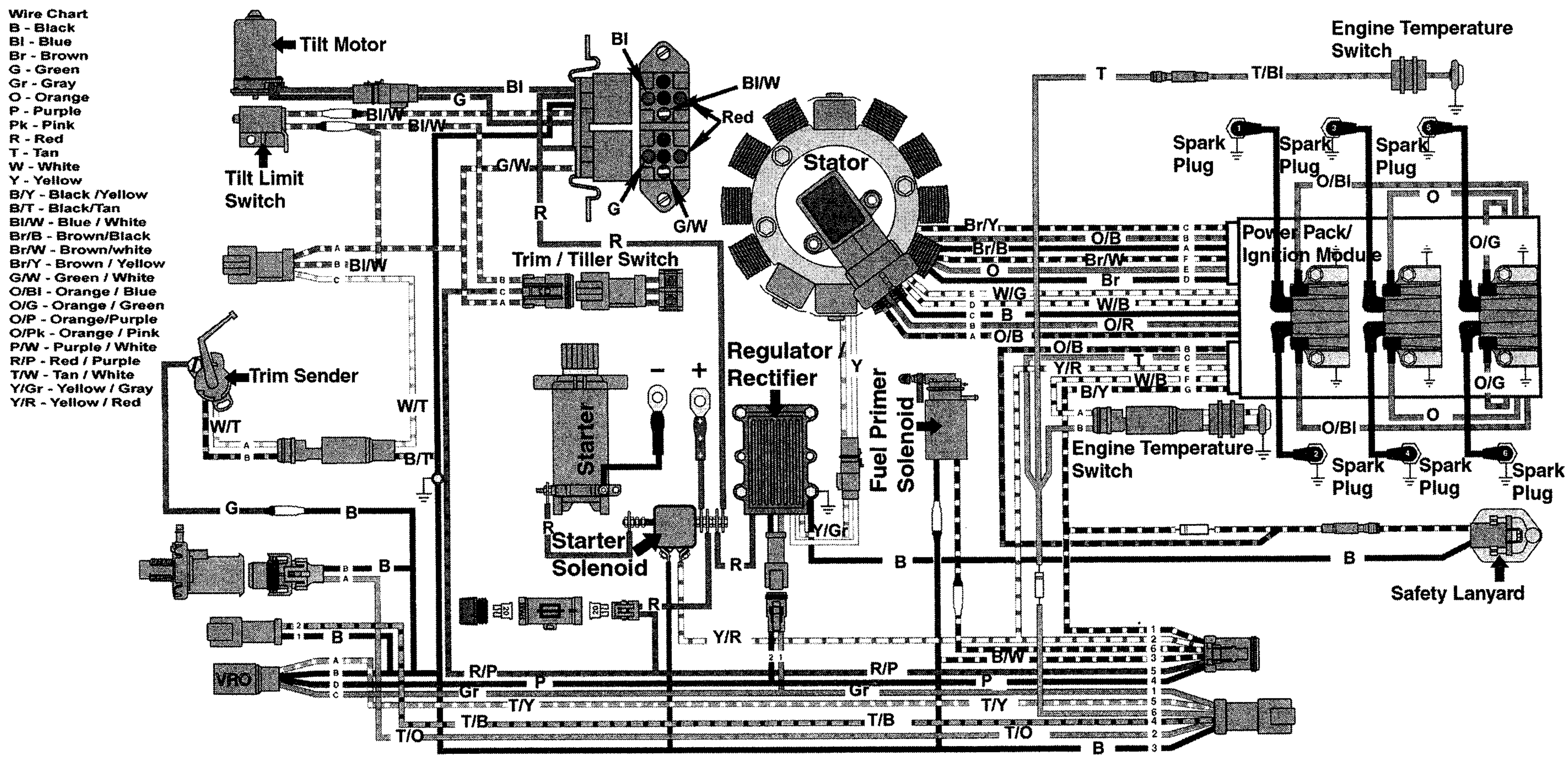
WIRING DIAGRAMS-V6 CARBURETED ENGINES



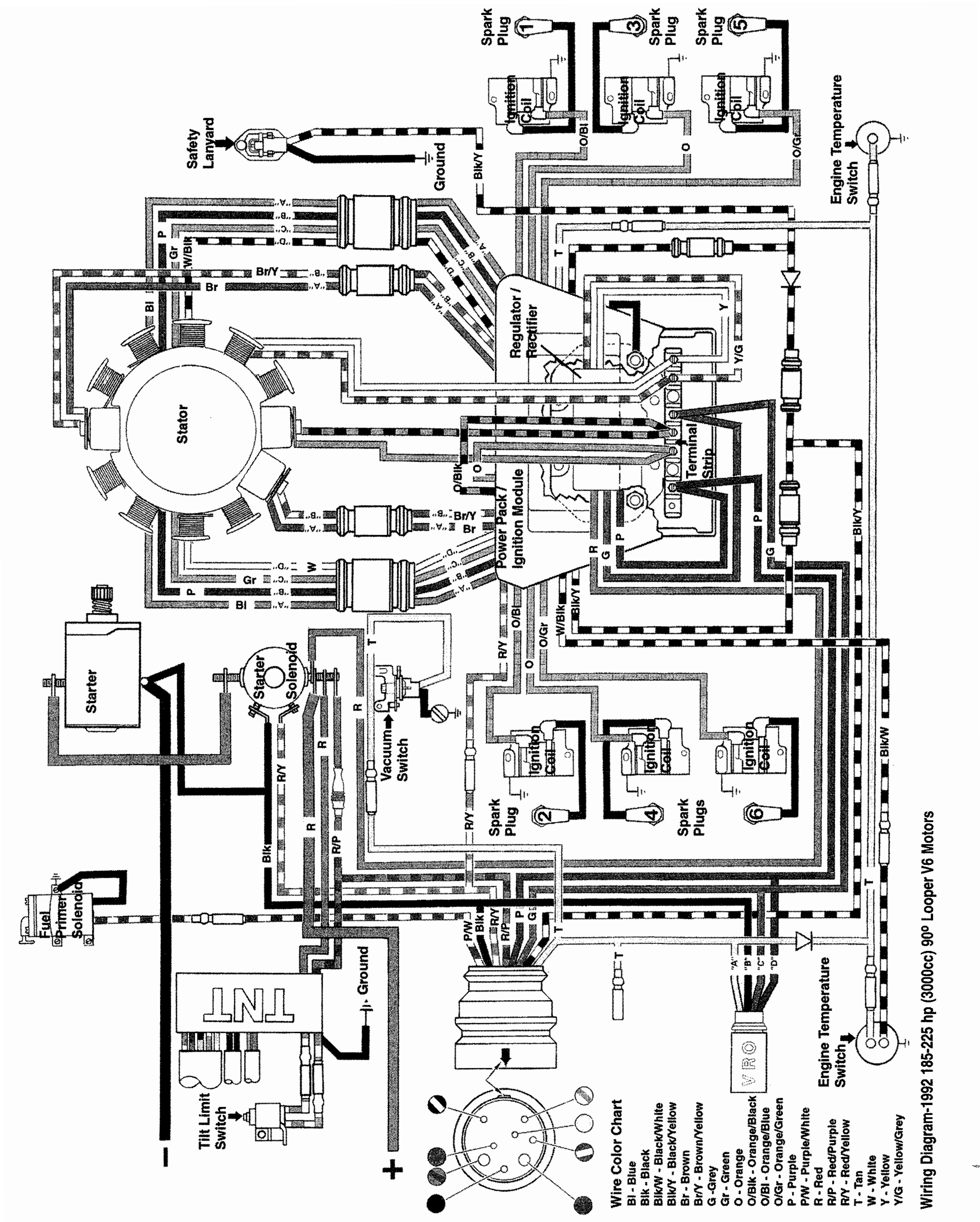
Wiring Diagram-1992-93 105 Jet-175 hp (2589cc) 60° Looper V6 Motors



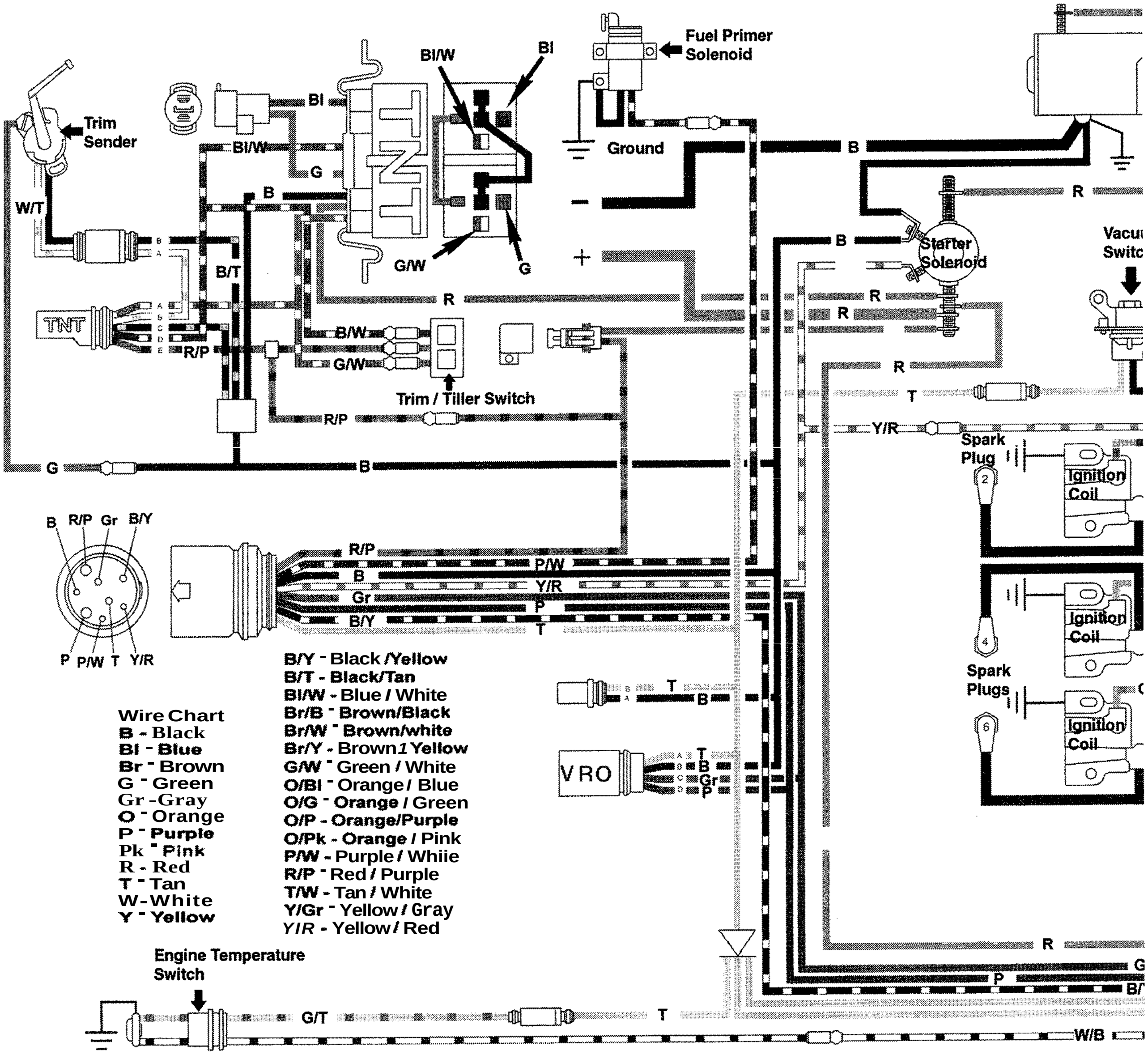
Wiring Diagram-1994-95 105 Jet-175 hp (2589cc) 60º Looper V6 Motors



Wiring Diagram-1996-01105 Jet-175 hp (2589cc) 60° Looper V6 Motors

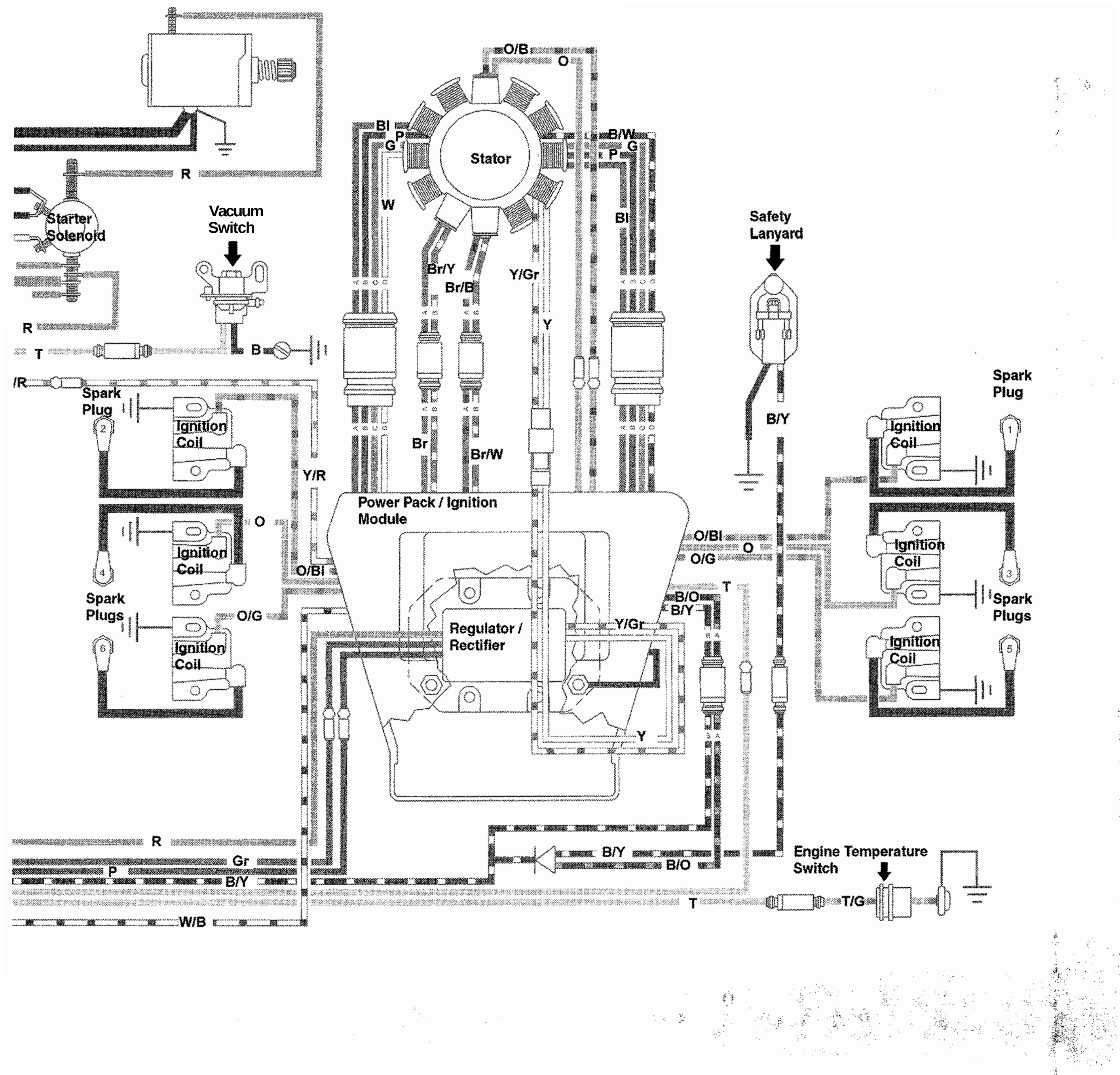


Wiring Diagram-1992 185-225 hp (3000cc) 90° Looper V6 Motors

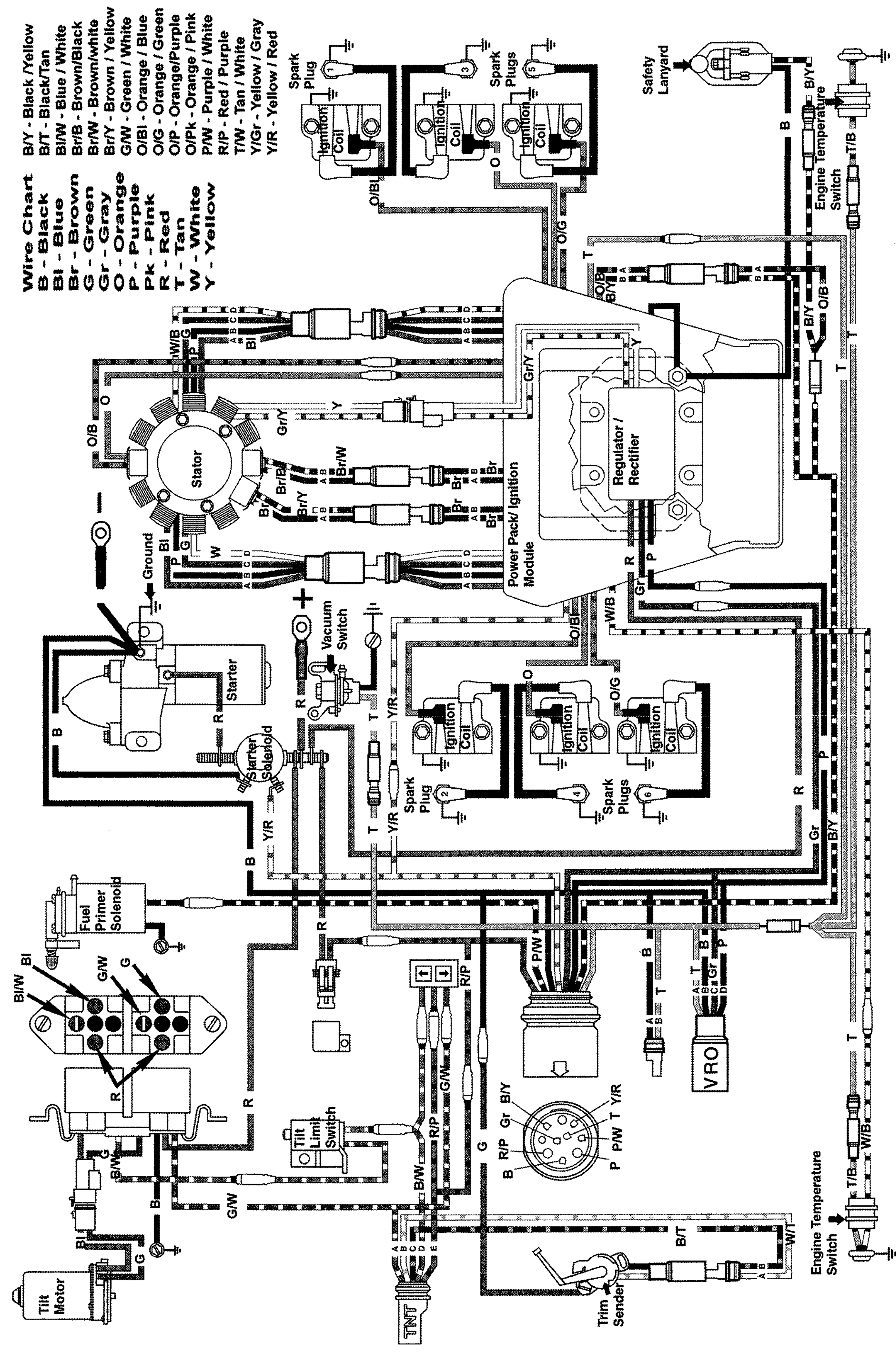


Wire Chart	
B - Black	B/Y - Black /Yellow
Bl - Blue	B/T - Black/Tan
Br - Brown	Bl/W - Blue / White
G - Green	Br/B - Brown/Black
Gr - Gray	Br/W - Brown/white
O - Orange	Br/Y - Brown/Yellow
P - Purple	G/W - Green / White
Pk - Pink	O/Bl - Orange / Blue
R - Red	O/G - Orange / Green
T - Tan	O/P - Orange/Purple
W - White	O/Pk - Orange / Pink
Y - Yellow	P/W - Purple / Whiie
	R/P - Red / Purple
	T/W - Tan / White
	Y/Gr - Yellow / Gray
	Y/R - Yellow / Red

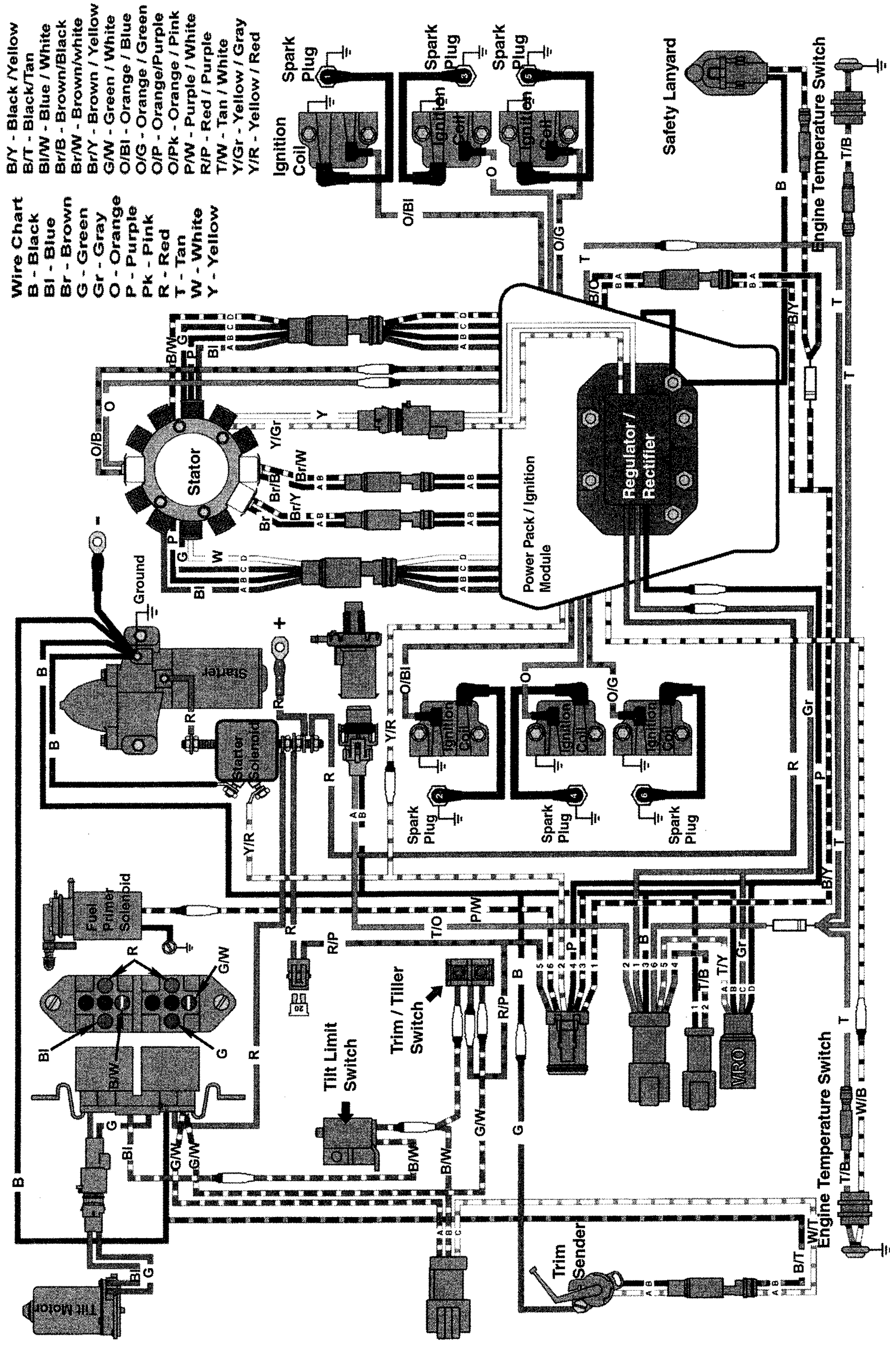
Wiring Diagram-1993 185-225 hp (3000cc) 900 Looper V6 Motors (Part 1)



Wiring Diagram-1993 185-225 hp (3000cc) 90º Looper V6 Motors (Part 2)

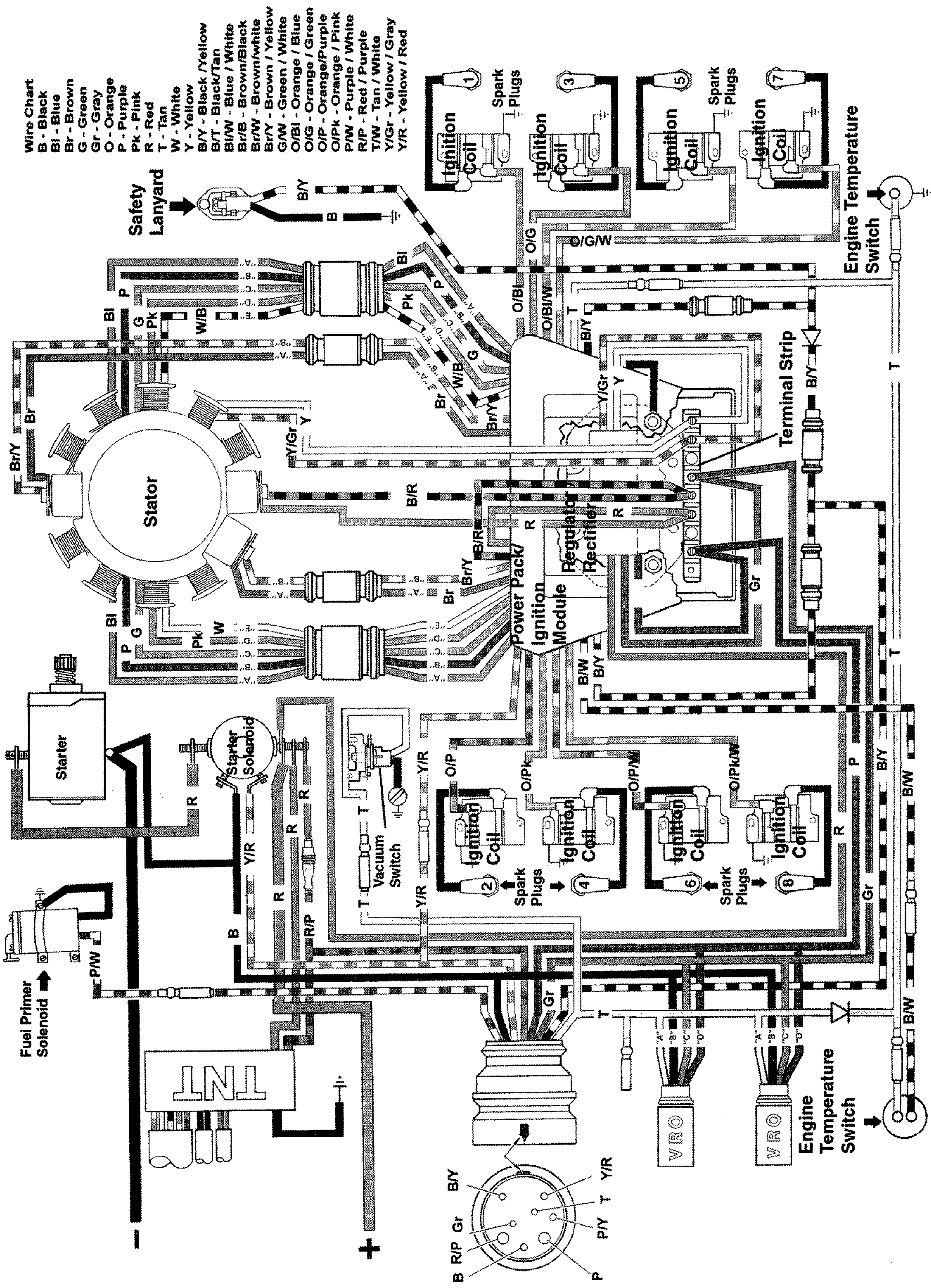


Wiring Diagram-1994-95 185-225 hp (3000cc) 90° Looper V6 Motors

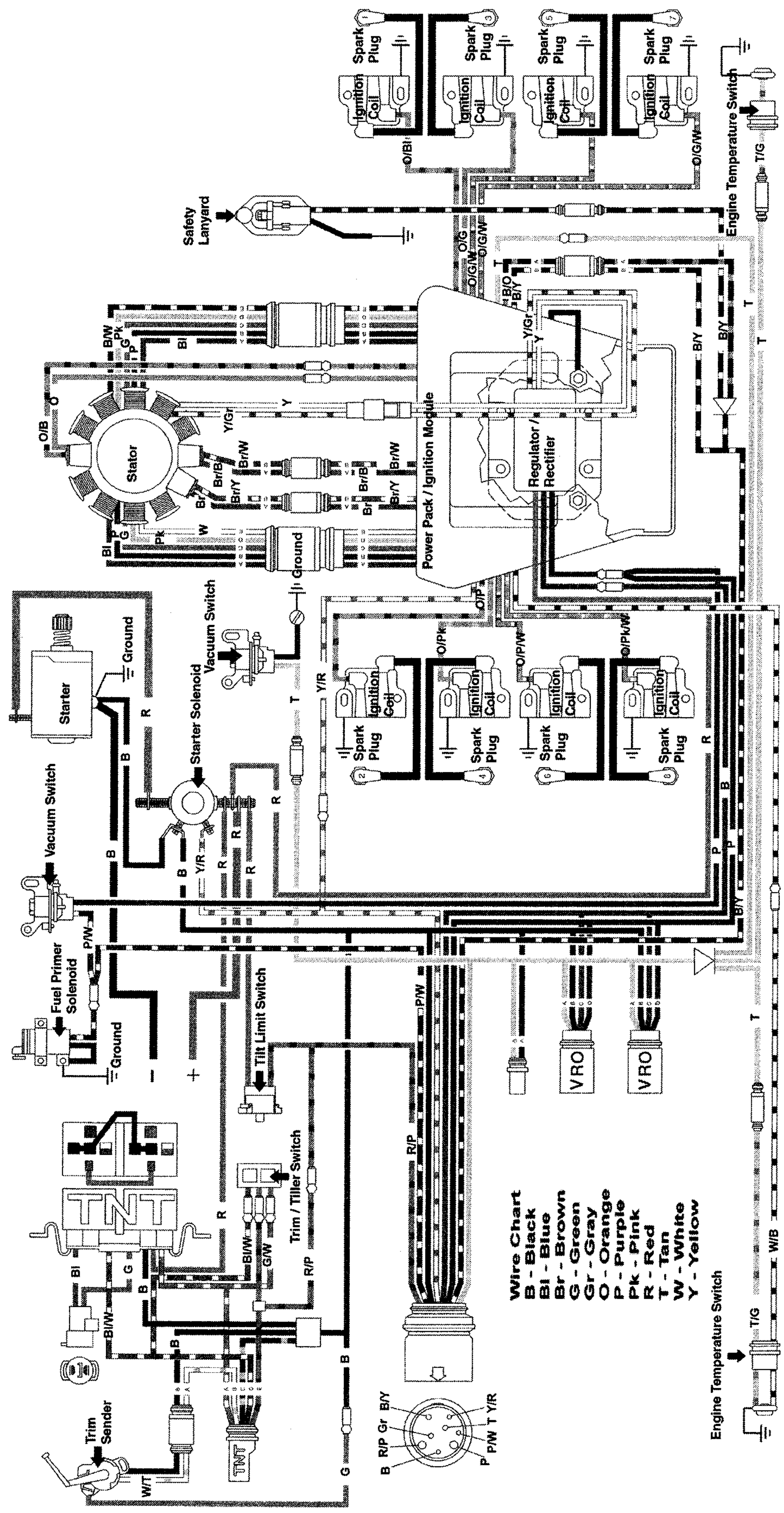


Wiring Diagram-1996-01 185-250 hp (3000cc) 90° Looper V6 Motors

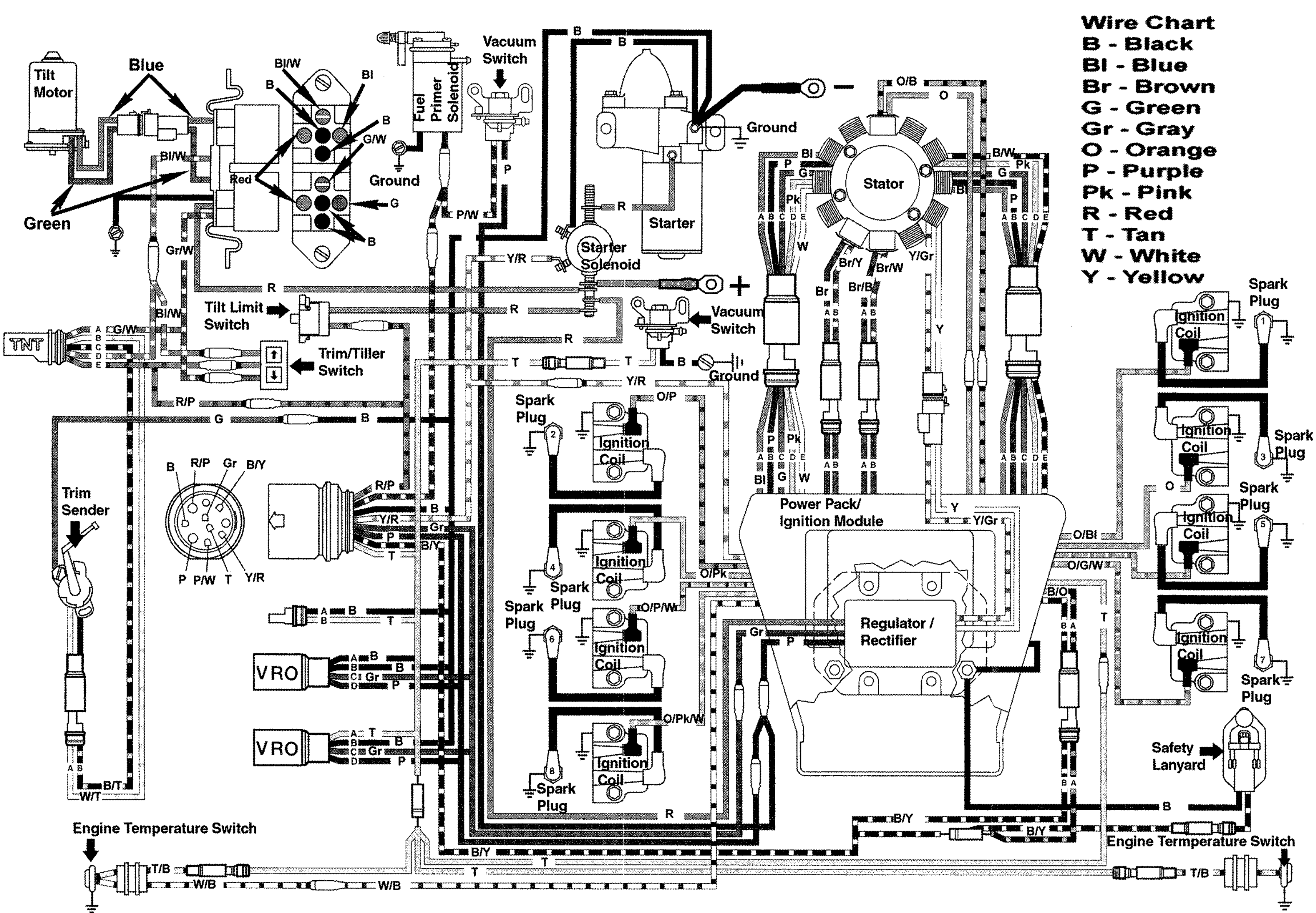
WIRING DIAGRAMS-V8 CARBURETED ENGINES



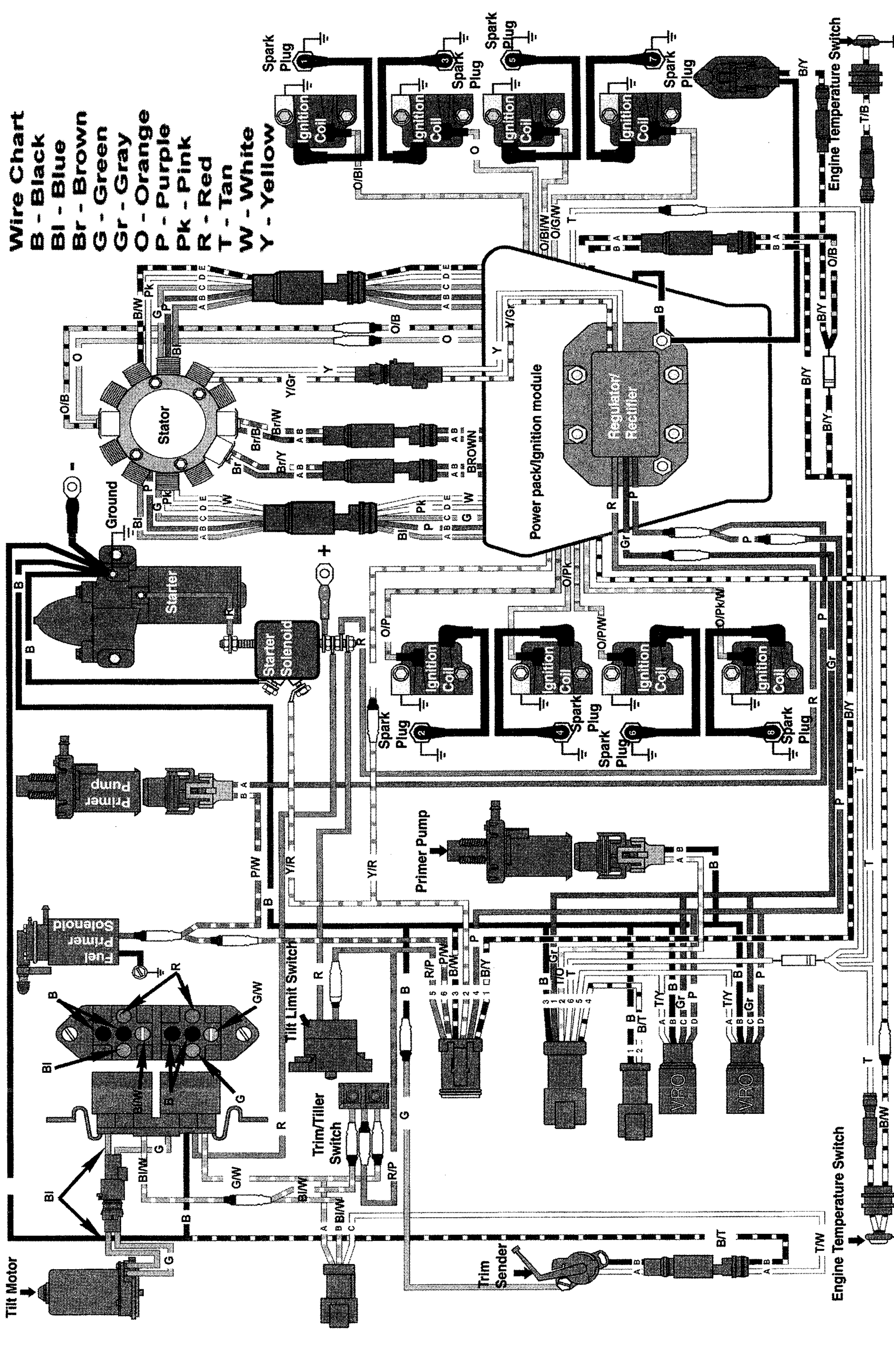
Wiring Diagram-1992 250/300 hp (4000cc) 90° Looper V8 Motors



Wiring Diagram-1993 250/300 hp (4000cc) 90° Looper V8 Motors

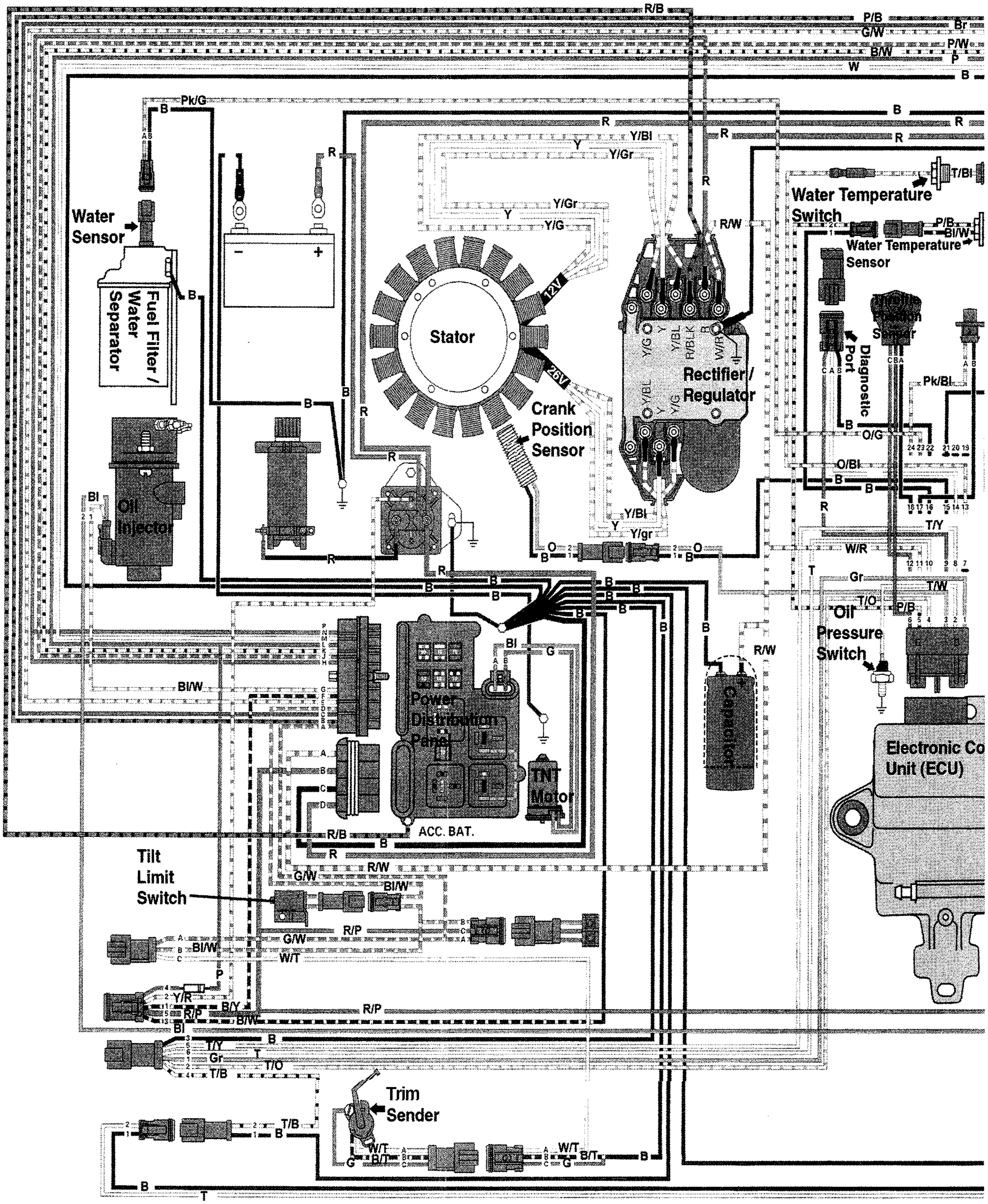


Wiring Diagram-1994-952501300 hp (4000cc) 90º Looper V8 Motors

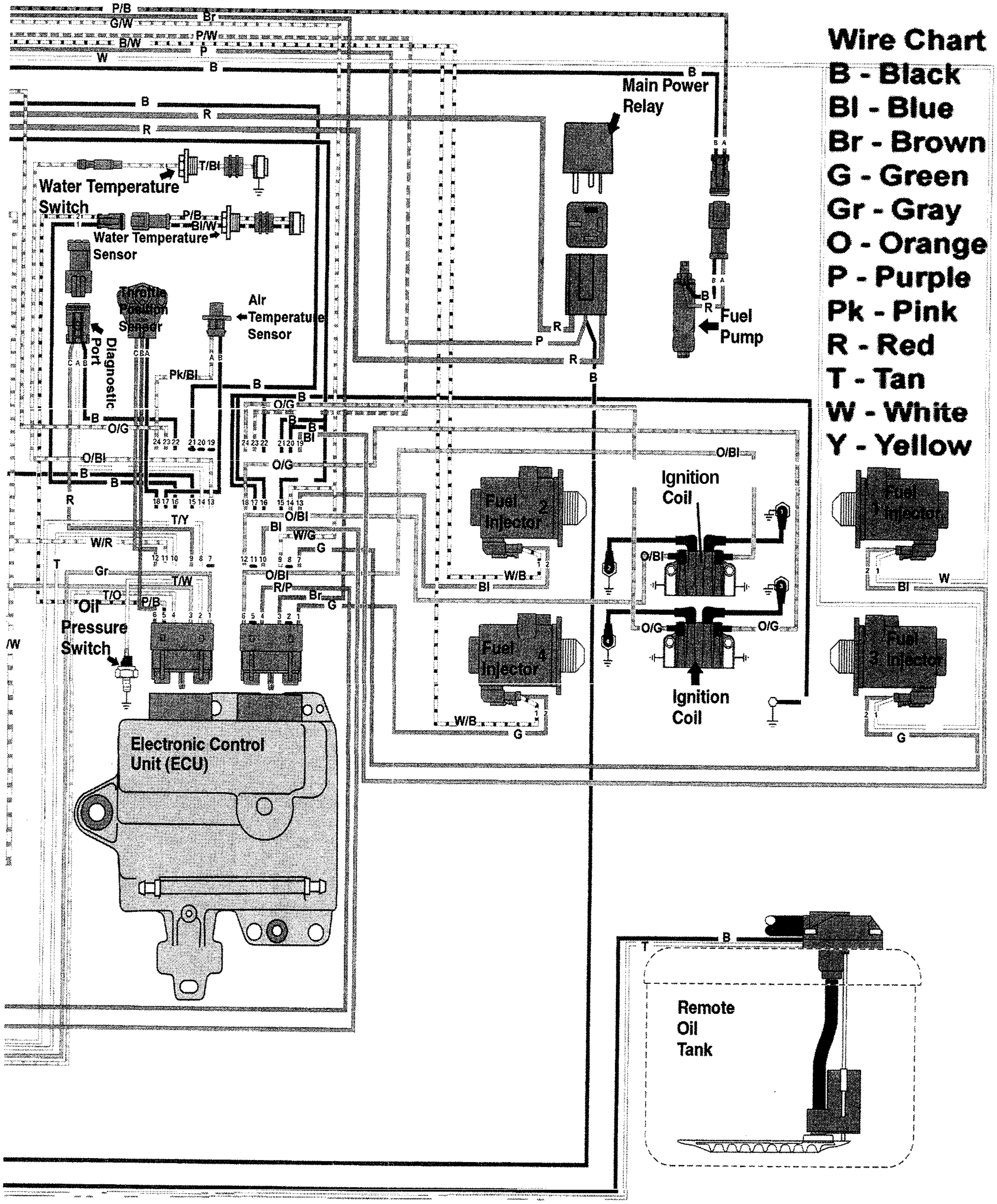


Wiring Diagram-1996-98 250 hp (4000cc) 90° Looper V8 Motors

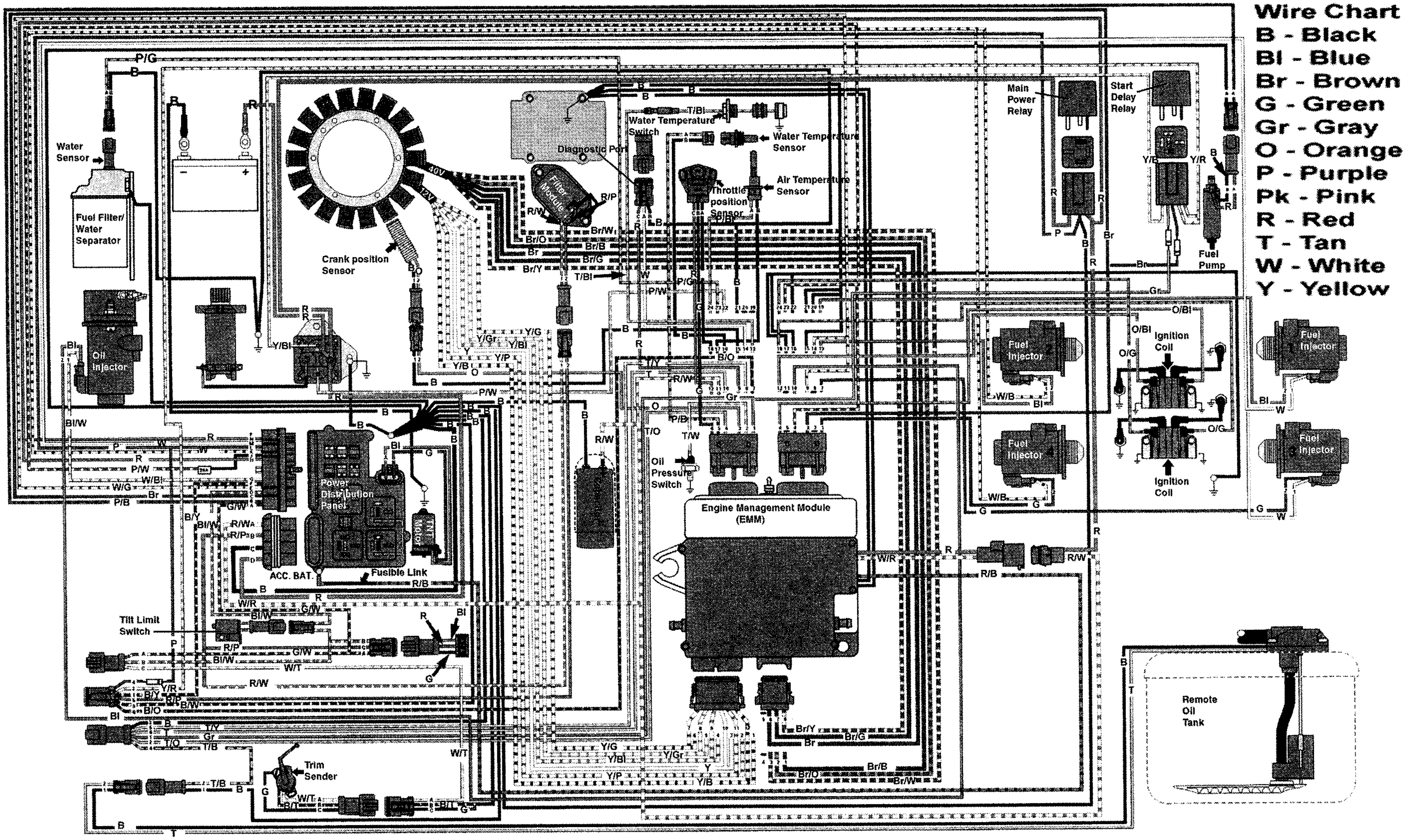
WIRING DIAGRAMS-V4 FICHT ENGINES



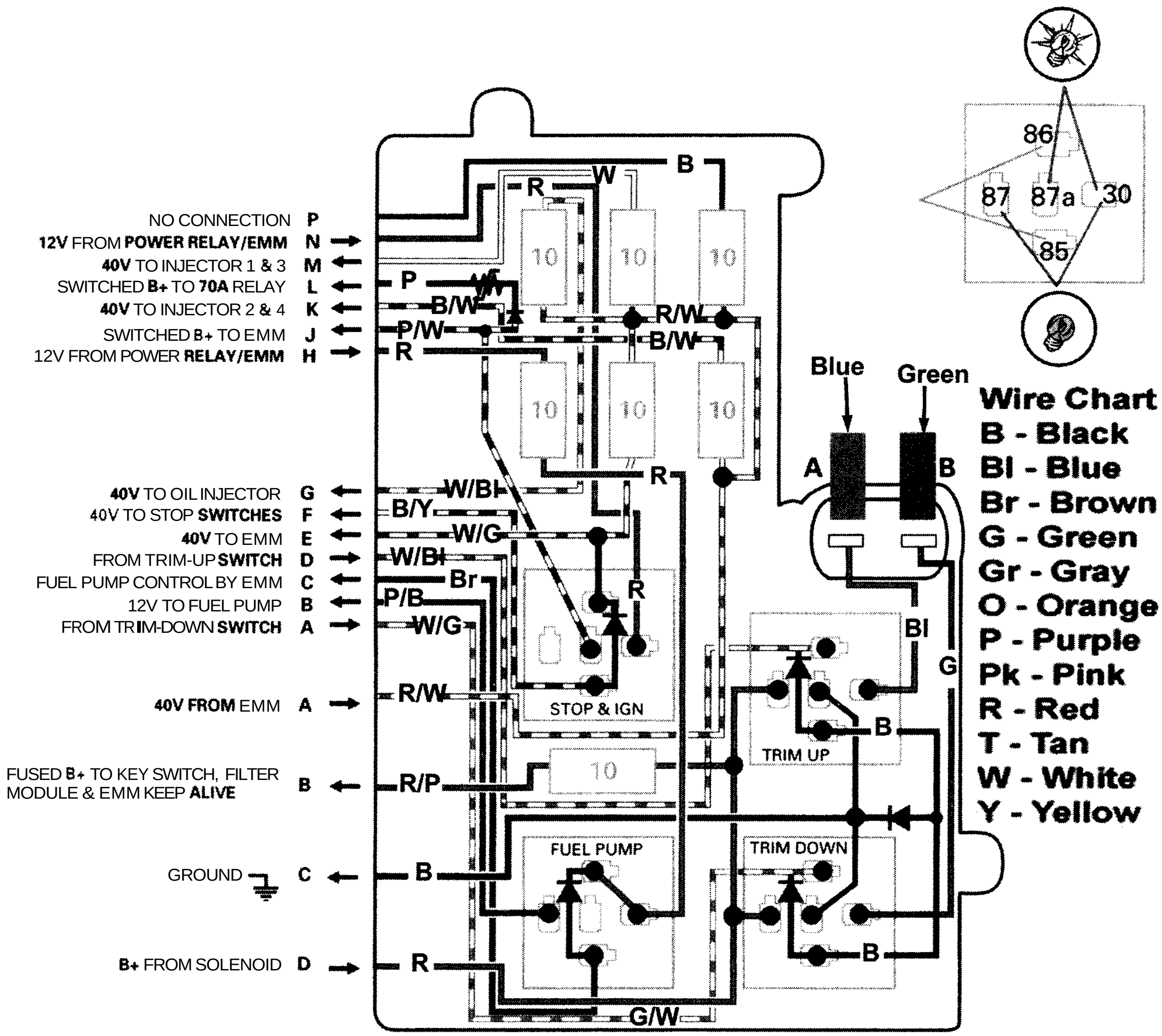
Wiring Diagram-90-115 hp (1726cc) 60° Looper FICHT V4 Motors through 1999 (Part 1)



Wiring Diagram-90-115hp (1726cc) 60° Looper FICHT V4 Motors through 1999 (Part 2)

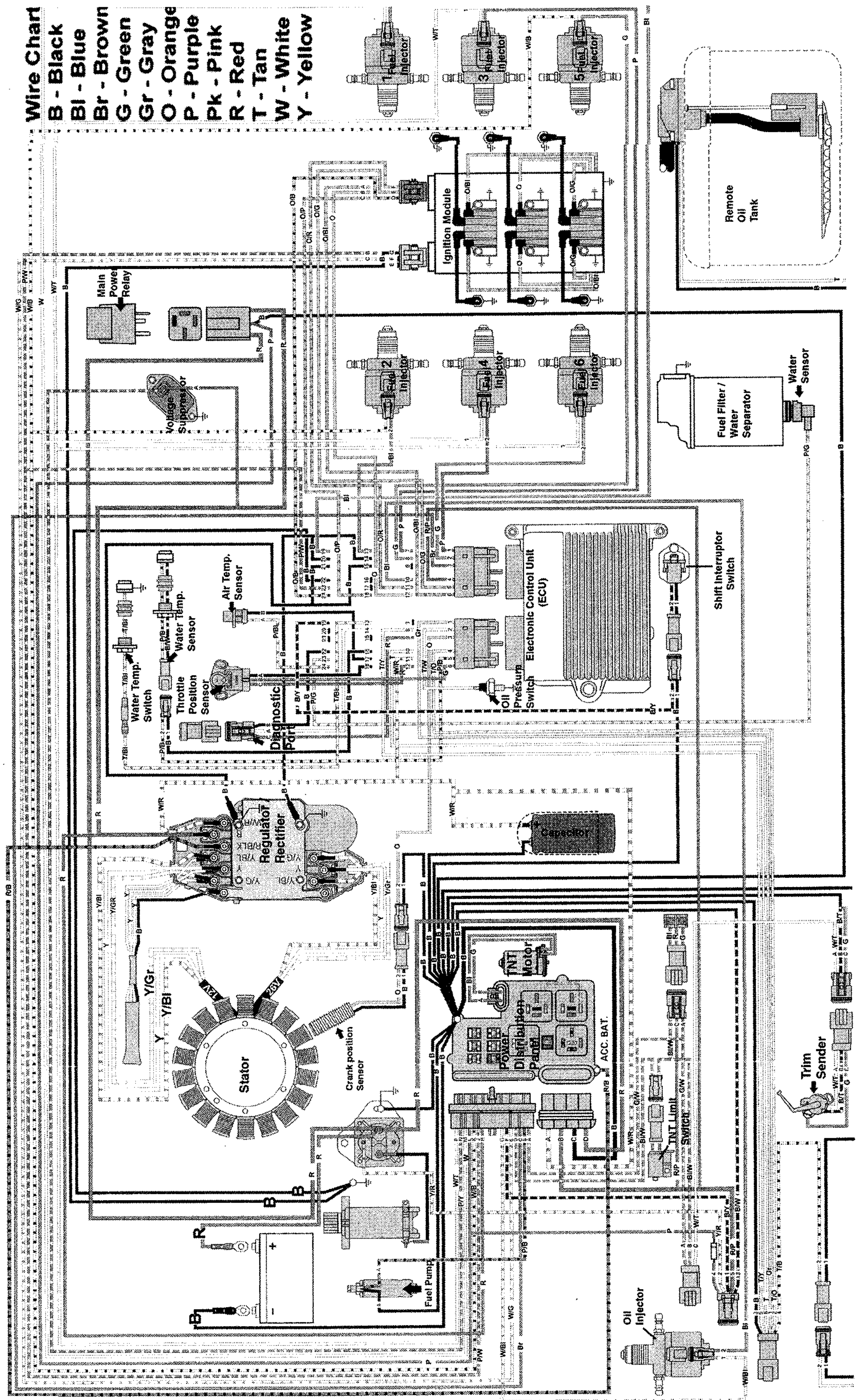


Wiring Diagram-2000 and later 75-115 hp (1726cc) 60º Looper FICHT V4 Motors

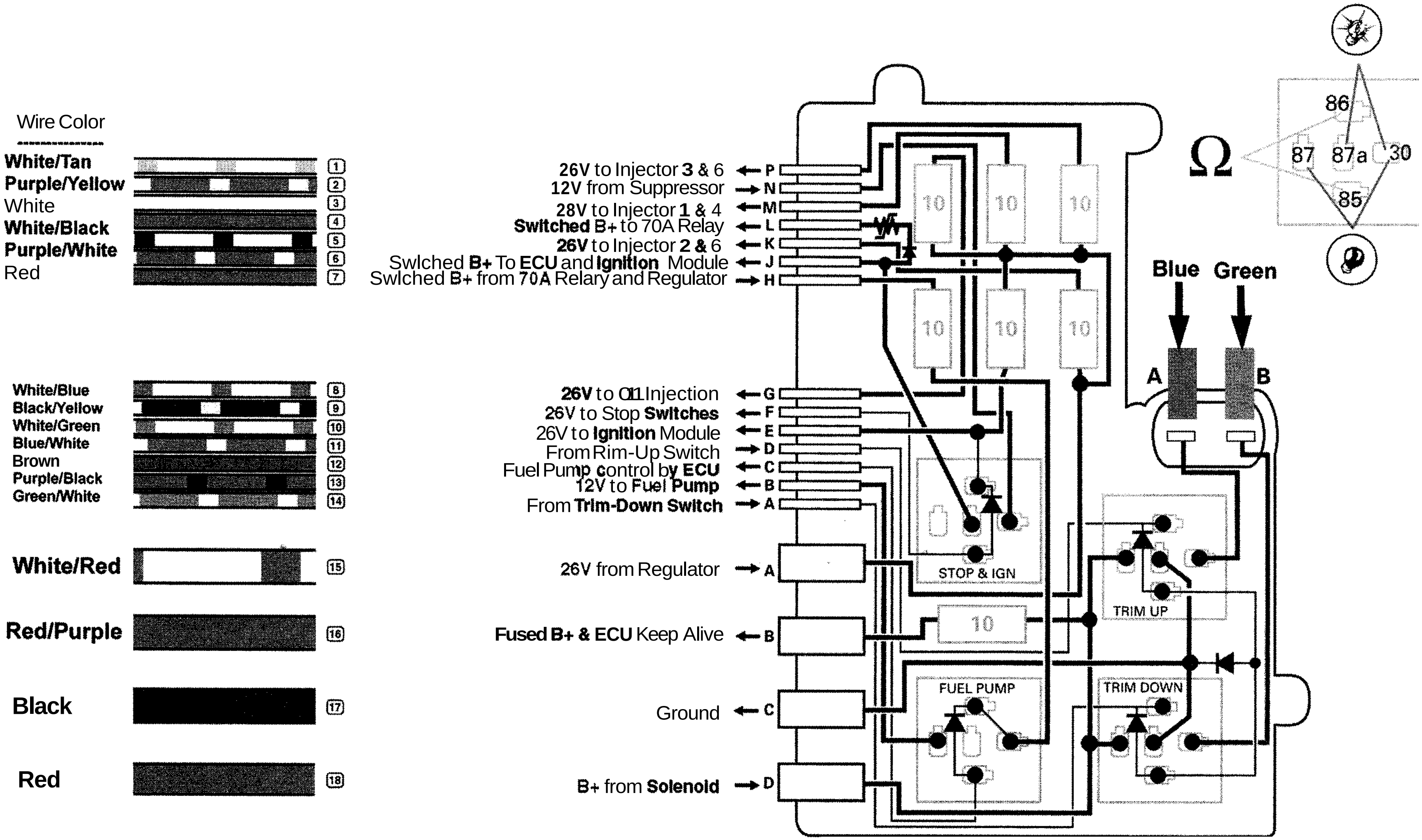


Power Distribution Block (Fuse Box) Wiring-2000 and later 75-115 hp (1726cc) 60° Looper FICHT V4 Motors

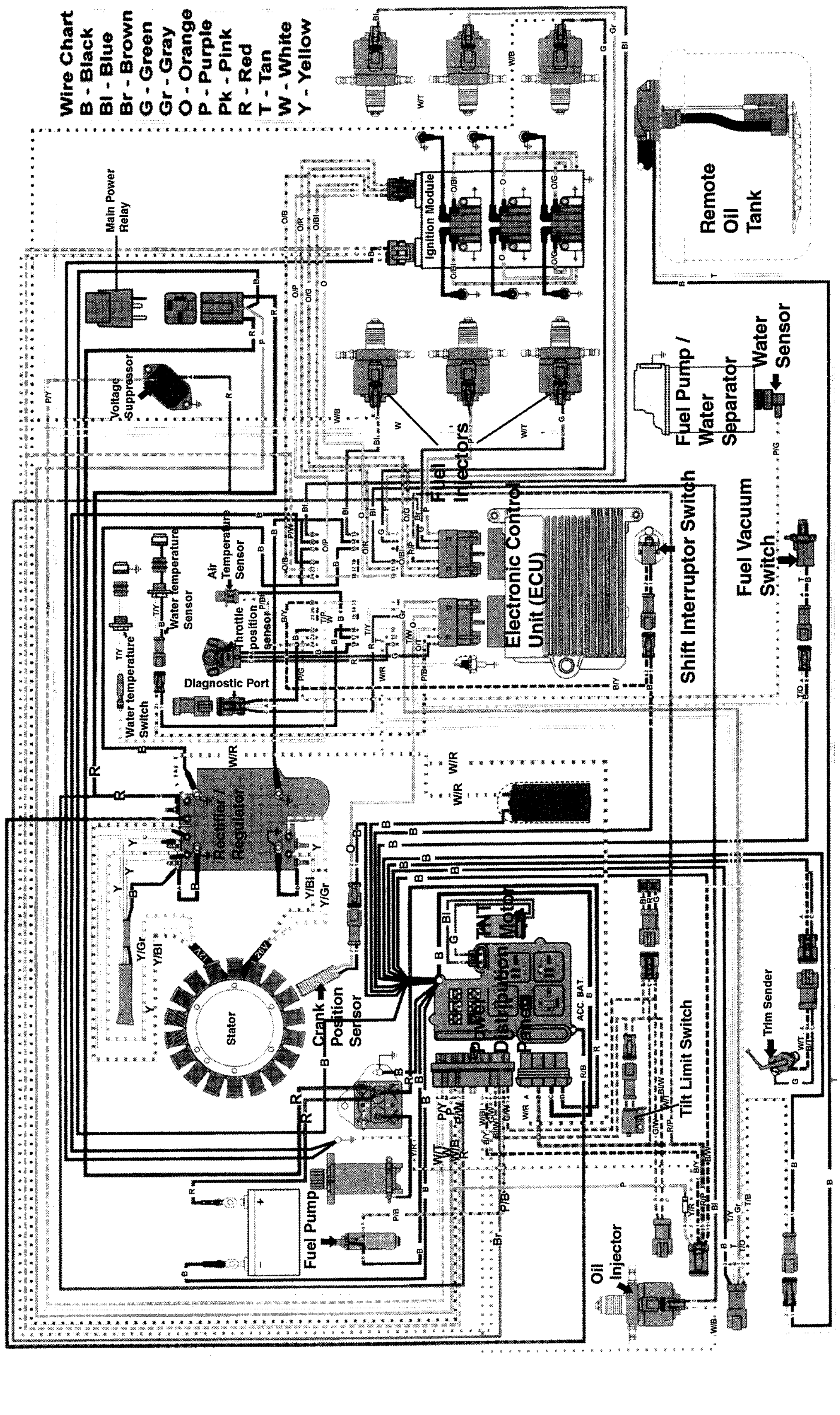
WIRING DIAGRAMS-V6 FICHT ENGINES WITH HARD FUEL RAILS



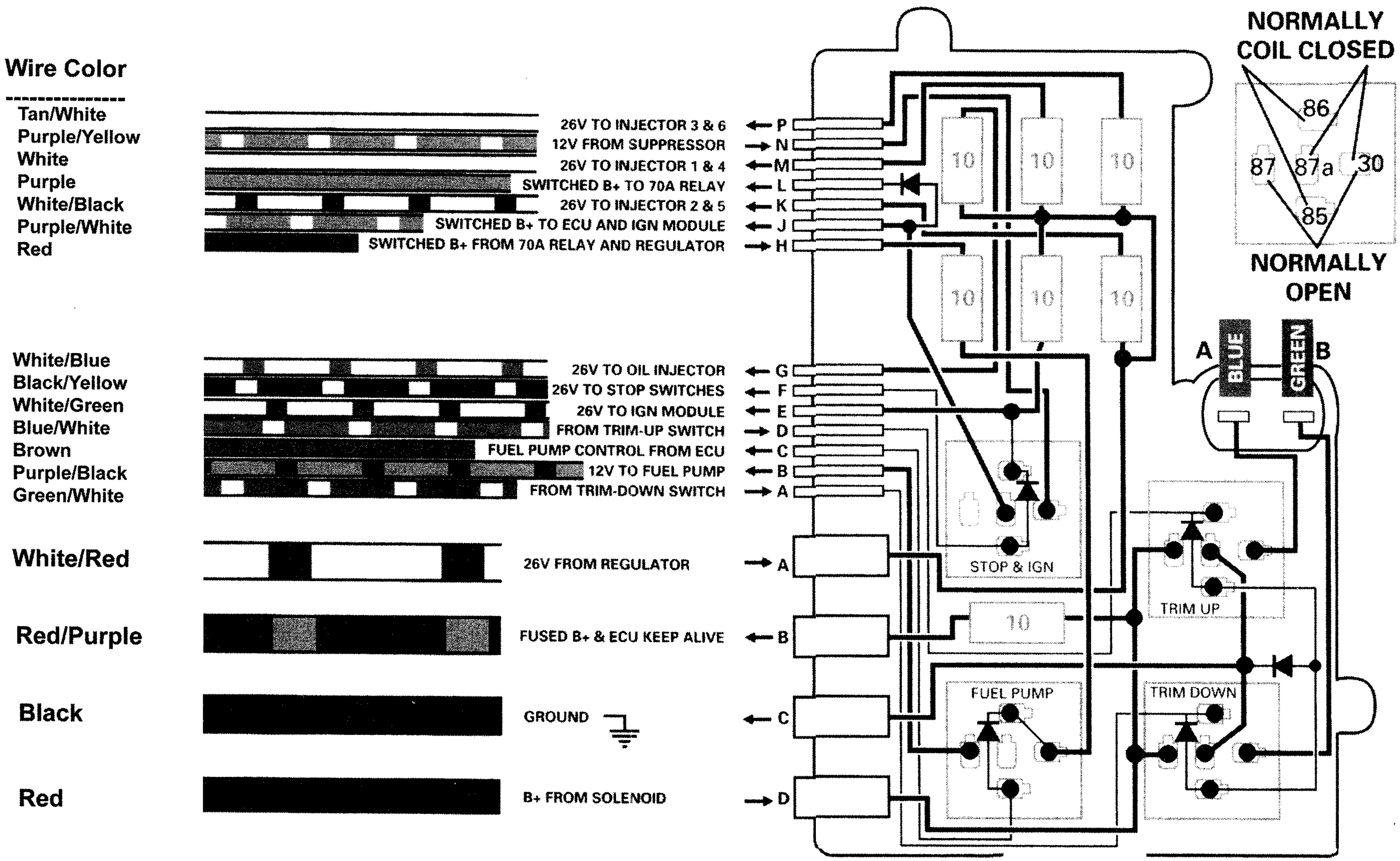
Wiring Diagram-Early-Model 150-175 hp (2589cc) 60° Looper FICHT V6 Motors Equipped with Hard Fuel Rails



Power Distribution Block (Fuse Box) Wiring-Early-Model **150-175** hp **(2589cc) 60º** Looper **FICHT** V6 Motors Equipped with Hard Fuel Rails

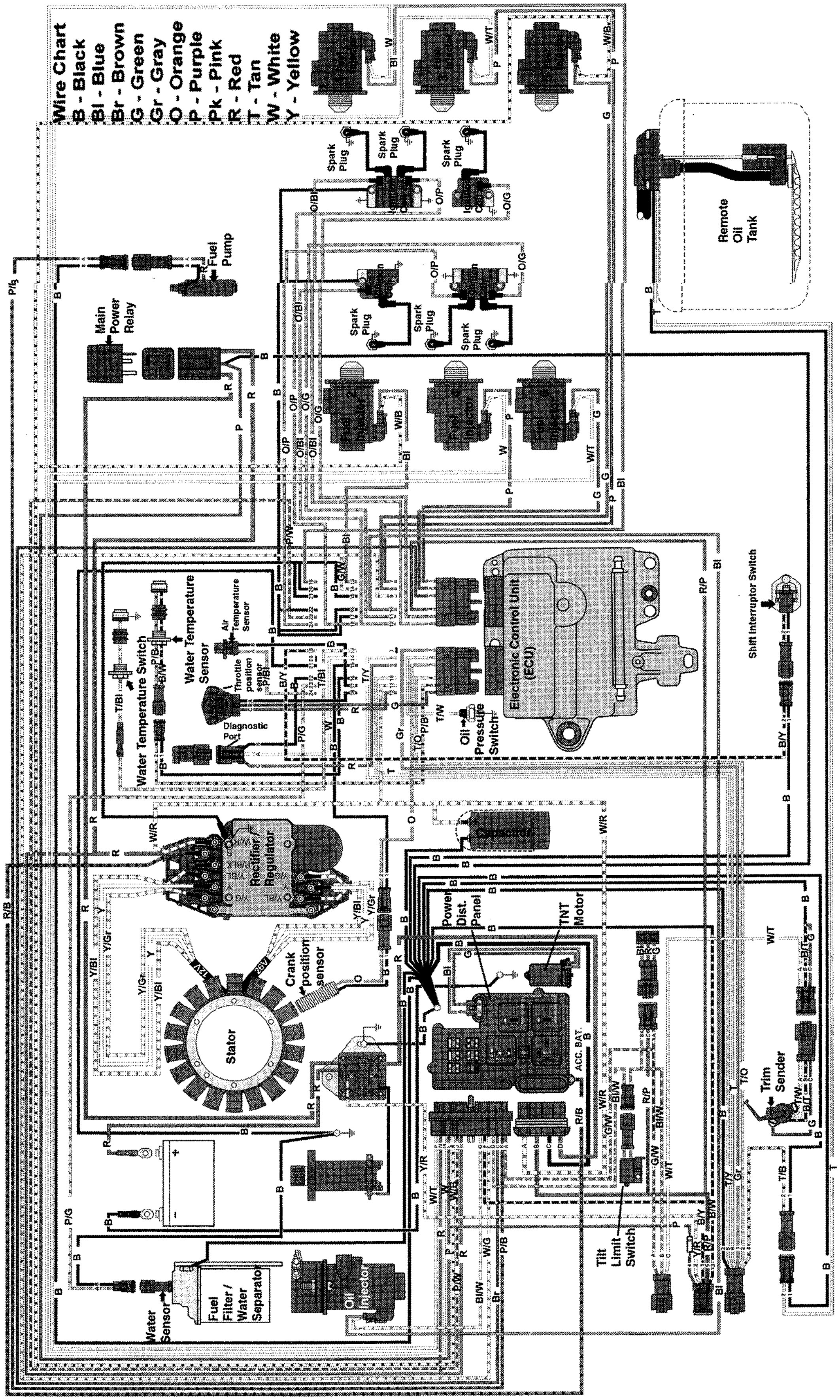


Wiring Diagram-Late-Model 150-175 hp (2589cc) 60° Looper FICHT V6 Motors Equipped with Hard Fuel Rails

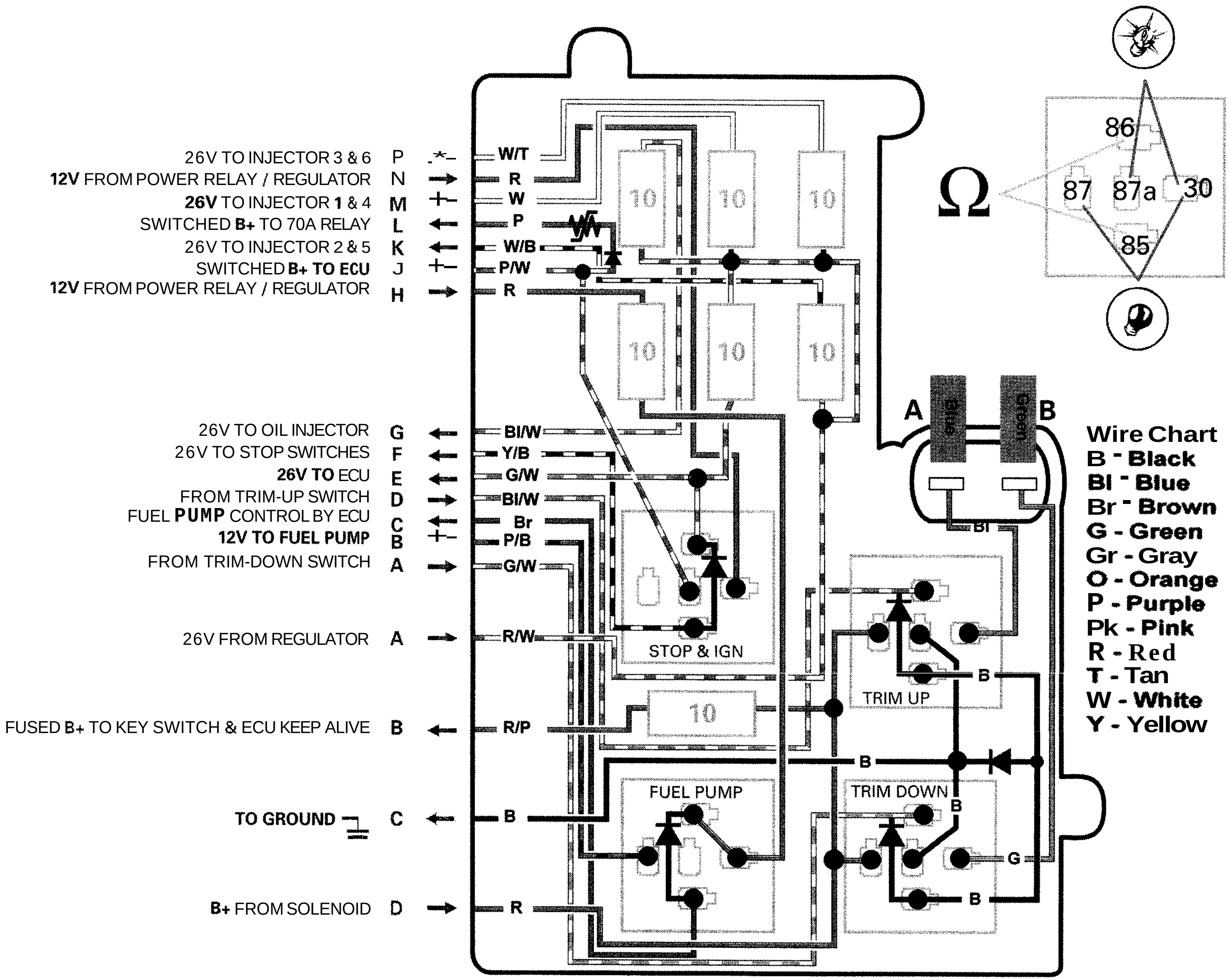


Power Distribution Block (Fuse Box) Wiring-Late-Model 150-175 hp (2589cc) 60° Looper FICHT V6 Motors Equipped with Hard Fuel Rails

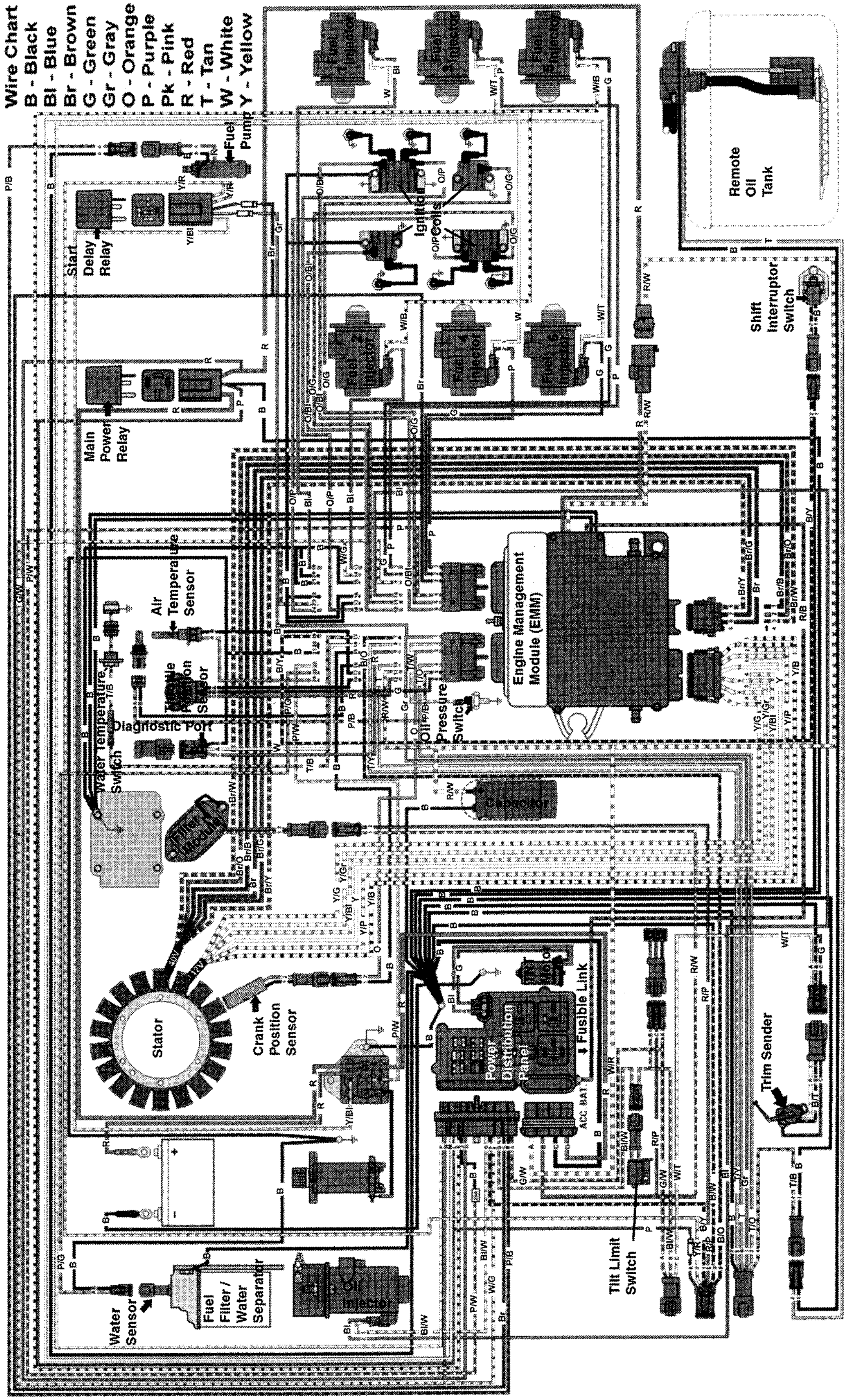
WIRING DIAGRAMS-V6 FICHT ENGINES WITHOUT HARD FUEL RAILS



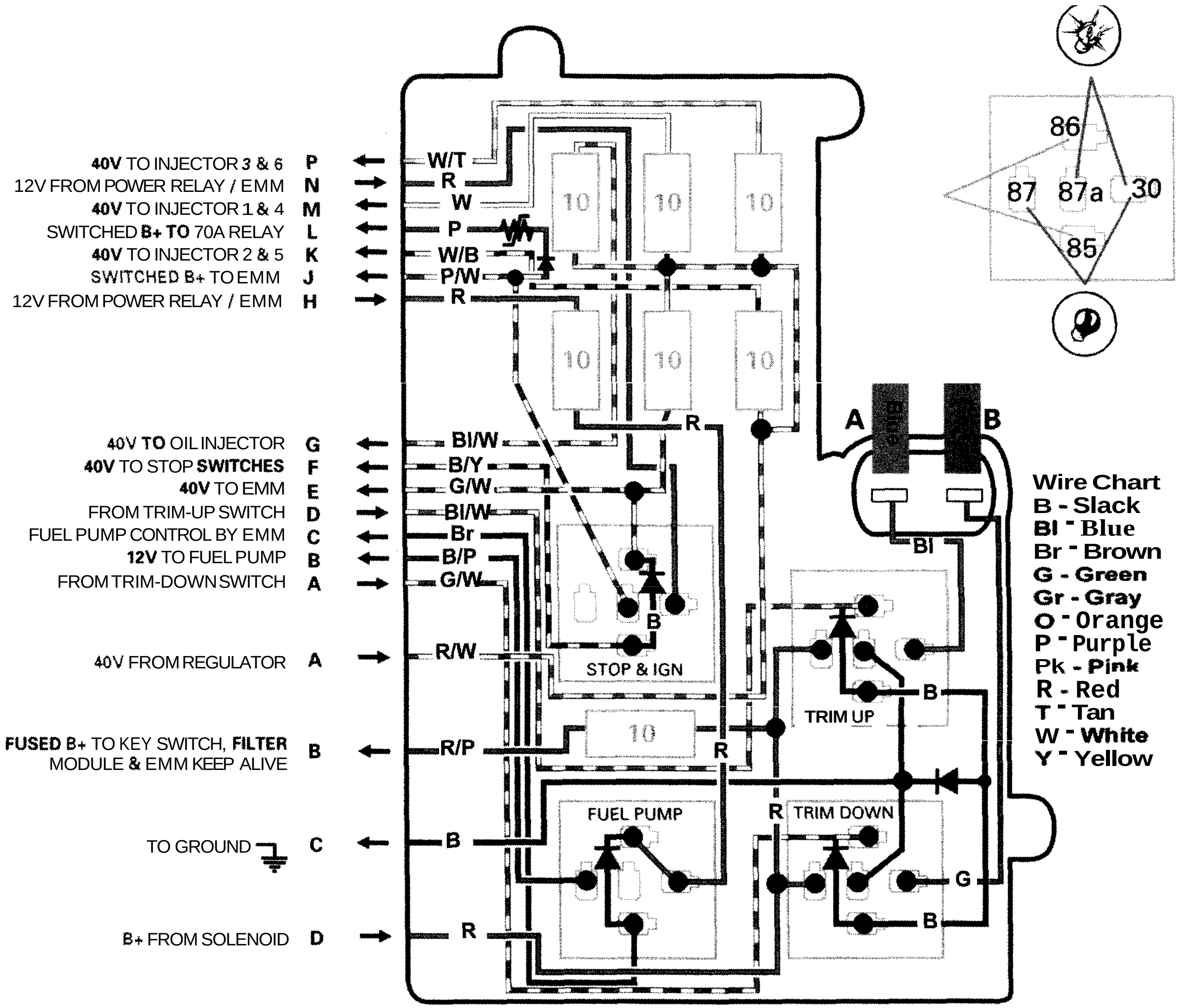
Wiring Diagram-150-175 hp (2589cc) 60° Looper FICHT V6 Motors WITHOUT Hard Fuel Rails, through 1999



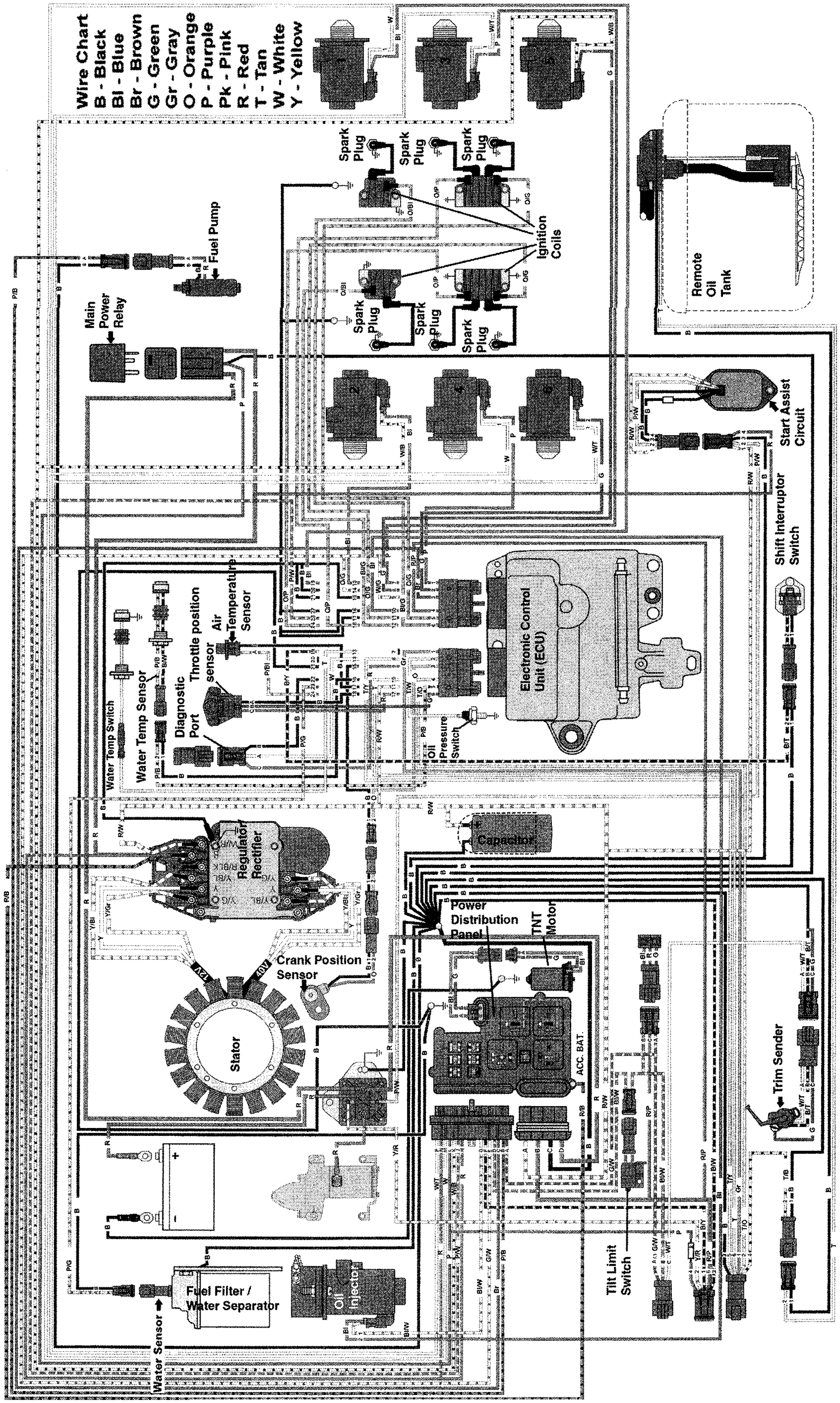
Power Distribution Block (Fuse Box) Wiring-150-175hp **(2589cc) 60°** Looper **FICHT V6** Motors WITHOUT Hard Fuel Rails, through 1999



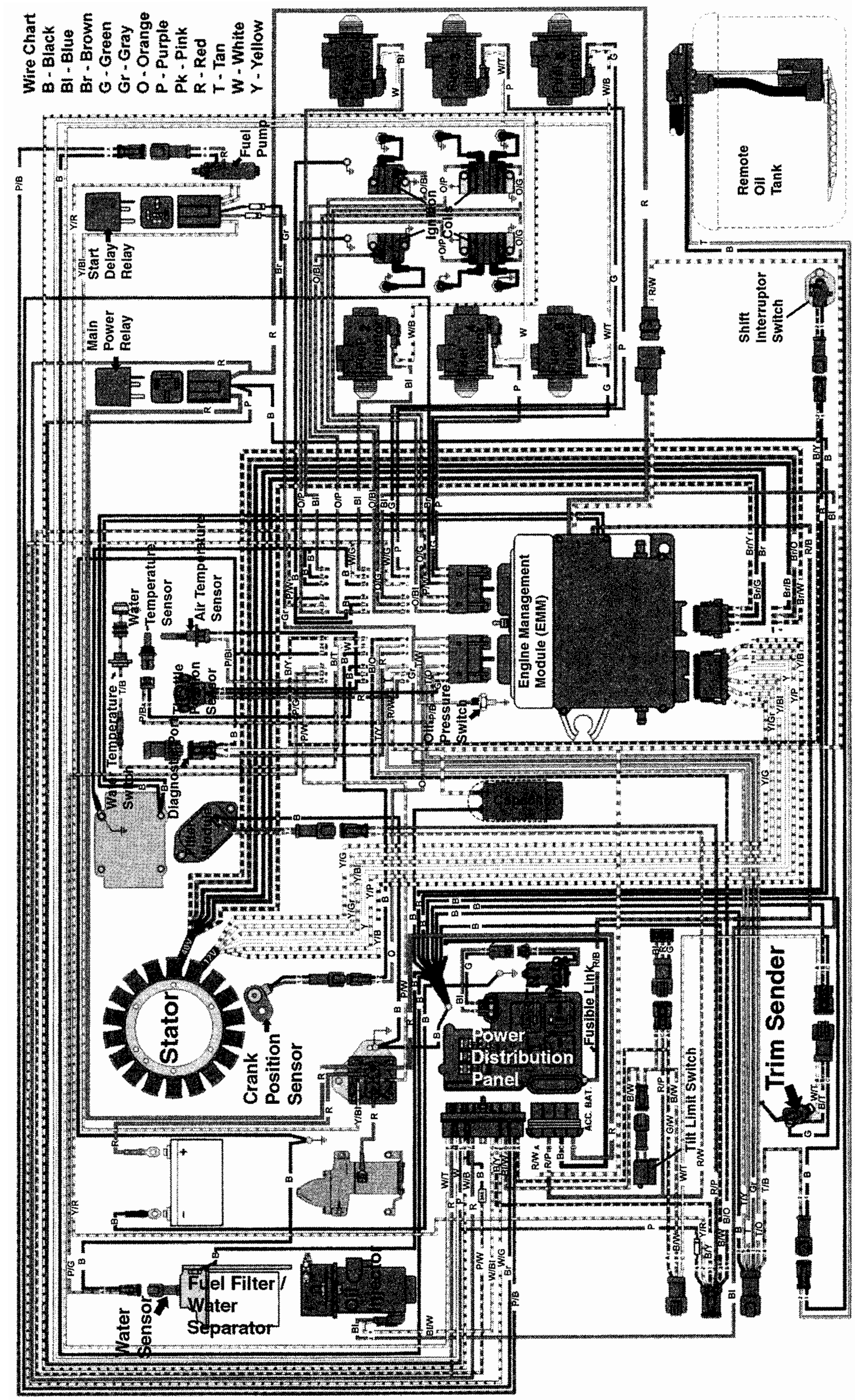
Wiring Diagram-2000 and later 135-175 hp (2589cc) 60° Looper FICHT V6 Motors WITHOUT Hard Fuel Rails



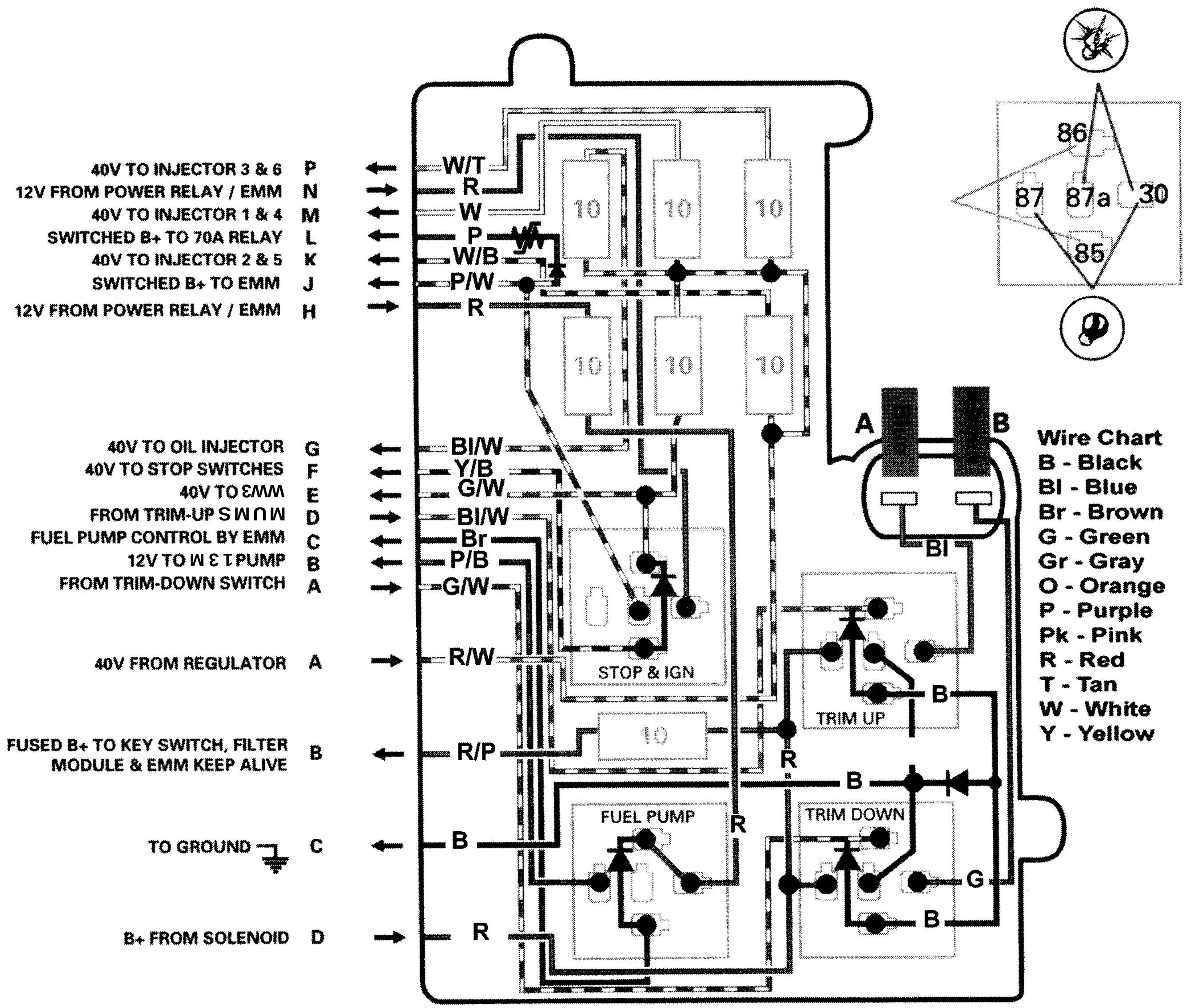
Power Distribution Block (Fuse Box) Wiring-2000 and later 135-175 hp (2589cc) 60° Looper FICHT V6 Motors WITHOUT Hard Fuel Rails



Wiring Diagram-200-250 hp (3000cc) V6 90° Looper FICHT V6 Motors, through 1999

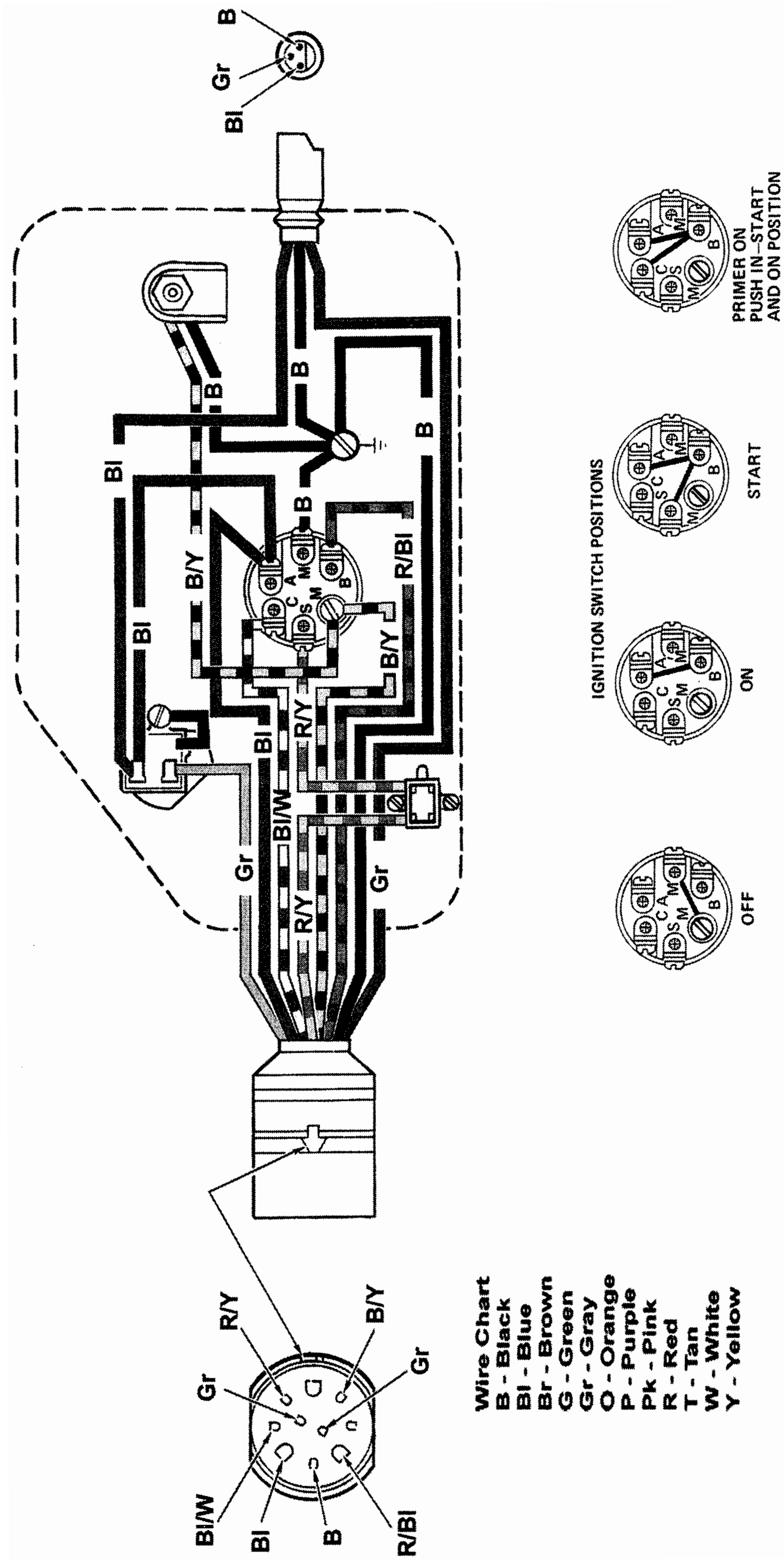


Wiring Diagram-2000 and later 200-250 hp (3000/3300cc) V6 90° Looper FICHT V6 Motors

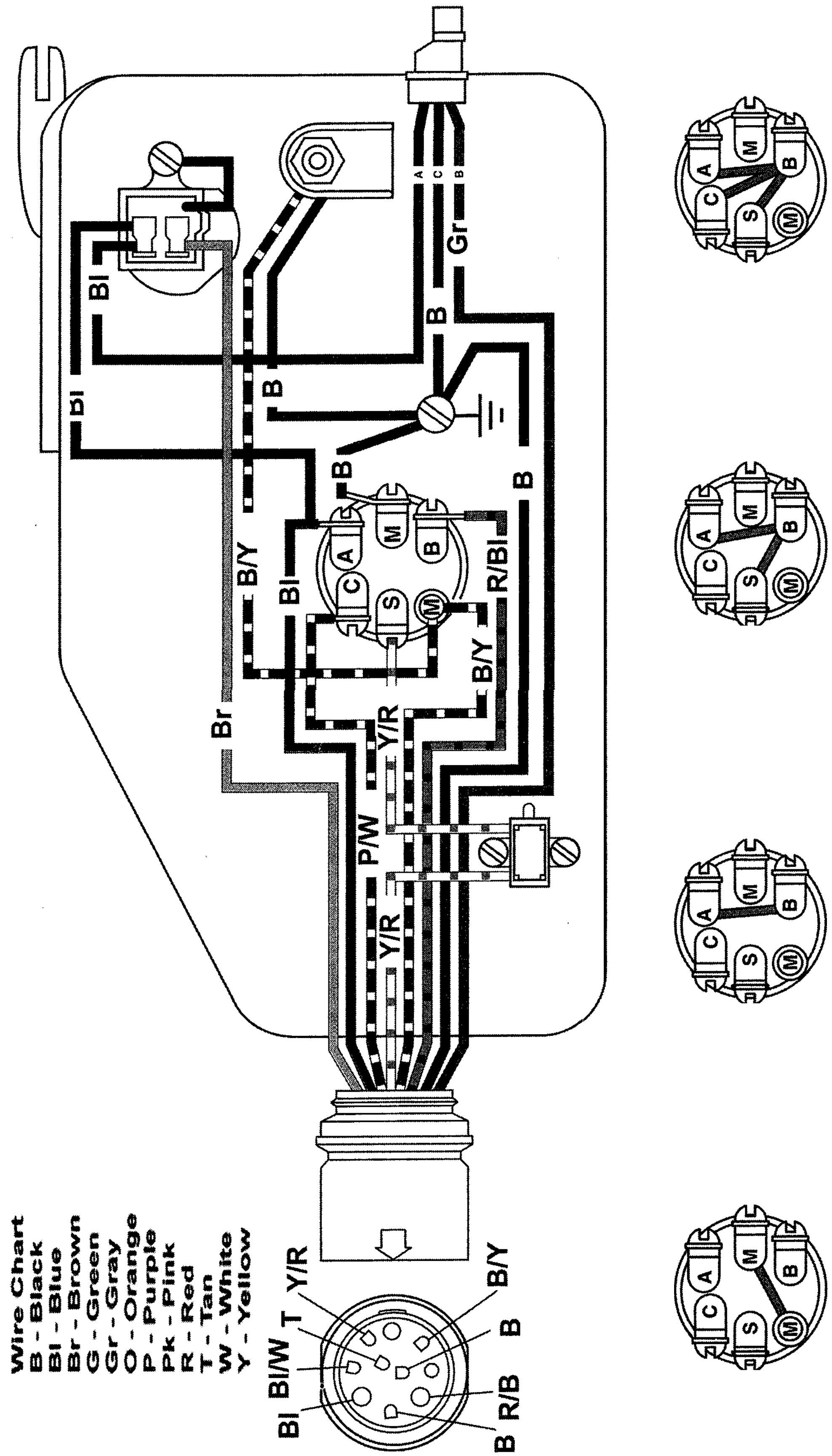


Power Distribution Block (Fuse Box) Wiring-2000 and later 200-250 hp (3000/3300cc) V6 90° Looper FICHT V6 Motors

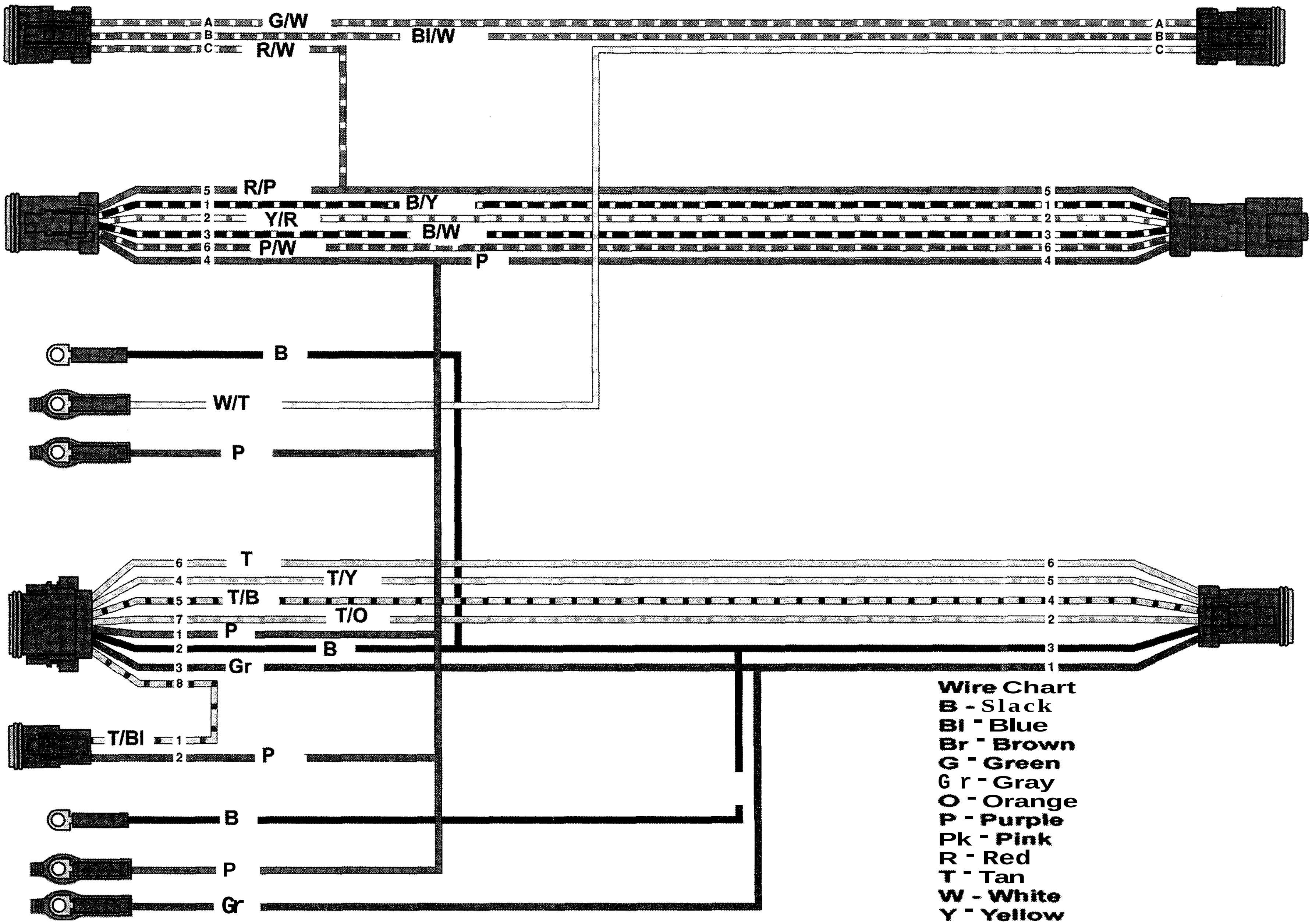
WIRING DIAGRAMS-RIGGING



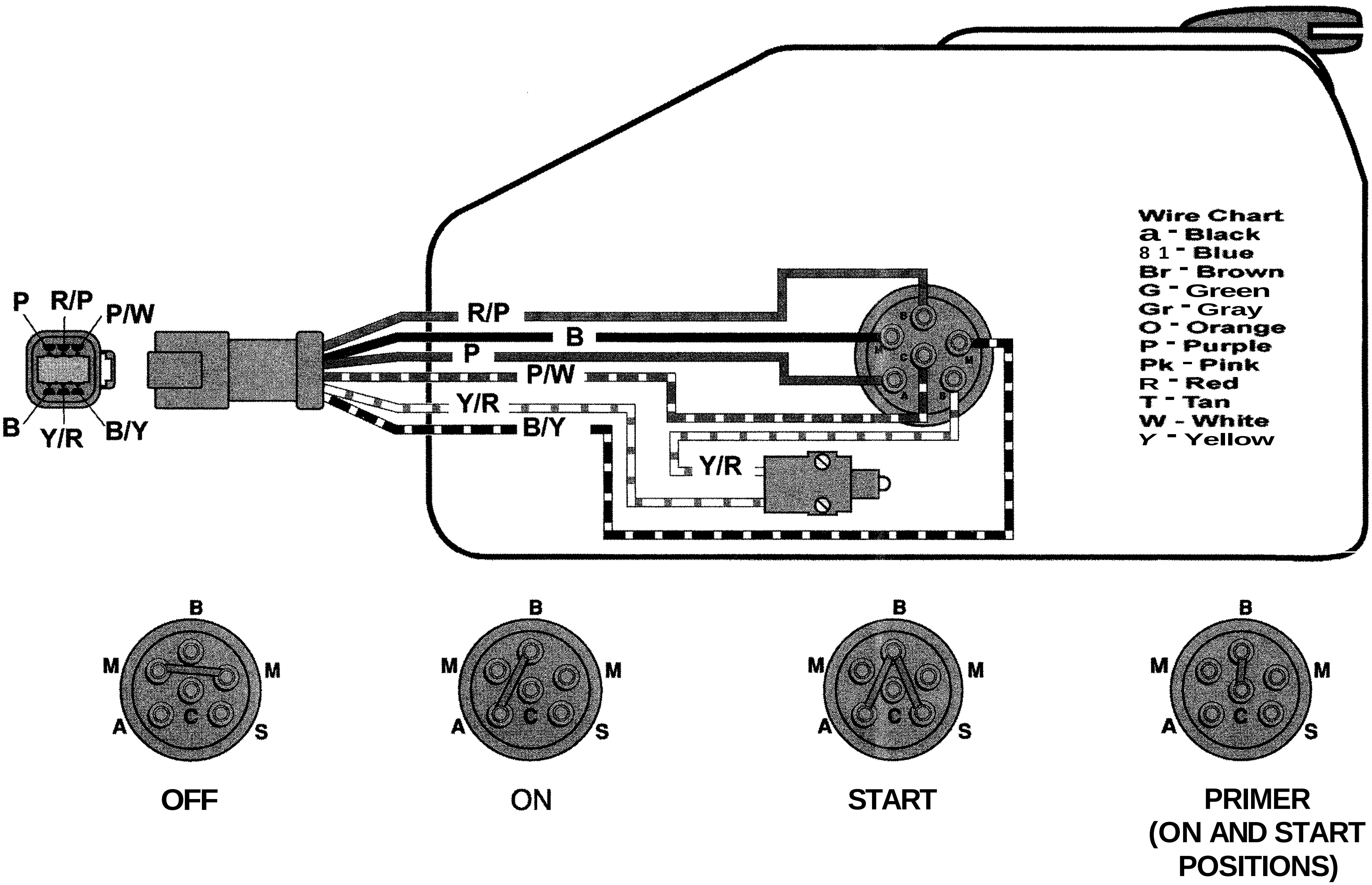
Wiring Diagram-1992-93 Evinrude/Johnson Remote Control and Keyswitch Assembly



Wiring Diagram-1994-95 Evinrude/Johnson Remote Control and Keyswitch Assembly



Wiring Diagram-1996-01 MWS Instrument Wiring Harness for **Evinrude/Johnson Remotes**



Wiring Diagram-1996-01 Evinrude/Johnson Remote Control/Keyswitch for MWS Wiring Harness

Ignition Testing Specifications - Carbureted Motors

Model (Hp)	No. of Cyl	Engine Type	Year	Displace cu. in. (cc)	Ignition Coil Primary Resistance	Ignition Coil Secondary Resistance	Charge Coil Resistance	Charge Coil Min. Volts Cranking	Power Coil Resistance	Power Coil Min. Volts Cranking	Sensor/Trigger Coil Resistance	Sensor/Trigger Coil Min. Volts Cranking	Power Pack Min. Volts Cranking	Power Pack Min. Volts Running
65 Jet	4	90 CV	1992-95	100 (1632)	0.05-0.15	225-325	①	150	NA	NA	30-50	0.3	150	230
80 Jet	4	90 CV	1992-97	100 (1632)	0.05-0.15	225-325	①	150	NA	NA	30-50	0.3	150	230
85	4	90 CV	1992-95	100 (1632)	0.05-0.15	225-325	①	150	NA	NA	30-50	0.3	150	230
88	4	90 CV	1992-96	100 (1632)	0.05-0.15	225-325	①	150	NA	NA	30-50	0.3	150	230
90	4	90 CV	1992-98	100 (1632)	0.05-0.15	225-325	①	150	NA	NA	30-50	0.3	150	230
100	4	90 CV	1992-97	100 (1632)	0.05-0.15	225-325	①	150	NA	NA	30-50	0.3	150	230
112 SPL	4	90 CV	1994-96	100 (1632)	0.05-0.15	225-325	①	150	NA	NA	30-50	0.3	150	230
115	4	90 CV	1992-98	100 (1632)	0.05-0.15	225-325	①	150	NA	NA	30-50	0.3	150	230
80 Jet	4	60 LV	1998-01	105 (1726)	0.05-0.15	225-325	1000-1200	250	45-65	50 ②	OS	OS	200	130
90	4	60 LV	1995-01	105 (1726)	0.05-0.15	225-325	1000-1200	250	45-65	50 ②	OS	OS	200	130
100	4	60 LV	1998-01	105 (1726)	0.05-0.15	225-325	1000-1200	250	45-65	50 ②	OS	OS	200	130
105 Com	4	60 LV	1997-01	105 (1726)	0.05-0.15	225-325	1000-1200	250	45-65	50 ②	OS	OS	200	130
115	4	60 LV	1995-01	105 (1726)	0.05-0.15	225-325	1000-1200	250	45-65	50 ②	OS	OS	200	130
120	4	90 LV	1992-94	122 (2000)	0.05-0.15	225-325	430-530	175	86-106	NA	35-55 ③	0.5	150	180
125 Com	4	90 LV	1992-98	122 (2000)	0.05-0.15	225-325	430-530	175	86-106	NA	35-55 ③	0.5 ④	150	180
130	4	90 LV	1994-00	122 (2000)	0.05-0.15	225-325	430-530	175	86-106	NA	35-55 ③	0.5	150	180
135	4	90 LV	2001	122 (2000)	0.05-0.15	225-325	430-530	175	86-106	NA	35-55 ③	0.5	150	180
140	4	90 LV	1992-94	122 (2000)	0.05-0.15	225-325	430-530	175	86-106	NA	35-55 ③	0.5	150	180
105 Jet	6	60 LV	1992-01	158 (2589)	0.05-0.15	225-325	495-605	150	⑤	50 ②	OS	OS	100	130
135	6	60 LV	2001	158 (2589)	0.05-0.15	225-325	495-605	150	45-65	35	OS	OS	100	130
150	6	60 LV	1992-01	158 (2589)	0.05-0.15	225-325	495-605	150	⑤	50 ②	OS	OS	100	130
175	6	60 LV	1992-01	158 (2589)	0.05-0.15	225-325	495-605	150	⑤	50 ②	OS	OS	100	130
185	6	90 LV	1992-94	183 (3000)	0.05-0.15	225-325	765-935	130	86-106	NA	⑥	0.2 ⑦	100	130
200	6	90 LV	1992-01	183 (3000)	0.05-0.15	225-325	765-935	130	86-106	NA	⑥	0.2 ⑦	100	130
225	6	90 LV	1992-01	183 (3000)	0.05-0.15	225-325	765-935	130	86-106	NA	⑥	0.2 ⑦	100	130
250	6	90 LV	1999-01	183 (3000)	0.05-0.15	225-325	765-935	130	86-106	NA	⑥	0.2 ⑦	100	130

Ignition Testing Specifications - Carbureted Motors

Model (Hp)	No. of Cyl	Engine Type	Year	Displace cu. in. (cc)	Ignition Coil Primary Resistance	Ignition Coil Secondary Resistance	Charge Coil Resistance	Charge Coil Min. Volts Cranking	Power Coil Resistance	Power Coil Min. Volts Cranking	Sensor/Trigger Coil Resistance	Sensor/Trigger Coil Min. Volts Cranking	Power Pack Min. Volts Cranking	Power Pack Min. Volts Running
250	8	90 LV	1992-98	244 (4000)	0.05-0.15	225-325	765-935	130	86-106	NA	⑥	0.2 ⑦	100	130
300	8	90 LV	1992-95	244 (4000)	0.05-0.15	225-325	765-935	130	86-106	NA	⑥	0.2 ⑦	100	130

NOTE: All resistance tests are based on a high-quality DVOM testing components at an ambient temperature of 68 degrees F (20 degrees C). Testing under other conditions, such as using lower quality meters or at testing different temperatures could lead to false results.

NA - not applicable or not available on this model OS - optical sensor

① Specification is 500-620 ohms for models with 6-amp charging systems, or 430-530 ohms for models with 9- or 10-amp charging systems

② Specification is for all models through 1998, for 1999-2001 models, min. cranking output is 35 volts

③ Specification is for the normal coil, the advance coil used on all but 125RW models should be 100-160 ohm, while cranking output is the same

④ Speciification is the cranking output of the normal or advance coil on all but the 125RW, on which the normal coil min cranking voltage is 0.3 volts

⑤ The resistance specification varies with year, 1992-93 90-110 ohms, 1994 50-70 ohms, 1995-01 45-65 ohms

⑥ Specification varries with meter, for both the normal and advance coils, resistance should be about: 330-390 ohms on a Stevens AT-101 meter or 870-1070 ohms on a Merc-O-Tronic M-700 meter

@Specification is for cranking output of the normal coil, for advance coils output should be about 1.2 volts for 1992-94 models or 0.8 volts for 1995 and later

5

LUBRICATION AND COOLING

VARIABLE RATIO OILING (VRO2) SYSTEM (CARBURETED MOTORS)

Unlike 4-stroke engines, which contain a reservoir of oil that is re-circulated during engine operation, 2-stroke engines are lubricated by mixing engine oil with the fuel. The internal engine components of 2-stroke motors are lubricated as this fuel/oil mixture passes through the crankcase and the cylinder.

Generally speaking, there are 2 methods of adding oil to a 2-stroke outboard. The first is to pre-mix oil with the gasoline whenever the fuel tank is filled. The pre-mix method is generally used on smaller (lower horse-power) motors and on most commercial outboards. It is easiest to perform ihis on portable fuel tanks that can be agitated to ensure proper mixture, but it can be successfullv accomolished on larger built-in tanks. as long as care is taken to properly measure'the amounts of fuel/oil being added.

For ease of service and to ensure a constant supply of 2-stroke oil, almost all Evinrude/Johnson V motors are equipped with an oil injection system. On carbureted motors, this system takes the form of the Variable Ratio Oiling (VRO2) system. For fuel injected motors, lubrication is completely controlled by the oil circuits of the FICHT Fuel Injection (FFI) system.

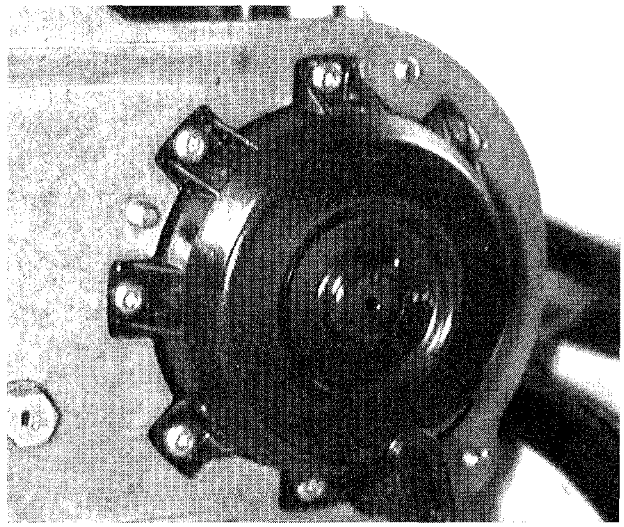


Fig. 1 Nearly all of the carbureted V configuration motors are equipped with a VR02 **pump/oil** injection system

Description and Operation

4 See Figure 1

The VR02 system consists of a remote oil reservoir (tank), a VR02 oil/fuel pump and mixer assembly, an integral NO or LOW OIL warning circuit and the necessary hoses and fittings to connect the various items for efficient operation. All connections in the system must be airtight to prevent serious damage to the powerhead.

As the name implies, the VRO pump moves oil from the oil reservoir to the powerhead. However, it is a dual pump and also pumps fuel. Pumping action of the pump stops automatically if fuel is not available at the pump for any reason. This automatic pump shutdown feature prevents the carburetors from filling with oil.

The warning circuits (horn and warning LEDs), located in the control box serve two functions.

First, as a low oil level warning; The horn will sound for 10 seconds and the LOW OIL LED in the System Check monitor gauge will illuminate if the oil tank level reaches 114 of the tank's capacity.

Secondly, the warning horn will sound for 10 seconds and the NO OIL LED in the System Check monitor gauge will illuminate if the no oil is reaching the pump via the oil supply line.

✳✳ WARNING

To continue powerhead operation after the NO OIL LED and warning horn sounds would almost certainly invite serious damage to internal moving **parts** and **powerhead** seizure!

In addition, V6 and V8 engines are equipped with a vacuum switch that will sound the warning horn should there be any restrictions in the fuel supply line. The switch monitors the amount of vacuum within the fuel supply hose from the fuel tank to the VR02 pump. If a restriction should develop in the fuel supply, the vacuum will begin to rise, particularly at higher power settings. When the vacuum reaches a pre-determined value, the switch will close and the warning horn will sound a continuous tone. In some situations, when the throttle is reduced from a high power setting, the vacuum in the fuel supply may be reduced because less fuel is required to operate the powerhead, silencing the warning horn.

VRO2 System Verification and Troubleshooting

When equipped, the VR02 system is vitally important to the life of an outboard. Upon initial installation or repair of the system, proper operation of the system and the warning circuits must be verified. If you have any reason to suspect the system, verify proper operation of the warning circuits. It is not a bad idea to go through the trouble of verifying proper warning circuit operation on an annual basis especially when the motor is being removed from storage.

If the NO or LOW OIL LEDs illuminate **and/or** the warning horn activates at anytime during engine operation, shut the engine down immediately and check the oil level. If adding oil to the tank does not rectify the situation, troubleshoot the problem before continuing to operate the powerhead. If necessary, pre-mix oil into the fuel supply to get the boat and motor safely to shore. An oil supply should be kept on board for this purpose, or if oil is present in the oil reservoir, it can be siphoned off for mixing in the tank (if sufficient oil is available to achieve a proper fuelloil ratio.

If adding oil to the tank does not shut the warning LOW OIL LED off, remove the pickup assembly from the tank and check to see if the float is **stuck. The** float can be manually repositioned to see if the circuitry may be at fault as opposed to the physical fuel supply. But remember that the NO OIL LED on these models signals that insufficient oil pressure is reaching the pump.

CHECKING THE LOW OIL WARNING CIRCUIT

② MODERATE

4 See Figure 2

Either remove the oil tank pickup and manually reposition the float so it is below the 114 level mark or siphon oil from the tank until there is less than 114 of tank capacity left in the reservoir. Turn the keyswitch on and wait for the System Check gauge to complete the self-test, then watch for the LOW OIL LED to illuminate, Slowly add oil to the tank or manually reposition the float upward, the LED should go out as soon as the float passes the 1/4 tank level.

☐ If the warning circuit does not function properly, check the Warning System circuitry. Refer to the information for Testing Warning Circuits, found in the Warning System Troubleshooting section.

CHECKING THE NO OIL WARNING CIRCUIT

② MODERATE

4 See Figure 3

Disconnect the oil line and fuel lines from the fuel tank or outboard, then connect a portable tank containing a 50:1 fuel/oil pre-mix to the engine's fuel inlet line. Connect a source of cooling water to the motor, then start and run the outboard at about 1500 rpm.

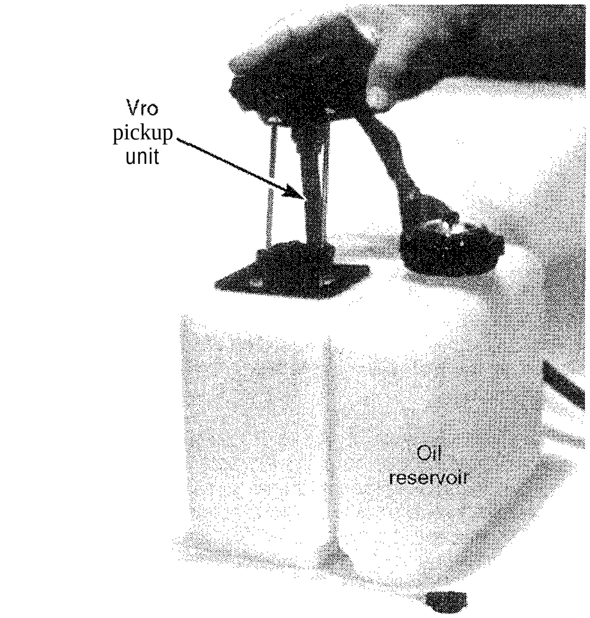


Fig. 2 If necessary for testing or inspection, the oil tank pickup unit is easily removed from the tank once the screws (usually **4 Torx®** head screws) are removed from the flange

It may take a few minutes to consume the residual oil in the pump and oil line.

Once any residual oil is consumed, the NO OIL LED should illuminate and the warning horn should sound for 10 seconds.

☐ If the warning circuit does not function properly, check the Warning System circuitry. Refer to the information for Testing Warning Circuits, found in the Warning System Troubleshooting section.

TESTING THE VR02 PUMP FOR SELF-PRIMING

② MODERATE

◆ See Figure 3

To properly test if the VR02 pump will self-prime you should start with a pump that is free of oil. If the pump was removed for service, this is no big deal, but if the pump remained installed it is best to empty the pump. The easiest way to accomplish this is to attach a pre-mixed source of fuel and run the motor without the oil line attached, refer to Checking the NO OIL Warning Circuit for more details.

1. If the oil line is empty, start with the hose disconnected from the VR02 pump. Use the primer bulb to fill the oil line (by holding the end of the line upward while gently squeezing the bulb until oil appears in the line itself.)
2. Connect the oil line to the VR02 pump, but do not squeeze the primer bulb after the line has been connected (or you will manually prime the pump).
3. With the outboard connected to a source of cooling water and the fuel line attached to a portable tank of 50:1 pre-mix fuel/oil, start and run the engine at 1500 rpm until the NO OIL warning LED goes out. If the LED remains illuminated, the pump is not self-priming properly.

TESTING THE VR02 FUEL/OIL PUMP CIRCUITS

OEM ③ DIFFICULT

If trouble is suspected with the fuel or oil circuits of the VR02 system functional tests can be conducted to check fuel pump or oil pump delivery.

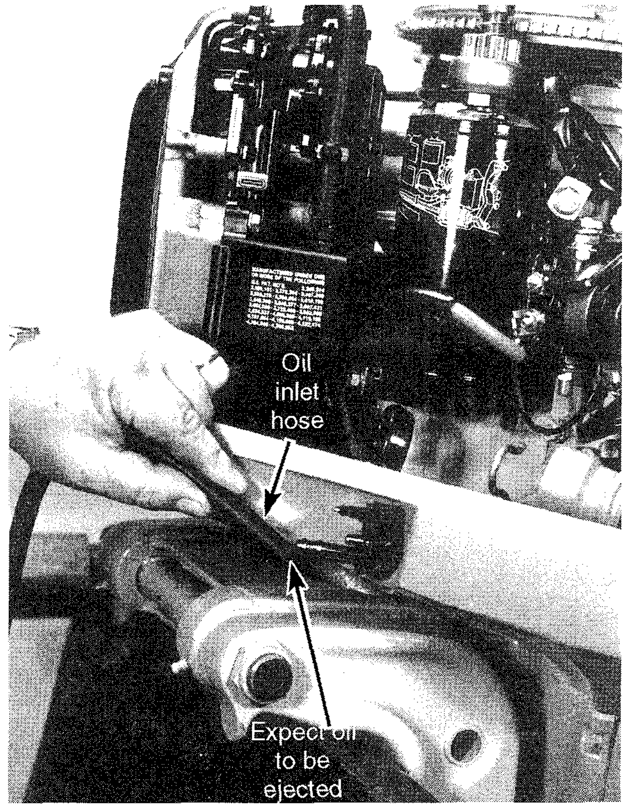


Fig. 3 One method of checking the NO OIL warning circuit is to disconnect the oil line from the motor and attach a tank of pre-mixed **fuel/oil,** then start and run the engine

Checking VR02 Fuel Pump Delivery

◆ See Figures 4,5 and 6

**** WARNING**

Use EXTREME care when working with fuel or flammable solvents. Refer to the cautions under General Information and under the Fuel System sections.

Because this test involves running the engine at speed and under load it must be conducted in a test tank with a suitable test wheel or on the boat (attached to a dock or using an assistant to navigate). You will also need a vacuum gauge, a T-fitting and various lengths of clear vinyl hose between 8-25 in. (20-630cm). Depending on test results, you might also need a fuel pressure gauge capable of reading 0-15 psi (0-103 kPa).

1. With the engine either mounted on a launched craft or in a test tank, start and run the engine at idle until it reaches normal operating temperature, then stop the engine.

**** WARNING**

When removing fuel hoses from fittings, always PUSH (never pull) on the hose itself to prevent the possibility of damaging the fitting. If pushing won't do it, use a small utility knife to carefully cut a slit in the end of the hose and peel it free of the fitting (the hose will then have to be trimmed or **replaced upon reconnection).**

2. Carefully install the vacuum gauge using the vinyl hose and T-fitting between the fuel inlet fitting on the lower engine cover and the fuel pump. The clear vinyl hose should run from the T-fitting to the fuel pump. Use wire-ties to secure the hoses on the fittings.

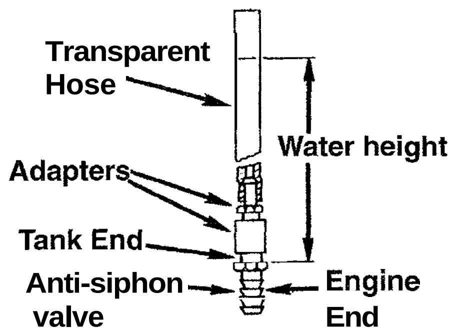


Fig. 4 Check the anti-siphon valve using a length of clear vinyl hose and water

✳✳ WARNING

To prevent damage to the vacuum gauge the primer bulb and the manual or electric fuel primer should not be used once the gauge is installed.

3. Start the engine and run at Wide-Open Throttle (WOT) for at least 2 minutes. During this time, keep a close eye on the clear vinyl hose. There should be no signs of air or vapor bubbles. Also, monitor the reading on the vacuum gauge-it should not exceed 4 in. Hg. (13.5 kPa) at any point. Based on your observations of the hose and of the gauge readings proceed as follows:

4. If the gauge read more than 4 in. Hg. (13.5 kPa), check the fuel delivery system for restrictions. For more details, refer to information on fuel lines and fittings found under the Fuel Sýstem section. If vou suspect the anti-siphon valve check it as follows:

a. Remove the anti-siphon valve from the fuel tank.

b. Connect a clear vinyl hose at least 25 in. (630mm) in length to the tank side of the valve using an adapter.

