



**SEA-DOO®**



# ENGINE Shop Manual

Watercraft

**2005** **ROTAX®**  
**717 and 787 RFI™**  
**Engines**

# ***2005 Engine Shop Manual***

**ROTAX®  
717 and 787 RFI™  
ENGINES**

**SEA-DOO®**



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# SAFETY NOTICE

This *ENGINE SHOP MANUAL* has been prepared as a guide to correctly service and repair the 717 and 787 RFI Rotax® engines.

This edition was primarily published to be used by technicians who are already familiar with all service procedures relating to BRP products. Mechanical technicians should attend training courses given by BRP Training Dept.

Please note that the instructions will apply only if proper hand tools and special service tools are used.

It is understood that this manual may be translated into another language. In the event of any discrepancy, the English version shall prevail.

The content depicts parts and/or procedures applicable to the particular product at time of writing. Service and Warranty Bulletins may be published to update the content of this manual. Make sure to read and understand these.

In addition, the sole purpose of the illustrations throughout the manual, is to assist identification of the general configuration of the parts. They are not to be interpreted as technical drawings or exact replicas of the parts.

The use of BRP parts is most strongly recommended when considering replacement of any component. Dealer and/or distributor assistance should be sought in case of doubt.

The engines identified in this document should not be utilized on product(s) other than those for which it was designed.

## **WARNING**

Unless otherwise specified, engine should be turned OFF and cold for all maintenance and repair procedures.

This manual emphasizes particular information denoted by the wording and symbols:

## **WARNING**

Identifies an instruction which, if not followed, could cause serious personal injury including possibility of death.

**CAUTION:** Denotes an instruction which, if not followed, could severely damage engine components.

**NOTE:** Indicates supplementary information needed to fully complete an instruction.

Although the mere reading of such information does not eliminate the hazard, your understanding of the information will promote its correct use. Always use common shop safety practice.

BRP disclaims liability for all damages and/or injuries resulting from the improper use of the contents. We strongly recommend that any services be carried out and/or verified by a highly skilled professional mechanic. It is understood that certain modifications may render use of the engine illegal under existing federal, provincial and state regulations.

## INTRODUCTION

# INTRODUCTION

## GENERAL INFORMATION

This *ENGINE SHOP MANUAL* covers the 717 and 787 RFI Rotax made engines. It should be used in conjunction with the appropriate *VEHICLE SHOP MANUAL*.

The information and component/system descriptions contained in this manual are correct at time of writing. BRP however, maintains a policy of continuous improvement of its products without imposing upon itself any obligation to install them on products previously manufactured.

BRP reserves the right at any time to discontinue or change specifications, designs, features, models or equipment without incurring obligation.

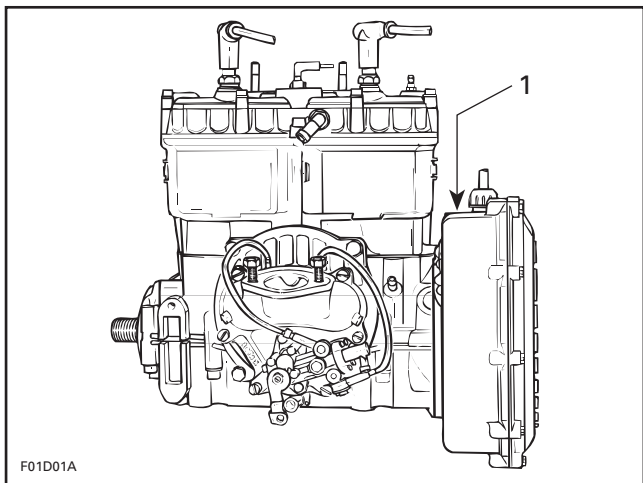
This *ENGINE SHOP MANUAL* uses technical terms which may be different from the ones of the Parts Catalogs.

When ordering parts always refer to the specific model Parts Catalogs.

## ENGINE IDENTIFICATION NUMBER (E.I.N.)

### 717 Engines

The Engine Identification Number is located on the upper side of the magneto housing.

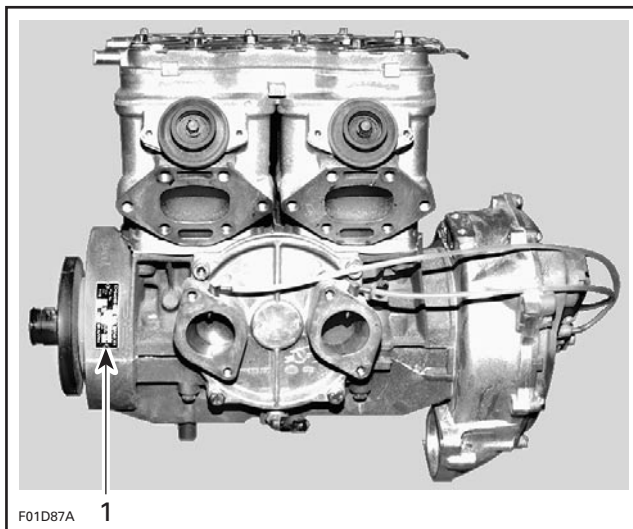


TYPICAL

1. Engine Identification Number (E.I.N.)

### 787 RFI Engines

The Engine Identification Number is located on the upper crankcase on PTO side.



1. Engine Identification Number (E.I.N.)

## ENGINE EMISSIONS INFORMATION

Refer to the appropriate *VEHICLE SHOP MANUAL*.

## TIGHTENING TORQUES

Tighten fasteners to torque mentioned in exploded views and/or text.

### WARNING

Torque wrench tightening specifications must strictly be adhered to. Locking devices (e.g.: locking tabs, elastic stop nuts, self-locking fasteners, etc.) must be installed or replaced with new ones, where specified. If the efficiency of a locking device is impaired, it must be renewed.

### ARRANGEMENT OF THIS MANUAL, ILLUSTRATIONS AND PROCEDURES

The manual is divided into many major sections as you can see in the main table of contents at the beginning of the manual.

Several sections are divided in various subsections. There is a table of contents at the beginning of many sections.

The illustrations show the typical construction of the different assemblies and, in all cases, may not reproduce the full detail or exact shape of the parts shown, however, they represent parts which have the same or a similar function.

**CAUTION:** These engines are designed with parts dimensioned mostly in the metric system. However some components may be from the imperial system. When replacing fasteners, make sure to use only those recommended by BRP.

As many of the procedures in this manual are inter-related, we suggest, that before undertaking any task, you read and thoroughly understand the entire section or subsection in which the procedure is contained.

A number of procedures throughout the book require the use of special tools. Before undertaking any procedure, be sure that you have on hand all the tools required, or approved equivalents.

TYPICAL PAGE

Page heading indicates section and subsection detailed.

Section 03 ENGINE  
Subsection 04 (MAGNETO SYSTEM)

Subsection title indicates beginning of the subsection.

**MAGNETO SYSTEM**

*717 Engine*

Italic sub-title above exploded view indicate pertaining models.

Drop represents a liquid product to be applied to a surface. In this case Loctite 243 to screw threads.

Exploded view assists you in identifying parts and related positions.

Bold face number indicates special procedure concerning this part.

Illustration number for publishing process.

Dotted box contains parts of a particular model or an exploded view.

Tightening torque nearby fastener. In this case, nut must be torqued to 145 N•m (107 lbf•ft).

Page number

**CAUTION:** Pay attention to torque specifications. Some of these are in lbf•in instead of lbf•ft. Use appropriate torque wrench.

## TYPICAL PAGE

Sub-title with part name(s) from exploded view.

**Section 06 FUEL SYSTEM**  
Subsection 03 (CARBURETORS)

**CARBURETOR REMOVAL**

To remove carburetors from engine, proceed as follows:

- Remove air vent tube support.
- Unlock retaining slides holding air intake silencer base.
- Remove air intake silencer base from watercraft.
- Remove screws holding flame arrester base support to cylinder head cover.
- Unscrew base retaining screws then remove base from carburetors and move to front of watercraft.
- Turn the valve to OFF position.

**NOTE:** For fuel line removal, use pliers (P/N 295 000 054).

- Disconnect pulse line from fuel pump.
- Disconnect fuel supply line from fuel pump.
- Disconnect fuel return line.
- Disconnect oil injection pump cable, throttle cable and choke cable.

**XP Model Only**

- Remove screws no. 6 and lock washers no. 7 retaining carburetors.

**All Others Models**

- Remove 4 bolts no. 8 and lock washers no. 12 from rotary valve cover then move carburetors and rotary valve cover on top of engine.

**NOTE:** When removing rotary valve cover, pay attention that the rotary valve stay in place, otherwise it must be timed.

- Remove carburetors from intake manifold.
- Disconnect fuel bypass line between carburetors (twin carburetors).
- Remove carburetor(s) from rotary valve cover.

**DISASSEMBLY AND INSPECTION**

Inspect parts for corrosion damage (shaft, butterfly, spring, etc., check valve housing, etc.).

**Diaphragm**

**PUMP DIAPHRAGM LEAK TEST**

Using a suitable pump gauge tester, perform the following test proceeding as follows:

- Install pump gauge tester (P/N 295 000 083) on pulse nipple.
- Pump tester until it reaches 28 kPa (4 PSI).

**Illustration**

**TYPICAL**

Step 1: Install pump gauge tester to pulse nipple.  
Step 2: Pump tester until it reaches the desired pressure.

1: Fuel outlet nipple  
2: Fuel inlet nipple  
A: 28 kPa (4 PSI)  
B: Diaphragm must stand pressure for 10 seconds. If pressure drops, replace diaphragm.

31

Title indicates main procedure to be carried-out.

Service tool to be used to perform a certain procedure.

Title in italic indicates a particular procedure concerning a model.

Sub-sub-title in this case indicates that particular procedure for XP is finished, so from this point, all others models are concerned.

Bold numbers in the text refer to the parts shown in the exploded view at the beginning of the subsection.

Numbers are used for description of components.

Sub-sub-title in capital indicates a particular testing, adjustment or repair procedure.

Illustration always follows text it is pertained to.

"TYPICAL" mention indicates a general view which does not represent full detail.

Numbered step are used to give a sequence to be performed.

Letters are used for any measures.



# MEASUREMENT PROCEDURES

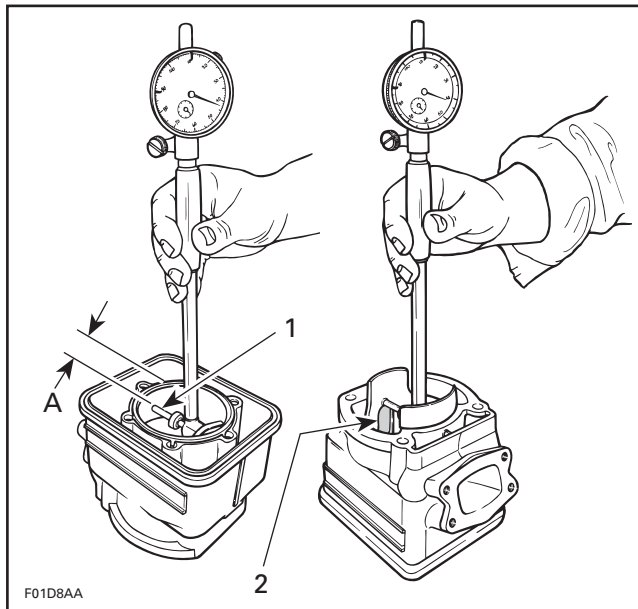
**NOTE:** This section explains the procedures to correctly measure engine components. For the engine technical specifications, refer to INSPECTION in the appropriate ENGINE subsection.

## CYLINDER HEAD WARPAGE

Check gasketed surface of the cylinder head with a straight edge and a feeler gauge. Make sure part is within the given specification. If cylinder head is out of specification, replace it. Verify combustion chamber volume to use the correct cylinder base gasket with the new part.

## CYLINDER TAPER

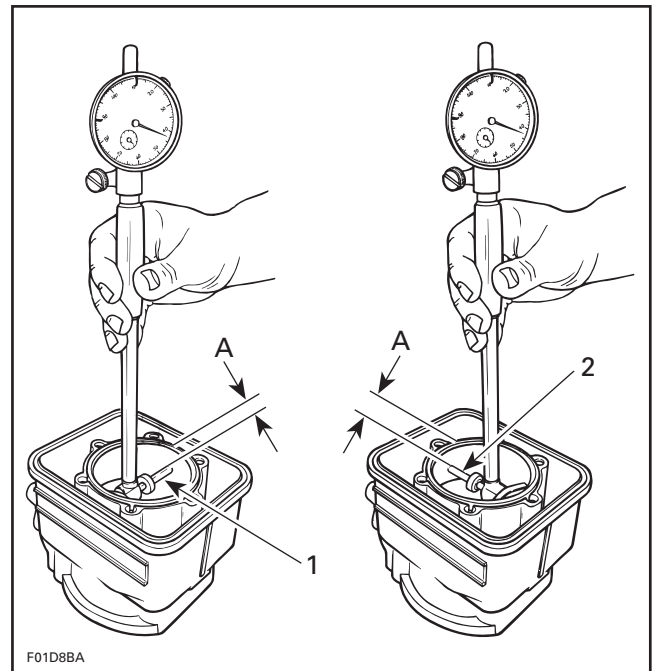
Using a cylinder bore gauge, measure cylinder diameter at 16 mm (5/8 in) from top of cylinder just below auxiliary transfer port, facing exhaust port and just below the auxiliary transfer port facing the exhaust port. Compare readings. If the difference between readings exceed specification, cylinder should be rebored and honed or replaced.



**TYPICAL**  
1. Measuring perpendicularly (90°) to piston pin axis  
2. Auxiliary transfer port  
A. 16 mm (5/8 in)

## CYLINDER OUT OF ROUND

Using a cylinder bore gauge, measure cylinder diameter at 16 mm (5/8 in) from top of cylinder. Measure diameter in piston pin axis direction then perpendicularly (90°) to it. If the difference between readings exceed specification, cylinder should be rebored and honed or replaced.



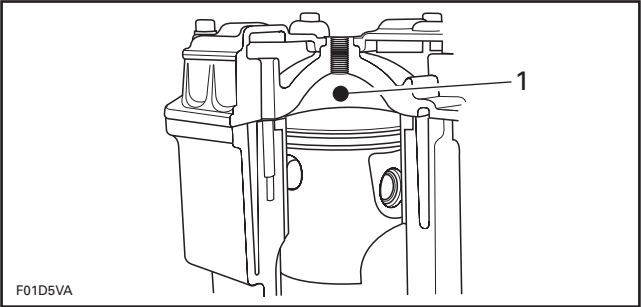
**TYPICAL**  
1. Measuring in piston pin axis  
2. Measuring perpendicularly (90°) to piston pin axis  
A. 16 mm (5/8 in)

## COMBUSTION CHAMBER VOLUME MEASUREMENT

**NOTE:** This procedure is required to determine the thickness of the cylinder base gasket to be installed if a crank repair has involved replacement of connecting rods or if you are experiencing repetitive engine seizure.

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

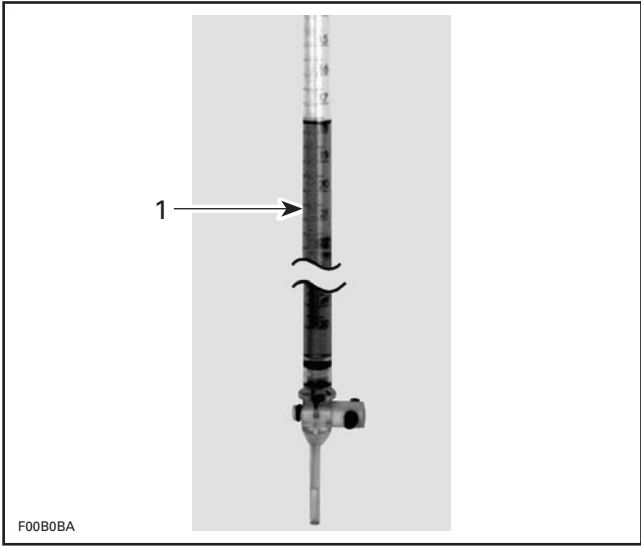
**Section 01 ENGINE MEASUREMENT**  
**Subsection 01 (MEASUREMENT PROCEDURES)**



1. Combustion chamber

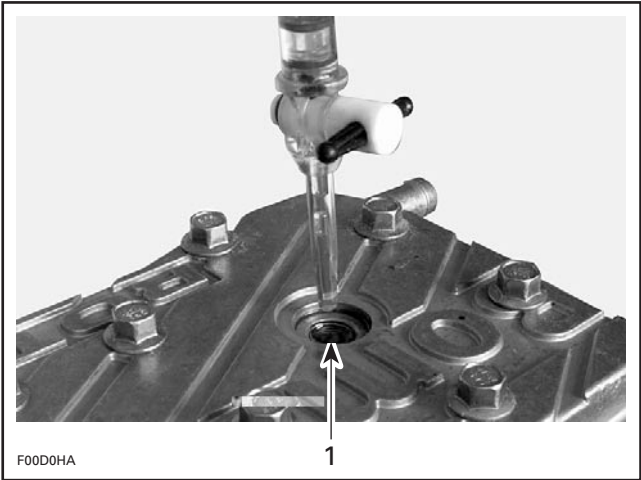
**NOTE:** When checking the combustion chamber volume, engine must be cold, piston must be free of carbon deposit and cylinder head must be leveled.

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

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



**TYPICAL**  
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.

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

The volume should be within the allowable range. Refer to TOP END section of the appropriate engine for the specifications.

If the volume of the combustion chamber is not within specifications, change cylinder base gasket thickness as follow.

A higher volume dictates a thinner gasket.

A lower volume dictates a thicker gasket.

- Repeat the procedure for the other cylinder.

**PISTON/CYLINDER WALL CLEARANCE**

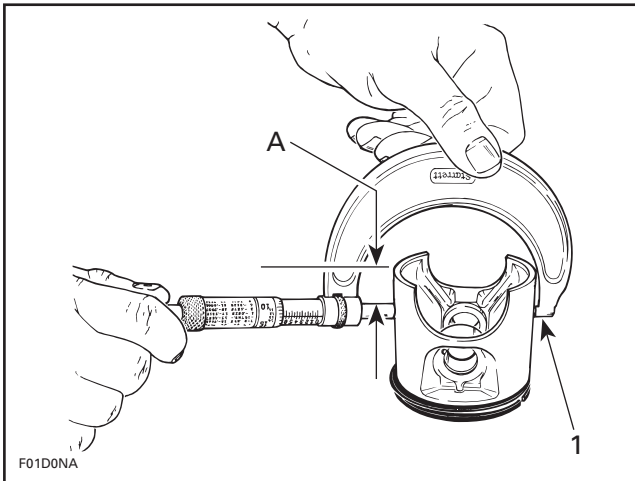
**Method with a Used Piston**

Using a micrometer, measure piston skirt perpendicularly (90°) to piston pin and at the specified distance as per following table.

ENGINE	MAXIMUM "A" mm (in)
717	29 (1.142)
787 RFI	28 (1.102)

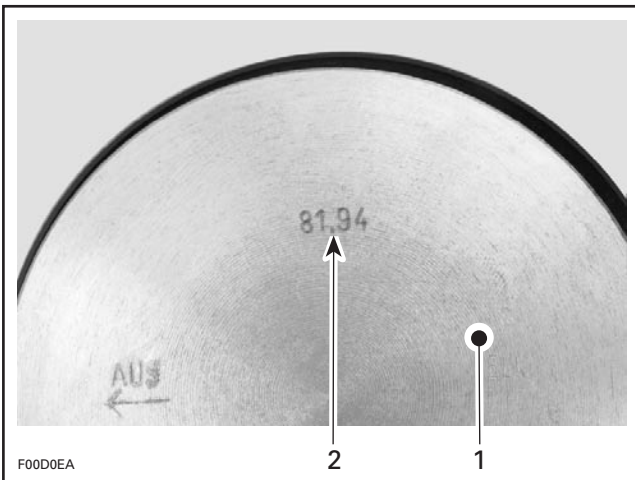
## Section 01 ENGINE MEASUREMENT

### Subsection 01 (MEASUREMENT PROCEDURES)



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

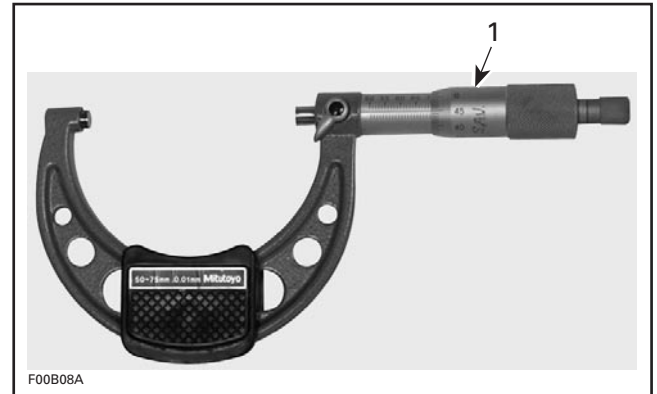
Note the piston dimension on the piston dome and compare it with the obtained result.



1. Piston dome  
2. Piston measurement

**NOTE:** The measured dimension must not be less than 0.12 mm (.005 in) of the one scribed on piston dome. Otherwise, use a new piston and measure piston/cylinder wall clearance following method with a new piston.

If piston is within specifications, adjust and lock the micrometer to the obtained piston dimension.

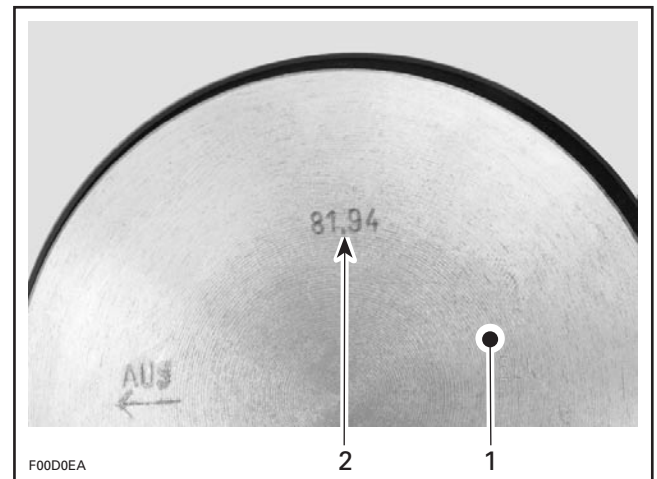


1. Micrometer set to the piston dimension

Proceed with FINAL MEASUREMENT PROCEDURE WITH EITHER A USED OR NEW PISTON below.

#### Method with a New Piston

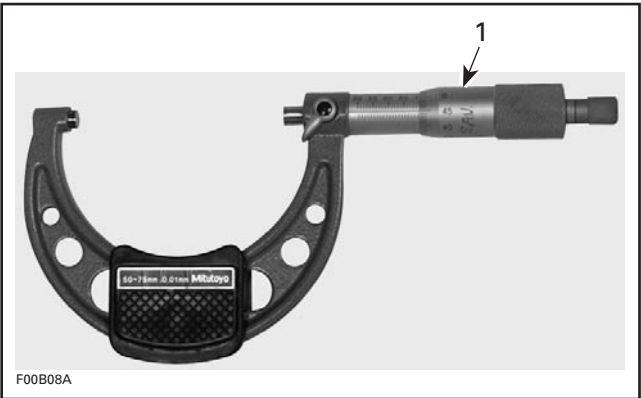
To determine the piston dimension, take the measurement on the piston dome.



1. Piston dome  
2. Piston measurement

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

**Section 01 ENGINE MEASUREMENT**  
**Subsection 01 (MEASUREMENT PROCEDURES)**

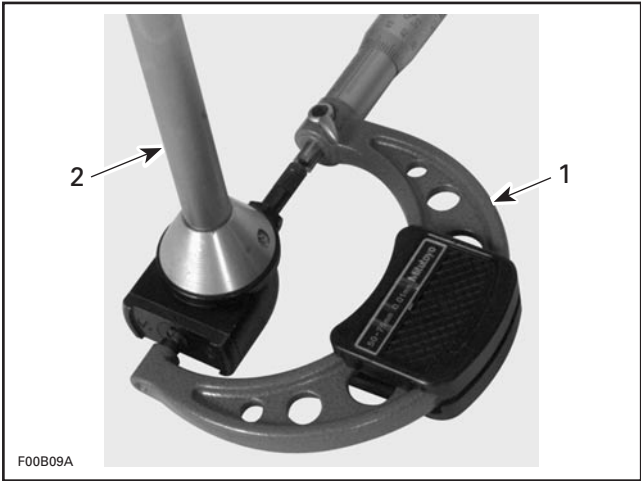


1. Micrometer set to the piston dimension

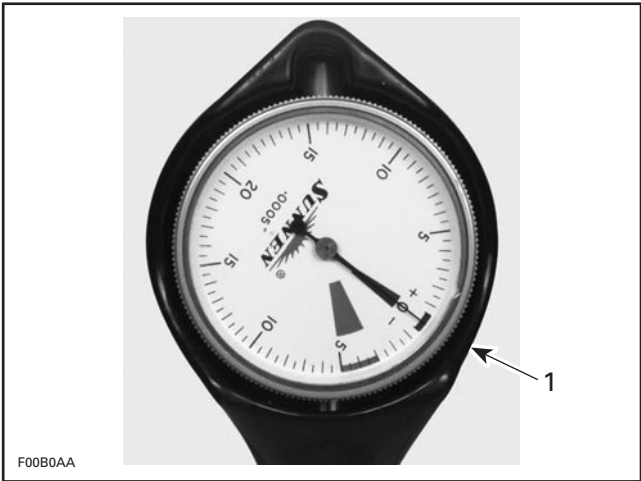
Proceed with FINAL MEASUREMENT PROCEDURE WITH EITHER A USED OR NEW PISTON below.

**Final Measurement Procedure with either a Used or New Piston**

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

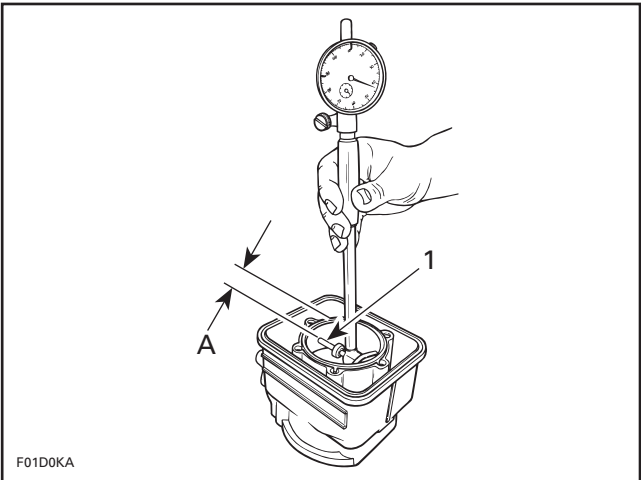


1. Use the micrometer to set the cylinder bore gauge  
2. Dial bore gauge



1. Indicator set to 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.

**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. If clearance exceeds specified tolerance, replace piston.

## Section 01 ENGINE MEASUREMENT

### Subsection 01 (MEASUREMENT PROCEDURES)

**NOTE:** Ring/piston groove clearance can be correctly measured only on rectangular ring which is bottom ring.



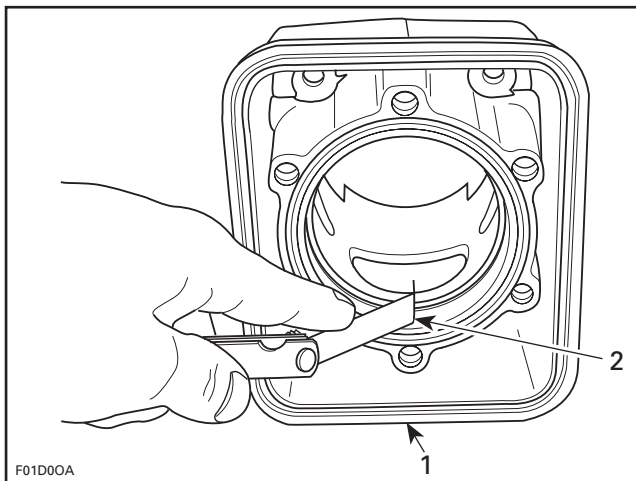
TYPICAL

## RING END GAP

Position ring halfway between exhaust port and top of cylinder.

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

Using a feeler gauge, check ring end gap. If gap exceeds specified tolerance, rings should be replaced.



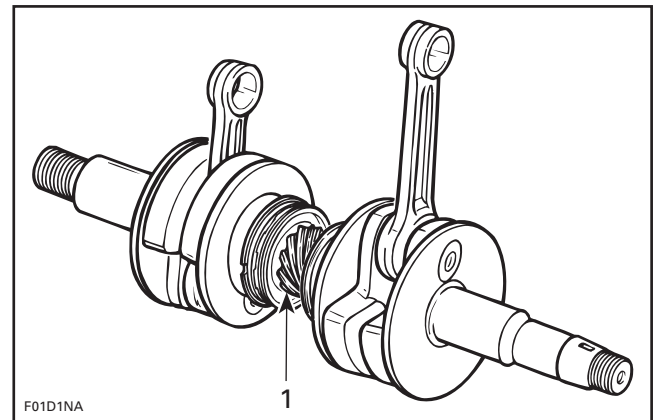
1. Top of cylinder  
2. Ring end gap

## CRANKSHAFT (ASSEMBLED ENGINE)

The following checks can be performed with engine in watercraft without overhauling engine.

### Crankshaft Alignment at Center Main Journal

Since it is an assembled crankshaft it can become misaligned or deflected. Crankshaft can be twisted on center main journal, changing timing of one cylinder in relation with the other.



