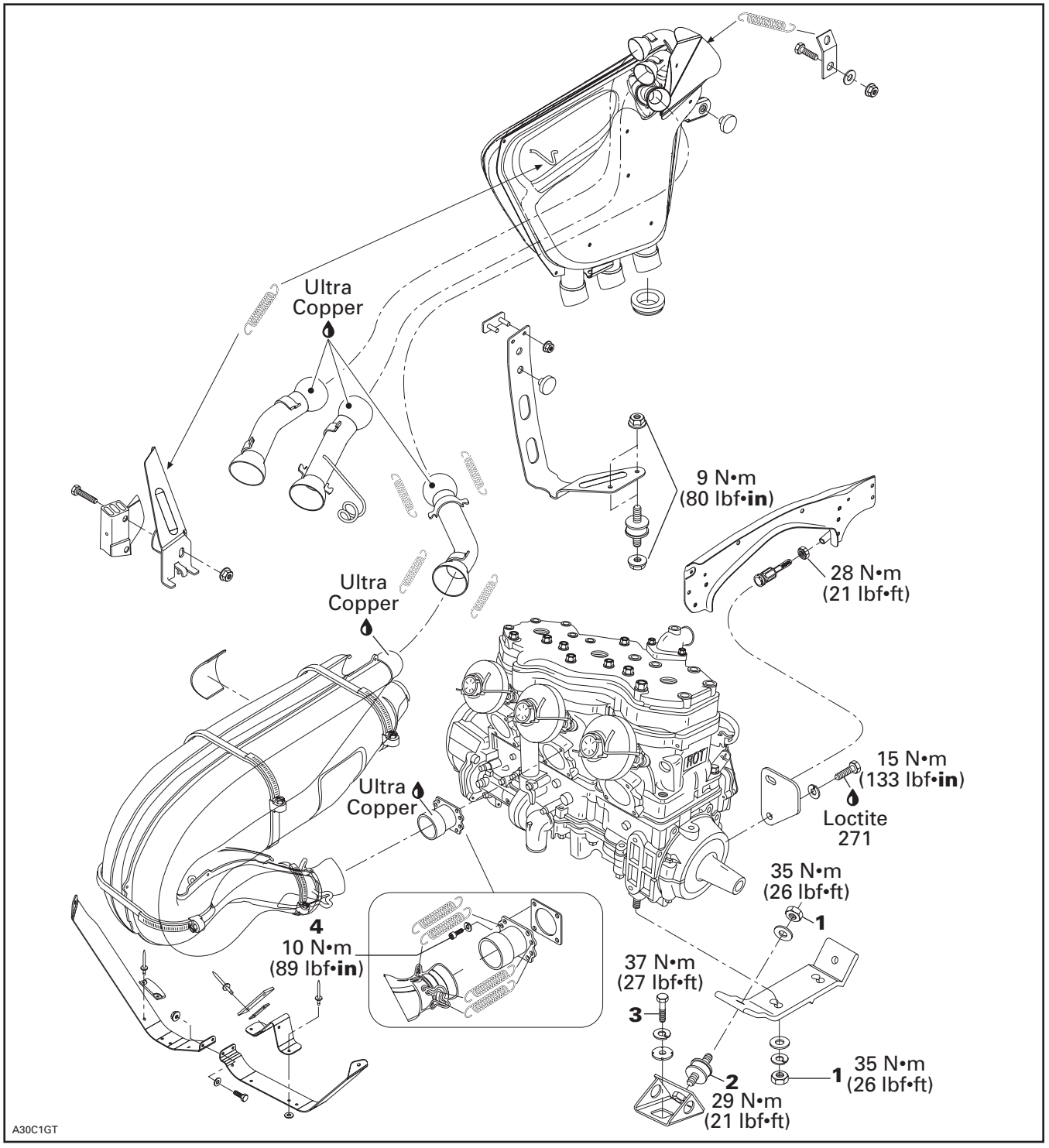
TABLE OF CONTENTS

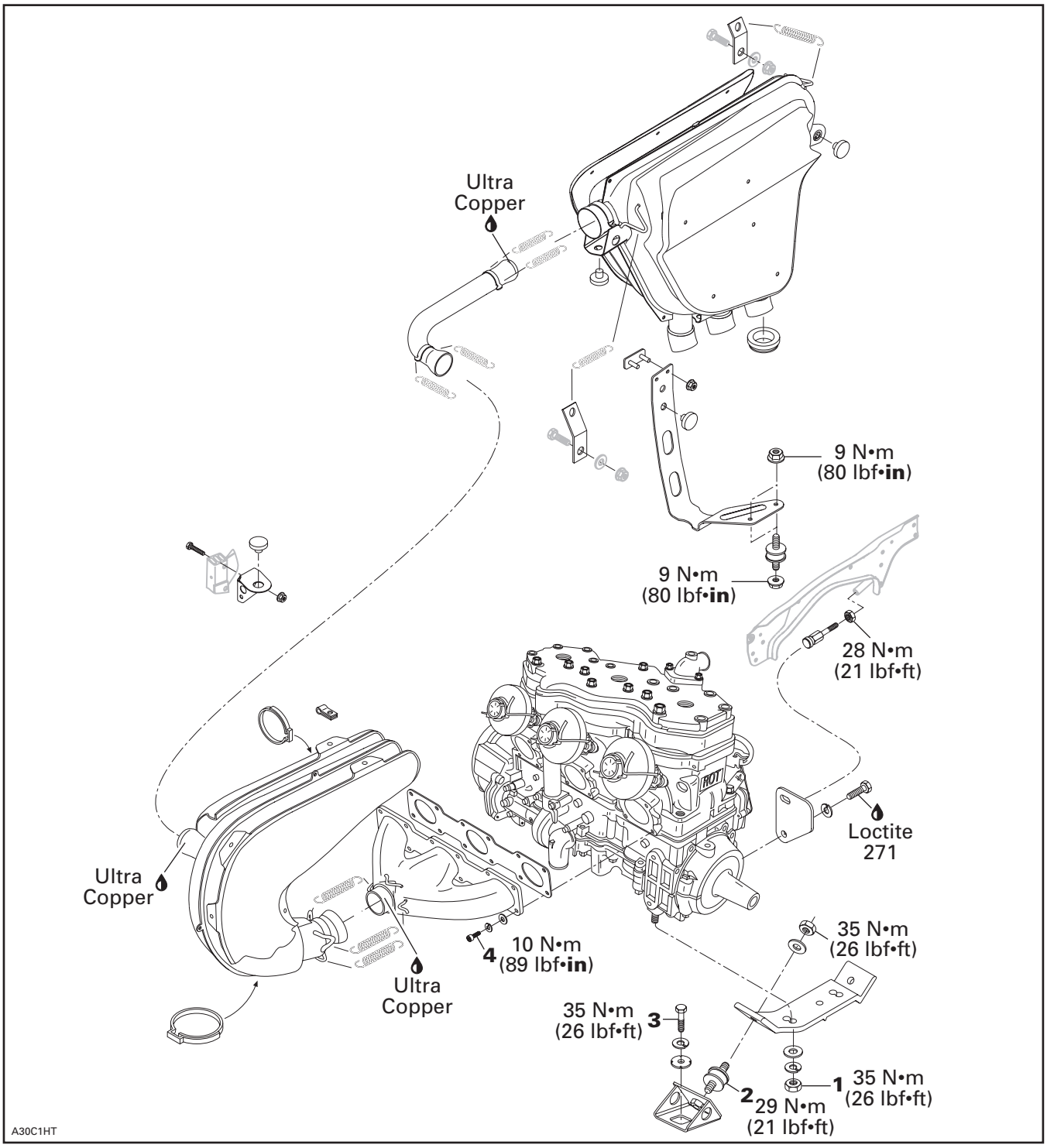
699 AND 809 ENGINE TYPES

Mach 1 R and Mach Z Series



TYPICAL

Formula III 700 R/800 and Grand Touring 700/SE



REMOVAL FROM VEHICLE

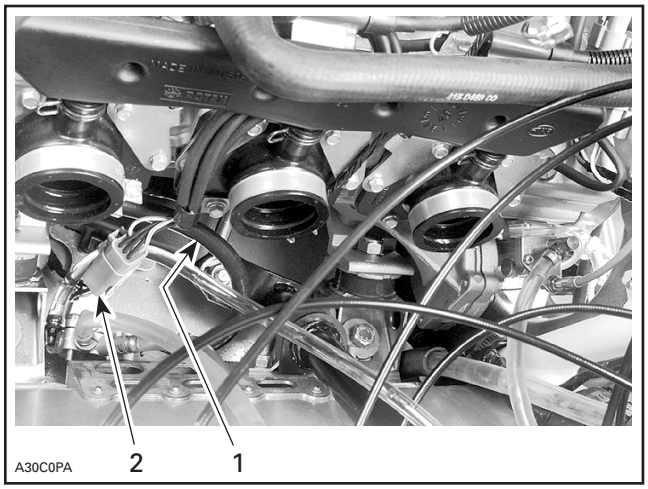
Open hood and close fuel shut-off valve.

Drain engine coolant.

Remove or unplug the following then lift off engine from engine compartment.

NOTE: 3-cylinder engine is more heavy then a 2 cylinder engine. It weights about 45 kg (100 lb). Use of a hoist is recommended.

– guard
– air silencer
– drive belt
– driven pulley
– speedometer cable from angle drive
– rewind starter handle
– drive pulley (not necessary if engine has not to be disassemble)
– hood, refer to 09-02 BODY
– carburetors
– impulse hose and high tension coil connector housing



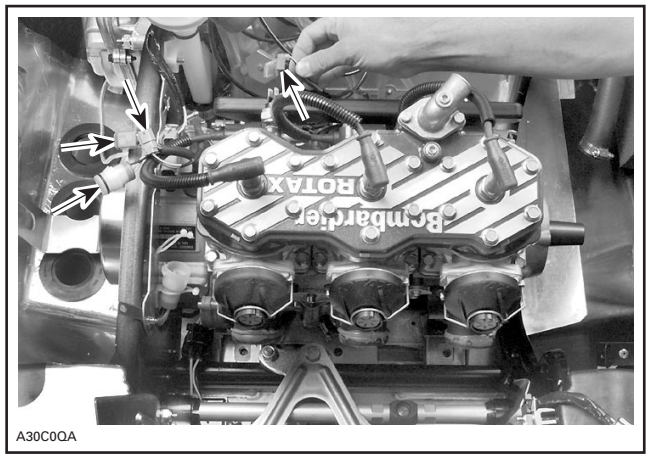
TYPICAL

1. *Impulse hose*
2. *High tension coil connector housing*

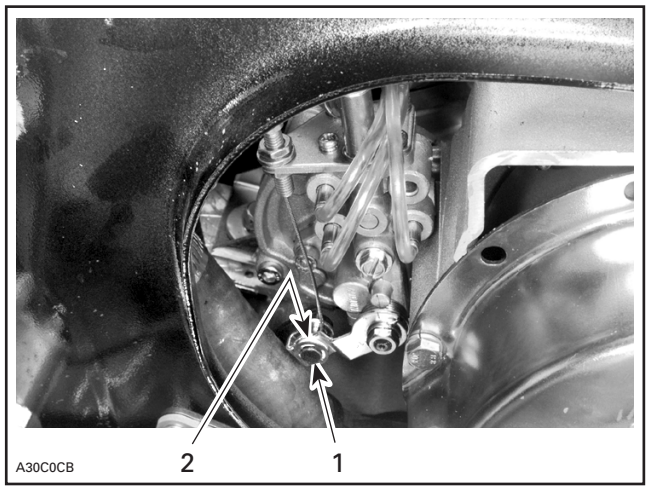
– exhaust pipes using exhaust spring remover/ installer (P/N 529 035 400)

TYPICAL

– tuned pipes
– after muffler
– wiring connections



– oil injection inlet line at oil injection pump, install hose pincher
– oil pump cable



1. Remove circlip
2. Plastic washer

– coolant hoses at cylinder head and at front bottom of engine
– engine support screws
– engine stopper (left rear of engine)
– removable side member

Turn steering left side. Remove engine from vehicle.

1,2,3,4, Engine Support Nut and Manifold Screw

Torque the engine/support nuts **no. 1** to 35 N•m (26 lbf•ft).

Torque rubber mount **no. 2** to support bracket to 29 N•m (21 lbf•ft).

Torque rubber mount/support screw to 37 N•m (27 lbf•ft).

Torque manifold screws **no. 4** to 10 N•m (89 lbf•**in**).

Torque removable side member screws to 7 N•m (62 lbf•**in**).

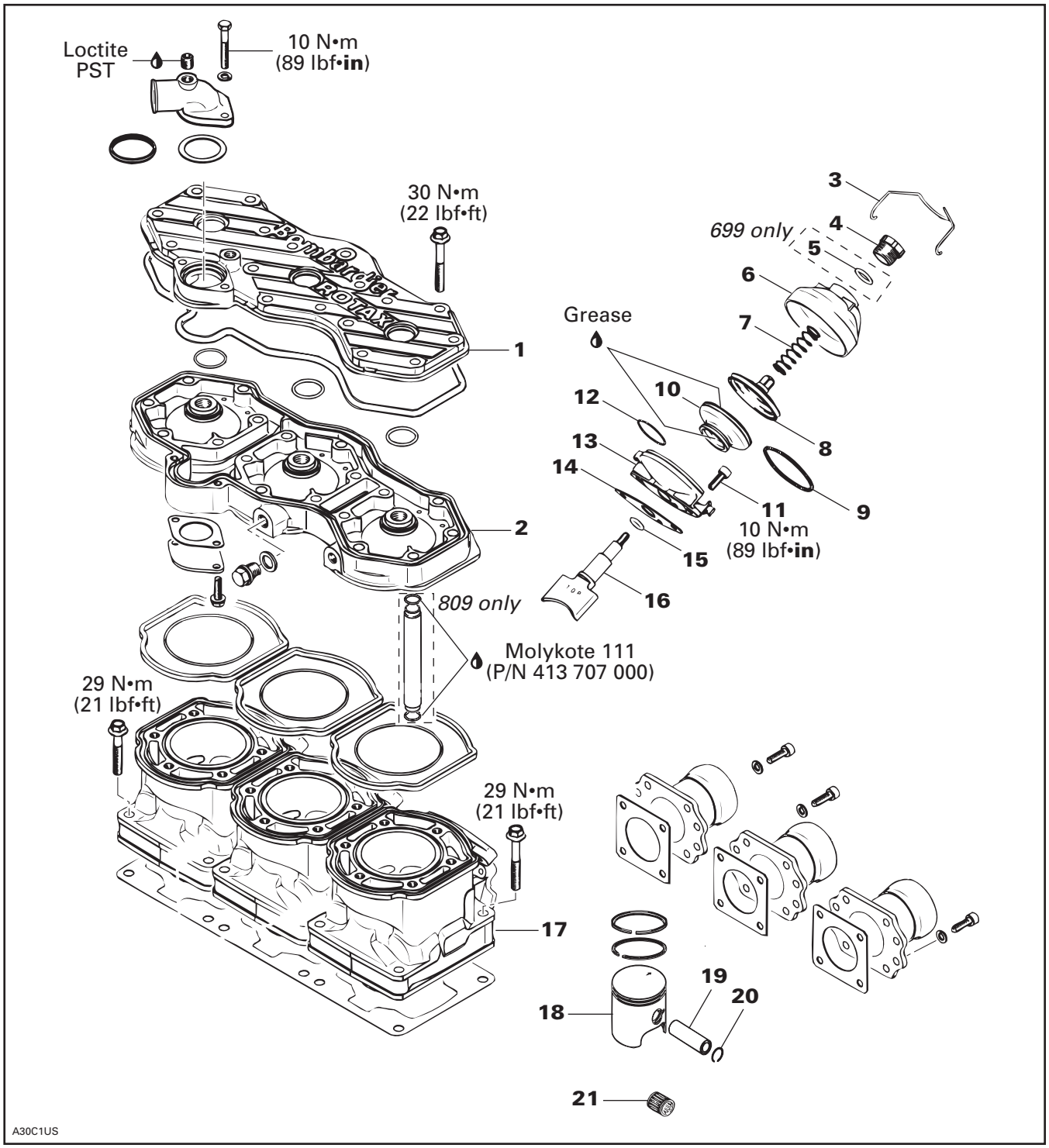
Torque removable side member nut over countershaft support to 15 N•m (133 lbf•**in**).

INSTALLATION ON VEHICLE

To install engine on vehicle, reverse removal procedure. However, pay attention, to all appropriate component/system reinstallation procedures described throughout this *Shop Manual* and to the following:

– It is easier to install oil pump cable before installing engine on vehicle.
– After throttle cable installation, check carburetor maximum throttle opening and oil injection pump adjustment.
– Check pulley alignment and drive belt tension.
– Should a light exhaust leak be experienced at muffler ball joint, Ultra Copper (P/N 413 710 300) can be used.

TOP END


Loctite
PST
10 N•m
(89 lbf•in)
30 N•m
(22 lbf•ft)
699 only
Grease
Molykote 111
(P/N 413 707 000)
809 only
29 N•m
(21 lbf•ft)
29 N•m
(21 lbf•ft)
10 N•m
(89 lbf•in)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
A30C1US

COMPONENT REMOVAL

Most engine components can be removed with engine on vehicle such as:

– cylinder head
– piston(s)
– cylinder(s)
– rewind starter
– oil pump
– water pump
– magneto flywheel
– RAVE valve(s)

CLEANING

Discard all gaskets and O-rings.

Clean all metal components in a non-ferrous metal cleaner.

Scrape off carbon formation from cylinder exhaust port cylinder head and piston dome using a wooden spatula.

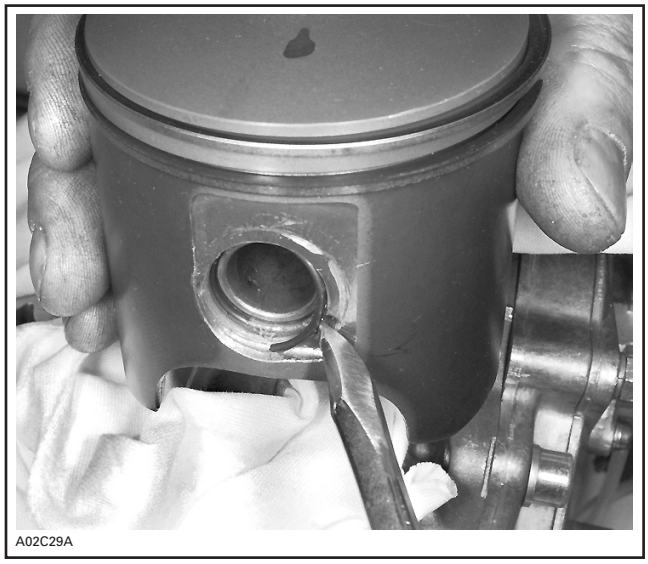
NOTE: The letters ''AUS'' (over an arrow on the piston dome) must be visible after cleaning.

Clean the piston ring groove with a groove cleaner tool or with a piece of broken ring.

DISASSEMBLY

18, Piston

Place a clean cloth or rubber pad (P/N 529 023 400) over crankcase then with a pointed tool inserted in piston notch, remove circlip **no. 20** from piston **no. 18**.



TYPICAL

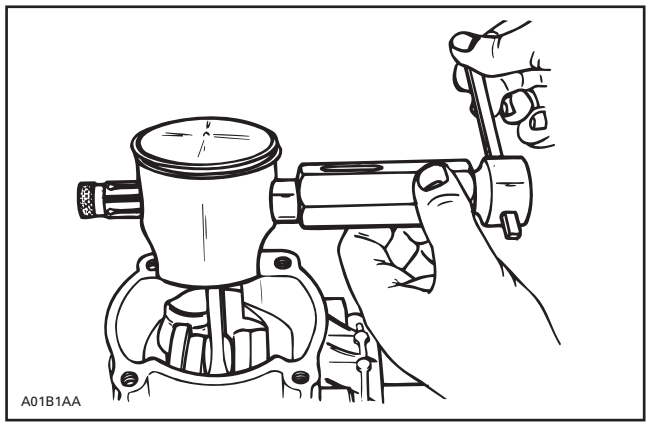
To remove piston pin **no. 19**, use piston pin puller (P/N 529 035 503) as follows:

Fully screw puller handle.

Insert puller end into piston pin.

Screw (LH threads) extracting nut.

Hold puller firmly and rotate puller handle counterclockwise to pull piston pin.



TYPICAL

RAVE System

NOTE: RAVE stands for Rotax Adjustable Variable Exhaust.

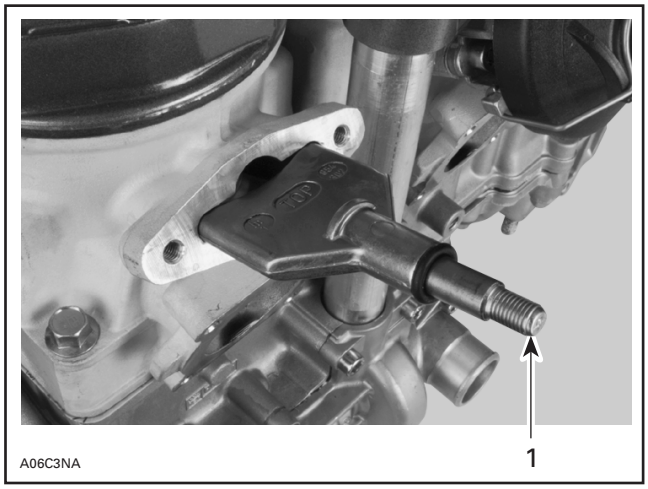
Remove spring clip **no. 3**, cover **no. 6** and spring **no. 7**.

Remove spring **no. 3**.

Unscrew valve piston **no. 9**.

Remove cylindrical screws **no. 11** then valve rod housing **no. 13**. Remove bellows **no. 10** and spring **no. 12**.

Pull out exhaust valve **no. 16**.



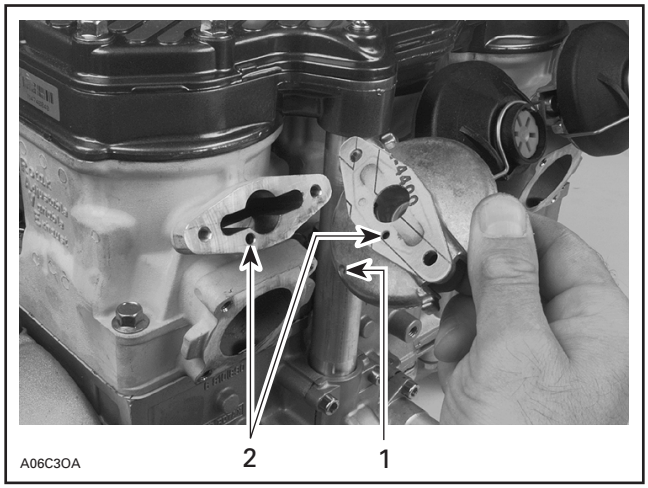
1. Exhaust valve

INSPECTION

NOTE: Refer to LEAK TEST AND ENGINE DIMENSIONS MEASUREMENT 04-03.

RAVE System

Check valve rod housing and cylinder for clogged passages.



1. Draining hole
2. Passages

NOTE: Oil dripping from draining hole indicates a loosen spring or damaged bellows.

10, Bellows

Check for cracked, dried or perforated bellows.

7, Spring

ENGINE TYPE	SPRING P/N	WIRE DIA. mm (in)	FREE LENGTH mm (in)	PRELOAD IN N (LBF) AT COMPRESSED LENGTH OF 14.7 mm (.579 in)
699 on Mach 1	420 239 944	0.9 (.031)	48.5 (1.91)	0.0169 (.0038)
699 on Formula III 700 and GT 700	420 239 945	1.0 (.039)	48.5 (1.91)	0.0203 (.0045)
809 on Formula III 800 and GT SE	420 239 945	1.0 (.039)	48.5 (1.91)	0.0203 (.0045)
809 on Mach Z	420 239 941	0.8 (.031)	52.5 (2.07)	0.0110 (.0025)

ASSEMBLY

RAVE System

Install RAVE valve with its mention top as illustrated in the removal photo. Tighten red cap **no. 4** screw to bottom.

17,18, Cylinder and Piston

NOTE: Be sure to restore the chamfer around all cylinder sleeve port openings.

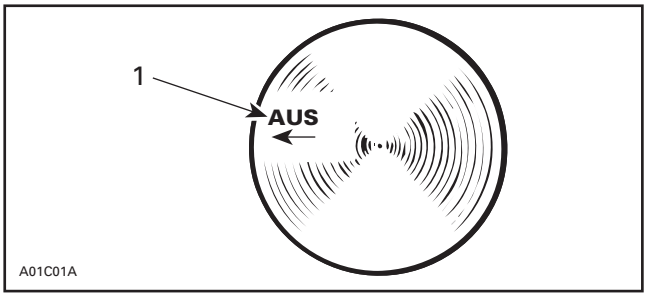
Before inserting piston in cylinder, lubricate the cylinder with new injection oil or equivalent.

1,2,17, Cylinder Head Cover, Cylinder Head and Cylinder

Check flatness of part sealing surfaces.

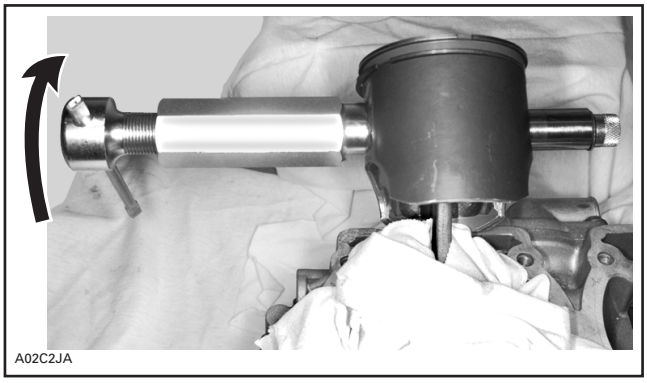
Refer to LEAK TEST AND ENGINE DIMENSION MEASUREMENT 04-03 and look for **Checking Surface Flatness**.

– Mount piston over connecting rod with the letters "AUS" (over an arrow on the piston dome) facing in the direction of exhaust port (see illustration below).



1. Exhaust

Install piston pin puller and turn handle until piston pin is correctly positioned in piston.

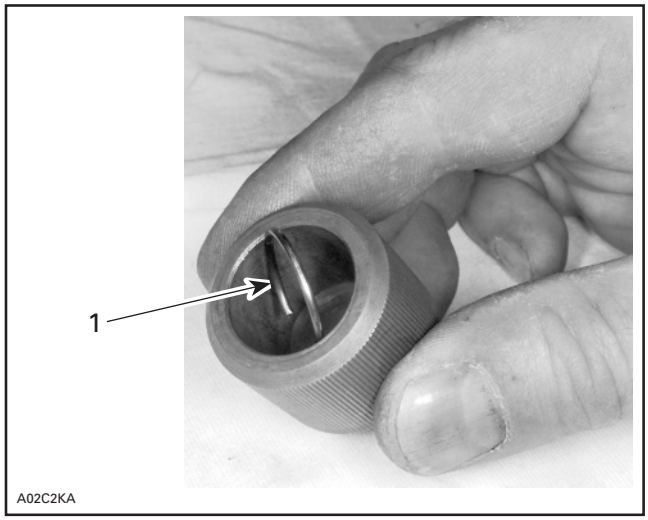


TYPICAL

CAUTION: Always install new circlips.

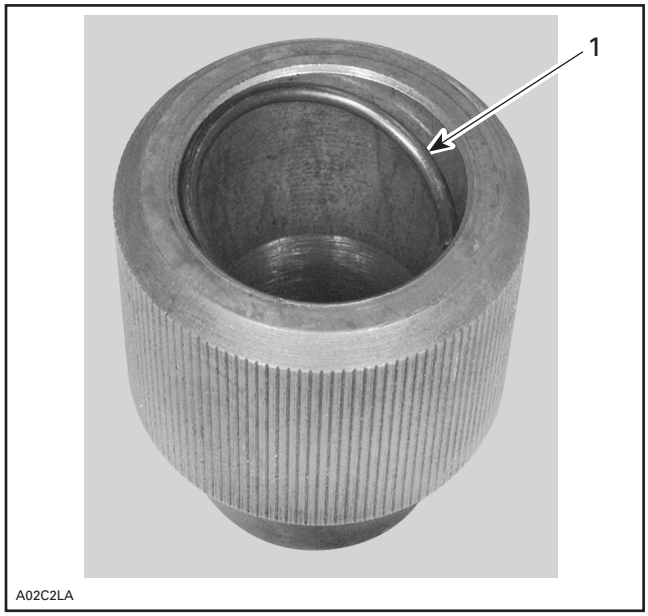
To minimize the effect of acceleration forces on circlip, install each circlip so the circlip break is at 6 o'clock as illustrated. Use piston circlip installer (P/N 529 035 561).

Insert circlip in tool at an angle.



TYPICAL
1. Circlip

Square it up using a finger.



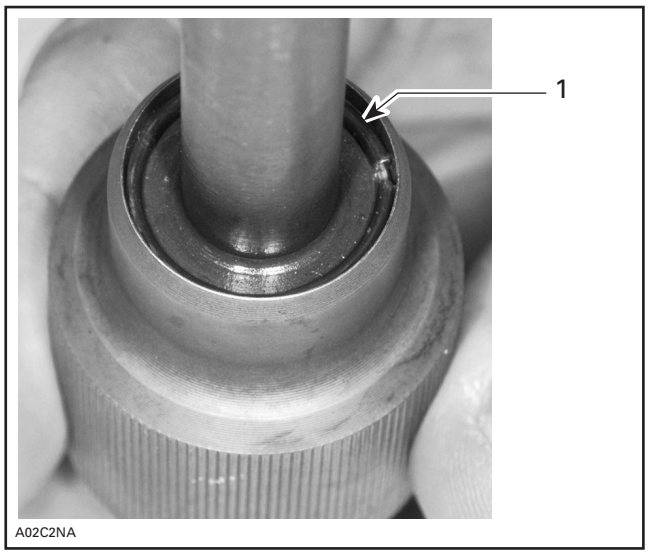
TYPICAL
1. Circlip

Continue to square it up using round end of circlip installer.


A02C2MA

TYPICAL

Using square end of tool, push circlip in until it rests in groove.

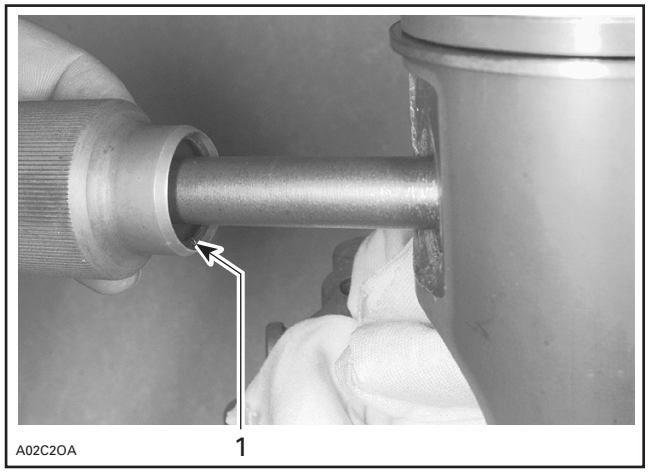


A02C2NA

TYPICAL

1. Circlip in groove

Mount tool in piston making sure that circlip break is facing down.



A02C2OA

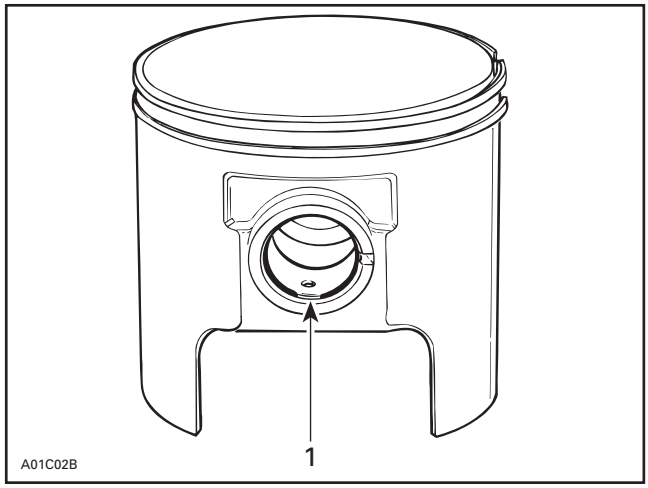
TYPICAL

1. Circlip break facing down

Hold tool firmly against piston then strike on round end of tool. Circlip will move from tool groove to piston groove.