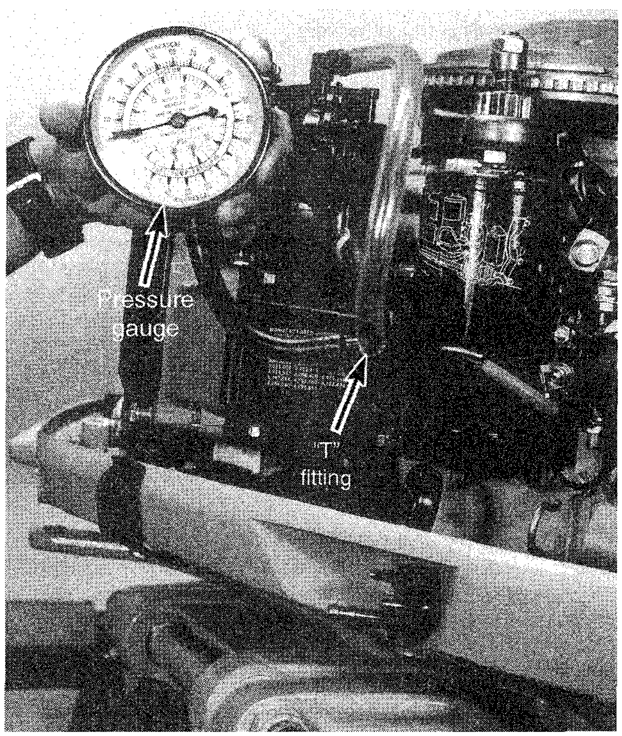


Fig. **5** VR02 fuel pump pressure is checked using a gauge between the pump and carburetors

c. Fill the clear hose with water until the height of water in the hose/valve (measured to the tank side flange of the anti-siphon valve) is 20 in. (500mm). No water should run through the valve.

d. Continue to slowly add water until the measured height of the water in the hoselvalve is 25 in. (630mm). Water must begin to run through the valve before the height reaches 25 in. (630mm) or the valve must be replaced.

5. If the gauge read less than 4 in. Hg (13.5 kPa) and air bubbles were present in the clear hose, check the entire fuel supply system for air leaks. For more details, refer to information on fuel lines and fittings found under the Fuel System section. Repair or replace any leaking hoses, fittings or connections.

☐ An air leak into a fuel supply line does not always create a visible fuel leak until the engine is turned off and the fuel system is pressurized (as it is naturally warmed say, in the heat of the afternoon sun).

6. If the gauge read less than 4 in. Hg (13.5 kPa) and no air bubbles were present in the clear hose, move the vinyl hose to the outlet side of the inline fuel filter. Start and run the engine again at WOT, watching for bubbles at this point in the hose as proceed as follows based on the results:

- If bubbles appear, test or replace the inline filter.
- If still no bubbles appear, remove the clear hose and install a 0-15 psi (0-103 kPa) fuel pressure gauge between the pump and the carburetors. Start and run the engine at 800 rpm in gear. Once fuel pressure stabilizes the gauge must not indicate less than 3 psi (21 kPa) when held level with the VRO fuel outlet fitting. If the pressure is less than 3 psi (21 kPa), service and check the Pulse Limiter as detailed in this section. If the pulse hose and pulse limiter are in good shape, refer to the accompanying VRO Pump Troubleshooting Chart.

CHECKING VR02 OIL PUMP DELIVERY

OEM ② MODERATE

◆ See **Figure 7**

If a functional check of the pump is desired or, if warning circuits check ok, but trouble is still suspected a pump out check must be performed to prevent the possibility of SEVERE damage to the powerhead if the oil circuit of the pump is not functioning properly. In order to perform this test you will need a 10 in. (25cm) long piece of 1/4 in. (6.35mm) inner diameter (ID) clear vinyl tube. Starting several inches from the open end use a permanent marker to make gradations on the line every 112 in. (12.7mm) for a total length of 4 in. (101.6cm). These gradations will be used to monitor the amount of oil drawn into the pump during the functional test.

☐ Since the engine is run, but NOT at Wide Open Throttle **(WOT),** for the VR02 oil pump delivery check this test CAN be performed using a flush fitting or any other suitable source of cooling water.

1. Hook up a supply of cooling water to the engine, then start and run the engine until it reaches normal operating temperature.

✳✳ WARNING

When removing fuel or oil hoses from fittings, always PUSH (never pull) on the hose itself to prevent the possibility of damaging the fitting. If pushing won't do it, use a small utility knife to carefully cut a slit in the end of the hose and peel it free of the fitting (the hose will then have to be trimmed or replaced **upon** reconnection).

2. Shut the engine OFF, then carefully push the oil supply hose from the pump fitting.

The oil supply hose attaches to the downward facing fitting at the rear of the oil pump. It is easy to identify by following the oil supply hose from the engine connector (through the oil sight tube) to the **pump. The** hose that connects just in front of the oil supply line is the fuel supply line, it is identified by the presence of an **inline** fuel filter.

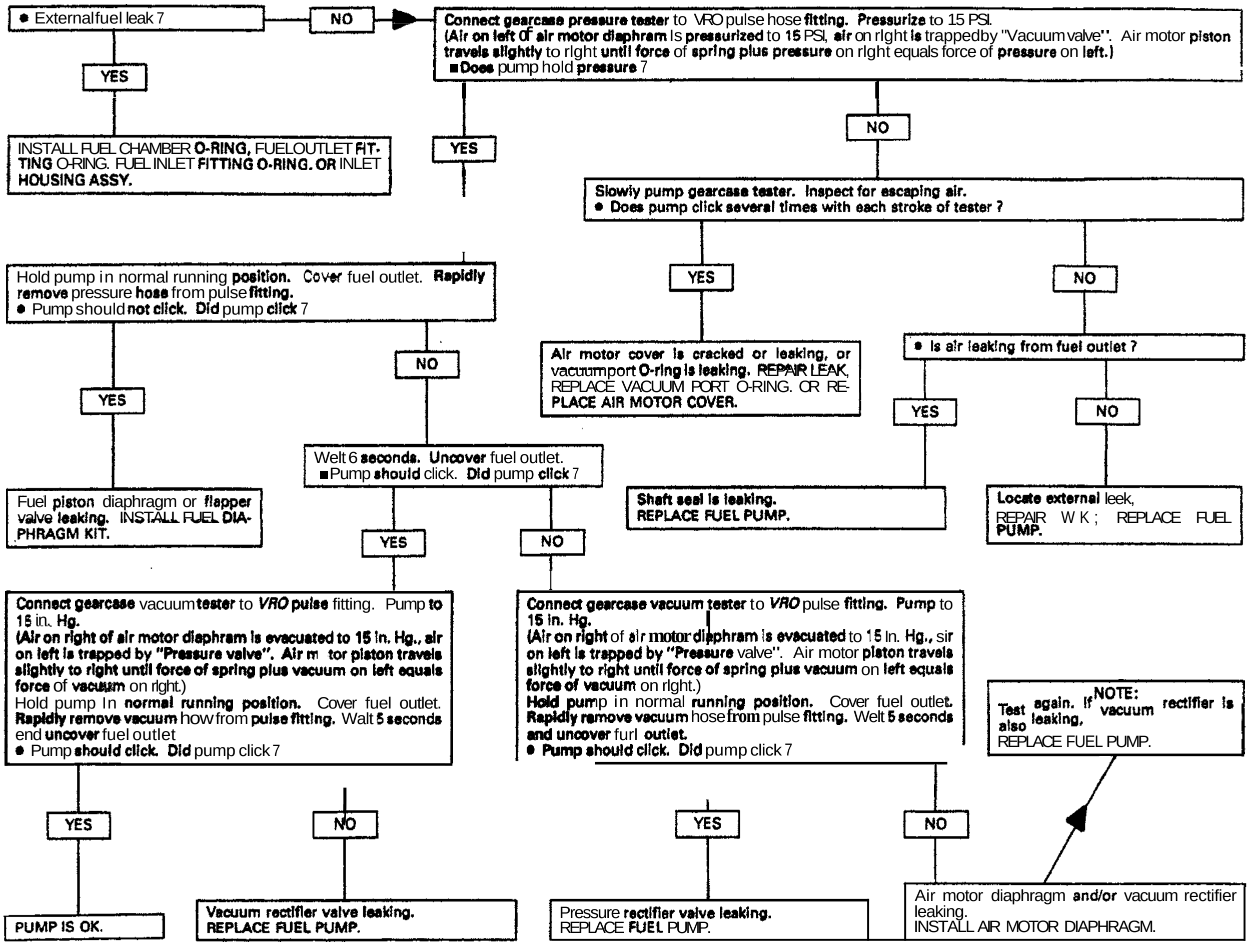


Fig. 6 VR02 pump troubleshooting chart

3. Install the 10 in. (25cm) clear vinyl hose (with the gradations) to the oil supply fitting on the pump. Fill the hose with Evinrude or Johnson 2-Stroke Outboard Engine Oil, then start and run the engine to eliminate any air trapped in the line or the base of the pump. Shut the engine off and add additional oil to the hose until it is even with or above the topmost gradation in the hose.

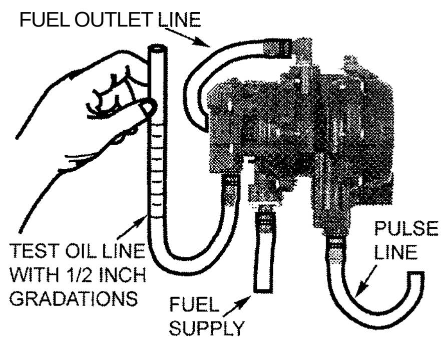


Fig. 7 VR02 oil pump delivery is checked by counting the number of fuel pulses it takes to consume a specific amount of oil

Although the illustration shows a hand holding the marked oil supply hose, this test will be much more pleasant if you secure the hose in an upright position using a coat hanger or length of mechanic's wire.

4. Start and run the engine at about 1500 rpm while monitoring the pump cycles. Although a fuel pressure gauge can be used to monitor fuel outlet pulses, light finger pressure on the outlet hose will accomplish the same result. Count the total number of pulses necessary for the oil level to drop 3 in. (76mm) within the hose. It must take 6-8 pulses for the oil level to drop 3 in. (76mm) inside a 1/4 in. (6.35mm) inner diameter (ID) hose. If results are different, remove and service the pulse limiter and recheck before overhauling or replacing the pump.

5. Once tests or repairs are completed, reconnect the oil supply line to the pump making sure there is an air tight seal. Replace the oil supply line metal spring clamp if it has become weak, damaged or deformed.

✻✻ CAUTION

Keep in mind that an air leak in the oil supply line could allow the pump to loose prime and stop delivering oil to the motor. Although the warning circuit should alert the operator to this condition, a leak could allow the motor to be operated with borderline oil pressure for sometime before it drops below safety spec. Don't take the risk, make sure the oil supply line a sealed and check the fittings visually after each outing.

VRO2 Pickup and Oil Supply Hose

SERVICING

OEM ② MODERATE

◆ See Figures 2,8 and 9

If the oil supply line is suspect of restrictions it should be removed and inspected/cleaned in 2 areas, the oil prckup and the oil supply line

1 Remove the oil pickup assembly and checked for a clogged or contaminated filter as follows

a Loosen the Torx®head retaining screws using a suitable driver, then carefully lift the oil plckup assembly from the tank

b Carefully separate the plckup filter from the pickup assembly, then flush the filter using a mild solvent or some fresh fuel

✳✳ WAI

Use EXTREME care when working with fuel or flammable solvents. Refer to the cautions under General **Information** and under the Fuel System sections.

c. Install the filter back onto the plckup assembly, taking care not to move the pickup assembly on its support rods (as the pickup assembly is specifically adjusted to tank height).

It is not necessary for the pickup assembly to be removed for the tank when checking the oil inlet line for restrictions. However, if both are being tested at the same time, it is best to leave the pickup out until it has been determined what repairs (if any) are necessary.

2. With the pickup assembly removed from the tank, perform a vacuum test on the system to check for air leaks as follows:

When removing fuel or oil hoses from fittings, always PUSH (never pull) on the hose itself to prevent the possibility of damaging the fitting. If pushing won't do it, use a small **utility** knife to carefully cut a slit **in** the end **of the** hose and peel it free of the fitting (the **hose** will then have to be trimmed or replaced upon reconnection).

a. Carefully disconnect the oil hose from the pickup assembly and from the oil inlet fitting on the outboard.

b. Use low-pressure air from a compressor (or your lungs) to purge the hose of oil

c. Carefully plug the pickup end of the hose (Evinrude/Johnson part # 329661 is available for this purpose).

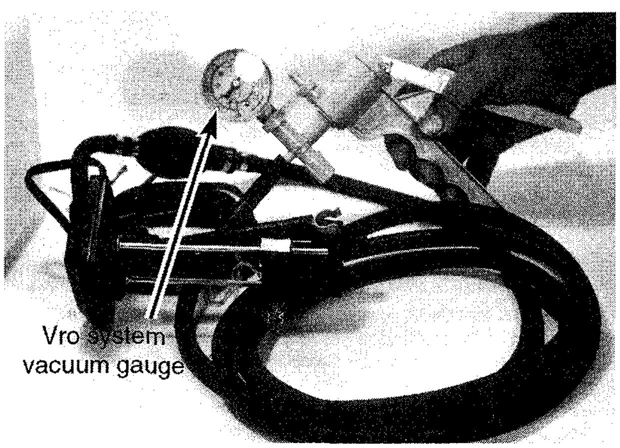


Fig. **8** An oil supply hose is checked by plugging one end of the hose and applying vacuum to the other

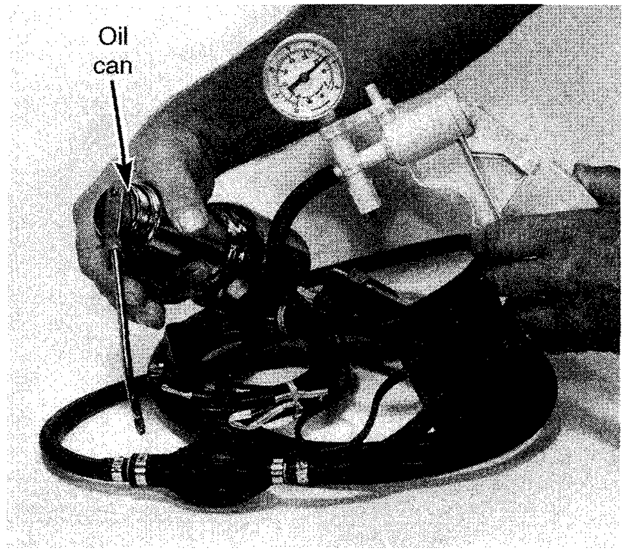


Fig. 9 If leaks are present, locate them by applying a small amount of engine oil. When oil is applied to a leaking fitting, the oil will temporarily seal the leak

d. Connect a hand-held vacuum pump tester to the outboard fitting end of the oil supply line, then apply 7 in. Hg (23.6 kPa) of vacuum to the line. Watch the gauge and make sure that the vacuum holds for at least 5 minutes. If it does not, make sure vacuum is not leaking at the plugged end of the hose otherwise, locate and repair the leak or replace the oil inlet line.

An easy way to locate vacuum leaks is by applying a small amount of clean engine oil to the hose at each of the fittings while watching the gauge. When oil is applied to a leaking fitting, the oil will temporarily seal the leak and stop the gauge from moving.

3. Once service has been completed, reconnect the oil lines and secure using clamps.

4. Check the total height of the prckup assembly to make sure it was not disturbed during service The height from the bottom of the pickup flange to the end of the plckup tube should be 6 84-6.96 In. (174-177mm) for 1.8 gallon tanks or 8.74-8 86 in (222-225mm) for 3.0 gallon tanks. If necessary, the plckup can be adjusted by sliding it on the support rods.

VRO2 Pulse Limiter

SERVICING

① EASY

If fuel pump pressure is less than 3 psi (21 **kPa)** when checked using a pressure gauge **inline** between the VR02 pump assembly and the carburetors with the engine running at **800** rpm, service and check the pulse limiter to make sure there are no clogs or restrictions.

An inline pulse limiting check valve is installed between the motor and the VR02 pump. It is designed to allow normal pressure/vacuum pulses from the engine to the pump, but to close in the event of a backfire, protecting the pump from damage. The check valve must be clean and free of clogs to work properly and ensure the engine receives a proper supply of fuel and oil.

1. Remove the pulse limiter from the crankcase and/or the pulse hose(s).

2. Visually check inside the limiter for signs of excessive carbon deposits.

3. If necessary use Evinrude/Johnson Carburetor and Choke Cleaner to backflush the valve, removing carbon deposits. The valve must be replaced if it cannot be cleaned sufficiently.

If excessive carbon deposits are found, check the outboard for possible causes of excessive backfiring such as:

- Incorrect linkage adjustments
- Incorrect engine operating temperatures
- Crankcase air leaks
- Carburetor problems
- Extended use of the flushing attachment
- Internal damage

4. On models equipped with a threaded pulse limiter, clean the threads and coat them using Evinrude/Johnson Pipe Sealant with Teflon (or an equivalent threadsealant). Install the pulse limiter, then connect the pulse hose and secure using the clamp.

5. On models equipped with an inline pulse limiter, install the limiter with the metal end facing toward the powerhead hose. Secure both hoses using clamps.

VRO2 Pump Assembly (Fuel and Oil Pump)

REMOVAL & INSTALLATION

② MODERATE

◆ See Figures **10** and **11**

1. Disconnect the negative battery cable for safety,

✳✳ WARNING

When removing fuel or oil hoses from fittings, always PUSH (never pull) on the hose itself to prevent the possibility of damaging the fitting. If pushing won't do it, use a small utility knife to carefully cut a slit in the end of the hose and peel it free of the fitting (the hose will then have to be trimmed or replaced upon **reconnection).**

2. Tag and disconnect the lines from the VR02 pump assembly as follows:
   a. Normally the fuel outlet line (attached to the top of the pump assembly) is secured using a plastic tie. The tie must be cut and then the line can be carefully pushed off the pump fitting.
   b. The pulse line from the powerhead is secured to the bottom of the pump assembly, at the front of the housing, it is normally secured by a metallic spring-type clamp. Use a pair of pliers to carefully compress the clamp tangs and slide it back over the hose, then push the hose from the pump fitting.
   c. The fuel inlet line is secured to the bottom, center of the pump assembly. It is usually secured by a spring-type metallic clamp and is removed in the same manner as the pulse hose.
   d. The oil inlet line is secured to the bottom, rear of the pump assembly. It is usually secured by a spring-type metallic clamp and is removed in the same manner as the pulse and fuel supply hoses.
3. Remove the pump wiring connector from the retainer and then disengage the connector from the wiring harness.
4. Loosen the pump-to-manifoldbracket screws (normally 3). They are located on the back side of the bracket, facing the opposite direction from the Torx® head cover screws located around the perimeter of the pump cover.
5. Carefully remove the pump from the manifold bracket.
6. If the pump is to be overhauled, disassemble it as detailed in this section.

To install:

7. If the pump was overhauled, assemble it as follows:
8. Position the pump to the manifold bracket and install the retaining screws. Tighten the screws to 18-24 inch lbs. (2-3 Nm).
9. Engage the pump connector to the wiring harness, then position the connector into the wire loom retainer.
10. Connect the hoses to the pump assembly as tagged during removal (pump-to-carburetorline at the top, pulse line on bottom furthest from wiring and the fuel supply line bottom center). DO NOT connect the oil supply line at this time. Secure each of the hoses either using plastic ties or metallic spring-type clamps, whichever was used prior to removal. Check each of the metallic spring-type clamps to make sure they have not lost their spring tension and replace if damaged, worn or weak.

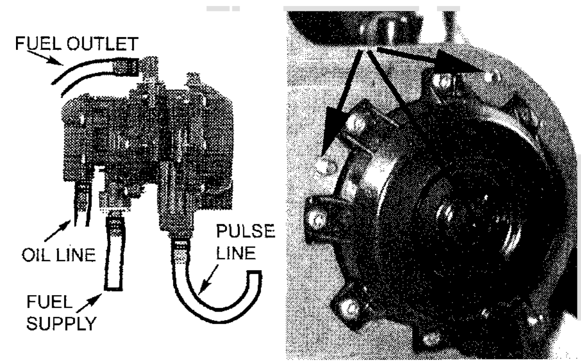


Fig. **10** VR02 pump hose connections (left) and mounting bolts (right). Note that the bolts are threaded from the other side

■ The oil supply line should be left disconnected until the oil pump delivery has been confirmed by following the procedure in this section for Checking VR02 Oil Pump Delivery.

11. Connect the negative battery cable, then verify proper pump operation using the procedure in this section for Checking VR02 Oil Pump Delivery.

OVERHAUL

③ DIFFICULT

◆ See Figures **12** thru **26**

For the various housing screws on most VR02 pumps you will need **Torx® T-10** and T-15 drivers or bits.

1. Remove the VR02 pump assembly from the powerhead as detailed in this section.
2. Place the pump assembly on a clean worksurface with the inlet housing assembly (the end of the pump with the wiring) facing downward and the air motor cover facing upward.

✳✳ CAUTION

There is a compressed spring mounted under the air motor cover, be sure to hold the cover downward when removing the covers screws to prevent injury or damage.

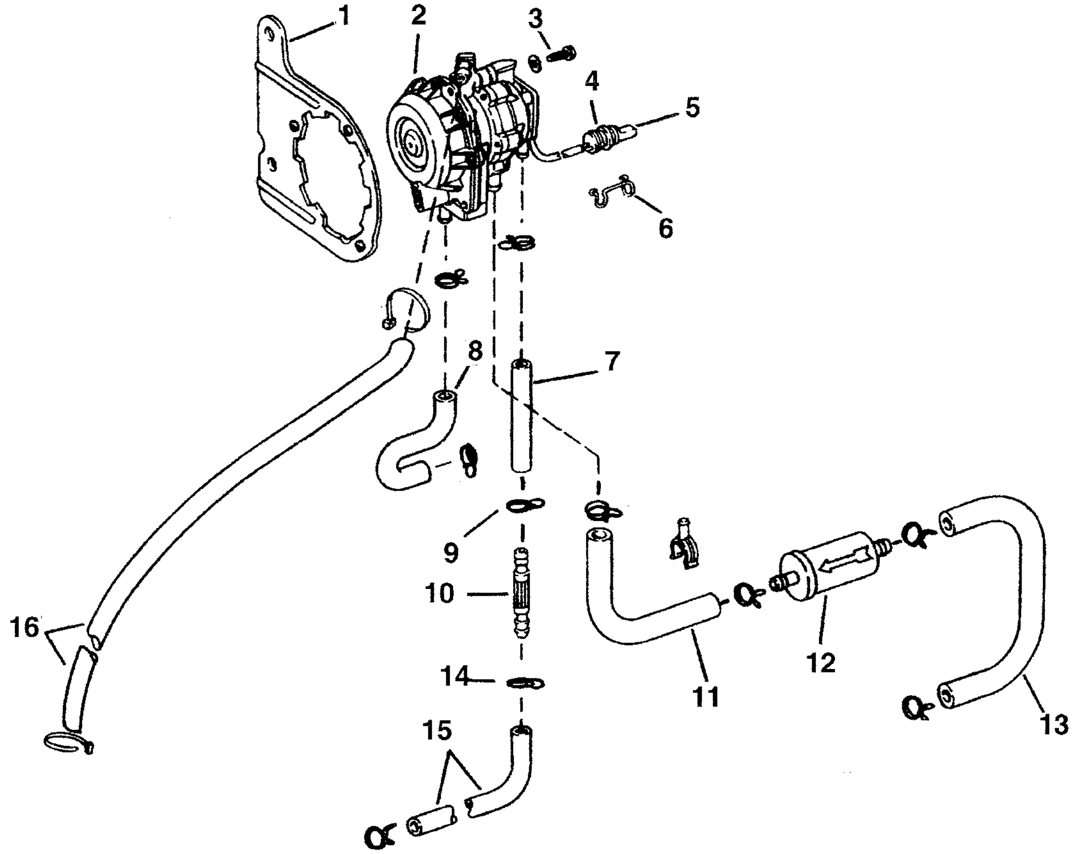
3. While holding the air motor cover downward against spring pressure loosen and remove the Torx® head screws securing the cover to the intermediate housing. Once the screws are removed, slowly lift the cover from the housing, releasing spring pressure as it is removed.

As with all overhaul procedures, lay out each component on the worksurface in the order and facing the same direction as it was removed.

4. Place the cover, screws, vacuum passage O-ring and 2 springs aside.
5. Invert the p u p assembly for ac ss to the fuel inlet housing sc e Remove th Torx® head screws securing the fuel inlet housing to the intermediate housing.
6. Lift the fuel inlet housing straight up and off the intermediate housing. The oil piston should remain behind, so pulling the housing upward with withdraw it from the pump.
7. Carefully disconnect the oil piston and link from the fuel piston, then position the components aside.

✳✳ WARNING

Handle the oil piston with great care to keep from denting the piston seal.



1 - Bracket, Fuel pump to manifold
2 - Fuel pump Assy
3 - Screw, fuel pump to mount
4 - Connector, 4 socket plug
5 - Terminal, socket
6 - Retainer, connector
7 - Hose assy, **oil supply**
8 - Pulse hose
9 - Clamp, connector
10- Sight tube, oil **(if equipped)**
11- Hose, filter to fuel pump
12 - Fuel filter assy
13 - Hose, fuel connector to filter
14 - Clamp, connector
15 - Hose, connector to sight tube
16 - Hose, **fuel/oil output mixture**

Fig. 11 Exploded view of a typical VR02 pump assembly mounting with hose connections

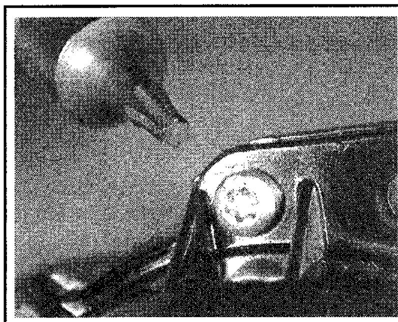


Fig. 12 You'll need a **T-10** or T-15 **Torx®** head driver to remove the housing cover screws

Fig. 13 Remove the air motor cover slowly, carefully releasing the spring pressure

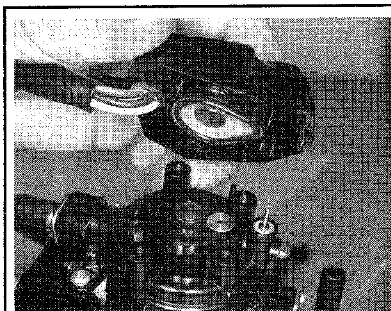


Fig. 14 Unless there are signs of **weepage,** there is usually no reason to remove the electronics module from the top of the inlet housing

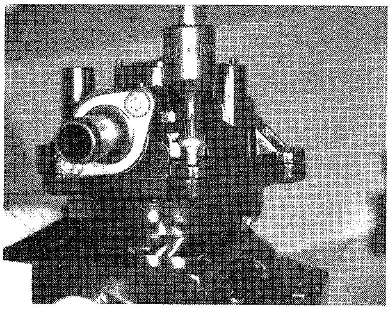


Fig. 15 Loosen **the Torx®** head screws securing the inlet housing to the intermediate housing...

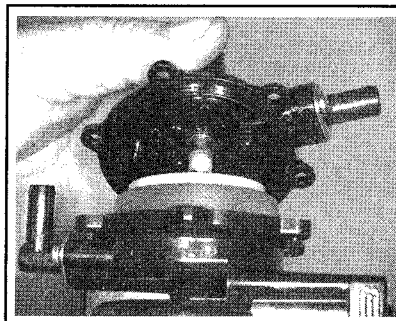


Fig. 16 ... then lift the inlet housing, carefully pulling the pump off the **oil piston**

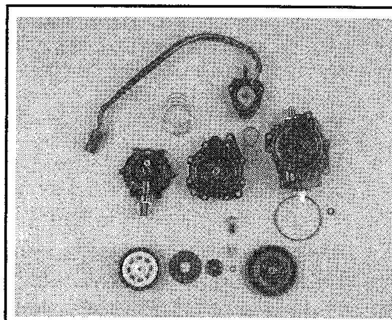
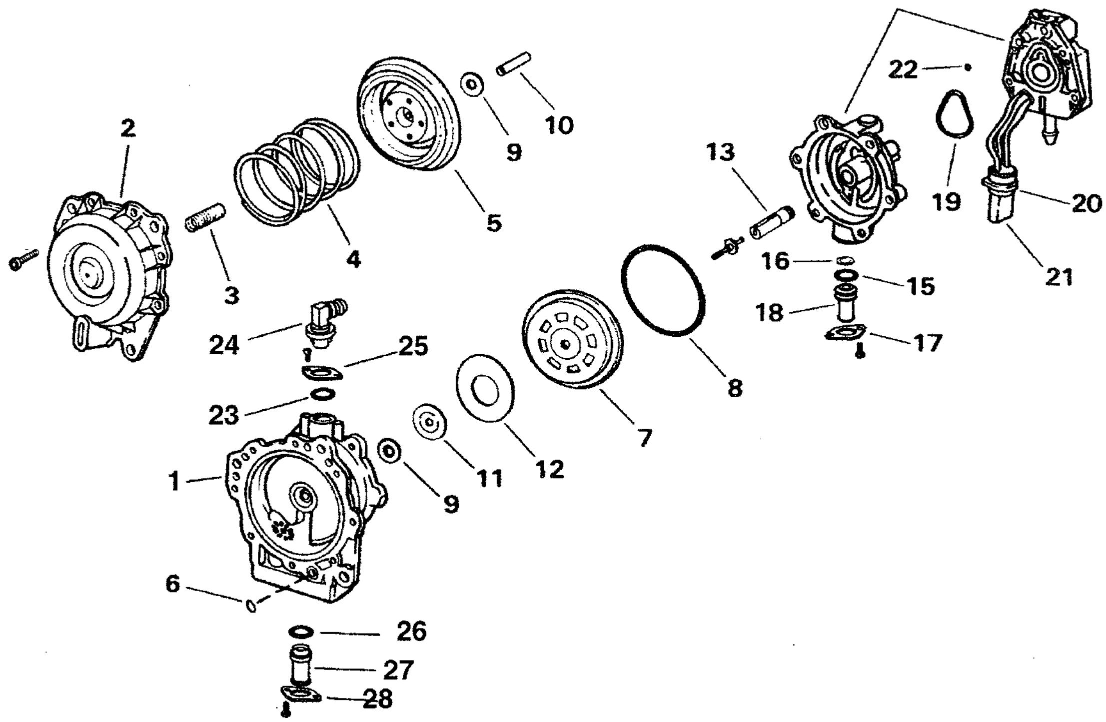


Fig. 17 Lay out each component on the worksurface in the order and facing the same direction as it was removed



1- Intermediate Housing
2- Motor housing cover
3- Spring, poppet
4- Spring, air motor
5- Diaphragm, air motor
6- 0-Ring, vacuum passage
7- Diaphragm, Fuel
8- Seal, fuel inlet housing
9- Washer, piston stem
10- Piston stem
11- Retainer, fuel valve
12- Valve, fuel
13- Piston & link, oil
14- inlet housing assy
15- Seal, fuel inlet
16 - Valve, fuel inlet
17 - Retainer, fuel inlet
18 - Nipple, fuel inlet
19 - Seal, Filter housing
20 - Connector
21 - Socket
22 - Seal, actuator shaft
23 - 0-Ring, fuel outlet
24 - Fitting, fuel outlet, V6
25 - Retainer, fuel outlet
26 - 0-Ring, pulse fitting
27 - Fitiing, pulse
28 - Retainer, pulse fitting

Fig. 18 Exploded view of the VR02 pump assembly

8. Hold the intermediate housing with the air motor piston down, then push the fuel piston down. Turn the air motor piston counterclockwise in order to loosen it, then spin the air motor piston off. The stem will unscrew from either the fuel or air motor piston.

9. Remove the fuel piston and air motor piston from the intermediate housing. Remove the fuel inlet housing O-ring.

10. Remove the stem from either piston. Set the air motor piston aside, then discard the stem and steel washers. Set the nylon valve retainer, flapper valve, fuel piston and stem screw aside.

**** WARNING**

DO NOT use **pliers** to remove a stem unless it is to be replaced.

An oil check valve and an oil filter that should not require cleaning or replacement are located under the oil-inleffelectronics module. There are no service parts available for these components.

The fuel inlet assembly, oil pulse lever and oil **inlet/electronics** module are a matched set and must not be mixed with components from another pump.

11. If replaceable fittings are to be removed, proceed as follows:

a. If removing a 90 degree fitting (such as the fuel outlet fitting on some models), matchmark or note the direction it faces before removal.

b. Remove the Torx® head screws securing the fitting retainer and fitting to the pump housing.

c. Carefully remove the retainer, fitting and O-ring from the housing. If removing the fuel inlet fitting, remove the valve located under the fitting as well,

To assemble:

d. If one or more of the replaceable fittings were removed, install them as follows:

e. If installing the fuel inlet fitting, position the fuel inlet valve with the hold over the alignment pin.

f. If installing the pulse or fuel inlet fittings, place a drop of clean 2-stroke engine oil on the thin O-rings to help ease installation.

g. Put the O-ring in position on the fitting. When installing the thin O-rings on the pulse or inlet fittings, they should be placed toward the end of the fitting.

h. Carefully push the fitting into the housing and twist slightly to seat it, then install the retainer.

☐ When thread-forming screws are reinstalled into a plastic component, first make sure the threads are clean and free of all oil. Next, position the screw against the threads and turn the screw backwards (counterclockwise) very slowly by hand until you can feel the screw fall down into the threads slightly, then turn the screw forward until it is finger-tight. Using this method the screw will find the old threads instead of cutting new ones, which might strip.

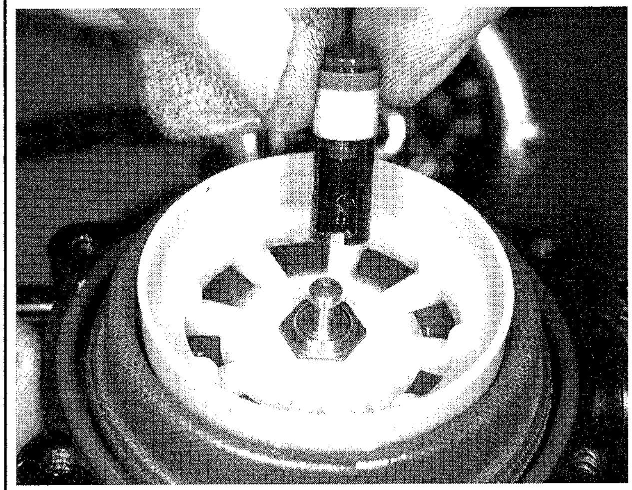


Fig. 19 Remove the oil piston and link from the fuel piston

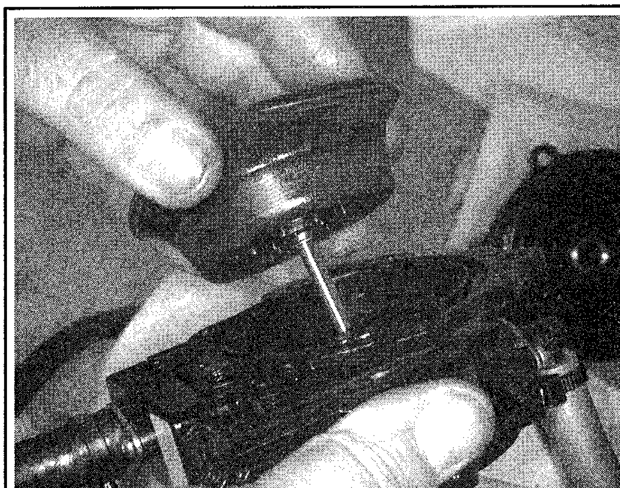


Fig. **20** Once the air motor and fuel **pistons/diaphragms** are compressed and unthreaded, carefully pull the air motor diaphragm (with the piston stem in this case) from the intermediate housing**...**

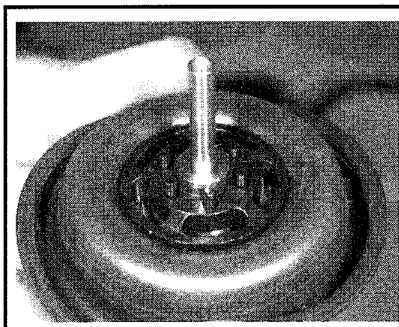


Fig. 21 **...** then inspect the air motor (shown) and fuel diaphragms for damage and replace, as necessary

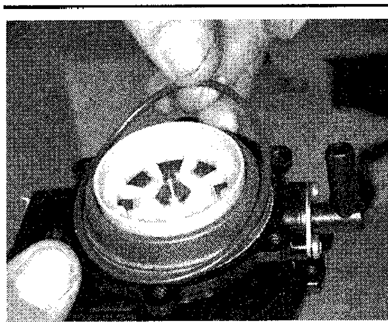


Fig. **22** During assembly, position O-rings carefully to keep them from getting pinched or cut

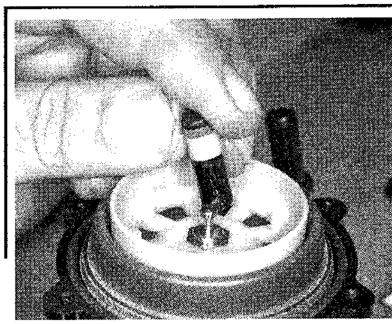


Fig. **23** Install the oil piston and link**...**

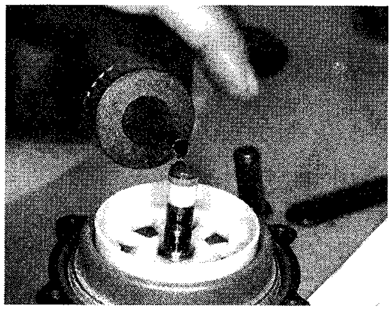


Fig. 24 ...then apply a drop of clean 2-stroke engine oil to the piston seal

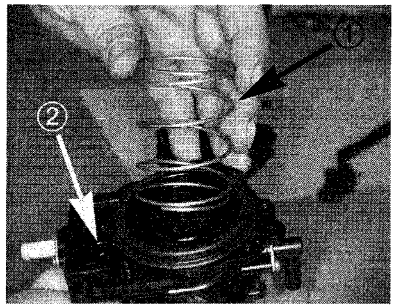


Fig. 25 Position the large spring (1) and the vacuum passage O-ring (2) to the intermediate housing...

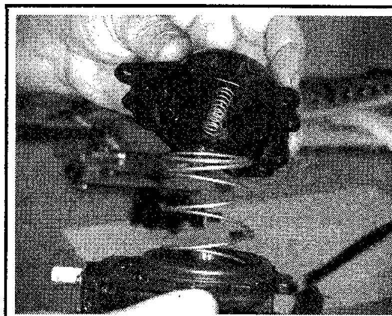


Fig. 26 ...then install the cover while carefully compressing the spring and making sure the passage O-ring does not dislodge

i. If a 90 degree fitting must be aligned directly over a retainer screw, apply a drop of oil to the fitting (where it enters the retainer) and position it just past the screw, then tighten the one retainer screw securely. Place a Phillips screwdriver in the end of the 90 degree fitting and carefully rotate it into alignment over, then tighten the other retaining screw.

j. Secure the retainers by tighten the Torx® head screws only until the retainer is bottomed on the housing. DO NOT overtighten the screws as they will strip easily.

Always use new washers and stem when assembling the air motor and fuel pistons. Install the stem by hand (never use pliers or damage will likely occur).

12. Working from the hex recess side, carefully insert the stem screw into the fuel piston. Place the flapper valve and valve retainer (with the recess facing outward) onto the screw. Place a new washer in the retainer recess, then thread the new stem onto the screw.

Make sure the hex head of the stem screw is in the hex recess and that the flapper valve and washer are centered on the piston, before finger-tightening the stem.

13. Apply a light coating of clean 2-stroke engine oil onto the stem, then insert the stem through the seal into the intermediate housing.

14. Place a new washer on the air motor piston screw. Hold the air motor piston under the intermediate housing with the poppet valve pushed fully upward.

■ The screw hex head will be held in the hex recess ONLY when the poppet valve is pushed fully upward.

15. Position the air motor piston screw upward against the stem (if necessary, the fuel piston can be pushed downward to extend the stem for better visibility). Hold the air motor screw up against the stem and turn the fuel piston a few revolutions to start the screw in the stem threads.

16. Push downward on the fuel piston while spinning the air motor piston onto the stem.

17. Very lightly tighten the 2 pistons against each other in order to tighten the stem on both screws.

□ Do not risk damaging either piston or the stem by over-tightening the assemblv. Besides, there is no need to over-tighten anything since, once the assembly is positioned between the **housings, they cannot** turn sufficiently to loosen again.

18. Snap the oil piston and link carefully onto the stem of the fuel piston screw, then place a drop of clean 2-stroke engine oil on the seal at the tip of the piston.

19. Place an O-ring seal in position around the fuel inlet housing flange, then lower the housing over the oil pump piston while inserting the piston into the oil pump bore.

20. Push the fuel inlet housing and O-ring down against the intermediate housing, rotating back-and-forth to seat the O-ring in the groove and align the flange screw holes. Then install and tighten the Torx® head screws using care not to damage the screws or housings.

■ When thread-forming screws are reinstalled into a plastic component, first make sure the threads are clean and free of all oil. Next, position the screw against the threads and turn the screw backwards (counterclockwise) very slowly by hand until you can feel the screw fall down into the threads slightly, then turn the screw forward until it is finger-tight. Using this method the screw will find the old threads instead of cutting new ones, which might strip.

21. Put a light coating of a marine grade grease on the vacuum port O-ring, then place the O-ring in its bore. Place the air motor spring on the piston.

22. Position the poppet spring in the air motor cover (over the center boss), then twist while gently pushing downward to wedge it in place.

23. Position the cover over the air motor piston spring, then push the cover straight downward, compressing the spring and guiding the poppet spring into the center of the piston.

24. Hold the cover in position and carefully start a couple of the cover screws. Verify that the vacuum port O-ring has remained in position, then install the remaining cover screws and gently tighten in a crisscross pattern.

25. Install the VR02 pump assembly to the powerhead, as detailed in this section.

26. Verify proper pump operation using the procedure in this section for Checking VR02 Oil Pump Delivery

FICHT OIL INJECTION SYSTEM (FFI MOTORS)

Unlike 4-stroke engines, which contain a reservoir of oil that is re-circulated during engine operation, 2-stroke engines are lubricated by mixing engine oil with the fuel. The internal engine components of 2-stroke motors are lubricated as this fuel/oil mixture passes through the crankcase and the cylinder.

Generally speaking, there are 2 methods of adding oil to a 2-stroke outboard. The first is to pre-mix oil with the gasoline whenever the fuel tank is filled. The pre-mix method is generally used on smaller (lower horsepower) motors and on most commercial outboards. It is easiest to perform this on portable fuel tanks that can be agitated to ensure proper mixture, but it can be successfully accomplished on larger built-in tanks, as long as care is taken to properly measure the amounts of fuel/oil being added.

For ease of service and to ensure a constant supply of 2-stroke oil on all fuel injected motors, lubrication is completely controlled by the oil injection circuits of the FICHT Fuel Injection (FFI) system.

Description and Operation

◆ **See Figures 27, 28 and 29**

All FFI motors are equipped with an Engine Management Module (EMM) controlled oil injection circuit. Components of the system include the boat mounted oil tank/reservoir, a diaphragm-displacement oil pump (similar in design and function to the fuel lift pump), an electronic oil injector and oil distribution manifold assembly, oil hoses and injection nozzles, a pressure regulator and a pressure switch. The 150-175 Hp (2589cc) models with fuel rails are also equipped with an oil filter and a pressure test point. All models NOT equipped with fuel rails do not utilize a filter or pressure test point (though pressure can be checked by threading a gauge into the pressure switch mounting point). However, models not equipped with fuel rails also utilize a check valve.

On all FFI motors, oil from the tank is supplied to the pump through a 114 in. (6.35mm) oil supply line. Oil is drawn through the line by the pump and forced downstream to the oil injector.

Functioning like a modern automotive fuel injector, the oil injector is a normally-closed EMM controlled solenoid valve. Whenever the EMM supplies ground to the circuit, the solenoid opens against internal spring pressure, allowing oil to flow out from the injector nozzle to the oil distribution manifold. The oil return hose circuit controls system pressure through function of the pressure regulator. The oil pump should supply a sufficient amount of oil so the regulator can maintain a constant pressure of 6-20 psi (41-138 kPa). The regulator vents excess oil back to the boat's oil tank.

The EMM monitors the oil injector circuit and can detect if an open should occur. In the event of an open injector circuit, the EMM will actuate the S.L.O.W. warning system and store a trouble code. It will also illuminate the **NO OIL** warning light.

Special operational modes are used by the EMM to protect the powerhead. During startup a priming mode occurs where the EMM will rapidly actuate the injector for approximately 20 seconds to purge air and fill the oil lines from the distribution manifold. This mode occurs on the first time the engine reaches 1500 rpm after startup for all models not equipped with fuel rails, but only on cold starts with engine temperatures below 104°F (40°C). For models equipped with fuel rails, this occurs on all starts (regardless of temperature) when the engine first reaches 2000 rpm.

A special powerhead break-in mode can be actuated using the FFI diagnostic software. During break-in, the EMM will operate the oil injection system as normal below 2000 rpm, but will automatically double system output above 2000 rpm up to a maximum ration of 50:1 for the first 5 hours of powerhead operation.

The FFI diagnostic software must be used to actuate the break-in mode whenever a powerhead is overhauled or replaced.

An oil pressure switch that receives a voltage signal from the EMM is mounted on top or side of the oil pump. The switch is normally closed, completing a circuit to ground, but opens during engine operation in response to oil pressure. Should pump pressure drop below 3-5 psi (20.7-34.5 kPa), the switch will close causing the EMM to store a trouble code, actuate the S.L.O.W. system and illuminate the **NO OIL** warning light.

The oil distribution manifold is used to supply oil to the various points of the system. The manifold contains various oil distribution lines, each equipped with some form of a check-valve to prevent oil drain-back when the injector is not actuated. The manifold utilizes one distribution outlet per cylinder and an additional outlet for the fuel supply system. On models equipped with hard fuel rails, the oiling hose for the fuel supply system connects to the vapor separator assembly. On models NOT equipped with fuel rails this oil line either connects to a T in the fuel supply line (located right before the lift pump), or to the lift pump itself (depending upon the model).

The individual cylinder oil supply lines connect to varying points, depending upon the model as follows:

The 75-175 Hp (1726/2859cc) V4/V6 motors (except models with fuel rails) contain cylinder sleeves with pressed in nipples. Each cylinder oil supply line from the distribution manifold connects directly to a cylinder nipple and is used to inject oil directly into the cylinder sleeves (thereby reducing pistonlcylinder wear).

■ The 150-175 Hp (2589cc) V6 motors (models with fuel rails) connect each cylinder oil distribution line to a metered orifice that discharges oil immediately behind the throttle plate for that cylinder.

The 200-250 Hp (3000/3300cc) V6 motors connect each cylinder oil distribution line to the crankcase air stream, immediately behind each of the reed valves.

The 75-175 Hp (1726/2859cc) V4/V6 motors (except models with fuel rails) are also equipped with an oil recirculation system to go along with the cylinder sleeve oil injection. On these motors, oil circulates from the low crankshaft bearing cavity to the upper cavity by means of a hose. A second hose connects the upper bearing cavity to the starboard intake manifold. When the engine is running, vacuum is used to pull oil from the lower bearing to the upper and then on to the intake manifold where it can be consumed. A check-valve is positioned in the hose connecting the 2 cavities to prevent drain-back whenever the engine is stopped. Additionally, the powerhead contains oil drain passages that connect the cylinders from top to bottom on each side of the cylinder block. In this way residual oil will move from the highest to the lowest cylinder during engine operation. A hose connects to a nipple at the lowest cylinder and passes oil through a check valve, back to the top cylinder. A separate system for this is utilizes on both sides of the engine block.

FFI Oiling System Troubleshooting

◆ **See Figures 27, 28 and 29**

Like the ignition system on these motors, the oil system is an integral of the FICHT Fuel Injection (FFI) system, overall system test procedures are provided here under Checking the FFI Oiling System. If overall system testing leads you to component diagnosis (such as the oil injector, check valve or pressure switch testing) refer to the Oil System Component Testing procedures, as also in this section.

Be sure to check for any trouble codes before starting these test procedures. If possible, make repairs and clear all codes before proceeding.

OEM

CHECKING THE FFI OILING SYSTEM

3 DIFFICULT

◆ **See Figures 27, 28 and 29**

Unless otherwise instructed by a trouble code, symptom chart or other test, follow each of the test procedures in the order provided to ensure a complete verification of the oil injection system.

If over or under-oiling still occurs after the conclusion of these tests, perform the Pressure Testing the Oil Injector check found in the Oil System Component Testing procedures.

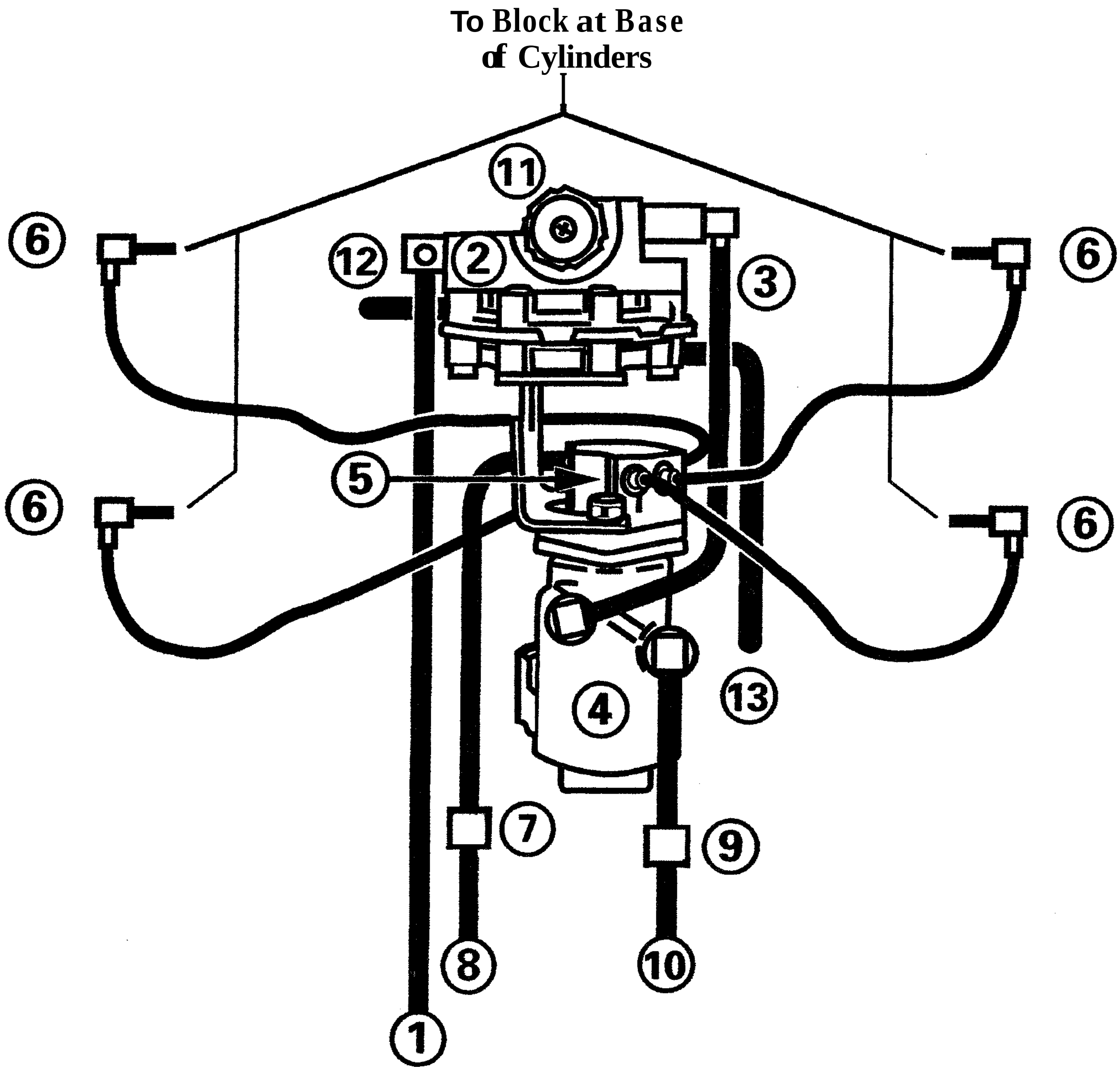
These tests are meant to help determine the cause of a **NO OIL** warning signal. If a **LOW OIL** light is illuminated, start by checking and filling the oil tank (or looking for problems with the sending unit).

Static System Verification

◆ **See Figures 30 and 31**

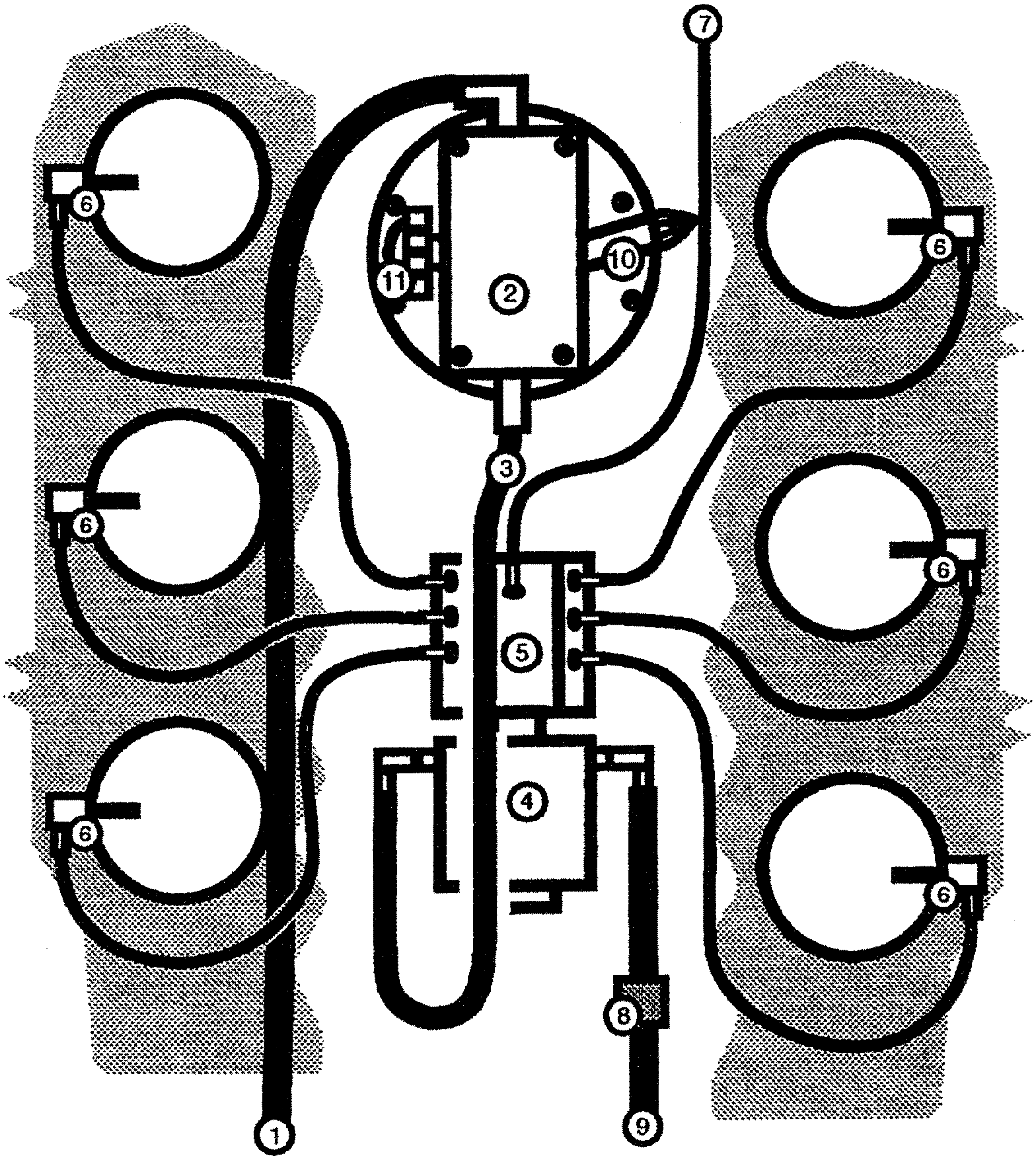
The Static System Verification test involves telling the EMM to actuate the oil injector while the engine is not running. Problem is, the only way to do that is by using the FFI Diagnostic Software. If this is not available, you won't be able to perform this test.

On 200 hp and larger motors, you may have to remove the starter and fuel filter assembly. But, since you may need to run or crank the engine to purge air from the distribution lines, check them first (refer to Step 1).



1. Oil Supply from Tank to Oil Pump Hose
2. Pulse Driven Oil Pump
3. Oil Pump to Oil Injector Hose
4. Oil Injector
5. Oil Distribution Manifold
6. Oil Inlet Nipples
7. Oil to Fuel Lift Pump Check Valve
8. Oil to Fuel Lift Pump Hose
9. Oil Pressure Regulator
10. Oil Return to Tank Hose
11. Oil Pressure Switch
12. Pulse Hose from No. 1 Cylinder
13. Pulse Hose from No. 3 Cylinder

Fig. 27 FFI oil system-75-175 Hp (1726/2859cc) V4/V6 motors (except models with fuel rails). NOTE: V4 shown, V6 similar, with additional distribution lines/oil inlet nipples



1 Oil Supply Hose
2 Oil Pump
3 Pump-To-Injector Hose
4 Oil Injector
5 Oil Distribution Manifold
6 Metered Orfices/Nozzles
7 Vapor Separator
8 Pressure Regulator
9 Oil Return Hose
10 Pressure Test Port
11 Pressure Switch

Fig. 28 FFI oil system-150-175 Hp (2589cc) V6 motors (models with fuel rails)

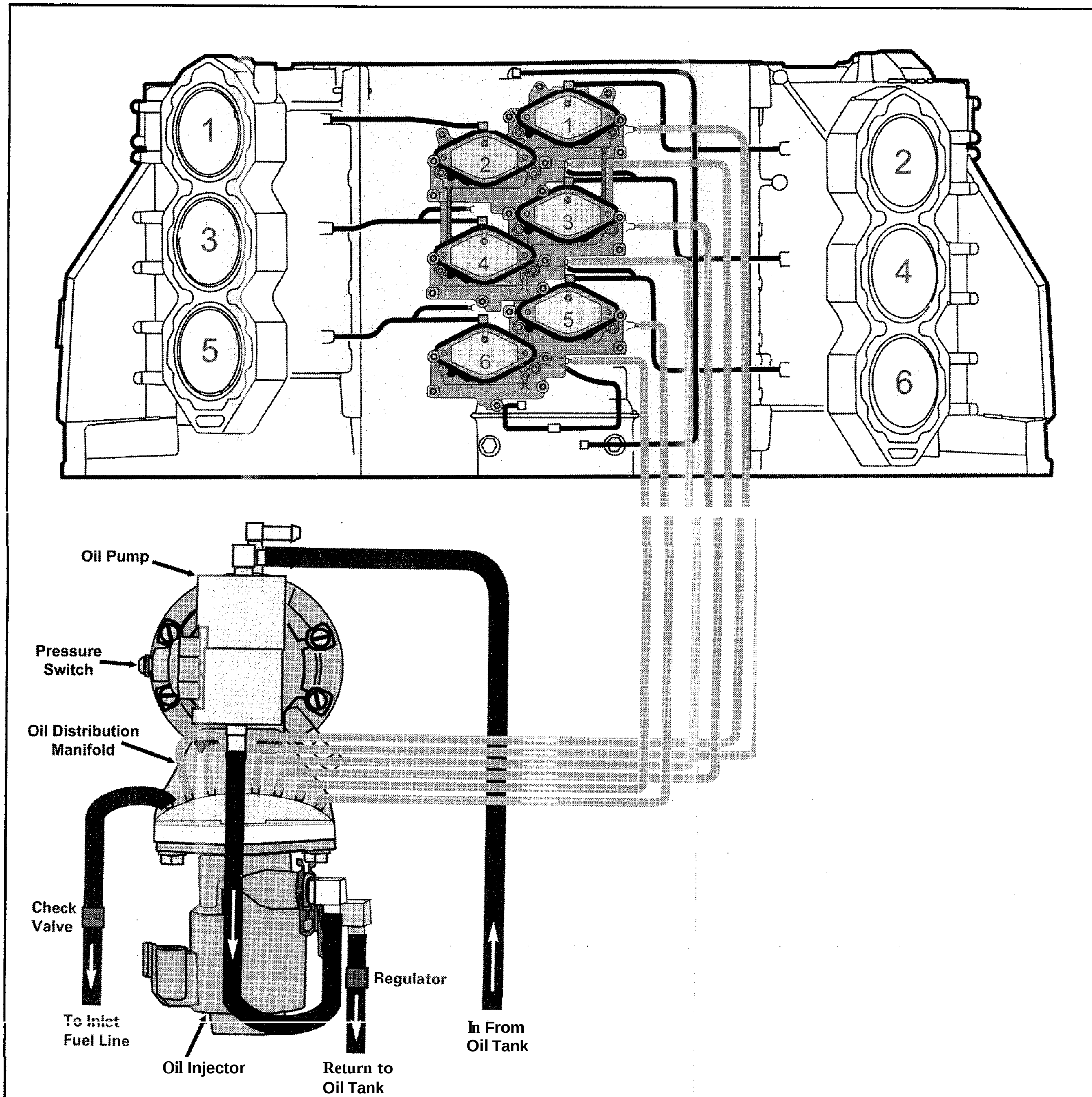


Fig. 29 FFI oil system-200-250 Hp **(3000/3300cc) V6** motors

1. Verify that the oil distribution hoses (from the manifold to the cylinders and fuel supply) are purged of air. Most hoses used on these models are clear and you should be able to see bubbles. If in doubt (or if air must be purged), crank (or run) the engine while restricting (squeezing or kinking) the oil return line. Continue until oil is present at the injector nozzles.
2. If necessarv for access on 200 hp and laraer motors, remove the starter and fuel filter assembly.

■ If you cannot tell is oil is flowing in the next step, tag and disconnect the oil distribution hoses at the powerhead.

3. Using the FFI Diagnostic Software, initiate the Oil Injector Test, while manually pumping the oil system primer bulb (to keep the system supplied with oil in absence of oil pump operation). The oil injector should click (when activated by the EMM) and a small amount of oil should discharge from each injector hose/nozzle. Proceed as follows, depending upon the results:

If the oil injector does NOT click, proceed with the Voltage Tests, in this section.

If the injector DOES click, but there is no oil output, proceed with the Oil Flow Verification procedure in this section.

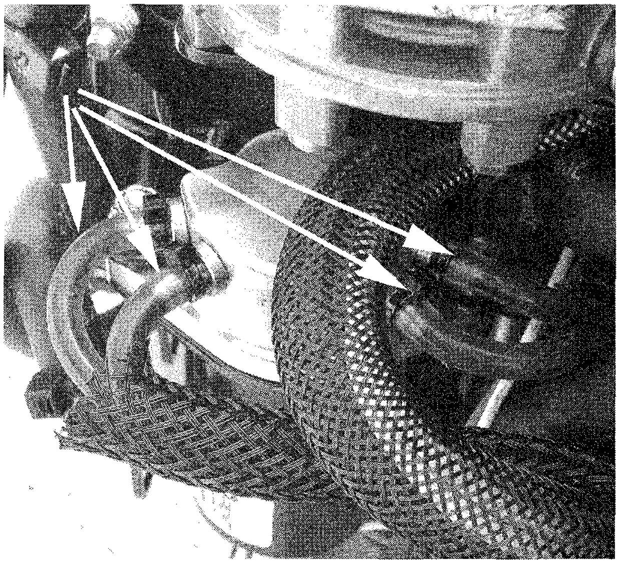


Fig. 30 Although the oil distribution lines are normally clear...

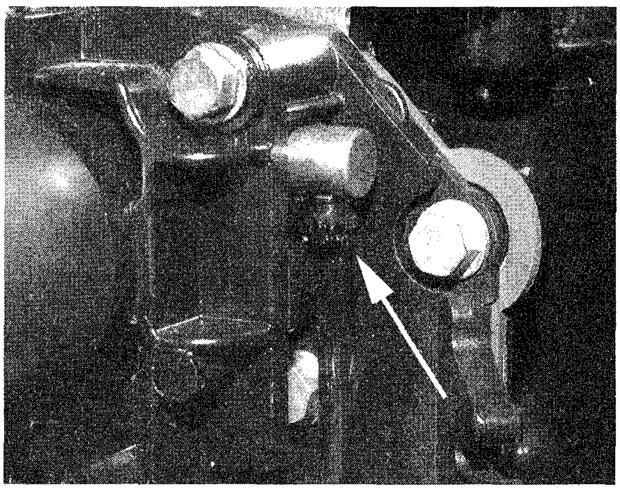


Fig. 31 ...you'll usually have to remove them from the injection nozzles to tell if oil is flowing

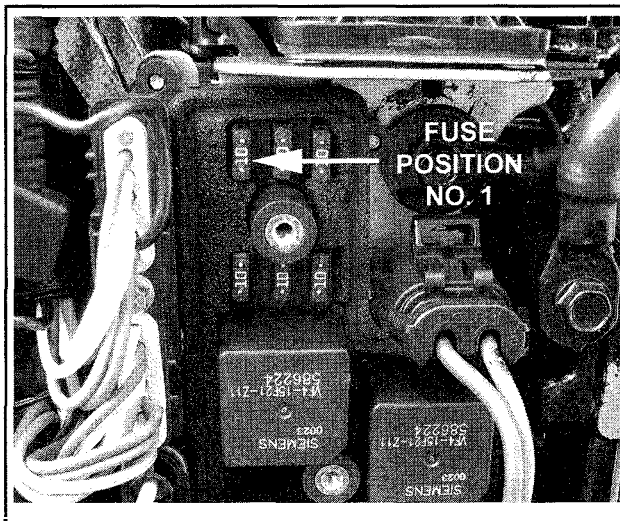


Fig. 32 First check for voltage at the fuse in the power distribution box (fuse box) position No. 1

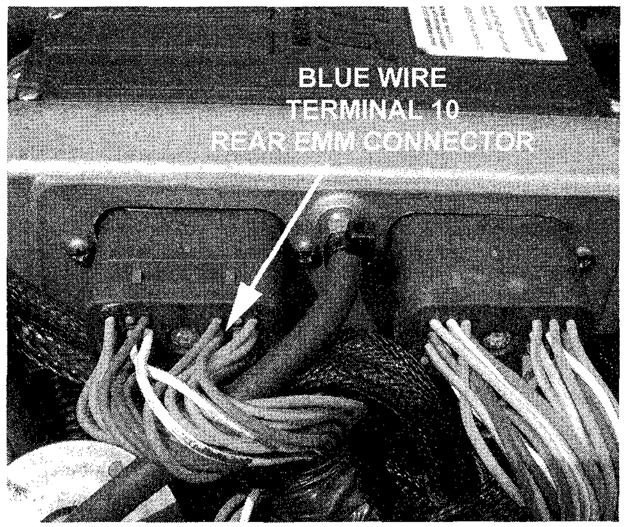


Fig. 33 Next, on models without hard fuel rails, check for voltage at the oil injector wire in the rear EMM connector, terminal 10 (blue wire)

- If there is oil output, but ONLY on some nozzles, note the problem hoses and proceed with the NozzlelManifold Test in this section.'
- If oil output seems good, verify that there is no blockage in the injector nipples, then proceed with the Oil Supply Verification test, in this section.

Voltage Tests

◆ **See Figures 32 and 33**

1 Check the fuse in position No 1 of the power distribution block (fuse box).

2 Check the injector wiring as follows, depending upon the model:

- Except for models equipped with fuel rails, use a DVOM with a test probe (such as Evinrude/Johnson probe No 342677 or equivalent) to carefully backprobe the EMM injector connector (terminal 10, blue'wire) with the keyswitch **on.** There should be slightly less than battery voltage between that wire and a good engine ground. If there is no voltage, check for voltage at the oil injector (on the white/blue wire). If there is voltage present here, suspect an open circuit in the blue wire or oil injector coil. If there is still no voltage present, suspect an open circuit in the whitelblue wire or a damaged power distribution panel (fuse box).
- For 1501175 hp motors equipped with hard fuel rails, use the DVOM to check for voltage at the oil injector blue wire with the keyswitch **on.** There should be slightly less than battery voltage between that wire and a good engine ground. If there is no voltage, suspect an open circuit in the white/blue wire or oil injector coil.

3. If voltage was present in the previous step, use the FFI diagnostic software to actuate the injector while rechecking'for voltage on the blue wire. If voltage fluctuates regularly, replace the oil injector. If voltage remains steady suspect a damaged connector (or harness) or a faulty EMM.

Oil Flow Verification

Connect the engine to a suitable source of cooling water and open the oil tank so that you can monitor return line oil flow. Start and run the engine while observing for return flow at the tank. If flow is good, perform the NozzlelManifold Test in this section. If there is no return oil flow, check for a kinked supply line or blockage in the oil injector. Repair or replace components, as necessary.

Nozzle/Manifold Test

If problems in the Static Verification Test or Oil Flow Verification test cause you to suspect one or more cylinder oil hose circuits, disconnect the hose from the suspected nozzle and recheck. If oil flows from the hose, clean or replace the injector nozzles If no oil flows, replace the oil injector and manifold assembly.

Oil Supply Verification

◆ See Figures 34 and 35

After repairs, or if other tests lead you to verrfy the oil supply, proceed as follows:

1. Check for a sufficient oil level in the boat oil tank.
2. Connect a pressure gauge to the oil system. For models equipped with hard fuel lines, the oil pump should be equipped with a pressure test port. For models NOT equrpped with hard fuel lines, remove the pressure switch from the oil pump and thread a gauge adapter into the bore.

The manufacturer recommends using a digital pressure gauge, such as the Snap-On **FIUG6** on models equipped with hard fuel rails. For models NOT equipped with hard fuel rails, the manufacturer recommends using a liquid-filled gauge along with a **1/8** in. NPT adapter fitting. When installing the NPT adapter fitting be sure to apply a light coating of **Evinrude/Johnson** Pipe Sealant (or an equivalent Teflon based pipe sealant) to the threads.

3. With the engine running or cranking, system pressure should be regulated at 6-20 psi (41-138 kPa). If pressure is within specification, perform the final test, Oil in Fuel Injection System Verification, in this section.
4. If pressure is below specification, check for the following potential causes:
   - Restricted or leaking supply line (not supplying sufficient oil flow). Pressure regulator stuck open (allowing too much return flow).
   - Faulty oil pump (not supplying sufficient flow).
   - Faulty oil injector (stuck open, allowing oil to flow constantly through the distribution manifold hoses),
5. If pressure is ABOVE specification, check for a restricted return line or a stuck closed pressure regulator.
6. For models not equipped with fuel rails, be sure apply a light coating of Evinrude/Johnson Pipe Sealant (or an equivalent Teflon based pipe sealant) to the threads of the pressure switch before installation. Also, be sure to tighten the switch to 120-168 inch lbs. (14-19 Nm).

Oil in Fuel Injection System Verification

During this test, you must maintain oil system pressure. You've got 2 options. The first is to run the engine (using the pump to maintain pressure). The second is to manually squeeze the oil primer bulb during the test.

1. Trace and drsconnect the oil metering hose from the manifold to the fuel injection system fitting as follows:

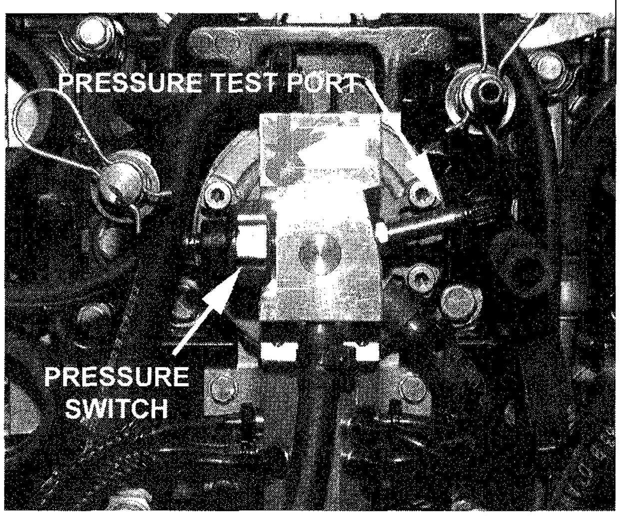


Fig. 34 FFI models equipped with hard fuel rails utilize a pump with both a pressure switch and pressure test port

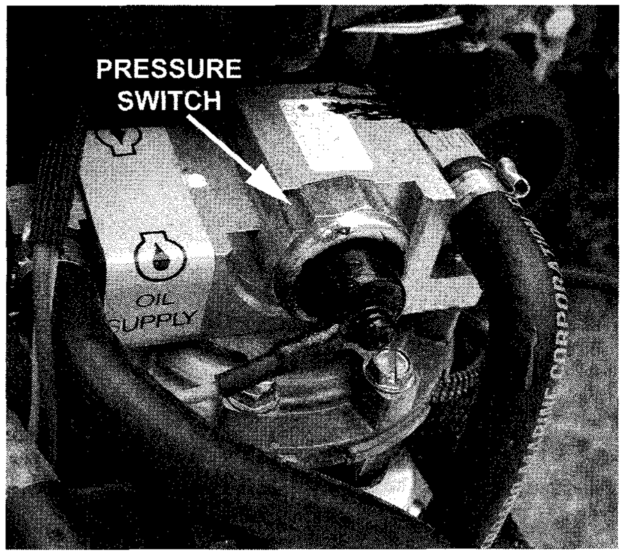


Fig. 35 On models without hard fuel rails, the oil pump only contains a pressure switch (no test port)

- On 75-175 Hp (1726/2859cc) V4/V6 motors (except models with fuel rails), the hose is connected to the lift pump. The fuel filter must usually be removed for access to it.
- On 150-175 Hp (2589cc) V6 motors (models with fuel rails) the hose is connected to the top of the fuel vapor separator.
- On 200-250 Hp (3000/3300cc) V6 motors, the hose is connected to a T fitting in the fuel lift pump (low pressure pump) supply line.

2. Verify that a small amount of oil discharges from the hose each time the oil injector clicks (when actuated using the FFI Diagnostic Software or by the EMM with the engine running or cranking).
3. Repair of replace any necessary oil system components if discharge does not occur. Suspect the hose or clogged fittings first. On models NOT equipped with hard fuel rails, there is a check valve in the line, inspect the valve before suspecting more expensive components.

OEM

OIL SYSTEM COMPONENT TESTING PROCEDURES

② MODERATE

Pressure Testing the Oil Injector

◆ See Figure 36

With the oil injector installed on the manifold, cap the outlet elbow or nipple (as applicable), then connect a hand held pressure tester and gauge capable of 0-30 psi (0-270 kPa) to the inlet elbowlnipple. Apply 30 psi (270 kPa) of pressure to the injector. Pressure must hold for at least 5 minutes, or the injector must be replaced.

Resistance Testing the Oil Injector

Disconnect the wiring harness from the injector itself. Using a DVOM, measure the resistance across the injector terminals. Injector coil resistance must be 0.90-1.10 ohms on models without hard fuel lines or 0.85-0.95 ohms on models WITH hard fuel lines. Remember however that this test must be conducted with a high quality Digital Volt-Ohm Meter (DVOM), and that specifications will vary slightly with temperature. The specifications provided here are for components at an ambient room temperature of about 68°F (20°C). If the component is tested at higher or lower temperatures, expect the readings to vary slightly.

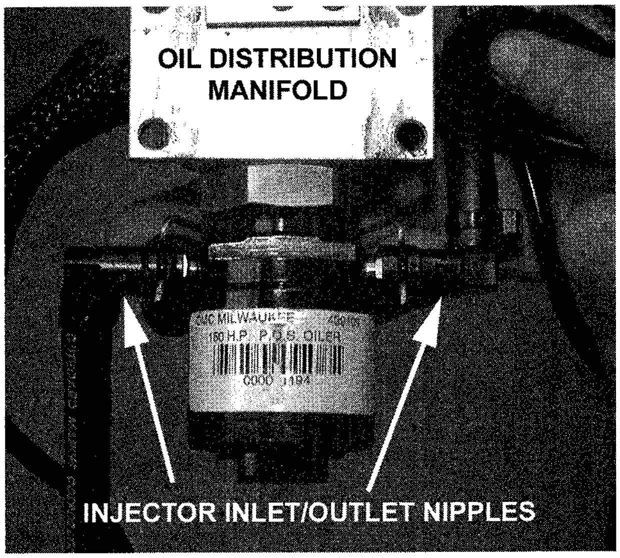


Fig. 36 When pressure testing the oil injector, you essentially apply pressure to the inlet nipple, with the outlet nipple capped and make sure that no pressure leaks from the injector into the distribution manifold

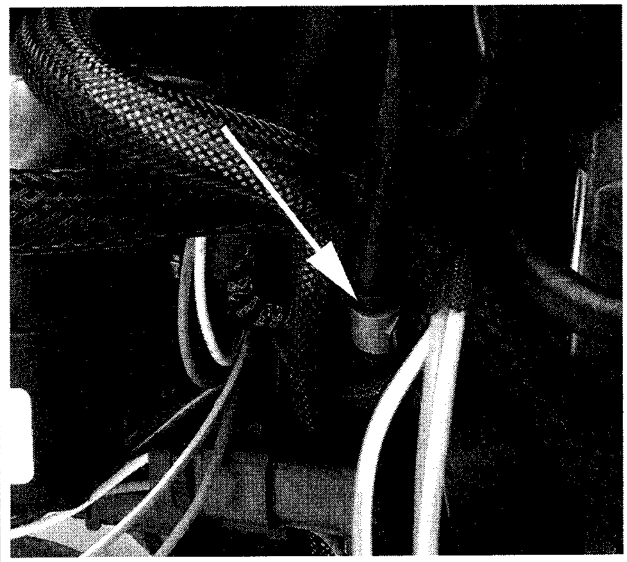


Fig. 37 Models without fuel rails utilize a check valve between the oil distribution manifold and the lift pump

Oil Pressure Switch Testing

◆ See Figure 34 and 35

To conduct this test you'll need an adapter made from a hose nipple and a 1/8 in. NPT pipe coupler. You'll also need a regulated source of pressure to apply 10 psi (69 **kPa)** to the switch itself. Absent a pressure tester, you can **simply** test the switch installed with the **engine running,** if **an Oil** Supply **Verification** Test has already shown system pressure to be at LEAST **6** psi (41 **kPa).**

1. Remove the pressure switch from the oil pump.
2. Apply a light coat of Evinrude/Johnson Pipe Sealant (or an equivalent Teflon based pipe sealant) to the threads of the pressure switch, then install it into the adapter.
3. Attach a pressure tester to the nipple on the adapter.
4. Connect one lead from an ohmmeter to the wiring terminal and the other to the housing. Make sure the connections are correct and that there is continuity. If necessary, move the probes around to ensure they are connected properly.
5. Apply approximately 10 psi (69 kPa) of pressure to the switch, the ohmmeter should show no continuity (infinite resistance) once pressure rises above about 2.85-5.85 psi (20-40 kPa).
6. Slowly release pressure and watch the ohmmeter. It should again show continuity as pressure drops below 2.85-5.85 psi (20-40 kPa).
7. Replace the pressure switch if it does not operate as noted.
8. Again, be sure apply a light coating of Evinrude/Johnson Pipe Sealant (or an equivalent Teflon based pipe sealant) to the threads of the pressure switch before installation. Then, install the switch to the pump and tighten the switch to 120-168 inch lbs. (14-19 Nm).

Check Valve Testing (Models w/out Hard Fuel Rails)

◆ See Figure 37

Models without fuel rails utilize a check valve between the oil distribution manifold and the lift pump. In order to test the check valve, note the orientation (which side faces the lift pump, there may be an arrow pointing towards the lift pump side of the valve) and remove it from the hoses.

Connect a hand-held vacuum pump to the lift pump side of the check valve, then apply vacuum to the valve watching and listening for what point it opens. The valve must open at about 13-17 in. Hg (330-432 mm Hg) of vacuum.

Next, remove the vacuum pump and install a pressure pump to the oil distribution manifold side of the valve. Slowly apply pressure to the valve while watching and listening for what point it opens. The valve must open at about 6.5-8.5 psi (45-58.5 kPa) of pressure.

If the valve does not operate properly, it must be replaced. During installation, be sure to orient the valve as noted during removal and secure using new wire ties.

Oil Component Assembly

Like the fuel components on these models the oil injection components are mounted together as an assembly. The oil pump, oil injector, oil distribution manifold and related lines are all easily removed as an assembly and then, the pump can be separated from the oil injector and distribution manifold. If only one or the other must be serviced, it may be possible to remove one (say the pump), leaving the injector and manifold behind. If that is desired, follow only the steps pertaining to disconnecting the component actually being removed. However, if the injector/manifold assembly requires service, it is probably easiest just to remove all of the oil components as detailed and then separate the pump.

REMOVAL, OVERHAUL & INSTALLATION

③ DIFFICULT

The oil injector and oil distribution manifold should be serviced and replaced only as an assembly. However, the injector itself on models equipped with fuel rails may be disassembled for rebuilding.

✳✳ WARNING

NEVER substitute a fuel injector for the oil injector, otherwise oil flow will be **disrupted.**

Except **150-175** Hp **(2589cc) V6** Motors with Fuel Rails

◆ See Figures **38, 39, 40** and 41

1. Disconnect the negative battery cable for safety.
2. Remove the engine covers. For details, please refer to Engine Cover (Top and Lower Cases) in the Maintenance and Tune-Up Section.
3. Remove the air intake silencer assembly.
4. For 200 hp and larger motors, in order to access the oil manifold-to-crankcase hoses, remove the throttle bodies, starter and fuel filter.

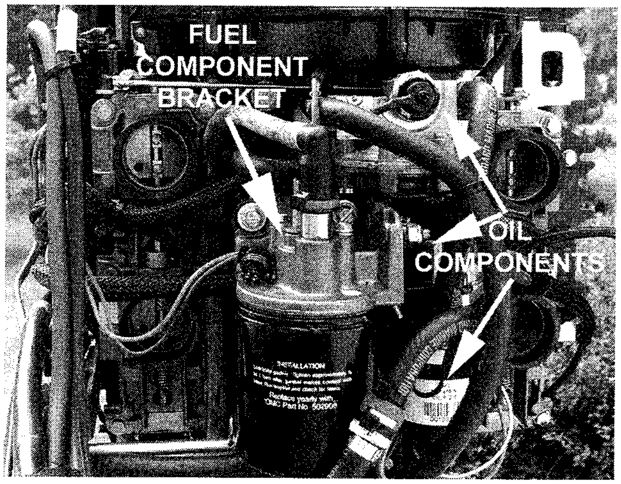


Fig. 38 The oil components are mounted to the powerhead and fuel component bracket

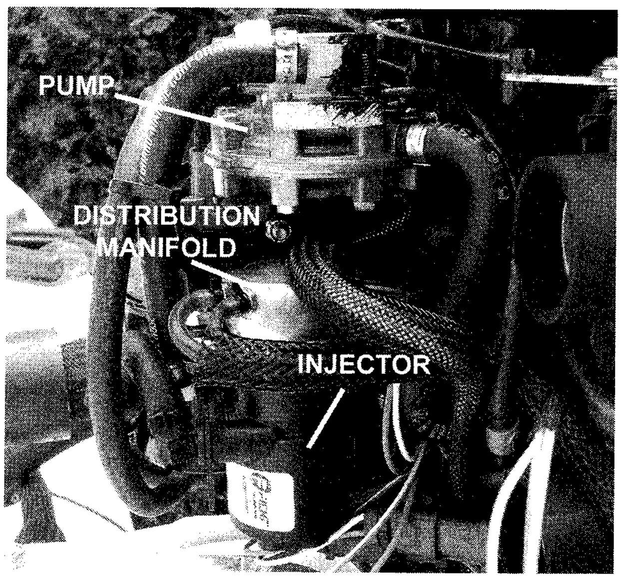


Fig. 39 The oil pump, distribution manifold and injector are all normally removed as an assembly

Refer to the Fuel System section for Throttle Body Removal and Installation, and to Ignition and Electrical Systems for Starter, Removal and Installation. If only the oil pump is being removed and the injector/manifold assembly is to remain installed, you can usually skip this step.

■ **If the oil manifold-to-crankcase hoses are tagged and disconnected from the manifold instead of the crankcase nipples, the throttle bodies, starter and fuel filter can remain installed.**

5. Locate and disconnect the oil outlet hose check valve. Inspect and replace, as necessary.
6. Tag and disconnect the upper pulse hose and the oil supply hose from the oil pump assembly.
7. For 200 hp and larger motors, tag and disconnect the lower pulse hose from the oil pump as well as the injector to tank hose.
8. Disconnect the wiring from the oil pressure switch.
9. For 175 hp and smaller motors, proceed as follows:
a. Remove the retainer from the injector outlet port, then disconnect the elbow with the hose.
b. Tag and disconnect the lower pulse hose from the oil pump.
c. Tag and disconnect the oil distribution lines from the nipples at the base of the cylinders on the block. Take care to note line routing for installation purposes (or better yet, take a digital photograph if you can).
d. Remove the nuts securing the bracket, then remove the bracket along with the pump and hoses.
e. Disconnect the oil pump-to-fuel pump hose on the oil pump side of the check valve.
f. Disengage the injector connector.

■ **On 200 hp and larger motors, the oil distribution lines can be tagged and removed either from the oil distribution manifold or from the crankcase nipples. However, removal from the crankcase nipples is more difficult, as it involves the removal of the throttle bodies, starter and fuel filter.**

10. For 200 hp and larger motors, remove the screws securing the oil pump/manifold/injector assembly to the engine bracket, then remove the assembly. Tag and disconnect the oil distribution lines, then disconnect the oil manifold-to-fuel lift pump hose at the manifold.
11. If necessary remove the locknuts retaining the oil injector and distribution manifold assembly and/or the oil pump assembly (as applicable) to the bracket.
12. If necessary, remove the oil pressure switch.
13. If necessary, remove the pump-to-injector hose.
14. If desired on 175 hp and smaller motors, remove the injector-to-manifold hoses, but keep in mind that the injector and manifold should NOT be serviced as individual components.
15. If necessary, tag and remove the oil distribution lines from the assembly or the motor (as applicable). The oil nozzles can be removed for inspection and cleaned or replaced, as necessary. Be sure to discard and replace any used O-rings.

To install:

16. If removed, install the oil nozzles and/or the distribution hoses. Secure using new wire ties.
17. If the oil pressure switch was removed, apply a light coating of Evinrude/Johnson Pipe Sealant (or an equivalent Teflon based pipe sealant) to the threads of the pressure switch before installation. Then, install the switch to the pump and tighten the switch to 120-168 inch lbs. (14-19 Nm).
18. If separated, install the oil pump and/or oil injector/distribution manifold assembly to the bracket and secure using NEW locknuts. Tighten the screws/locknuts to 60-80 inch lbs. (7-9 Nm) for the injector/manifold assembly or to 45-55 inch lbs. (5-6 Nm) for the oil pump assembly.
19. For 200 hp and larger motors, proceed as follows:
a. Connect the oil manifold-to-lift pump hose to the oil manifold. Connect the oil distribution lines to the manifold or nozzles, as applicable. Secure the lines using new wire ties.
b. Install the oil pump/injector assembly to the engine bracket and tighten the retaining screws to 45-55 inch lbs. (5-6 Nm).
20. For 175 hp and smaller motors, proceed as follows:
a. Connect the oil pump-to-lift pump hose on the check valve and secure using a new tie strap.
b. Engage the injector electrical connector.
c. Install the oil pump assembly bracket on the fuel component bracket. Apply a light coating of Evinrude/Johnson Nut Lock, or equivalent threadlock to the retaining screw threads, then install the nuts and tighten to 60-80 inch lbs. (7-9 Nm).
d. Connect the lower pulse hose on the oil pump, then secure using a new wire tie.
e. Connect the injector outlet hose and elbow, then secure using the retainer.
f. Connect the oil distribution lines as tagged to the nipples at the base of the cylinders and secure using new wire ties. Make sure the lines are routed properly as tagged and noted prior to removal.
21. Connect the wiring to the oil pressure switch.
22. For 200 hp and larger motors, connect the lower pulse hose to the oil pump and the injector tank hose, as tagged. Secure using new wire ties.
23. Connect the oil supply hose and upper pulse hose to the oil pump and secure using the clamp (if equipped) and/or new wire ties (as applicable).
24. Connect the oil outlet hose check valve. Make sure the red end of the connector in on the engine side, then secure using new wire ties.
25. Connect the negative battery cable.
26. Perform the Static System Verification procedure as detailed in this section under Checking the FFI Oiling System.

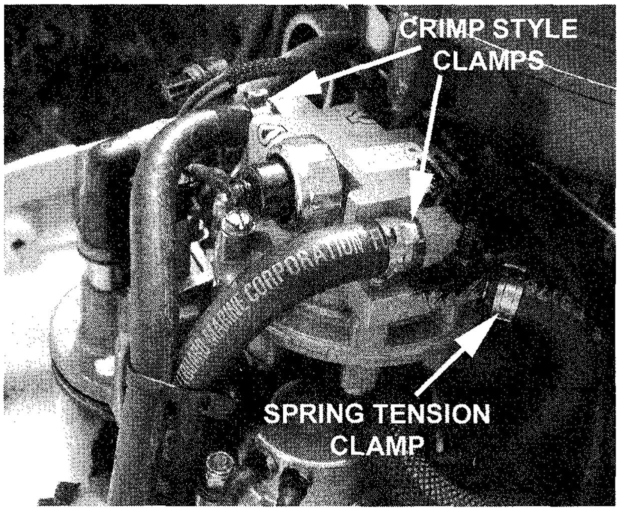


Fig. **40** Various types of clamps are used (try to avoid disconnecting crimp clamps unless you have replacement clamps and a proper crimping tool)

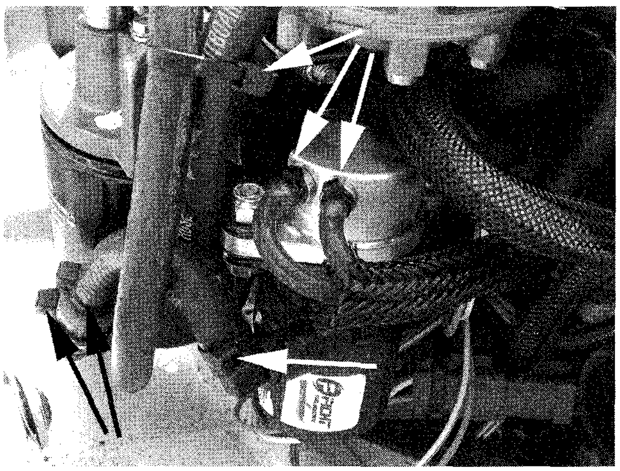


Fig. 41 Most oil line connections are secured using wire ties over the hoses

On 200 hp and larger motors, you'll need the FFI Diagnostic Software, or you will have to install the starter motor (if removed) in order to crank the motor.

27 For 200 hp and larger motors, if removed, install the fuel filter, starter and throttle bodies

28 If the Static System Verification procedure was not performed (you're taking a risk), but purge the air from the system at this point by starting the motor (using a source of cooling water) and restricting the oil return line (between the injector and the outlet port and check valve) Visually watch each oil distribution line to be sure it is purged of air Continue to restrict the outlet for at least another 20 seconds to be certain, then eliminate the restriction and verify oil flow by checking for return oil discharge in the oil tank assembly

29 Thoroughly Inspect the system for fuel or oil leaks

30 Install the air intake silencer assembly

31 Install the engine covers For details, please refer to Engine Cover (Top and Lower Cases) in the Maintenance and Tune-up Section

150-175 Hp **(2589cc)** V6 Motors with Fuel Rails

On 1501175 hp motors equipped with fuel rails, the oil components are removed as an assembly (same as on other FICHT motors), BUT, the injector itself may be disassembled for overhaul. Both procedures are provided here

Oil Component Assembly Removal and Installation

◆ See Figures **42, 43, 44, 45, 46, 47, 48, 49, 50** and 51

1. Disconnect the negative battery cable for safety.
2. Remove the engine covers. For details, please refer to Engine Cover (Top and Lower Cases) in the Maintenance and Tune-up Section.
3. Remove the flywheel cover.
4. Remove the air intake silencer assembly.
5. The oil components are mounted to a bracket on the front of the powerhead, beneath some of the fuel components. Remove fuel components from the powerhead, as necessary for access.
6. Locate and disconnect the oil outlet hose check valve. Inspect and replace, as necessary.
7. Tag and disconnect the upper pulse hose and the oil supply hose from the oil pump assembly.
8. Tag and disconnect the lower pulse hose from the oil pump.
9. Disconnect the wiring from the oil pressure switch.
10. Tag and disconnect the seven oil distribution manifold hoses. In most cases, it is probably easier to disconnect them from the manifold so you don't have to worry about routing.

Although we don't recommend it, because installation would be more difficult, you can disconnect the oil distribution hoses from the nozzles on **the powerhead** and leave them connected to the manifold **assembly. This** might be useful if the entire assembly is being replaced (along with the hoses). But even then, we'd leave them installed and replace each hose, ONE at a time to avoid confusion or misrouting.

II. Disengage the injector connector.

12. Remove the 4 screws securing the pump/oil block, then remove the 4 screws securing the manifold/injector assembly. Remove the assemblies from the powerhead.
13. If necessary, tag and disconnect the oil distribution hoses at the intake manifold elbows. Then, use a small prytool to carefully free the oil nozzles from the manifold. Inspect the hoses and nozzles for blockage or damage and replace, as necessary.
14. To service the individual assemblies (oil pump or manifold/injector assembly), remove the screws retaining the plate. The pump-to-block screws MUST be reinstalled and tightened, however the manifold screws and plate may be discarded. Remove the oil block-to-injector hose.
15. If necessary, remove the oil block, oil pressure switch and oil maintenance valve form the pump.
16. If necessary, remove the wire ties that hold the injector fuel line retainers in position. Then remove the retainers and disconnect the elbows from the injector inlet and outlet nipples.
17. If injector service is requiredldesired, follow the Injector Overhaul procedure in this section.

To install:

18. If removed, install the inlet and outlet elbows onto the injector nipples, install the wire retainers and secure using new wire ties.
19. If the oil pressure switch and/or maintenance valve was removed from the oil pump, apply a light coating of Evinrude/Johnson Pipe Sealant (or an equivalent Teflon based pipe sealant) to the threads before installation. Then, install the valve and/or switch to the pump. Tighten the switch to 120-168 inch lbs. (14-19 Nm) or the valve to 120-140 inch lbs. (14-16 Nm). Install the block on the pump and tighten the screws securely.
20. If separated and reusing the plate to join the pump and manifold assemblies, install the screws and tighten securely. Connect the block-to-injector hose and secure using new wire ties.
21. If removed, apply a light coating of EvinrudelJohnson Triple-Guard or equivalent marine grease to the NEW oil injection nozzle O-rings. Install the O-rings and use a blunt punch to gently tap the nozzles into position on the intake manifold. Connect the oil distribution hoses to the nozzles and secure using new wire ties.
22. Apply a light coating of EvinrudelJohnson Nut Lock, or equivalent threadlock to the pump and manifold assembly retaining screws. Position the assembly to the powerhead and tighten the screws to 60-80 inch lbs. (7-9 Nm).
23. If removed from the manifold, connect the 7 oil distribution hoses to the oil distribution manifold nipples (6 are from the cylinder nozzles and one is from the vapor separator hose). Secure using new wire ties.
24. Engage the injector electrical connector and the wiring to the pressure switch.

25 Connect the lower pump pulse hose on the oil pump, then secure using a new wire tie.

26. Connect the oil pump inlet hose and upper pulse hose and secure using new wire tres.

27 Connect the oil outlet hose check valve Make sure the red end of the connector m on the engine side, then secure usmg new wire ties

28 Install the fuel components that were removed for access to the oil components

29 Connect the negative battery cable

30. Perform the Static System Verification procedure as detailed in thrs section under Checking the FFI Oiling System.

31 If the Static System Verification procedure was not performed (you're taking a risk), but purge the air from the system at thrs point by starting the motor (using a source of cooling water) and restricting the oil return line. Release the restriction prior to completely filling the hoses, but visually watch each oil distribution line to be sure it is purged of air. Oil should move up the lines in 0.10 in. (2.5mm) increments at 12-25 second intervals with the engine running at idle. If oil seems to be flowing at about this rate, re-pinch the return line until the oil completely fills the hoses. Once the system is full, eliminate the restriction and verify oil flow by checking for return oil discharge in the oil tank assembly.

32. Thoroughly inspect the system for fuel or oil leaks.

33. Install the air intake silencer assembly.

34. Install the engine covers. For details, please refer to Engine Cover (Top and Lower Cases) in the Maintenance and Tune-up Section.

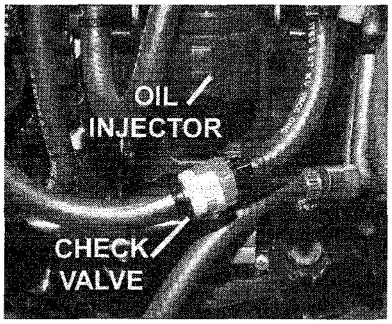


Fig. 42 The oil outlet hose check valve is found near the oil injector

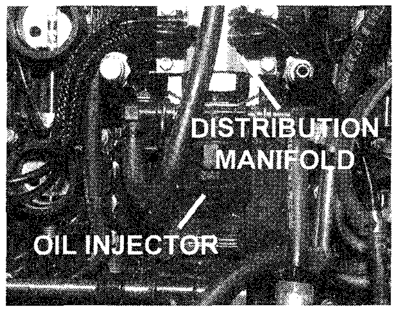


Fig. 43 The oil pump components (injector, manifold and pump) are normally removed as an assembly

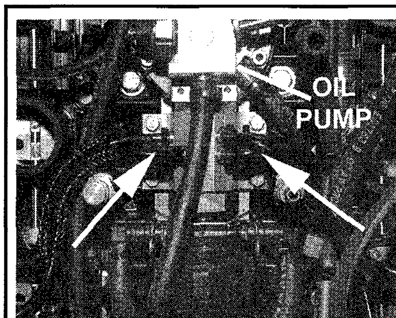


Fig. 44 Tag and disconnect the hoses and wiring from the assembly...

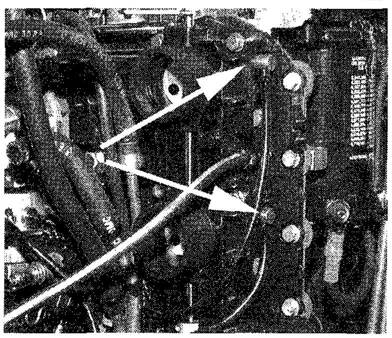


Fig. 45 ... or from their connections on the powerhead (the cylinder nozzles in this case)

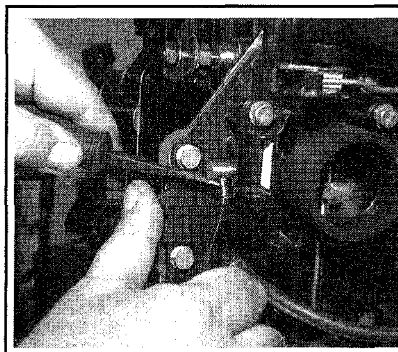


Fig. 46 If nozzles are to be removed for inspection or replacement, carefully disconnect the hoses...

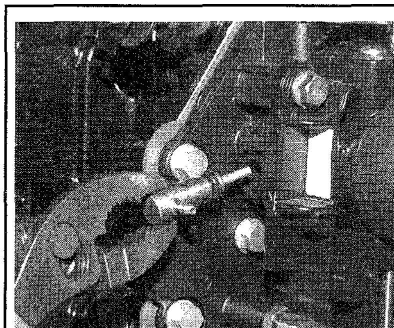


Fig. 47 ... then gently pull or pry the nozzles from the intake manifold

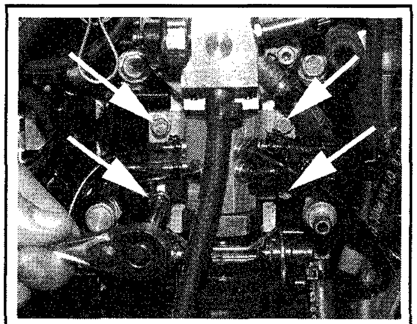


Fig. 48 To remove the assembly itself, loosen the 4 distribution manifold bolts...

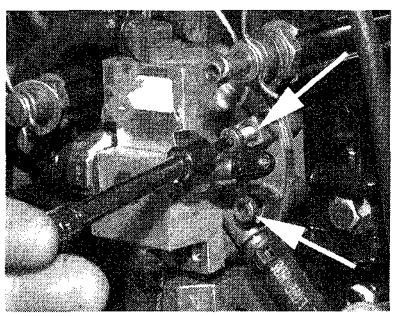


Fig. 49 ... and the 4 oil pump bolts (2 on each side)

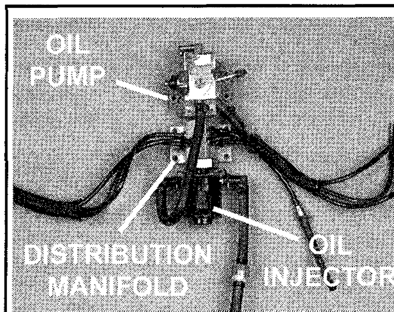


Fig. 50... then remove the assembly from the powerhead

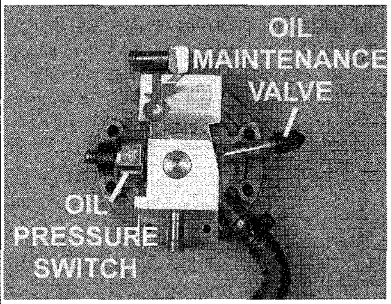


Fig. 51 The oil pump can be removed for replacement or service

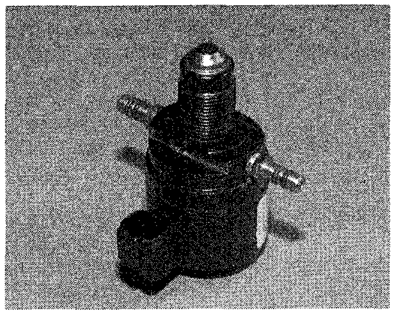


Fig. 52 The injector on models with hard fuel rails may be overhauled

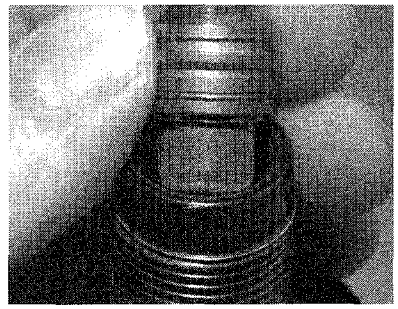


Fig. 53 Carefully disassemble the injector...

Injector Overhaul (Models with Hard Fuel Rails Only)

◆ **See Figures 52, 53, 54, 55, 56, 57, 58, and 59**

When servicing the oil injector, DO NOT intermix parts from a fuel injector (even if they look similarlsame). Do so would change the flow characteristics of the injector assembly.

1. Remove the pump/injector/manifold assembly from the powerhead, the separate the injector/manifold from the pump/block as detailed under Oil Component Assembly Removal and Installation, in this section.
2. Carefully position the manifold assembly in a soft-jawed vise with the injector downward, but at an angle for access. Loosen and remove the injector and retaining nut from the manifold.
3. Check the manifold for signs of blockage or damage.
4. Loosen and remove the nut from the injector, then unthread the nozzle.
5. Using Evinrude/Johnson Injector Check Valve Remover/Installer No. 342678 (which is essentially a dual-pin spanner which can be inserted into the injector nozzle bore) remove the outlet check valve. Place the tool in the housing while aligning the pins with the holes in the check valve, then using a socket or wrench on the tool flats, carefully loosen the valve from the housing.
6. Remove the check valve, with the O-ring, from the injector housing. Remove and discard the old O-ring.
7. Remove the check ball and spring from the housing (beneath the check valve).
8. Remove the O-rings from the inlet and outlet nipples, then loosen and remove the nipples from the housing using a wrench or socket. Remove the O-rings from the threaded ends of the nipples. Discard the old O-rings.
9. Using a wrench on the top rear of the housing, loosen and remove the coil, then remove the O-ring from inside the coil. Discard the old O-ring.
10. Remove the bushing and stop from the end of the armature, then remove the armature and large spring from the housing.

✳✳ WARNING

DO NOT compress or stretch the large spring or flow rate will be altered.

11. Thoroughly clean the injector components (except the coil) using Evinrude/Johnson Carburetor and Choke Cleaner.

✳✳ WARNING

DO NOT attempt to clean components by submerging them in a strong carburetor cleaning solvent or hot soaking tank. Those cleaners mightdamage components and remove sealing compounds.

12. Inspect all injector components for wear or damage, replace any that show signs. Some parts are available either individually or in the service kit, but note that ALL parts are not available and if some components are damaged the only resort is to replace the injector.

To install:

13. Install the large spring and armature into the housing, then place the stop and bushing (with the O-ring relief facing upwards) on the shaft.
14. Apply a light coating of Evinrude/Johnson Triple-Guard or equivalent marine grease to a NEW O-ring, then install it on the bushing and install the coil onto the housing.

Apply a light coating of Evinrude/Johnson Triple-Guard or equivalent marine grease to all of the O-rings as they are installed. If the injector has been in service for any length of time, ALL of the old O-rings should be discarded and replaced with new ones.

15. Using a crowfoot wrench positioned 90° to the torque wrench, tighten the coil to 20-30 ft. lbs. (27-40.5 Nm).
16. Grease and install NEW O-rings on the threaded ends of the inlet and outlet nipples, then install the nipples and tighten to 60-72 inch lbs. (6.5-8 Nm). Grease and install new O-rings on the exposed ends of the nipples.

■ **Good news, the replacement O-rings from the manufacturer are color-coded. Brown is for use on the inlet nipple and black for the outlet nipple.**

17. Insert the check ball and small spring into the injector housing, then grease and install a NEW O-ring to the outlet check valve. Install the check valve and tighten to 80-100 inch lbs. (9-11 Nm).
18. Position the nozzle on the housing, then push on the retaining ring and seat the nozzle in the housing. It is usually necessary to use a small tool, like a flat-bladed screwdriver to press on the retaining ring, BUT, be very careful not to scratch the beveled surfaces of the housing or the nozzle.
19. Verify that the injector threads (and the threads of the nut and the cylinder head) are all completely clean and free of debris. The threads MUST be clean and in good condition. If necessary clean all dirt or debris from the injectors using solvent and lint free towels.
20. Apply a light coating of Evinrude/Johnson Ultra Lock, or equivalent high-strength threadlock to the external threads of the nut and the threads of the injector (the threads starting at the injector body going about halfway down to the nozzle). Thread the nut into the manifold until seated. Back the nut out ONE FULL TURN from the seated position.

■ **REMEMBER that the fuel inlet nipple is larger than the outlet nipple.**

21. Hold the nut from turning, then thread the injector **counterclockwise** into the nut until the injector is seated. THEN turn the injector **clockwise** slightly JUST until the inlet and outlet nipples are properly positioned (with the nipples precisely horizontal, the INLET nipple facing port and the electrical connector facing upward).

■ **Evinrude/Johnson has a positioning tool, No. 342673, designed to hold the injector in place (keep it from turning) while the nut is tightened.**

22. Using a tool on the injector body only (NOT the coil), hold the injector to keep it from turning and tighten the injector locknut. Use a 1 1/2 in. crowfoot adapter mounted at a 90° angle to the torque wrench and tighten the nut to 50-60 ft. lbs. (68-81 Nm).
23. Secure the injector/manifold assembly to the pump/block, then install the assembly as detailed under Oil Component Assembly Removal and Installation, in this section.

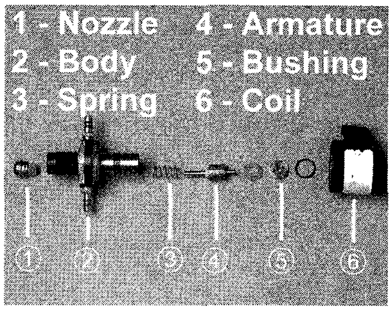


Fig. 54 ...laying out the components for inspection

Fig. 55 To assemble, insert the large spring and armature...

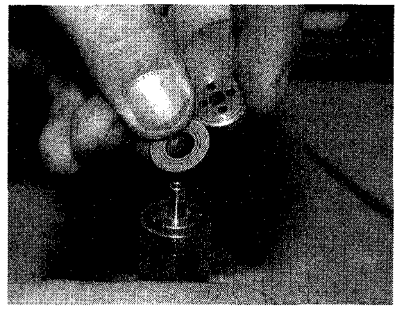


Fig. 56 ...then position the stop and bushing on top...

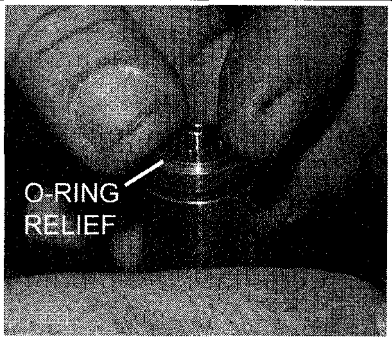


Fig. 57 ...with the O-ring relief facing up

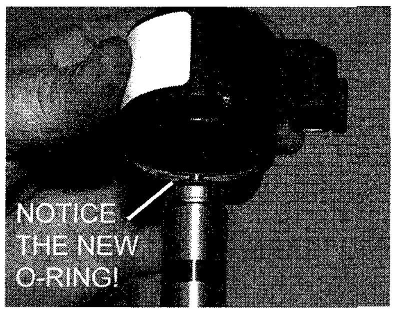


Fig. 58 Position the coil over the armature and housing

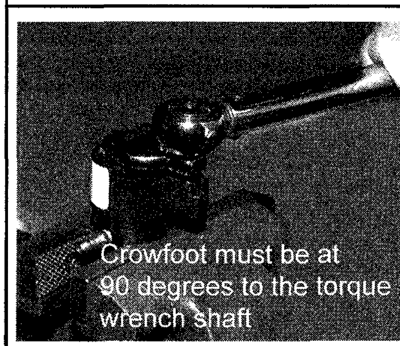


Fig. 59 Then tighten using crowfoot adapter and torque wrench

COOLING SYSTEM

◆ **See Figure 61**

■ **For specific water flow diagrams showing the cooling system components and water passages for each Evinrude/Johnson outboard, please refer to Cooling System Schematics in this section.**

All Evinrude/Johnson outboard engines are equipped with a raw water cooling system, meaning that sea, lake or river water is drawn through a water intake in the gearcase lower unit and pumped through the powerhead by a water pump impeller. The exact mounting and location of the pump/impeller varies slightly on some of the smaller models, but on all V configuration motors, it is mounted to the lower unit along the gearcase-to-intermediate section split line.

For many boaters, annual replacement of the water pump impeller is considered cheap insurance for a trouble-free boating season. This is probably a bit too conservative for most people, but after a number of trouble-free seasons, an impeller doesn't owe you anything and you should consider taking the time and a little bit of money necessary to replace it. Remember that should an impeller fail you'll be stranded. Worse, a worn impeller will simply supply less cooling water than required by specification, allowing the powerhead to run hot placing unnecessary stress on components and best or risking overheating the powerhead at worst.

All motors covered here are equipped with a thermostat (usually 2) that restricts the amount of cooling water allowed into the powerhead until the powerhead reaches normal operating temperature. The purpose of a thermostat is to increase engine performance and reduce emissions by making sure the engine warms as quickly as possible to operating temperature and remains there during use under all conditions. Running a motor without a thermostat may prevent it from fully warming, not only increasing emissions and reducing fuel economy, but it will likely lead to carbon fouling, stumbling and poor performance in general. It can even damage the motor, especially if the motor is then run under load (such as full-throttle operation) without allowing it to thoroughly warm. A restricted thermostat can promote engine overheating. The good news is that should you be caught on the water with a restricted thermostat, you should be able to easily remove it and get back to shore, just make sure you replace it before the next outing.

Most motors are also equipped with one or more water-pressure valves (also known as blow-off valves because they open in response to high-pressure regardless of engine temperature). The purpose of the pressure valve is to prevent possible damage to the cooling system should pressure rise above a certain point.

The water intake grate and cooling passages throughout the powerhead and gearcase comprise the balance of the cooling system. Both components require the most simple, but most frequent maintenance to ensure proper cooling system operation. The water intake grate should be inspected before and after each outing to make sure it is not clogged or damaged. A damaged grate could allow debris into the motor that could clog passages or damage the water pump impeller (both conditions could lead to overheating the powerhead). Cooling passages have the tendency to become clogged gradually over time by debris and corrosion. The best way to prevent this is to flush the cooling system **after each use** regardless of where you boat (salt or freshwater). But obviously, this form of maintenance is even more important on vessels used in salt, brackish or polluted waters that will promote internal corrosion of the cooling passages.

On FICHT motors, the cooling system is altered slightly to include some additional plumbing. In order to protect the EMM circuitry from overheating, the module itself is part of the cooling circuit. An inlet and outlet cooling hose attached to the EMM allows the raw cooling water to circulate and cool the module. Also, in order to prevent fuel evaporation and vapor problems with the high-pressure fuel circuit, the fuel/vapor separator assembly is also water cooled on FFI motors. Other components, such as the regulator/rectifier may also be included in the water cooling circuits on these motors.

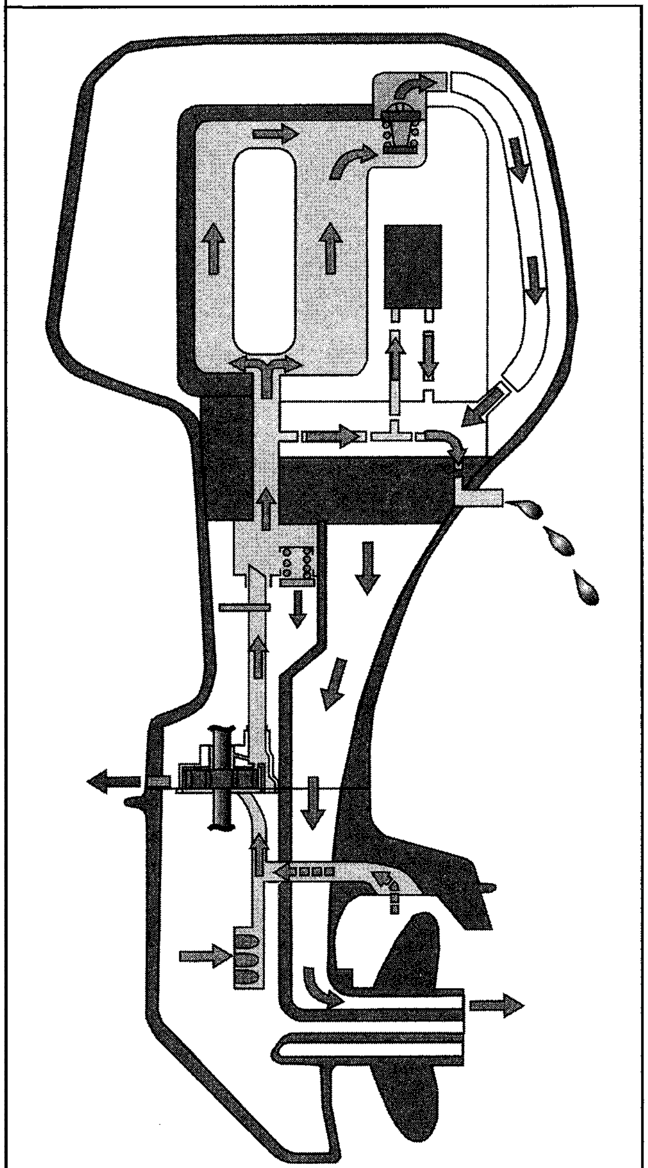


Fig. 61 Cut-away view of **a** typical outboard cooling system showing water flow

Description and Operation

◆ See Figures **62, 63, 64** and 65

The water pump uses an impeller driven by the driveshaft, sealing between an offset housing and lower plate to create a flexing of the impeller blades. The rubber impeller inside the pump maintains an equal volume of water flow at most operating speeds.

At low speeds the pump acts like a full displacement pump with the longer impeller blades following the contour of the pump housing. As pump speed increases, and because of resistance to the flow of water, the impellers bend back away from the pump housing and the pump acts like a centrifugal pump. If the impeller blades are short, they remain in contact throughout the full RPM range, supplying full pressure.

✳✳ WARNING

The outboard should never be run without water, not even for a moment. As the dry impeller tips come in contact with the pump housing or insert, the impeller will be damaged. In most cases, damage will occur to the impeller in seconds.

On most powerheads, if the powerhead overheats, a warning circuit is triggered by a temperature switch to signal the operator of an overheat condition. This should happen before major damage can occur. Reasons for overheating can be as simple as a plastic bag over the water inlet, or as serious as a leaking head gasket.

Whenever the powerhead is started and the cooling system begins pumping water through the powerhead, a water indicator stream will appear from a cooling system indicator in the engine cover. The water stream fitting commonly becomes blocked with debris (especially when lazy operators fail to flush the system after each use, yes we said LAZY, does this mean YOU?) and ceases flowing. This leads one to suspect a cooling system malfunction. Clean the opening in the fitting using a stiff piece of wire before testing or inspecting other cooling system components.

Some motors are equipped with a water pressure relief valve that allows additional water flow at higher engine speeds by providing an additional exit passage. Increased pump flow and pressure at higher engine speeds causes the valve to open.

Whenever water is pumped through the powerhead it absorbs and removes excessive heat. This means that anytime a motor begins to overheat, there must be not enough (or no) water flowing to the powerhead (or not enough heat is being exchanged with the water that is flowing). This can happen for various reasons, including a damaged or worn impeller, clogged intake or passages or a stuck closed/restricted thermostat.
A sometimes overlooked cause of overheating is the inability of the linings of the cooling passage to conduct heat. Over time, large amounts of corrosion deposits will form, especially on engines that have not received sufficient maintenance. Corrosion deposits can insulate the powerhead passages from the raw water flowing through them.

Troubleshooting the Cooling System

◆ See Figures **62, 63, 64** and 65

■ When troubleshooting the cooling system, especially for overheat conditions, the motor should be run in a test tank or on a launched vessel (to simulate normal running conditions.). Running the motor on a flushing device may provide both a higher volume of water than the system would deliver (and often, water that is much colder than water that would normally be drawn into the system).

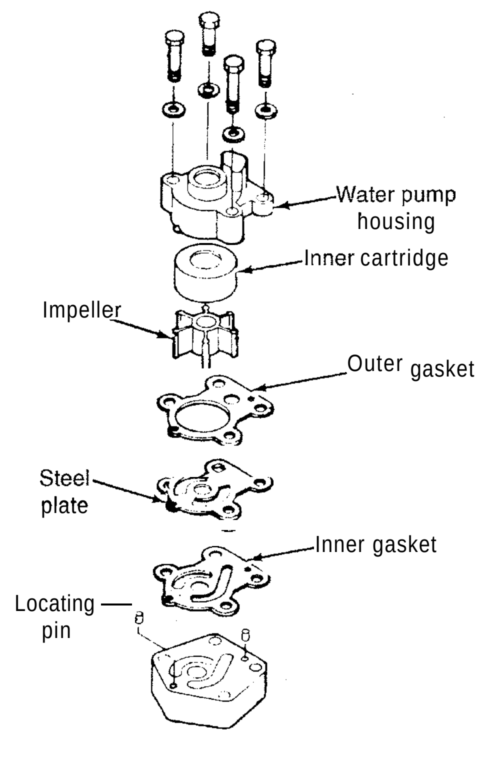


Fig. 62 Exploded view of a typical water pump assembly

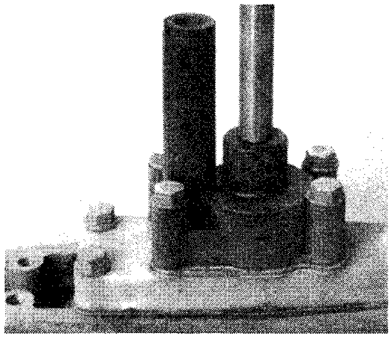


Fig. 63 Most water pumps are mounted to the top of the gearcase lower unit

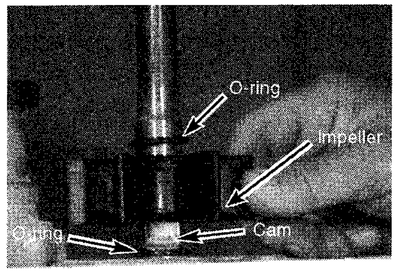


Fig. 64 The water pump impeller is the heart of the cooling system

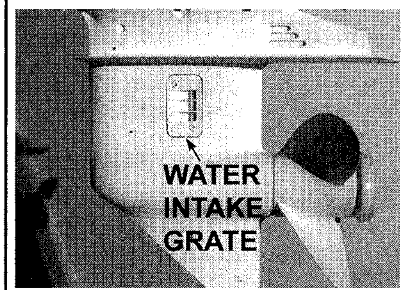


Fig. 65 The water intake grate and cooling passages should be checked and cleaned with each use

A water-cooled powerhead has a lot of problems to consider when talking about overheating. The most overlooked tends to be the simplest, clogged cooling passages or water intake grate. Although a visual inspection of the intake grate will go a long way, the cooling passage condition can really only be checked by operating the motor or disassembling it to observe the passages.

Damaged or worn cooling system components tend to cause most other problems. And since there are relatively few components, they are easy to discuss. The most obvious is a thermostat that is damaged or corroded will often cause the motor to run hot or cold (depending on the position in which the thermostat is stuck, closed or open). The water pump impeller is really the heart of the cooling system and it is easy to check, easy that is once it is accessed.

Periodic inspection and replacement of the water pump impeller is a mainstay for many mariners. There are those that wouldn't really consider launching their vessel at the beginning of a season without first replacing (or at least checking) the impeller. If the water pump is removed for inspection, check the impeller and housing for wear, grooves or scoring that might prevent proper sealing. Check for grooves in the driveshaft where the seal rides. Any damage in these areas may cause air or exhaust gases to be drawn into the pump, putting bubbles into the water. In this case, air does not aid in cooling. When inspecting the pump, consider the following:

- Is the pump inlet clear and clean of foreign material or marine growth? Check that the inlet screen is totally open. How about the impeller?
- Try and separate the impeller hub from the rubber. If it shows signs of loosening or cracking away from the hub, replace the impeller.
- Has the impeller taken a set, and are the blade tips worn down or do they look burned? Are the side sealing rings on the impeller worn away? If so, replace the impeller.

Remember that the life of the powerhead depends on this pump, so don't reuse any parts that look damaged. Are any parts of the impeller missing! If so, they must be found. Broken pieces will migrate up the water tube into the water jacket passages and cause a restriction that could block a water passage. It can be expensive or time consuming to locate the broken pieces in the water passages, but they must be found, or major damage could occur.

The best insurance against breaking the impeller is to replace it at the beginning of each boating season (are you sensing a pattern here?), and to NEVER run it out of the water. If installing a metal-bodied pump housing, coat all screws with non-hardening sealing compound to retard galvanic corrosion. The water tube carries the water from the pump to the powerhead. Grommets seal the water tube to the water pump and exhaust housing at each end of the tube, and can deteriorate. Also, the water tube(s) should be checked for holes through the side of the tube, for restrictions, dents, or kinks.

Overheating at high RPM, but not under light load, may indicate a leaking head gasket. If a head gasket it leaking, water can go into the cylinder, or hot exhaust gases may go into the water jacket, creating exhaust bubbles and excessive heat. Remember that aluminum heads have a tendency to warp, and usually need to be surfaced each time they are removed. If necessary, they can be resurfaces by using emery paper and a surface block moving in a figure-eight motion. Also, inspect the cylinders and pistons for damage. Other areas to consider are the exhaust cover gaskets and plate. Look for corrosion pin holes. This is rare, but if the outboard has been operated in salt water over the years, there may just be a problem.

If the outboard is mounted too high on the transom, air may be drawn into the water inlet or sufficient water may not be available at the water inlet. When underway the outboard anti-ventilation plate should be running at or near the bottom of the boat and parallel to the surface of the water. This will allow undisturbed water to come to the lower unit, and the water pick-up should be able to draw sufficient water for proper cooling.

Whenever the outboard has been run in polluted, brackish or saltwater, the cooling system should be flushed. Follow the instructions provided under Flushing the Cooling System in the Engine Maintenance section for more details. But in most cases, the outboard must be flushed for at least five minutes. This will wash the salt from the castings and reduce internal corrosion.

There is no need to run in gear during the flushing operation. After the flushing job is done, rinse the external parts of the outboard off to remove the salt spray. As a matter of fact, almost all of these motors contain some form of flush fitting, which when used, allows the motor to be properly flushed without running the engine at all.

When service work is done on the water pump or lower unit, all the bolts that attach the lower unit to the exhaust housing, and bolts that hold the water pump housing (unless otherwise specified), should be coated with nonhardening gasket sealing compound to guard against corrosion. If this is not done, the bolts may become seized by galvanic corrosion and may become extremely difficult to remove the next time service work is performed.

Last but not least, check to be sure that the overheat warning system is working properly. By grounding the wire at the sending unit, the horn should sound, and/or a light should illuminate. More details can be found under Warning System in the Ignition and Electrical System section.

■ **On FFI motors, refer to the troubleshooting information found in the FICHT Fuel Injection (FFI) section and at the information under Engine Symptom Diagnostic Charts for more hints on troubleshooting an overheating motor.**

OEM

TESTING COOLING SYSTEM EFFICIENCY

2 MODERATE

◆ **See Figure 66**

If trouble is suspected, you can check cooling system efficiency by running the motor in a test tank or on a launched boat (while an assistant navigates) and monitoring cylinder head temperatures. There are *2* common methods available to monitor cylinder head temperature, the use of a heat sensitive marker or an electronic pyrometer.

■ **We want to take a moment here to sing the praises of an electric pyrometer. The MiniTemp® in the accompanying illustration is simply too handy to pass up. A laser pyrometer such as this will give you an instant surface temperature reading anywhere you point it. You can**

use it to check outboard running temperatures, to look for hot spots automotive cooling systems, to check air conditioning output in your home or car, to check fish tank temperatures in the living room, to search for drafts or insulation problems in your house. We could go on, but probably shouldn't need to at this point. Suffice it to say that once you one, you'll wonder why it took you so long to buy it.

The Stevens Instrument company markets a product known as the Markal Thermomelt Stik®. This is a physical marker that can be purchased to check different heat ranges. The marker is designed to leave a chalky mark behind on a part of the motor that will remain chalky until it is warmed to a specific temperature, at which point the mark will melt appearing liquid and glossy.

When using a Thermomelt Stik or equivalent indicator, markers of 2 different heat specifications are necessary for this test. For all models you will want a 163ºF (73ºC) marker to check for overheating and a 1250 (52ºC) marker to determine if the motor is failing to reach normal operating temperature.

Alternately, an electronic pyrometer may be used. Many DVOMs are available with thermosensor adapters that can be touched to the cylinder head in order to get a reading. Also, some instrument companies are now producing relatively inexpensive infra-red or laser pyrometers (such as the Raytek® MiniTemp®) of a point-and-shoot design. These units are simply pointed toward the cylinder head while holding down the trigger and the electronic display will give cylinder head temperature. For ease of use and relative accuracy of information, it is hard to beat these infra-red pyrometers. Be sure to follow the tool manufacturer's instructions closely when using any pyrometer to ensure accurate readings.

To test the cooling system efficiency, obtain either a Thermomelt Stik (or equivalent temperature indicating marker) or a pyrometer and proceed as follows:

1. If available, install a shop tachometer to gauge engine speed during the test.
2. Make sure the proper propeller or test wheel is installed on the motor.
3. Place the motor in a test tank or on a launched craft.

■ **In order to ensure proper readings, water temperature must be approximately 60-80ºF (18-24ºC).**

4. Start and run the engine at 3000 rpm for **at least** five minutes.
5. Reduce engine speed to about 900 rpm as proceed as follows depending on the test equipment:

If using Thermomelt Stiks, make 2 marks on the top of each cylinder head (on most models, there should be a thermostat pocket on which you should make the marks), one with the low-range marker and one with the high-range marker. Continue to operate the motor at 900 rpm. The low-range mark must turn liquid and glossy or the engine is being overcooled (check the thermostats for a stuck open condition). The high-range mark must remain chalky, or the motor is overheating (check the thermostats for a stuck closed condition and then check the cooling system passages and the water pump impeller).

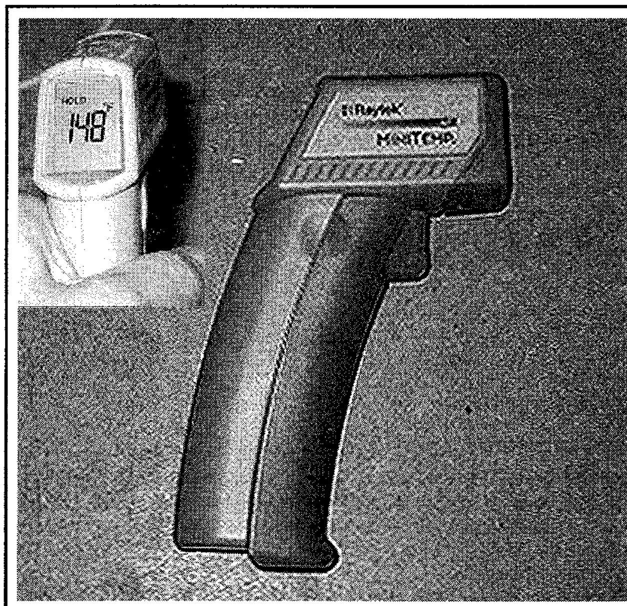


Fig. 66 By far the easiest way to check cylinder head temperature is with a hand-held pyrometer like the MiniTemp® from Raytek® pictured here

■ **Although we direct you to take temperature readings on the thermostat pockets at the top of each cylinder head, keep in mind that a few motors do not have a thermostat mounted in the top of each cylinder head. The cross-flow V4s utilize thermostats mounted in the exhaust housing directly below the powerhead. Also, the V4 FICHT motors utilize a lower thermostat pocket on one bank of cylinders. When testing V4 FICHTs check for the presence of hoses and a thermostat pocket at the bottom of each cylinder as well, take additional test readings in these locations.**

■ If using a pyrometer, take temperature readings on the top of each cylinder head (on most models, there should be a thermostat pocket on which to take the reading). Temperature readings must be 125-155ºF (53-67ºC) for all motors, except the 200 hp and larger FFI models which should be 125-145ºF (52-63ºC) otherwise the engine is being over/under cooled. Check the thermostats first for either condition and then suspect the cooling water passages and/or the impeller.

■ **When checking the engine at speed (5000 rpm) expect temperatures to vary slightly from the idle test. Some models will run slightly hotter and some slightly cooler due to the differences in volume of water delivered by the cooling system when compared with engine load.**

6. Increase engine speed to 5000 rpm and continue to watch the markers or the reading on the pyrometer. The engine must not overheat at this speed either or the system components must be examined further. Examine the cooling system further if temperatures rise above the following figures, depending upon the model:

120ºF (50ºC) for all 90º V4 and V8 looper models, meaning the 120-140 hp (2000cc) and 2501300 Hp (4000cc) motors.

150ºF (66ºC) for all FICHT 900 V6 looper models, meaning the 185-250 hp (3000/3300cc) motors.

155ºF (68ºC) for all carbureted 90º V6 looper models, meaning the 185-250 hp (3000cc) motors.

- 160ºF (71ºC) for all other models, meaning 65 Jet-115 hp (1632cc) 900 CV4 motors and 75-175 Hp (1726/2859cc) 60º LV4/LV6 motors.

TESTING THE THERMOSTAT

OEM ② MODERATE

All motors are equipped with a thermostat that restricts the amount of cooling water allowed into the powerhead until the powerhead reaches normal operating temperature. Actually, on V configuration motors, there is usually one thermostat per cylinder bank (at the top of each cylinder head). The purpose of the thermostat is to prevent cooling water from reaching the powerhead until the powerhead has warmed to normal operating temperature. In doing this the thermostat will increase engine performance and reduce emissions.

However, this means that the thermostat is vitally important to proper cooling system operation. A thermostat can fail bv seizina in either the open or closed positions, or it can, due to wear or deterioration, open or close'at the wrong time. All failures would potentially affect engine operation.