1. Main journal alignment here

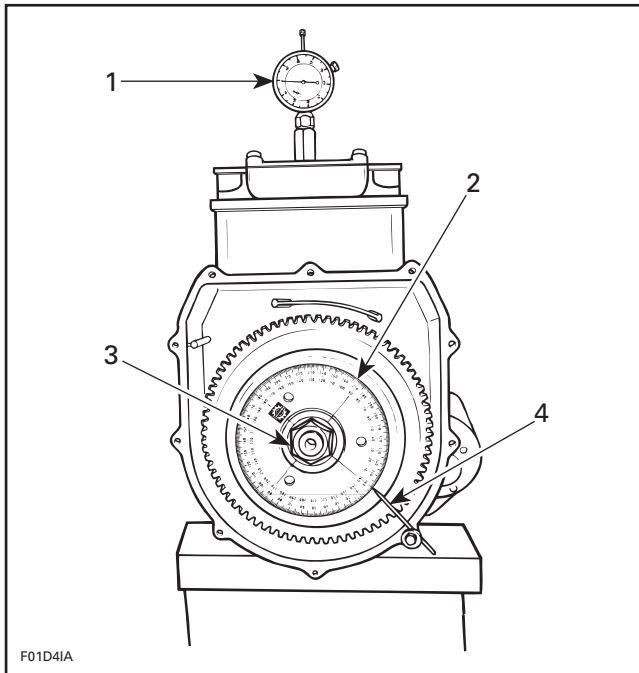
To accurately check if crankshaft is twisted on center main journal, proceed as follows:

- Remove magneto housing cover.
- Remove flywheel nut and magneto roto. Refer to MAGNETO SYSTEM for procedures.
- Install the degree wheel (P/N 529 035 607) on crankshaft end. Hand-tighten nut only.
- Remove both spark plugs.
- Install a TDC gauge in spark plug hole on MAG side.
- Bring MAG piston at Top Dead Center.
- As a needle pointer, secure a wire with a cover screw and a washer.
- Rotate degree wheel (NOT crankshaft) so that needle pointer reads 360°.



## Section 01 ENGINE MEASUREMENT

### Subsection 01 (MEASUREMENT PROCEDURES)



#### TYPICAL

1. TDC gauge
2. Degree wheel
3. Hand tighten nut
4. Needle pointer

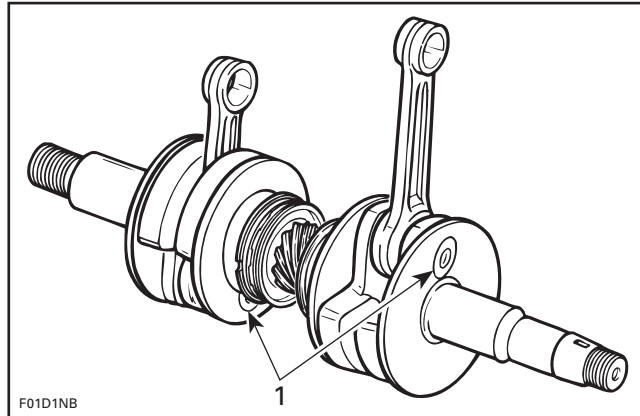
- Remove TDC gauge and install on PTO side.
- Bring PTO piston at Top Dead Center.

Interval between cylinders must be exactly  $180^\circ$  therefore, needle pointer must indicate  $180^\circ$  on degree wheel ( $360^\circ - 180^\circ = 180^\circ$ ).

Any other reading indicates a misaligned crankshaft.

### Crankshaft Alignment at Connecting Rod Journal

Counterweights can also be twisted on connecting rod journal on any or both cylinder(s).



1. Connecting rod journal alignment here

Such misalignment may make it difficult to manually turn the crankshaft. Verification can be done by measuring deflection each end of crankshaft.

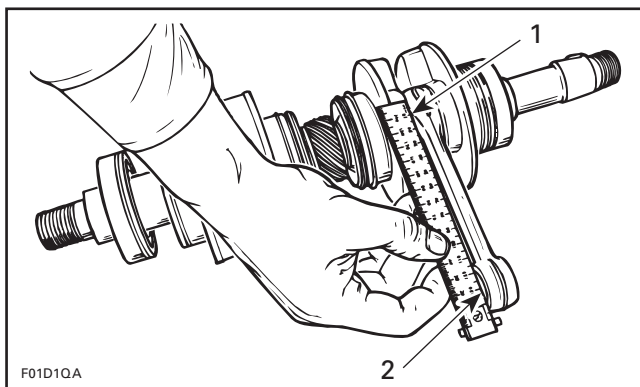
If deflection is found greater than specified tolerance, this indicates worn bearing(s), bent and/or misaligned crankshaft. Proceed with the disassembly of the engine.

### CRANKSHAFT (DISASSEMBLED ENGINE)

The following verifications can be performed with the engine disassembled.

#### Connecting Rod Straightness

Align a steel ruler on edge of small end connecting rod bore. Check if ruler is perfectly aligned with edge of big end.



1. Ruler must be aligned with edge of connecting rod here
2. Align ruler here



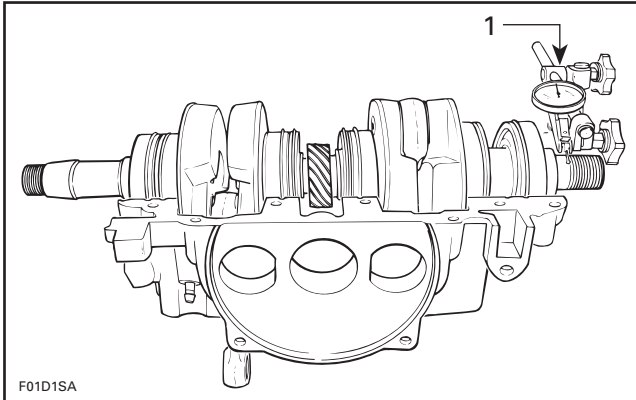
## Section 01 ENGINE MEASUREMENT

### Subsection 01 (MEASUREMENT PROCEDURES)

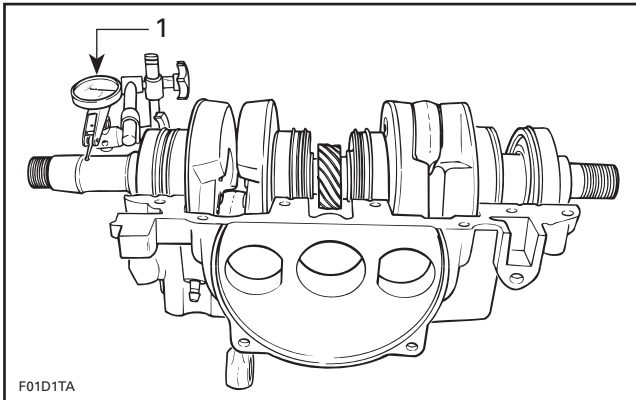
#### Crankshaft Deflection

Crankshaft deflection is measured each end with a dial indicator.

First, check deflection with crankshaft in crankcase. If deflection exceeds the specified tolerance, it can be either ball bearings wear, bent or twisted crankshaft at connecting rod journal.

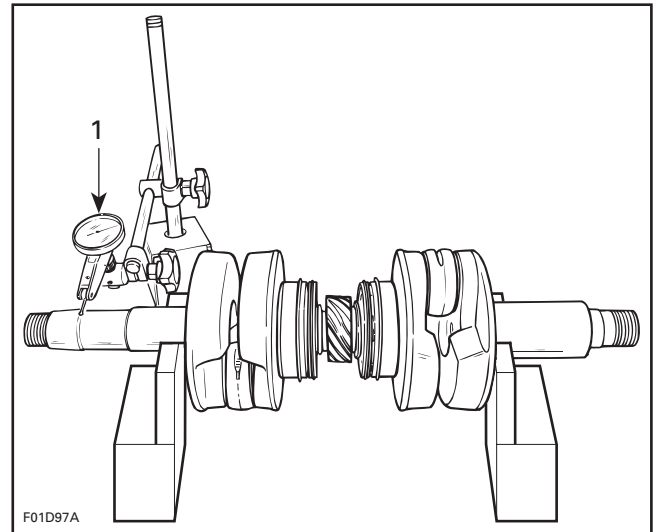


1. Measuring PTO side deflection in crankcase

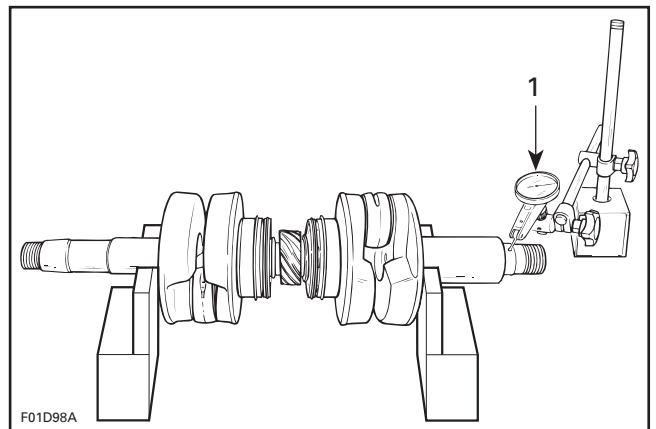


1. Measuring MAG side deflection in crankcase

Remove crankshaft bearings and check deflection again on V-shaped blocks as illustrated.



1. Measuring MAG side deflection on V-shaped blocks



1. Measuring PTO side deflection on V-shaped blocks

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

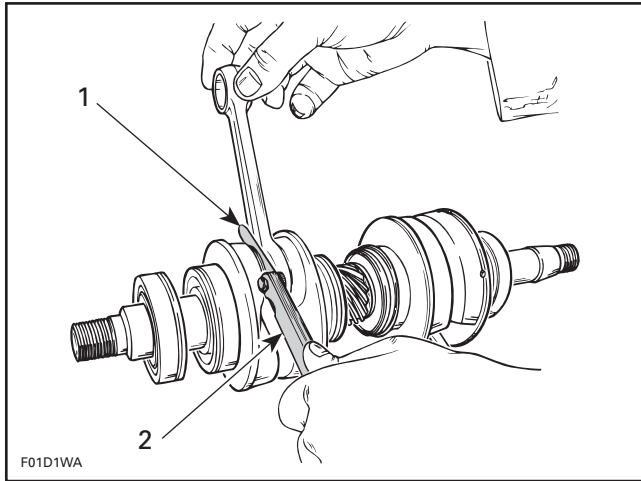
If the deflection exceeds the specified tolerance, crankshaft should be repaired or replaced.

#### Connecting Rod Big End Axial Play

Using a feeler gauge, measure distance between thrust washer and crankshaft counterweight.

## Section 01 ENGINE MEASUREMENT

### Subsection 01 (MEASUREMENT PROCEDURES)



1. Measuring big end axial play
2. Feeler gauge

### Connecting Rod Straightness

Align a steel ruler on edge of small end connecting rod bore. Check if ruler is perfectly aligned with edge of big end.

## ROTARY VALVE

### Rotary Valve/Cover Clearance

#### 45° FEELER GAUGE METHOD

Remove intake manifold from rotary valve cover.

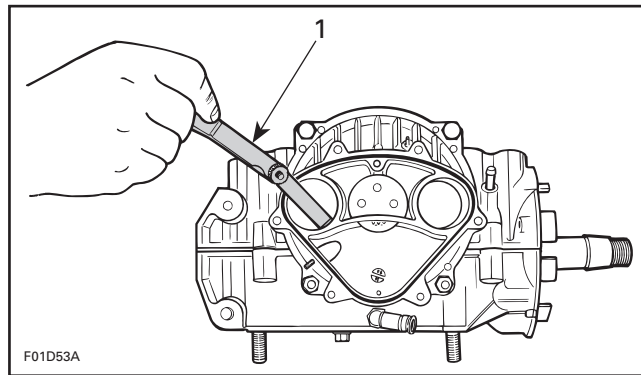
Remove rotary valve cover and valve.

Remove O-ring from rotary valve cover.

Reinstall cover **WITHOUT** its O-ring and torque screws to 20 N•m (15 lbf•ft).

Insert a feeler gauge blade through cover inlet ports to verify clearance. At least verify clearance at two different places in each port.

Feeler gauge blade thickness according to specifications should fit between rotary valve and cover.



1. 45° feeler gauge

If rotary valve cover clearance is out of specifications, machine rotary valve cover seating surface or replace the cover.

### SOLDERING WIRE METHOD

Remove rotary valve cover.

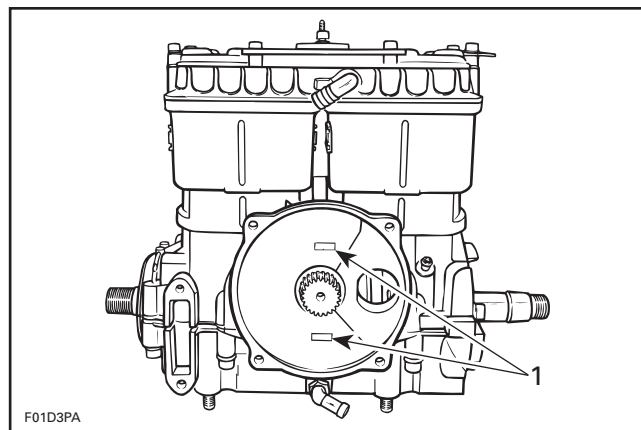
Remove O-ring from rotary valve cover.

Use the following type of solder:

- resin core
- diameter : 0.8 mm (.032 in)
- electronic application (available at electronic stores).

Install 2 soldering wire pieces of 13 mm (1/2 in) long directly on rotary valve, one above and one below rotary valve gear. Apply grease to hold solder in position.

Refer to the following illustration for proper position of rotary valve and pieces of soldering wire.



- TYPICAL**
1. Soldering wires

Reinstall cover **WITHOUT** its O-ring and torque screws to 20 N•m (15 lbf•ft).

## Section 01 ENGINE MEASUREMENT

### Subsection 01 (MEASUREMENT PROCEDURES)

Remove cover then clean and measure compressed soldering wire thickness, it must be within the specified tolerance.

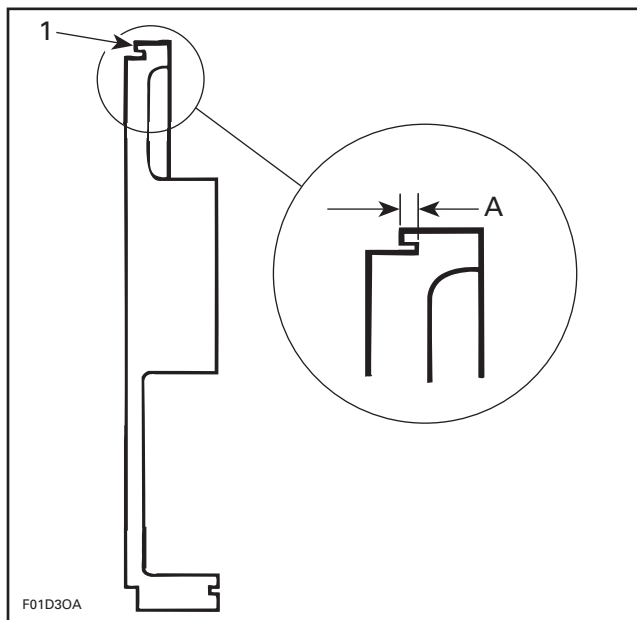
If rotary valve cover clearance is over specified tolerances, machine rotary valve cover seating surface or replace the cover.

#### Machining the Rotary Valve Cover

The amount of material over tolerance must be removed from the rotary valve cover seating surface.

Also cut the O-ring groove the same amount to keep the  $1.00 \pm 0.03$  mm ( $.039 \pm .001$  in) depth between the bottom of the groove and the seating surface.

Remove burrs on the edges of the seating surface and O-ring groove.



**SAME AMOUNT REMOVED FROM COVER SEATING SURFACE AND O-RING GROOVE BASE**

1. Cover seating surface

A. O-ring groove depth must be  $1.00 \pm 0.03$  mm ( $.039 \pm .001$  in)

Reverify the clearance.

At assembly, the rotary valve timing must remain as per original setting.

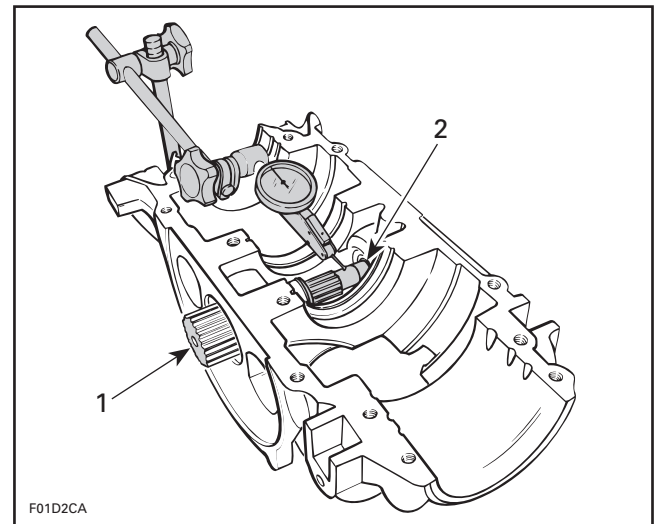
**NOTE:** If rotary valve crankcase surface is worn, it is possible to have it reworked at the factory.

#### Rotary Valve Shaft Deflection

Deflection is measured with a dial gauge. Install rotary valve shaft in crankcase half, without its gear.

**NOTE:** End bearing must be in crankcase half.

Measure shaft deflection next to gear splines.



1. Rotary valve shaft
2. End bearing in place

If the deflection of rotary valve shaft exceeds the specified tolerance, replace it.

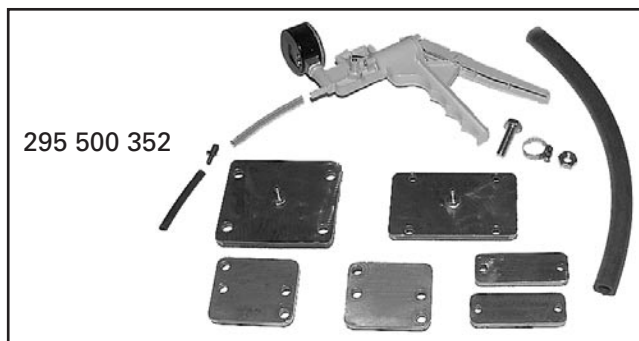
# LEAK TEST

## SERVICE TOOLS

Description	Part Number	Page
engine leak test kit .....	295 500 352 .....	11
large hose pincher .....	529 032 500 .....	13
small hose pincher.....	295 000 076 .....	11–13

## GENERAL

The engine leak test kit (P/N 295 500 352) is available to help diagnose engine problems such as engine seizure, poor performance, oil leakage, etc.



ENGINE LEAK TEST KIT

Before disassembling any components of the engine, it is important to perform a leakage test to determine which part is defective.

It is also very important after servicing the engine, even for a complete engine rebuilt, to perform another leakage test; at this stage, it may avoid further engine problems and minimizing the risk of having to remove and reinstall the engine again.

Static bench testing is the most effective way to conduct a leakage test. Inboard testing does not allow complete access to, and observation of all engine surfaces and should be avoided whenever possible.

On this engine, cylinders can not be verified individually due to leakage from one cylinder to another through a common intake manifold.

When installing hoses of the leak test kit, use the collars provided in the kit to ensure a proper sealing.

When pressurizing the engine, first confirm that the components of the leak test kit are not leaking by spraying a solution of soapy water on all hoses, connections, fittings, plates, etc. If there is a leak, bubbles will indicate leak location.

Three areas of the engine will be tested in sequence as per the diagnostic flow chart (see the end of this subsection).

1. Engine Cooling System.
2. Bottom End and Top End.
3. Rotary Valve Shaft.

**NOTE:** If a leak is found, it is important to continue testing as there is the possibility of having more than one leak. Continue pumping to compensate for the air lost to find another leak.

## PREPARATION

Using the appropriate *VEHICLE SHOP MANUAL*, remove the engine from the vehicle and place it on a bench or an appropriate engine support.

## TESTING PROCEDURE

### Engine Cooling System

Remove the exhaust manifold gasket and ensure the surface is clean.

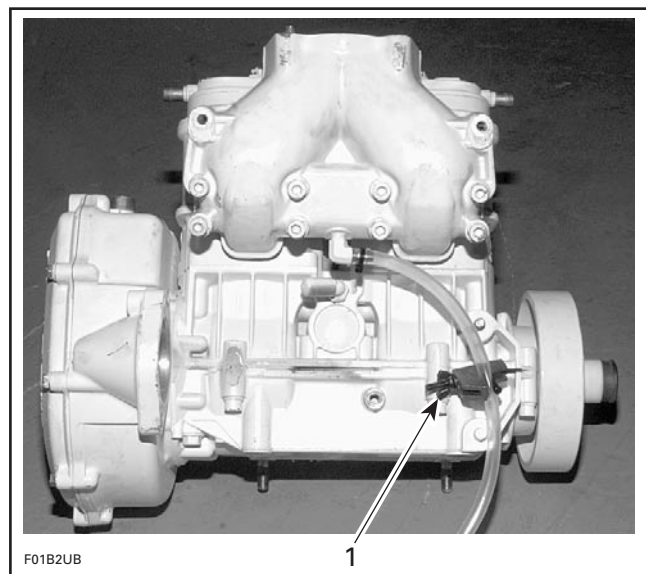
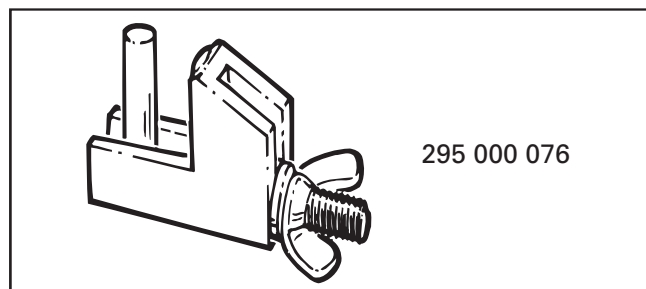
Install the appropriate exhaust manifold plate from the engine leak test kit (P/N 295 500 352). Tighten plate using fasteners provided in the kit.

**NOTE:** Do not torque plate excessively.

Install a small hose pincher (P/N 295 000 076) on engine drain hose.

## Section 02 717 ENGINE

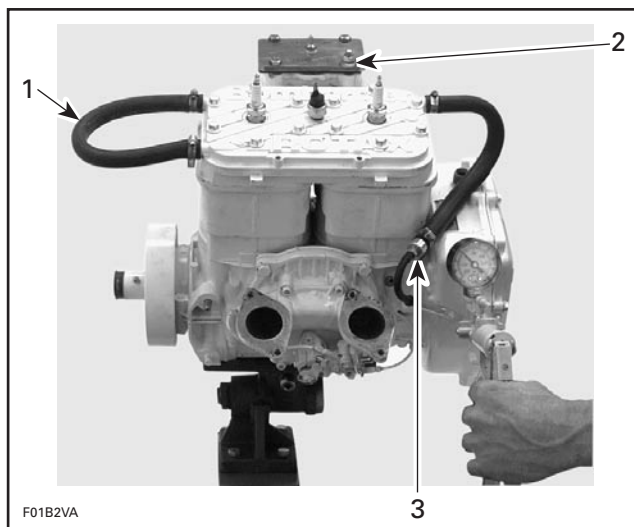
### Subsection 01 (LEAK TEST)



1. Engine drain hose blocked with a hose pincher

Use hoses provided in the kit and install them on the engine.

Install pump using reducer and appropriate tube(s) as necessary.



1. Loop hose and use clamps
2. Use two washers with exhaust manifold stud
3. Hose with adapter and nipple

Activate pump and pressurize engine cooling system to 34 kPa (5 PSI).

Wait 3 minutes and check if pressure drops; if so, verify all testing components.

- If kit components are not leaking and pressure drops, verify all external jointed surfaces, temperature sensor and the O-ring between the spark plug area and the cylinder head cover. If none of these components are leaking, there is an internal leak and it can be detected with BOT-TOM END AND TOP END testing.

### Bottom End and Top End

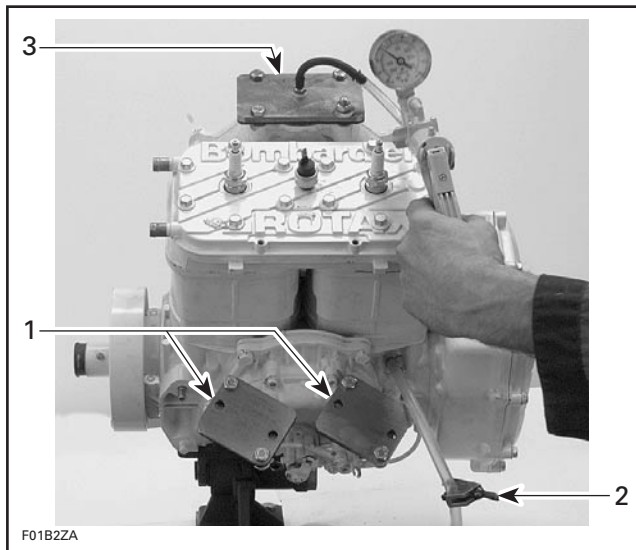
Remove the carburetor and gasket. Make sure the surface of the intake manifold is clean.

Install the intake plate with fasteners from the kit and tighten adequately.

Make sure the spark plugs are installed and tightened.

Block pulse hose using a small hose pincher (P/N 295 000 076).

**NOTE:** Do not block the rotary valve shaft hoses. Install pump to the exhaust plate fitting.



1. Intake plates
2. Pulse hose blocked with a hose pincher
3. Exhaust plate

Activate pump and pressurize engine to 34 kPa (5 PSI).

**CAUTION:** Do not exceed this pressure.

Wait 3 minutes and check if pressure drops; if so, verify all testing components.

If kit components are not leaking, verify engine jointed surfaces as per following areas:

- spark plugs
- cylinder head gasket
- cylinder base gasket
- crankcase halves
- rotary valve cover
- engine plugs
- exhaust manifold
- intake manifold
- oil injection pump.

Check also small oil injection pump lines and fittings; check for air bubbles or oil column going toward pump, which indicate a defective check valve.

If the above mentioned components are not leaking, block both oil hoses of the rotary valve shaft using small hose pincher (P/N 295 000 076) on each side.

**NOTE:** If leakage stops at this point, proceed with ROTARY VALVE SHAFT testing.

If there is still some leakage, remove the PTO flywheel to verify outer seal.

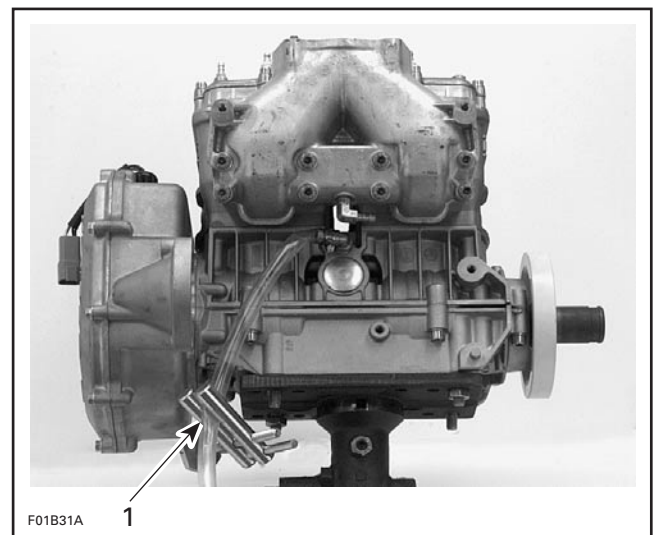
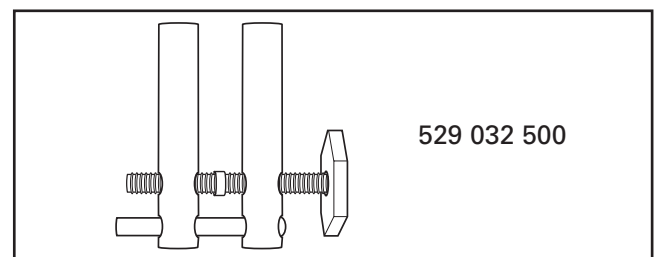
If no leak is found on the PTO side outer seal, remove magneto flywheel and verify crankshaft outer seals.

Proceed with the ROTARY VALVE SHAFT testing if the crankshaft outer seals are not leaking.

### Rotary Valve Shaft

**NOTE:** It is mandatory to drain the injection oil from the rotary valve shaft.

Block oil return hose of the rotary valve shaft with a large hose pincher (P/N 529 032 500).



1. Oil return hose blocked with hose pincher

Install pump with reducer and nipple to the oil supply hose of the rotary valve shaft.



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## Section 02 717 ENGINE

### Subsection 01 (LEAK TEST)

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1. Pump with reducer and nipple

Activate pump and pressurize to 34 kPa (5 PSI).

Check plug of the rotary valve shaft in crankcase.

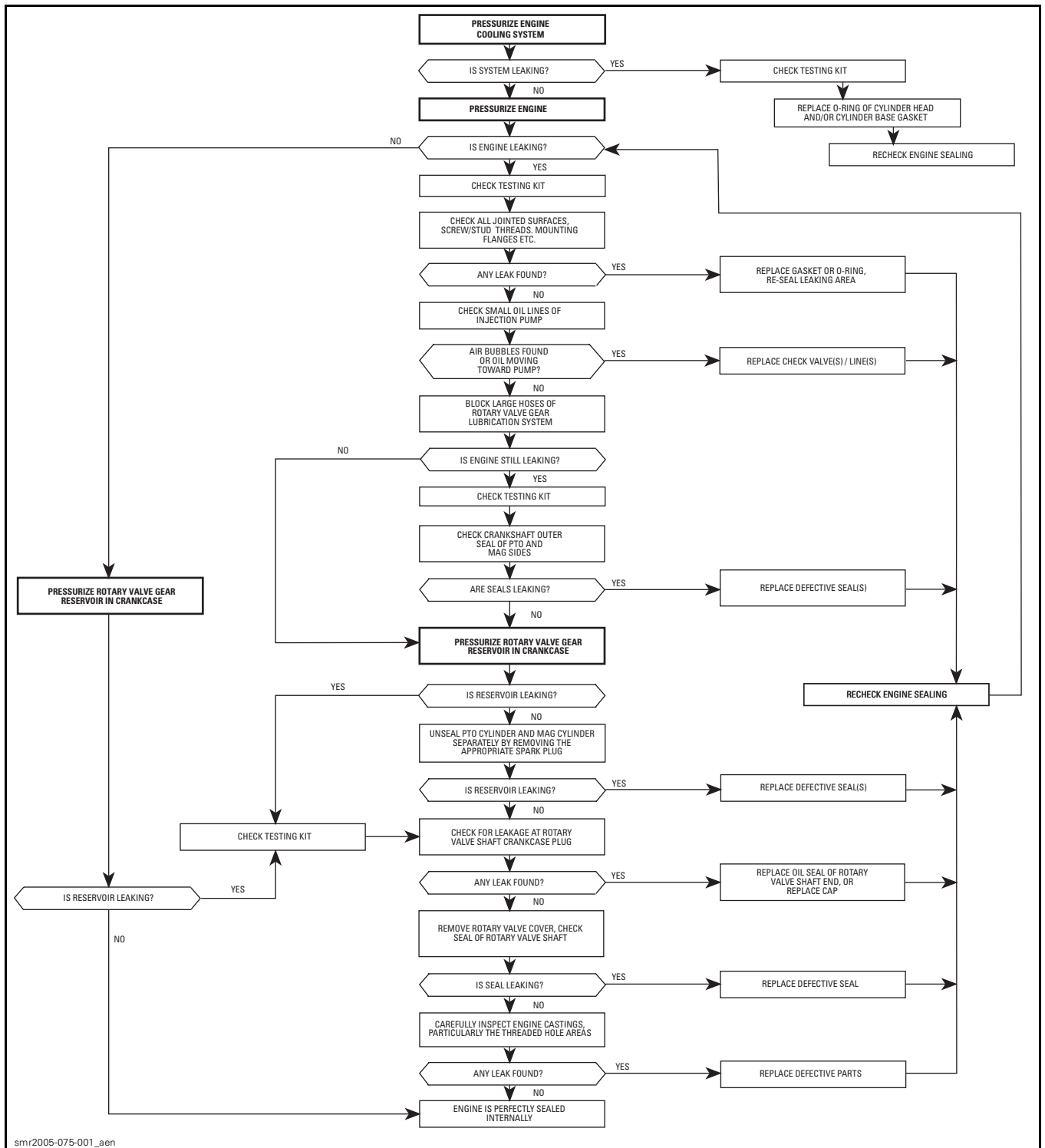
Remove PTO side spark plug. If pressure drops, it indicates a defective PTO side crankshaft inner seal or crankcase is not sealed correctly.