A02C2PA

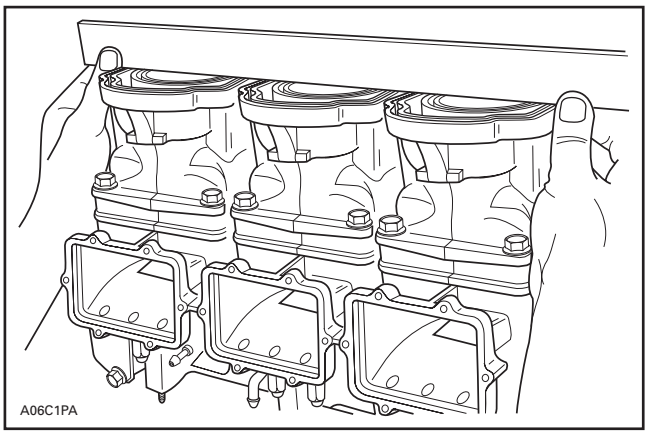
TYPICAL



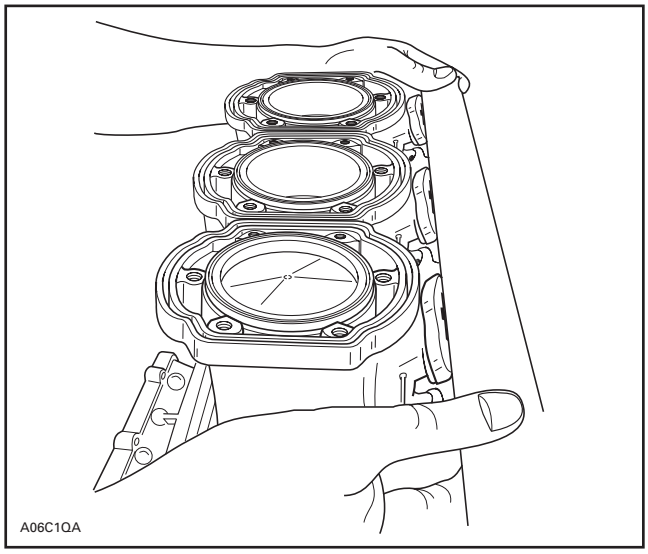
TYPICAL
1. Circlip break

CAUTION: Circlips must not move freely after installation; if so, replace them.

Install cylinders and check for same height.



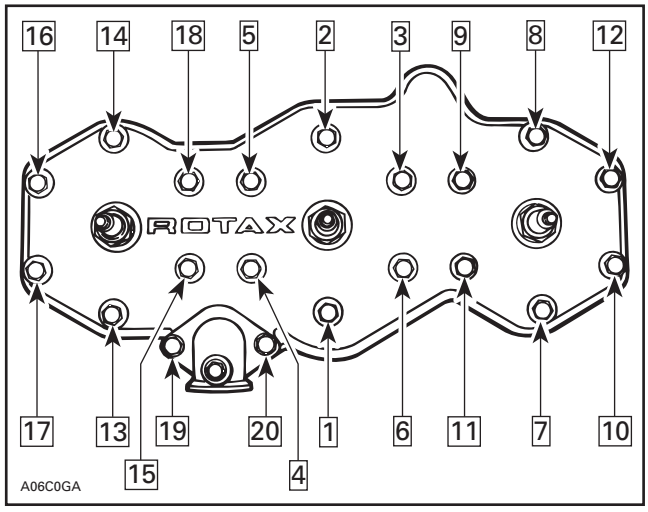
Also check for proper cylinder alignment.



At assembly, torque cylinder head screws in the following illustrated sequence. Tightening torques are:

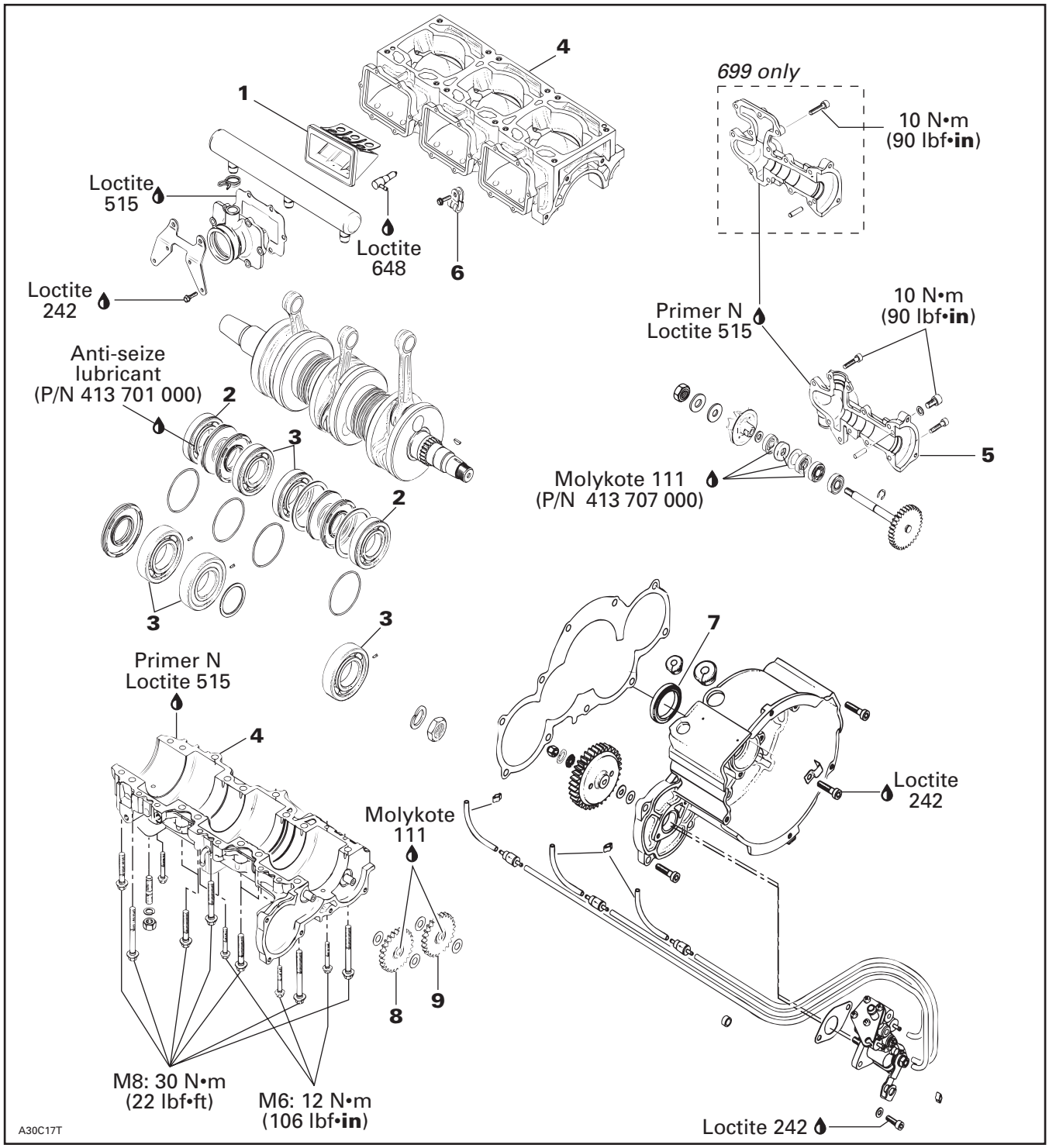
M6 screws: 12 N•m (106 lbf•**in**)

M8 screws: 30 N•m (22 lbf•ft)



TYPICAL

BOTTOM END


4
1
699 only
10 N•m
(90 lbf•in)
Loctite
515
Loctite
648
6
Loctite
242
Primer N
Loctite 515
10 N•m
(90 lbf•in)
Anti-seize
lubricant
(P/N 413 701 000)
2
3
2
5
Molykote 111
(P/N 413 707 000)
3
3
7
Primer N
Loctite 515
4
Loctite
242
Molykote
111
8
9
M8: 30 N•m
(22 lbf•ft)
M6: 12 N•m
(106 lbf•in)
Loctite 242
A30C17T

NOTE: Engine must be removed from chassis to perform the following procedures.

CLEANING

Discard all oil seals, gaskets, O-rings and sealing rings.

Clean all metal components in a non-ferrous metal cleaner. Use Gasket remover (P/N 413 708 500) accordingly.

Remove old paste gasket from crankcase mating surfaces with Gasket remover (P/N 413 708 500).

CAUTION: Never use a sharp object to scrape away old sealant as score marks incurred are detrimental to crankcase sealing.

DISASSEMBLY

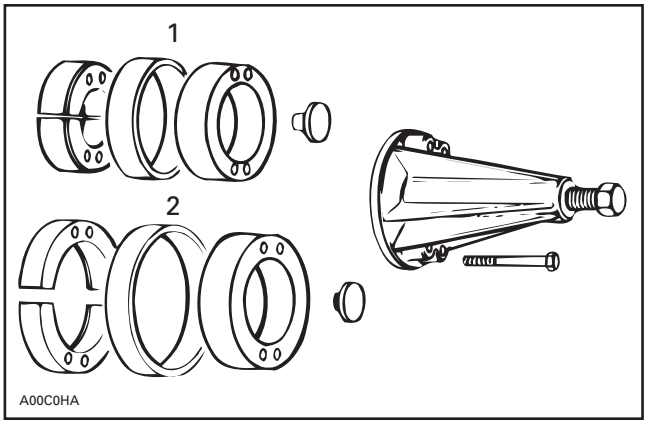
General

To remove drive pulley, refer to DRIVE PULLEY 05-03.

To remove magneto, refer to CDI SYSTEM 04-04.

2,3, Crankshaft Bearing

To remove bearings from crankshaft, use a protective cap and special puller, as illustrated.



1. PTO side
2. MAG side

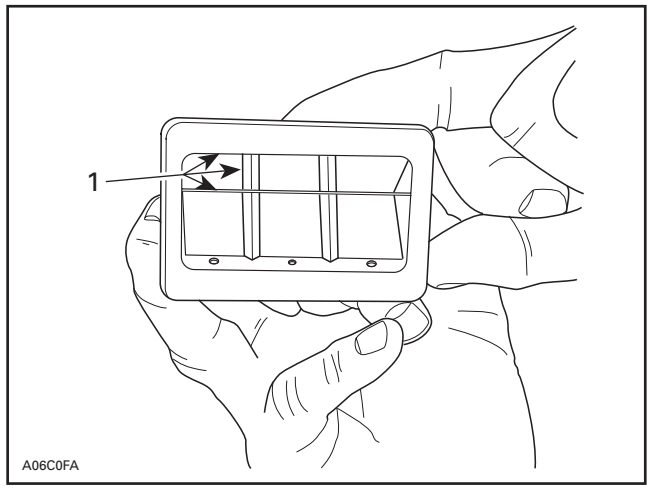
INSPECTION

NOTE: Refer to LEAK TEST AND ENGINE DIMENSIONS MEASUREMENT 04-03.

1, Reed Valve

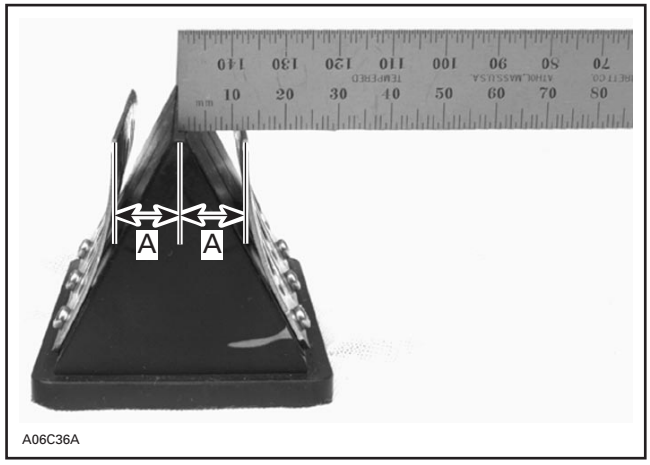
With blade stopper removed, check reed valve for proper tightness. There must be no play between blade and valve body when exerting a finger pressure on blade at blade stopper location.

In case of a play, turn blade upside down and recheck. If there is still a play, replace blade and/or valve body.



1. No play

Check distance from blade stopper outer edge and center of reed valve block.



TYPICAL

A. 699 and 809 engines: 17.0 - 0, + 0.75 mm (.669 - 0, + .030 in)

Bent blade stopper as required to obtain the proper distance.

Blade stoppers may slightly interfere with crankcase during installation. Adjusted distance will be reduced automatically upon installation.

ASSEMBLY

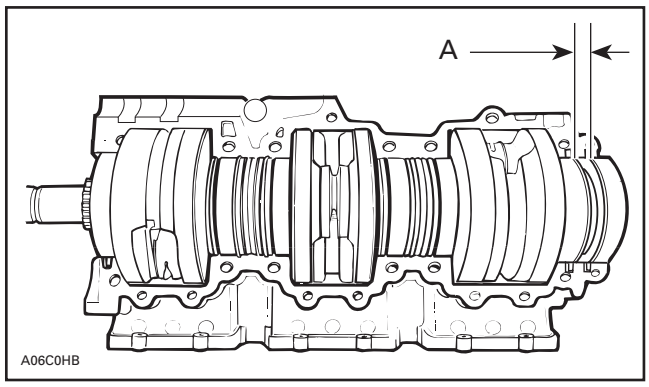
2,3, Crankshaft Bearing and Anti-Seize Lubricant

Smear anti-seize lubricant (P/N 413 701 000) on part of crankshaft where bearing fits.

Prior to installation, place bearings into an oil container filled with injection oil previously heated to 75°C (167°F). This will expand bearing and ease installation.

809 Engine Only

Outer PTO bearing is 8 mm (5/16 in) from inner bearing.



TYPICAL — 809 ENGINE
A. 8 mm (5/16 in)

Outer PTO Bearing Lubrication

All Engines

Outer PTO bearing must be lubricated with Isoflex grease (P/N 293 550 021).

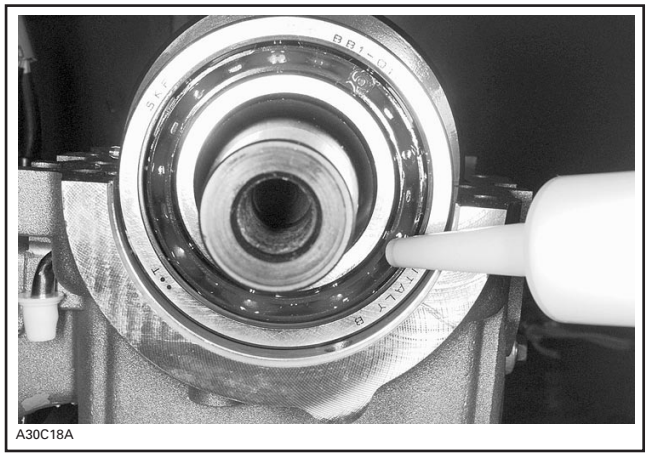
CAUTION: Use only the recommended Isoflex grease. Make sure not to push Isoflex grease between outside bearing race and half crankcase.

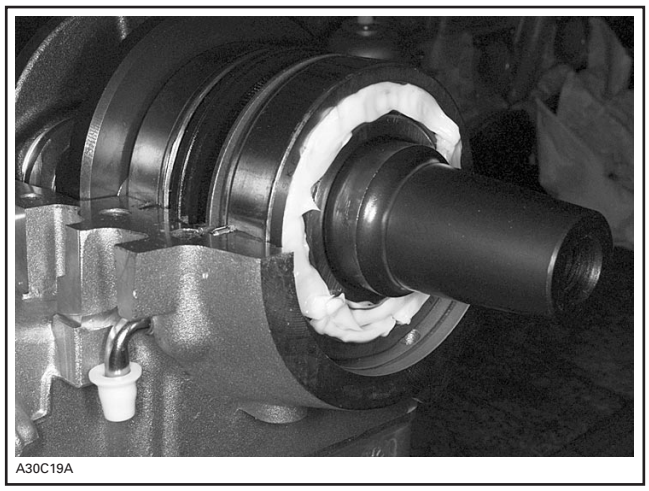
NOTE: The 50 g tube corresponds to 50 cc of grease.

699 Engine

Total quantity of Isoflex grease to be applied is 50 cc.

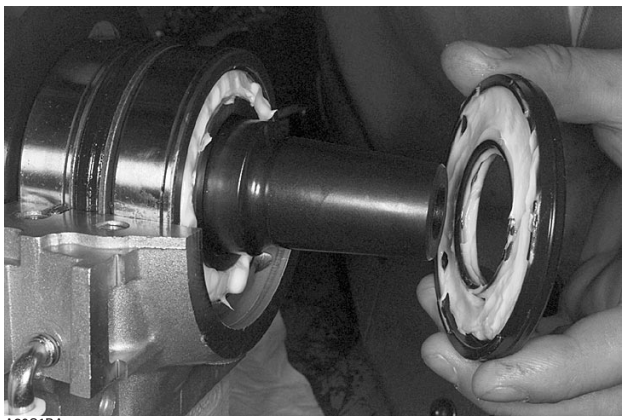
Apply about 7 cc of Isoflex grease to outside bearing cage.





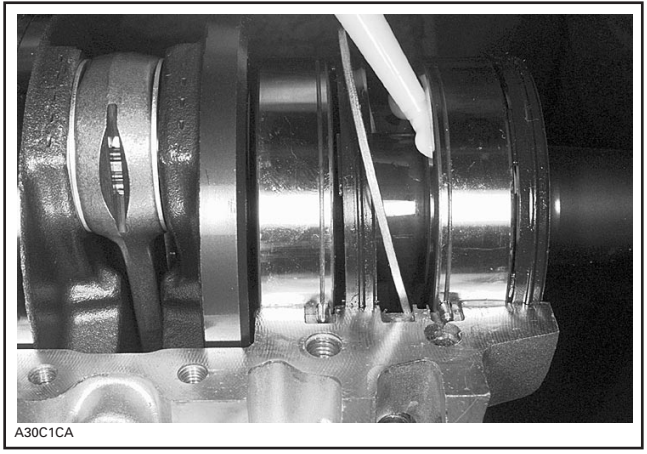
Fill up PTO seal with about 10 cc of Isoflex grease.

Install PTO seal on crankshaft.


A30C1BA

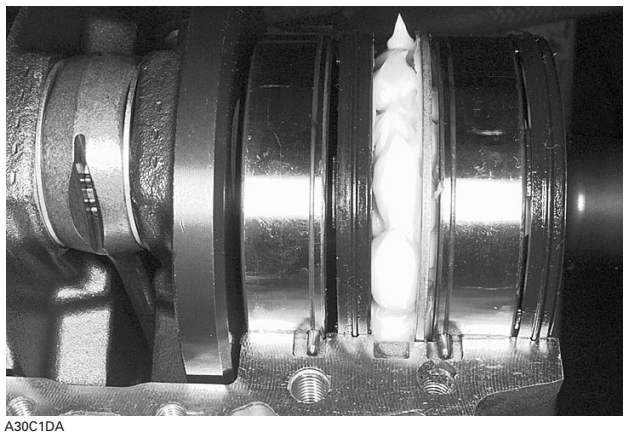
TYPICAL

Apply Isoflex grease to inner side of bearing cage.


A30C1CA

Install washer in its crankcase groove.

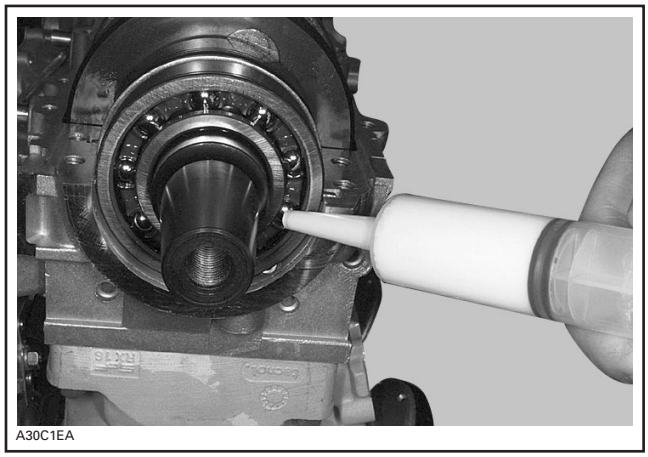
Fill space between inner side of bearing cage and seal with remaining quantity of Isoflex grease.

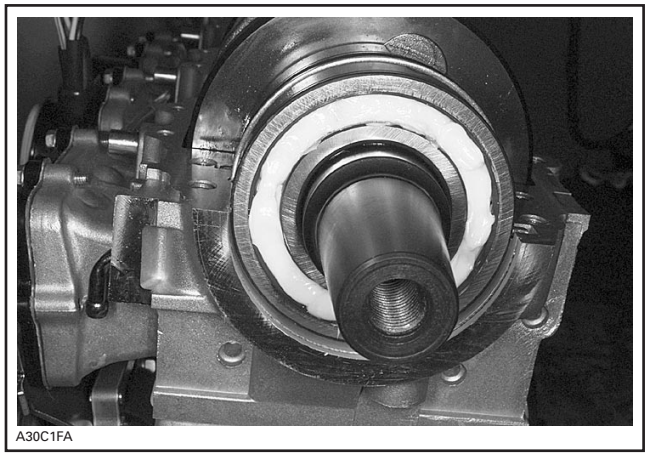

A30C1DA

809 Engine

Total quantity of Isoflex grease to be applied is 21 cc.

Apply 21 cc of grease to outside bearing cage and seal.

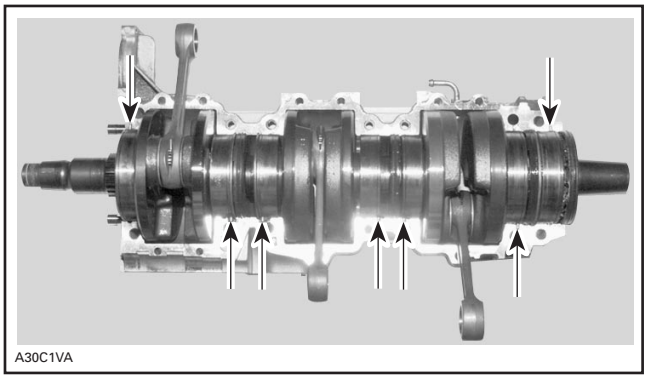

A30C1EA


A30C1FA


A30C1AA

4, Crankcase

At crankshaft installation, position drive pins as illustrated.



TYPICAL — DRIVE PINS

Crankcase halves no. 4 and water pump housing are factory matched and therefore, are not interchangeable as single halves.

Prior to joining of crankcase halves, spray some new injection oil (or equivalent) in bearings and on all moving parts of the crankshaft. Spray Primer N (P/N 413 708 100) on one of mating surfaces. Let it dry for 10 to 20 minutes.

Apply Loctite 515 (P/N 413 702 700) on the other mating surface.

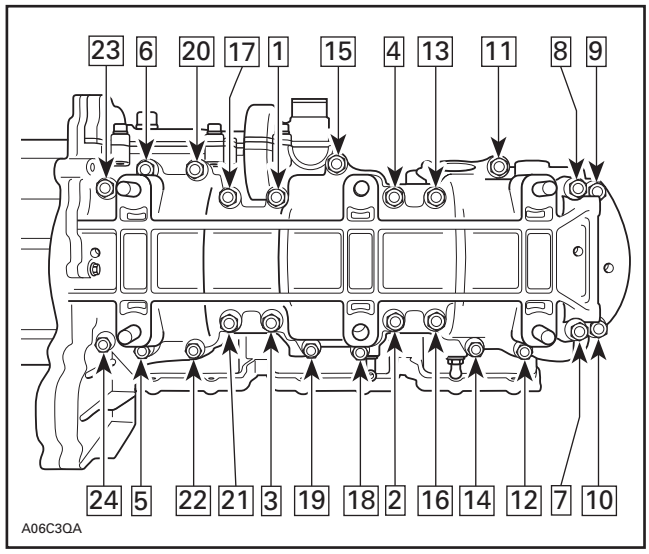
NOTE: Primer N allows Loctite 515 to fully cure on aluminum surfaces. It increases filling capacity and reduce curing time.

Align both crankcase halves before tightening screws.

Torque crankcase screws in the following illustrated sequence. Tightening torques are:

M6 screws: 12 N•m (106 lbf•**in**)

M8 screws: 30 N•m (22 lbf•ft)



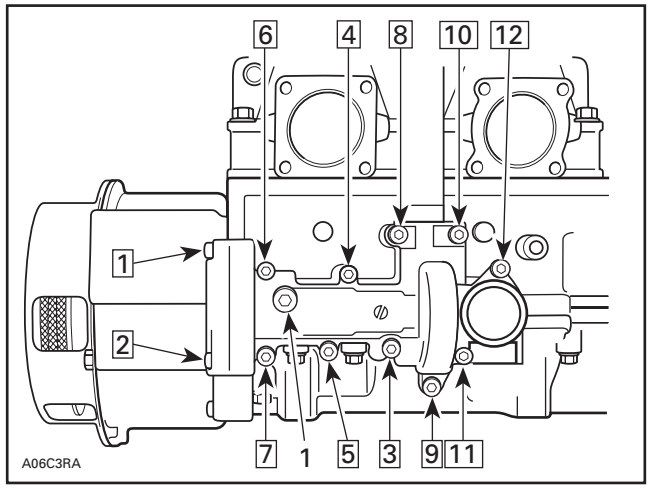
TYPICAL

5, Water Pump Housing

Spray Primer N (P/N 413 708 100) on one of mating surfaces. Let it dry for 10 to 20 minutes.

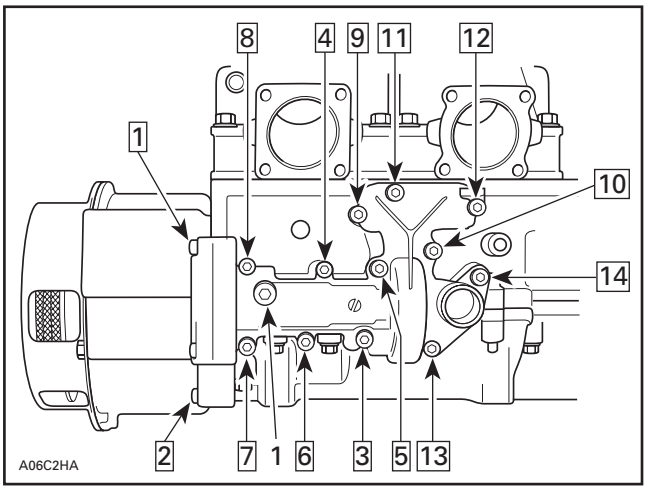
Apply Loctite 515 (P/N 413 702 700) on the other mating surface.

Tighten water pump housing screws to 10 N•m (90 lbf•**in**) following sequence as illustrated.



809 ENGINE

1. Oil level plug



699 ENGINE
1. Oil level plug

Add chaincase synthetic oil (P/N 413 802 800) into water pump housing until oil level reach bottom of plug hole. See above illustration. Total capacity is about 14 cc (.47 U.S. oz).

This oil addition is needed only when servicing water pump. During normal engine operation, this oil can flow through engine. After that fuel/oil mixture will lubricate water pump bearings by scavenging.

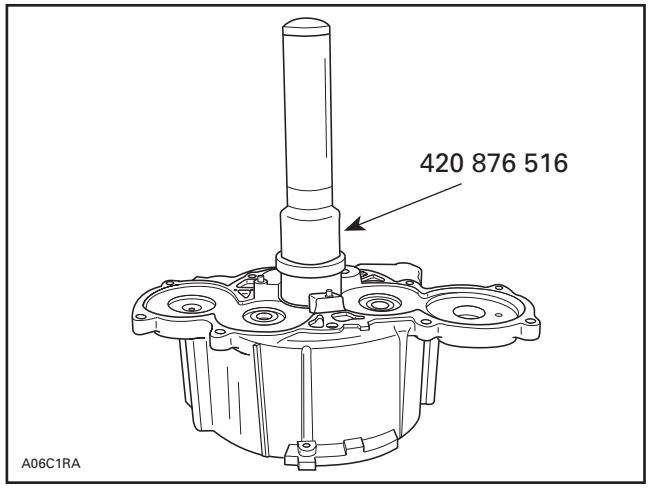
6, Screw

Apply Loctite 242 on screw threads. Install the screw retaining oil line clip first. If experiencing leaks at carburetor adaptor, use primer N and Loctite 515 on sealing surfaces of crankcase and adaptor.

7, Seal

Install seal using pusher (P/N 420 876 516).

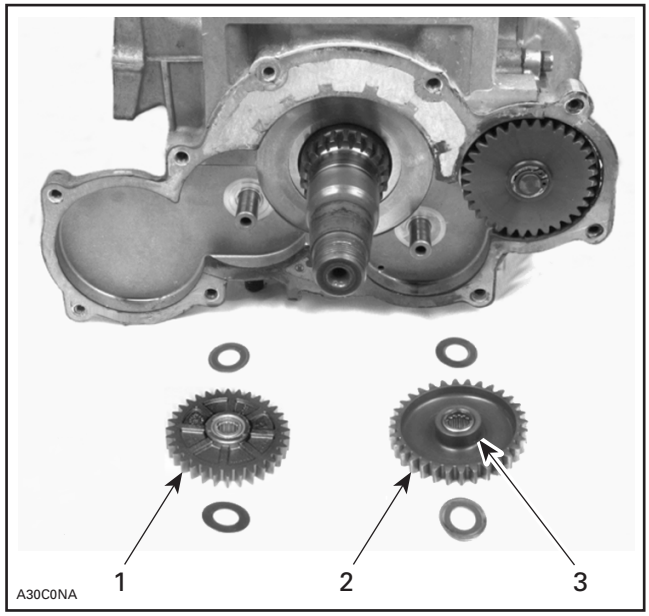
CAUTION: Make sure oil seal is fully pushed against stator shoulder.



8,9, Plastic Gear and Steel Gear

Apply Molykote 111 to needle bearing of each gear.

Install plastic gear on oil pump side. Steel gear goes on water side, its shoulder first.



TYPICAL
1. Plastic gear
2. Steel gear
3. Shoulder facing crankcase

LEAK TEST AND ENGINE DIMENSION MEASUREMENT

LEAK TEST

The following gives verification procedures for liquid cooled engines though it also applies to fan cooled engines. For FC engines, do not consider information pertaining to coolant system and crankcase rotary valve gear reservoir/components.

On twin-cylinder engines, each cylinder cannot be verified individually due to leakage from one cylinder to the other through rotary valve (except on engines with separate intake manifolds). Besides, on FC engines, leak will occur through labyrinth sleeve in center of crankshaft.

PREPARATION

1. Remove tuned pipe/muffler and exhaust manifold.
2. Install plugs over exhaust flanges. Tighten with previously removed screws.
3. On engines with RAVE system, remove RAVE valves and install plugs over flanges. Tighten with previously removed screws.
4. Remove carburetor(s).
5. Insert plug(s) in intake rubber boot(s). Tighten with clamps already there.
6. Using a hose pincher(s) (P/N 295 000 076), block impulse hose(s).

NOTE: Do not block large hoses of rotary valve gear lubrication system.

7. Install air pump on any valve of exhaust plug.

NOTE: If necessary, lubricate air pump piston with mild soap.

CAUTION: Using hydrocarbon lubricant (such as engine oil) will damage rubber seal of pump piston.

8. Rotate crankshaft so that piston goes to BDC (Bottom Dead Center) on side where the pump is installed. This will open exhaust port.
9. Activate pump and pressurize engine to 34 kPa (5 PSI). Do not exceed this pressure.
10. Engine must stand this pressure during 3 minutes. If pressure drops before 3 minutes, check tester kit by spraying a soapy solution on pump piston, all plugs and fittings.
    - If tester kit is leaking, bubbles will indicate where leak comes from.
    - If tester kit is not leaking, check engine as per following procedure.

PROCEDURE

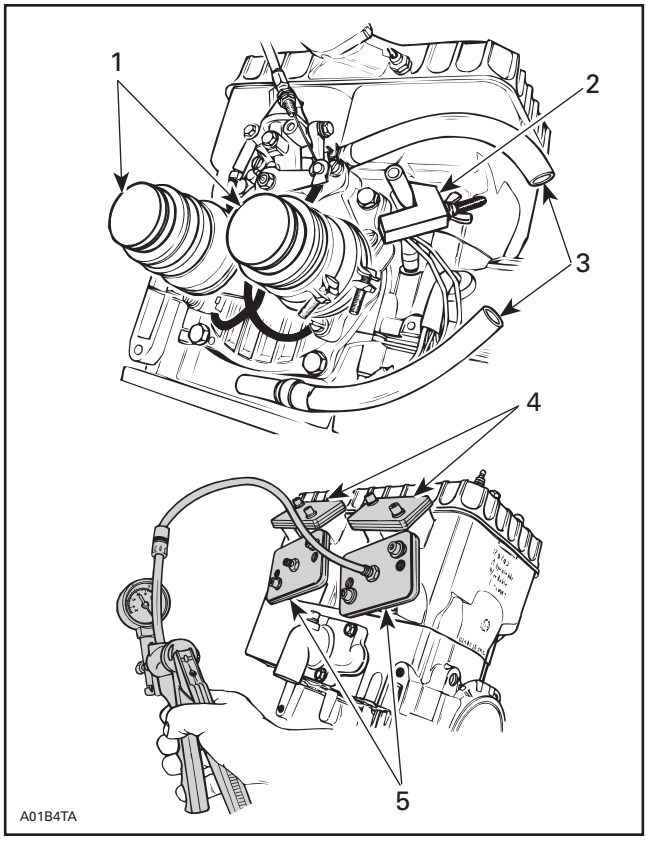
NOTE: A flow chart has been prepared as a visual reference. See last page of this chapter.