A thermostat that is stuck open or will not fully close, may prevent a powerhead from ever fully warming, this could lead to carbon fouling, stumbling, hesitation and all around poor performance. Although these symptoms could occur at any speed, they are more likelv to affect most motors at idle when high water flow through the open orifice will allow for more cooling than the lower production of heat in the powerhead requires.

A thermostat that is stuck closed will usually reveal itself right away as the engine will not only come up to temperature quickly, but the temperature warning circuit should be triggered shortly thereafter. However, thermostat that is stuck partially closed may be harder to notice. Cooling water may reach the powerhead and keep it within normal operating temperature range at various engine rpm, but allow heat to build up at other rpm. Generally speaking, engines suffering from this type of thermostat failure will show symptoms at part or full throttle, but problems can occur at idle as well. Symptoms, besides overheating, may include hesitation, stumbling, increased noise and smoke from the motor and, general, poor performance.

Testing a thermostat is a relatively easy proposition. Simply remove the thermostat from the oowerhead and suspend it in a container of water. then heat the water watching for the thermostat element to move (open) and noting at what temperature it accomplishes this. Unfortunately, some of the thermostats used on carbureted Evinrude/Johnson engines are assembled in the thermostat housing on the powerhead. On some of these motors. changes in the thermostat element (or vernatherm) may not be obvious. If you suspect a faulty or inoperable thermostat and cannot seem to verify proper opening/closing temperatures, it may be a good idea (especially since you've already gone through the trouble of removing the thermostat) to simply replace it (it's a relatively low cost part, that performs an important function). Doing so should remove it from suspicion for at least a couple of seasons.

1. Locate and remove the thermostat from the powerhead, as detailed in this section.
2. Suspend the thermostat and a thermometer in a container of water. For most accurate test results, it is best to hang the thermostat and a thermometer using lengths of string so that they are not touching the bottoms or sides of the container (this ensures that both components remain at the same temperature as the water and not the container).
3. Slowly heat the water while observing the thermostat vernatherm for movement. The moment you observe movement, check the thermometer and note the temperature. If the water begins to boil (reaches about 212ºF/100ºC at normal atmospheric pressure) and NO movement has occurred, discontinue the test and throw the piece of junk thermostat away (if you are SURE there was no movement from the vernatherm).
4. Remove the source of heat and allow the water to cool (you can speed this up a little by adding some cool water to the container, but if you're using a glass container, don't add too much or you'll risk breaking the container). Observe the vernatherm again for movement as the water cools. When movement occurs, check the thermometer and record the temperature.
5. In most cases, the thermostat should open by 125ºF (53ºC) and it MUST be fully open by about 136-144ºF (58-62ºC).
6. Specifications for closing temperatures are not specifically provided by the manufacturer, but typically a thermostat must close a temoerature close to, but below the temperature for the opening specification: Refer to the Testing Cooling System Efficiency in this section to determine the operating temperatures for your motor. The thermostat MUST close below that temperature. A slight modulation (repeated opening and closing) or the thermostat can occur at borderline temperatures to make sure the powerhead remains in the proper operating range.
7. Replace the thermostat if it does not operate as described, or if you are unsure of the test results and would like to eliminate the thermostat as a possible problem. Refer to the removal and installation procedure for Thermostat in this section for more details.

Thermostat (and Pressure Relief Valve)

All motors are equipped with a thermostat that restricts the amount of cooling water allowed into the powerhead until the powerhead reaches normal operating temperature. Actually, on V configuration motors, there is usually one thermostat per cylinder bank (at the top of each cylinder head). The purpose of the thermostat is to prevent cooling water from reaching the powerhead until the powerhead has warmed to normal operating temperature. In doing this the thermostat will increase engine performance and reduce emissions.

On all models, the thermostat components are mounted in a cooling passage, under an access cover that is sealed using a gasket or an O-ring. On most models the thermostat is mounted directly into the top of the cylinder head, though a few FICHT motors utilize a lower thermostat on one bank. Also, the 65 Jet-115 hp (1632cc) 90º cross-flow V4 motors utilize thermostats mounted in the exhaust housing directly below the powerhead.

Some models, including most FFI and V6/V8 engines are also equipped with a pressure relieve valve. In some cases, like the cross-flow V4 motors, these valves are mounted under the same cover as the thermostat. In most cases, they are mounted separately under a cover secured by 2 or more bolts. On carbureted motors, the covers are obvious due to the presence of 2 or more cooling system hoses connected to fittings on the outside of the cover. On V4 FFI motors, the cover is usually secured to the lower side of the powerhead by 2 hex head bolts.

REMOVAL & INSTALLATION

② MODERATE

◆ See Figures **67, 68, 69, 70, 71, 72, 73, 74** and **75**

On all models, the thermostat assembly is mounted under a cover on the powerhead. Some covers are bolted into position and those are sealed with a gasket (lightly coated with sealant). Other covers are threaded into position and are sealed using an O-ring (which is installed dry, though we fail to see how a very light coating of marine grade grease would hurt). In either case, the thermostat itself MAY also contain its own seal or gasket that is mounted between the thermostat lip and cylinder head. The size, shape and location of this cover, including the number of components and seals found underneath varies by model:

- For 65 Jet-115 hp (1632cc) 90CV4 motors, the thermostats and pressure relief valves are mounted in the exhaust housing adapter found immediately below the powerhead. Access is achieved by unbolting and removing the cover and valve body, each of which is sealed with its own gasket.
- For 75-175 hp (1726/2589cc) 60LV4 and LV6 motors, a thermostat is normally found under a cover at the top of each cylinder head. The cover itself is usually threaded into position with hex flats for the use of a wrench or socket and sealed with an O-ring. However, some FFI models (V6 without hard fuel rails) may have a cover with an integral hose fitting (that prevents the use of a socket). In addition, most V4 FFI models are also equipped with a lower thermostat and pressure relief valve, both mounted at the base of the powerhead. The pressure relief valve is found under a cover (which looks more like the neck of a hard hose than a cover) secured by 2 hex bolts, while the lower thermostat is normally mounted in the cover itself (downstream from the pressure valve).
- For 120-300 hp (2000/3000/3300/4000cc) 90LV4/V6/V8 motors are normally equipped with a thermostat mounted in a housing on top of each cylinder head. With the exception of the FFI models, these covers are bolted in place and sealed with a gasket. Some models (usually the carbureted V6 motors) may have a cooling hose fitting attached to the cover itself. On all carbureted motors, the thermostat assemblies are mounted horizontally, facing outward from the top side of the cylinder head. But, on FFI motors, the thermostats are mounted vertically in the top of the cylinder head, under a threaded cover with a hex fitting (similar to the assemblies used on 60º motors).

Although we have attempted to accurately describe all possible thermostat installations, keep in mind that components may vary in design as well as direction of orientation. For this reason it is important that you take note of the order and orientation of each component as you disassemble them to ensure proper installation and operation.

1. Disconnect the negative battery cable for safety.

2. Remove the engine top cover for access.

To access the lower thermostat on FFI V4 motors, or the pressure relief valves on some models, it may be necessary to remove the lower engine covers. It is also usually necessary to remove the lower engine covers on cross-flow V4 motors, where both the thermostats and pressure relief valves are located in the exhaust adapter at the base of the powerhead.

3. Locate the thermostat housing for the motor undergoing service. Refer to the accompanying paragraphs describing thermostat components and mounting locations (as well as the accompanying illustrations).

4. On some motors, there is a hose is attached to the thermostat housing cover. On these motors, the hose can either be disconnected or, in most cases if there is sufficient play in the hose, it can be left attached while the cover is removed and pushed aside for access to the thermostat. If necessary or desired, cut the wire tie or loosen the hose clamp, then carefully push the hose from the cover fitting.

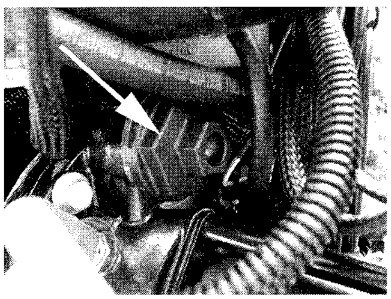


Fig. 67 Thermostats are either mounted under a threaded...

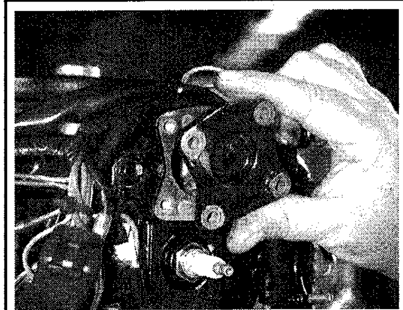


Fig. 68 ... or a bolted cover

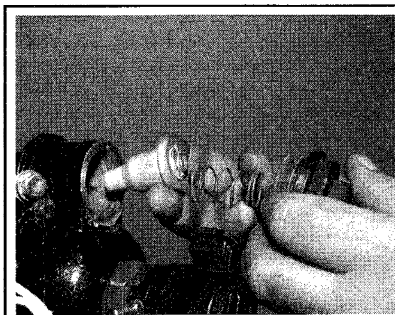


Fig. 69 In either case, the components are easily accessed

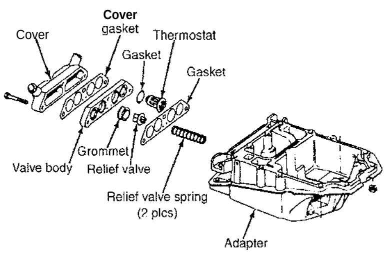


Fig. 70 Exploded view of the thermostat assembly-65 Jet-115 hp **(1632cc) 90CV4** motors

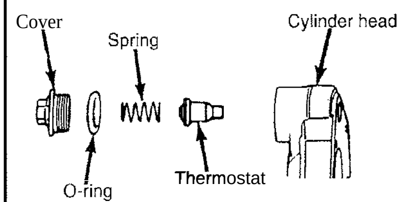


Fig. 71 Exploded view of the thermostat assembly-75-175hp **(1726/2589cc) 60LV4/V6** motors (except FFI V6 without hard fuel rails)

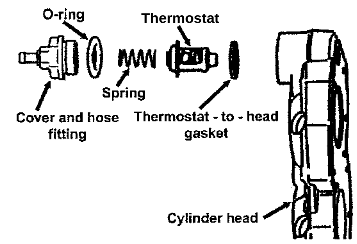


Fig. 72 Exploded view of the thermostat assembly-135-175 hp **(2589cc) 60LV6** FFI motors without hard fuel rails

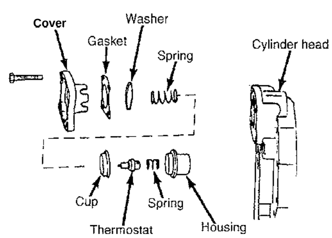


Fig. 73 Exploded view of the thermostat assembly-120-140hp **(2000cc) 90LV4** and 2501300 hp **(4000cc) 90LV8** motors

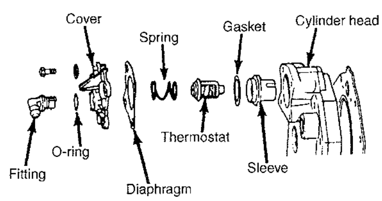


Fig. 74 Exploded view of the **thermostat** assembly-carbureted **185-250** hp **(3000cc) 90LV6** motors

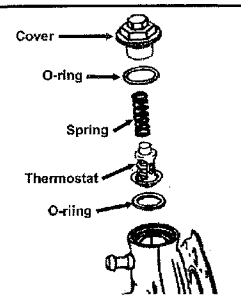


Fig. 75 Exploded view of the thermostat **assembly-FICHT 200-250** hp **(3000/3300cc) 90LV6** motors

In a few cases, covers that are bolted in position can be installed facing different directions. For these models, matchmark the cover to the mating surface or otherwise make a note of cover orientation to ensure installation facing the proper **direction. This** is especially important for covers to which hoses attach (that have been removed).

5. Loosen and remove the thermostat cover as follows:

- For models on which the cover is bolted into place, carefully loosen and remove the cover bolts. If necessary, tap around the outside of the cover using a rubber or plastic mallet to help loosen the seal, then remove the cover from the powerhead. On cross-flow V4 motors, the valve body may or may not come off with the cover, if the thermostats and pressure relief valves are not visible when the cover is removed, gently tap around the perimeter of the valve body to break the gasket seal, then remove the valve body.
- For models on which the cover is threaded into position, there is a normally large flat or hex on the center of the cover. Use a suitably-sized wrench (or a large adjustable or large pair of slip-joint pliers) to loosen the cover and then unthread it from the cylinder head. When the cover has an integral hose nipple, you'll have to grip the flats from the side and not above (meaning a socket usually won't cut it).

■ Remove the thermostat cover slowly, on most (but not all) models there is a spring located under the cover that may come loose when the cover is removed. Keep track of all components, including the order and the orientation of all components as they are removed.

6. Check if the seal or gasket was removed with the cover. When a composite gasket and/or sealant was used, make sure all traces of gasket and sealant material are removed from the cover and the powerhead mounting surface.

7. Remove the thermostat and any mounting components. On most motors that means removing the spring usually mounted above the thermostat. On some motors, such as ihe cross-flow V4s, that also includes removing the pressure relief valves and springs (mounted under the valves). On 90º V4 and V8 engines it includes removing assembled thermostat components including the cup, vernatherm (thermostat), spring and housing. Pay close attention to each component's orientation. Lay each component out on the worksurface in order to ensure installation facing the same directions.

8. If the thermostat itself was sealed to the cylinder head with its own gasket, be sure to remove and discard that gasket or seal as well. This should be true on all 900 V6 motors as well as some 600 V6 FFI motors (that are NOT equipped with hard fuel rails).

9. Visually inspect the thermostat for obvious damage including corrosion, cracks/breaks or severe discoloration from overheating. Make sure any springs have not lost tension. If necessary, refer to the Testing the Thermostat in this section for details concerning using heat to test thermostat function.

To install:

10. Install each of the thermostat components in the reverse of the removal procedure. Replace any gaskets, seals and/or O-rings. Pay close attention to the direction each component is installed.

■ For all models that utilize a gasket and a cover that is bolted in position, lightly coat both sides of the new gasket using **Evinrude/Johnson** Gasket Sealing Compound or equivalent sealant before installation.

11. Assemble the thermostat and/or pressure relief valve components as follows, depending upon the model:

- For 65 Jet-115 hp (1632cc) 90° CV4 motors, position the thermostats and their seals in the valve body, then install pressure relief valves in the valve body. Apply a light coating of sealant to both sides of both gaskets, then install one gasket on the cover and the other gasket on the exhaust housing adapter. Insert the *2* relief valve springs into the adapter, then place the cover on the valve body and the cover/valve body assembly on the exhaust adapter. Tighten the retaining bolts to 60-84 inch lbs. (7-9 Nm).

On **60° V4** and **V6** motors the cylinder head also uses a small internal thermostat seal mounted from underneath the cylinder head. When the thermostat is removed take a moment to inspect that seal for leaks, deterioration or damage and replace if necessary. Unfortunately however, the cylinder head must be removed from the motor in order to replace **that seal.** If this is done, be sure to position the seal with the **markings TO** CYL HEAD facing toward the thermostat.

- For 75-175 hp (1726/2589cc) 60° LV4/V6 motors and 200-250 Hp (3000/3300cc) 90° V6 FFI motors, position the thermostat assembly into the cylinder head. On 60° V6 FFI motors without hard fuel rails and all 90° V6 FFI motors, be sure to position the thermostat-to-cylinder head seal before inserting the thermostat into the cylinder head. Position the spring, then install the cover using a new O-ring and tighten to 120-144 inch lbs. (14-16 Nm).
- When installing the pressure relief valve and lower thermostat on V4 FFI motors, apply a light coating of marine grease to the cover O-ring and a light coating of RTV sealant to the outer edge of the cover. Install the relief valve assembly and cover, then tighten the retaining bolts to 84-96 inch lbs. (9.5-11 Nm). Next, apply a light coating of sealant to both sides of the new thermostat gasket and install that on the cover, install the thermostat assembly and secure using the screws/nuts, also tightened to 84-96 inch lbs. (9.5-11 Nm).

On all carbureted **90°** looper motors, the thermostat mounts in a removable housing or cup in the cylinder head. Always inspect the cup and seal for damage. If replacement is necessary, remove the cup and seal from the cylinder head, then apply a light coating of sealant to the outer diameter of the replacement cup. Install the cup into the cylinder head with the lid facing outward and press it inward until seated.

- For carbureted 120-300 hp (2000/3000/4000cc) 90LV4/V6/V8 motors assemble the thermostats carefully, in the order and orientation noted during removal. Start by inserting the pin into the vernatherm with the convex end facing outward. Next, position the vernatherm and spring(s) into the housing. Coat both sides of the new gasket lightly using sealant, then position the gasket on the cover. Install the cover, making sure the relief spring is properly seated, then install and tighten the cover bolts to 60-80 inch lbs. (7-9 Nm).

12. If removed on motors so equipped, connect the hose to the thermostat cover fitting and secure using the clamp or a new wire tie.

13. Connect the negative battery cable and verify proper cooling system operation.

Water Pu

◆ See Figures **76, 77** and 78

On all Evinrude/Johnson motors, the water pump is attached to the inside of the gearcase. The pump itself usually consists of a multi-vane composite material impeller attached to a portion of the driveshaft that runs through a pump housing and cover. On all models the housing is located on the top of the gearcase lower unit (along the gearcase-to-midsection or adapter section split line). For this reason, the lower unit must be removed for access. Although there are slight differences in water tubes or sleeves/grommets that may be attached to the water pump grommet depending on the year, model and gearcase, the basic design and water pump removal/installation procedure remains the same for all V configuration motors.

For specific water flow diagrams showing the cooling system components and water **passages** for each **Evinrude/Johnson** outboard. please refer to Cooling **System** Schematics in this section.

REMOVAL & INSTALLATION

② MODERATE

◆ See Figures **76** thru 93

■ Replace the impeller, gaskets and any **O-rings/seal** whenever the water pump is removed for inspection or **service. There** is no reason to use questionable parts. Keep in mind that damage to the powerhead caused by an overheating condition (and the subsequent trouble that can occur from becoming stranded on the water) quickly overtakes the expense of a water pump service kit.

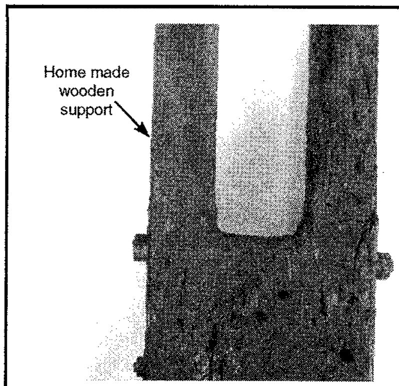


Fig. **76** A wooden fixture is easily fabricated to hold the lower unit during service

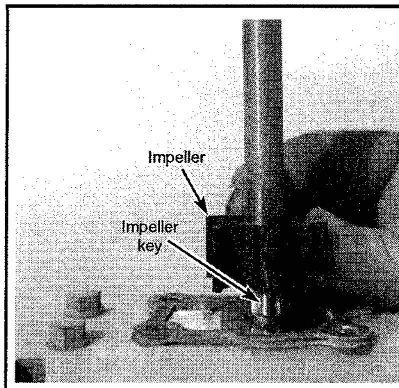


Fig. **77** The impeller (the heart of the water pump) is turned by the driveshaft using an impeller key

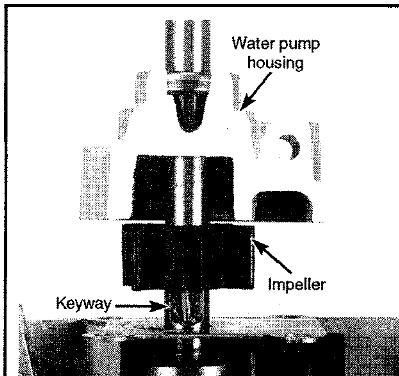


Fig. **78** This cutaway shows the difference in size between the impeller and housing. The impeller blades must bend to one side to fit within the housing

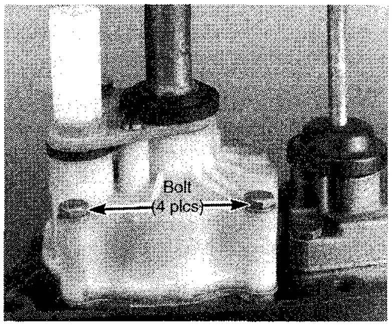


Fig. 79 Remove the 4 retaining bolts in order to free the pump from the lower unit

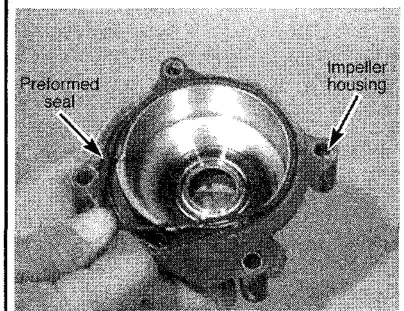


Fig. 80 You should completely disassemble the pump housing removing the impeller, cup, seal and driveshaft O-ring from the underside...

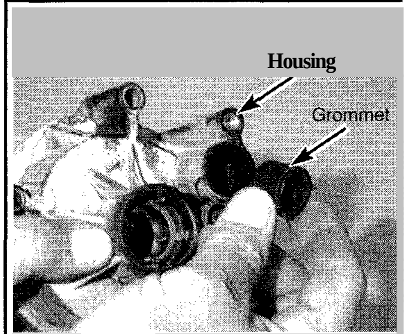


Fig. 81 ... and the cover and grommets from the top of the housing

For ease of service mount the gearcase in a support such as a home-made cavitation plate holder. To fabricate a cavitation plate holder, cut a groove in a short piece of 2" x 6" or 2 x 8" piece of wood. Cut the groove so it can accommodate the lower unit with the cavitation plate resting on top of the wood. Clamp the wood in a vise to hold the lower unit securely during service.

1. Remove the gearcase lower unit from the intermediate housing. For details, refer to the Lower Unit section.
2. Remove the 4 bolts securing the water housing to the lower unit, then rotate the driveshaft slowly by hand in a counterclockwise direction to unlock the impeller cam.
3. Slide or work the housing up off the driveshaft.

☐ Depending on whether or not the impeller pulls off the driveshaft with the housing, either remove it from the housing using a pair of needle-nose pliers or gently pry it upward from the shaft using a **prybar.**

4. If the impeller did not come off with the cover, work the impeller off the driveshaft.
5. Remove the impeller drive pin from the driveshaft.
6. Remove and discard the impeller housing O-ring.
7. Remove the impeller plate, then remove and discard the old plate-to-lower unit gasket. Carefully remove all traces of gasket and sealant from the mating surfaces.
8. Thoroughly inspect the impeller, cover, insert (also known as an impeller cup) and impeller plate for signs of damage or wear and replace, as necessary. For more details, please refer to Inspection & Overhaul, in this section. If the insert is damaged or if the driveshaft O-ring (located between the seal and housing) is to be replaced, pull the insert out of the cover with the needlenose pliers.

■ If you've taken the trouble to go this far (to service a water pump) it is always a good idea to replace both the impeller and the insert to ensure proper pump and cooling system operation.

9. Remove the driveshaft O-ring from the underside of the water pump housing (located under the insert with the housing inverted).
10. Remove all grommets or O-rings included in the repair kit from the top of the housing. If these parts are not included in the repair kit, inspect them and determine if replacement is necessary and obtain the necessary replacement parts.

To install:

11. With the insert removed from the housing, inspect it carefully for any signs of damage, cracks, wear or melting and replace, if necessary.
12. Apply a drop of Evinrude/Johnson Adhesive M or an equivalent sealant to the 4 ribs of the driveshaft O-ring seal groove (located in the underside of the water pump housing, above the insert when it is installed).

✳✳ WARNING

Be careful not to get any sealant on the air bleed groove or the pump could loose its prime and fail to pump water in service.

13. Install the driveshaft O-ring to the groove in the underside of the water pump housing (above the insert).
14. If removed (and you had to in order to access the driveshaft O-ring), coat the outer diameter of the impeller insert lightly using Evinrude/Johnson Gasket Sealing Compound, or equivalent sealant, then install the insert into the water pump housing. Again, be conscious of the air bleed, do not obstruct or get any sealant into the hole.
15. Install the water tube grommet into the water pump housing with the inside taper facing upward.
16. Install the impeller housing cover.
17. Apply a light coating of Evinrude/Johnson Adhesive M or an equivalent sealant to the flat side of the impeller housing grommet (the grommet that seals the driveshaft), then install the grommet with the flat side facing downward.

When **installing** the **impeller** to the water **pump** insert, be sure the drive pin slot is **facing** outward.

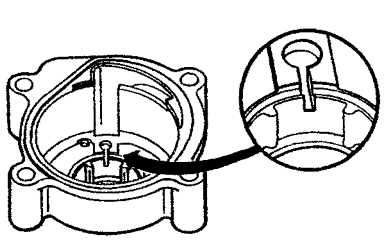


Fig. 82 DO NOT get any sealant on the air bleed groove

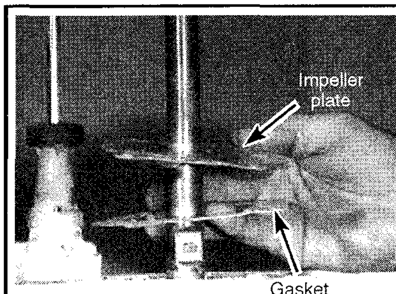
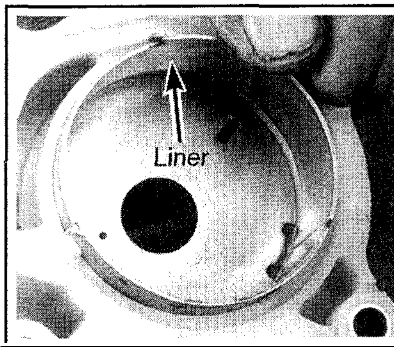


Fig. 83 To prepare for installation, install the impeller plate using a new gasket...



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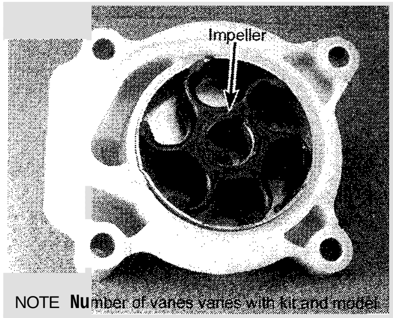


Fig. **85** **...** then install the impeller while rotating counterclockwise (so the blades face clockwise, the normal direction of rotation)

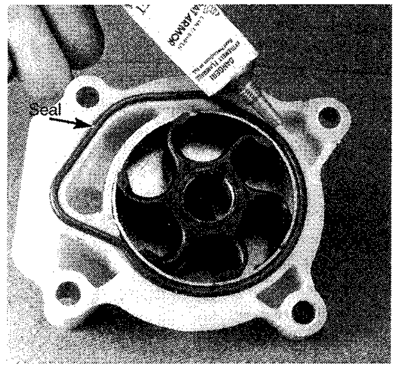


Fig. **86** Apply a thin bead of sealant, then install the pump housing O-ring seal

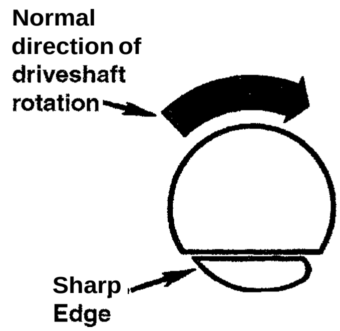


Fig. 87 Driveshaft and impeller drive key installation viewed from ABOVE the **housing**

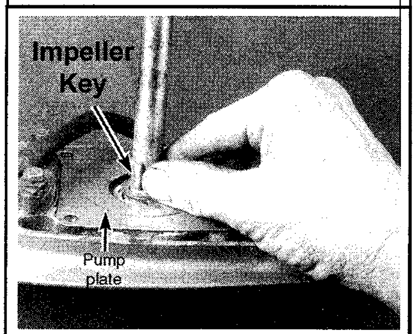


Fig. 88 Use a dab of grease to hold the impeller drive pin in position **...**

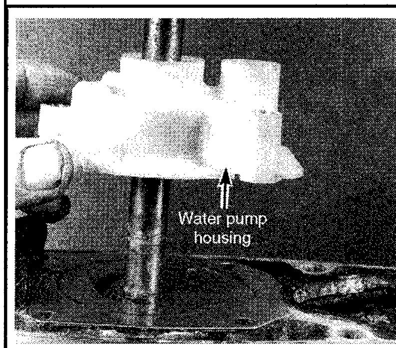


Fig. **89** **...** then slide the water pump housing and impeller down the shaft

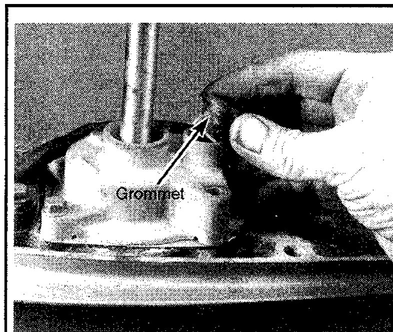


Fig. **90** If not done already, the water tube grommet should be replaced**...**

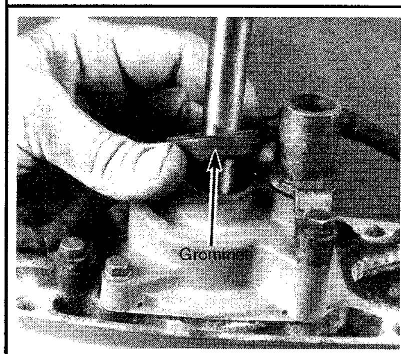


Fig. 91 **...**along with the housing grommet (secure both with adhesive sealant)**...**

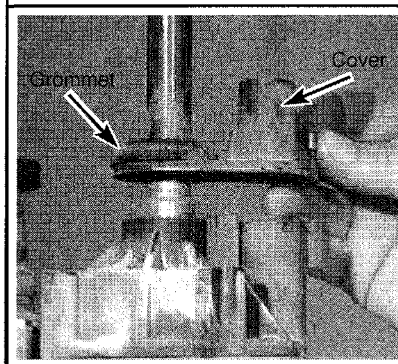


Fig. **92** **...** and the cover must be in position

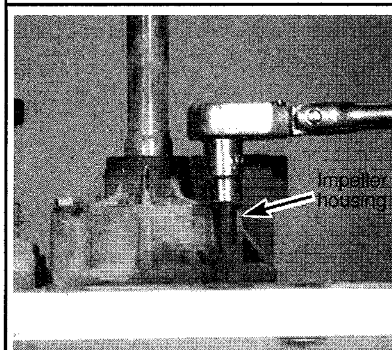


Fig. 93 With all parts installed and the housing aligned, install and tighten the pump bolts

18. Apply a light coat of engine or gear oil to the insert, then install the impeller to the insert while rotating the impeller counterclockwise. In this way the impeller blade tips will be facing the clockwise when looking at the underside of the pump housing (this is the same direction that they will face when the housing is installed and the driveshaft rotates clockwise, the normal direction of rotation, when viewed from above).

19. Apply a thin bead of Evinrude/Johnson Adhesive M or an equivalent sealant in the groove for the water pump housing-to-impellerplate O-ring (the irregular shaped O-ring that mounts in the bottom of the pump housing). Install the O-ring to the groove.

20. Apply a bead of Evinrude/Johnson Gasket Sealing Compound or equivalent sealant to both sides of a new impeller plate gasket, then position the gasket and plate on the gearcase lower unit.

21. Apply a light coating of EvinrudelJohnsonTriple-Guardor an equivalent marine grease to a new impeller O-ring, then place the O-ring over the driveshaft and slide it down into contact with the plate.

22. Apply a dab of EvinrudelJohnson Needle Bearing Assembly Grease or another suitable lubricant onto the pump impeller drive pin, and then place it against the flat on the driveshaft. Insert the drive key with the sharp edge facing the normal direction of rotation for the driveshaft.

23. Slide the water pump assembly down the driveshaft, aligning the impeller housing with the gearcase. Before the impeller comes to the drive pin, rotate the driveshaft to align the drive pin with the slot in the impeller and then slide the pump the rest of the way down against the impeller plate.

✻✻ WARNING

It is critical that the drive pin does not move out of position when sliding the **pump/impeller** down over the driveshaft.

24. Make sure the drive pin has properly engaged the impeller.
25. Apply a light coating of Evinrude/Johnson Gasket Sealing Compound, or equivalent sealant to the threads of the water pump housing bolts.
26. Install and finger-tighten the 4 water pump housing bolts, then tighten the bolts to 60-84 inch lbs. (7-9 Nm).
27. If equipped install the water tube or sleeve extension to the pump housing.
28. Install the gearcase, as detailed in the Lower Unit section.

INSPECTION & OVERHAUL

Let's face it, you've gone through the trouble of removing the water pump for a reason. Either, you've already had cooling system problems and you're looking to fix it, or you are looking to perform some preventive maintenance. Although the truth is that you can just remove and inspect the impeller, replacing only the impeller (or even reusing the impeller if it looks to be in good shape) WHY would you? The cost of a water pump rebuild kit is very little when compared with the even the time involved to get this far. If you've misjudged a component, or an O-ring (which by the way, never reseal quite the same way the second time), then you'll be taking this lower unit off again in the very near future to replace these parts. And, at best this will be because the warning system activated or you noticed a weak coolant indicator streams or, at worst, it will be cause you're dealing with the results of an overheated powerhead.

In short, if there is one way to protect you and your engine, it is to replace the impeller and insert (if used) along with all O-ring seals, grommets and gaskets, anytime the pump housing is removed. If not, take time to thoroughly clean and inspect the old impeller, housing and related components before assembly and installation. New components should be checked against the old. Seek explanations for differences with your parts supplier (but keep in mind that some rebuild kits may contain upgrades or modifications.)

1. Remove and disassemble the water pump assembly as detailed in this section.
2. Carefully remove all traces of gasket or sealant material from components. If some material is stubborn, use a suitable solvent in the next steps to help clean material. Avoid scraping whenever possible, especially on plastic components whose gasket surfaces are easily scored and damaged.
3. Clean all metallic components using a mild solvent (such as Simple Green® cut with water or mineral spirits), then dry using compressed air (or allow them to air dry).
4. Clean plastic components using isopropyl alcohol or Evinrude/Johnson Cleaning Solvent.

☐ Skip the next step, we really mean it, don't INSPECT the impeller, REPLACE IT. Ok, we've been there before, if you absolutely don't want to replace the impeller. Let's say it's only been used one season or so and you're here for another reason, but you're just being thorough and checking the pump, then perform the next step.

5. Check the impeller for missing, brittle or burned blades. Inspect the impeller side surfaces and blade tips for cracks, tears, excessive wear or a glazed (or melted) appearance. Replace the impeller if these defects are found. Next, squeeze the vanes toward the hub and release them. The vanes should spring back to the extended position. Replace the impeller if the vanes are set in a curled position and do not spring back when released.
6. The water pump impeller should move smoothly up or downward on the driveshaft. If not, it could become wedged up against the housing or down against the impeller plate, causing undue wear to the top or bottom of the blades and hub. Check the impeller on the driveshaft and, if necessary, clean the driveshaft contact surface (inside the impeller hub) using emery cloth.
7. Inspect the water pump body or the lining inside the water pump body, as applicable, for burned, worn or damaged surfaces. Replace the impeller lining, if equipped, or the water pump body if any defects are noted.
8. Visually check the water pump housing (and insert, if equipped), along with the impeller wear plate for signs of overheating including warpage (especially on the plate) or melted plastic. Some wear is expected on the impeller plate and, if equipped, on the housing insert, but deep grooves (with edges) are signs of excessive wear requiring component replacement.

A groove is considered deep or edged if it catches a fingernail.

9. Check the water tube grommets and seals for a burned appearance or for cracked or brittle surfaces. Replace the grommets and seals if any of these defects are noted.

Cooling System Schematics

◆ See Figures 94, 95, 96, 97, 98, 99, 100, 101 and 102

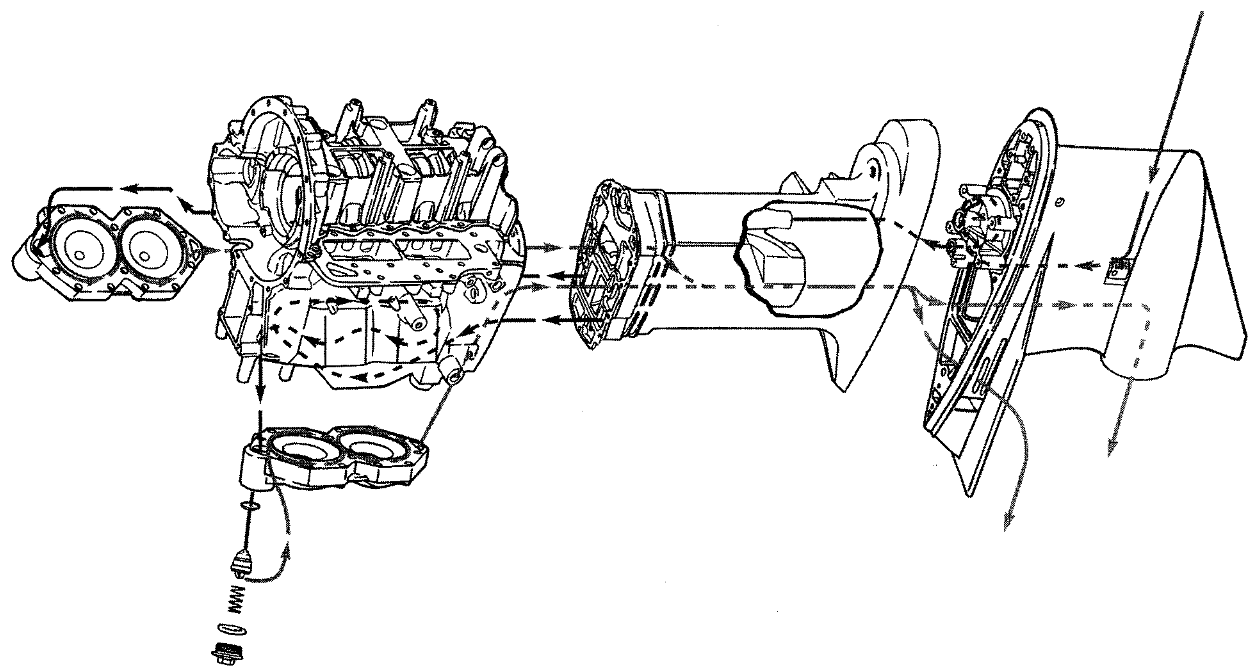


Fig. 95 Cooling system water flow schematic-75-115 hp (1726cc) 60LV4 motors

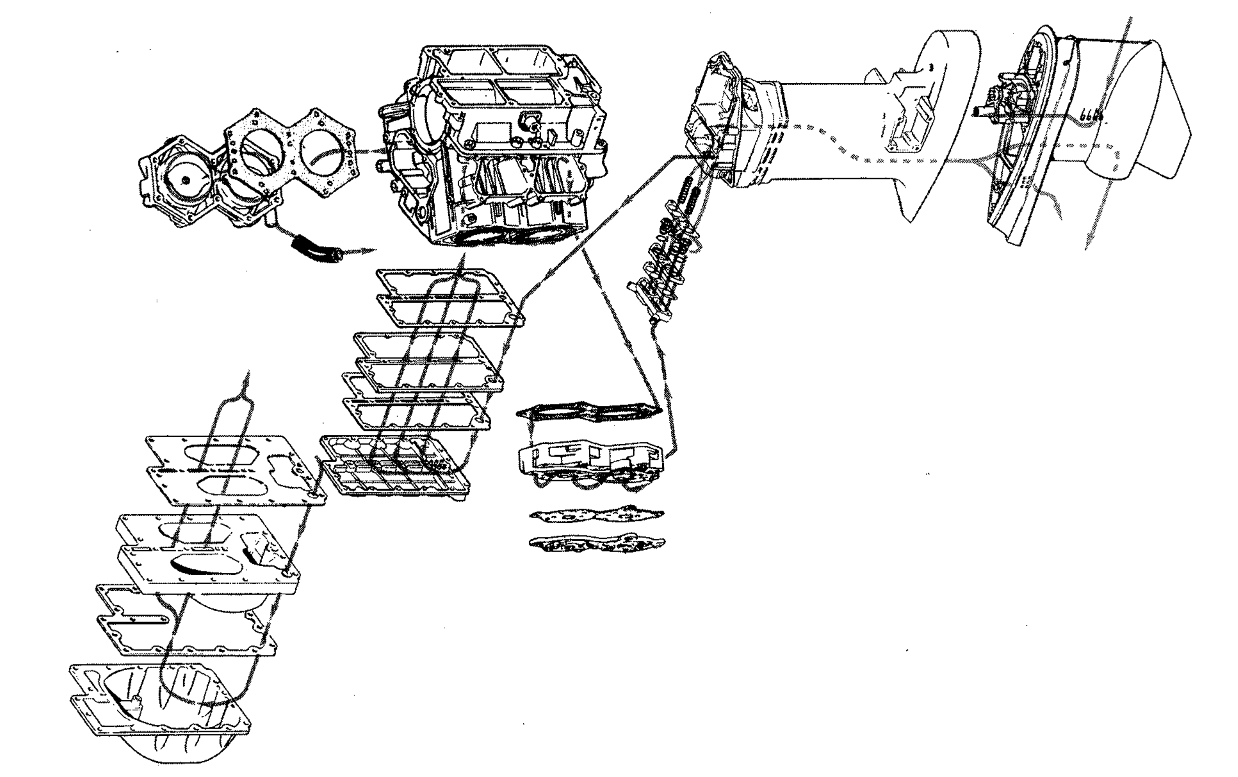
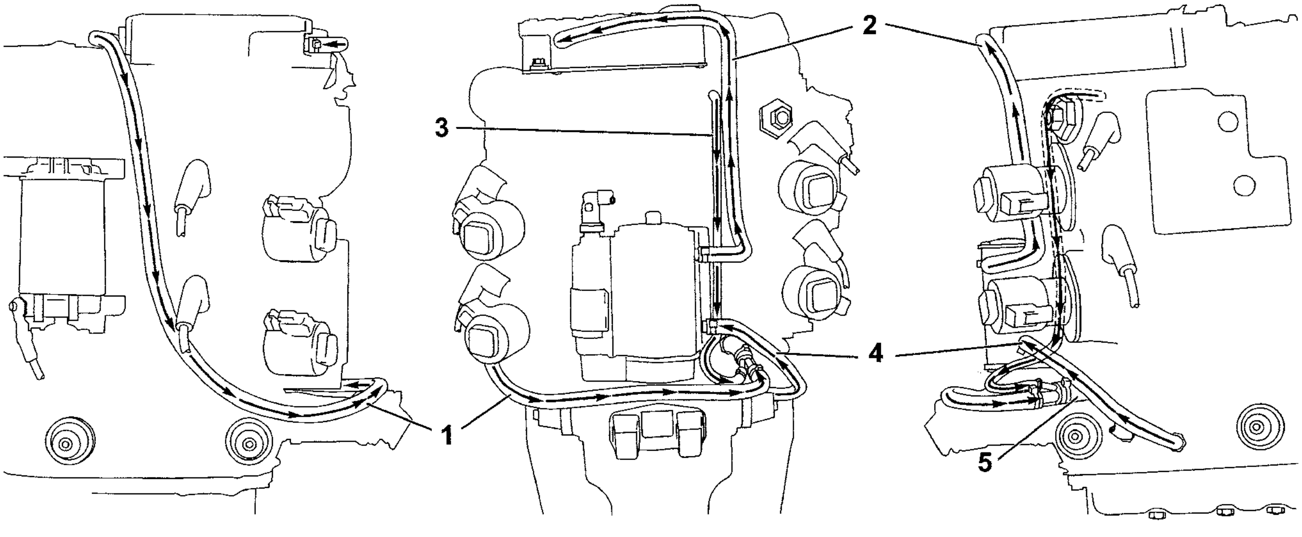
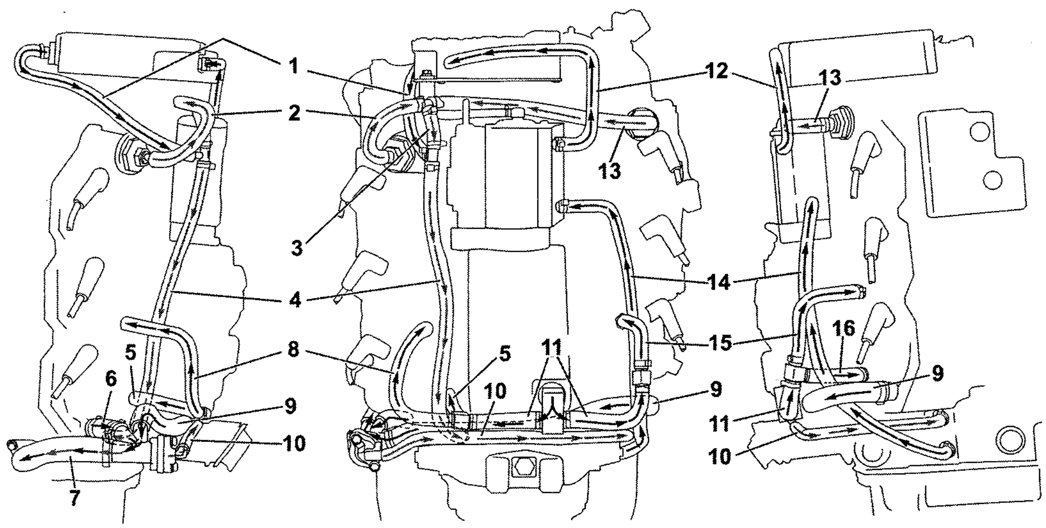


Fig. 94 Cooling system water flow schematic-65 Jet-115 hp (1632cc) 90CV4 motors



1 EMM Drain to Tee
2 Vapor separator to EMM
3 Block Drain to Tee
4 Block to Vapor Separator
5 Tee to Block Drain

Fig. 96 FICHT cooling hose routing schematic-2000 and later 75-115 hp (1726cc) 60LV4 motors



1 EMM Drain
2 Upper Thermostat Drain, Port
3 Thermostat Drain Tee
4 Drain to Cylinder Block
5 Block to Cylinder Head, Lower Port
6 Port Cylinder Head to Drain
7 Pressure Relief Drain
8 Block to Cylinder Head, Upper Port
9 Starboard Cylinder Head to Drain
10 Lower Thermostat Drain
11 Block to Cylinder Head
12 Vapor Separator to EMM
13 Upper Thermostat Drain, Starboard
14 Block to Vapor Separator
15 Block to Cylinder Head, Upper Starboard
16 Block to Cylinder Head, Lower Starboard

Fig. 97 FICHT cooling hose routing schematic-2000 and later 150-175 hp (2589cc) 60LV6 motors with hard fuel rails

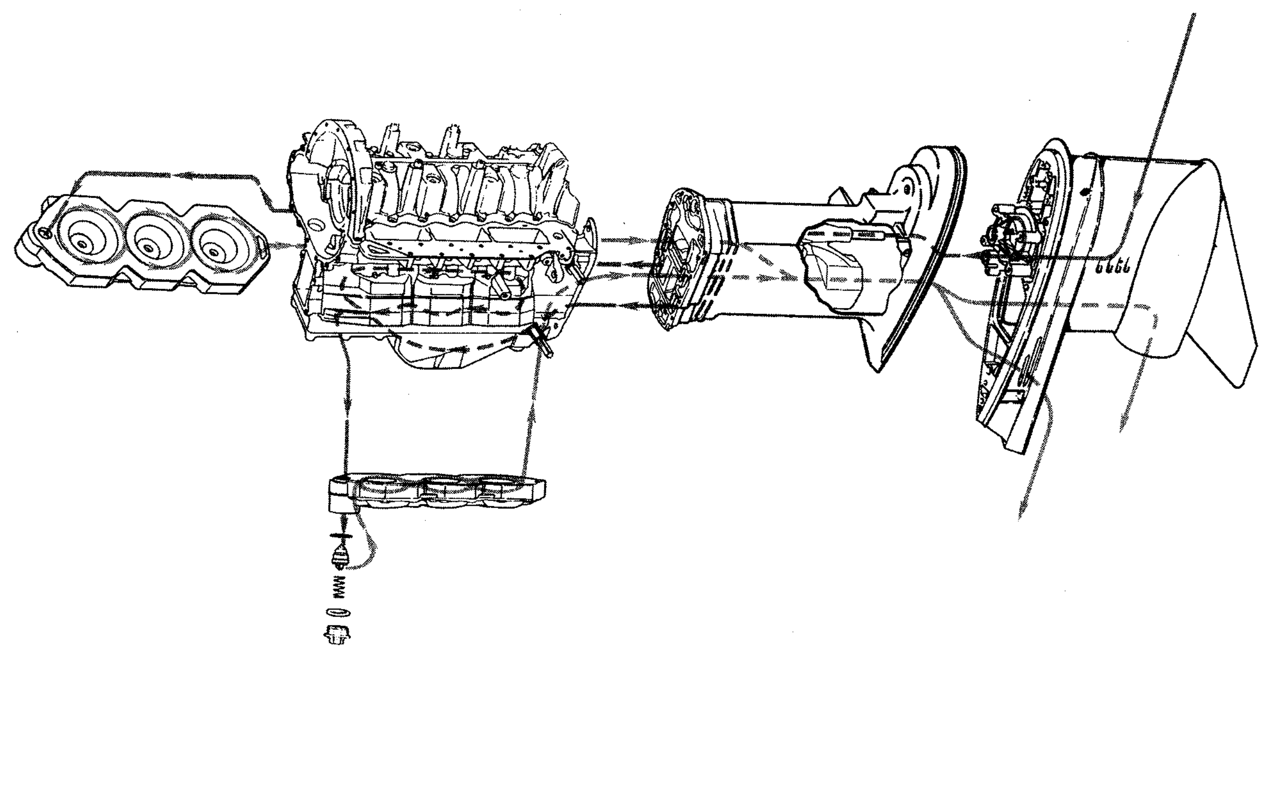


Fig. 99 Cooling system water flow schematic-105 Jet-175 hp (2589cc) 60LV6 motors

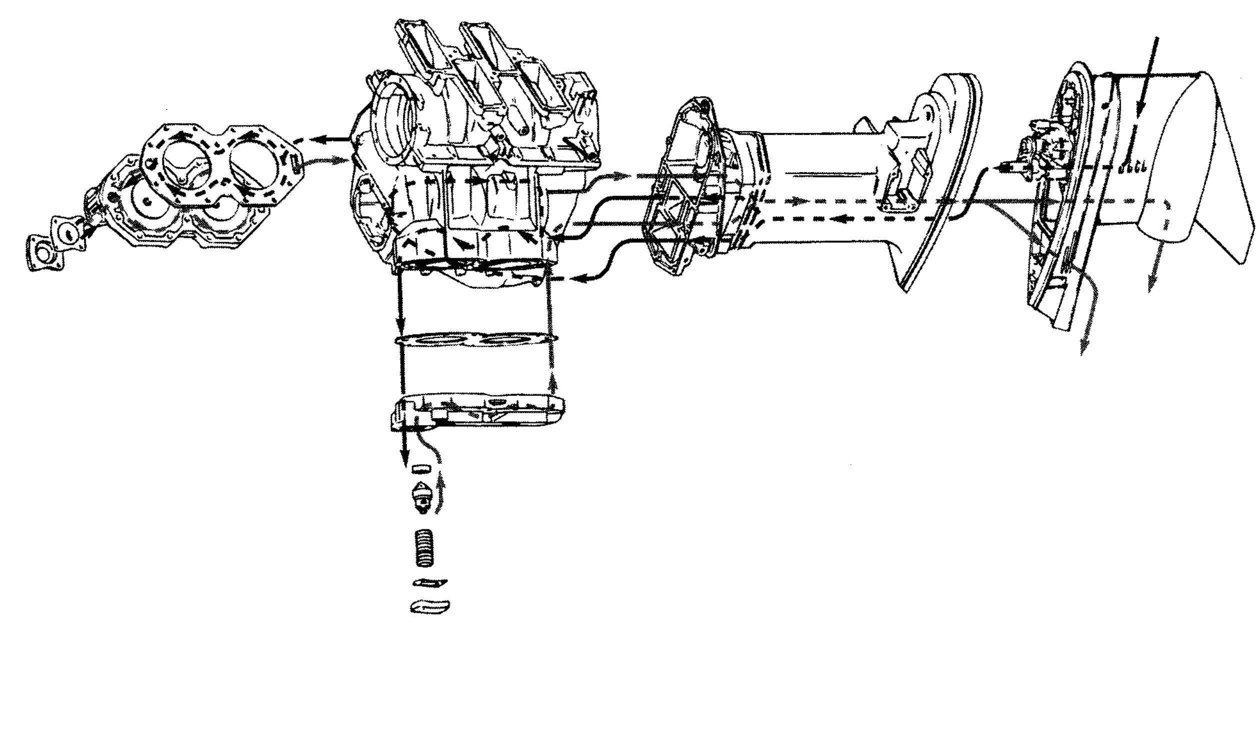


Fig. 98 Cooling system water flow schematic-120-140 hp (2000cc) 90LV4 motors

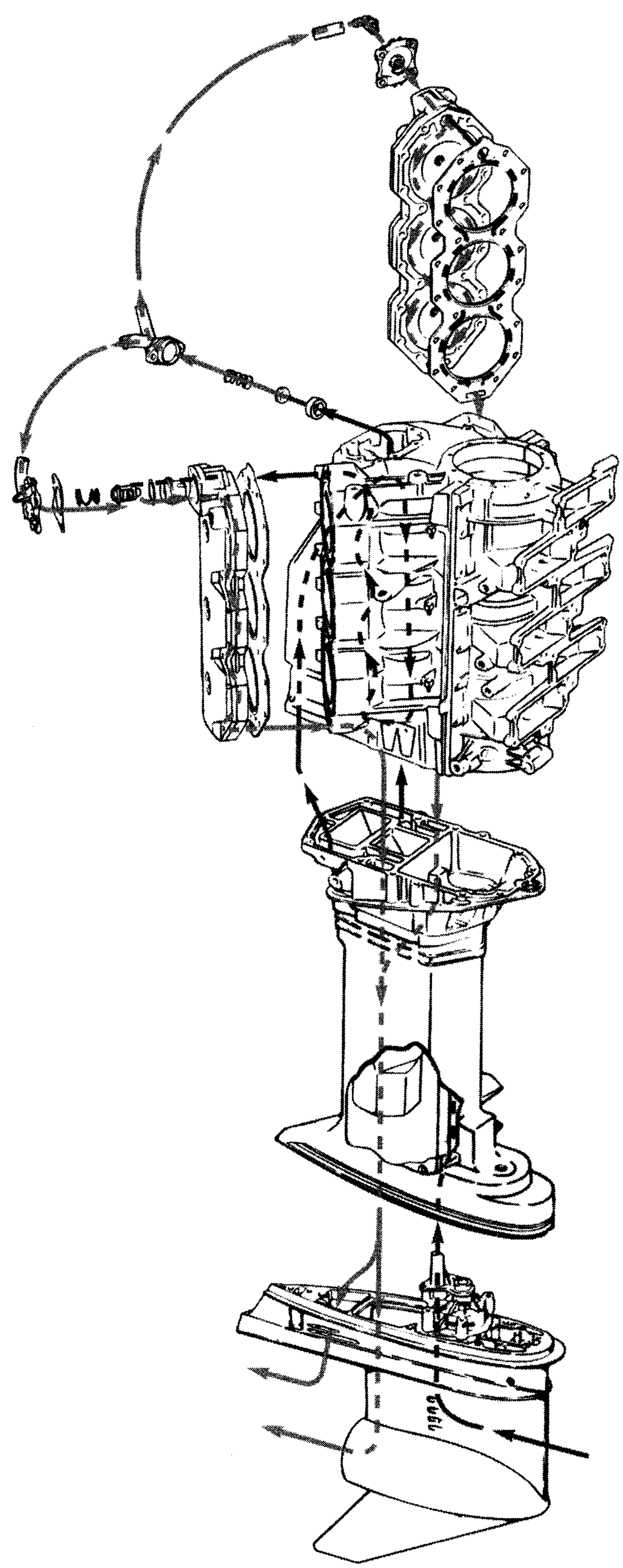


Fig. 100 Cooling system water flow schematic-185-250 hp (3000/3300cc) 90LV6 motors

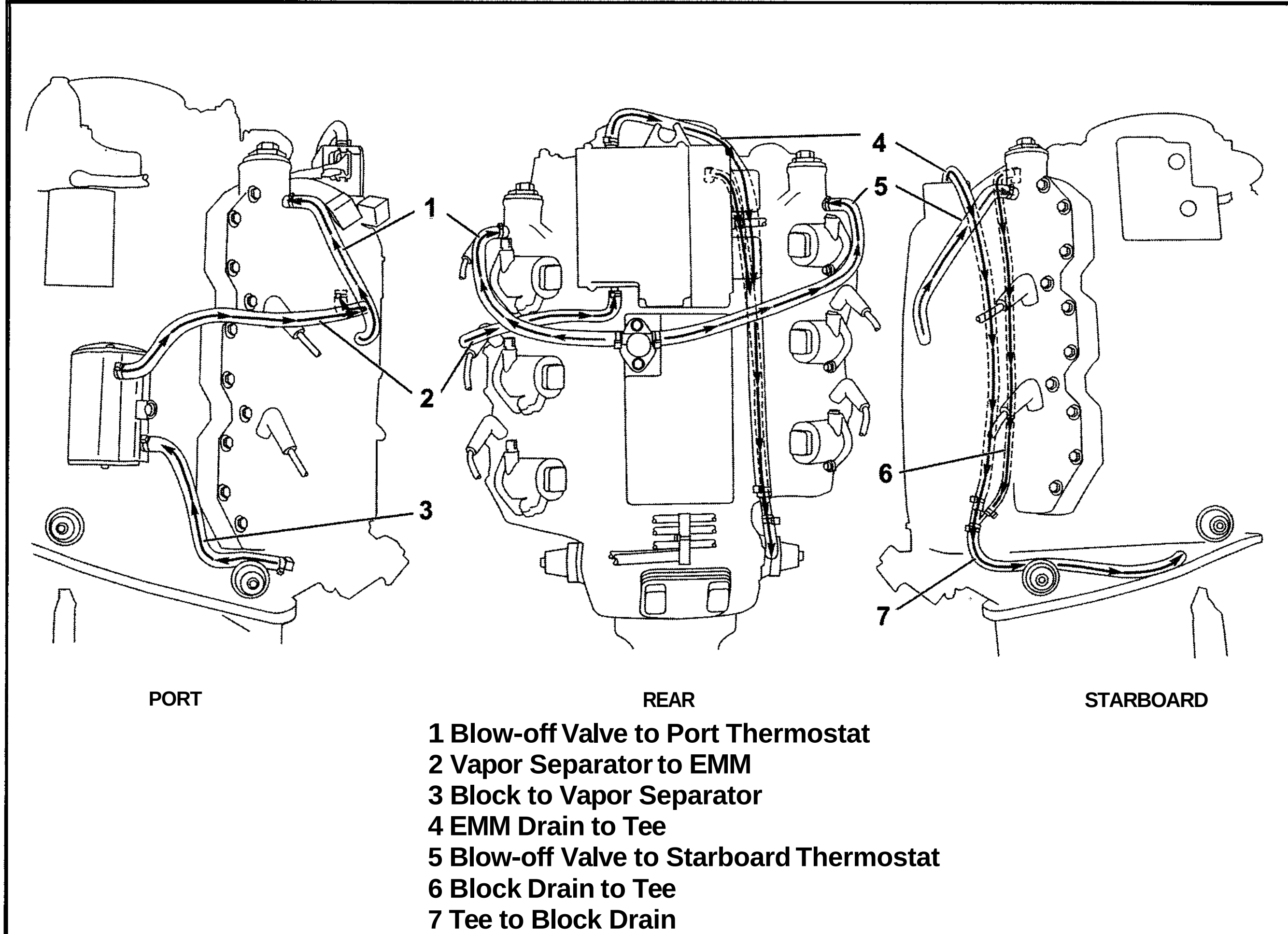


Fig. 101 FICHT cooling hose routing schematic-200-250 hp (3000/3300cc) 90LV6 motors

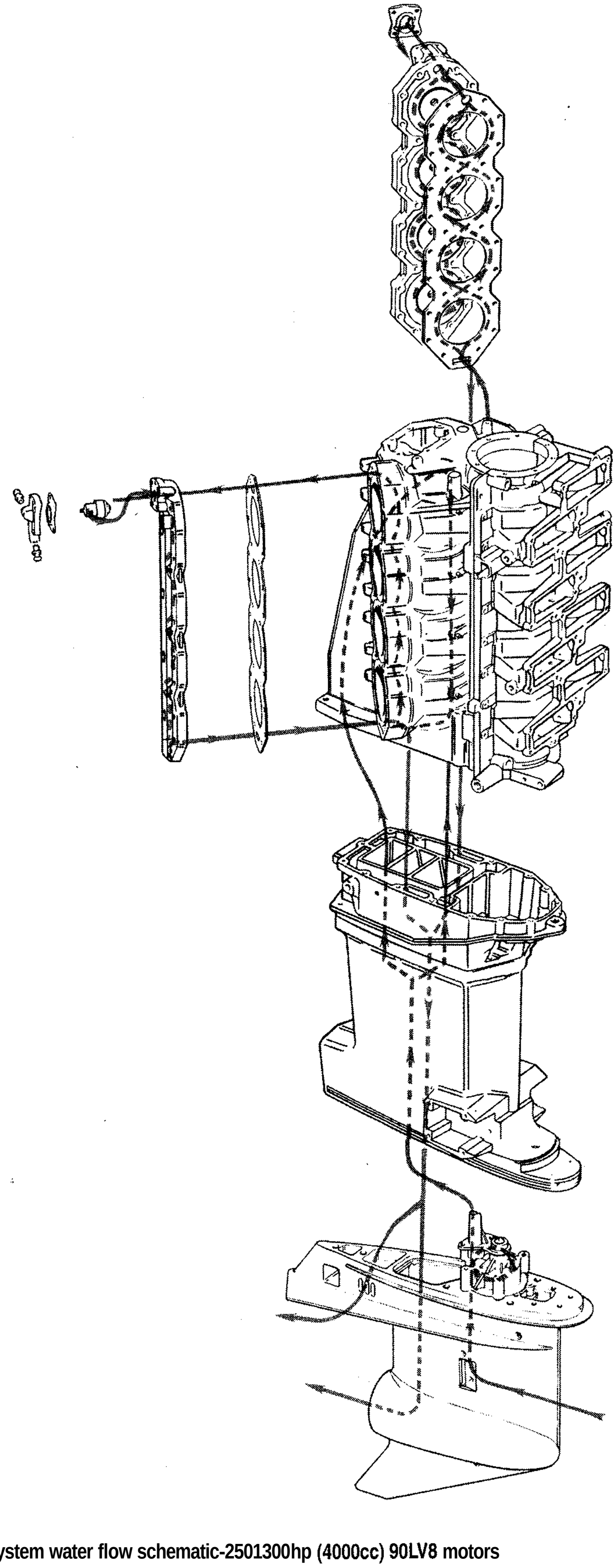


Fig. 102 Cooling system water flow schematic-2501300hp (4000cc) 90LV8 motors

6 ENGINE MECHANICAL

POWERHEAD

You can compare the major components of an outboard with the engine and drivetrain of your car or truck. In doing so, the powerhead is the equivalent of the engine and the gearcase is the equivalent of your drivetrain (the transmissionltransaxle).The powerhead is the assembly that produces the power necessary to move the vehicle, while the gearcase is the assembly that transmits that power via gears, shafts and a propeller (instead of tires).

Speaking in this manner, the powerhead is the "engine" or "motor" portion of your outboard. It is an assembly of long-life components that are protected through proper maintenance. Lubrication, the use of high-quality 2-stroke oil and proper fuel/oil ratios are the most important ways to preserve powerhead condition. Similarly, proper tune-ups that help maintain proper air/fuel mixture ratios and prevent pinging, knocking or other potentially damaging operating conditions are the next best way to preserve your motor. But, even given the best of conditions, components in a motor begin wearing the first time the motor is started and will continue to do so over the life of the powerhead.

Eventually, all powerheads will require some repair. The particular broken or worn component, plus the age and overall condition of the motor may help dictate whether a small repair or major overhaul is warranted. The complexity of the job will vary with 2 major factors. As much as you can generalize about mechanical work:

The age of the motor (the older OR less well maintained the motor is) the more difficult the repair

The larger and more complex the motor, the more difficult the repair.

Again, these are generalizations and, working carefully, a skilled do-it-yourself boater can disassemble and repair a 200 hp FFI powerhead, as well as a seasoned professional. But both DIYers and professionals must know their limits. These days, many professionals will leave portions of machine work (from cylinder block and piston disassembly, cleaning and inspection to honing and assembly up to a machinist). This is not because they are not capable of the task, but because that's what a machinist does day in and day out. A machinist is naturally going to be more experienced (and efficient) with the procedures.

If a complete powerhead overhaul is necessary on your outboard, we recommend that you find a local machine shop that has both an excellent reputation and that specializes in marine work. This is just as important and handy a resource to the professional as a DIYer. If possible, consult with the machine shop before disassembly to make sure you follow procedures or mark components, as they would desire. Some machine shops would prefer to perform the disassembly themselves. In these cases, you can usually remove the powerhead from the gearcase and deliver the entire unit to the shop for disassembly, inspection, machining and assembly.

If you decide to perform the entire overhaul yourself, proceed slowly, taking care to following instructions closely. Consider using a digital camera (if available) to help document assemblies during the removal and disassembly procedures. This can be especially helpful if the overhaul or rebuild is going to take place over an extended amount of time. If this is your first overhaul, don't even THINK about trying to get it done in one weekend, YOU WON'T. It is better to proceed slowly, asking help when necessary from your trusted parts counterman or a tech with experience on these motors.

Keep in mind that anytime pistons, rings and bearings have been replaced, the powerhead must be broken-in again, as if it were a brand-new motor. Once a major overhaul is completed, refer to the section on Powerhead Break-In for details on how to ensure the rings set properly without damage or scoring to the new cylinder wall or the piston surfaces. Careful break-in or a properly overhauled motor will ensure many years of service for the trusty powerhead.

Flywheel

On all models, the flywheel is secured to the top of the crankshaft. The flywheel is important to engine operation on multiple levels. First and foremost, it represents a means by which the crankshaft can be rotated (usually by means of an electric starter motor) for engine start-up. Mechanically, the flywheel is used as a means of continuing engine rotation and momentum between piston powerstrokes. Additionally, permanent magnets are mounted to all EvinrudelJohnson flywheels that are used with the electrical and ignition systems to generate voltage in various coils mounted underneath the flywheel (for more details, refer to the Ignition and Electrical System section).

REMOVAL & INSTALLATION

OEM ② MODERATE

◆ See Figures **1, 2, 3, 4** and **5**

Flywheel removal and installation is a relatively straightforward procedure during which a tool of some sort it used to hold the flywheel (and therefore the crankshaft) from rotating while the retaining nut (90° motors) or bolts (600 motors) is/are loosened. Then once the flywheel is unbolted, a universal puller is usually necessary to free it from the tapered portion of the crankshaft.

However, before this can be accomplished, you will have to access the flywheel, which us mounted under a timing cover on 60° motors. The design of timing cover on carbureted versions of these motors makes flywheel removal a little more involved and therefore, we've noted the differences in the procedure. On carbureted versions of the 80 Jet-175 hp (1726/2589cc) V4/V6 motors, you'll need a piston stop tool to hold the crankshaft from turning while loosening the timing wheel bolt (the wheel must first be removed in order to remove the flywheel timing cover).

✳✳ WARNING

Never strike the flywheel to loosen **it** otherwise the magnets may crack or dislodge resulting in poor charging **and/or** ignition system performance. Always use a **puller** to **help dislodge** a tight **flywheel.**

On most models, various tools can be used to hold the flywheel itself. On most models a suitably sized (large) strap wrench that fits around the entire flywheel can usually be used to hold the flywheel steady. But, keep in mind that you'll be generating rotational forces in the neighborhood of 140-150 ft. lbs. (190-204 Nm) on the larger EvinrudelJohnson motors and that could make the use of a standard strap wrench unfeasible. A flywheel holding tool designed to engage with multiple teeth along the curved circumference of the flywheel is a better alternative. The manufacturer recommends the use of either Snap-On Flywheel Holding Fixture No. A-144 or EvinrudelJohnson Flywheel Holder No. 771311.

■ Although mechanics have been known to do it, we don't recommend using a flywheel holding tool or **prybar** against just ONE flywheel tooth and a boss or bolt in the top of the powerhead. Placing that much stress on a single tooth can result in damage to the flywheel (such as breaking teeth from the ring gear) resulting in a need for flywheel replacement.

On 600 motors, the flywheel retaining screws should NOT be reused. Make sure that you have 5 replacements handy come installation time.

1. Disconnect the negative battery cable for safety.
2. If equipped, remove the flywheel cover or hand-rewind starter from the top of the motor and the flywheel as follows:

For details on rope start models, refer to the Hand Rewind Starter section.

On 60° FFI models, remove the Engine Management Module (EMM) and disconnect the 2-pin harness for the crankshaft position sensor, then remove the 11 screws securing the flywheel cover and remove the cover from the motor.

On carbureted 60° models, unbolt and remove the timing sensor and regulatorlrectifier cover, then disconnect the timing sensor plug. Rotate the crankshaft about 30° After Top Dead Center (ATDC) and install a piston stop tool, such as the EvinrudelJohnson Piston Stop 384887 into the spark plug bore for the No. 1 cylinder. Turn the tool until it bottoms on the piston and lock it in place, then loosen the timing wheel retaining screw (using the stop tool to keep the crankshaft from turning). Remove the piston stop tool. Remove the pointer from the timing cover and the timing wheel from the crankshaft. Remove the 17 screws securing the flywheel cover, then lift the cover upward and gently tap the throttle shaft out of the throttle arm. Finally, remove the roller arm shaft and throttle shaft retainers, then remove the cover completely from the engine.

3. Secure the flywheel using a suitable holding tool.

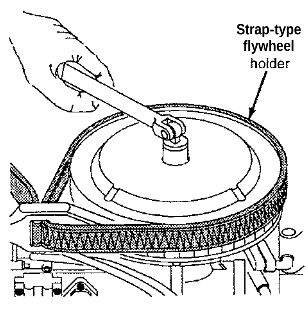


Fig. 1 Use a strap wrench or holding fixture to secure the flywheel while removing the **retainer(s)**

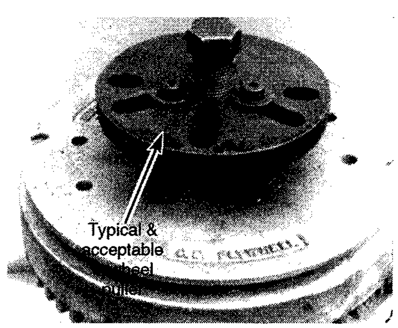


Fig. 2 Install a puller to free the flywheel **...**

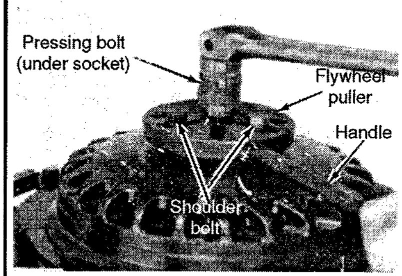


Fig. 3 **...** then hold the puller steady while tightening the pressing bolt

4. Using a large breaker bar and suitably sized socket (1 7/16 in. on all 90° powerheads), turn the flywheel retaining nut (90° motors) or bolts (60° motors) counterclockwise to loosen. Remove the single nut (900) or 5 bolts (600) and remove it from the top of the flywheel.

5. On 90° V6 or V8 motors equipped with power steering, release the tension on the power steering belt using the idler pulley (for details, please refer to the Power Steering Belt procedures in the Maintenance and Tune-Up section). Then, remove the 6 bolts securing the pulley to the flywheel.

☐ To protect the crankshaft from damage, apply a light coating of **Evinrude/Johnson** Moly Lube or equivalent lubricant to the puller center (pressing) screw threads and to the center hole of the crankshaft

6. install a suitable puller to the top of the flywheel by aligning the puller slots with 3 bolt holes (90° motors) or 2 bolt holes (60° motors) in the top of the flywheel. On 60° motors, use two 3/8 - 24 x 1 in. screws into 2 of the 5 flywheel holes (2 of which are tapped to match those bolt threads, refer to bolt positions 3 and 4 of the flywheel torque sequence in the accompanying illustration), Install the puller bolts to secure the assembly, then installed center screw to the puller to drive the flywheel off the top of the crankshaft. Make sure the puller assembly is sitting level, parallel to the top of the flywheel (adjust the puller bolts as necessary).

☐ A universal threaded puller is best for this purpose, refrain from using a jawed puller, even if you have one **that is** big enough, because they do not spread the force out as well as a bolted puller.

7. Carefully tighten the puller center screw until the flywheel releases from the crankshaft taper. Remove the flywheel and puller tool assembly and then remove the puller tool from the flywheel.

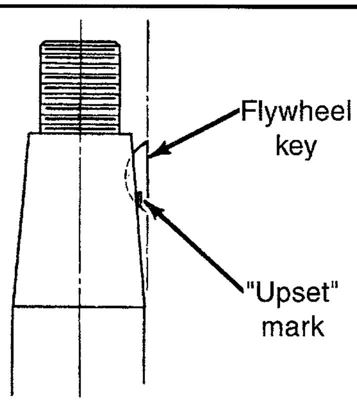


Fig. **4** Install the key to the crankshaft so it is parallel to the shaft centerline (the upset mark, when present, should normally face downward)

8. Thoroughly clean and inspect the flywheel assembly for signs of damaged/missing teeth or magnets and for any cracks, severe discoloration or other signs of damage. Replace the flywheel, if necessary.

9. Remove the flywheel key from the crankshaft taper. Check the end of the crankshaft and key for damage. If the key is damaged in any way, replace it to ensure proper engine operation.

To install:

10. Install the flywheel drive key (a NEW one, if necessary) into the key slot in the crankshaft. Be sure to face the rounded side of the key toward the crankshaft. Paying close attention to key alignment, make sure the outside of the key (flat side) is positioned parallel to the centerline of the crankshaft (straight up and down).

11. Clean the crankshaft and flywheel tapers using solvent and allow to air dry. The surfaces must be clean and dry to allow the proper taper locking once the flywheel is installed.

12. Lower the flywheel onto the crankshaft taper, turning the flywheel in order to align the keyway properly with the key. Once aligned, carefully push downward on the flywheel to seat it.

■ On **60°** motors, make sure the crankshaft roll pin is aligned with the roll pin hole in the flywheel while the flywheel is lowered into position. Again, referring to the accompanying flywheel torque sequence illustration, notice the round pin hole located between bolt holes 2 and 5. Also, please note that an installation tool, No. **434649,** from the **Evinrude/Johnson** Flywheel Service Kit, is available from **Evinrude/Johnson** to help seat the flywheel over the crankshaft.

13. Verify that the keyway and key are properly engaged by rotating the flywheel slowly by hand in the normal direction of rotation (clockwise when viewed from above), The crankshaft must turn along with the flywheel or the key and keyway are not properly engaged (if so, remove the flywheel and realign it, inspect they key again to make sure there is no damage.)

14. On 90° motors, apply a coating of Evinrude/Johnson Gasket Sealing Compound or equivalent sealant to the threads of the flywheel nut.

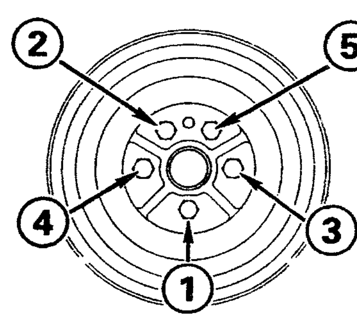


Fig. 5 On **600** motors, be sure to tighten the flywheel retainers using the illustrated torque sequence (note the positioning of the crankshaft roll pin between bolts 2 and 5 in the sequence)

15. Install the flywheel retaining nut (90° motors) or the 5 NEW bolts (600 motors),

16. Using the flywheel holder, secure the flywheel from turning and tighten the flywheel retainer(s) to:

- 65 Jet-115 hp (1632cc) 900 CV4 motors: 100-105 ft. lbs. (135-140 Nm).
- 75-175 hr, (1726/2589cc) 60° LV4/V6 motors: 23-25 ft. lbs. (31-34 Nm) using the star-patterned crossing sequence in the accompanying illustration.
- On carbureted 120-300 hp (2000/3000/4000cc) 90° LV4/V6/V8 motors: 140-150 ft. lbs. (190-204 Nm).
- On FFI 200-250 hp (3000/3300cc) 90° LV6 motors: 140-145 ft. lbs. (190-196 Nm).

17. Remove the flywheel holder. If equipped, install the flywheel cover or hand rewind starter.

18. On carbureted 60° motors, install the flywheel timing cover and related components, as follows:

a. Make sure the wave washer is still positioned on the starter pinion shaft.

b. Install the flywheel cover and tighten the 17 retaining bolts to 40-50 inch lbs. (4.5-5.6 Nm).

c. Install the spark lever assembly to the throttle shaft and secure using the retainer.

d. Position the timing wheel on the crankshaft and install the timing pointer. Adjust the timing pointer as detailed under Timing and Synchronization in the Maintenance and Tune-Up section.

e. Clean the threads of the timing wheel retaining screw, then coat it lightly using EvinrudelJohnson Locquic primer. Allow it to dry and then apply a light coating of EvinrudelJohnson HT 400 or equivalent to the threads. Install the timing wheel screw and tighten to 120-140 inch lbs. (14-16 Nm).

f. Refer to the Timing and Synchronization section for additional checks and adjustments, but remember, because sources of bright sunlight can disrupt the optical ignition sensor, avoid running the engine in direct sunlight with the timing wheel cover removed. Install the balance of the components, as necessary, while making adjustments.

19. On FFI 60° motors, install the flywheel cover and tighten the 11 retaining bolts to 40-50 inch lbs. (4.5-5.6 Nm). Next, install the throttle lever assembly and properly check/adjust the crankshaft position sensor, For more details, please refer to the Timing and Synchronization procedures found in the Maintenance and Tune-up section.

20. For rope start models, install the manual starter assembly, as detailed in the Hand Rewind Starter section.

21. Connect the negative battery cable.

Powerhead

**** CAUTIOI**

When removing the powerhead, always secure the gearcase in a suitable holding fixture to prevent injury damage if the powerhead releases from the gearcase suddenly (which often occurs on outboards that have been in service for some time or that are extensively corroded).

These engines are large enough that you really must use an engine hoist when lifting the powerhead assembly. This not only makes sure that the powerhead is secured at all times, but helps prevent injuries, which could occur if the powerhead releases suddenly. Also, keep in mind the components such as the driveshaft could be damaged if the powerhead is removed or installed at an angle other than perfectly perpendicular to the gearcase. It is a lot easier to align the powerhead when it is supported, than when you are holding the powerhead and trying to raise it from or lower it into position.

**** WARNING**

If powerhead removal is difficult, first check to make sure there are no missed fasteners between the gearcase (midsection, exhaust housingladapter) and the powerhead itself. If none are found, apply suitable penetrating oil, like WD-40® or our new favorite, PB Blaster® to the mating surfaces. Give a few minutes or a few hours for the oil to work and then carefully pry the powerhead free while lifting it from the gearcase. Be careful not to damage the mating surfaces by using any sharp-tipped prybars or other by prying on thin/weak gearcase or powerhead bosses/surfaces.

When working on a powerhead, use either a very sturdy workbench or an engine stand to hold the assembly. The powerheads on these motors can weight several hundred pounds.

Although removal and installation is relatively straightforward on most models, the overhaul procedures can be quite involved. Whatever portion you decide to tackle, always, always, ALWAYS take good notes and tag as many partslhoseslconnections as you can during the removal process. As they are removed, arrange components along the worksurface in the same orientation to each other as they are when installed.

All EvinrudelJohnson V-motors are equipped with needle/roller bearings for the crankshaft, connecting rod and/or wrist pins. Most of these bearings are contained completely within cages, while some (of the wrist pin bearings) use loose needle assemblies. When working with loose needle bearings, care must be taken that none are lost during removal and that all are aligned during installation.

The connecting rods on these models are of the fractured cap design. This means that, during manufacture, the connecting rod and cap were once 1 piece, but they were broken apart. This style of manufacturer is common in many high-performance applications from marine engines to motorcycles and some automobiles. It affects service in 2 ways. For starters, it becomes critical that connecting rod-to-cap alignment is maintained. Not only can you not install a connecting rod cap from a different rod, but also you can't install a given cap in the reverse direction on its correct rod. Although the manufacturer places alignment marks or dimples on the rod and car, of most fractured connecting rods, be sure to matchmark all connecting rod'caps before removal. When installed, the fracture lines of the caps should all but disappear. To check alignment, run a fingernail or a pick or sharp pencil across the fracture line. If the nail, pencil or pick catches, recheck the alignment marks or make sure the connecting rod cap is properly bolted in position.

When it comes to bolting the connecting rod cap to the rod end, the second issue arises. On all models, to ensure proper alignment, it is a good idea to loosen or tighten the bolts in stages, alternating from one bolt to the other, turning each bolt the same amount each time. Make sure that amount is less than one full turn (try 114-112 turn each time). This may seem tedious, but it helps ensure proper seating of the cap and bearing needle cage. Proper rod and bearing alignment are so critical on these motors, that the manufacturer recommends the use of a special tool (a bearing cap centeringlholding fixture) for connecting rod cap alignment.

We are well aware that many shops use alternate methods to tighten the connecting rod caps. One popular method is to run the caps down (alternating the bolts until finger tight) then tightening the bolts in stages. Still only turning them less than one turn until the torque specification is reached. Once all connecting rod cap bolts are tightened using this method, a soft-faced (brass) mallet or hammer is held against one side of the rod and cap, then the other side is gently tapped with another hammer. The position of the hammers is then reversed and the tapping is repeated. This method **should** and we emphasize the word SHOULD fit the caplbearing assembly to the rod. However, there is no way to be certain except to return the motor to service. If it worked, she'll be fine. If it didn't, she'll eventually wear the crankshaft journal, connecting rod and bearing, causing premature powerhead Failure. We therefore, cannot really recommend this method with full confidence, and would prefer that you buy or borrow the alignment tool

Service procedures provided in this section for the powerhead include Removal & Installation, Overhaul (Disassembly & Assembly), as well as Cleaning & Inspection. Since multiple engines of varying hp are normally produced from the same basic mechanical design, sharing components and procedures across different hp models, most powerhead service procedures are divided by engines or engine families. However, Overhaul, as well as Cleaning & Inspection procedures share much more features between motors of different families and are covered mostly under a common section. We will point out any differences in cleaning and inspection procedures, and will mostly occur in the lack or inclusion of different components.

REMOVAL & INSTALLATION

Because of differences in powerhead components and mounting, we've chosen to provide individual procedures for Powerhead Removal & Installation. However, once the fuel, starting and ignition systems are out of the way and you've reduced a powerhead to a crankcase, pistons and components awaiting disassembly, the differences begin to melt away. For this reason, we've provided a single Overhaul as well as Cleaning & Inspection procedures later in this section.

In the following procedures, we've only mentioned the components that MUST be removed from the powerhead in order to separate it from the midsection/gearcase.

However, fuel or electrical components like carburetors or starter motors are left installed, use extreme caution when working on or around the powerhead not to damage them. If the powerhead is being removed for overhaul, you are going to have to replace these components anyway, so we'd advise that you remove all fuel and electrical system components prior to start of the powerhead removal procedure (but that's your call). If necessary, refer to the procedures in the Fuel System and Ignition and Electrical System sections for more details on individual component removal.

■ When necessary, please refer to the Powerhead Exploded Views found at the end of this section. Detailed exploded views are provided for each of the basic engine families covered here.

OEM ② MODERATE

65 Jet-115 Hp **(1632cc) 90°** CV4 Motors

◆ See Figures **6, 7, 8, 9, 10** and 11

■ When necessary, please refer to Powerhead Exploded Views found at the end of this section. Detailed exploded views are provided for each of the basic engine families covered here.

1. Disconnect the negative battery cable for safety.
2. Remove the top engine cover for access.
3. Remove the 2 front port and starboard rubber mount screws (threaded downward from mounting tabs at the base of the powerhead). At least one normally contains a ground strap.
4. Remove the shift rod connector from the side of the powerhead, normally found on the starboard side of the motor, toward the front, just above the trim/tilt switch (if equipped).
5. Remove the 4 exhaust housing cover screws (2 from the port side and 2 from the starboard side).
6. Tag and disconnect the thermostat hoses at the cylinder heads.
7. Remove the 2 lower engine cover-to-rear exhaust housing cover screws (they are threaded downward, just outside each of the thermostat hoses). Remove the rear exhaust housing cover.
8. With the fasteners now exposed (since the rear exhaust housing cover was removed), loosen and remove the 2 front exhaust housing cover-to-lower engine cover screws. There is one on each side (port and starboard) of the motor. Front of the front exhaust housing cover.
9. Remove the powerhead-to-exhausthousing adapter nuts (found at the rear of the exhaust housing, they are threaded upward onto powerhead studs).
10. Tag and disconnect the cooling system indicator hose from the fitting in the lower engine cover.
11. Loosen and remove the 6 long exhaust housing-to-powerhead screws (there are 3 on each side port and starboard, threaded upward into the powerhead).
12. Remove the screw and nut from the starboard front of the powerhead. Remove the screw and nut from the port front of the powerhead.
13. For pre-mix models, equipped with a standard diaphragmidisplacement fuel pump, tag and disconnect the fuel inlet hose from the fuel pump itself.
14. If equipped with the VR02 system, unbolt the pump from the powerhead and support aside with the fuel/oil supply hoses intact. Carefullv tag and remove the pulse hose and the fuel outlet hose from the pump. In order to prevent possible damage to the fittings, be sure to push hoses off fittings and not to pull them free.

■ The manufacturer's instructions include installing a lifting bracket to the top of the flywheel to lift the motor. Althouah the manufacturer makes a'special **lifting** hook adapter that attache; to their universal puller, a lifting eye that is directly bolted to the 3 flywheel bolt holes can be substituted.

15 Install **Evinrude/Johnson** Universal Puller and Lift Eye # 321537 or Evinrude/Johnson I Fixture 396748, c equivalent, to the top f tl flywheel assembly.

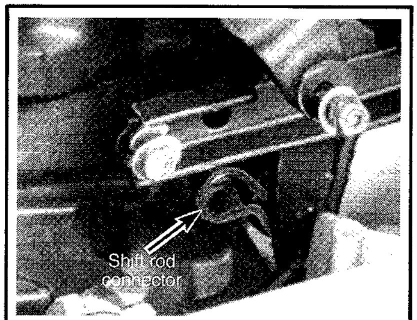


Fig. 6 Shift rod connector-900 CV4 Motors

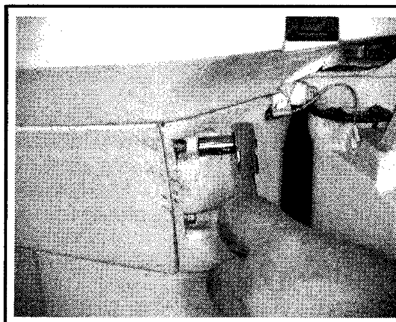


Fig. 7 Remove the exhaust housing covers for access to the powerhead-to-exhaust housing retainers

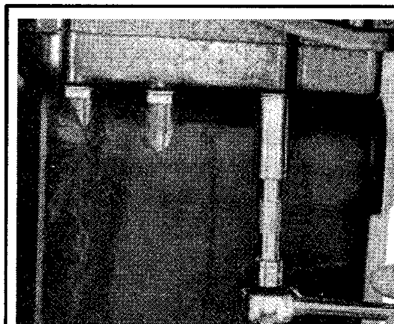


Fig. 8 Loosen and remove the long...

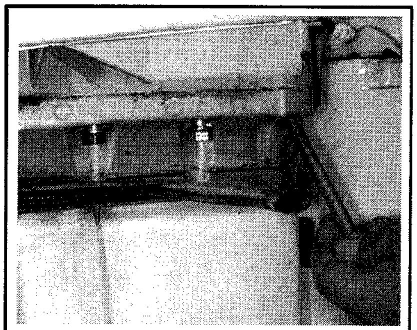


Fig. 9 ... exhaust housing-to-powerhead bolts (on each side of the motor)

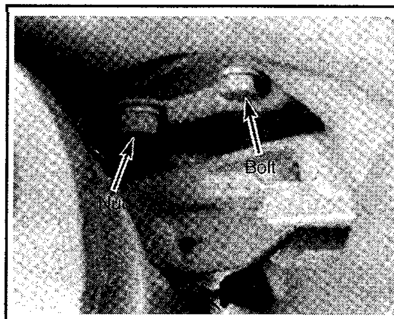


Fig. 10 On **90°** CV4 motors, loosen the nut and bolt at the front port and starboard sides

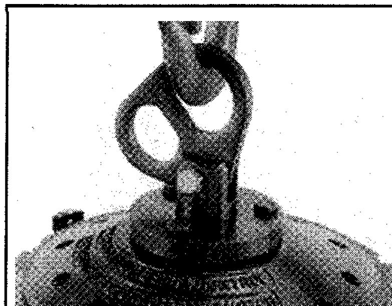


Fig. **11** Use a suitable lifting fixture (like the **Evinrude/Johnson** one pictured here) to lift the powerhead

16. Slowly and carefully lift the powerhead assembly straight up and off the exhaust housing.
17. Unless you are using them to mount the powerhead to an engine stand, thread nuts onto the powerhead studs in order to protect the threads.
18. Remove and discard the old powerhead gasket.
19. Mount the powerhead on an engine stand. If not already done and if necessary, strip it for overhaul by removing the carburetors (refer to Fuel System) and any electrical or ignition components (refer to Ignition and Electrical Systems).

To install:

20. Position a new powerhead gasket in place without any sealant.
21. Apply a light coating of Evinrude/Johnson Moly Lube, or equivalent lubricant to the driveshaft splines. But, **do not** coat the top surface of the shaft, as the resultant hydraulic pressure could prevent it from seating in the crankshaft.

■ **If nuts were placed onto the powerhead studs to protect the threads, remove them at this time.**

22. Use the lifting eye(s) to carefully lift the powerhead from the workbench or engine stand and lower it slowly onto the exhaust housing. If necessary, turn the powerhead slowly clockwise (as viewed from above) to help align the crankshaft-to-driveshaft splines.
23. Apply a light coating of Evinrude/Johnson Gel-Seal II, or equivalent to the threads of the exhaust housing-to-powerhead bolts and nuts. Install the 6 bolts from underneath exhaust housing flange (on either side of the powerhead), then tighten the bolts in stages to 16-18 ft. lbs. (22-24 Nm). Next, install the screws and nuts on the starboard front and port front of the powerhead. Tighten the 2 screws and 2 nuts to 120-145 inch lbs. (14-16 Nm).
24. Engage the shift rod into the shift rod link (toward the lower front, on the starboard side of the motor) and secure using a clip.
25. Install the front rubber mount bolts and washers (along with the ground strap, when used) and tighten to 60-84 inch lbs. (7-9 Nm).
26. Install the front exhaust housing cover-to-lower engine cover screw.

■ **Although we're telling you to install the lower covers now, you might want to skip a couple of steps and come back later. ALL of the powerhead-to-exhaust housing fasteners must be retorqued after the engine has been run to normal operating temperature and allowed to fully cool. This can be done, under controlled conditions, with the lower exhaust covers removed. However, if the engine is going to be run for an extended period of time on the first outing, it may be worth the extra protection to install the covers at this time and remove them again for retorquing later.**

27. Install the rear exhaust housing cover to the lower engine cover, then tighten the 2 screws threaded vertically downward (just outboard of each thermostat hose) to 60-84 inch lbs. (7-9 Nm).
28. Install the front exhaust housing cover-to-rear exhaust housing cover screws.
29. Connect the thermostat hoses to the cylinder heads.
30. If removed for overhaul (and not installed yet) install the fuel, ignition and electrical components to the powerhead.
31. On pre-mix models, equipped with a standard diaphragm/displacement fuel pump, connect the fuel line.
32. For VR02 models, reposition and install the VR02 pump assembly to the powerhead. Secure the pulse and fuel outlet lines as tagged during removal. HOWEVER, if the oil hose was removed for any reason, be sure to purse air from the oil hose before installing. Also, it is recommended that you add a 50:1 pre-mix in the boat fuel tank (or using a portable tank such as the 6 gallon you keep around for winterization, you do winterize it properly don't you?) and mark the level in the oil tank. Verify that the oil level is dropping in the oil tank before changing to unmixed gasoline.

■ **For more details on the VR02 system, please refer to the Lubrication and Cooling section.**

33. Connect the cooling system indicator hose to the fitting in the lower engine cover.
34. Connect the negative battery cable.
35. Perform the Timing and Synchronization adjustments found in the Maintenance and Tune-up section.

Remember to retorque the powerhead-to-exhaust housing retainers after the first time the engine has been run and allowed to cool.

36. Install the top engine cover.
37. If a new or rebuilt powerhead was just installed, refer to Break-In in this section for details on how to ensure proper break-in of the new powerhead components.

OEM ② MODERATE

75-175 Hp (1726/2589cc) 60° LV4/LV6 Motors

◆ **See Figures 12, 13, 14 and 15**

□ **When necessary, please refer to Powerhead Exploded Views found at the end of this section. Detailed exploded views are provided for each of the basic engine families covered here.**

1. If equipped, disconnect the negative battery cable.
2. Remove the engine covers. For details, please refer to Engine Cover (Top and Lower Cases) in the Maintenance and Tune-up Section.
3. Disconnect the appropriate trim/tilt wiring, depending upon the model:
   - For carbureted motors, disconnect the 2 tilt limit switch blue/white wire lead bullet connectors. Then, disconnect the trim sender lead bullet connector and the 2 pin connector.
   - For FFI motors, disconnect the tilt limit switch connector, followed by the sending unit connector. Finally, disconnect ht power trim/tilt connector from the power distribution panel itself.
4. Remove the retaining pin and disconnect the shift rod (at the front of the motor).
5. If not done during cover removal, tag, disconnect and plug the fuel and oil supply lines from the powerhead.
6. Loosen and remove the fasteners retaining the powerhead to the exhaust housing. Typically there are as many as 7 on each side of the motor (though number and location can vary). There are normally 3 or 4 bolts threaded upward from underneath the exhaust housing flange on either side (3 long bolts along the side and one short bolt at the front). Also, there are usually 3 retainers on the top side of the flange (two threaded downward at either end of the powerhead and one threaded horizontally from the front).

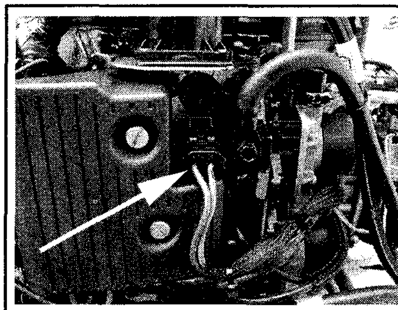


Fig. 12 On FFI motors, unplug the trim/tilt connector from the fuse box

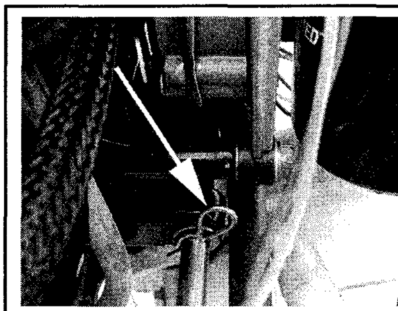


Fig. 13 Remove the pin and disconnect the shift rod

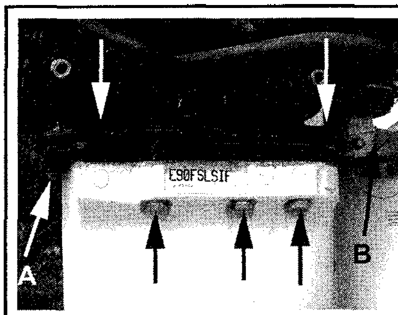


Fig. 14 Starboard powerhead fasteners-(A) is actually on port side and (B) is horizontal

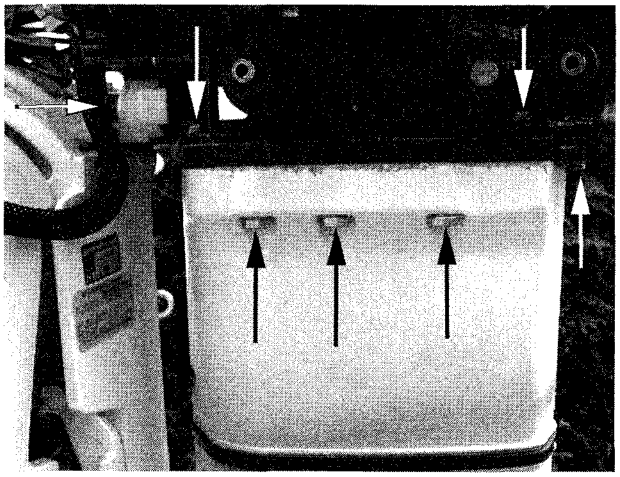


Fig. 15 Port side powerhead fasteners-FFI shown, others similar

7. Install a suitable lifting device/bracket, depending upon the model:
- For carbureted motors, attach hooks and a chain to the powerhead lifting brackets. The chain must be at least 36 in. (914mm) in length and, along with the hooks, capable of lifting 500 lbs. (227 kg). Also note that the hoist must be centered on the chain with at least 18 in. (460mm) of chain from each hook to the hoist. The hooks MUST move freely in the lift eyes, if they bind, they could break the lift eyes dropping the motor.
- For FFI motors, install the Evinrude/Johnson Lifting Fixture No. 342672 to the center of the crankshaft using the 1/4 in. Allen screw that comes with the kit. If the kit is not available, a lifting hook may be attached to the crankshaft in the same fashion but the hook and the hardware must be of sufficient strength to hold at least 500 lbs. (227 kg) of weight.

The threads at the end of the crankshaft are tapped for a 5/16 x 18 in thread screw.

8. Using the engine hoist, take up the slack in the chain until the weight of the powerhead is JUST resting on the hoist. Using a wide-bladed prybar to spread the force, carefully pry the powerhead free of the exhaust housing at the aft corners of the seam. Be careful not to force and damage the mating surface. Working slowly and carefully, lift the powerhead assembly straight up and off the exhaust housing.
9. Remove and discard the old powerhead gasket.
10. Mount the powerhead on an engine stand. If not already done and if necessary, strip it for overhaul by removing the carburetors or FFI fuel system components (refer to Fuel System) and any electrical or ignition components (refer to Ignition and Electrical Systems). On rope start models, if necessary for overhaul, remove the manual starter assembly. For details, refer to the procedures in the Hand Rewind Starter section.

To install:

11. Apply a light coating of Evinrude/Johnson Moly Lube, or equivalent lubricant to the driveshaft splines. But, **do not** coat the top surface of the shaft, as the resultant hydraulic pressure could prevent it from seating in the crankshaft.
12. In order to ensure a good seal, make sure the powerhead-to-exhaust housing mating surfaces are clean and dry.

While the powerhead base gasket is installed DRY on V4 motors, for V6 motors the gasket should be coated lightly on both sides using Evinrude/Johnson Gasket Sealing Compound or an equivalent sealant. Also on V6 engines, be sure to coat the inner exhaust housing flange using Permatex No. 2 or equivalent sealant.

13. Position a new powerhead base gasket, then use the lifting eye(s) to carefully lift the powerhead from the workbench or engine stand and lower it slowly onto the exhaust housing. If necessary, turn the powerhead crankshaft slowly clockwise (as viewed from above) to help align the crankshaft-to-driveshaft splines.
14. Install the 2 horizontally mounted powerhead bolts (the steering arm-to-upper mount bolts) and tighten to 100-105 ft. lbs. (136-142 Nm) for carbureted motors or to 100 ft. lbs. (136 Nm) for FFI motors.
15. For FFI motors only, wait 20 minutes, then without loosening the 2 horizontally mounted powerhead (steering arm-to-upper mount) bolts, retorque them again to 100 ft. lbs. (136 Nm).
16. Apply a light coating of Evinrude/Johnson Gasket Sealing Compound, or equivalent sealant to the threads of the remaining powerhead retaining bolts.
17. Install the 6 long bolts from underneath exhaust housing flange (on either side of the powerhead), then tighten the bolts in stages to 18-20 ft. lbs. (24-27 Nm).
18. Next, install the 5 smaller screws (4 of them are threaded downward from powerhead side of the flange and one is usually threaded upward from underneath) and tighten them to 60-84 inch lbs. (7-9 Nm).

Although we're telling you to install the lower during this procedure, you might want to skip this step and come back later. ALL of the powerhead-to-exhaust housing fasteners must be retorqued after the engine has been run to normal operating temperature and allowed to fully cool. This can be done, under controlled conditions, with the lower exhaust covers removed. However, if the engine is going to be run for an extended period of time on the first outing, it may be worth the extra protection to install the covers at this time and remove them again for retorquing later.

19. If removed for overhaul, install the fuel, ignition and electrical system components to the powerhead.
20. Remove the plugs, then reconnect the fuel and oil supply lines to the powerhead as tagged during removal. Refer to the Fuel System as well as the Lubrication and Cooling sections for information on priming the systems to ensure proper operation.
21. Engage the shift rod into the shift rod link (toward the lower front of the powerhead) and secure using a clip.
22. Reconnect the trim sender and tilt limit switch bullets and/or connectors, as applicable.
23. For rope start models, if removed, install the manual starter assembly. For details, refer to the procedures in the Hand Rewind Starter section.
24. If equipped, connect the negative battery cable.
25. Perform the Timing and Synchronization adjustments found in the Maintenance and Tune-up section.

Remember to retorque the powerhead-to-exhaust housing retainers after the first time the engine has been run and allowed to cool.

26. Install the engine covers.
27. If a new or rebuilt powerhead was just installed, refer to Break-In in this section for details on how to ensure proper break-in of the new powerhead components.

OEM ② MODERATE

120-300 Hp (2000/3000/3300/4000cc) 90° LV4/LV6/LV8 Motors

◆ **See Figures 8, 9, 16 and 17**

When necessary, please refer to Powerhead Exploded Views found at the end of this section. Detailed exploded views are provided for each of the basic engine families covered here.

1. If equipped, disconnect the negative battery cable.
2. Remove the engine covers. For details, please refer to Engine Cover (Top and Lower Cases) in the Maintenance and Tune-up Section.
3. Remove the flywheel from the top of the powerhead. For details, please refer to the Flywheel procedure in this section.
4. For FFI models, remove the air intake silencer and remove the air temperature sensor. Although it is not absolutely necessary to remove the air intake silencer on carbureted models, it is not a bad idea to give better access to the powerhead.
5. For models equipped with power steering, proceed as follows:
   a. Remove the 4 screws securing the stator coil assembly to the powerhead, then tilt the stator coil assembly and pulley in order to remove the 3 screws securing the power steering reservoir.

■ **DO NOT disconnect the power steering hoses.**

Fig. 16 **The powerhead alone for V8 motors can weigh more than** 370 **lbs.** (161 **kg)...**

b. Lift the oil cooler, filter and hoses supports from the powerhead, then carefully support the power steering system out of the way (with the hoses still attached). Be careful not to stress or damage and hoses or fittings.

6. Disconnect the power trim wiring harness from the powerhead.
7. If not done during cover removal, tag, disconnect and plug the fuel and oil supply lines from the powerhead.
8. Remove the retaining pin and then disconnect the shift rod.
9. Loosen and remove the fasteners retaining the powerhead to the exhaust housing. For V4 and V6 engines there are 4 bolts and 1 nut on each side, while on V8 engines there are 5 bolts and one nut on each side. On all motors, there are also 2 bolts and a nut at the rear of the powerhead securing the powerhead to the exhaust adapter.
10. Install a suitable lifting device/bracket such as the Evinrude/Johnson Lifting Eye No. 396748 to the threaded top end of the crankshaft. If the kit is not available, a lifting hook may be attached to the crankshaft in the same fashion but the hook and the hardware must be of sufficient strength to hold at least 500 lbs. (227 kg) of weight.

An assembled V8 powerhead typically weighs around 370 **lbs. (161 kg). For safety, make sure the hoist is capable of lifting at least** 1000 **lbs.** (454 **kg).**

11. Using the engine hoist, take up the slack in the chain until the weight of the powerhead is JUST resting on the hoist, then carefully lift the powerhead straight up and off the gearcase/exhaust adapter. If the powerhead is difficult to, using a wide-bladed prybar to spread the force, carefully pry the powerhead free of the exhaust housing along the seam of the powerhead-to-exhausthousing seal. Be careful not to force and damage the mating surface. Working slowly and carefully, lift the powerhead assembly straight up and off the exhaust housing.
12. Remove and discard the old powerhead gasket.
13. Mount the powerhead on an engine stand. If not already done and if necessary, strip it for overhaul by removing the carburetors or FFI fuel system components (refer to Fuel System) and any electrical or ignition components (refer to Ignition and Electrical Systems). On rope start models, if necessary for overhaul, remove the manual starter assembly. For details, refer to the procedures in the Hand Rewind Starter section.

To install:

14. Apply a light coating of Evinrude/Johnson Moly Lube, or equivalent lubricant to the driveshaft splines. But, **do not** coat the top surface of the shaft, as the resultant hydraulic pressure could prevent it from seating in the crankshaft.

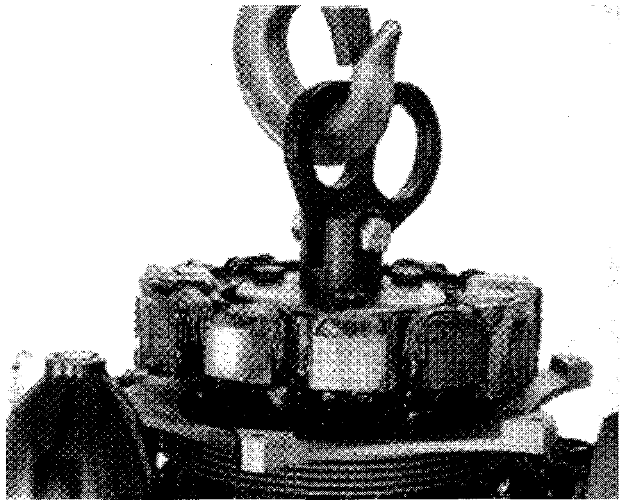


Fig. 17 ... use a sturdy lifting device attached to the crankshaft threads in order to lift it

15. In order to ensure a good seal, make sure the powerhead-to-exhaust housing mating surfaces are clean and dry.

The powerhead base gasket on these models is covered with a heat activated coating. In order to achieve proper sealing, the components must be assembled dry and clean/free of any traces of dirt, debris, oil, grease or foreign matter.

16. Position a new powerhead base gasket, then use the lifting eye to carefully lift the oowerhead from the workbench or engine stand and lower it slowly onto the exhaust housing. If necessary, turn the powerhead crankshaft slowly clockwise (as viewed from above) to help align the crankshaft-to-driveshaft splines.
17. Apply a light coating of Evinrude/Johnson Locquic Primer, followed by Gel Seal II to the, or equivalent to the threads of the powerhead-to-exhaust housing retaining bolts and studs (located on the each side of the motor).
18. Install and finger-tighten the powerhead retaining bolts and nuts (on either side of the motor), then tighten them in stages to 18-20 ft. lbs. (24-27 Nm).

■ **Although we're telling you to install the lower covers in this procedure, you might want to skip that step and come back later. The powerhead-to-exhaust housing fasteners must be retorqued after the engine has been run to normal operating temperature and allowed to fully cool. This can be done, under controlled conditions, with the lower exhaust covers removed. However, if the engine is going to be run for an extended period of time on the first outing, it may be worth the extra protection to install the covers at this time and remove them again for retorquing later.**

19. Next, install the smaller powerhead-to-adapter bolts and nuts (found at the rear of the powerhead). Tighten them to 144-168 inch lbs. (16-19 Nm).
20. Install the flywheel. For details, please refer to the procedure in this section.
21. If removed for overhaul, install the fuel, ignition and electrical system components to the powerhead.
22. Remove the plugs, then reconnect the fuel and oil supply lines to the powerhead as tagged during removal. Refer to the Fuel System as well as the Lubrication and Cooling sections for information on priming the systems to ensure proper operation.
23. Engage the shift rod and linkage, then secure using the retaining pin.
24. Reconnect the power trim wiring harness to the powerhead.
25. For rope start models, if removed, install the manual starter assembly. For details, refer to the procedures in the Hand Rewind Starter section.
26. If equipped, connect the negative battery cable.

27. Perform the Timing and Synchronization adjustments found in the Maintenance and Tune-Up section.

■ Remember to **retorque** the powerhead-to-exhaust housing retainers after the first time the engine has been run and allowed to cool.

28. Install the engine covers.
29. If a new or rebuilt powerhead was just installed, refer to Break-In in this section for details on how to ensure proper break-in of the new powerhead components.

OVERHAUL

Disassembly

◆ See Figures 18 thru 44

☐ When necessary, please refer to Powerhead Exploded Views found at the end of this section. Detailed exploded views are provided for each of the basic engine families covered here.

Although due to differences in powerhead components and mounting, we chose to provide individual procedures for Powerhead Removal & Installation, we also realize how similar the internal components and procedures are for the powerhead. Once the fuel, starting and ignition systems are out of the way and you've reduced a powerhead to a crankcase, pistons and components awaiting disassembly, the differences begin to melt away. For this reason, we've provided a single Overhaul procedure here. However, since some differences still occur, we will refer to those differences in the following procedure. Since most of these differences occur according to engine family and not just to one or another hp model, we'll normally refer to them by the degree V configuration and possibly the number of cylinders. All motors covered here are either of the 60° or 90° configurations. Additionally, only the smallest of the 900 motors are cross-flow design, all others, including all 60° models are loopers. For more details on engine identification, please refer to Engine Identification and the Engine Identification Charts in the Maintenance and Tune-up section.

Even though the majority of the powerhead overhaul procedure on these motors is fairly easy and straightforward, the connecting rod cap bolt torque procedure requires a special holding fixture. The procedure and fixture are used in order to ensure that the connecting rodlcap and bearing are properly centered. Attempting to center and tighten the connecting rod caps without this fixture may cause unexpected, total powerhead failure sometime after the motor is returned to service. That is not to say people have not succeeded in centering and tightening the caps without the fixture, but to say that we cannot recommend it, as there are no guarantees.

To simplify assembly, remember to layout all bolts, components and clamps in the order of removal. This is especially true for the wiring harness and related clamps. Matchmark all component assemblies such as pistons, connecting rods to ensure installation of the correct pairs and installation in the correct orientation. Most of all, take your time.

Throughout the overhaul procedure, be sure to remove and discard all O-rings and gaskets, taking care not to remove any metal from the mating surface when removing traces of the old gasket material.

1. Remove the powerhead from the lower unit as detailed under Removal & Installation.
2. If not done already, strip the powerhead for overhaul by removing all fuel system, ignition system and electrical components from the powerhead. For details, refer to the procedures in the Fuel System and the Ignition and Electrical System sections.
3. For V8 engines, using a 112 in. drive impact wrench and a 1 314 in. impact socket, loosen and remove the nut securing the torsional damper to the end of the crankshaft. Use a threaded universal puller set (not a jawed set) to carefully draw the damper off the end of the crankshaft.
4. If equipped, tag and disconnect the crankcase recirculation hoses.
5. For 90° looper motors, if equipped, disconnect the PowerBoost® cooling hose from the starboard cylinder head.
6. For carbureted 60° motors, remove the clip and washer from the shift link. Remove the trunnion block from the crankcase. Also on these motors, locate and remove the lower drain nipple.
7. Remove the intake manifold retaining bolts and remove the manifold(s) from the powerhead. Inspect the manifold and leaf valves for damage and repair/replace, as necessary. For details, please refer to Intake Manifold and Leaf Valves, in this section.
8. For 90° cross-flow motors, loosen and remove the cylinder head cover retaining screws, then remove the cylinder head covers and gaskets from the heads.
9. For 90° looper motors, if equipped, tag and disconnect the water hose between the cylinder heads.
10. Using multiple passes of a spiraling pattern that starts at the outer and works toward the center fasteners, loosen and remove the cylinder head retaining bolts. Remove the cylinder head from the block. If necessary, remove any cylinder head mounted components such as the thermostat assembly (on most except cross-flow models) or engine temperature switches. For details, refer to the Thermostat procedures in the Lubrication and Cooling System section.

■ On **60°** motors, remove and discard the thermostat seal mounted to the back (cylinder block) side of the cylinder head.

11. For 90° cross-flow motors, proceed as follows:
    a. Inspect the water deflectors in the cylinder cooling passages (there are normally 2 on each side of the motor). The deflectors are used to direct water circulation and must be replaced if damaged or deteriorated. Be sure to use the correct replacement part for the year and model on which you are working.
    b. Loosen and remove the outer exhaust cover retaining screws and then remove the outer and inner exhaust covers from the side of the cylinder block. Remove and discard the gaskets.
    c. Remove the intake bypass covers. Since 3 of these covers are interchangeable, but 1 (the lower starboard cover) is not, be sure to note the locations of the covers, bolts and clamps for assembly purposes.
12. Using multiple passes of a spiraling pattern that starts with the outward retainers and works toward the center, loosen and remove the crankcase flange screws.

☐ On **600** motors there are **20** flange screws on carbureted models, **12** flange screws on V4 FFI models and **16** flange screws on **V6** FFI models.

13. On all 900 motors, loosen and remove the crankcase upper and lower head retaining screws.

■ On looper motors, be sure NOT to remove the 4 inner bolts on the lower crankcase head.

14. Using multiple passes of a spiraling pattern that starts from the outward retainers and works toward the center, loosen the main bearing bolts. A 318 in. Allen head socket is required for the upper port screw on 900 looper models.

On **60°** models there are **8** main bearing bolts for carbureted motors and on V6 FFI motors, but there are only **6** main bearing bolts on FFI V4 motors.

15. Either use a fabricated taper pin tool (as shown in the accompanying illustration) to carefully push the crankcase taper pin toward the intake manifold surface or use a punch with a diameter larger than the pin (118 in. on most models, including all 600 motors). The taper pin is found along the crankcase-to-cylinderblock seam, usually (but not always) towards the top end of the crankcase. If necessary, refer to the exploded views to help identify the pin location.

✳✳ WARNING

NEVER use a tool smaller than the taper pin bore or a tapered drift pin to remove the pin or damage could occur.

16. With the crankcase facing upward, use a plastic or rubber mallet to tap upward on the exposed portion of the crankshaft

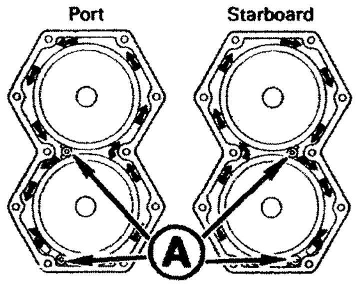


Fig. 18 With the cylinder heads removed from cross-flow motors, check the condition of the water deflectors

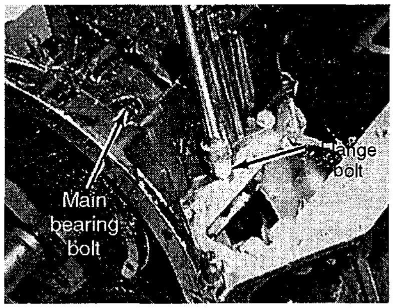


Fig. 19 Remove the flange and then the main bearing bolts, as directed...

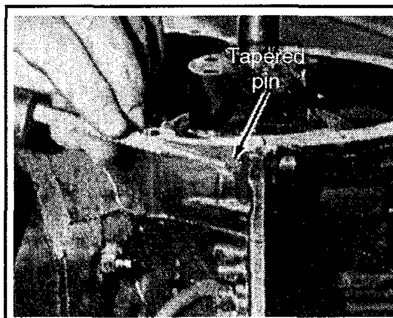


Fig. 20 ... then remove the taper pin

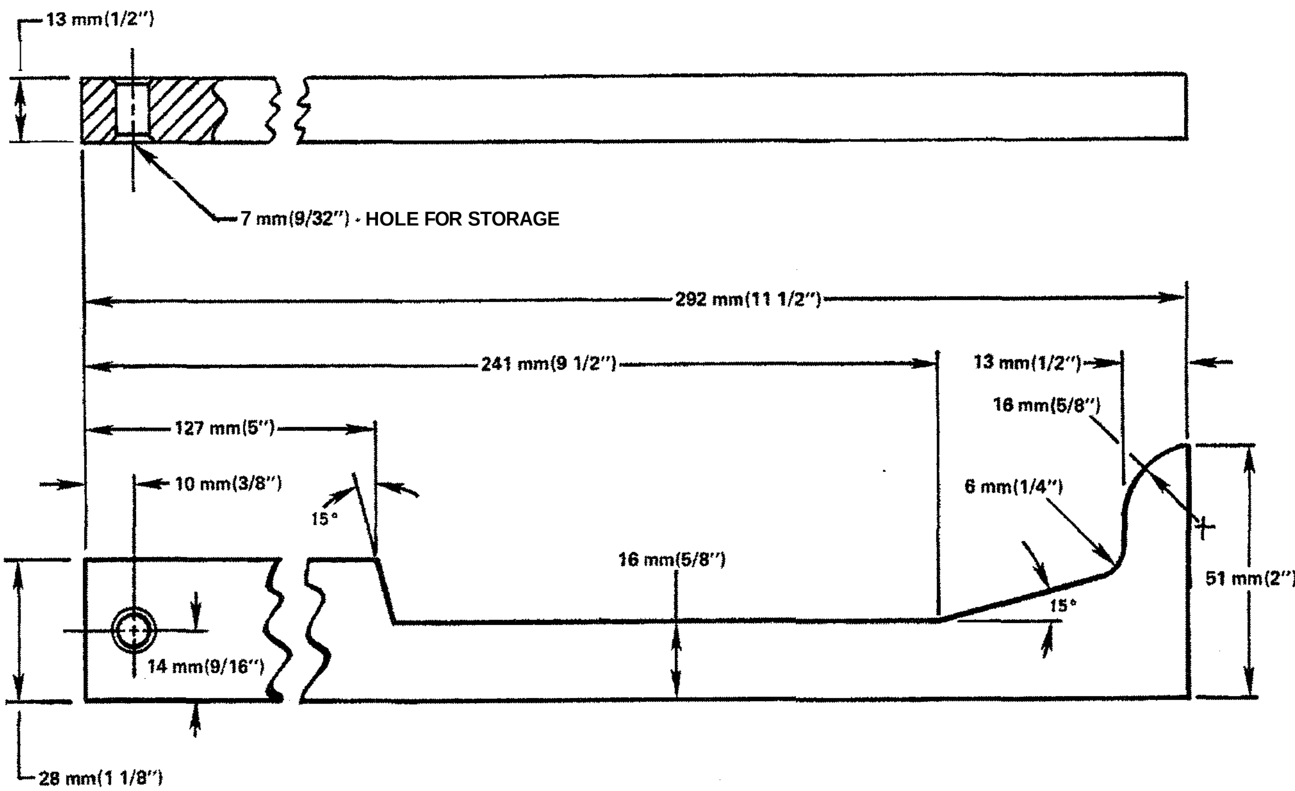


Fig. 21 You can fabricate a crankcase taper pin tool using a piece of 1 118 in. **(28mm)** wide x 112 in. **(13mm)** thick cold roll steel (though a suitably sized drift pin will usually work just as well)

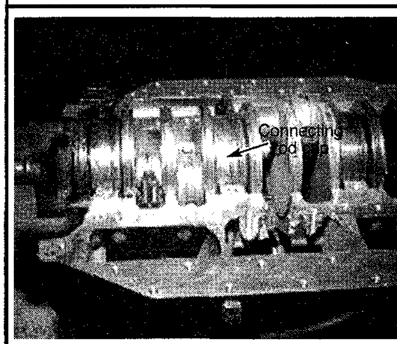


Fig. 22 The connecting rods are secured using special **12-point** bolts...

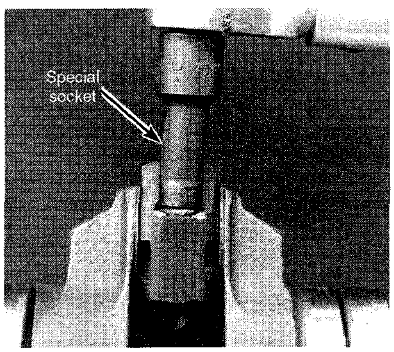


Fig. 23 ... use the special socket (not a cheap imitation) to loosen them

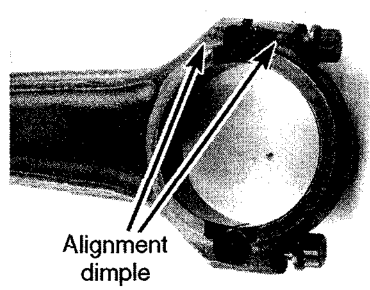


Fig. 24 Some **Evinrude/Johnson** connecting rods comes with alignment marks...

(at a 90º angle to the shaft). Tap lightly until the crankcase half just starts to separate from the cylinder block half. Lift and remove the crankcase from the bottom of the cylinder block (exposing the crankshaft).

■ Keep in mind that all wear parts (such as pistons, connecting rods and needle bearings) MUST be installed in their original positions (and with the same orientations) if they are to be reused. Mark each component with a permanent marker, a scribe or punches to ensure proper assembly.

17. Using a felt-tipped marker or numbered/lettered punches, label the piston domes. Number everything starting at the flywheel end working toward the driveshaft end of the crankshaft.

■ If a felt-tipped marker is used to label components during disassembly, watch the marks during cleaning. Replace any marks that are dulled or removed by solvent as soon as the component is dry.

18. Matchmark the connecting rod caps and then use the appropriate torquing socket to loosen the connecting rod cap bolts. Be sure to use Evinrude/Johnson Torque Socket # 331638 for the 5/16 in. bolts used on most motors and/or #346187 for the 3/8 in. screws also used on some 90º looper models. Don't use a cheap socket on these fasteners or you'll strip them. Work on one piston at a time, supporting the piston at the dome with one hand while loosening the bolts on that piston's rod cap alternately, no more than one turn at a time. Remove each cap along with the connecting rod cap needle bearing and cage. Carefully push the piston from the bore and out the top of the cylinder block.

**** WARNI**

When removing each piston, take great care to prevent the connecting rod from contacting and damaging the crankshaft journal, cylinder wall and, finally, once removed, the cylinder piston skirt. One method to help prevent this is to stuff rags in the skirt before or after the piston is removed to keep the connecting rod centered. ALSO, make sure that the piston does not fall from the open bore. If you need both hands on the crankshaft end of the job, either use an assistant to hold the piston OR, if necessary, loosely reinstall the cylinder head to retain the pistons.

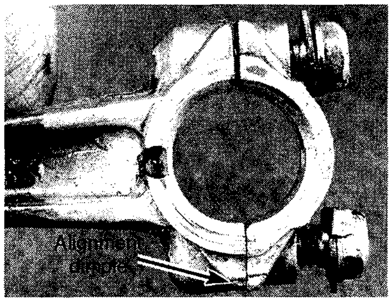


Fig. **25** ... but if not, be sure to matchmark the caps before removal and align them during assembly

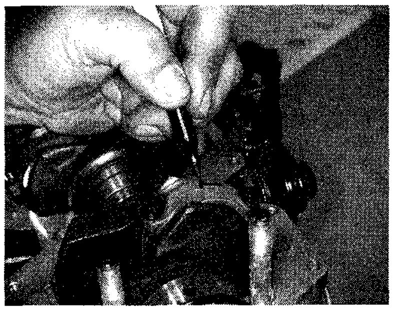


Fig. **26** Label all components before removal

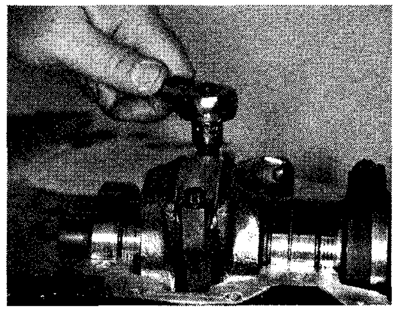


Fig. **27** Loosen the connecting rod cap bolts while alternating from side-to-side...

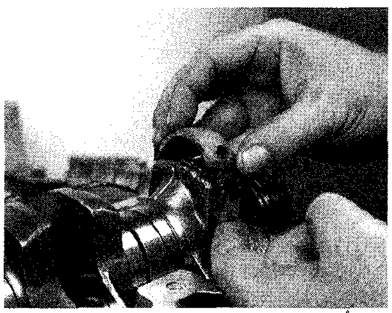


Fig. **28** Then push upward on the cap...

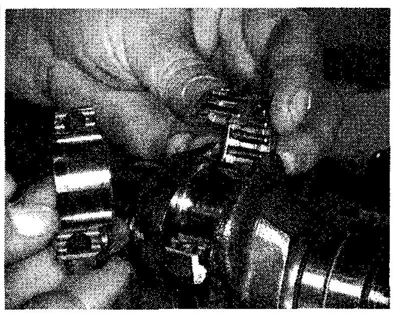


Fig. 29 ... to remove the cap and bearing from the **crankpin**

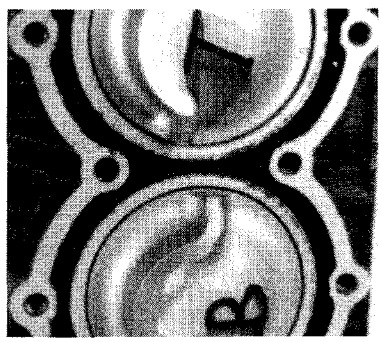


Fig. 30 Before removal, label the tops of the pistons to identify the Top and **Bottom (or No. 1 and No. 2 pistons)**

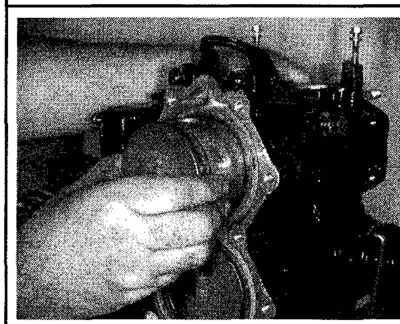


Fig. **31** Use care when removing the pistons

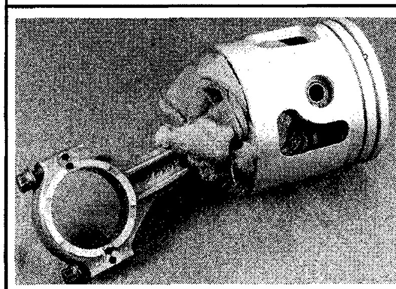


Fig. **32** Stuff rags inside the piston skirt to protect it from damage by the connecting rods anytime the rod is removed from the crankshaft journal

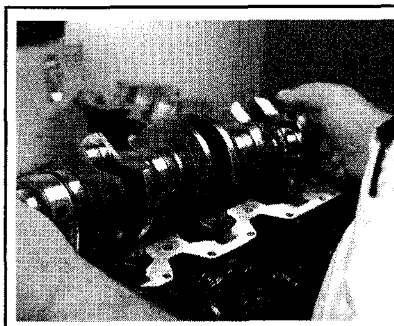


Fig. 33 Carefully lift the crankshaft from the cylinder block

19. Repeat the previous step for each of the other pistons. To prevent any possible mix-up reinstall each bearing assembly and connecting rod cap to the piston and connecting rod as soon as it is removed from the cylinder block.

20. Lift the crankshaft assembly carefully out of the cylinder block.

21. Service the upper crankshaft seal, as appropriate depending upon the model:

For 600 motors, the upper crankshaft seal MUST be replaced upon assembly, so remove and discard the old seal at this time.

- On 90° cross-flow motors, if the upper crankcase head seal or bearing requires service, remove it from the crankshaft and discard the O-rings. Pierce the seal with a punch (from the bottom of the bearing) to engage the seal lip and then carefully tap the seal out of the housing. If the bearing is damaged or worn the crankcase head and bearing assembly must be replaced. If not, a new seal must be installed during assembly.

On 900 looper motors, if the seal must be replaced, position the upper head with the crankshaft side facing upward, then use a drift punch to carefully drive the seal out of the center of the housing. Also, remove and discard the 2 head O-rings.

22. If the lower crankcase head seal (or seal and bearing on 90° motors) requires service, proceed as follows, depending upon the model:

On 600 motors, if the lower crankshaft seal must be replaced, carefully slide the seal housing assembly off the crankshaft, then remove and discard the housing O-ring. Use a drift punch to carefully drive the seal from the center of the housing.

On 900 motors, to service the lower seal and bearing, remove the 4 bolts from the lower crankcase head-to-retainer plate, then remove the lower head from the shaft by rotating the head while gently tapping on the flange. Use a drift punch to carefully drive the seal from the center of the head. Discard the seal, then remove and discard the 2 O-rings.

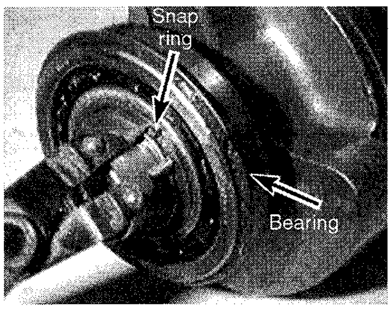


Fig. 34 If lower bearing replacement is necessary, first remove the snap ring...

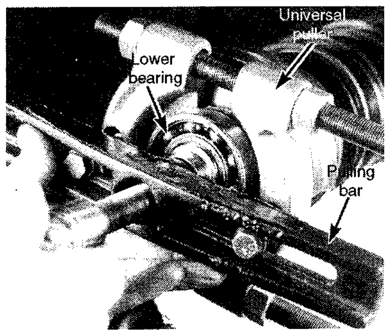


Fig. 35 ... then use a puller or a bearing separator (depending on the model) to remove it from the crankshaft

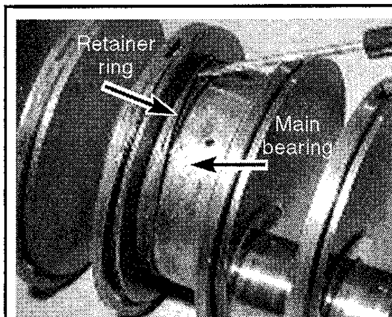


Fig. 36 To remove the main bearings, carefully lift off the retaining ring...

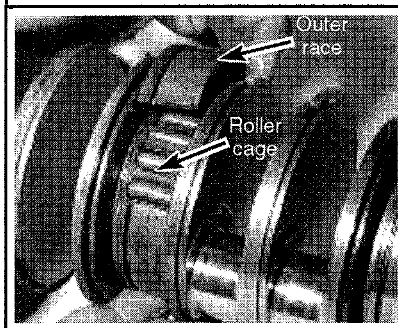


Fig. 37 ...then separate the bearing race and cage halves

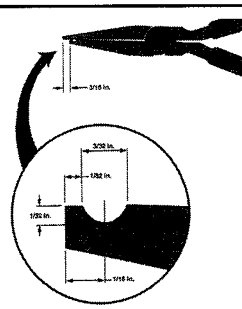


Fig. 38 To ease wrist pin retaining ring removal on **Evinrude/Johnson** motors, modify a pair of needle-nose pliers as shown

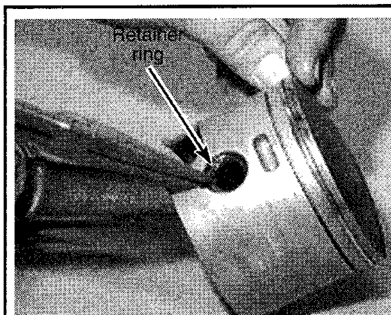


Fig. 39 Remove the wrist pin retaining rings from the bores in the sides of the pistons...

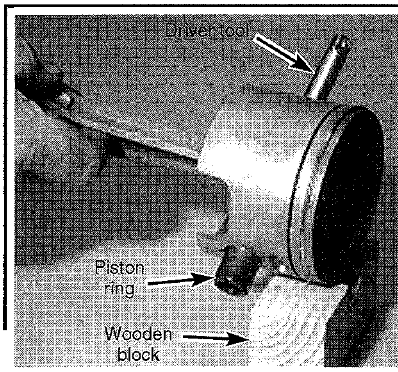


Fig. 40 ...then carefully remove the wrist pins

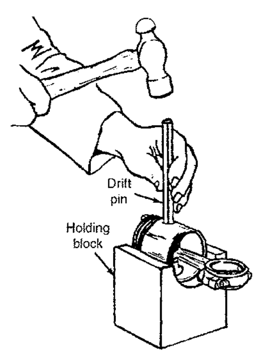


Fig. 41 The best method for removing wrist pins is using a holding block and a drift pin (driver) along with a shop press or hammer to push the wrist pin from the piston

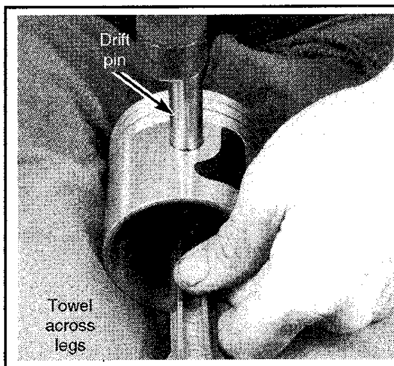


Fig. 42 If the wrist pin does not have an interference fit, you can support the piston on your legs with a shop cloth when carefully tapping the wrist pin free of the piston bore

■ On 90° motors, DO NOT reuse the lower crankcase head bearing retainer screws. If removed, discard the 4 screws and replace with new ones during assembly.