Remove MAG side spark plug. If pressure drops, it indicates a defective MAG side crankshaft inner seal or crankcase is not sealed correctly.

If the above mentioned components are not leaking and there is a pressure drops, remove the rotary valve cover. Check the seal of the rotary valve shaft.

If the rotary valve shaft is not leaking, it could indicate a defective engine casting. Disassemble engine and carefully check for defects in castings. Pay attention to tapped holes which may go through sealed areas of engine and thus lead to leakage.

## ENGINE LEAKAGE DIAGNOSTIC FLOW CHART



# MAGNETO SYSTEM

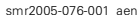
## SERVICE TOOLS

<b>Description</b>	<b>Part Number</b>	<b>Page</b>
extension handle .....	295 000 125 .....	19
M8 x 35 screws .....	420 841 591 .....	19
magneto coil centering tool .....	420 876 922 .....	22
magneto puller .....	529 035 547 .....	19
puller plate .....	420 876 081 .....	19
sleeves .....	420 847 220 .....	19

## SERVICE PRODUCTS

<b>Description</b>	<b>Part Number</b>	<b>Page</b>
anticorrosion spray .....	219 700 304 .....	22
Loctite 243 (blue) .....	293 800 060 .....	22–23
Loctite 648 (green) .....	413 711 400 .....	22
Loctite 767 (antiseize lubricant) .....	293 800 070 .....	23
Loctite chisel (gasket remover) .....	413 708 500 .....	21

## Subsection 02 (MAGNETO SYSTEM)



## DISASSEMBLY

**NOTE:** The magneto system can be disassembled without removing the engine from the watercraft.

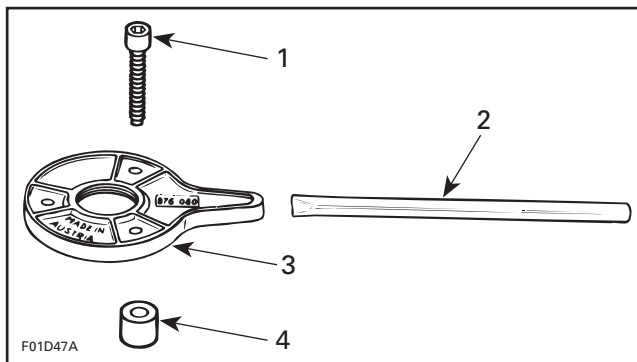
### Magneto Cover

Remove screws **no. 1** and wire support **no. 2**, then withdraw magneto cover **no. 3**.

### Magneto Flywheel and Ring Gear

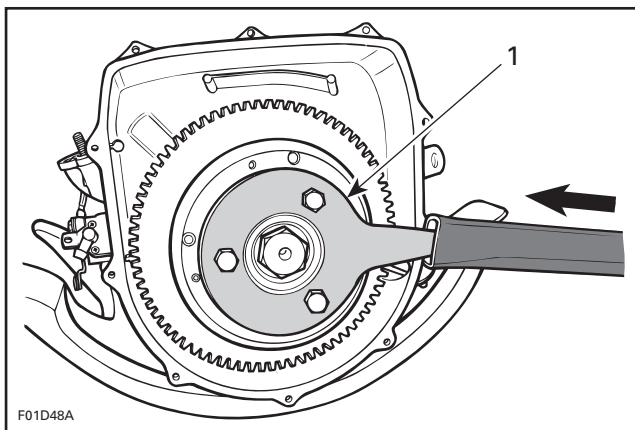
To remove magneto flywheel **no. 4**, lock it with puller plate (P/N 420 876 081), sleeves (P/N 420 847 220) and extension handle (P/N 295 000 125).

Using three M8 x 35 screws (P/N 420 841 591), install screws through puller plate and slide sleeves on screws then secure puller plate on magneto flywheel so that sleeves are against ring gear **no. 5**.



1. Screw
2. Extension handle
3. Puller plate
4. Sleeve

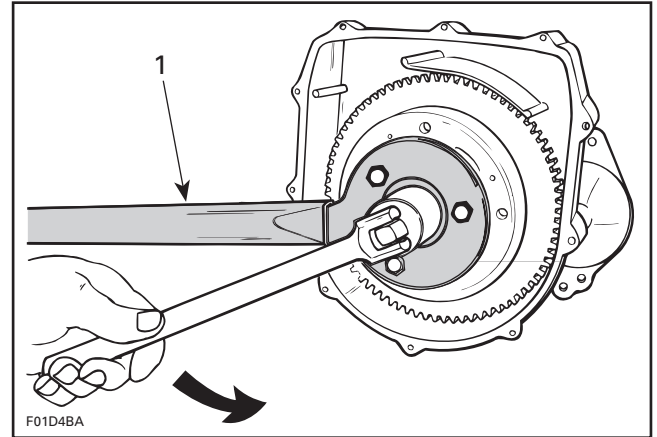
Install extension handle on end of puller plate.



**TYPICAL**  
1. Sleeves on opposite side

Using a suitable socket, unscrew retaining nut **no. 6** COUNTERCLOCKWISE when facing it.

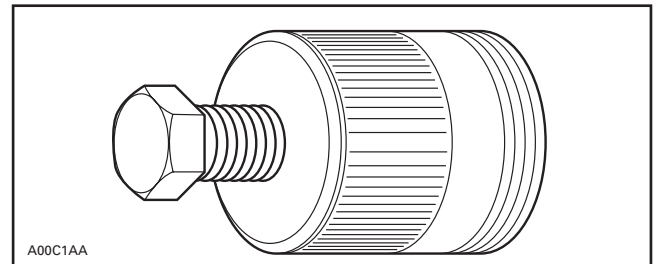
**NOTE:** If socket is found too large to be inserted in puller plate, machine or grind its outside diameter as necessary.



**TYPICAL**  
1. Extension handle locking crankshaft

Remove nut **no. 6** and lock washer **no. 7** from magneto flywheel.

Magneto flywheel is easily freed from crankshaft with magneto puller (P/N 529 035 547).

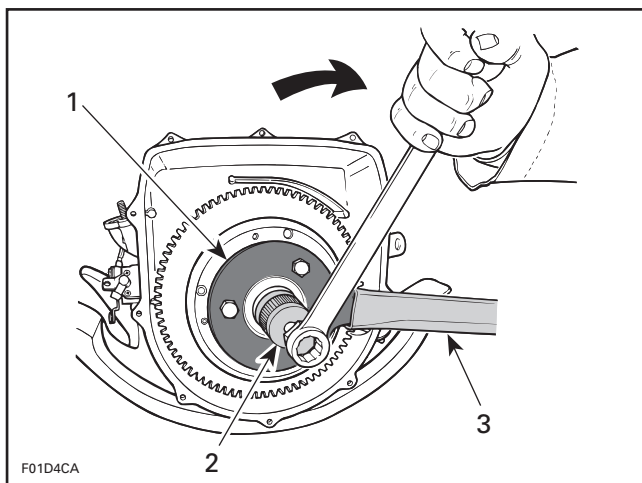


Fully thread on puller in puller plate.

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

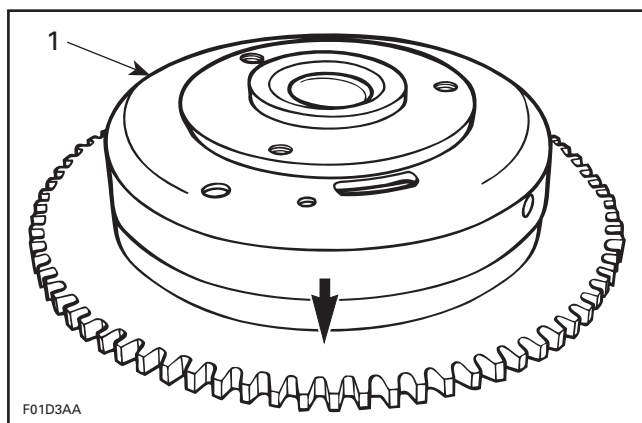
## Section 02 717 ENGINE

### Subsection 02 (MAGNETO SYSTEM)



1. Puller plate
2. Puller
3. Extension handle

Lay magneto flywheel **no. 4** on a steel plate. Tap lightly on ring gear **no. 5** using a hammer to release it from magneto flywheel.



1. Magneto flywheel

### Armature Plate

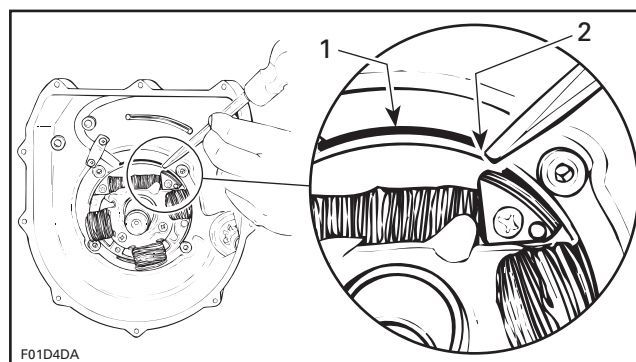
Before removing, locate the manufacturer's reference mark on the armature plate **no. 8** and ensure there is a corresponding indexing mark on the crankcase housing.

**NOTE:** Since replacement crankcases do not have timing mark for armature plate location, indexing marks should be made on armature plate and crankcase to ease reassembly and further ignition timing.

The following procedure is to find a common reference point on both crankcases (old and new) to position armature plate.

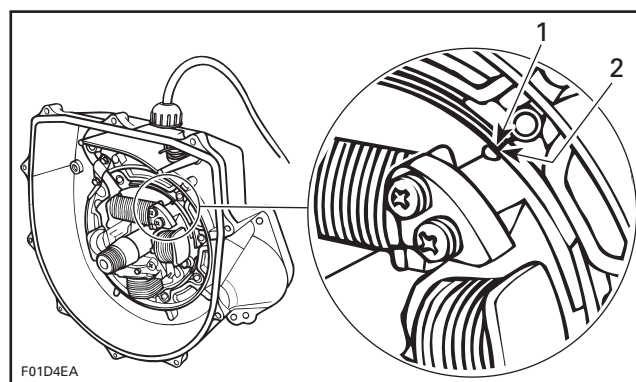
Proceed as follows:

- Before removing the armature plate, find a crankcase locating lug (the top one in this example).
- Place a cold chisel at the end of chosen lug, then punch a mark on armature plate at this point.



1. Crankcase locating lug
2. Mark armature plate at the end of lug

- At assembly, align armature plate mark (previously punched) with the end of the corresponding locating lug on the new crankcase.



### TYPICAL

1. Lug end of crankcase
2. Align mark and lug end here

Remove three retaining screws **no. 9** and withdraw armature plate.

### Magneto Housing

To remove magneto housing **no. 10**, starter has to be removed. Refer to appropriate *VEHICLE SHOP MANUAL*.

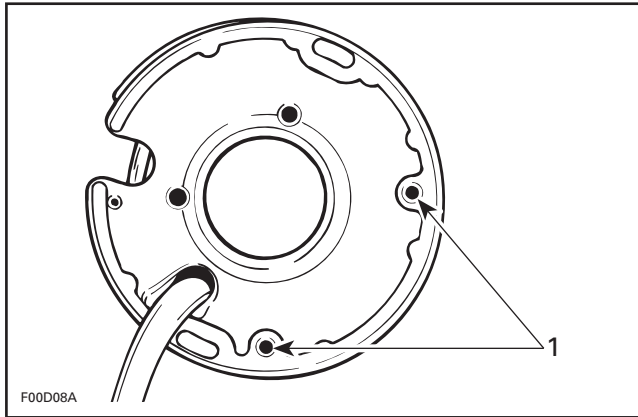
Unscrew retaining screws **no. 11**, then withdraw housing.



### Generating Coil

To replace generating coil no. 12:

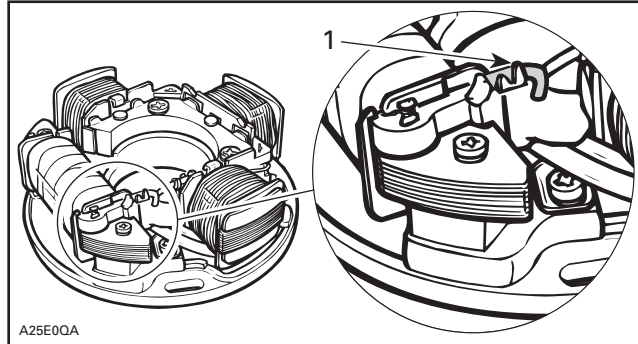
- Heat the armature plate to 93°C (200°F) around the screw holes to break the threadlocker bond.



1. Heat the armature plate

**CAUTION:** Protect harness from flame.

- Remove screws no. 13.
- Uncrimp and unsolder BLACK/RED wire from coil.

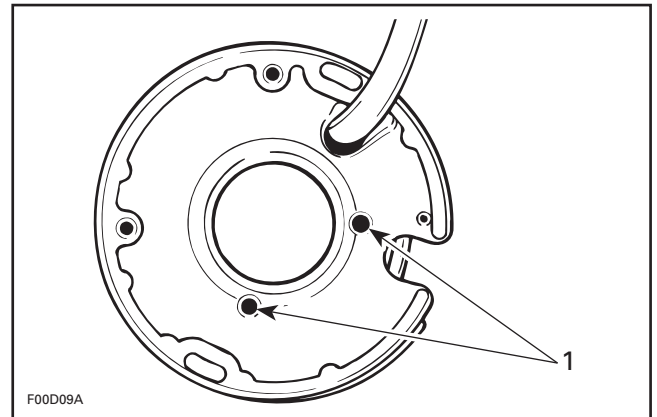


1. Uncrimp and unsolder wire here

### Battery Charging Coil

To replace battery charging coil no. 14:

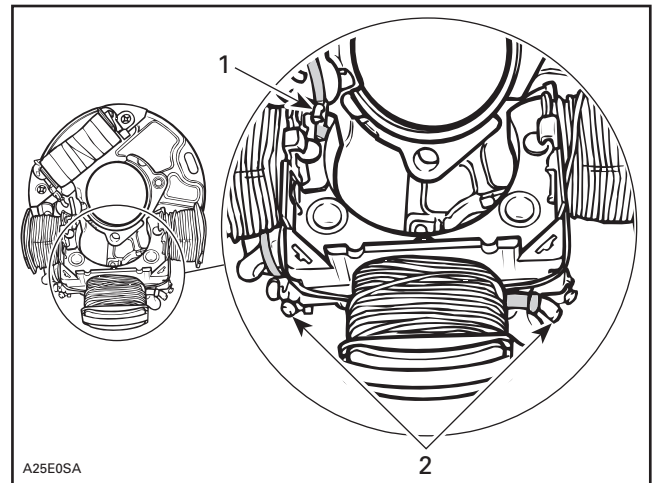
- Heat the armature plate to 93°C (200°F) around the screw holes to break the threadlocker bond.



1. Heat the armature plate

**CAUTION:** Protect harness from flame.

- Remove screws no. 15.
- Uncrimp and unsolder YELLOW and YELLOW/BLACK wires from coil.
- Uncrimp and unsolder ground wire (BLACK) from coil core.



1. Uncrimp and unsolder ground wire (BLACK)  
2. Uncrimp and unsolder YELLOW and YELLOW/BLACK wires

### CLEANING

Clean all metal components in a solvent.

**CAUTION:** Clean coils and magnets using only a clean cloth.

Clean crankshaft taper and threads using Loctite chisel (gasket remover) (P/N 413 708 500). Apply the product on a rag first then clean the crankshaft.

## Section 02 717 ENGINE

### Subsection 02 (MAGNETO SYSTEM)

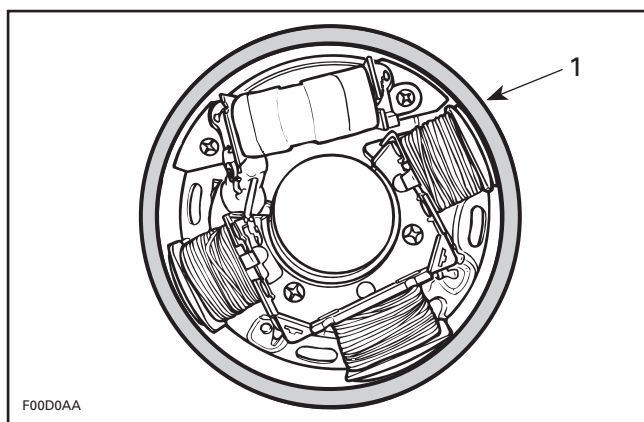
## ASSEMBLY

### Generating Coil

Strip end of old wire then crimp and solder on new coil.

Apply Loctite 243 (blue) (P/N 293 800 060) to screws **no. 13** and install the new coil **no. 12** on armature plate.

Use the magneto coil centering tool (P/N 420 876 922) and install so that it fits around armature plate before tightening screws.



1. Magneto coil centering tool

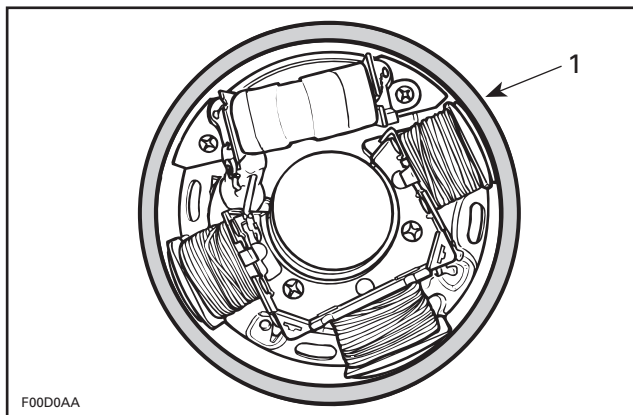
**CAUTION:** Before reinstalling the magneto, remove the loose epoxy from harness.

### Battery Charging Coil

Position new coil **no. 14**, crimp and solder all wires.

Prior to assembly, apply Loctite 243 (blue) (P/N 293 800 060).

Use the magneto coil centering tool (P/N 420 876 922) and install it so that it fits around armature plate before tightening screws **no. 15**.

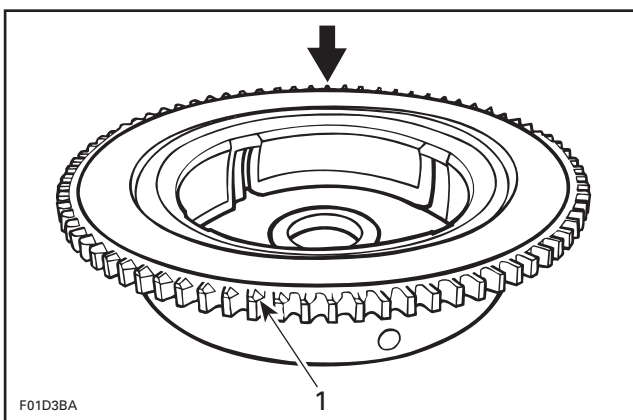


1. Magneto coil centering tool

### Magneto Flywheel and Ring Gear

Apply Loctite 648 (green) (P/N 413 711 400) to magneto flywheel mating surface. Lay ring gear on a steel plate, then heat with a propane torch in order to install it on magneto flywheel.

Pay particular attention to position ring gear teeth chamfer side as per following illustration.



1. Teeth chamfer

**NOTE:** Ensure that ring gear contacts magneto flywheel flange.

Whenever replacing either ring gear or magneto flywheel, anticorrosion spray (P/N 219 700 304) must be applied to prevent possible corrosion.

**CAUTION:** Always assemble magneto flywheel and ring gear prior to apply anticorrosion spray. If not done correctly, ring gear won't contact magneto flywheel flange.

To apply anticorrosion spray proceed as follows:

**NOTE:** Do not spray anticorrosion spray into magneto flywheel threaded holes.

1. Clean thoroughly and degrease replacement part using a non oil base solvent.
2. Apply coating in light thin coats. Refer to the manufacturer's instructions.

### Magneto Housing

Install gasket **no. 16** between magneto housing **no. 10** and engine crankcase.

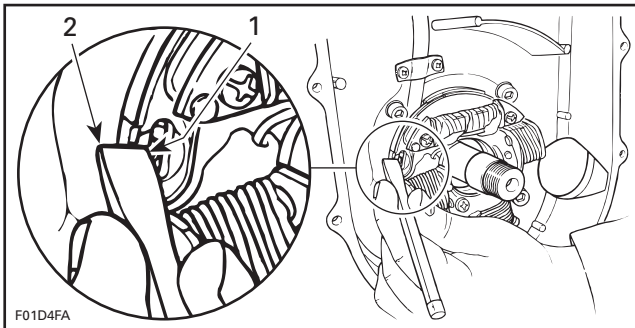
Install magneto housing and torque screws **no. 11** to 9 N•m (80 lbf•in).

### Armature Plate

Position the armature plate on the crankcase, aligning the marks on both parts.

When reinstalling armature plate on a new crankcase housing, proceed as follows.

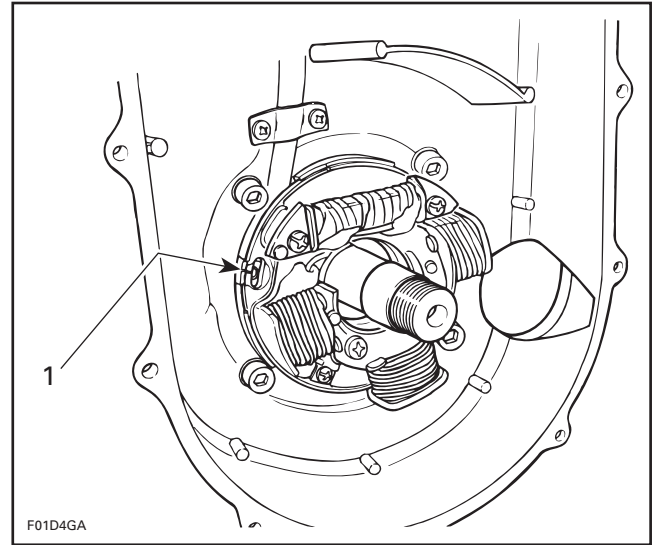
Find manufacturer's mark on armature plate. In line with this mark, punch another mark on adjacent crankcase lug.



**TYPICAL**

1. Manufacturer's mark on armature plate
2. Punch a mark on crankcase lug aligned with plate mark

The new mark on crankcase will be used for further assembly positioning as a pre-timing position.



**TYPICAL**

1. For further assembly, use these marks

Apply a drop of Loctite 243 (blue) (P/N 293 800 060) on threads of screws **no. 9** and torque to 5.5 N•m (49 lbf•in).

### Magneto Flywheel

Apply Loctite 243 (blue) (P/N 293 800 060) on crankshaft taper.

Position Woodruff key and magneto flywheel. Apply Loctite 243 (blue) (P/N 293 800 060) on nut **no. 6**. Install nut with lock washer **no. 7** and torque to 145 N•m (107 lbf•ft).

**CAUTION:** Never use any type of impact wrench at magneto installation.

### Ignition Timing

For ignition timing procedures, refer to appropriate **VEHICLE SHOP MANUAL**.

### Magneto Housing Cover

Properly install O-ring **no. 17** in magneto housing. Apply Loctite 767 (antiseize lubricant) (P/N 293 800 070) on screws **no. 1**, install cover and wire support **no. 2**. Torque screws **no. 1** in a criss-cross sequence to 9 N•m (80 lbf•in).

# TOP END

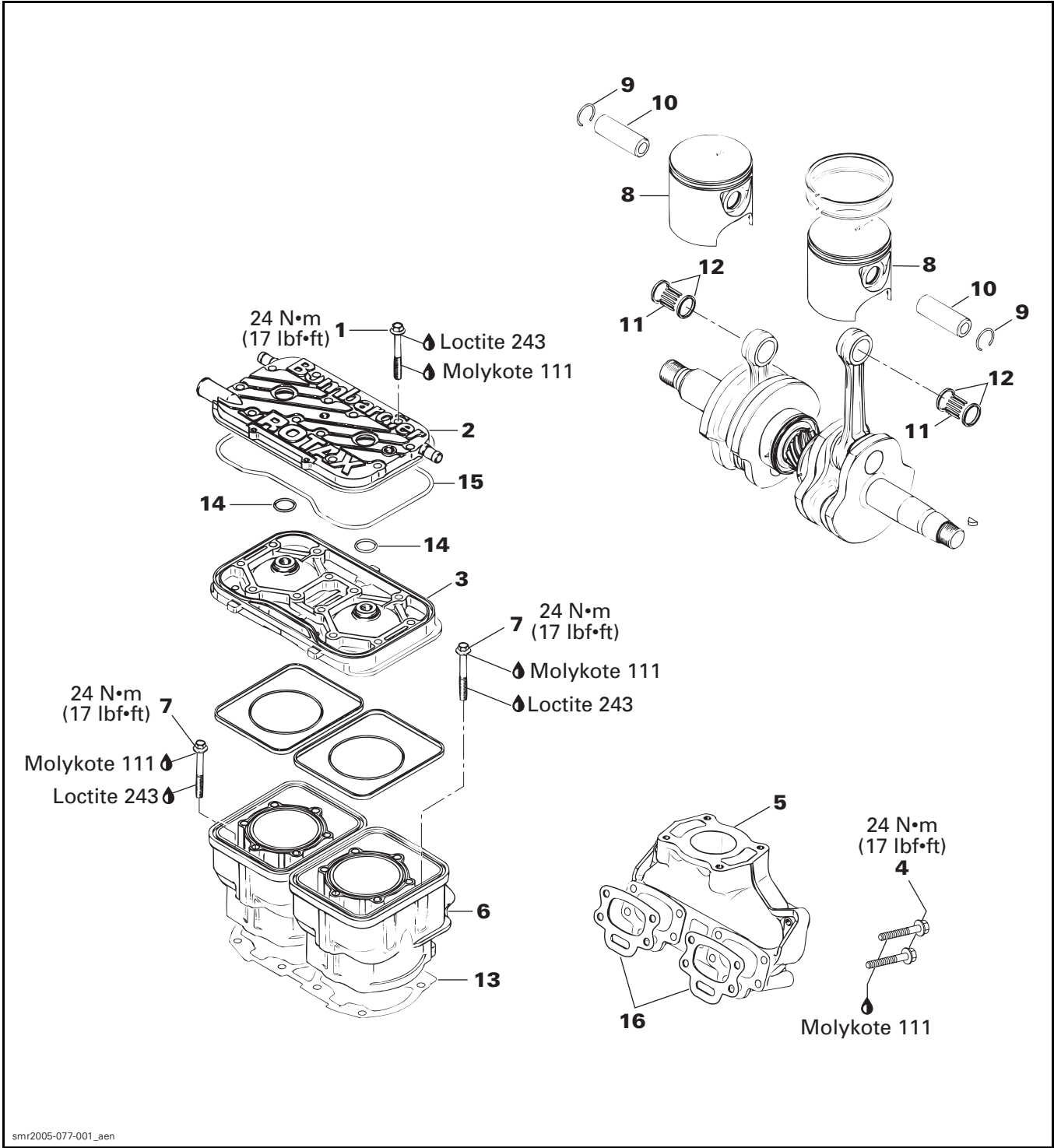
## SERVICE TOOLS

<b>Description</b>	<b>Part Number</b>	<b>Page</b>
aligning tool .....	420 876 904 .....	34
circlip installer .....	529 035 562 .....	32
piston pin puller .....	529 035 503 .....	28, 30
piston ring compressor .....	420 876 979 .....	33
rubber pad .....	295 000 101 .....	27
sleeves .....	529 035 542 .....	28, 30

## SERVICE PRODUCTS

<b>Description</b>	<b>Part Number</b>	<b>Page</b>
Loctite 243 (blue) .....	293 800 060 .....	34–35
Loctite 518 .....	293 800 038 .....	35
Molykote 111 .....	413 707 000 .....	34–35

**Section 02 717 ENGINE**  
**Subsection 03 (TOP END)**



smr2005-077-001\_aen

## GENERAL

The 2-stroke Rotax® engine rotates counterclockwise seen from the rear (PTO flywheel).

The **717 engine** has a rotary valve to control opening and closing of the intake.

## DISASSEMBLY

### Cylinder Head Cover and Cylinder Head

#### Engine in Watercraft

If engine is left in watercraft, refer to the appropriate *VEHICLE SHOP MANUAL* to remove the following components:

- temperature sensor wire
- spark plug cables
- air intake silencer and support.

Proceed with ENGINE ON BENCH WORK below.

#### Engine on Bench Work

Remove cylinder head cover screws **no. 1**.

Remove cylinder head cover **no. 2**.

If shells, sand, salt or any other particles are present in cylinder head, clean with a vacuum cleaner.

Remove cylinder head **no. 3**.

If shells, sand, salt water or any other particles are present in cylinder cooling jacket, clean with a vacuum cleaner.

### Exhaust Manifold

Remove 8 Allen screws **no. 4** then withdraw exhaust manifold **no. 5**.

## Cylinder

**NOTE:** When removing cylinders **no. 6**, make sure connecting rods do not hit crankcase edge.

#### Engine in Watercraft

If engine is left in watercraft, refer to the appropriate *VEHICLE SHOP MANUAL* to remove the tuned pipe.