Using flow chart and following text, pressurize area to be tested and spray soapy solution at the indicated location.

TEST PRESSURE: 34 kPa (5 PSI) for 3 minutes

- If there is a leak at the tested location, it is recommended to continue testing next items before overhauling engine. There is a possibility of more than one leak.
- If there is no leak at the tested location, continue pumping to maintain pressure and continue with next items until leak is found.

Engine



TYPICAL

1. *Blocked intake flanges*
2. *Blocked impulse fitting*
3. *Open ends (if applicable)*
4. *Blocked RAVE valve flanges (if applicable)*
5. *Blocked exhaust flanges*

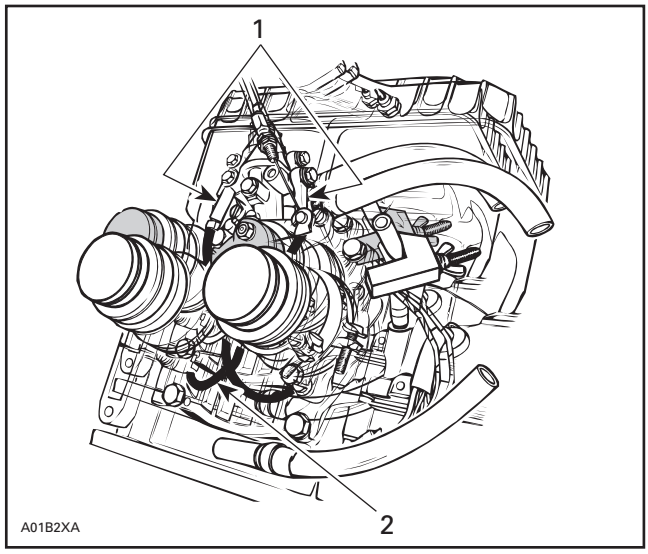
When exhaust manifold is installed, use rubber plug. (In this case it is not necessary to move piston to BDC).

TYPICAL

1. *Rubber plug*

Check the following:

1. All jointed surfaces and screw/stud threads of engine:
   - spark plug base, insulator
   - cylinder head
   - cylinder base
   - crankcase halves (joint)
   - rotary valve cover
   - oil injection pump mounting flange (O-ring, seal)
   - coolant pump housing
   - bleed screws/plugs
2. Small injection oil lines coming from pump.



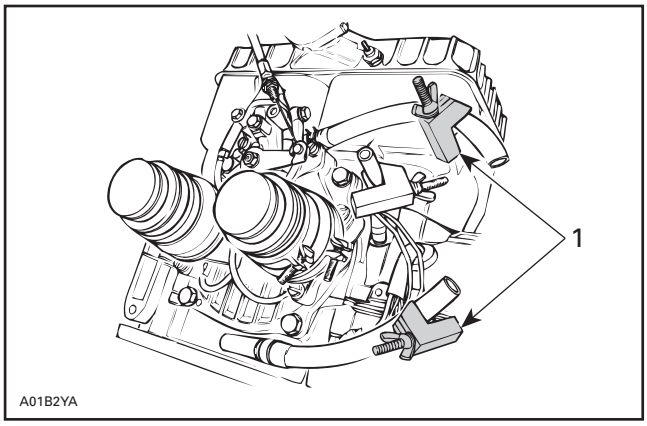
1. *Banjo fittings*
2. *Small injection oil lines*

Check for air bubbles or oil column going toward pump. It indicates defective check valve in banjo fitting (or lines).

3. Remove cooling system cap.

Check for air bubbles in antifreeze. It indicates defective cylinder head O-ring or cylinder base gasket.

4. Block both hoses of rotary valve gear lubrication system with hose pinchers.



1. Block both hoses

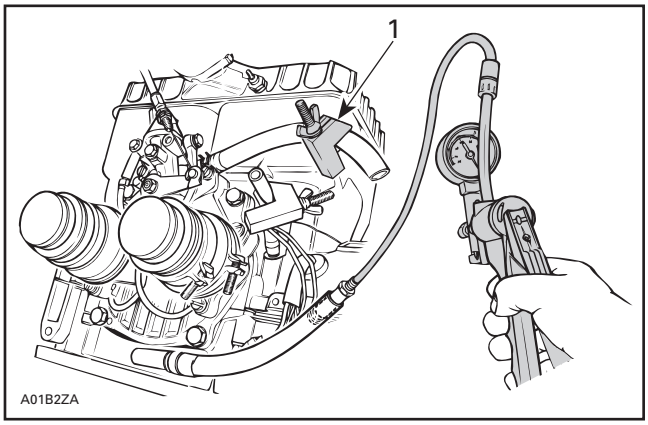
If leakage stops, ignore remaining items and check crankcase rotary valve gear reservoir as per Crankcase Rotary Valve Gear Reservoir of this section.

5. Remove drive pulley then check crankshaft outer seal.
6. Remove rewind starter and magneto system then check crankshaft outer seal.
7. Check crankcase rotary valve gear reservoir.

Crankcase Rotary Valve Gear Reservoir

Block one hose of rotary valve gear lubrication system with a hose pincher and install an adapter in remaining hose.

Install air pump on adapter and pressurize as before.

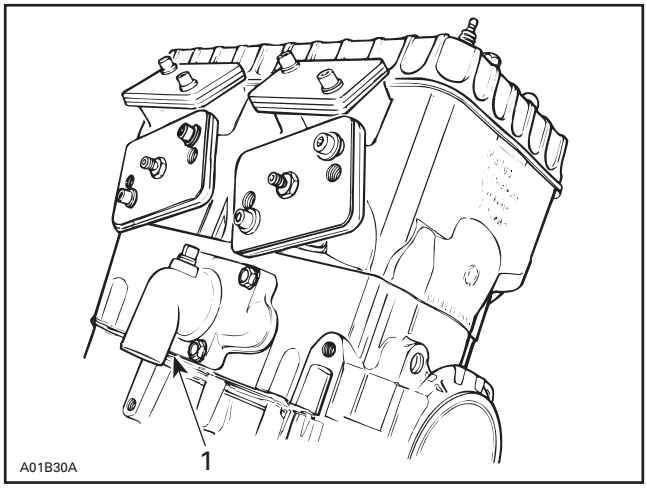


1. Blocked hose

1. Remove a spark plug or any plug of leak tester kit on PTO side.

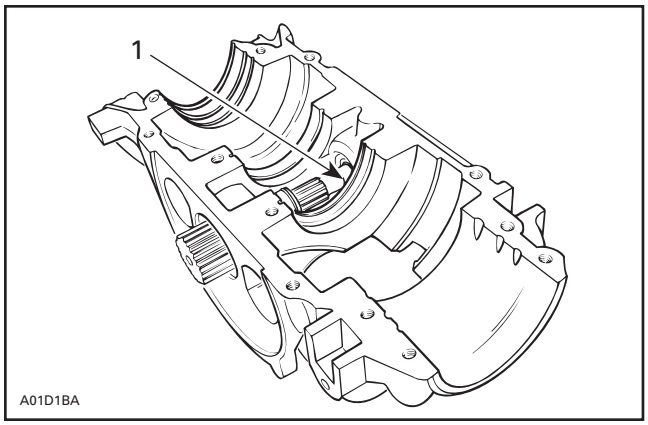
   If pressure drops, it indicates defective crankshaft inner seal on PTO side.
2. Remove a spark plug or any plug of leak tester kit on MAG side.

   If pressure drops, it indicates defective crankshaft inner seal on MAG side.
3. Check drain hole below coolant pump housing with soapy water.



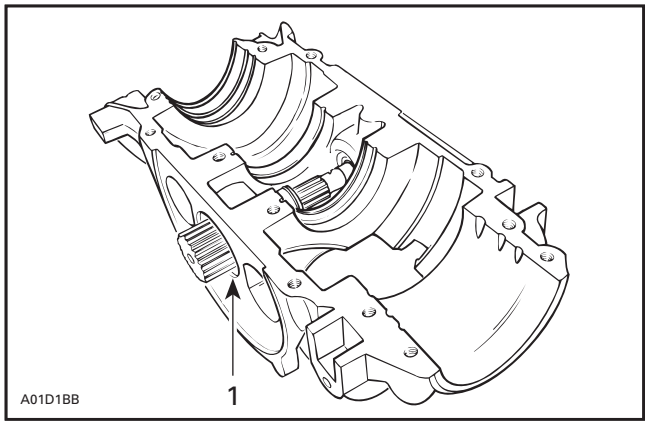
1. Drain hole

If there is a leak, it indicates defective seal of rotary valve shaft (oil seal beside coolant seal).



1. Oil seal

4. Remove rotary valve cover and check for leak of rotary valve seal with soapy water.



1. Seal

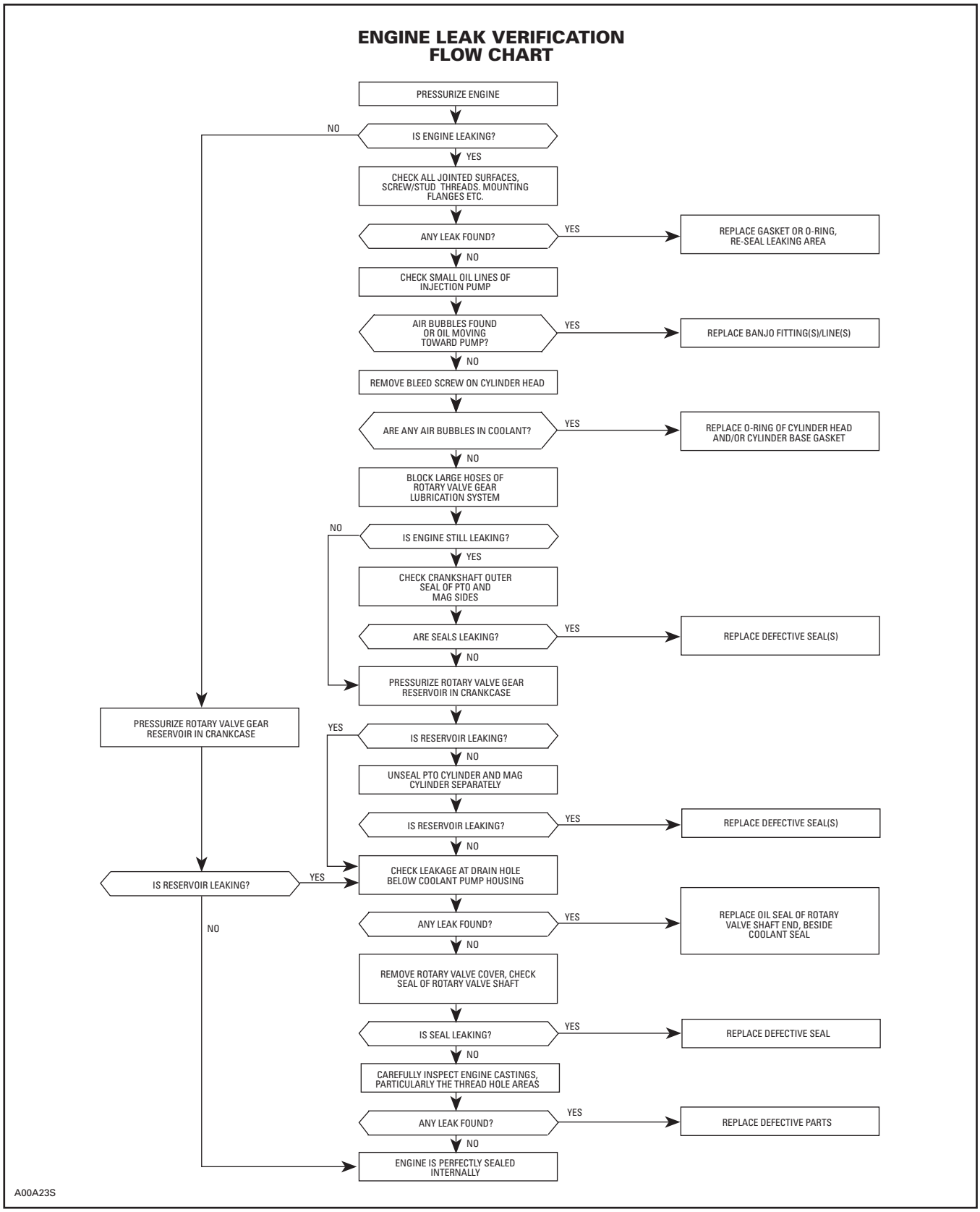
5. If leak still persists, it indicates a defective casting somewhere in engine.

   Disassemble engine and carefully check for defects in castings. Pay attention to tapped holes which may go through engine sealed area and thus lead to leakage.

FINALIZING REASSEMBLY

After reassembling engine, always recheck for leakage.

ENGINE LEAK VERIFICATION FLOW CHART



ENGINE DIMENSION MEASUREMENT

This section covers all engine types.

CYLINDER HEAD WARPAGE

ENGINE TYPE	MAXIMUM
All	0.05 mm (.002 in) per 50 mm (2 in) of surface
	0.5 mm (.020 in) for total length of cylinder head

Check gasketed surface of the cylinder head with a straightedge and a feeler gauge.

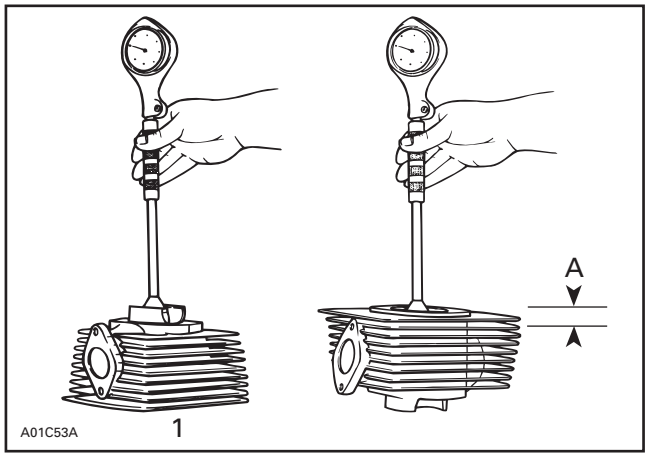
CYLINDER TAPER

ENGINE TYPE	MAXIMUM
All	0.10 mm (.004 in)

Compare cylinder diameter 16 mm (5/8 in) from top of cylinder to just below its intake port area.

On rotary valve engines, measure just below auxiliary transfer port, facing exhaust port. If the difference exceeds the specified dimension the cylinder should be rebored and honed or should be replaced.

NOTE: Be sure to restore the chamfer around all cylinder sleeve port openings.



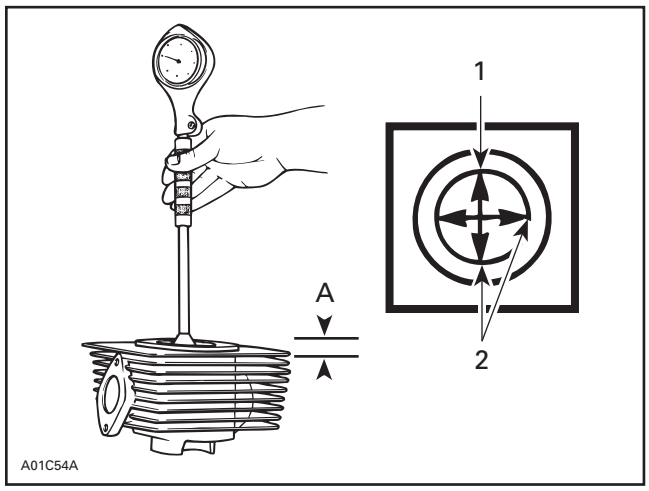
1. Below the intake port
A. 16 mm (5/8 in) from top

CYLINDER OUT OF ROUND

ENGINE TYPE	MAXIMUM
699	0.05 mm (.002 in)
809	0.08 mm (.003 in)

Measuring 16 mm (5/8 in) from top of cylinder with a cylinder gauge, check if the cylinder out of round is more than the specified dimension. If larger, cylinder should be rebored and honed or should be replaced.

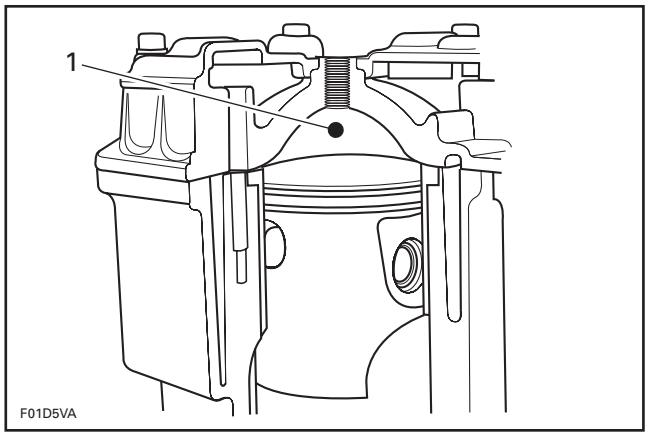
NOTE: Be sure to restore the chamfer around all cylinder sleeve port openings.



1. Piston pin position
2. Measures to be compared
A. 16 mm (5/8 in)

COMBUSTION CHAMBER VOLUME MEASUREMENT

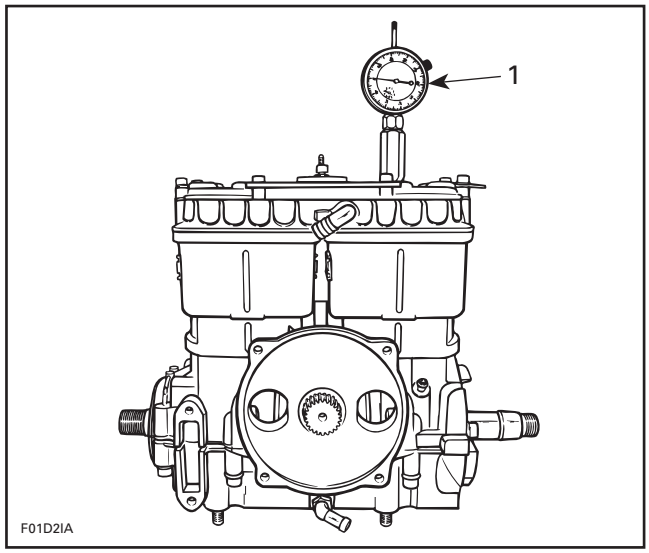
The combustion chamber volume is the region in the cylinder head above the piston at Top Dead Center. It is measured with the cylinder head installed on the engine.



1. Combustion chamber

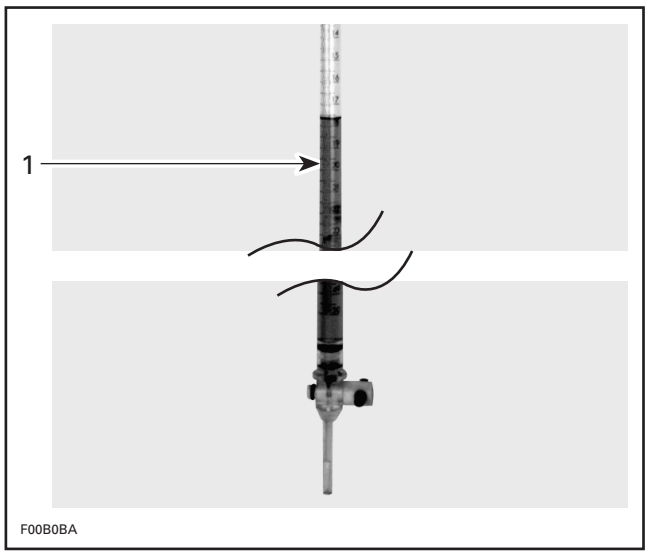
NOTE: When checking the combustion chamber volume, engine must be cold, piston must be free of carbon deposit and cylinder head must be leveled.

1. Remove both spark plugs and bring one piston to Top Dead Center a using a TDC gauge.



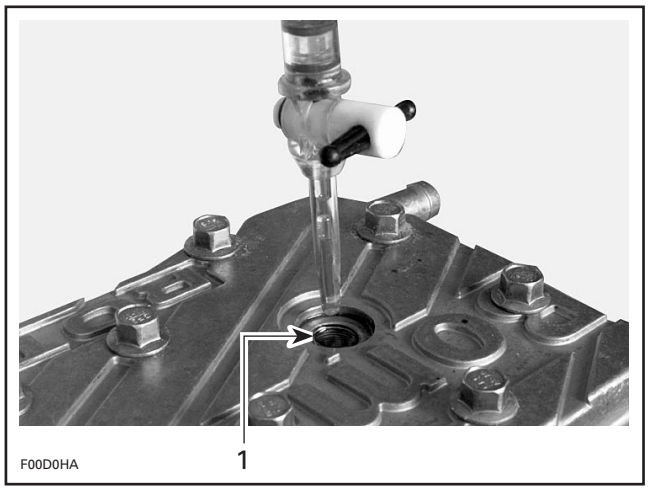
1. Bring piston to TDC

2. Obtain a graduated burette (capacity 0 - 50 cc) and fill with an equal part (50/50) of gasoline and injection oil.



1. Graduated burette (0 - 50 cc)

3. Open burette valve to fill its tip. Add liquid in burette until level reaches 0 cc.
4. Inject the burette content through the spark plug hole until liquid touches the top spark plug hole.



1. Top of spark plug hole

NOTE: The liquid level in cylinder must not drop for a few seconds after filling. If so, there is a leak between piston and cylinder. The recorded volume would be false.

5. Let burette stand upward for about 10 minutes, until liquid level is stabilized.
6. Read the burette scale to obtain the quantity of liquid injected in the combustion chamber.

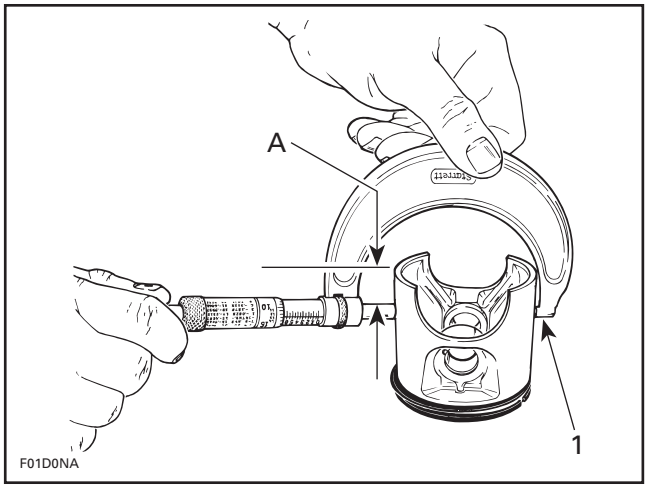
NOTE: When the combustion chamber is filled to top of spark plug hole, it includes an amount of 2.25 cc corresponding to the spark plug tip.

7. Repeat the procedure for the other cylinder.

ENGINE TYPE	COMBUSTION CHAMBER VOLUME (cc) (up to top thread of spark plug hole)
699	23.39 ± 1.0
809	26.29 ± 1.1

USED PISTON MEASUREMENT

Using a micrometer, measure piston at A perpendicularly (90°) to piston pin.



1. Measuring perpendicularly (90°) to piston pin axis
A. See table below

ENGINE TYPE	DIMENSION A mm (in)
699 and 809	28.7 (1.13)

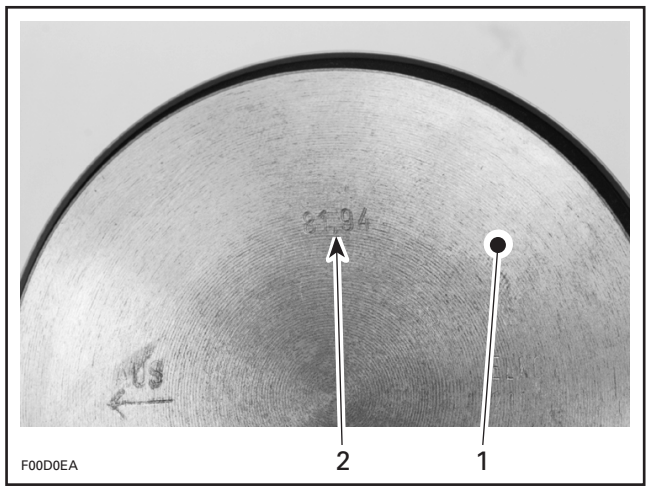
The measured dimension should be the same as the one scribed on piston dome. If not, install a new piston.

CYLINDER/PISTON CLEARANCE

Used and New Pistons

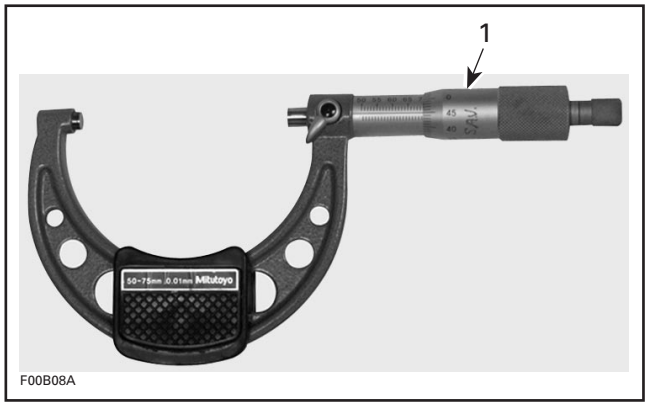
NOTE: Make sure used piston is not worn. See USED PISTON MEASUREMENT above.

Take the measurement on the piston dome.



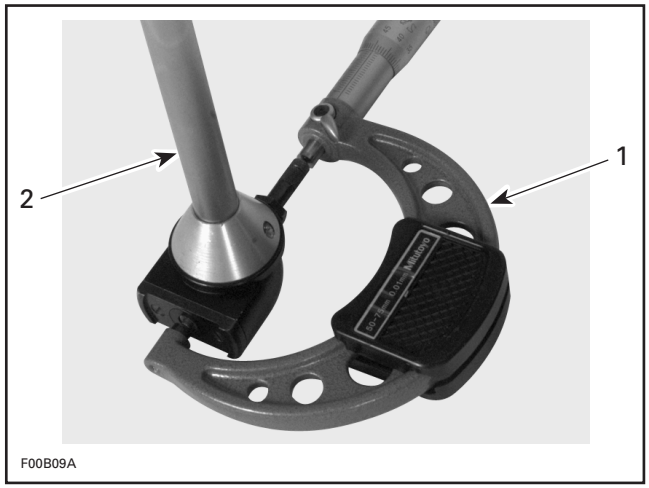
1. Piston dome
2. Piston measurement

Adjust and lock a micrometer to the specified value on the piston dome.

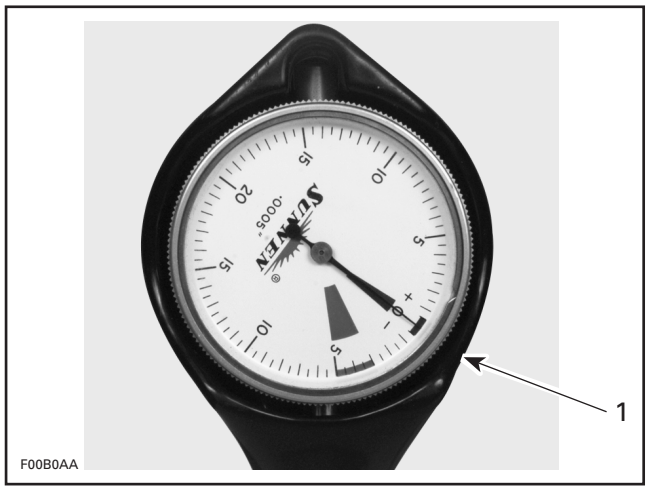


1. Micrometer set to the piston dimension

With the micrometer set to the piston dimension, adjust a cylinder bore gauge to the micrometer dimension and set the indicator to 0.

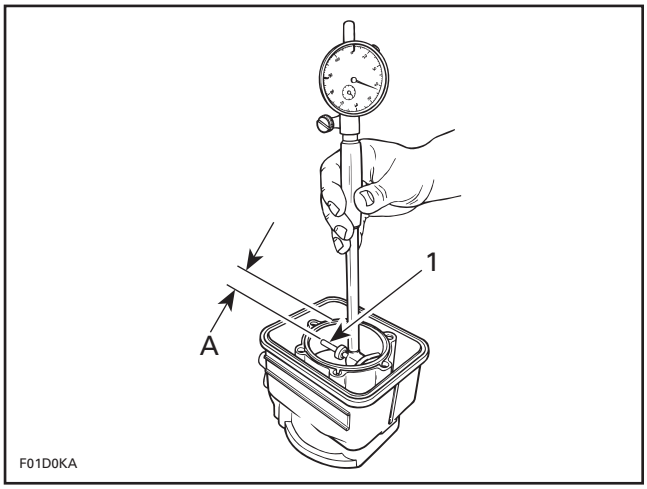


1. Use the micrometer to set the cylinder bore gauge
2. Dial bore gauge



1. Indicator set to 0 (zero)

Position the dial bore gauge at 16 mm (5/8 in) below cylinder top edge.



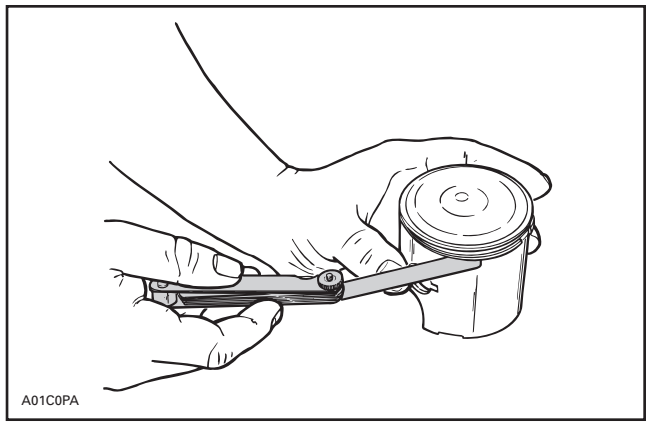
1. Measuring perpendicularly (90°) to piston pin axis
A. 16 mm (5/8 in)

Read the measurement on the cylinder bore gauge. The result is the exact piston/cylinder wall clearance. If clearance exceeds specified tolerance, replace cylinder or rebore. Refer to TECHNICAL DATA 10.

NOTE: Make sure the cylinder bore gauge indicator is set exactly at the same position as with the micrometer, otherwise the reading will be false.

RING/PISTON GROOVE CLEARANCE

Using a feeler gauge check clearance between rectangular ring and groove. Replace piston if clearance exceeds specified tolerance. Refer to TECHNICAL DATA 10.

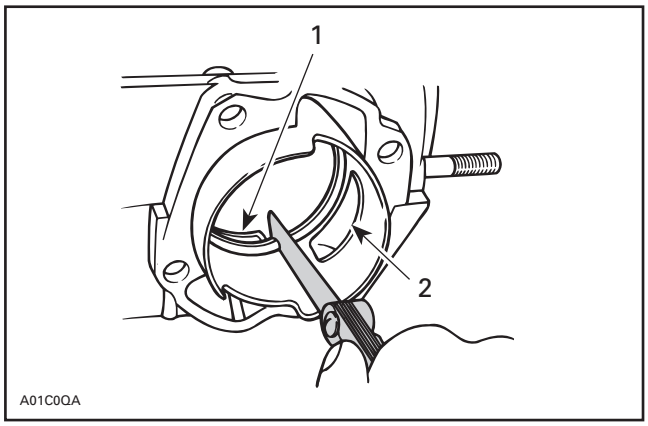


RING END GAP

Position ring half-way between transfer ports and intake port. On rotary valve engines, position ring just below transfer ports.

NOTE: In order to correctly position the ring in the cylinder, use piston as a pusher.

Using a feeler gauge, check ring end gap. Replace ring if gap exceeds specified tolerance. Refer to TECHNICAL DATA 10.



1. Transfer port
2. Intake port

CRANKSHAFT DEFLECTION

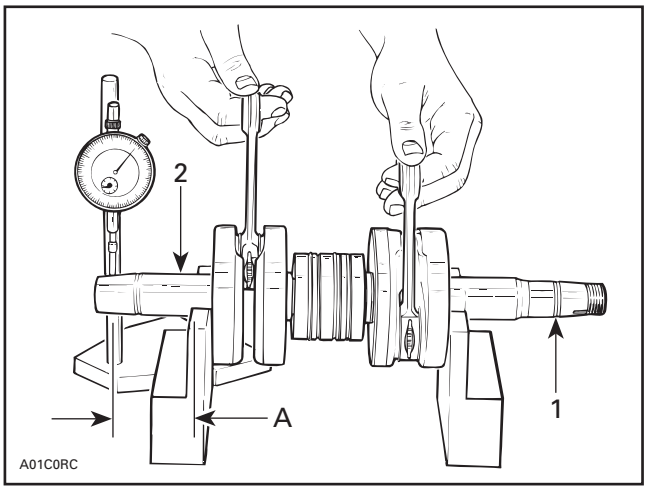
Crankshaft deflection is measured with a dial indicator.

Measuring (in engine)

First, check deflection with crankshaft in engine. If deflection exceeds the specified tolerance, recheck deflection using V-shaped blocks to determine the defective part(s). See below.