23. Remove O-ring from the end of the crankshaft sleeve, Inspect the O-ring and, if worn or damaged, install a new O-ring during assembly. On these models, check the crankshaft sleeve. If damaged, remove it using a large-jawed puller and either a puller bridge or a slide hammer.
24. ONLY remove the lower crankshaft bearing if it requires replacement. First remove the retaining ring using a pair of external snapring pliers and then remove the bearing itself using a suitable bearing separator or puller, depending upon the model. For all looper (60° and 900 motors), support the bearing in a shop press using a bearing separator tool, and then press the bearing off the shaft. For all cross-flow motors use a universal puller with four 1/4-28 x 3 in. screws threaded into the tapped holes in the plate to remove the bearing from the shaft.
25. Remove the crankcase's split seal rings for inspection.
26. Remove the retaining rings, then remove the center main bearings and split sleeves. Be sure to matchmark/identify all components and keep the assemblies separate if they are going to be reused.

■ Note the direction of that the retaining ring groove in the bearing race faces for installation purposes. It is normally positioned facing the bottom of the crankshaft.

27. Disassemble each piston for further inspection and component replacement, as follows:
a. Use a universal ring expander to remove the rings from the pistons. The manufacturer warns NOT to reuse the rings. Retain them in sets for inspection purposes (marking their original locations), but discard them before installation,

■ We've said it before. We know there will be some circumstances that will prompt people to reuse rings (for example, if for some reason the motor was disassembled after only a few hours of usage). But for the most part, if you've come **THIS** far, it is probably a good idea to bite the bullet and replace the rings to ensure long-lasting performance from the powerhead.

b. Using a pair of modified needle-nosed pliers as shown in the accompanying illustration, or a suitable pair of snapring pliers, remove the wrist pin retaining rings. Discard the old retaining rings.

■ If necessary, a piston cradle can be fabricated from a large block of wood. The important design features of the cradle are that it is semi-circular on top to hold (or cradle, get it?) the piston and that there is a bore at the bottom center into which the wrist pin can tapped or pressed. The final important feature of the cradle is that it is STURDY enough to withstand the force of the shop press. Keep in mind that the fit is loose on all but the 90° looper motors, so no significant pressing force is needed, except on those models.

c. For 60° looper and 900 cross-flow motors, the piston-to-wrist pin fit should be loose on both sides. Support the piston and use a suitable drift pin (like Evinrude/Johnson # 326356 to carefully and smoothly tap or push the wrist pin free of the piston bore). If the EvinrudelJohnson tool is not available, be sure to use a drift pin that is just slightly smaller than the diameter of the wrist pin itself. Be sure to retain the 28 loose needle bearings and 2 thrust washers.

■ As the wrist pin is removed from the piston on these models you must retain the loose needle bearings and the 2 thrust washers from the connecting rod bore. If you can, stop tapping or pressing once the wrist pin JUST clears the bottom of the connecting rod bore. Then carefully withdraw the rod along with the needle bearings (place a thin bladed tool like a putty knife or your finger under the rod hole as it is pulled free of the piston borelwrist pin). Inspect the bearings, if any of the needles are lost or worn, replace the entire bearing assembly.

d. For 90° looper models, support the piston in a suitable cradle (such as EvinrudelJohnson No. 326572), then use a wrist pin driver (such as No. 396747) to carefully and smoothly tap the wrist pin free of the piston bore. If the EvinrudelJohnson tool is not available, be sure to use a driver that is slightly smaller than the piston bore. Also, be sure to retain the loose needle bearings and 2 thrust washers. These models may are equipped with either 28 (1992 models) or 33 (1993 and later models) loose needle bearings.
28. Refer to the information found under Cleaning & Inspection, in this section for details on inspecting the oowerhead comoonents to determine which should be replaced and to prepare the ones that are being reused for assembly.

Assembly

◆ See Figures 45 thru **60**

■ When necessary, please refer to Powerhead Exploded Views found at the end of this section. Detailed exploded views are provided for each of the basic engine families covered here.
During assembly, take your time and NEVER force a component unless a shop press or drive **tool** is specifically required by the procedure.

■ Lightly coat all components (except those that are coated with sealant) with clean, fresh EvinrudelJohnson Outboard Lubricant or equivalent oil during assembly. Always replace all gaskets, O-rings and seals.

1. Before assembly, check the markings on all components. Hopefully, there is no question as to what cylinder or position each pistons, bearings and caps belongs. However, there are a few additional markings provided by the manufacturer that you should consider on the pistons and connecting rods. They vary slightly with the type of motor (looper or cross-flow), as follows:
- On cross-flow motors, the pistons contain a semi-circular edge running across the deflector dome. The sharp (rounded) edge of the deflector must face the intake ports. An oil hole located at the top end of each connecting rod (where the shaft meets the bore for the wrist pin) must always face the flywheel.

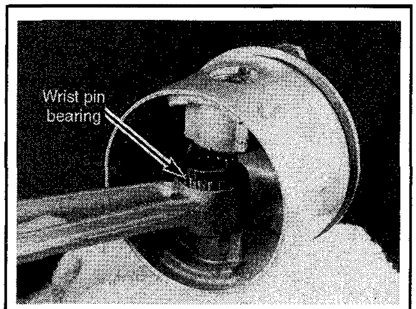


Fig. 43 When removing the wrist pin, take care not to lose the loose needle bearings

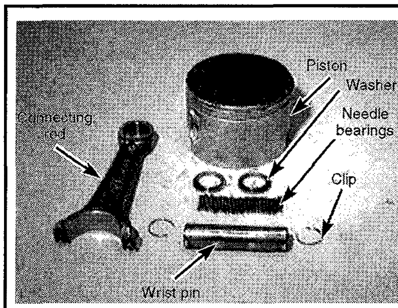


Fig. 44 Exploded view of a piston component including the connecting rod, wrist pin and bearing assembly

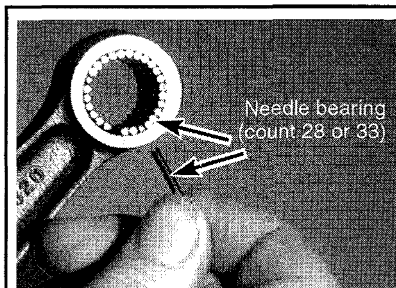


Fig. 45 During assembly, carefully place the loose bearing needles in the wrist pin...

■ Looper motors use a flat-topped (as opposed to a deflector) piston. The manufacturer marks these pistons on the edge of the dome with a stamping "exhaust side" so be sure to face them in the proper direction. Like the cross-flow motors, there is an oil hole located at the top end of each connecting rod (where the shaft meets the bore for the wrist pin). The diagonal oil hole on these motors must also always face the flywheel.'

2. If disassembled for inspection and/or component replacement, assemble each piston as follows:

a. Apply a light coating of Evinrude/Johnson Needle Bearing Assembly grease (or equivalent) to the wrist pin bearing needles, then insert the 28 or 33 needles around the inner circumference of the connecting rod wrist pin bore. If available, install the Evinrude/Johnson Wrist Pin Bearing tool # 336660 (for 60° looper and 900 cross-flow models) or Bearing tool # 338646 (for 90° looper models) into the bore to align the needles and hold them in place during assembly.

☐ The wrist pin bearing tool is, essentially, a short round pin, roughly the same outer diameter of the wrist pin, but very short, just long enough to insert it through the connecting rod wrist pin bore and install the thrust washers on either side. A similarly sized dowel pin can be substituted, or an old connecting rod wrist pin (which has been machined down to slightly smaller size on **900** looper models to ease installation) from the same size piston could be used. If substituting another rod or drift pin, make sure the surface is smooth and **clean/free** of all corrosion. Also, make sure the outer diameter of the tool is smaller than the wrist pin and bore to prevent the possibility of binding or damage.

b. With the bearings and the wrist pin tool in position, install the thrust washers with the flat sides facing outward. Again, a dab of grease should hold the thrust washers in position.

c. Apply a light coating of clean engine oil or assembly lube to the wrist pin and the pin bore in the piston.

☐ Remember, the pistons and connecting rods on these models have specific orientations. When placing the piston in the cradle, position it with the top side (as determined by the intake and exhaust sides) facing upward. Then, when inserting the wrist pin, make sure the oil hole is also facing upward.

d. Support the piston (in a piston cradle if available, though a clean workbench SHOULD suffice). Insert the wrist pin into the bore and gently press it by hand through the bore until it just starts to appear inside the piston skirt. Stop, then position the connecting rod with the needle bearings, thrust washers and wrist pin bearing installation tool inside the piston skirt. Continue to push the wrist pin into the position, through the thrust washers and bearings, pushing the wrist pin bearing installer through the other side and out of the piston.

■ On most models the wrist pin fit should be loose enough to install it by hand. However, if the wrist pin fit is tight on **900** looper models, first make sure that the wrist pin and bore is free and clean of corrosion. Next, make sure a needle bearing has not come loose and caused binding, before using a driver to gently tap the wrist pin into position.

e. Once the wrist pin is properly positioned, use a small driver to install a NEW snapring in each end of the wrist pin bore. Make sure the snapring fully seats in the groove. Turn the ring in the groove until the gap faces downward, directly away (180° opposite) from the semi-circular relief in the side of the wrist pin bore.

☐ When using the ring expander, spread each ring JUST enough to slip over the piston.

f. Use a ring expander to install the pistons rings on each piston. Each piston ring groove should contain a dowel pin, around which the ring gap must be squarely situated. If not the rings will likely break during installation (or if by they don't by some miracle, during the first start-up). The 90° looper models are equipped with 1 or 2 tapered rings, depending on the year and model and/or the ring set. When only 1 tapered ring is supplied per pistons, be sure to install the tapered ring in the top groove and the squared ring in the bottom groove.

3. On cross-flow motors, prepare the block as follows:

a. For models such as the 115 that use filler blocks in the "V" between the cylinder block banks, if they were removed they must be installed flush with the cylinder block. New blocks must be machined flush after installation. Be sure to use brass screws coated with Evinrude/Johnson Ultra-Lock or an equivalent high-strength thread lock to install them. The screws should be tightened to 30-54 inch lbs. (3.4-6.1 Nm). The center and lower screws use lock tabs that should be bent in place after tightening.

b. On all cross-flow motors, if removed, install the water deflectors to the passages in the cylinder block.

4. Oil the center main roller bearing and split sleeve assemblies, then install them around the crankshaft center journals in their original positions. Be sure to face the split sleeve ring grooves away from flywheel. Secure the sleeves using the retaining rings.

5. If the lower main bearing assembly was removed from 900 models, position the bearing retainer plate with the flat side facing downward, on the lower end of the crankshaft, then install a NEW lower main bearing assembly.

6. If removed, install a NEW lower main bearing assembly. Apply a light coating of clean engine oil or assembly lube to the new lower main bearing and to the end of the crankshaft, then use a suitably sized driver to carefully press or tap the bearing into position with the lettered side of the bearing facing outward toward the driver.

If available, use the appropriate **Evinrude/Johnson** bearing installation tool to install a new lower bearing **and/or** a new lower sleeve, depending upon the model. For **60°** models, use Crankshaft **Bearing/Sleeve** installer # **338647.** For **900** cross-flow models, use **Crankshaft Bearing/Sleeve installer # 338648. For 90° models either use Crankshaft Bearing/Sleeve installer # 338649** for **V4** and **V6** engines or Bearing installer **314426** for **V8** engines (the **V8** motors don't use a sleeve). If the specified driver is not available, be sure to use a suitable driver that contacts the entire diameter of the bearing cage or the sleeve but does NOT contact or damage the crankshaft.

7. If the crankshaft sleeve was removed from the lower end of the crankshaft, install a NEW sleeve. Apply a light coating of clean engine oil or

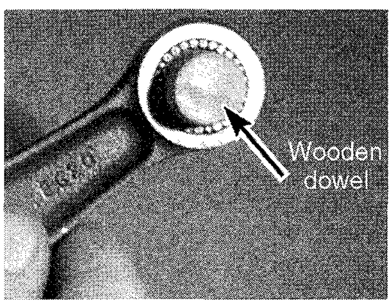


Fig. **46** ... then hold them in position using a small dowel or wrist pin installation tool

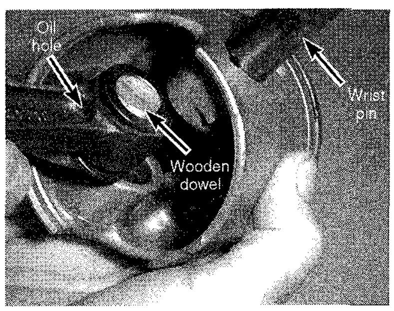


Fig. **47** Make sure the connecting rod oil hole and piston are facing the proper direction...

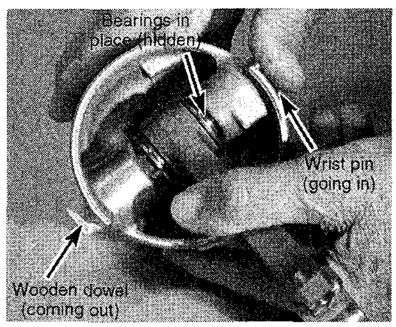


Fig. **48** ... then install the wrist pin, displacing the installation tool and securing the bearing needles assembly lube to the NEW crankshaft sleeve, position the sleeve and gently drive or press the sleeve onto the shaft until the installer contacts the lower main bearing (use the same installer that was recommended for the lower bearing). Remove the installer, then apply a light coating of Evinrude/Johnson Moly Lube or equivalent assembly lube to the NEW O-ring (which should be used if a new sleeve is installed) and position it in the end of the sleeve.

**** WARNING**

Make sure the sleeve surface is not nicked or damaged during installation or it must be removed and discarded (and another NEW sleeve installed).

■ If the installer sticks on the sleeve after installation, use a slide hammer to pull it free.

8. Install the lower bearing retaining ring in the crankshaft groove with the sharp (square) edge facing away from the bearing.
9. For all EXCEPT the upper seal on 60° motors, prepare and install NEW upper and lower case seals. If the seal casing is metal, apply a light coating of EvinrudelJohnson Gasket Sealing Compound, or equivalent sealant to the outside diameter. If the seal casing is rubber coated, then apply a light coating of EvinrudelJohnson DPL Penetrating Lubricant, or equivalent.

■ The upper seal on **60°** motors is installed without any sealant or penetrating lubricant and without the use of a driver. It is positioned on the crankshaft later during the assembly procedure, JUST before the crankshaft is lowered into the block.

10. Except for the upper seal on 60° motors, use suitably sized drivers to install the seals to the upper and lower crankcase heads with the seal lips properly positioned. Use the following drivers or equivalents and pay attention to seal positioning, depending upon the model:

On 60° motors, use a driver that presses only against the outer metal casing of the seal.

On 90° cross-flow motors, use # 325453 on the upper seal and position the seal in the upper head with the lip facing the bearing. Use # 326567 for the lower seal and position the seal in the head with the extended lip facing the gearcase.

- On 90° looper motors, use # 325453 to install the lower seal on all models and both the lower and upper (using the flat end) seals on FFI models. The manufacturer says that any flat driver can be used to install the upper seal on carbureted models (but this should include the flat end of 325453 as well). Position the lower seal in the crankcase head with the extended seal lip facing down. Position the upper seal in the crankcase head with the lip facing downward and install until flush with the upper head.

11. Once installed, lubricate the upper and lower crankshaft seal lips along with the replacement O-rings for the upper and lower head housings using a light coating of Evinrude/Johnson Triple-Guard, or equivalent marine grease. Position the O-rings in their grooves.

☐ Each crankcase head (upper and lower) on **90°** motors utilizes 2 O-rings. The lower head (the only one which utilizes an O-ring) on **60°** motors uses a single O-ring.

12. Install the lower crankcase head/seal assembly over the crankshaft, depending upon the model, as follows:

- On 60° motors, carefully slide the lower seal housing in position over the crankshaft.

On 900 motors, use 2 guide pins, such as EvinrudelJohnson 383175 and slide the head over the crankshaft. Apply a light coating of EvinrudelJohnson Nut Lock to the threads of 4 new lower bearing retainer screws, then install and tighten to 96-120 inch lbs. (11-14 Nm).

With the each of the pistons and the crankshaftlbearings assembled, it is time to turn out attention back to the cylinder block and motor assembly.

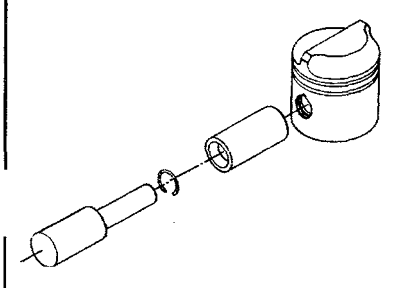


Fig. 49 If available, you can use a shouldered driver to install the wrist pin retaining ring inside the wrist pin bore

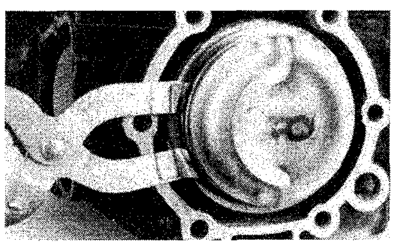


Fig. 50 Use a universal ring expander to spread the rings JUST enough to slip over the piston

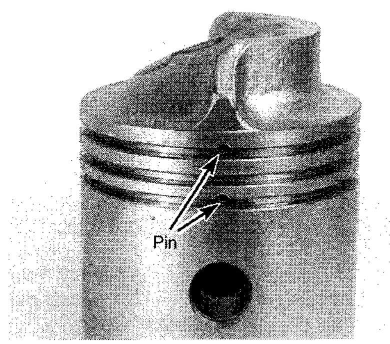


Fig. 51 EvinrudelJohnson 2-stroke piston ring grooves are equipped with dowels on which to align the ring gaps

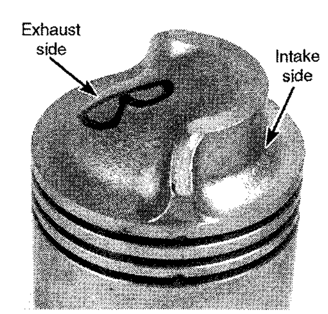


Fig. 52 When installing the pistons on cross-flow motors, be sure the curved intake side faces the intake port

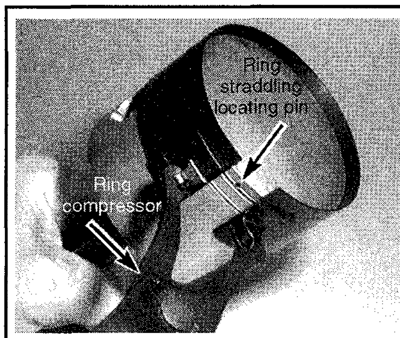


Fig. 53 Use a standard 2-stroke engine ring compressor to hold the rings in the grooves during assembly...

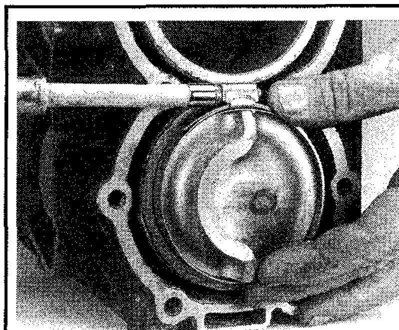


Fig. 54 ...if not, a suitably sized, smooth inner surface band-type hose clamp can substitute for a ring compressor

13. Inspect the cylinder block-to-crankcase mating surface to ensure there are NO traces of sealant left. If necessary, remove any remaining traces of hardened sealant to prevent potential problems with bearing alignment.
14. Rotate the cylinder block so the PORT head faces downward, parallel with the floor.
15. If removed, install each piston on the PORT side as follows:
a. Apply a light coating of clean engine oil or assembly lube to the piston and piston bore.
b. Use a suitable ring compressor or a band-type clamp with a solid inner ring to evenly compress the rings (oiling the inside of the compressor or clamp will also help ease installation). Make sure the rings are still properly positioned with the gaps over the dowels. Also, make sure the connecting rod remains centered in the piston to prevent possible damage to the cylinder walls or piston skirt.
c. Start the piston into the bore facing the proper direction (with the "exhaust side" stamping facing the exhaust ports on loopers or the sharp curved edge of the deflector dome facing the intake ports on cross-flow motors. In both cases, the diagonal oil hole on the side of the wrist pin should be facing up toward the flywheel.
d. Slowly insert the piston, making sure the connecting rod does not strike and damage the piston skirt, or the strike/scrape and damage the cylinder wall. If the piston hangs up on a ring, don't force it, push the piston back upward and remove the compressor to check for potential problems, such as a ring that has shifted the gap away from the dowel.

■ Protect the inside of the cylinder bores using rags to keep the connecting rods from striking, scoring or otherwise damaging the cylinder walls. But, you can't leave the pistons facing downward, as they may fall out, so slowly and carefully rotate the cylinder block until the PORT bank is facing sideways (now the pistons won't move and rags will hold the connecting rods).

16. Prepare and install the cylinder heads, depending upon the model, as follows:
On 600 motors, apply a 1116 in. (2mm) bead of RTV adhesive around EACH water passage on the cylinder block (for details, refer to the accompanying illustrations). DO NOT apply sealant around the thermostat seat area at the end of the block. Next, apply a light coating of Evinrude/Johnson Gasket Sealing Compound, or equivalent sealant to the threads of the cylinder head retaining bolts, Install the cylinder head and finger-tighten the retaining bolts. Finally, using multiple passes of a torque sequence that starts at the center and spirals to the outer retainers, tighten the cylinder head bolts to specification. The bolts should be tightened to 20-22 ft. lbs. (24-27 Nm) for all except 2000 and later FFI motors, or to 14-16 ft. lbs. (19-22 Nm) for 2000 and later FFI motors.

■ If the thermostat seal was removed from the back of the head on **600** motors, be sure to install a new seal with the marking "TO CYL **HEAD"** facing toward the thermostat.

On 90° motors, apply a light coating of EvinrudelJohnson Gasket Sealing Compound, or equivalent sealant to both sides of a NEW cylinder head gasket, then position the gasket on the cylinder block. On looper motors, make sure the gasket tab is positioned facing upward. Next, install the cylinder head using the retaining bolts (the threads should be clean and dry, do NOT use sealant on the bolts). For most models (except as follows), tighten the bolts to 18-20 ft. lbs. (25-27 Nm). But, for all 1992 loopers, tighten the bolts to 20-22 ft. lbs. (24-27 Nm). For 1994 and later carbureted V6 motors, tighten the bolts to 15-17 ft. lbs. (20-23 Nm).
17. Carefully rotate the cylinder block so the STARBOARD bank is facing the floor (make sure the connecting rods from the port bank do not contact and damage the cylinder walls). Repeat the piston and cylinder head installation steps for the STARBOARD bank of cylinders.
18. If removed, install the thermostat assembly. For details, please refer to the Lubrication and Cooling section.
19. Carefully rotate the cylinder block so the crankcase mating flange is now facing upward.
20. Carefully push all pistons downward (up in their bores) to Top Dead Center (TDC) in order to ease crankshaft installation.
21. Remove the connectina rod end caps and cap bearing halves (positioning them aside to keep track of their location'and orientations). If matchmarks are not readily visible, matchmark the connecting rods to the caps and bearing halves before removal to ensure proper installation. Continue to use rags or use rubber bands to hold the connecting rods off the cylinder walls.

■ Leave the connecting rod bearing halves (as opposed to the rod cap halves) in position in the rods.

22. On 600 motors, make sure the upper seal area of the crankshaft is completely clean of dirt or debris, then install a NEW upper seal on the crankshaft. DO NOT apply sealer to the outside diameter of the seal.
23. On 900 looper motors, apply a LIGHT coating of Evinrude/Johnson Gel-Seal II or equivalent sealant to the cylinder block, ONLY at the upper crankcase head flange surface at this time.
24. If not already done, apply a light coating of clean engine oil or assembly lube to the crankshaft journals, as well as to the connecting rod bearings.
25. Gently lower the crankshaft into the position. Face each of the crankcase seal ring gaps upward. On 900 motors, gently tap upward on the crankshaft using a rubber or plastic mallet in order to seat the crankshaft and lower crankcase head. On 60° motors, locate the tab on the lower bearing seal housing into the recess in the crankcase. For all motors, make sure each center main bearing split sleeve is positioned on its dowel pin.

■ On **900** motors, loosely install **2** bolts each into the upper and lower crankcase heads to hold them in position.

26. Install each of the connecting rods to the crankshaft, one at a time, as follows:
a. Slowly and carefully pull the connecting rod up until the bearing in the rod contacts the crankshaft journal (crankpin).
b. Seat the rod journal against the crankpin and then move the bearings from the cap to the connecting rod journal. Finally, align the matchmarks and position the cap over the bearing.

■ Besides any matchmarks made during removal, the connecting rod caps on most models are normally equipped with dots on the connecting **rod/cap.** These dots should also be aligned.

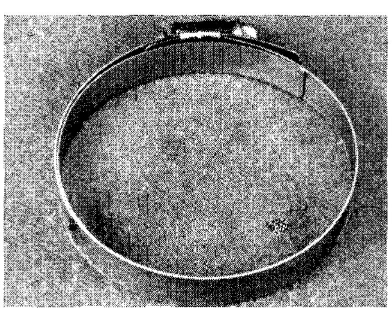


Fig. **55** **A** Mercruiser exhaust bellows hose band clamp is smooth on the inner surface and can often be used as a ring compressor on these motors

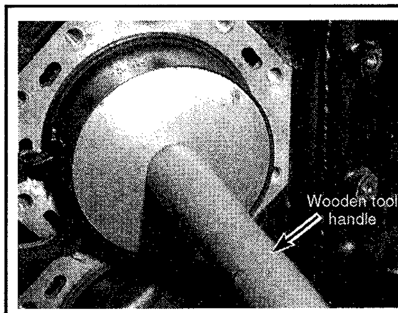


Fig. **56** Gently tap the piston into position, through the ring compressor (or hose clamp, shown)

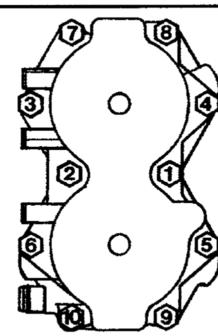


Fig. **57** Typical cylinder head torque sequence-cross-flow motor shown

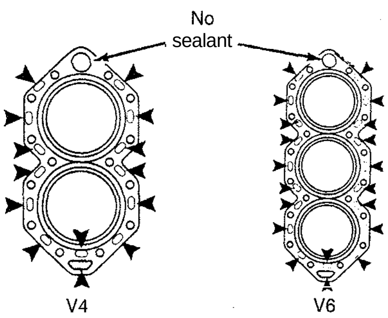


Fig. 58 Apply a thin bead of R N around each of the cylinder water passage before cylinder head installation-600 motors only

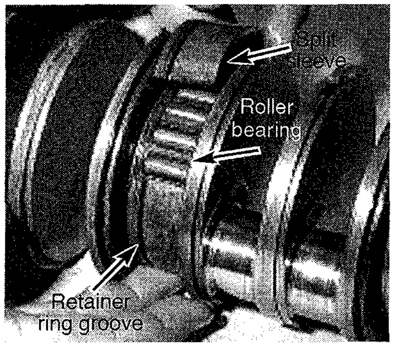


Fig. 59 During installation be sure face the retaining ring groove faces AWAY from the flywheel (toward the bottom of the crankshaft)

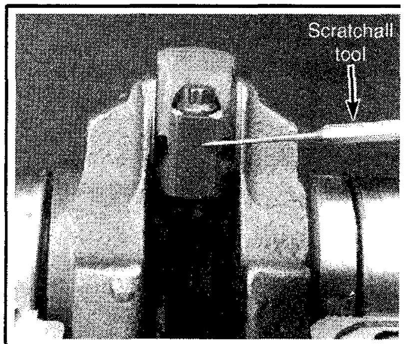


Fig. 60 One method used to check bearing cap installation is to move a sharp pick or "scratchall" tool back and forth across the split line. When properly aligned and tightened, the tool will NOT catch

c. Oil and install the connecting rod cap bolts, then finger-tighten the bolts alternating from side-to-side on the rod cap.

d. Use a pencil or your fingernail to determine if the rod caps are fully aligned and seated. Scrape the pencil across the mating surface to see if it catches.

e. Center and align each of the connecting rod caps in turn using the Evinrude/Johnson Rod Cap Alignment Fixture # 396749 as follows:

- Rotate the knob on the top of the tool until the flat marked SET aligns with the arrow on the fixture frame. Rotate the adjustment knob 180° to the lock position.
- Make sure the retaining jaw (with the flat head screw in the frame bore) and the forcing jaw (with the hex key at the base and the threaded flat protruding from the frame) are positioned on the fixture tool.
- Tighten the connecting rod cap screws to 25-30 inch lbs. (2-3 Nm).
- Apply a light coating of engine oil to the corners of the connecting rod and cap where the fixture will be installed.
- Position the frame to the so the contact area of the forcing jaw is centered on the connecting rod and cap. Tighten the forcing screw until the jaws contact the connecting rod, then slide the frame downward until the adjustment stop (at the center of the frame) just contacts the top of the connecting rod cap. Verify that the groove lines in the jaws are centered on the rod/cap diameter.

**** WARNING**

The frame MUST be squarely in position as described in order to perform its function properly. Failure to center the frame, and therefore the connecting **rod/cap,** will lead to premature crankshaft, rod and bearing failure.

- With the frame centered, tighten the forcing screw to 23 inch lbs. (2.5 Nm).
- Loosen both connecting rod cap bolts 114 turn, then tighten each bolt to 40-60 inch lbs. (5-7 Nm).
- Next, tighten the connecting rod cap bolts to 15-17 ft. lbs. (20-23 Nm), and lastly, tighten them to the final torque specification. For all for 90° cross-flow and 60° motors the final torque specification is 30-32 ft. lbs. (40-43 Nm). For 900 looper motors it is 42-44 ft. lbs. (57-60 Nm) for all except 2000 and later 318 in. screws which are 58-62 ft. lbs. (78-84 Nm).

■ The 2000 and later **90°** loopers may be equipped with 5116 in. or **3/8** in. cap screws. The 318 in. screws are tightened to the same 42-44 ft. lbs. as the cap screws on all other **90°** loopers.

- Loosen the forcing screw, remove the frame from the connecting rodlcap assembly, then repeat for the remaining rod(s)/cap(s).

27. Carefully and thoroughly clean and degrease the mating flange of the crankcase and cylinder block halves using Evinrude/Johnson Cleaning Solvent, or an equivalent solvent. Allow the flanges to air dry.

28. Apply a light coating of Evinrude/Johnson Locquic Primer or equivalent to the mating flange of the crankcase half and allow it to air dry.

29. Apply a light coating of Evinrude/Johnson Gel-Seal II or equivalent to the cylinder block flange. Be sure that the sealant coats the entire flange evenly, but be careful not to apply excessive amounts. The sealant must not be applied within 114 in. (6mm) of the crankcase seal rings or bearings otherwise the sealant could be forced out from between the flanges into contact with the bearings during assembly.

■ Although **Evinrude/Johnson** Gel-Seal **II** has a shelf life of one year when stored at room temperature, buy a new tube if in doubt. Keep in mind that using an old tube of Gel-Seal **II** could allow crankcase air leaks (leading to performance problems).

30. Carefully lower the crankcase half into place over the cylinder block half.

31. Install and finger-tighten the main bearing bolts and, if applicable, nuts.

■ The 2 shorter main bearing screws on 600 motors are installed in the bottom end.

32. Make sure the crankcase is seated, then install and seat the crankcase taper pin.

33. Tighten the main bearing screws to specification using multiple passes of a spiraling sequence that starts with the center screws and works outward. Main bearing bolt torque varies with model, as follows:

On 600 motors, tighten the main bearing bolts to 31-35 ft. lbs. (42-47 Nm).

- On 900 cross-flow motors, tighten the main bearing bolts to 18-20 ft. lbs. (24-27 Nm)
- On 900 looper motors, tighten the main bearing bolts to 26-30 ft. lbs. (35-41 Nm) for all except 2000 and later models. On 2000 and later models, tighten the main bearing bolts to 28-32 ft. lbs. (38-43 Nm) and the upper 2 main bearing nuts to 35-40 ft. lbs. (47-54 Nm).

34. On cross-flow motors, temporarily position the flywheel and key on the end of the crankshaft, then rotate the crankshaft clockwise (when viewed from above the flywheel) to check for binding. The crankshaft and main bearings must move smoothly or the cause must be found and remedied before returning the motor to service.

35. On 60° motors, install the lower drain nipple.

36. Install the crankcase flange screws then tighten to 60-84 inch lbs. (7-9 Nm).

37. On 90° motors, install and tighten the crankcase upper and lower head screws. For all cross-flow and for 1992-97 looper models, apply a light coating of Evinrude/Johnson Locquic Primer followed by Evinrude/Johnson Nut Lock, or an equivalent threadlocking compound to the threads of the bolts. For 1998 and later loopers, install the crankcase head bolts dry. In all cases, tighten them to specification depending upon the year and model, as follows:

- On cross-flow motors, tighten them to 96-120 inch lbs. (11-14 Nm) for 1992-94 models or to 120-145 inch lbs. (14-16 Nm) for 1995 and later models.

- On looper motors, tighten them to 72-96 inch Ibs. (8-11 Nm) for 1992-97 models. For 1998 and later models tighten them to either 72-96 inch Ibs. (8-11 Nm)-V4 models; or to 96-120 inch Ibs. (11-14 Nm)-V6 models.

38. On cross-flow models, proceed as follows:

a. If removed, install the temperature senders in the cylinder heads.

b. Apply a light coating of Evinrude/Johnson Gasket Sealing Compound, or equivalent sealant to both sides of NEW cylinder head cover gaskets, then install the head covers. Tighten the bolts using a spiraling pattern that starts and the center and works outward to 60-84 inch Ibs. (7-9 Nm).

c. Apply a light coating of Evinrude/Johnson Gasket Sealing Compound, or equivalent sealant to both sides of 2 new exhaust cover gaskets, then install the inner and outer exhaust covers and gaskets. Apply a light coating of Evinrude/Johnson Nut Lock or equivalent threadlocking compound to the retaining bolts, then install and tighten to 60-84 inch Ibs. (7-9 Nm).

d. If the cooling system indicator fitting was removed, seal the threads using EvinrudelJohnson Gel-Seal II or equivalent, then install it to the exhaust manifold cover.

e. Apply a light coating of Evinrude/Johnson Gasket Sealing Compound, or equivalent sealant to both sides of new bypass cover gaskets, then install the covers and gaskets to the cylinder block. Tighten the bolts to 50-84 inch Ibs. (5.7-9 Nm).

39. Install the intake manifold and leaf valve assemblies. For details, please refer to the Intake Manifold and Leaf Valve procedure in this section.

40. Reconnect the crankcase recirculation hoses, as tagged during removal.

41. Install all fuel, ignition and electrical system components that were removed for accessloverhaul, as detailed in the Fuel System and Ignition and Electrical System sections.

42. Install the powerhead assembly and then refer to Break-In in this section for details on how to ensure proper break-in of the new powerhead components.

CLEANING & INSPECTION

Although due to differences in powerhead components and mounting, we chose to provide individual procedures for Powerhead Removal & Installation, we also realize how similar the internal components and procedures are for the powerhead. Once the fuel, starting and ignition systems are out of the way and you've reduced a powerhead to a crankcase, pistons and components awaiting disassembly, the differences begin to melt away. For this reason, we've provided a single Cleaning & Inspection procedure here. However, since some differences still occur, we will refer to those differences in the following procedures. Since most of these differences occur according to engine family and not just to one or another hp model, we'll normally refer to them by the degree V configuration and possibly number of cylinders. All motors covered here are either of the 60° or 90° configurations. Additionally, only the smallest of the 900 motors are cross-flow design, all others, including all 60° models are loopers. For more details on engine identification, please refer to Engine Identification and the Engine Identification Charts in the Maintenance and Tune-up section.

All powerhead components must be clean and free of gasket material, oil and carbon deposits before they are inspected. Take your time when cleaning components. Before using solvent to clean something, make sure the chemical is compatible with the material of which the component is constructed. Also, check each component for matchmarks or ID marks before cleaning (as some solvents may remove even permanent marker). If necessary, re-ID the component as soon it has been cleaned and dried (before moving onto the next component). When 2 removed components are matchmarked to ensure exact alignment during installation, if possible, fasten them together during cleaning (in case the marks come off). In this way, they can be re-matchmarked after the cleaning process is through.

When it comes to inspection, this section will provide information on how to check various components. But, keep in mind that not all components will be found on all motors. If in doubt whether a component is used (or should be checked) refer to the Disassembly & Assembly or Overhaul procedures AND to the Specifications Chart for your motor. If a component is not listed in the specification chart, it is either not used, or, does not have a specific tolerance for which it must be inspected. Whether or not a tolerance is provided, all components must be clean and free of obvious defects (deep cracks, scoring, excessive carbon deposits that cannot be removed, warpage, etc). If in doubt whether or not a component is serviceable, seek someone with more Evinrude/Johnson experience than yourself.

When inspection involves precision measurements, not only must the components be clean, but they must be measured roughly at room temperature, using the appropriate measurement equipment to ensure accurate results.

It is very important to keep in mind that all wear components (pistons, rings, bearings, etc) **must** be reinstalled in their original locations whenever they are being reused. Wear patterns form on all contact surfaces during use. Mismatching wear patterns will accelerate wear, while matching wear patterns helps ensure a durable and reliable repair.

OEM ② MODERATE

Cleaning

◆ **See Figures 61, 62, 63, 64, 65, 66, 67 and 68**

✳✳ WARNIN

Avoid removing excessive amounts of metal when removing carbon deposits.

1. Use a blunt-tip scraper or dulled chisel to loosen carbon deposits from various components of the combustion chamber and portslvalves. Work slowly and carefully to prevent damaging or excessively scoring the surfaces. Then use a Scotchbrite pad and mild solvent to remove most/all of the remaining deposits. Remove deposits from the following components, as applicable:

- Remove carbon from the combustion chambers in the cylinder head.
- Remove all carbon deposits from the areas around exhaust ports.
- If equipped, remove carbon deposits or corrosion from the exhaust cover.

Piston domes can be cleaned when still installed in the bores. This is handy when the cylinder head is removed for service without completely disassembling the crankcase. If this is to be accomplished, position the piston to be cleaned at TDC and cover the other piston bore(s) using rags and plastic. Thoroughly clean all debris using solvent and compressed air (WHILE WEARING SAFETY GLASSES) before moving to the next piston.

- Remove carbon deposits from the top of the piston(s). When working on the piston domes, use a light touch to prevent scratching, or worse, gouging the piston. Be especially careful on the raised surface of the deflector type pistons used in cross-flow motors.

✳✳ WARNII

Wire brushes are not recommended for cleaning piston domes since particles of steel could become lodged into the piston surface. If this occurs, they could glow hot when the piston is returned to service, causing pre-ignition or detonation that could damage the piston and combustion chamber.

- Remove carbon from the ring grooves either using a ring groove cleaner, or, better yet, using a broken piece of the piston ring with an angle ground on the end. When using a ring to clean the piston grooves, use the ring actually removed from the groove (since it is supposed to be replaced anyway) or one from the same groove on another piston.

✳✳ WARNING

When cleaning piston ring grooves, use the same caution as with the pistons. Do NOT remove excessive amount of material or the piston will be damaged beyond use. Some ring groove cleaning tools are heavy duty and will easily remove too much material, so use them with care. Believe it or not, the manufacturer recommends the filed broken ring method and we concur.

2. Inspect all water passages for corrosion deposits, debris or blockage. Remove debris and clean corrosion as needed and accessible. Use low pressure compressed air to blow out all water passages.

3. Clean and degrease all regularly oiled surfaces (including the crankshaft, pistons and connecting rods) using solvent or degreaser. Use low pressure compressed air to remove all build-up from shaft and rod oil holes.

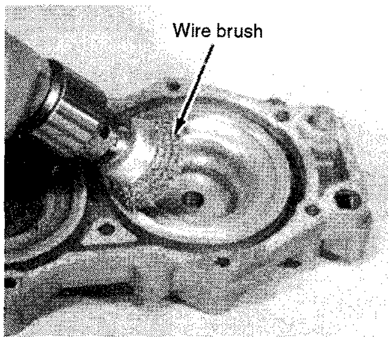


Fig. 61 Although a blunt chisel is preferred, a wire brush can be used **WITH** CARE to clean most carbon deposits

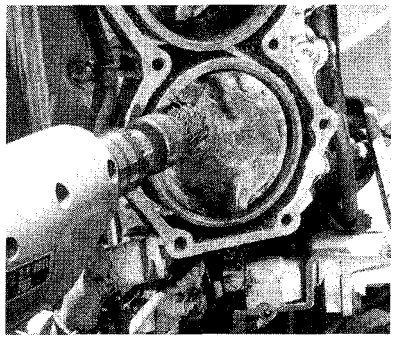


Fig. 62 Pistons CAN be cleaned while still installed, but again use care, and leave NO metallic deposits behind

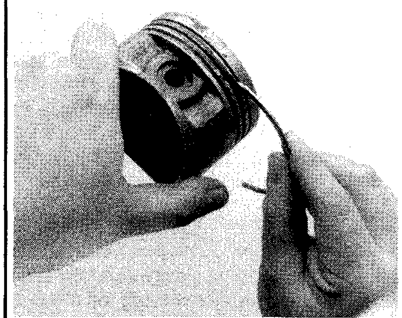


Fig. 63 The preferred method for cleaning piston grooves is to use the filed end of a broken ring**...**

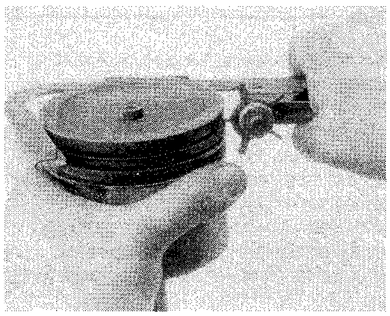


Fig. 64 **...** but a ring groove cleaning tool can be used, with care to prevent damaging the piston

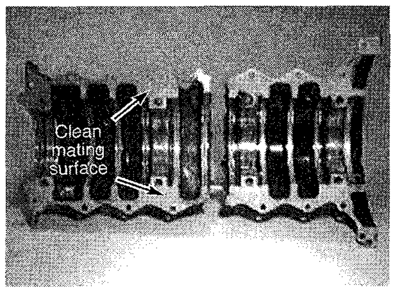


Fig. 65 Gasket surfaces must be clean and free of all gasket material, sealant and nicks or scratches

Fig. 66 The cylinder walls must show obvious cross-hatching(tiny grooves, criss-crossedin a pattern around the bore)**...**

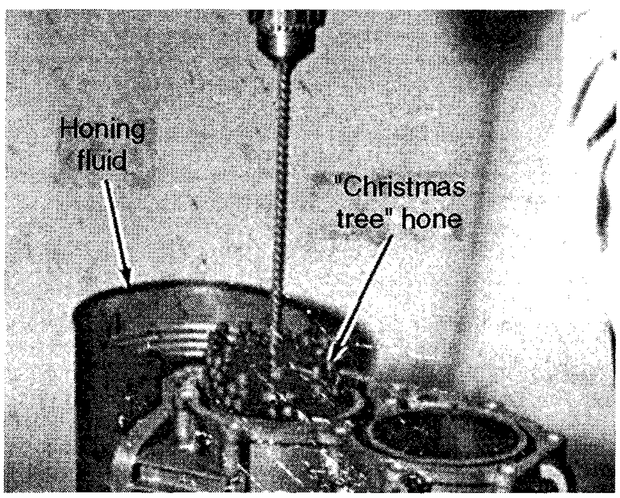


Fig. 67 **...** otherwise a cylinder hone must be used to break the smooth glazed surface into a cross-hatch pattern

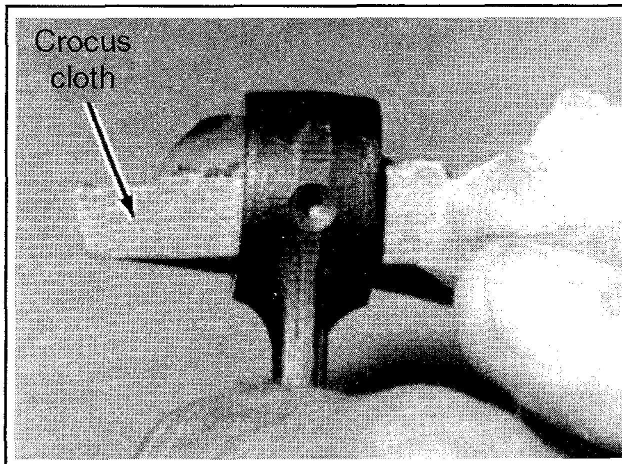


Fig. 68 Never use anything more abrasive than crocus cloth to clean a bearing surface, like the piston end of this connecting rod

4. Remove all traces of gasket or sealant using Evinrude/Johnson Gel Seal and Gasket Remover or equivalent gasket removing solvent. Whenever possible, avoid the use of gasket scrapers to help avoid the possibility of scoring and damaging the gasket mating surfaces.

5. Check the cylinder walls for glazing (a smooth, glassy appearance) and, if found, hone the cylinder walls using a medium grit cylinder hone. Use a slow rpm while raising and lowering the hone through the cylinder in order to cross-hatch the cylinder walls for maximum oil retention.

✳✳ WARNING

Use the cylinder hone slowly, carefully and as little as possible to avoid the possibility of removing too much material from the cylinder walls. If the bores are over-honed, it could cause the pistons to be below specification for the new cylinder measurement; or worse, it could cause the cylinder bores to be **overspec** for what pistons are available.

6. Wash the entire cylinder block, crankcase and head using warm, soapy water to remove all traces of contaminants. Use low-pressure compressed air to blow-dry all passageways.

7. Apply a light coating of clean engine oil to all machined surfaces that are not about to be measured right away. When you return to the task of measuring components that have been oiled, use a solvent covered rag to wipe away the oil before measurements are taken.

8. Cover all components using a plastic sheet to keep dust, dirt or debris from contaminating the cleaned and especially the oiled surfaces.

OEM ② MODERATE

Cylinder Head Component Inspection

◆ See Figures **69** and 70

Unlike 4-stroke motors (in which the cylinder heads usually contain a valve train), the cylinder head on a 2-stroke motor is usually nothing more than a head or cover that is bolted in place on top of the pistons. It is really used more as an access to the pistons themselves than anything else. For these motors, the only real applicable procedure is to check cylinder head flatness to make sure it is not warped.

■ Before going any further, if you haven't already, check the Engine Specifications chart for the motor on which you are working. Keep it handy when reviewing the inspection process, both to determine which checks are applicable to your motor and to provide the required specification.

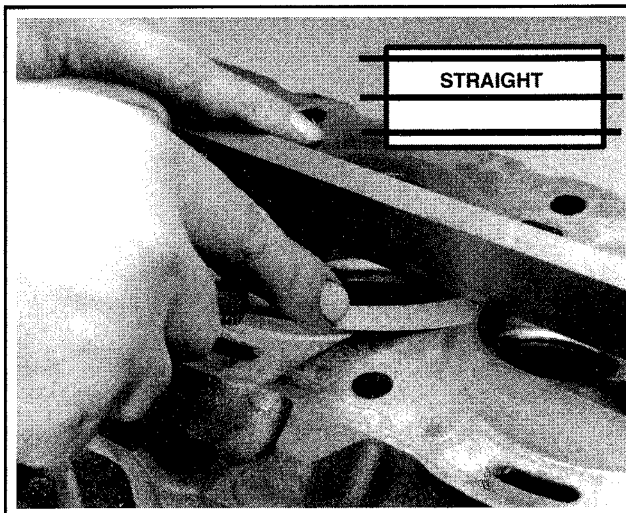


Fig. 69 Use a machinist's straightedge and a feeler gauge set to check the cylinder head for **warpage** across the mating surfaces, both straight across**...**

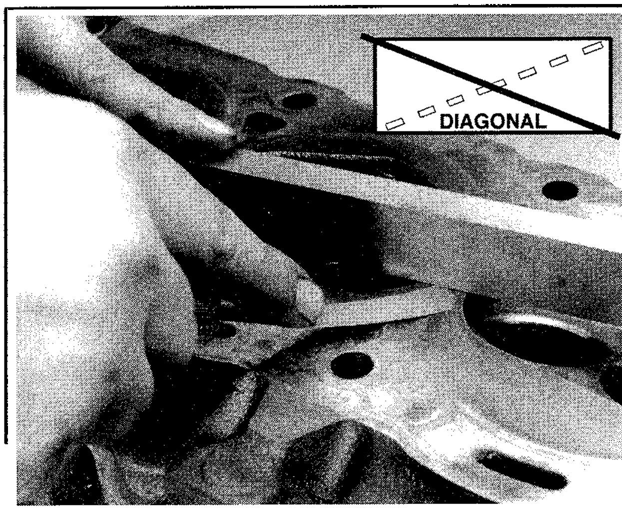


Fig. **70 ...** and at diagonals across the head to be sure the surface is within specification for reuse

Check the cvlinder head flatness bv measurinq the amount of warp across the head at various directions across the head mating surfaces. As with all inspection procedures, make sure the head is completely free of dirt, debris, oil or gasket materials. A machinist's straightedge and a feeler gauge set are necessary for this check. Be sure to hold the straightedge firmly on the head and use the feeler gauge to measure the gap at the midpoint. The warpage measurement is the largest feeler gap that can be inserted between the straightedge and the head with a slight drag. The next larger gauge should not pass and the next smaller should pass without drag. Check the Engine Specifications chart for maximum allowed warpage for the motor on which you are working.

If the surface is just slightly out of spec, you can usually true it using a surfacing plate and 600-grit sandpaper as follows:

1. Cover a large, completely flat metal plate (a surfacing plate) with abrasive sandpaper (600-grit) with the abrasive surface facing upward.

2. Place the cylinder head on the plate, over the paper with the gasket mating surface downward.

3. Move the cylinder head in a figure-eight motion over the paper while pushing downward with gentile pressure.

✳✳ WARNING

DO NOT remove too much material from the cylinder head mating surface, as you will affect (increase) engine compression. Significant changes in engine compression from cylinder head or block resurfacing and the increase of carbon deposits (which will occur naturally in use) can lead to performance problems (such as pinginglpre-ignition).

4. Clean and recheck the surface constantly, until the cylinder head is back within specification.

5. When finished, clean the surface thoroughly with hot soapy water, then dry using low pressure compressed air.

Cylinder Block Component Inspection

Make sure the work area is suitable to cylinder block reconditioning.This means it will have to be relatively clean and free of dust, dirt, debris or moisture. The presence of any one of the aforementionedcontaminants will force you to take steps to protect the components. For instance, mop a dirty floor to help prevent kicking up dust and debris when you are working. Or, if necessary, place some large, flattened cardboard boxes down over the otherwise dusty floor (this will help when oil or assembly lube is invariably spilled or dripped during the rebuilding process.) Make sure there is sufficient light, especially when you are checking for cracks or damage on the component surfaces.

Make sure that you are comfortable with your ability to read the various precision measuring equipment including micrometers and bore gauges. If necessary, you might want to consider handing the block over to a reputable marine machine shop for inspection and overhaul and assembly.

■ All components must be clean and dry before taking precision measurements. Remember too that all specifications, unless otherwise noted, are for components at about room temperature. Temperature variations will also cause differences in measurements.

Although not all components are used by all models, there are more similarities than differences in these engine families. These motors are equipped with needle-roller bearings. In some cases, the manufacturer recommends that components are not to be reused (such as rings) even though many traditional rebuilds would include measuring and possibly reusing these components. Just keep in mind that in the end, following the manufacturer's recommendations will not normally cause a problem, but the same can't be said for ignoring them.

OEM 3 DIFFICULT

Checking the Cylinder Block

◆ See Figure **71**

Once clean, visually inspect the cylinder bores for cracks, glazing (a smooth surface), scoring or deep gouges. A cylinder hone is used to clean up a glazed or lightly scratched/scored surface. However, a hone cannot usually help with deep gouges. If deep cuts are found in the cylinder walls you'll either have to replace the block or, if an oversize piston is available (see a friendly parts supplier), have a machine shop bore the cylinder oversize. Another option that might be available on some models is to have the cylinder sleeved (a process in which a new cylinder wall is pressed into place in the block, giving a fresh wear surface that can be bored or honed to match the piston size).

After inspecting the cylinders, turn your attention to the crankcase, cylinder block, head, and exhaust cover (if applicable) mating surfaces. These surfaces must be clean and free of ali dirt, debris or sealant. Visually inspect these surfaces for signs of deep scratches, cracks or other damage. If dowel pins are used, make sure they are not loose or damaged, and replace, as necessary.

■ White almost powder-like deposits are sometimes formed when water enters the combustion chamber. If such contamination is noted before cleaning the cylinder head, check the cylinder walls and cylinder head for cracks. Also, think back to the condition of the cylinder head gasket or seal, as that too can be the culprit.

Visually check all bolts, studs, nuts and bolt holes for cracks, corrosion or damaged threads. Using the proper size tap or die is usually a good idea to make sure they are completely free of dirt, debris or corrosion. The main bearing and the cylinder head bolts/holes are probably the most critical, so pay special attention to them.

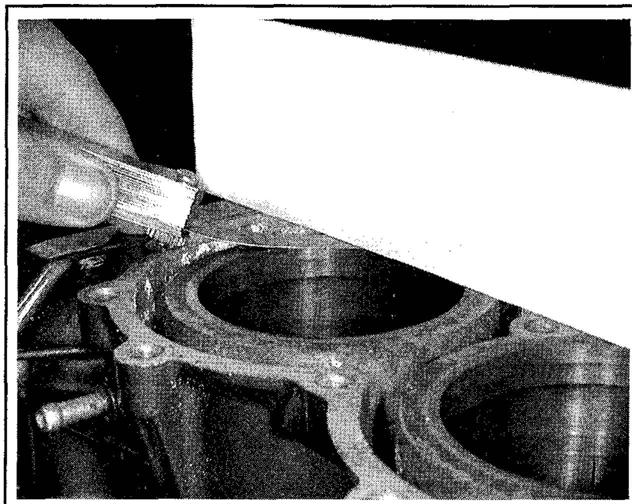


Fig. 71 Check the cylinder block along the head gasket mating surfaces for flatness

■ Although threaded inserts can sometimes be used to repair bolt holes, a block that is heavily corroded or experiences problems in multiple holes should be replaced. If corrosion has caused threads to fail in multiple holes, the rest are probably not far behind.

The cylinder block and the crankcase are normally a matched set and must be replaced as an assembly. For details, refer to your parts supplier.

Once the block is cleaned and otherwise ready for use, check the cylinder head gasket surface for flatness by measuring the amount of warp across the block at various directions across the head mating surfaces. As with all inspection procedures, make sure the block is completely free of dirt, debris, oil or gasket materials. A machinist's straightedge and a feeler gauge set are necessary for this check. Be sure to hold the straightedge firmly on the block and use the feeler gauge to measure the gap at the midpoint. The warpage measurement is the largest feeler gap that can be inserted between the straightedge and the head with a slight drag. The next larger gauge should not pass and the next smaller should pass without drag. Check the Engine Specifications chart for maximum allowed cylinder head gasket surface warpage for the motor on which you are working (all motors use the same spec for both block and head).

If the surface is just slightly out of spec, you can usually true it using a surfacing plate and 600-grit sandpaper as follows:

1. Cover a large, completely flat metal plate (a surfacing plate) with abrasive sandpaper (600-grit) with the abrasive surface facing upward.
2. Place the cylinder block on the plate, over the paper, with the mating surface facing downward.
3. Move the cylinder block in a figure-eight motion over the paper while pushing downward with gentile pressure.

**** WARNING**

DO **NOT** remove too much material from the cylinder block-to-head mating surface, as you will affect (increase) engine compression. Significant changes in engine compression from cylinder head or block resurfacing and the increase of carbon deposits (which will occur naturally in use) can lead to performance problems (such as **pinging/pre-ignition).**

4. Clean and recheck the surface constantly, until the surface is back within specification.
5. When finished, clean the surface thoroughly with hot soapy water, then dry using low pressure compressed air.

OEM 4 SKILLED

Checking the Cylinder Bores

◆ See Figures **72, 73, 74, 75, 76** and **77**

A cylinder bore gauge or a telescoping gauge must be used to take various measurements of the cylinder bore size. The major reason for measuring the cylinder bore is simply to determine how much wear has occurred in the motor. The most basic check of bore size is to make sure that the bore is the proper size for the pistons (that it has not worn beyond use). A piston that has too loose a fit in the cylinder block will allow combustion gasses to escape past the rings, losing both compression and power. A lack of engine compression is another symptom of a worn bore,

Additionally, you must check to make sure that the cylinder has not worn unevenly. So, it is not enough to measure the bore at one point (vertically or horizontally), because the cylinder could be worn in a slightly oval shape (out-of-round) giving a larger or smaller measurement across the diameter in when the measurement is taken in different directions. Similarly, because the cylinder could be wider at the top or bottom (tapered) it must be measured at different depths.

It is critical to the success of the rebuild that these measurements are taken accurately. Only use precision gauges, with all gauges and the cylinder block at room temperature. Practice using the gauges and double or triple-check all measurements. Work slowly and carefully. Most bore gauges will have a thumb-wheel that is designed to free-wheel over a certain torque. If equipped, be sure to use it, as it will prevent pre-loading the gauge to the point where it would give inaccurate readings.

If either the proper gauges or the confidence to use them is not available, then refer this task to a reputable marine machine shop.

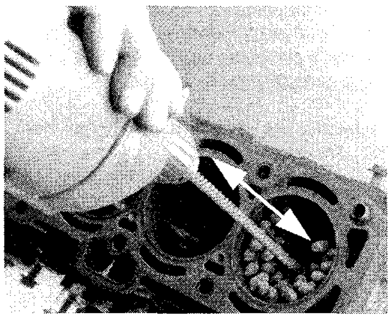


Fig. 72 If the cylinders are glazed, use a hone to achieve a cross-hatching

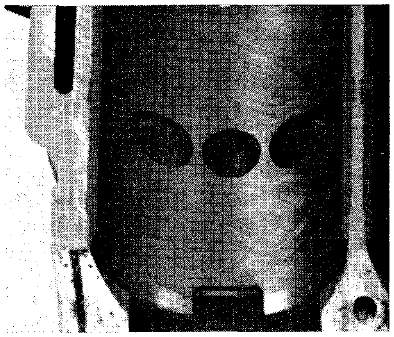


Fig. 73 This photo shows a well cross-hatched cylinder bore

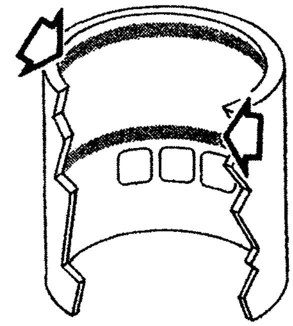


Fig. 74 Measure the cylinder bores at 2 heights to determine taper

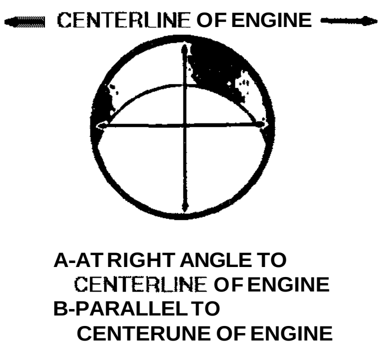


Fig. 75 Measure the bores in 2 directions, at right angles to each other (to determine out-of-round)

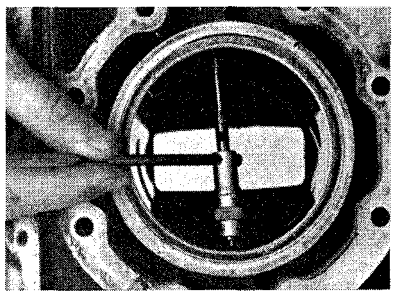


Fig. 76 Using a telescoping gauge to measure across the bore

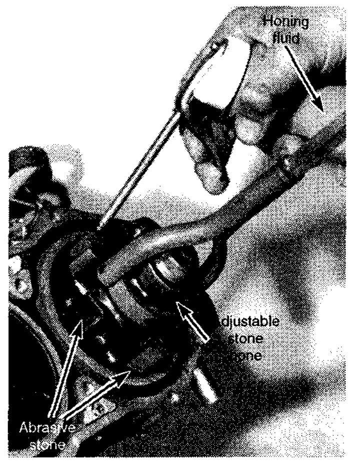


Fig. 77 A machinist can use a hone to cut the bore oversize

1. If not done during the initial cleaning, hone the cylinder bore lightly to remove any glazing prior to measurement. Remember that cross-hatching will be necessary for proper oil retention and honing will change the measurements slightly, so it would be pointless to measure, then hone, since re-measurement will be necessary after honing.

■ When using a cylinder hone follow any instructions from the tool manufacturer. Also, keep in mind the following points. Always use a suitable honing oil, keep the hone perfectly parallel to the depth of the bore and be sure to move it slowly in and out of the cylinder.

2. Using the cylinder bore gauge or telescoping gauge, measure the cylinder bores at 2 depths, the first about 1/4 (6mm) below the deck of the cylinder bore. The second depth should be in the lower area of piston travel (at least halfway down the bore), but make sure it is slightly above the ports. At each depth, measure the bore 2 times-he first time, measure across the bore (side-to-side of the block, at a right angle to the centerline of the engine), and the second time, straight through the bore (from end-to-end of the block, parallel to the centerline of the engine). Compare the measurements to each other and the Engine Specifications chart, as follows:

a. All of the measurements must be either within bore specification, or must not exceed oversize limit.

b. In order to calculate cylinder taper, subtract the smallest diameter measured at the lower point in the bore from the largest diameter measured near the top of the bore.

c. In order to calculate cylinder out-of-roundness, subtract the smaller of the measurements taken at each depth from the larger of the measurements taken at the same depth.

d. Compare all measurements to the Engine Specifications chart to determine if the cylinder is usable or if it must be honed, sleeved (if possible) or discarded. Speak with your parts supplier and machine shop regarding oversize piston availability and how to proceed if boring is necessary.

Remember that there are always variances in production. Be certain to obtain the oversize pistons and provide them, along with the block, to the machine shop for boring. Do NOT bore the cylinder without having the pistons on hand for matching.

OEM 4 SKILLED

Checking the Crankshaft

◆ See Figures **78, 79** and **80**

Once the crankshaft has been cleaned, it should be thoroughly inspected to make sure it is not damaged or excessively worn. Obvious defects, such as visible warpage or cracks are signs of un-serviceability. Similarly, significant etching are discolored areas may be signs that the crankshaft should not be reused.

Specifications will vary greatly from engine-to-engine. On most motors, specs are provided to help gauge the amount of wear on crankshaft or crankpin journals as well as the crankcase seal rings. A crankshaft that contains one or more journals, which are now out of spec, must be replaced. Refer to the Engine Specifications chart for the motor on which you are working and proceed as follows:

1. Inspect the crankshaft surfaces for signs of damage. Look closely at the bearing surfaces (journals and seal rings) for signs of heat discoloration, etching or cracks. If you are uncertain of the condition, consult a reputable machine shop for advice before condemning the shaft.

2. If main crankshaft journal and crankpin diameter specifications are available, use an outside micrometer to measure the diameter the journals and crankpin(s). The crankshaft must be replaced if any readings are out of spec (lower than specified diameter).

3. Double-check all out of spec readings and seek the advice of a reputable marine machine shop if the crankshaft fails these checks.

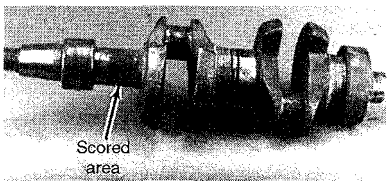


Fig. **78** For all motors, visually inspect the crankshaft for damage or excessive wear

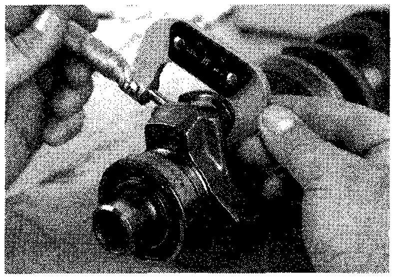


Fig. 79 Measure the main bearing and **crankpin** surfaces using a micrometer

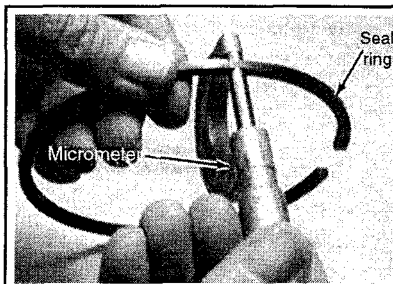


Fig. **80** If they look worn, check crankcase seal ring thickness with a micrometer

4. The crankcase seal rings located along the shaft should be checked visually for signs of damage or wear. If they appear worn, remove them (keeping track of their locations, as with all wear parts) and measure their diameters with a micrometer. Replace and seal rings that are thinner than specification.

OEM ④ SKILLED

Checking the Pistons

◆ See Figures **81, 82, 83, 84** and **85**

Check the pistons for signs of erosion at the edges of the dome or for cracks or physical damage to the dome. Check the ring grooves signs of erosion as well. Check the piston skirt for scoring or obvious damage. The piston must be replaced if any of these signs of damage are found:

Evinrude/Johnson provides few specifications for , ;t Refer t the Engine Specifications chart for the motor on which you are working and proceed as follows:

1. Inspect the pistons as noted for signs of obvious damage.
2. To determine piston out-of-round, measure the diameter of the piston skirt using a micrometer. Measurements should be taken at about 114 in. (6.4mm) from the bottom edge of the skirt and record the specification. Repeat the diameter measurement around the base of the piston at a 900 angle from the previous measurement. Subtract the smaller measurement from the larger to determine out-of-roundness.
3. Damaged, corroded or worn pistons must be replaced.

OEM ④ SKILLED

Checking the Piston Rings

+ See Figures **86, 87, 88** and **89**

The manufacturer recommends replacing ALL piston rings anytime the powerhead is disassembled for service and we concur. Unless the powerhead is disassembled for some bizarre reason during very low hours of usage, there is no reason to skip this critical part of the rebuild. Replacing the rings will help with power, performance and durability.

Each of the rings must be measured to check gap and groove clearance. Once a new set of rings has been measured and confirmed within spec, either install them on the piston or keep the sorted with the piston to ensure installation only in the bore and on the corresponding piston for which they were measured.

■ Ring gap cannot be measured until after all honing is completed. Remember that honing will remove additional amounts of cylinder bore metal, which would change the ring gap.

1. Measure the installed ring gap for the 2 rings intended for each pistonlcylinder bore as follows:
   a. Apply a light coating of engine oil or assembly lube to the walls of the cylinder bore (this will help prevent scuffing or damage to the bore surface).
   b. Carefully squeeze the ring and install it to the top of the bore, then use the piston dome (inverted and facing downward toward the ring) to slowly and carefully push the ring into the bore until square. Check the ring gap can with the rings positioned towards the top of piston travel on these motors.
   c. Use a feeler gauge set to measure the gap between the ring ends. Remember the thickness of the feeler gauge that passes through with a slight drag is the measurement (the next larger should not pass and the next smaller should pass freely).

■ If the gap is too large/small, try a different ring. DO NOT use rings with an incorrect gap.

2. Measure the ring-to-groove clearance for each ring in the intended piston groove as follows:
   a. Install the ring over the piston into the groove, or hold the ring into the groove by hand. In either case, be CERTAIN that you are checking the ring in the correct groove and for the correct piston/cylinder bore that you've just measured its end gap (and determined that it was in spec).

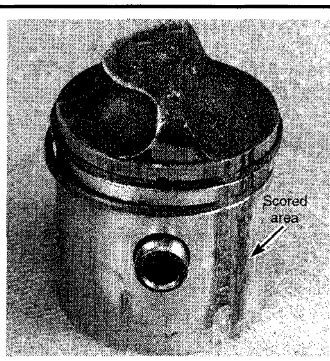


Fig. **81** Visually inspect the pistons for signs of damage or scoring

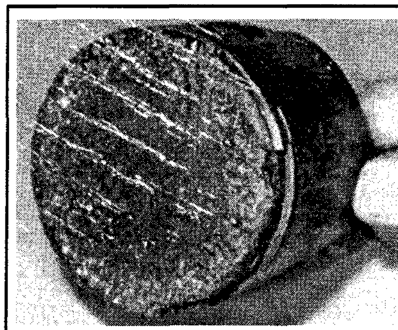


Fig. **82** The pitting on this piston was likely caused by a broken ring in the combustion chamber causing hot spots that contributed to "dieseling" after the ignition was shut down

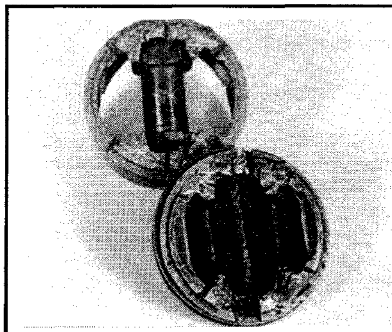


Fig. **83** This crown probably seized in the cylinder bore at high RPM, but crankshaft rotation tore the skirt free of the crown (this engine was a victim of severe neglect)

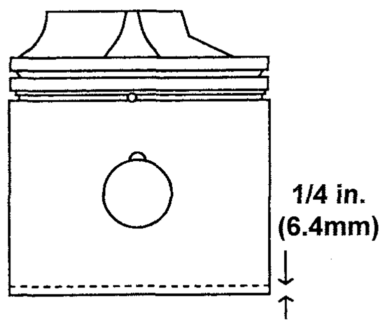


Fig. 84 Measure piston diameter about 1/4 in. (6.4mm) above the edge of the skirt

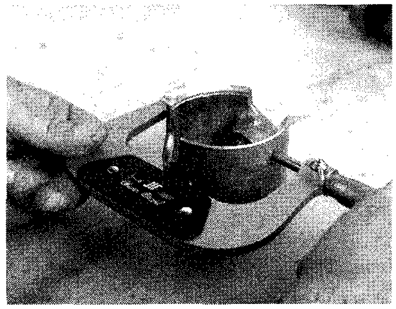


Fig. 85 Measure the piston outer diameter using a micrometer

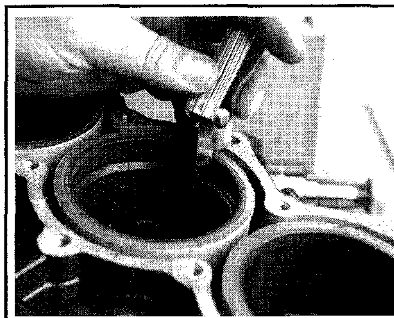


Fig. 86 Position each ring squarely in its intended bore...

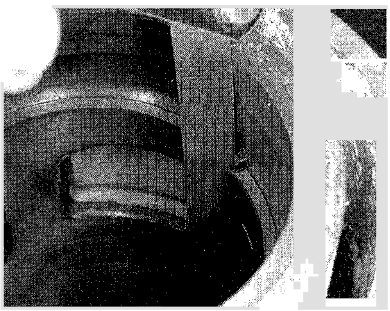


Fig. 87 ...then use a feeler gauge to check end-gap

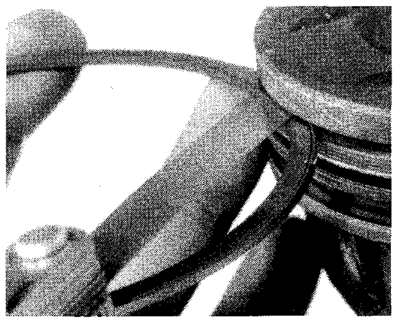


Fig. 88 Check the ring-to-groove clearance

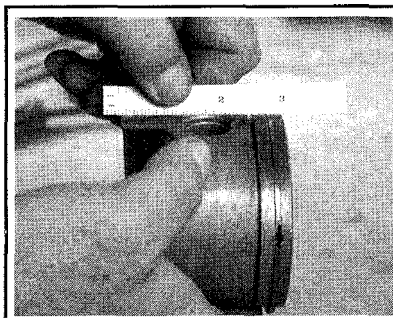


Fig. 89 Use a straight-edge to double-check the installed tapered rings

Most motors utilize at least one tapered ring, the only way to get a proper measurement on a tapered ring is to install it to the piston.

b. Use a feeler gauge to check the clearance between the ring and the piston groove. Again, the measurement is equal to the gauge that passes with a slight drag.

c. If clearance is insufficient, recheck the piston groove for carbon deposits and clean, CAREFULLY if found. If the clearance is too great, the piston must be replaced.

3. Install each tapered ring to the piston and lay a machinists straight edge across the side of the piston (from dome-to-skirt). The rings must NOT hold the straight edge away from the piston. If they do, check for additional carbon deposits in the grooves or recheck for the part number to ensure they are the correct rings.

OEM 3 DIFFICULT

Checking the Connecting Rod(s)

◆ **See Figure 90**

Once a connecting rod has been cleaned, it should be thoroughly inspected to make sure it is not damaged, bent or excessively worn. Obvious defects, such as visible warpage or cracks are signs of un-serviceability.

1. Inspect the connecting rod for twisted, bend or otherwise damaged surfaces for signs of damage. Look closely for cracks, chips, pitting or other signs of rough/damaged surfaces. Replace any damaged rod. If you are uncertain of the condition, consult a reputable machine shop for advice before condemning the rod.

Clean the connecting rods with solvent and dry them with compressed air. Working with one rod at a time, remove the rod cap from the connecting rod. Lay the connecting rod horizontally on a precision surface plate and check the alignment. The rod is bent and unfit for further service if:

a. Light can be seen under any portion of the machined surfaces.

b. The connecting rod has even the slightest wobble on the surface plate.

Repeat the same inspection for the remaining connecting rods. If a connecting rod is found to be bent, warped or twisted, the rod must be replaced. Inspect the connecting rod bearings for rust or signs of bearing failure. Never inter-mix new and used bearings. If one bearing in a set needs to be replaced, all bearings at that location must be replaced.

Inspect the bearing surfaces of the rod and the rod cap for rust, pitting, and water marks. Water marks are caused by the bearing surface being subjected to water contamination, which causes the bearing needles to "etch" themselves into the connecting rod surface.

Inspect the bearing surface of the rod and the rod cap for signs of spalling. Spalling is the loss of bearing surface, and resembles flaking or chipping. A spalling condition will be most evident on the thrust portion or upper half of the connecting rod between the 1:00 and 2:00 o'clock position. Bearing damage is usually caused by improper lubrication.

Check the bearing surface of the rod and rod cap for signs of chatter marks. This condition is identified by a rough bearing surface resembling a tiny washboard. This condition is caused by a combination of low speed low load operation in cold water, and is aggravated by inadequate lubrication and improper fuel. Under these conditions, the crankshaft journal is hammered by the connecting rod. As ignition occurs in the cylinder, the piston pushes the connecting rod with tremendous force. This force is transferred to the connecting rod journal. Since there is little or no load on the crankshaft, it bounces away from the connecting rod. The crankshaft then remains immobile for a mili-second, until the piston travel causes the connecting rod to catch up to the waiting crankshaft journal, then hammers it. In some instances, the connecting rod crankpin bore becomes highly polished.

While the powerhead is operating, a "whirr" and/or "chirp" sound may be heard when the powerhead is accelerated rapidly from idle speed to about 1500 rpm, then quickly returned to idle. If chatter marks are discovered, the crankshaft and the connecting rods should be replaced.

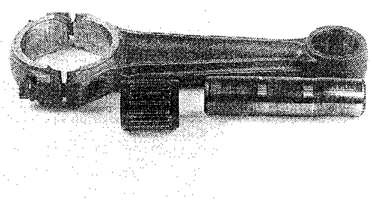


Fig. 90 Visually inspect the connecting rod for signs of damage

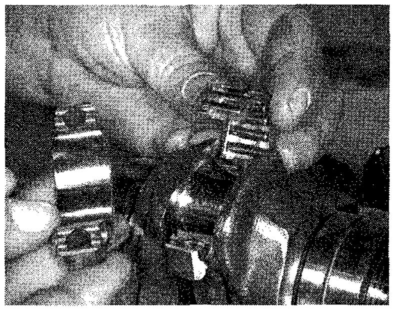


Fig. 91 These motors use caged (shown) or loose needle roller bearings

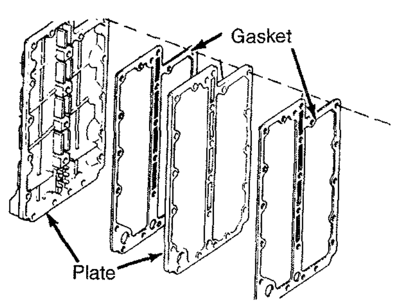


Fig. 92 Exploded view of the exhaust cover used on cross-flow motors

Inspect the bearing surfaces of the rod and rod cap for signs of uneven wear and possible overheating. Uneven wear is usually caused by a bent or twisted connecting rod. Overheating is identified as a bluish bearing surface color and is caused by inadequate lubrication or operating the powerhead at excessive high rpm.

Use only crocus cloth to clean the bearing surface at the crankshaft end of the connecting rod. Never use any other type of abrasive material.

OEM ③ DIFFICULT

Checking the Rod and Main Bearings

◆ **See Figure 91**

These Evinrude/Johnson outboards are equipped needle roller bearings. Some of those bearing assemblies are mounted in bearing cages (most main and connecting rod bearings), while others, (such as the wrist-pin end of the connecting rods) are loose.

In all cases, bearings and bearing surfaces should be checked for obvious signs of wear or damage. Bearing surfaces (journals and inserts) should be smooth, free of scratches, cracks, pitting, scoring or other damage. Needle bearings and cages should also be free of damage. Check needles for signs of uneven wear. Needle bearings, especially bearings that use loose needles, must be checked closely for missing needles.

All bearings are subjected to heat in use. Keep a close eye out for heat discoloration.

To ensure durability and dependability, replace bearings unless they appear like new.

Unless the crankshaft and/or cylinder block is replaced, always purchase replacement bearings of the same size and type.

Check thrust bearings for signs of damage, including highly polished or heat discolored surfaces and, replace if found.

OEM ② MODERATE

Checking the Cylinder Block Exhaust Covers

◆ **See Figure 92**

Although many Evinrude/Johnson outboards use some form of exhaust cover mounted to the side of the cylinder block, no specifications for warpage are available. However, each time the cover is removed, take some time to inspect it for signs of excessive corrosion, damage or warpage. A cover that is damaged or warped cannot ensure an affective seal and should be replaced. Be especially careful when working on a motor that has suffered an overheat condition as exhaust covers are prone to warpage under these conditions.

☐ **Improper removal or installation procedures can sometimes warp an exhaust cover. Whenever possible, use a crossing or spiraling pattern can help prevent damage.**

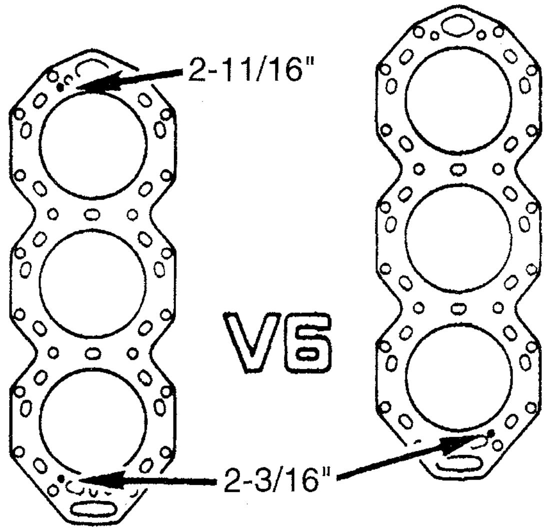


Fig. 93 On 90° V6 motors, check the water deflectors in these positions for wear

OEM ② MODERATE

Checking the Water Deflectors

◆ **See Figure 93**

Most Evinrude/Johnson outboards utilize water deflectors in the cylinder cooling passages. They are exposed when the cylinder heads are removed. The Powerhead Overhaul procedure in this section mentioned them specifically for cross-flow motors, however, no specifications are available for the deflectors on those motors.

But, on some 90° V6 motors, specifications were provided for water deflector size (to be used as an indication of wear). For these motors, if deflectors are present in the positions shown in the accompanying illustration, remove them and measure them for excessive wear. The upper deflector should measure 2 11116 in. (68mm) while the 2 lower deflectors should measure 2 3116 in. (55mm).

Regardless of specifications, check for the presence of water deflectors and replace them if they are obviously damaged or worn. Similarly, the cooling passages themselves must be checked for corrosion and cleaned or the block replaced if excessive corrosion cannot be removed. Remember that blockages can cause the powerhead to overheat, destroying internal components and possibly causing a complete powerhead failure.

Intake Manifolds and Leaf Valves

◆ **See Figures 94, 95 and 96**

Intake manifold and leaf plate assembles are mounted to the cylinder crankcase on all motors. They provide a both a mounting point for the carburetors or throttle bodies on FFI motors and for the leaf valves that regulate the intake air charge. Leaf valves are pressure actuated valves that open in response to crankcase vacuum (when the cylinder is moves upward, drawing a fresh charge into the crankcase). The valves also close, to seal the crankcase, in response to crankcase pressure (when the cylinder moves downward, forcing the fresh charge to move through the intake ports and into the combustion chamber).

Leaking or damaged intake manifold seals or leaf valves can be responsible for a variety of performance problems. They should be inspected with any engine overhaul, but can also be serviced with the powerhead installed and the carburetors or throttle bodies (as applicable) removed for access.

REMOVAL, INSPECTION & INSTALLATION

◆ **See Figures 94, 95, 96, 97, 98 and 99**

1. Remove the carburetors or throttle bodies from the powerhead, as applicable. Refer to the procedures in the Fuel System section for more details and remove any remaining interfering components, depending upon the model, as follows:

On cross-flow motors, disconnect the throttle cam and linkage, then tag and disconnect the crankcase recirculation hoses.

- On carbureted 60° motors, remove the 2 balance tube retaining clips from the crankcase flange, then pull the balance tube out of the intake manifold.

On FFI 600 motors, remove the 8 bolts securing the port and starboard throttle bodies, disconnect the vent hoses from the intake AND the throttle linkage.

On carbureted versions of the 90° looper motors, remove the carburetors as an assembly and DO NOT remove any throttle shaft links. Cut the tie straps securing the fuel distribution manifolds, then remove the fuel system. If necessary, remove the air silencer base screws and disconnect the fuel primer solenoid (purple/white) lead in order to remove the air silencer base assembly.

- On 90° FFI motors, remove the throttle bodies as an assembly and DO NOT remove the throttle linkage. Remove the screw and washer securing the throttle cam and disengage it from the throttle position sensor. Remove the vapor separator vent hose, loosen the fuel lift pump bracket nuts and remove the assembly.

2. If removing the starboard intake manifold on 60° models, remove the 2 screws securing the upper throttle shaft retainer, then remove the retainer itself.

3. Remove the bolts from the intake manifold using multiple passes of a spiraling or crossing pattern that starts on the outside and works toward the center fasteners, then remove the intake manifold. Remove and discard the gasket. On 90° looper models, you must remove the LOWER intake manifold first. On 60° models, pay close attention as there are 11 manifold bolts.

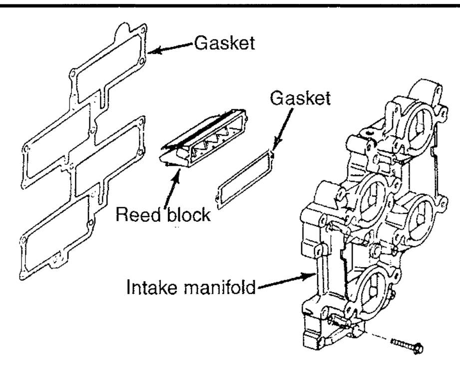


Fig. 94 Exploded view of a typical intake manifold and leaf valve used on 90° LV4 and LV8 motors

✳✳ WARNING

Do not bend and leaf valves by hand as this could damage them so they either do not seal properly at best, or at worst, will break off during service. Do not disassemble the leaf plate unless some portion of the plate and valve assemblies is corroded or damaged and requires replacement. ALSO, check Dart availabilitv before starting, since the valves ARE replaced and not serviced on'some models.

4. Inspect the leaf plate assemblies and the intake manifold, as follows:

a. Two screws secure each leaf plate. If necessary, loosen the screws and remove the assembly. Remove and discard the gaskets.

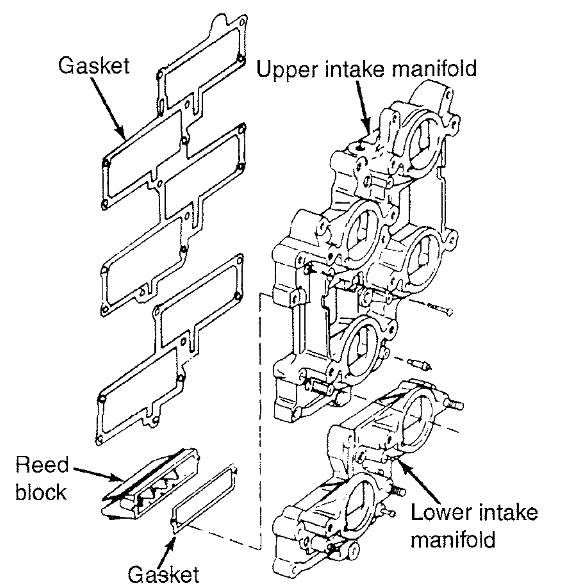


Fig. 95 Exploded view of an intake manifold and leaf valve assembly used on 90° LV6 motors

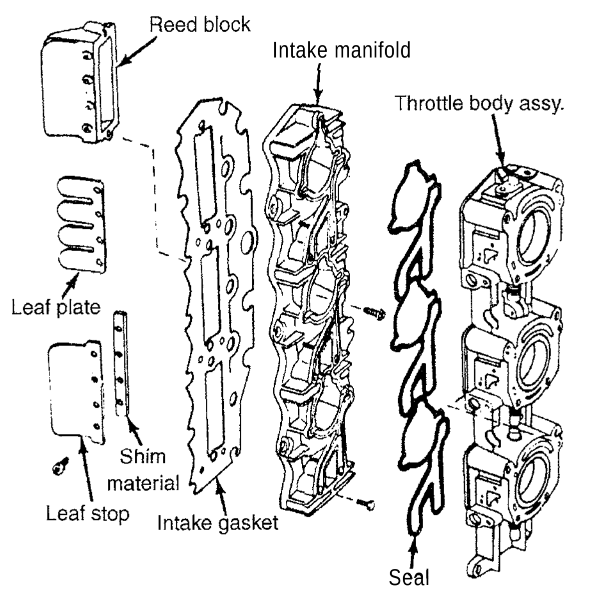


Fig. 96 Serviceable leaf valve assemblies are used on cross-flow and 60° motors-a V6 is shown here, but the 60° V4 are very similar (the cross-flow uses a one-piece manifold design)

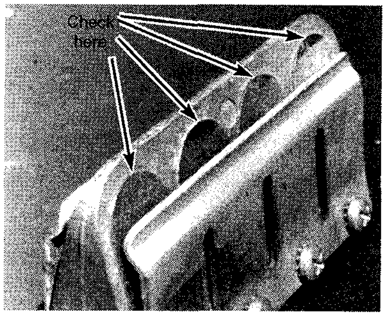


Fig. 97 Check the reed valves to make sure they close fully...

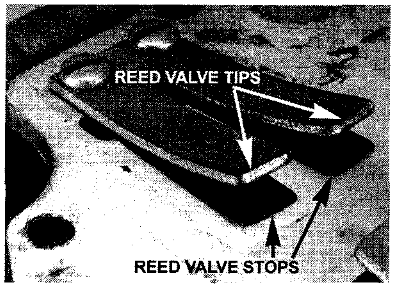


Fig. 98 ...and are centered over their stops

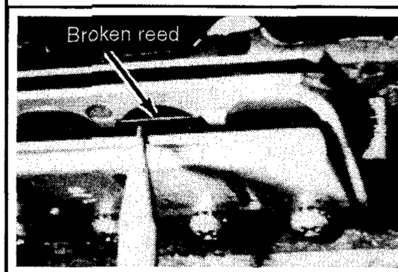


Fig. 99 When a broken valve is discovered, not only must it be replaced, but the pieces must be located and removed from the crankcase

The leaf valve assemblies are not serviceable on 90° looper models and on some cross-flow models, they must be replaced if damaged. However, components may be available for some cross-flow and most 60° models.

b. Visually check ior obvious signs of distortion on the valves or plates. Inspect the valve tips for signs of cracks, chips or other obvious damage. Make sure the leaf stops are not distorted or loose. If there are any obvious defects, that component must be replaced.

c. Use a machinist's straightedge and a feeler gauge to check the leaf plate gasket area for distortion. Lay the straightedge across the plate only (not the leaf valves) at various points, then see if a 0.003 in. (0.08mm) or large feeler gauge can be inserted underneath the straightedge at any point. If it does, the plate is warped and must be replaced.

d. Check the leaf plate screws to make sure they are tight. If they have loosened at all, retighten each one individually as follows. Loosen the screw a turn or two, just enough to apply a light coating of Evinrude/Johnson Screw Lock or an equivalent threadlock, then tighten the screw to 25-35 inch lbs. (3-4 Nm) and proceed on to the next screw.

An even better solution is (still servicing each screw 1 at a time) to remove all previous traces of sealant from the screw threads, then apply **Evinrude/Johnson** Locquic Primer and allow it to dry. **Finally, apply** the Screw Lock, reinstall and **tighten** the screw. But this **process** takes considerably more time.

e. Check the intake manifold gasket surfaces to make sure they are smooth and free of nicks. If necessary, a gasket surface may be dressed to smooth shallow nicks using a fine emery cloth.

f. Use the straightedge and feeler gauge to check for warpage across the intake manifold gasket surfaces. Check at the center of the straightedge to make sure a 0.004 in. (0.10mm) or large feeler gauge cannot be inserted underneath the straightedge.

g. Check the manifold balance passage to make sure it is free of restrictions.

h. If disassembly is necessary, matchmark the components and remove the leaf stop screws, then remove the leaf valves and stops. If they are being reused, do not allow the leaves and stops to become mismatched.

**** WARNING**

Do not lift or bend the leaf valves during disassembly or they could become damaged. If a damaged leaf valve is installed it could break in use.

5. If disassembled for component replacement, prepare and assemble the leaf plates as follows:

a. Place the leaf valves on the plate. If new valves do not seat on the plate; try turning them over.

**** WARNING**

NEVER turn over used valves on the plate, as they may break when they are returned to service. If used valves do not seat in their original direction of installation, they must be replaced.

b. Check the valves, if any leaves are standing open, apply light pressure using the eraser end of a pencil (the valve should close with light pressure). If not, check the plate for high spots or burrs.

**** WARNII**

NEVER lap **the** leaf plate. **A** plate that is too smooth may cause the leaf valves to stick closed when returning a motor to service after winterization,

c. Remove all previous traces of sealant from the screw threads, then apply a light coating of Evinrude/Johnson Locquic Primer or equivalent to the valve screws and allow it to air dry.

d. Apply a light coating of Evinrude/Johnson Screw Lock, or equivalent threadlock to the mounting screw threads, wiping off any excessive adhesive compound.

e. Assemble the leaf valve shim (if used) and the leaf stop, then loosely install (but do not tighten) the retaining screws.

f. Hold the leaf valve assembly in a horizontal position (this will usually align the leaf valves over the ports in the leaf plate). Tighten the 2 screws evenly.

g. Mark the edges of the leaf valve using a sharp pencil, then use the pencil eraser to gently open the leaf valves to check alignment over the port. Once again, the valves must be spaced evenly over the port. If not, loosen the mounting screws and reposition the valve.

h. Once centered, tighten all the screws to 25-35 inch lbs. (2.8-4 Nm).

i. Apply a light coating of Evinrude/Johnson Locquic Primer or equivalent to the valve assembly-to-manifold screw threads and allow it to air dry. Then, apply a light coating of Evinrude/Johnson Nut Lock, or equivalent threadlock to the screw threads.

j. Install the leaf valve assemblies to the manifold using NEW gaskets (dry, without sealer) and tighten the retaining screws to 25-35 inch lbs. (2.8-4 Nm).

6. Install the intake manifold using a new gasket (dry, without any sealant). Remember, on 90° loopers, the Upper manifold must be installed first.

7. Check the intake manifold bolts for traces of sealant, and, if present carefully remove all traces of old sealant. On 90° looper models, apply a light coating of Permatex No. 2 sealant to the threads of the manifold bolts that protrude into the crankcase cavity. For 60° models, apply a light coating of Evinrude/Johnson Nut Lock, or equivalent threadlock to the threads of the mounting bolts that install adjacent to the crankcase.

On some models, pay attention to the throttle linkage, as part must be engaged as one of the manifold is positioned.

8. Install the intake manifold and tighten the retaining bolts to specification using a spiraling or crossing pattern that starts at the center and works outward. Tighten the bolts to 60-84 inch lbs. (7-9 Nm) for 90° motors or to 40-50 inch lbs. (4.5-5.6 Nm) for 60° motors.

9. Install any components that were removed for access and the carburetors or throttle body assemblies. For details on Carburetor or Throttle Body installation, please refer to the Fuel System section.

POWERHEAD BREAK-IN

Anytime a new or rebuilt powerhead is installed (this includes a powerhead whose wear components such as pistons and rings and bearings have been replaced), the motor must undergo proper break-in.

By following break-in procedures largely consisting of specific engine operating limitations during the first 10 hours of operation, you will help you will help ensure a long and trouble-free life. Failure to follow these recommendations may allow components to seat improperly, causing accelerated wear and premature powerhead failure.

On all motors, special attention is required to the fuelloil mixture requirements.

During break-in, pay close attention to all pre- and post- operation checks. This goes double when checking for fuel, oil or water leaks. At each start-up and frequently during operation, check for presence of the cooling indicator stream.

At the completion of break-in, double-check the tightness of all exposed engine fasteners.

While each engine requires slightly different steps for powerhead break-in, one procedure is common. During the entire first 10 hours of engine operation, vary the engine speed and perform the special 20 hour service at the end of the first 20 hours of operation.

Varying engine speed allows parts to wear in under conditions throughout the powerband, not just at idle or mid-throttle. Conducting the 20 hour service makes sure that you find and correct any problems or change any settings that may have occurred/changed during break-in (or replaced parts expected to wear during break-in).

During break-in, check your hourmeter or a watch frequently and be sure to change the engine speed at least every **15** minutes (that means between every **2-3** tenths on the hourmeter).

Be sure to always allow the engine to reach operating temperature before setting the throttle anywhere above idle. This means you should always start and run the motor for at least 5 minutes before advancing the throttle, but be especially aware of engine warm-up time during break-in.

** WARNING

NEVER run the engine when it's out of the water, unless a flush fitting is used to provide a source of cooling. Remember that the water pump can be destroyed in less than a minute just from a lack of water. The powerhead will suffer damage in very little time as well, but even if it is not overheated out of water, reduced cooling from a damaged water pump impeller could destroy it later. Don't risk it.

BREAKING IN A POWERHEAD

Carbureted Motors

For the first 10 hours of engine operation, you must use a 50:1 pre-mix fuelloil mixture in the primary fuel tank in addition to the oil supplied by the VR02 oiling system. If the motor is not equipped with VRO2, or the system is disconnected, run a *25:1* pre-mix for this time period. After *10* hours, verify that the oil level has dropped in the VR02 system tank before ceasing the use of pre-mix in the primary fuel tank. For more details, please refer to the information for Engine Oil in the Maintenance and Tune-up section.

■ If, for any reason during the first **10** hours of engine operation, the **VR02** system is disconnected, you must run a **25:1 fuel/oil** ratio pre-mix in the primary fuel tank.

During break-in, observe the following time-table and limitations on engine operation.

☐ Check the cooling indicator stream repeatedly to ensure proper engine cooling.

- During the first 10 minutes, operate the engine in gear at only fast idle.
- During the next 50 minutes, operate the engine in gear below 3500 rpm. If the boat planes easily, use full throttle to quickly bring the boat on plane, then immediately reduce throttle to 112 or less, but making sure the boat remains on plane. Vary the engine speed at least every 15 minutes.
- During the second hour of break-in, use full throttle to quickly plane the boat, then immediately reduce throttle to 314 or less, but make sure the boat remains on plane. Continue to vary the engine speed at least every 15 minutes. At various intervals, operate the engine at full throttle for 1-2 minutes, then reduce the throttle to 314 for an additional minute or two in order to allow the pistons to cool off slowly. Don't just drop from Wide Open Throttle (WOT) to idle.
- For the next 8 hours, continue to vary the engine speed. Be sure to avoid continuous full-throttle operation for long periods.
- After the first 20 hours, the powerhead should be fully broken-in. follow the steps of the 20-hour service. Be sure properly retorque the cylinder head bolts (this should be done after the engine is run, but only after the cylinder head has cooled to the touch).

FFI Motors

The electronic control system used on FFI motors automatically provides for additional oiling to the motor during certain engine operating conditions for the first 5 hours of new powerhead operation. However, the Evinrude/Johnson FFI Diagnostic Software must first be used to initiate the Break-In operating mode. During the first 20 hours of engine operation pay close attention to engine oil tank levels. Mark the initial level and check it frequently to make sure the oil level is dropping (slowly, but dropping nonetheless).

During break-in, observe the following time-table and limitations on engine operation.

Check the cooling indicator stream repeatedly to ensure proper engine cooling.

- During the first 5 minutes (and every time the engine is cold-started), operate the engine in gear only at slow idle.
- During the first *5* hours, vary the engine speed at least every 15 minutes, but do not exceed either 112 throttle.

■ **If** the boat planes easily, use full throttle to quickly accelerate the boat onto plane, then immediately slow throttle to **1/2** or less, while making sure the boat remains on plane at this throttle setting.

- During the next 10 hours of engine operation, vary the engine speed at least every 15 minutes. Continue to bring the boat quickly on plane using full throttle, then reduce the throttle setting below to somewhere between 112 and 314 throttle. About every 30 minutes, run the engine at full throttle for 30 seconds and then slow the motor to about 112 throttle, allowing the pistons to cool.
- After the first 20 hours, the powerhead should be fully broken-in, follow the steps of the 20-hour service.

POWERHEAD SPECIFICATIONS AND EXPLODED VIEWS

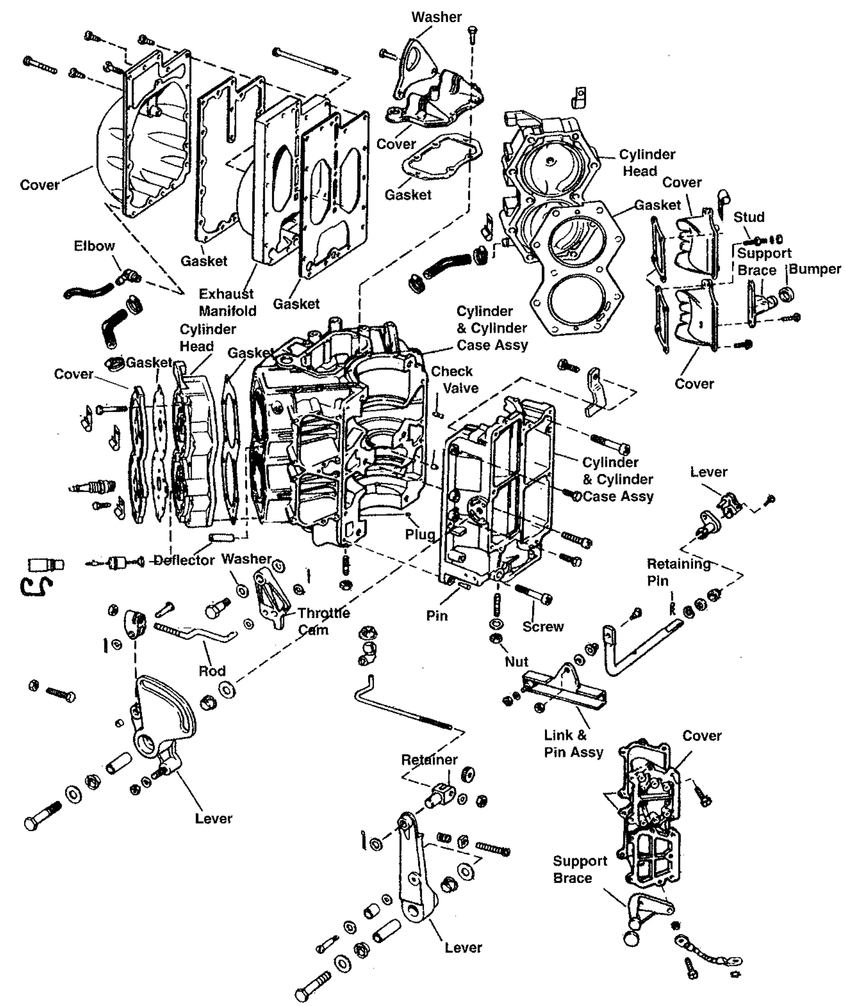
ENGINE SPECIFICATIONS - 65 JET-115 HP (1632cc) 90 DEGREE V4 ENGINES

Component	U.S. (in.) ①	Metric (mm) ①
Cylinder Bore		
Standard Bore Diameter	3.4995-3.5005	88.89-88.91
Oversize Service Limit	0.004 Max	0.10 Max
Out-of-round		
Service Limit	0.004 Max	0.10 Max
Taper		
Service Limit	0.002 Max	0.05 Max
Cylinder Head		
Gasket Surface Warpage	0.004 Max	0.10 Max
Crankshaft		
Top Journal		
Diameter	1.6199-1.6204	41.15-41.16
Center Journal		
Diameter	2.1870-2.1875	55.55-55.56
Bottom Journal		
Diameter	1.3779-1.3784	35.00-35.01
Crankpin		
Diameter	1.3757-1.3762	34.94-34.96
Crankcase Seal Ring Thickness		
Service Limit	0.154 Min.	3.9 Min.
Piston		
Out-of-round ②	0.004 Max	0.10 Max
Ring Gap		
Production (Both Rings)	0.019-0.031	0.48-0.79
Ring Side Clearance		
Service Limit	0.004 Max	0.10 Max

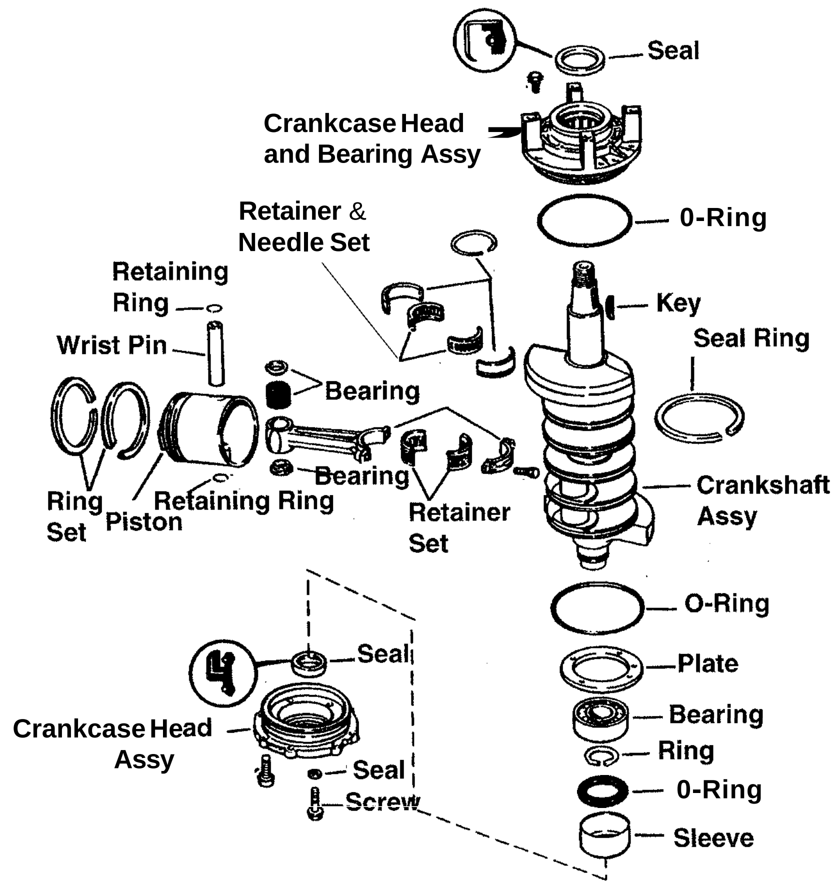
① Unless otherwise noted

② To determine out-of-round measure piston diameter at a minimum of 2 locations, 90 degrees to each other, then subrtract the smaller measurement from the larger

Engine Specifications-65Jet-115 Hp (1632cc) 900 CV4 motors



Exploded view of a typical cross-flow powerhead assembly-65 Jet-115 Hp (1632cc) 900 CV4 motors (some commercial models vary slightly)



Exploded view of the crankshaft, piston and main bearing assembly-65 Jet-115 Hp (1632cc) 90° CV4 motors

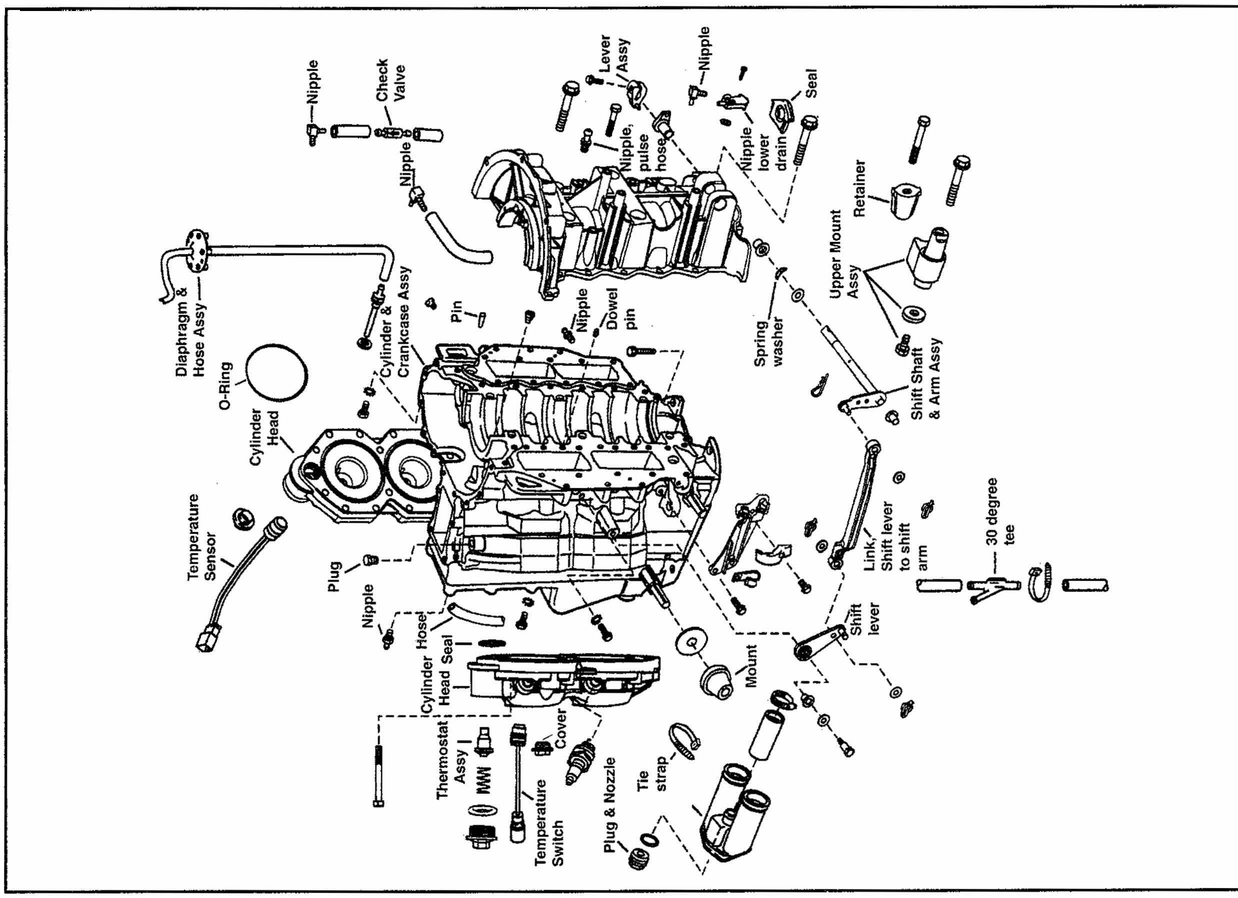
ENGINE SPECIFICATIONS - 60 DEGREE 75-115 HP (1726cc) V4 AND 105J-175 HP (2589cc) V6 ENGINES

Component	U.S. (in.) ①	Metric (mm) ①
Cylinder Bore		
Standard Bore Diameter	3.5995-3.6005	91.43-91.45
Oversize Service Limit	0.004 Max	0.10 Max
Out-of-round		
Service Limit	0.004 Max	0.10 Max
Taper		
Service Limit	0.002 Max	0.05 Max
Cylinder Head		
Gasket Surface Warpage		
1995-98	0.004 Max	0.10 Max
1999-01	0.003 Max	0.08 Max
Crankshaft		
Top Journal		
Diameter	2.1870-2.1875	55.55-55.56
Center Journal(s)		
Diameter	2.1870-2.1875	55.55-55.56
Bottom Journal		
Diameter	1.5747-1.5752	40.00-40.01
Crankpin		
Diameter	1.3757-1.3762	34.94-34.96
Crankcase Seal Ring Thickness		
Service Limit	0.154 Min.	3.9 Min.
Piston		
Out-of-round ②	0.003 Max	0.08 Max
Ring Gap		
Production (Both Rings)	0.011-0.023	0.28-0.58
Ring Side Clearance		
Service Limit (1992-93 V6 only)	0.004 Max	0.10 Max

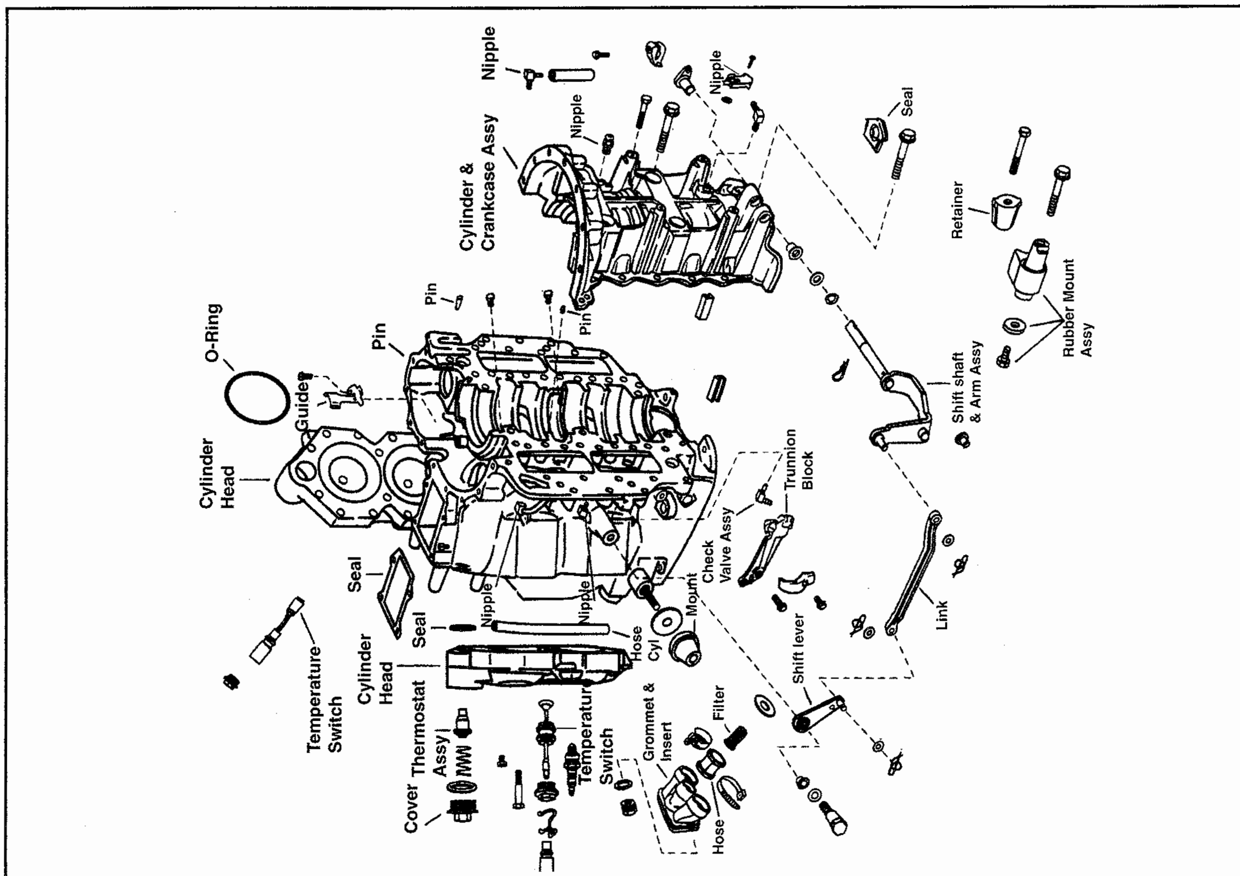
① Unless otherwise noted

② To determine out-of-round, measure diameter at a minimum of 2 locations, 90 degrees to each other 1/4 in. (6.4mm) above the edge of the piston skirt, then subrtract the smaller measurement from the larger

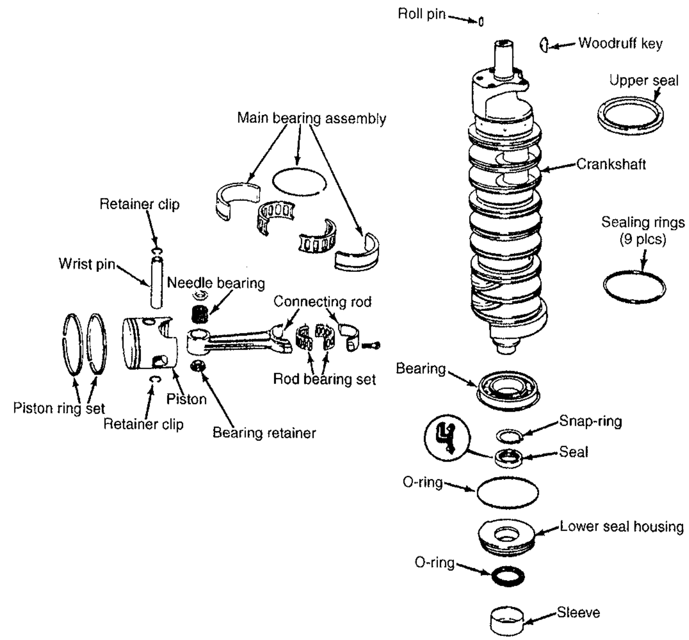
Engine Specifications-75-175hp (1726/2589cc) 60° Looper V4/V6 motors



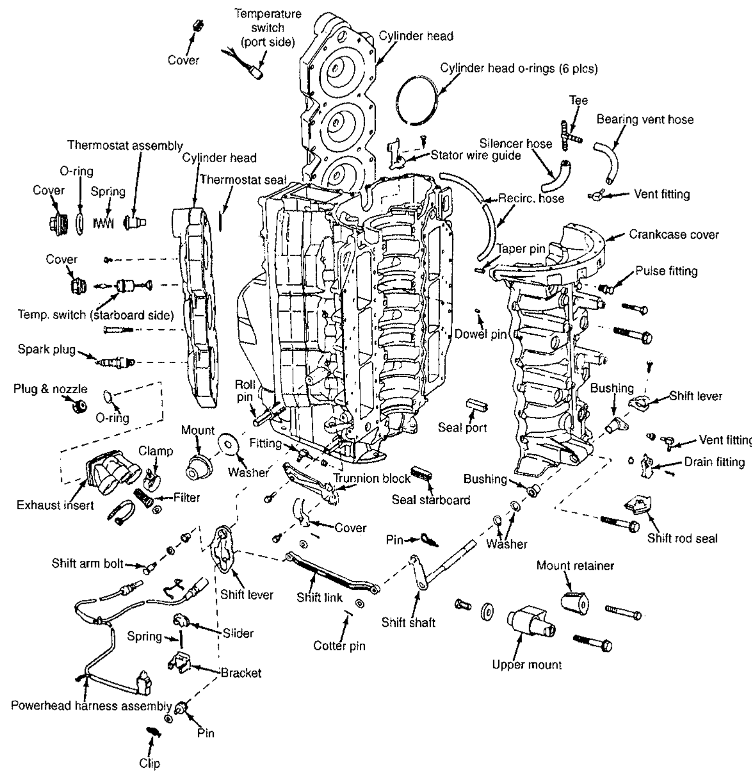
Exploded view of the powerhead assembly-FICHT 75-115 hp (1726cc) 60º Looper V4 motors



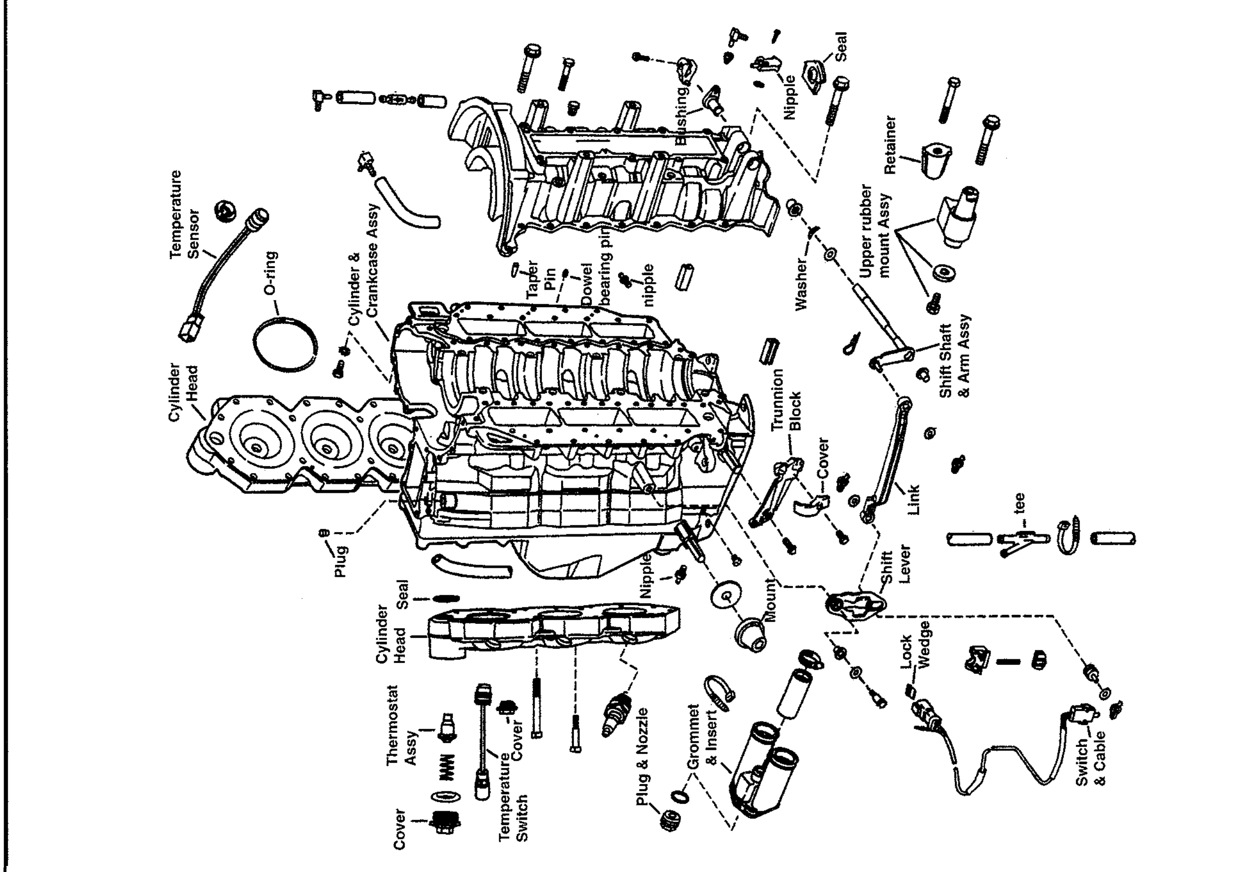
Exploded view of the powerhead assembly-carbureted 80 Jet-115 hp (1726cc) 60º Looper V4 motors



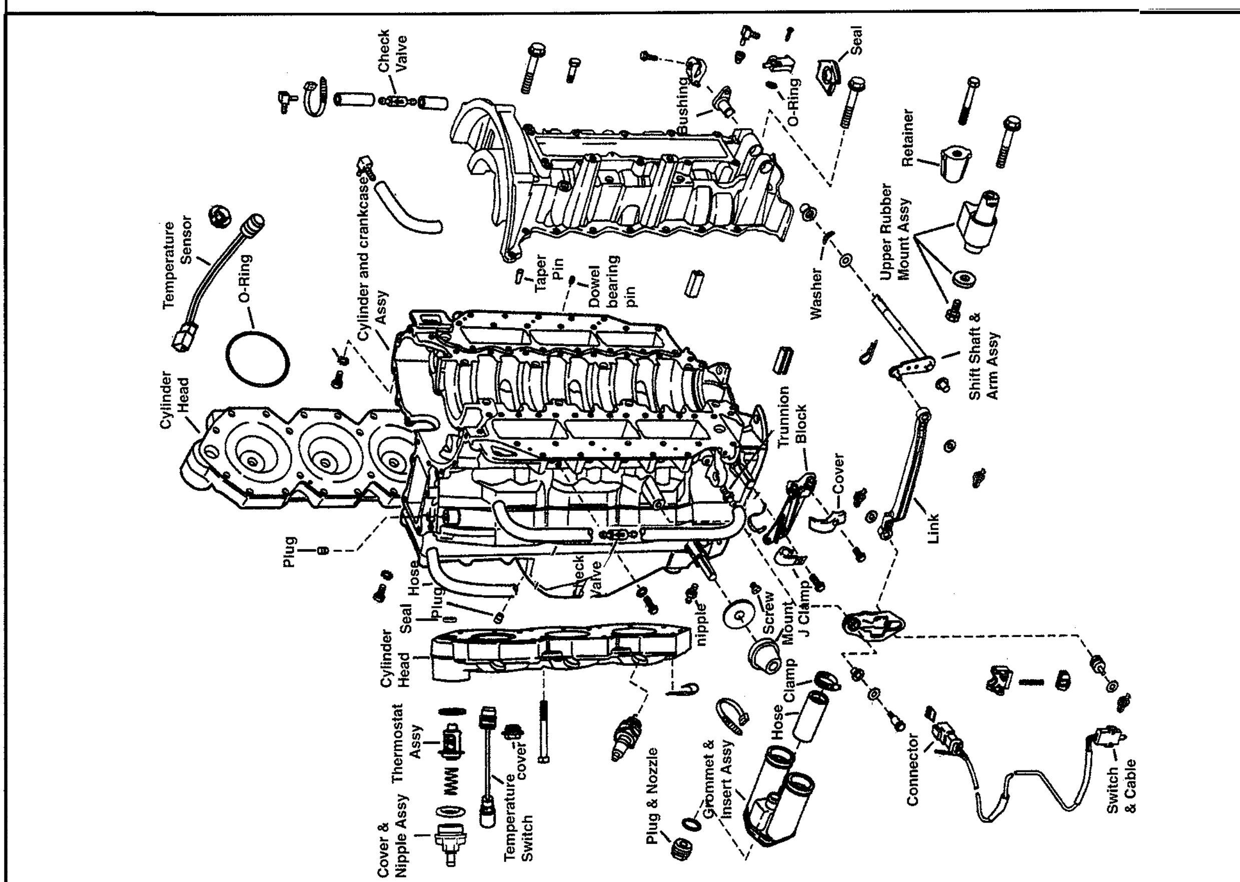
Exploded view of the crankshaft, piston and main bearing assembly-75-175 hp (1726/2589cc) 60º Looper V4/V6 motors (V6 shown, V4 similar, but shorter)



Exploded view of the powerhead assembly-carbureted 105 Jet-175 hp (2589cc) 60º Looper V6 motors



Exploded view of the powerhead assembly-FICHT 150-175 hp (2589cc) 60° Looper V6 motors with hard fuel rails



Exploded view of the powerhead assembly-FICHT 135-175 hp (2589cc) 60° Looper V6 motors without hard fuel rails

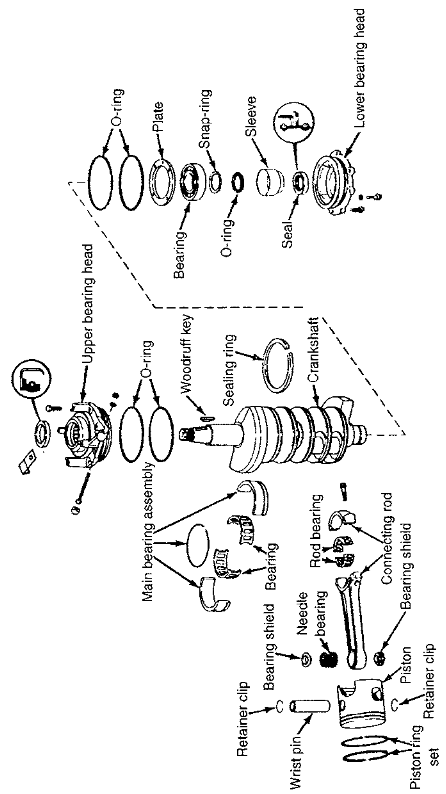
ENGINE SPECIFICATIONS - 90 DEGREE 120-140 HP (2000cc) V4, 185-250 HP (3000cc) V6 AND 250-300 HP (4000cc) V8 ENGINES

Component	U.S. (in.) ①	Metric (mm) ①
Cylinder Bore		
Standard Bore Diameter	3.6845-3.6855	93.59-93.61
Oversize Service Limit	0.004 Max	0.10 Max
Out-of-round		
Service Limit	0.004 Max	0.10 Max
Taper		
Service Limit	0.002 Max	0.05 Max
Cylinder Head		
Gasket Surface Warpage		
1992-98	0.004 Max	0.10 Max
1999-01	0.003 Max	0.08 Max
Crankshaft		
Top Journal		
Diameter	1.6199-1.6204	41.15-41.16
Center Journal(s)		
Diameter	2.1870-2.1875	55.55-55.56
Bottom Journal		
Diameter	1.5747-1.5752	40.00-40.01
Crankpin		
Diameter	1.4995-1.5000	38.09-38.10
Crankcase Seal Ring Thickness		
Service Limit	0.154 Min.	3.9 Min.
Piston		
Standard Diameter	3.6803-3.6823	93.48-93.53
Out-of-round ②	0.004 Max	0.10 Max
Ring Gap		
Production (Both Rings)	0.019-0.031	0.48-0.79
Ring Side Clearance		
Service Limit (V8 and 1992-94 V4, V6 only)	0.004 Max	0.10 Max

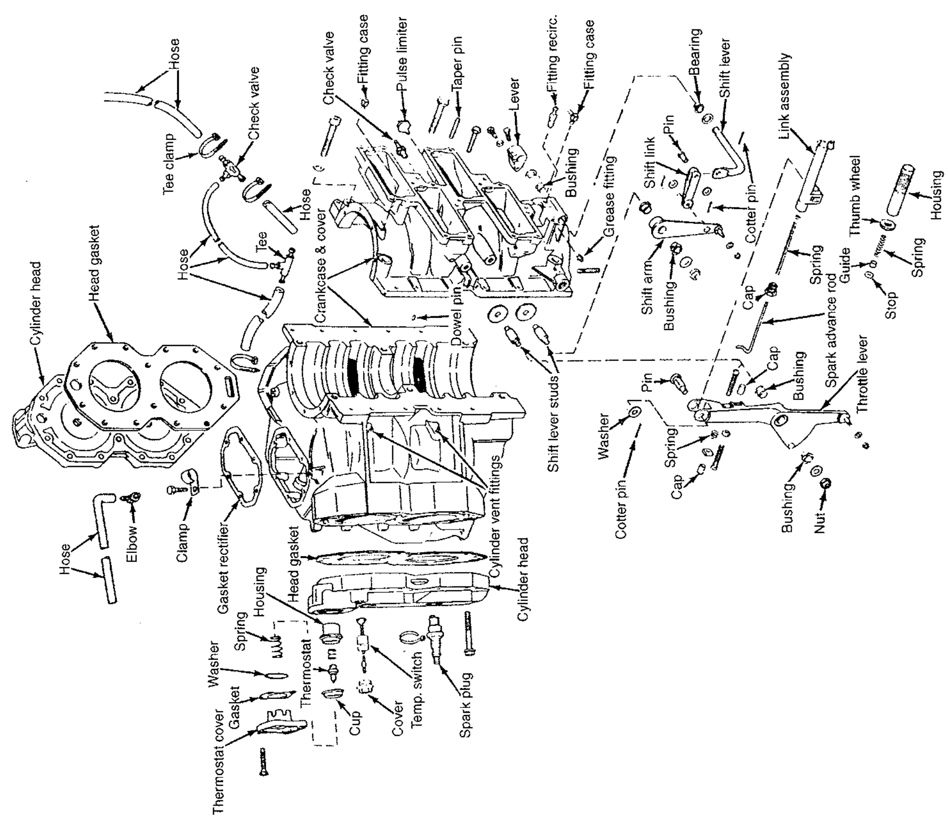
① Unless otherwise noted

② To determine out-of-round, measure diameter at a minimum of 2 locations, 90 degrees to each other 1/4 in. (6.4mm) above the edge of the piston skirt, then subrtract the smaller measurement from the larger

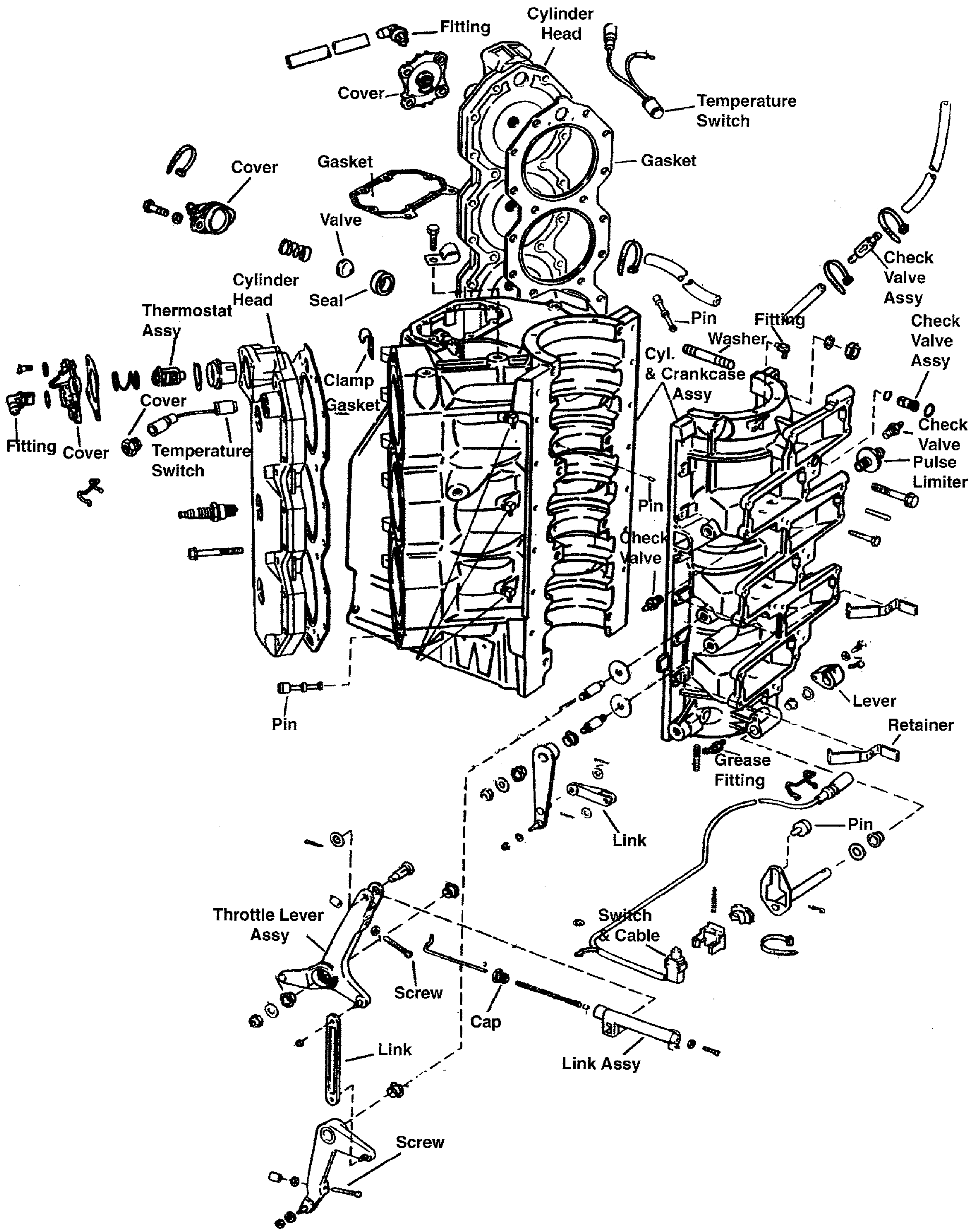
Engine Specifications-120-300 hp (2000/3000/4000cc) 90° Looper V4/V6/V8 motors



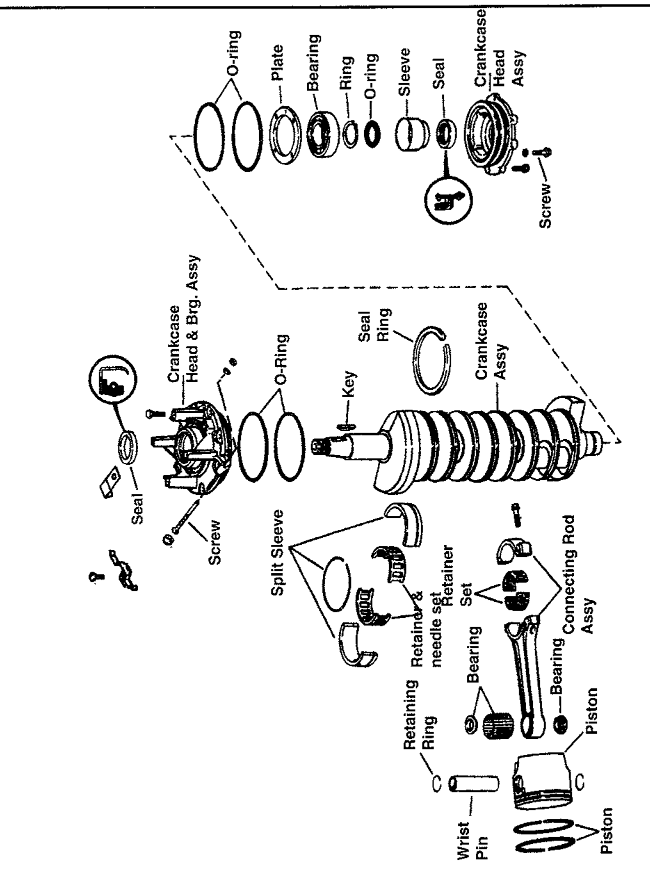
Exploded view of the crankshaft, piston and main bearing assembly-120-140 hp (2000cc) 90º Looper V4 motors



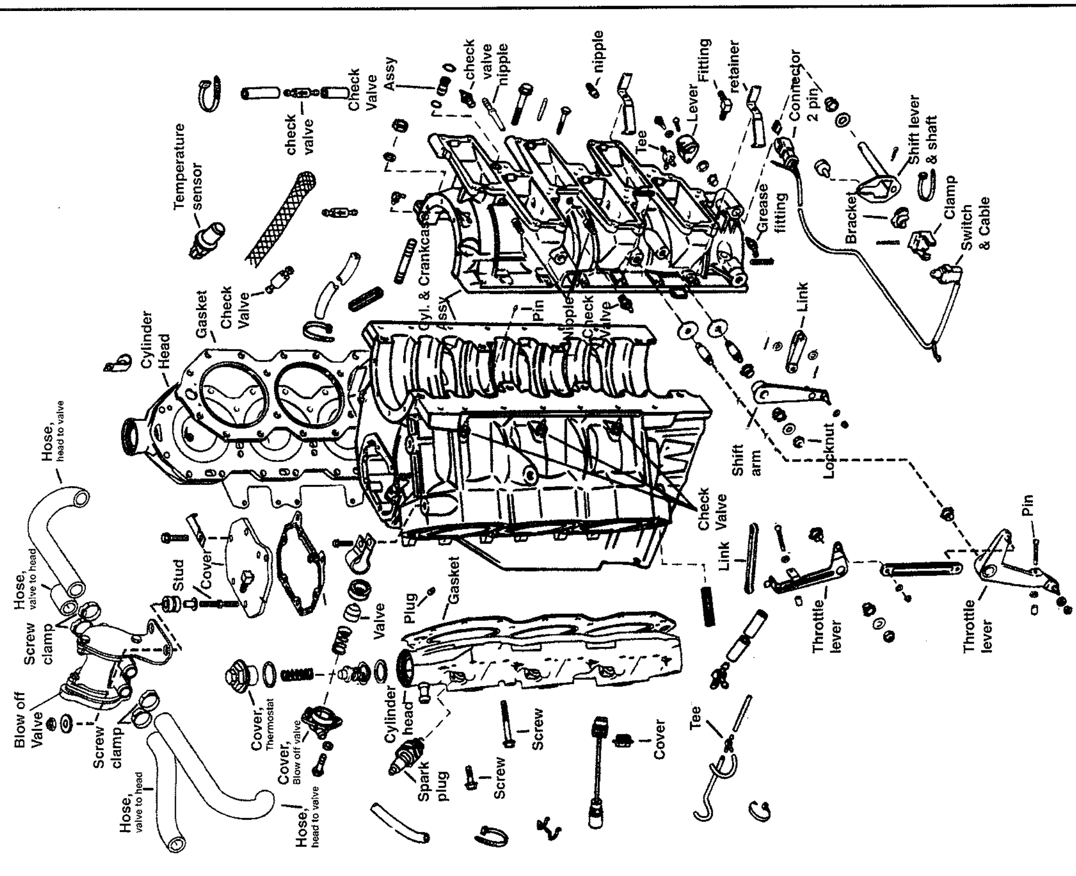
Exploded view of the powerhead assembly-120-140 hp (2000cc) 90º Looper V4 motors



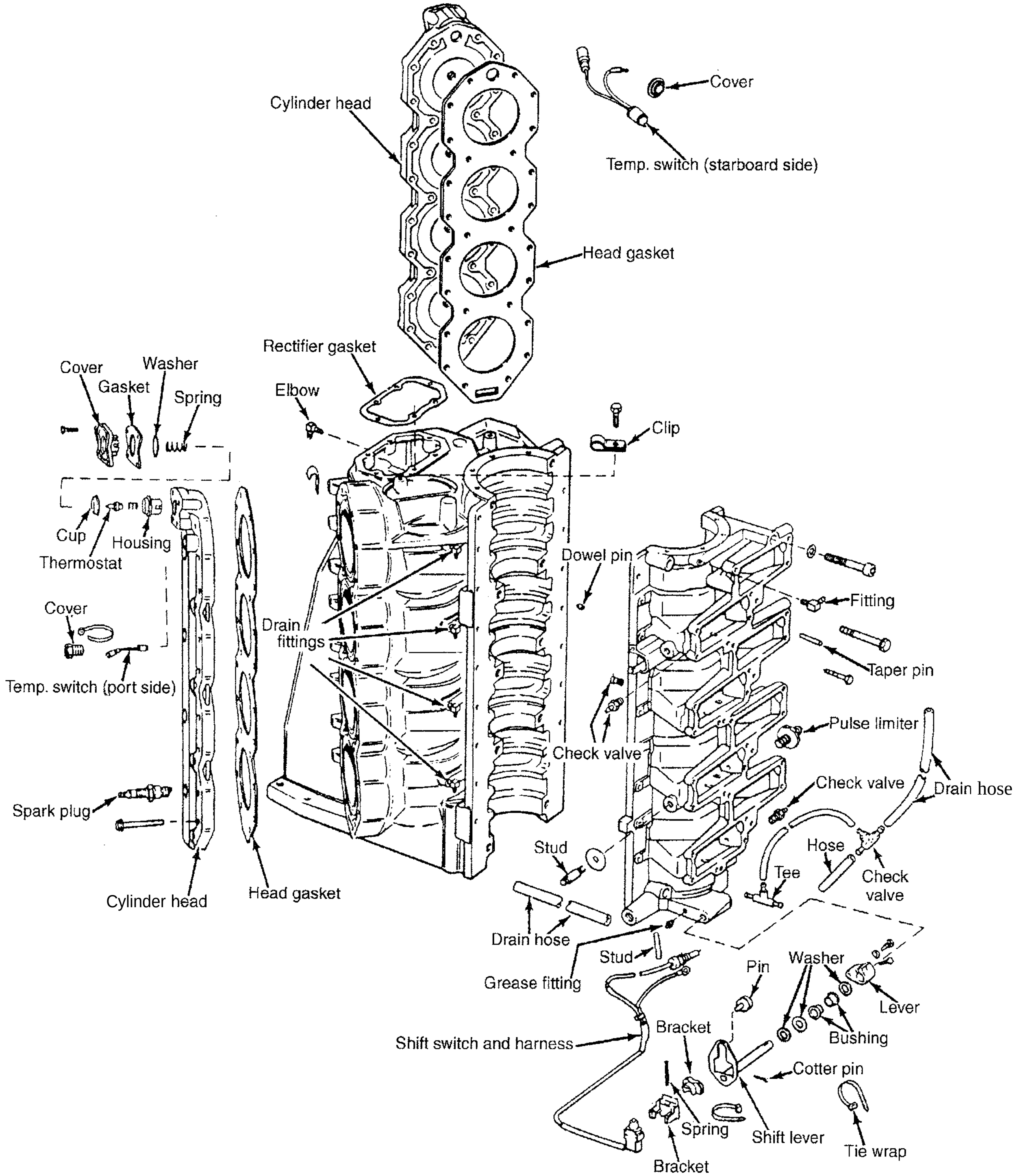
Exploded view of the powerhead assembly-carbureted185-250 hp (3000cc) 90° Looper V6 motors



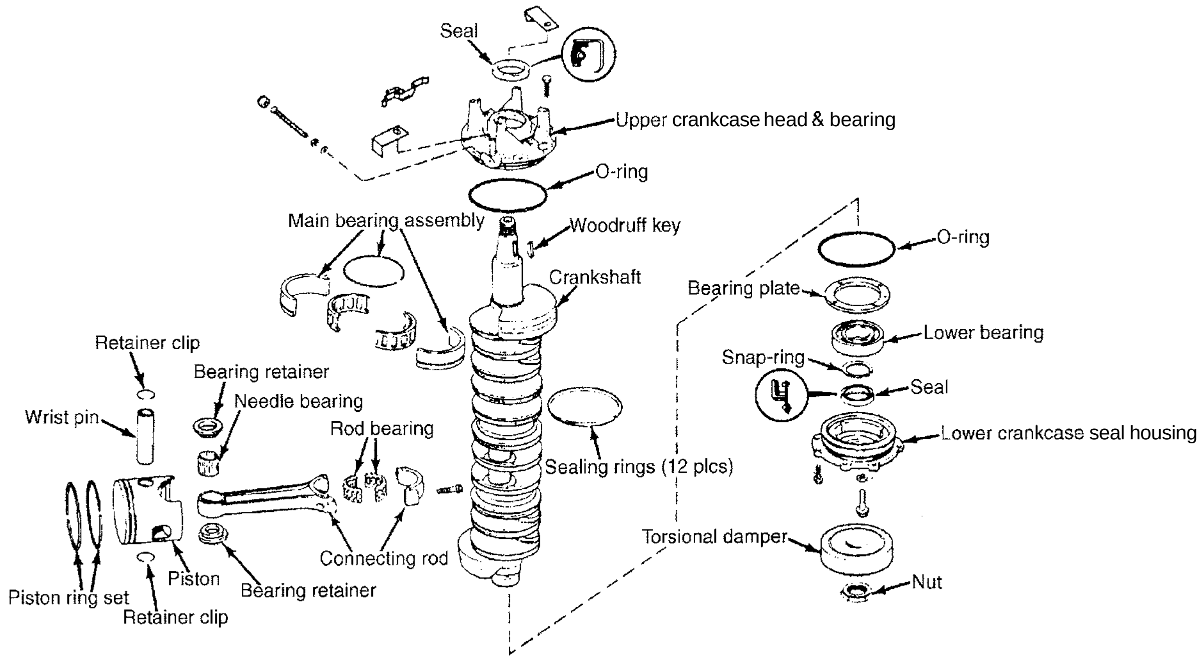
Exploded view of the crankshaft, piston and main bearing assembly-185-250 hp (3000/3300cc) 90° Looper V6 motors



Exploded view of the powerhead assembly-FICHT 185-250 hp (3000/3300cc) 90° Looper V6 motors



Exploded view of the powerhead assembly-FICHT 250-300 hp (4000cc) 900 Looper V8 motors



Exploded view of the crankshaft, piston and main bearing assembly- FICHT 250-300 hp (4000cc) 90° Looper V8 motors

7

GEARCASE

GEARCASE

The lower units found on all Evinrude/Johnson V-motors are very similar. The few differences are clearly indicated in the text. Because this chapter covers such a wide range of powerhead models, the illustrations included with the procedural steps are those of the most popular lower units. In some cases the unit being serviced may not appear exactly the same in all respects as the unit illustrated. However, the step-by-step work sequence will be valid in all cases. If there is a special procedure or unique component, the differences will be clearly indicated in the step.