Proceed with ENGINE ON BENCH WORK.

#### Engine on Bench Work

Remove cylinder head cover **no. 2** and cylinder head **no. 3** as explained above.

Remove exhaust manifold **no. 5**.

Remove cylinder screws **no. 7**.

Remove cylinders **no. 6**, while making sure connecting rods do not hit crankcase edge.

### WARNING

If screws need to be heated for removal when engine is in watercraft, fuel system pressurization must be done first. Do not use open flame; use a heat gun.

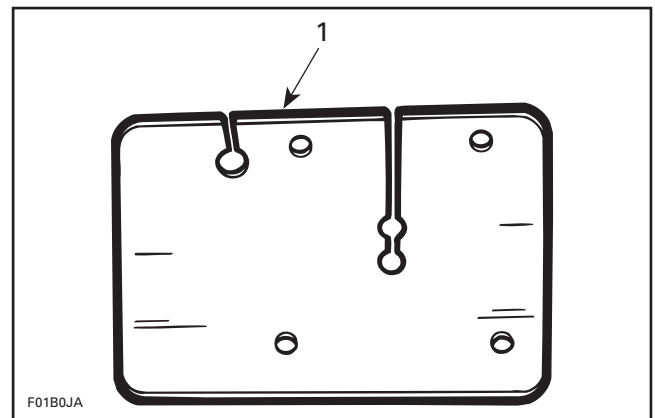
**NOTE:** Even if only 1 cylinder needs repair, both cylinders should be lifted to allow 1-piece cylinder base gasket replacement.

## Piston

**NOTE:** Engine features cageless piston pin bearings.

Remove cylinders **no. 6** as explained above.

Bring piston **no. 8** to Top Dead Center (TDC) and install the rubber pad (P/N 295 000 101) over crankcase opening. Secure with screws. Lower piston until it sits on pad.

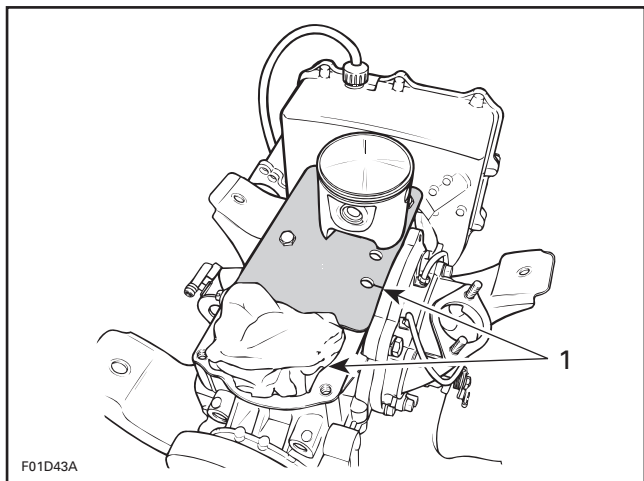


1. Rubber pad

If the other cylinder has been removed, completely cover its opening with a clean rag.

## Section 02 717 ENGINE

### Subsection 03 (TOP END)

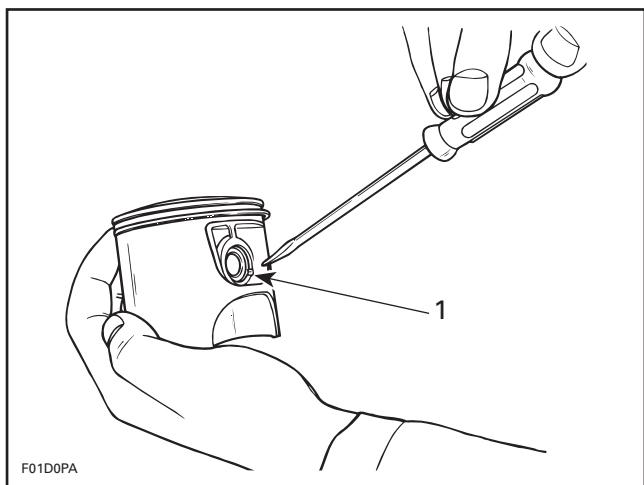


1. Openings covered with rag and rubber pad

To remove circlip **no. 9**, insert a pointed tool in piston notch then pry it out and discard.

#### **WARNING**

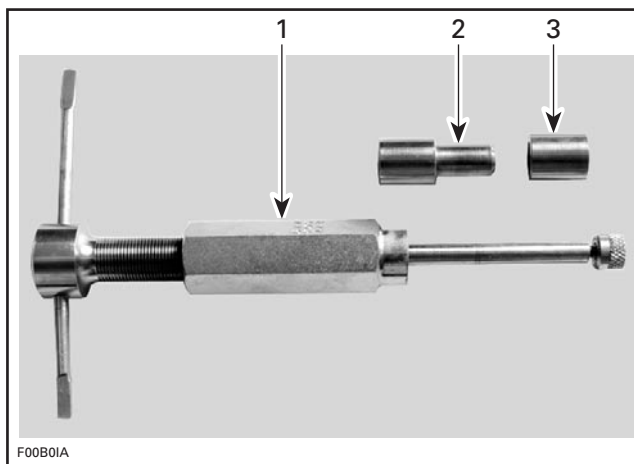
Always wear safety glasses when removing piston circlips.



**TYPICAL**

1. Piston notch

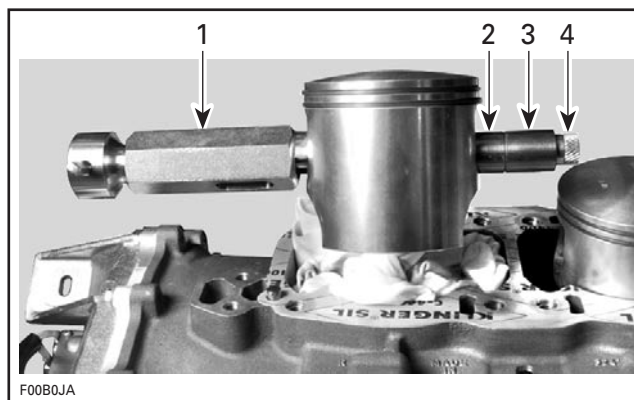
To extract piston pin **no. 10**, use the piston pin puller (P/N 529 035 503) with the sleeves (P/N 529 035 542).



**TYPICAL**

1. Puller  
2. Shoulder sleeve  
3. Sleeve

- Fully thread on puller handle.
- Insert extractor spindle into the piston pin.
- Slide the sleeve and shoulder sleeve onto the spindle.
- Screw in extracting nut with the movable extracting ring toward spindle.



**TYPICAL**

1. Puller  
2. Sleeve  
3. Shoulder sleeve  
4. Extracting nut

**NOTE:** The tool cutout must be positioned toward the bottom of the piston.

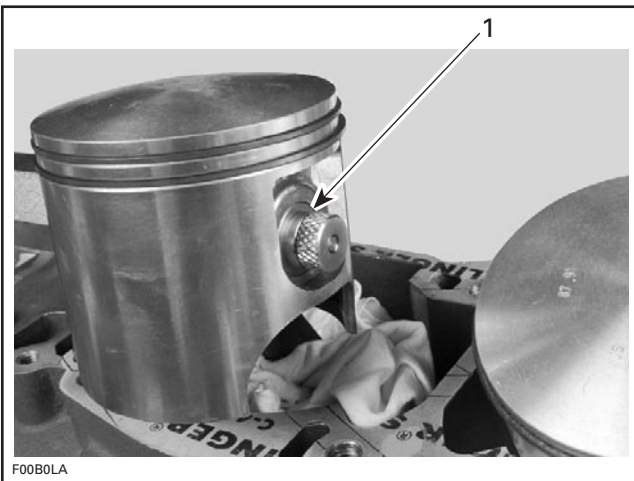




**TYPICAL**

1. Tool cut-out toward bottom of piston

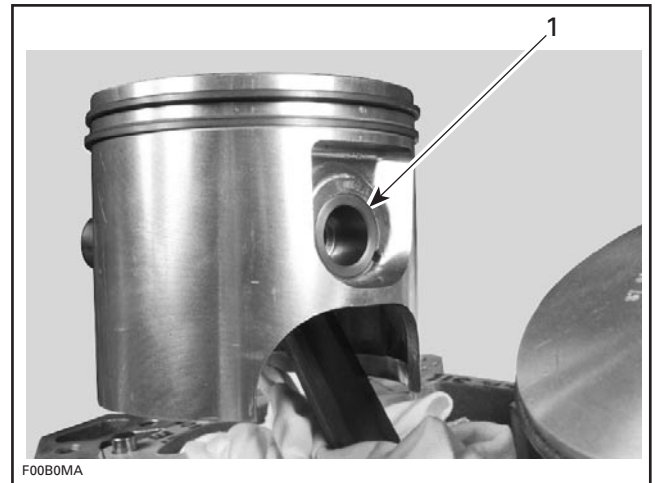
- Firmly hold puller and rotate handle to pull piston pin **no. 10**.
- Rotate spindle until the shoulder sleeve is flushed with the piston recess.



**TYPICAL**

1. Shoulder sleeve flush with piston recess

- Loosen the extracting nut and remove puller.
- Remove the shoulder sleeve from piston.

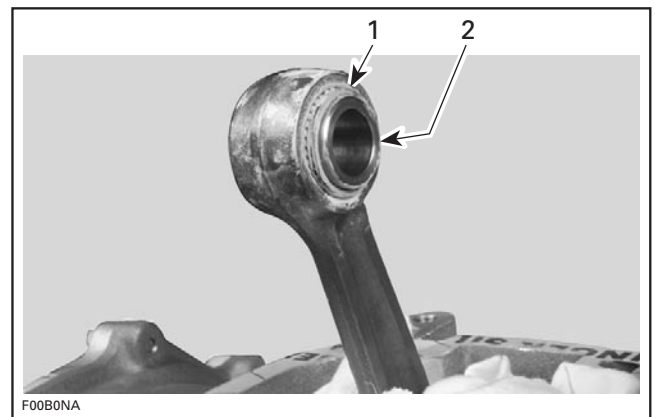


**TYPICAL**

1. Remove shoulder sleeve

Carefully remove the piston **no. 8**.

The needles **no. 11**, thrust washers **no. 12** and the sleeve remain in the connecting rod bore and may be used again.



**TYPICAL**

1. Needles and thrust washer
2. Sleeve

## CLEANING

Discard all gaskets and O-rings.

Clean all metal components in a solvent.

Clean water passages and make sure they are not clogged.

Remove carbon deposits from cylinder exhaust port, cylinder head and piston dome.

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

Section 02 717 ENGINE

Subsection 03 (TOP END)

INSPECTION

Refer to table below to find top end engine dimension specifications. For dimension measurement procedures, refer to ENGINE MEASUREMENT.

Visually inspect all parts for corrosion damage.

Inspect pistons for damage. Light scratches can be sanded with a fine sand paper.

**NOTE:** When repairing a seized engine, connecting rods should be checked for straightness and crankshaft for deflection/misalignment.

Inspect plane surfaces for warpage. Small deformation can be corrected by grinding surface with a fine sand paper. Install sand paper on a surface plate and rub part against oiled sand paper.

ENGINE MEASUREMENT	TOLERANCES		
	NEW PARTS (min.)	(max.)	WEAR LIMIT
Combustion chamber volume	31.2 cc	34.0 cc	N.A.
Cylinder taper	N.A.	0.05 mm (.002 in)	0.1 mm (.004 in)
Cylinder out of round	N.A.	0.008 mm (.0003 in)	0.08 mm (.003 in)
Piston skirt	N.A.	N.A.	0.12 mm (.005 in)
Piston/cylinder wall clearance	0.10 mm (.0039 in)	N.A.	0.20 mm (.008 in)
Ring/piston groove clearance	0.025 mm (.001 in)	0.070 mm (.0027 in)	0.20 mm (.008 in)
Ring end gap	0.25 mm (.010 in)	0.40 mm (.016 in)	1.0 mm (.039 in)

N.A.: NOT APPLICABLE

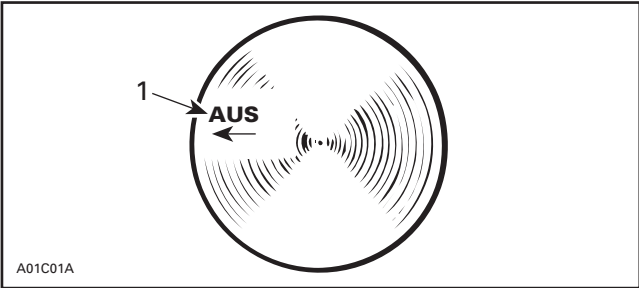
**NOTE:** Replacement cylinder sleeves are available if necessary. Also, oversize pistons of 0.25 mm (.010 in) and 0.5 mm (.020 in) are available.

ASSEMBLY

Assembly is essentially the reverse of disassembly procedures. However pay particular attention to the following.

Piston

At assembly, place the pistons **no. 8** with the letters "AUS" (over an arrow on the piston dome) facing in direction of the exhaust port.



1. Exhaust side

Carefully cover crankcase opening as for disassembly.

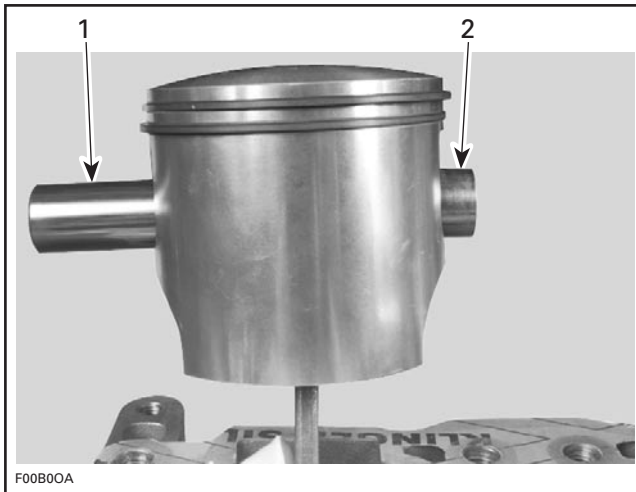
Piston Pin and Roller Bearing

To install roller bearing **no. 11** and piston pin **no. 10** use, piston pin puller (P/N 529 035 503) with the sleeves (P/N 529 035 542).

- Replacement bearings are held in place by a locating sleeve outside and 2 plastic cage halves inside.
- Push needle bearing together with inner halves out of the locating sleeve into the connecting rod bore.
- Replace the inner halves by the appropriate sleeve tool in the connecting rod bore.
- Insert piston pin into piston until it comes flush with inward edge of piston hub.
- Warm piston to approximately 50 - 60°C (122 - 140°F) and install it over connecting rod.

**NOTE:** Make sure thrust washers **no. 12** are present each side of needles.

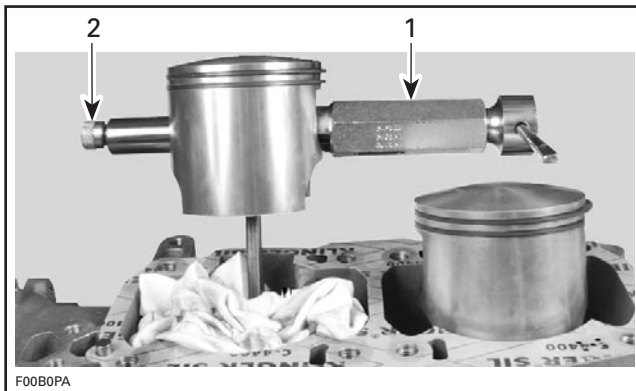
- Install the shoulder sleeve tool on the opposite side of the piston pin.



#### TYPICAL

1. Piston pin
2. Shoulder sleeve

- Insert extractor spindle into the piston pin, screw on extracting nut.



#### TYPICAL

1. Puller installed on the opposite side of the piston pin
2. Tighten extracting nut

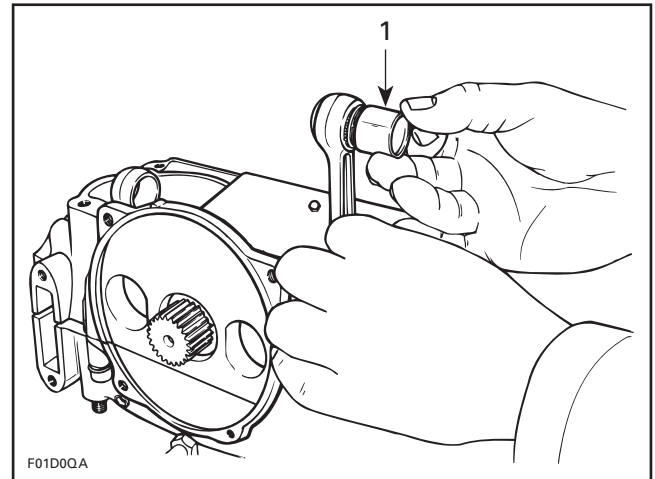
- Rotate handle to pull piston pin carefully into the piston.

#### Plastic Mounting Device Method

This is an alternate method when no service tool is available.

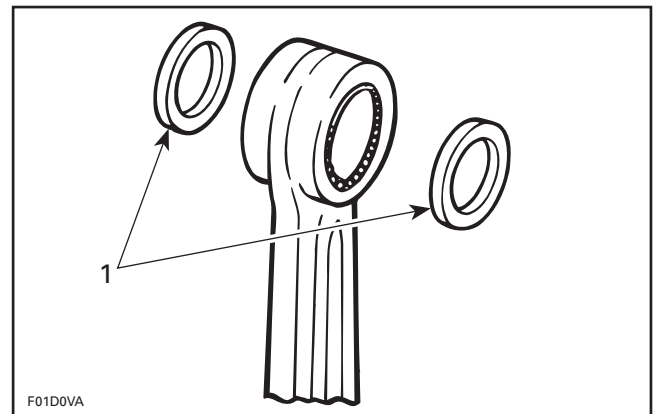
Replacement roller bearings are delivered in a convenient plastic mounting device. For installation, proceed as follows:

- Align replacement roller bearing with connecting rod bore.
- Carefully push inner plastic sleeve into connecting rod bore; outer plastic ring will release rollers.



1. Outer ring removal after inner sleeve insertion into bore

- Make sure thrust washers no. 12 are present each side of rollers.

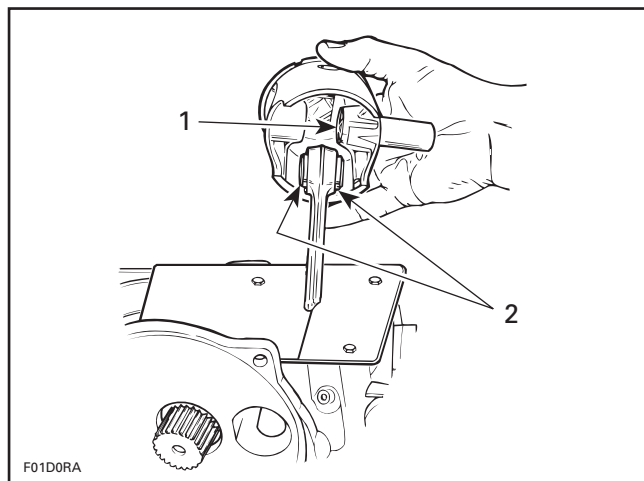


1. Thrust washer each side

- Insert piston pin no. 10 into piston no. 8 until it comes flush with inward edge of piston hub.

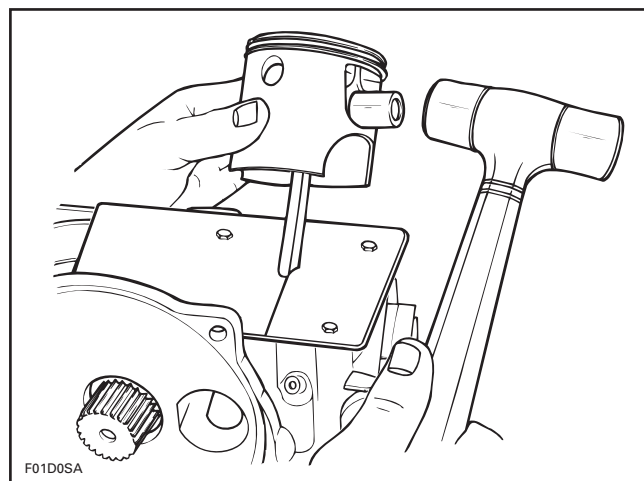
## Section 02 717 ENGINE

### Subsection 03 (TOP END)

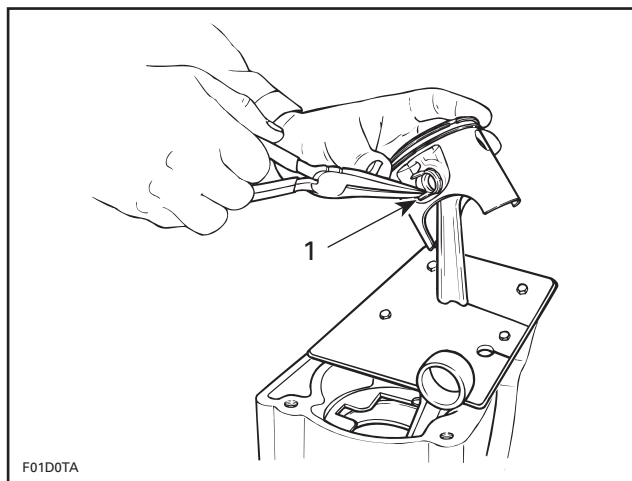


1. Piston pin flush here
2. Thrust washers

- Place piston over connecting rod and align bores, then gently tap piston pin with a fiber hammer to push out inner plastic ring on opposite side. Support piston from opposite side.



- As necessary, pull halves of inner sleeve with long nose pliers.



1. Pulling inner sleeve half

### Circlip

Always use new circlips no. 9.

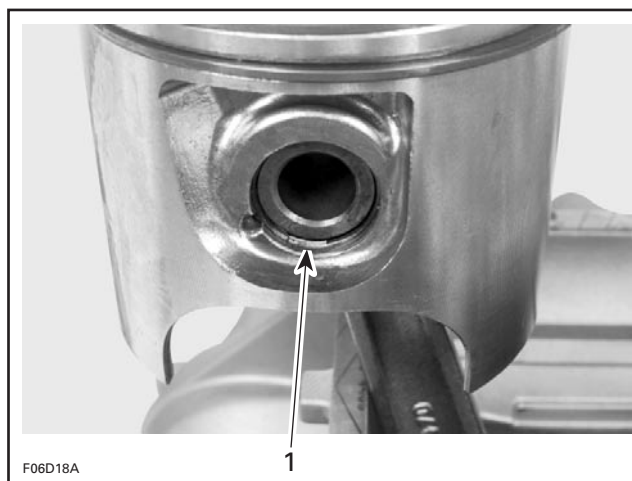
#### **⚠ WARNING**

Always wear safety glasses when installing piston circlips.

**CAUTION:** Always use new circlips. At installation, take care not to deform them. Circlips must not move freely after installation.

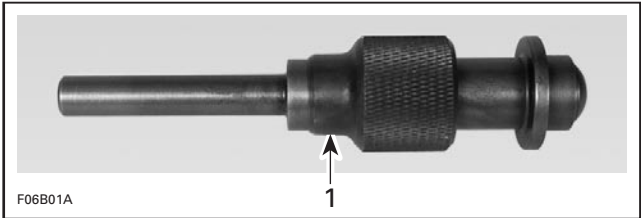
Secure circlip with its opening located at the bottom of the piston.

**CAUTION:** To minimize the stress on the circlips, it is important to install them as described.



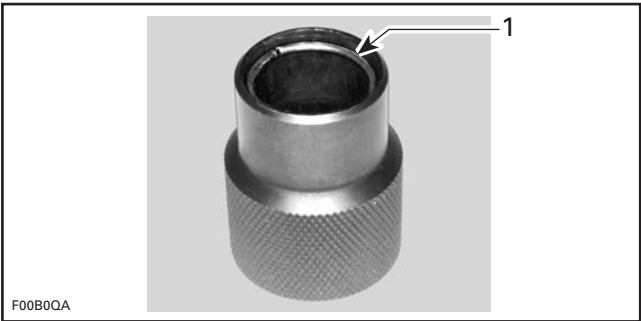
1. Circlip opening at 6 o'clock (at bottom)

To easily insert circlip into piston, use the circlip installer (P/N 529 035 562).



**TYPICAL**  
1. Circlip installer

- Remove sleeve from pusher then insert circlip into its bore.
- Reinstall sleeve onto pusher and push until circlip comes in end of tool.



**TYPICAL**  
1. Circlip near end of tool

- Position end of tool against piston pin opening.
- Firmly hold piston against tool and tap tool with a hammer to insert circlip into its groove.



**TYPICAL**

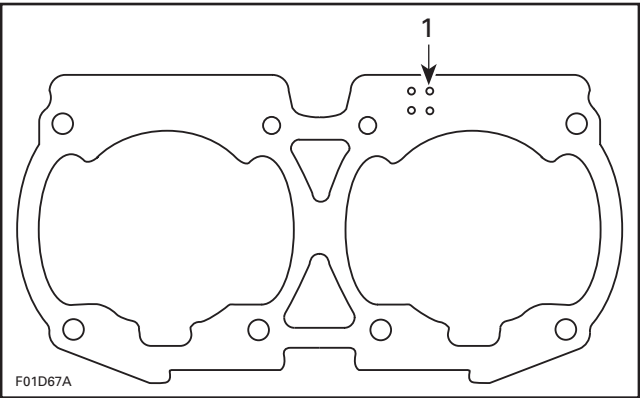
**CAUTION:** The hand retaining the piston should absorb the energy to protect the connecting rod.

### Cylinder Base Gasket

**NOTE:** The general procedure is to install a new gasket of the same thickness. However, if you do not know the gasket thickness that was installed or if a crank repair has involved replacement of connecting rods, refer to COMBUSTION CHAMBER VOLUME MEASUREMENT in ENGINE MEASUREMENT section to properly determine the required gasket thickness.

Different thicknesses of cylinder base gaskets **no. 13** are used for a precise adjustment of the combustion chamber volume.

To identify gasket thickness, refer to the identification holes on the gasket.



**TYPICAL**  
1. Identification holes

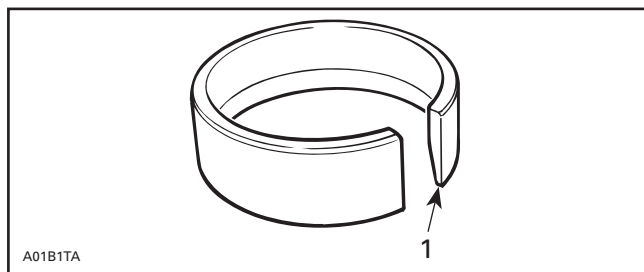
GASKET THICKNESS	IDENTIFICATION HOLES
0.3 mm (.012 in)	3
0.4 mm (.016 in)	4
0.5 mm (.020 in)	5
0.6 mm (.024 in)	6
0.8 mm (.031 in)	8

### Cylinder

To easily slide cylinder **no. 6** over piston **no. 8**, use the piston ring compressor (P/N 420 876 979).

## Section 02 717 ENGINE

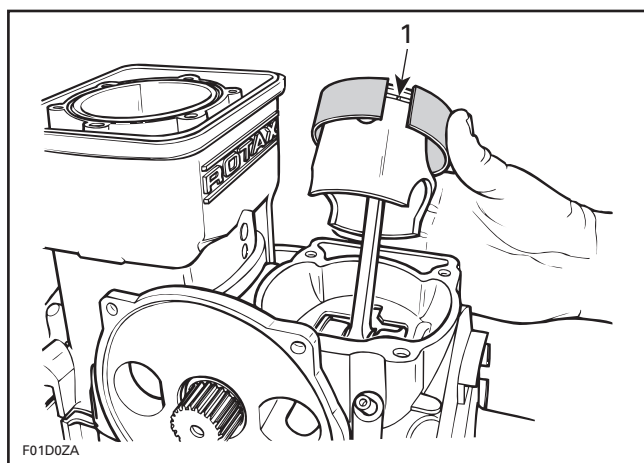
### Subsection 03 (TOP END)



1. Slide this edge

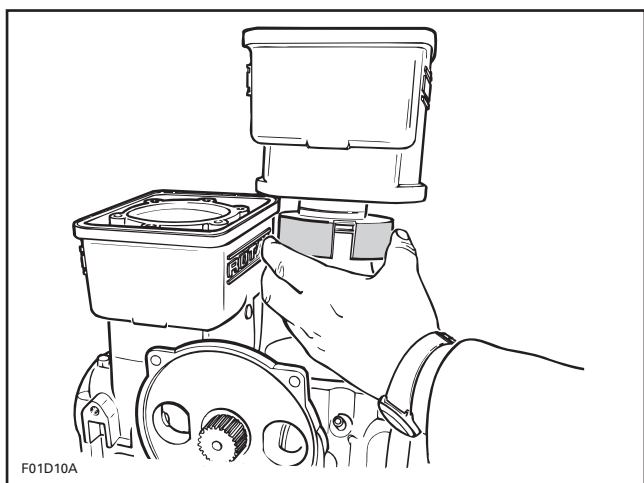
**NOTE:** Ring compressor will not fit on oversize parts.

Make sure to align ring end gap with piston locating pin. Slide tool over rings.



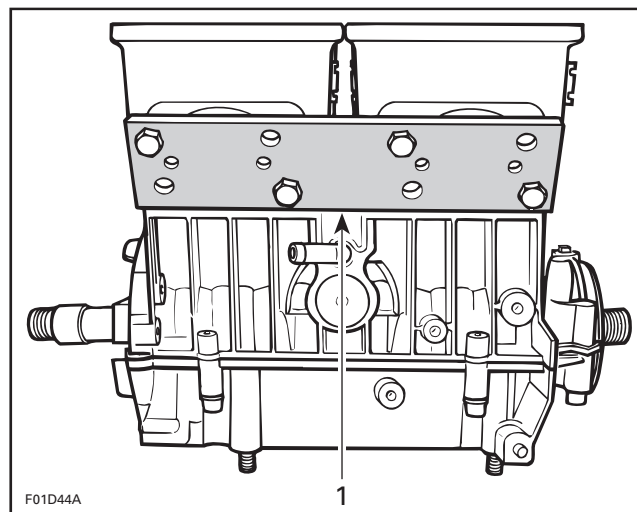
1. Ring end gap aligned with piston locating pin

Slide cylinder over piston.