Measuring (on bench)

Once engine is disassembled, check crankshaft deflection on V-shaped blocks. If deflection exceeds the specified tolerance, it can be worn bearings or a bent crankshaft. Remove crankshaft bearings and check deflection again on V-shaped blocks to determine the defective part(s). See measurement A in following illustration.



TYPICAL

1. Measure at mid point between the key and the first thread
2. Mid point of crankshaft bearing
A. See table below

Crankshaft Deflection on PTO Side

ENGINE TYPE	DISTANCE A mm (in)	MAXIMUM ON PTO SIDE mm (in)
699	105.9 (4.169)	0.06 (.0024)
809	94.4 (3.717)	

Crankshaft Deflection on MAG Side

ENGINE TYPE	MAXIMUM ON MAG SIDE mm (in)
All	0.05 (.002)

Crankshaft Deflection in Center of Crankshaft

ENGINE TYPE	MAXIMUM IN CENTER OF CRANKSHAFT
All	0.08 mm (.0031 in)

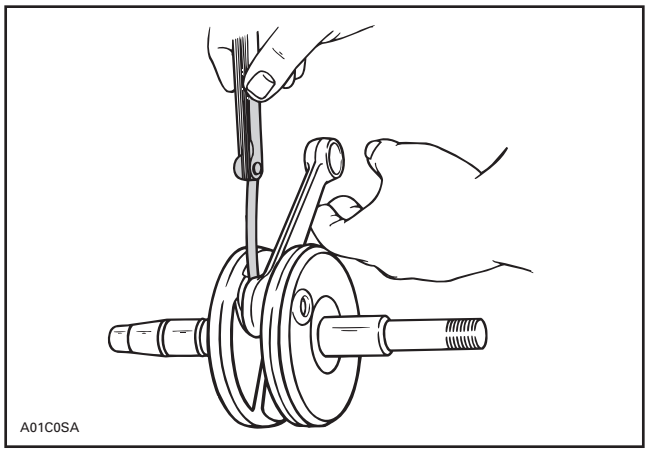
NOTE: Crankshaft deflection cannot be correctly measured between centers of a lathe.

If the deflection exceeds the specified tolerance, crankshaft should be repaired or replaced.

CONNECTING ROD BIG END AXIAL PLAY

ENGINE TYPE	NEW PARTS MIN. - MAX.	WEAR LIMIT
699	0.39 - 0.74 mm (.015 - .029 in)	1.20 mm (.047 in)
809	0.31 - 0.68 (.012 - .027 in)	1.20 mm (.047 in)

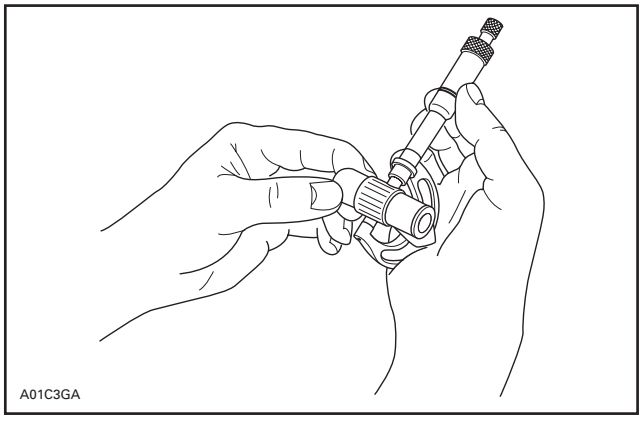
Using a feeler gauge, measure distance between thrust washer and crankshaft counterweight. If the distance exceeds specified tolerance, repair or replace the crankshaft.

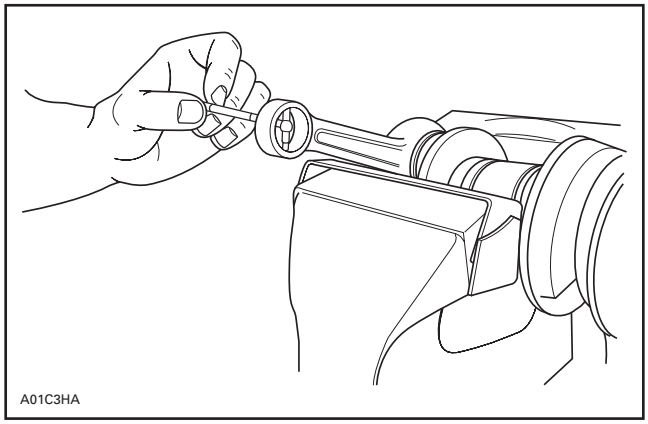


TYPICAL

CONNECTING ROD/PISTON PIN CLEARANCE

Measure piston pin with its needle bearing. Compare to inside diameter of connecting rod.





ENGINE TYPE	NEW PARTS MIN. - MAX.	WEAR LIMIT
All	0.003 - 0.012 mm (.0001 - .0005 in)	0.015 mm (.0006 in)

CONNECTING ROD/CRANKPIN CLEARANCE

ENGINE TYPE	NEW PARTS MIN. - MAX.	WEAR LIMIT
All	0.024 - 0.038 mm (.0004 - .0015 in)	0.06 mm (.0024 in)

CRANKSHAFT END-PLAY

All Engine Types

End-play is not adjustable but it should be between 0.10 - 0.30 mm (.004 - .012 in).

CHECKING SURFACE FLATNESS

Intake manifold, intake manifold cover can be checked for perfectly mating surfaces.

Lay part on a surface plate (marble, mirror or thick glass plate).

Holding down one end of part, try pushing down the other end.

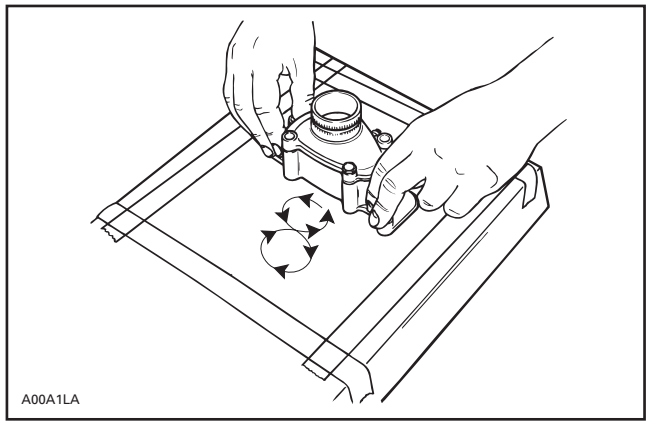
If any play is felt, part must be rectified.

RECTIFYING SURFACES

Stick a fine sand paper sheet on the surface plate then lightly oil the sand paper.

Rub part mating surface on sand paper using 8-figure movements.

Sand until mating surface is perfectly straight.



CHECKING CRANKSHAFT ALIGNMENT

Install a degree wheel (P/N 414 352 900) on crankshaft end.

Remove both spark plugs.

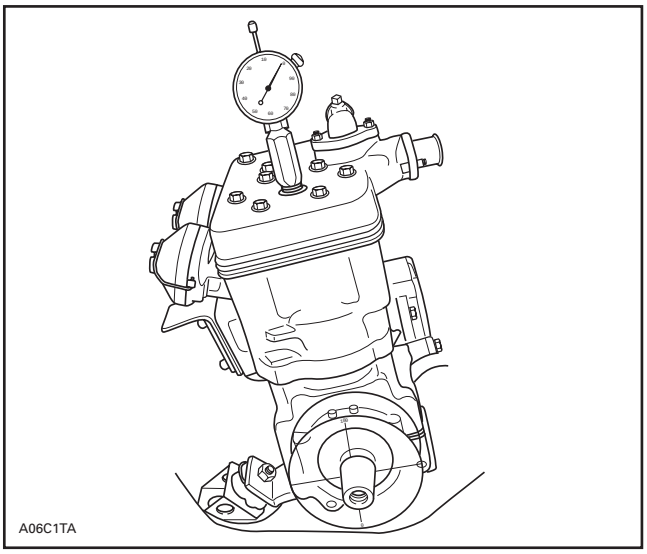
Install a TDC gauge (P/N 414 104 700) in spark plug hole on MAG side.

Bring MAG piston at top dead center.

Rotate degree wheel (not crankshaft) so that 360° mark aligns with center of crankcase. Scribe a mark on crankcase.

Remove TDC gauge and install it on center cylinder.

Bring center piston to top dead center. Degree wheel must rotate with crankshaft.



TYPICAL

Interval between cylinders must be 120° ± 0.5.

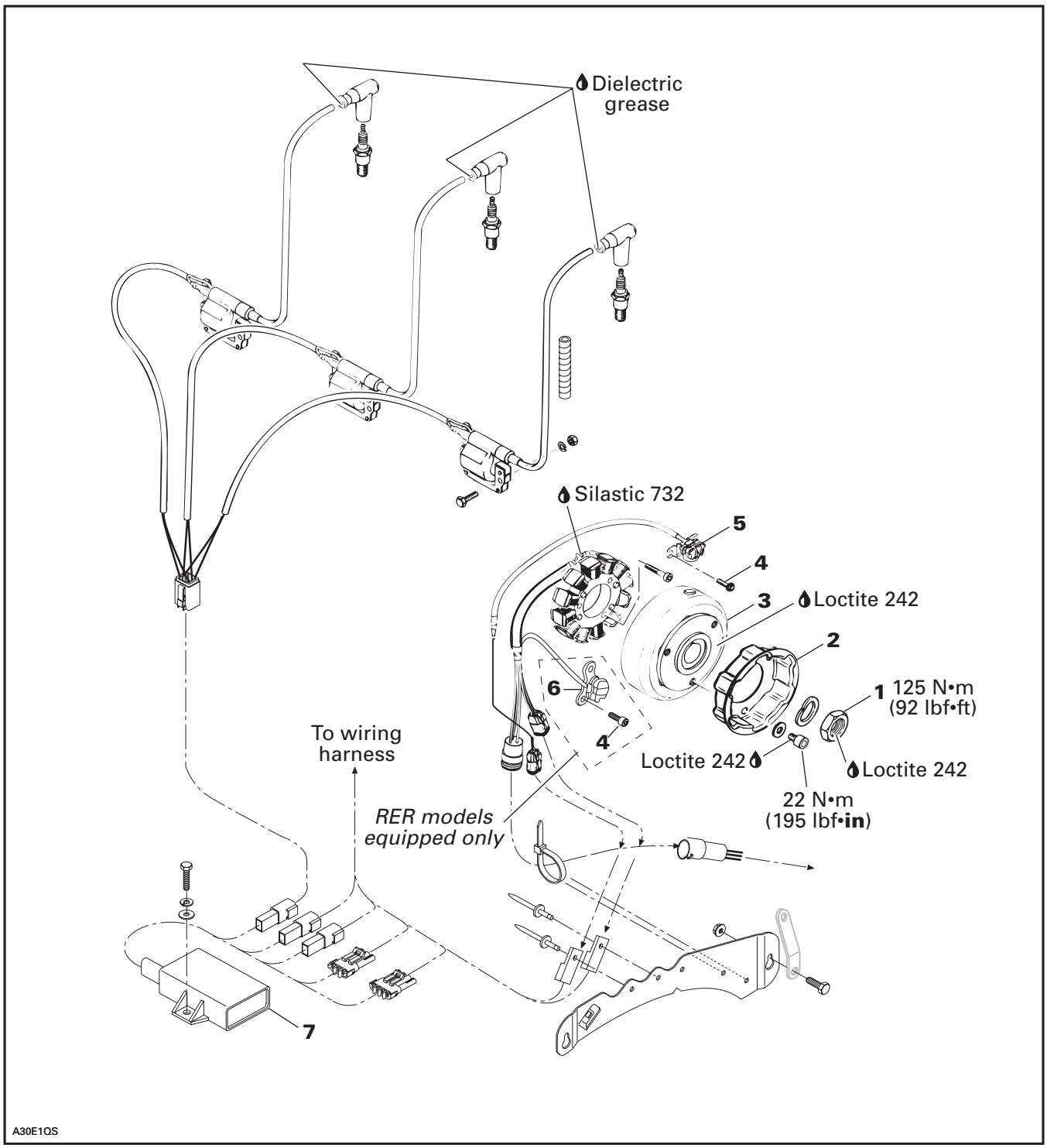
Proceed the same with MAG side piston.

Any other reading indicates a misaligned (twisted) crankshaft.

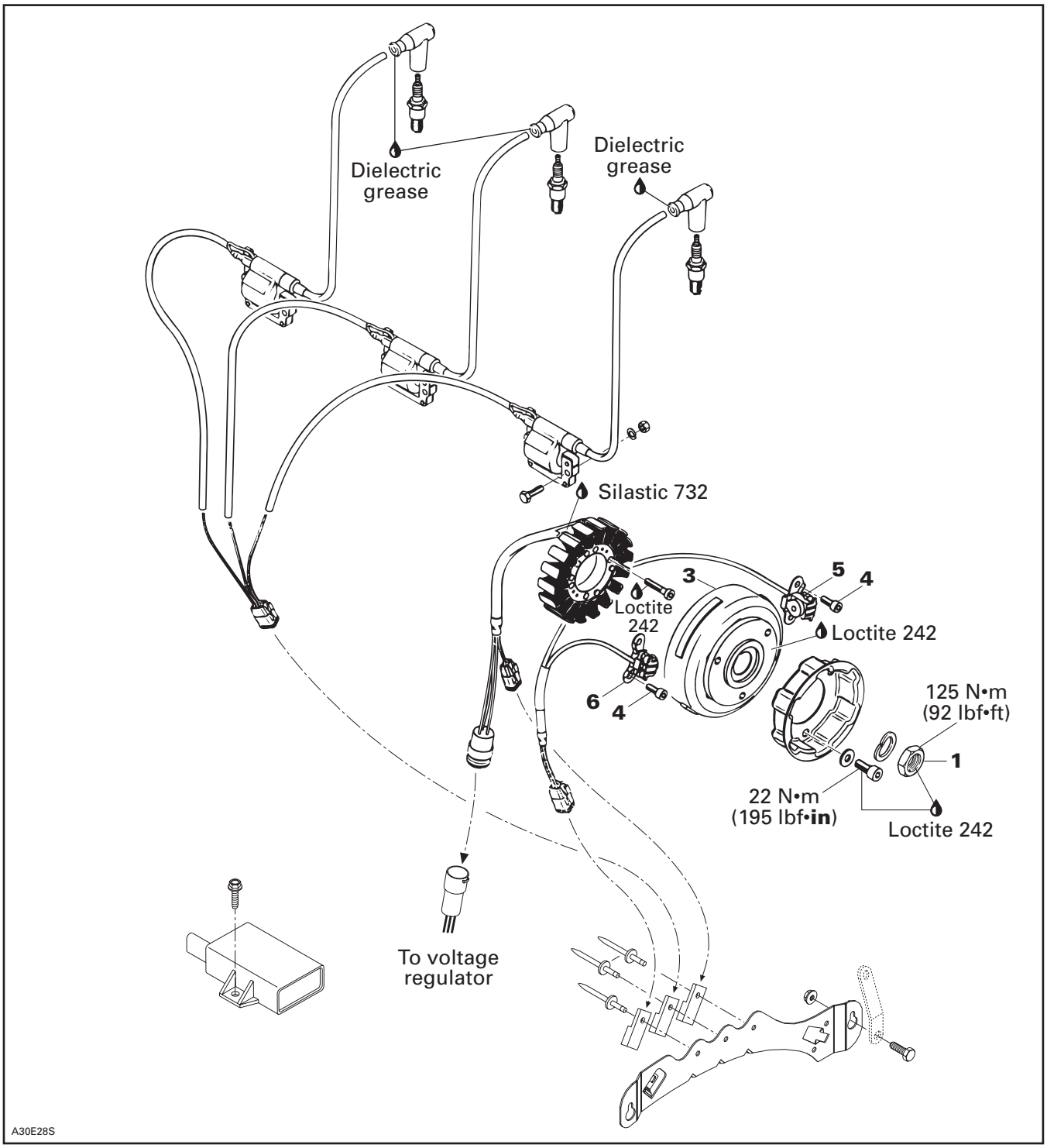
CDI SYSTEM

NIPPONDENSO TRIGGER COIL IGNITION SYSTEM

290 W on Formula III 700 R/800 and Mach 1 R/Z/Z R



360 W on Grand Touring 700/SE



NOTE: The following procedures can be done without removing the engine from chassis. To facilitate magneto removal, hold drive pulley with tool (P/N 529 027 600).

CDI means Capacitor Discharge System.

CLEANING

Clean all metal components in a non-ferrous metal cleaner.

CAUTION: Clean stator and magneto using only a clean cloth.

DISASSEMBLY

3, Magneto Flywheel

To gain access to magneto assembly, remove the following parts as needed on different engines:

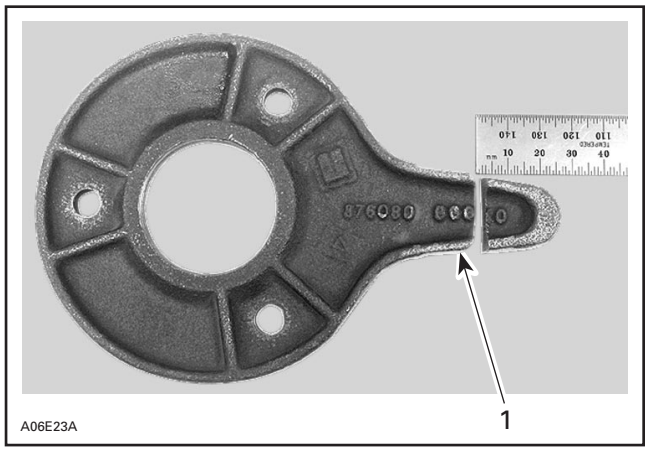
– tuned pipe(s) and muffler

– rewind starter

– starting pulley **no. 2**

To remove magneto flywheel retaining nut **no. 1**:

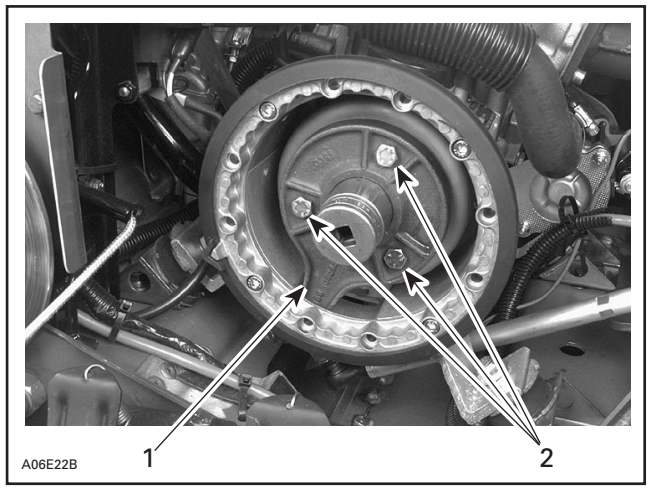
Use magneto puller ring (P/N 420 876 080). Former puller has to be modified as shown.



1. Cut by 25 mm (1 in)

Install puller with its tab in magneto housing opening.

CAUTION: Use only M8 x 20 mm screws to bolt puller to magneto.



TYPICAL

1. Tab in magneto housing opening
2. M8 x 20 mm screws

– Remove magneto flywheel nut, using a 30 mm socket machined to 40 mm (1.580 in) outside diameter by 16 mm (5/8 in) long.

NOTE: To correctly remove a threadlocked fastener it is first necessary to tap on the fastener to break threadlocker bond. This will eliminate the possibility of thread breakage.

To remove magneto flywheel, install the puller (P/N 529 022 500).

– Tighten puller bolt and at the same time, tap on bolt head using a hammer to release magneto flywheel from its taper.

5,6, Trigger Coil

NOTE: As spare parts only trigger coil with GN/BL and GY/BL wires is available. This trigger coil can replace any of both trigger coils installed on RER models.

Magneto and stator plate must be removed before trigger coil removal.

To replace trigger coil:

– Disconnect trigger coil connector housing.

– Remove grommet from crankcase where trigger coil wire exits magneto housing.

– Remove retaining screws **no. 4**.

– Remove trigger coil and carefully pull wires.

– Install new trigger coil and other parts removed.

ASSEMBLY

3, Magneto Flywheel

Clean crankshaft extension (taper) and apply Loctite 242 (blue) on taper, then position Woodruff key, flywheel and lock washer on crankshaft.

Clean nut threads and apply Loctite 242 (blue) then tighten nut 125 N•m (92 lbf•ft).

At reassembly coat all electric connections except Deutsch housings (waterproof gray housing) with silicone dielectric grease (P/N 413 701 700) to prevent corrosion or moisture penetration.

CAUTION: Do not use silicone sealant, this product will corrode contacts. Do not apply silicone dielectric grease on any Deutsch (gray) housing otherwise housing seal will be damaged.

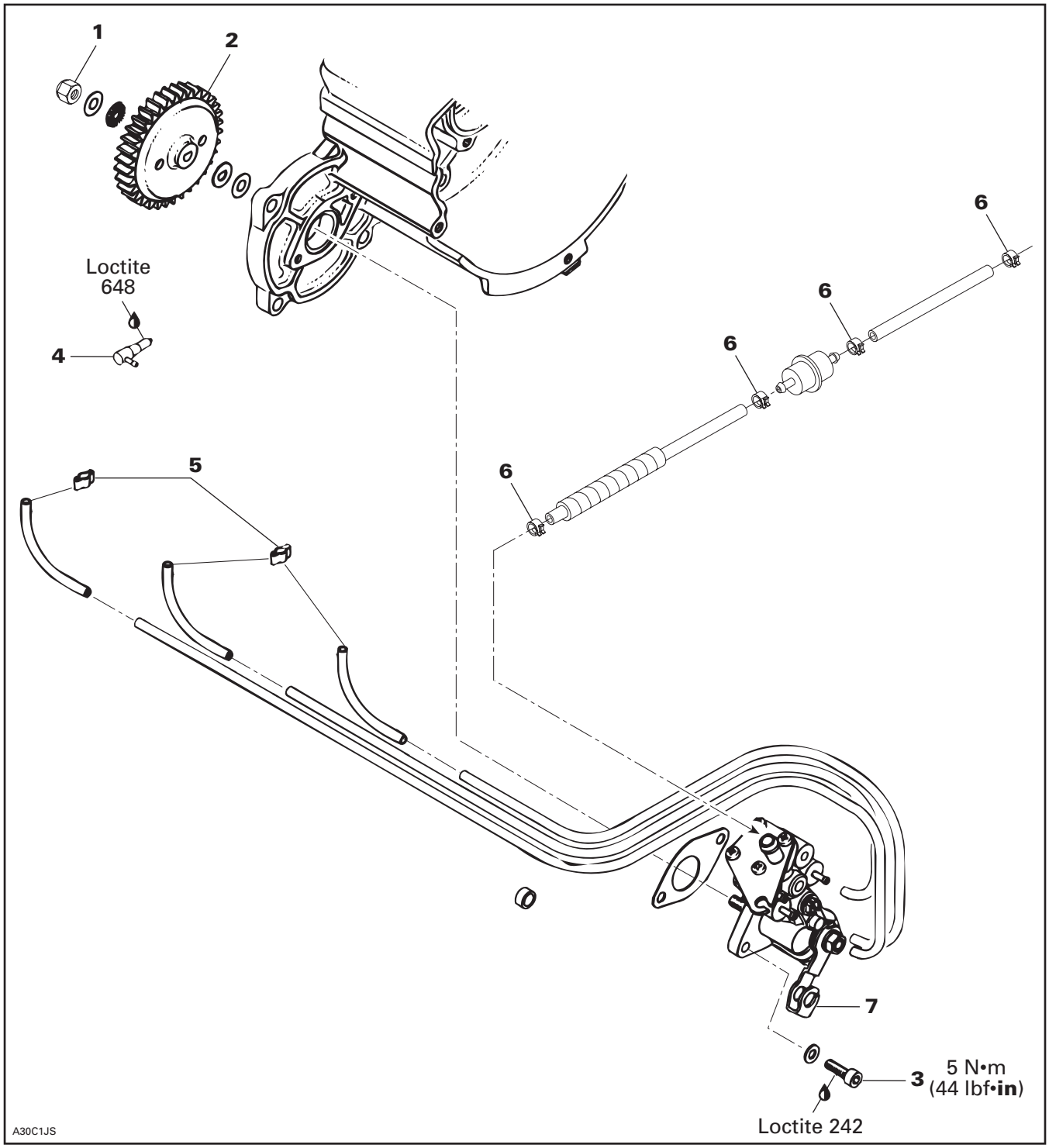
Ignition Timing

Check as described in IGNITION TIMING 06-02.

OIL INJECTION SYSTEM

OIL INJECTION PUMP

699 and 809 Engines



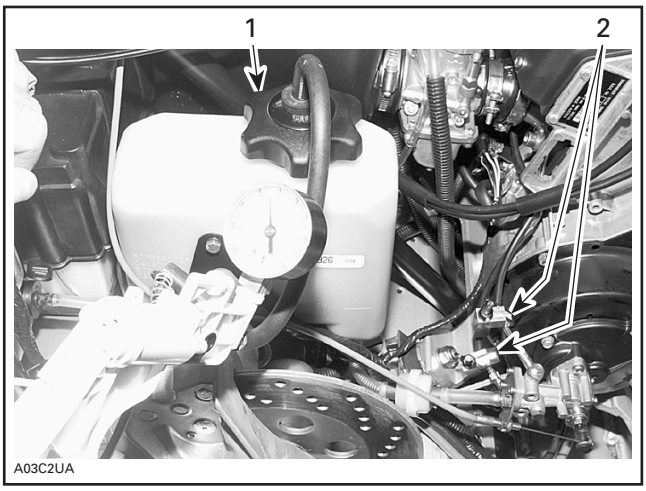
OIL SYSTEM LEAK TEST

All Models

The following test will indicate any leak from oil reservoir to the banjo fitting(s).

Install on oil reservoir special cap of leak testing kit (P/N 529 033 100).

Install hose pinchers (P/N 295 000 076) on outlet hoses.



TYPICAL

1. *Special cap on reservoir*
2. *Hose pinchers on outlet hoses*

Connect pump of leak testing kit to special cap.

Pressurize oil system to 34 kPa (5 PSI). That pressure must not drop during 3 minutes.

If pressure drops, locate leak(s) and repair/replace leaking component(s). To ease locating leak(s) spray soapy water on components, bubbles will indicate leak location(s).

OIL PUMP IDENTIFICATION

7, Pump Lever

Different engines need different pumps. See identification on lever no. 7.

CAUTION: Always mount proper pump on engine.

ENGINE TYPE	OIL PUMP IDENTIFICATION
699 with VM carb.	12
699 with TM carb.	18
809	15

NOTE: The following procedures can be done without removing the engine from chassis.

CLEANING

Clean all metal components in a non-ferrous metal cleaner.

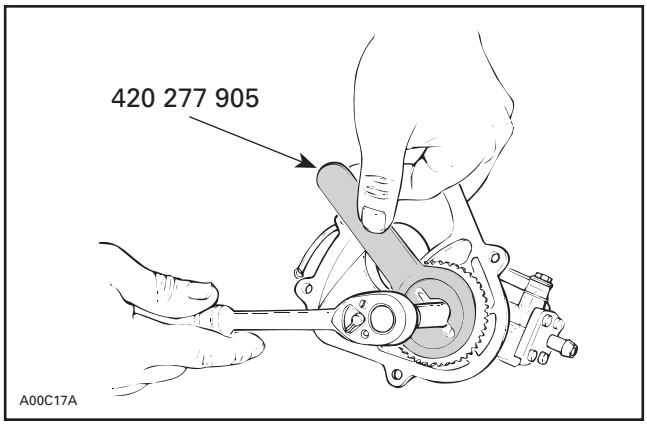
DISASSEMBLY

NOTE: Some oil pump components are not available as single parts.

1,2, Gear Retaining Nut and Oil Pump Gear

To remove gear retaining nut, first extract the needle roller with pliers then lock gear in place using one of the following gear holder.

ENGINE TYPE	TOOL P/N
699/809	420 277 905



TYPICAL

ASSEMBLY

2, Oil Pump Gear

At gear assembly, apply a light coat of low temperature grease (P/N 413 706 100) on gear teeth.

5,6, Spring Clip and Clamp

Always check for spring clips tightness.

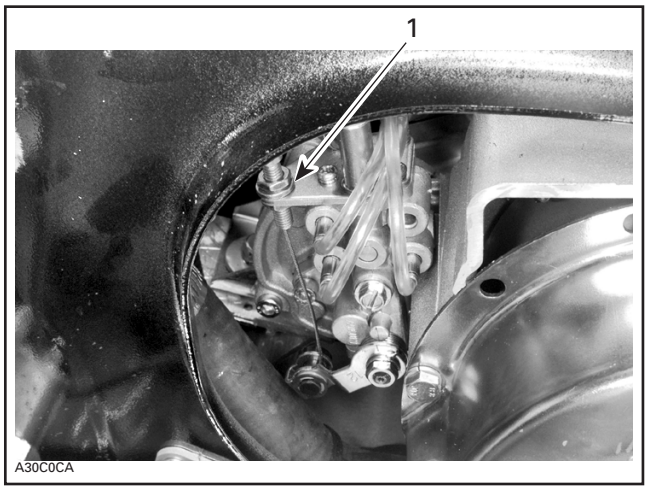
3, Screw

Torque to 5 N•m (44 lbf•**in**).

Make sure cable barrel is well seated in oil pump lever.

Secure barrel with plastic washer and circlip.

Install cable lock washer above support.



1. Lock washer

Verify cable and oil pump lever operation.

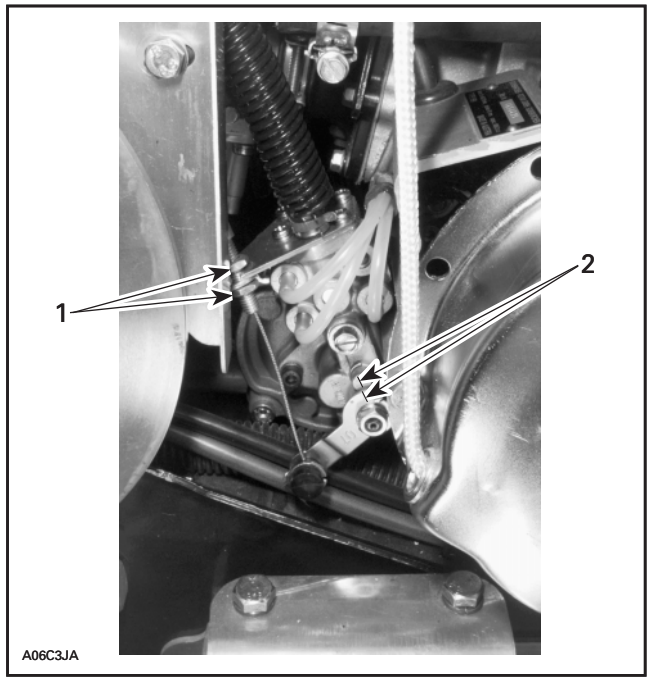
ADJUSTMENT

Prior to adjusting the pump, make sure all carburetor adjustments are completed.

Synchronizing Pump with Carburetor

Eliminate the throttle cable free-play by pressing the throttle lever until a light resistance is felt, then hold in place. The aligning marks on the pump casting and on the lever must align. If not, loosen the adjuster nut and adjust accordingly.

Retighten the adjuster nut.

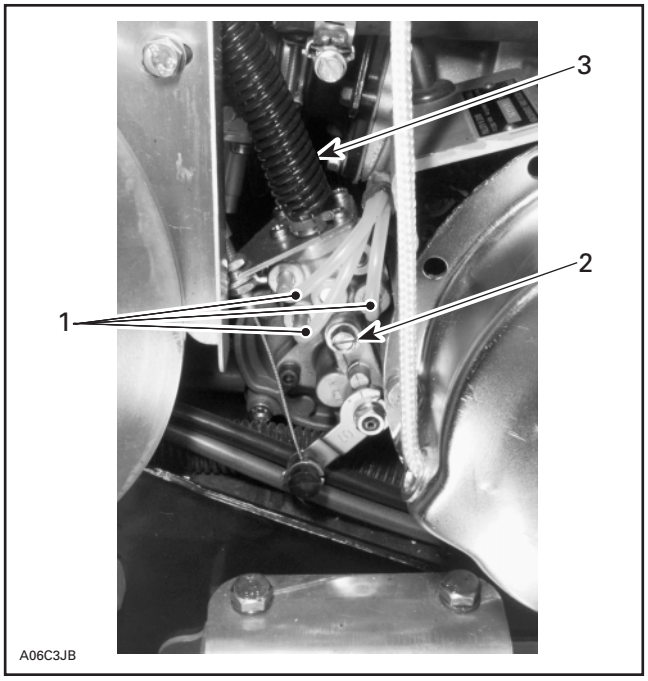


1. Adjuster nut
2. Marks in line

CAUTION: Proper oil injection pump adjustment is very important. Any delay in the opening of the pump can result in serious engine damage.

To Bleed Oil Lines

Bleed main oil line (between tank and pump) by loosening the bleeder screw until air has escaped from the line. Add injection oil as required.