Description and Operation

◆ See Figure 1

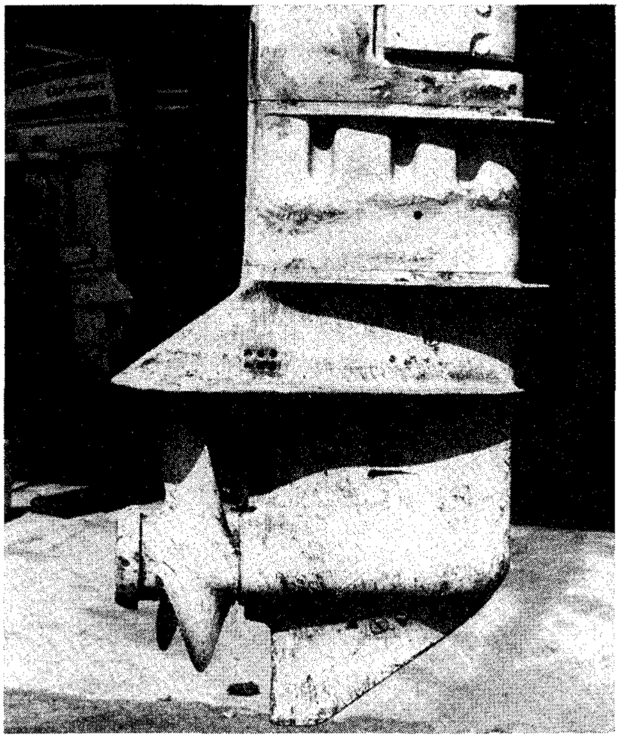


Fig. 1 **A** neglected lower unit cannot be expected to perform to maximum efficiency, compared with a unit receiving TLC (tender loving care)

GENERAL INFORMATION

Design and Components

◆ See Figure **2**

The lower unit is considered that part of the outboard below the exhaust housing (sometimes known as the intermediate housing). The unit contains the propeller and drive shafts, pinion gear, forward, reverse gears and the water pump. The shifting capabilities, including the forward and reverse gears together with the clutch, shift assembly, and related linkage, are all housed within the lower unit. The lower unit may be removed and serviced without disturbing the remainder of the outboard unit.

The lower units covered in this chapter are all mechanical shift units. A shift cable from the remote control attaches to the powerhead shift linkage arm. A shift rod extends from the shift linkage arm under the lower carburetor, down through the exhaust housing into the lower unit. The end of the shift rod is threaded into the shift detent arm on the end of the shifting mechanism.

Rotational power from the powerhead is transferred through the vertical driveshaft to the lower unit. The driveshaft is splined to the crankshaft on the upper end and a pinion gear is splined to the driveshaft and secured by a nut on the lower end. The forward and reverse gears are in constant mesh with the pinion gear and rotate anytime the powerhead is operating.

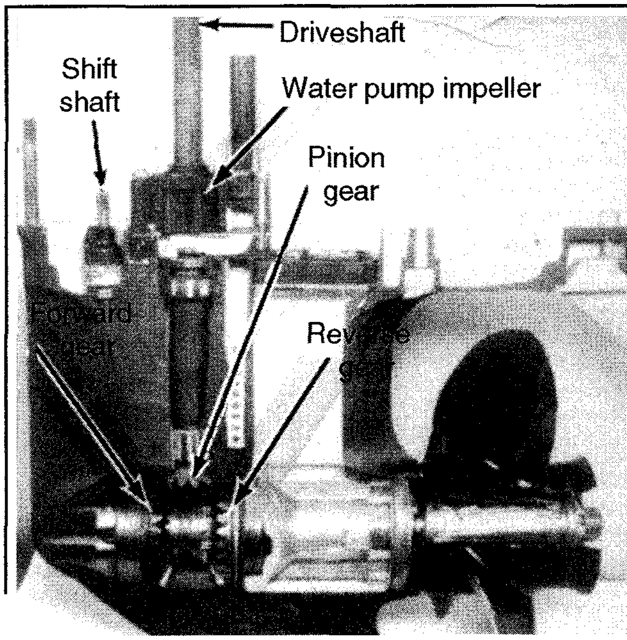


Fig. **2** Classroom-type cutaway view of a lower unit with major parts, including the propeller and water pump, installed. Notice how the forward, reverse and pinion gears all are "bevel cut".

The position of the forward and reverse gears are exchanged in a counter-rotating lower unit. The propeller rotates counterclockwise when the unit is in forward gear and in the opposite direction when in reverse. These units are operated when a twin outboard installation is used.

A sliding clutch rests between the two gears and is splined to the propeller shaft. The shift shaft extends from the top of the intermediate housing down into the forward end of the lower unit nose cone. The end of the shift shaft threads into the end of a shift detent lever. There are two detents on the shift detent lever-the first detent pulls the sliding clutch into the forward gear, the second detent pushing the sliding clutch into the reverse gear. The center position-or no detent-pushes the sliding clutch away from the forward or reverse gear into neutral.

The sliding clutch has teeth on each end which mate with the forward or reverse gear hubs. When the shifter is moved into forward or reverse gear, the sliding clutch teeth engage with the teeth in the center hub of the gear. Once the teeth are engaged, the power is transferred through the pinion gear to the selected gear, through the sliding clutch to the propeller shaft to rotate the propeller in the desired direction. Forward gear causes the propeller and shaft to rotate clockwise, reverse gear causes the propeller and shaft to rotate counterclockwise.

Counter-Rotation Lower Units

Because of the increasing popularity and size of most outboards, especially the larger horsepower units, a common practice has evolved-using dual outboards. These dual units are usually installed on larger vessels-sports fishing, charter and some commercial fishing boats.

In early years, a torque load problem existed with dual outboards installations. The propeller drastically rocked the vessel to one side as the powerheads were accelerated. To offset this torque load from the propellers, the manufacturer developed a left-handed drive or counter-rotating lower unit. Therefore, when dual powerheads are accelerated, the torque from the right hand rotation propeller is offset by the torque of the left hand or counter-rotating propeller. This improvement has now made dual outboard installations a very popular choice when selecting propulsion for larger boats. The major differences between the standard right hand drive and the left hand drive counter-rotating unit is in the gear arrangement within the lower unit. The forward and reverse gear locations are exchanged-along with the thrust bearing and shims. With the gears in the new location, the direction of the propeller rotation is reversed-opposite to the right hand drive lower unit.

In the few cases when procedures for the left hand counter rotating unit differ from the right hand lower unit, special instructions have been provided and are clearly identified. The driveshaft, water pump and remainder of the lower unit-is identical to the right hand rotation unit. Therefore, the procedures and illustrations are valid for both units.

Maintenance and Service

The single most important task for proper gearcase maintenance is inspecting it for signs of leakage after each use and properly maintaining the oil level/condition. For starters, remember that if oil can get out, then water can get in. And, water, mixing with or replacing the oil in the gearcase will wreak havoc with the bearings, shafts and gears contained within the housing. Besides a visual inspection after each use, periodically check and maintain the oil inside the case. Not only is it important to make sure the oil is at the proper level (not above or below), but it is important to check the oil for signs of contamination from moisture. Water entering the gearcase will usually cause the oil to turn a slightly milky-white color. Also, significant amounts of water mixed with the oil will give the appearance of an overfilled condition.

If you suspect water in the gearcase, start by draining and closely inspecting the fluid (refer to the procedures found in the Maintenance and Tune-Up section). Then, refill the unit with fresh oil and test the outboard (by using it!). Watch the fluid level closely after the test, and for the first few outings. If any oil leaks out or water enters, either the propeller shaft seal must be replaced or the gearcase must be disassembled, inspected and completely overhauled. To be honest, a complete overhaul is recommended, because corrosion and damage may have occurred if moisture was in the gearcase long enough. But, in some cases, if the leak was caught in time, and there is no significant wear, damage or corrosion in the gearcase, the propeller shaft seal can usually be replaced with the gearcase still installed to the outboard.

The next most important task you can perform to help keep your gearcase in top shape, is to flush the inside and outside of the gearcase after each use. Rinse the outside of the unit with a hose to remove any sea life, salt, chemicals or other corrosion inducing substances that you may have picked up in the water. Cleaning the gearcase will also help you spot potential trouble, such as gearcase oil leaks, cracks or damage that may have occurred during use. Remove any sand, silt or dirt that could potentially damage seals or clog passages. Once you've rinsed the outside, hook up a flushing device and do the same for the inside. Again, details are found in the Maintenance and Tune-Up section, look under Flushing the Cooling System.

Important Gearcase Service Tips:

- All threaded parts on these units are right-handed unless otherwise indicated in the text.
- If the presence of any water or metal particles is discovered in the gear lubricant, the lower unit should be completely disassembled, cleaned, and inspected. All defective and/or excessively worn components must be replaced to restore the unit to maximum performance.
- Use "soft jaws" in a vise to prevent damage to expensive parts. Usually a couple pieces of scrap wood will suffice.
- Take time to obtain a suitable size mandrel, which will contact only the bearing race or seal casing, when it is necessary to press or drive bearings into place.
- Keep a record of all shim material removed, as an aid during installation.

Problems in the lower unit can be classified into three broad areas:

- Lack of proper lubrication in the lower unit. Most often such a condition is caused by failure of the operator to check the gear oil level frequently and to add lubricant when required.
- Faulty seals, allowing water to enter the lower unit. Water allowed to remain in the lower unit over a period of non-use time will corrode the finish on bearings, gears and bushings causing premature failure.
- Excessive clutch dog and clutch ear wear on the forward and reverse gears. This condition is caused by excessive wear in the bellcrank under the powerhead. A worn bellcrank will result in "sloppy" shifting of the lower unit and cause the clutch components to wear and develop shifting problems.

Excessive high idle speeds will cause the clutch dog and clutch ears on the forward and reverse gears to wear extremely fast. Continued service over a long period of time will cause parts to wear and require replacement.

TROUBLESHOOTING

If at all possible, preliminary troubleshooting should be performed before the lower unit is disassembled and with the powerhead operating, to verify shifting problems.

Begin by mounting the outboard unit in a test tank, on a boat in a body of water, or connect a flush attachment and garden hose to the lower unit. If the flush attachment is used, never operate the powerhead above an idle speed, because the no-load condition on the propeller could cause the powerhead to runaway at high rpm, resulting in serious damage or destruction of the powerhead.

**** CAUTION**

Water must circulate through the lower unit to the powerhead any time the powerhead is run to prevent damage to the water pump mounted in the lower unit. Just a few seconds without water will damage the water **pump.**

Attempt to shift the unit into neutral and reverse. It is possible the propeller may turn very slowly while the unit is in neutral, due to "drag" through the various gears and bearings. If difficult shifting is encountered, the problem is in the shift linkage or in the lower unit.

The second area to check is the quantity and quality of the lubricant in the lower unit. If the lubricant level is low, contaminated with water, or is broken down because of overuse, the shift mechanism may be affected. Water in the lower unit is very bad news for a number of reasons. Water may have entered past one of the seals contaminating the lubricant and weakening its ability to do its job with bearings, gears, etc.

Remember, when the powerhead is not operating, the unit should be left in forward gear.

Before making any further tests, remove the propeller, as outlined in the Maintenance and Tune-Up Section. Check the propeller carefully to determine if the hub has been slipping and giving a false indication the unit is not in gear. If there is any doubt, the propeller should be taken to a shop properly equipped for testing, before the time and expense of disassembling the lower unit is undertaken. The expense of the propeller testing and possible rebuild is justified.

The following troubleshooting procedures are presented on the assumption the lower unit lubricant, and the propeller have been checked and found to be satisfactory.

Lower Unit Locked

Determine if the problem is in the powerhead or in the lower unit. Attempt to rotate the flywheel (in a clockwise direction when viewed from above in order to prevent damage to the impeller). If the flywheel can be moved even slightly in either direction, the problem is most likely in the lower unit. If it is not possible to rotate the flywheel, the problem is a "frozen" powerhead. To absolutely verify the powerhead is "frozen", separate the lower unit from the exhaust housing and then again attempt to rotate the flywheel. If the attempt is successful, the problem is definitely in the lower unit. If the attempt to rotate the flywheel with the lower unit removed still fails, you've verified that the "frozen" component is the powerhead.

Unit Fails to Shift Neutral, Forward, or Reverse

With the outboard mounted in a test tank, on a boat in a body of water, or with a flush attachment and garden hose connected to the lower unit, disconnect the shift lever at the powerhead. Attempt to manually shift the unit into neutral, reverse, forward. At the same time move the shift handle at the shift box and determine if the linkage and shift lever are properly aligned for the shift positions. If the alignment is not correct, adjust the shift cable at the thumbwheel. Detailed remote cable adjustment procedures are provided under the Timing and Synchronization Adjustments in the Maintenance and Tune-Up section.

It is also possible the inner mechanical cable may have slipped in the shift box. This condition would result in a lack of the inner cable to make a complete "throw" on the shift handle. Check to be sure the shift handle and linkage to the lower unit is traveling to the full shift position.

If it is not possible to shift the unit into gear by manually operating the shift rod while the powerhead is running, the lower unit will require servicing as described in this section.

DEALING WITH A FROZEN PROPELLER

MODERATE

◆ **See Figures 3 thru 10**

The exhaust gases pass through the propeller hub on modern outboard units. For this reason, the propeller must be removed more frequently than other standard propellers. Removal after each weekend use or outing is not considered excessive. These propellers do not have a shear pin, instead, the shaft and propeller have splines which must be coated with an anti-corrosion lubricant-Evinrude/Johnson Triple Guard grease or equivalent-prior to installation, as an aid to removal the next time the propeller is pulled. As mentioned, the lubricant applied to the shaft splines will assist, but the propeller is sometimes still difficult to remove.

The propeller with the exhaust hub is more expensive than the standard propeller and therefore, the cost of rebuilding the assembly, if the hub is damaged, is usually justified.

A replaceable diffuser ring on the backside of the propeller disperses the exhaust away from the propeller blades as the boat moves through the water. If the ring becomes broken or damaged "ventilation" would be created pulling the exhaust gases back into the negative pressure area behind the propeller. This condition would create considerable air bubbles and reduce the effectiveness of the propeller.

A "frozen" propeller is caused by the inner sleeve becoming corroded and stuck to the propeller shaft. Therefore, special procedures are required to free the propeller and remove it from the shaft.

The following detailed procedures are presented as the only practical method to remove a "frozen" propeller from the shaft without damaging other more expensive parts. In almost all cases the attempt will be successful.

☐ **If an exhaust propeller is "frozen" to the propeller shaft and the usual methods of removal fail, using a mallet to beat on the propeller will have little or no affect. This is due to the cushioning affect the rubber hub has on the blows being struck.**

If the propeller appears to be "frozen" to the shaft, first spray a coating of penetrating lubricantlrust inhibitor such as WD-40® or our new favorite, PB Blaster® to the shaft and propeller hub. Spray liberally and give it about 10 minutes to work, and then try to tap the propeller free of the shaft again. If this does not free the propeller, use some solvent to carefully clean all traces of flammable penetrant from the shaft, allow the area to dry thoroughly and then proceed as follows:

✳✳ WARNING

Heating the propeller/hub will almost certainly damage or destroy the rubber hub, so the propeller will require rebuilding after removal. Furthermore, a concentration of heat on the propeller shaft will likely damage the propeller shaft bearing hub seals. Be sure to check the seals after the hub has been removed.

1. Disconnect the negative battery cable and/or tag and disconnect the spark plug leads for safety.
2. Remove the cotter pin, and then the nut keeper (if used), the propeller nut and the splined washer
3. CAREFULLY heat the inside diameter of the propeller with a torch. Do not apply the heat to the outside surface of the propeller. Concentrate the heat in the area of the hub and shaft where the nut was removed and as far into the hub as possible. This concentration of heat will most likely damage the propeller shaft bearing hub seals. Be sure to check the seals after the hub has been removed. Continue applying heat, and at the same time have an assistant use a piece of 2 in, x 4 in. wood block wedged between one of the blades and the lower unit housing. Use a prying force on the propeller while the heat is being applied, As the heat melts the inner rubber hub, the propeller will come free.

✳✳ WARNING

As the force and heat are applied, the propeller may "pop" loose suddenly and without warning. Therefore, stand to one side while applying the heat, as a precaution against personal injury.

4. After the propeller has been removed, the sleeve and what's left of the rubber hub will still be stuck to the propeller shaft. Attach a puller to the thrust washer. Apply more heat to the sleeve and rubber hub, and at the same time take up on the puller. When the sleeve reaches the proper temperature, it will be released and come free.
5. If a puller is not available, as described in the previous Step use a sharp knife and cut the rubber hub from the sleeve. Heat the sleeve with a torch, while it is still hot, use a chisel, punch, or similar tool with a hammer, and drive the sleeve free of the shaft.

✳✳ WA

Use care when removing traces of the rubber hub to prevent damage to the propeller shaft splines.

6. Allow the propeller shaft to cool and inspect the propeller shaft oil seals on the end of the propeller shaft bearing carrier. If the seals are damaged from the heat, they must be replaced before placing the unit back into service. Clean the splines thoroughly and remove any corrosion. Install a propeller with a new hub and sleeve according to the instructions outlined in next section.

Fig. 3 Propeller with exhaust hub (the defuser ring is visible)

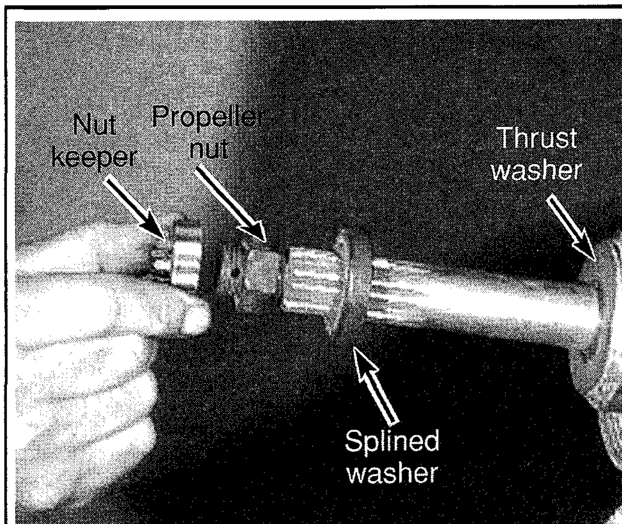


Fig. 4 Propeller attaching hardware. The propeller is not shown for photographic clarity to emphasize the arrangement of the nut keeper (if used), propeller nut (castellated if no keeper is used), splined washer, and the thrust washer

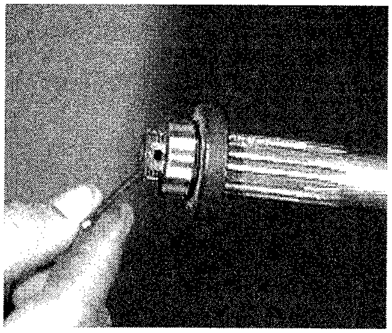


Fig. 5 A cotter pin is installed through the nut or keeper and a hole in the propeller shaft

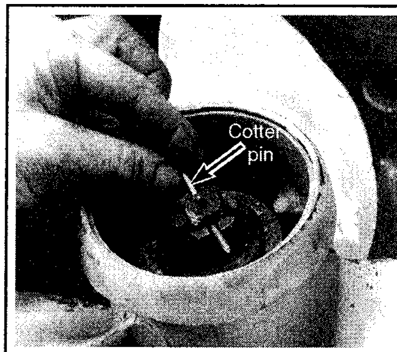


Fig. 6 Remove the cotter pin, and then the nut keeper (if used), the propeller nut and the splined washer

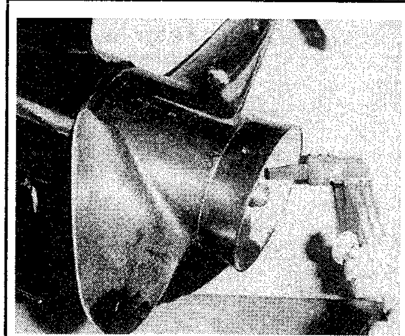


Fig. 7 CAREFULLY heat the inside diameter of the propeller with a torch

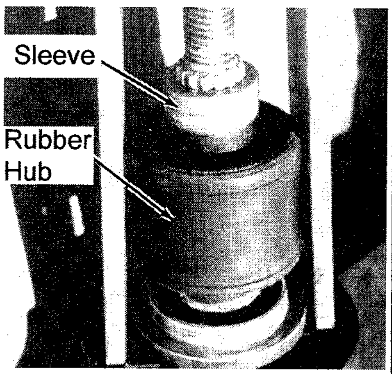


Fig. 8 If the propeller leaves behind the rubber hub, use a puller on the thrust washer to pull it off the shaft

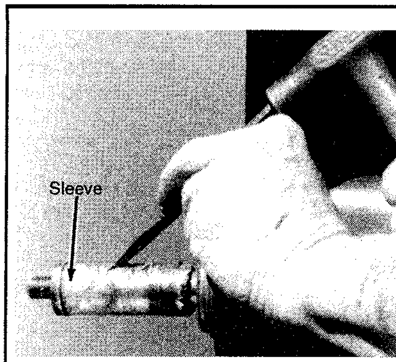


Fig. 9 If a puller is not available, use a sharp knife to cut the rubber hub from the sleeve

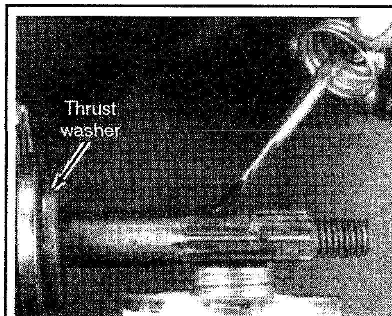


Fig. 10 Applying Triple Guard Grease to the propeller shaft to prevent the propeller from "freezing" on the shaft. This grease should always be applied to the shaft, as an assist in removing the propeller the next time.

Gearcase Assemb

REMOVAL & INSTALLATION

2 MODERATE

◆ See Figures 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21 and 22

Water pump service (specifically impeller and housing inspection or replacement) is by far the most common reason for removal of the lower unit For complete and detailed procedures for water pump removal, rebuilding and installation, please refer to the Lubrication and Cooling section On all motors, the water pump is found on the gearcase-to-midsection (sometimes known as the intermediate or exhaust housing) split line

1. Disconnect the negative battery cable and/or tag and disconnect the spark plug leads, then ground them to the cylinder head for safety

✳✳ CAUTION

Although propeller removal is really only necessary if you are going to service the **gearcase** itself, it is a good idea for safety reasons. Why take the risk of moving and handling the **gearcase** with a sharp propeller installed. Also, keep in mind that you need to remove, inspect and lubricate the propeller splines anyway, so take the time to do that now and make your life both easier and safer.

2. Remove the propeller, for details please refer to the procedure in the Maintenance and Tune-Up section.
3. If necessary, drain the lower unit of lubricant, for details please refer to the procedure in the Maintenance and Tune-Up section. If you are NOT draining the lubricant, at LEAST take a small sample out to check for contamination.

If water is discovered in the lower unit and the propeller shaft seal is damaged and requires replacement, the lower unit does not have to be removed to accomplish the **work. The** bearing carrier can be removed and the seal replaced without disassembling the lower unit. However, such a procedure is not considered good **shop** practice, but merely a "quick-fix". If water has entered the lower unit, the unit should be disassembled and a detailed check made to determine if any other seals, bearings, bearing races, O-rings or other parts have been rendered unfit for further service by the water.

4. Tilt the outboard to the full up or trailering position and engage the tilt-up lock.
5. On 60º motors, remove the air intake silencer for access to the shift rod linkage.
6. Remove the bolt (90º looper) or pull the pin (cross-flow and 60º loopers) from the shift rod linkage, under the lower carburetor or throttle body on the powerhead. Shift the unit into forward (60º motors) or reverse (90º motors) gear and free the shift rod from the shift linkage. On all the 90º loopers, you'll have to carefully push the shift rod link toward the powerhead to free the shift rod.
7. Scribe a matchmark on the trim tab and lower unit to ensure the trim tab will be installed back in the same position from which it is removed. Remove the bolt and lift off the trim tab.

☐ There are normally 3-4 bolts on the underside of the ventilation plate. One secures the trim tab, another secures the anode and 2 more (one that is usually not visible because it is under the trim tab) secure the gearcase.

8. Use a 9/16 in. socket with a short extension to remove the rearmost gearcase retaining bolt (usually found in the trim tab cavity). Failure to remove this bolt may result in the housing being damaged beyond repair during the attempt to separate the lower unit from the exhaust housing.

9. Use a 518 in. thin wall socket to remove the bolt recessed in the counterbore just ahead of the trim tab. Some units may have both a 9116 in. and a 518 in. bolt forward of the trim tab, but the second 9/16 in. bolt is normally for the anode.

10. Using a 9116 in. socket or wrench, remove the 4 bolts, two on each side, securing the lower unit to the exhaust housing. Carefully pull and work the lower unit free of the exhaust housing. Support both ends of the lower unit, and at the same time, guide the shift rod and driveshaft out of the exhaust housing to prevent bending them until free of the exhaust housing. Sometimes the inner exhaust housing may come out with the lower unit. If this happens, lift the housing off the lower unit, verify the upper and lower rubber seals are in place. Slide the inner exhaust housing back up inside the exhaust housing. Push on the inner housing until the seal and inner housing are seated.

To install:

11. Coat the driveshaft splines only with EvinrudelJohnson Moly Lube, or an equivalent grease. Do not coat the top of the driveshaft because grease on the end of the driveshaft may cause a hydrolock condition in the crankshaft, prevent the driveshaft splines from completely meshing up into the powerhead.

12. If used, install a new O-ring on the groove just below the driveshaft splines.

13. The manufacturer recommends replacing the inner exhaust housing seals regardless of condition. Apply a light coating of EvinrudelJohnson Adhesive M or an equivalent sealant/adhesive to the top and bottom sealing surfaces of the inner exhaust housing. Then position 2 new seals on the housing. Apply a thin coating of Evinrude/Johnson Triple Guard grease to the outer surface of the seals to help them seat easier. Position the housing onto the gearcase.

14. Check to be sure that the water tubes are clean, smooth, and free of any corrosion. Coat the water pickup tubes and grommets with a light coating of marine grease as an aid to installation.

15. Dip all the attaching bolts in EvinrudelJohnson Gasket Sealing Comoound, or an eaquivalent oroduct and out them on a clean surface to be used'in the next step.

16. Align the driveshaft and shift rod with the intermediate housing. Now, three things are to be done at the same time. Bring the two units together, while guiding the water pickup tube into the rubber grommet of the water pump, and simultaneously rotating the flywheel slowly to permit the splines of the driveshaft to index with the splines of the crankshaft.

You can rotate the flywheel to turn the crankshaft OR you can rotate the driveshaft itself, but either way an extra set of hands will be appreciated. In all cases, MAKE SURE you rotate the shafts CLOCKWISE when viewed from above, to prevent impeller damage.

17. After the surfaces of the lower unit and intermediate housings are close, thread the bolt in the recess of the trim tab to hold the assembly in position (but do not fully tighten). Thread the bolt forward of the trim tab which extends up through the cavitation plate, followed by the 2 bolts on either side of the housing.

The manufacturer provides torque specifications based on bolt, NOT HEAD HEX **sizes. The** smaller **gearcase** retaining (318 in.) bolts are tightened to one specification while the larger (7116 in.) bolts to a higher spec. It stands to reason that the smaller hex head (9116 in.) bolts SHOULD correspond to the smaller **(3/8** in.) bolt shank, (and the larger to the larger) but if you've got a sliding caliper, double-check this measurement to be certain.

18. Now tighten the lower unit attachment bolts alternately and evenly to specification, as follows:

- V4 models: 318 in. (smaller) bolts to 22-24 ft. lbs. (30-33 Nm) and 7/16 in. (larger) bolts to 30-32 ft. lbs. (40-43 Nm).
- 1992 V6/V8 models: 318 in. (smaller) bolts to 37-40 ft. lbs. (50-54 Nm) and 7116 in. (larger) bolts to 65-70 ft. lbs. (88-95 Nm).
- 1993 and later V6/V8 models: 318 in. (smaller) bolts to 26-28 ft. lbs. (35-38 Nm) and 7116 in. (larger) bolts to 45-50 ft. lbs. (61-68 Nm).

19. Apply a light coating of EvinrudelJohnson Gasket Sealing compound or equivalent sealant to the trim tab retaining bolt threads. Install the trim tab

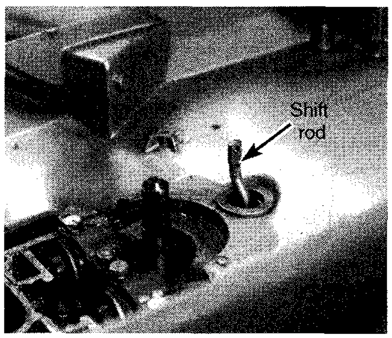


Fig. 11 View of the shift rod extending through the exhaust housing

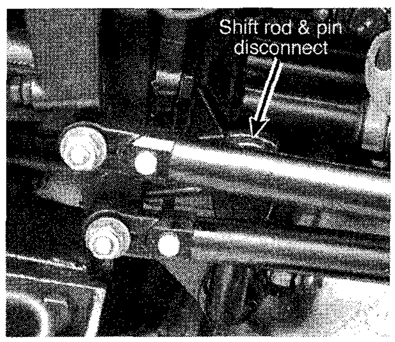


Fig. 12 Remove the bolt, or pull the pin from the shift rod linkage, under the lower carburetor...

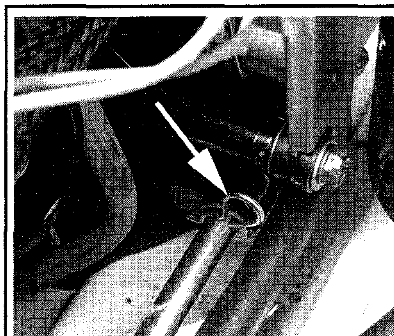


Fig. 13 ... or FICHT throttle body on the powerhead

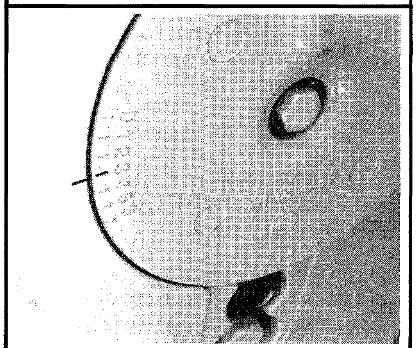


Fig. 14 Scribe a matchmark for installation (if equipped use the scale provided on the trim tab)...

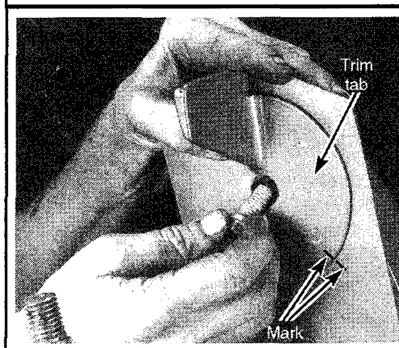


Fig. 15 ... then remove the bolt and lift off the trim tab

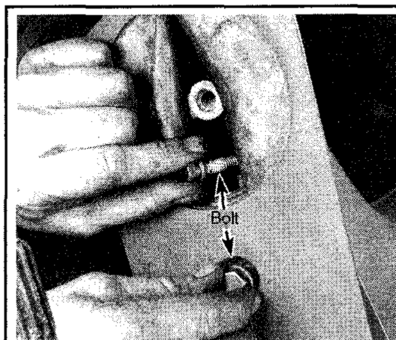


Fig. 16 Remove the **2 gearcase** bolts threaded upward under the ventilation plate **(location** varies)

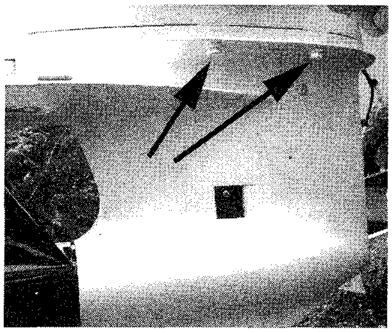


Fig. **17** Next remove the 4 **gearcase** bolts **...**

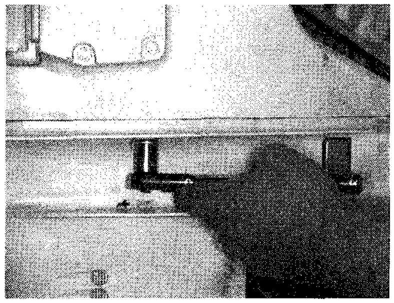


Fig. **18** **...** two on each side, securing the lower unit to the exhaust housing


Fig. 19 Carefully lower the **gearcase** from the motor

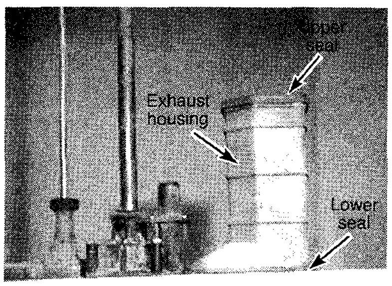


Fig. **20** The inner exhaust housing must be properly sealed (refer to the procedure)

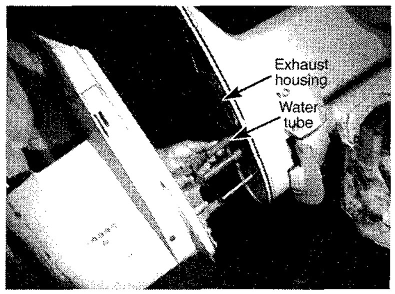


Fig. **21** **Install** the gearcase, carefully aligning the driveshaft, water tube and shifter rod

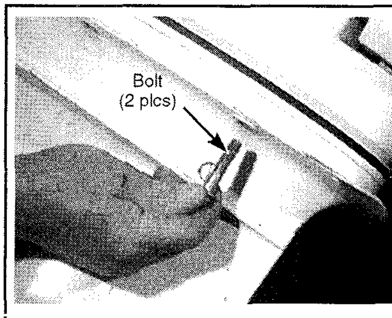


Fig. **22** With the **gearcase** almost flush, thread and slowly tighten the bolts

and align the matchmarks on the tab and the lower unit housing during disassembly. Install the bolt through the trim tab and tighten it to 35-40 ft. lbs. (47-54 Nm) for all models except 1992 motors and all years of the cross-flow motors. For all cross-flow motors and for all 1992 loopers, tighten the bolt to 120-144 inch lbs. (14-16 Nm).

20. Engage the shift rod into the link and secure it with a bolt or pin, depending on the model being serviced.

21. If drained, fill the lower unit with lubricant according to the procedures in the Maintenance and Tune-Up section.

22. If the propeller was removed, install it according to the procedures in the Maintenance and Tune-Up section.

23. Reconnect the negative battery cable and/or the spark plug leads.

If the unit was rebuilt, remember to perform a break-in lubricant change sometime after **10-20** hours of operation. If the unit was NOT rebuilt, BUT seals were replaced, check the **gearcase** lubricant after the first couple of outings to make sure no moisture is getting into the gearcase.

DISASSEMBLY

MODERATE

◆ See Figures **23, 24, 25, 26, 27 and 28**

A complete overhaul of the gearcase involves removing and inspecting all components, replacing all O-rings, seals, gaskets or grommets along with any worn components and properly assembling the components. If gears, shafts and/or bearings are replaced, certain measurement and shimming procedures must be followed during assembly to ensure proper operation and prevent premature component failure. If only the propshaft seal is to be replaced (and we don't necessarily condone this), follow only the appropriate steps of the disassembly procedure for propeller shaft bearing carrier removal, seal replacement and installation.

As with all overhaul procedures, make sure the work area is clean and free of dirt and moisture. Keep all components covered with a light coating of oil and a plastic sheet to protect them. Take your time and don't look for shortcuts.

1. Remove the Gearcase Assembly from the outboard as detailed earlier in this section.

2. Secure the lower unit in the vertical position on the edge of the work bench resting on the cavitation plate. Secure the lower unit in this position with a C-clamp. The lower unit will then be held firmly in a favorable position during the service work. An alternate method is to cut a groove in a short piece of 2 in. x 6 in. wood to accommodate the lower unit with the cavitation plate resting on top of the wood. Clamp the wood in a vise and service work may then be performed with the lower unit erect (in its normal position), or inverted (upside down). In both positions, the cavitation plate is the supporting surface.

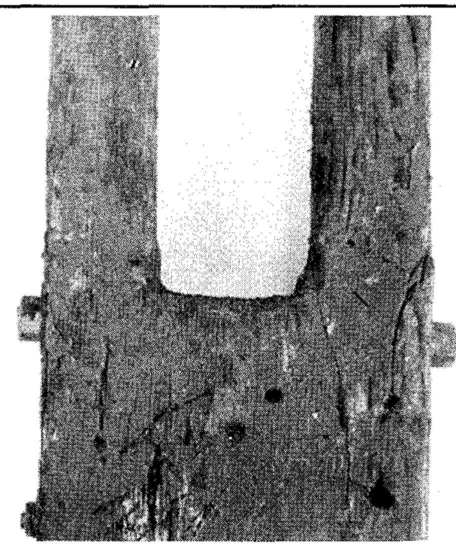


Fig. **23** **A** holding fixture can be cut out of a **2** x **6** in. block of wood

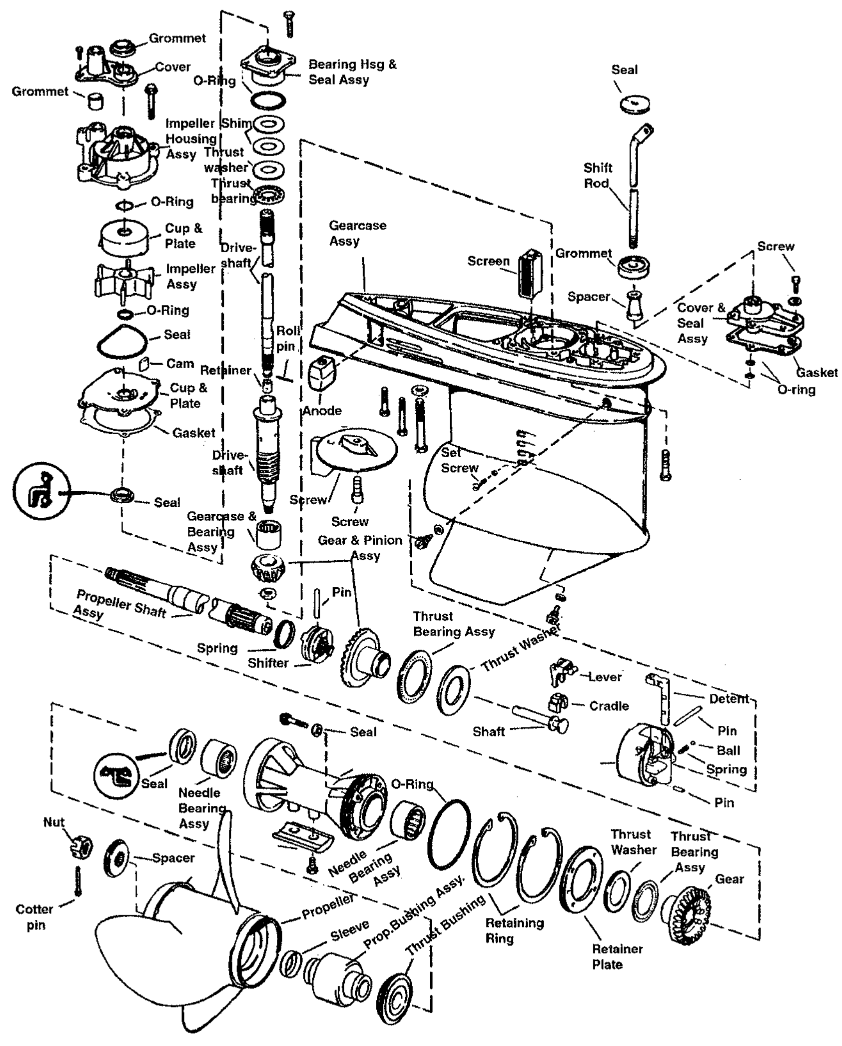


Fig. 24 Exploded view of the gearcase assembly used on standard rotation 900 Cross-flow V4 motors, EXCEPT commercial models

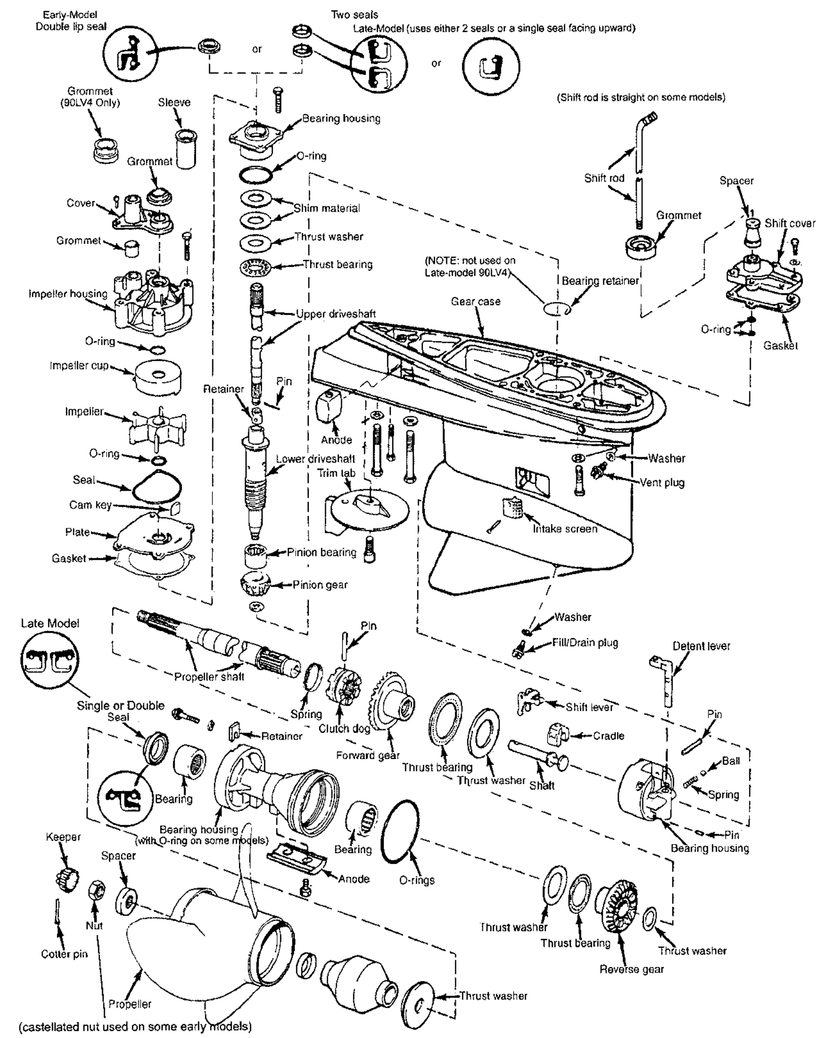


Fig. 25 Exploded view of the gearcase assembly used on most standard rotation V4 motors, including 600 and 900 loopers, as well as most 90º Cross-flow commercial models

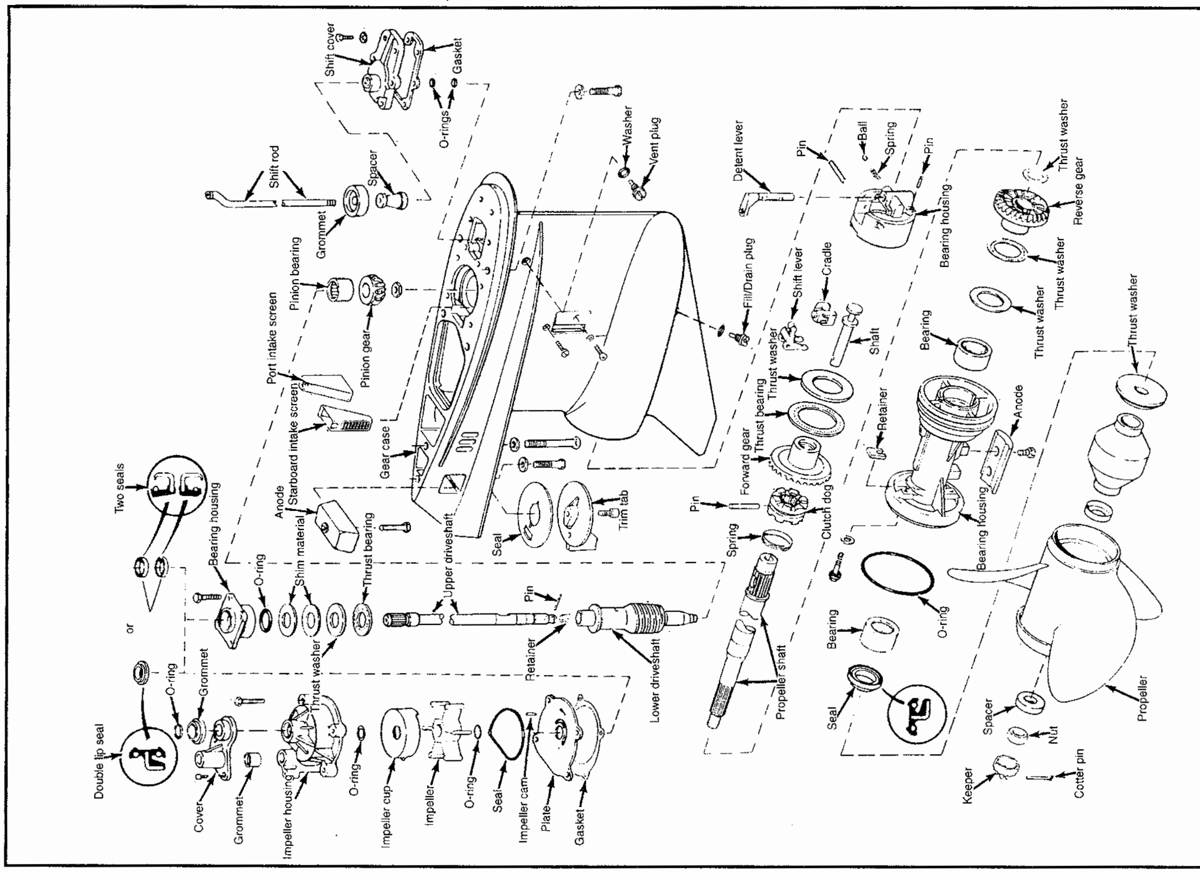


Fig. 27 Exploded view of the gearcase assembly used on most standard rotation V8 motors

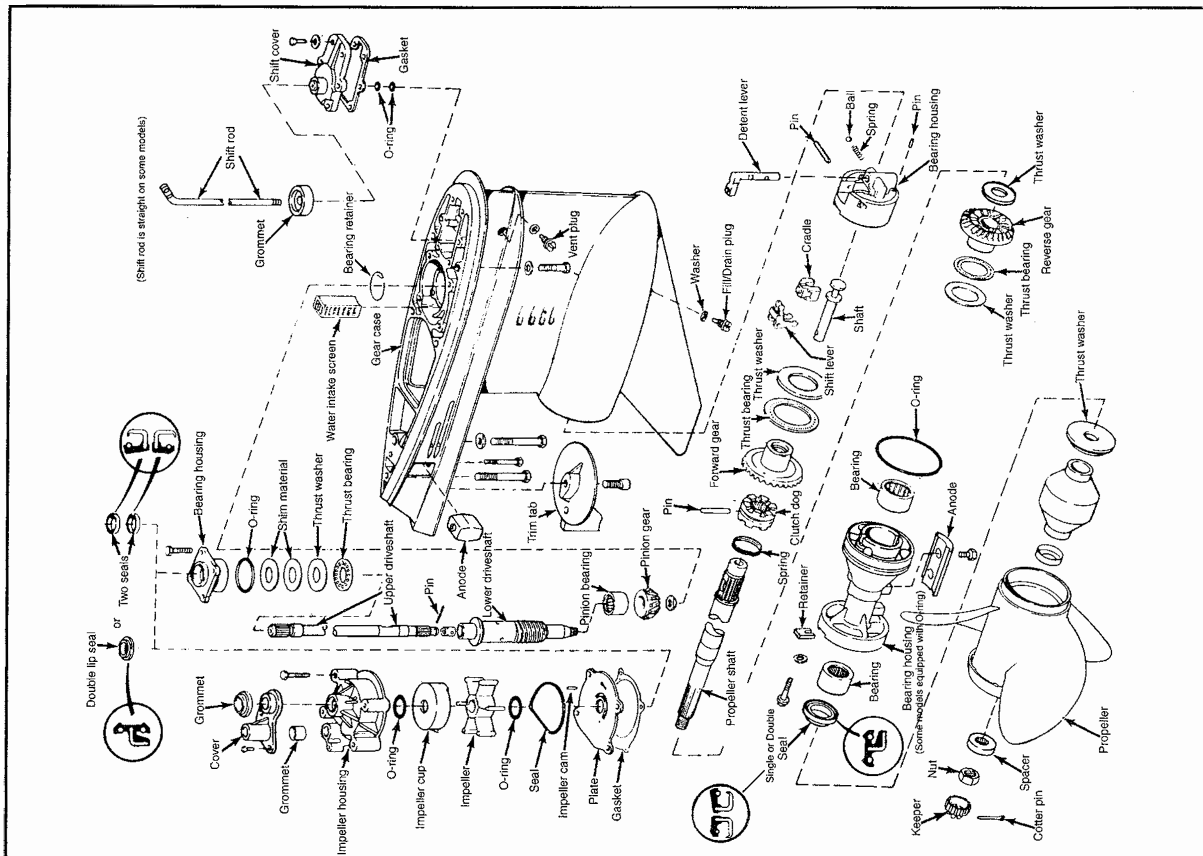


Fig. 26 Exploded view of the gearcase assembly used on most standard rotation V6 motors

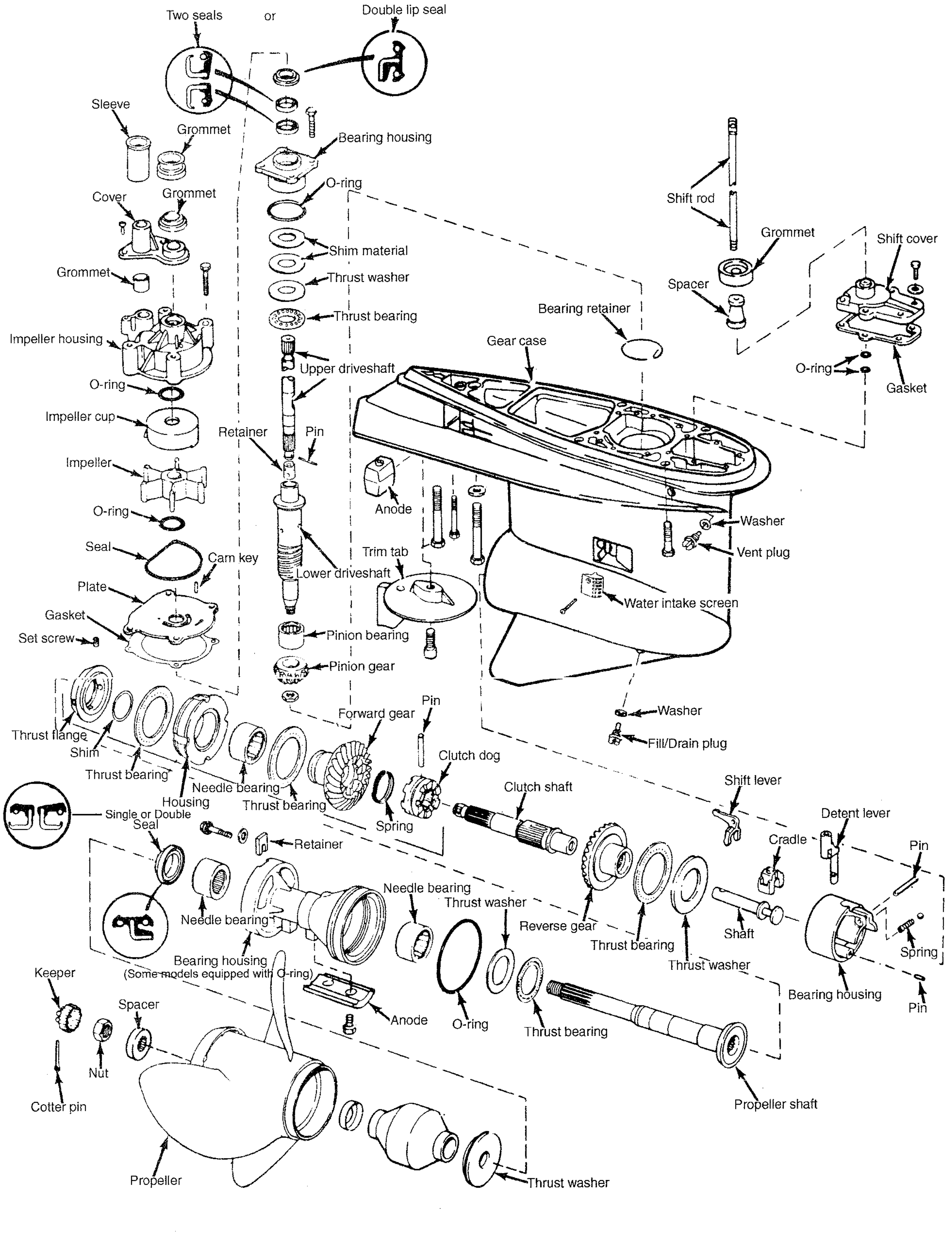


Fig. 28 Exploded view of the gearcase assembly used on most counter rotation V4/V6/V8 motors

3. If not done already, remove the propeller and drain the gearcase oil. For details, please refer to the procedures found in the Maintenance and Tune-up sections.

4. If service to the driveshaft and/or the water pump is necessary, remove the water pump housing and impeller from the top of the gearcase. For details, please refer to the Water Pump procedure in the Lubrication and Cooling section.

☐ **There are very few good excuses for not at least removing and checking the water pump impeller and housing at this time.**

5. Follow the appropriate sub-procedures for the additional components being disassembled. Of course, we recommend a thorough disassembly and inspection, especially if seals have failed (allowing moisture to contaminate the gearcase for any length of time) or damage has occurred from freezing, impact, neglect or misuse. If this overhaul is the result of time/wear, then all components must be removed and thoroughly inspected to ensure durability.

Propeller Shaft Bearing Carrier-Removal

◆ **See Figures 29 thru46**

The bearing carrier is attached to the gear case using one of three methods. Early model V8 bearing carriers are held in place by two retainers inside the carrier web secured by two bolts and washers threaded into the retainers. There are no threaded screw holes in the carrier which require the use of a special puller with arms.

The second method has two external retainers on the bearing carrier held in place by two bolts and washers.

The third method (usually found on 900 cross-flow motors and some early-model loopers) uses four bolts through the forward end of the bearing carrier which are threaded into a retainer plate. The retainer plate is held in place by two large snap rings.

The bearing carrier fits very tightly into the lower unit opening. Therefore, on very difficult and extremely tight bearing carriers, it is not uncommon to apply some heat to the outside surface of the lower unit with a torch, while at the same time using the puller or a slide hammer. Keep in mind that the puller is preferred over the slide hammer as it slowly presses out the housing, rather than jarring it loose, which can damage components.

Identify the bearing carrier for the unit being serviced with the illustrations and text in the following steps, follow the step(s) for that particular model.

1. For models (usually 90CV4 motors and some early-model loopers) with a 4 bolt bearing carrier, remove the four 3/8 in. bolts from inside the bearing carrier using a socket and extension. Next, thread two 5/16 in.-18 x 11 in. thread-all rods into the two threaded holes in the bearing carrier. Attach a universal flywheel puller to the thread-all rods. Align the center bolt in the flywheel puller on the end of the propeller shaft. Tighten the center bolt on the flywheel puller and withdraw the bearing carrier from the lower unit.

2. For models (usually only early-model V8s) with 2 internal retainers loosen and remove the two bolts and washers from the end of the bearing carrier. Reach inside the web of the bearing carrier and lift out the retainers. This bearing carrier requires a special puller with arms-such as EvinrudeIJohnson P/N 330278 or an equivalent. Set the puller on the end of the propeller shaft. Place the end of the arms, which have a hooked end, onto the rim of the bearing carrier. Thread the bolt in the center of the puller against the propeller shaft. Tighten the bolt on the puller until the bearing carrier is pulled from the lower unit.

Some 90° looper models are equipped with a wedge retainer/retaining screw along the edge of the bearing carrier housing. If equipped, loosen the screw 3-4 turns and pry gently upward equally on both side of the wedge in order to free the wedge before installation and use of the puller.

3. All other models should be equipped with 2 external retainers, on these, remove the two bolts, washers and retainers from the end of the bearing carrier. Next, thread two 5/16 in.-18 x 11 in. thread-all rods into the two threaded holes in the bearing carrier. Attach a universal flywheel puller to the thread-all rods. Align the center bolt in the flywheel puller on the end of the propeller shaft. Tighten the center bolt on the flywheel puller and withdraw the bearing carrier from the lower unit.

4. Lift the bearing carrier out of the lower unit housing

✳✳ WARNING

The snaprings used to retain the retainer plate are spring loaded. If the ring should accidentally slip free of the Truarc pliers, the ring could possibly cause injury. Be sure to wear safety glasses or safety shield while removing the two snap rings.

5. For cross-flow models using a 4 bolt bearing carrier there is a retainer plate in the housing, secured by snaprings, blocking further disassembly. Insert the tips of a suitable pair of snapring pliers into the holes of the first retaining ring. Now, carefully remove the retaining ring from the groove and the gearcase without allowing the pliers to slip. Release the grip on the pliers in the manner described in the above caution. Remove the second retaining ring in the same manner. Slide the retainer plate rearward and out of the housing.

6. Slide the large thrust washer, thrust bearing and reverse gear back and free of the propeller shaft. Some V6 models have a small thrust washer in front of the reverse gear. If so, slide this thrust washer off the propeller shaft.

■ **A very small thrust washer is installed on the propeller shaft between the reverse gear and the clutch "dog" on some lower units matched with a V6 powerhead.**

7. Slide or cut the O-ring(s) off the bearing carrier. Some models may have O-rings on both ends and some may have up to three O-rings on one end only. Note the location and number of O-rings on each end of the bearing carrier, as an aid to correct installation.

8. Examine the anode on the bottom of the bearing carrier. If the anode is corroded 1/3 or more (reduced to 2/3rds or less of the original size), remove the 2 hex bolts and separate the anode from the bearing carrier. Discard the anode and replace it with a new unit.

9. Obtain a seal extractor tool, or equivalent, and remove the one double lip seal or the two back-to-back lip seals from the end of the bearing carrier. Discard the seals.

10. Examine the two roller bearing sets in the bearing carrier housing. If the bearings are rough, discolored, or pitted, they must be replaced with a new set. Obtain EvinrudeIJohnson Bearing Puller tool 432127 and 432129, or the correct size mandrel and driver. Remove the bearings from both ends of the bearing carrier and discard them. If the bearings are removed for any reason, a new bearing must be installed.

When installing replacement bearings, the lettered side of the bearing case normally faces the installation driver. The bearings should be gently pushed into position, avoid tapping if possible. When installing the replacement seals, apply a light coating of EvinrudeIJohnson Gasket Sealing Compound, or equivalent sealant to the metal casing of each seal before carefully pushing it into position. Face the seals with the lips in the same orientation as noted during removal (unless the replacement is of a different design). After the seals have been positioned, apply a light coating of EvinrudeIJohnson Triple Guard or equivalent marine grade grease to the seal lips.

Some units, mostly attached to cross-flow models, contain a rubber cased double-lip seal. For ease of installation on these seals DO NOT use Gasket Sealing Compound, but instead apply a light coating of DPL Penetrating Lubricant or equivalent before seal installation. For more details, please refer to Propeller Shaft Bearing Carrier-Installation.

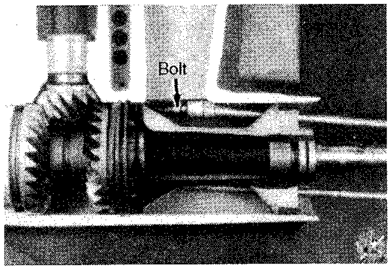


Fig. 29 To remove the bearing carrier, remove the four 318" bolts located inside housing (models with 4 bolt bearing carrier)...

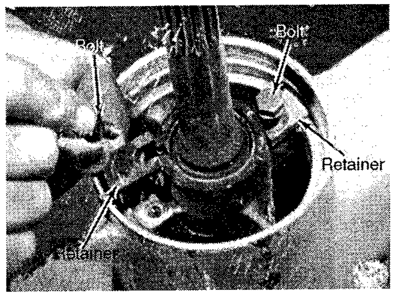


Fig. 30 ... or remove the two bolts, washers and retainers from the end of the bearing carrier (all other models except early-model V8s with internal retainers)

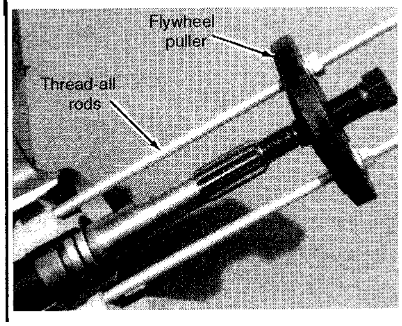


Fig. 31 On most models, use thread-all rods and a universal puller to remove the carrier

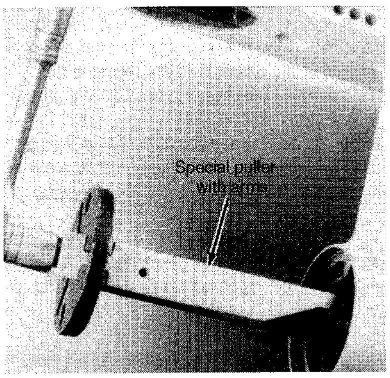


Fig. 32 But on most V8 motors (which utilize 2 internal retainers), use a puller with arms to grasp and withdraw the bearing carrier

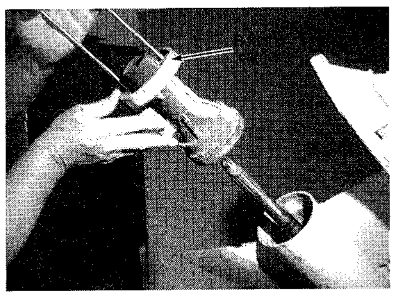


Fig. 33 Lift the bearing carrier out of the lower unit housing

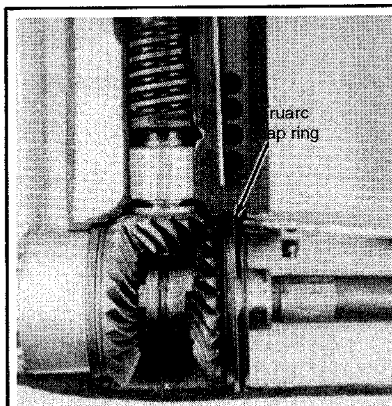


Fig. 34 On cross-flow motors with 4 bolt carriers, snaprings secure the bearing retainer plate, which must be removed for further disassembly...

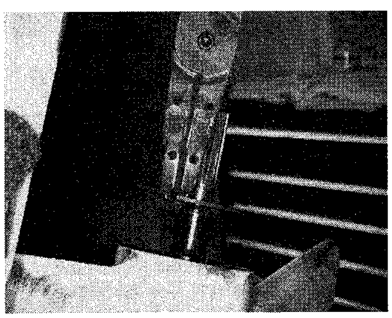


Fig. 35 Use a pair of **snapring** pliers to carefully remove the rings...

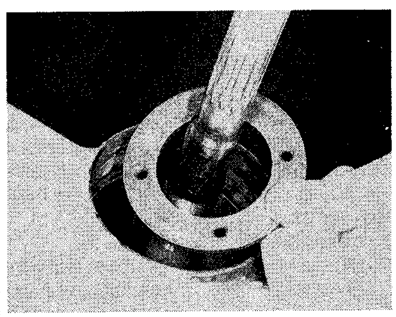


Fig. 36 ...then remove the retainer plate from the housing

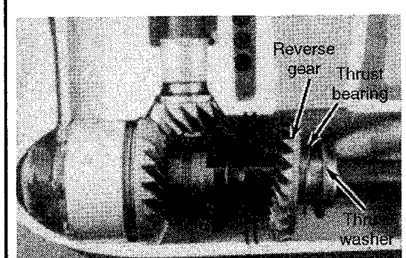


Fig. 37 Cut-away view showing the thrust washer, thrust bearing and reverse gear

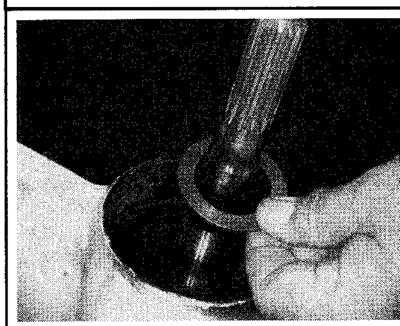


Fig. 38 Remove the thrust washer...

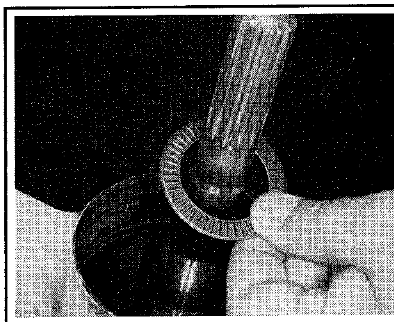


Fig. 39 ... thrust bearing...

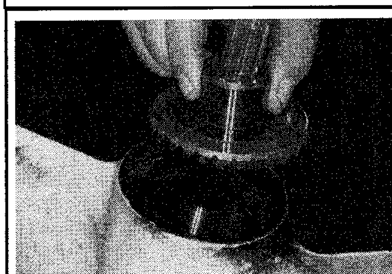


Fig. 40 ... and finally, the reverse gear from the housing

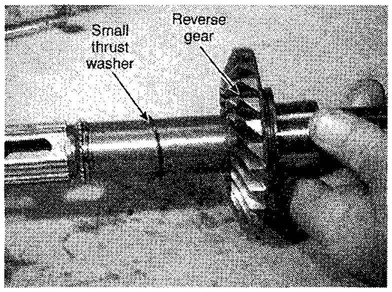


Fig. 41 On some V6 models, a tiny thrust washer is installed on the shaft between the reverse gear and the clutch

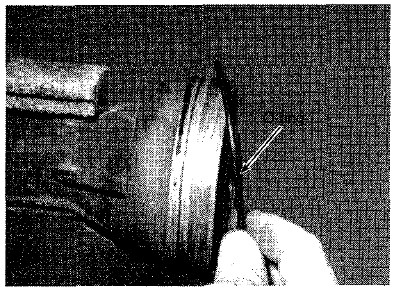


Fig. 42 Slide or cut the **O-ring(s)** off the bearing carrier (number and location vary, so note them for installation purposes)

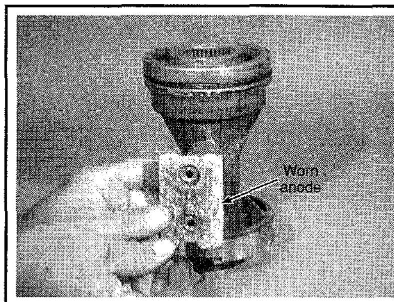


Fig. 43 Replace the bearing carrier anode if **worn/corroded**

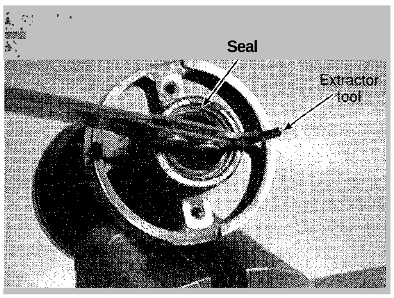


Fig. 44 Seal design and positioning vary, so note the type and location, before removing the **seal(s)** from the housing

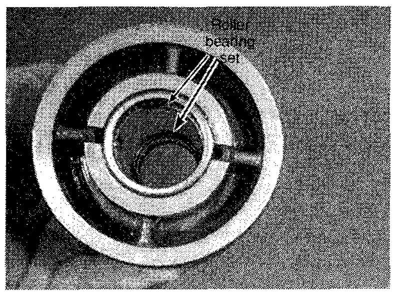


Fig. 45 Examine the roller bearing sets in the bearing carrier housing and replace, if necessary

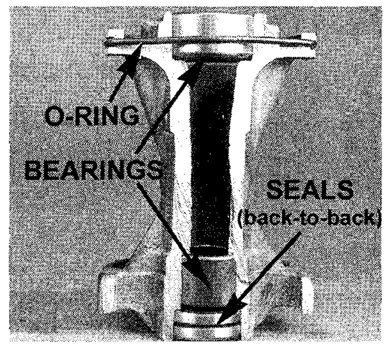


Fig. 46 Cutaway view of a typical bearing carrier showing seals, bearings and O-rings

OEM ② MODERATE

Pinion Gear-Removal

◆ See Figures 47, 48, 49 and 50

For this procedure you'll need a special driveshaft socket (essentially a socket designed to mate with the splines on the top of the driveshaft) and a pinion nut holding tool (or a wrench thin enough, yet long and strong enough to mate with the pinion nut in the gearcase).

To remove the pinion nut, a wrench is placed onto the pinion nut and an adapter (splined socket) is placed over the splined upper end of the driveshaft. All force and rotation to remove the nut is applied at the driveshaft itself. The pinion nut may be tightened to as much as 100-110 ft. lbs. (136-149 Nm) on some models, requiring an equal amount of force to remove the nut. A special tool to perform this task is should be obtained before attempting to remove the pinion nut. Using any alternate methods could bend or damage the driveshaft or lower unit housing.

1. From the top of the gearcase, loosen and remove the 4 bolts securing the driveshaft bearing housing.

2. Pull up on the shift rod to place the unit in forward gear. This action will move the shift dog forward providing better access to the pinion nut. Rotate the propeller shaft to ensure the unit is in forward gear.

3. Obtain a Driveshaft Spline Holding Socket, such as Evinrude/Johnson PIN 311875 or equivalent. Place the socket over the end of the driveshaft with the splines of the socket indexed with the splines of the driveshaft. Attach a 1/2 in. drive ratchet or breaker bar onto the socket.

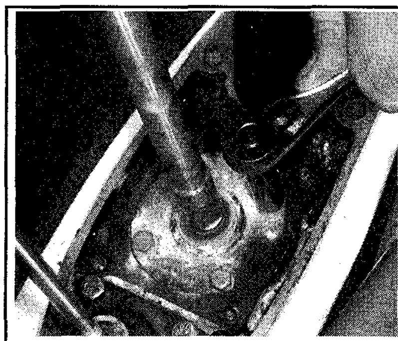


Fig. 47 Remove the 4 bolts from the driveshaft bearing housing.

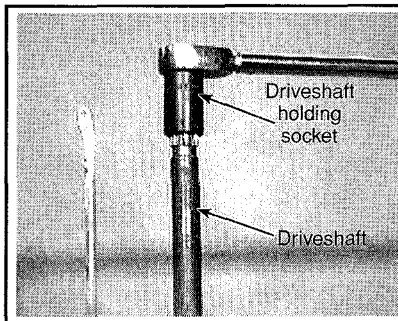


Fig. 48 Use a special driveshaft socket to turn the driveshaft...

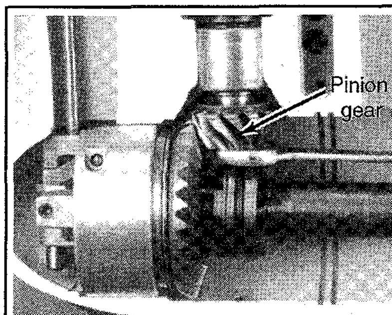


Fig. 49 ... while the pinion nut is held with a special tool or suitable wrench

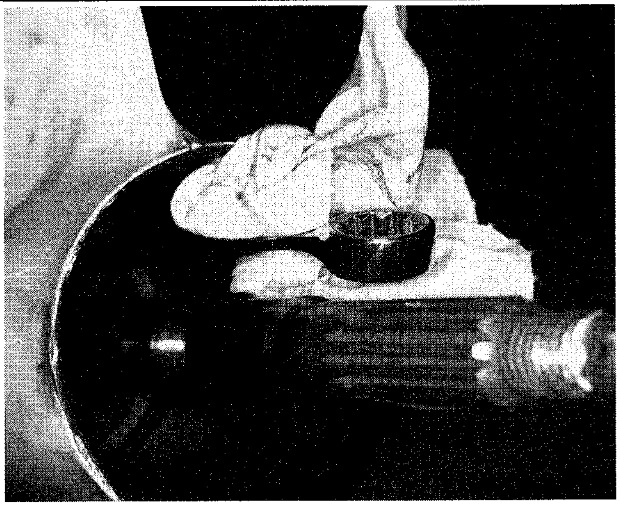


Fig. 50 Protect the **gearcase** itself from the wrench using rags or padding

4. Obtain a Pinion Nut Holding wrench, such as Evinrude/Johnson P/N 334455 or place the appropriate size long handle end wrench onto the pinion nut. A piece of padding should be placed between the wrench and the lower unit to prevent damaging the housing. Hold the pinion gear nut stationary using the wrench/tool and at the same time, rotate the driveshaft slowly counterclockwise with the special socket and breaker bar until the pinion nut is free.

The pinion gear itself, though freed, cannot be removed from the **gearcase** until after the driveshaft is withdrawn.

OEM ② MODERATE

Driveshaft-Removal

◆ See Figures **51, 52, 53, 54, 55, 56** and **57**

1. Using a pair of small prytools, carefully pry the bearing housing upward and away from the lower unit, and then slide it free of the driveshaft.
2. Slip the O-ring free of the bearing housing and discard the O-ring. Examine the roller bearing in the bearing housing. If the bearings are rough, discolored, or pitted, the bearing must be replaced.

The driveshaft bearing is NOT serviceable, if worn or damaged the driveshaft bearing and housing must be replaced as an assembly.

3. Place a small prytool or seal extractor into the driveshaft seal on the bearing housing. Pry the single or back-to-back seals out of the bearing housing. Note the seal positioning for installation purposes.
4. Reach inside the lower unit where the bearing housing previously fit. Slide the shim material, thrust washer, and thrust bearing up and free of the driveshaft. Note the shim thickness for later assembly reference.

The **Evinrude/Johnson** puller tool is essentially a 2-piece unit that clamps to the driveshaft itself (and secures to the water pump cam area using a set-screw). It is used by tightening pusher screws that are threaded through either side of the tool against a protective backing plate placed **over** the **gearcase. The screws** force the tool (and therefore the driveshaft) upward, pulling it out of the pinion gear (when stuck).

5. Lift up on the driveshaft and attempt to pull it from the lower unit housing. The pinion gear is a taper fit onto the lower end of the driveshaft. After the nut has been removed it may be difficult to free the gear from the

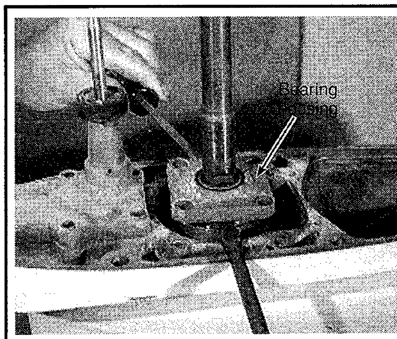


Fig. 51 Carefully pry the bearing housing upward off the driveshaft

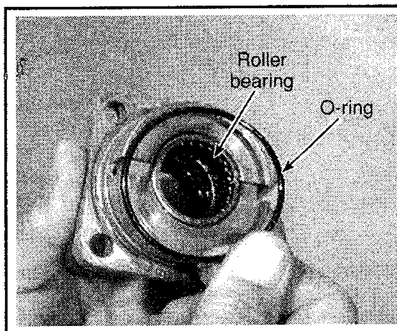


Fig. 52 Remove the O-ring and inspect the bearings

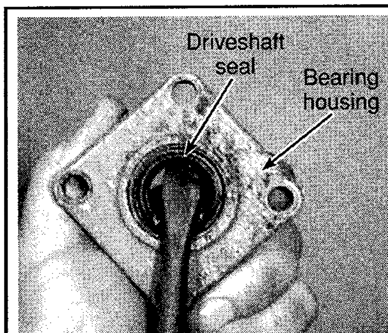


Fig. 53 Carefully pry the driveshaft **seal(s)** from the housing

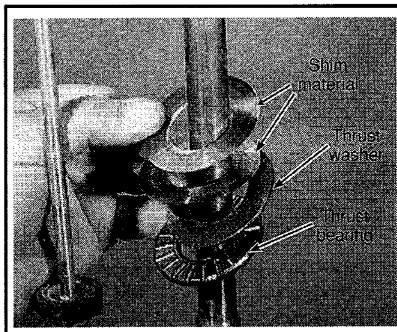


Fig. 54 Remove the shim material, thrust washer, and thrust bearing

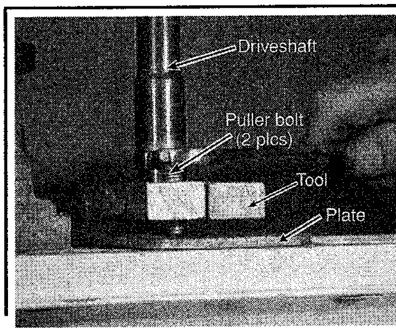


Fig. 55 If removal is difficult, use a 2-piece puller to free the driveshaft

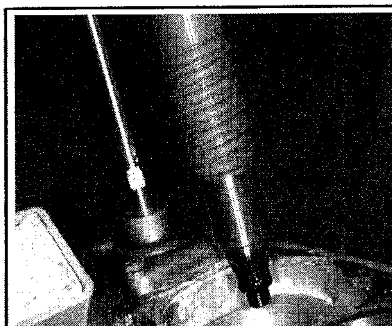


Fig. 56 **Lift** the driveshaft from the housing

end of the shaft. If necessary, obtain a special puller tool, such as Evinrude/Johnson PIN 390706 and plate PIN 325867. Slide the plate down the driveshaft and center it with the driveshaft on the lower unit. Attach the puller tool to the driveshaft with the set screw aligned with the water pump cam. Tighten the clamping bolts and the set screw. Tighten the two puller bolts alternately and equally-same number of turns-until the pinion gear is free of the driveshaft.

An alternate method is to clamp the driveshaft in a vise equipped with soft face jaws. Use a soft headed mallet and tap on the top side of the lower unit **housing. This** action should jar the pinion gear free of the driveshaft. BUT, be sure to have an assistant SUPPORTTHE LOWER **UNIT** HOUSING to prevent it from falling and suffering impact damage when the driveshaft pulls free of the pinion gear.

6. Most of these motors are equipped with 2-piece driveshafts (connected at the center using a collar and roll pin). In some cases, the upper driveshaft will become separated from the lower driveshaft, leaving the lower piece behind during removal. If this occurs you'll need a hooked puller such as Evinrude/Johnson #342681 and a slide-hammer to remove the lower driveshaft. Install the hooked puller into the lower driveshaft and turn 90° to secure the hook under the roll pin in the driveshaft. Next, thread a slide hammer onto the end of the puller and carefully remove the lower driveshaft.
7. Lift the driveshaft out from the lower unit housing.
8. Reach inside the propeller shaft end of the lower unit and remove the pinion gear and nut from the housing.

When the driveshaft is pulled out of the lower (pinion) bearing, some or all of the needle bearings may fall free. It is recommended the needle bearings be removed to prevent loosing **them. The V4** and **V6** bearing normally contain **18** needles-the **V8** normally contains **19** needles. Remove all loose needles from the driveshaft bearing.

Fig. 57 Reach inside the **gearcase** and remove the pinion gear

② MODERATE

Propeller Shaft and Shift Unit-Removal

◆ See Figures **58, 59, 60, 61, 62, 63** and **64**

1. Push down on the shift rod to move the shift unit into the reverse gear position.

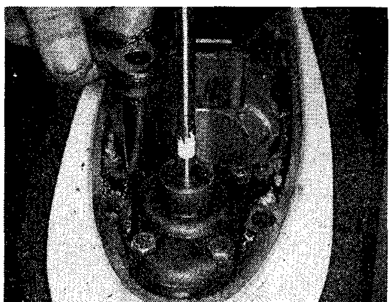


Fig. 58 Remove the six bolts securing the shift rod cover...

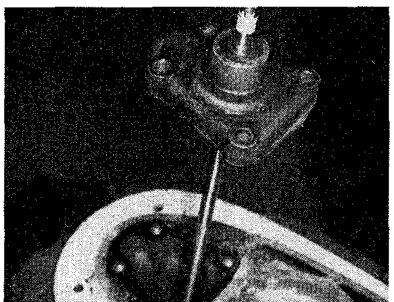


Fig. 59 ... then lift upward and remove the shift rod/cover assembly

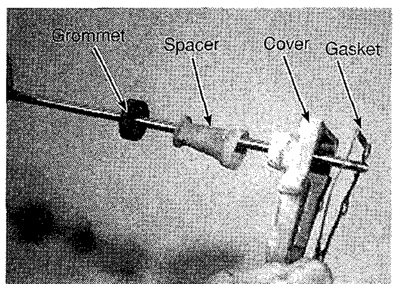


Fig. 60 Slide the gasket, cover, spacer (if equipped), and **grommet** off the shift rod

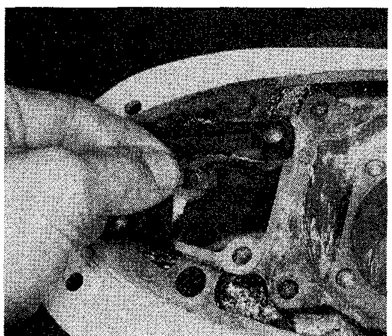


Fig. 61 If the gasket remained behind, remove it from the **gearcase**

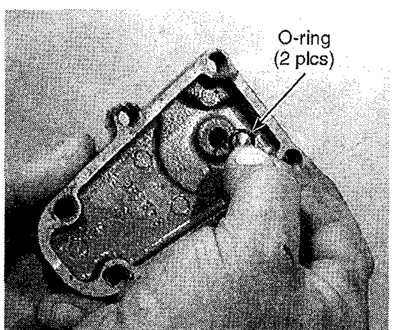


Fig. 62 Remove the O-rings (usually 2) from inside the shift rod cover

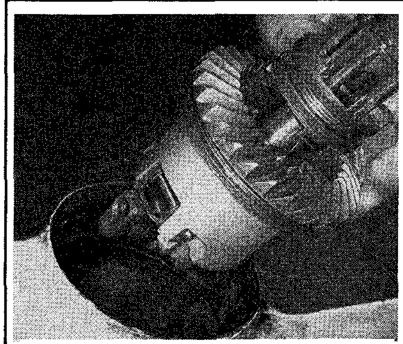


Fig. **63** Remove the propeller shaft from the **gearcase...**

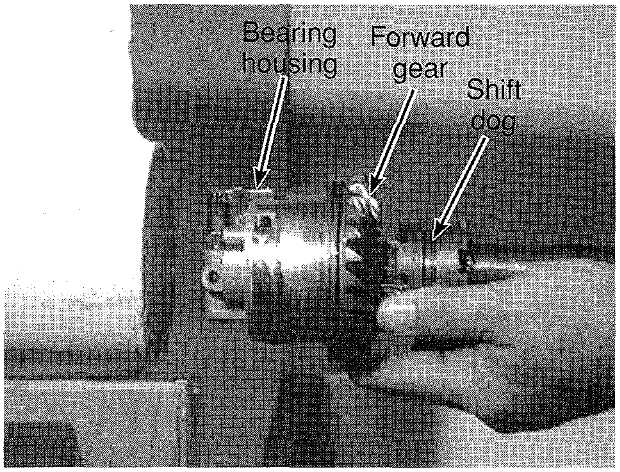


Fig. 64 ... the shift dog, forward gear and bearing housing will come out with the shaft

2. Remove the 6 bolts securing the shift rod cover to the lower unit housing.

3. Rotate the shift rod counterclockwise until it is free of (unthreaded from) the shifter detent in the lower unit. Lift up on the shift rod and cover as an assembly and remove it from the lower unit.

4. Slide the gasket, cover, spacer (if equipped), and grommet off the shift rod. Discard the gasket and grommet,

5. Remove the two O-rings from inside the shift rod cover. Discard the two O-rings.

6. Grasp the propeller shaft firmly with one hand and remove the propeller shaft from the lower unit. The forward gear, bearing housing and shifting unit will come out with the shaft as an assembly.

DIFFICULT

Propeller Shaft (Forward Gear Bearing Housing and Shift Unit) Disassembling

◆ See Figures **65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75** and **76**

1. There is a small spring at the center of the clutch dog. While wearing safety glasses to protect your eyes, use a small prytool or screwdriver inserted under one end of the spring to carefully lift it from the groove and unwrap it from the clutch dog. Remove and discard the spring.

2. Using a small screwdriver, carefully push the retaining pin out of the clutch dog. This will free the bearing housing assembly from the shaft and the clutch dog will also be free to slide from the splines.

3. Remove the bearing housing assembly, followed the thrust washer, thrust bearing and forward gear. Note the order of positioning for installation purposes. Inspect the gear, bearing and thrust washer for discoloration, corrosion, and galling. If desired, slide the clutch dog from the splines.

■ When removing the bearing housing, keep track of any loose needle bearings that may fall from the housing.

4. At the front, side of the bearing housing assembly, push downward on the detent lever, making sure it is in the most depressed position. Withdraw the shift shaft and cradle from the housing.

5. Now pull upward on the detent lever until it snaps into the neutral position. This is necessary for access to the pivot pin.

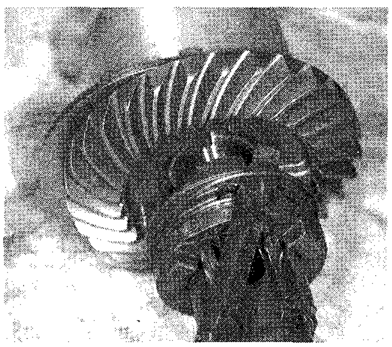


Fig. 65 Remove the spring from the clutch dog

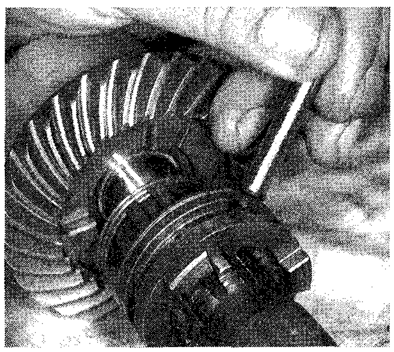


Fig. 66 Push the shift shaft retaining pin out from the clutch dog.


Fig. 67 Remove the shift bearing **hous-**ing assembly from the shaft...

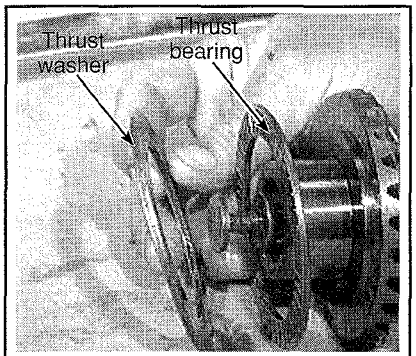


Fig. 68 ... then remove the thrust washer and gear

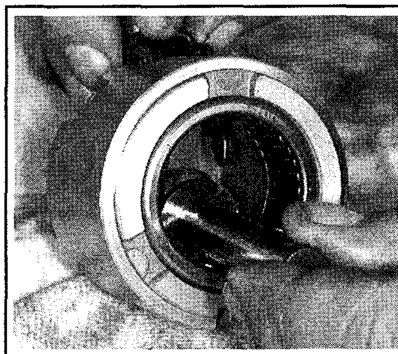


Fig. 69 Push downward on the detent lever and remove the shift shaft with cradle


Fig. **70** Remove the pivot pin from the bearing housing**...**

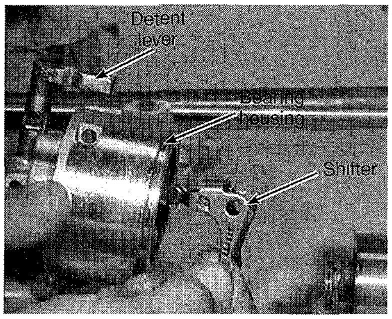


Fig. 71 ... then reach inside the bearing housing and remove the shifter

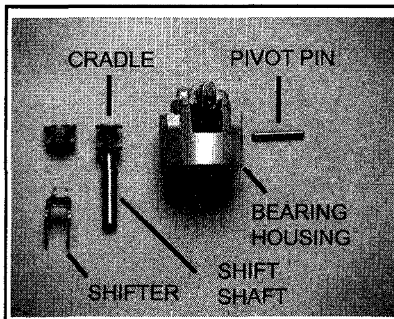


Fig. 72 Exploded view of the bearing housing shifter components

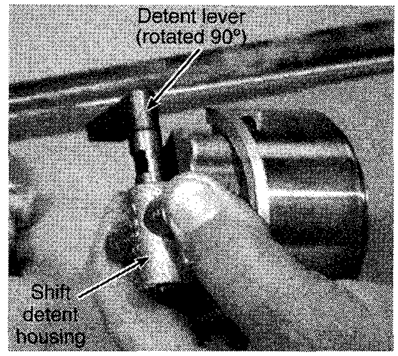


Fig. 73 Rotate the detent lever 90°...

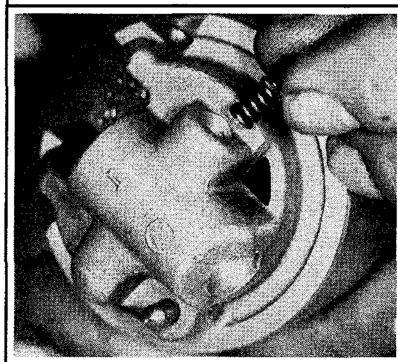


Fig. 74 ... then carefully remove the detent ball and spring

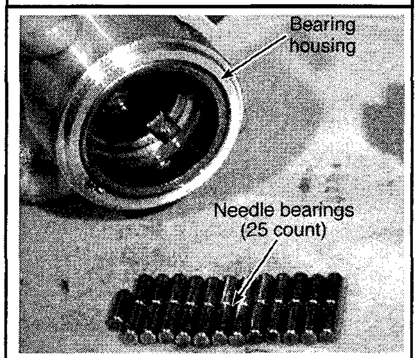


Fig. 75 Remove the needle bearings from the bearing housing

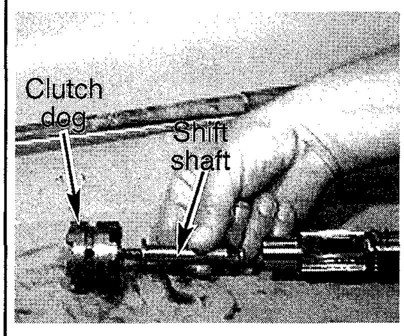


Fig. 76 Remove the clutch dog to inspect the dog and shaft splines

6. Using a small common screwdriver, push the pivot pin out of the bearing housing.
7. Reach inside the bearing housing and lift the end of the shifter from the detent lever. Remove the shifter from the bearing housing.

**** WARNING**

For the next step, it is a good idea to wear safety glasses for protection. Another method for retaining the components is to wrap the shift detent housing with a clean shop rag during the procedure to catch toe ball and spring.

8. Place a thumb and forefinger over the shift detent housing, as shown in the accompanying illustration, to catch the detent ball and spring. Rotate the detent lever 900 degrees-left or right-and pull the detent lever out of the housing.
9. Remove the detent ball and spring from the shift detent housing.
10. Remove the remaining needle bearings from the bearing housing and keep them in a safe place. There are a total of 25 needle bearings. If one is lost or damaged, the bearing housing and bearing must be replaced as an assembly.
11. If not done already, slide the clutch dog off the end of the propeller shaft, and then withdraw the shift shaft from inside the propeller shaft. Examine the clutch dog teeth for chipped edges and excessive wear. Check the splines for rough or broken edges. If the clutch dog shows any sign of damage or excessive wear, the clutch dog must be replaced with a new unit.

Water Intake Screen

◆ **See Figures 77, 78 and 79**

Examine the water intake screen on both sides of the lower unit housing. If the screen is clogged and cannot be cleaned or is damaged it must be replaced. Water intake screens are either snapped into position from inside the gearcase using tabs or are held in position by small screws (normally Phillips head design) threaded from outside the case.

1. For models on which the screens are secured using snap-tabs, use two small screwdrivers to carefully press in on the locking tabs on each side of the intake screen. Push in and up and at the same time to unlock the tabs and push the screen upwards. Lift the screen out from the lower unit housing.
2. For models on which the screens are secured by screws, loosen and remove the screw above the screen on the starboard side of the lower unit. Place a small common screwdriver on each side of the intake screen under the locating tabs. Press in and up on both screwdrivers and at the same time, push the screen free of the housing. Lift the screen out of the lower unit housing.

Lower Driveshaft Pinion Bearing-Removal

◆ **See Figures 80 and 81**

Carefully examine the needle bearings (loose on V6 and V8 models) and the bearing cage for discoloration, corrosion and damage. If the bearing appears to be serviceable, do not remove it from the housing. If the bearing is removed, it MUST be replaced.

If the bearing is damaged and must be removed a special tool must be used on V6 and V8 to remove it from the lower unit housing. On these units the bearing must be pulled out of the unit from the top. The bearing has a slight taper fit and if an attempt is made to drive it out the bottom, such action could possibly severely damage the lower unit (a very, very expensive part to replace).

The caged bearing used on V4 models differs slightly both in design and in mounting. This bearing is removed from the gearcase using a suitable driver to force it out the bottom of the gearcase, so no special tool is actually needed for removal.

The problem comes during installation on ALL models. It is critical that the bearing is installed to the proper height in the gearcase.

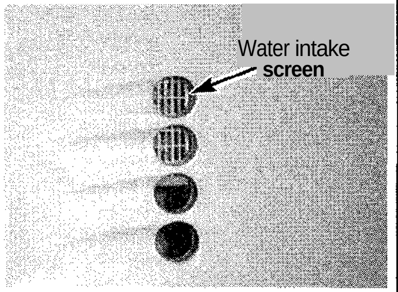


Fig. **77** If no screw is visible, the water intake screen is secured from within the **housing using snap tabs**

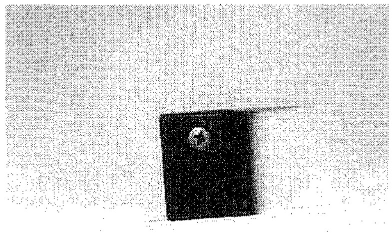


Fig. **78** This screen is obviously secured using a **Philips** head screw

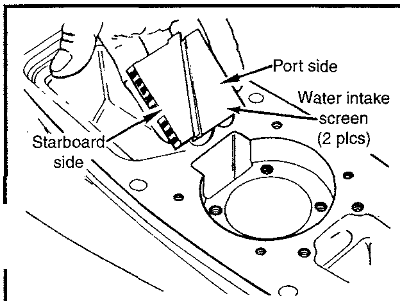


Fig. **79** Common water intake screen installation **(V8** engines shown)

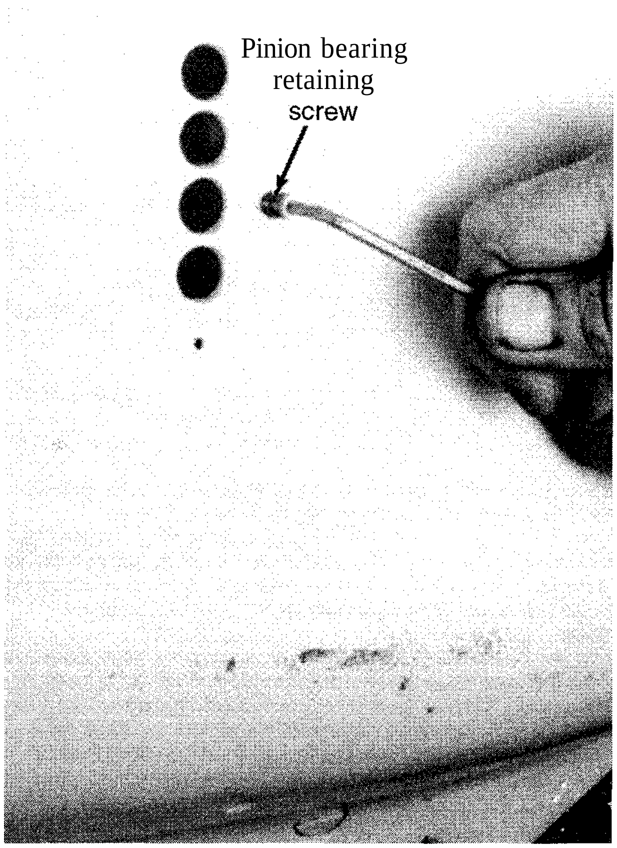


Fig. **80** Remove the bearing retaining circlip or set screw (pictured), as applicable, before attempting to remove the pinion bearing

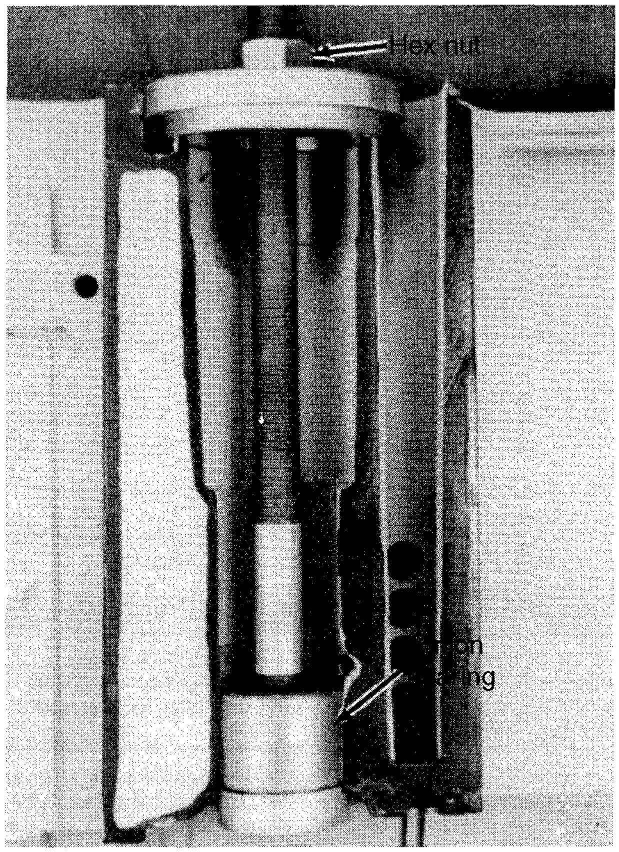


Fig. **81** Cut-away view showing puller positioning for pinion bearing removal, the bearing MUST be pulled upward to safely remove it from the **gearcase** on **V6** and **V8** models

The Evinrude/Johnson installation tool ensures this with the use of specific spacers depending upon the given gearcase. The only alternate is to measure the installed height of the pinion bearing prior to disassembly (we'd say measure it at least twice) and then manually driving the bearing into the bore to the same depth during installation.

The pinion bearing is secured to the lower unit by one of two methods. Most gearcases have a retaining screw on the side (usually starboard) and directly in front of the water intake screen. All other units have a circular spring clip down inside the driveshaft cavity above the pinion bearing. Check the unit being serviced for the device used to secure the pinion bearing.

1. If equipped with a pinion bearing retaining screw, loosen and remove the screw from the side of the gear case in front of the water pickup screen. Discard the O-ring on the screw.

2. If equipped with a pinion bearing retaining circlip, use a long pair of needle nose pliers to remove the spring clip from the driveshaft bore above the pinion bearing.

3. If the Evinrude/Johnson removal and installation tool is NOT available (and, even if it is, this isn't a bad idea), take a careful measurement of the depth to which the bearing is currently installed. Measure it twice to be sure. This information is critical to the proper assembly of the gearcase, especially without the special tool.

Because the bearing puller uses the needles as part of the pulling surface, make sure ALL **18** of the loose needles **(V6** motors) or **19** loose needles **(V8** motors) are in position in the bearing before positioning the removal tool.

4. For V6 and V8 engines, obtain a bearing removal, tool such Evinrude/Johnson PIN 391257. Assemble the tool in the lower unit. Tighten the upper hex nut on the tool and pull the pinion bearing up from the lower unit housing. The bearing must be "pulled" upward to come free. Never make an attempt to "drive" it down and out on these models.

After the bearing is free of the lower unit, lift the tool and bearing out of the lower unit. Discard the bearing.

5. For V4 engines, use a suitable driver (the right sized socket and extension will usually do, but don't admit it to the Snap-On@man when he calls) to carefully drive the bearing down and out the bottom of the bore into the gearcase.

CLEANING & INSPECTION

2 MODERATE

◆ See Figures **24, 25, 26, 27, 28** and 82

Wash all parts in solvent and dry them with compressed air. Following "good shop practice", discard all removed O-rings and seals. A new seal kit for this lower unit is available from the local dealer. The kit will contain the necessary seals and O-rings to restore the lower unit to service.

Inspect all splines on shafts and in gears for wear, rounded edges, corrosion, and damage.

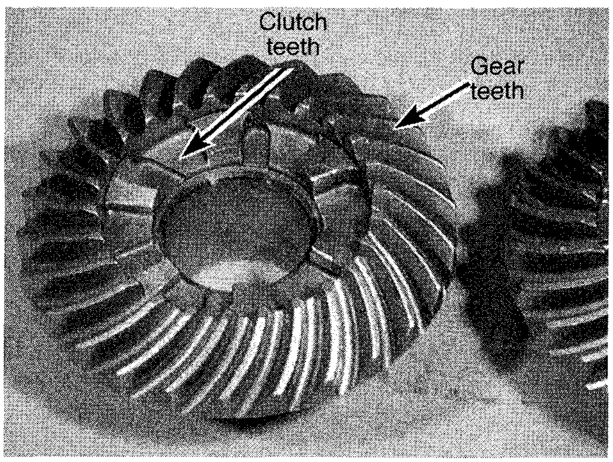


Fig. **82** Careful inspection of the forward and reverse gear teeth and the clutch teeth for worn, damaged or broken teeth, will ensure smooth shifts and reliable performance from the lower unit.

Carefully check the driveshaft and the propeller shaft to verify they are straight and true without any sign of damage. If there is evidence to suspect the shaft is not true it must be checked by turning it in a lathe.

Check the water pump housing for corrosion on the inside and verify the impeller and base plate are in good condition. Good shop practice dictates a new impeller be installed any time the water pump is opened for any reason. The small cost is rewarded with "peace of mind" and satisfactory service.

Inspect the lower unit housing for nicks, dents, corrosion, or other signs of damage. Nicks may be removed with No. 120 and No. 120 emery cloth. Make a special effort to ensure all old gasket material has been removed and mating surfaces are clean and smooth.

Inspect the water passages in the lower unit to be sure they are clean. The screen may be removed and cleaned.

Check the gears and clutch dog to be sure the ears are not rounded. If doubt exists as to the part performing satisfactorily, it should be replaced.

Inspect the bearings for "rough" spots, binding, and signs of corrosion or damage.

ASSEMBLY

◆ See Figures **24, 25, 26, 27, 28, 83** and 84

Read and **Believe**: The lower unit should not be assembled in a dry condition. Coat all internal parts with EvinrudelJohnson HI-VIS gear lube for units prior to 1993 and EvinrudelJohnson Ultra-HPF gear lube for units from 1994 and on, as they are assembled. All seal rubber lip surfaces should be coated with EvinrudelJohnson Triple Guard Grease. Gaskets, bolt threads, and seal metal cases should be coated with EvinrudelJohnson Gasket

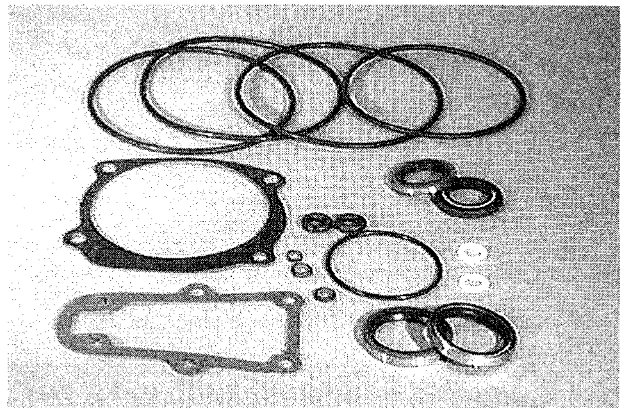


Fig. 83 All seals, gaskets, and O-rings must be replaced when assembling the lower unit. **A** typical kit, with contents, is shown and is available from an EvinrudelJohnson dealer. It is usually more economical to purchase these items in a kit, rather than as individual parts.

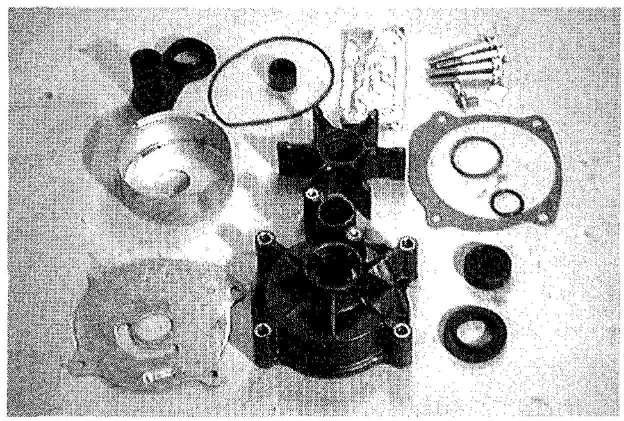


Fig. 84 The water pump components may be purchased in various kits with three or four components, or the entire water pump unit including the housing. Check with a local dealer for the kits available for the model being serviced. In most cases, the entire kit is less expensive than three or four individual components.

Sealing Compound. When two seals are installed back-to-back, fill the void between the seals with EvinrudelJohnson Triple Guard Grease.

☐ Slightly different pinion bearing and propeller shaft component arrangements are used on some of the lower units covered in this manual. Refer to the accompanying exploded views for some idea of how the bearings and components are mounted in each common gearcase. The preponderance of propeller **shaft** bearing carriers are mounted using 2 external retainers, but there are some exceptions (including many V8 models and most cross-flow models).

Also, depending upon the year and model, the pinion bearing is either secured with a spring clip down in the driveshaft bore or with a retaining screw threaded from the side of the gearcase.

The most common change between the lower units are the seals. Over the years, the manufacturer often changed seal designs. Many 1992-94 units use double or two seals back-to-back on the propeller and driveshafts and many late-model units also use this arrangement. However, some seals on 1995 and later units were changed to a single seal with dual lips forming a double lip seal. Consult with a local Evinrude/Johnson dealer when ordering parts for the unit being serviced with the powerhead serial numbers for the correct seal applications.

OEM ② MODERATE

Lower Driveshaft Pinion Bearing-Installation

◆ **See Figure 85**

In most instances the lower driveshaft pinion bearing is tapered. In ALL instances, incorrect positioning and installation will severely reduce bearing life. Make sure the lettered side of the assembly is installed facing UPWARD. Because of the taper it is important that the bearing assembly is properly pushed, downward and into position using a suitable tool. The absolute best method is to use the proper EvinrudelJohnson Bearing Installation tool #391257.

If the installation tool is not available, use the measurement taken during disassembly as a guide to pinion bearing installation. The bearing must be driven to that same exact depth in the gearcase (assuming it was correct in the first place, but that's a risk you'll have to take without the tool). Make sure you don't leave the bearing higher or lower in the bore. Also, keep in mind that the bore is tapered on some models and driving the bearing lower than the proper installed height will distort and damage the bearing, so take your time.

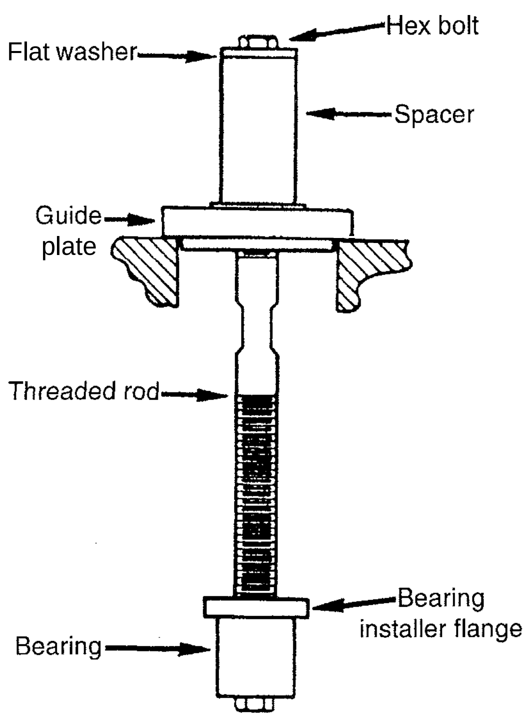


Fig. 85 The EvinrudelJohnson universal lower pinion bearing installation tool. When the proper combination of spacers are used, this tool ensures installation of the bearing to the proper depth for each gearcase

1. Obtain bearing installer, special tool, EvinrudelJohnson PIN 391257. Assemble the tool with the hex bolt, flat washer, guide plate, threaded rod, and bearing installer, as shown in the accompanying illustration and as detailed with the tool kit. Onlv the oroper combination of soacers and kit components will result in thecorrect pinion bearing installation depth.
2. The V6 and V8 engines use a bearing with loose needles. On these models, apply a thick coating of EvinrudelJohnson Needle Bearing Grease to the bearing needles. Install the 18 (V6) or 19 (V8) needles into the bearing cage.
3. Slide the bearing assembly over the end of the bearing installer tool with the lettered side of the bearing toward the shoulder. Place the lower driveshaft bearing and tool in position in the lower unit.

■ **If you don't have access to the EvinrudelJohnson installation tool, this is the hardest and most critical part of the procedure. Take your time, driving the bearing into the gearcase, just a little bit at a time until it sits and the exact depth measured during disassembly.**

4. Now, drive the bearing into the lower unit until the flat washer on top of the tool contacts the tool guide plate. Remove the tool from the gearcase.
5. For models on which the bearing is secured by a screw, place a new O-ring on the bearing retaining screw and coat the threads with EvinrudelJohnson Nut Lock or equivalent threadlock. Install the screw and tighten to a torque value of 48-80 inch lbs. (5-9 Nm).
6 For models on which the bearing is secured by a circlip, use a long pair of needle nose pliers to place the pinion bearing spring retainer into the groove above the pinion bearing. Make sure the circlip is properly seated.

① EASY

Water Intake Screen

◆ **See Figures 77, 78 and 79**

If the model being serviced has a one piece intake screen, place the screen into the lower unit with the curved side facing forward and the locking tabs up. Slide the screen into the cavity until the locking tabs are visible in the top hole of the water intake.

If the model being serviced has a two piece intake screen, place the port side into the lower unit first, with the wide end down. Place the starboard side into the lower unit with the narrow end down. Push down on the starboard side until the screen snaps into place. If the intake screen is retained by a screw, there will be a screw hole immediately above the screen on the starboard side. Install the screen retaining screw and tighten it securely.

OEM ③ DIFFICULT

Propeller Shaft (Forward Gear Bearing Housing and Shift Unit) Assembly

+ **See Figures 72, 86, 87, 88, 89, 90, 91 and 92**

1. Apply a coating of EvinrudelJohnson Needle Bearing Assembly lube to the detent ball and spring. Insert the spring followed by the ball into the detent housing.

✳✳ CAUTION

The detent ball will be placed under extreme pressure as it is depressed while inserting the shift lever in the next step. Be sure to wear a pair of safety glasses or a shield while performing this procedure.

2. Depress the ball and spring into the housing with a drift punch, and at the same time, insert the detent shift lever with the lever arm facing to the rtght or left side. Once the lever is inserted deeper than the ball, turn it 90° toward the rear of the housing to engage the ball. Next, move the detent lever to the **neutral** position.
3 Apply a coating of EvinrudelJohnson Needle Bearing Assembly lube to the 25 needle bearings. Install the needle bearings into the forward gear bearing carrier.
4. Position the shift lever arm facing forward (the narrow arms should face the housing). Pull up or push down on the shift lever placing it in the neutral position. Insert the shift lever into the bearing housing without disturbing the 25 needle bearings. Connect the forks of the shift lever into the detent lever notch.
5. Align the shift lever with the bearing housing and insert the shift lever pin through the housing and shift lever. Verify the pin is centered in the housing and not exposed on either end.

Push the detent lever down to the lowest (most depressed) position. With the cradle mounted on the end of the shift shaft, connect the cradle to the shifter's wide arms. Pull the detent lever back up into **neutral** in order to hold the cradle and shift shaft in position.

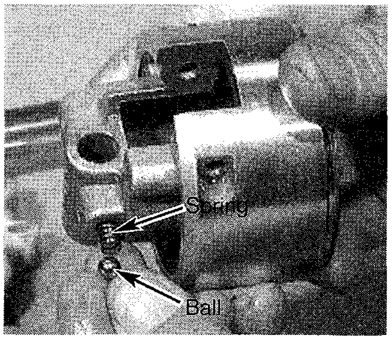


Fig. 86 Insert the spring followed by the ball into the detent housing...

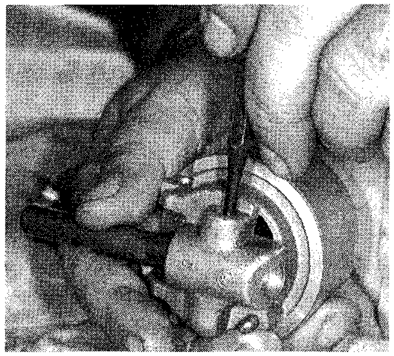


Fig. 87 ... then, depress the ball and spring using a drift punch...

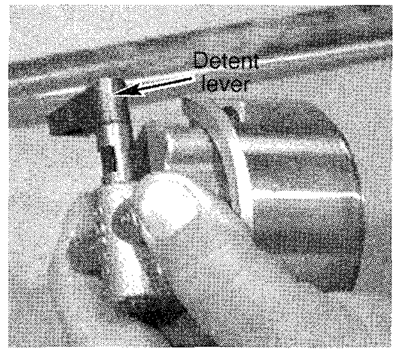


Fig. 88 ...at the same time, insert the detent shift lever, then turn it 900 to engage the ball

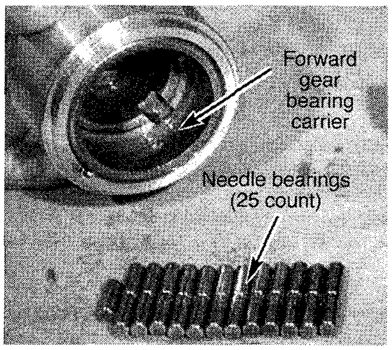


Fig. 89 Install the 25 loose needles to the bearing housing using grease to hold them in position

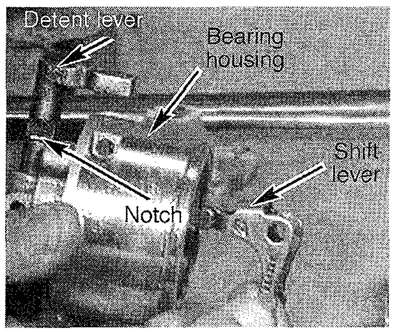


Fig. 90 Install the shift lever arm (narrow arms facing the housing)...

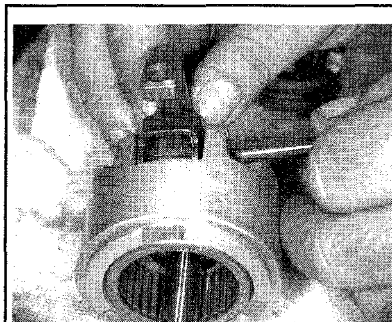


Fig. 91 ... then, secure using the roll pin

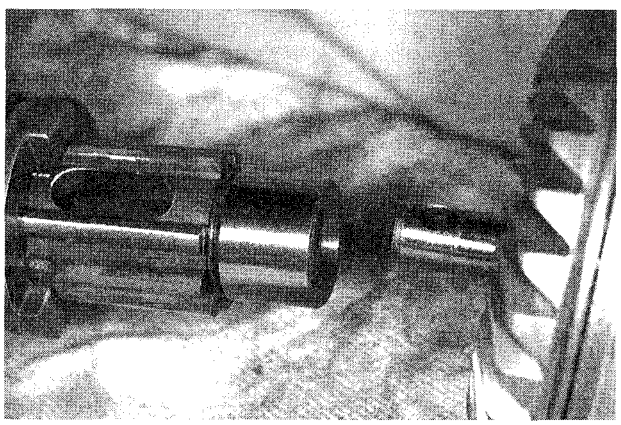


Fig. 92 When the shift shaft is installed to the propeller shaft, be sure to align the shift shaft pin hole with the slot in the propeller shaft (clutch dog removed for clarity)

6. Apply a light coating of Evinrude/Johnson Needle Bearing Assembly Grease, or eauivalent to the thrust bearing and the thrust washer. Place the bearing on the back of the forward gear and position the wash& over top of the bearing.
7. Connect the gear/thrust bearinglthrust washer assembly to the bearing housing, taking great care not to dislodge any of the loose needles inside the bearing housing.
8. Apply a coating of Evinrude/Johnson Needle Bearing Grease, or equivalent, to the propeller shaft shifter splines and the shift shaft. Slide the clutch "dog" onto the propeller shaft with the propeller end of the clutch "dog" going on first. Be sure the hole in the clutch "dog" is aligned with the slot in the center of the propeller shaft.

The words "prop end" are embossed onto the propeller end of the clutch **"dog". The** clutch "dog" is not symmetrical. If it is installed backward, it will not fully engage the reverse gear, causing severe damage to both the gear and clutch "dog".

9. Connect the shifter/gear/bearing assembly to the propeller shaft by carefully inserting the shift shaft through the center of the propeller shaft while aligning the hole in the shaft with the propeller shaft and clutch "dog".
10. Insert the retaining pin through the clutch "dog", propeller shaft and shift shaft. Next, start one end of a new retaining spring and begin to roll the spring around the recess in the center of the clutch "dog". Do not allow the spring wires to overlap each other or become loose. Roll the retaining spring around until at least three wires are covering each end of the retaining pin.

② MODERATE

Propeller Shaft, Shift Rod and Cover-Installation

◆ See Figures **93, 94, 95** and 96

Since the shift rod threads into the shift detent lever on the propeller shaft, the shaft must be inserted and aligned in the gearcase, before the shift rod assembly can be installed.

1. Push down on the propeller shaft detent lever to place the shift unit in reverse. Position the shift unit and propeller shaft behind the gearcase with the detent lever facing upward, as shown in the accompanying illustration. Slowly, slide the assembly into the lower unit with the pin on the front of the bearing housing aligned with the hole in the front of the gearcase.

■ When the propeller shaft is properly positioned (with the bearing housing pin in the hold at the front of the gearcase) peer down through the top of the **gearcase** (at the shift housing mounting point) to verify the shift detent lever is aligned for rod installation.

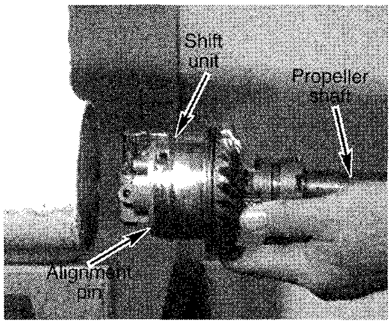


Fig. 93 Install the propeller shaft into the **gearcase** with the detent lever toward the top...