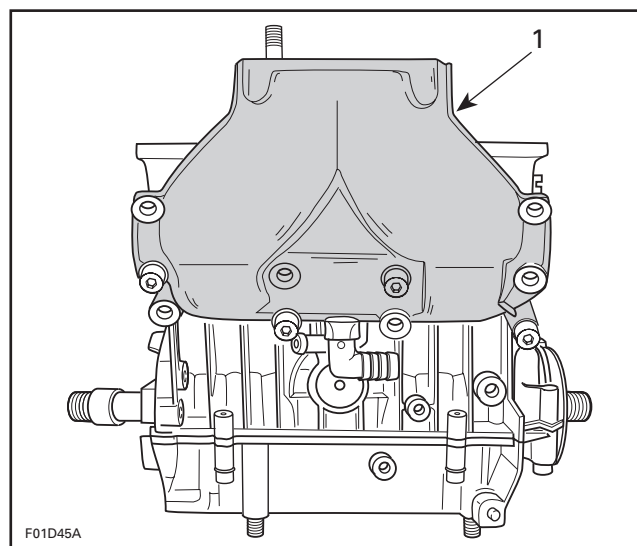


When reassembling cylinders to crankcase, it is important to have them properly aligned so that exhaust flanges properly match up with exhaust manifold **no. 5**.

The aligning tool (P/N 420 876 904) or the exhaust manifold can be used to align cylinders.



1. Exhaust flange aligning tool



1. Aligning cylinders using exhaust manifold

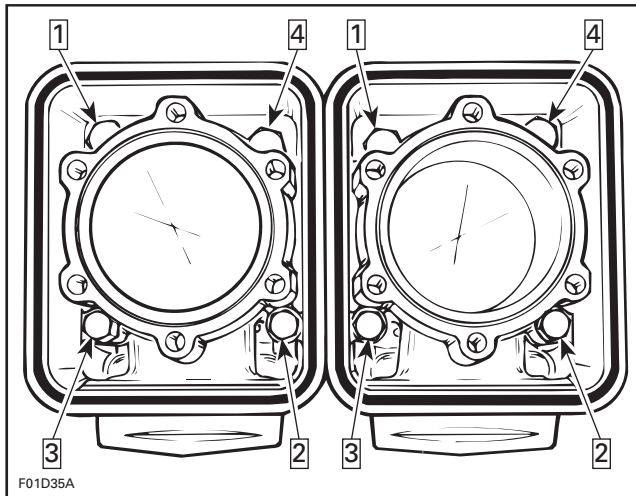
### Cylinder Screw

Apply Molykote 111 (P/N 413 707 000) below the screw head.

Apply also Loctite 243 (blue) (P/N 293 800 060) on screw threads.

Install and torque screws **no. 7** in a criss-cross sequence for each cylinder to 24 N•m (17 lbf•ft). Refer to the following illustration.

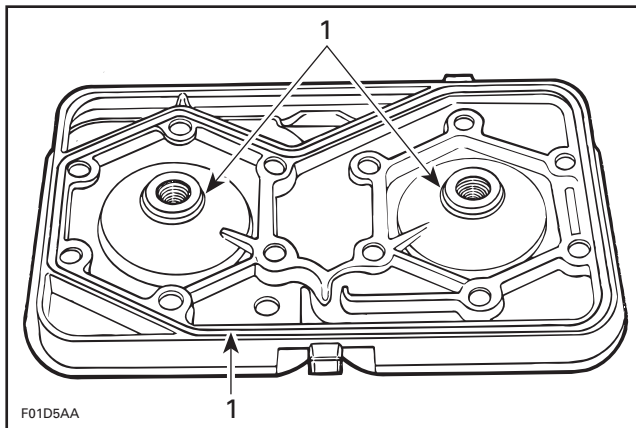




### Cylinder Head

Install cylinder head gasket.

Make sure to install O-rings **no. 14** around spark plug holes and O-ring **no. 15** of cylinder head as shown in the following illustration.



1. O-rings

Apply Loctite 518 (P/N 293 800 038) in O-ring groove of cylinder sleeves.

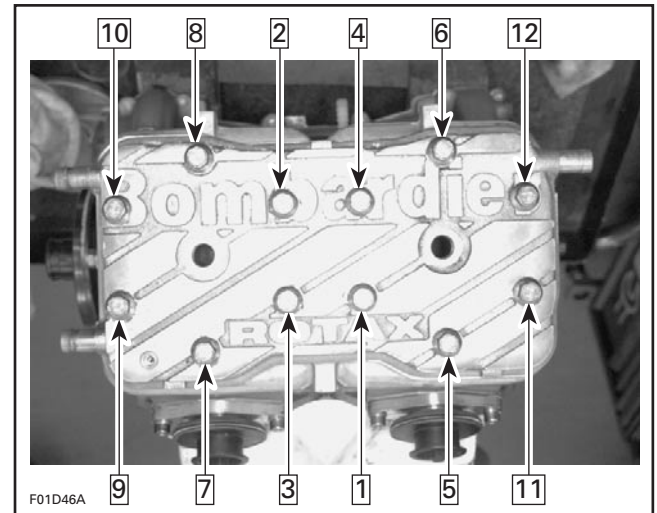
### Cylinder Head Cover

Install cylinder head cover **no. 2**.

Apply Loctite 243 (blue) (P/N 293 800 060) below head of screws **no. 1**.

Apply also Molykote 111 (P/N 413 707 000) on threads of screws **no. 1**.

Torque cylinder head screws **no. 1** to 12 N•m (106 lbf•in) as per following illustrated sequence. Repeat the procedure, retightening all screws to 24 N•m (17 lbf•ft).



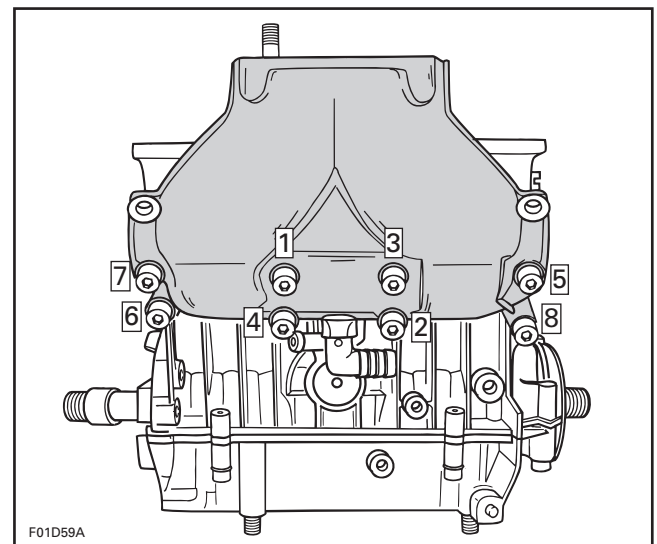
TORQUING SEQUENCE

### Exhaust Manifold

Make sure gaskets are properly positioned prior to finalizing manifold installation.

Apply Molykote 111 (P/N 413 707 000) on threads of exhaust manifold screws **no. 4**.

Install exhaust manifold **no. 5** and torque screws to 24 N•m (17 lbf•ft) as per following illustrated sequence.



# BOTTOM END

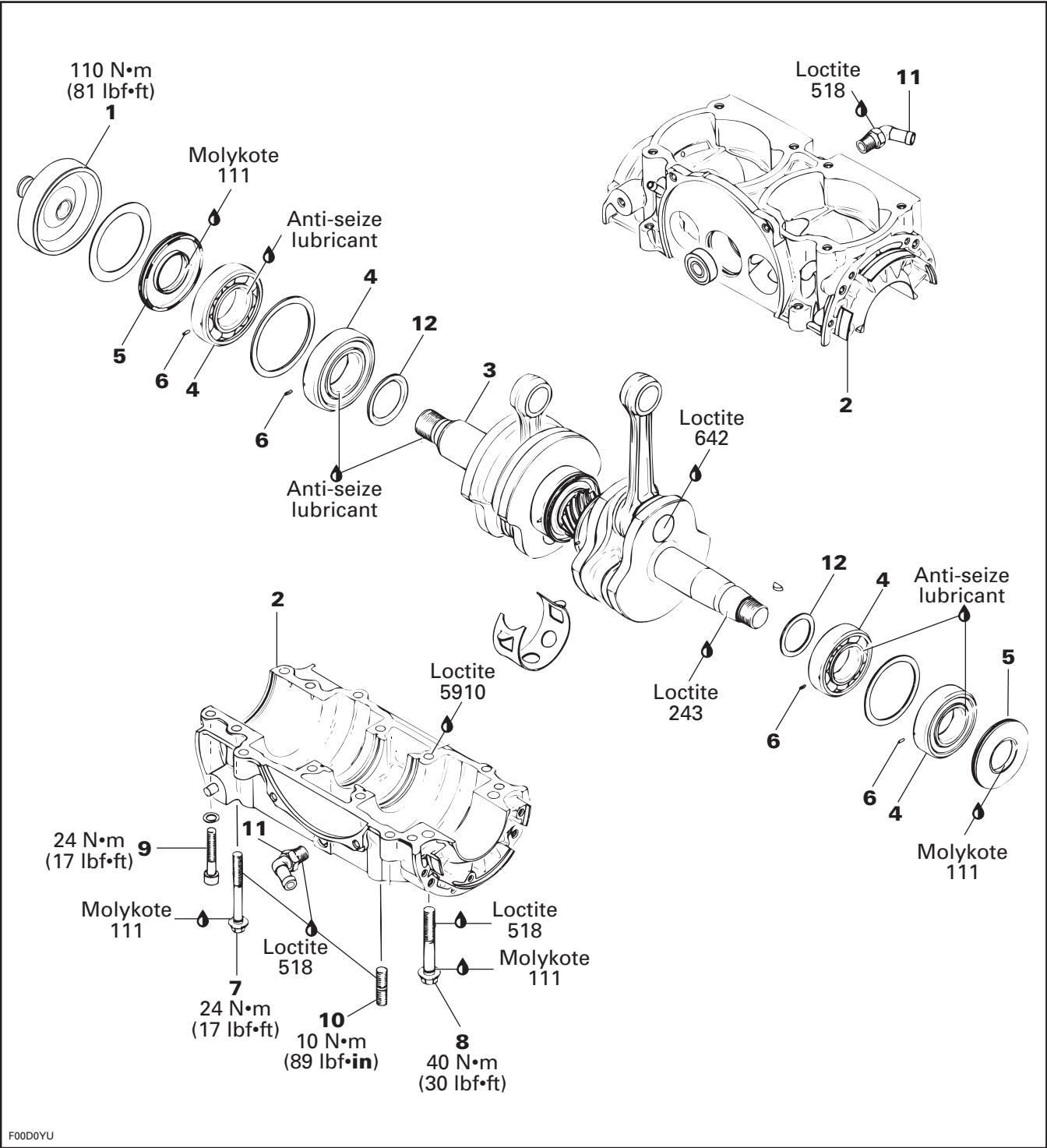
## SERVICE TOOLS

Description	Part Number	Page
bearing heater.....	529 035 969 .....	43
distance gauge .....	529 034 800 .....	44
Distance ring.....	420 876 569 .....	41
MAG side ring halves .....	420 276 025 .....	41
Protective cap.....	420 876 557 .....	41
PTO flywheel remover.....	295 000 001 .....	39
PTO side ring halves.....	420 977 475 .....	41
Puller.....	420 877 635 .....	41
Ring .....	420 977 490 .....	41
Screw M8 x 40 .....	420 840 681 .....	41
Screw M8 x 70 .....	420 841 201 .....	41
temperature indicator stick.....	529 035 970 .....	44

## SERVICE PRODUCTS

Description	Part Number	Page
chisel gasket remover .....	413 708 500 .....	42
Loctite 518.....	293 800 038 .....	46
Loctite 5910.....	293 800 081 .....	45
Loctite 767 (antiseize lubricant) .....	293 800 070 .....	44, 46
Molykote 111.....	413 707 000 .....	45–46
pulley flange cleaner.....	413 711 809 .....	41

**Section 02 717 ENGINE**  
**Subsection 04 (BOTTOM END)**



F00D0YU

## GENERAL

Engine has to be removed from watercraft to take apart bottom end. Refer to appropriate *VEHICLE SHOP MANUAL*.

Engine top end has to be disassembled to take apart bottom end. Refer to TOP END section in this manual.

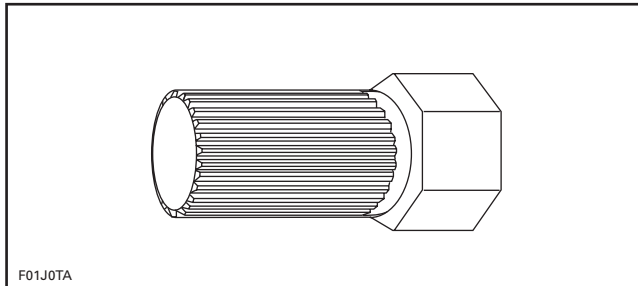
**NOTE:** Crankcase halves are factory matched and therefore, are not interchangeable or available as single halves.

## DISASSEMBLY

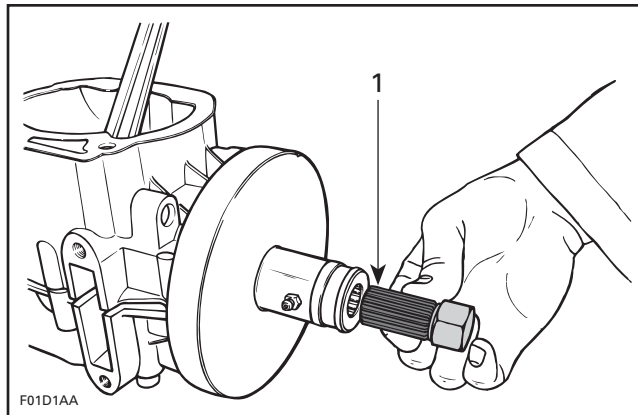
### PTO Flywheel

To remove PTO flywheel **no. 1**, the crankshaft must be locked. Refer to MAGNETO SYSTEM and follow the procedure to lock the magneto flywheel.

PTO flywheel is loosen using the PTO flywheel remover (P/N 295 000 001).

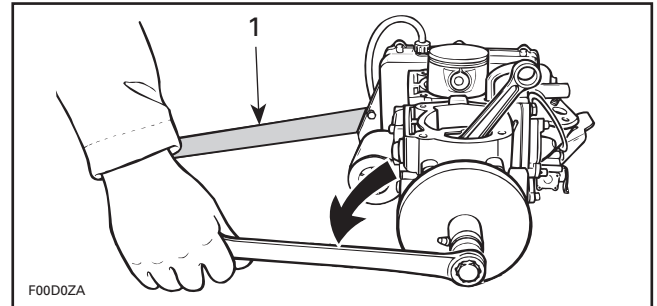


Insert special tool in PTO flywheel splines.



**TYPICAL**  
1. PTO flywheel remover

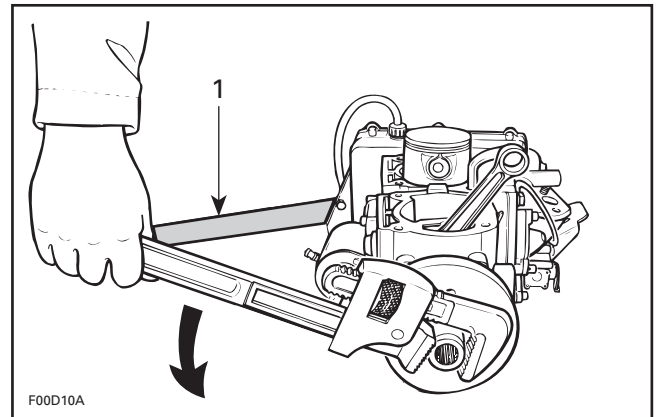
Using a suitable wrench or socket with a breaker bar, unscrew PTO flywheel **COUNTERCLOCKWISE** when facing it and hold extension handle locking the magneto flywheel.



**TYPICAL**  
1. Extension handle locking crankshaft

**NOTE:** When splines of PTO flywheel are worn out and special tool cannot be used, proceed with the following alternate method.

Use a pipe wrench and install it on PTO flywheel as illustrated.



**TYPICAL**  
1. Extension handle locking crankshaft

### Crankshaft End Seals

If crankshaft end seals **no. 5** have to be replaced, bottom end must be opened. Refer to CRANKCASE and CRANKSHAFT END BEARINGS below.

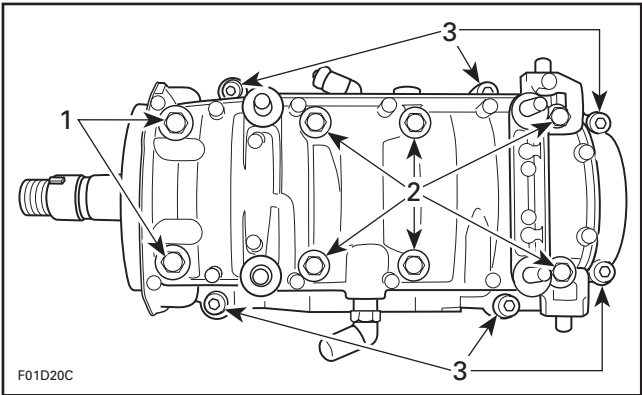
### Crankcase

Before opening crankcase **no. 2**, remove the following parts:

- engine supports
- magneto flywheel and housing, refer to MAGNETO SYSTEM section

**Section 02 717 ENGINE**  
**Subsection 04 (BOTTOM END)**

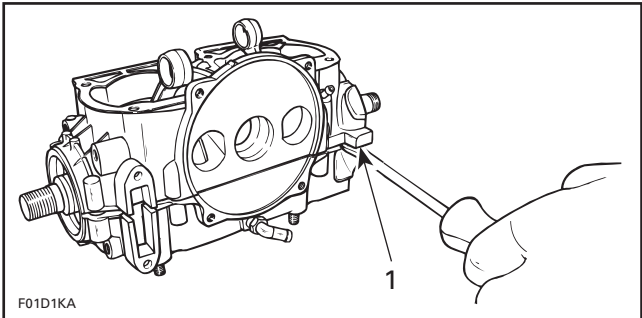
- starter, refer to appropriate *VEHICLE SHOP MANUAL*
  - rotary valve cover and valve, refer to *ROTARY VALVE* section
  - engine top end, refer to *TOP END* section.
- Put engine on a stand. Loosen crankcase screws.



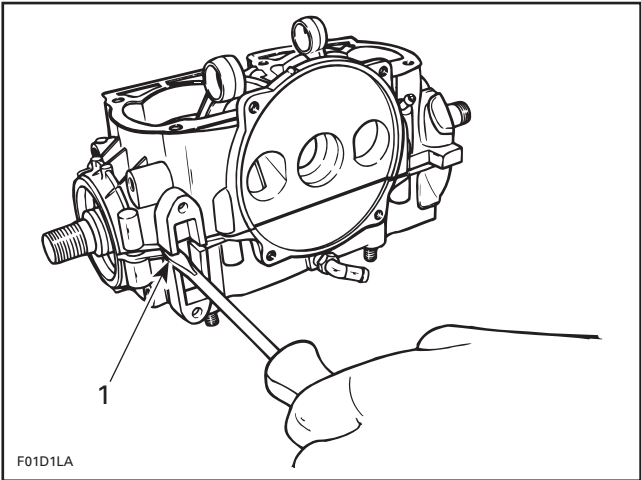
1. M10 x 73.5 flanged screws
2. M8 x 68.5 flanged screws
3. M8 x 45 socket head screws

Put engine back on a support. Insert a pry bar between crankcase lugs to separate halves.

**CAUTION:** Be careful to precision machined surfaces.



- TYPICAL**
1. Separate halves by prying at provided lugs



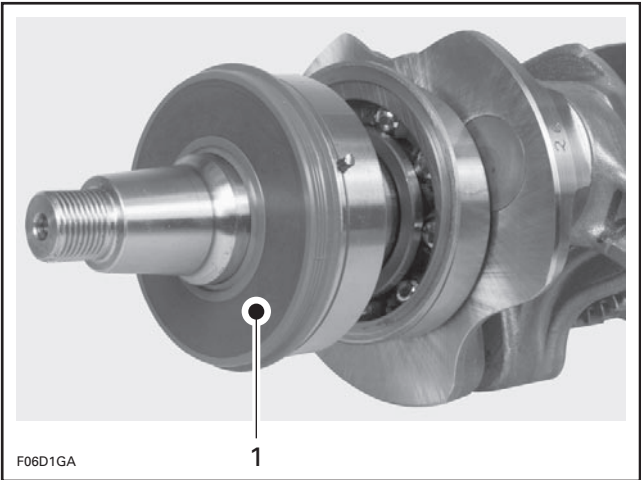
- TYPICAL**
1. Separate halves by prying at provided lugs

Remove crankshaft **no. 3**.

**Crankshaft End Bearings**

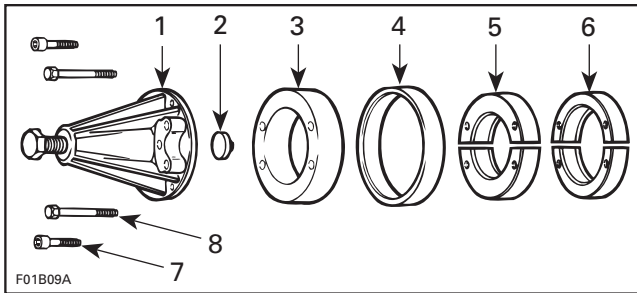
**NOTE:** Do not needlessly remove crankshaft bearings **no. 4**.

Take apart crankcase as per procedure above.  
Remove end seals.



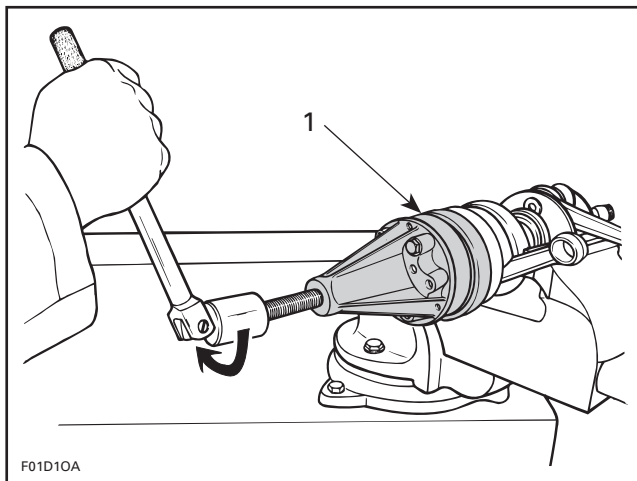
- TYPICAL**
1. End seal

To remove end bearings **no. 4** from crankshaft **no. 3**, use the following tools.



1. Puller (P/N 420 877 635)
2. Protective cap (P/N 420 876 557)
3. Distance ring (P/N 420 876 569), MAG side only
4. Ring (P/N 420 977 490), both sides
5. MAG side ring halves (P/N 420 276 025)
6. PTO side ring halves (P/N 420 977 475)
7. Screw M8 x 40 (P/N 420 840 681)
8. Screw M8 x 70 (P/N 420 841 201)

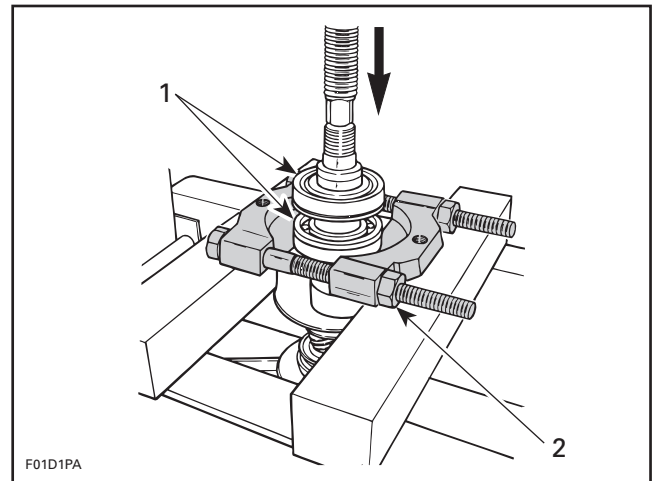
**NOTE:** To facilitate ring or distance ring installation, lubricate their inside diameters.



**TYPICAL**

1. Removing crankshaft bearing

As an alternate method, use a bearing extractor such as Proto no. 4332 and a press to remove two bearings at a time.



1. Press bearings out
2. Bearing extractor

## CLEANING

### General

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

Clean oil passages and make sure they are not clogged.

Clean all metal components in a solvent.

### Crankshaft

Clean crankshaft end with sand paper no.180 and remove all residue using pulley flange cleaner (P/N 413 711 809).



**Section 02 717 ENGINE**  
**Subsection 04 (BOTTOM END)**

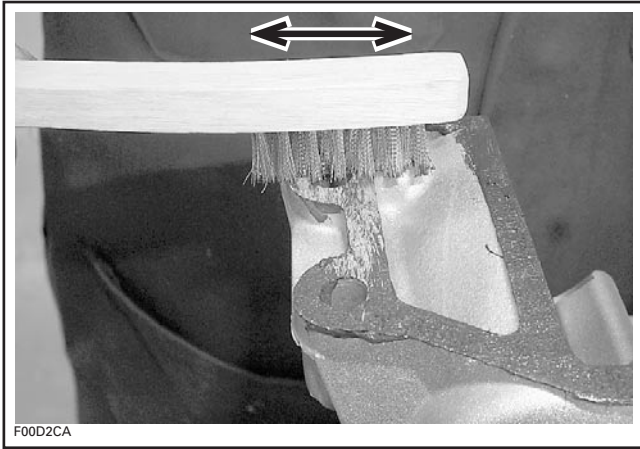


TYPICAL

**Crankcase**

Crankcase mating surfaces are best cleaned using a combination of the chisel gasket remover (P/N 413 708 500) and a brass brush. Brush a first pass in one direction then make the final brushing perpendicularly (90°) to the first pass cross (hatch).

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



FIRST PASS



SECOND PASS

Finish the cleaning with acetone.

**CAUTION:** Be careful not to spray cleaner on the painted surface of the engine. Do not wipe with rags. Use a new clean hand towel only.

**INSPECTION**

Refer to table below to find bottom end engine dimension specifications. For dimension measurement procedures, refer to ENGINE MEASUREMENT.



ENGINE MEASUREMENT		TOLERANCE		
		New parts		Wear limit
		Min	Max	
Crankshaft deflection	MAG	N.A.	N.A.	0.050 mm (.002 in)
	PTO	N.A.	N.A.	0.030 mm (.001 in)
Connecting rod big end axial play		0.311 mm (.012 in)	0.677 mm (.026 in)	1.2 mm (.047 in)

## Crankcase

Inspect plane surfaces for warpage. Small deformation can be corrected by grinding surface with a fine sandpaper. Install sandpaper on a surface plate and rub part against oiled sand paper.

## Bearings

Inspect crankshaft bearings **no. 4**. Check for corrosion, scoring, pitting, chipping or other evidence of wear. Make sure plastic cage is not melted. Rotate and make sure they turn smoothly.

## ASSEMBLY

Assembly is essentially the reverse of disassembly procedures. However pay particular attention to the following.

**NOTE:** It is recommended to spray injection oil on all moving parts when reassembling the engine.

## Crankshaft End Bearings

Heat up the bearing(s) using the bearing heater (P/N 529 035 969). This will expand bearings and ease installation.



TYPICAL

**CAUTION:** Bearing should not be heated to more than 80°C (176°F). Do not heat bearing with direct flame or heat gun or heated oil. Inappropriate heating procedure(s) may cause inner seal failure.

Turn bearing(s) several times during heating process for heating it (them) properly.

**NOTE:** Normally it takes approximately 10 minutes to heat up a bearing so in the event of replacing bearing, it's recommended to start the bearing heating process prior to removal operation. Two bearings can be heated at the same time on one bearing heater.



TYPICAL  
1. Bearings

**Section 02 717 ENGINE**  
**Subsection 04 (BOTTOM END)**

Touch the inner race of the bearing with the temperature indicator stick (P/N 529 035 970). Stick will liquefy when the bearing reach the proper temperature.

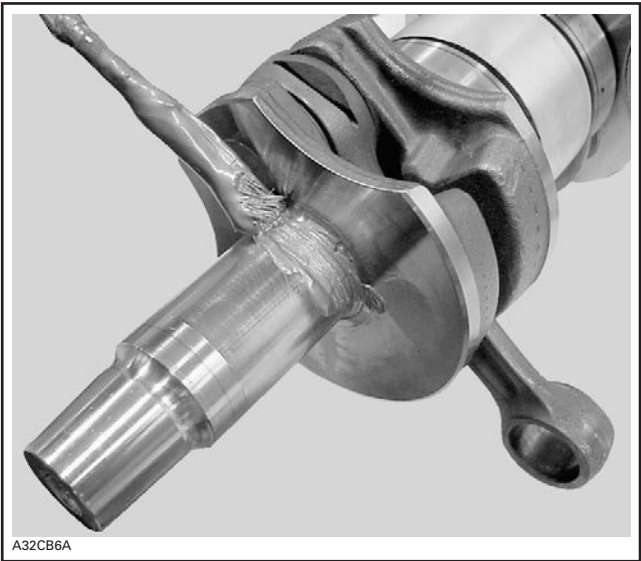


TYPICAL

**⚠ WARNING**

Do not touch heated bearing with bare handle. Wear heat resisting gloves before handling the heated bearing(s).

Smear Loctite 767 (antiseize lubricant) (P/N 293 800 070) on part of crankshaft where bearing fits.



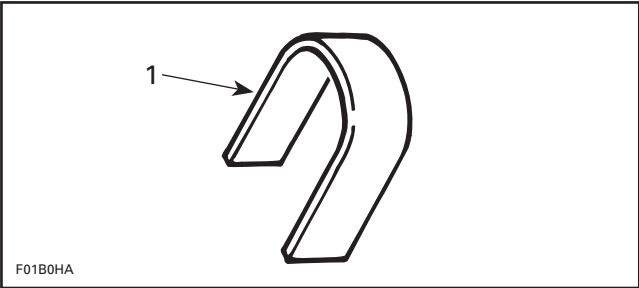
TYPICAL

Install the distance ring **no. 12**. Make sure to position it with its chamfer toward the counterweight of the crankshaft.