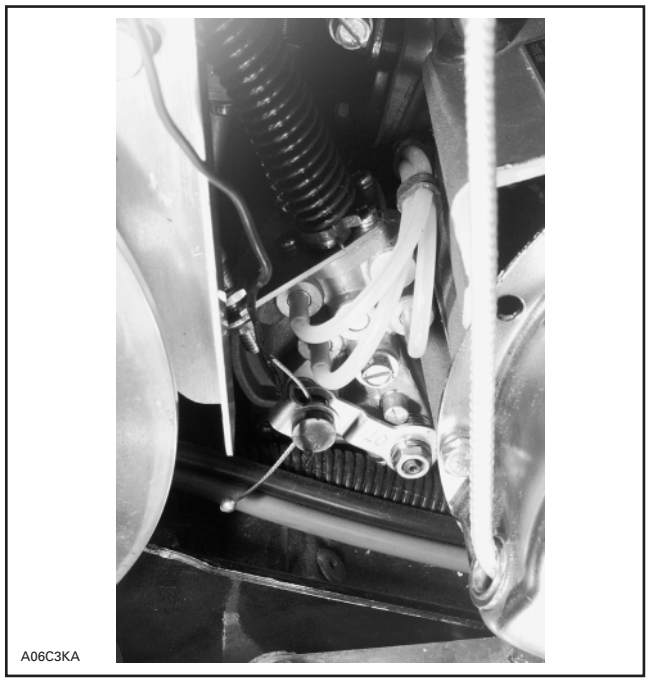


1. Small oil lines
2. Bleeder screw
3. Main oil line

Reinstall all parts.

Bleed the small oil line between pump and intake manifold by running engine at idle while holding the pump lever in fully open position.

NOTE: Make a J hook out of mechanical wire to lift the lever.



TYPICAL — ENGINE AT IDLE

⚠ WARNING

Ensure not to operate carburetor throttle mechanism. Secure the rear of the vehicle on a stand.

CHECKING OPERATION

Oil Pump

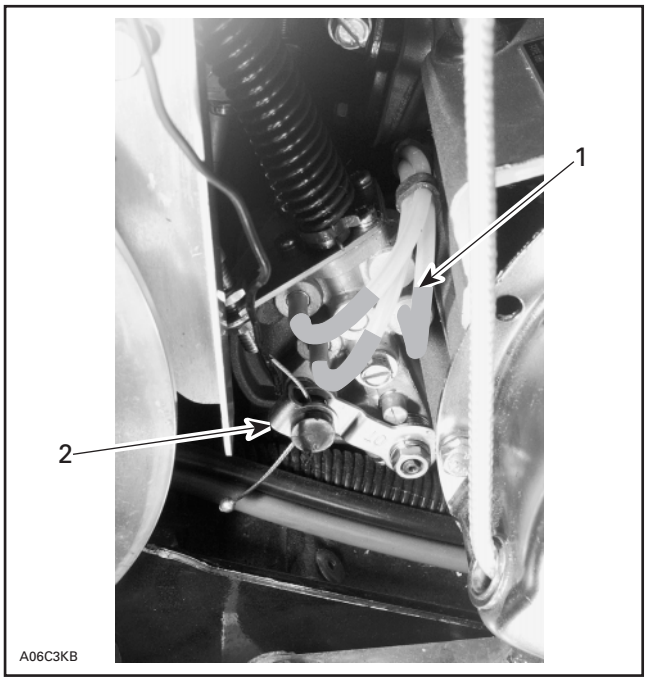
On Vehicle

NOTE: Main oil line must be full of oil. See bleeding procedure above.

Lift rear of vehicle and support with a mechanical stand. Unplug oil lines from pump. Start engine and stop it as soon as it fires.

Check that oil in small oil lines has been sucked up (this will be indicated by a clear section of small oil lines). Repeat the procedure until this condition is attained.

Reconnect small oil lines, start engine and run at idle while holding the pump lever in fully open position. Oil columns must advance into small oil lines.



TYPICAL — ENGINE AT IDLE

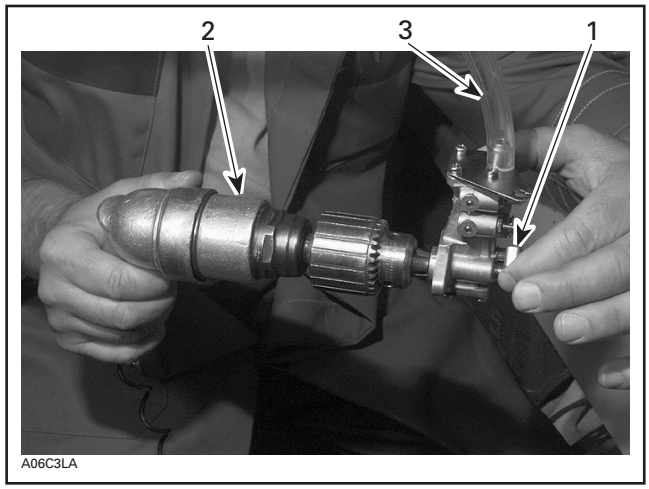
1. *Oil columns advancing*
2. *Fully open position*

If not, remove pump assembly and check the pump gear and drive shaft (if applicable) for defects, replace as necessary. Test pump as describes below.

NOTE: Through normal use, oil level must not drop in small tubes. If oil drops, verify check valve operation in injection nozzle. Replace as necessary.

Test Bench

Connect a hose filled with injection oil to main line fitting. Insert other hose end in an injection oil container. Using a clockwise rotating drill rotate pump shaft. Oil must drip from outer fittings while holding lever in a fully open position. If not replace pump.



TYPICAL

1. *Fully open position*
2. *Clockwise rotating drill*
3. *Main line*

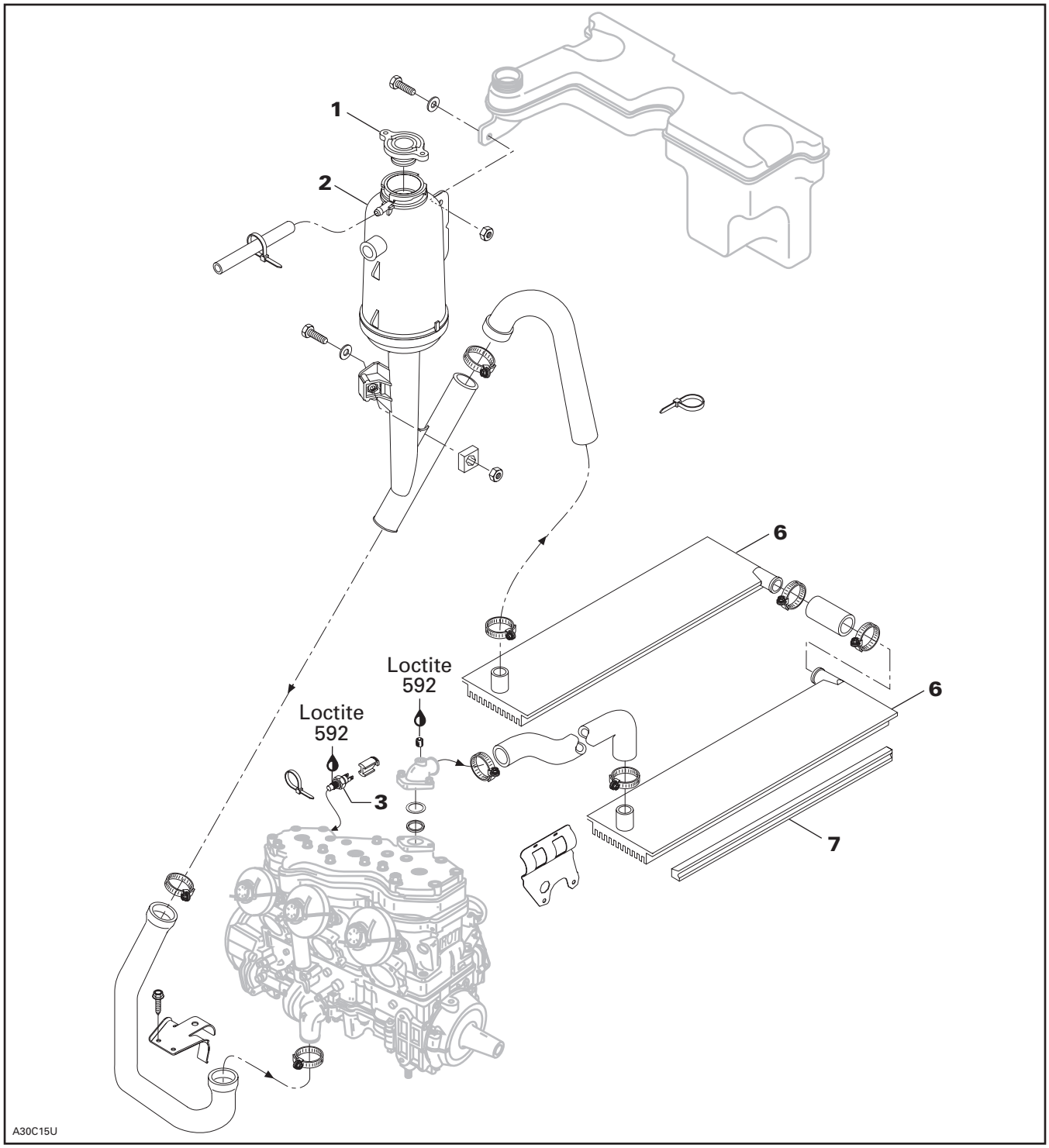
4, Check Valve

To verify this check valve, proceed the same as for checking pump operation on vehicle. First unplug oil line from check valve. After restarting the engine, check that a clear section in small oil line is present. Reconnect oil line.

Run engine at idle. Oil column must advance. If the check valve is faulty, oil column will go back and forth. Replace if so.

LIQUID COOLING SYSTEM

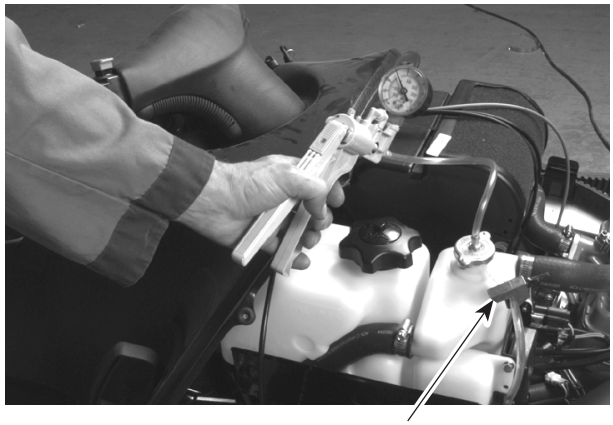
699 and 809 Engines



COOLING SYSTEM LEAK TEST

Install special plug (radiator cap) (P/N 529 021 400) and hose pincher (P/N 529 009 900) on overflow hose. Pressurize coolant reservoir to 100 kPa (15 PSI).

Check all hoses and cylinder/base for coolant leaks. Spray a soap/water solution and look for air bubbles.



TYPICAL

INSPECTION

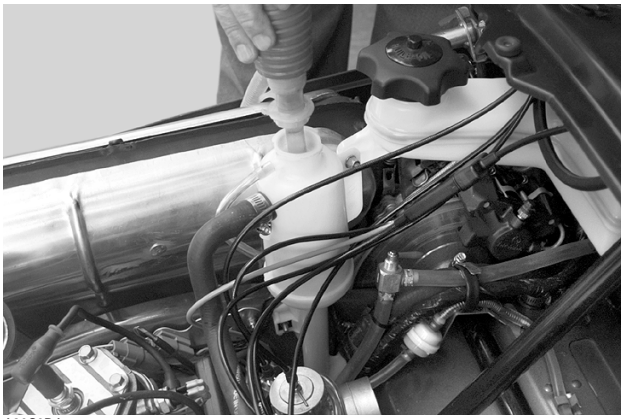
Check general condition of hoses and clamp tightness.

DRAINING THE SYSTEM

⚠ WARNING

Never drain or refill the cooling system when engine is hot.

To drain the cooling system, siphon the coolant mixture from the coolant tank. Use a primer pump with a plastic hose inserted as deep as possible into the lower hose.



TYPICAL

When the coolant level is low enough, lift the rear of vehicle to drain the radiators.

DISASSEMBLY AND ASSEMBLY

3,4, Sender and Plug

Apply Loctite 592 (P/N 413 702 300) thread sealant on sender and plug to avoid leaks.

1, Pressure Cap

Check if the cap pressurizes the system. If not, install a new 90 kPa (13 PSI) cap (do not exceed this pressure).

6,7, Radiator and Radiator Protector

Insert radiator protector into radiator C-rail and crimp C-rail at both ends. Refer to FRAME 09-03 for radiator removal.

COOLING SYSTEM REFILLING PROCEDURE

Recommended Coolant

Use a blend of 60% antifreeze with 40% water. Do not reinstall pressure cap.

CAUTION: To prevent rust formation or freezing condition, always replenish the system with 60% antifreeze and 40% water. Pure antifreeze without water freezes. Always use ethylene glycol antifreeze containing corrosion inhibitors specifically recommended for aluminum engines.

System Capacity

Refer to TECHNICAL DATA 10.

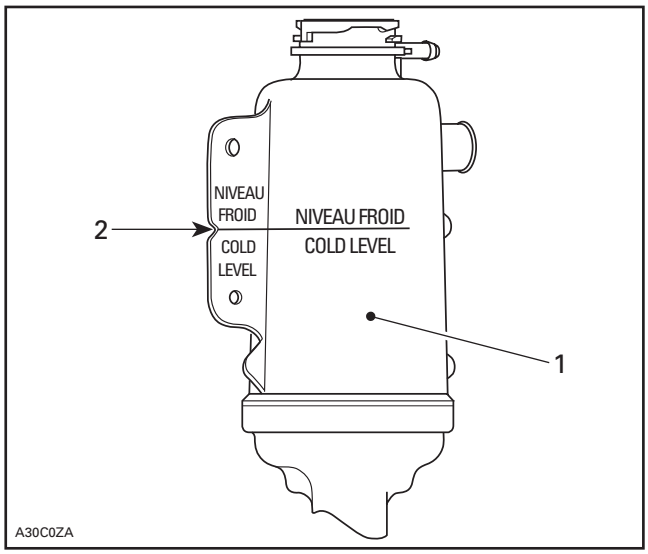
Refilling Procedure

Lift front of vehicle until the tunnel is horizontal. With engine cold, refill coolant tank up to cold level line. Wait a few minutes then refill to line. Install pressure cap. Start engine. Refill up to line while engine is idling until all air bubbles have excaped from system (about 4 to 5 minutes). Install pressure cap.

To make sure coolant flows through radiators, touch them by hand. They must feel warm.

Put back front of vehicle on the ground.

When engine has completely cooled down, recheck coolant level in coolant tank and refill up to line.

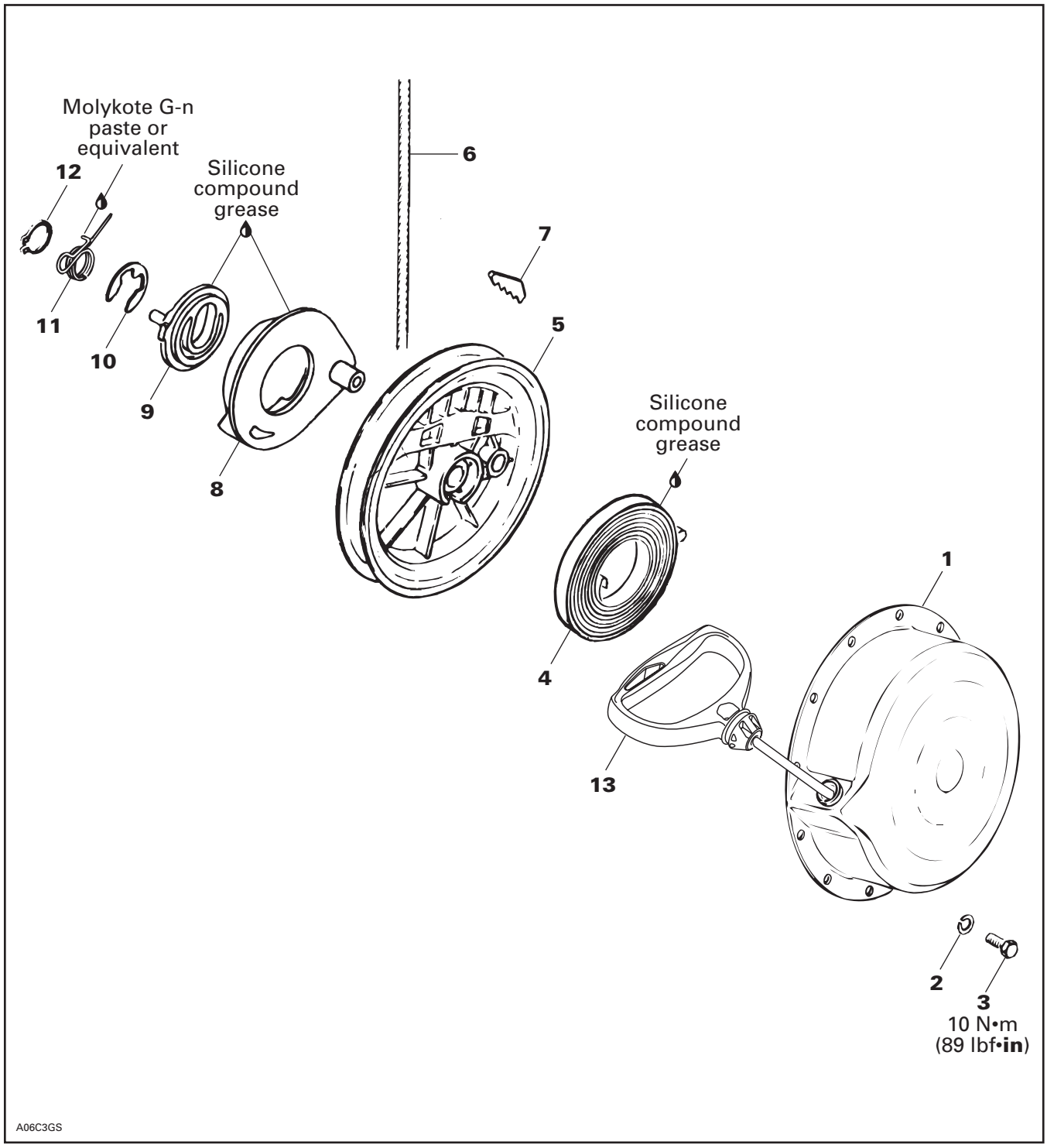


1. Coolant tank
2. COLD LEVEL line

Check coolant concentration (freezing point) with proper tester.

REWIND STARTER

All Models



INSPECTION

NOTE: Due to dust accumulation, rewind starter must be periodically cleaned, inspected and relubricated.

CAUTION: It is of the utmost importance that the rewind starter springs be lubricated periodically using specific lubricants. Otherwise, rewind starter component life will be shortened and/or rewind starter will not operate properly under very cold temperatures.

Check if rope no. 6 is fraying, replace if so.

When pulling starter grip, mechanism must engage within 30 cm (1 ft) of rope pulled. If not, disassemble rewind starter, clean and check for damaged plastic parts. Replace as required, lubricate, reassemble and recheck.

When releasing starter grip, it must return to its stopper and stay against it. If not, check for proper spring preload or damages. Readjust or replace as required.

When pulling starter grip 10 times in a row, it must return freely. If not, check for damaged parts or lack of lubrication. Replace parts or lubricate accordingly.

REMOVAL

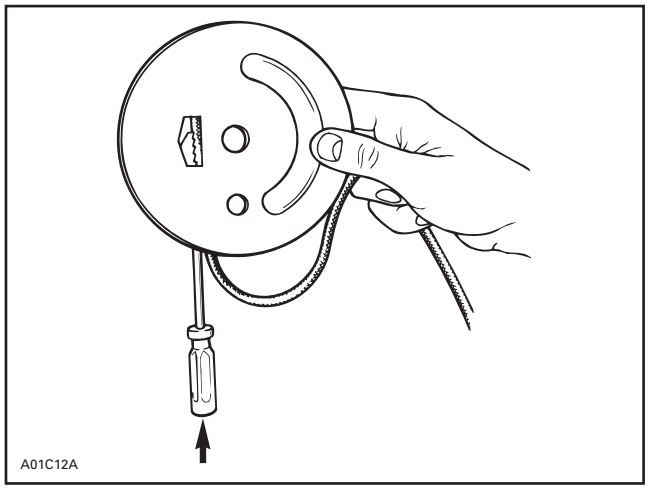
Using a small screwdriver, extract rope knot from starter grip no. 13. Cut rope close to knot. Tie a knot near starter.

Remove screws no. 3 and washers no. 2 securing rewind starter no. 1 to engine then remove rewind starter.

DISASSEMBLY

To remove rope from rewind starter mechanism:

– First remove locking ring no. 12, locking spring no. 11, circlip no. 10, pawl lock no. 9 and pawl no. 8.
– Let sheave get free to release spring preload.
– Remove sheave no. 5 from starter housing no. 1.
– Disengage key no. 7 and pull out rope no. 6.



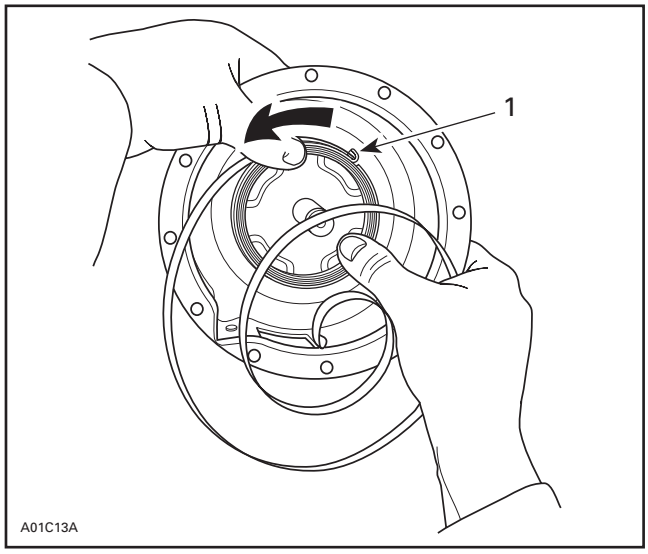
GENTLY TAP ON KEY

ASSEMBLY

At assembly, position spring no. 4 outer end into spring guide notch then wind the spring counterclockwise into guide.

⚠ WARNING

Since the spring is tightly wound inside the guide it may fly out when rewind is handled. Always handle with care.



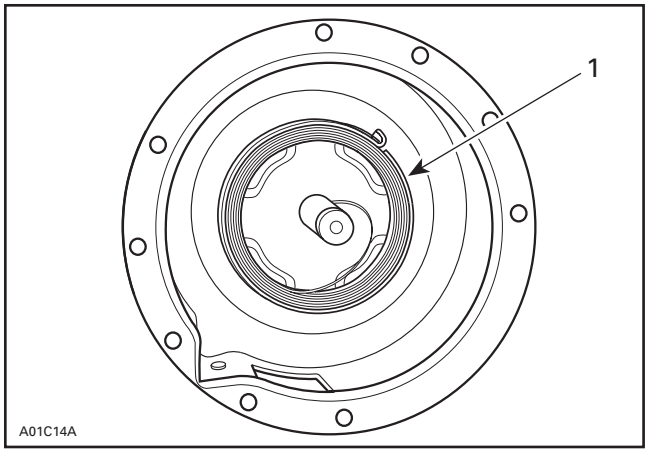
1. Outer end into guide notch

NOTE: Due to dust accumulation, rewind starter must be periodically cleaned, inspected and relubricated.

CAUTION: It is of the utmost importance that the rewind starter spring(s) be lubricated periodically using specific lubricants. Otherwise, rewind starter component life will be shortened and/or rewind starter will not operate properly under very cold temperatures.

Lubricate spring assembly with silicone compound grease (P/N 420 897 061) and position into starter housing as illustrated.

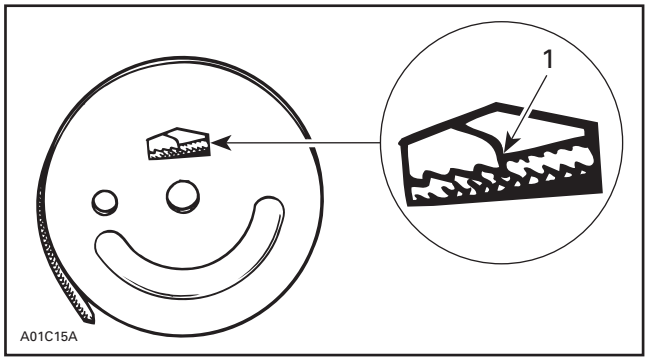
CAUTION: This lubricant must NOT be used on rewind starter locking spring as it does not stay on under vibration.



1. Grease inside spring guide

CAUTION: The use of standard multi-purpose grease could result in rewind starter malfunction.

To install a new rope **no. 6**: insert rope into sheave **no. 5** orifice and lock it with the key **no. 7** as illustrated.



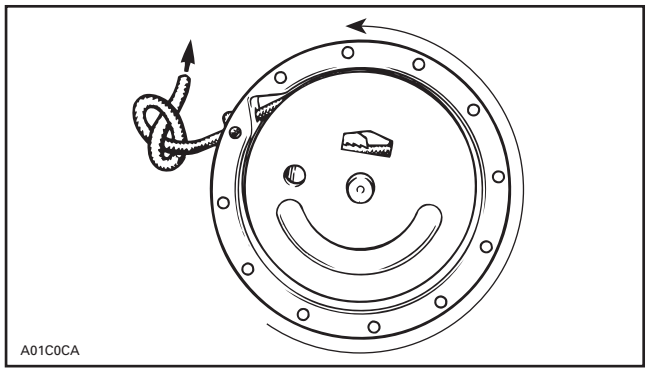
1. Push to lock

To adjust rope tension:

Wind rope on sheave and place rope sheave into starter housing making sure that the sheave hub notch engages in the rewind spring hook.

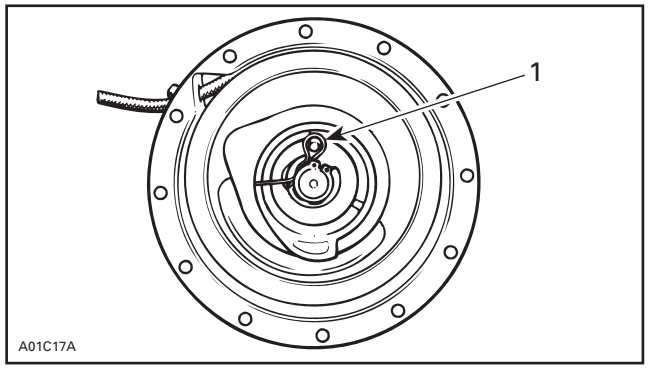
Rotate the sheave counterclockwise until rope end is accessible through starter housing orifice.

Pull the rope out of the starter housing and temporarily make a knot to hold it. One turn preload will give 7 turns of tension when fully extended.



Position pawl **no. 8**, pawl lock **no. 9** and circlip **no. 10**.

Install locking spring **no. 11** and lubricate with MOLYKOTE G-n paste from Dow Corning® or equivalent.



1. Spring coated with MOLYKOTE G-n paste

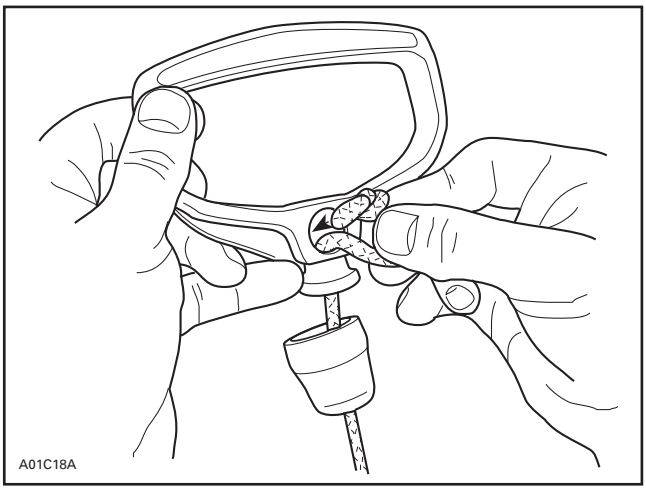
Install locking ring.

CAUTION: This lubricant must NOT be used on rewind springs as it does not stay on when dry.

INSTALLATION

Reinstall rewind starter assembly on engine.

Prior to installing starter grip no. 13 on new rope, it is first necessary to fuse the rope end with a lit match. Pass rope through starter grip and tie a knot in the rope end. Fuse the knot with a lit match then insert rope end down and pull the starter grip over the knot.

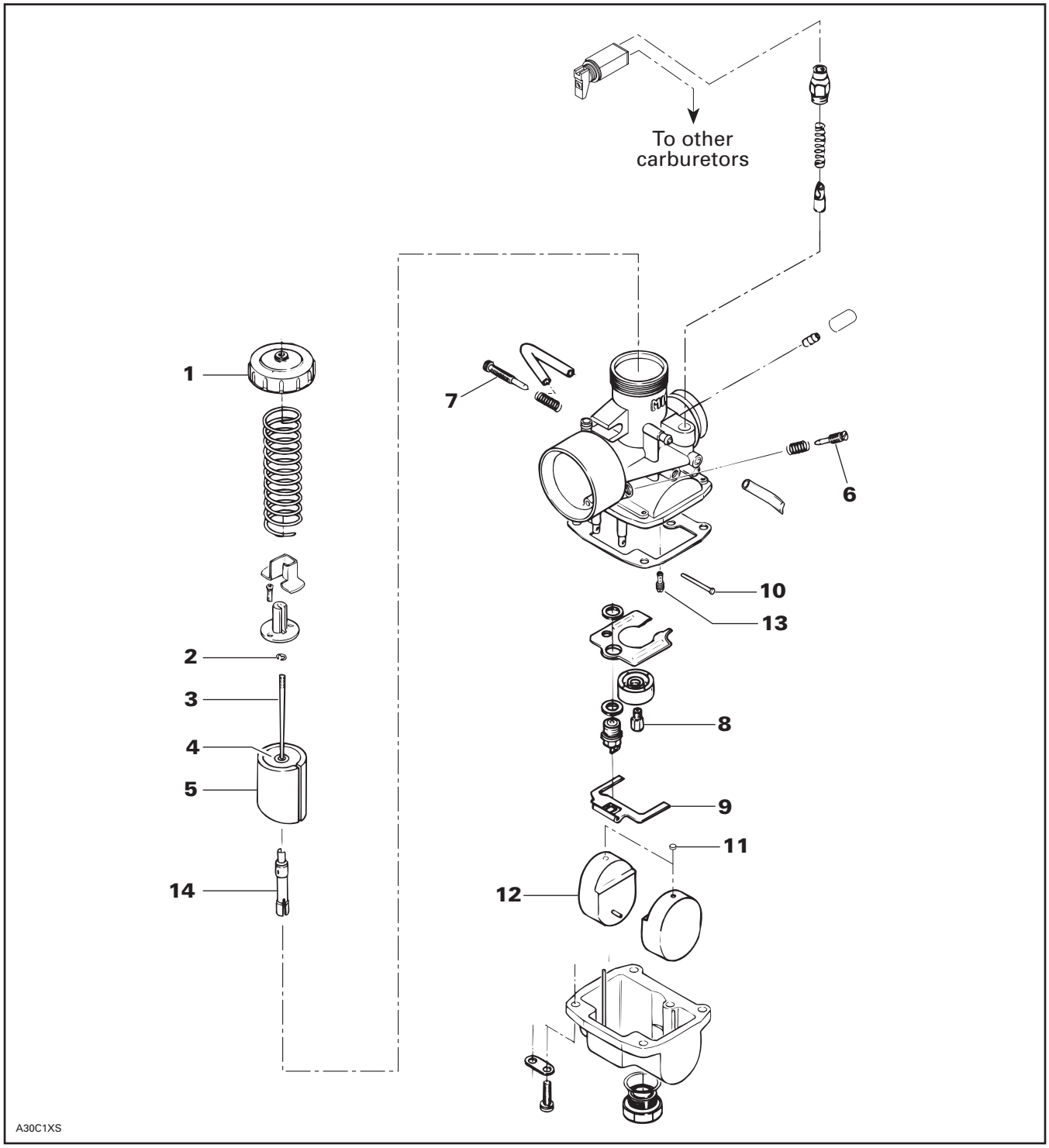


TYPICAL

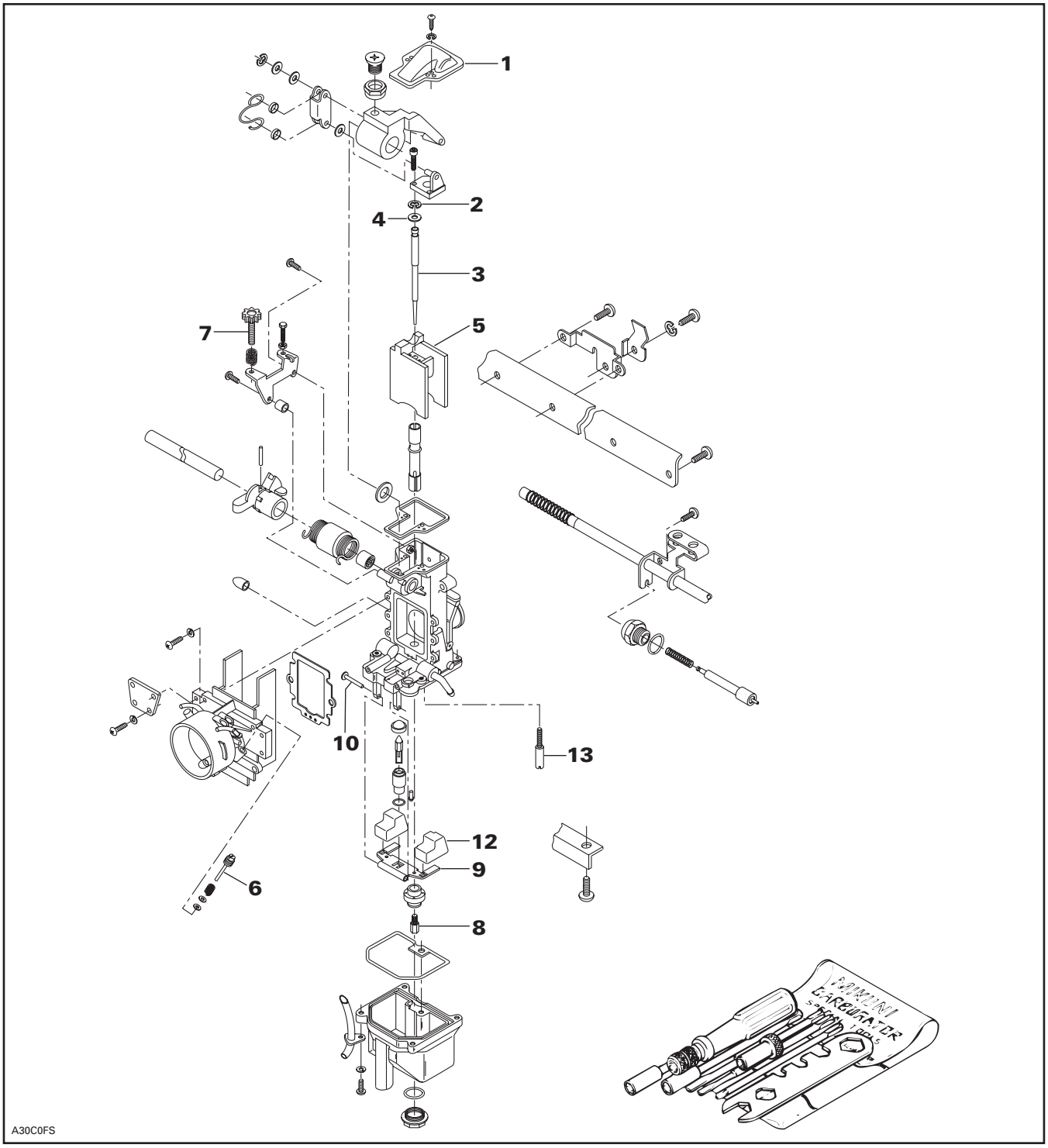
CARBURETOR AND FUEL PUMP

CARBURETOR

VM Type on Formula 700 and GT 700



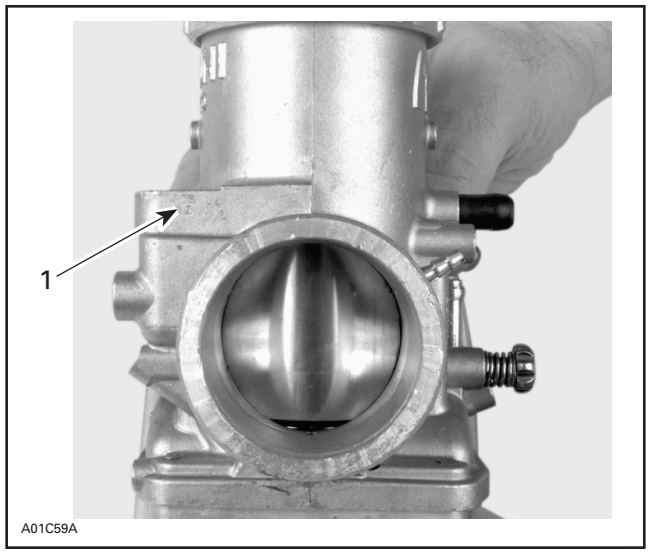
TM Type on GT SE, Formula III 800, Mach 1 and Mach Z Series



PARTS FLAT RATE

IDENTIFICATION

All carburetors are identified on their body.