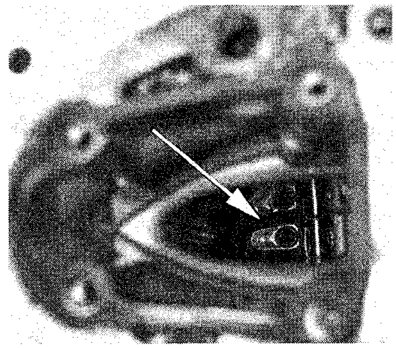


Fig. 94 **...** making sure to align the lever with the **gearcase** shifter bore

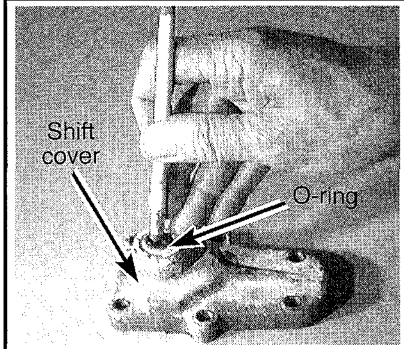


Fig. 95 Assemble the cover for installation, using new O-rings

2. Apply a coating of EvinrudelJohnson Triple Guard grease to 2 new shift cover O-rings. Insert one of the O-rings in the top of the shift cover. The O-ring is easily installed if it is folded in half and inserted into the shift rod bore. Use the eraser end of a pencil and push the O-ring down into the groove in the shift cover. Repeat this step for the second O-ring, working from the bottom of the shift cover.

3. Lubricate the threaded end of the shift rod with Triple Guard grease, or, equivalent. Slide the threaded end of the rod through the shift cover, and at the same time, rotate it slowly back and forth to avoid damaging the O-rings in the cover. As equipped, slide the spacer-the spacer is only used on long and extended shaft models-and rubber grommet down the rod.

4. Coat both sides of a new cover gasket with Evinrude/Johnson Gasket Sealing compound, or equivalent and then place the gasket onto the lower unit. Lower the shift rod into the housing and thread it into the shift detent lever about 4 turns. Move the shift rod from side to side and at the same time, push in on the propeller shaft to ensure proper alignment of the bearing housing locator pin in the opening of the lower unit.

5. Tap the end of the propeller shaft with a soft head mallet to fully seat the bearing housing. The final setting for the shift rod height is made immediately prior to gearcase installation. For more details, please refer to Shift Rod Height Adjustment, later in this section.

6. Apply a coating of EvinrudelJohnson Gasket Sealing Compound to the threads of the six bolts for the shift cover. Install the six bolts and tighten them alternately to a torque value of 60-84 inch lbs. (7-9 Nm).

OEM 3 DIFFICULT

Shimming the Driveshaft

◆ See Figures **97, 98, 99, 100** and **101**

The driveshaft bearing in the housing is not a serviceable component. If the bearing shows signs of damage, roughness, or discoloration from overheating, replace the housing and bearing as an assembly BEFORE performing the driveshaft shimming procedure. Be sure to check the driveshaft surface for damage, if the bearing is defective. The driveshaft must be replaced, if the upper bearing surface is damaged.

The driveshaft pinion gear is precisely meshed with the forward and reverse gears. Proper contact is achieved through an adjustment that ads or removes shim material between the driveshaft bearing housing and the thrust washer. If a new thrust bearing, thrust washer, bearing housing, pinion gear, or driveshaft has been installed, the unit must be precisely measured and the proper amount of shim material selected and installed to provide the required clearance.

If none of the above listed components have been replaced you may use the same thickness of shim material as recorded during disassembly. In that case, skip this procedure and move on to Driveshaft Bearing Housing Installation in order to continue assembling the lower unit.

There is no alternate process to correctly perform this procedure without the proper tools and fixtures. EvinrudelJohnson Shimming Tool Kit PIN 393185 must be used in order to shim the pinion gear correctly. If the tool is not available, an authorized EvinrudelJohnson dealer should be able to perform this task for a nominal charge.

Use the appropriate gauge and shimming tool for the model on which you are working, as follows:

On 90° V4 Models, use gauge: 328366 and either collar: 328362 for 1992-94 models, or collar 341440 for all 1995 and later models.

On 600 V4 Models, use gauge: 328367 and collar: 341440

On V6 Models, use gauge: 328367 and either collar: 328362 for 1992-94 900 models, or collar 341440 for all 600 models and for 1995 and later 90° models.

■ On V8 Models, use gauge: 330224 and collar: 328362 and either collar: 328362 for 1992-94 models, or collar: 341440 for all 1995 and later models.

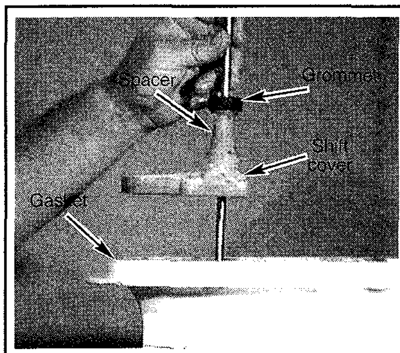


Fig. 96 Carefully lower the cover and shift rod into the **gearcase**

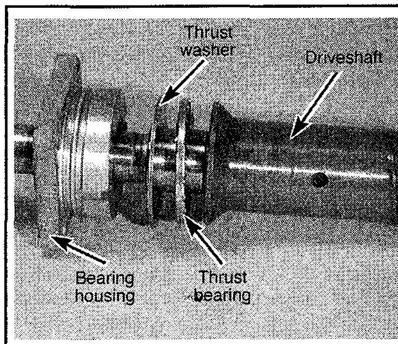


Fig. 97 To shim the driveshaft, start by assembling the bearing end**...**

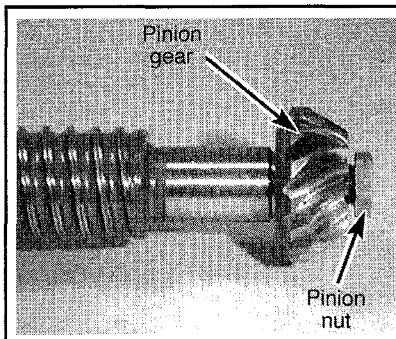


Fig. 98 **...** and pinion end components (tighten the nut to spec)

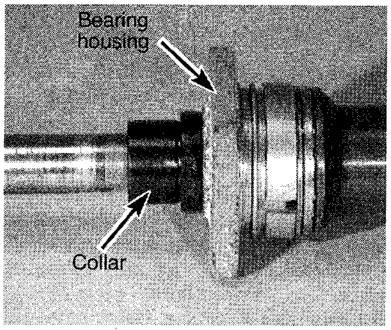


Fig. 99 Position the appropriate collar tool...

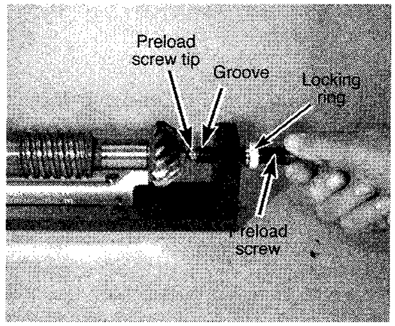


Fig. 100 ... then secure the assembly in the holding fixture

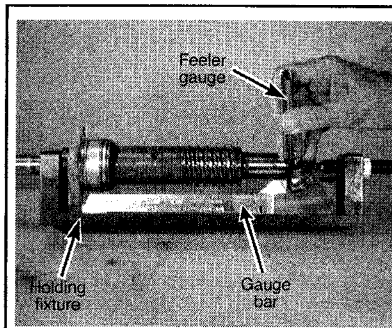


Fig. 101 Use the appropriate gauge to measure clearance at the pinion

1. If a 2-piece driveshaft was disassembled (for inspection or because the halves separated during removal), connect them now using the collar and the roll pin. Make sure the spring and collar are in place, then connect the shafts, compress the spring and insert the pin. On V4 models the pin should be installed flush. On V6 and V8 models, the pin must be inserted to the appropriate depth of 0.062-0.125 in. (1.6-3.2mm) depending upon the year and model. In all cases, the pin is centered in the bore.

■ **For all 60° V6 motors, the roll pin is installed to a depth of 0.125 in. (3.2mm). For 90° V6 motors, the pin should be inserted to a depth of 0.110 in. (2.8mm) for motors through 1994 or to 0.125 in. (3.2mm) for 1995 and later models. For V8 motors the pin should be installed to a depth of 0.075 in. (1.9mm) for 1992 models or to 0.062 in. (1.6mm) for 1993 and later units.**

2. If not done already, use a suitable solvent to completely degrease the pinion and driveshaft tapers prior to shimming measurements.
3. Obtain Driveshaft Shimming Tool Kit PIN 393185 along with the appropriate gauge/collar as directed earlier.
4. Place a seal protector (such as Evinrude/Johnson 318674) over the end of the driveshaft splines or wrap cellophane tape around the splines to protect the seals in the housing. Slide the thrust bearing, thrust washer, and bearing housing down the driveshaft onto the driveshaft flange. Do not install any shim material, at this time.
5. Next, install the pinion gear and nut, then tighten the nut to 70-80 ft. lbs. (95-108 Nm) for V4 and V6 motors; or to 100-110 ft. lbs. (136-149 Nm) for V8 motors.
6. Slide the collar tool down the driveshaft with the large end against the bearing housing.
7. Position the driveshaft over the holding fixture and place the collar into the fixture. Align the pinion gear end of the driveshaft with the preload screw. Tighten the preload screw until the tip is making contact in the center of the driveshaft. Continue to tighten the preload screw until the groove around the tip is flush with the screw threads. Tighten the lockring in place. Rotate the driveshaft several turns to seat the thrust bearing and washer.
8. Turn the tool base on its side and position the correct shim gauge against the tool guide pins.
9. Check the squareness of the bearing housing mounting surface by holding the gauge against the back of the pinion gear while rotating the bearing housing, Insert a feeler gauge and measure the gap between the gauge and housing. Take a measurement between each pair of mounting holes. The maximum allowable gap is 0.004 in. (0.10mm). Replace the bearing housing if the measurement is over the limit.
10. Check the squareness of the pinion gear to the driveshaft by holding the gauge bar against the bearing housing between the screw holes and rotating the driveshaft. Insert a feeler gauge between the back of the pinion gear and the end of the gauge. The maximum allowable gap is 0.002 in. (0.050mm). Replace the pinion gear or driveshaft if the measurement is over the limit.
11. Now, subtract the average clearance from the previous step (measured at the pinion gear), from the nominal factory figure of 0.020 in. (0.508mm) for V4 and V6 motor gearcases (including counter-rotating units) or 0.030 in. (0.762mm) for V8 gearcases (in both standard and counter-rotating units). The difference is the total thickness of shim material needed for proper mesh of the pinion gear to the forward and reverse gears.

Select and install the fewest number of shims in order to obtain the correct thickness.

12. Remove the driveshaft from the holding fixture. Slide the collar and bearing housing off the driveshaft. Place the required amount of shim material between the bearing housing and thrust washer. Repeat the check using the gauge tool to verify the correct shim material has been installed. Now the average measurement between the gauge and the pinion gear should be 0.020 in. (0.508mm) for V4 and V6 motor gearcases (including counter-rotating units) or 0.030 in. (0.762mm) for V8 gearcases (in both standard and counter-rotating units).
13. Remove the nut and pinion gear from the shaft so they are ready for installation.

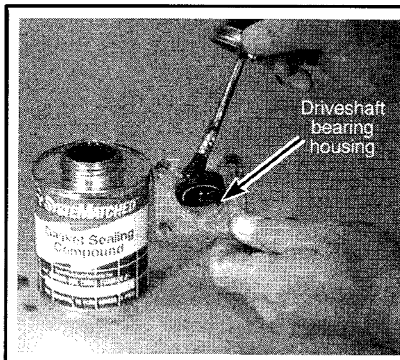


Fig. 102 For dual back-to-back seals with metal casings, apply a light coating of sealant to the seal cases or their mating surface in the bearing housing

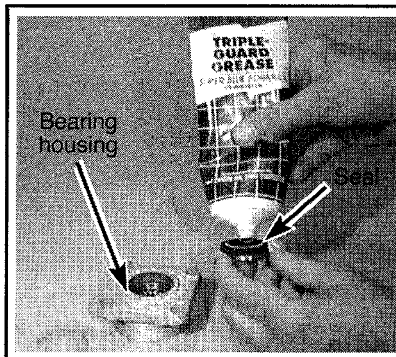


Fig. 103 Apply a light coating of grease to the seal lips (though this is best done after the seal is pressed into the housing)

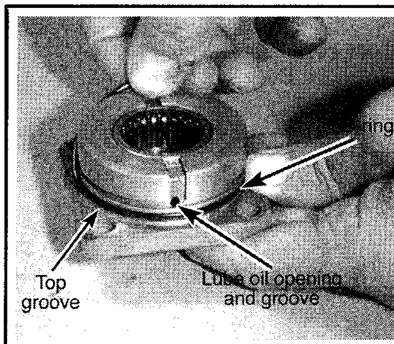


Fig. 104 Install the O-ring in the groove closest to the flange (NOT in the groove further away, as it is an oil passage)

OEM ② MODERATE

Driveshaft Bearing Housing-Assembly

◆ **See Figures 102,103 and 104**

The bearing in the housing is not a serviceable component. If the bearing shows signs of damage, roughness, or discoloration from overheating, replace the housing and bearing as an assemblv. Be sure to check the driveshaft surface for damage, if the bearing is defective. The driveshaft must be replaced, if the upper bearing surface is damaged.

■ **If the driveshaft or bearing housing assembly is replaced, the driveshaft must be properly shimmed to ensure proper operation. For details, please refer to the Shimming the Driveshaft procedure earlier in this section.**

1. The driveshaft seal(s) should be replaced to ensure durability. If not removed earlier, it or they (depending on the application there may be 2 back-to-back seals or a single double-lipped seal) can be removed at this time.
2. Prepare the replacement *seal(s)*. Most units use dual back-to-back seals with metal casing. For these, apply a light coating of EvinrudelJohnson Gasket Sealing Compound or equivalent sealant to the metal casings (or to the seal case mating surface in the bearing housing) then install them using a suitable Seal Installer such as EvinrudelJohnson330268 or equivalent. If one seal has a raised lip and the other a flush lip, install the seal with the flush lip to the inner position, with the lip facing toward the bearing housing. Then install the extended lip seal in the outer position with the extended lip facing upward toward the exhaust housing.

■ **Original and replacement seal designs may vary. Check with your parts supplier to make sure you're using the recommended replacement seal, regardless of what type was originally installed. Some models are equipped with a single dual-lipped seal. On these models, apply a light coating of oil to the seal casing (instead of sealant) to help ease installation and use EvinrudelJohnson Seal Installer #341439 to press the seal into position with the extended lip facing away from the bearing housing.**

3. Apply a light coating of EvinrudeIJohnson Triple Guard, or equivalent marine grade grease to the seal lips (and to the cavity between the seal lips on dual back-to-back seals).
4. Place a new O-ring around the outside of the housing in the groove closest to the flange. The second (lower) groove is for lubricating oil to flow up to the bearing. If this groove is blocked, the upper bearing will be severely damaged. Verify the lubricant opening in the housing is clear and free of any sealant material.

Apply a coating of EvinrudelJohnson Needle Bearing Grease or equivalent to the needle bearings.

OEM ③ DIFFICULT

Driveshaft-Installation

◆ **See Figures 105, 106, 107, 108, 109 and 110**

OK, this part can be a little tricky. Not the whole procedure, but starting the pinion nut. The manufacturer recommends assembling the driveshaft, THEN inverting the gearcase, inserting the driveshaft, turning the gearcase right site up and FINALLY starting the pinion nut using a holding tool to position it. Unfortunately, if you haven't got the pinion nut starting tool this can be darn near impossible. But there are ways to cheat. Inverting the housing and keeping it that way while starting the nut is handy for this, it allow the pinion nut to sit on top of the gearlshaft while you are trying to start it.

Also, if you don't assemble the driveshaft (*i.e.* if you leave the bearing housing and thrust washer off until after the pinion nut is started) it will be probably be easier to start the nut. You'll be able to hold the shaft so the threads are JUST below the bottom of the pinion gear while you try and position the nut. If you don't have the nut positioning tool you'll have to figure out a way to get the nut to sit right dead center on the bottom of the pinion gear. One option is to use some tape to attach the nut to a screwdriver (awkward, but it helps to position the nut). Another is to place the nut in the housing and move it into position with a screwdriver, then peer from the driveshaft opening in the top of the case to see if the nut is centered. Use a long screwdriver from this angle to center the nut. Finally, slowly and carefully insert the pinion shaft and start the nut. All of this is much easier if you haven't coated the gearcase mating surface with sealant and installed the bearing housing, but it's up to you. Make your decision and perform the following steps (in the order you've decided).

1. If not done earlier, remove the nut and pinion gear from the end of the driveshaft. Clean all grease and oil from the pinion gear taper.
2. If you're installing the driveshaft components first (as recommended by the manufacturer) apply a light coating of EvinrudelJohnson Needle Bearing Grease or equivalent to the thrust bearing. Install the thrust bearing, thrust washer, and shims, in THAT order.
3. Now, position a seal protector (such as EvinrudelJohnson318674) over the end of the driveshaft splines or wrap cellophane tape around the splines to protect the seals in the housing, Carefully slide the bearing housing into position on the driveshaft and in contact with the shims.
4. Apply a light coating of EvinrudelJohnson Gasket Sealing compound, or equivalent, to the driveshaft housing seal surface inside the gearcase. Be EXTRA careful not to apply sealant on the bearing bore or down in the small oil passage opening.
5. Pull up on the shift rod to engage **forward** gear.
6. Invert the gearcase for better access and so the pinion gear and nut can be installed. Check the pinion needle bearings in the case to make sure there isn't an excessive amount of grease (which will just muck up the surface you degreased).

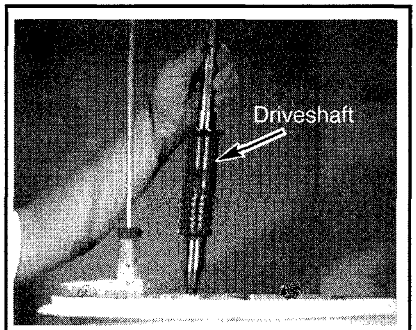


Fig. 105 The driveshaft can be installed with or without first installing the thrust bearing and bearing housing assembly...

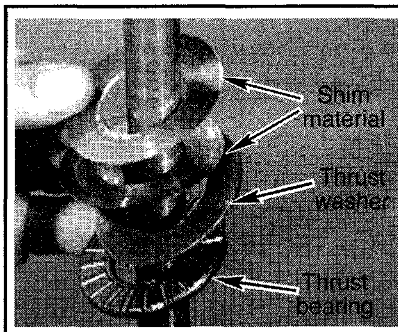


Fig. 106 ... just make sure that when they are installed, the thrust bearing goes on first, followed by the thrust washer and shims

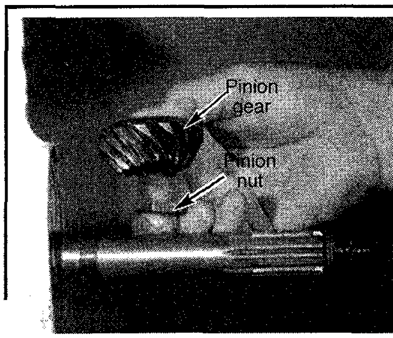


Fig. 107 Install the pinion gear and then carefully thread the nut by slowly turning the driveshaft

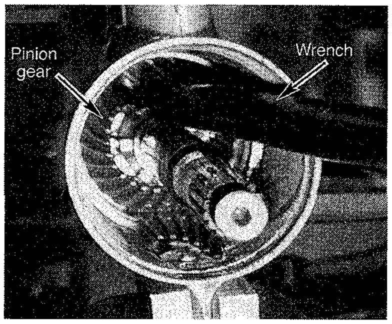


Fig. **108** A pinion holder tool or wrench will be necessary to hold the nut...

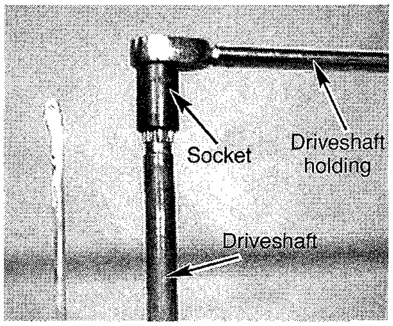


Fig. **109** ... while the driveshaft is turned using an adapter in order to obtain the specified pinion nut torque

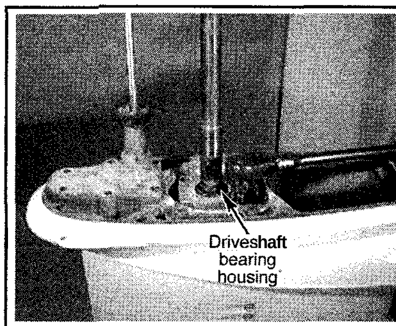


Fig. **110** Once finished, install and tighten the bearing housing bolts

7. Position the pinion gear inside the gearcase, then insert the driveshaft. If you are working with the factory tools (in the recommended order of assembly, then go ahead and turn the gearcase right-side-up at this time). If you are working with an unassembled driveshaft without the factory tools, leave the gearcase inverted.

Examine the pinion nut for damaged threads or rounded hex edges. If the nut is damaged in any way, it must be replaced.

8. Apply a light coating of gearcase oil to the pinion nut, then position it (using the EvinrudelJohnson Pinion Nut Starting Tool #311875 or a suitable substitute). By hand, slowly turn the driveshaft clockwise (when viewed from the powerhead end) until you are certain that the pinion nut is started, but DO NOT apply torque using tool #311875.

9. If you've been working up until this point with an unassembled driveshaft, turn the gearcase right side up and install the thrust bearing, washer, shims and bearing housing. Use GREAT care not to damage the housing seal lips. Also, be sure that you haven't contaminated the oil groove or bearings with sealant.

10. Place either the Pinion Nut Holder (EvinrudelJohnson P/N 334455), or an equivalent size open end wrench securely over the pinion nut. Then, place the Driveshaft Adapter Socket (Evinrude/Johnson PIN 311875), or an equivalent, over the end of the driveshaft.

11. Have an assistant hold the pinion nut wrench on the nut (using some method OTHER than fingers to keep force OFF of the gearcase). Tighten the pinion nut by rotating the driveshaft with the socket to 70-80 ft. lbs. (95-108 Nm) for V4 and V6 motors or to 100-110 ft. lbs. (136-149 Nm) for V8 motors.

12. Tap the bearing housing gently with a soft head mallet to make sure it is fully seated in the lower unit. Apply a light coating of EvinrudelJohnson Gasket Sealing Compound to the threads of the 4 bolts. Install the bolts finger tight.

13. Tighten the four bolts securing the upper bearing housing to the lower unit in a criss-cross sequence to a 168-192 inch lbs. (19-22 Nm). Rotate the driveshaft and verify it rotates smoothlv without bindinq. If the shaft is bound tight, check the amount of shim material between the bearing housing and thrust washer. Repeat the driveshaft shimming procedures if the shaft is tight,

OEM ② MODERATE

Reverse Gear and Bearing Carrier-Assembly

◆ See Figures **111** thru **117**

1. Check the two sets of needle bearings in the propeller shaft bearing housing. If the bearings are scored, pitted, rough or discolored from overheating, they must be replaced. if the bearing is removed from the housing, it must be replaced, because the act of removal usually damages the bearing cage. The bearings may be driven out from each end of the housing using a blunt punch and tapping evenly on the bearing cage.

Although there are other possible methods for bearing **and/or** seal removal, the manufacturer recommends the use of the **Evinrude/Johnson** Puller Bridge # **432127** and Large Puller Jaws **# 432129** or equivalent.

2. New bearings are installed using suitable sized drivers. Apply a light coatinq of gearcase lubricant to the outside surface of the bearing, then position it with the lettered end of the bearing facing the driver. Insert the bearing and installer into the end of the bearing housing. Drive the bearing into the housing until the tool is seated.

A shop press is preferred for bearing installation over tapping to make sure the bearings are not damaged while they are seated, but if no press is available, tap slowly and gently in order to seat the bearing.

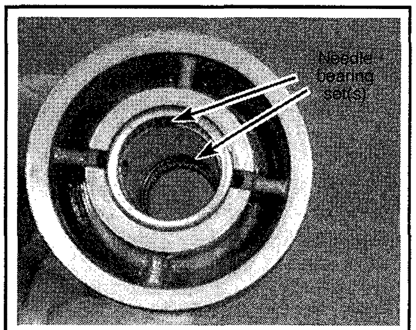


Fig. **111** Check the propeller shaft needle bearings for wear or damage

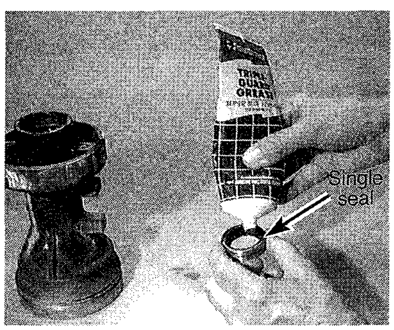


Fig. **112** Coat all seal lips with marine grade grease

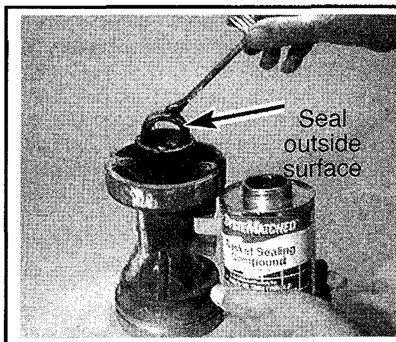


Fig. **113** For dual back-to-back seals, apply a light coating of sealant to the metal seal case

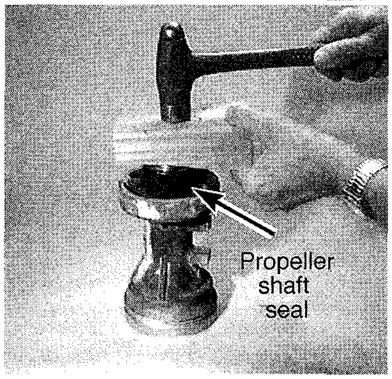


Fig. 114 Carefully drive the **seal(s)** into position

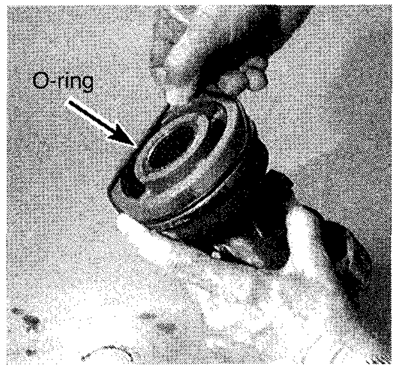


Fig. 115 Grease and install the NEW housing **O-ring(s)**

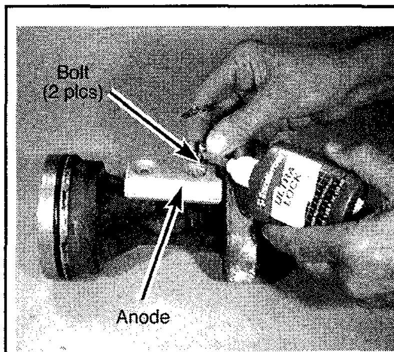


Fig. 116 Check the anode for wear and replace, if necessary

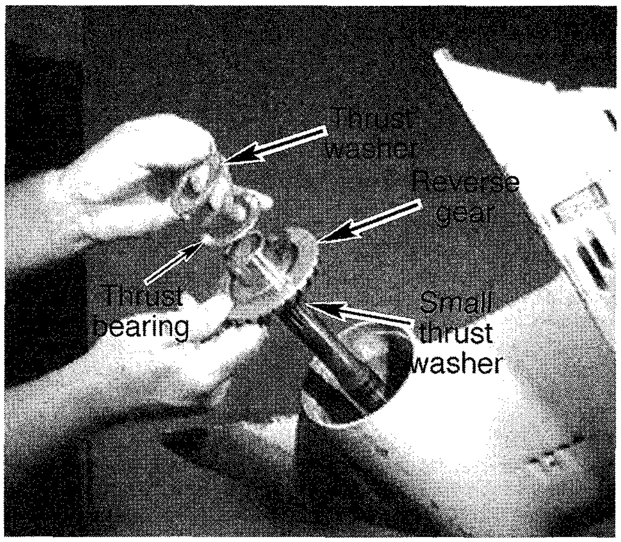


Fig. 117 Install the reverse gear, thrust bearing and thrust washer (some models also use a small thrust washer in the front face of the reverse gear)

3. Apply a coating of EvinrudelJohnson Needle Bearing Grease or equivalent to the needle bearings.

4. Some models covered in this manual will have a single-double lip seal and others will have two single lip seals installed back-to-back. One seal lip is used to prevent gear lubricant from escaping and the other seal lip is to prevent water from entering.

■ [illegible]p a c[illegible] g of **Evinrude/Johnson Triple Gua**[illegible] Grease to the **inside (spring side)** [illegible]rf[illegible] **of all seals.** [illegible] **insta**[illegible] le- seals, apply **a** lightcoating of outboard lubricant to **the seal** casing in order to ease **installation. When** installing metal-cased dual **back-to-**back seals, **apply** a light coating of **Evinrude/Johnson** Gasket **Sealing Compound or equivalent sealant** to the outside case surface of the seal.

5. Prepare the seal(s) for installation using oil (single seal) or sealant (dual back-to-back seals), as applicable.

A suitably sized seal installer is necessary to tap the seal into position. In some cases a smooth socket or block of wood can be substituted, but only if the seal lips will not be damaged. Obviously, the tool will only work if it allows the seal to seat fully (a block of wood won't work alone for the lower seal in a dual seal arrangement). The manufacturer recommends various **Evinrude/Johnson** Seal Installers, depending upon the model as follows:

V4 # 326551 for dual back-to-back seals or # 342665 for dual-lipped (extended lip) seals.

V6/V8 # 336311 for dual back-to-back seals or # 341439 for dual-lipped (extended lip) seals.

6. Set the first seal into the housing with the lip of the seal (spring side) facing down. Tap the seal into the housing using a suitable seal installer.

7. Place the second single lip seal into the housing with the lip of the seal (spring side) facing up. Tap the seal into the housing using a wooden block or installer tool until the seal makes contact with the first seal.

8. Apply a coating of EvinrudelJohnson Triple Guard Grease to the NEW propeller shaft bearing housing O-ring(s), if used. Slip the O-ring(s) around the end(s) of the housing and into the groove(s).

9. If not done already, check the anode for wear. If the anode is worn more than 113 of its surface, it should be replaced. Apply a few drops of Evinrude/Johnson Ultra-Lock to the threads of the two bolts. Position the anode over the mounting boss on the bearing housing and install the bolts. Tighten the bolts securely.

10. On some models a small thrust washer is located in a recess on the front face of the reverse gear. If the model being serviced contained this washer during disassembly, apply a coating of EvinrudelJohnson Needle Bearing Assembly lube to the washer. Insert the washer into the recess on the front face of the reverse gear.

11. Coat the thrust bearing and thrust washer with gear lubricant and place them onto the hub of the reverse gear. Slide the reverse gear down the propeller shaft and index the teeth of the reverse gear with the teeth of the pinion gear.

12. Install the propeller shaft Bearing Housing using the appropriate procedure in this section. Follow either the Bearing Housing With Snap Rings and 4-Bolt Retainer or the Bearing Housing with 2-Bolt Retainers procedure, as applicable.

② MODERATE

Bearing Housing with Snap Rings and 4-Bolt Retainer-Installation

◆ See Figures **118** thru **123**

1. Insert the retainer plate over the propeller shaft and into the lower unit against the reverse gear.

✳✳ CAUTION

The snaprings used to secure the retainer plate are spring loaded. If the ring should accidentally slip free of **the Truarc** pliers, the ring would travel with high speed and could possibly cause serious personal **injury. Therefore,** always use safety glasses or safety shield while installing the two snap rings.

2. Using a suitable pair of snapring pliers, carefully install the two snaprings to the retainer.
Be sure each ring is fully seated in the groove. Position the ends (gaps) of the snaprings at the top of the housing.

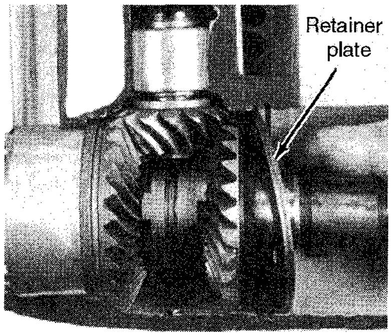


Fig. 118 Insert the retainer plate ...

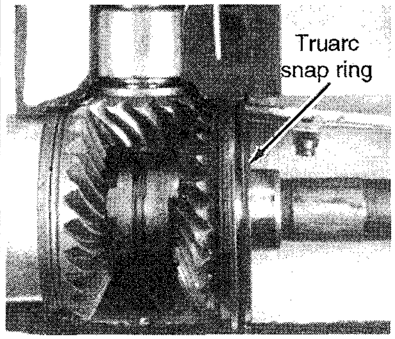


Fig. 119 ... then install the 2 snaprings

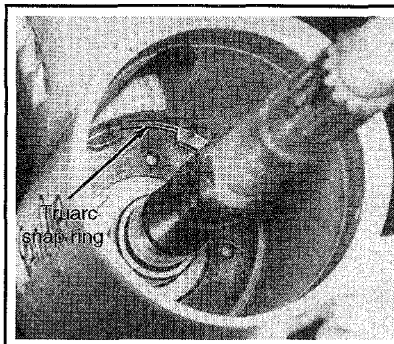


Fig. 120 Make sure the rings are secure in their grooves with their gaps on top

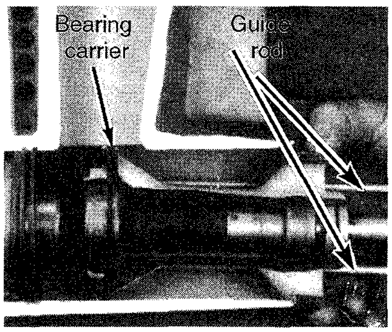


Fig. 121 Using 2 thread-all rods as guides carefully insert the bearing housing ...

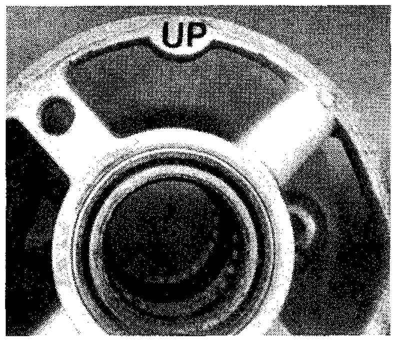


Fig. 122 ... with the "UP" marking toward the powerhead

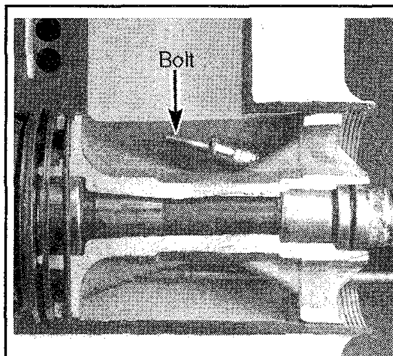


Fig. 123 Install the retaining bolts and tighten to spec

3. Obtain two 1/4 x 18-10 in. thread-all rods to be used as guide pins. Thread the two rods into opposite holes in the retainer plate for no more than two full turns.

4. Apply a coating of Evinrude/Johnson Gasket Sealing Compound to the O-ring flange and the rear support flange. Keep the needle bearings in the propeller bearing housing free of any sealant. Position the propeller bearing housing with the word "up" at the top or 12 o'clock position (facing upward toward the powerhead).

5. Slide the propeller bearing housing onto the two thread-all guide pins and into the lower unit housing. Be sure the word "up" remains at the top. Apply a coating of Evinrude/Johnson Gasket Sealing Compound to the threads of the four retaining bolts, Insert 2 of the bolts loosely and remove the 2 guide pin rods. Install the remaining 2 bolts and tighten the 4 bolts to 120-144 inch lbs. (14-16 Nm).

6. If possible, pressure test the gearcase before filling it with lubricant or returning it to service. For details, please refer to Pressure Testing the Gearcase, in this section.

7. If removed, install the water pump, as detailed in the Lubrication and Cooling section.

8. If the gearcase was removed for overhaul, check and adjust the Shift Rod Height, as detailed in this section, then install the Gearcase Assembly, as also detailed in this section.

② MODERATE

Bearing Housing with 2-Bolt Retainers-Installation

◆ **See Figures 124 and 125**

1. Apply a light coating of Evinrude/Johnson Gasket Sealing Compound to the O-ring flange and, except for models equipped with a gearcase lock wedge, to the rear support flange. Do not allow any sealant on the needle bearings in the propeller bearing housing.

2. Carefully slide the propeller shaft bearing housing into the lower unit with the 2 bolt holes in the housing in the vertical position and the anode facing down. Tap the housing with a soft head mallet to seat the housing and O-ring.

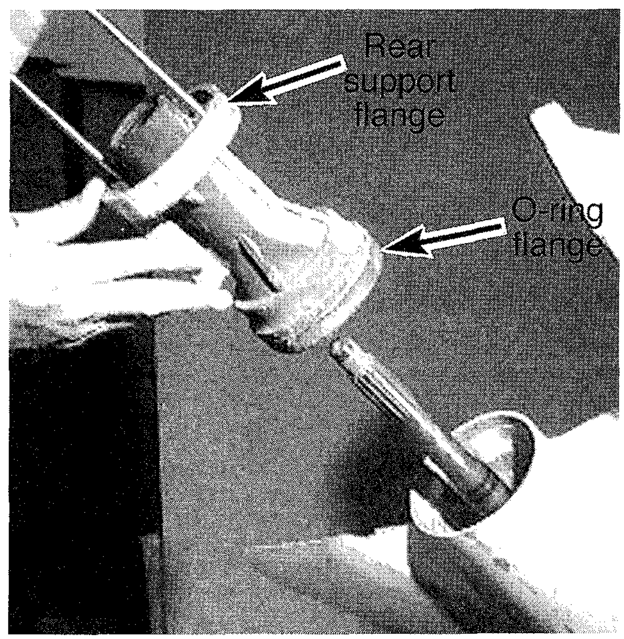


Fig. 124 Carefully insert the bearing housing to the gearcase...

3. On models equipped with a gearcase lock wedge, position the wedge in the cavity between the bearing housing and gearcase, then install the wave washer. Apply a light coating of Evinrude/Johnson Nut Lock, or equivalent threadlock to the wedge screw threads, then install and loosely tighten the screw.

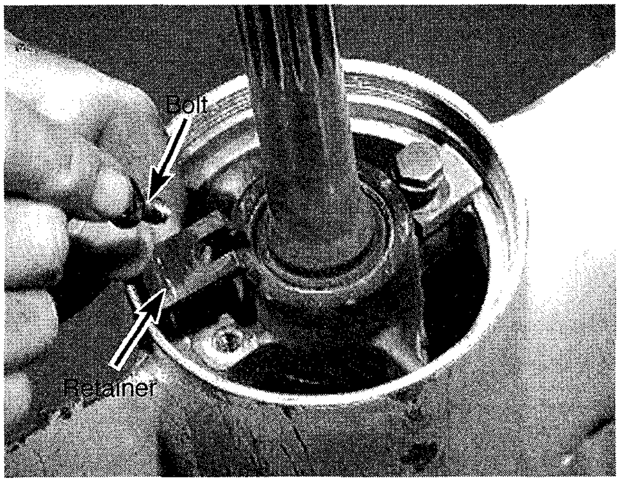


Fig. 125 ... then secure using the retainers (retainer design varies slightly with application)

4. Apply a few drops of Evinrude/Johnson Ultra Lock, or equivalent high-strength threadlock, to the threads of the 2 retainer bolts. Loosely install the retainers (this usually means placing them over the housing and into the groove of the lower unit, though designs will vary slightly), then tighten the 2 bearing housing retainer bolts to 24-26 ft. lbs. (33-35 Nm).
5. For models equipped with a gearcase lock wedge, re-loosen the 2 bearing retainer bolts about 1/4 turn each, then tighten the wedge screw to 16-18 ft. lbs. (1.8-2.0 Nm). Next, retighten the 2 bearing housing retainer bolts to 24-26 ft. lbs. (33-35 Nm) again, and recheck the torque on the wedge screw.
6. If possible, pressure test the gearcase before filling it with lubricant or returning it to service. For details, please refer to Pressure Testing the Gearcase, in this section.
7. If removed, install the water pump, as detailed in the Lubrication and Cooling section.
8. If the gearcase was removed for overhaul, check and adjust the Shift Rod Height, as detailed in this section, then install the Gearcase Assembly, as also detailed in this section.

OEM ② MODERATE

Pressure Testing the Gearcase

To uncover any possible problems with a newly rebuilt gearcase, or an overlooked problem on a gearcase that was not completely disassembled, use a hand-held vacuum/pressure pump to check the gearcase for leaks before it is filled with fluid and returned to service.

1. Remove the oil level plug from the top side of the gearcase.
2. Attach a hand vacuum pump with pressure gauge to the gearcase, then slowly apply 3-6 psi (21-42 kPa) of pressure to the assembly. Observe the gauge, the pressure gauge should indicate a steady reading. If pressure is leaking, submerge the gearcase in a tank of water and look for bubbles, then disassemble and rectify the leak. Recheck the gearcase after repairs are complete.
3. Remove the pressure pump and connect a vacuum pump (or reverse the connections on dual pump tools). Pump out the air in the gearcase in order to produce 3-5 in. Hg (76-127 mm Hg) of vacuum and watch the gauge to see if it holds. Slowly increase the vacuum to 15 in. Hg (381 mm Hg) and again, watch the gauge to see that it holds. If the needle shows leakage at either level, apply a small amount of gearcase lubricant to the suspected seal and repeat the check. If the leak stops or oil is drawn into the case, replace the defective seal.
4. Once repairs are made and verified, refill the gearcase with lubricant.

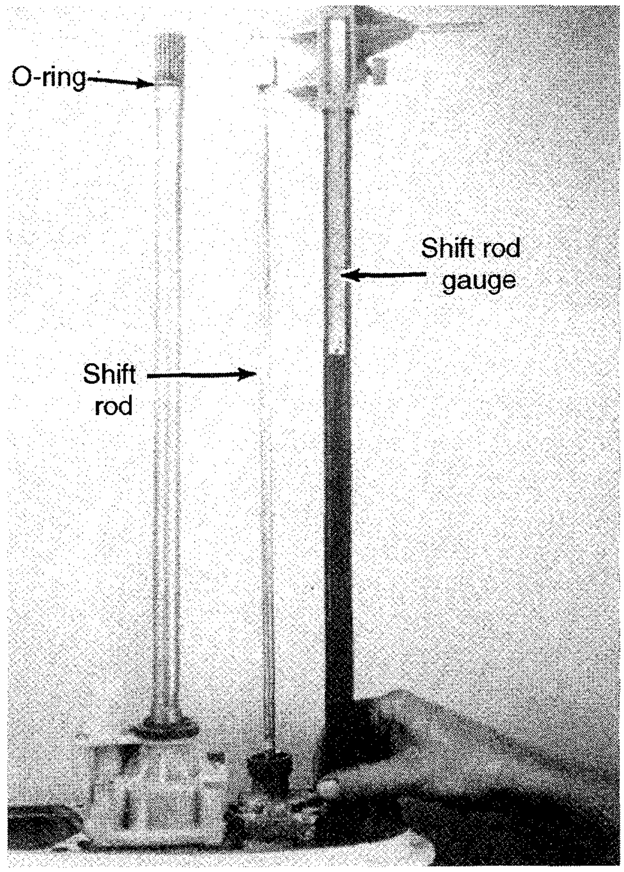


Fig. 126 Measure the rod length from the upper surface of the lower unit to the center of the shift rod opening, using a precision measuring device

OEM ② MODERATE

Shift Rod Height

◆ **See Figure 126 and Shift Height Adjustment Chart**

If the shift rod positioning is disturbed (if it is turned in or outward on the threads) or it is removed from the gearcase for any reason you must properly adjust the shift rod height before installation. When installing a gearcase to a motor for the first time this adjustment should be verified to ensure proper operation.

If vou are rigging an engine to non-Evinrude/Johnson manufactured controls you'll have to check the shift throw (amount of shift cable movement at the engine). These gearcases are only compatible with controls that produce a 1.125-1.330 in. (28.6-33.8mm) throw (movement) at the engine when shifted between **Neutral** and **Forward.**

In order to make this measurement, you need a precision gauge capable of reading measurements between approximately 20 and 30 inches (508 and 762mm). Don't attempt to us a tape measure, as the flexible tape will make your measurement off by more than 1/32 in. (0.8mm) allowed by the range.

The measurement is taken of the installed rod length from the upper surface of the lower unit to the center of the shift rod opening. In order to accurately take the measurement, place the shift rod in the neutral position with the rod offset or hole facing forward.

SHIFT ROD HEIGHT ADJUSTMENT - 60 DEGREE V4 and V6 ENGINES

Year	Model	Shift Rod Height	
		Ideal	Acceptable Range
1992-96	Long Shaft	21 114 in. (539.8mm)	21 7/32-21 9132 (539.0-540.6mm)
	Extra Long Shafl	26 114 in. (666.8mm)	26 7/32-26 9132 (666.0-667.6mm)
1997	20 in Shaft	21 1/4 in. (539.8mm)	21 7/32-21 9132 (539.0-540.6mm)
	22.5 in. Shaft	23 3/4 in. (603.3mm)	23 23/32-23 25132 (602.5-604.1mm)
	25 in. Shaft	26 114 in. (666.8mm)	26 7/32-26 9132 (666.0-667.6mm)
1998-2001	EL, GL. PL, SL. WEL, WGL, WPL, WQL, WSL, and WTPL	21 114 in. (539.8mm)	21 7/32-21 9132 (539.0-540.6mm)
	FT, FPL., FSL, IL, RWL, WEL, WRL, WRP	21 3/4 in. (552.5mm)	21 23/32-21 25132 (551.7-553.3mm)
	RWY, WRY	23 3/4 in. (603.3mm)	23 23/32-23 25132 (602.5-604.1mm)
	CX, EX, NX, PX, SX, WPX, WQX, WTPX	26 1/4 in. (666.8mm)	26 7/32-26 9132 (666.0-667.6mm)
	FC. FCX, FPX, FSX,	26 314 in. (679.5mm)	26 23/32-26 25/32 (678.7-680.3mm)

Use using Evinrude/Johnson special measuring tool PIN 389997, or an equivalently long precision measuring gauge. Compare the measured rod height with the accompanying data (90° motors) or chart (60° motors) and determine if the rod requires any minor adjustments. Specifications vary by year, model and shaft length (if necessary, refer to the information on Engine Identification and the model ID tag found in the Maintenance and Tune-up section. Specifications are provided for an ideal shift rod height, with an allowable range to account for positioning the shift rod properly in the threads. If necessary, rotate the rod clockwise to shorten the rod and counterclockwise to lengthen it.

On 900 V4 Cross-Flow motors, shift rod heights are as follows:

- Long shaft, ideal height specification of 21 27132 in. (554.6mm) and an allowable range of 21 26/32-21 28/32 in. (553.8-555.4mm).
- Extra-long shaft, ideal height specification of 26 27/32 in. (581.6mm) and an allowable range of 26 26/32-26 28132 in. (680.8-682.4mm).

On 90° V4 Looper motors, shift rod heights are as follows:

- 20 in. Shaft, ideal height specification of 21 15116 in. (557.3mm) and an allowable range of 21 29/32-21 31132 in. (556.5-558.1mm).
- 22.5 in. Shaft, ideal height specification of 24 7116 in. (620.7mm) and an allowable range of 24 13/32-24 15132 in. (619.9-621.5mm).
- 25 in. Shaft, ideal height specification of 26 15116 in. (684.3mm) and an allowable range of 26 29/32-26 31132 in. (683.5-685.1mm).

On 90° V6 Looper motors, shift rod heights are as follows:

- 20 in. Shaft, ideal height specification of 21 15116 in. (557.3mm) and an allowable range of 21 29/32-21 31132 in. (556.5-558.1mm).
- 25 in. Shaft, ideal height specification of 26 15116 in. (684.3mm) and an allowable range of 26 29/32-26 31132 in. (683.5-685.1mm).
- 30 in. Shaft, ideal height specification of 31 15/16 in. (811.3mm) and an allowable range of 31 29/32-31 31132 in. (810.5-812.1mm).

For 90° V8 Looper motors, shift rod heights are as follows:

- 20 in. Shaft, ideal height specification of 22 13132 in. (569mm) and an allowable range of 22 12/32-22 14132 in. (568.2-569.8mm).
- 25 in. Shaft, ideal height specification of 27 13132 in. (696mm) and an allowable range of 27 12/32-27 14/32 in. (695.2-696.8mm).
- 30 in. Shaft, ideal height specification of 32 13132 in. (823mm) and an allowable range of 32 12/32-32 14132 in. (822.2-823.8mm).

FUNCTIONAL **CHECK**

Perform a functional check of the completed work by mounting the outboard in a test tank, in a body of water, or with a flush device attached to the lower unit.

✳✳ CAUTION

Water must circulate through the lower unit to the powerhead any time the powerhead is operating to prevent damage to the water pump impeller in the lower unit. Just five seconds without water will damage the impeller.

Never operate the powerhead above idle rpm with only a flush attachment connected. Without a load on the propeller, the powerhead could exceed the maximum limit-"runaway"-severely damaging the powerhead.

Start the powerhead and observe the tattle-tale flow of water from the rear of the lower cowling. The water pump installation work is verified by a steady stream of water flowing out of the by-pass hose. Shift the powerhead into **Forward** and then back to **Neutral** to for smoothness of operation and satisfactory performance. Wait a few seconds and repeat the process shifting into **Reverse** for the same reason.

Propeller Shaft Se

If the gearcase oil is contaminated by water or there are signs of leakage at the propshaft seal, the gearcase REALLY should be disassembled, thoroughly inspected and assembled again, using new seals. However, if the propeller shaft seal is the culprit AND you are certain that there is no damage (due to lack of proper oiling or from corrosion) inside the gearcase, you CAN replace just the prop shaft seal. Furthermore, this task can usually be accomplished with the gearcase still attached to the outboard. This is especially handy if you've been diligent about inspecting the gearcase and notice a damaged seal (perhaps from tangled fishing line or the like) i mmediately upon removing the boat/motor from the water after an excursion.

Read and believe, replacing ONLY the propeller shaft seal is rarely the right way to handle the situation (unless you've discovered the problem before most of the oil is lost and before moisture has had the opportunity to do much damage). However, it is often the way the situation is handled. If you want to be certain about the long-life and condition of the components in your gearcase, disassemble and thoroughly overhaul it. Replace all of the seals, not just the propeller shaft. If, however, you decide to only replace the propeller shaft seal, you have been fairly warned.

REPLACEMENT

MODERATE

The propeller shaft for these motors is equipped with a removable bearing carrier in the gearcase, just before the propeller. The carrier is sealed into the gearcase on the outside by one or more O-rings and sealant. Inside the bearing carrier, the propeller shaft passes through one or more seals that are designed to keep water out and gearcase oil in. Should seal replacement become necessary, the bearing carrier itself must be removed from the gearcase housing.

However it is not physically necessary to remove the gearcase from the motor or to completely disassemble the gearcase JUST to perform this seal replacement. That is fact, no matter how much we feel it is still advisable to do so, in order to make sure no damage has occurred to the internal components of the gearcase either from a lack of lubricant or from the presence of moisture.

If you decide to replace the propeller shaft seal only, please refer to the Disassembly procedures for the Gearcase Assembly, found earlier in this section. Specifically, follow the steps necessary for Propeller Shaft Bearing Carrier Removal in order to access the seal and the relevant Installation steps.

JET DRIVE

Description and Operation

+ **See Figures 127,128 and 129**

The Outboard Jet Drive provides reliable propulsion with a minimum of moving parts. The units operate under the same laws and principles employed for the other jet drive units. Simply stated, water is drawn into the unit through an intake grille by an impeller driven by a driveshaft off the powerhead's crankshaft. The water is immediately expelled under pressure through an outlet nozzle directed away from the stern of the boat.

As the speed of the boat increases and reaches planing speed, the jet drive discharges water freely into the air, and only the intake grille makes contact with the water.

No gears are used in the jet drive assembly. Because of this, anytime the motor is operating the crankshaft and anything attached to it rotates. This means the driveshaft and the impeller are always turning when the motor is operating. **Forward, Neutral** or **Reverse** is determined by the position of a linkage controlled gate. In the normal position the gate leaves the nozzle completely uncovered, allowing thrust to move the boat forward. When the shifter is placed in the neutral position, the gate moves partially over the nozzle so it deflects the thrust downward (which usually results in very slow creeping of the craft forward or rearward, depending on trim position). With the shifter in the reverse position the gate moves to completely cover the nozzle, deflecting thrust in the exact opposite direction of normal operation.

Conventional controls are used for powerhead speed, movement of the boat, shifting and power trim and tilt.

Jet Drive Servicing includes impeller removal, shimming and installation, jet drive assembly removal and installation, overhaul and reverse gate adjustment.

Impeller

REMOVAL, SHIMMING & INSTALLATION

MODERATE

+ **See Figures 130,131,132,133,134,135 and 136**

The jet drive impeller is designed to draw water through an opening and force it outward through a smaller nozzle, thus pressurizing the water flow and producing thrust to move the boat. In order for the jet drive to operate properly (create maximum thrust), there must be the proper amount of clearance between the outer edge of the jet drive impeller and the water intake housing cone wall. The jet drive impeller should be periodically checked for nicks, burrs, damage or wear that could adversely affect clearance. For more details, please refer to Jet Drive Impeller in the Maintenance and Tune-Up section.

Clearance must be adjusted anytime a new impeller is installed or anytime inspection reveals that wear has caused the gap to increase beyond spec. Adjustment is a relatively simple matter of removing the impeller and removing shims mounted below the impeller to a spot above the impeller. Moving the shims will place the impeller slightly lower in the tapered housing, decreasing clearance. If, upon installation of a new impeller you find insufficient clearance, move the impeller slightly upward, into the tapered housing, by removing shims from above the impeller and placing them below it.

Always check impeller clearance before removal. If clearance is within specification, keep track of all shims as they are removed and return them to their original positions (above and/or below the impeller).

1. For safety, either disconnect the negative battery cable and/or disconnect the spark plug leads and ground them to the cylinder head.
2. Remove the 6 retainers (some models use bolts, others use nuts) securing the intake housing (grille) to the jet housing assembly.
3. Using a screwdriver or small prytool, carefully bend the locktab washer ears back off the impeller nut, then loosen and remove the nut and washer. Discard the locktab washer and replace with a new one.

The locktab washer prevents the possibility of the impeller nut loosening during service (which could lead to a catastrophic failure of the jet drive). Don't risk damage to the unit or your safety on the water by reusing a locktab washer, as the bendable tabs may become brittle and break off after multiple uses. Replace the locktab washer anytime it is removed.

4. Remove the impeller, along with any shims that are installed below it. Keep track of all shims for installation in their original positions (even if the impeller is being replaced, use these shims as a starting point for adjustment).

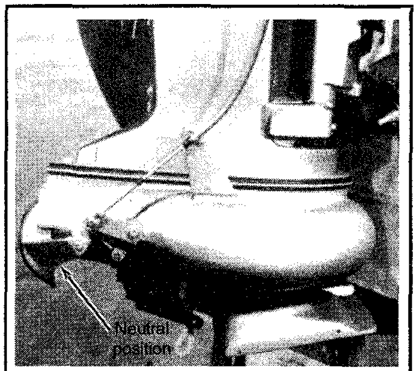


Fig. 127 Forward, Neutral or Reverse is determined by gate position on a jet drive

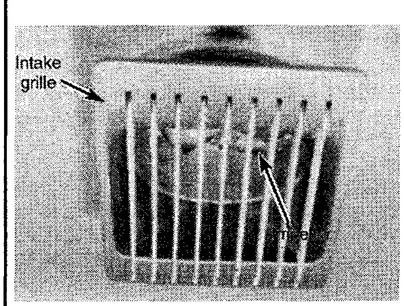


Fig. 128 The impeller is protected by an intake grate

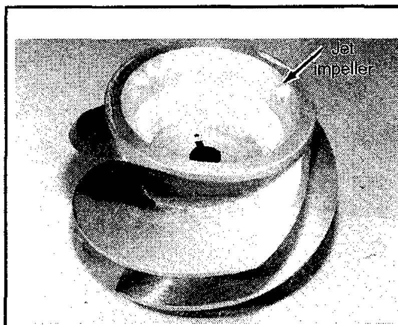


Fig. 129 The impeller is the heart of the jet drive

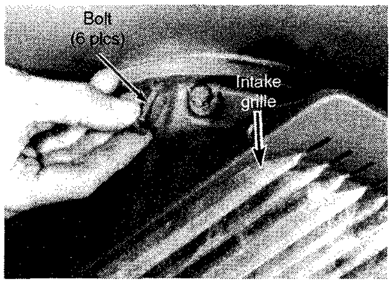


Fig. **130** To remove the impeller, first remove the intake grille...

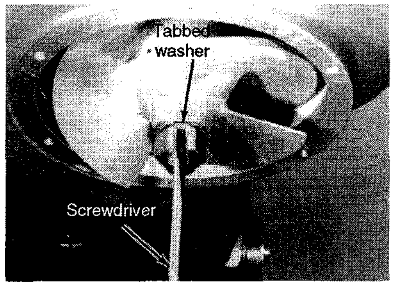


Fig. **131** ... then bend the tab washer ears off the nut

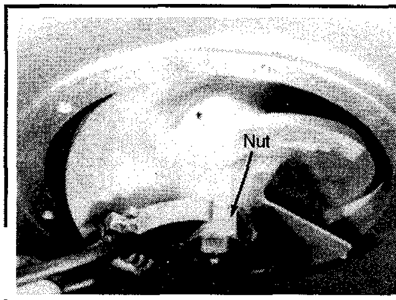


Fig. **132** Remove the impeller nut using a wrench...

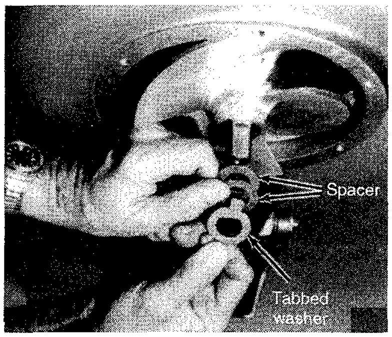


Fig. **133** ... then remove the tab washer and any spacers

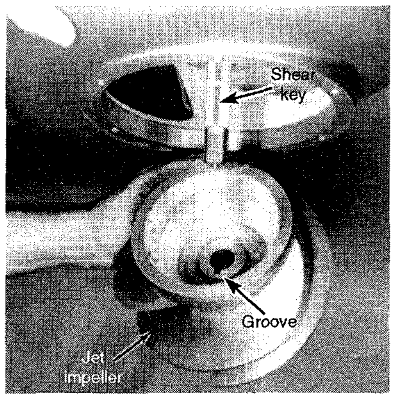


Fig. **134** Lower the impeller from the driveshaft...

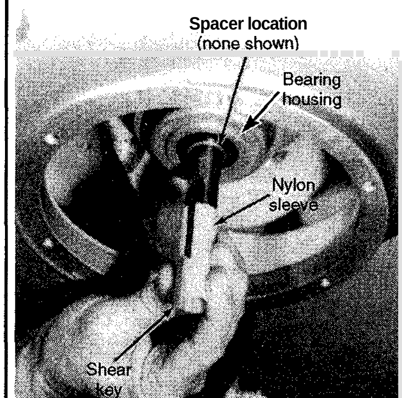


Fig. **135** ...then remove the key, sleeve and any other shims

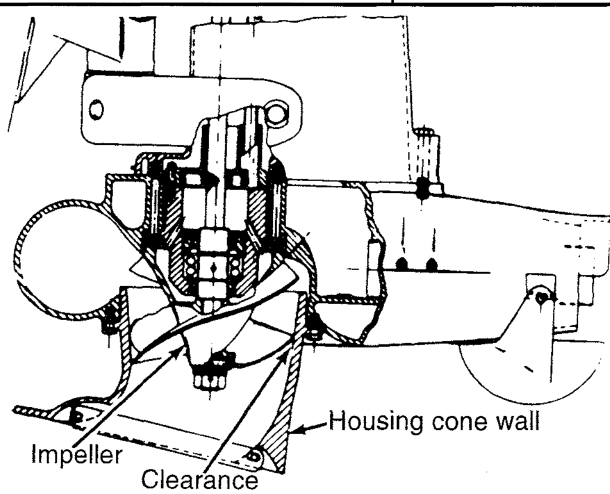


Fig. **136** Jet drive impeller clearance is adjusted by shimming the impeller higher or lower in the housing. Usually, moving the impeller downward (moving shims from below to above the impeller) decreases clearance

5. Remove the impeller key and sleeve, then remove any shims that were installed above the impeller. Again, keep track of these shims for installation purposes.

To install:

6. Install the upper shims, key and sleeve (bushing) followed by the impeller, lower shims, a NEW tabbed washer and nut. Finger-tighten the nut and check impeller clearance. It must be 0.020-0.030 in. (0.5-0.8mm) or the nut must be loosened and shims must be moved (either taken from above the impeller and moved below, or vice versa).

7. Once proper clearance has been verified or obtained, tighten the impeller nut to 16-18 ft. lbs. (22-24 Nm).

8. Bend the tabs of the new tabbed lockwasher down against the impeller nut to lock it in position.

9. Apply a light coating of Evinrude/Johnson Gasket Sealing Compound, or equivalent sealant to the threads of the intake housing (grille) retainers bolts or studs, as applicable. Install the intake housing and finger-tighten the retainers, then check to make sure there is no binding or rubbing between the casing liner and impeller.

☐ If there is greater clearance on one side of the intake housing than the other, loosen the retaining retainers and make sure the housing is centered before re-tightening.

10. Once you've verified that the housing is centered, tighten the intake housing (grille) retaining bolts or nuts to 10-12 ft. lbs. (14-16 Nm).

11. Recheck housing and impeller clearance to make sure no components have shifted during installation.

12. Reconnect the spark plug leads and, if applicable, connect the negative battery cable.

Jet Drive Assembly

REMOVAL & INSTALLATION

③ DIFFICULT

◆ See Figures **137,138 and 139**

Most of the jet drive assembly retaining bolts are found in the impeller cavity (above the impeller). For this reason, the impeller must be removed in order to remove the drive assembly.

1. For safety, either disconnect the negative battery cable and/or disconnect the spark plug leads and ground them to the cylinder head.

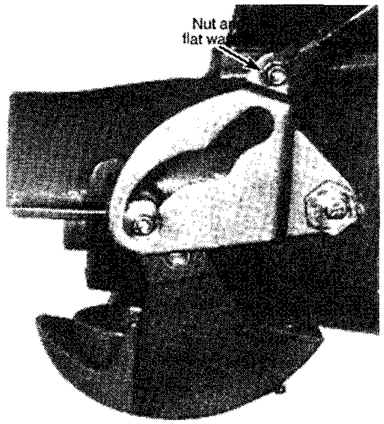


Fig. **137** To remove the assembly, first disconnect the shift cable or rod

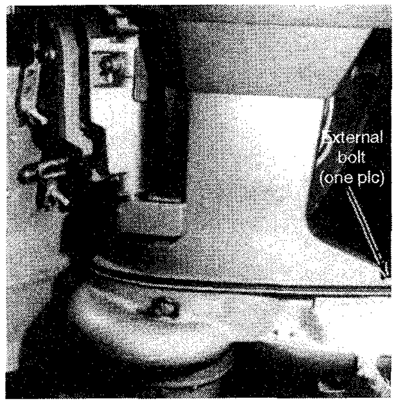


Fig. **138** The Jet drive assembly is secured by one external bolt **...**

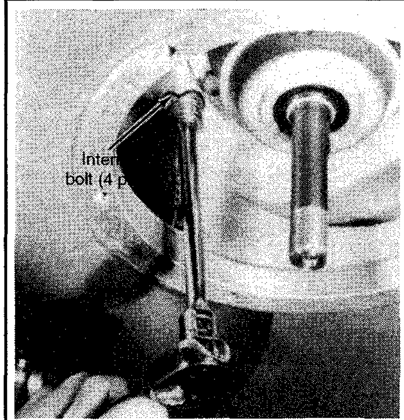


Fig. **139** **...** and **4** internal bolts (found in the impeller cavity)

2. Remove the Impeller as detailed in this section.
3. Disconnect the shift linkage from the reverse gate. On some models this involves removing the retaining clip, washer and spring from the lower shift rod, then pulling the rod out of the gate cam. On other models, you'll have to remove the nut and flat washer in order to free the cable end from the reverse gate cam. On these models the cable is usually freed by rotating the cable to the vertical position and removing the adjusting nut and cable from the anchor.
4. Remove the adapter-to-jet housing bolt (external bolt threaded downward into the top of the jet housing from the adapter flange).

In the next step, keep close track of the bolts, as they are different lengths on some models and should be returned to their original bores.

5. Remove the 4 internal bolts and lockwashers that are threaded upward into the adapter from underneath the jet drive assembly (inside the impeller cavity).

■ Do NOT mistake the 4 bearing housing bolts for the jet drive assembly retaining bolts. The jet drive bolts are found outboard from the bearing housing.

6. Once the jet drive assembly bolts are removed, carefully lower the assembly (including the jet drive housing, bearing housing, driveshaft and water pump) from the adapter.

To install:

7. Apply a light coating of EvinrudelJohnson Adhesive M or equivalent sealant to the inner surfaces of the lower exhaust housing seal. Next, position 2 NEW seals on the housing (at the upper and lower positions), then apply a light coating of EvinrudelJohnson Triple Guard or equivalent marine grade grease to the outer surfaces of the seal. Position the exhaust housing to the jet drive housing assembly.
8. If equipped (and if removed), install the water tube extension on the tube.
9. Apply a light coating of EvinrudelJohnson Moly Lube, or equivalent assembly lubricant to the driveshaft splines. But, be careful not to coat the top surface of the driveshaft, as lubricant there could hydraulically prevent the driveshaft from seating in the crankshaft.
10. Apply a light coating of EvinrudelJohnson Gasket Sealing Compound, or equivalent sealant to the threads of the 5 jet drive housing fasteners (if they're of different lengths don't mix them up now). Place the fasteners aside on a clean surface for use in the next steps.
11. Install the jet drive housing assembly, while carefully aligning the water tube into the water pump outlet and the driveshaft to the crankshaft splines. If necessary, slowly rotate the flywheel clockwise (when viewed from above) to align the crankshaft splines with the driveshaft.
12. Install the 4 jet drive housing bolts from underneath the housing (in the impeller cavity) and finger-tighten. If the bolts are of different lengths, be sure to return them to their original bores.

WHAT? You didn't read that note earlier telling you to sort them (or your buddy kicked the tray over)? That's ok. Normally, when the bolts are of different lengths, the two **3/8-16** x **2 1/2** in. bolts are threaded into the forward holes, while the two **3/8-16** x **3** in. bolts are threaded into the rear holes. If you're unsure, threads the bolts slowly by hand and finger-tighten to ensure they are in their proper bores.

13. Install the upper retaining bolt (threaded downward through the adapter to the top of the housing assembly). Tighten all 5 of the jet drive housing assembly retaining bolts to 18-20 ft. lbs. (24-27 Nm).
14. Install the Impeller, as detailed in this section.
15. Reconnect the spark plug leads and, if applicable, the negative battery cable.
16. Follow the Jet Drive Bearing lubrication procedure, as detailed in the Maintenance and Tune-up section.

DISASSEMBLY

◆ See Figure **140**

The following procedures are valid for the various sized EvinrudelJohnson jet drive units, because they are identical in design, function and operation. Differences lie in size and with the attaching hardware.

To prepare the jet drive assembly for overhaul, first remove it from the outboard, as detailed under earlier in this section under Removal & Installation. Then, remove the water pump assembly, for details please refer to the procedures found in the Lubrication and Cooling section. Finally, follow each of the Disassembly, Cleaning & Inspection, as well as the Assembly procedures found in this section, in the order they are given.

OEM ③ DIFFICULT

Disassembling the Bearing Carrier

◆ See Figures **141** and **142**

A slightly involved procedure must be followed to dismantle the bearing carrier including "torching" off the bearing housing. Naturally, excessive heat will destroy the seals and possibly damage the bearings. Therefore, this procedure should be avoided unless you are planning (or at least open to the possibility) of a complete overhaul to the Jet Drive. Otherwise, use great care or leave this part of the service work to someone who is familiar with Jet Drives.

However, if you have the experience and the shop tooling required to perform the torch heating and bearing press tasks, use the following procedures and illustrations to perform this work. Refer to the exploded view provided under the Disassembly heading in this section to help identify

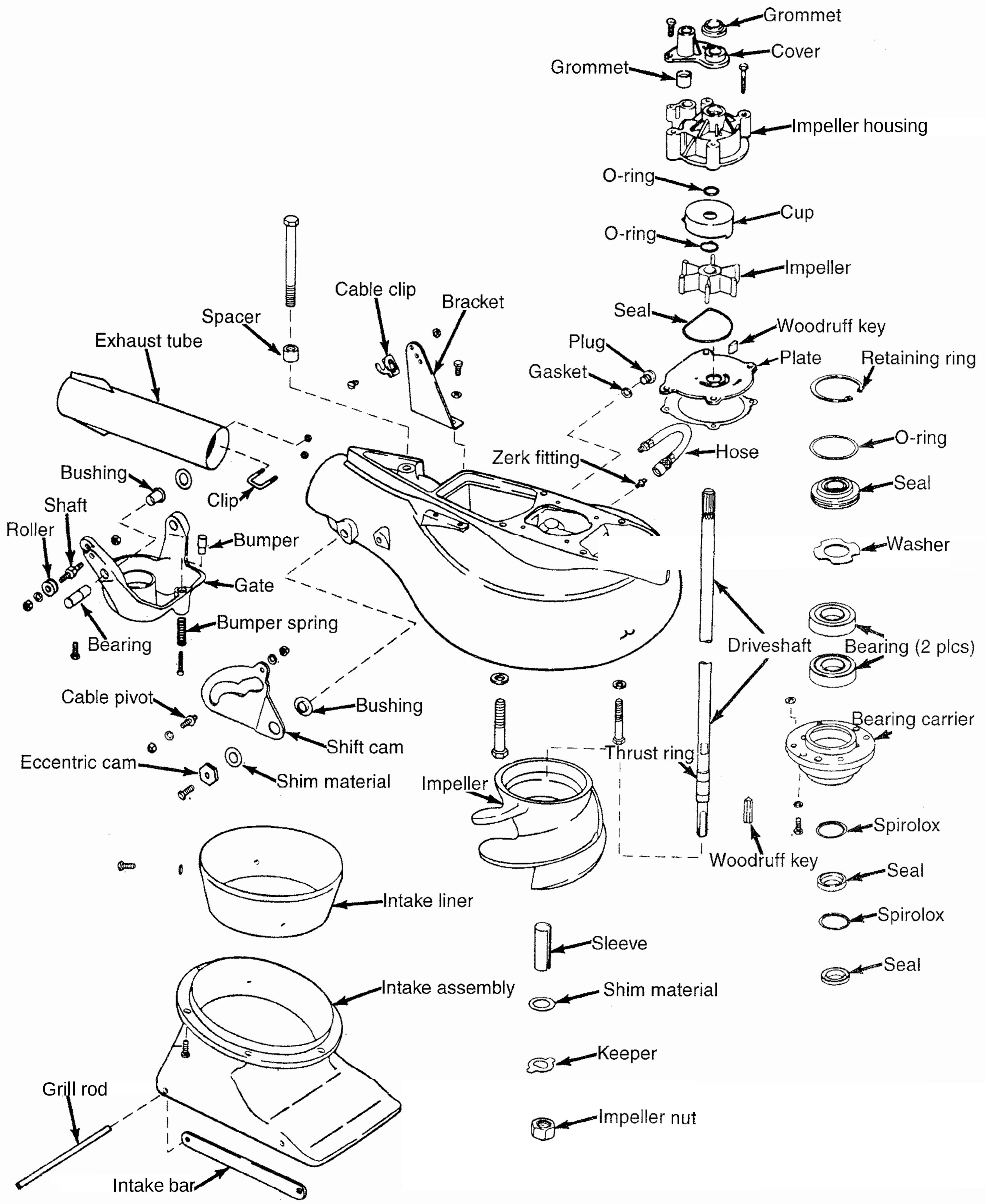


Fig. 140 Exploded view of a typical jet drive assembly
(note: internal components will vary slightly from model-to-model)

internal components, but remember that assemblies may vary slightly. A photographic exploded view is also provided in this section.

The following procedures pickup the work after the water pump assembly has been removed from the jet pump housing:

1. Remove the four bolts securing the bearing carrier assembly in the jet pump housing. Lift out and discard the four small O-rings from the bolt holes on top of the bearing carrier flange.

**** CAUTION**

The retaining ring is under considerable force when installed. Use caution and wear eye protection when removing or installing this retaining ring.

2. Reach inside the top of the bearing carrier with a pair of snap ring pliers and remove the Truarc retaining ring.

3. Apply heat evenly all around the bearing carrier using a hand held propane torch or equivalent item. Apply only enough heat to the bearing carrier so it is very warm to the touch. Now, invert the assembly in a bearing press and support the carrier between two plates as shown in the accompanying illustration. Press on the impeller end of the driveshaft and drive the shaft and bearings out the bottom of the carrier.
Have an assistant standing by to catch the shaft as it falls free of the bearing carrier, otherwise the splined end of the shaft could be damaged if it strikes a concrete floor.

■ **Use gloves or hand protection when handling the components such as the shaft, as should still be a bit hot.**

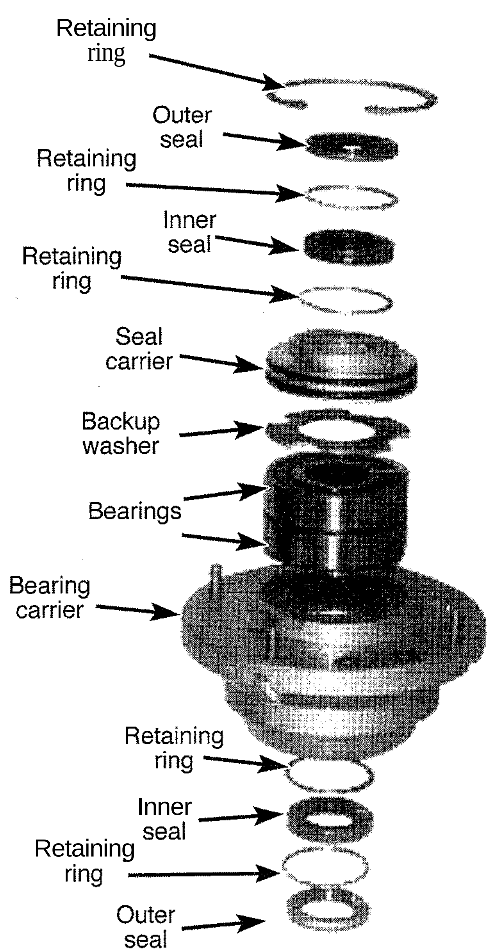


Fig. 141 Exploded view of the bearing carrier assembly

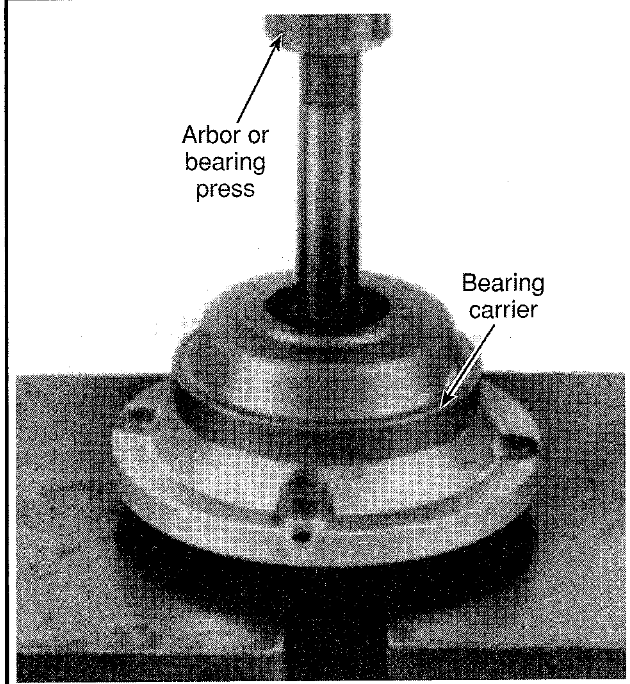


Fig. 142 After heating, use a shop press to separate the driveshaft from the carrier

4. Remove the outer seal in the bearing carrier by placing the blunt end of a punch down through the bearing carrier onto the seal metal case. Tap the seal down and out the bottom of the bearing carrier. Next, grasp the tab end of the spiral retaining ring below the inner seal, Unwind the spiral retaining ring from the bearing carrier.

Again, place the blunt end of a punch down through the bearing carrier onto the seal metal case. Tap the seal down and out the bottom of the bearing carrier. Discard both seals and remove the remaining spiral retaining ring inside the bearing carrier. Thoroughly clean the bearing carrier in cleaning solvent and blow dry with compressed air.

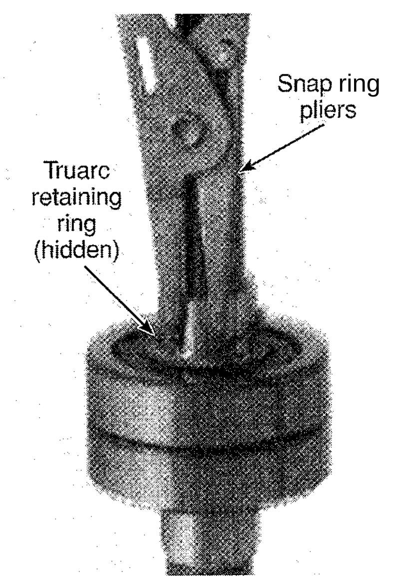


Fig. 143 To replace the bearings, first remove the snapring...

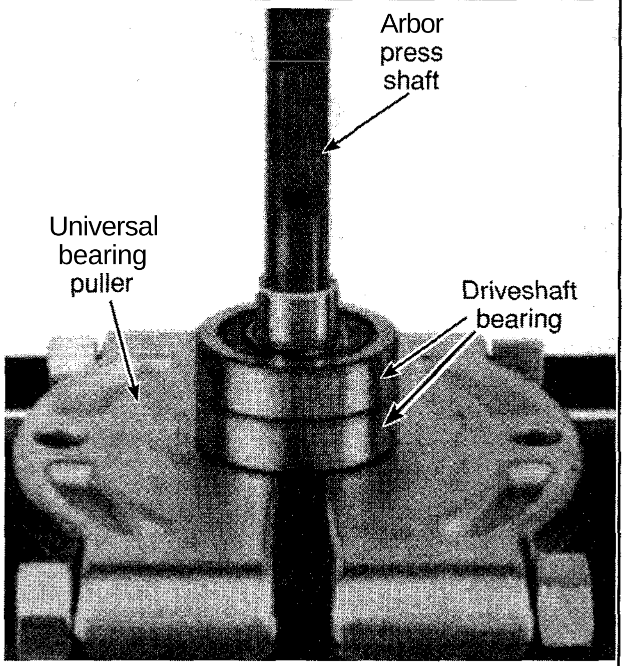


Fig. 144 ... then use a shop press the free the bearings from the shaft

Disassembling the Driveshaft

◆ **See Figures 143 and 144**

This procedure picks up where Disassembling the Bearing Carrier leaves off, at least, after the part where the driveshaft is removed from the carrier.

1. Slide the seal carrier and backup (thrust) washer off the end of the driveshaft.
2. Remove the two O-rings from the outer grooves and discard the O-rings.
3. Carefully, and closely, examine the seals inside the seal carrier. If there is any doubt as to the sealing action of the seals, replace the seal carrier with a new unit. Individual serviceable parts for the seal carrier are not available.
4. Inspect the driveshaft bearings carefully for roughness, dragging, or excessive clearance. If the bearings are defective or are removed from the driveshaft for any reason, they must be replaced with new bearings.

✳✳ WARNI

The driveshaft bearings need not be removed, unless they are unfit for further service. Once they are removed, they cannot be installed and used a second time.

5. To remove the bearrngs, first remove the Truarc snapring using safety glasses and a suitable pair of snapring pliers, then support the shaft ın a shop press (with the impeller end up) usıng a bearing separator and press the bearings off the shaft. Discard both drrveshaft bearings.
6. If necessary, remove and discard the retarning ring in the shaft itself.

Intake Liner Removal

The intake liner can be easily removed by first removing the two bolts with lockwashers-some models may have four bolts-and then pushing the liner free of the housing.

CLEANING & INSPECTION

◆ **See Figure 140**

Wash all parts in solvent and blow them dry with low-pressure compressed air. Do not wash the bearings on the driveshaft if they are to be used again for service. Rotate the bearing assembly on the driveshaft to inspect the bearing for "rough" spots, binding, and signs of corrosion or damage. Replace the bearing if there is any sign of damage or roughness.

Bearing Carrier

Wash the bearing carrier in solvent, scrub the inside surface free of any grease, dirt, or metal fillings. Clean the internal lubrication passages using a bottle brush or similar tool. Blow the bearing carrier dry with compressed air.

Driveshaft and Associated Parts

Inspect the threads and splines on the driveshaft for wear, rounded edges, corrosion and damage.

Carefully check the driveshaft to verify the shaft is straight and true without any sign of damage.

Inspect the jet drive housing for nicks, dents, corrosion, or other signs of damage. Nicks may be removed with No. 120 and No. 180 emery cloth.

Reverse Gate

Inspect the gate and its pivot intake grille for straightness. Straighten any bent slats, if possible. Use the utmost care when prying on any slat, because they tend to break if excessive force is applied. Replace the intake grille, if a slat is lost, broken, or bent, and cannot be repaired. The slats are spaced evenly and the distance between them is critical, to prevent large objects from passing through and becoming lodged between the jet impeller and the inside wall of the housing.

Jet Impeller

The jet impeller is a precisely machined and dynamically balanced aluminum spiral. Observe the drilled recesses at exact locations to achieve this delicate balancing. Some of these drilled recesses are clearly shown in the accompanying illustration.

Excessive vibration of the jet drive may be attributed to an out-of-balance condition caused by the jet impeller being struck repeatedly by rocks, gravel or cavitation "burn".

The term cavitation "burn" is a common expression used throughout the world among people working with pumps, impeller blades, and forceful water movement.

"Burns" on the jet impeller blades are caused by cavitation air bubbles exploding with considerable force against the impeller [illegible] The edges of the blades may develop small "dime size" areas resembling a porous sponge, because the aluminum is actually "eaten" by the condition just described.

Excessive rounding of the jet impeller edges will reduce efficiency and performance. Therefore, the impeller should be inspected at regular intervals. If rounding is detected, the impeller should be placed on a work bench and the edges restored to as sharp a condition as possible, using a file.

Draw the file in only one direction. A back-and-forth motion will not produce a smooth edge. Take care not to nick the smooth surface of the jet impeller. Excessive nicking or pitting will create water turbulence and slow the flow of water through the pump.

Inspect the shear key. A slightly distorted key may be reused although some difficulty may be encountered in assembling the jet drive. A cracked shear key should be discarded and replaced with a new key.

Water Pump

Clean all water pump parts with solvent, and then blow them dry with compressed air. Inspect the water pump housing for cracks and distortion, possibly caused from overheating. Inspect the steel plate, the cup and the water pump housing for grooves and rough spots.

As mentioned in the Lubrication and Cooling section, the water pump impeller really should always be replaced anytime pump is disassembled. A new impeller will ensure extended satisfactory service and give "peace of mind" to the owner. If the old impeller must be returned to service, never install it in reverse of the original direction of rotation. Installation in reverse will cause premature impeller failure.

If installation of a new water pump impeller is not possible, check the sealing surfaces and be satisfied they are in good condition. Check the upper, lower, and ends of the impeller vanes for grooves, cracking, and wear. Check to be sure the indexing notch of the impeller hub is intact and will not allow the impeller to slip.

ASSEMBLY

◆ See Figure 140

② MODERATE

Intake Liner Installation

Start the liner into the housing with the bolt holes in the liner roughly aligned with the holes in the housing. Continue pushing the liner in until it bottoms out, and then rotate it until the bolt holes are aligned. Secure the liner in place with the bolts and lockwashers.

OEM ② MODERATE

Assembling the Driveshaft

If certain items were not removed, simply skip the affected steps and move on to the necessary work required to return the jet pump to service.

New bearings are pressed onto the driveshaft from the impeller end. Apply a coating of EvinrudelJohnsonWheel Bearing grease or an equivalent to the shaft bearing surface and the inside race of the new bearings.

1. Remove the round bearing thrust ring from the groove in the driveshaft using a pair of blunt nose snap ring pliers.
2. Place a new Truarc bearing retaining ring into the groove closest to the threaded end of the driveshaft.
3. Slide a new bearing onto the shaft with the lettered side of the bearing facing away from the retaining ring. Set the driveshaft and bearing into an arbor press on a universal bearing plate with the impeller end of the shaft facing up. Press against the inner race only, until the bearing race makes contact with the Truarc retaining ring.
4. Place the upper bearing onto the shaft with the lettered side of the bearing facing away from the lower bearing. Press against the inner race only, until the bearing makes contact with the upper bearing.
5. Install a new bearing thrust ring into the groove in the driveshaft, using a pair of blunt nose snap ring pliers. Verify the ring is fully seated into the groove in the shaft. Rotate the driveshaft bearings and check for smooth action without binding or dragging.
6. Slide the back-up washer onto the driveshaft with the dished center section facing up.
7. Apply a coating of EvinrudelJohnsonTriple Guard grease or equivalent product to two new O-rings. Slip the O-rings into the grooves around the seal carrier.

OEM ③ DIFFICULT

Assembling the Bearing Carrier

◆ See Figure 141

■ The jet pump assembly and bearing carrier exploded views will prove most helpful during bearing carrier assembly. However, the two sets of retaining rings and seals shown underneath the bearing carrier in the photograph might be **misleading. The** inner seal and retaining ring are installed from the top of the carrier and the outer seal and retaining ring are installed from the bottom.

1. Install the outer seal spiral retaining ring into the groove in the lower portion of the bearing carrier. Apply a coating of Evinrude/Johnson Gasket Sealing Compound to the outer metal casing of the outer seal. Place the seal into the carrier with the lip facing out. Tap the seal into place using a socket or universal seal driver, until the seal contacts the retaining ring, just installed.
2. Again, coat the outer metal case of the inner seal with EvinrudelJohnson Gasket Sealing Compound. Position the seal with the lip facing up and set the seal into the cavity in the upper portion of the bearing carrier. Drive the seal down into the bearing carrier using a socket the same size as the seal or a universal seal driver. Tap the seal in until it contacts the retaining ring, just installed, Install the spiral retaining ring above the inner seal. Apply a coating of EvinrudelJohnsonTriple Guard grease or equivalent to the lips of both seals.
3. Apply a coating of EvinrudelJohnson Wheel Bearing grease, or equivalent, to the bearing cavity in the bearing carrier. Set the driveshaft impeller end into the bearing carrier. Place the bearing carrier and driveshaft into an arbor press. Support the bearing carrier in the press to permit the impeller end of the shaft to pass through the bottom.
4. Heat the bearing carrier slowly and evenly all around using a hand held propane torch or equivalent item. Apply only enough heat to the bearing carrier so it is very warm to the touch. Begin pressing on the splined end of the driveshaft and press the bearings into the carrier housing until the lower bearing contacts the carrier.
5. Allow the bearing carrier to cool to the touch.
6. Slide the back-up (thrust) washer onto the driveshaft with the dished center section facing up. Slide the seal carrier down the driveshaft and into the bearing carrier.

✳✳ CAUTION

The seal carrier retaining ring is under considerable force when installed. Use caution and wear eye protection when removing or installing this retaining ring.

7. [illegible] Truarc retaining ring into the [illegible] of [illegible] bearing carrier with the beveled side [illegible] facing [illegible]t. Verify the ring is fully seated in the groove.
8. Apply a coating of EvinrudelJohnsonTriple Guard grease to four new small O-rings. Install the O-rings into the bolt holes on the upper surface of the bearing carrier flange.

② MODERATE

Assembling the Jet Pump

The following procedures pickup the work after all parts have been cleaned, inspected, and new components have been obtained to replace items no longer fit for service.

1. Place the driveshaft bearing assembly into the jet drive housing. Rotate the bearing assembly until all bolt holes align. There is only one correct position.
2. Move the assembled bearing housing assembly into the jet pump housing and secure it in place with the four attaching bolts. Tighten the bolts to 60-84 inch lbs. (7-9 Nm).
3. Install the water pump, as detailed in the Lubrication and Cooling section.
4. Install the Jet Drive Assembly, as detailed earlier in this section.

After repairs, parts replacement or rigging, it is possible that the reverse gate or remote cable will require adjustment to ensure proper operation.

Reverse Gate

② MODERATE

GATE ADJUSTMENT

◆ See Figure 145,146 and 147

To adjust the reverse gate on the jet drive housing, proceed as follows:

1. Set the shifter handle to the neutral detent.
2. Hold the reverse gate *up* and check to make sure there is a 15132 in. (11.9mm) gap between the top of the gate and the water flow passage.
3. If adjustment is necessary, have an assistant continue to hold the reverse gate up and check the clearance, while you loosen the cam screw (1) and rotate the eccentric nut (2) until the clearance is correct.
4. Tighten the cam screw, then recheck the adjustment.

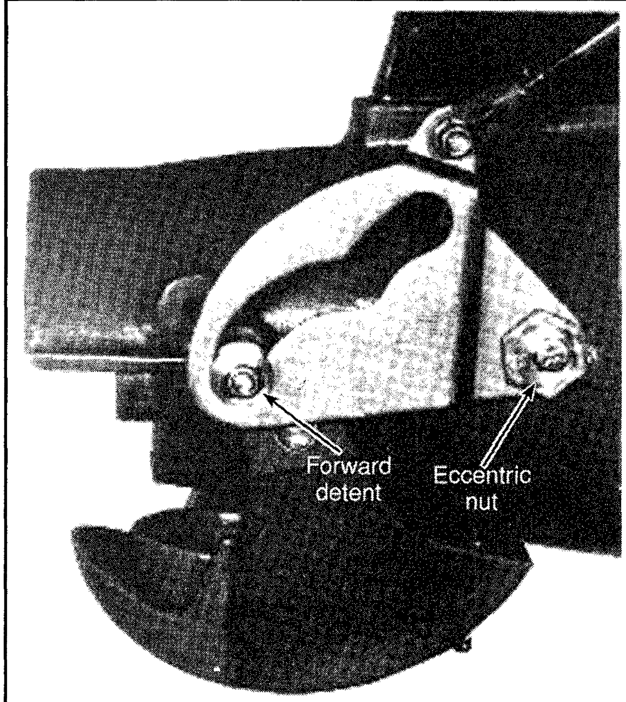


Fig. 145 Reverse gate in the FORWARD position with the cam roller at the lower end of the cutout in the bracket

5. Move the shifter handle to the forward detent.
6. With the gate now in the forward detent try to lift up on the reverse gate by hand (moving it back toward neutral). The gate should NOT move. If necessary, adjust the eccentric nut again, so the neutral gap is correct, but the gate will not move upward in the forward position.

REMOTE CABLE ADJUSTMENT

(2) MODERATE

◆ See Figures 145,146,147,148 and 149

Proper cable adjustment is necessary in order to keep water pressure (from boat movement) from moving the reverse gate upward blocking normal thrust.

✱✱ CAUTION

Should be reverse gate shift suddenly and unexpectedly over the thrust nozzle, the boat will stop violently, shifting and possibly ejecting passengers and cargo. Proper adjustment is critical.

This procedure starts with the cable disconnected, for replacement, re-rigging or installation of a jet drive assembly

1. Pull upward on the shift cam (I) until the roller is n the far end of the forward range (2).

2. Shift the remote control to the forward position. Temporarily, push the insert the cable guide onto the shift cam stud, then pull firmly on the cable casing to remove all free-play. Next, adjust the cable trunnion until it aligns with the anchor bracket, then remove the cable from the cam stud.

3. Connect the cable trunnion to the anchor bracket, then turn 900 to lock the trunnion in position.

4. Push the cable guide back onto the cam stud, then install the washer and finger-tighten the locknut.

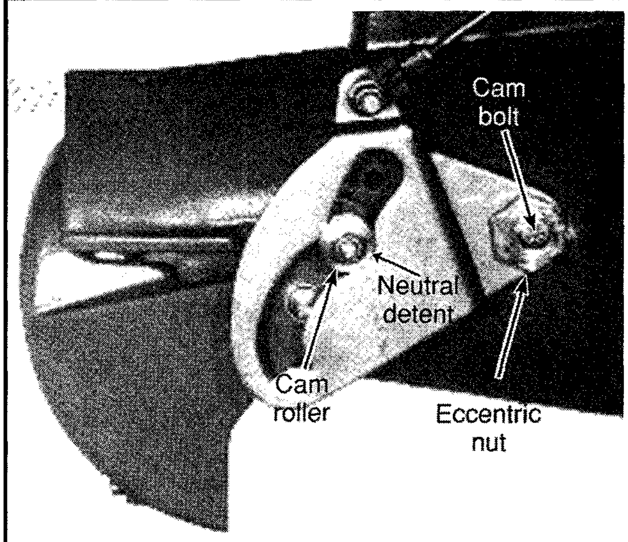


Fig. 146 Reverse gate in the NEUTRAL position, with the cam roller indexed into the neutral detent

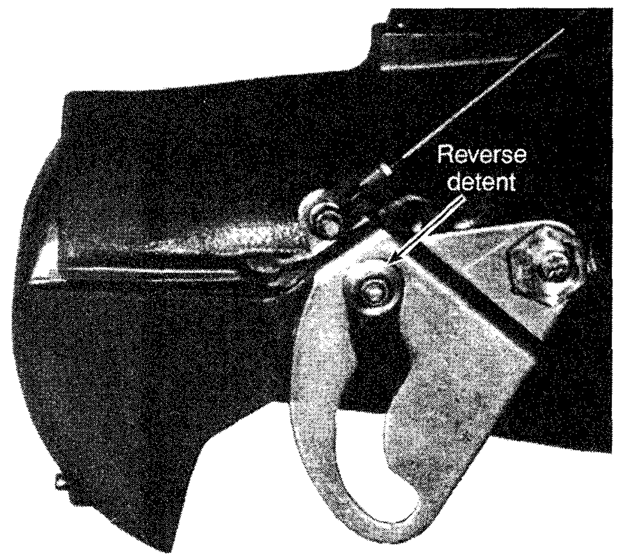


Fig. 147 Reverse gate in the REVERSE position, with the cam roller at the upper end of the cutout in the bracket

5. Shift the remote control to the neutral position (3). The cam roller must snap into the neutral detent when you pull upward'on the reverse gate with moderate pressure. If the gate does not shift properly into neutral, lengthen the cable slightly and recheck the adjustment.

Remember, it is CRITICAL that the reverse gate remains locked into the FORWARD position when the remote is shifted into **FORWARD. You** should NOT be able to move the gate out of this position by hand.

6. Tighten the cam locknut securely, then loosen it 118-114 of a turn in order to allow free movement of the cam.
7. Secure the cable loosely to the steering cable using a wire tie, but be sure NOT to restrict shift cable movement.

■ With the engine running in NEUTRAL and the warm-up lever raised, the engine will run rough due to exhaust restriction from the reverse **gate. This** is normal.

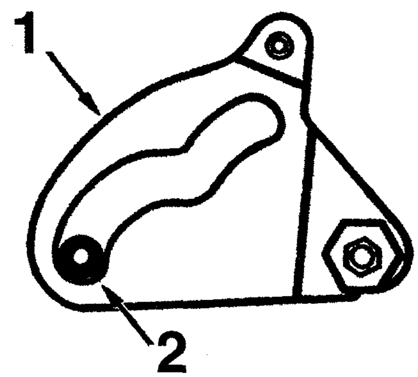


Fig. 148 When adjusting the remote **cable/shift** rod first move the cam **(1)** to the FORWARD position **(2) ...**

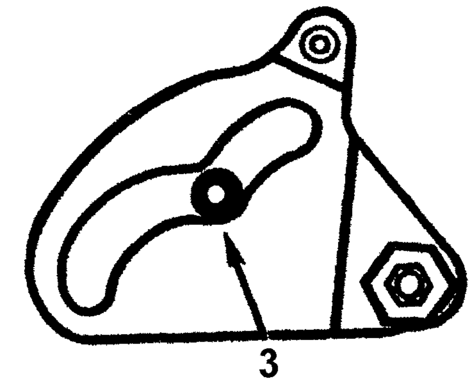


Fig. 149 **...** next, check that the cam snaps into the NEUTRAL position (3)

TILLER SHIFT ROD ADJUSTMENT

2 MODERATE

◆ See Figures 145,146 and 147

Proper shift rod adjustment is necessary in order to keep water pressure (from boat movement) from moving the reverse gate upward blocking normal thrust.

⁂ CAUTION

Should be reverse gate shift suddenly and unexpectedly over the thrust nozzle, the boat will stop violently, shifting and possibly ejecting passengers and cargo. **Proper** adjustment is critical.

This procedure starts with the shift rod (and connector pin) disconnected, for replacement, re-rigging or installation of a jet drive assembly.

1. Pull upward on the shift cam (1) until the roller is in the far end of the forward range (2).

2. Move the shift handle to the forward position, then thread the connector onto the shift rod until it is aligned with the hole in the shift cam.

3. Install the connector pin, then secure using the cotter pin and washer.

4. Move the shifter to the neutral position (3).The cam roller must snap into the neutral detent when you pull upward on the reverse gate with moderate pressure. If the gate does not shift properly into neutral, remove the connector pin again and rotate the connector in order to lengthen the shift rod VERY slightly, then recheck the adjustment.

Remember, it is CRITICAL that the reverse gate remains locked into the FORWARD position when the handle is shifted into **FORWARD. You** should NOT be able to move the gate out of this position by hand.

5. Tighten the adjuster locknut securely.

■ With the engine running in NEUTRAL and the twist grip in the START position or higher, the engine will run rough due to exhaust restriction from the reverse gate. This is normal.

8

TRIM/TILT SYSTEMS

TRIM/TILT SYSTEMS

This section covers basic system troubleshooting and major component removal, replacement and installation for the 2 power trimltilt systems that are normally installed on EvinrudelJohnson V-motors.

GENERAL INFORMATION

Trim

Motor trim is generally defined as the angle of the gearcase when compared with the vertical line of the transom. Adjusting motor trim will affect a boat's handling. Loosely speaking, the bow tends to moves in the direction of the trim.

When the motor is trimmed up (outward, away from the transom) the bow will tend to move upward. This can be used to raise the bow slightly to increase fuel economy or performance, or it can be used to help stabilize the boat when running with chop. However, in bow up positions, the boat may tend to pull to the port side (if equipped with a single engine and a standard rotation gearcase). Be careful as excessive bow-up trim may cause propeller ventilation (resulting in slippage) and, could cause the bow to rise suddenly or excessively when encountering a wake or rough surf.

When the motor is trimmed down (toward the transom) the bow will tend to move downward. This position is best for quick acceleration onto plane and for maximum towing power (such as for water skiing). This position is generally used for climbing onto plane from a standing start or idle operation or for stabilizing the boat when running against chop. With bow down trim, the motor will tend to push the boat starboard slightly (when equipped with a single engine and a standard rotation gearcase) and the boat will have more of a tendency to plow (as more of the bow will be pushed into the water).

✳✳ CAUTION

Trim must be carefully set for safe boat operation. Running the boat with the motor trimmed excessively up or down will cause dangerous conditions. Excessive upward **trim could** cause the boat to react violently to surf or wakes. Excessive downward trim. **especially** at speed, **may** cause plowing that could turn or spin the boat suddenly. Either condition could eject passengers.

Trim should be adjusted to suit operational, boat/passenger load and weather conditions. Generally speaking, small adjustments in or out from vertical will usually achieve the desired results of optimum handling and fuel economy for the boat and conditions

Tilt

One advantage to an outboard is the ability to fully raise the motor out of the water for beaching, trailering or even storage or docking in salt water (to keep the motor out of the corrosive water over long periods of time).

Generally speaking, many smaller motors are tilted manually while the majority of larger motors are tilted using a power trimltilt system. However, this is a generalization, as some larger EvinrudelJohnson outboards are equipped with a gas-charge assisted manual tilt system. And, at the same time, some smaller inline motors (though often remote models) are equipped with power trimltilt systems.

When equipped with a manual system, a lever on the stern/swivel bracket must be released and the engine case is then grasped in order to manually raise or lower the motor. A tilt pin may be used to manually adjust downward trim position on these motors.

With power systems, a tilt rod can be used to lift the motor upward, past operating trim levels or it can be used to lower the motor back to operating levels.

In ALL cases, some manual locking bracket must be used to secure the motor when trailering. The power trimltilt systems available for EvinrudelJohnson motors include an integral trailering bracket.

System Identification

◆ See Figures 1 and **2**

Most of the EvinrudelJohnson V-motors covered here are equipped with a power trimltilt system from the factory. Also, power trimltilt systems may be added at the time of motor installationlboat rigging. There are essentially 2 basic versions of the trim-tilt system that are normally found on larger EvinrudelJohnson outboards and, since systems may be changed or added when rigged, it is nearly impossible to identify the type of trim tilt system used based on solely on engine type. However, the 2 systems normally used can be identified visually.

Although system identification is necessary for parts replacement and for specifications during some test procedures, the actual operation (especially the wiring) is virtually the same for all systems. Differences generally occur in the manifoldlvalve designs.

TYPES OF TRIM/TILT SYSTEMS

Large-Motor Conventional System

◆ See Figures 1,3 and 4

Generally speaking, this system is normally found on early-model V-motors, but it could have been rigged to most any EvinrudelJohnson V-motor at a later time. The large-motor conventional system utilizes a dual-ram trim system, along with a single tilt cylinderlshock absorber, all of which are mounted to a single manifold assembly. These characteristics make it similar in operation to the FasTrak® system that is also used on many large motors. The major difference is that, on the conventional system, the motor and reservoir are bolted vertically down onto the manifold (whereas on the FasTrak® system, those components are bolted horizontally to the manifold).

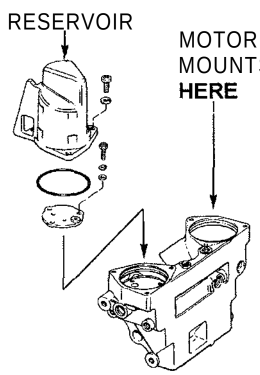


Fig. 1 The large motor conventional system is identified by the motor and reservoir mounted vertically onto the cylinderlmanifold mating surface

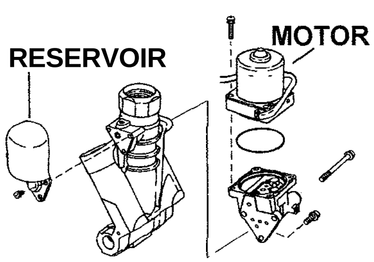


Fig. **2** The **FasTrak®** system is similar to the large motor conventional, but the motorlvalve assembly and reservoir bolt horizontally to the cylinder body

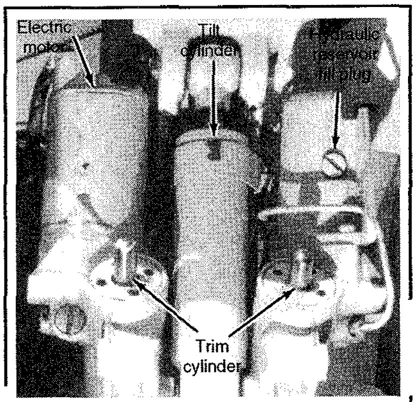


Fig. 3 Major components of conventional large-motor systems

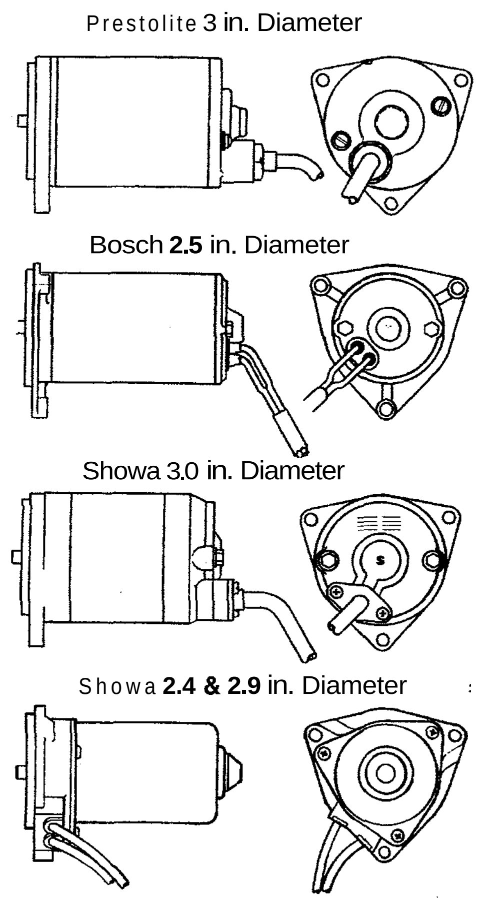


Fig. 4 Identifying the electric motor installed on conventional large-motor systems

When testing or repairing the electric motor on large-motor conventional systems, it is important to identify the type of motor installed on the system (Prestolite, Bosch or one of 3 Showa models) in order to ensure you have the proper specifications. Refer to the visual and statistical information in the accompanying illustration to help make the correct motor identification for testing and replacement purposes.

FasTrak® System

◆ See Figures **2** and **5**

The FasTrak® system is found on some early-model and most late-model V-motor outboards. Like the large-motor conventional system, the FasTrak® system utilizes a dual-ram trim system, along with a single tilt cylinder/shock absorber mounted to a single cylinder body. The major difference between the FasTrak® and the conventional system is that on the FasTrak® assembly, the pumplvalve manifold assembly and the reservoir, although positioned vertically like on the conventional system, are actually fastened to the cylinder body horizontally (bolted from the side). A less obvious difference at first glance is the fact that the cylinder body does not contain the manifold valves on the FasTrak® system, as a separate valve body is bolted between the cylinder body and the motor.

Description and Operation

FASTRAK® SYSTEM

◆ See Figures **6,7** and **8**

The FasTrak® system is completely self-contained in an assembly that is mounted to the engine stern bracket. The main system components include

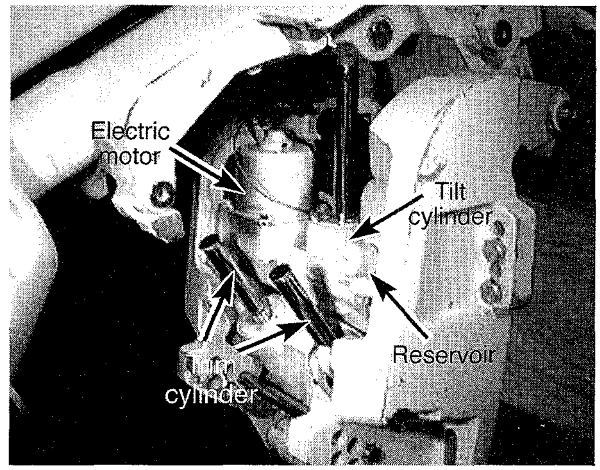


Fig. **5** Major components of **FasTrak®** systems

an electric motor, a fluid reservoir and pump/valve manifold assembly and a cylinder body.

The FasTrak® system utilizes a cylinder body with 2 trim cylinder rams and one combination tilt cylinder/shock absorber. Whenever the trim button is pressed upward the electric motor rotates clockwise, (as viewed from the pump end) pumping hydraulic fluid to force the cylinders upward. Because of a mechanical advantage, the trim cylinders perform most, but not all, of the work. Once the motor is raised 21° (to the end of the trim cylinder travel), the tilt cylinder moves the engine through the remaining 54° of the tilt range.

■ While in the tilt range (above the trim range) the engine will only operate at **idle/low** throttle.

When the down switch is activated, fluid is pumped only to the top of the tilt cylinder whose piston moves the engine downward (pushing fluid from underneath the tilt piston as it travels downward). The force of the engine moving down pushes against the trim cylinder rams, forcing fluid out from underneath the trim cylinder pistons as they return to the bottom of their travel.

A manual release valve is provided in order to provide tilt/trim function in the event of certain electrical or mechanical system failures. The valve is normally located on the port side of the trimltilt bracket assembly and is accessed with a screwdriver through a hole on the outside of the stern bracket.

An integral trailering bracket is provided to protect the system from stress and shock. The bracket should be used whenever the boat is towed or in storage.

A tilt limit switch can be set to prevent the engine from contacting the boat's motorwell during trimltilt operation. However, setting the trim limit switch will not prevent the engine from striking the motorwell if moved manually or due to a severe impact.

Manually Tilting **A FasTrak®** Engine

◆ See Figure 7

To manually tilt a FasTrak® engine, open the manual release valve by rotating it about 3 1/2 turns counterclockwise using a screwdriver inserted through the access hole on the outside of the stern bracket. Turn lightly until the valve just contacts the retaining ring.

With the valve open you can manually raise the engine (which will allow fluid to flow from the top of the tilt cylinder to the reservoir and to the underside of the tilt cylinder).

**** WARNING**

Once the release valve is opened, the engine must be supported when it is lifted, either using a hoist or the trailering bracket. DO NOT attempt to hold the engine up, above the trim range using the tilt cylinder and manual release valve. Similarly, do not allow the engine to **drop** suddenly once the support is removed.

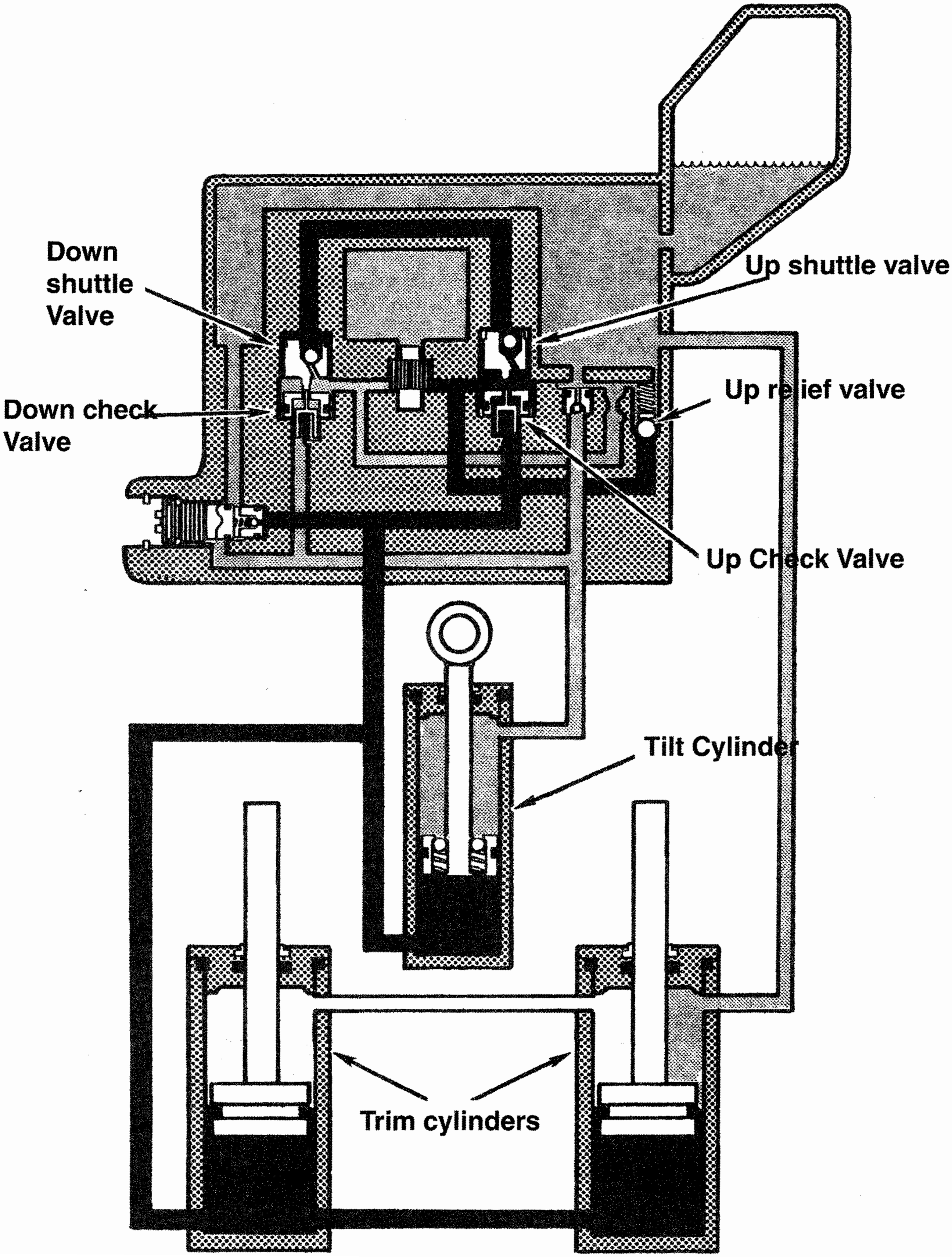


Fig. 6 Fluid flow diagram of FasTrak® system during up (trim out/tilt up) operation—darkest passages represent pressurized fluid flow

Fig. 7 A manual release valve is located on the port side of the FasTrak® system

To trim the engine out, start by releasing the valve and raising the motor further than the final desired trim position. Close the release valve and gently allow the tilt cylinder to take the motor's weight; then slowly open the release valve, bleeding off pressure using the weight of the engine. Close the valve again once the desired trim level has been reached.

☐ **Remember that the manual release valve must be closed (turned gently inward) in order for the FasTrak® system to operate properly.**

CONVENTIONAL LARGE MOTOR SYSTEM

◆ **See Figure 9**

The large motor conventional trim/tilt system is completely self-contained in an assembly that is mounted to the engine stern bracket. The entire assembly is secured to the engine stern brackets by 3 bolts on either side. Mounted on or in the main manifold assembly are all system components including an electric motor, a fluid reservoir and *2* trim cylinder/ram assemblies and a single tilt cylinderlshock absorber.

Whenever the trim button is pressed upward, the electric motor rotates clockwise, (as viewed from the pump end) pumping hydraulic fluid to force the cylinders upward. Because of a mechanical advantage, the trim cylinders perform **most,** but not all of the work. Once the motor is raised 15° (to the end of the trim cylinder travel), the tilt cylinder moves the engine through the remaining 50° of the tilt range.

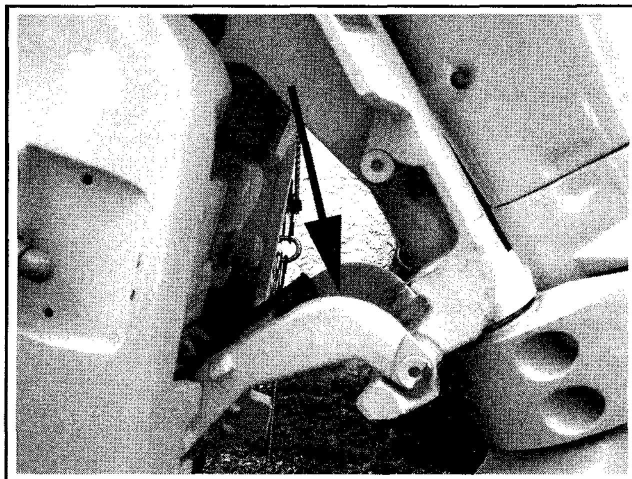


Fig. 8 An integral trailering bracket provides support when the engine is raised

■ **Although the engine can be operated above the 15° trim tilt level (for shallow water driving), at speeds above 1500 rpm, the trim-up relief valve will open, automatically lowering the motor back to the fully trimmed out (15° position). Also, when the motor is running above 1500 rpm, it will NOT tilt upward past the 15° position.**

When the down switch is activated, fluid is pumped to the top of the trim and tilt cylinders whose pistons move the engine downward (pushing fluid from underneath the pistons as they travel downward).

A manual release valve is provided in order to provide tilt/trim function in the event of certain electrical or mechanical system failures. The valve is normally located on the starboard side of the trim/tilt bracket assembly and is accessed with a slotted screwdriver through a hole on the outside of the stern bracket.

✳✳ WARNING

NEVER open the manual release valve more than 1 112 turns. And, the valve must be closed again in order for the shock absorption system and reverse thrust system to work.

A trim gauge is provided with the motor and a sending unit is attached to the port stern bracket. The switch can be accessed with the motor fully tilted.

An integral trailering bracket is provided to protect the system from stress and shock. The bracket should be used whenever the boat is towed or in storage.

Troubleshooting

TRIM/TILT SYSTEM DIAGNOSIS

FasTrak® System

◆ **See Figures 10 and 11**

Should the FasTrak® system malfunction, use the accompanying symptom and service chart to help determine the cause. Unfortunately, some of the service steps require "substituting" a known good part, which is often not available unless purchased. Occasionally, substituting a known good part will fix the problem; but, more often than not, it only proves that the original part was fine. For this reason, substitution should be avoided unless absolutely necessary (unless the parts counter person is a real buddy and will take back the good part if it doesn't fix the problem). If one of the service steps involves substitution, skip it and eliminate the other possibilities first.

Also, keep in mind these basic points for system troubleshooting:

- If the system does not work **and** the motor does not run or make any noise, then refer to the Power Supply procedure in this section.
- If the engine tilts part of the way upward, but does not move smoothly or with a constant sound, there is probably air in the system (usually caused by low fluid level). Check and refill the reservoir (as detailed in the Maintenance and Tune-Up section). Bleed air from the system by running the engine fully up and down with the trim/tilt motor for at least 5 complete cycles, pausing between each cycle to recheck fluid level and top-off, as necessary.
- If the motor seems to be binding mechanically, open the manual release valve and tilt the motor manually up and downward to check for smooth operation or binding.
- If the engine does not tilt as high as it should or the motor stops operating at the maximum position (does not sound like it is stalled, but shuts off), check the Tilt Limit Switch Adjustment, as detailed in this section.
- If, after a repair or manual release valve replacement, the motor will not lower from the shallow water drive position at any throttle setting, make sure the proper manual release valve is installed. The manual release valve used on some motors should have a shallow groove in the valve face. If a groove is present, the valve is designed for V6 engines.

Conventional Large Motor System

If problems are encountered with a conventional large motor system, use the following list of symptoms and possible causes to help determine the problem.

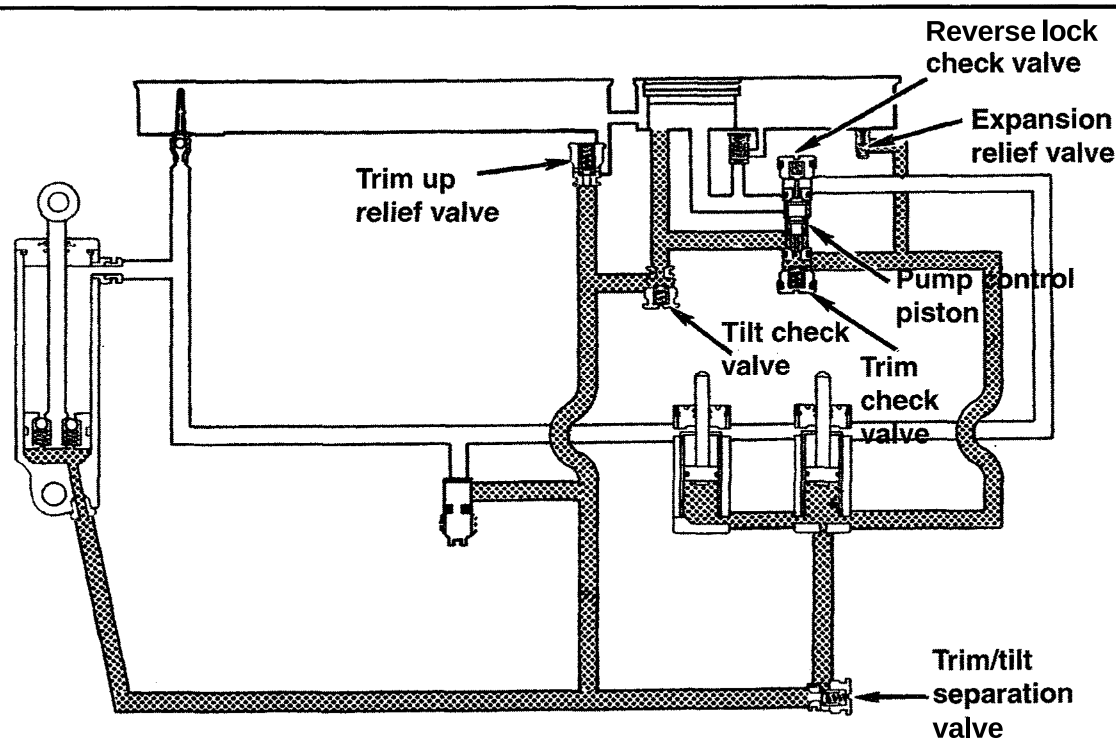


Fig. 9 Fluid flow diagram of the conventional large motor system during up (trim **out/tilt** up) operation—shaded passages represent pressurized fluid flow

symptoms	Service Steps
Unit will not move in either direction	① ② ③ ④ ⑥
Unit runs slowly in one direction, normal speed in other direction	① ② ⑥
Unit runs slowly in both **directions** (if low hours) (if high hours)	① ② ⑦ ① ② ⑤ ⑦
Unit leaks DOWN **and/or** will not hold trim position against thrust in forward.	① ② ⑤ ⑦
Unit leaks UP, will not hold a trim position against propeller thrust in reverse. Does not leak down or lose trim **position** in forward.	① ② ⑥
Unit leaks both UP and DOWN - Leaks down in tilt range **and/or** will not hold trim position against thrust in forward or reverse.	① ② ⑦
Unit will not **trim/tilt** one way, but works okay the other way Unit will not run DOWN - but runs UP okay; or it runs DOWN okay - but will not run UP.	② ③ ⑥

Service Steps

A. Be sure the manual release valve is closed, If NOT, tighten firmly and retest.

B. Temporarily, install a known good manual release valve and retest. If symptoms remain, original valve is not the problem. Reinstall original valve.

C. If symptoms disappear, the original valve was faulty. Remove temporary valve and replace with correct valve.

D. Go to Power Supply in this section to determine if problem is power supply.

E. Remove trim motor and check condition of drive coupling. If coupling is damaged, replace it.

F. **Temporarily, install a known good pump manifold assembly and retest. If symptoms [illegible] original [illegible] is not the [illegible]**

G. If symptoms disappear, the original pump manifold assembly was faulty. Remove temporary assembly and replace it with correct one.

H. Install replacement pump manifold **assembly** and retest. If all symptoms are not corrected, reconsider the problem using the new symptoms.

I. Install O-ring kit. Look for any cylinder damage. Look for chips in fluid or Impact valves. Look for other abnormal conditions. If all symptoms are not corrected, reconsider the problem using the new symptoms.

Fig. 10 **FasTrak®system** diagnosis—perform the appropriate service steps in order for the applicable symptom

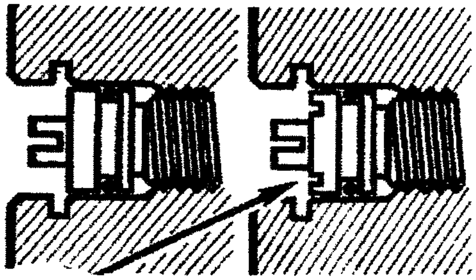


Fig. 11 Make sure the proper manual release valve is installed the face of the manual release valve should have a groove on FasTrak® equipped V6 motors

Before starting the troubleshooting procedure, make sure all basic system checks are completed as follows:

- If the system does not work **and** the motor does not run or make anv noise, then refer to the Power Supply procedure in this section.
- If the engine tilts part of the way upward, but does not move smoothly or with a constant sound, there is probably air in the system (usually caused by low fluid level). Check and refill the reservoir (as detailed in the Maintenance and Tune-up section). Bleed air from the system by running the engine in ten second spurts fully up and down with the trim/tilt motor for at least 5 complete cycles, pausing between each cycle to recheck fluid level and top-off, as necessary.
- If the motor seems to be binding mechanically, open the manual release valve and tilt the motor manually up and downward to check for smooth operation or binding.

1. If only the tilt cylinder leaks down, check the following:
- Oil lines
- Manual relief valve
- Trim-up relief valve
- Tilt pistons and/or seals
- Tilt check valve

2. If both the tilt and trim cylinders leak down, check the following:
- Trim pistons and seals
- Trim cylinder sleeves
- Trim check valve
- Expansion relief valve

3. If there is no reverse lock, check the following:
- Manual release valve
- Filter valve
- Tilt pistons and/or seals
- Reverse lock check valve
- Oil lines

4. If the unit works, but slower than normal, check the following:
- Make sure there is no mechanical binding
- Hydraulic pump
- Electric motor
  Trim-down relief valve
- Expansion relief valve

5. If the motor runs but the system does not move the engine, check the following:
- Fluid level
- Pump coupler
- Hydraulic pump

6. If there is no trim when under load, check the following:
- Manual release valve
- Trim relief valve
- Trim pistons and/or seals
- Trim cylinder sleeves
- Expansion relief valve

7. If the tilt down function does not work, check the following:
- Manual release valve
- Filter valve
  Trim-down relief valve
- Pump control piston

8. If the unit becomes locked in the tilt up position, check the expansion relief valve.

CHECKING CURRENT DRAW WITH AN AMMETER

2 MODERATE

◆ **See Figures 12, 13 and 14**

One of the quickest ways to narrow down system problems is through the use of an ammeter to check current draw by the motor during system operation. In order to accomplish this test, you'll need a fully charged battery with at least 360 CCA (50 amp-hour). Also, you'll need a stopwatch and an ammeter. The capacity of the ammeter will vary with the system you are testing. You'll need one capable of reading 0-100 amps (for FasTrak® systems) or 0-60 amps (for large-motor conventional systems).

	Prestolite 3 in. Dia.		*Bosch* 2.5 in. Dia.		*Showa* 3 in. Dia.		*Showa* 2.4 in. Dia.	
	Normal Current Draw	Time in Seconds	Normal Current Draw	Time in Seconds	Normal Current Draw	Time in Seconds	Normal Current Draw	Time in Seconds
(B) Trim Up	11-15	7-9	7-10	7-9	5-8	8-10	7-9	8-10
(C) Tilt Up	11-15	7-9	7-10	6-9	8-10	7-9	9-12	6-7
Stall Up	30-35	•	30-35	•	19-23	•	25-29	•
Stall Down	21-25	•	18-32	•	14-18	•	12-17	•
Full Range Up	•	15-20	•	14-16	•	16-18	•	14-16
Full Range Down	•	15-20	•	15-20	•	16-18	•	15-17

Fig. 12 On large-motor conventional systems, motor test specifications will vary with the type of electric motor installed

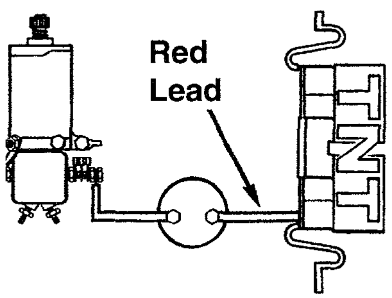


Fig. 13 Wire an ammeter between the solenoid and the **trim/tilt** motor power feed to check current draw

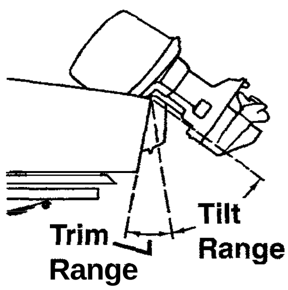


Fig. 14 Current draw and performance should be timed in the trim range (while the motor is in contact with the trim rams)

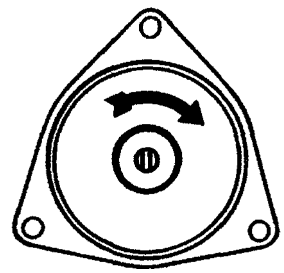


Fig. **15** The motor must rotate clockwise (viewed from pump) with power applied to the BLUE lead

The test should occur with the boat either on a trailer or sitting dockside/moored with little or no current.

☐ If testing a large-motor conventional system, refer to System Identification in this section for information on identifying the type of electric motor installed. Specifications for the types of electric motors installed on large-motor conventional systems will vary by motor type.

1. Connect a suitable ammeter in series, between the battery side of the starter solenoid and the red 14 gauge lead to the trimltilt motor/junction box, as shown.

☐ In the next step, time only the trim up for **FasTrak®** systems or both the time for trim up and, separately, the time for tilt up on large-motor conventional systems.

2. Start with the motor trimmed fully inward (toward the transom), then operate the trimltilt switch to move the motor fully out through the trim range (FasTrak® motors) or the trim and tilt range (conventionalmotors). Watch the ammeter while the motor runs through its range and use the stopwatch to determine the amount of time it takes. On FasTrakB systems, the motor should move through trim range (NOT the tilt range) in 9 seconds and draw approximately 22 amps. For large-motor conventional systems, refer to the accompanying chart to determine trim up acceptable trim up and tilt up current draws and times.

☐ For all **dual-ram** systems (both **FasTrak®** and large-motor conventional systems) the motor has reached the end of the trim-out (up) range once it begins to JUST come off the 2 trim rams.

3. For FasTrakB systems, run the engine the rest of the way up through tilt range, the amount of time does not matter.

4. Once the motor reaches stall height, check the ammeter reading with the motor operating against the stall. At the stall-up position, current draw should be approximately 60-75 amps for FasTrakB systems. For large-motor conventional systems, refer to the accompanying chart, as specifications vary with the type of electric motor installed.

5. Run the motor back down in the same manner as up. That means for large-motor systems, you'll time the trim and tilt ranges separately, while watching the ammeter both times. For FasTrakB systems. run the motor back down until it just contacts the trim rams. This is the beginning of the trim-down range. Then, run the motor down through the trim range until it is fully trimmed inward, while watching the ammeter and using the stopwatch to time it. The electric motor on FasTrakB systems should draw approximately 16 amps and take 9 seconds to run inward through the trim range.

6. Once the motor is fully trimmed inward (at the trimmed-in stall position), continue to operate the system while observing the ammeter. At the stall-down position, current draw should be approximately 35-45 amps for FasTrakB systems. For large-motor conventional systems, refer to the accompanying chart, as specifications vary with the type of electric motor installed.

7. If there is a normal current draw, but there is a slow operating speed on FasTrakB systems, check the following:
- Damaged impact valves
- Malfunctioning check or shuttle valves
- Damaged manual release valve

8. If there is a normal current draw, but there is a slow operating speed on large-motor conventional systems, check the following:
- Damaged pump control piston
- Malfunctioning check valve

9. If there is a low current draw, check the following:
- Leaking valves or O-rings
- Weak relief valve springs
- Damaged pump
- Fouled or damaged check valves (FasTrakB only)
- Damaged manual release valve (FasTrakB only)

10. If there is a high current draw, check the following:
- Binding pump
- Binding motor
- Sticking valves
- Damaged relief valve springs (on FasTrakB systems, this should only cause stall up malfunctions)

CHECKING THE MOTOR NO LOAD OPERATION

DIFFICULT

◆ **See** Figure **15**

The electric motor used on these systems can be tested as a stand-alone component, but you will need an ammeter and a vibration or mechanical tachometer. The ammeter must be capable of reading 0-50 amps for both the FasTrak® and large-motor conventional systems. Also, you will need a fully charged battery with at least a 360 CCA (50 amp-hour) rating, and a vise or mounting to hold the motor steady during the test.
The motor must first be removed from the assembly.

If testing a large-motor conventional system, refer to **System** Identification in this section for information on identifying the type of electric motor installed. Specifications for the types of electric motors installed on large-motor conventional systems will vary by motor type,

1. Remove the Trim/Tilt motor from the valve bodylmanifold assembly, as detailed in this section.
2. Mount the trimltilt motor in a suitable holding fixture or a soft-jawed vise.
3. Connect an ammeter in series between a freshly charged battery (of at least 360 CCA/50 amp hour rating) and the motor during the next series of steps. The ammeter red lead should be connected to the battery.

4. While holding the vibration or mechanical tachometer against the motor to determine rotational speeds, connect the battery to the motor's **blue** lead. The motor must rotate clockwise when viewed from the pump end. Note the readings on both the ammeter and the tachometer.

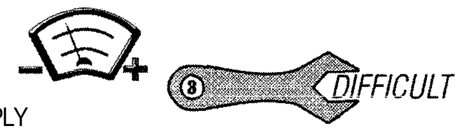
5. While holding-the vibration or mechanical tachometer against the motor to determine rotational speeds. connect the battery to the motor's **green** lead. The motor must rotate counterclockwise when viewed from the pump end. Note the readings on both the ammeter and the tachometer.