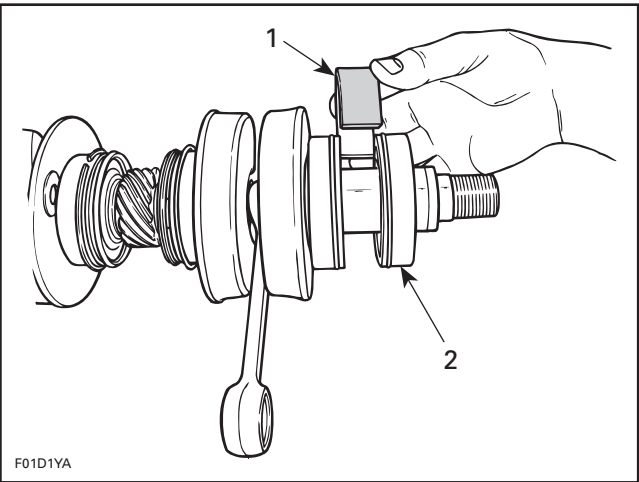
Slide in the inner bearing. Push bearing to end position.

Install the retaining disk.

To properly position the outer bearing(s), the distance gauge (P/N 529 034 800) must be temporarily installed against the inner bearing. Slide the outer bearing until stopped by the distance gauge, then remove the distance gauge.



1. Distance gauge



TYPICAL

1. Distance gauge  
2. Outer bearing

**Crankcase**

**NOTE:** Rotary valve shaft must be installed in crankcase before closing halves.

**CAUTION:** Before joining crankcase halves, make sure that crankshaft gear is well engaged with rotary valve shaft gear.

**Crankcase Sealant Application**

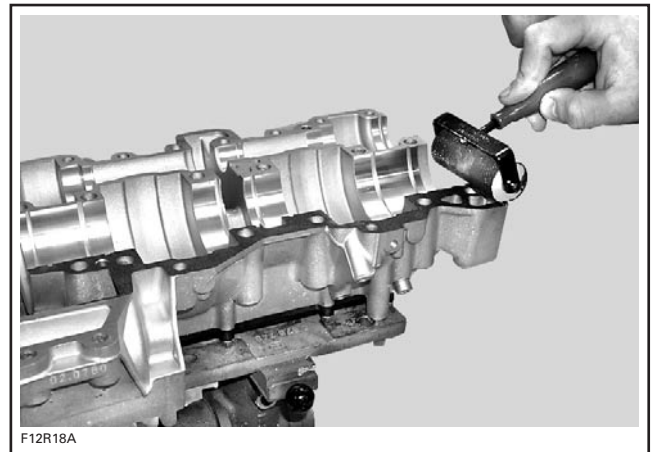
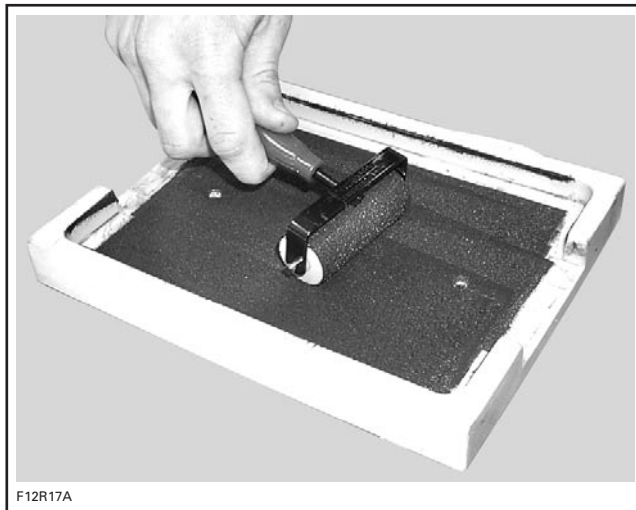
**IMPORTANT:** When beginning the application of the crankcase sealant, the assembly and the first torquing should be done within 10 minutes. It is suggested to have all you need on hand to save time.

**NOTE:** It is recommended to apply this specific sealant as described here to get an uniform application without lumps. If you do not use the roller method, you may use your finger to uniformly distribute the sealant.

Use the Loctite 5910 (P/N 293 800 081) on mating surfaces.

**CAUTION:** Do not use other products to seal crankcase. Do not use an activator with the Loctite 5910. Using other products or non silicone-based sealant over a previously sealed crankcase with Loctite 5910 will lead to poor adhesion and possibly a leaking crankcase. Even after cleaning, the Loctite 5910 would leave incompatible microscopic particles.

Use a plexiglass plate and apply some sealant on it. Use a soft rubber roller (50 - 75 mm (2 - 3 in)) (available in arts products suppliers) and roll the sealant to get a thin uniform coat on the plate (spread as necessary). When ready, apply the sealant on crankcase mating surfaces.



*TYPICAL*

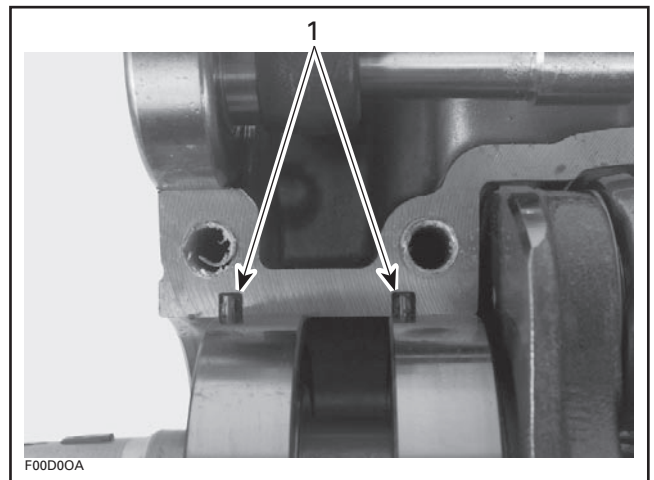
Do not apply in excess as it will spread out inside crankcase.

### **Crankshaft Seals**

When installing seals **no. 5**, apply a light coat of Molykote 111 (P/N 413 707 000) on seal lips.

### **Crankshaft**

When installing crankshaft in crankcase, make sure drive pins **no. 6** of bearings are properly installed in crankcase recesses.



1. Drive pins

### **Crankcase Halves**

Assemble crankcase halves.

**NOTE:** Temporarily install armature plate to align crankcase halves with each other.

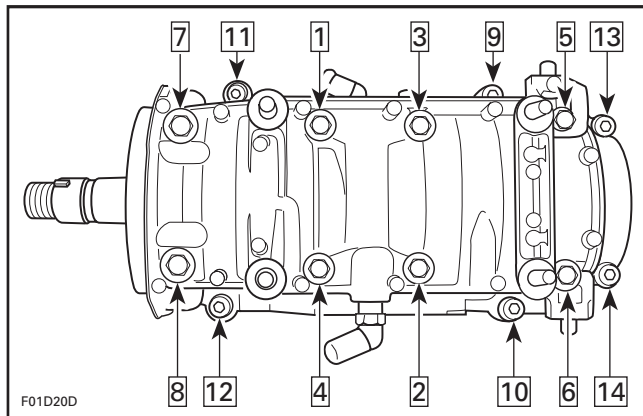
## Section 02 717 ENGINE

### Subsection 04 (BOTTOM END)

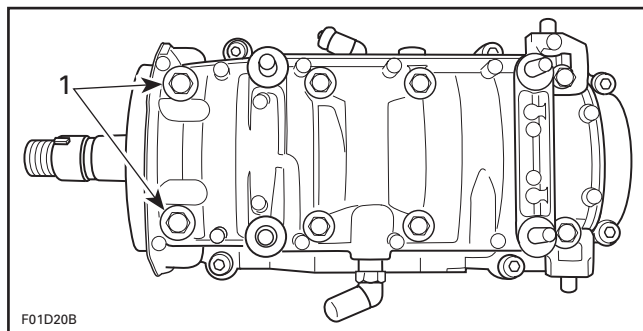
#### Crankcase Screws

Apply Loctite 518 (P/N 293 800 038) on screw threads and Molykote 111 (P/N 413 707 000) below head screws.

Torque crankcase screws **no. 7** and **no. 9** to 24 N•m (17 lbf•ft) as per following illustrated sequence.



Torque 2 M10 crankcase screws **no. 8** to 40 N•m (30 lbf•ft).



1. Torque to 40 N•m (30 lbf•ft)

#### Oil Fittings

If inlet and outlet oil fittings **no. 11** of rotary valve shaft have been removed from crankcase, reinstall them with their end pointing toward ignition housing. Apply Loctite 518 (P/N 293 800 038) on threads of fittings.

#### Studs

At assembly in crankcase, apply Loctite 518 (P/N 293 800 038) on threads of studs **no. 10**. Torque to 10 N•m (89 lbf•in).

#### PTO Flywheel

Apply Loctite 767 (antiseize lubricant) (P/N 293 800 070) to crankshaft threads.

Using the same tools as for disassembly procedure, torque PTO flywheel to 110 N•m (81 lbf•ft).

# ROTARY VALVE

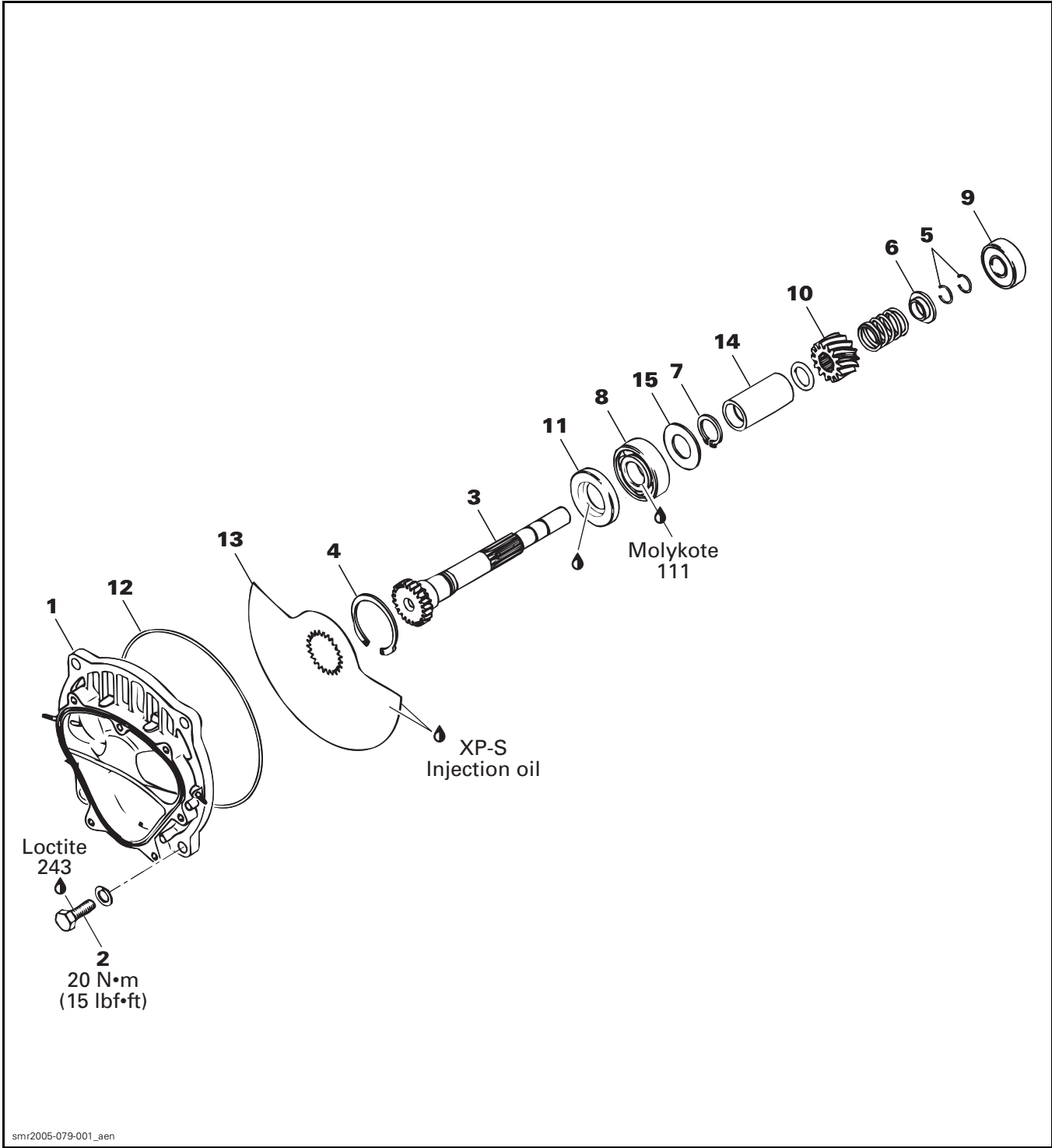
## SERVICE TOOLS

Description	Part Number	Page
degree wheel.....	529 035 607 .....	55
puller.....	420 876 488 .....	49
pusher.....	420 876 501 .....	51
pusher.....	420 876 605 .....	52
TDC gauge.....	295 000 143 .....	55

## SERVICE PRODUCTS

Description	Part Number	Page
Loctite 243 (blue).....	293 800 060 .....	56
Molykote 111.....	413 707 000 .....	52
XP-S mineral injection oil .....	413 802 900 .....	56

**Section 02 717 ENGINE**  
Subsection 05 (ROTARY VALVE)



## GENERAL

The clearance of rotary valve cover or rotary valve shaft gear backlash can be performed without taking apart engine.

However engine must be disassembled to work on rotary valve shaft/components.

## INSPECTION (ASSEMBLED ENGINE)

### Rotary Valve/Cover Clearance

Remove air intake silencer and carburetor. Refer to appropriate *VEHICLE SHOP MANUAL*.

Refer to table below to find dimension specifications. For measurement procedures, refer to ENGINE MEASUREMENT section.

ENGINE MEASUREMENT	TOLERANCES	
	NEW PARTS (min.)	(max.)
Rotary valve/cover clearance	0.25 mm (.010 in)	0.3 mm (.014 in)

**NOTE:** If the rotary valve/cover clearance is too small, this could create an overheating situation and if the clearance is too high, this could create a hard starting situation.

### Rotary Valve Shaft Gear Backlash

Verify rotary valve shaft gear backlash as follows:

Remove PTO flywheel guard.

Remove spark plugs, rotary valve cover and valve.

Manually feel backlash at one position, then turn crankshaft about 1/8 turn and recheck. Continue this way to complete one revolution.

Backlash must be even at all positions. Otherwise overhaul engine to find which part is faulty (gear, rotary valve shaft or crankshaft with excessive deflection).

## DISASSEMBLY

### Rotary Valve Cover

Remove air intake silencer. Refer to appropriate *VEHICLE SHOP MANUAL*.

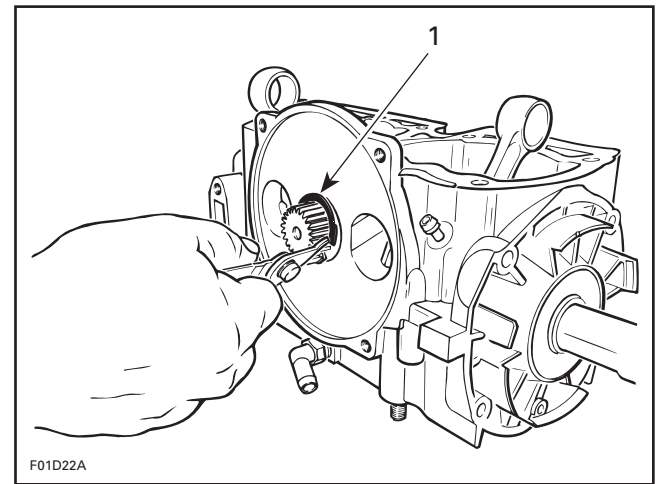
Unscrew 4 retaining screws **no. 2** and withdraw rotary valve cover **no. 1** and rotary valve **no. 13**.

### Rotary Valve Shaft

To remove the rotary valve shaft assembly, the engine must be removed from watercraft (refer to appropriate *VEHICLE SHOP MANUAL*).

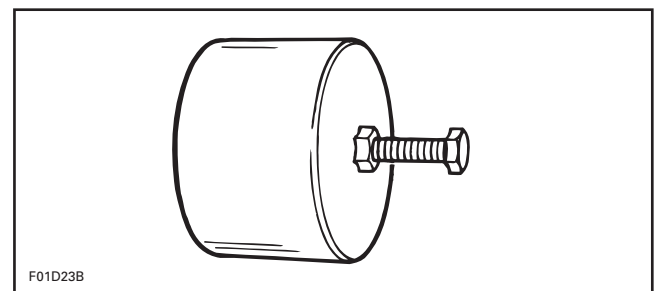
Open bottom end and remove crankshaft (refer to BOTTOM END section).

First remove rotary valve cover and valve then remove snap ring **no. 4** from crankcase.



1. Removing snap ring

To remove rotary valve shaft assembly, use the puller (P/N 420 876 488).

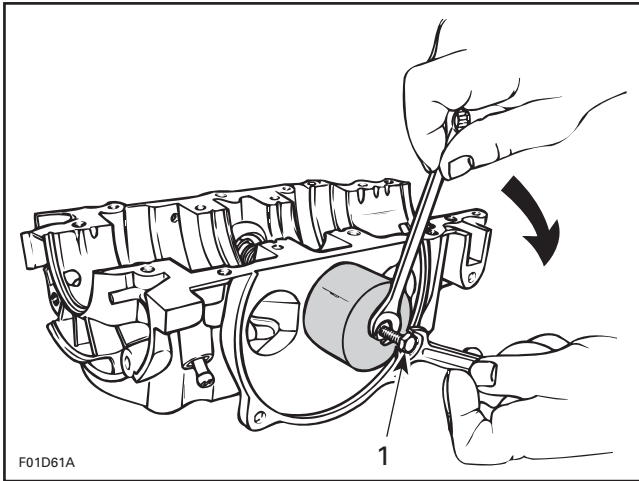


Place puller over rotary valve shaft end and screw on puller bolt into shaft. While retaining bolt with a wrench, turn puller nut **CLOCKWISE** until shaft comes out.

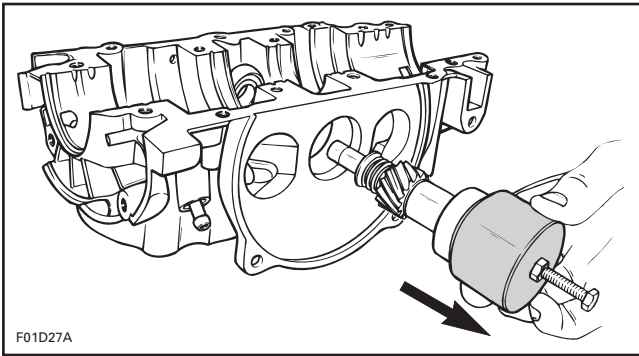


## Section 02 717 ENGINE

### Subsection 05 (ROTARY VALVE)

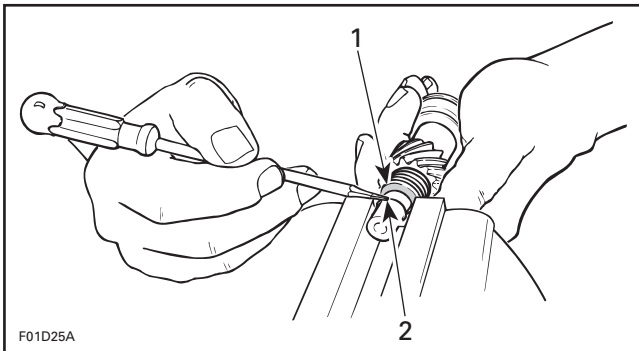


1. Hold bolt



### Circlip and Spring Seat

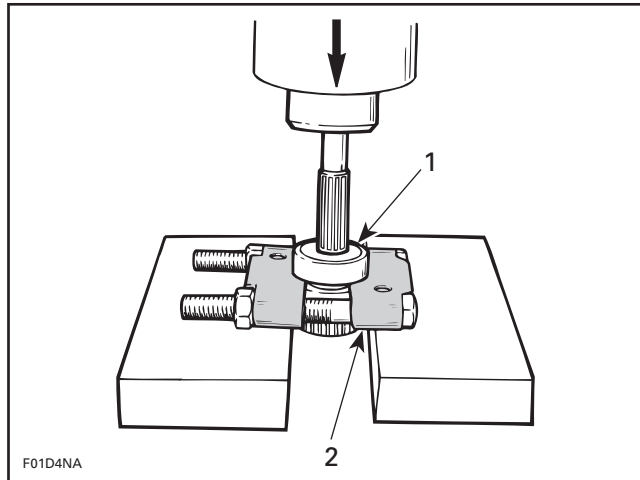
If it is necessary to disassemble components of rotary valve shaft assembly, use seat **no. 6** to compress spring and remove circlips **no. 5**.



1. Compress seat  
2. Remove circlips

### Shaft Bearing

To remove bearing **no. 8** use a bearing extractor such as Snap-on **no. CJ-950** (or equivalent) as illustrated. Slide off distance sleeve **no. 14**, remove snap ring **no. 7** and washer **no. 15** then press shaft out.

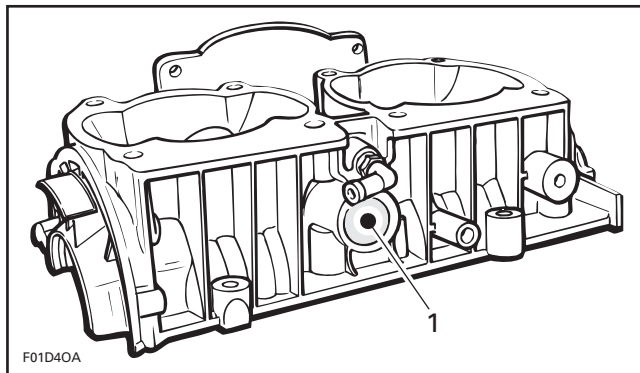


1. Bearing  
2. Bearing extractor Snap-on CJ-950

**CAUTION:** Ensure that rotary valve shaft is perfectly perpendicular with press tip.

### End Bearing

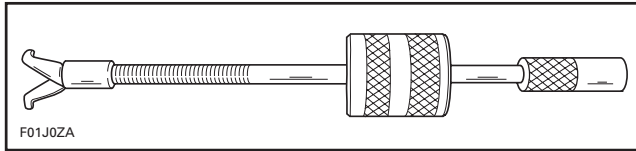
**CAUTION:** Do not remove plug against bearing in upper crankcase half.



1. Do not remove this plug

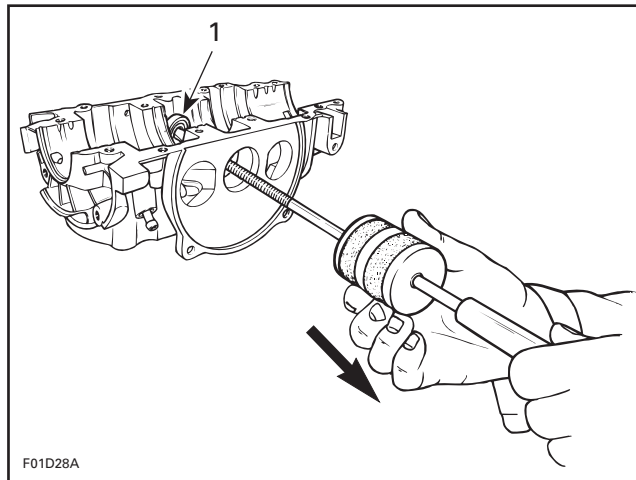
End bearing **no. 9** can be easily removed from upper crankcase half using the following suggested tool (or equivalent):

- Snap-on hammer puller including:
  - handle CJ93-1
  - hammer CJ125-6
  - claws CJ93-4.



Close puller claws so that they can be inserted in end bearing. Holding claws, turn puller shaft clockwise so that claws open and become firmly tight against bearing.

Slide puller hammer outwards and tap puller end. Retighten claws as necessary to always maintain them tight against bearing. Continue this way until bearing completely comes out.



1. End bearing

## CLEANING

Discard all seals and O-rings.

Clean all metal components in a solvent.

Clean oil passages and make sure they are not clogged.

Clean rotary valve shaft and inside of distance sleeve **no. 14**.

## INSPECTION (DISASSEMBLED ENGINE)

### Rotary Valve Cover

Inspect rotary valve cover **no. 1** for warpage. Small deformation can be corrected by surfacing with fine sand paper on a surface plate. Surface part against oiled sand paper.

### Rotary Valve Shaft

Refer to table below to find dimension specifications. For measurement procedures, refer to ENGINE MEASUREMENT section.

ENGINE MEASUREMENT	TOLERANCES	
	NEW PARTS (min.)	(max.)
Rotary valve shaft deflection	N.A.	0.08 mm (.003 in)

### Gear

Visually check gear wear pattern. It should be even on tooth length all around. Otherwise it could indicate a bent shaft, check deflection. Replace gear if damaged.

Check for presence of brass filings in gear housing.

### Bearings

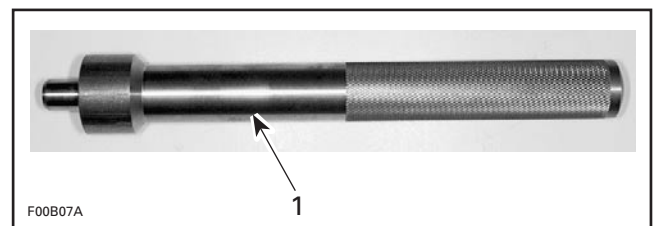
Inspect bearings **no. 8** and **no. 9**. Check for scoring, pitting, chipping or other evidence of wear. Make sure plastic cage (on bigger bearing) is not melted. Rotate them and make sure they turn smoothly.

## ASSEMBLY

Assembly is essentially the reverse of disassembly procedures. However pay particular attention to the following.

### End Bearing

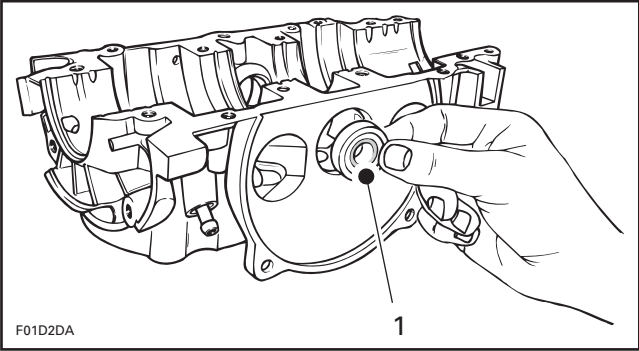
To install end bearing **no. 9** in crankcase, use the pusher (P/N 420 876 501).



1. Pusher

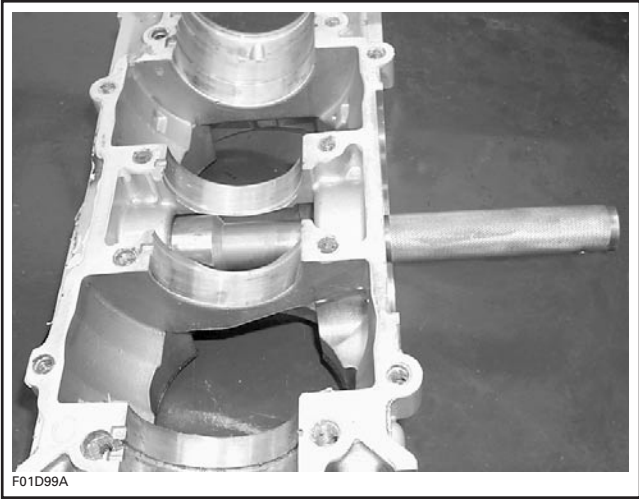
Position ball bearing shielded side towards rotary valve.

**Section 02 717 ENGINE**  
**Subsection 05 (ROTARY VALVE)**



1. Shield side (toward gear)

Push bearing until it stops on its seat.

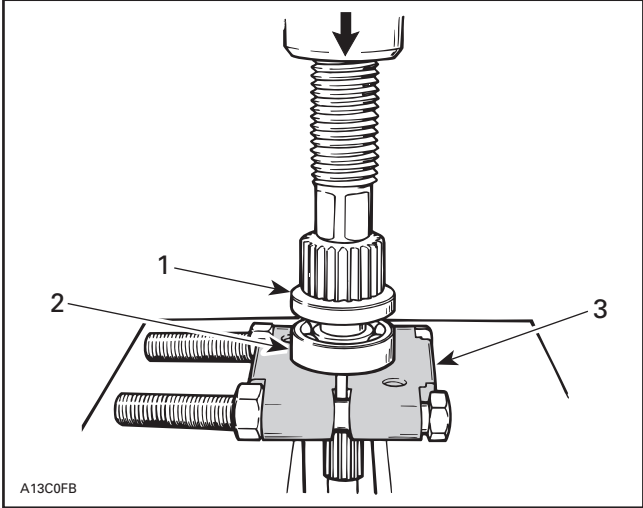


**Seal**

Apply Molykote 111 (P/N 413 707 000) on seal lips. Position seal no. 11 with shielded portion against shaft splines.

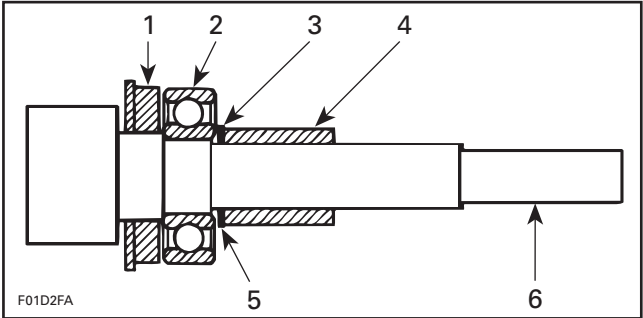
**Shaft Bearing**

Install ball bearing as illustrated.



- 1. Seal
- 2. Ball bearing
- 3. Bearing extractor Snap-on CJ-950

Install washer no. 15, snap ring no. 7 and slide distance sleeve no. 14 on shaft no. 3.