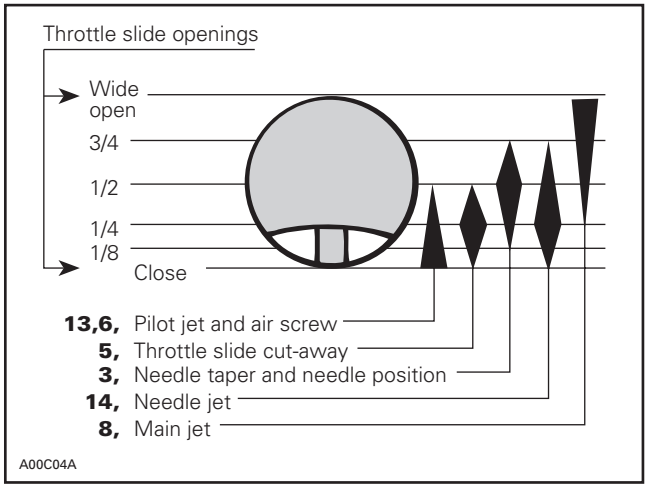
TYPICAL

1. Identification: 34-482

CARBURETOR CIRCUIT OPERATION VERSUS THROTTLE OPENING

The following illustration shows the part of the carburetor which begins and stops to function at different throttle slide openings.

Note that the wider part of symbol corresponds to the opening mostly affected. For instance, throttle slide cut-away begins to function at closed position but it is most effective at 1/4 opening and decreases up to 1/2 opening.



VIEW FROM AIR INTAKE OPENING

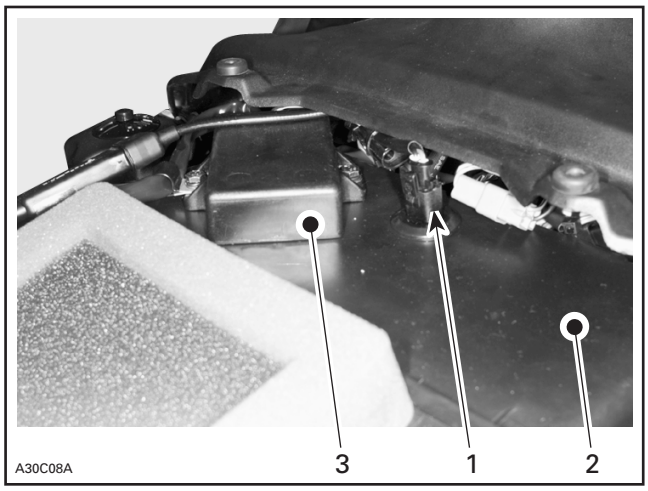
NOTE: For fine tuning refer to TECHNICAL DATA 10 and to SPARK PLUG 06-03.

NOTE: For high altitude regions, the *High Altitude and Sea Level Technical Data Booklet* (P/N 484 200 019 and 484 054 500 for binder) gives information about calibration according to altitude and temperature.

REMOVAL

Grand Touring 700/SE Only

Unplug air temperature sensor connector from air intake silencer and remove MPEM, as shown in the next photo.



TYPICAL

1. Air temperature sensor
2. Air intake silencer
3. MPEM

Twist DPM manifold and detach from air intake silencer.

All Models

Unhook latches then, remove air intake silencer from left hand side.

Disconnect fuel inlet lines.

Grand Touring 700/SE Only

Unplug DPM solenoid connectors. Disconnect air pump inlet at DPM manifold.

VM Type Carburetor

Unscrew carburetor cover no. 1 then pull out throttle slide no. 5 from carburetor.

⚠ WARNING

Exercise care when handling throttle slide. Scratches incurred may cause throttle slide to stick open in operation.

Disconnect throttle cable from throttle slide.

TM Type Carburetor

Disconnect throttle cable from throttle shaft.

Disconnect choke cable.

All Models

Remove carburetors from engine.

VM Type Carburetor

Unscrew choke plunger from each carburetor.

CLEANING AND INSPECTION

All Models

The entire carburetor should be cleaned with a general solvent and dried with compressed air before disassembly.

CAUTION: Heavy duty carburetor cleaner may be harmful to the float material and to the rubber parts, O-rings, etc. Therefore, it is recommended to remove those parts prior to cleaning.

Carburetor body and jets should be cleaned in a carburetor cleaner following manufacturer's instructions.

⚠ WARNING

Solvent with a low flash point such as gasoline, naphtha, benzol, etc., should not be used as they are flammable and explosive.

Check inlet needle tip condition. If worn, the inlet needle and seat must be replaced as a matched set.

NOTE: Install needle valve for snowmobile carburetor only. It is designed to operate with a fuel pump system.

Check throttle slide for wear. Replace as necessary.

Check idle speed screw straightness. Replace as necessary.

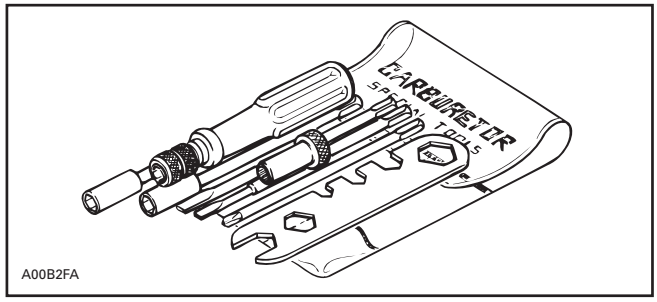
Check for fuel soaked into float no. 12; replace as necessary.

Check float for cracks or other damages affecting free movement; replace as necessary.

Inspect throttle cable and housing for any damages. Replace as necessary.

DISASSEMBLY AND ASSEMBLY

NOTE: To ease the carburetor disassembly and assembly procedures it is recommended to use carburetor tool kit (P/N 404 112 000).



A00B2FA

2,3, E-Clip and Needle

VM Type Carburetor

Remove screws from needle retaining plate to withdraw the needle.

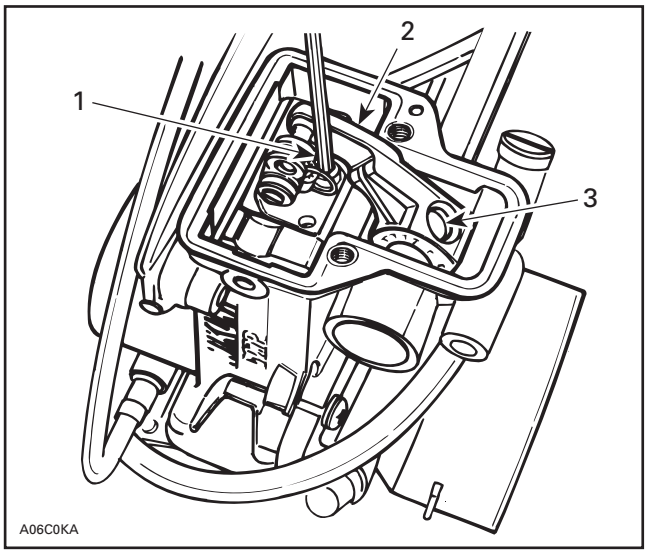
TM Type Carburetor

To remove needle or to change its position or to remove throttle slide, remove carburetor cover.

Except for MAG side carburetor, unscrew locking screw and adjusting nut form throttle shaft.

Move arm aside just enough for unscrewing Allen screw retaining throttle slide.

For MAG side carburetor, raise throttle slide half way then unscrew Allen screws.



1. Allen screw
2. Arm moved aside
3. Locking screw and adjusting nut removed

All Models

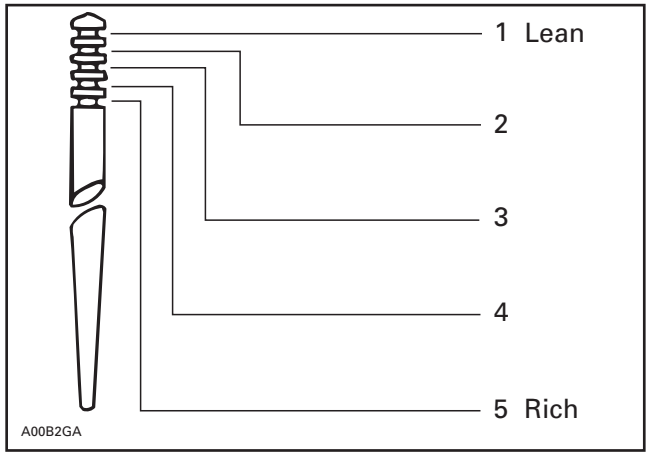
The position of the needle in the throttle slide is adjustable by means of an E-clip inserted into 1 of 5 grooves located on the upper part of the needle. Position 1 (at top) is the leanest, 5 (at bottom) the richest.

NOTE: The last digit of the needle identification number gives the recommended calibrated position of the E-clip **from the top** of the needle.

Example: 6DH4-3

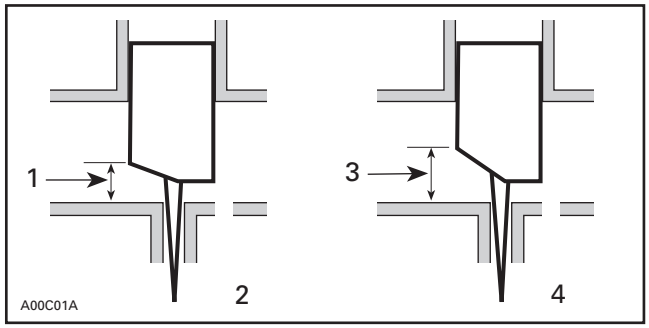
Needle identification

Recommended calibrated position. of the E-clip **from top**



CLIP POSITIONS

The size of the throttle slide cut-away affects the fuel mixture between 1/8 to 1/2 throttle opening.



1. Low cut-away
2. Rich mixture
3. High cut-away
4. Lean mixture

8, Main Jet

The main jet installed in the carburetor has been selected for a temperature of - 20°C (0°F) at sea level. Different jetting can be installed to suit temperature and/or altitude changes. Refer to *High Altitude and Sea Level Technical Data Booklet* (P/N 484 200 019).

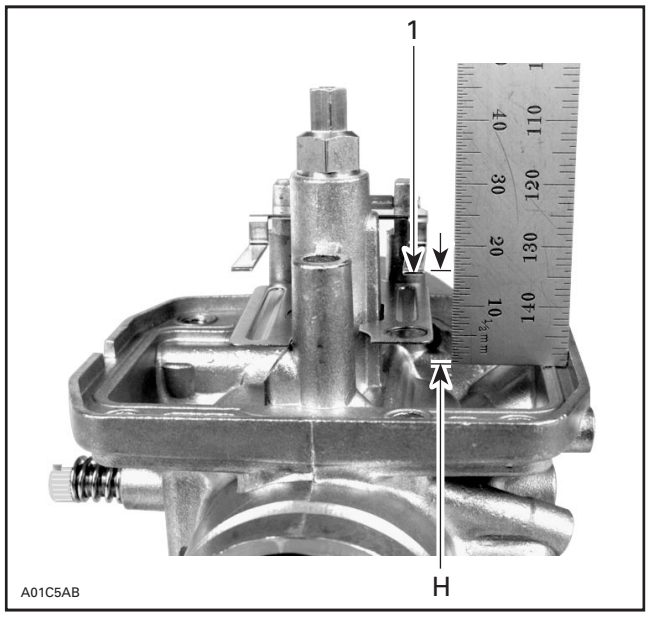
CARBURETOR FLOAT LEVEL ADJUSTMENT

CAUTION: Spark plugs will foul if float is adjusted too low. Engine may be damaged if float is adjusted too high.

9,10, Float Arm and Float Arm Pin

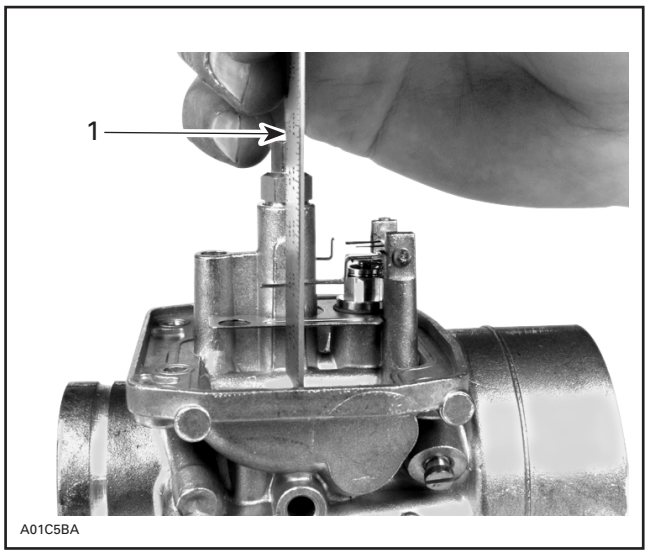
Correct fuel level in float chamber is vital toward maximum engine efficiency. To check for correct float level proceed as follows:

– Make sure that float arm is symmetrical — not distorted.
– Remove float bowl and gasket from carburetor.
– With carburetor chamber upside-down on a level surface, measure height H between bowl seat and **top** edge of float arm. Keep ruler perfectly vertical and in line with main jet hole.



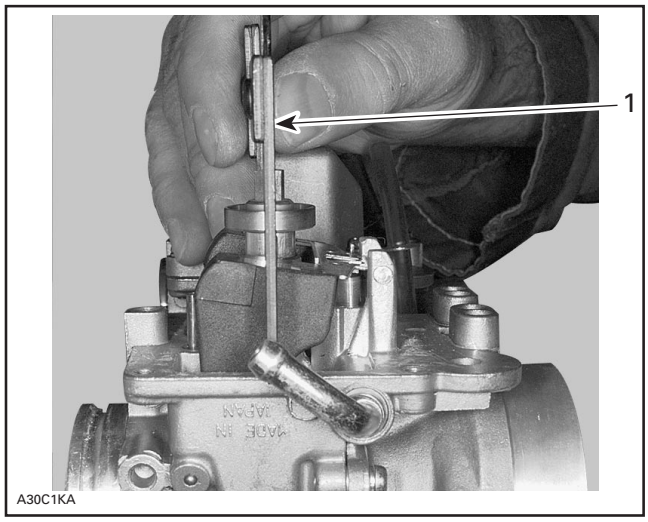
TYPICAL — VM TYPE

1. Measure from top of float arm
H: Float height (including float arm thickness)



TYPICAL — VM TYPE

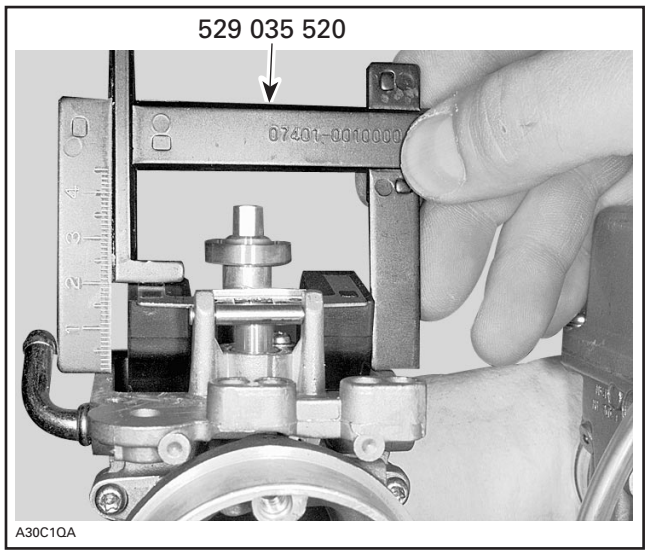
1. Ruler vertical and in line with main jet



TYPICAL — TM TYPE

1. Ruler vertical and in line with main jet

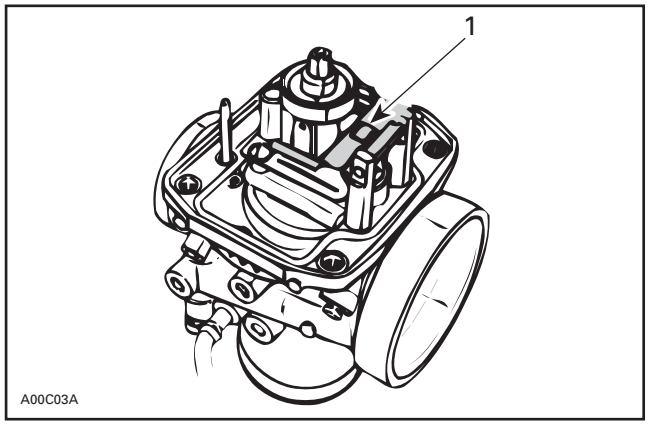
Float level height can be check using tool (P/N 529 035 520). Keep tool in line with main jet as explained above.



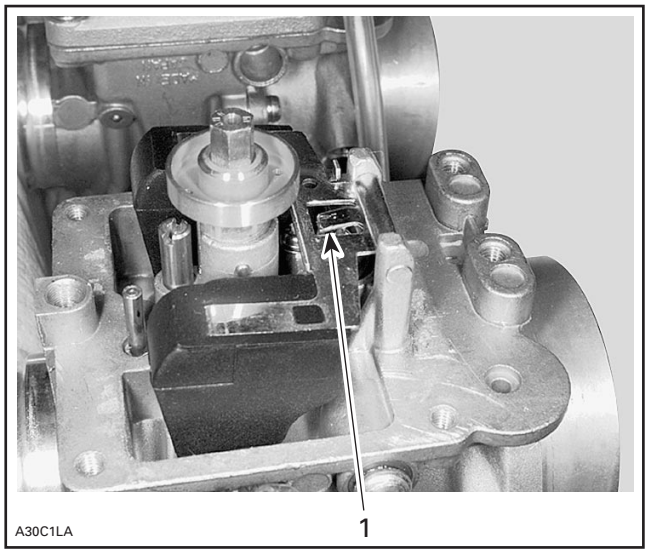
CARBURETOR TYPE	FLOAT HEIGHT H	
	± 1 mm	(± .040 in)
All VM	18.1	(.713)
All TM	21.0	(.827)

To Adjust Height H

– Bend the contact tab of float arm until the specified height is reached.



TYPICAL — VM TYPE
1. Contact tab



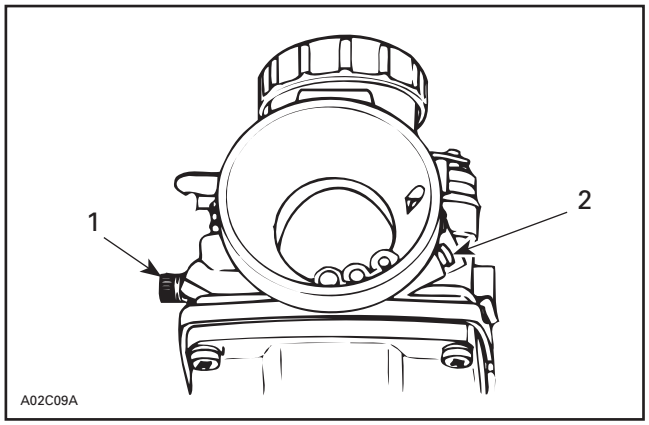
TYPICAL — TM TYPE
1. Contact tab

CARBURETOR ADJUSTMENTS

Adjustments should be performed following this sequence:

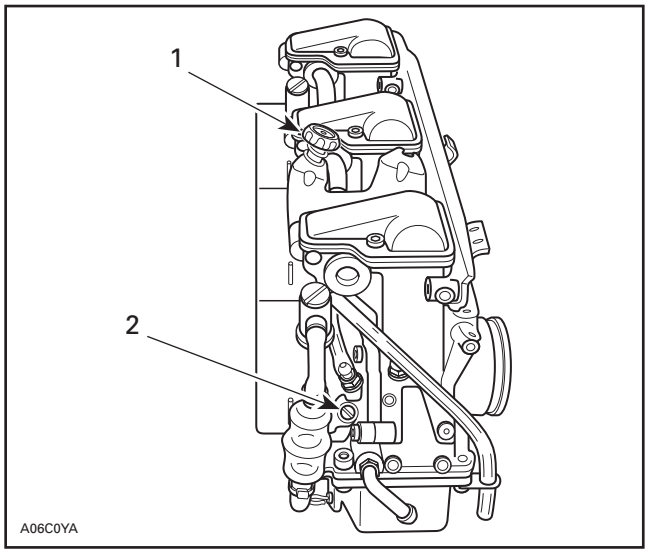
– air screw adjustment
– throttle slide height (preliminary idle speed adjustment)
– throttle cable adjustment
– carburetor synchronization (triple carburetor models)
– final idle speed adjustment (engine running)
– oil pump and carburetor synchronization

VM Type Carburetor



1. Idle speed screw
2. Air screw

TM Type Carburetor



TYPICAL
1. Idle speed screw
2. Air screw (on each carburetor)

6, Air Screw Adjustment

All Models

Completely close the **air screw** (until a slight seating resistance is felt) then back off as specified.

Turning screw in clockwise enrichners mixture and conversely, turning it out counterclockwise leans mixture.

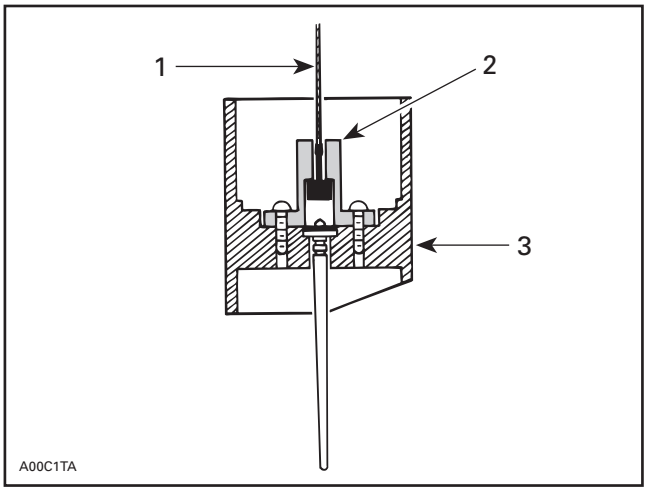
Refer to TECHNICAL DATA 10 for the specifications.

Throttle Slide Height (preliminary idle speed adjustment)

VM Type Carburetor

Hook throttle cable into the needle retainer plate.

NOTE: Do not obstruct hole in throttle slide when installing needle retaining plate. This is important to allow air escaping through and thus allowing a quick response.

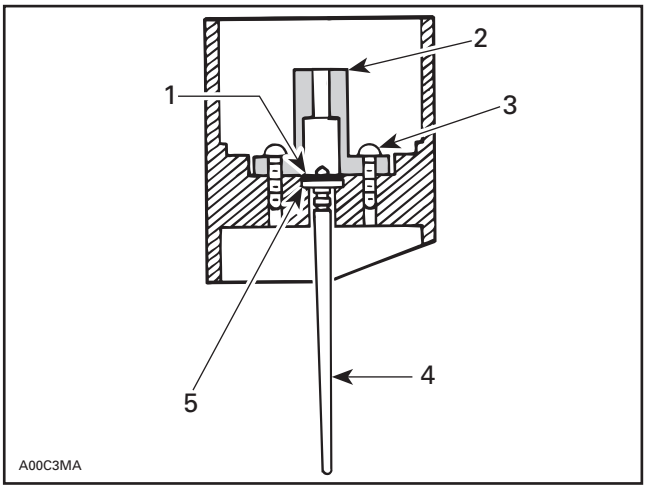


CENTER POST TYPE

1. *Throttle cable*
2. *Needle retaining plate*
3. *Throttle slide*

Make sure the nylon packing **no. 4** is installed on all applicable throttle slides.

CAUTION: Serious engine damage can occur if this notice is disregarded.



CENTER POST TYPE

1. *E-clip*
2. *Needle retaining plate*
3. *Screw*
4. *Needle*
5. *Nylon packing*

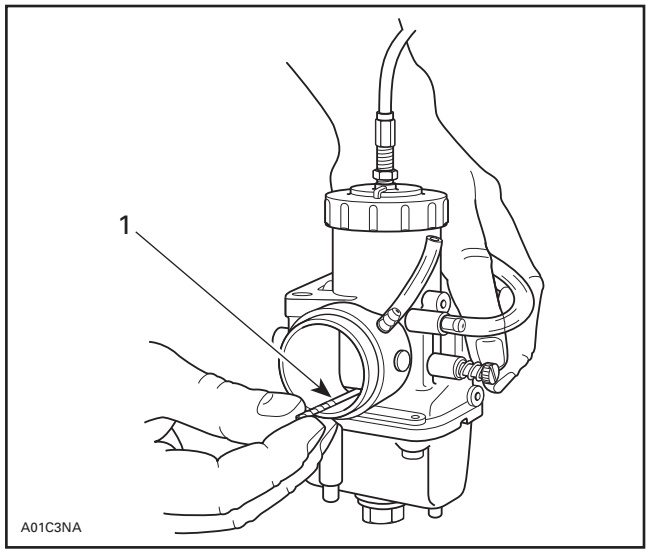
Using a drill bit adjust throttle slide height (see following table) by turning idle speed screw **no. 7**.

Throttle slide height is measured on **outlet** side of carburetor (engine side).

NOTE: Make sure that throttle cable does not hold throttle slide. Loosen cable adjuster accordingly.

Final idle speed adjustment (engine running at idle speed) should be within 1/2 turn of idle speed screw from preliminary adjustment.

MODELS	THROTTLE SLIDE HEIGHT mm (in)
Formula III 700 R and GT 700	1.3 (0.51)



TYPICAL

1. *Drill bit used as gauge for throttle slide height*

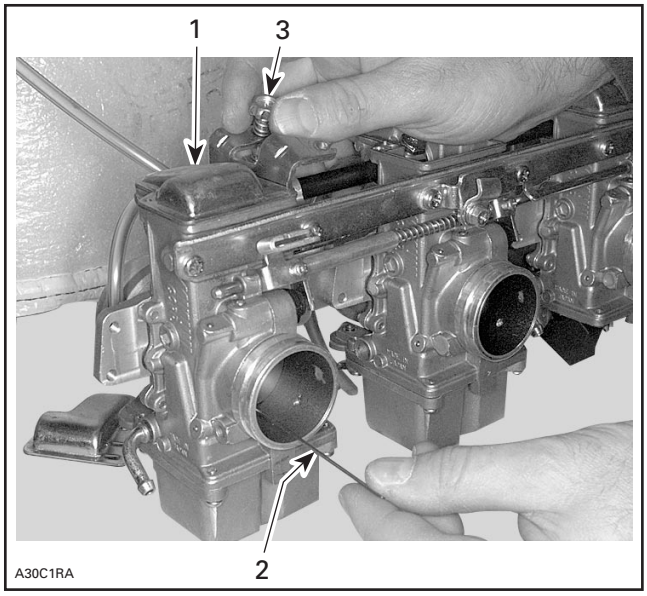
TM Type Carburetor

Remove carburetor covers.

First proceed on MAG carburetor.

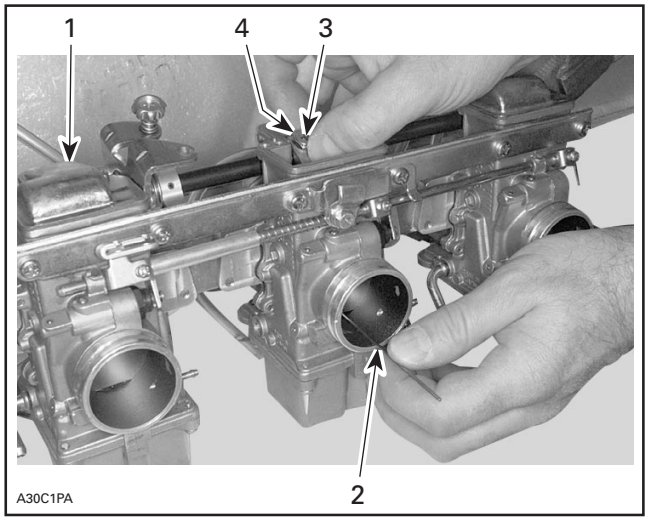
Using a drill bit to measure throttle slide height (see following table) on **outlet** side of carburetor (engine side).

Adjust by turning idle speed screw **no. 7**.



1. Adjust MAG carburetor first
2. Drill used as a gauge to measure throttle height
3. Idle speed screw

For center and PTO carburetors loosen locking screws. Use same drill bit as for MAG carburetor to measure throttle slide height. Turn adjusting nut to adjust.



1. MAG carburetor adjusted first
2. Drill used as a gauge to measure throttle height
3. Locking screw
4. Adjusting nut

Tighten locking screws and recheck throttle height.

NOTE: By adjusting all throttle slides at same height TM carburetors synchronization is done at same time.

Final idle speed adjustment (engine running at idle speed) should be within 1/2 turn of idle speed screw from preliminary adjustment.