6. The motor must turn the correct direction for each test, as noted in the previous steps. The motors must draw the appropriate maximum amperage (or less) while turning the appropriate minimum speed. For FasTrak® systems, the motor must draw no more than 10 amps while rotating at least 7000 rpm. For large-motor conventional systems specifications vary with the type of electric motor installed:

Prestolite motors should draw no more than 7 amps while turning at least 4700 rpm.

- Bosch motors should draw no more than 4.5 amps while turning at least 5450 rpm.
- 3.0 and 2.4 diameter Showa motors should draw no more than 4.5 amps while turning at least 5000 rpm.

2.9 in diameter Showa motors should draw no more than 10 amps while turning at least 7000 rpm.



POWER SUPPLY

◆ **See Figure 16**

In order to properly check the power supply to the trimltilt motor, make sure the battery is in good condition and fully charged. Also make sure the key switch is turned to the **Off** position, with the kev removed and the safetv lanyard removed from the switdh.

The following tests are made on the relay side of the trimltilt relay sockets. Terminals may be identified using the wire colors. Remember that the up relaylup circuit contains blue motor wiring while the down relayldown circuit contains green circuit wiring. The referenced terminals can also be identified using the Trim/Tilt Wiring Diagrams in this section.

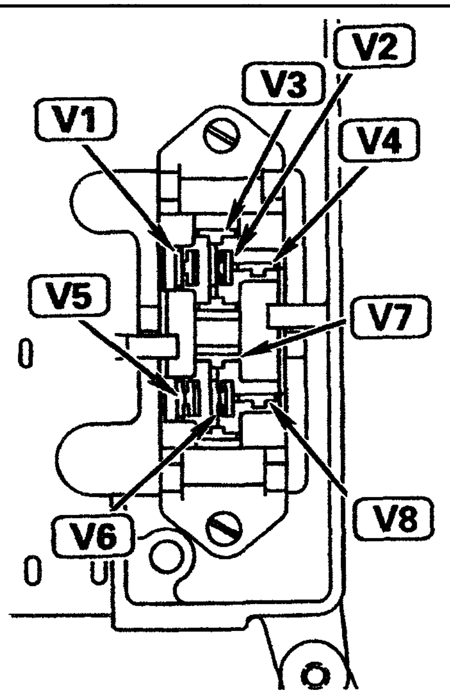


Fig. 16 Although the bracket (and relay positioning within the bracket) may vary, the relative positions of the terminals does not change. V1 and V2 (or V5 and V6) are always the pair of parallel terminals, when compared to the other 3 in the socket

1. Connect the DVOM black lead to a good engine ground and check for voltage at the battery side of the starter solenoid by probing with the red DVOM lead. If there is no voltage, check the battery and wiring, otherwise proceed with the next step.

2. Mark the UP and DOWN relays, then remove them from the relay sockets.

3. Check the UP circuit, start by connecting the red DVOM lead to **V1** (up circuit/red wire) and the black lead to **V2** (up circuit/black wire at center of relay socket). There should be battery voltage present, otherwise check the red wire between the relay socket and starter solenoid. If the power feed is not the problem check the ground wire between relay socket (or terminal strip) and engine ground. If power is present, proceed with the next step.

4. Connect the black DVOM lead to a good engine ground and the red lead to **V3** (bluelwhite wire). Push the UP trim button and watch for battery voltage on the DVOM. If no voltage is present, check the remote trim switch and wiring (if they check out, proceed with the next step). If voltage was present at **V3,** proceed with the next step.

5. Push the trimltilt UP button on the lower motor cover and check for voltage at **V3.** If voltage is present, skip the remainder of this and the entire next step. If there is no voltage, trace the bluelwhite wire out of the trim switch on the lower motor cover to the bullet connector and check for voltage there. If there is still no voltage present, check for voltage at the red bullet connector that supplies the motor cover trim switch. If the switch and wire is good, proceed with the next step.

6. Some models (such as most/all FasTrak® systems and some conventional systems) contain a tilt/limit switch. On models so equipped, if there was no voltage at **V3** in one of the previous steps, try isolating the tilt limit switch. Disconnect the blueiwhite tilt limit switch bullet connectors, then reconnect them, bypassing the tilt limit switch and repeat the previous step to test for voltage at **V3** when pressing the trimltilt up button on the lower motor cover, If voltage is now present adjust or replace the tilt limit switch.

7. Install the up relay to the bracket, **but** only slide the blades halfway into the relay socket so that you can still access them with the DVOM probes.

8. Connect the red DVOM lead to relay blade M for terminal **V4** (the bottom blade that slides into the terminal socket for the blue motor wire) and the black lead to a good engine ground. Press the UP trim button and watch for voltage on the blade. If there is no voltage, perform the Checking the Relay procedure in this section. If voltage was present, proceed with the next step.

9. Push the relay the rest of the way into the bracket, now disconnect the blue and green wire connector from the trim motor. Using the red DVOM lead, check for voltage on the blue wire coming from the relay bracket while the UP button is pressed. If voltage is not present, check the blue wire between the connector and the relay bracket. If voltage is present, but the motor was not operating, check the blue lead to the motor and the motor itself.

10. Repeat the same test, but for the DOWN circuit (which never uses a tilt limit switch). We'll take you through it again though, so as not to get confused with the terminal identifications and wire colors that differ slightly. Start by removing both the up and down relays from the relay bracket (if installed after the previous steps).

11. Connect the red DVOM lead to **V5** (down circuitired wire) and the black lead to **V6** (up circuitiblack wire at center of relay socket). There should be battery voltage present, otherwise check the red wire between the relay socket and starter solenoid. If the power feed is not the problem, check the ground wire between the relay socket (or terminal strip) and engine ground. If power is present, proceed with the next step.

12. Connect the black DVOM lead to a good engine ground and the red lead to **V7** (greenlwhite wire). Push the DOWN trim button and watch for battery voltage on the DVOM. If no voltage is present, check the remote trim switch and wiring (if they check out, proceed with the next step). If voltage was present at **V7,** proceed with the next step.

13. Push trimltilt DOWN button on the lower motor cover and check for voltage at **V7.** If voltage is present, proceed with the next step. If there is no voltage, trace the greenlwhite wire out of the trim switch on the lower motor cover to the bullet connector and check for voltage there. If there is still no voltage present, check for voltage at the red bullet connector that supplies the motor cover trim switch.

14. Install the down relay to the bracket, **but** only slide the blades halfway into the relay socket so that you can still access them with the DVOM probes.

15. Connect the red DVOM lead to relay blade M for terminal **V8** (the bottom blade that slides into the terminal socket for the green motor wire) and the black lead to a good engine ground. Press the DOWN trim button

and watch for voltage on the blade. If there is no voltage, perform the Checking the Relay procedure in this section. If voltage was present, proceed with the next step.

16. Push the relay the rest of the way into the bracket, now disconnect the blue and green wire connector from the trim motor. Using the red DVOM lead, check for voltage on the green wire coming from the relay bracket while the DOWN button is pressed. If voltage is not present, check the green wire between the connector and the relay bracket. If voltage is present, but the motor was not operating, check the green lead to the motor and the motor itself.

CHECKING THE RELAYS

MODERATE

◆ **See Figure 17**

A relay is essentially a remote controlled switch. Typically speaking, a relay works when a switch circuit is energized, pulling the contacts of a normally open electro-magnetic switch closed, completing the circuit that the relay controls. Therefore, 2 wires from this type of relay will connect to the control circuit (the **S** terminals). One of those wires will be ground for the control circuit (black in this case) and one of them will be colored (either bluelwhite for the UP circuit or green/white for the DOWN circuit). Two other terminals of these relays are connected to the battery (one to battery positive or **B+**, the red wire and the other to battery negative or **B-**, the black wire). The battery circuit blades are the center blade and the other blade directly above it or to the side (depending on how the relay is oriented) that is parallel to the center blade. The final blade terminal, known as the M terminal, is the wire to the controlled motor (blue for the UP circuit or green for the DOWN circuit).

Because relays consist of various internal wiring connections (of the electro-magnetic switch), it can be tested using a DVOM to check resistance or voltage during various test conditions. In addition to a DVOM, you'll need a fully-charged 12 volt battery and jumper leads that are used to apply battery voltage to the signal circuit.

Use the accompanying illustration for quick and easy terminal identification.

1. Remove the relay to be tested from the relay bracket.
2. onnect the DVOM meter leads (set to read resistance) across the **B-** and M terminals. The meter must show no continuity at this time.
3. Connect the DVOM meter leads (set to read resistance) across the **B+** and M terminals. The meter must show no continuity at this time.
4. Connect the DVOM meter leads (set to read resistance) across the 2 **S** terminals. The meter must show 70-100 ohms resistance.
5. Using the set of jumper wires, apply 12 volts to the **S** terminals, while checking for continuity between the **B+** and M terminals. There must now be continuity.

■ **Remember, when power is applied to the signal circuit (S terminals) the internal relay switch contacts should close, providing power to the relay controlled circuit (battery power to the motor).**

6. With power still applied to the **S** terminals, check for continuity between the **B-** and M terminals, there should still be NO continuity.
7. Replace the relay if any test results vary.

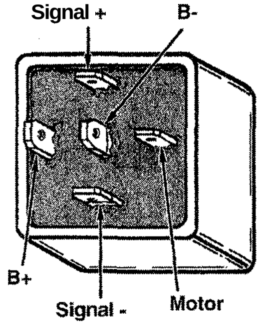


Fig. 17 Relay terminal identification

CHECKING THE TRIM GAUGE

MODERATE

◆ **See Figures 18 and 19**

The trim gauge can be quickly checked using a voltmeter and a jumper wire. To determine if a problem is with the gauge or the circuit, proceed as follows:

1. Locate the trim switch wiring. Refer to the accompanying diagrams, the wiring in this section or the wiring under Wiring Diagrams in the Ignition and Electrical Systems section, as necessary.
2. Turn the key switch to the **ON** position, then use the DVOM to check for voltage between the trim gauge **I** (purple wire) and ***G*** (black wire) terminals.
3. If there was no voltage in the previous step, suspect the instrument harness, key switch or 20-amp fuse.
4. If voltage is present, disconnect the whiteltan lead from the gauge **S** terminal. With the key switch still **ON,** the gauge should indicate full-downward trim position. Now, us a jumper wire to connect the **S** (whiteltan wire) and ***G*** (black wire) terminals. If power is applied to the circuit and the gauge is operating properly, it will now indicate full-upward trim position.
5. Replace the gauge if it does not operate properly with power applied. If the gauge checks out in the previous step, refer to Checking the Trim Sender, in this section, as the sender or wiring is the likely culprit.

CHECKING THE TRIM SENDER

MODERATE

◆ **See Figure 20**

The trim sender can be checked using an ohmmeter. To ensure accurate test readings, a digital meter is recommended. Also, remember that resistance specifications are for readings taken at ambient temperatures of about 68°F (20°C) and readings taken with components at other t emperatures will vary.

1. Locate the 3-pin connector for the trim control harness between the instrument and engine trim harness. The connector normally contains the whiteltan lead from the trim sender, as well as the blue/white and green/white motor control circuit wires.
2. With the key switch **OFF** to prevent possible damage to the meter, connect the DVOM (set to read resistance) between the whiteltan wire (terminal **C** of the 3-pin connector) and a good engine ground.
3. With the engine in the full-downward trim position, the meter must show a reading above 80 ohms.
4. With the engine in the full-upward trim position, the meter must show a reading below 10 ohms.
5. If readings differ, replace the trim sender. If the sender tests good, suspect the trim gauge or circuit, refer to Checking the Trim Gauge in this section.

Tilt Limit Swith (Fas Trak® Only)

◆ **See Figure 21 and 22**

Some models (normally including all motors equipped with the FasTrak® system) are equipped with a tilt limit switch mounted to the assembly at the tilt/swivel bracket. The switch can be adjusted to electronically limit the maximum amount of tilt, therefore protecting the operator from striking the motorwell with the engine using the tilt feature. However, keep in mind that this switch only stops the motor from operating past a certain point, and does nothing to mechanically stop the motor from raising upward, past that point due to manual intervention. This means that, in the case of a severe impact, the motor could be thrust upward, striking the motorwell. If possible, the motor should be repositioned on the transom bracket to prevent such possible collisions. In the event that this is not possible, the tilt limit switch provides some small measure of protection during normal raising of the motor via the tilt system.

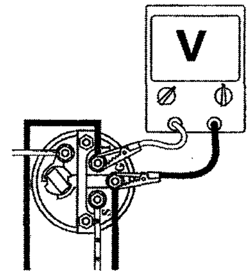


Fig. 18 With the key switch ON, there must be voltage between the **I** and ***G*** terminals otherwise the gauge cannot operate properly

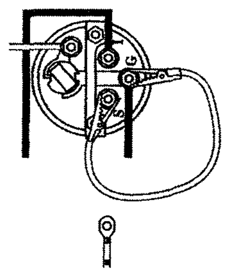


Fig. **19** With voltage present and the whiteltan wire from the harness disconnected from the gauge, use a jumper wire between the ***G*** and **S** terminals, and see if the gauge reads trim fully-upward

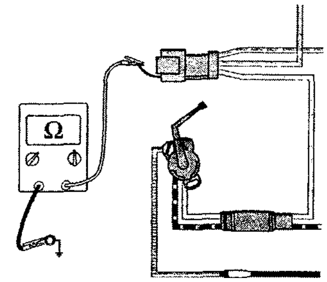


Fig. **20** The trim sender is checked using an ohmmeter to take resistance readings between the **white/tan** lead and a good engine ground

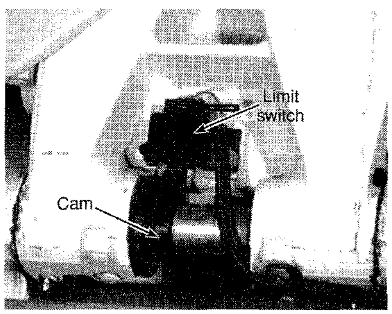


Fig. **21** The tilt limit switch**...**

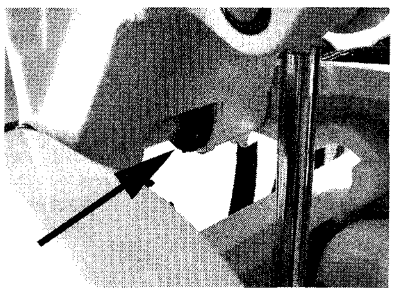


Fig. **22** **...** and cam are mounted on the tilt bracket

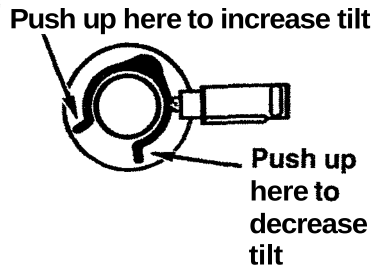


Fig. 23 Typical tilt limit switch adjustment

ADJUSTMENT

◆ See Figure **23**

If switch adjustment is necessary, proceed as follows

1. Using the trimltilt switch, trim the motor all the way inward (toward the boat).

2. With the motor trimmed in, locate the switch and adjustment tab on the tilt bracket. It is accessible through a housing where part of the tilt pivot passes into the bracket. Although the adjustment may vary on some models, typically you:

- Push the lower adjustment tab upward to reduce the maximum amount of tilt electronically allowed by the system.
- Push the upper adjustment tab upward to increase the maximum amount of tilt electronically allowed by the system.

■ If your limit switch varies, move the **tab(s)** in the opposite direction, as necessary, to properly adjust the system.

3. Verify the adjustment using the trimltilt switch and repeat, as necessary, for optimum adjustment (to stop the motor at a point before it strikes the motor well).

Trim Sending Unit

Component repair, overhaul or replacement may require trim sending adjustment. Similarly, if the motor is rigged to a different boat, the unit will have to be adjusted to the new positioning.

ADJUSTMENT

FasTrak® Systems

◆ See Figures **24 and 25**

1. Tilt the engine and engage the trailering bracket.
2. Temporarily install a thrust rod (heavy drift pin or Evinrude/Johnson # 436541) into the No. 3 hole on the stern bracket.

■ If a thrust rod is not available, note the current location of the trim stop pin, then remove the spiral spring clip securing it and temporarily move the trim stop pin itself to the No. **3** hole in the bracket.

3. Locate the sending unit by tracing the wiring (normally there's a white/tan, a black/tan and a green wire). Refer to the Wiring Diagrams, either in this section or the Ignition and Electrical Systems section for more details.

■ The sending unit is normally located immediately adjacent to the lower tilt pin assembly.

4. Disengage the trailering bracket, then lower the motor against the thrust rod. Check the trim gauge needle, it should show a centered position.
5. If the gauge is not reading a centered position, tilt the engine up slightly, loosen the sending unit screws and adjust the sending unit (by pivoting it up or down). Then lower the engine back against the thrust rod to check the adjustment. Repeat until the gauge shows the motor is centered when it is sitting against the thrust rod.
6. After adjustment is correct, tighten the screws, making sure the sending unit does not move.
7. Remove the temporary thrust rod/drift pin.

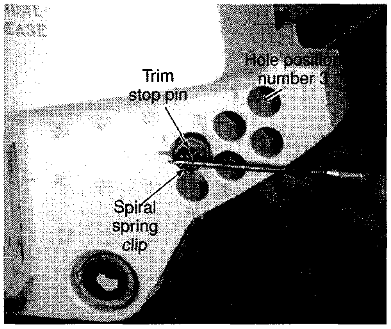


Fig. **24** Temporarily install a thrust rod (or the trim pin) in the bracket No. **3** hole**...**

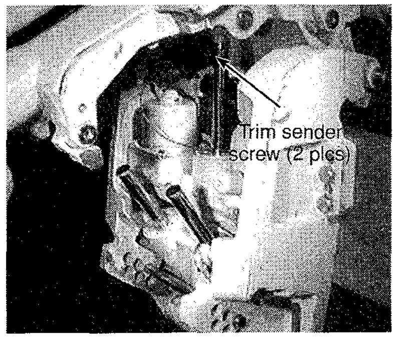


Fig. **25** **...** then lower the motor onto the pin and carefully adjust the switch

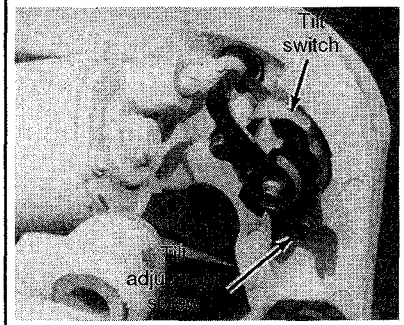


Fig. **26** Trim sending unit on large-motor conventional systems

LARGE-MOTOR CONVENTIONAL SYSTEMS

② MODERATE

◆ See Figure ***26***

On these models, the sending unit is initially adjusted to the center position, however on some motors, additional adjustment may be necessary for the gauge to read full trim up when the motor reaches the upward limit of trim adjustment (upward movement on the trim rams).

To adjust the sending unit, proceed as follows:

1. Turn the key switch ON.
2. Using the trimltilt assembly, raise the motor to the maximum trim-up position (the point at which the tilt cylinder would just start to lift the motor off the trim rams, but make sure the motor is still sitting on the rams).
3. On V4 motors, move the horizontally mounted angle adjusting rod (trim limit pin in the holes of the transom bracket) to the center hole.
4. Loosen the sending unit screws, leaving them snug, but not completely tightened (in this way the unit can be gently pivoted, but should not shift on its own accord).
5. On V4 motors, lower the outboard against the angle adjusting rod. For V8 motors, lower the engine to the midpoint of the trim range.
6. Now, check the trim gauge needle. It should show the center position. If necessary, adjust the sending unit using a screwdriver to gently pivot it up or down slightly to center the needle.
7. Raise the engine back up to the top of the trim range again and tighten the sending unit screws securely.
8. On V4 motors, remove the angle adjusting rod from the center hole and return it to its former position (normally the hole closest to the transom).

Trim/Tilt Assembly—Fast Trak® System

REMOVAL & INSTALLATION

② MODERATE

+ See Figures **27, 28, 29, 30, 31, 32, 33, 34** and **35**

✳✳ WARNING

Anytime ***a*** steel tool is struck with a hammer, there is the possibility of chips flying which could cause serious eye injury. Therefore, wear safety glasses while removing the tilt cylinder pin.

1. Disconnect the negative battery cable for safety.
2. Remove the harness clamp (wire loom), then disengage the system 2-pin connector.
3. Disengage the 2 bullet connectors for the tilt limit switch.
4. Disconnect the remaining power trim/tilt wiring connector, then remove the rubber grommet. Using a small-bladed terminal removal tool, carefully depress the locktabs and remove each of the wire terminals from the connector. Note each of the wiring locations for installation purposes.
5. Pull the wires through the hole in the port side of the lower engine cover.
6. Using a screwdriver inserted through the hole in the port side bracket, unscrew the manual release valve, then raise the engine and lock it in place using the tilt support. For safety, install a holding strap or sturdy rope around the motor to make sure it will not accidentally drop if disturbed during service.
7. Disconnect the ground wire from the trim/tilt unit.
8. Separate the trimltilt unit wires that are located in the braided tube, so they can be removed through the hole in the stern bracket.
9. Using a pair of snapring pliers, carefully remove the external snaprings from the tilt upper pin, then, using a punch, carefully push the upper pin out of the bore.
10. Manually push the tilt piston downward into the cylinder for clearance.
11. Using the snapring pliers, carefully remove the snaprings from the lower pin, then use the punch to gently drive the lower pin from the bracket.
12. Remove the trimltilt unit from the stern brackets.
13. Refer to the overhaul procedures and accompanying exploded views, if disassembly or component replacement is necessary.
14. Keep the following points in mind when servicing the hydraulic *trim/tilt* assembly:

Before disassembly, thoroughly clean and degrease the unit. All outer surfaces should be cleaned with a siiff synthetic needle (not wire) brush and hot soapy water. It is important to prevent dirt or debris from entering the unit during service.

Before removing the manual release valve or disassembling the unit, temporarily connect the motor wiring and run the unit to the full upward trim position then jog the unit DOWN and loosen the reservoir cap 1 full turn to equalize system pressures. But, remember that there could be significant residual hydraulic pressure left behind some components, so always wear safety goggles and loosen fittings gradually, allowing pressure to bleed off before removal.

NEVER apply heat to the cylinder body or cylinders, as excessive heat can lead to high pressure leaks or component failure during operation.

- Never paint individual components while the unit is disassembled. The fear is that some portion of the paint might flake off and enter a hydraulic passage during assembly.

Some of the components in the assembly (such as the reservoir or valvelpump body mounting) are retained by Pozidriv screws that look similar to Philips screws, but would be damaged by the use of an improper (Philips) driver. Be sure to use the appropriate sizeltype of driver on all screws.

- Always use clean, lint-free shop cloths when handling assembly components.
- During assembly, replace all seals and O-rings to ensure proper, trouble-free operation.
- During valvelpump body installation (once the body is attached to the hydraulic unit), fill the pump cavity up to the top of the 2 bosses using Evinrude/Johnson Power Trim/Tilt and Steering Fluid (or equivalent). Then, using a slotted-screwdriver, rotate the pump-to-motor coupler back and forth to bleed air from the pump. Continue to rotate it a few turns in each direction until bubbles stoo coming out of the pump.

To install:

15. Apply a light coating of EvinrudelJohnson Triple-Guard, or equivalent marine grease to the lower and upper pins. Place the pins in a clean plastic bag until they are installed.
16. Position the trimltilt assembly to the stern bracket and carefully insert the lower pin to secure it.

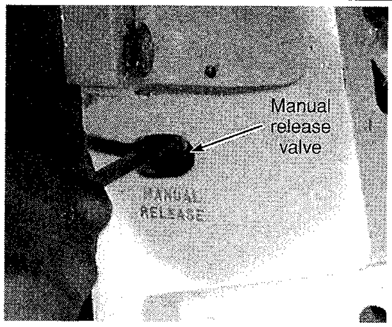


Fig. **27** Using a screwdriver, loosen the manual release valve and then engine the trailer bracket

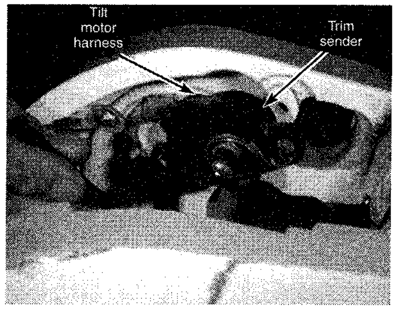


Fig. **28** Locate and disconnect the tilt motor and trim sender wiring**...**

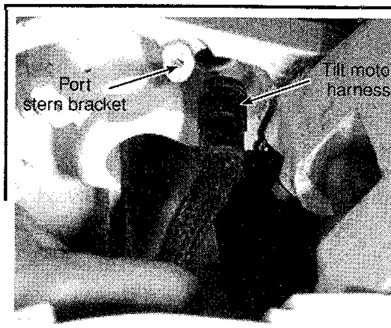


Fig. **29** **...** then feed the tilt motor harness through the opening in the stern bracket

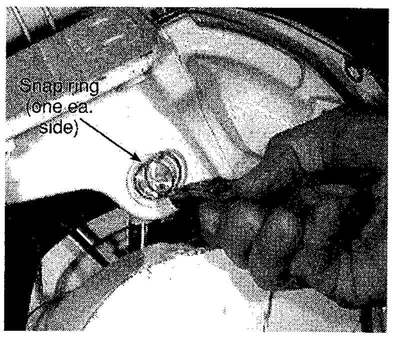


Fig. **30** Remove the **2** snaprings--one each side--from the tilt piston pin**...**

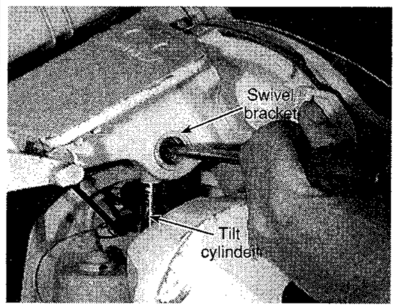


Fig. **31** **...** then carefully drive the upper tilt pin from the swivel bracket and tilt cylinder**...**

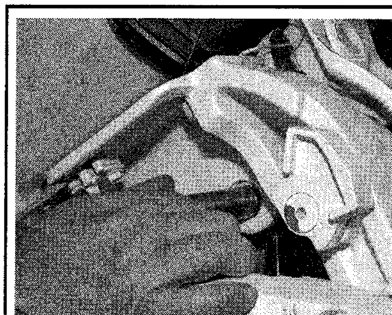


Fig. **32** **...** remove the pin from the upper tilt cylinder

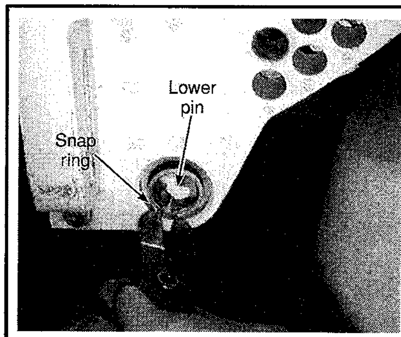


Fig. **33** Remove the enaprings from the lower pin **...**

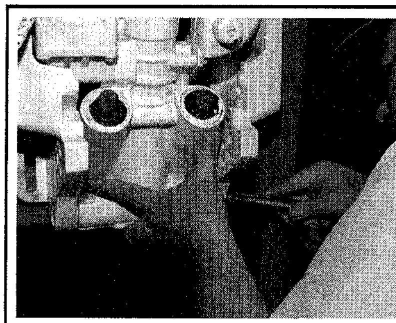


Fig. **34** **...**then remove lower pin, while supporting the trimltilt assembly

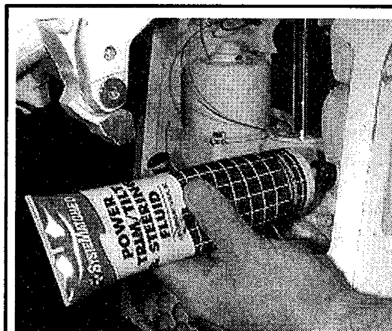


Fig. 35 Upon installation, check and top-off the reservoir fluid level

17. If the tilt tube nut was loosened, tighten it to 50-54 ft. lbs. (68-73 Nm), then back off one nut 1/8-1/4 turn.
18. Install the external snaprings to the lower pin with the sharp edge facing outward.
19. Manually extend the tilt cylinder rod until it aligns with the holes in the swivel bracket and install the upper pin. Secure using the external snaprings (also with the sharp edge facing outward).
20. Reconnect the wiring:
   a. Place the trim/tilt wires back into the braided tube and then install them through the hole in the stern bracket.
   b. Reconnect the ground wire to the trimltilt unit.
   c. Release the tilt support and lower the engine for ease of access, then firmly retighten the manual release valve.
   d. Install the 2 wires through the hole in the port side of the lower engine cover.
   e. Connect the 2 trim limit switch bullet connectors, the 2-pin system connector and the trimltilt connector (after the terminals are properly reinstalled). Install the rubber grommet and the wire loom, to the appropriate connectors.
21. Reconnect the negative battery cable, then run the engine up and down through several cycles, checking for proper operation and proper fluid level, top-off, as necessary.

OVERHAUL

◆ **See Figure 36**

Disassembly

◆ **See Figures 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50 and 51**

Thoroughly clean the external surfaces of all dirt and scale build-up before disassembling. Clean the unit with a wire brush and plenty of soap and water, to prevent any contamination of internal components.

1. Remove the reservoir fill cap; invert the unit over a drain pan; and drain all fluid from the unit.
2. Slide out the two nylon bushings from the end of the tilt cylinder.
3. Remove the three Phillips head screws securing the reservoir to the cylinder body. Lift off the reservoir and discard the O-ring in the cylinder body. Using a 6mm hex key wrench, remove the hex plug from the cylinder body and lift out the filter.
4. Tighten the manual release valve until it is snug. Using a pair of snap ring pliers, remove the internal snap ring at the end of the cavity. Back-out the manual release valve and withdraw it from the manifold.
5. Remove the screw securing the motor wire harness clamp to the side of the pump body. Remove the three remaining bolts securing the pump motor to the manifold. Lift off the motor assemblv and remove the O-ring from the end of the motor housing.
6. Using a hex wrench, remove the three Allen head screws securing the pump manifold assembly to the cylinder body. Lift off the pump manifold and remove the five O-rings from the cylinder body.
7. Secure the lower body of the trim/tilt unit in a vise with soft jaws to prevent damaging the finish on the unit. Using a universal spanner wrench or EvinrudelJohnsonTilt Cylinder End Cap Tool PIN 326485, loosen and back the end cap out of the tilt cylinder.
8. Remove the trimltilt unit from the vise and drain any fluid in the cylinder into a suitable container. Pull up on the tilt cylinder piston and withdraw it from the cylinder.
9. Remove and discard the large O-rings from the end cap and piston.
10. Place the end of the tilt cylinder in a vise with the piston end up. Remove the nut and washer from the end of the rod and slide the piston off the rod.
11. Lift out the spring, plunger and ball from each bore in the piston. Make a note of the position from which each spring<em dash>size and number of coils<em dash>is removed from the piston.
12. Using a screwdriver, pry the scraper seal out of the end cap. Lift out the O-ring inside the cap.
13. Secure the lower body of the trimltilt unit in a vise with soft jaws to prevent damaging the finish on the unit. Using a universal spanner wrench or EvinrudelJohnsonTrim Cylinder End Cap Tool PIN 436710, loosen and back out the trim rod end cap from the trim cylinder. Repeat this step for the other trim cylinder end cap.
14. Remove the unit from the vise and drain any fluid in the cylinders into an appropriate container. Pull the trim rod out from the cylinder and remove the O-rings from the end cap. Remove the two split rings and O-ring from the piston end of the trim rod.
15. Place the trim cylinder into EvinrudeIJohnsonRod Holder Tool PIN 983213 or similar device and clamp the unit in a vise. Remove the wear plate from the end of the rod and slide the end cap off the rod.
16. Using a small pryber, pry the scraper seal out of the end cap. Lift out the quad O-ring inside the trim end cap.

The trim/tilt pump, valve body, and motor do not contain any serviceable components. Therefore, do not attempt to disassemble these items. If one of these components is suspected of malfunctioning, a new replacement item must be obtained and installed.

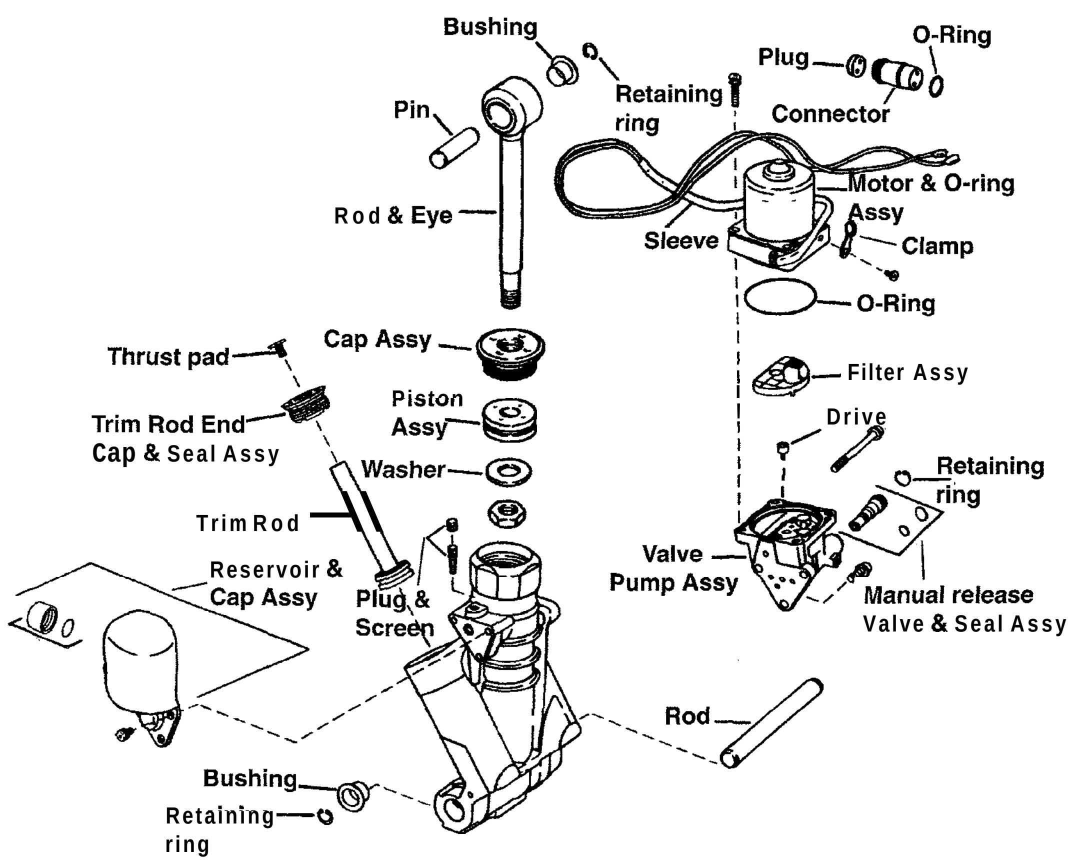


Fig. 36 Exploded view of a FasTrak® trimltilt assembly—carbureted motors

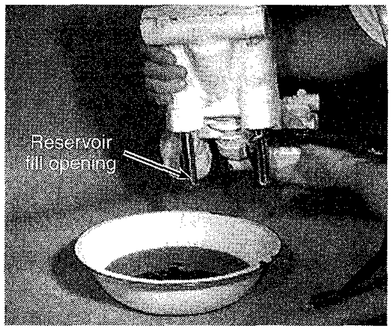


Fig. 37 Drain all fluid from the unit

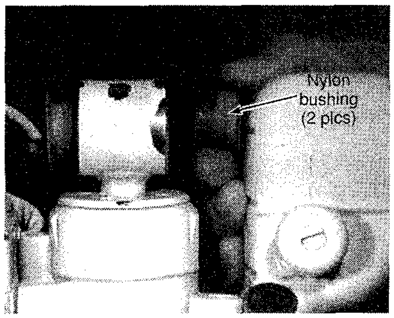


Fig. 38 Remove the two nylon bushings from the tilt cylinder

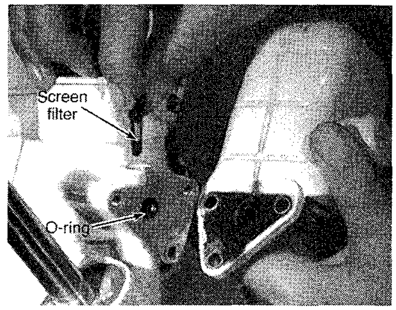


Fig. 39 Remove the reservoir

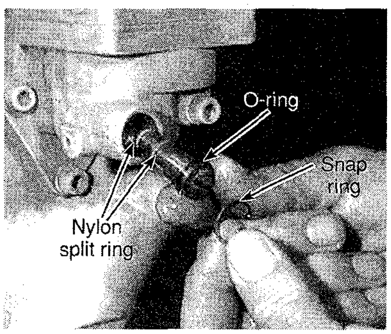


Fig. 40 Remove the snapring, followed by the manual release valve

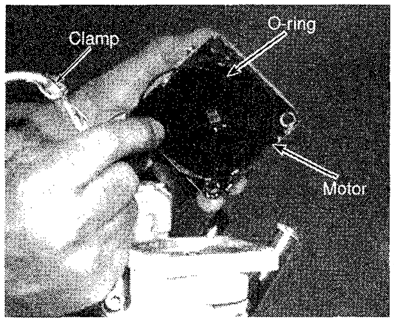


Fig. 41 Remove the motor assembly and the O-ring

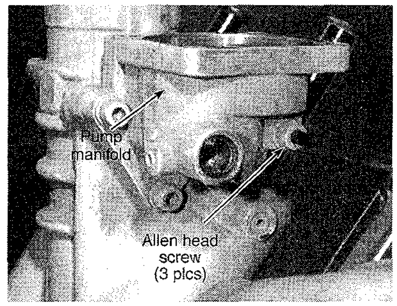


Fig. 42 Remove the 3 Allen head screws securing the pump manifold assembly

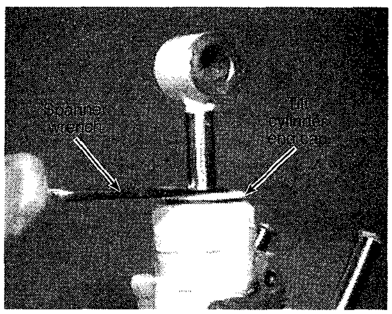


Fig. 43 Use a universal spanner to loosen and back the end cap out of the tilt cylinder

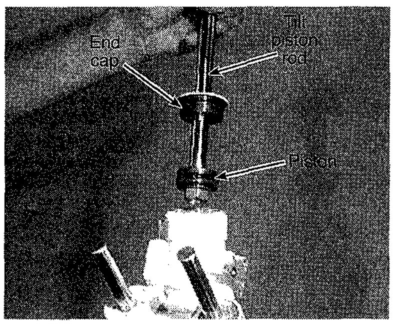


Fig. 44 Pull up on the **tilt** cylinder piston and withdraw it from the cylinder

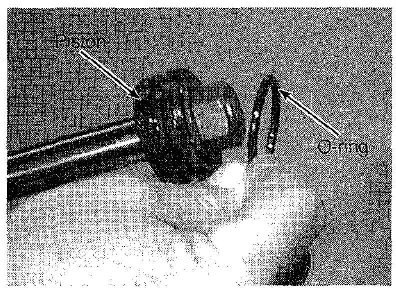


Fig. 45 Remove and discard the large O-rings from the end cap and piston

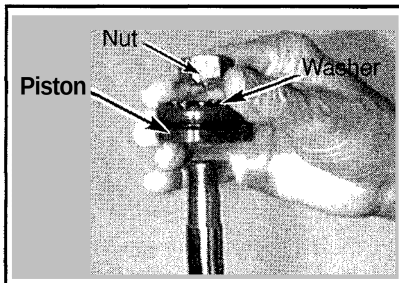


Fig. 46 Remove the nut and washer from the end of the rod and slide the piston off the rod

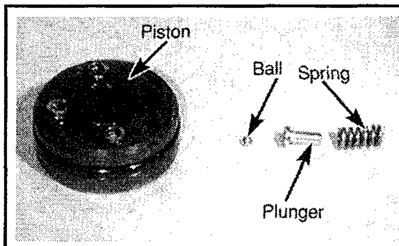


Fig. 47 Lift out the spring, plunger and ball from each bore in the piston

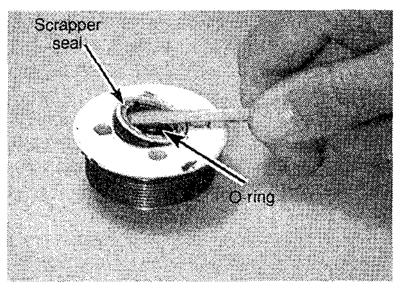


Fig. 48 Carefully, pry the scraper seal out of the end cap, then remove the O-ring

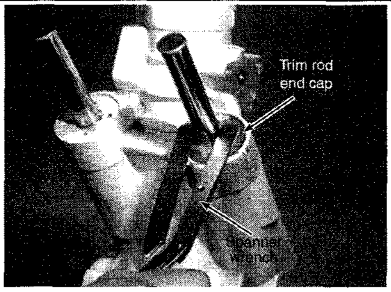


Fig. **49** Use a universal spanner to loosen and back out each trim rod end cap from the trim cylinder

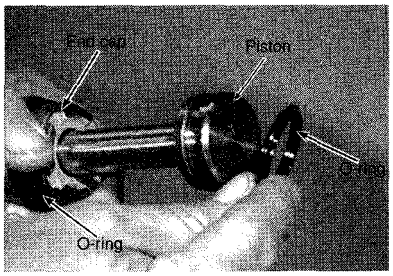


Fig. 50 Pull the trim rod out from each cylinder and remove the O-rings from the end cap

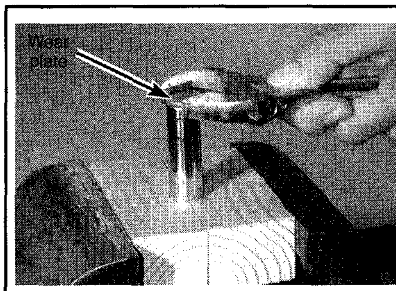


Fig. 51 Remove the wear **plate** from the end of the rod and slide the end cap off the rod.

Cleaning and Inspection

◆ See Figure 36

Wash all disassembled components and parts in solvent and blow them dry with low-pressure compressed air. Always use a lint free shop cloth when handling trim/tilt components.

Never use O-rings a second time. Always replace the O-rings with new ones. During assembling always lubricate new O-rings and seals with Evinrude/Johnson Power Trim/Tilt and Power Steering Fluid or GM Dexron II automatic transmission fluid.

Inspect the two nylon rings on the manual release valve for cuts or a split. If the nylon rings are damaged, a new manual release valve will have to be purchased. Check and replace the O-ring on the end of the valve.

Check the machined surfaces on the reservoir and cylinder body for nicks and scratches. Minor scratches may be removed with crocus cloth.

Inspect the bores in the trim and tilt cylinders for excessive scoring. If the bores are heavily scored, such a condition will result in excessive wear on new piston O-rings and wiper seals, causing internal leakage.

Clean the threaded end of the tilt rod with a wire brush to remove all traces of the nut locking agent. Keep the threads clean, dry and free of power trim fluid.

Check the nylon bushings in the end of the tilt cylinder for excessive wear. If the bushings are worn, replace them.

If the unit requires painting, wait until the unit is completely assembled. Plug all exposed fittings, ports, and electrical connector pins. Tape any exposed portions of the tilt and trim rods. Painting individual components is not recommended, because such action may allow paint chips to contaminate the fluid and possibly block the small hydraulic ports and valves.

Assembly

◆ See Figures 36 and 52 thru 64

1. Lubricate a new tilt cylinder scraper seal and O-ring with power trim/tilt fluid. Insert the O-ring and the scraper seal with the lip of the seal facing out. Place Scotch Tape over the threads on the piston end of the rod to protect the scraper seal from being damaged. Slide the end cap down onto the tilt rod with the threaded end facing up.
2. Place the tilt rod into a vise with the piston end facing up. Set the piston onto the end of the rod and a new O-ring, Insert the check ball, plunger and springs back into the piston bores, as noted during disassembly.
3. Apply a coating of Evinrude/Johnson Locquic Primer on the threads of the piston nut and the tilt rod threads and allow it to dry. Apply Evinrude/Johnson Nut Lock to the nut and rod, and then slide the washer over the piston and install the nut. Tighten the nut to 58-87 ft. lbs. (79-118 Nm).
4. Lubricate a new trim cylinder scraper seal and quad ring for the trim rod end cap with Power Trim/Tilt Fluid. Insert the quad ring and the scraper seal with the lip of the seal facing out.
5. Place the trim rod into Evinrude/Johnson Rod Holder Tool PIN 983213 or similar device and clamp the unit in a vise. Slide the end cap onto the trim rod and thread the wear plate into the end of the rod. Tighten the wear plate to a torque value of 84-108 inch lbs. (9.9-12 Nm). Remove the trim rod from the vise and holding fixture.
6. Lubricate and slide a new O-ring onto the outside groove of the trim rod end cap.
7. Lubricate a new O-ring and two split rings, and then slide the O-ring onto the piston. Insert one split ring on each side of O-ring. Position the ends of the split rings 180° apart. Repeat these steps for the other trim rod.
8. Place a new or clean filter into the pump manifold cavity.
9. Lubricate five new O-rings and install them into the cylinder body. Position the pump manifold against the cylinder body and align the three bolt holes. Install the three Allen head bolts and tighten them alternately until snug. Tighten the three bolts to a torque value of 60-84 inch lbs. (7-9 Nm).
10. Lubricate and insert the manual release valve into the pump manifold. Thread the valve in until it is seated, and then install the snap ring into the end of the opening, using a pair of snap ring pliers.
11. Mount the cylinder body upright into a vise with soft jaws. Lubricate the O-rings and back-up rings on the trim rods and insert the trim rods into

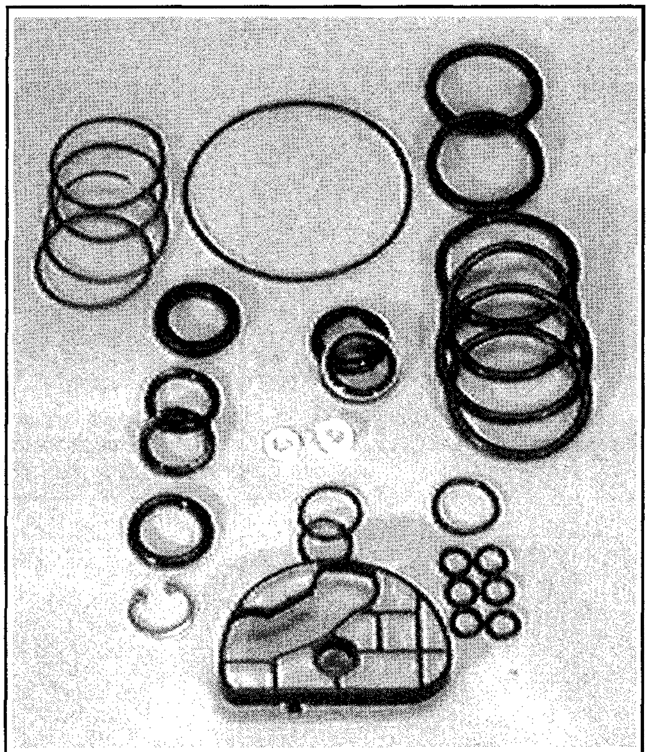


Fig. 52 Typical contents of a **Trim/Tilt** Pump Seal Kit include the necessary seals, O-rings, and filter screen for a complete overhaul. Usually there are extra parts in the package, because the same part number and package is used for several different units.

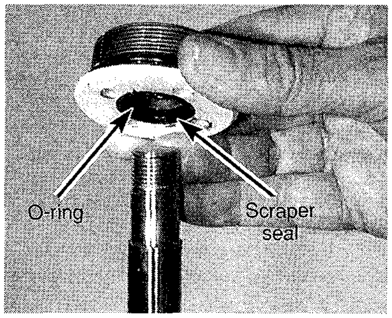


Fig. **53** Slide the end cap down onto the tilt rod with the threaded end facing up**...**

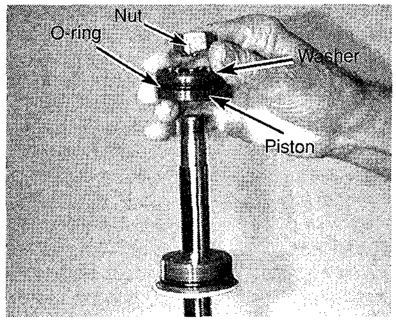


Fig. **54** **...** then, assemble the piston, washer and nut, along with the piston components (check ball, plunger, springs and O-ring)

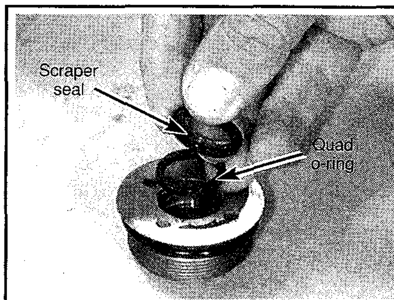


Fig. **55** Lubricate and install a new trim cylinder scraper seal and quad ring

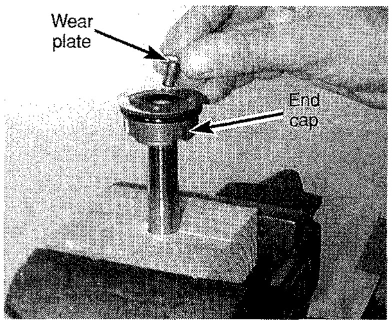


Fig. **56** Slide the end cap onto the trim rod and thread the wear plate into the end of the rod

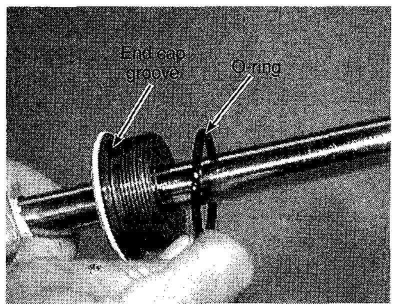


Fig. **57** Lubricate and install a new O-ring onto the outside groove of the trim rod end cap

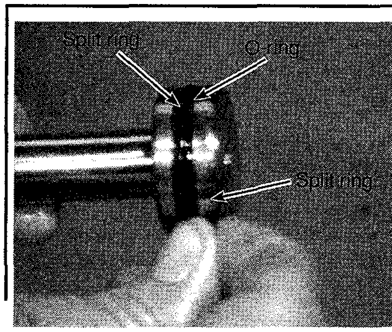


Fig. **58** Lubricate a new O-ring and two split rings, then install onto the piston

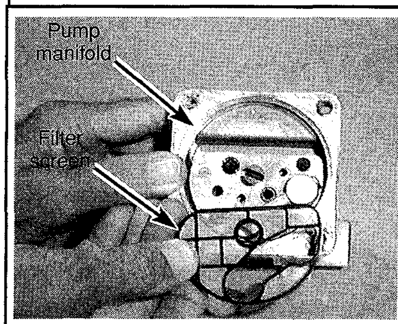


Fig. **59** Place a new or clean filter into the pump manifold cavity

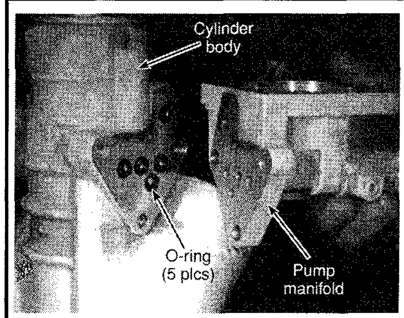


Fig. **60** Lubricate five new O-rings and install them into the cylinder body

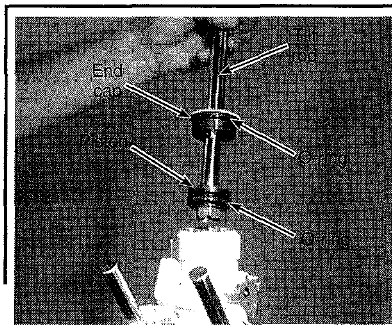


Fig. **61** Lower the tilt rod into the tilt cylinder bore

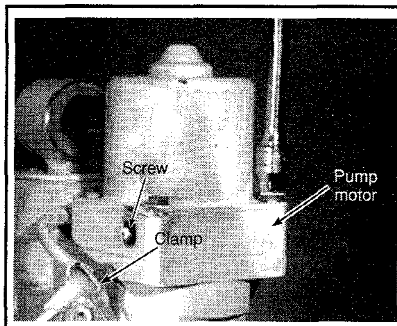


Fig. **62** Install the motor onto the pump and secure

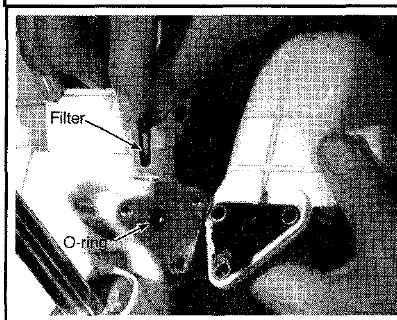


Fig. **63** Insert a new or clean filter into the cylinder body

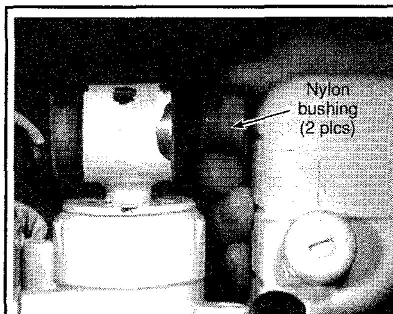


Fig. **64** Install two nylon bushings in the end of the tilt cylinder and the end of cylinder body.

the trim cylinders. Fill the cylinder with EvinrudelJohnson Power Trim/Tilt Steering Fluid. Thread the end cap into the trim cylinder, using a universal spanner wrench or EvinrudelJohnsonTrim Cylinder End Cap tool PIN 436710. Tighten the trim cylinder end cap to a torque value of 60-70 ft. lbs. (81-95 Nm). Repeat this step for the other trim rod and cylinder.

12. Place a new O-ring on the piston and end cap of the tilt rod. Lower the tilt rod into the tilt cylinder bore. Fill the cylinder with EvinrudelJohnson Power Trim/Tilt Steering Fluid. Thread the end cap into the tilt cylinder, using a universal spanner wrench or EvinrudelJohnson Tilt Cylinder End Cap tool PIN 326485. Tighten the end cap to 58-87 R. lbs. (79-118 Nm).

13. Lubricate and slip a new O-ring over the lip on the pump motor. Fill the oumo cavity with EvinrudelJohnson Power Trim/Tilt Steering Fluid and lower the motor onto the pump. Install the three bolts and tighten them to 35-52 inch lbs. (4-6 Nm). Attach the motor wire leads to the side of the motor with the clamp and screw.

14. Insert a new or clean filter into the cylinder body. Install the 6mm hex plug and tighten it securely. Lubricate a new O-ring and place it into the bore of the cylinder body. Align the reservoir with the cylinder body and secure it with three Allen head screws. Tighten the Allen head screws to 35-52 inch lbs. (4-6 Nm).

15. Install two nylon bushings in the end of the tilt cylinder and the end of cylinder body.

Trim/Tilt Assembly—Motor Conventional Systems

REMOVAL & INSTALLATION

② MODERATE

◆ See Figures 65, 66 and 67

✻✻ WARNING

Anytime a steel tool is struck with a hammer, there is the possibility of chips flying which could cause serious eye injury. Therefore, wear safety glasses while removing the tilt cylinder pin.

1. Disconnect the negative battery cable for safety.
2. Matchmark the angle of the adjusting rod location, then remove the rod.
3. Manually lift the engine and engage the tilt support. For safety, install a holding strap or sturdy rope around the motor to make sure it will not accidentally drop if disturbed during service.
4. Disconnect the blue and green wires from the pump motor connector housing.
5. Using a punch and mallet, carefully remove the spring clip from the tilt cylinder pin.
6. Manually push the tilt piston downward into the cylinder for clearance.
7. Remove the bolts (usually 3 on each side) securing the assembly to the port and stern brackets.
8. Remove the trimltilt unit from the stern brackets while pulling the cable through the bracket.
9. Refer to the Disassembly and Assembly procedures, along with the accompanying exploded views if overhaul or component replacement is necessary.
10. Keep the following points in mind when servicing the hydraulic trimltilt assembly:

- Before disassembly, thoroughly clean and degrease the unit. All outer surfaces should be cleaned with a siiff synthetic needle (not wire) brush and hot soapy water. It is important to prevent dirt or debris from entering the unit during service.
- Before disassembling the unit, temporarily connect the motor wiring and run the unit until the trim rams and tilt piston are in the complete down position. Then, momentarily operate it in the reverse direction (upward) in order to equalize internal pressures. But, remember that there could be significant residual hydraulic pressure left behind some components, so always wear safety goggles and loosen fittings gradually, allowing pressure to bleed off before removal.
- NEVER apply heat to the cylinder body or cylinders as excessive heat can lead to high pressure leaks or component failure during operation.
- Never paint individual components while the unit is disassembled. The fear is that some portion of the paint might flake off and enter a hydraulic passage during assembly.
- Always use clean, lint-free shop cloth when handling assembly components.

During assembly, replace all seals and O-rings to ensure proper, trouble-free operation.

During pump assembly installation, position the pump and install the 3 bolts (2 Allen® head and 1 hex-head). Tighten each of the 3 bolts gradually (one turn at a time) alternating between the bolts to draw the pump evenly into position.

To install:

11. Apply a light coating of EvinrudelJohnsonTriple-Guard, or equivalent marine grease to the tilt rod.
12. Position the trimltilt assembly and insert the tilt cylinder pin.
13. Pull the wiring through the stern brackets.
14. Insert the spring clip to the tilt cylinder pin.
15. Apply a light coating of EvinrudelJohnson Nut Lock, or equivalent threadlock to the threads of the stern bracket-to-trimltilt assembly manifold bolts. Install and tighten the bolts to 18-20 ft. lbs. (24-27 Nm).
16. Align the marks made during removal and install the angle adjusting rod in the same position from which it was removed.
17. If the tilt tube nuts were loosened, tighten them to 50-54 ft. lbs. (68-73 Nm), then back off one nut 114 turn.
18. Reconnect the negative battery cable and run the engine up and down through several cycles, checking for proper operation and proper fluid level.

DISASSEMBLY

③ DIFFICULT

◆ See Figures 65, 68 and 69

This section contains complete detailed procedures to disassemble the complete unit. However, open the system and remove only the necessary parts to inspect, replace, and restore the system to satisfactory service.

TAG EVERYTHING as it is removed, in order to ensure proper assembly.

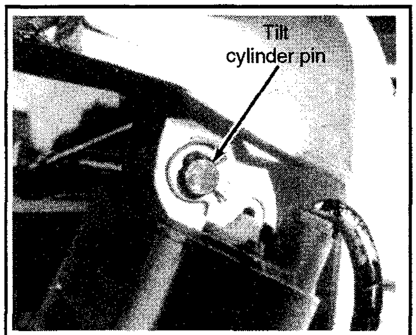


Fig. 65 Remove the spring clip from the tilt cylinder pin

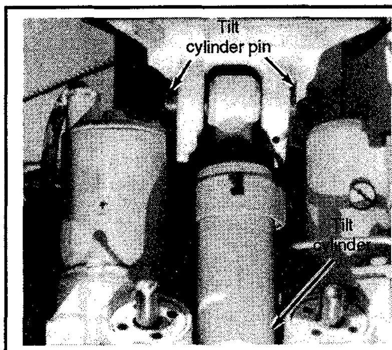


Fig. 66 Push the tilt cylinder pin out of the bore to free the cylinder

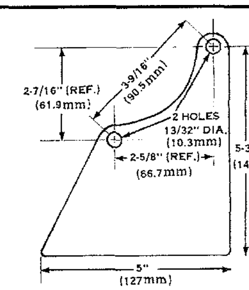


Fig. 67 Simple drawing to assist in making a holding bracket to secure the trim and tilt assembly during service work.

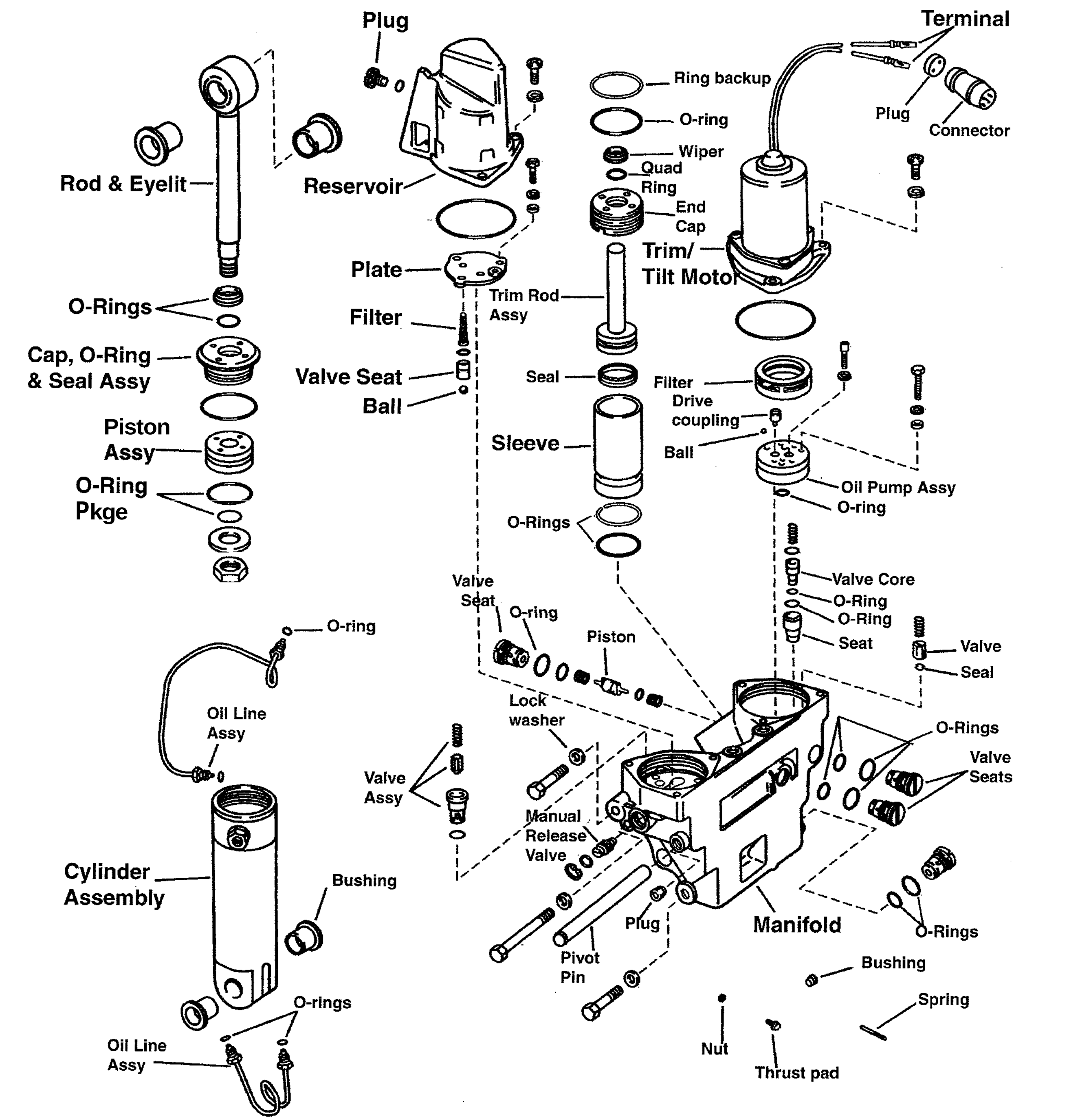


Fig. 68 Exploded view of a large-motor, conventional system **trim/tilt** assembly

Drain the system by removing the reservoir plug and draining the hydraulic fluid into a suitable container. observe any local restrictions on the disposal of this type material.

A holding bracket (fixture) can be quickly and easily made from scrap plywood to hold the **trim/tilt** unit while service work is being performed. The drawing at the bottom of the last page gives dimensions and a rough plan. The illustration at the top of the next page shows the unit mounted in such a fixture.

Valves and Pistons

♦ See Figure 70

1. Remove the manual release valve by first using a pair of snapring pliers to remove the retaining ring. Next, use the trim switch to run the motor fully down and loosen the manual release valve one full turn. Tap the trim switch up and down a few times, then slowly remove the valve.
2. Tag and remove each of the external (outside) valves using a proper size drag link socket to fit the slot properly.

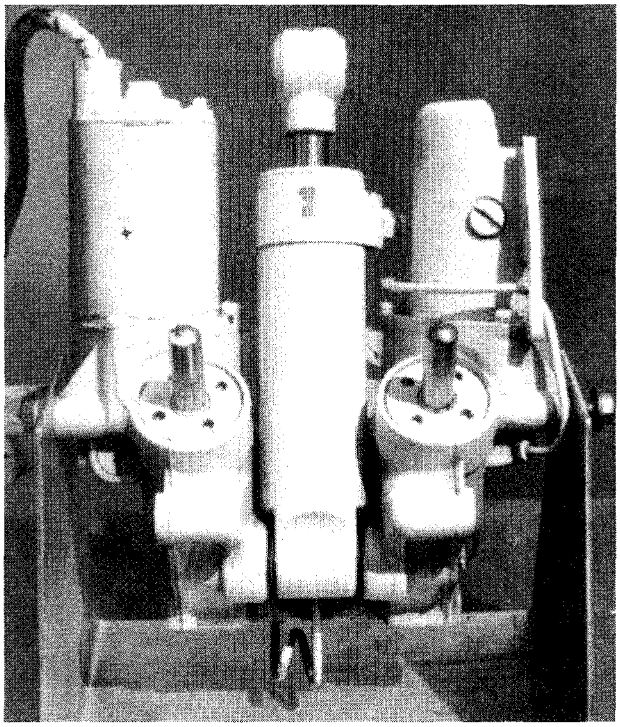


Fig. 69 Trim and tilt assembly mounted in the illustrated holding bracket

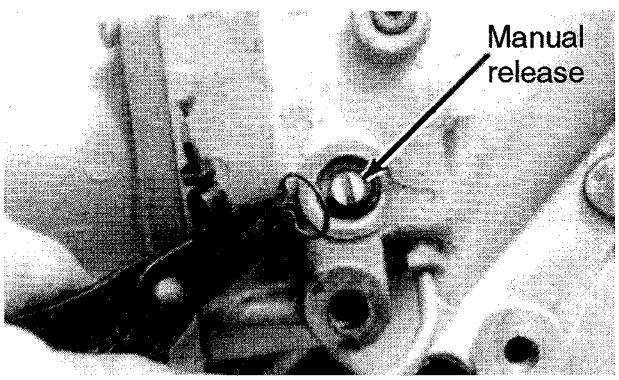


Fig. 70 Remove the manual release valve, followed by all necessary external valves

3. The letdown control dston can be reached by first removing the impact letdown valve, and then carefully removing the piston with a pair of needle nose pliers.
4. The pump control piston and springs are removed by first removing the reverse lock check valve and then lifting the piston and springs free with a pair of needle nose pliers. The pump control piston can only be removed from the aft end of the hole.

Reservoir and Valves

1. The reservoir is removed by first removing the upper and lower hydraulic lines and fittings. Next, remove the screws from the reservoir flange and lift the reservoir free.
2. Remove and discard the O-ring. If further disassembly of the reservoir is desired, hold down on the reservoir manifold plate and at the same time remove the three screws securing the plate. Lift the plate free.
3. Remove the relief valve and impact sensor valve assemblies by lifting them free of the body with a pair of needle nose pliers. The filter valve may be lifted out with a small stiff hook.
4 Because damage usually occurs during removal, the filter valve seat and O-ring must be replaced, if they are removed.

Motor and Pump

1. Remove the screws on the motor flange and lift the motor free. Remove and discard the O-ring.
2. Remove the hydraulic pump filter. The hydraulic pump may be removed by simply removing the attaching screws and lifting the pump free. Lift the trim down pump relief valve free of the body.
3. The expansion relief valve core can now be lifted out with a small hook shaped piece of wire.

Trim Cylinders

◆ See Figures **71, 72** and **73**

1. Obtain special tool Trim Cylinder End Cap Remover, EvinrudelJohnson PIN 324958 or an adjustable spanner wrench. Use the special tool or the spanner wrench to remove the end cap.
2. Lift the trim piston assembly free of the cylinder. The sleeve fits snugly. Therefore, Trim Sleeve Remover, EvinrudelJohnson PIN 325065 or a screwdriver with the tip bent 90° must be used to remove the sleeve. Slip the tool in under the sleeve, and then remove the sleeve.

Tilt Cylinder

◆ See Figure **74**

Disconnect the upper and lower hydraulic lines at the tilt cylinder and at the manifold. Push the cylinder pivot pin to one side and remove the cylinder.

Two types of tilt cylinders are normally found on these motors, one manufactured by Showa and the other by Prestolite. Identification is important due to minor differences in service. The Showa tilt cylinder is identified **by** an **"S"** after the part number stamped on the side of the cvlinder. The Prestolite cylinder is identified with a **"P"** stamped on the bottom side by the part number. When ordering replacement parts, be sure to identify the specific cylinder being serviced.

1. Clamp the cylinder in a vise at the flats of the cylinder end. Obtain and use special End Cap Remover, Evinrude/Johnson PIN 326485 with a 112 in. breaker bar to loosen the end cap assembly. Removal of the end cap is not an easy task, even by using the special tools mentioned.
2. After the end cap is removed, the piston and rod assembly may be withdrawn free of the cylinder.
3. The piston contains four valves. These valves cannot be serviced separately. If the valves are worn or are not functioning properly, the piston must be replaced as an assembly.
4. For Presolite pistons, remove and discard the O-ring from around the piston. Heat with a torch, a vise and bar through the rod end will be necessary to break the Locktite bond on the thread of the piston and piston rod. Clamp the piston securely in a vise, apply the heat, and then use the bar through the rod end to unscrew the rod from the piston. Clean all traces of old sealant from the piston rod threads.
5. For Showa pistons, clamp the piston rod end in a vise and remove the nut securing the piston to the rod. Clean all traces of sealant from the piston rod threads.

Cleaning and Inspection

Discard all used O-rings and seals. Clean all parts in solvent and blow them dry with compressed air. Inspect the cylinders and sleeves for any sign of excessive wear or scoring. Inspect all parts for dirt, chips, and damage. Replace any damaged valve seats or other questionable parts.

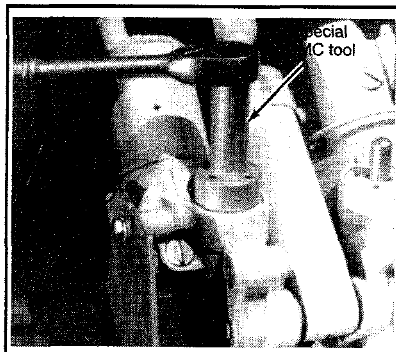


Fig. 71 Use a special tool or spanner wrench to remove the end cap...

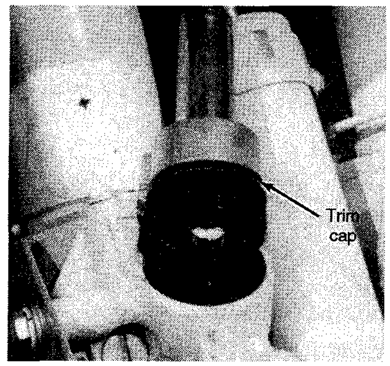


Fig. 72 ... then remove the trim piston, followed by the sleeve

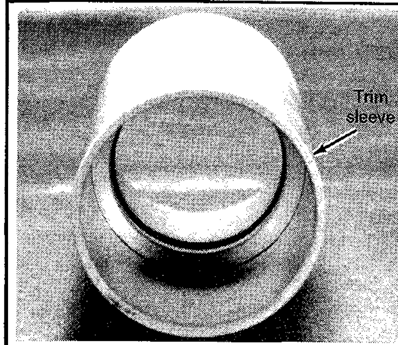


Fig. 73 The trim cylinder sleeve must be clean and free of any scratches or other damage

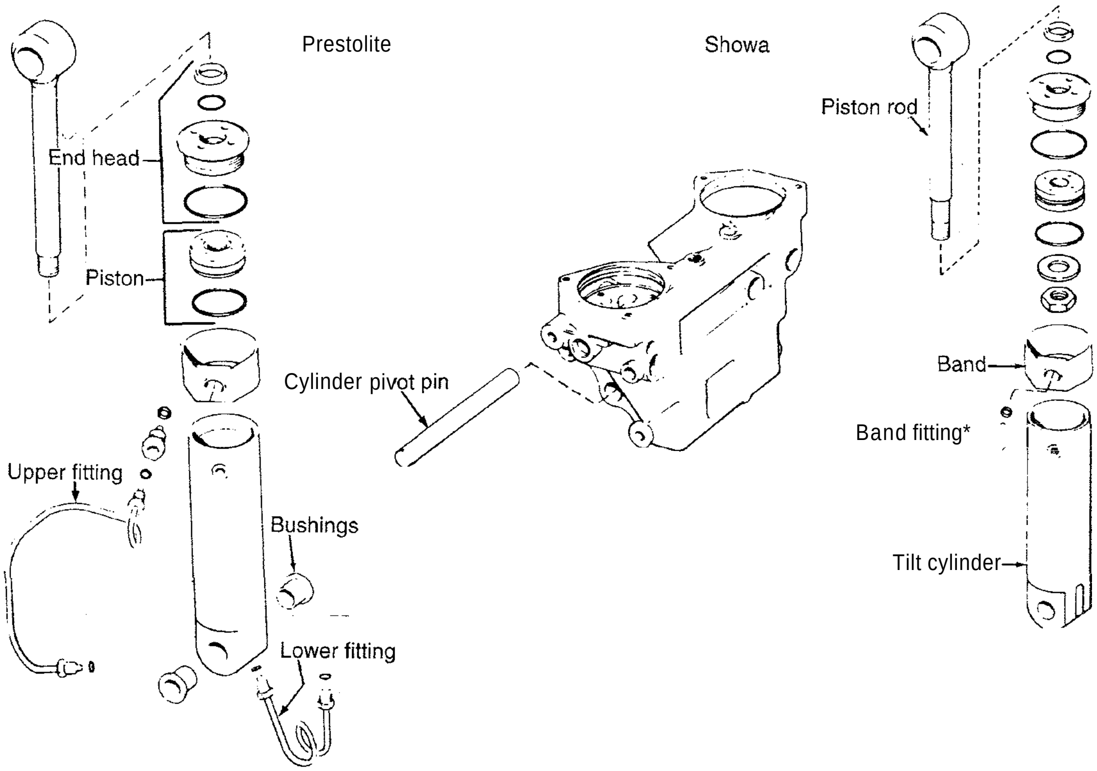


Fig. 74 Exploded view of the Prestolite and Showa tilt cylinders

ASSEMBLY

DIFFICULT

◆ See Figure 69

Use the accompanying exploded views, along with the following procedures to reassemble the trim/tilt assembly.

Lubricate all internal parts with EvinrudelJohnson Power Trim/Tilt Fluid prior to assembling.

Tilt Cylinder

1. Lubricate a new O-ring and seal with EvinrudelJohnson Power Trim/Tilt Fluid, and then install both into the cylinder end cap. Install Seal Protector EvinrudelJohnson PIN 326005 onto the threads of the piston rod and then install the end cap onto the rod. If the seal protector is not available, wrap the threads with tape as a protection against damaging the seal when the end cap is installed to the rod. Remove the tape after the end cap is installed.

2. If assembling a Prestolite cylinder (which was disassembled), clean the piston rod threads with EvinrudelJohnson Locquic Primer, EvinrudelJohnson PIN 384884, or equivalent. Clamp the rod in a vise holding the pin end. Coat the rod threads with EvinrudelJohnson Ultra Lock, EvinrudelJohnson PIN 388517, or equivalent. Thread the piston assembly onto the rod. Take care not to damage the surface of the piston. Use a flywheel strap wrench to bring the piston up snug.

3. If assembling a Showa cylinder (which was disassembled), clean the piston rod threads with EvinrudelJohnson Locquic Primer, EvinrudelJohnson PIN 384884 and install the small O-ring, washer, and piston onto the piston rod. The small holes on the piston must face upward. Apply EvinrudelJohnson Nut Lock, EvinrudelJohnson PIN 384849 to the piston rod threads. Secure the rod in a vise and then install and tighten the nut to 58-87 ft. lbs. (79-118 Nm).

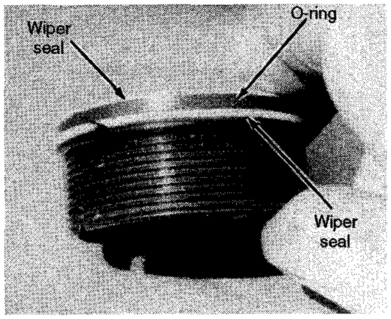


Fig. 75 Trim cap with the O-ring and the two wiper seals properly installed.

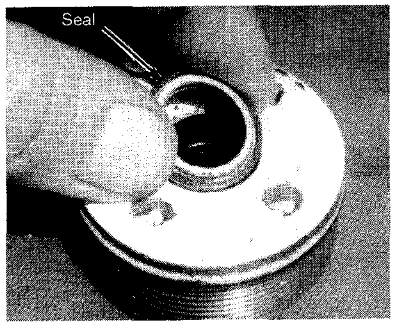


Fig. 76 Inserting the seal into the trim cylinder cap.

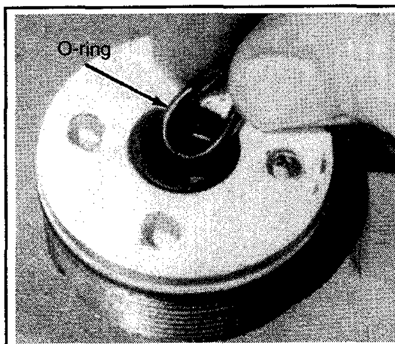


Fig. 77 Inserting the O-ring into the trim cylinder cap.

4. Lubricate the piston assembly. Install a new O-ring to the outside diameter of the piston. Carefully insert the piston assembly into the cylinder. Tighten the end cap assembly using End Cap Remover EvinrudelJohnson PIN 326485, or an adjustable spanner wrench.
5. If the band has been removed, slide it into the cylinder. Use a new O-ring on the fitting and screw the fitting into the band, with the pilot on the fitting indexing into the hole in the cylinder.
6. Lubricate the cylinder pivot pin and pivot pin bushings with EvinrudelJohnson Triple-Guard Grease. Install the cylinder to the manifold assembly. Attach the hydraulic line fitting on the starboard side.

Trim Cylinder

◆ See Figures 75, 76 and 77

1. Insert the piston and rod assembly into the end cap. Carefully slide the piston into the trim cylinder until the piston and cylinder sleeve are butted against the end cap.
2. Slide the assembled unit into the cylinder cavity. Obtain End Cap Remover EvinrudelJohnson PIN 324958 or an adjustable spanner wrench and tighten the end cap to 30-40 ft. lbs. (40-54 Nm).

Reservoir and Valves

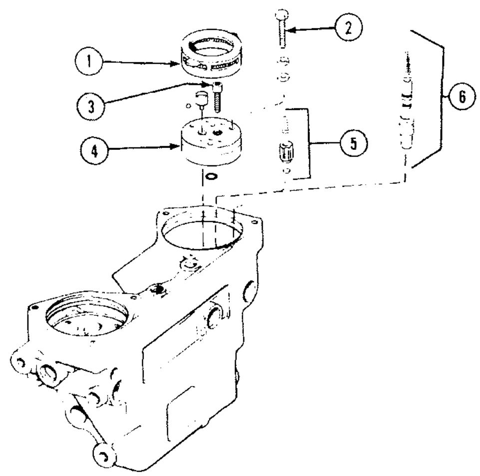
◆ See Figures 78 and 79

1. To replace a valve, first install the valve seat. Next install the ball, core and spring in that order. Install the filter valve ball, and then insert the filter valve seat with the O-ring end facing up.
2. Slide the filter into the manifold plate. Shift the manifold plate until the filter is on top of the filter valve and the attaching screw holes are aligned. Thread the screws into place, and then tighten them alternately and evenly to keep the valve spring positioned properly.
3. Place a new O-ring in position. Secure the reservoir in place with the attaching screws. Tighten the screws securely.

Pistons and Valves

+ See Figure 80

1. Slide the letdown control piston into the starboard cavity with the rounded end going in first. Install the impact letdown valve. Slide the pump control piston into the port cavity from the rear with the small end going in first.
2. Install the reverse lock check valve and the trim check valve. Install the tilt check valve and the trim/tilt separation valve (long body valve). Tighten the valve securely.
3. Install the manual release valve with a new O-ring. Tighten the valve to provide operator with shock absorber protection. Install the snap ring with the flat side facing out.



1- Pump filter
2- Screw
3- Screw
4- Hydraulic pump
5- Trim down pump relief valve
6- Expansion relief valve

Fig. 78 Exploded view of the pump filter mounting and some internal valves

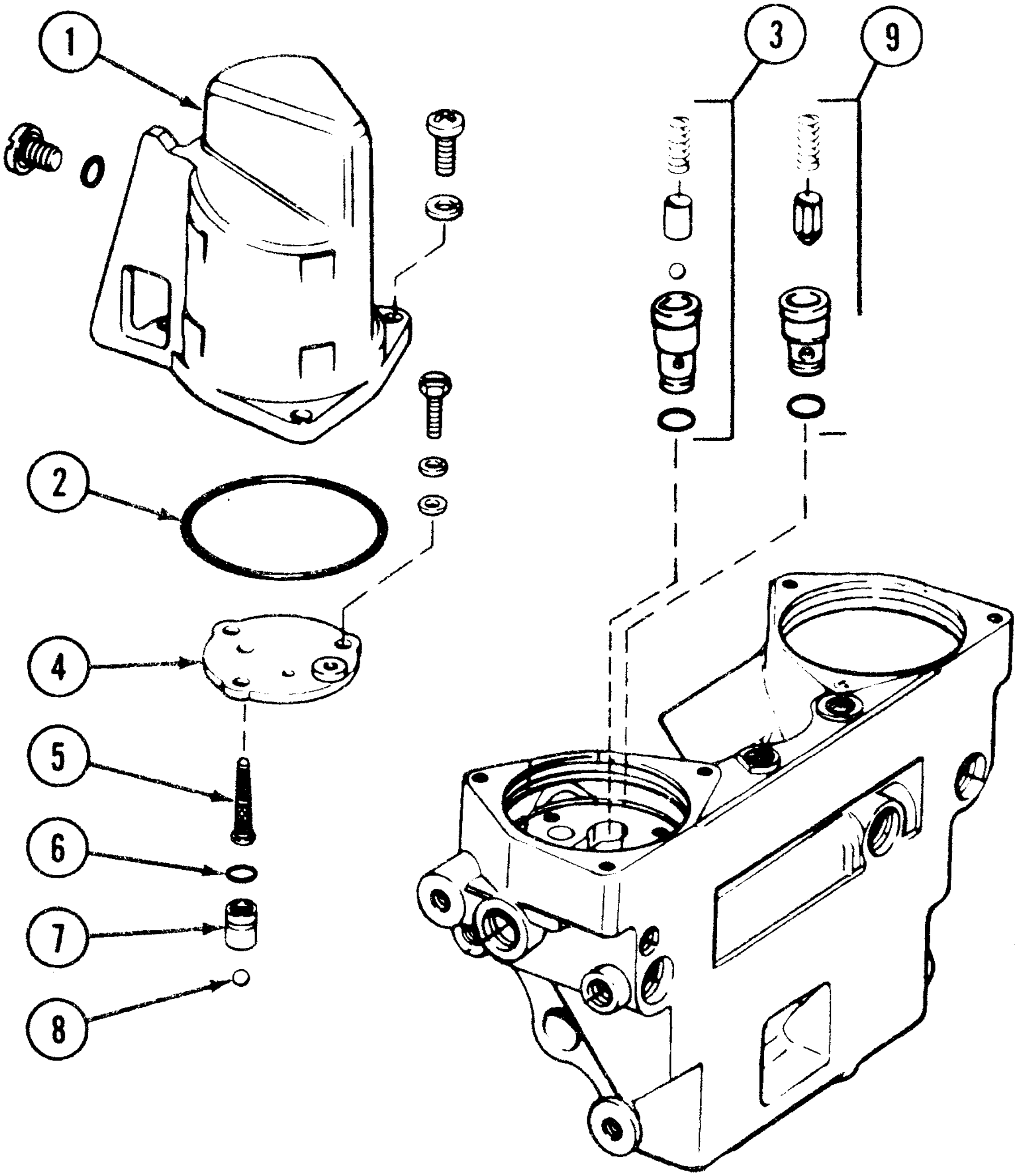
Pump Assembly and Motor

◆ See Figures 78 and 79

1. Install the pump relief valve and spring, Install a new O-ring. Check to be sure the pump drive tang indexes with the hole directly opposite the round locating boss.
2. Install the pump with the locating boss indexed into the pump cavity recess. Secure the pump in place with the three attaching screws. Tighten the screws securely, Install the pump filter and fill the filter cavity and the area over the pump with EvinrudelJohnson Power Trim/Tilt hydraulic fluid.

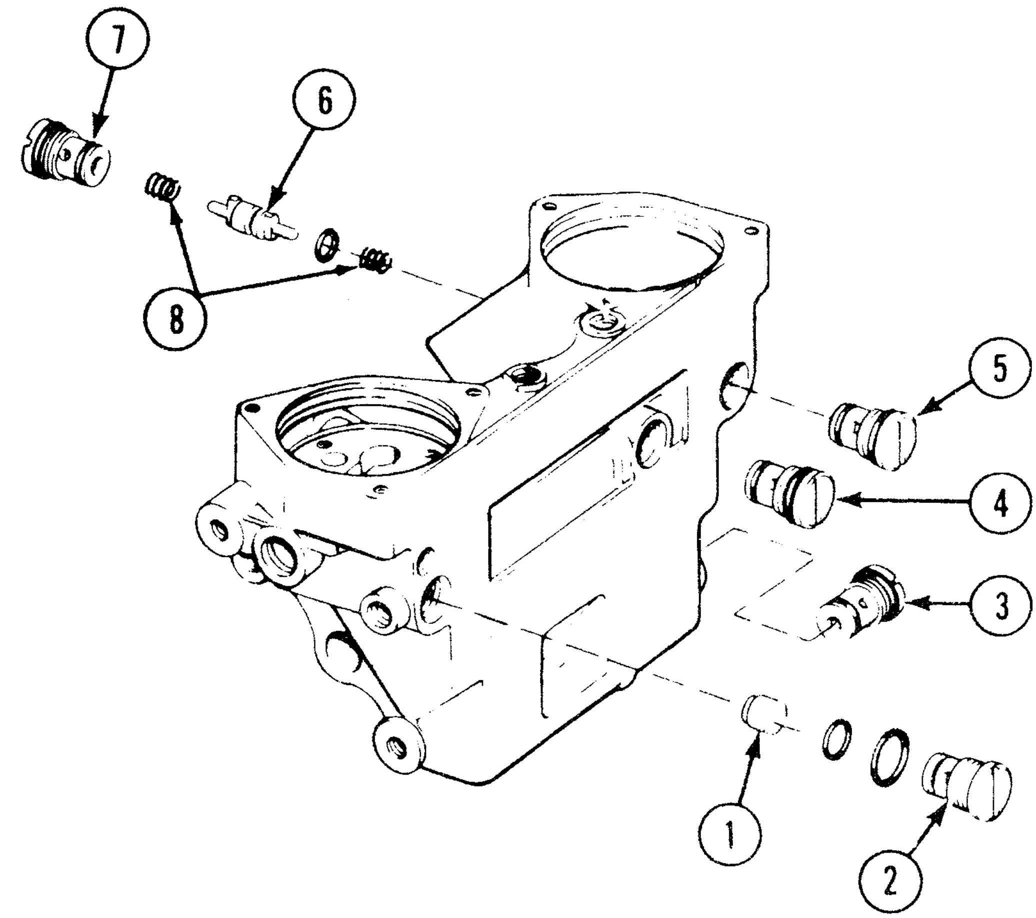
The pump cavity must be filled with hydraulic fluid during assembling, or the unit will not operate.

3. Install a new O-ring onto the trim motor. Install the motor and at the same time rotate the motor shaft until the shaft engages with the pump shaft. Position the motor with the cable on the port side of the assembly. Install the three attaching screws. Tighten the screws securely.
4. Fill the reservoir with EvinrudelJohnson Power Trim/Tilt Fluid and purge the system of air.



1- Reservoir
2- O-ring
3- Impact sensor valve assembly
4- Manifold plate
5- Filter
6- O-ring
7- Valve seat
8- Filter valve ball
9- Trim up relief valve

Fig. 79 Exploded view of the reservoir mounting and some internal valves

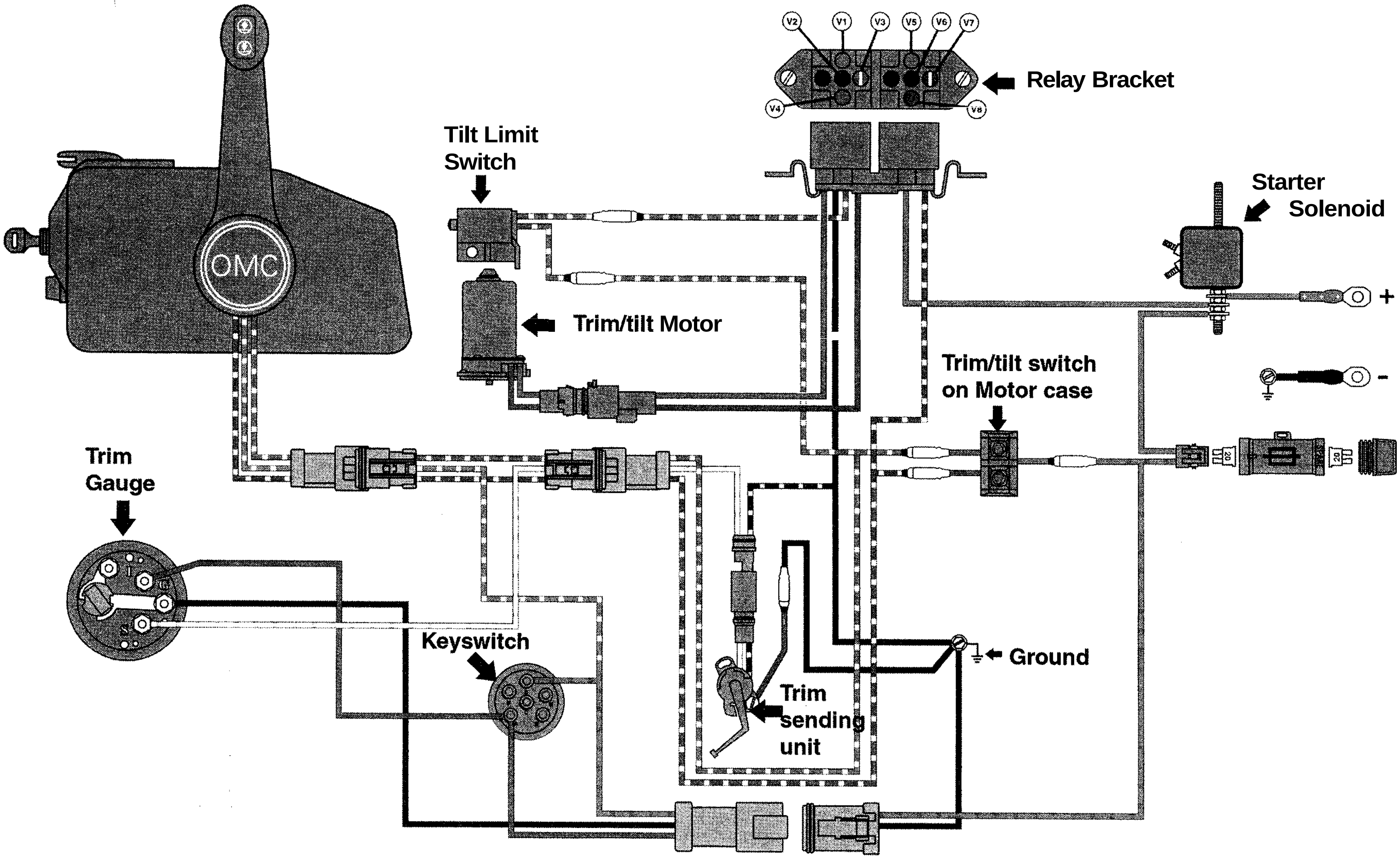


1- Letdown control
2- Impact letdown valve
3- Tilt/Trim separation valve
4- Tilt check valve
5- Trim check valve
6- Control piston
7- Reverse lock check valve
8- Spring

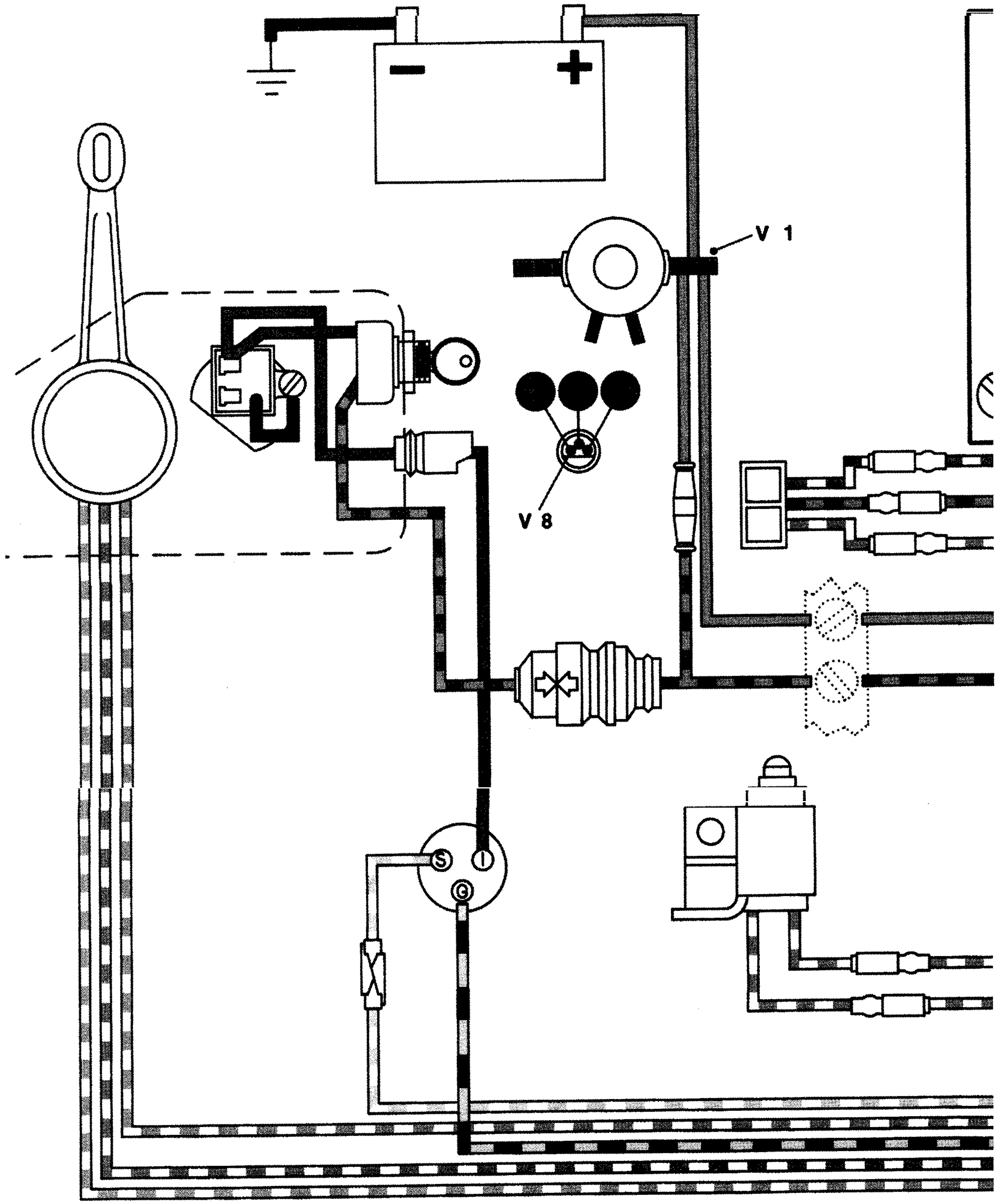
Trim/Tilt Wiring

For power trim/tilt systems installed at the factory as part of original motor equipment, details on the exact system used for that specific outboard are included in the individual engine schematics found under Wiring Diagrams in the Ignition & Electrical Systems section. However, most wiring colors and connectors should be standardized and the accompanying system diagrams should also be applicable.

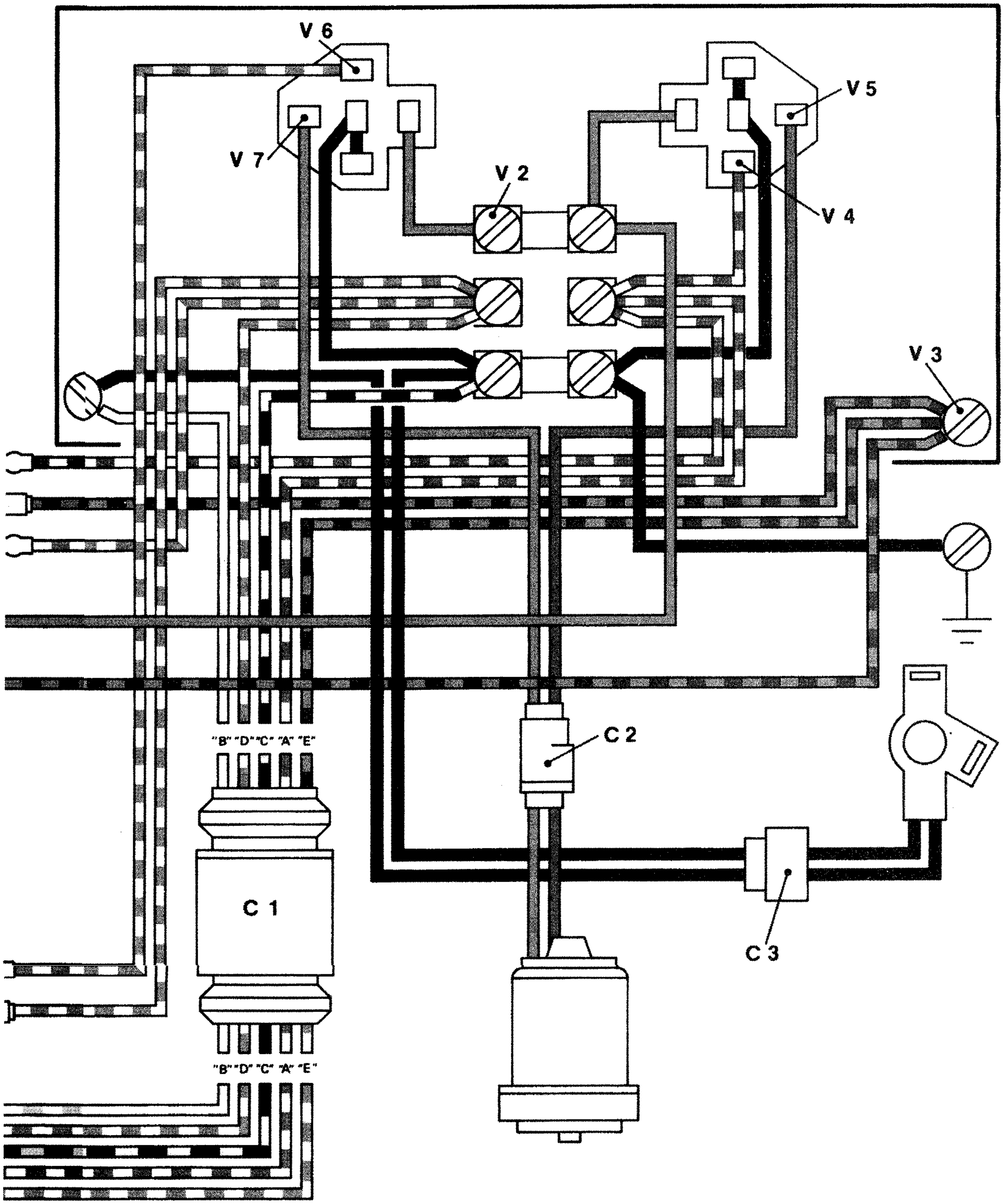
For all motors where the OE trim/tilt system was added during rigging, use the accompanying diagrams.



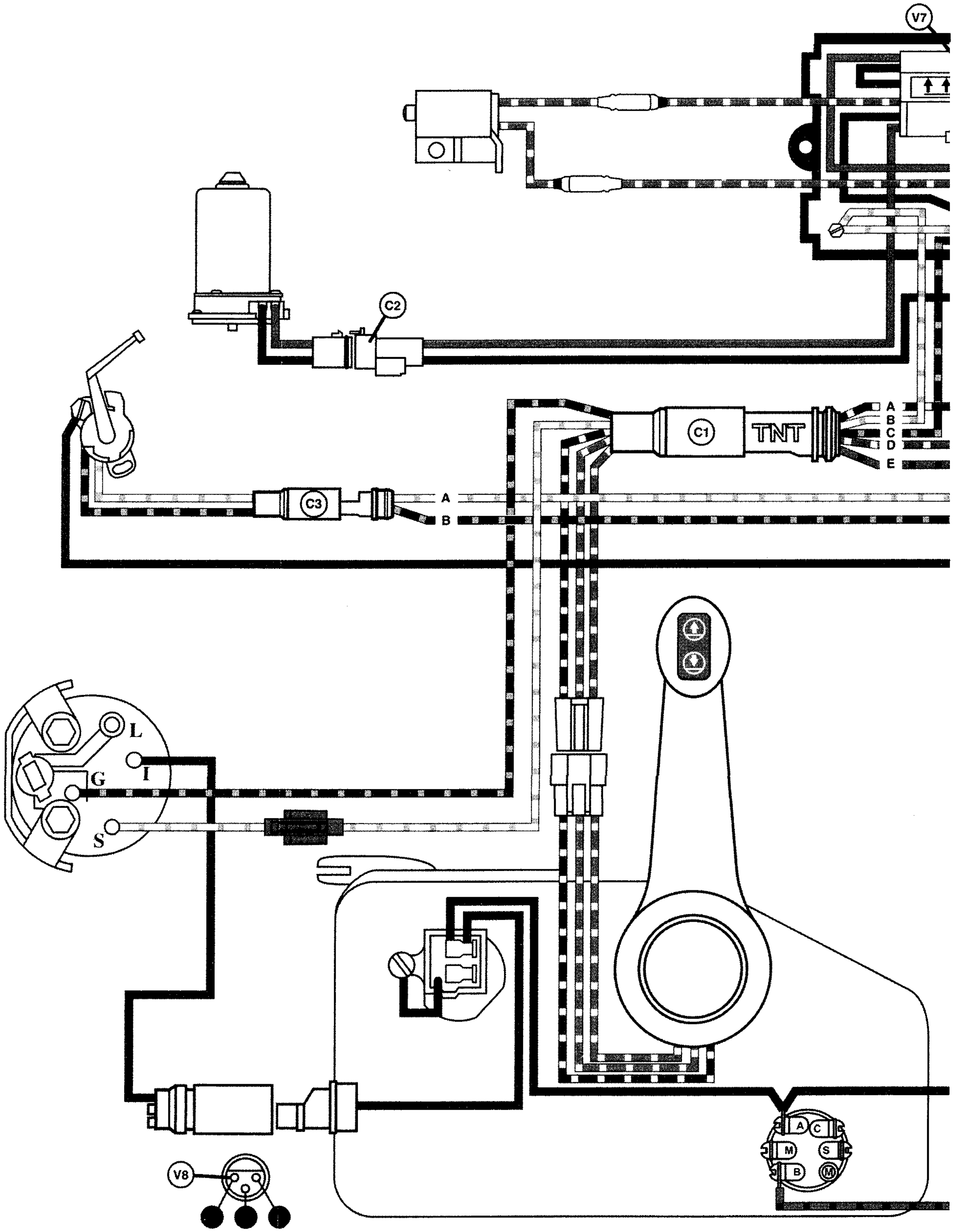
Trimltilt wiring for most 1996 and later conventional systems



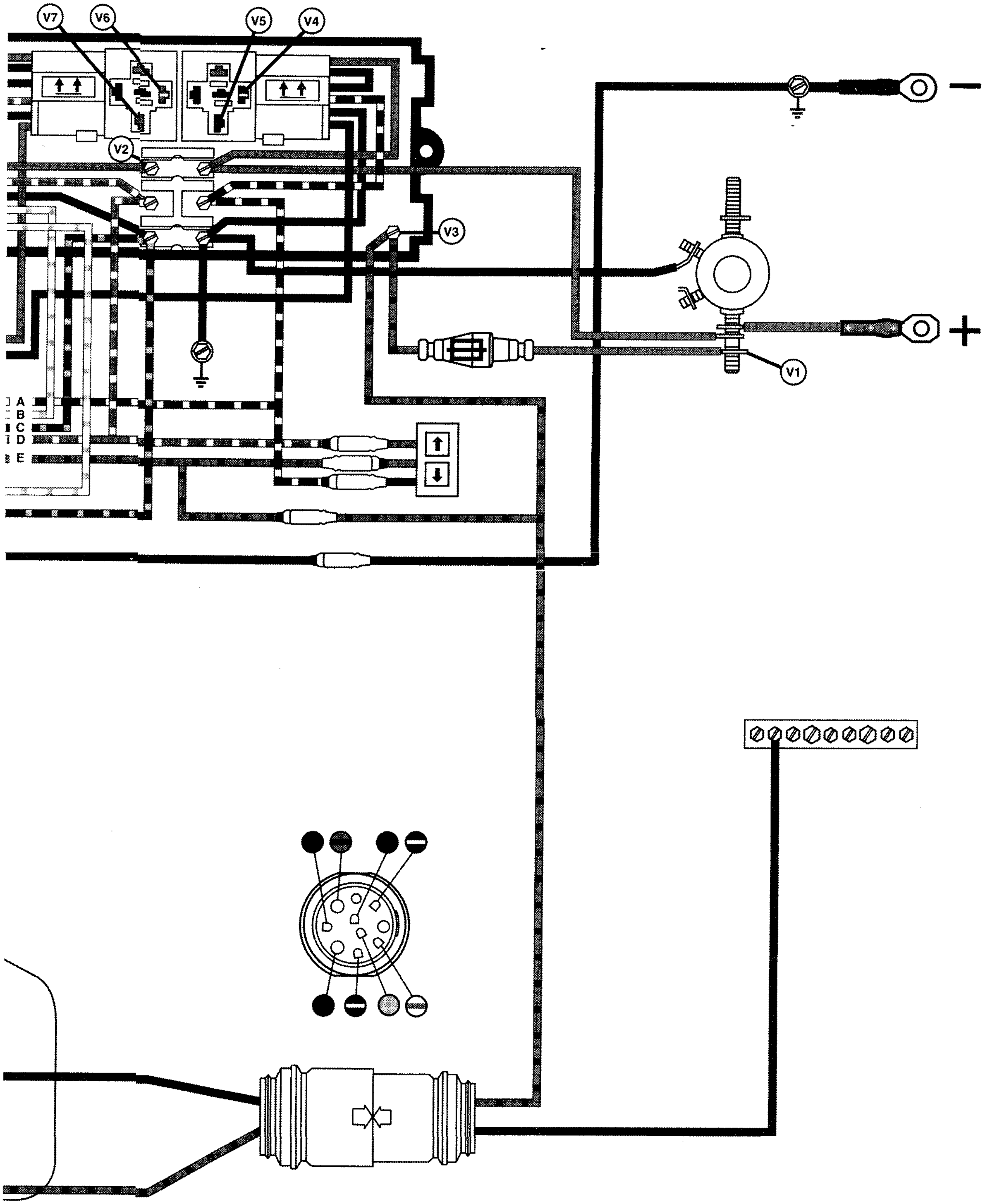
Trim/tilt wiring for most 1992-93 motors (Part 1)



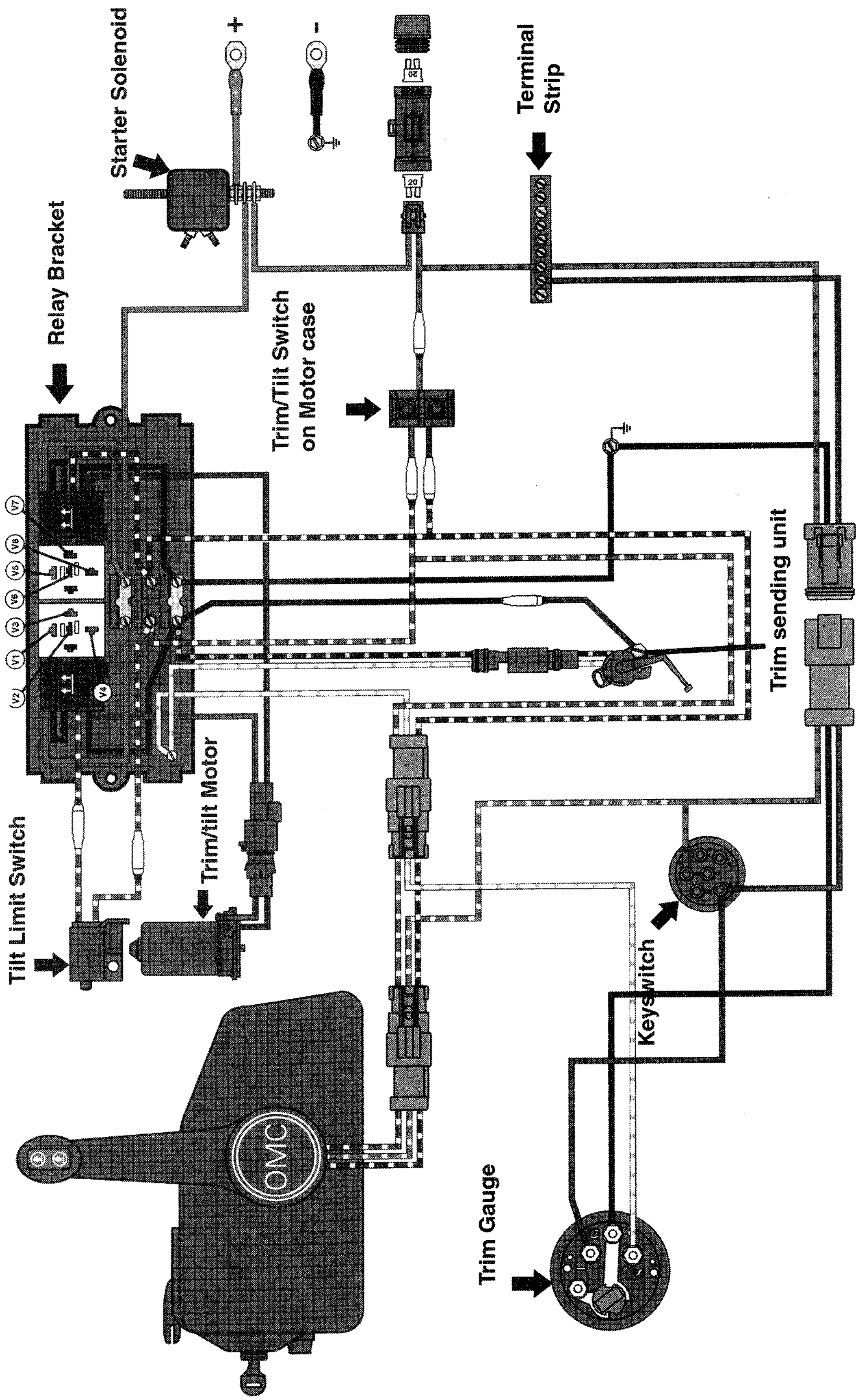
Trimltilt wiring for most 1992-93 motors (Part 2)



Trim/tilt wiring for most 1994-95 motors (note that for 1995 motors, relay positions may physically vary in mounting, so use wire colors to ensure proper terminals are tested) (Part 1)



Trim/tilt wiring for most 1994-95 motors (note that for 1995 motors, relay positions may physically vary in mounting, so use wire colors to ensure proper terminals are tested) (Part 2)



Trim/tilt wiring for most 1996 and later FasTrak® systems

9

REMOTE CONTROLS

REMOTE CONTROLS 9-2
CONTROL CABLES 9-15

REMOTE CONTROLS

Introduction

◆ See Figures 1 and 2

A remote control unit is seldom sold with just an outboard unit. In most cases, the control box is sold separately as an option or it is included with a "package" deal-boat, outboard, control box, and trailer.

If the control box was included in the "package," the unit will most likely be one of the latest production models from the engine manufacturer at the time-with Johnson or Evinrude colors and decals. But. the final decision on what control unit is mounted rests in the hands of the'boat manufacturer and the dealer that performs the initial rigging. For this reason, caution must be used when following the procedures contained here to ensure that they apply to the unit installed on the boat. Newer motors rigged to older boats (and vice versa) could be equipped with aftermarket, or older/newer units, that are not detailed here for obvious reasons. We've included procedures for the various Evinrude/Johnson remotes that were produced and sold at the same time these motors were manufactured.

This section covers overhaul (disassembly and assemblv procedures) which includes removal of the unit from the boat, separating ihe two halves and replacement of switches/warning horns contained within. We also provide a few additional words on lubrication.

Like with many marine components, non-use is absolutely the greatest enemy of the control unit. The large number of eccentrics, cams, levers, linkages, etc. should be operated at regular intervals-as often as once a month and the interior parts lubricated whenever the components begin to show signs of stiffness and binding.

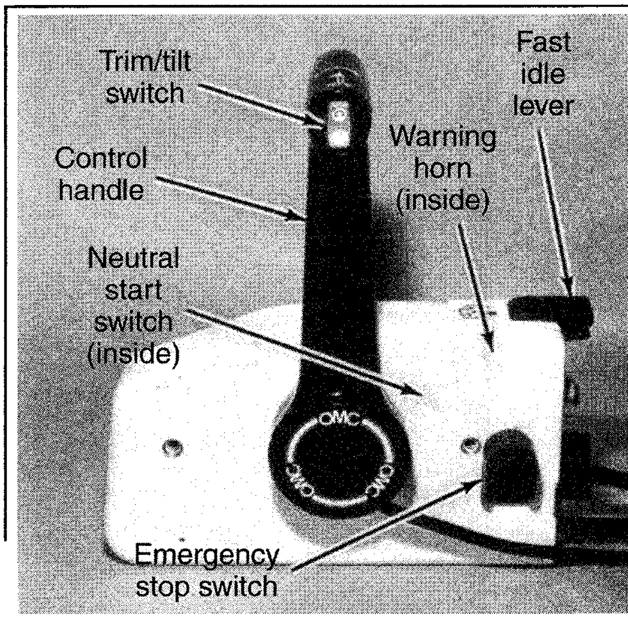


Fig. 1 Typical EvinrudelJohnson side-mount remote control unit

☐ WOULD YOU BELIEVE, as much as 90% of steering and shifting problems are directly caused by the system simply not being operated. Without movement, steering and shifting cables and linkages have a tendency to "freeze." Would you also believe that well over 50% of boat cables replaced every year is due to lack of movement.

Perhaps the most important thing you can do to preserve the function of your remote control unit is to use it. Therefore, during off-season, when the boat is laid up in a yard, or on a trailer alongside the house, take time to go aboard and operate the steering from hard-over to hard-over. Also, shift the remote control unit through the full range several times to ensure corrosion does not develop causing a fitting or joint to "freeze" preventing proper movement.

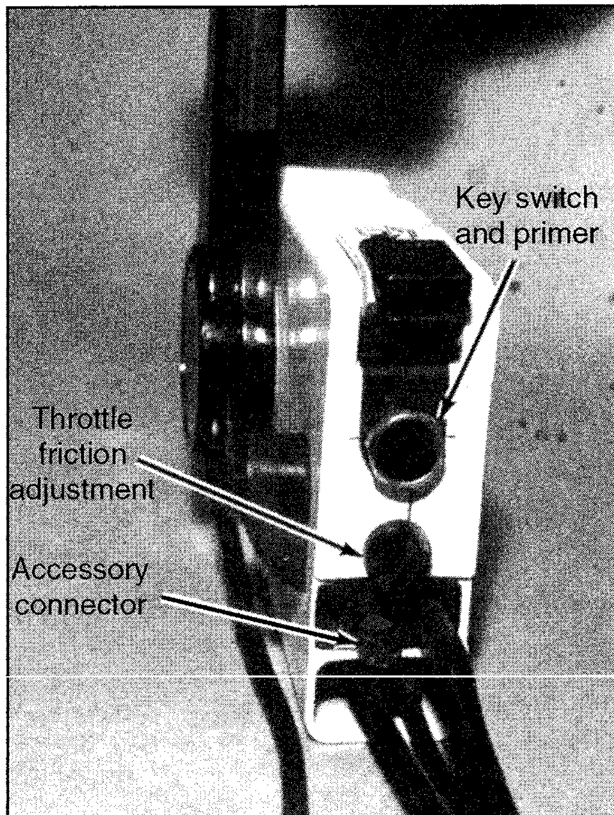


Fig. 2 Some EvinrudelJohnsonremote control units incorporate the key switch and primer on the housing instead of utilizing a separate switch on the dash

DESCRIPTION AND OPERATION

The following components and features may be incorporated in the Evinrude/Johnson remote control box (such as the one pictured in the photos for this section) and are usually associated with the outboard units covered here.

Locations of the various parts in or on the control box are identified within the accompanying illustrations.

The function of the item is usually described in the name.

Control Handle

As the name implies, this handle controls the gear position of the lower unit-Neutral, Forward, and Reverse. It also controls the powerhead rpm. From the vertical position (straight up), movement about 32° fotward shifts the lower unit into fotward gear and movement of the handle about 32° aft of vertical shifts the unit into reverse gear. Further movement past the 32° position in either forward or reverse will increase powerhead rpm.

Key Switch and Primer

◆ See Figure 3

Rotating the key switch clockwise to the first detent energizes all powerhead accessories. Further movement clockwise to the second detent will energize the solenoid to activate the cranking motor. Pushing the key inward at the first or second detent position will energize the fuel primer solenoid to choke the carburetor.

Rotating the key back to the full counterclockwise position will cut power to the ignition system and all powerhead-controlled accessories.

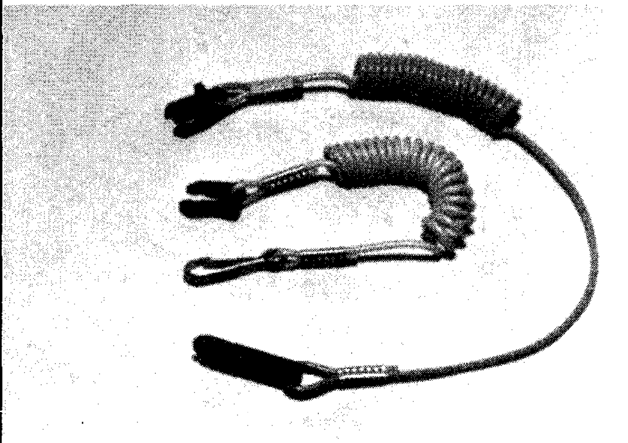


Fig. 3 Two different emergency switch lanyards used with the remote control units. Remember-on some models, it is not possible to start the powerhead if the lanyard is not in place

Neutral Lockout

This safety feature prevents the control handle from moving to the forward or reverse positions when the control handle is in the neutral position.

With the outboard operating, the helms-person simply depresses the knob upward against the handle to release the handle for movement-either forward or aft. The neutral lockout will automatically engage when the control handle is returned to the neutral position.

Throttle Friction Adjustment Screw/Knob

The throttle friction adjustment screw/knob does exactly what the name implies-places friction on the control handle to prevent unwanted "creep" of the control handle while the powerhead is operating and/or the boat is underway. Rotating the knob clockwise will increase friction on the control handle. Logically, rotating the knob counterclockwise will decrease friction and the handle movement will be more "free."

Neutral Start Switch

Again, the function of this switch is obvious-to prevent the cranking motor circuit from being energized except when the control handle is in the neutral position. On many Evinrude/Johnson remote controls (when the ignition key switch is integral), this is a mechanical switch. Stated another way, the start switch will only allow the key switch to be rotated to the start position when the control handle is in the neutral position. On other remotes (usually when the key switch is mounted separately from the remote), this switch is electrical, breaking the circuit regardless of key switch position unless the control lever is in Neutral.

Emergency Stop Switch

◆ **See Figure 3**

This switch prevents operation of the powerhead unless a safety lanyard is in place holding the switch button in an outward position. The other end of the lanyard should be attached to an item of clothing or the life jacket worn by the helmsperson. Should the individual be thrown overboard or away from the control station the clip will be pulled from the switch and the powerhead will immediately shut down.

Warning Horn

This audible warning device is intended to alert the operator that a critical operating condition has developed; the powerhead should be shut down; and the cause determined before extensive and expensive damage is done.

Depending on the powerhead being serviced, the warning device may emit different signals to indicate varying conditions (for more details, please refer to your owner's manual, to the Cooling and Lubrication section and, on FFI engines to the Ficht Fuel Injection section):

Continuous Tone-indicates a powerhead overheat condition.

Continuous Tone-at or near Wide Open Throttle (WOT) indicates a restriction in the fuel supply.

10 Second Continuous Tone on models equipped with the System Check Monitor gauge-alerts the operator that one or more LEDs have been illuminated.

Continuous Short Pulse Tone-indicates a no oil condition-bad news-very bad news.

■ Short Pulse Tone-sounded 1/2 second every 20 seconds indicates a low oil condition.

Fast Idle Lever

When equipped, this lever controls powerhead rpm when the control handle is in the neutral position. The lever should be raised to assist during powerhead startup and favorable idle speed. The lever must be returned to the run position before moving the control handle out of the neutral position.

Accessory Connector

The accessory connector permits easy access to the powerhead accessory and tachometer circuits. Several Evinrude/Johnson tachometers and wiring kits provide a mating connector simplifying accessory installation. Maximum draw on the accessory circuit must not exceed 5 amps.

Trim/Tilt Switch

This switch is included on control boxes with power trim/tilt systems installed. The switch permits the helms-person to raise or lower the outboard through about 0-21º while the unit is operating in Forward gear. When the powerhead is shut down or is operating below 1500 rpm, this same switch allows and controls the outboard to tilt about 22-75º.

Standard Surface Mount Remote Units

◆ **See Figure 4**

② MODERATE

OVERHAUL

◆ **See Figures 5, 6, 7, 8, 9, 10, 11 and 12**

Refer to the accompanying illustration for parts identification.

1. Disconnect the battery cables for safety. This will help prevent the possibility of potential burns or shorts that could occur while working on the control unit.

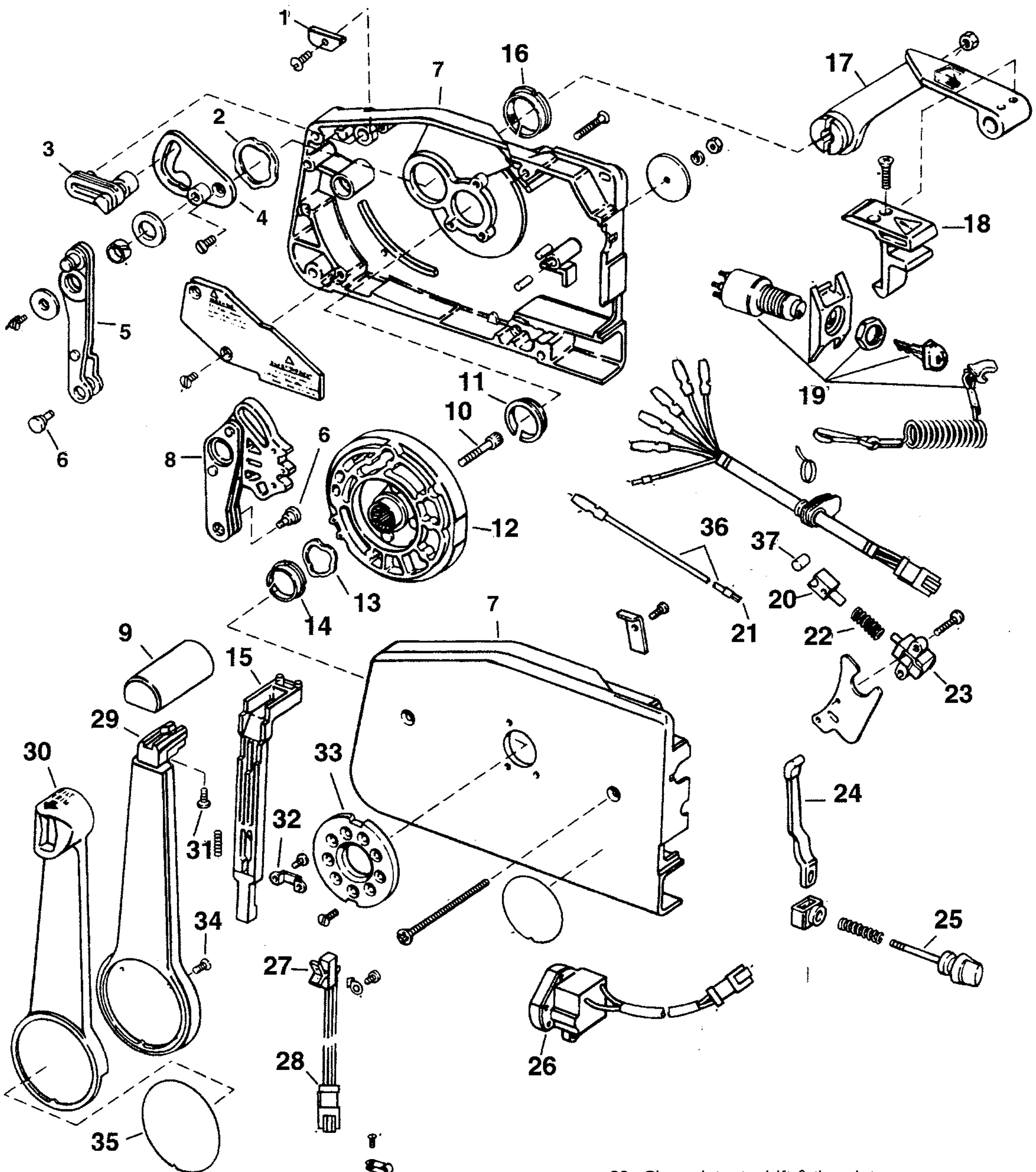
✱✱ CAUTION

Disconnecting the battery cables will also make sure that the engine is not accidentally cranked or started (which could lead to injury or damage).

2. Loosen the retainers and separate the remote from the boat with the cable still attached.
3. Place the control housing so the control handle side (the face of the housing) is positioned downward on small wooden blocks. Position the blocks on either side of the handle, contacting the housing face.
4. From the back of the housing (now facing upward), loosen the Allen head screw (for the remote handle) 3 complete turns.

☐ The remote control Allen head screw can be found at the base of the handle. It is accessed through the small round bore on the back of the remote housing.

5. Place a punch inside the head of the Allen screw, then gently tap on the punch using a soft-faced mallet to dislodge the control handle splines from the hub splines.



1 - Keeper plate
2 - Spring washer, cam to housing
3 - Lever, shift lockout
4 - Cam, shift lockout
5 - Throttle lever Assy
6 - Clevis pin, shift and throttle lever
7 - Housing and cover assy
8 - Shift lever assy
9 - Knob, handle
10 - Screw, handle
11 - Bushing, shift and throttle plate
12 - Shift and throttle plate assy
13 -Wave washer, shift and thr. hub
14 - Bushing, cab, hub cover
15 - Slide, neutral lock
16 - Bushing, fast idle lever
17 - Lever, fast idle
18 - Latch, fast idle lever
19 - Switch, key and lanyard
20 - Shoe, detent, shift & thr. plate
21 - Retainer plate
22 - Spring, detent
23 -Switch assy, neutral start
24 - Friction adjustment lever
25 - Knob & friction **adj.** screw assy
26 - Horn
27 -Trim and tilt switch
28- Connector, 3 pin
29 - Handle, remote control
30 - Cover, Handle
31 - Screw, knob to control handle
32 - Plate, slide control lever
33 - Index plate, neutral lock
34 - Screw, cover, handle
35 - Applique
36 -Lead assy, neutral start

Fig. 4 Exploded view of a typical **Evinrude/Johnson** standard surface mount remote that has been prewired for a key switch and the System **Check®** monitor wiring.

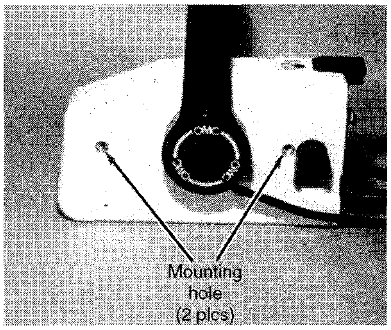


Fig. 5 Standard remote housings are normally mounted using 2 screws

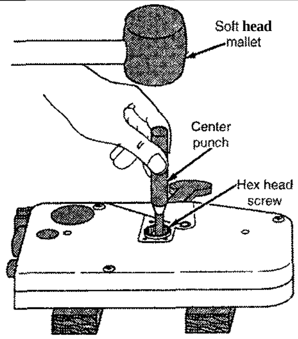


Fig. 6 Once the control handle Allen screw is loosened, dislodge the handle splines as shown

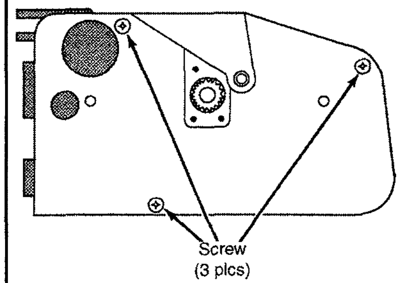


Fig. 7 Remove the housing-to-cover screws...

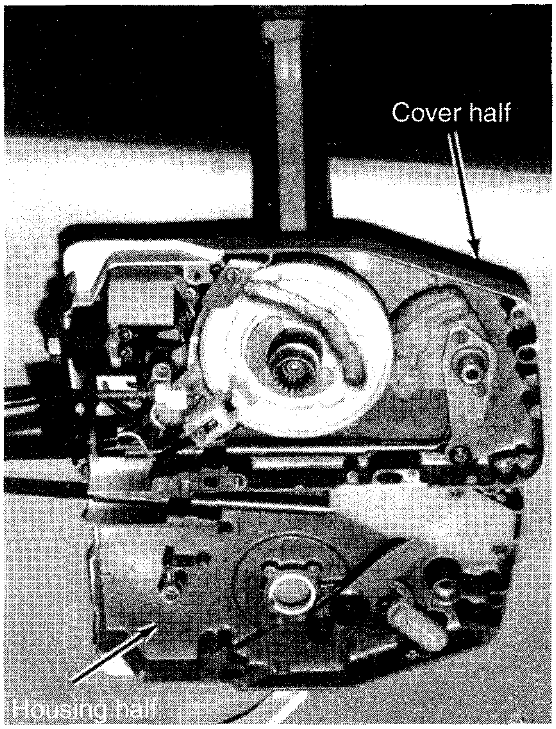


Fig. 8 ... then separate the housing from the cover

6. Finish unthreading the Allen screw, then remove the remote handle.
7. Remove the housing-to-housing cover screws (3) from the back of the housing. Carefully separate the housing and cover.
8. Remove the shift cable pin from the shift control clevis (at the bottom of the shift lever). Disconnect the shift cable.
9. Lift the throttle cable trunion from the housing pocket and then pull back on the cable to expose the pin. Remove the cable and pin from the throttle lever.
10. Remove the screw and retainer plate hooked into the top of the housing assembly.
11. Remove the friction adjustment lever along with the knob/screw assembly.
12. Remove the screws (2) securing the neutral start switch and then remove the switch from the housing.

✳✳ CAUTION

The detent spring is compressed and may fly free when removing the shift and throttle **plate** from the **housing.** In order to prevent the possibility of injury, be sure to wear **safety glasses.**

13. Slowly lift the shift and throttle plate from the housing.
14. Remove the detent roller, shoe and spring.
15. Lift the shift lever assembly from the control housing.
16. Remove and discard the flat-head screw at the center of the throttle lever assembly. Remove the countersunk washer from the lever as well and then lift the throttle lever assembly and spacer from the housing.
17. Remove the screw and locknut fastening the shift lockout cam to the fast idle lever. Discard the locknut, as it must be replaced once it is removed.
18. Remove the keeper plate screw at the top of the housing (directly above the shift lockout lever). Lift the shift lockout cam and lever from the housina and then remove the spring washer and fast idle lever from the housing.