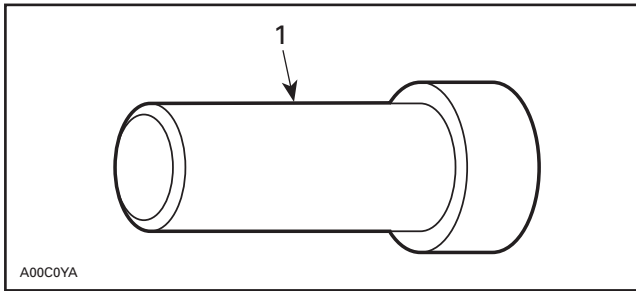


- 1. Seal
- 2. Ball bearing
- 3. Snap ring
- 4. Distance sleeve
- 5. Washer 0.5 mm (.020 in)
- 6. Rotary valve shaft

**Rotary Valve Shaft Assembly**

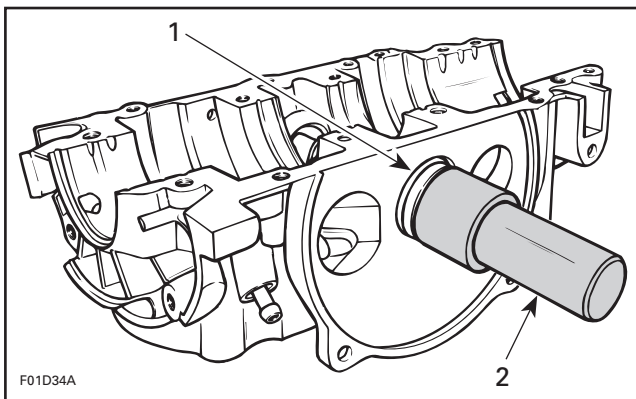
**CAUTION:** Crankcase halves must be separated and crankshaft must not be present to install rotary valve shaft assembly in crankcase.

To install rotary valve shaft in crankcase, use the pusher (P/N 420 876 605).



1. Pusher

Push shaft until it stops on bearing seat.



1. Rotary valve shaft  
 2. Push shaft until it stops

## Snap Ring

Position snap ring **no. 4** so that its sharp edge faces outwards.

## Rotary Valve

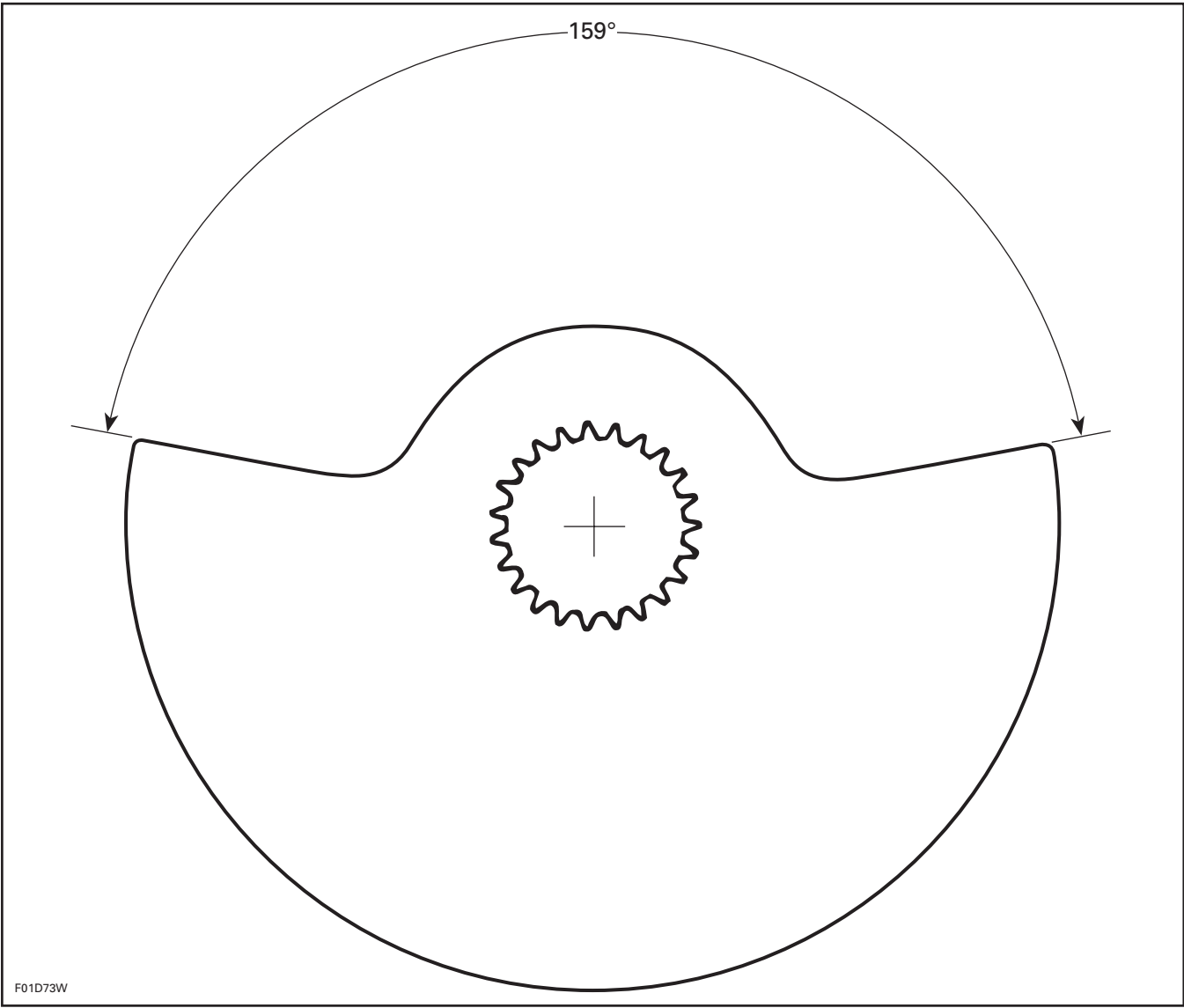
The rotary valve **no. 13** controls the opening and closing of the inlet ports. Therefore its efficiency will depend on the precision of its installation.

### IDENTIFICATION OF THE ROTARY VALVE

ENGINE	ROTARY VALVE P/N	DURATION
717	420 924 502	159°

There is no identification code on the valve. To find out the duration, place an angle finder on the valve and measure the valve cut-out angle or use the following template.

**Section 02 717 ENGINE**  
Subsection 05 (ROTARY VALVE)

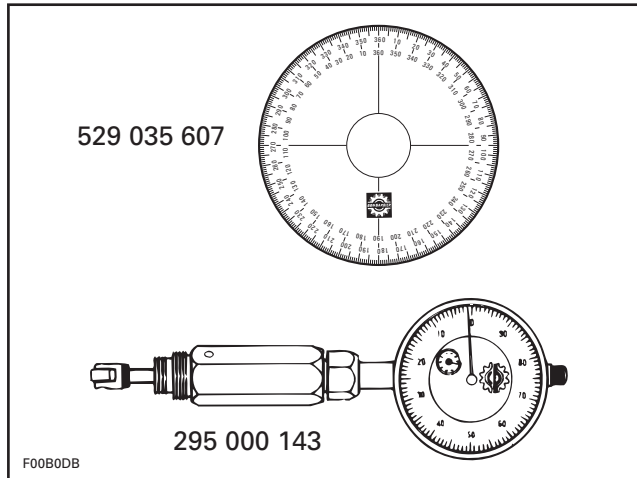


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## ROTARY VALVE TIMING

**CAUTION:** Never use the ridge molded in crank case as a timing mark.

The degree wheel (P/N 529 035 607) and the TDC gauge (P/N 295 000 143) are required to measure rotary valve opening and closing angles in relation with MAG side piston.



Rotary valve must be set so that timing occurs as follows:

ENGINE	TIMING	
	OPENING BTDC	CLOSING ATDC
717	147° ± 5	65.5° ± 5

### Timing Procedure

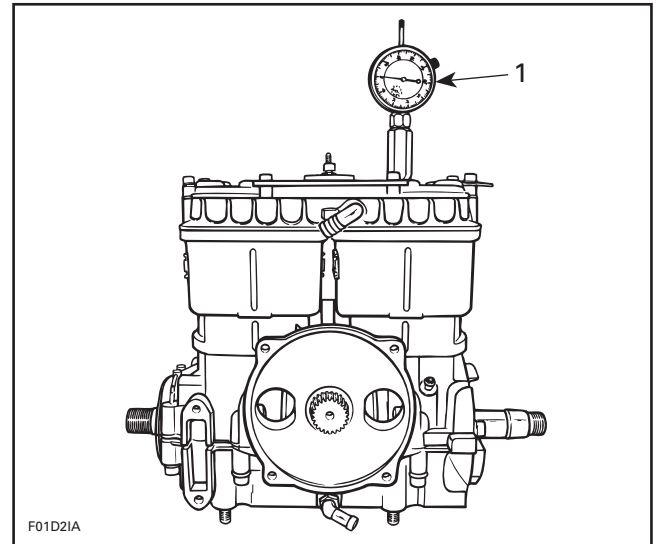
The following timing procedure example uses these specifications:

OPENING: 147° BTDC

CLOSING: 65° ATDC

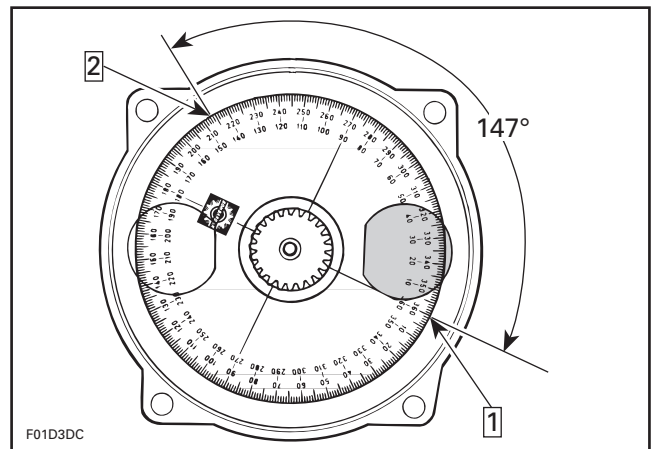
Proceed as follows:

- Turning crankshaft, bring MAG side piston to Top Dead Center using the TDC gauge.



1. Bring piston to TDC

- For opening mark, first align 360° line of degree wheel with BOTTOM of MAG side inlet port. Then, find 147° line on inner scale of degree wheel and mark crankcase at this point.



#### OPENING MARK

Step 1: Bottom of MAG inlet port. Align 360° line of degree wheel  
Step 2: Find 147° on inner scale of degree wheel and mark here

**NOTE:** Do not rotate the crankshaft.

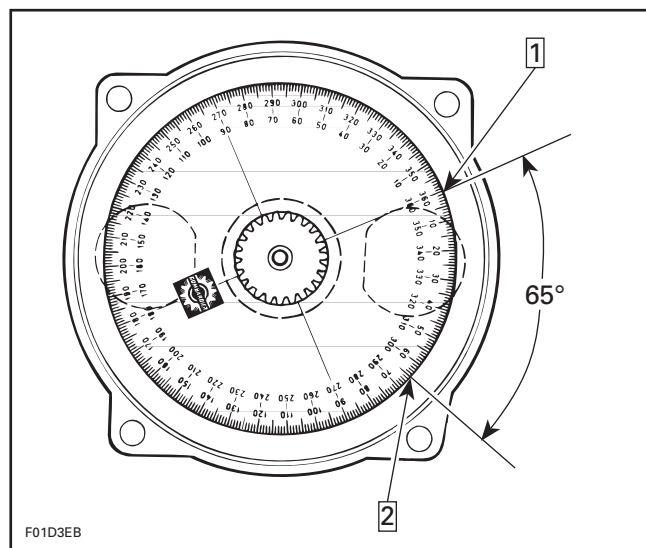
- For closing mark, first align 360° line of degree wheel with TOP of MAG side inlet port. Then, find 65° line on outer scale of degree wheel and mark crankcase at this point.

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## Section 02 717 ENGINE

### Subsection 05 (ROTARY VALVE)

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#### CLOSING MARK

Step 1: Top of MAG inlet port. Align 360° line of degree wheel

Step 2: Find 65° on outer scale of degree wheel and mark here

- Remove degree wheel.
- Position rotary valve on shaft splines to have edges as close as possible to these marks with the MAG piston at TDC.

**NOTE:** Rotary valve is asymmetrical. Therefore, try flipping it over then reinstall on splines to obtain best installation position.

Apply XP-S mineral injection oil (P/N 413 802 900) on rotary valve before reassembling rotary valve cover.

- Remove TDC gauge.

### Rotary Valve Cover

Install O-ring **no. 12** and rotary valve cover **no. 1**.

Apply Loctite 243 (blue) (P/N 293 800 060) on threads of rotary valve cover screws **no. 2** then torque them to 20 N•m (15 lbf•ft) in a criss-cross sequence.



# TECHNICAL SPECIFICATIONS

ENGINE		GTI
Engine type		ROTAX 717, 2-stroke
Induction type		Rotary valve
Exhaust system	Type	Water cooled, water injected
	Water injection fitting (head)	3.5 mm (.139 in)
	Water injection fitting (cone)	3.5 mm (.139 in)
Starting system		Electric start
Lubrication	Fuel/oil mixture	VROI (Variable Rate Oil Injection)
	Oil injection pump	Gear driven
	Oil injection type	XP-S™ synthetic 2-stroke or XP-S™ synthetic blend or XP-S™ mineral injection oil
Number of cylinders		2
Bore	Standard	82 mm (3.228 in)
	First oversize	82.25 mm (3.238 in)
	Second oversize	82.50 mm (3.248 in)
Stroke		68 mm (2.677 in)
Displacement		718.2 cm <sup>3</sup> (43.81 in <sup>3</sup> )
Corrected compression ratio		6.2:1
Cylinder head volume		42.4 ± 0.4 cc
Cylinder head warpage (maximum)		0.05 mm (.002 in)
Piston ring type and quantity		1 semi-trapez — 1 rectangular
Ring end gap	New	0.25 - 0.40 mm (.010 - .016 in)
	Wear limit	1.00 mm (.039 in)
Ring/piston groove clearance	New	0.025 - 0.070 mm (.001 - .003 in)
	Wear limit	0.2 mm (.008 in)
Piston/cylinder wall clearance	New (minimum)	0.10 mm (.0039 in)
	Wear limit	0.20 mm (.008 in)
Cylinder taper (maximum)		0.10 mm (.004 in)
Cylinder out of round (maximum)		0.080 mm (.003 in)
Connecting rod big end axial play	New	0.311 - 0.677 mm (.012 - .027 in)
	Wear limit	1.2 mm (.047 in)
Crankshaft deflection		MAG: 0.050 mm (.002 in) PTO: 0.030 mm (.001 in)
Rotary valve timing	Opening	147° ± 5 BTDC
	Closing	65.5° ± 5 ATDC
Rotary valve duration		159°
Rotary valve/cover clearance		0.25 - 0.35 mm (.010 - .014 in)
Connecting rod/crankshaft pin radial clearance	New	0.020 - 0.033 mm (.0008 - .0013 in)
	Wear limit	0.050 mm (.002 in)
Connecting rod/piston pin radial clearance	New	0.020 - 0.033 mm (.0008 - .00013 in)
	Wear limit	0.05 mm (.002 in)
ADDITIONAL INFORMATION:		

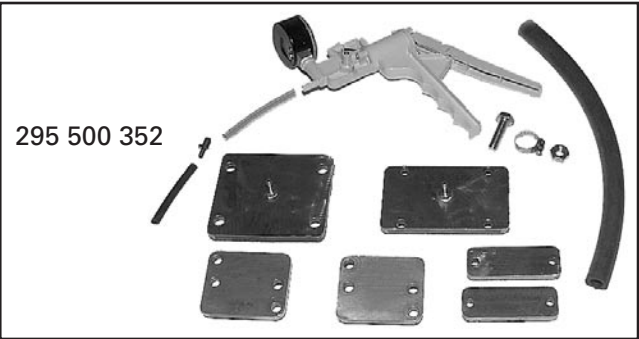
# LEAK TEST

## SERVICE TOOLS

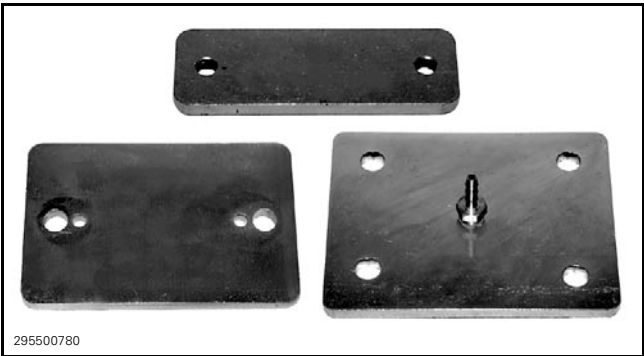
Description	Part Number	Page
engine leak test kit .....	295 500 352 .....	59–60
small hose pincher.....	295 000 076 .....	60–61
supplementary engine leak test kit.....	295 500 780 .....	59–60

## GENERAL

An engine leak test kit (P/N 295 500 352) and a supplementary engine leak test kit (P/N 295 500 780) are available to help diagnose engine problems such as engine seizure, poor performance, oil leakage, etc.



ENGINE LEAK TEST KIT



SUPPLEMENTARY ENGINE LEAK TEST KIT

Before disassembling any components of the engine, it is important to perform a leakage test to determine which part is defective.

It is also very important after servicing the engine, even for a complete engine rebuilt, to perform another leakage test; at this stage, it may avoid further engine problems and minimizing the risk of having to remove and reinstall the engine again.

Static bench testing is the most effective way to conduct a leakage test. Inboard testing does not allow complete access to, and observation of all engine surfaces and should be avoided whenever possible.

When installing hoses of the engine leak test kit or supplementary engine leak test kit, use the collars provided in the kit to ensure a proper sealing.

When pressurizing the engine, first confirm that the components of the engine leak test kit or supplementary engine leak test kit are not leaking by spraying a solution of soapy water on all hoses, connections, fittings, plates, etc. If there is a leak, bubbles will indicate leak location.

Three areas of the engine will be tested in sequence as per the diagnostic flow chart (see the end of this subsection).

1. Engine Cooling System.
2. Bottom End and Top End.
3. Rotary Valve Shaft.

**NOTE:** If a leak is found, it is important to continue testing as there is the possibility of having more than one leak. Continue pumping to compensate for the air lost to find another leak.

## TESTING PROCEDURE

Using the appropriate *VEHICLE SHOP MANUAL*, remove the engine from the vehicle and place it on a bench.

## Section 03 787 RFI ENGINE

### Subsection 01 (LEAK TEST)

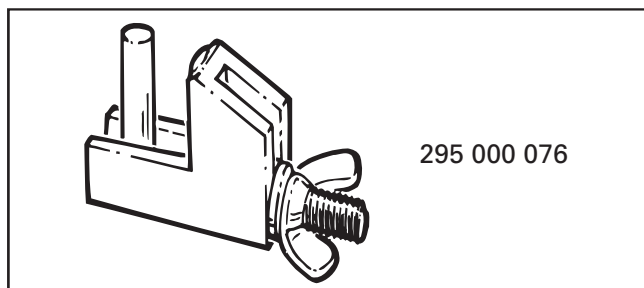
#### Engine Cooling System

Remove the exhaust manifold gasket and ensure the surface is clean.

Install the appropriate exhaust manifold plate from the engine leak test kit (P/N 295 500 352). Tighten plate using fasteners provided in the kit.

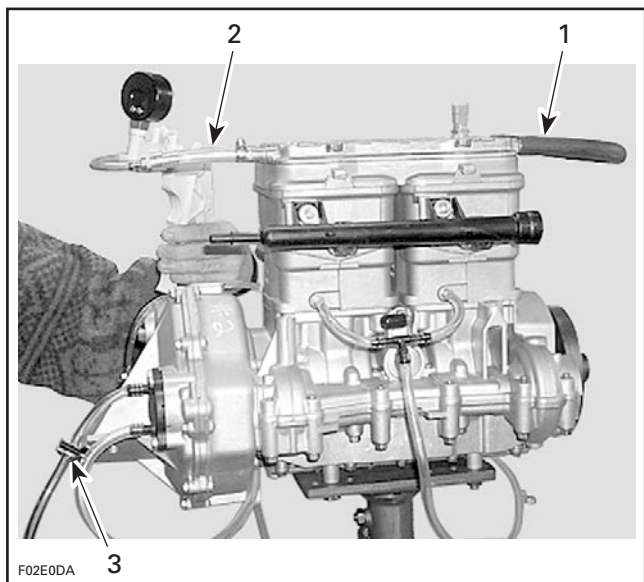
**NOTE:** Do not torque plate excessively.

Install a small hose pincher (P/N 295 000 076) on engine drain hose.



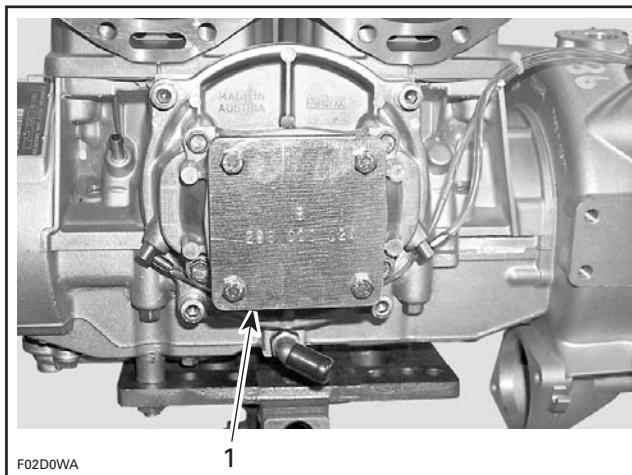
Use hoses provided in the kit and install them on the engine.

Install pump using reducer and appropriate tube(s) as necessary.



#### REAR VIEW

1. Loop hose and use clamps
2. Hose with clamps. Install pump to the end
3. Block engine drain hose with a hose pincher



#### FRONT VIEW

1. Exhaust manifold plate

Activate pump and pressurize engine cooling system to 34 kPa (5 PSI).

Wait 3 minutes and check if pressure drops; if so, verify all testing components.

- If kit components are not leaking and pressure drops, verify all external jointed surfaces, temperature sensor and the O-ring between the spark plug area and the engine cylinder head cover. If none of these components are leaking, there is an internal leak and it can be detected with BOTTOM END AND TOP END testing.

#### Bottom End and Top End

Make sure the surface of the rotary valve cover is clean.

Install the intake plates with fasteners from the kit and tighten adequately.

**NOTE:** Use the intake and exhaust plates included in the supplementary engine leak test kit (P/N 295 500 780).

Remove the RAVE valves and gaskets.

Install the RAVE valve plates with fasteners from the kit and tighten adequately.

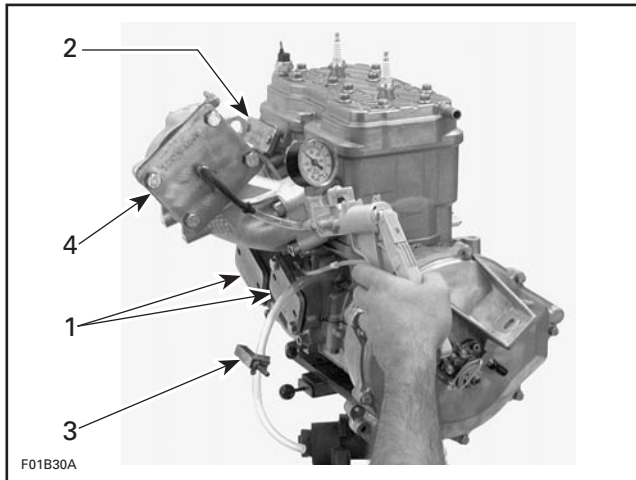
**NOTE:** On RAVE system, the boot and O-ring can be checked for leakage with the valve in place. Simply remove the cover to expose the parts.

Make sure the spark plugs are installed and tightened.

Block pulse hose using a small hose pincher (P/N 295 000 076).

**NOTE:** Do not block the rotary valve shaft hoses.

Install pump to the exhaust plate fitting.



1. Intake plates
2. RAVE valve plates
3. Pulse hose blocked with a hose pincher
4. Exhaust plate

Activate pump and pressurize engine to 34 kPa (5 PSI).

**CAUTION:** Do not exceed this pressure.

Wait 3 minutes and check if pressure drops; if so, verify all testing components.

If kit components are not leaking, verify engine jointed surfaces as per following areas:

- spark plugs
- cylinder head gasket
- cylinder base gasket
- crankcase halves
- rotary valve cover
- engine plugs
- exhaust manifold
- oil injection pump.

Check also small oil injection pump lines and fittings; check for air bubbles or oil column going toward pump, which indicate a defective check valve.

If the above mentioned components are not leaking, block both oil hoses of the rotary valve shaft using a small hose pincher (P/N 295 000 076) on each.

**NOTE:** If leakage stops at this point, proceed with ROTARY VALVE SHAFT testing.

If there is still some leakage, remove the PTO flywheel to verify outer seal.

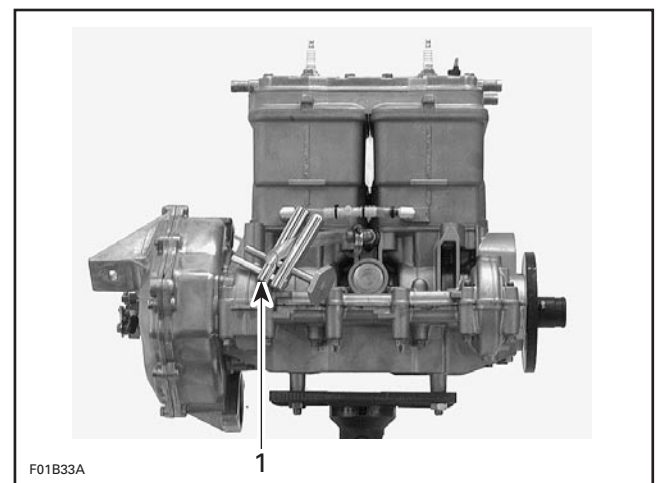
If no leak is found on the PTO side outer seal, remove magneto flywheel and verify crankshaft outer seals.

Proceed with the ROTARY VALVE SHAFT testing if the crankshaft outer seals are not leaking.

### Rotary Valve Shaft

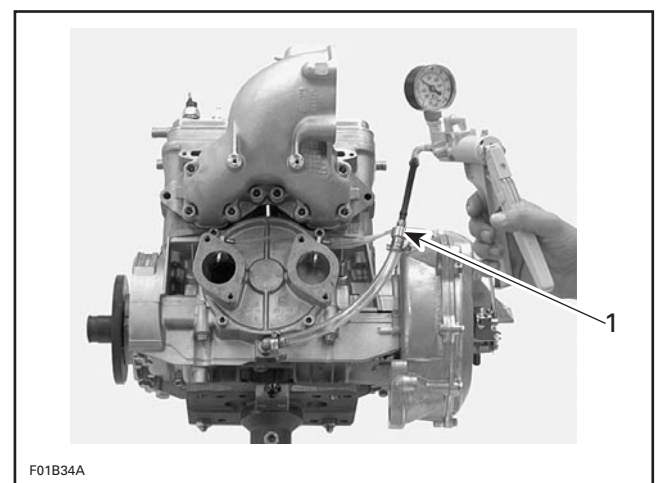
**NOTE:** It is mandatory to drain the injection oil from the rotary valve shaft.

Block oil return hose of the rotary valve shaft with a hose pincher.



1. Oil return hose blocked with hose pincher

Install pump with reducer and nipple to the oil supply hose of the rotary valve shaft.



1. Pump with reducer and nipple

Activate pump and pressurize to 34 kPa (5 PSI).

Check plug of the rotary valve shaft in crankcase.

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## **Section 03 787 RFI ENGINE**

### **Subsection 01 (LEAK TEST)**

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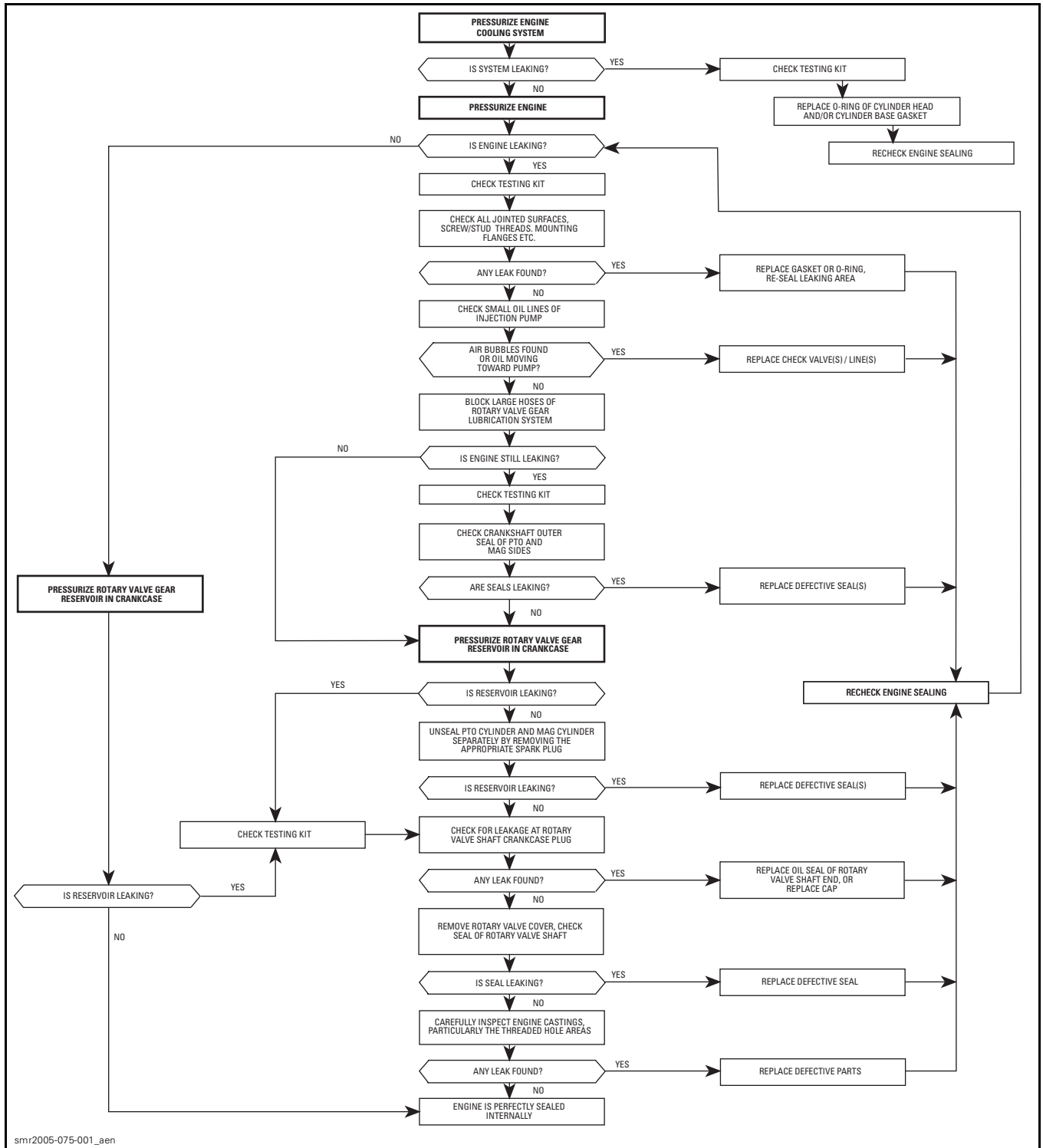
Remove PTO side spark plug. If pressure drops, it indicates a defective PTO side crankshaft inner seal or crankcase is not sealed correctly.