MODELS	THROTTLE SLIDE HEIGHT mm (in)
All TM	1.3 (.051)

INSTALLATION

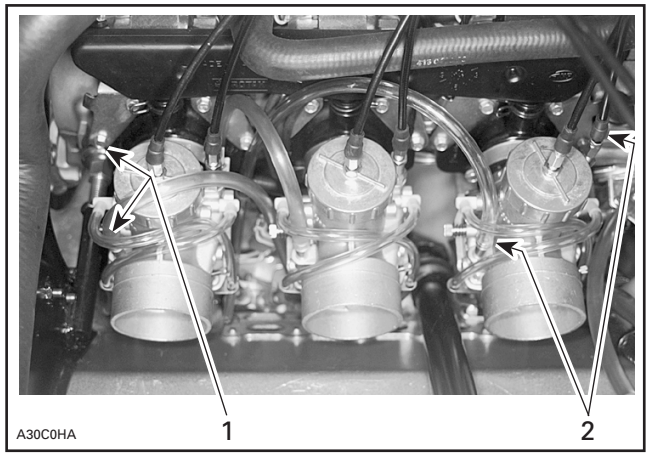
CAUTION: Never allow throttle slide(s) to snap shut.

Prior to install carburetor, adjust air screw and preliminary idle speed as described above.

To install carburetor on engine, inverse removal procedure.

However, pay attention to the following:

Match hose colored dot with the one on coil support.



1. Blue dots
2. Red dots

On applicable models, make sure to align tab of carburetor and air intake silencer (if applicable) with notch of adaptor(s). On applicable models, install adaptor with UP mark facing up.

CAUTION: The rubber flange must be checked for cracks and/or damage. At assembly, the flange must be perfectly matched with the air intake manifold or severe engine damage will occur. Beside do not interchange carburetors, the jetting may be different on each side. A red dot is printed on MAG carburetor (blue on PTO side) and on the high tension coil support. Match the carburetor and the support dots.

Install clamps in a way that their tightening bolts are staggered — not aligned.

Throttle Cable Adjustment

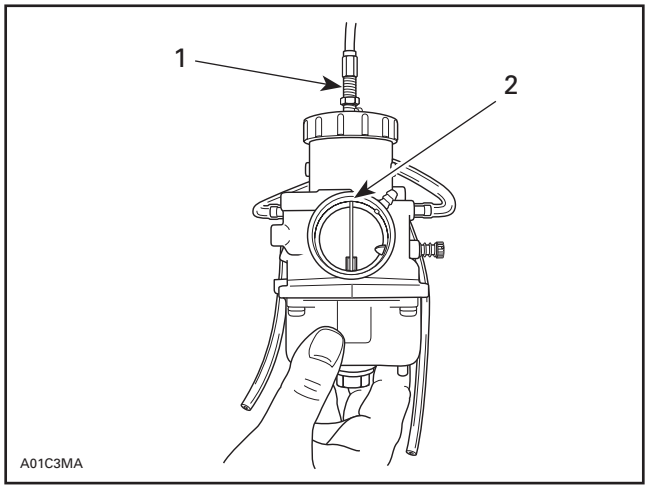
⚠ WARNING

Ensure the engine is turned OFF, prior to performing the throttle cable adjustment.

For maximum performance, correct cable adjustment is critical.

At full opening throttle slide must be flush or 1.0 mm (.040 in) lower than the top of carburetor **outlet** bore (engine side).

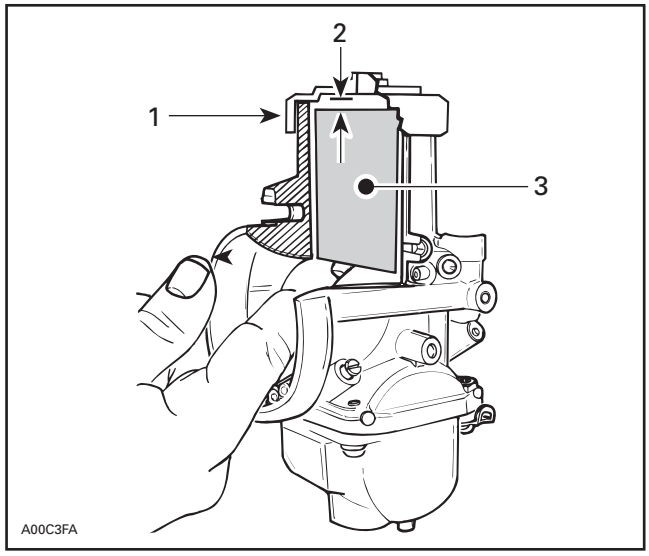
First loosen adjuster nut then turn throttle cable adjuster accordingly.



FULL OPENING (THROTTLE LEVER AGAINST HANDLE GRIP)

1. *Throttle cable adjuster*
2. *Throttle slide flush or 1.0 mm (.040 in) lower than carburetor outlet bore (engine side)*

Check that **with the throttle lever fully depressed**, there is a free play between the carburetor cover and top of throttle slide.



FULL OPENING (THROTTLE LEVER AGAINST HANDLE GRIP)

1. *Cover*
2. *Free play*
3. *Throttle slide*

⚠ WARNING

This gap is very important. If the throttle slide rests against the carburetor cover at full throttle opening, this will create too much strain and may damage the throttle cable or other components in throttle mechanism.

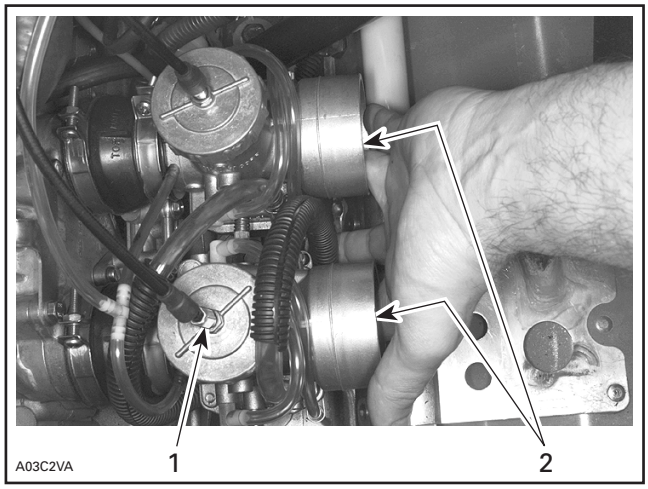
Carburetor Synchronization

VM Type Carburetor

When depressing throttle lever, all three carburetor slides must start to open at same time.

Unlock cable adjustment lock nut on one carburetor.

Screw or unscrew cable adjuster until all carburetor slides start to open at same time. Cable play will be identical on all carburetors. Retighten jam nut.



TYPICAL

1. *Screw or unscrew adjuster*
2. *Check that all slides start to open at the same time*

Check throttle slide position at wide open throttle. Throttle slide must be flush or 1.0 mm (.040 in) lower than carburetor **outlet** bore. At that same position, check that throttle slide does not contact carburetor cover. Turn cable adjuster and recheck synchronization.

CAUTION: If the throttle slide rests against the carburetor cover at full throttle opening, this will create too much strain and may damage the throttle cable or other components in throttle mechanism.

CAUTION: Make sure all carburetors start to operate simultaneously.

TM Type Carburetor

All 3 carburetor slides must start to open at the same time.

Carburetor synchronization is done when adjusting throttle slide height. See above.

Idle Speed Final Adjustment

CAUTION: Before starting engine for the final idle adjustment, make sure that oil pump is adjusted. The oil injection pump adjustment must be checked after each time carburetor idle is adjusted. Refer to OIL INJECTION SYSTEM 04-05.

Start engine and allow it to warm then adjust idle speed to specifications by turning **idle speed** screw clockwise to increase engine speed or counterclockwise to decrease it.

Refer to TECHNICAL DATA 10 for the specifications.

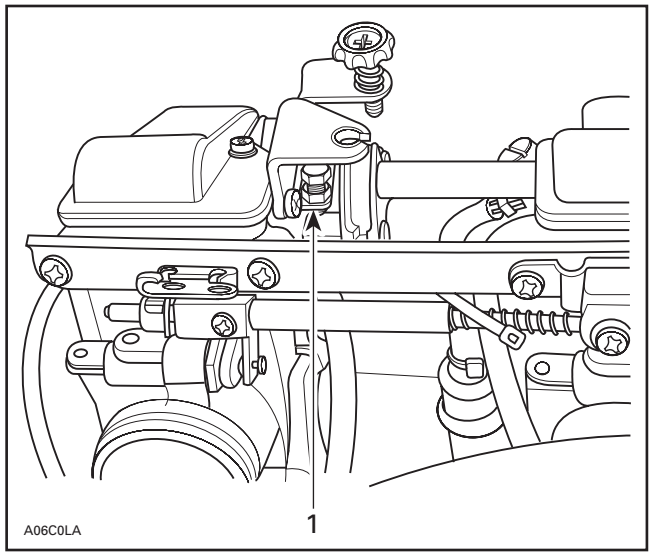
NOTE: Turn adjustment screw the same amount to keep carburetors synchronized.

CAUTION: Do not attempt to set the idle speed by using the air screw. Severe engine damage can occur.

Full Throttle Adjustment

TM Type Carburetor

To avoid stress on throttle cable when throttle lever is against handlebar grip, stop screw must not contact stopper. There must be slight free play (up to 0.5 mm (.020 in)) between stop screw and its stopper.



TYPICAL — FULL THROTTLE POSITION

1. *Free play between stop screw and its stopper*

CHOKE

Choke Plunger Adjustment

VM Type Carburetor

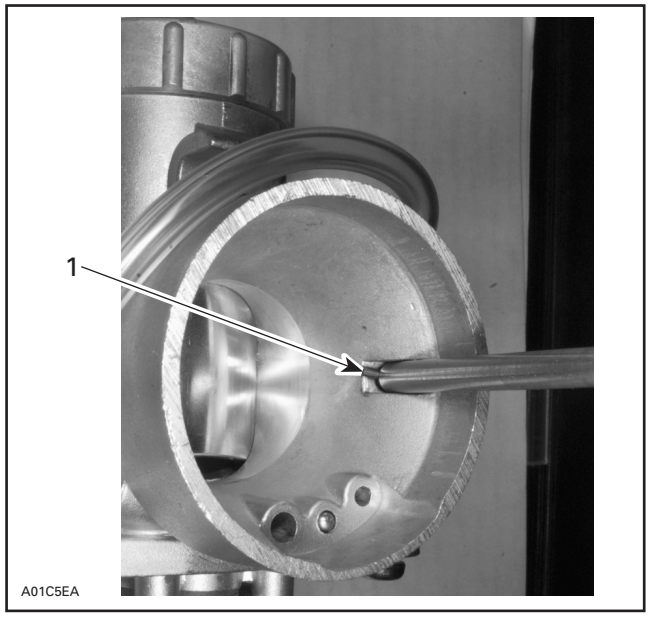
Set choke lever to fully open position.

CHOKE LEVER — FULLY OPEN POSITION

Insert choke plunger tool into choke air inlet of each carburetor.

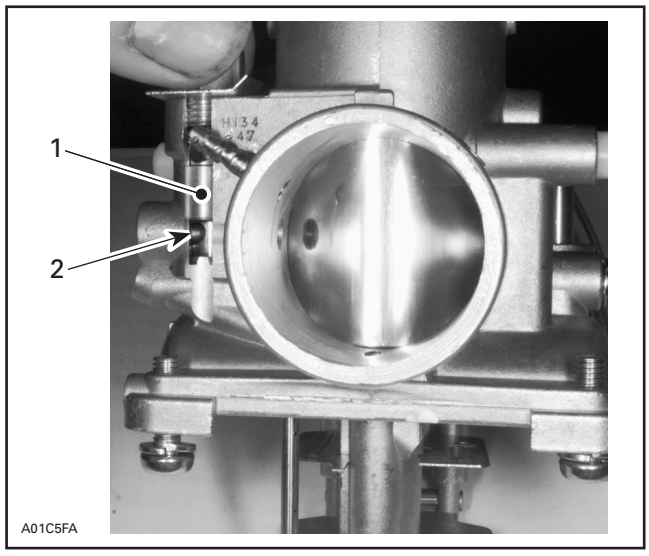
CAUTION: Make sure that tool stopper is properly lean on venturi recess. This will ensure that tool tip is properly seated under choke plunger, as shown on the next photos.

NOTE: Choke plunger tool can be used both sides depending on carburetor type. Use larger diameter for Mikuni 38 mm and smaller diameter for Mikuni 34 mm.



AIR SILENCER SIDE SHOWN

1. *Tool stopper properly leaned on venturi recess*

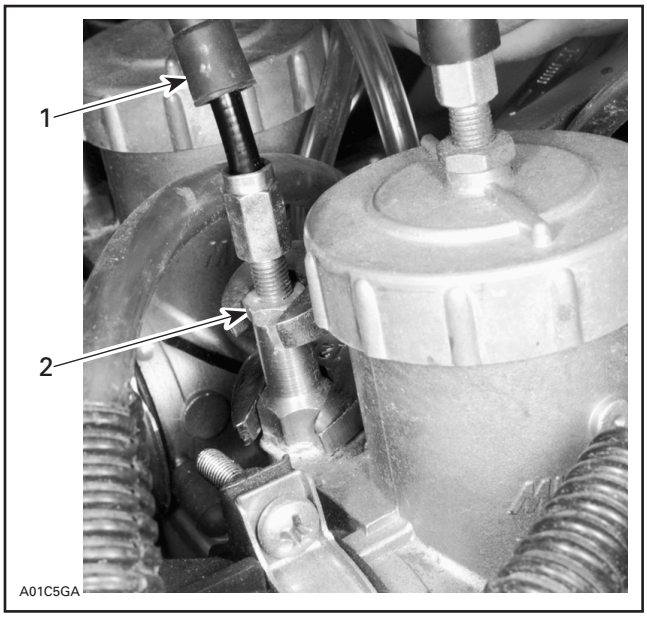


ENGINE SIDE SHOWN (CUT-AWAY)

1. *Choke plunger*
2. *Tool properly seated under choke plunger*

If tool tip does not seat under choke plunger, adjust as follows:

Lift up protector cap and loosen choke cable lock nut, as shown in the next photo.

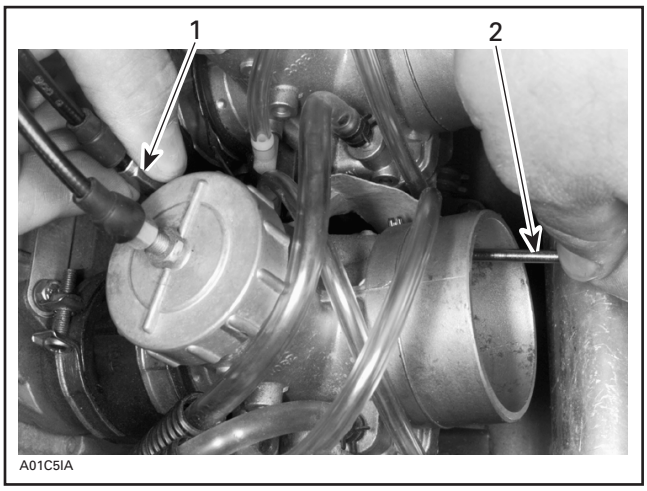


1. *Lift up protector cap*
2. *Loosen lock nut*

Set choke lever to fully open position.

Turn choke cable adjustment nut by hand until tool properly seats under choke plunger.

NOTE: A light pressure should be needed to positioned tool under plunger.



1. *Choke cable adjustment nut*
2. *Choke plunger tool*

Tighten choke cable lock nut and reinstall protector cap.

Set choke lever to close and open positions and ensure that tool properly seats under plunger **only** when lever is set to fully open position.

Set choke lever to close position and, by pulling and pushing choke lever, make sure there is no tension on cable (free play).

CHOKE LEVER — CLOSED POSITION

Choke Rod

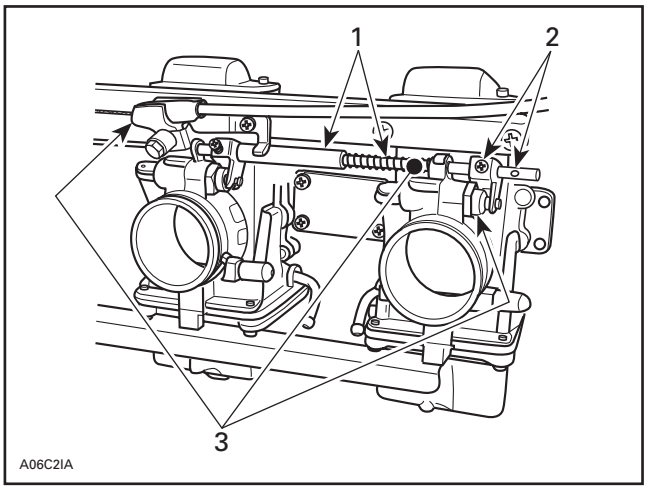
TM Type Carburetor

Check for free movement of choke rod. If hard to slide, remove 3 plunger ferrules then choke rod.

Thoroughly clean choke rod and its mounting hole on each carburetor.

Remove plunger grommet from each carburetor. Fill the grommet interior with dielectric grease (P/N 413 701 700). Reinstall the grommets.

Apply dielectric grease (P/N 413 701 700) on choke rod and reinstall it with its return spring and spacer on PTO side. Make sure that ferrule screws align with each rod hole. Tighten screws to 2 N•m (18 lbf•**in**).



1. Spacer and spring on PTO side
2. Ferrule screw aligned with rod hole
3. Dielectric grease

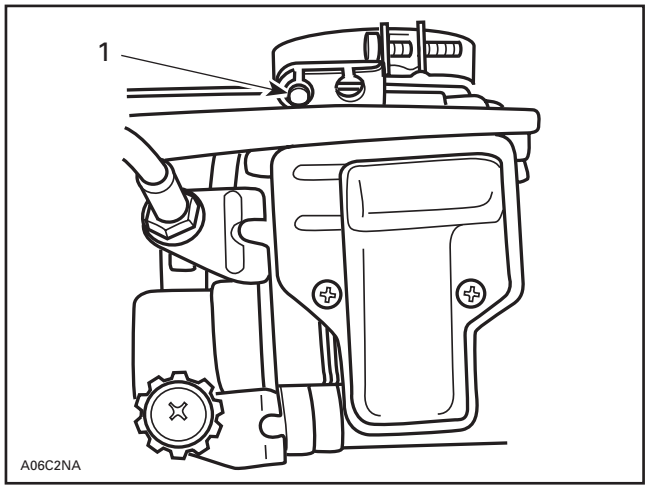
Apply dielectric grease (P/N 413 701 700) on cable housing end.

All 3 plungers must start to open at the same time. Bend ferrule end as required. Do not change position of ferrule on rod. Its screw must remain in line with choke rod hole.

Choke Cable Adjustment

TM Type Carburetor

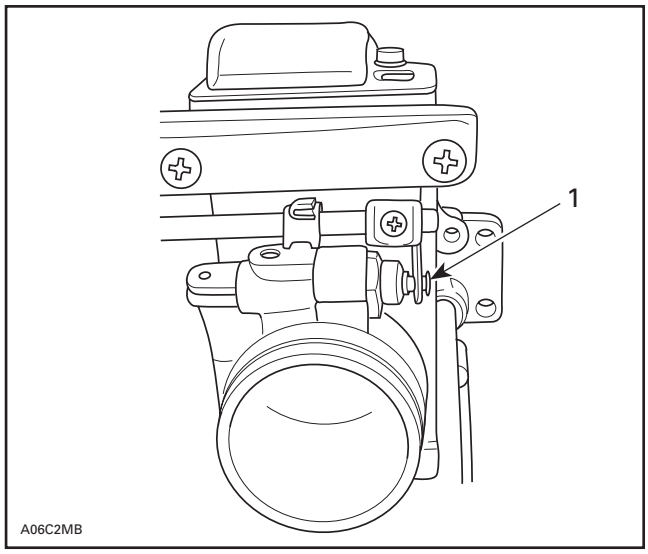
Choke cable barrel must be in left hole of sliding rod lever.



1. Cable barrel in left hole

Air intake silencer must be reinstalled and choke cable properly routed before finalizing adjustment.

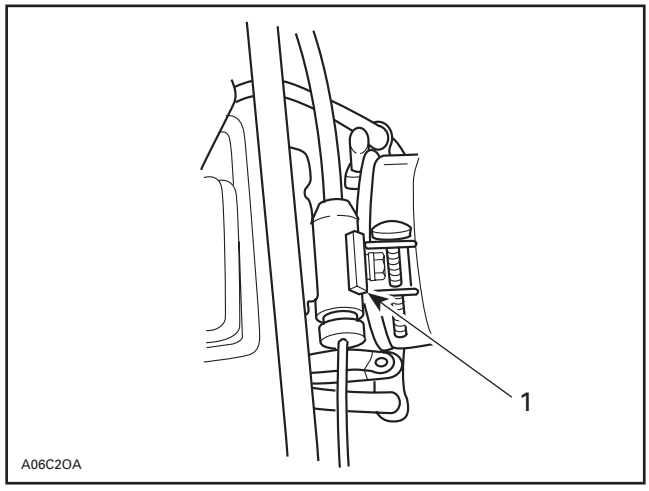
Adjust choke cable to obtain a maximum gap of approximately 0.3 mm (.012 in) between tab and plunger when choke lever is not activated.



1. 0.3 mm (.012 in) gap maximum

NOTE: If there is no gap between tab and plunger, a rich condition will occur and throttle response will be affected; if the gap is too great, the plunger stroke will be reduced causing poor cold engine starting.

If adjustment is required, loosen cable support on middle carburetor to change choke cable position.

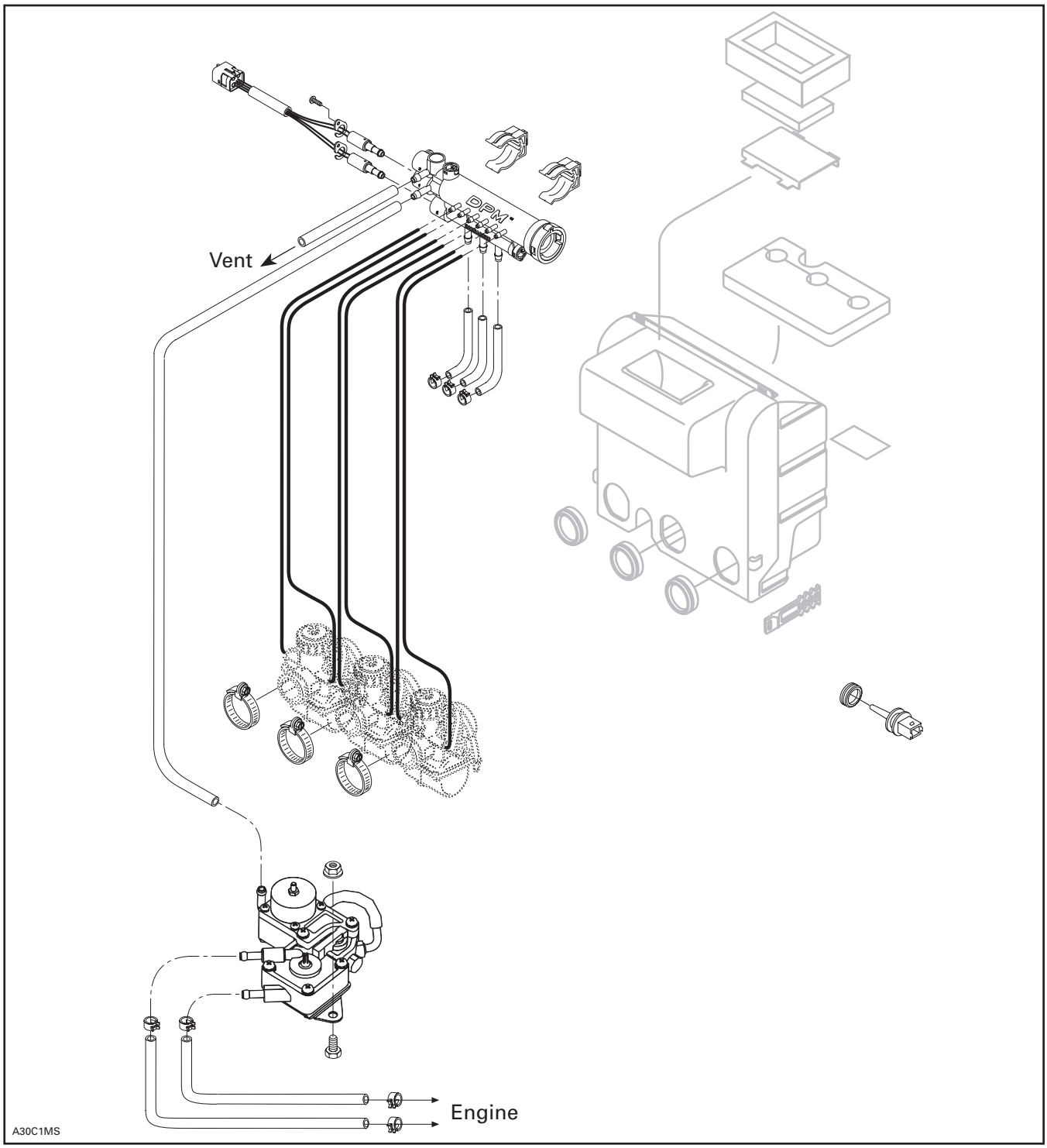


1. Choke cable support

After adjustment, retighten screw.

DPM

Grand Touring 700/SE



PURPOSE

Calibrate the air/fuel mixture in order to optimize the engine output while reducing fuel consumption.

METHOD

The system makes the pressure vary within the carburetor bowl.

OVERALL SYSTEM OPERATION

Introduction

NOTE: The Multi Purpose Electronic Module (MPEM) includes the DPM system.

The Digital Performance Management (DPM) system increases pressure within all 3 carburetor bowls thus the air/fuel mixture is enriched. This is what we call the enrichment mode.

As soon as the spark plug gives off its first spark, the DPM system calculates the enrichment time and rate based on the engine temperature.

Once enrichment mode is completed carburetor bowls return to atmospheric pressure (DPM in standby mode), and the air/fuel mixture is identical to that of carburetors without the DPM system.

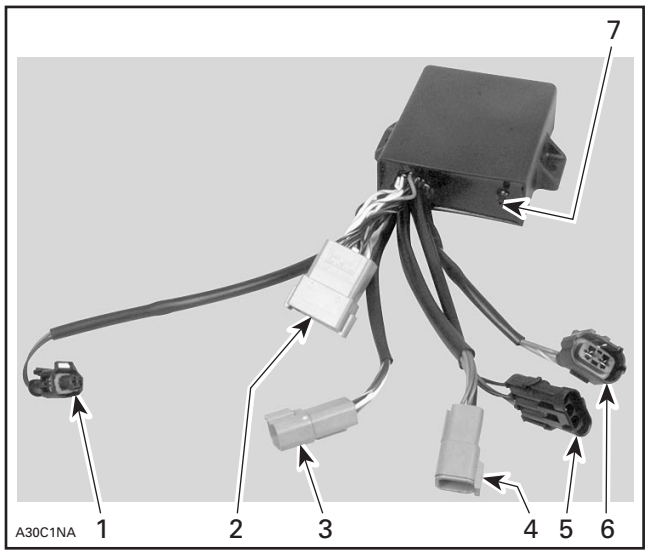
Over 3000 RPM, compensation mode is activated but will compensate only if the air temperature exceeds - 20°C (- 4°F) and the air pressure is lower than 1000 mbar.

Float bowls are now under vacuum (lower than atmospheric pressure) and the air/ fuel mixture is leaner.

NOTE: Both modes can never operate at the same time. The system either makes the mixture richer or leaner. Or, the mixture remains unchanged when module is on standby.

MPEM OPERATION

General



1. Air temperature sensor, 4-22 housing
2. Power supply, ground, DESS switch, reverse switch and alarm, RPM signal for cluster, high tension coils, kill switch, 6-15 housing
3. Trigger coils, 6-14 housing
4. DPM engine temp. sensor and solenoids, 4-21 housing
5. Enrichment switch, 4-20 housing
6. Battery/regulator connection, 6-13 housing
7. Atmospheric pressure nipple

Direct current is supplied to the module which is protected with a 1 A fuse.

BLACK/GREEN and WHITE/GRAY wires (4-06 housing) are used for programming by the manufacturer. Nothing must be plugged to this housing.

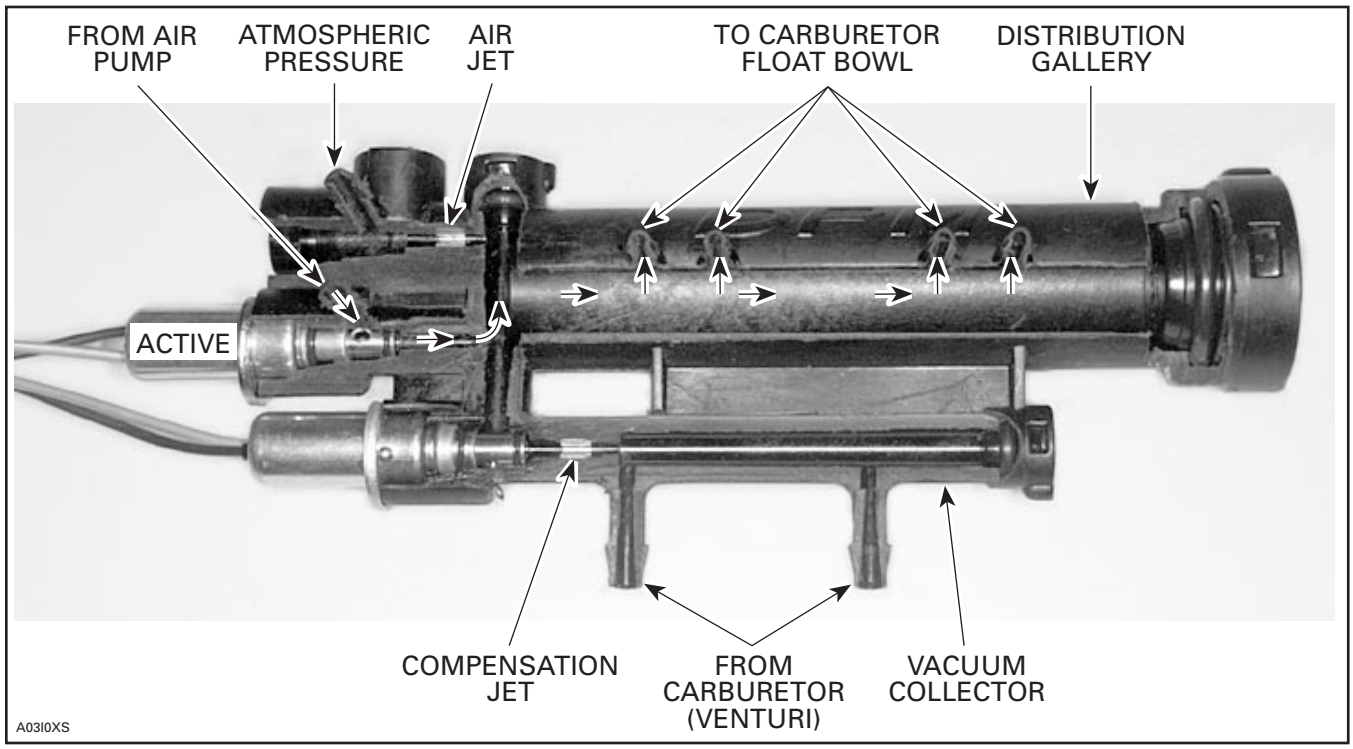
Enrichment Mode (starting)

When turning the ignition key to the ON position, the module is energized and goes on standby. The module uses no electricity when on standby.

Once the engine begins to turn (using either the electrical or rewind starter), the MPEM receives pulses from ignition system.

The MPEM then comes on by reading the engine temperature through the sensor located on the cylinder head. The MPEM calculates the enrichment solenoid opening time and the enrichment rate according to the temperature. The air/fuel mixture is then enriched in order to facilitate starting.

The system pressurizes all 3 carburetor bowls in order to enrich the air/fuel mixture. This is accomplished with the help of an air pump.



TYPICAL — ENRICHMENT MODE

This enrichment process of the air/fuel mixture takes place at start-up and during engine warm-up, and it depends on engine temperature.

The higher the engine temperature upon start-up, the leaner the mixture.

This enrichment progressively decreases (with time) by reducing the solenoid duty cycle. The warmer the engine, the shorter the enrichment mode.

If the throttle opening exceeds one quarter before engine runs, the enrichment mode is interrupted by a switch during the starting process, which allows unflooding the engine.

However, the enrichment mode is restored when releasing the throttle.

Following the enrichment mode, carburetors are operating normally, i.e. without additional pressure within bowls.

NOTE: Calibration is normally the same on engines with a DPM system and those without.