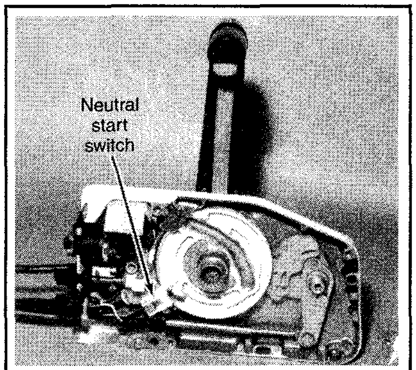


Fig. 9 Once separated, components such as the neutral start switch...

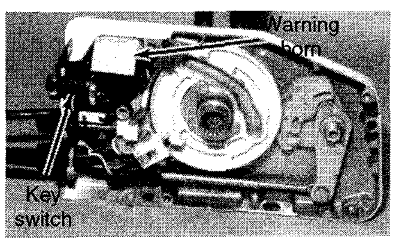


Fig. 10 ... ignition key switch and warning horn are accessible

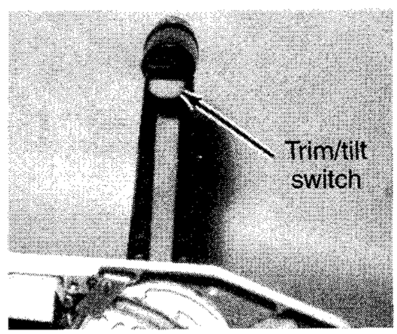


Fig. 11 The **trim/tilt** switch is inside the handle, above the neutral lockout **slider**

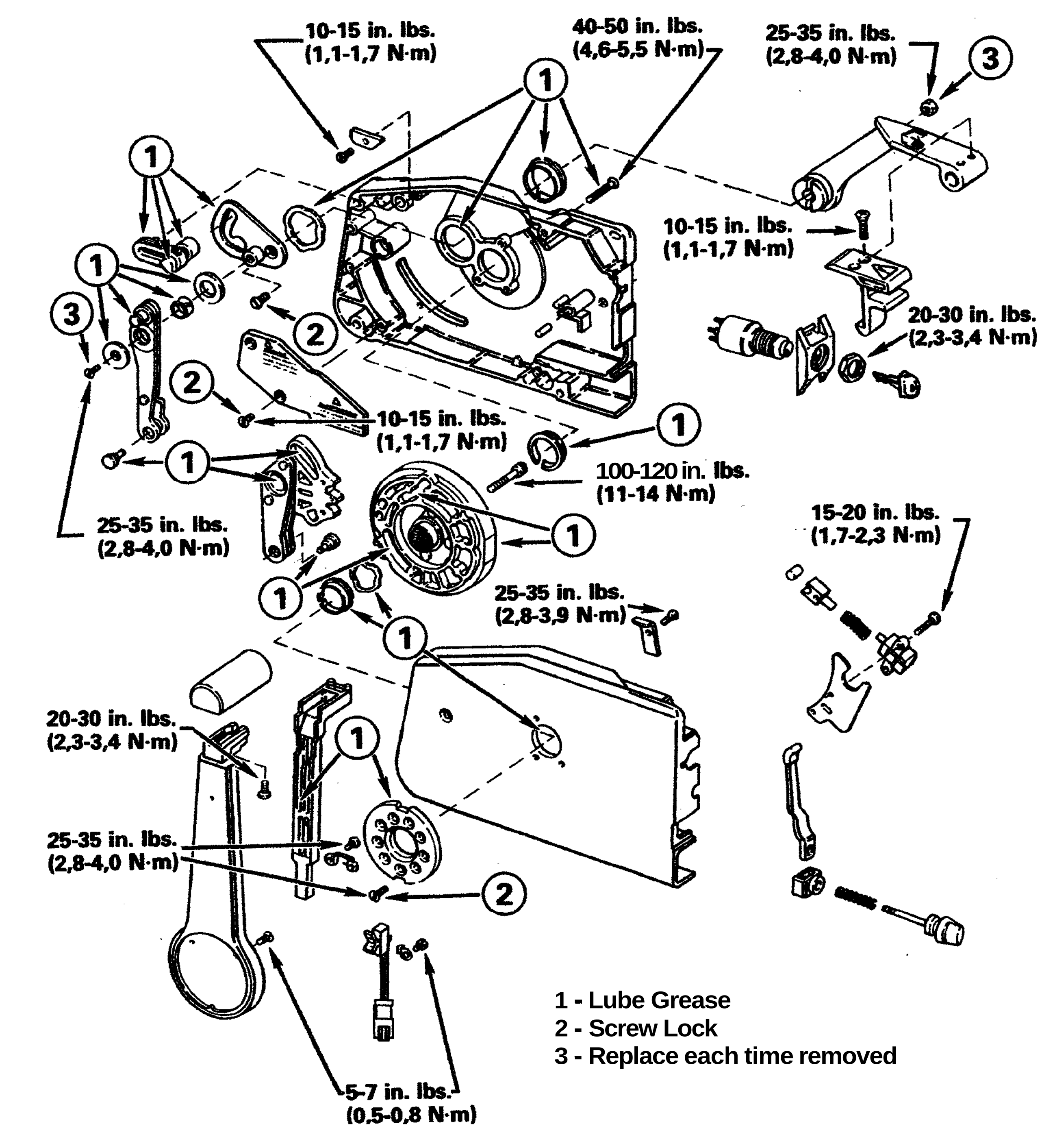


Fig. 12 For safety, pay close attention to component bolt torque and lubrication during assembly-typical standard surface mount remote

19. If necessary, remove the ignition key switch assembly for replacement.

20. If control handle disassembly is desired (such as for access to the trim/tilt switch), proceed as follows:

a. Remove the screws *(2)* fastening the slide control lever plate to the base of the handle.

b. Lift the neutral lock slide out of the control handle, remove the screws (3) fastening the handle cover and the one screw fastening the handle knob. Remove the cover and knob.

c. Remove the screw securing the trim/tilt switch to the cover and then remove the switch assembly.

21. Clean and inspect the remote control components as follows:

a. Wipe all metallic, non-electrical, parts with a clean rag soaked in a mild solvent. Electrical and plastic components should be cleaned using a dry rag and/or low pressure compressed air.

b. Check the flange bosses inside the shift lockout cam for signs of rounding at the edges. If found, the cam should be replaced.

c. Check the slots inside the fast idle lever for wear and replace the lever, if necessary.

d. Check the balance of the mechanical components for signs of cracks, damage or excessive wear. Replace any worn or damaged components to ensure proper remote operation.

22. Assembly is essentially the reverse of disassembly. Refer to the accompanying illustration for critical torque values and lubrication points. Also, be sure to pay particular attention to the following:

a. Sliding surfaces and pivot points must be properly lubricated using Evinrude/Johnson Moly Lube, or an equivalent assembly grease to ensure long-life and trouble-free, binding-free operation.

b. Apply a light coating of Evinrude/Johnson Screw Lock or equivalent threadlock to the threads of the screws noted in the accompanying illustration.

c. All wiring must be connected and secured at the points noted during removal. Wiring must be routed in a manner that will prevent contact with moving components and must not be pinched between the housing and cover during assembly.

d. **Do not** over or under tighten the fasteners for the remote housing components. Loose fasteners could allow components to shift, come loose, or worse-wedge stuck in a given position, leading to loss of throttle or shift control. Similarly over-tightened fasteners may lead to binding or breaking components.

e. Once assembly is complete, slowly move the remote handle through the range of operation. Feel for smooth and free movement. Adjust the friction screw/knob assembly so the throttle does not change in response to vibration from engine or boat operation. Do not set the friction adjuster so tight as to bind the control handle causing jerky shift/throttle adjustments.

When adjusting the friction screwlknob, turn the knob CLOCKWISE to increase friction or COUNTERCLOCKWISE to decrease friction. NEVER overtighten the screw, which would lock the throttle in position.

f. Refer to the Timing and Synchronization adjustments in the Maintenance and Tune-Up section for information on additional information on control cable adjustment and lubrication.

Small Motor Standard Surface Remote Units

OK, let's face it. Few, if any, of the Evinrude/Johnson V-motors are considered "small" but the truth is, as we stated at the beginning of this section, it's not in the engine manufacturer's hands what remotes their motors MIGHT be matched with. We've included repair for the Small Motor Standard Surface Remote Unit, just in case one of these motors becomes matched up with it.

OVERHAUL

(2) MODERATE

◆ **See Figures 13 and** 14

Refer to the accompanying illustration for parts identification.

1. Disconnect the battery cables for safety; this will help prevent the possibility of potential burns or shorts that could occur while working on the control unit.

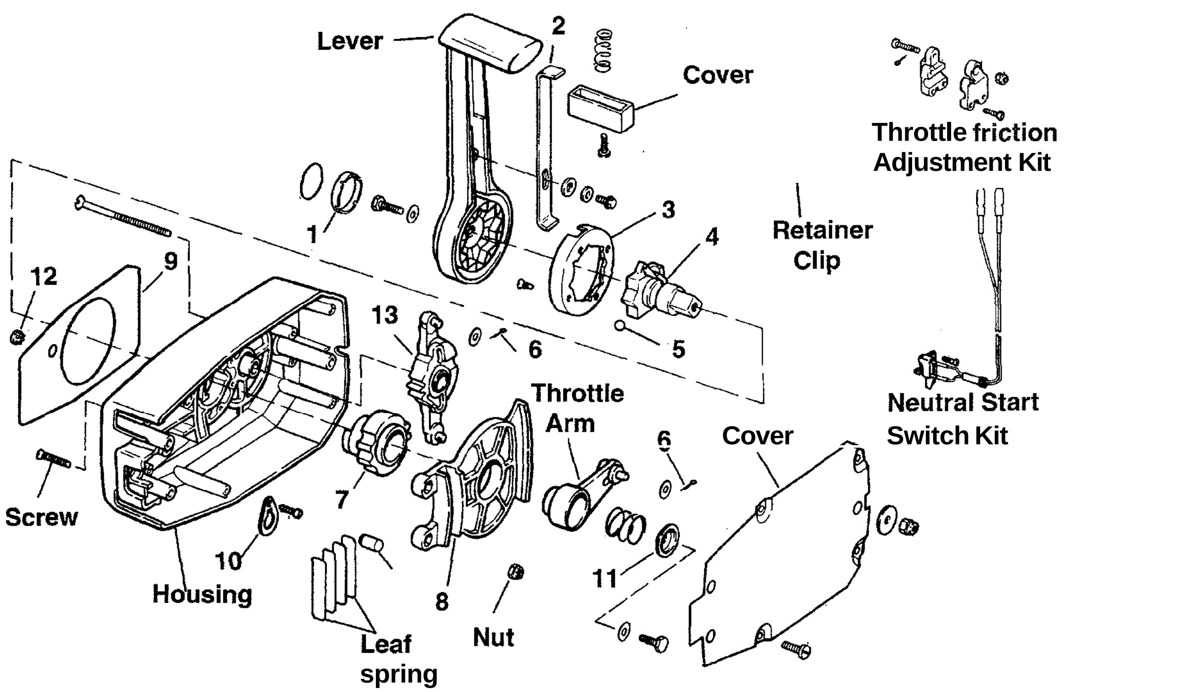
✳✳ CAUTION

Disconnecting the battery cables will also make sure that the engine is not accidentally cranked or started (which could lead to injury or damage).

2. Loosen the retainers and separate the remote from the boat with the cable still attached.

3. Loosen the flat-head screws (usually 4) and remove the control housing cover (back plate) from the back of the housing.

4. Place the control handle in **Neutral.**



1 - Button
2 - Rod, neutral lock
3 - Plate, neutral lock
4 - Driveshaft
5 - Ball, neutral lock
6 - Cotter pin
7 - Gear, drive
8 - Support, shift & throttle
9 - Decal
10 - Plate, trunnion mounting
11 - Retainer, spring
12 - Plug, friction adjustment
13 - Shift gear & pin

Fig. 13 Exploded view of a typical small motor standard surface mount remote

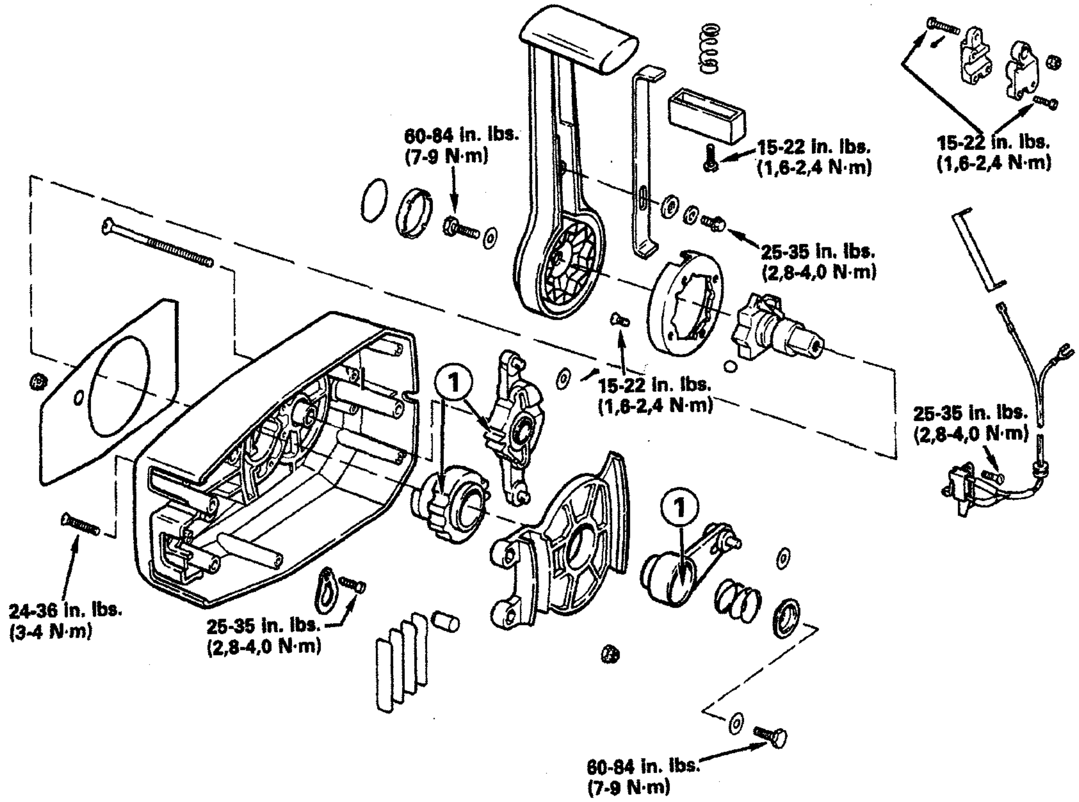


Fig. 14 For safety, pay close attention to component bolt torque and lubrication during assembly-typical small motor standard surface mount remote

5. Remove the shift and throttle cable trunion plates (the plates that fasten the cable housings to the end of the remote housing).

6. Disconnect the shift and throttle cables from the remote assembly by removing the cotter pins.

7. If equipped, remove the cotter pin from the throttle friction adjustment screw. Remove the adjustment assembly retaining screws and then remove the assembly.

8. If equipped, and if necessary for service, remove the neutral switch.

9. Carefully pry the cover out from the base of the remote handle, then remove the handle bolt.

10. Remove the neutral lock plate.

11. Loosen the bolt fastening the throttle lever, then remove the lever with the screw, washer, spring and arm. Remove the driveshaft.

12. If necessary, disassemble the internal drive components as follows:

a. Remove the friction adjustment plug and then carefully separate the decal from the handle side of the remote housing assembly.

b. Hold the drive components in position (by pushing on the shift and throttle support) and remove the retaining screws (3) on the outside of the cover, on the decal mounting surface.

c. Remove the shift and throttle support, the shift lever gear and pin, drive gear, neutral lock ball, detent roller and leaf springs.

13. Clean and inspect the remote control components as follows:

a. Wipe all metallic, non-electrical, parts with a clean rag soaked in a mild solvent. Electrical and plastic components should be cleaned using a dry rag and/or low pressure compressed air.

b. Check all mechanical comoonents for signs of cracks. damage or excessive wear. Replace any worn'or damaged components to ensure proper remote operation.

14. Assembly is essentially the reverse of disassembly. Refer to the accompanying illustration for critical torque values and lubrication points. Also, be sure to pay particular attention to the following:

a. Sliding surfaces and pivot points must be properly lubricated using *Evinrude/Johnson* Moly Lube, or an equivalent assembly grease to ensure long-life and trouble/binding-free operation.

b. **Do not** over or under tighten the fasteners for the remote housing components. Loose fasteners could allow components to shift, come loose, or worse-wedge stuck in a given position, leading to loss of throttle or shift control. Similarly, over-tightened fasteners may lead to binding or breaking components.

c. The shift and throttle support is retained by 3 locking nuts, replace any of the nuts that have lost their locking action.

d. When installing the throttle lever (using the spring, washer and screw), be sure to check the patch lock screw and replace it if it has lost its locking action. Also, be sure that the throttle lever points away from the trunnion pockets.

e. Apply a very light coating of Evinrude/Johnson Adhesive M or equivalent to hold the decal to the handle side of the control housing.

f. The neutral lock plate was equipped with thread-forming screws; the safe way to install them is to turn each of the screws backwards (counterclockwise) until they just drop into the original threads, and then tighten them by turning clockwise.

g. All wiring must be connected and secured at the points noted during removal. Wiring must be routed in a manner that will prevent contact with moving components and must not be pinched between the housing and cover during assembly.

h. Once assembly is complete, slowly move the remote handle through the range of operation. Feel for smooth and free movement. Adjust the friction screw so the throttle does not change in response to vibration from engine or boat operation. Do not set the friction adjuster so tight as to bind the control handle causing jerky shift/throttle adjustments.

■ **The friction screw is located under the small cover on the housing, just in front of the remote handle on starboard installations, or just behind the remote handle on port installations. Turn the screw CLOCKWISE to increase friction or COUNTERCLOCKWISE to decrease friction. NEVER overtighten the screw, which would lock the throttle in position.**

i. Refer to the Timing and Synchronization adjustments in the Maintenance and Tune-Up section for information on additional information on control cable adjustment and lubrication.

Dual Handle Surface Mount Remote Units for Single Motors

MODERATE

OVERHAUL

◆ **See Figures 15 and 16**

Refer to the accompanying illustration for parts identification.

1. Disconnect the battery cables for safety; this will help prevent the possibility of potential burns or shorts that could occur while working on the control unit.

✳✳ CAUTION

Disconnecting the battery cables will also make sure that the engine is not accidentally cranked or started (which could lead to injury or damage).

2. Loosen the retainers and separate the remote from the boat with the cable still attached.
3. Remove the 2 screws from the lower corners of the housing, then carefully separate the cover and housing while removing the control housing spacer.
4. Remove the screw and washer securing the shift lever
5. Lift the lever from the cover, remove the bushing from the lever and remove the plastic spring and washer from the lever hub.
6. Remove the screw and locknut fastening the shift cable to the casing guide and then remove the cable. To separate the casing guide from the shift lever, gently push the insert out.
7. Loosen the throttle friction adjustment knob.
8. Remove the screw and washer that secure the throttle lever assembly.
9. Gently lift the throttle lever from the housing, then remove the bushing from the lever and the two washers from the hub.
10. Remove the screw and locknut fastening the throttle cable in the casing guide and then remove the cable. To separate the casing guide from the throttle lever, gently push the insert out.
11. Fully unscrew the throttle friction adjustment knob, then pull the throttle friction detent arm (with spring and bushing) from the housing.
12. Remove the idle stop lever adjustment screw, plastic washer, lever and bushing from the housing.
13. Fully unscrew the idle stop adjustment knob, then remove the retainer and spring from the housing.
14. Clean and inspect the remote control components as follows:

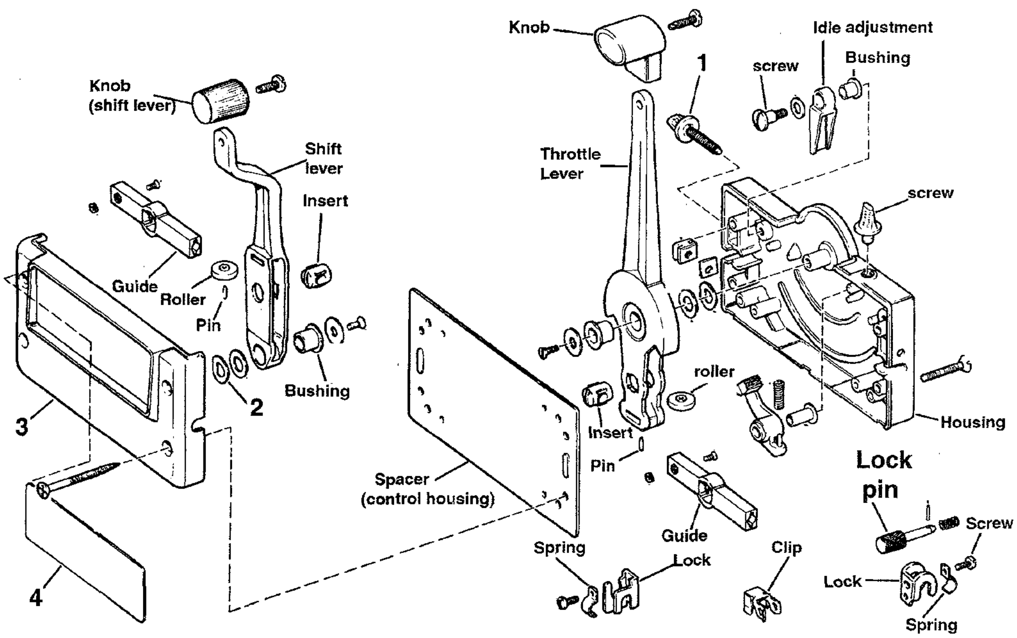
a. Wipe all metallic, non-electrical, parts with a clean rag soaked in a mild solvent. Electrical and plastic components should be cleaned using a dry rag and/or low pressure compressed air.
b. Check all mechanical components for signs of cracks, damage or excessive wear. Replace any worn or damaged components to ensure proper remote operation.

15. Assembly is essentially the reverse of disassembly. Refer to the accompanying illustration for critical torque values and lubrication points. Also, be sure to pay particular attention to the following:

a. Sliding surfaces and pivot points must be properly lubricated using Evinrude/Johnson Moly Lube, or an equivalent assembly grease to ensure long-life and troublelbinding-free operation.
b. **Do not** over or under tighten the fasteners for the remote housing components. Loose fasteners could allow components to shift, come loose, or worse-wedge stuck in a given position, leading to loss or throttle or shift control. Similarly, over-tightened fasteners may lead to binding or breaking components.
c. Once assembly is complete, slowly move the remote handle through the range of operation. Feel for smooth and free movement. Adjust the friction knob so the throttle does not change in response to vibration from engine or boat operation. Do not set the friction adjuster so tight as to bind the control handle causing jerky shift/throttle adjustments.

Turn the friction adjustment knob CLOCKWISE to increase friction or COUNTERCLOCKWISE to decrease friction. NEVER overtighten the knob, which would lock the throttle in position.

d. Refer to the Timing and Synchronization adjustments in the Maintenance and Tune-up section for information on additional information on control cable adjustment and lubrication. To set Idle rpm, turn the idle adjustment knob **clockwise** to increase engine idle or **counterclockwise** to decrease idle.



1 - Idle Stop knob and shaft
2 - Spring washer, Pivot
3 - Housing, Shift lever half
4 - Emblem

Fig. 15 Exploded view of a dual handle, surface mount remote for single motors

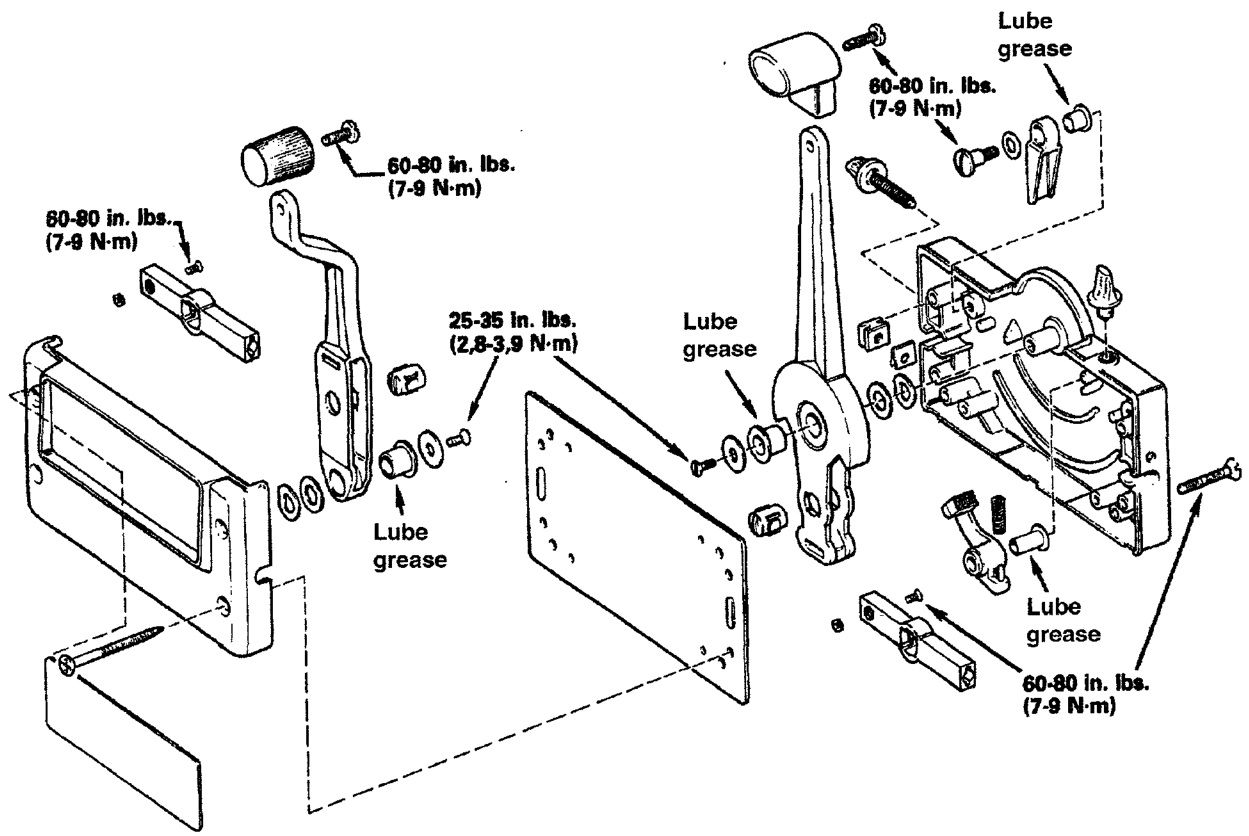


Fig. 16 For safety, pay close attention to component bolt torque and lubrication during assembly-dual handle, surface mount remote for single motors

Concealed Side Mount Remote Units

MODERATE

OVERHAUL

Replacing the Trim/Tilt Switch

◆ **See Figures 17 and 18**

Refer to the accompanying illustration for parts identification.

1. Disconnect the battery cables for safety; this will help prevent the possibility of potential burns or shorts that could occur while working on the control unit.

✳✳ CAUTION

Disconnecting the battery cables will also make sure that the engine is not accidentally cranked or started (which could lead to injury or damage).

Take note of the wire routing for installation purposes.

2. Cut the wire tie securing the trim switch leads to the lower corner of the control body. Disconnect the trim switch leads from the cable connector.
3. Remove the rubber boot from the warm-up knob at the base of the remote handle. Remove the retaining screw and knob.
4. Move the control handle fully into the **Reverse** position and insert a 118 in. hex-key into the opening at the bottom of the control handle. Loosen the set-screw (using the hex key), then carefully pull the control handle from the shaft while freeing the trim switch wires from the mounting plate.
5. Remove the screws (2) fastening the cover to the back of the remote handle and then separate the cover from the remote handle.

✳✳ CAUTION

The neutral lock rod spring is under tension and could fly free when removing the lockrod. Wear safety glasses to protect your eyes.

6. Carefully remove the neutral lock slide and spring while keeping track of the spring.
7. Remove and discard the retaining clip from the back of the trim/tilt switch, but use care not to damage or gouge the housing in the head of the remote handle.
8. With the retaining clip free, carefully pull the switch and wire leads from the handle. Take note of the wire routing to ensure trouble-free installation.
9. Installation is essentially the reverse of removal, but pay particular attention to the following:
   a. The wires molded into the trim switch are off-center, so be sure to position them toward the top of the handle when inserting the switch into the cover.
   b. The switch retaining clip must be replaced whenever it is removed, so be sure to use a new retaining clip when securing the switch to the housing in the remote handle.
   c. Route the switch wires through the hole in the lockout lever as noted during removal.
   d. Once the remote handle is fully assembled, make sure the housing is still in the full **Reverse** setting, then carefully push the handle onto the shaft. Verify that the neutral lock slide drops into the slot when shifting the handle up into **Neutral,** then tighten the set-screw.
   e. Route the switch wires as noted during removal and secure with a new wire tie.

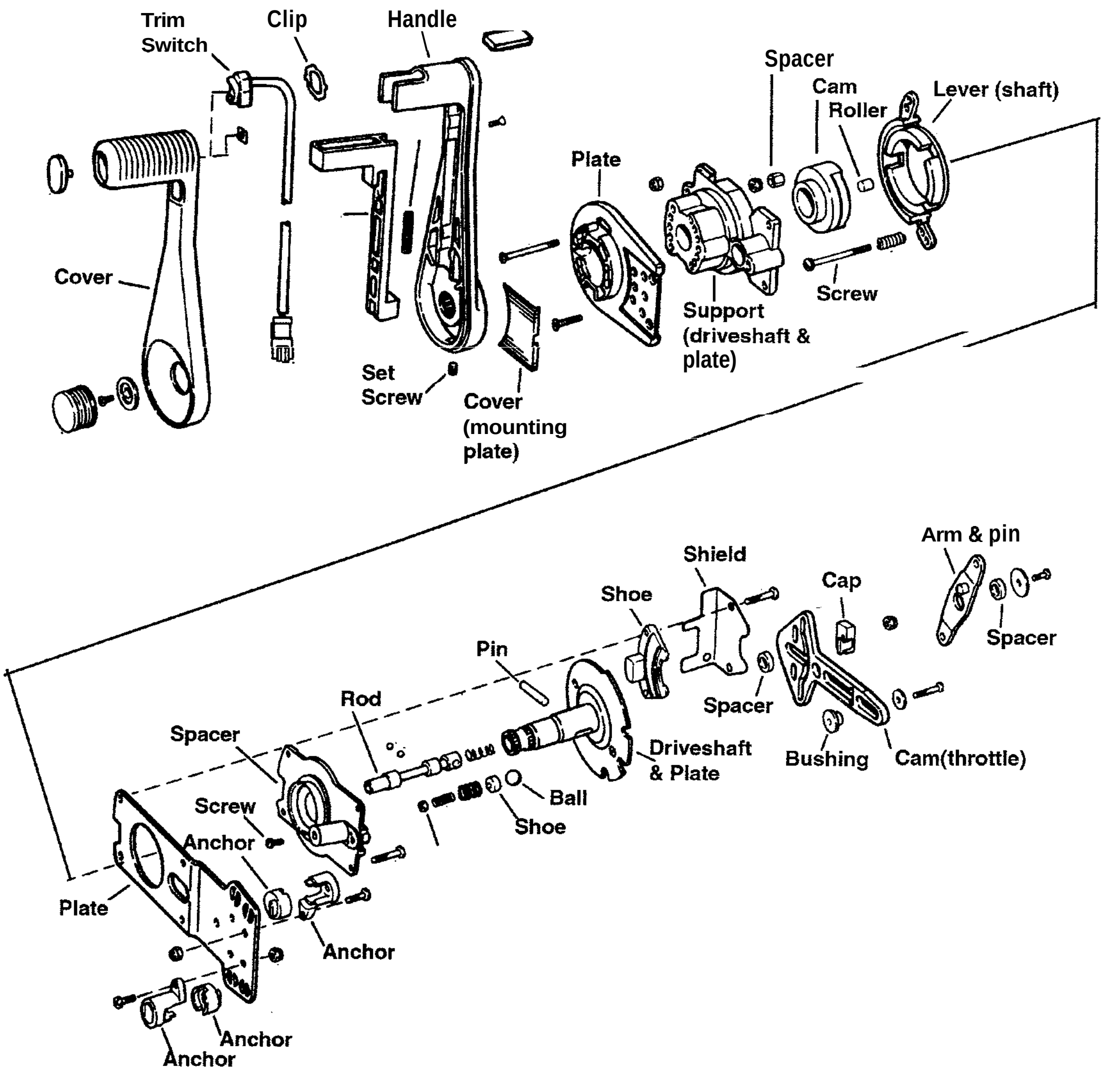


Fig. 17 Exploded view of a concealed side mount remote

Disassembling and Assembling the Housing

◆ **See Figures 17 and 18**

Refer to the accompanying illustration for parts identification.

1. Disconnect the battery cables for safety; this will help prevent the possibility of potential burns or shorts that could occur while working on the control unit.

✳✳ CAUTION

Disconnecting the battery cables will also make sure that the engine is not accidentally cranked or started (which could lead to injury or damage).

2. Remove the remote handle from the control assembly as detailed in Replacing the Trim Switch. Unless the switch or components in the remote handle are faulty, there is no need to disassemble the handle.
3. Remove the Philips screws (3) securing the remote assembly to the mounting plate and then remove the control from the boat (with the cables attached).
4. Disconnect the throttle and shift cables from the control assembly.
5. Position the remote handle back on the control assembly in order to shift the assembly into **Neutral,** then remove the handle once again
6. Remove the screw and washer securing the throttle arm and then remove the throttle arm.
7. Remove the throttle arm spacer and then remove the screw and washer securing the throttle cam. Remove the frrction control cap and locknut from the far end of the throttle cam and then remove the throttle cam from the assembly.
8. Remove the 2 spacers from the driveshaft and plate.
9. Remove the 2 screws and locknuts from the neutral switch shield. Remove the shield, shoe and the neutral switch, taking care not to loose the detent ball and related components.
10. Remove the final 2 screws and nuts (on the other end of the assembly from the shield and shield screws), then lift out the driveshaft and plate along with the detent spacer as an assembly.
11. Lift the cable mounting plate off the support.
12. If the driveshaft neutral detent components must be inspected, lubricated or replaced, disassemble them as follows:
   a. Press inward on the neutral warm-up rod (at the end of the shaft) and hold it down while withdrawing the shift cam drive pin from the base of the shaft.
   b. Separate the shaft from the spacer and remove the detent ball. Be ready to catch the detent ball as it will likely fall free when the shaft is removed from the spacer.
   c. Remove the neutral warm-up rod, driveshaft ball and spring from the shaft.
   d. Remove the detent shoe, inner spring, outer spring and the left-hand

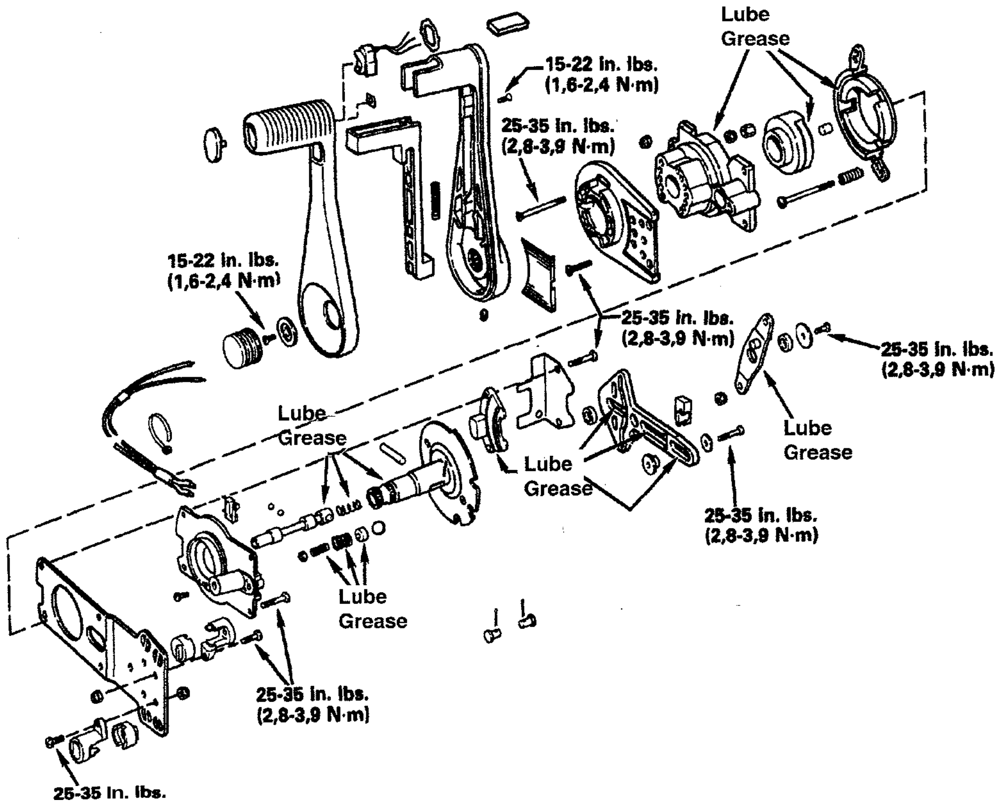


Fig. 18 For safety, pay close attention to component bolt torque and lubrication during **assembly-** concealed side mount remote

thread screw and nut (which is removed by turning clockwise). Don't mix-up this left-hand thread screw with other fasteners, as only this screw or another left-hand thread screw, must be installed during assembly.

13. If the driveshaft shift cam and roller assembly must be inspected, lubricated or replaced, disassemble the balance of the control assembly, as follows:

a. Remove the shift lever from the center of the driveshaft support.

b. Remove the throttle friction screw and spring from the end of the driveshaft support.

d. Remove the 3 shift cam rollers, followed by shifter cam.

e. Remove the ball from the bore in the side of the shifter cam.

f. Remove the 3 hex spacers and locknuts from the holes in the driveshaft support.

14. Clean and inspect the remote control components as follows:

a. Wipe all metallic, non-electrical, parts with a clean rag soaked in a mild solvent. Electrical and plastic components should be cleaned using a dry rag and/or low pressure compressed air.

b. Check all mechanical components for signs of cracks, damage or excessive wear. Replace any worn or damaged components to ensure proper remote operation.

15. Assembly is essentially the reverse of disassembly. Refer to the accompanying illustration for critical torque values and lubrication points. Also, be sure to pay particular attention to the following:

a. Sliding surfaces and pivot points must be properly lubricated using Evinrude/Johnson Moly Lube, or an equivalent assembly grease to ensure long-life and troublelbinding-free operation.

b. Do not over or under tighten the fasteners for the remote housing components. Loose fasteners could allow components to shift, come loose, or worse-wedge stuck in a given position, leading to loss of throttle or shift control. Similarly, over-tightened fasteners may lead to binding or breaking components.

c. Don't forget the left-hand threaded screw and nut used in the neutral detent assembly. DO NOT substitute a normal, right-hand thread screw if they are lost or damaged, obtain a suitable left-hand thread replacement.

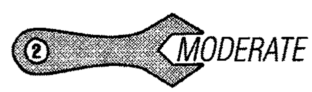
d Once assembly is complete. slowly move the remote handle through the range of operation. Feel for smooth and free movement. Turn the throttle friction adjustment screw (located in the bore on the mounting plate, nearest to the remote handle) so the throttle does not change in response to vibration from engine or boat operation. Do not set the friction adjuster so tight as to bind the control handle causing jerky shift/throttle adjustments.

■ Turn the friction adjustment screw CLOCKWISE to increase friction or COUNTERCLOCKWISE to decrease friction. NEVER overtighten the screw, which would lock the throttle in position.

e. Use the shifter detent friction screw (mounted through the bore in the mounting plate, furthest from the remote'handle), to adjust the shifter feel. Turn the screw clockwise to increase friction or counterclockwise to decrease it. As with the throttle friction screw adjustment, do not overtighten the screw to lock the shifter in position. The best way to set the detent riction screw is to adjust it while slowly moving the shifter slowly back and forth from Forward to Neutral and Reverse, until the desired amount of friction is obtained at the handle.

f. Refer to the Timing and Synchronization adjustments in the Maintenance and Tune-Up section for information on additional information on control cable adjustment and lubrication.

Pre-wired Binnacle Mount Remote Units



OVERHAUL

◆ See Figures **19, 20, 21** and **22**

Refer to the accompanying illustration for parts identification.

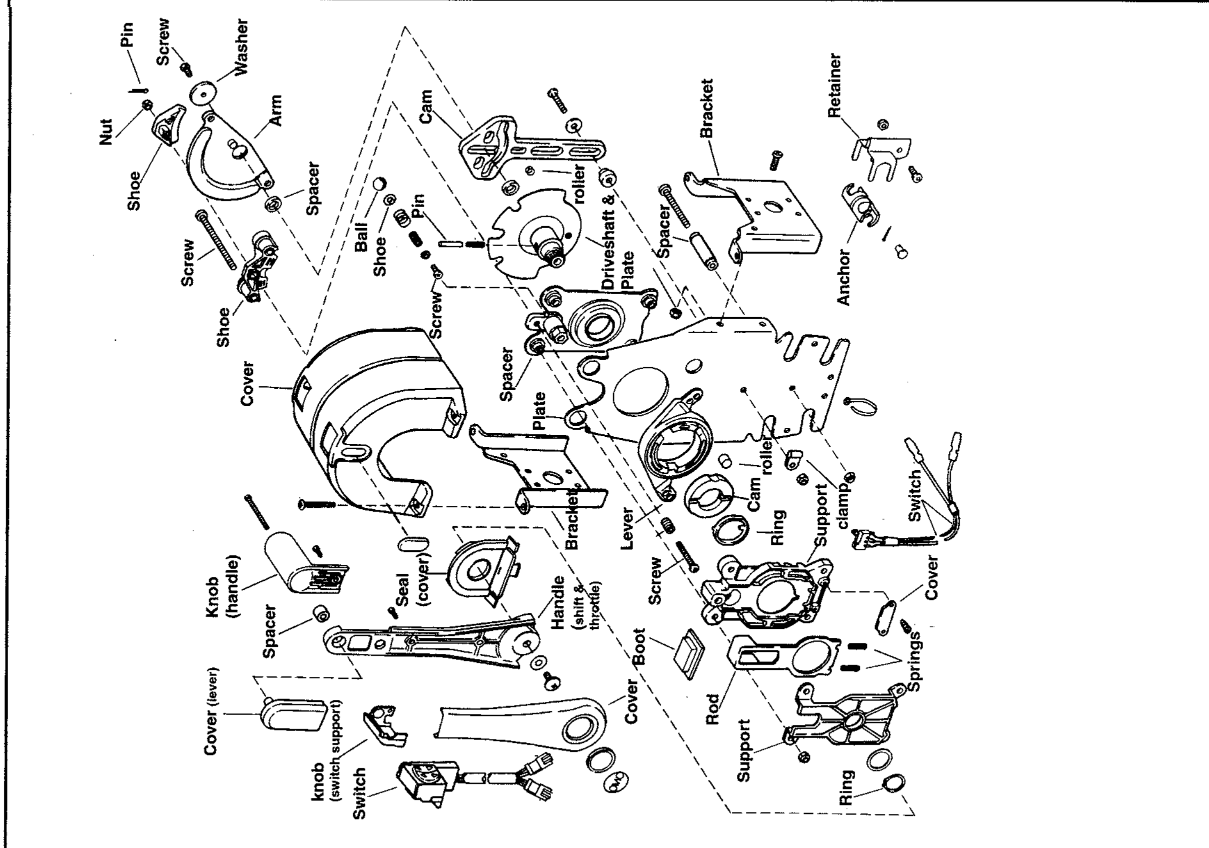


Fig. 20 Exploded view of a dual lever binnacle remote without a key switch

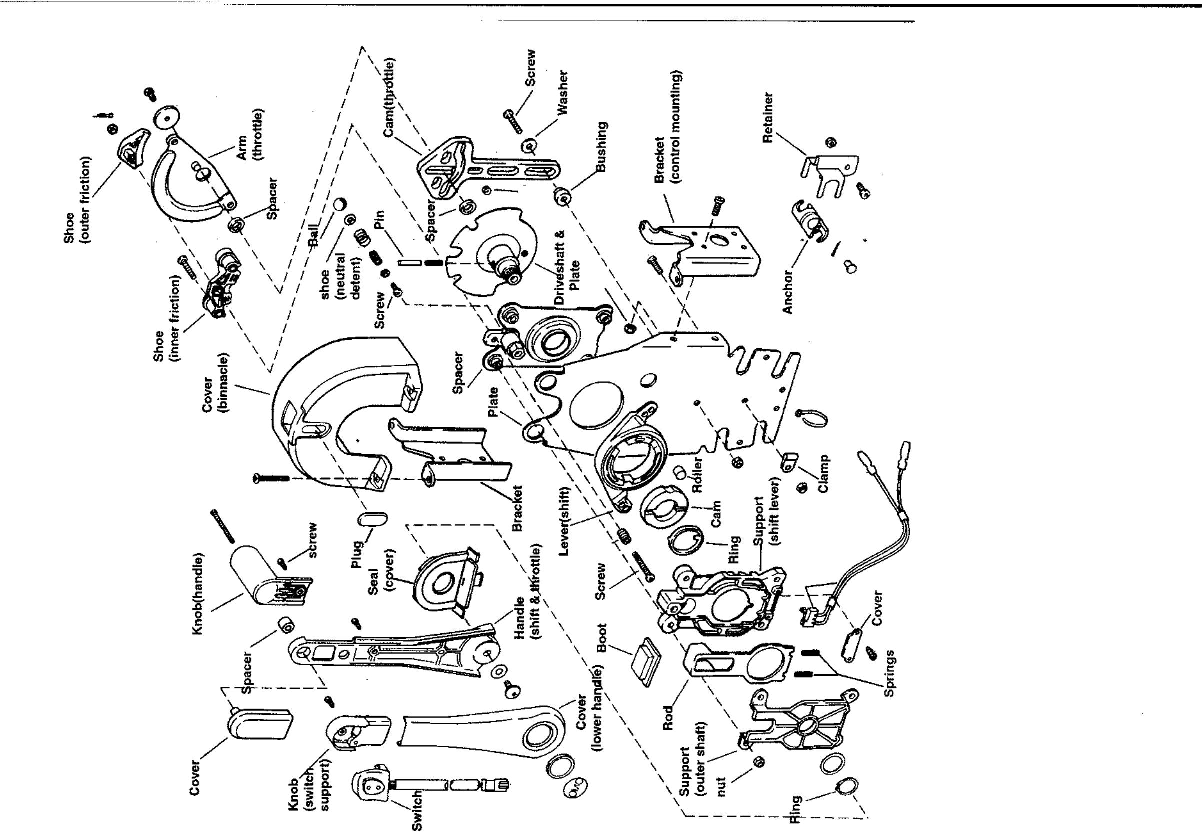


Fig. 19 Exploded view of a single lever binnacle remote without a key switch

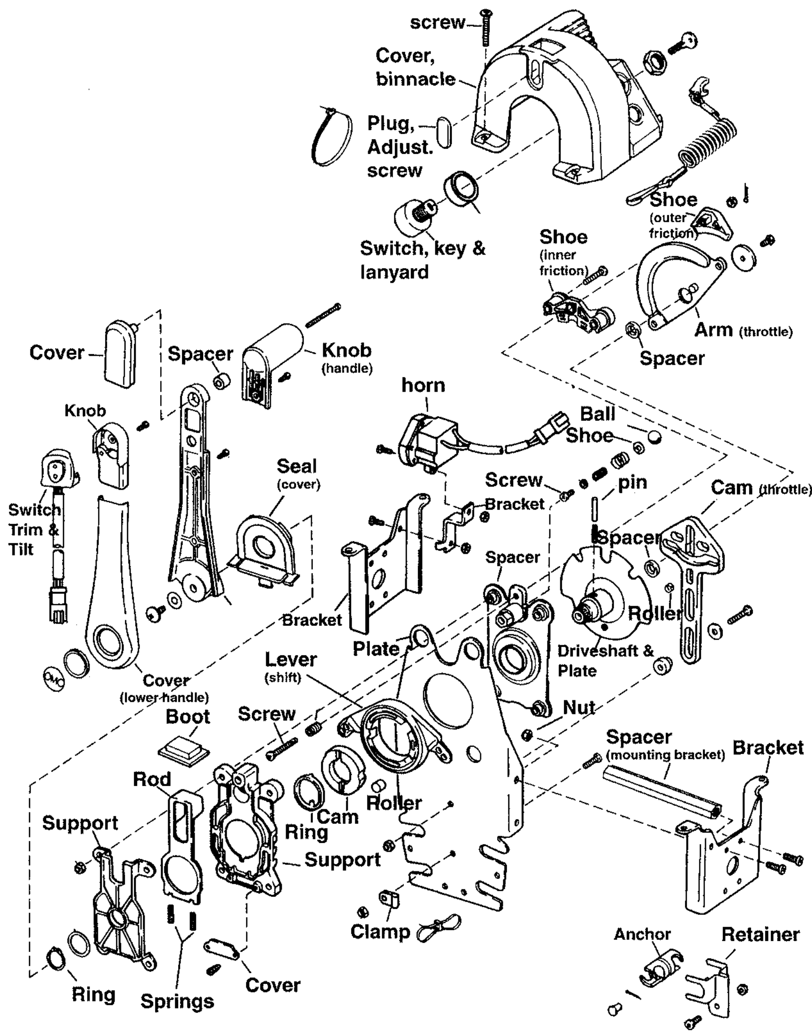


Fig. 21 Exploded view of a single lever binnacle remote prewired for an ignition key switch and System Check® monitor

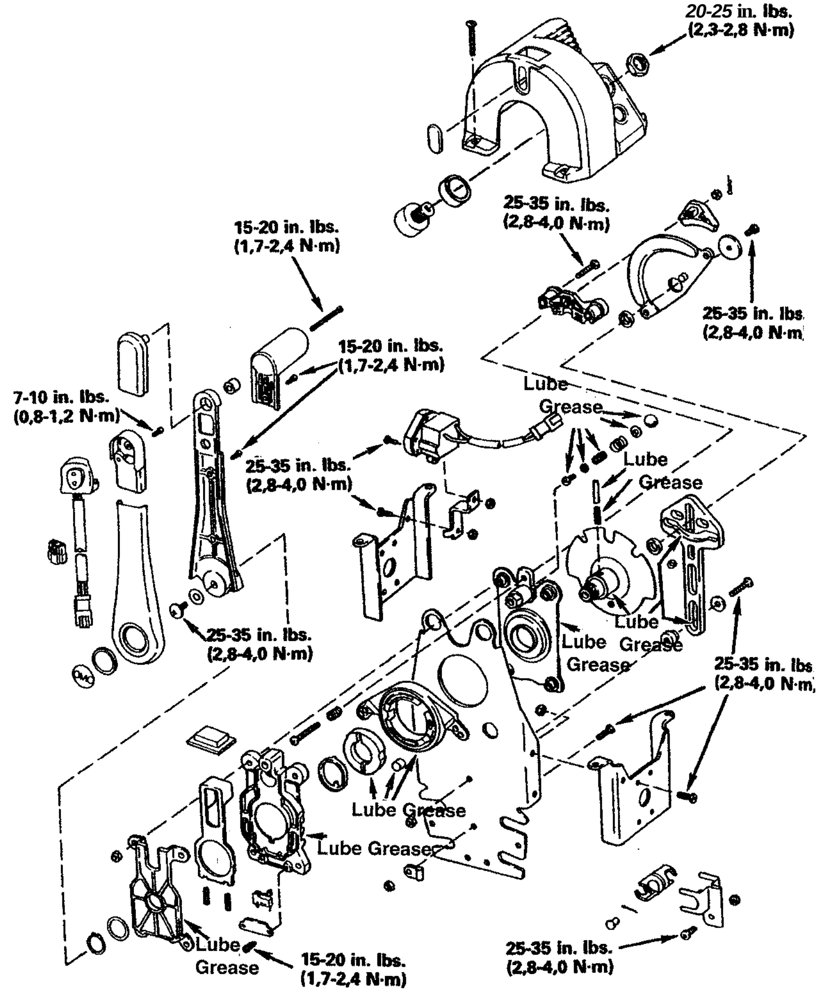


Fig. 22 For safety, pay close attention to the illustrated component bolt torque and lubrication points during assembly-single and dual-lever binnacle remotes

1. Disconnect the battery cables for safety; this will help prevent the possibility of potential burns or shorts that could occur while working on the control unit.

** CAUTION

Disconnecting the battery cables will also make sure that the engine is not accidentally cranked or started (which could lead to injury or damage).

2. Loosen the retainers and separate the remote from the boat with the cable still attached.
3. If equipped, remove the nut securing the ignition key switch, then remove the cover.
4. Disconnect the throttle and shift cables from the control assembly.
5. Position the shifter handle in **Neutral.** then carefully pry the screw cover from the base of the handle. Remove the screw and washer, and then gently pry the remote handle from the driveshaft splines.
6. If necessary, disassemble and inspect the handle.

■ **The trim/tilt switch assembly is mounted in the top of the handle.**

7. If equipped, remove the screws (2), then lift off the clamp and the neutral switch from the shift lever support. Cut the wire tie and remove the screw securing the wire clamp (but be sure to take note of the wire routing for installation purposes).
8. If equipped, remove the warning horn mounting screw, then remove the horn and wiring harness assembly. Again, note the wiring routing for installation purposes.
9. Remove the cover mounting brackets from either side of the housing.
10. Remove the cotter pin from the friction adjustment screw (at the top of the throttle lever plate), then loosen the screw and remove it along with the nut and outer friction shoe.
11. Remove the screw, washer, throttle lever plate and bushing.
12. Remove the screw, washer and nut from the throttle cam and bushing. Remove the throttle cam, bushing, spacer and throttle pin roller.
13. Using a pair of snapring pliers, remove the ring from the splined end of the driveshaft.
14. Remove the screws and nuts fastening the inner friction shoe and then remove the shoe.

15. Remove the screws and nuts (usually 4) holding the rest of the assembly together and then pry the outer shaft support carefully off the driveshaft.
16. Wearing safety glasses (to protect from injury) slowly remove the neutral warm-up rod, keeping pressure on the springs at the bottom of the rod until spring tension is released. This will help prevent the springs from flying free and either hitting someone in the eyes or disappearing into the darkest recesses of the shop, Fully remove the shift lever support.
17. Remove the friction adjustment screw (with spring) from the shift lever support or the neutral detent plate spacer.
18. Remove the cable mounting plate and shift lever from the driveshaft, detent plate and shifter cam.
19. Remove the shift lever from the cable mounting plate and then remove the rollers from the lever.
20. If necessary for inspection, lubrication or repair, disassemble the driveshaft and neutral detent plate spacer comoonents as follows:
    a. Push the drive pin into the shaft using ihe neutral warm-up ring and then carefully lift the ring from the cam.

■ **Use finger pressure over the drive pin to hold it in place as the cam is lifted free, otherwise the pin will become a projectile.**

    b. Slowly release the spring pressure on the pin once the cam is removed, then remove the pin and spring.
    c. Carefully pry the shaft from the detent plate, making sure to retain the detent ball located between them.
    d. Remove the ball (if it did not fall out earlier), shoe, springs, nut and screw from the detent plate.
21. Clean and inspect the remote control components as follows:
    a. Wipe all metallic, non-electrical, parts with a clean rag soaked in a mild solvent. Electrical and plastic components should be cleaned using a dry rag and/or low pressure compressed air.
    b. Visually check all mechanical components for signs of cracks, damage or excessive wear. Replace any worn or damaged components to ensure proper remote operation.
22. Assembly is essentially the reverse of disassembly. Refer to the accompanying illustration for critical torque values and lubrication points. Also, be sure to pay particular attention to the following:
    a. Sliding surfaces and pivot points must be properly lubricated using Evinrude/Johnson Moly Lube, or an equivalent assembly grease to ensure long-life and troublelbinding-free operation.
    b. **Do not** over or under tighten the fasteners for the remote housing components. Loose fasteners could allow components to shift, come loose, or worse-wedge stuck in a given position, leading to loss af throttle or shift control. Similarly, over-tightened fasteners may lead to binding or breaking components.
    c. During installation, be sure to attach both cables to the **handle side** of the throttle lever plate. First, insert one cable pin through the throttle lever, then through the throttle cable. Next insert the other pin through the shift cable, then through the shift lever.
    d. All wiring must be connected and secured at the points noted during removal. Wiring must be routed in a manner that will prevent contact with moving components and must not be pinched between components during assembly.
    e. Once assembly is complete, slowly move the remote handle through the range of operation. Feel for smooth and free movement. Adjust the throttle friction adjustment screw so the throttle does not change in response to vibration from engine or boat operation. Do not set the friction adjuster so tight as to bind the control handle causing jerky throttle adjustments.

The throttle friction adjustment screw is located under a small cover on the side, top of the housing (just below the peak of the curve). There are actually 2 screws which can be accessed through an oval cutout in the side of the housing, the top of these is the throttle friction screw (the lower of these is the shifter detent screw). Turn the either friction adjustment screw CLOCKWISE to increase friction or COUNTERCLOCKWISE to decrease friction. NEVER overtighten the screw, which would lock the throttle or shifter in position.

    f. Once the throttle friction screw is set, adjust the shifter detent friction screw (at the bottom of the same oval cutout) to adjust the shifter feel. The best way to set the detent friction screw is to adjust it while slowly moving the shifter slowly back and forth from **Forward** to **Neutral** and **Reverse,** until the desired amount of friction is obtained at the handle. As with the throttle friction screw adjustment, do not overtiqhten the screw to lock the shifter in position.
    g. Refer to the Timing and Synchronization adjustments in the Maintenance and Tune-Up section for information on additional information on control cable adjustment and lubrication.

CONTROL CABLES

Rigging

◆ **See Figure 23**

The control cables should be replaced if inspection reveals any signs of damage, wear or even fraying at the exposed ends. Remember that loss of one or more cables while underway could cause loss of control at worst or, at best, strand the boat. Check cable operation frequently and inspect the cables at each service. Replace any that are hard to move or if excessive play is noted. Never replace just one cable (unless a freak accident caused damage to the cable). if one cable is worn or has failed. assume the other is in like condition and will soon follow.

Before removal, mark the cable mounting points on the remote control using a permanent marker. This will help ensure easy and proper installation of the replacement. Unless there is a reason to doubt the competence of the person who originally rigged the craft, match the cable lengths as closely as possible. Otherwise, re-measure and determine proper cable lengths as if this was a new rigging.

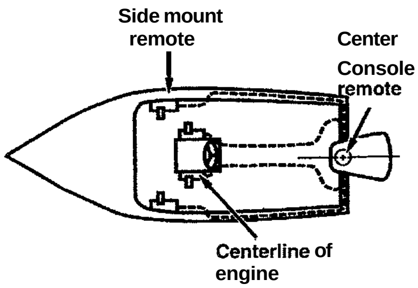


Fig. 23 For cable replacement or rigging, measure the distance from the centerline of the motor to the remote (and add 3 **ft. 4 in./1.02** meters to the measurement)

When rigging an engine to a new boat, determine cable length by measuring from the centerpoint of the motor along the intended cable route to either the side-mount or center-console remote location (refer to the accompanying illustration). Add 3 ft. 4 in. (1.02 M) to the measurement and purchase a cable of the same length (or one that is slightly longer than that measurement. Evinrude/Johnson replacement cables are normally available in one-foot increments from 5-20 ft. and in two-foot increments to 50 ft.

**** CAUTION**

To prevent the danger of cable binding or other conditions that could cause a loss of steering control when underway, take care to route all cables with the fewest number and most gentle bends possible. **A** bend should NEVER have a radius of less than **6 in. (15cm).**

Follow the procedures for remote service in this section and the Timing and Synchronization adjustments in the Maintenance and Tune-Up section whenever removing/installing or replacing the throttle and shift cables.

10

HAND REWIND STARTER

HAND REWIND STARTER

Introduction to Manual Starters

◆ See Figure 1

Because of the large size (and significant force necessary to manually start) EvinrudelJohnson V-motors, VERY few are produced only with a manual rope starter assembly. Specifically, some 90º and 60º V4 commercial models were designed with a rope start to keep the engines simple, reliable and affordable for commercial fisherman and other watermen. If the motor has a long (and jaded history), there is no reason why an electric starter many not have been added to a model that was originally rope only. Likewise, a manual starter could be used as an auxiliary starter on any motor to which a rope start assembly was installed. Therefore, you could find a non-commercial rope start that was rigged that way for an emergency backup (or a cheap fix when electrical problems may have occurred in the engine's history).

Rope-start EvinrudelJohnson outboards utilize a hand rewind starter assembly to turn the flywheel for engine start-up and to automatically recoil the rope afterwards. Most of the hand rewind starters installed on EvinrudelJohnson outboards consist of a flat disc type assembly that is mounted atop the flywheel. These starters engage a ratchet plate that turns the flywheel when the rope is pulled.

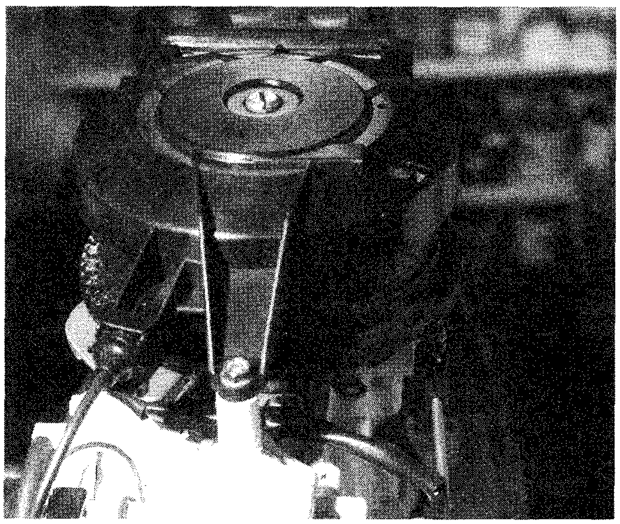


Fig. 1 Typical hand rewind starter assembly mounted atop the flywheel

MANUAL STARTER SERVICE

◆ See Figure 2

Essentially, the hand rewind starter is strictly a mechanical device used to crank the powerhead for starting. Because it is such a basic mechanical device, one normally encounters very few problems with the assembly. The spring will last an incredibly long time, if used properly. The greatest enemy of the spring is the operator.

Three causes can contribute to starter failure. Two may be prevented, the third cannot.

The most common problem is the result of the operator pulling the starter rope too far outward. If the operator places one hand on the powerhead and pulls the rope with the other hand, it is physically impossible, in this position, to pull the rope too far. Problems develop when the operator uses both hands to pull on the rope, with no control on how far ihe rope can be extended. The rope may be broken or the knot released from the starter disc. In either case, the spring rewinds with tremendous speed and in almost all cases travels past its normal rewind position bending the end of the spring in reverse. Therefore, more maintenance work is involved than merely replacing the rope.

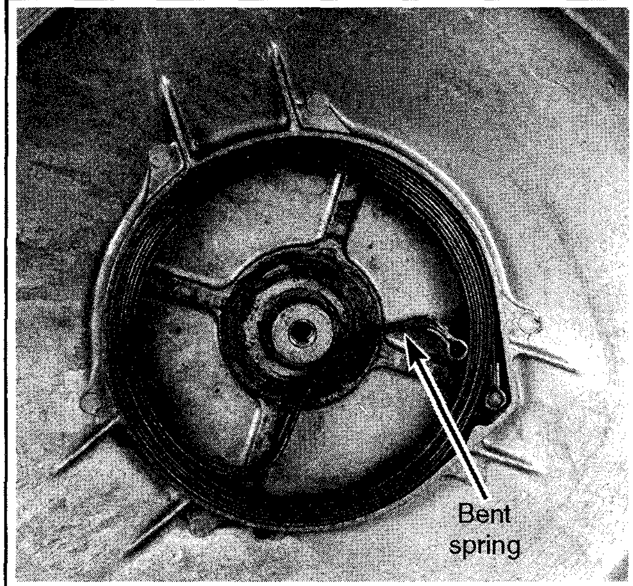


Fig.2 The pull rope broke on this starter assembly causing the spring to rewind with such incredible speed, it actually bent back in a reverse direction

Another bad habit while using the hand rewind starter, is the operator releasing his/her grip on the rope when it is in the extended position, allowing the rope to freely rewind. The operator should never release his grip, but hold onto the rope and slowly feed it back into the assembly, thus controlling the rewind.

The owner should remain alert to any wear on the rope and replace it long before the possibility of breaking might occur. When a rope breaks, the spring usually rewinds with incredible speed, the same as if the rope is suddenly released, and usually causes damage to the spring or other starter assembly components.

The third cause of spring failure cannot be prevented—age. As the outboard continues to perform year after year, the age of the spring steel will finally take its toll.

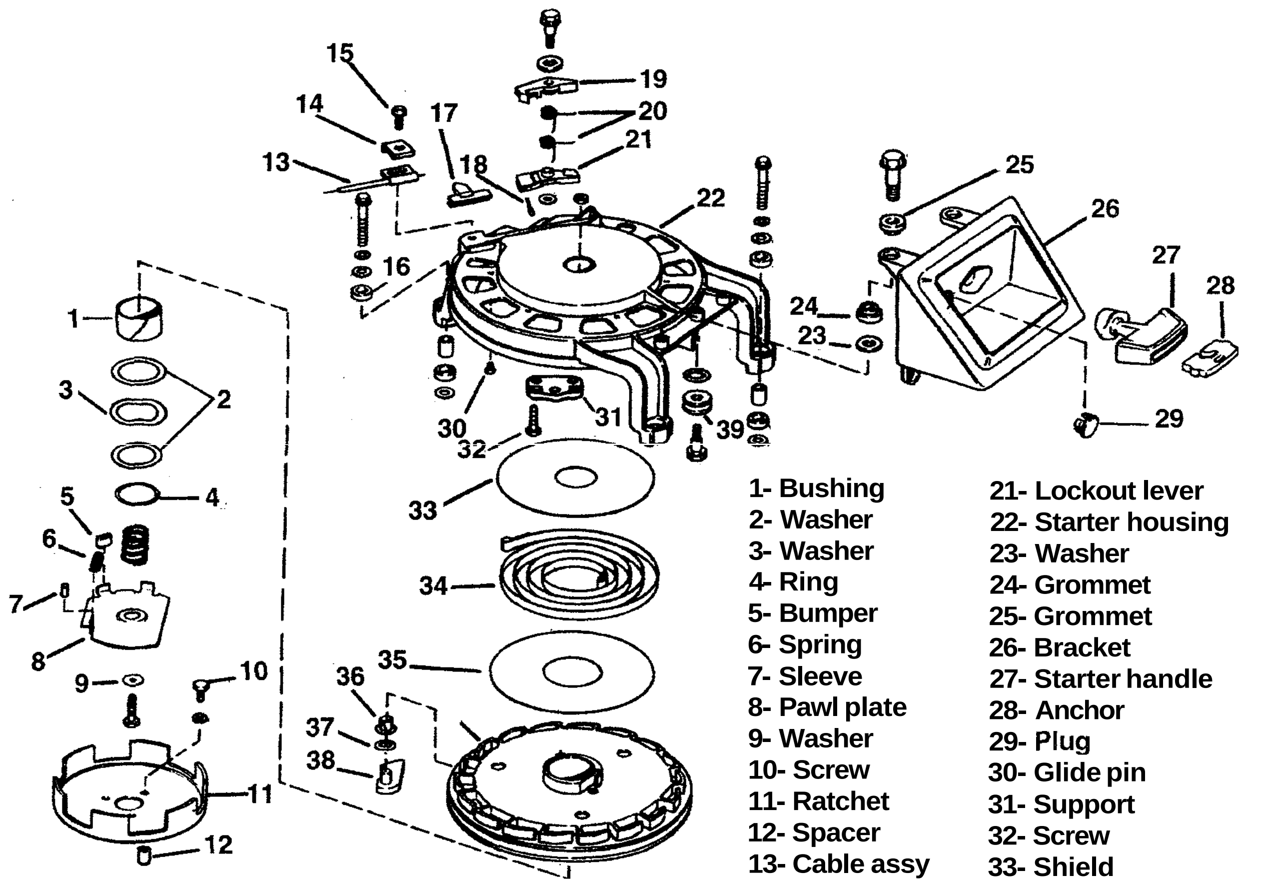
■ Depending on the model and the powerhead, anywhere from **6** to **12** feet of spring steel length is wound into about a ***4*** in. diameter. This places the spring under unbelievable tension—a real "tiger in a cage"—making it a potentially dangerous force. Therefore, any time the hand starter is serviced, especially during work on the spring, safety glasses should be worn and the work performed with the utmost care. The procedures must be followed exactly as presented for each starter, to prevent possible injury to the worker or others in the area.

Any time the rope is broken, the starter spring will rewind with incredible speed. Such action will cause the spring to rewind past its normal travel and the end of the spring will be bent back out of shape. Therefore, if the rope has been broken, the starter should be completely disassembled and the spring repaired or replaced.

Manual Starter Assembly—80 Jet-115 Hp (1726cc) 60LV4 Motors

◆ See Figure 3

This hand rewind starter is found on the largest of the carbureted Evinrude/Johnson inline outboards and also on certain V4 motors, so it is therefore the largest, most heavy-duty of hand starter assemblies. Although similar in appearance, each application (600 and 900) detailed here utilizes



1- Bushing
2- Washer
3- Washer
4- Ring
5- Bumper
6- Spring
7- Sleeve
8- Pawl plate
9- Washer
10- Screw
11- Ratchet
12- Spacer
13- Cable assy
14- Clamp
15- Screw
16- Grommet
17- Slide
18- Grommet
19- Lockout lever
20- Spring
21- Lockout lever
22- Starter housing
23- Washer
24- Grommet
25- Grommet
26- Bracket
27- Starter handle
28- Anchor
29- Plug
30- Glide pin
31- Support
32- Screw
33- Shield
34- Starter spring
35- Shim
36- Bushing
37- Washer
38- Pawl
39- Pulley & O-ring

Fig. 3 Exploded view of a TYPICAL hand-rewind starter assembly which is SIMILAR (but not identical) to the one used on V4 motors

slightly different procedures and will be covered individually. Similar to most outboards, the starter is mounted atop of the flywheel on three mounting legs. The unit has a large rectangular pawl plate visible on the underside surface.

Because this starter is used on fairly large horsepower powerheads, the actual number in the field is rather small. As can be imagined, the operator of such a motor must be somewhat stout.

REMOVAL

1 EASY

◆ **See Figures 3 and 4**

1. For safety, disconnect the spark plug leads, then ground them to the cylinder head.
2. If equipped with a starter lockout cable, these models normally use a lockout slider mounted to the top of the housing (as opposed to a cable with plunger used on many smaller Evinrude/Johnson models). To release the lockout cable, remove the screw from the cable clamp, then separate the lockout slide from the housing.
3. If necessary for replacement or service, remove the starter handle as follows: pull the starter rope partially out of the pulley, then use a bolt to wedge the pulley against the starter housing, holding it in position against spring pressure. Another option is to tie a slipknot in order to hold it in this position and keep tension off the starter handle. Carefully pry the rope anchor out of the handle and then separate the rope from the anchor and the handle. While holding tension on the rope, release the bolt or slipknot and then slowly allow the rope to rewind into the pulley until spring tension is fully released.

It is NOT necessary to remove the starter handle bracket in order to remove the starter housing.

4. Remove the bolts (usually 4) securing the power pack to the flywheel cover.
5. Remove the bolts securing the hand rewind starter assembly to the powerhead (on these models there are usually 3 bolts arranged in a triangle, 2 on the legs of the assembly, near the rope handle, and an additional bolt opposite them). Carefully lift the assembly from the powerhead.
6. If the starter handle bracket must be replaced, disengage the stop switch connector at the power pack and the stop switch ground wire, then remove the 4 bolts securing the starter handle bracket along its flange.

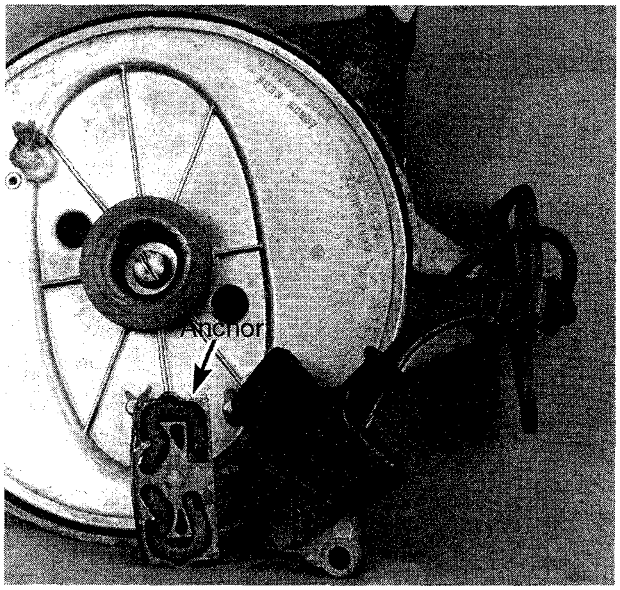


Fig. 4 The starter rope is secured to an anchor seated within the starter handle

DISASSEMBLY

◆ See Figure 3

No special tools are required in order to disassemble the hand rewind starter assembly for these motors. However, the Evinrude/Johnson Starter Spring Winder and Installer (No. 392093) is recommended for installation. Please review the assembly procedure before proceeding.

✳✳ CAUTION

The spring is under a tremendous amount of tension, wear safety glasses and heavy gloves to protect yourself.

1. Remove the starter assembly from the top of the powerhead.
2. Remove the shoulder screw and rope guide from the starter housing.
3. Remove the bolt retaining the lockout lever, the lockout lever springs, housing washer and, on the other side of the housing, the pulley support with screw. Remove the components.
4. Place one hand under the housing to prevent all the large pawl plate and other small parts from flying loose. Keep one finger over the center bolt.
5. Remove the large center nut from atop the center of the starter housing. Carefully turn the starter housing over without disturbing any parts.

✳✳ CAUTION

The rewind spring is a potential **hazard. The** spring is under tremendous tension when it is wound—a real "tiger" in a cage! If the spring should accidentally be released, severe personal injury could result from being struck by the **spring. Therefore,** the following steps must be performed with care to prevent personal injury to self and others in the area.

6. Lift off the center bolt and washer, and then lift off the starter pawl plate and the plate return spring (the spring is attached to the side of the pawl plate and to a post on the starter housing).
7. Remove the center spring, starter pawl and spring washer from the starter housing.
8. Use a small prytool to carefully pry out the pulley lockring from the housing (normally mounted to the center of the assembly, under the spring). Lift off the friction plates (flat washers) surrounding the spring washer beneath the plate.
9. Hold the pulley and the housing together tightly and turn the complete assembly over with the legs extending downward in the normal manner. Now, lower the complete assembly to the floor. When the legs make contact with the floor, release your grip. The pulley will fall and the spring will be released from the housing almost instantly and with considerable force. However, the legs should contain the spring and prevent it from lashing out causing possible injury to self or others in the area. If the spring was not released from the housing as just described, the only safe method is to again jar the legs on the floor and dislodge the spring.
10. If necessary, unwind the rope out of the pulley groove.

CLEANING & INSPECTION

◆ See Figures 3,5 and ***6***

Wash all metallic parts in solvent, and then blow them dry with low-pressure compressed air.

Remove any trace of corrosion and wipe all metal parts with an oil-dampened cloth.

Inspect the rope. Replace the rope if it appears to be weak or frayed. If the rope is frayed, check the pulley and housing (especially the holes through which the rope passes and the rope guide pulley) for rough edges or burrs. Remove the rough edges or burrs with a file and polish the surface until it is smooth.

■ Replacement ropes on these models should be trimmed to a length of about 96 **1/2** in. **(245cm).** Use a heat source or small open flame to fuse 112 in. **(12mm)** of each end to help prevent fraying.

Inspect the starter spring end hooks. Replace the spring if it is weak, corroded or cracked, Inspect the inside surface of the pulley rewind recess for grooves or roughness. Grooves may cause erratic rewinding of the starter rope.

Check all starter components for signs of wear or damage. Be sure to check the pawl for wear and replace, as necessary.

Check the lockout assembly components for wear or damage and replace, as necessary.

ASSEMBLY

◆ See Figures **3, 7, 8, 9, 10, 11, 12, 13, 14** and **15**

The outer spring hook (loop) is installed on the pin located in the starter housing found inline with one of the housing legs, just adjacent to the

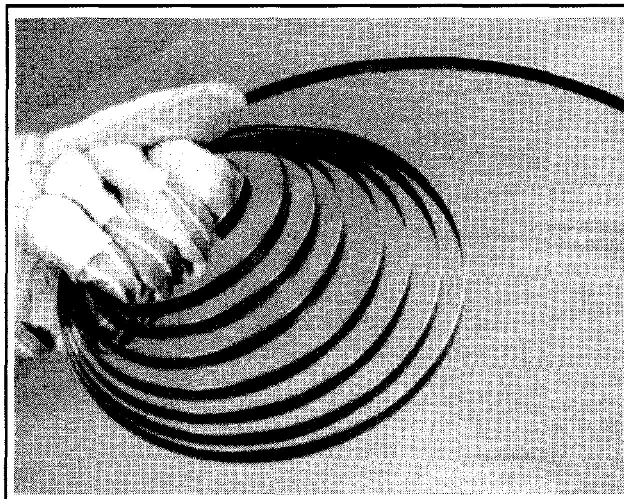


Fig. 5 Inspect the spring for wear, damage or corrosion—handle with care

opening for the rope. The inner spring hook is attached to the pulley. The spring itself should be positioned so that if you travel along the coil from the inner hook to the outer hook (when the spring is positioned in the starter housing) you will travel in a clockwise spiral.

During assembly there are multiple ways to achieve this spring installation. The safest and easiest method is to use the Evinrude/Johnson Starter Spring Winder and Installer (No. 392093). The next best method is to hand wind the spring (using gloved hands, and keeping in mind than an extra set of them will come in handy for this). When using this method, you actually wind the spring starting at the outer loop instead of the inner and work in the opposite direction (turning it in the opposite direction too) towards center. If this method is used, take your time and make sure you are winding the spring in the same direction it was previously wound. Lastly, in some cases, it may be possible to install a pre-wound replacement spring with the outer hook over the pin in the housing, then release the hog ring or metal retaining pin using a metal plate or wooden block to keep the spring in position.

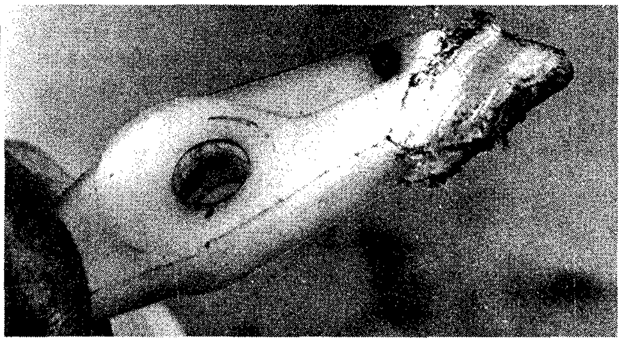


Fig. **6** Inspect the pawl for wear or damage (this one must be replaced)

1. Place the starter housing upside-down (spring side facing upward) on the workbench and then install the starter spring shield into the starter housing.

✳✳ CAUTION

Wear a good pair of gloves while installing the **spring. The** spring will develop tension and the edges of the spring steel are sharp. The gloves will prevent cuts on hands and fingers. **It** is also strongly recommended that you wear a pair of safety goggles or a face shield while the spring is being installed. As the work progresses a "tiger" is being forced into a cage. If the spring is accidentally released, it will lash out with tremendous ferocity and very likely could cause personal injury to the installer or other persons nearby.

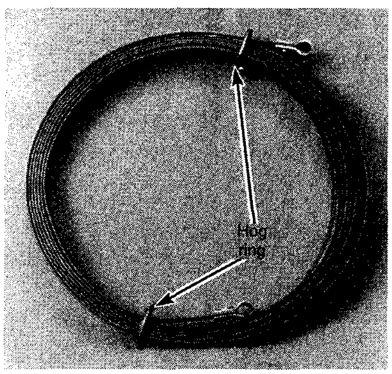


Fig. **7** When installing a new pre-wound spring, remove only the hog ring near the outer loop**...**

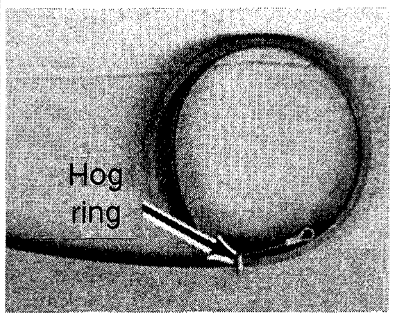


Fig. **8** **...** then pull on the outer loop until the spring is small enough to fit in the housing

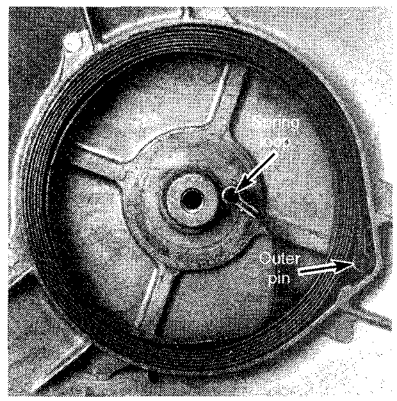


Fig. **9** When installed, make sure the spring is coiled clockwise when followed from inner toward outer loop

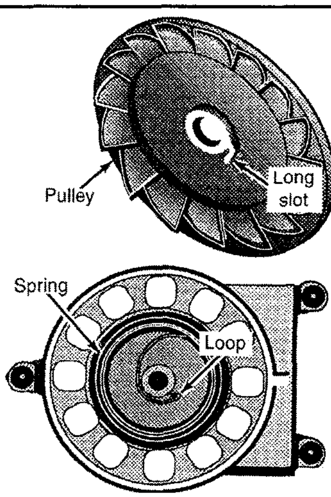


Fig. 10 The pulley slot must engage the inner hook of the spring to ensure correct starter function

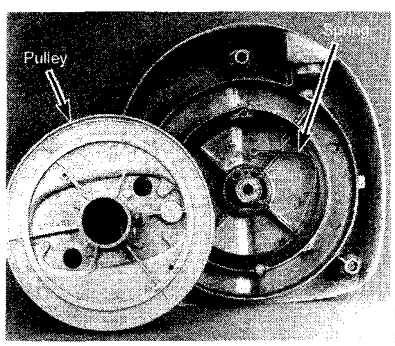


Fig. **11** Typical pulley and spring assembly, as positioned to the housing assembly

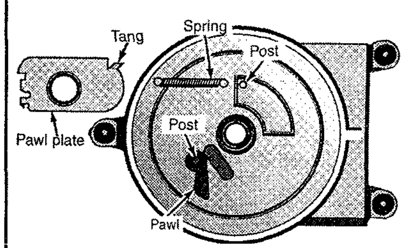


Fig. **12** The pawl plate return spring is positioned between the plate tang and pulley post

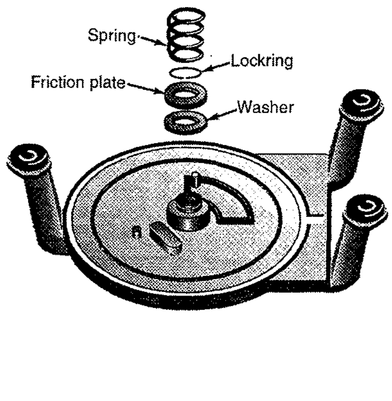


Fig. 13 The friction plates (lower not pictured) and spring washer are secured using the pulley **lockring**

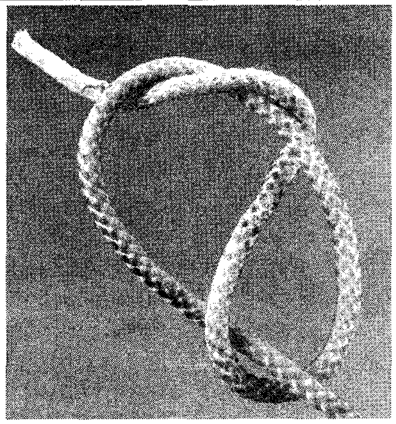


Fig. 14 Use this knot (a "figure **8**" knot) to retain the starter rope ends

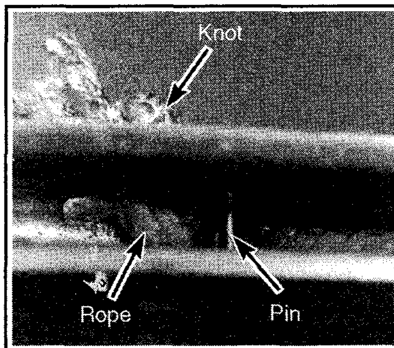


Fig. **15** Make sure the rope is threaded through the hole in the pulley behind the roll pin and that the knot is fully seated

2. If available, prepare the spring for installation by winding using the Evinrude/Johnson Winder and Installer (No. 392093), as follows:

a. Clamp the spring winder base in a vise and then insert the release plate into the winder base.

b. Apply a light coating of Evinrude/Johnson Triple-Guard, or equivalent marine grease (or even Lubriplate 777, if available) to the spring.

c. Position the inner spring loop in the winder base (with the open loop facing inward). Next, insert the pin of the crank and pin assembly (a rectangular plate with a handle on one end and a pin toward the center, on the opposite face of the plate from the handle) into the inner spring loop.

d. Using the crank retainer screw, bolt the crank and pin assembly to the winder base.

e. Turn the crank assembly slowly in the direction indicated on the tool (should be clockwise) in order to draw the spring into the base and wind it. Continue until the outer loop contacts the winder base.

f. Unbolt and remove the crank retainer screw and then remove the crank and pin assembly from the winder base and spring.

g. Lift the adapter release plate, along with the spring, from the winder base.

h. Position the wound spring into the starter assembly housing so the outer spring loop is located over the pin in the housing. Press through the holes in the tool to push the spring out of the tool and into the housing.

3. If the spring winder tool is not available, wind it by hand, as follows:

a. Slide the spring onto the outer pin and then start the spring from the outside edge of the housing and insert it into the housing counterclock. In the end, this will have the same final result in spring winding (i.e. that you would follow the spring in a clockwise pattern from the inner loop toward the outer loop).

b. Work the first turn into the housing, and then hold the spring down with one hand and continue to wind the spring into the housing.

☐ Patience and time are required to work the spring completely into the housing.

4. If installing a pre-wound replacement spring, proceed as follows:

a. Replacement springs are usually retained by 2 hog rings. Cut the one ring adjacent to the outer loop end of the spring, but leave the other hog ring in place.

b. See if the spring, as it is wound, will fit in the housing, if not, gently pull on the outer loop end while holding the inner loop end to make the circle tighter. Once the circle is small enough, wrap the outer end back around the spring and the spring is ready to install.

c. Position the wound spring into the starter assembly housing so the outer spring loop is located over the pin in the housing. If using the adapter tool, press through the holes in the tool to push the spring out of the tool and into the housing.

5. If installing a pre-wound spring, place a wooden block or metal plate against the spring to keep it from escaping when the second hog ring is cut free, then carefully cut and remove the ring. Remove the block or plate slowly, making sure the spring doesn't jump free.

6. Apply a light coating of Evinrude/Johnson Triple-Guard, or equivalent marine grease (or even Lubriplate 777, if available) to the pulley bushing and to the boss of the starter pawl. Install the bushing onto the pulley and then put the shim in place.

☐ The starter pawl boss should be installed in the pulley, but, if it was removed or has become dislodged, reserve it for installation later.

7. Bend the inner spring loop toward the center of the starter assembly in order to align the loop with the slot in the pulley, then slowly lower the pulley into the position, making sure the slot properly engages the loop. Rotate the pulley very slightly against the spring pressure to ensure proper engagement and then slowly rotate the pulley back into the pressure-relieved position.

8. Install the friction plate spring washer between the 2 friction plates (flat washers) and position the assembly over the pulley hub. Secure the assembly by positioning the lockring over the plate and gently tapping around the circumference of the ring until it is well seated into the groove of the hub. Place the starter housing spring over the lockring.

9. Make sure the lubricated starter pawl boss is in place, or install it at this time, then position the spring washer and install the pawl.

10. Make sure the starter housing spring is positioned in the center of the pulley.

☐ Read ahead, it is easier to clean the threads of the pawl plate retaining screw and nut at this point.

11. Hook one end of the pawl plate return spring on the pawl plate tang, then press the other end over the pulley post. Slide the pawl plate into position to align with the pulley hub.

12. Clean all traces of threadlock, corrosion or debris from the pawl plate retaining screw and nut threads, then install the screw and washer through the pawl plate and thread it into the starter housing. Tighten the pawl plate screw to 120-144 inch lbs. (14-16 Nm). Next, apply a light coating of Evinrude/Johnson Locquic Primer to the portion of the screw threads that protrude through the starter housing. Apply a light coating of Evinrude/Johnson Nut Lock, or equivalent threadlock to the nut threads, then install the nut and tighten securely.

13. Install the rope guide pulley, secure by using the shoulder screw. Tighten the screw securely.

14. If removed, tie a figure " 8 knot as illustrated into one end of the replacement starter rope.

15. Position the starter housing upside down on the workbench with the pulley facing upward, then wind the pulley counterclockwise by hand until the spring is tight. Back off the spring just until the rope cavity of the pulley is aligned with the rope guide, then thread the rope through the pulley, guide and starter handle bracket. Make sure the knot in the rope fully seats in the pulley.

16. Tie a slipknot in the rope to hold the pulley in position (or use the help of an assistant), then apply a light coating of Evinrude/Johnson Triple-Guard or an equivalent marine grease to the very end of the starter rope. Thread the rope through the starter handle (a Starter Rope Threading Tool # 378774 is available to make this task easier). Then press the rope into the rope anchor channel so the rope end firmly contacts the end of the channel.

Next, press the anchor into the handle and give a tug on the rope to seat the anchor into the pulley.

17. Untie the slipknot while holding spring tension via the starter rope and then allow the pulley to slowly rewind the rope into the starter housing.

18. Pull the rope back outward while observing the pawl and feeling for smooth operation. Make sure the pawl extends when the starter rope is pulled and retracts when the rope is rewound.

19. Install the starter lockout lever, springs (with the lower tang of the upper spring positioned on the casting), and thick washer onto the housing. Install the bolt with the thin washer under the bolt head and tighten securely. Apply a thin coating of Evinrude/Johnson Nut Lock or equivalent threadlock to the threads of the support screw, then install the pulley support and tighten the screw to 60<en dash>84 inch lbs. (7<en dash>9 Nm).

20. Install the hand rewind starter assembly.

INSTALLATION

◆ See Figure 3

1. If removed, install the starter handle bracket to the housing. Tighten the 4 shoulder screws to 60-84 inch lbs. (7-9 Nm). Engage the stop button connector to the powerpack and connect the ground wire terminal to the block.

2. If the starter rope was removed, install it or the replacement now as detailed under Assembly, in this section.

3. Position the starter over the flywheel with the legs aligned over the holes in the powerhead for the retaining bolts.

4. Install and tighten the 3 starter housing bolts to 120-144 inch lbs. (14-16 Nm).

5. Install the powerpack to the flywheel cover using the 4 retaining bolts.

6. If equipped, apply a light coating of Evinrude/Johnson Triple-Guard, or equivalent marine grease (or even Lubriplate 777, if available) to the starter lockout slide channel on the starter housing. Next, install the lockout slide into the channel and loosely secure the cable to the housing using the clamp and screw.

7. With the gearcase in Neutral adjust the lockout cable so the lockout slide is centered on the lever, then tighten the cable clamp screw securely to hold this adjustment.

8. Shift the lower unit into Forward and then Reverse and make a check of the starter lockout system. The starter must be locked, and unable to rotate when the lower unit is in any gear other than Neutral.

9. If the starter fails this test, loosen the cable clamp and adjust the position of the slide until no motion of the starter is possible when the lower unit is in Forward or Reverse gear.

10. Reconnect the spark plug leads, as tagged during removal.

Manual Starter Assembly—120-140 Hp (2000cc) 90LV4 Motors

◆ See Figure **16**

This hand rewind starter is found on the largest of the carbureted Evinrude/Johnson inline outboards and also on V4 motors, so it is therefore the largest, most heavy-duty of hand starter assemblies. Although similar in appearance, each application (60° and 90°) detailed here utilizes slightly different procedures and will be covered individually. Similar to most outboards, the starter is mounted atop of the flywheel on three mounting legs. The unit has a large rectangular pawl plate visible on the underside surface.

Because this starter is used on fairly large horsepower powerheads, the actual number in the field is rather small. As can be imagined, the operator of such a motor must be somewhat stout.

REMOVAL

◆ See Figures **16** and **17**

1. For safety, disconnect the spark plug leads, then ground them to the cylinder head.

2. These models normally use a lockout cable attached to a slider mounted to the top of the housing. To release the lockout cable, remove the screw from the cable clamp, then separate the lockout slide from the housing by sliding it forward and lifting up.

■ It is NOT necessary to remove the starter handle bracket in order to remove the starter housing.

3. Remove the horizontally-threaded bolts (usually 2) securing the starter handle bracket to the air intake silencer base.

4. Remove the bolts securing the hand rewind starter assembly to the powerhead (on these models there are usually 3 bolts arranged in a triangle, 2 on the legs of the assembly, near the rope handle, and an additional bolt opposite them). Carefully lift the assembly from the powerhead.

DISASSEMBLY

◆ See Figure **16**

No special tools are required in order to disassemble the hand rewind starter assemblv for these motors. However, the Evinrude/Johnson Starter Spring Winder and Installer (No. 392093) is recommended for installation. Please review the assembly procedure before proceeding.

✳✳ CAUTION

The spring is under a tremendous amount of tension, wear safety glasses and heavy gloves to protect yourself.

1. Remove the starter assembly from the top of the powerhead.

2. Remove the bolt(s) for the triangular bracket containing the lockout lever assembly, remove the assembly from the starter housing.

3. Remove the starter handle as follows: pull the starter rope partially out of the pulley, then tie a slipknot in order to hold it in this position and keep tension off the starter handle. Carefully pry the rope anchor out of the handle and separate the rope from the anchor and the handle.

4. Remove the bolts (usually 2) threaded vertically from the starter handle bracket to the starter housing, then separate the bracket from the housing.

5. Remove the timing pointer and pulley support from the edges of the housing.

■ For the next step, you'll need a sturdy C-clamp and 2 blocks of **wood. The** clamp is used to hold the pulley in position, while the blocks of wood are positioned between the clamp and the pulley (on one side) and the housing (on the other side) to protect them.

6. Pull the starter rope slowly outward until it is fully extended, then use the C-clamp and blocks of wood to carefully secure the pulley in this position. Make sure the clamp is tight enough to keep the pulley from suddenly pulling loose, but NOT so tight as to crack and damage the housing.

7. Untie the knot in the starter rope and remove it from the pulley.

8. Keeping as much tension as possible on the pulley, carefully loosen the clamp JUST ENOUGH to turn slowly allowing the spring to gradually release tension.

9. Place one hand under the housing to prevent all the large pawl plate and other small parts from flying loose. Keep one finger over the center bolt.

10. Remove the large center nut from atop the center of the starter housing. Carefully turn the starter housing over without disturbing any parts.

✳✳ CAUTION

The rewind spring is a potential **hazard. The** spring is under tremendous tension when it is wound—a real "tiger" in a cage! If the spring should accidentally be released, severe personal injury could result from being struck by the spring with force. Therefore, the following steps must be performed with care to prevent personal injury to self and others in the area.

11. Lift off the center bolt (pulley screw), then lift off the starter pawl plate and the plate return spring (the spring is attached to the side of the pawl plate and to a post on the starter housing).

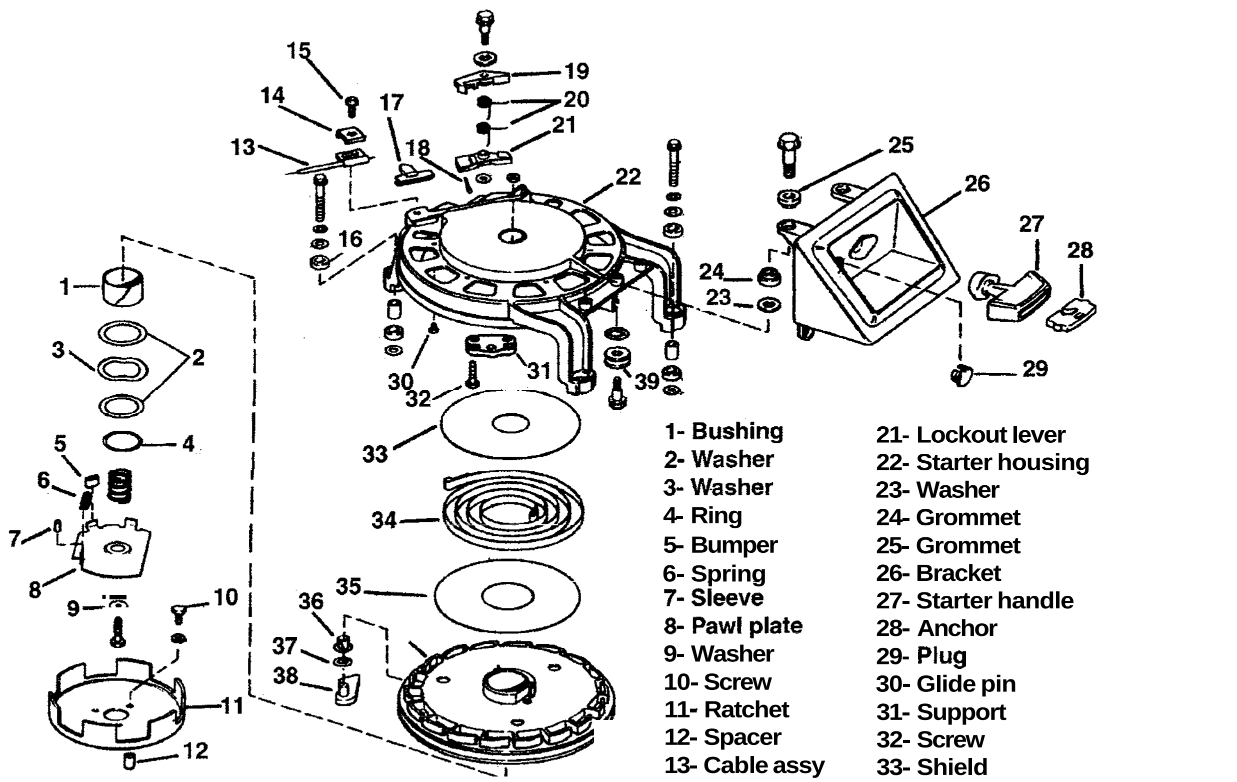


Fig. 16 Exploded view of a TYPICAL hand-rewind starter assembly which is SIMILAR (but not identical) to the one used on V4 motors

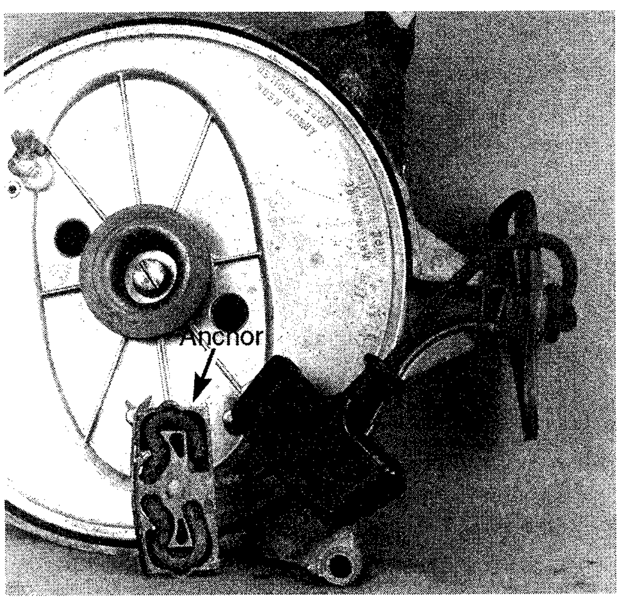


Fig. 17 The starter rope is secured to an anchor seated within the starter handle

12. Remove the center spring from the starter housing, then remove the starter pawl, spring washer (wave washer) and bushing from the starter housing.

13. Use a screwdriver or small prytool to carefully pry out the pulley lockring from the housing (mounted to the center of the assembly, under the spring). Lift off the friction plates (flat washers) surrounding the spring washer beneath the plate.

14. Hold the pulley and the housing together tightly and turn the complete assembly over with the legs extending downward in the normal manner. Now, lower the complete assembly to the floor. When the legs make contact with the floor, release your grip. The pulley will fall and the spring will be released from the housing almost instantly and with considerable force. However, the legs should contain the spring and prevent it from lashing out causing possible injury to self or others in the area. If the spring was not released from the housing as just described, the only safe method is to again jar the legs on the floor and dislodge the spring.

CLEANING & INSPECTION

1 EASY

◆ See Figures 16, 18 and 19

Wash all metallic parts in solvent, and then blow them dry with low-pressure compressed air.

Remove any trace of corrosion and wipe all metal parts with an oil-dampened cloth.

Inspect the rope. Replace the rope if it appears to be weak or frayed. If the rope is frayed, check the pulley and housing (especially the holes

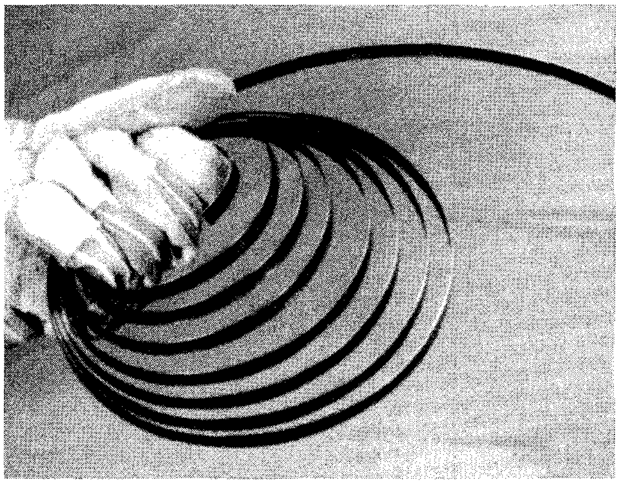


Fig. 18 Inspect the spring for wear, damage or corrosion handle with care

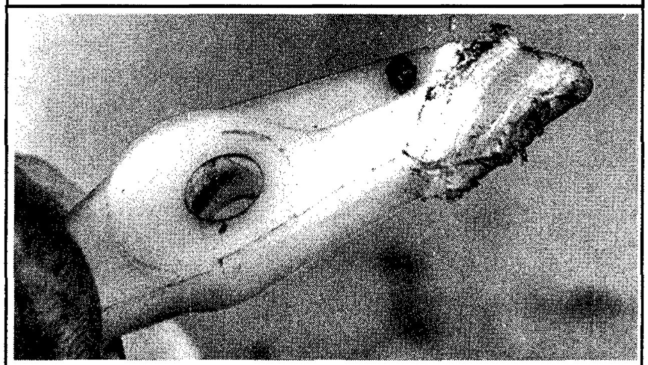


Fig. 19 Inspect the pawl for wear or damage (this one must be replaced)

through which the rope passes and the rope guide pulley) for rough edges or burrs. Remove the rough edges or burrs with a file and polish the surface until it is smooth.

■ **Replacement ropes on these models should be trimmed to a length of about 96 1/2 in. (245cm). Use a heat source or small open flame to fuse 1/2 in. (12mm) of each end to help prevent fraying.**

Inspect the starter spring end hooks. Replace the spring if it is weak, corroded or cracked, Inspect the inside surface of the pulley rewind recess for grooves or roughness. Grooves may cause erratic rewinding of the starter rope.

Check all starter components for signs of wear or damage. Be sure to check the pawl for wear and replace, as necessary.

Check the lockout assembly components for wear or damage and replace, as necessary.

ASSEMBLY

OEM ② MODERATE

◆ **See Figures 16, 20, 21, 22, 23, 24, 25, 26, 27 and 28**

The outer spring hook (loop) is installed on the pin located in the starter housing found inline with one of the housing legs, just adjacent to the opening for the rope. The inner spring hook is attached to the pulley. The spring itself should be positioned so that if you travel along the coil from the inner hook to the outer hook (when the spring is positioned in the starter housing) you will travel in a clockwise spiral.

During assembly there are multiple ways to achieve this spring installation. The safest and easiest method is to use the EvinrudelJohnson Starter Spring Winder and Installer (No. 392093). The next best method is to hand wind the spring (using gloved hands, and keeping in mind than an extra set of them will come in handy for this). When using this method, you actually wind the spring starting at the outer loop instead of the inner and work in the opposite direction (turning it in the opposite direction too) towards center. If this method is used, take your time and make sure you are winding the spring in the same direction it was previously wound. Lastly, in some cases, it may be possible to install a pre-wound replacement spring with the outer hook over the pin in the housing, then release the hog ring or metal retaining pin using a metal plate or wooden block to keep the spring in position.

1. Place the starter housing upside-down (spring side facing upward) on the workbench and then install the starter spring shield into the starter housing.

✳✳ WARNING

Wear a good pair of gloves while installing the spring. The spring will develop tension and the edges of the spring steel are sharp. The gloves will prevent cuts on hands and fingers. It is also strongly recommended that you wear a pair of safety goggles or a face shield while the spring is being installed. As the work progresses a "tiger" is being forced into a cage. If the spring is accidentally released, it will lash out with tremendous-ferocity and very likely could cause personal injury to the installer or other persons nearby.

2. If available, prepare the spring for installation by winding using the EvinrudelJohnson Winder and Installer (No. 392093), as follows:
   a. Clamp the spring winder base in a vise and then insert the release plate into the winder base.
   b. Apply a light coating of EvinrudelJohnson Triple-Guard, or equivalent marine grease (or even Lubriplate 777, if available) to the spring.
   c. Position the inner spring loop in the winder base. Next, insert the pin of the crank and pin assembly (a rectangular plate with a handle on one end and a pin toward the center, on the opposite face of the plate from the handle) into the inner spring loop.
   d. Using the crank retainer screw, bolt the crank and pin assembly to the winder base.
   e. Turn the crank assembly slowly in the direction indicated on the tool (should be clockwise) in order to draw the spring into the base and wind it. Continue until the outer loop contacts the winder base.
   f. Unbolt and remove the crank retainer screw, then remove the crank and pin assembly from the winder base and spring.
   g. Lift the adapter release plate, along with the spring, from the winder base.
   h. Position the wound spring into the starter assembly housing so the outer spring loop is located over the pin in the housing. Press through the holes in the tool to push the spring out of the tool and into the housing.
3. If the spring winder tool is not available, wind it by hand, as follows:
   a. Slide the spring onto the outer pin and then start the spring from the outside edge of the housing and insert it into the housing **counterclockwise.** In the end, this will have the same final result in spring winding (i.e. that you would follow the spring in a clockwise patter from the inner loop toward the outer loop).
   b. Work the first turn into the housing, and then hold the spring down with one hand and continue to wind the spring into the housing.

■ **Patience and time are required to work the spring completely into the housing.**

4. If installing a pre-wound replacement spring, proceed as follows:
   a. Replacement springs are usually retained by 2 hog rings. Cut the one ring adjacent to the outer loop end of the spring, but leave the other hog ring in place.
   b. See if the spring, as it is wound, will fit in the housing, if not, gently pull on the outer loop end while holding the inner loop end to make the circle tighter. Once the circle is small enough, wrap the outer end back around the spring and the spring is ready to install.
   c. Position the wound spring into the starter assembly housing so the outer spring loop is located over the pin in the housing. If using the adapter tool, press through the holes in the tool to push the spring out of the tool and into the housing.

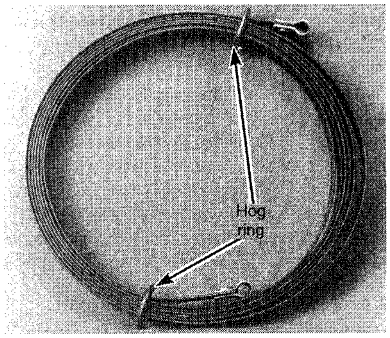


Fig. 20 When installing a new pre-wound spring, remove only the **hog ring near the outer loop...**

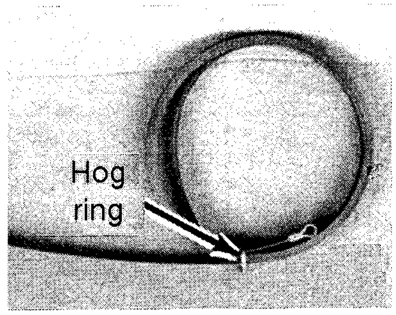


Fig. 21 **...** then pull on the outer loop until the spring is small enough to fit in the housing

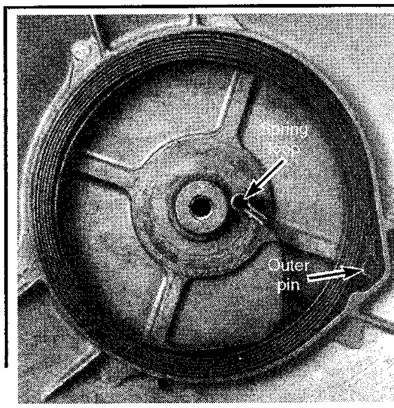


Fig. **22** When installed, make sure the spring is coiled clockwise when followed **from inner toward outer loop**

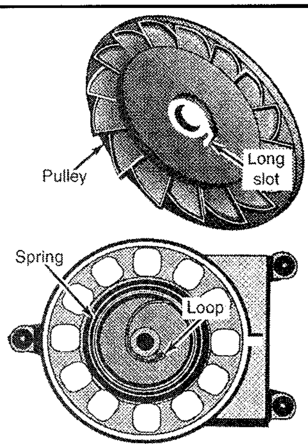


Fig. 23 The pulley slot must engage the inner hook of the spring to ensure correct starter function

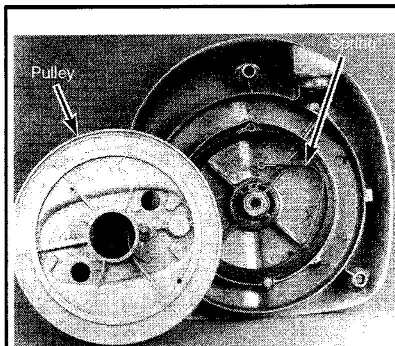


Fig. 24 Typical pulley and spring assembly, as positioned to the housing assembly

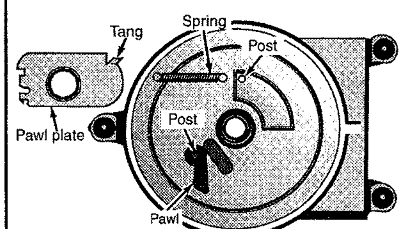


Fig. 25 The pawl plate return spring is positioned between the plate tang and pulley post

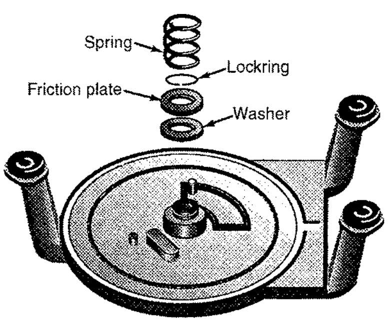


Fig. 26 The friction plates (lower not pictured) and spring washer are secured using the pulley **lockring**

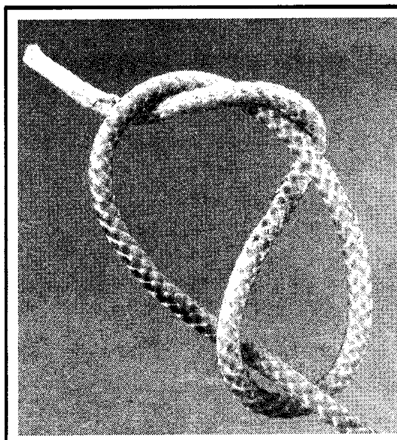


Fig. **27** Use this knot (a "figure **8**" knot) to retain the starter rope ends

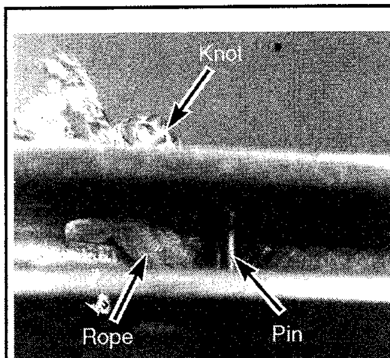


Fig. **28** Make sure the rope is threaded through the hole in the pulley behind the roll pin and that the knot is fully seated

5. If installing a pre-wound spring, place a wooden block or metal plate against the spring, to keep it from escaping when the second hog ring is cut free, then carefully cut and remove the ring. Remove the block or plate slowly, to make sure the spring won't jump free.

6. Apply a light coating of EvinrudeIJohnson Triple-Guard, or equivalent marine grease (or even Lubriplate 777, if available) to the pulley bushing, to the boss of the starter pawl and to the pawl shaft. Install the bushing onto the pulley and put the shim in place.

■ The starter pawl boss should be installed in the pulley, but, if it was removed or has become dislodged, reserve it for installation later.

7. Bend the inner spring loop toward the center of the starter assembly in order to align the loop with the slot in the pulley, then slowly lower the pulley into the position, making sure the slot properly engages the loop. Rotate the pulley very slightly against the spring pressure to ensure proper engagement and then slowly rotate the pulley back into the pressure-relieved position.

8. Install the friction plate spring washer between the 2 friction plates (flat washers) and position the assembly over the pulley hub. Secure the assembly by positioning the lockring over the plate and gently tapping around the circumference of the ring until it is well seated into the groove of the hub. Place the starter housing spring over the lockring.

9. Make sure the lubricated starter pawl boss is in place, or install it at this time, then position the spring washer and install the pawl (with the shaft lubricated).

10. Make sure the starter housing spring is positioned in the center of the pulley.

11. Hook one end of the pawl plate return spring on the pawl plate tang, then press the other end over the pulley post. Slide the pawl plate into position to align with the pulley hub.

12. Install the pawl plate screw and washer through the plate and thread it into the starter housing. Tighten the pawl plate screw to 60-84 inch lbs. (7-9 Nm) on 1992-93 models or to 120-144 inch lbs. (14-16 Nm) for 1994 and later models.

13. Carefully invert the housing, then install the nut to the pawl plate/pulley center screw. Tighten the nut to 60-84 inch lbs. (7-9 Nm) on 1992-93 models or to 120-144 inch lbs. (14-16 Nm) for 1994 and later models.

It is a good idea to check pawl operation at this point. **Keep** in mind that the pawl should extend when the pulley moves counterclockwise and retract when the pulley moves clockwise.

14. Install the starter handle bracket using a rubber bushing above and below the leg, with the small inner lip of each bushing facing the leg. A flat washer is positioned between the lower bushing and the starter housing itself. For more details, refer to the exploded view of the typical starter housing provided in this section. Tighten the bracket retaining screws to 60-84 inch lbs. (7-9 Nm).

15. Have the C-clamp and wooden blocks ready to secure the pulley against spring tension. Slowly wind the pulley counterclockwise by hand until the spring is tight, then back off the pulley in a clockwise direction for 1 112-2 turns until the rope cavity of the pulley aligns with the rope guide. Use the C-clamp to secure the pulley in this position.

16. Thread the rope through the starter handle bracket, rope guide and pulley, then tie a figure "8" knot as illustrated into the end of the replacement starter rope. Insert the knot in to the starter pulley rope cavity (make sure the knot fully seats in the pulley).

17. Tie a slipknot in the rope about 12 in. (30.5cm) from the handle end to hold the pulley in position (or use the help of an assistant), then slowly loosen the C-clamp and allowing the pulley to rotate slowly drawing the rope into the housing. You've got 2 choices here, you can hold the rope itself in order to keep tension on the rope controlling the movement of the pulley or you can use the C-clamp and/or gloved hands to control the pulley. The rope is really the easier and safer method (although NOT the one specifically mentioned by the manufacturer for some reason).

18. Apply a light coating of Evinrude/Johnson Triple-Guard or equivalent marine grease to the very end of the starter rope. Thread the rope through the starter handle (a Starter Rope Threading Tool # 378774 is available to make this task easier). Press the rope into the rope anchor channel so the rope end firmly contacts the end of the channel. Next, press the anchor into the handle and give a tug on the rope to seat the anchor into the pulley.

19. Untie the slipknot while holding spring tension via the starter rope and then allow the pulley to slowly rewind the rest of the rope into the starter housing.

20. If not done earlier, pull the rope back outward, while observing the pawl and feeling for smooth operation. Make sure the pawl extends when the starter rope is pulled and retracts when the rope is rewound.

21. Install the starter lockout lever assembly to the housing and tighten the retaining bolts to 60-84 inch lbs. (7-9 Nm). If not done earlier, inspect the starter lockout levers for damage or wear. If necessary replace the lockout components as follows:

a. Apply a light coating of EvinrudeIJohnson Triple Guard or equivalent marine grade grease to the shaft.

b. Place the thicker flat washer on the shaft, followed by the lower lockout lever.

c. Position the 2 springs on the shaft.

d. Install the upper lockout lever, followed by the thinner flat washer.

e. Install the locknut (you REALLY should replace it, and you MUST replace it if you do not feel resistance to tightening). Tighten the locknut to 60-84 inch lbs. (7-9 Nm).

22. Make sure the lockout springs are in place.

23. If removed, install the rope guide and/or the timing pointer. Install the pulley support with the ribs on the support facing away from the pulley.

24. Install the hand rewind starter assembly as detailed in this section.

INSTALLATION

◆ See Figure 16 and **29**

1. If the flywheel ratchet was removed for any reason, install and tighten the retainers to 120-140 inch lbs. (14-16 Nm).

2. Position the starter over the flywheel with the legs aligned over the holes in the powerhead for the retaining bolts. The same sequence of washers and bushing are used between the starter handle bracket and the air intake silencer base. A rubber bushing is used on either side of the handle bracket leg, with the smaller lip of the isolator facing the leg. The washer is positioned between a rubber isolator and the air intake silencer base. Loosely thread the 2 starter handle bracket-to-intake silencer base bolts to hold isolators and washers in position.

3. Install and tighten the 3 starter housing bolts to 120-144 inch lbs. (14-16 Nm).

4. Tighten the 2 starter handle bracket bolts to 60-84 inch lbs. (7-9 Nm).

5. Apply a light coating of EvinrudeIJohnson Triple-Guard, or equivalent marine grease (or even Lubriplate 777, if available) to the starter lockout slide channel on the starter housing. Next, install the lockout slide into the channel and secure the cable to the housing using the clamp and screw.

6. Check and adjust the Starter Lockout Cable, as detailed in this section.

7. Reconnect the spark plug leads, as tagged during removal.

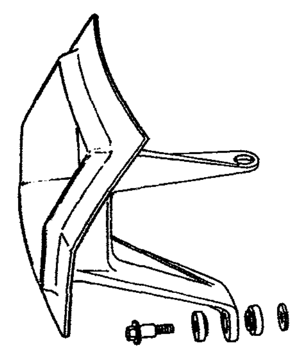


Fig. **29** Make sure the rubber isolators and washers are positioned in the correct order when installing the starter handle bracket

STARTER LOCKOUT CABLE ADJUSTMENT

EASY

◆ **See Figure. 29**

The starter lockout cable must be positioned so that the manual starter will only rotate when the gearcase is shifted into **Neutral.** This prevents accidental starting of the engine when in gear **(Forward** or **Reverse)** which could cause the boat to launch suddenly and dangerously before the person starting the engine has the time to take a seat and give attention to navigating the craft.

Adjustment is a simple matter of aligning a mark on the lockout slider assembly with a tang on the lockout lever itself.

1. Shift the gearcase into **Neutral,** then check the slider mark (a line on the slider that is perpendicular to the cable). The mark on the slider must align with the tang on the lockout lever. The tang is positioned facing the lever.
2. If adjustment is necessary, loosen both cable clamps and reposition the cable so the slider mark and lever tang align, then tighten the cable both clamps securely to hold this adjustment.
3. Shift the lower unit into **Forward** and then **Reverse** gear and make a check of the starter lockout system. The starter must be locked, and unable to rotate when the lower unit is in any gear other than **Neutral.**
4. If the starter fails this test, loosen the cable clamp and adjust the position of the slide until no motion of the starter is possible when the lower unit is in **Forward** or **Reverse** gear.

■ **If the starter lockout levers cannot perform their function, even when adjusted, they should be replaced. Refer to the Installation procedure in this section for details.**

GLOSSARY

Accumulator: An air-filled tank used to smooth out pressure in a freshwater system; also a tank used in a refrigeration system to trap liquid refrigerant that might otherwise damage the compressor.

Aerial: See antenna.

Aft: Toward the rear of your vessel.

Alternating Current (AC): Electrical current reversing its direction at regular intervals. Each repetition of these changes is a cycle and the number of cycles that take place in 1 second is the frequency.

Alternator: A machine for generating electricity by spinning a magnet inside a series of coils. The resulting power output is alternating current (AC).

Ambient Conditions: The surrounding temperature or pressure, or both.

Ammeter: An instrument for measuring current flow.

Ampere: A measure of the rate of electric current.

Anode: A sacrificial alloy (zinc) that attracts electrolysis before the metal (usually aluminum) in your drive system

Anti-Siphon Valve: A valve that admits air to a line and prevents siphonic action.

Armature: The rotating windings in a generator (AC or DC).

ATDC: After top dead center. The point after the piston reaches the top of its travel on the compression stroke.

BTDC: Before top dead center. The point just before the piston reaches the top of its travel on the compression stroke.

Backlash: The clearance, or play, between two parts, such as gears.

Ball Valve: Either a valve with a spring-loaded ball or one with a ball rotating in a spherical seat.

Beam: A vessel's dimension, measured at its widest point.

Bearing: A device for supporting a rotating shaft with minimum friction. It may take the form of a metal sleeve (a bushing), a set of ball bearings (a roller bearing), or a set of pins around the shaft (a needle bearing). Also, heading, or position on a compass.

Bearing Race: The outer cage within which a set of balls rotates in a roller bearing.

Binnacle: A housing for a compass.

Bleeding: The process of purging air from a fuel or hydraulic system.

Bow: The front of your vessel.

Breaker Points: A set of points inside the distributor, operated by a cam, which make and break the ignition circuit.

Bridge Rectifier: An arrangement of diodes for converting alternating current (AC) to direct current (DC).

Cable Clamp: A U-shaped bolt with a saddle used to join or to make loops in wire rope.

Camshaft: A shaft in the engine on which are the lobes (cams) which operate the valves. The camshaft is driven by the crankshaft, via a belt, chain or gears, at one half the crankshaft speed.

Carburetor: A device, usually mounted on the intake manifold of an engine, which mixes the air and fuel in the proper proportion to allow even combustion.

Cavitation: The rapid formation and collapse of water vapor bubbles in a low pressure area on the leading edge of the propeller.

Check Valve: An electrical or mechanical valve that allows flow in only one direction.

Chine: The intersection of the bottom and sides on a flat or V-bottomed boat.

Circlip: A split steel snapring that fits into a groove to hold various parts in place.

Circuit: The path of electric current. A closed circuit has a complete path. An open circuit has a broken or disconnected path. A short circuit has an unintentional direct path bypassing the equipment (appliance, resistance) in the circuit.

Circuit Breaker: A load-sensitive switch that trips (opens a circuit) if a threshold-exceeding current flows through it.

Cleat: Hardware used to tie up line. Usually on the deck or dock.

Clevis Pin: A metal pin with a flattened head at one end and a hole for a cotter pin (split pin) at the other. It is used to fasten rigging together.

Clew: The lower, aft corner of a sail.

Clutch: A device used to couple and uncouple a power source from a piece of equipment. It may be manually, hydraulically, or electro-magnetically operated. A cone clutch forces a tapered seat onto a tapered friction pad. A brake-band clutch tightens a friction band around a smooth face on a gear. A disc clutch holds alternating metal and friction plates together.

Compression Ratio: The volume of a combustion chamber with the piston at the top of its stroke as a proportion of the total volume of the cylinder with the piston at the bottom of its stroke.

Connecting Rod: The connecting link between the piston and the crankshaft.

Corrosion: A process that leads to the destruction of two metals. Galvanic corrosion arises when dissimilar, electrically connected metals are immersed in an electrolyte (e.g., salt water). A current is generated, leading to the destruction of the anode (less noble metal) and the protection of the cathode (more noble metal). Pinhole and crevice corrosion are the results of galvanic corrosion occurring in just one piece of metal due to differences in the composition of the metal. Stray-current corrosion is the result of external current leakage through metal fittings in contact with an electrolyte, such as salt water. Massive corrosion can occur where the current leaves a fitting. The term electrolysis refers to the passage of electricity through the electrolyte.

Cotter Pin: A pin with two legs. With legs together the pin is placed through the hole in a clevis pin. The legs are then opened outward to prevent the cotter pin from backing out of the hole. The cotter pin, in turn, prevents the load-bearing clevis pin from backing out of its retaining hole.

Crankshaft: The engine component that converts the reciprocating (up and down or back and forth) motion of the pistons into the rotary motion used to turn the driveshaft.

CV-Joint: (constant velocity joint): A type of propeller shaft coupling that permits considerable engine misalignment.

Displacement Hull: A type of hull (usually round) that displaces water with forward motion. Common in sailboats.

Distributor: A mechanically driven device on an engine which is responsible for electrically firing the spark plug at a pre-determined point of the piston stroke.

Dowel: A round metal or wooden pin.

Drift: Any suitable sized round metal bar used to knock out bushings, clevis pins and the like.

DVOM: Digital volt ohmmeter.

Electrolysis: A chemical change or breakdown of an electrolyte caused by an electric current.

Electrolyte: The solution in a battery. A liquid conductor of electricity. Also, an electrically conductive solution (saltwater) with a high mineral content.

Feeler Gauge: Thin strips of metal machined to precise thicknesses or round metal wires of precise diameters that are used for measuring small gaps.

Firing Order: The order in which combustion occurs in the cylinders of an engine.

Flap Valve: A simple rubber flap, sometimes weighted. Fluid pressure opens it in one direction and closes it in the other.

Fuel Filter: A filter used to prevent impurities from entering the engine via the fuel system,

Fuel/Water Separator: In line filter used to remove water particles from the fuel prior to entering the engine.

Fuse: A protective device in a circuit which prevents circuit overload by breaking the circuit when a specific amperage is present. The device is constructed around a strip or wire of a lower amperage rating than the circuit it is designed to protect. When an amperage higher than that stamped on the fuse is present in the circuit, the strip or wire melts, opening the circuit.

Fusible Link: A piece of wire in a wiring harness that performs the same job as a fuse. If overloaded, the fusible link will melt and interrupt the circuit.

Gear Ratio: The relative size of two gears. If the gears are in contact, their relative speed of rotation will be given by the gear ratio.

Example: If the gear ratio is 8:1, the smaller gear will rotate eight times faster than the larger gear.

Generator: A machine for generating electricity by winding a series of coils inside a magnet. The resulting power output is alternating current. In DC systems, this output is rectified via a commutator and brushes.

Glow Plug: A heating element installed in diesel engine precombustion chambers to aid in cold-starting.

Governor: A device for maintaining an engine or electric motor at a constant speed, regardless of load.

Ground: A connection between an electric circuit and the earth, or some conducting body serving in place of the earth.

Gudgeon: One-half of a rudder hinge, the other half being a pintle.

Gunwale: The upper edge of the sides of a vessel.

Header Tank: A small tank set above an engine on heat exchanger-cooled systems. The header tank serves as an expansion chamber, coolant reservior, and pressure regulator (via a pressure cap).

Heat Exchanger: A vessel containing a number of small tubes through which cooling water is passed, while raw water is circulated around the outside of the tubes to carry off heat from the cooling water.

Heat Sink: A mounting for an electronic component designed to dissipate heat to the atmosphere.

Helm: The driver's control center

Hose Clamp: An adjustable stainless steel or plastic band used primarily for securing hose ends to their fittings.
Hull: The bottom of a vessel, structurally.

Hydrometer: A float-type instrument that measures specific gravity. Most often used to determine the state of charge of a battery by measuring the specific gravity of the electrolyte.

Impeller: The rotating fitting that imparts motion to a fluid in a rotating pump. Commonly found in marine water pumps and jet drives.

Inboard: An engine located inside the hull of a vessel

Injector: A device for atomizing fuel and spraying it into a cylinder or fuel delivery chamber. Used on all diesel and gasoline injected engines.

Jet Drive: Propulsion system where water is drawn into a drive unit via an impeller and expelled at high pressure through an outlet directed away from the vessel.
Keel: The centerline of the bottom of the hull.

Leeward: The side of a landform or object sheltered from the wind.

Mast: A vertical pole, usually wood or aluminum, that a sail is attached to.

Noble Metal: A metal high on the galvanic table. Noble metals are likely to form a cathode in many cases of galvanic corrosion and therefore are unlikely to corrode.

OEM: Original equipment manufacturer.

Ohm: A unit of electrical resistance

Ohmmeter: An instrument for measuring resistance. Usually incorporated as one function of a multi-meter.

Outboard: An engineldrive system connected to the transom of a vessel.

Outdrive: The lower half of a stern drive unit.
PFD: Personal flotation device

Pinion: A small gear designed to mesh with a large gear (for example, a starter-motor drive gear).

Pintle: One-half of a rudder hinge, the other half being a gudgeon.

Pitch: The total distance a propeller would travel in one revolution, as determined by the amount of deflection of its blades, if there were no losses as it turned.
Planetary Gears: An arrangement of small gears around a central drive gear, with a large ring gear around the outside of the small gears.

Planing Hull: A type of hull that lifts out of the water at a certain speed in order to reduce drag.
Port: The left side of the boat as you face the bow.

Potentiometer: A variable resistor used for adjusting some voltage regulators.

Propeller: A multi-bladed device at the end of the vessel's drive system used to propel the vessel through the water.

PWC: Personal watercraft.

RPM: Revolutions per minute (usually indicating engine speed).

Raw Water: The water the boat sits in, which is used to cool the engine and components. May be used in conjunction with a closed system that uses conventional anti freeze.

Reed Valve: Essentially a one-way check valve(s) allowing the air/fuel mixture from the carburetor to enter the crankcase, but not exit it. Usually found on 2-stroke engines.

Resistance: The opposition an appliance or wire offers to the flow of electric current, measured in ohms.

Rudder: A flat, vertical structure usually attached to the stern of a boat for steering purposes.

Shim Stock: Very thin, accurately machined pieces of metal.

Skeg: A small keel aft, used to support a rudder.

Spade Rudder: A rudder with no support beneath the hull.

Specitic Gravity: A measure of the density of a liquid when compared with water. Most often used to measure the density of electrolyte in a battery, i.e., the strength of the acid and therefore the battery's state of charge.

Split Pin: See cotter pin

Spreader: A strut on a mast to improve the angle of shrouds and stiffen the mast panels.

Starboard: The right side of the boat as you face the bow.

Starter: A high-torque electric motor used for the purpose of starting the engine, typically through a high ratio geared drive connected to the flywheel ring gear.

Stern: The rear of your vessel.

Stern Drive: A drive unit attached to the stern of a vessel and connected to an inboard engine.

Stroke: The distance that the piston travels from bottom dead center to top dead center.

TDC: Top dead center. The point at which the piston reaches the top of its travel on the compression stroke.

Thermistor: A resistor that changes in value with changes in temperature.

Thermostat: A heat-sensitive device used to control the flow of coolant through an engine; or a heat sensitive switch used to turn a water-heating element off and on.

Thickness Gauge: See feeler gauge.

Tiller: The lever used to turn the rudder from side-to-side.

Transom: The stern of a square-ended boat

Trim Tab: A small rudder hinged to the trailing edge of a main or auxiliary rudder, or the drive unit. Also, hydraulic devices mounted to the transom on many planning hull vessels, used to adjust the vessel's attitude (fore-to-aft or port-to-starboard) while on plane.

Turnbuckle: An adjustable fitting used to tension standing rigging.

Valve Clearance: The gap between a valve stem and its rocker arm when the valve is fully closed.

Valve Cover: The housing of an engine bolted over the valve mechanism. Also, cylinder head cover.

Viscosity: The ability of a fluid to flow. The lower the viscosity rating, the easier the fluid will flow. 10 weight motor oil will flow much easier than 40 weight motor oil.

Volt: Unit used to measure the force or pressure of electricity.

Voltage Regulator: A device that controls the current output of the alternator or generator.

Voltmeter: An instrument used for measuring electrical force in units called volts. Voltmeters are always connected parallel with the circuit being tested.

Windlass: Any of various mechanisms used to hoist or haul and anchor.

Windward: The side of a landform or object that the wind in blowing on.

Zinc: See Anode.

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