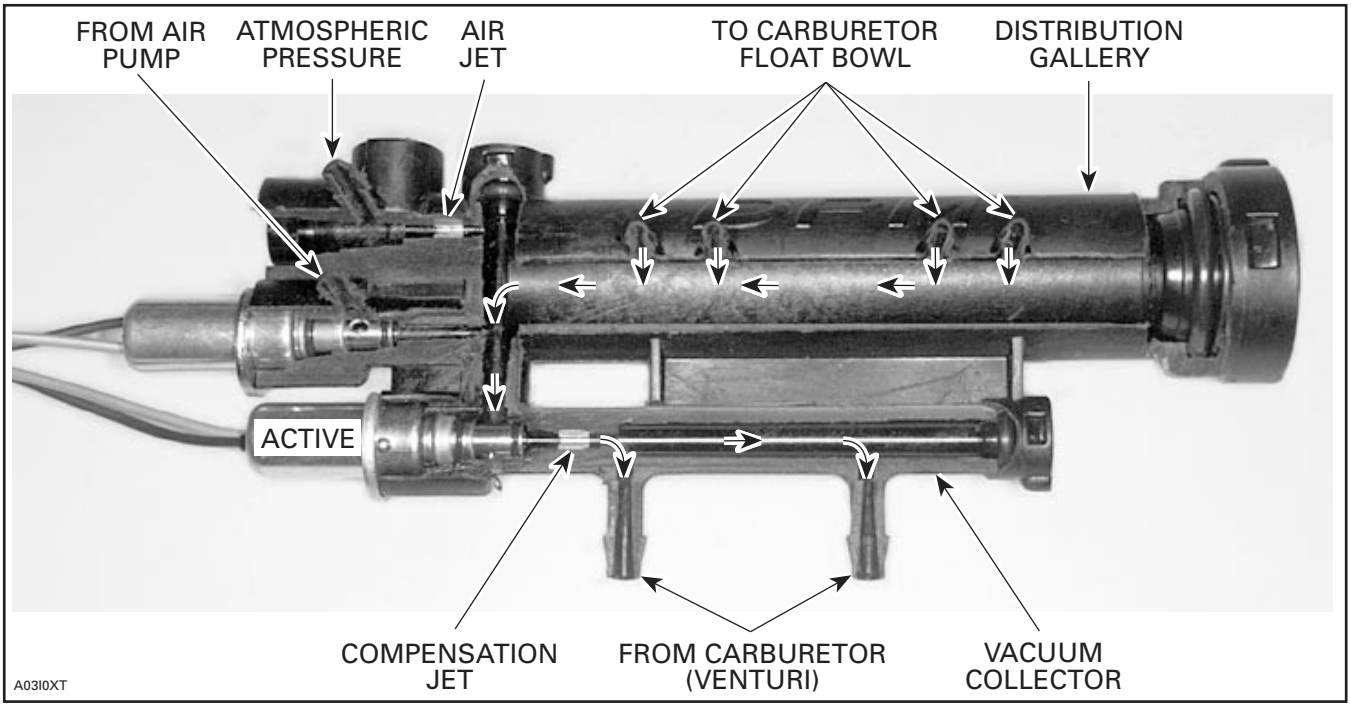
Compensation Mode

Two conditions must be met for the compensation mode to operate:

1. Engine must rev over 3000 RPM.

2. Air temperature must exceed - 20°C (- 4°F) and/or atmospheric pressure must be lower than 1000 mbar.

The compensation mode brings all 3 carburetor bowls under vacuum (lower than the atmospheric pressure) in order to make the air/fuel mixture leaner. The required vacuum is produced within the needle jet air inlet.



TYPICAL

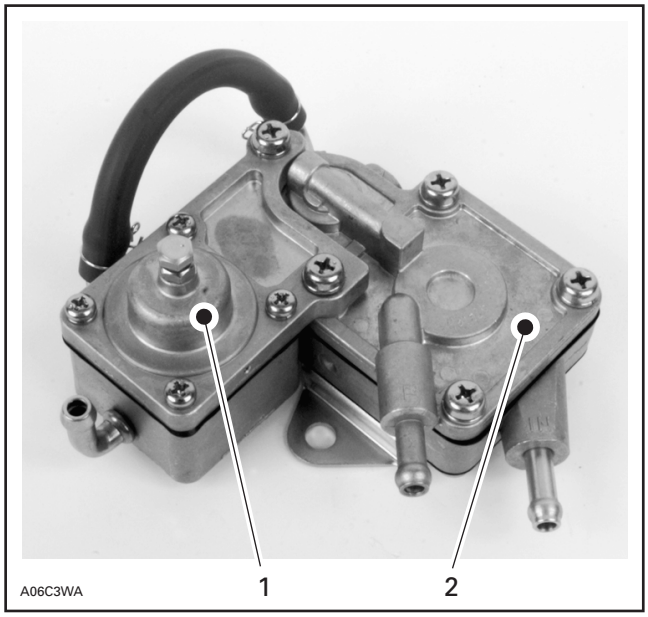
The compensation ratio will depend on the air temperature and the atmospheric pressure.

The higher the air temperature, the leaner the air/fuel mixture.

The lower the atmospheric pressure, the leaner the air/fuel mixture.

NOTE: The atmospheric pressure decreases as the altitude increases.

AIR PUMP OPERATION



1. *Regulator*
2. *Pump*

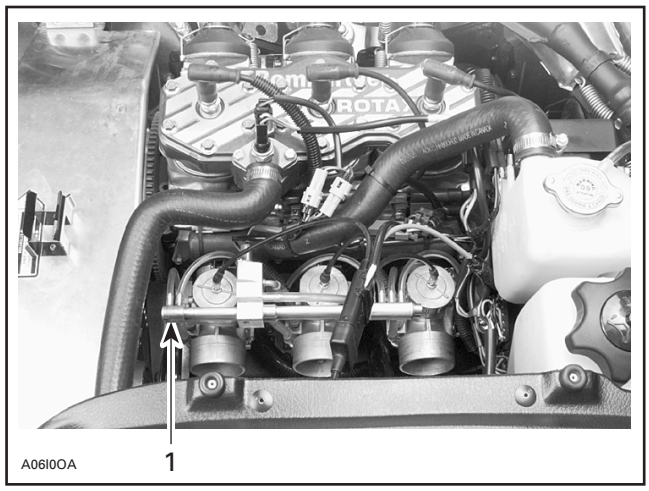
Air pump supplies the distribution gallery through a unique pipe.

Pump diaphragm is activated by the alternating pressure/vacuum within the engine crankcase. Two hoses connect the crankcase (cylinders nos. 2 and 3) to the pump.

A regulator within the pump stabilizes the pump pressure.

Since the pump pressure is insufficient upon starting, the regulator is fed directly by the crankcase pressure.

DPM MANIFOLD OPERATION



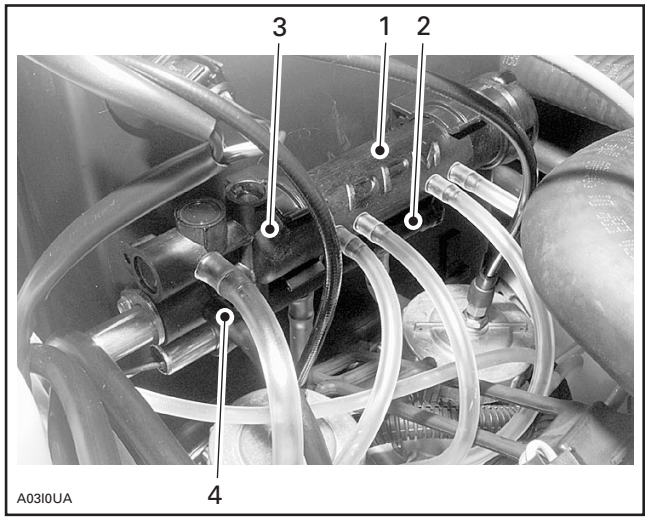
TYPICAL

1. *Manifold*

The DPM manifold consists of 2 tubes. Depending on the mode, the upper tube (distribution gallery) distributes pump pressure or vacuum to each bowl through 2 hoses. The passage is then opened by the enrichment or the compensation solenoid, depending on the mode.

The lower tube (vacuum collector) receives the vacuum created by each carburetor within the needle jet air inlet.

An air jet (manifold air jet) also allows the atmospheric pressure to enter.



TYPICAL — MANIFOLD ASS'Y

1. *Upper tube: distribution gallery*
2. *Lower tube: vacuum collector*
3. *Manifold air jet — Atmospheric pressure*
4. *From air pump*

Enrichment Solenoid

Solenoid Operating Principle

A solenoid is a winding coiled in order to produce a magnetic field. A metal rod crosses the coil and cuts the magnetic field. Each time the coil is activated, the magnetic field attracts the rod. If the supply current is interrupted, a spring pushes the rod.

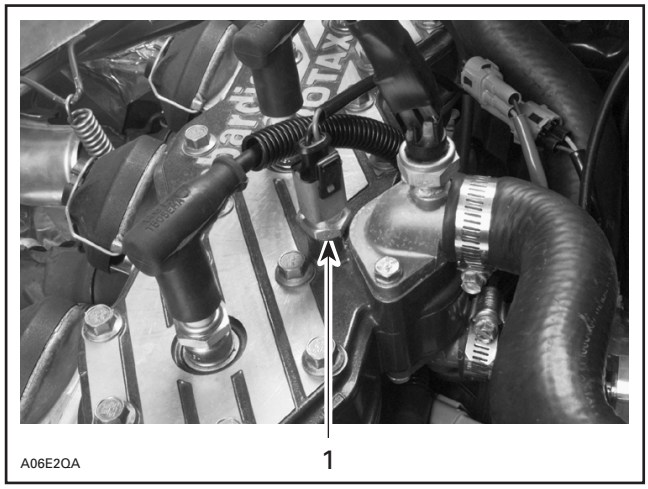
Solenoid Function within the DPM System

The MPEM turns the solenoid on and off 10 times per second, which means that it operates at 10 cycles/second or 10 Hertz (Hz). The solenoid therefore opens and closes 10 times per second, thus allowing the pump pressure to reach the distribution gallery (upper tube).

For the pressure to vary within the bowls, the solenoid is activated in part by the MPEM during each cycle. This is what is called the duty cycle. In other words, the solenoid will not open throughout the whole cycle. The duty cycle depends on the engine temperature.

The colder the engine, the longer the duty cycle. Therefore, the solenoid will stay open longer, thus giving way to pressure.

MPEM reads engine temperature at once (when starting) through a sensor.



TYPICAL
1. DPM engine temperature sensor

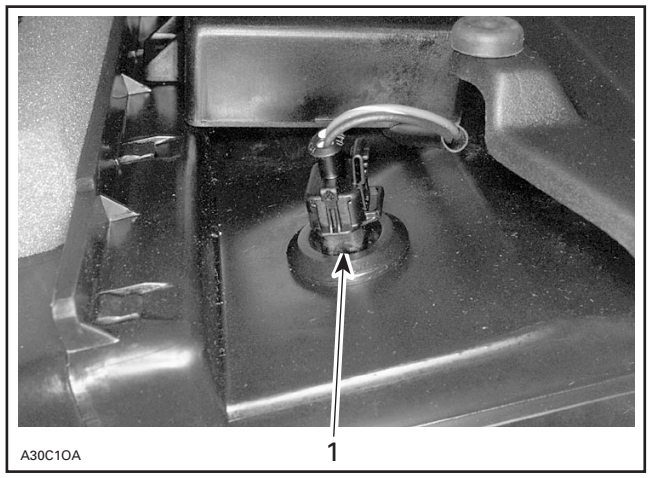
Compensation Solenoid

NOTE: Same principle as enrichment solenoid. Read *Operating Principle of a Solenoid* at the beginning of the chapter concerning the Enrichment Solenoid.

The duty cycle of the compensation solenoid depends on the air temperature and the atmospheric pressure.

The warmer the air, the longer the duty cycle. Therefore, the solenoid will stay open longer, thus giving way to vacuum. The same applies when the altitude increases.

MPEM reads air temperature through a sensor.



1. Air temperature sensor

Manifold Air Jet

This jet allows the atmospheric pressure to reach carburetor bowls when the DPM system is on standby (returned to atmospheric pressure).

See manifold ass'y illustration.

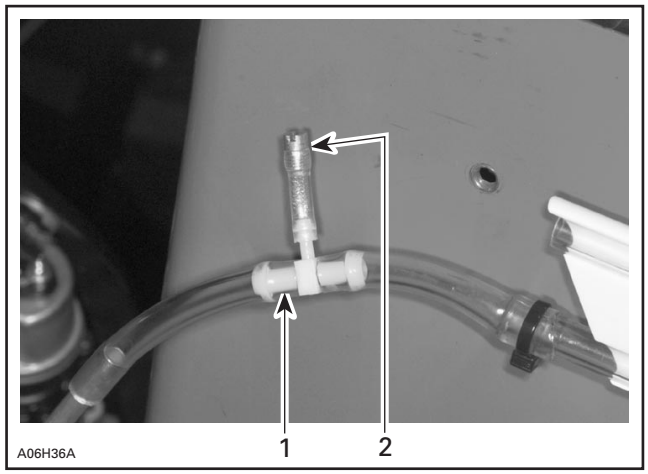
TESTING PROCEDURE

Pump

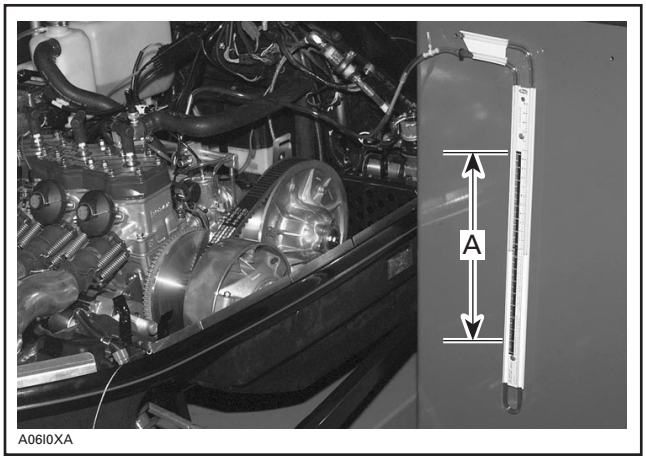
Pressure Test

The pump must create a minimum pressure of 400 ± 50 mm (15.75 ± 2.00 in) of water.

Connect a jet (P/N 270 500 157) to a hose then connect that little tube to the small nipple of a T-fitting (P/N 414 222 500). Install that T-fitting between a U-tube and air pump outlet.



1. T-fitting (P/N 414 222 500)
2. Jet (P/N 270 500 157)



A. 400 ± 50 mm (15.75 ± 2.00 in) of water

Start engine and note water height.

MPEM

Solenoids are supplied by the MPEM. If this MPEM does not work, there will be no current on the compensation solenoid RD/BL and BK connectors (3-10 housing); and on the RD/GN and BK connectors (3-11 housing).

Unplug upper solenoid wire (enrichment). Connect a good solenoid to MPEM output connector.

CAUTION: Do not disconnect both DPM connectors. The compensation solenoid must remain plugged.

Disconnect engine temperature sensor connector. The MPEM now operates as though the engine temperature was - 20°C (- 4°F) to allow maximum mixture enrichment.

For the compensation solenoid, the air temperature sensor must be at room temperature. Operate the engine at 3500 RPM. The solenoid must vibrate.

Start the engine and observe the solenoid. A vibrating solenoid indicates that the MPEM is in good working order. If not, replace the MPEM and repeat test.

Solenoid

Static Test

Unplug electric connector of solenoid and connect it to a 12 V battery. The solenoid must sound when it opens. Repeat test several times.

Dynamic Test

When checking the enrichment solenoid, disconnect engine temperature sensor connector. The DPM system now operates as though the engine temperature was - 20°C (- 4°F) to allow maximum mixture enrichment.

Remove the solenoid, hold it in hand and start the engine.

For the enrichment solenoid, check if it vibrates as soon as the engine is started.

For the compensation solenoid, the air temperature sensor must be at room temperature. Operate the engine at 3500 RPM. The solenoid must vibrate.

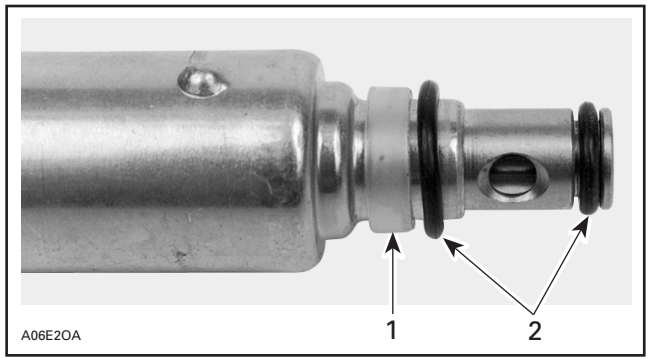
Temperature Sensor (air and engine)

At room temperature 20°C (68°F), the sensor resistance must be 2500 Ω ± 300.

PARTS REMOVAL AND INSTALLATION

Solenoid

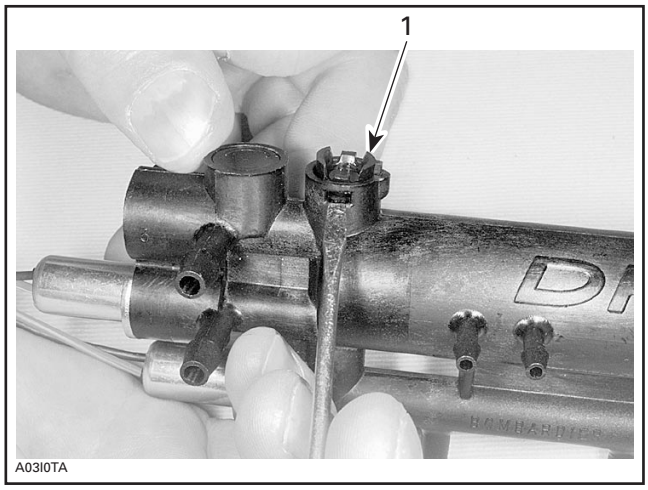
At reassembly, ensure that solenoid seals are in place.



1. *Plastic seal*
2. *O-rings*

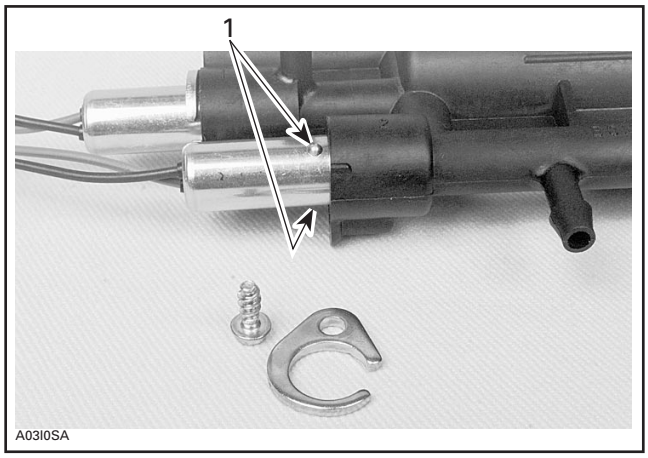
Installation of compensation solenoid must be done as follows:

Remove transfer gallery plug by pushing 2 tabs.



1. Transfer gallery plug

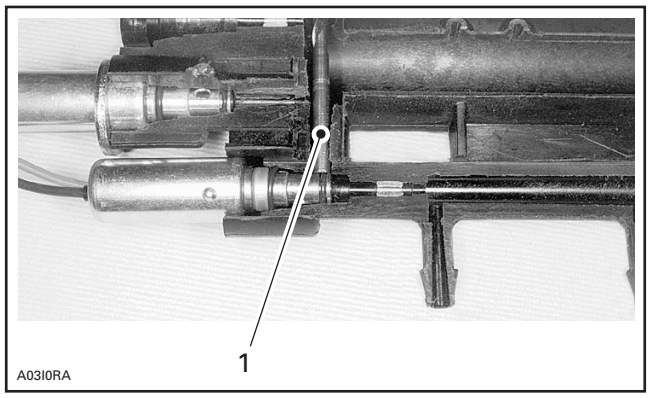
Partially insert compensation solenoid into DPM manifold.



1. Embosses not engaged

Insert a 5/32 in drill bit with its round end first into the transfer gallery.

Fully push solenoid into DPM manifold while maintaining a pressure on drill bit. This will guide the solenoid O-ring.

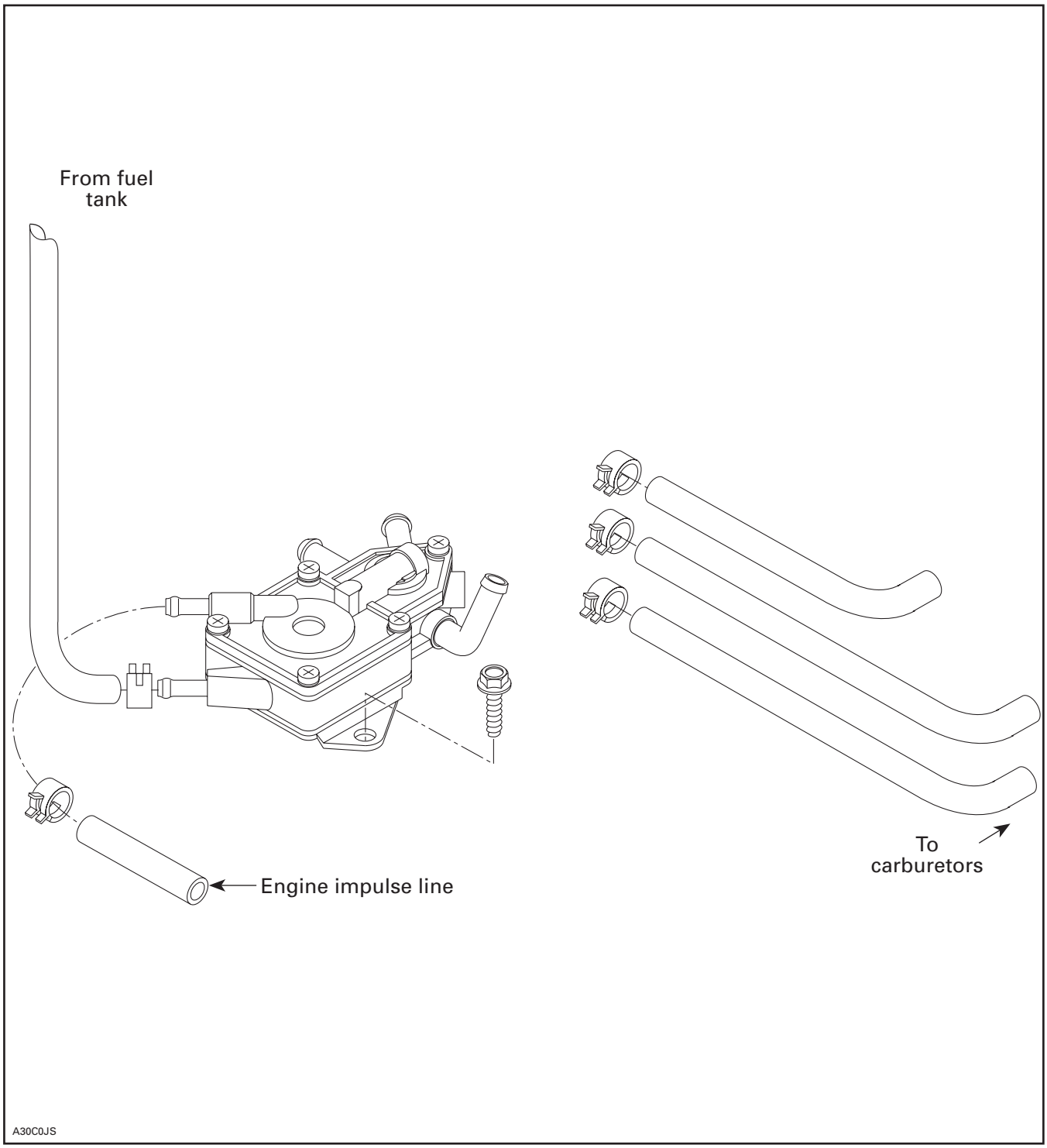


TYPICAL — CUT-AWAY

1. Drill bit round end guiding solenoid O-ring

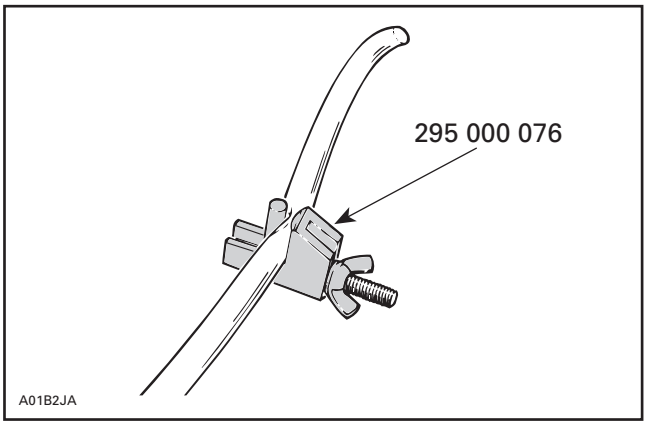
FUEL PUMP

All Models



REMOVAL

Install a hose pincer (P/N 295 000 076) on fuel supply line close to pump inlet.



Disconnect fuel outlet line(s).

Disconnect impulse line.

Remove screws securing fuel pump support to chassis.

PUMP VERIFICATION

Check fuel pump valves operation as follows:

Connect a clean plastic tubing to the inlet nipple and alternately apply pressure and vacuum with pump of leak test kit. The inlet valve should release with pressure and hold under vacuum.

Repeat the same procedure at the outlet nipple. This time the outlet valve should hold with pressure and release under vacuum.

NOTE: Plug 2 outlets with finger while checking outlet valve.

Check impulse diaphragm and gasket on high-supply fuel pump with twin outlets as follows:

Connect a clean plastic tubing to the impulse nipple and plug vent hole on top cover. Either apply pressure or vacuum. The diaphragm/gasket must not leak.

CLEANING AND INSPECTION

The entire pump should be cleaned with general purpose solvent before disassembly.

Fuel pump components should be cleaned in general purpose solvent and dried with compressed air.

⚠ WARNING

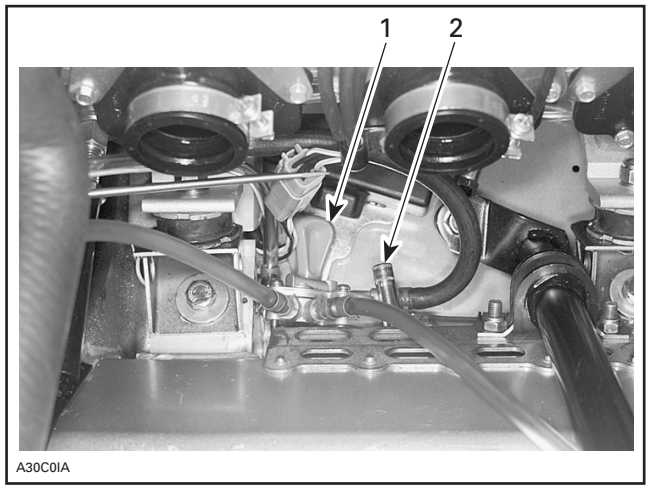
Solvent with a low flash point such as gasoline, naphtha, benzol, etc., should not be used as each is flammable and explosive.

Inspect diaphragm. The pumping area should be free of holes, tears or imperfections. Replace as needed.

INSTALLATION

To install, first insert a pick in bottom hole of pump support to hold it in place.

Fasten top screw using a long socket with grease inside to restrain screw.



1. Pick inserted in pump support bottom hole
2. Socket on top screw head to be fastened

⚠ WARNING

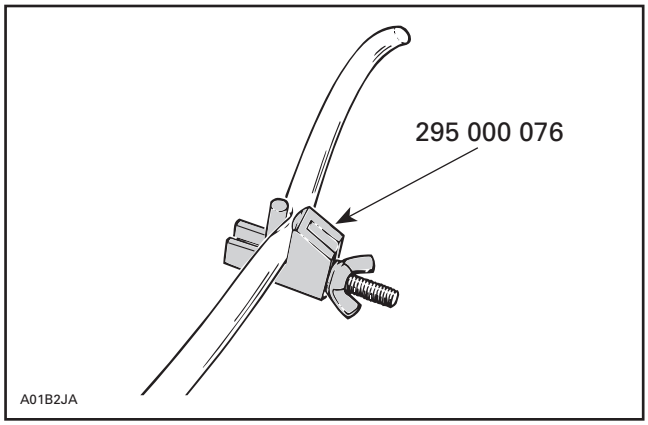
Pressure test to ensure there is no leak in fuel system.

FUEL TANK AND THROTTLE CABLE

Fuel Tank Lines

⚠ WARNING

When draining a fuel tank or whenever a fuel line is disconnected, obstruct line with a hose pincher (P/N 295 000 076) or equivalent device. Fuel is flammable and explosive under certain conditions. Ensure work area is well ventilated. Do not smoke or allow open flames or sparks in the vicinity.



Impulse/Fuel Lines Spring Clips (all models)

Always reposition spring clips after any repair to prevent possible leaks.

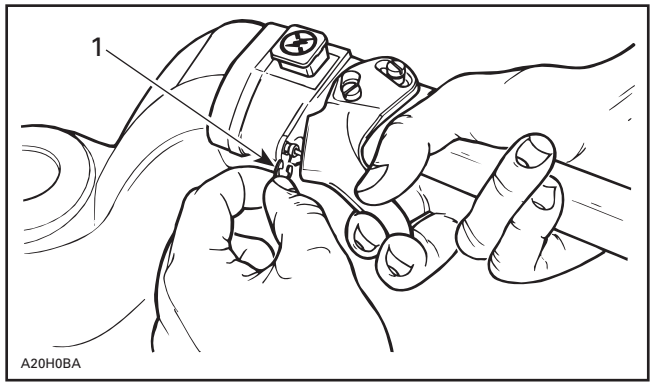
Throttle Cable Circlip at Handlebar (all models)

Put silicone grease (P/N 293 550 004) around cable barrel. Locate circlip as per illustration.

⚠ WARNING

If this procedure is disregarded, throttle might be half-open at normally closed position and the engine will speed up when starting.

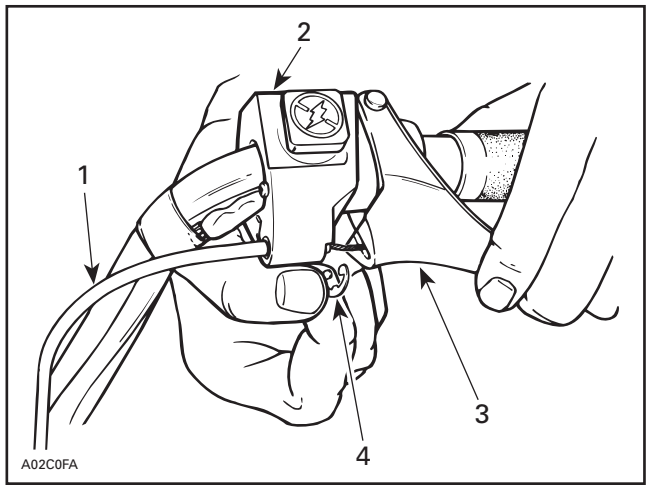
Models with Easy Action Throttle Lever



TYPICAL

1. Circlip

Other Models

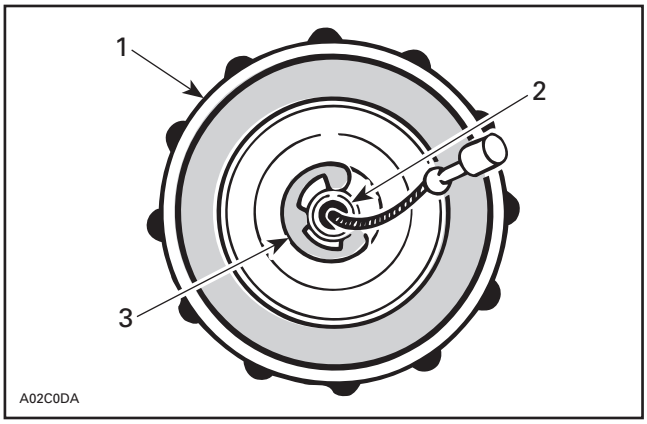


TYPICAL

1. Throttle cable housing
2. Throttle handle housing
3. Throttle handle
4. Circlip

Throttle Cable O-Ring and Retaining Ring at Carburetor (some models)

Locate O-ring outside of carburetor cover and retaining ring inside.



1. Carburetor cover
2. Throttle cable housing
3. Retaining ring

Adjust throttle cable as specified in CARBURETOR AND FUEL PUMP 04-08.

Throttle Cable Routing

CAUTION: Check that throttle cable is routed away from sharp edges, hot or vibrating parts. When turning steering while engine is running, idle speed must not vary.

Fuel Level Sensor

Inspection

Visually inspect the condition of connectors and wiring throughout the circuit. Connections must be clean and tight, and wiring free of damage. Repair as necessary. Use silicone dielectric grease to prevent corrosion at the connectors. Operate the engine to see if the problem has been corrected.

Fuse Replacement

A 0.25 ampere fuse protects fuel level sensor circuitry. Remove seat to gain access.

Fuel Level Sensor Screws

Torque fuel level sensor retaining screws to 1 N•m (8 lbf•**in**) in the sequence shown and then to 2.5 N•m (22 lbf•**in**), using the same sequence.