Remove MAG side spark plug. If pressure drops, it indicates a defective MAG side crankshaft inner seal or crankcase is not sealed correctly.

If the above mentioned components are not leaking and there is a pressure drops, remove the rotary valve cover. Check the seal of the rotary valve shaft.

If the rotary valve shaft is not leaking, it could indicate a defective engine casting. Disassemble engine and carefully check for defects in castings. Pay attention to tapped holes which may go through sealed areas of engine and thus lead to leakage.

## ENGINE LEAKAGE DIAGNOSTIC FLOW CHART



# MAGNETO SYSTEM

## SERVICE TOOLS

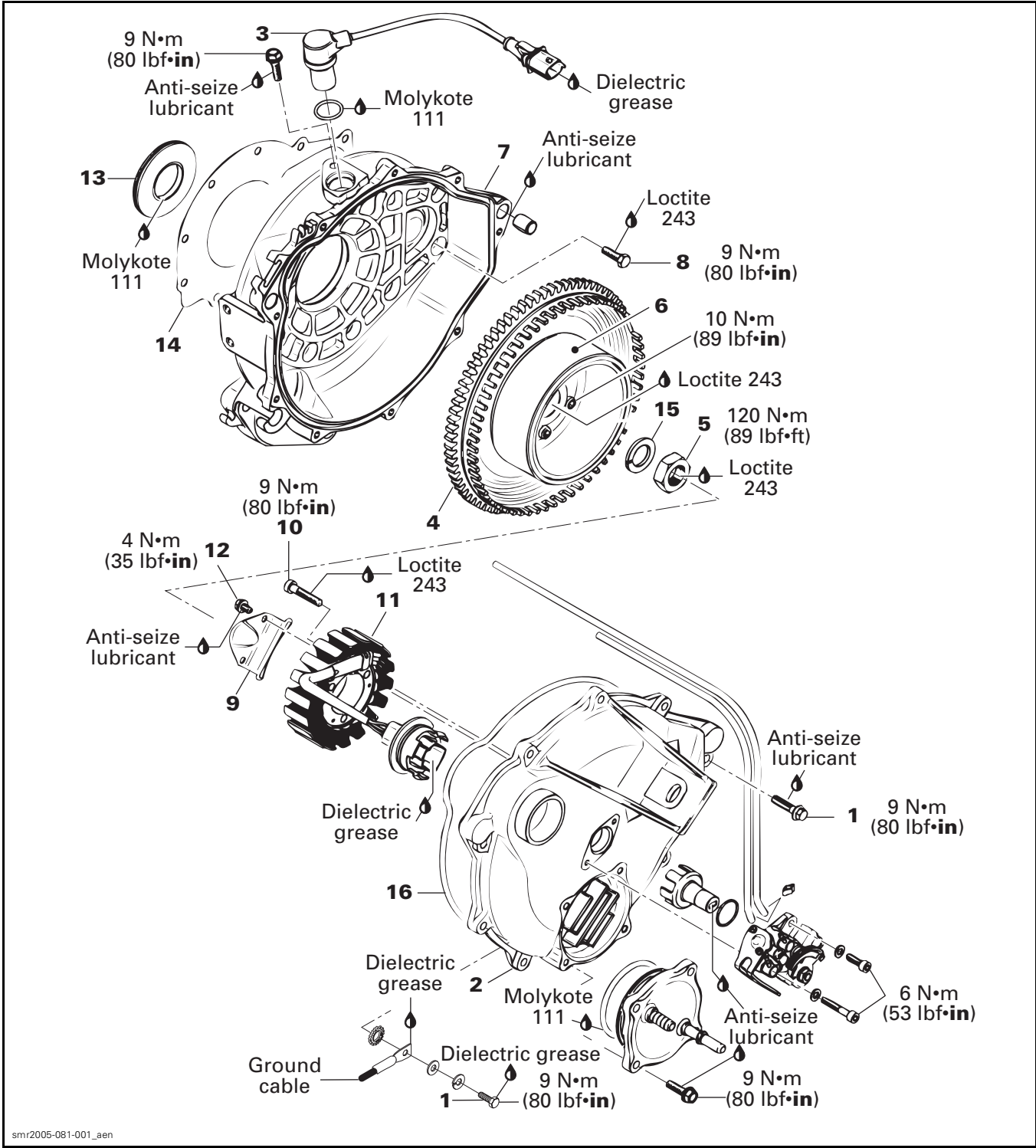
Description	Part Number	Page
crankshaft protector .....	420 876 557 .....	67
installer handle .....	420 877 650 .....	69
magneto puller.....	420 976 235 .....	67
oil seal pusher.....	420 877 740 .....	69
ring gear locking tool .....	529 035 846 .....	67

## SERVICE PRODUCTS

Description	Part Number	Page
dielectric grease .....	293 550 004 .....	70
Loctite 243 (blue).....	293 800 060 .....	69
Loctite 767 (antiseize lubricant) .....	293 800 070 .....	69–70
Molykote 111.....	413 707 000 .....	69–70
pulley flange cleaner.....	413 711 809 .....	69



**Section 03 787 RFI ENGINE**  
**Subsection 02 (MAGNETO SYSTEM)**



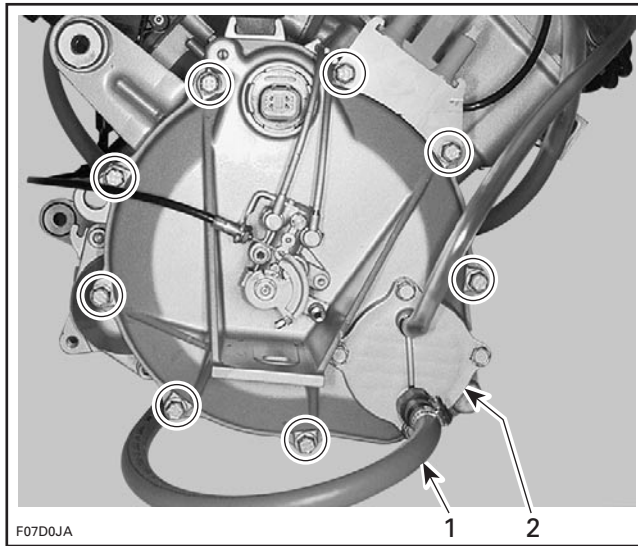
## DISASSEMBLY

**NOTE:** The magneto system can be disassembled without removing the engine from the watercraft.

### Magneto Housing Cover

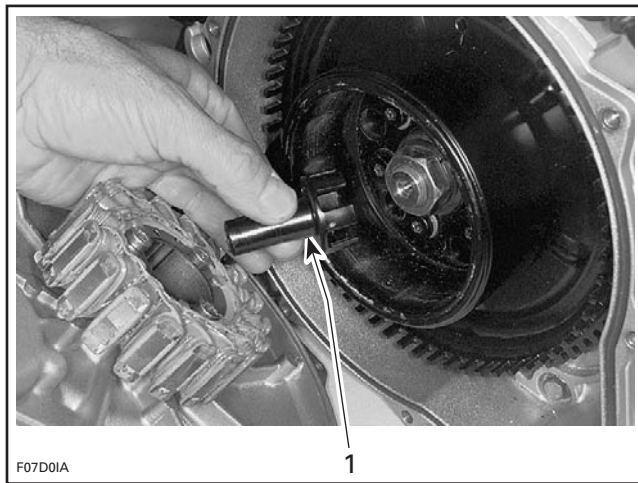
Disconnect water hoses from heat exchanger cover.

Loosen magneto cover screws **no. 1**. Remove magneto cover **no. 2**.



1. Disconnect water inlet hose
2. Heat exchanger cover

Remove oil pump shaft from magneto rotor nut.



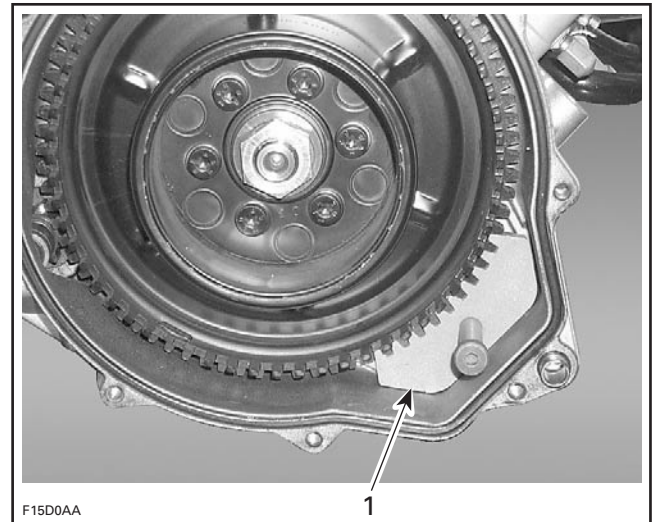
1. Oil pump shaft

### Rotor and Ring Gear

**NOTE:** Crankshaft can also be locked by using the PTO flywheel extractor tool. For procedure, refer to BOTTOM END.

Remove crankshaft position sensor **no. 3**.

Lock ring gear **no. 4** using the ring gear locking tool (P/N 529 035 846).



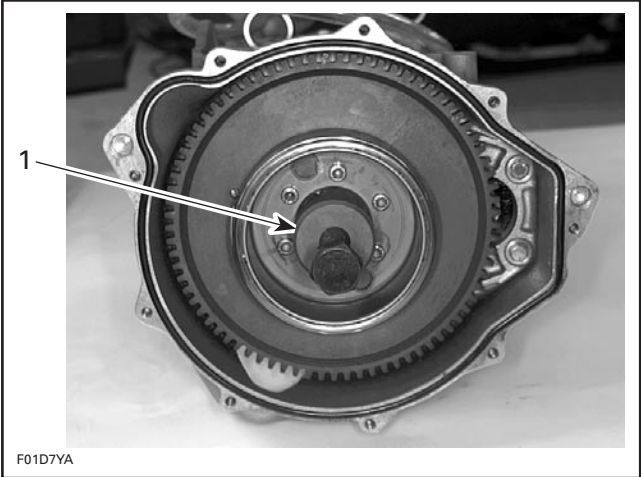
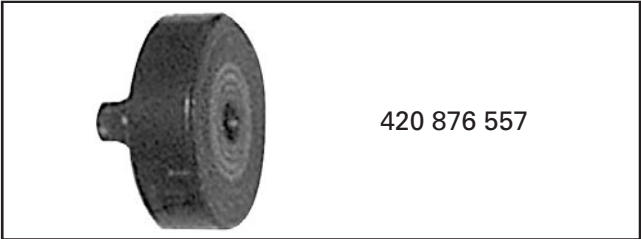
1. Ring gear locking tool

Using a suitable socket, unscrew retaining nut **no. 5** of magneto rotor COUNTERCLOCKWISE when facing it.

Remove the ring gear locking tool.

Insert the crankshaft protector (P/N 420 876 557) to outer end of crankshaft and fully thread the magneto puller (P/N 420 976 235) in magneto rotor **no. 6**.

**Section 03 787 RFI ENGINE**  
**Subsection 02 (MAGNETO SYSTEM)**

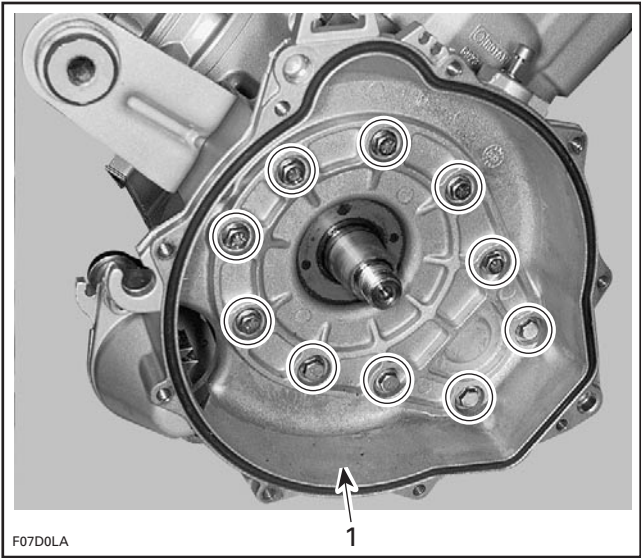


*TYPICAL*  
1. Puller

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

**Magneto Housing**

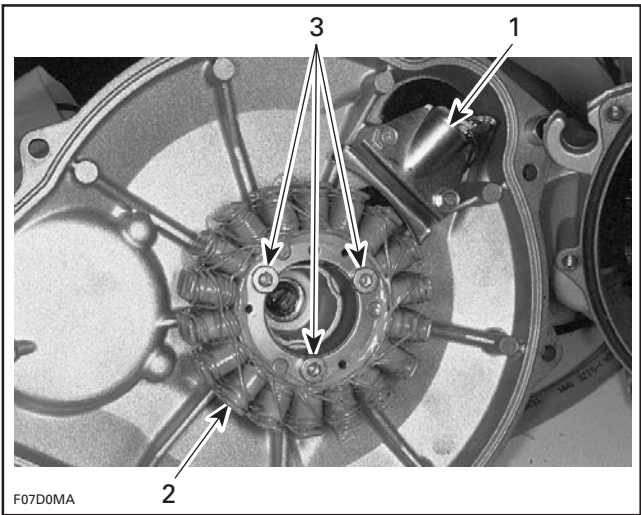
To remove magneto housing **no. 7**, starter has to be removed. Refer to STARTING SYSTEM.  
Unscrew retaining screws **no. 8**, then withdraw housing.



**REMOVE SCREWS**  
1. Magneto housing

**Stator Assembly**

Remove holding plate **no. 9** and withdraw plug from cover.  
Unscrew bolts **no. 10** and remove stator **no. 11** from magneto cover.



1. Holding plate  
2. Stator assembly  
3. Remove screws

**CLEANING**

Clean all metal components in a solvent.  
**CAUTION:** Clean coils and magnets using only a clean cloth.

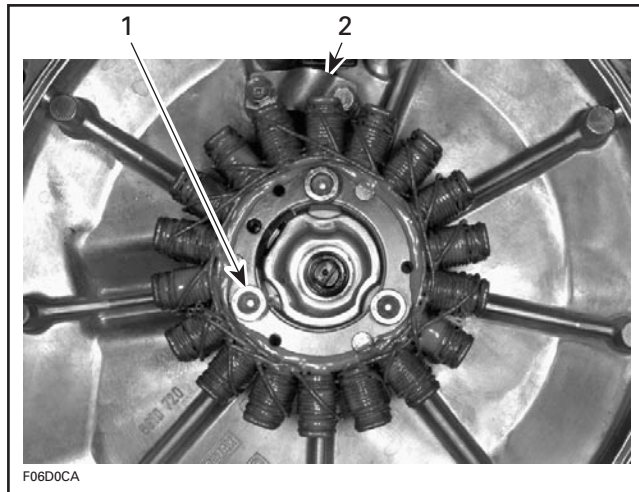
Clean crankshaft taper and threads using pulley flange cleaner (P/N 413 711 809). Apply the pulley flange cleaner (P/N 413 711 809) on a rag first then clean the crankshaft.

## ASSEMBLY

### Stator

Install the stator **no. 11** in magneto housing cover **no. 2** and torque screws **no. 20** to 9 N•m (80 lbf•in). Apply Loctite 243 (blue) (P/N 293 800 060) on screw threads.

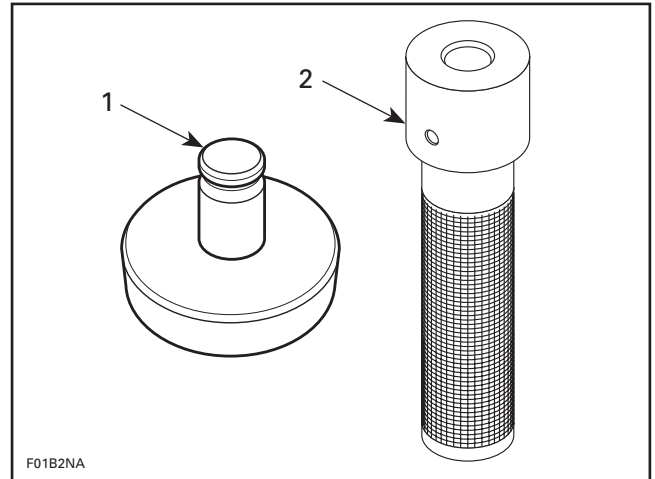
Install wiring harness bracket **no. 9** of stator and torque screws **no. 12** to 4 N•m (35 lbf•in). Apply Loctite 767 (antiseize lubricant) (P/N 293 800 070) on screw threads.



1. Stator screws
2. Bracket

### Magneto Housing

To install oil seal **no. 13** of magneto housing **no. 7**, use the oil seal pusher (P/N 420 877 740) and the installer handle (P/N 420 877 650).



1. Oil seal pusher
2. Installer handle



Apply Molykote 111 (P/N 413 707 000) on oil seal lips.

Install gasket **no. 14** between magneto housing and engine crankcase.

Install magneto housing. Apply Loctite 243 (blue) (P/N 293 800 060) on threads of housing screws **no. 8** and torque them to 9 N•m (80 lbf•in).

### Rotor and Ring Gear

Apply Loctite 243 (blue) (P/N 293 800 060) on crankshaft taper.

Install ring gear on crankshaft.

Apply Loctite 243 (blue) (P/N 293 800 060) on nut **no. 5**. Install nut with lock washer **no. 15** and torque to 120 N•m (89 lbf•ft).

**CAUTION:** Never use any type of impact wrench at magneto installation.

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## Section 03 787 RFI ENGINE

### Subsection 02 (MAGNETO SYSTEM)

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#### Crankshaft Position Sensor

Install crankshaft position sensor **no. 3** on magneto housing. Apply Molykote 111 (P/N 413 707 000) on its O-ring.

Apply Loctite 767 (antiseize lubricant) (P/N 293 800 070) on screw threads then torque it to 9 N•m (80 lbf•in).

**NOTE:** The crankshaft position sensor is not adjustable.

#### Cover

Before installing cover, make sure oil pump shaft is properly positioned. Apply Loctite 767 (antiseize lubricant) (P/N 293 800 070) to the end of shaft.

Before installation, properly install O-ring **no. 16** in engine magneto cover **no. 2**.

Apply Loctite 767 (antiseize lubricant) (P/N 293 800 070) on screws **no. 1**. Torque screws in a criss-cross sequence to 9 N•m (80 lbf•in).

Apply dielectric grease (P/N 293 550 004) on electrical connections.



# TOP END

## SERVICE TOOLS

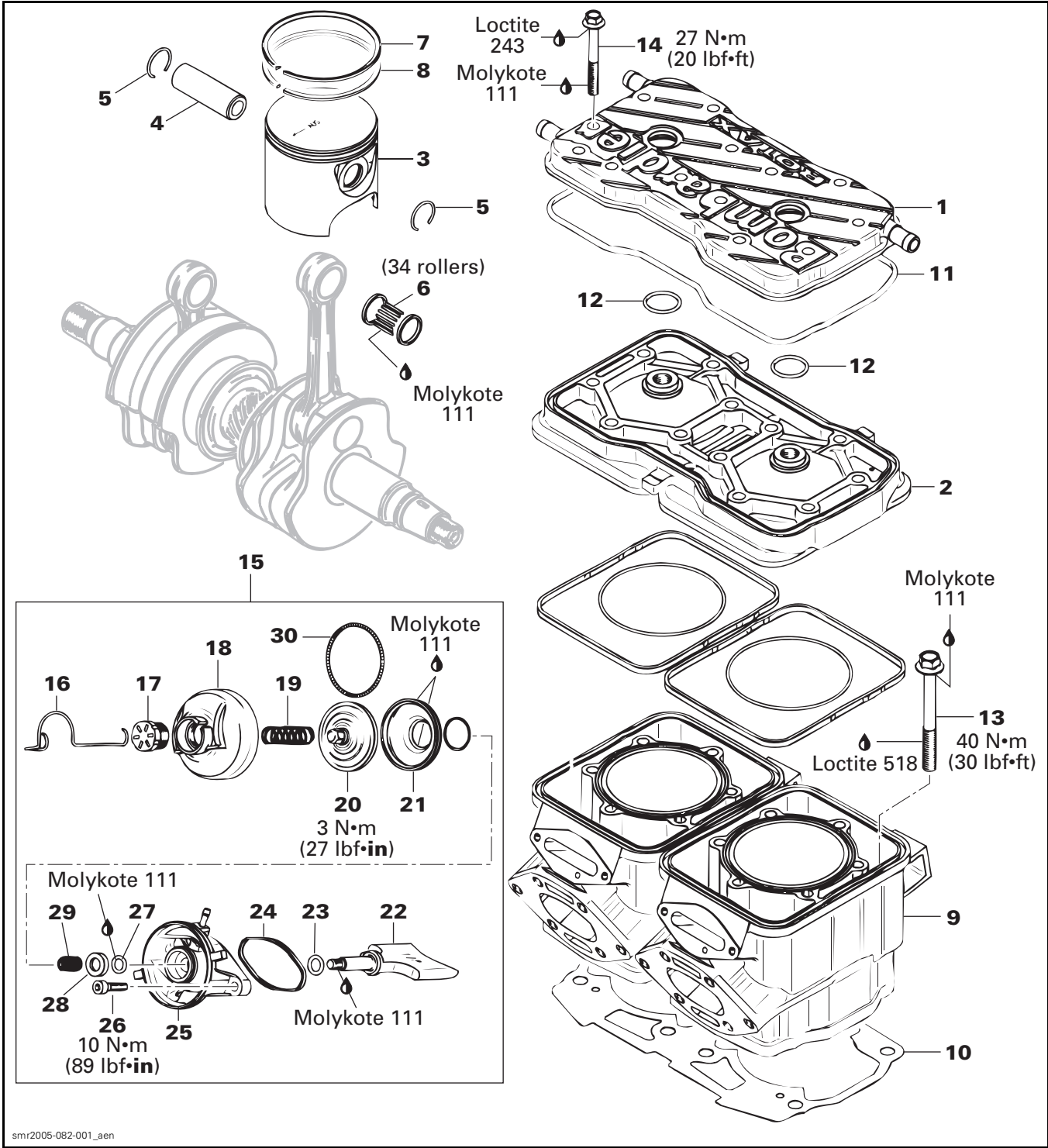
Description	Part Number	Page
circlip installer .....	529 035 562 .....	83
piston pin puller .....	529 035 503 .....	78, 81
piston ring compressor .....	420 876 979 .....	84
rubber pad .....	295 000 101 .....	77
set of sleeves .....	529 035 542 .....	78, 81

## SERVICE PRODUCTS

Description	Part Number	Page
Loctite 243 (blue) .....	293 800 060 .....	85
Loctite 518 .....	293 800 038 .....	85–86
Molykote 111 .....	413 707 000 .....	85–86



**Section 03 787 RFI ENGINE**  
Subsection 03 (TOP END)



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## GENERAL

The 2-stroke ROTAX engine rotates counterclockwise seen from the rear (PTO flywheel).

The 787 RFI engine has a rotary valve to control opening and closing of the intake and it is also equipped with the Rotax Adjustable Variable Exhaust (RAVE) system.

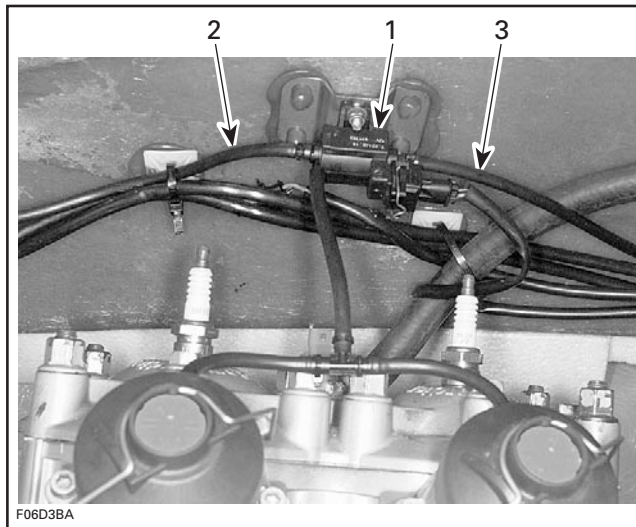
## RAVE System (Rotax Adjustable Variable Exhaust)

### BASIC OPERATION

The RAVE valves change the height of the exhaust port. The RAVE valve solenoid, which is controlled by the Engine Control Module (ECM), allows positive crankcase pressure to inflate the bellows and open the RAVE valves.

On 787 RFI engine, the RAVE valves are controlled by the ECM.

To open the RAVE valves, the ECM activates a solenoid which directs the positive pressure from engine crankcase to the valves.

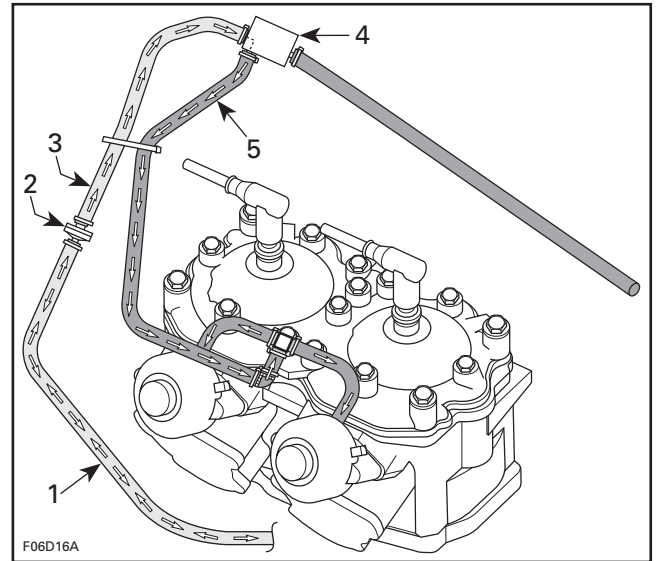


#### TYPICAL

1. Solenoid
2. Pressure hose from crankcase
3. To atmospheric pressure

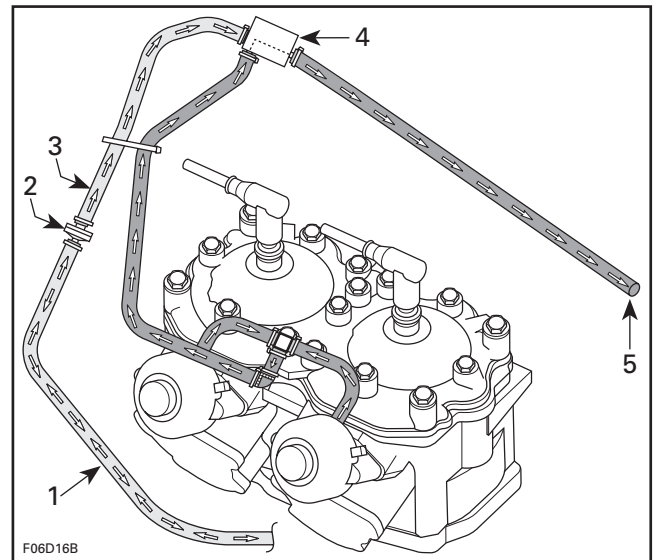
**NOTE:** A check valve on the pressure line eliminates the negative pressure from the crankcase.

To close the RAVE valves, the ECM deactivates the solenoid which blocks the crankcase positive pressure. The RAVE valves are opened to the atmosphere.



#### RAVE VALVE OPENED

1. Pulse from crankcase
2. Check valve
3. Positive pressure to solenoid
4. Solenoid activated
5. Positive crankcase pressure to RAVE valves



#### RAVE VALVE CLOSED

1. Pulse from crankcase
2. Check valve
3. Positive pressure blocked by the solenoid
4. Solenoid deactivated
5. RAVE valves are opened to atmosphere

## ADJUSTMENT

On top of the RAVE, there is a red plastic adjustment knob. Turning the adjustment in or out changes the preload on the return spring which, in turn, will change the RPM at which the RAVE valve opens and closes.

## Section 03 787 RFI ENGINE

### Subsection 03 (TOP END)

#### MAINTENANCE

There are no wear parts anywhere in the system and there are no adjustments to be periodically checked. The only possible maintenance required would be cleaning of carbon deposits from the guillotine slide. Cleaning intervals would depend upon the user's riding style and the quality of the oil used. We suggest annual cleaning of the valve. If a customer uses a lower than recommended quality oil, more frequent cleaning may be required.

No special solvents or cleaners are required when cleaning the valve.

#### BORING PRECAUTION

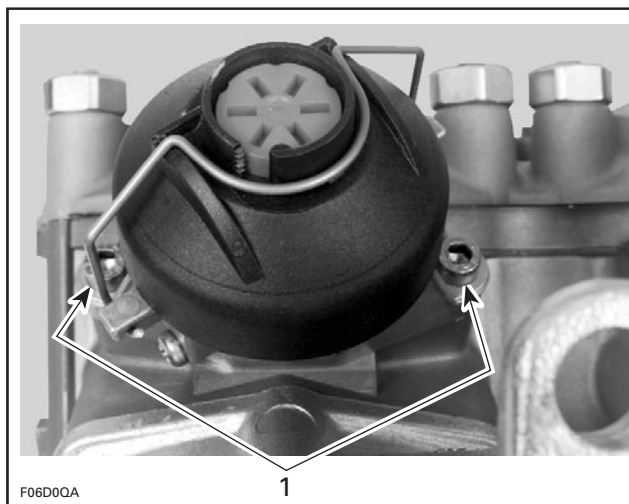
In its stock configuration the RAVE valve guillotine has a minimum of 0.5 mm (.020 in) clearance to the cylinder bore measured at the center line of the cylinder. This is the minimum production clearance.

There is only a first oversize piston available for the 787 RFI engine. That piston is 0.25 mm (.010 in) larger in diameter than the stock piston. When the oversize is installed, the guillotine will have a minimum clearance of 0.375 mm (.015 in) with the cylinder bore. This is the minimum operating clearance the guillotine should be used with. Clearance less than 0.375 mm (.015 in) will require reworking of the guillotine to achieve the proper clearance and radius.

#### DISASSEMBLY

##### RAVE Valve

Loosen Allen screws **no. 26** each side of RAVE valve.



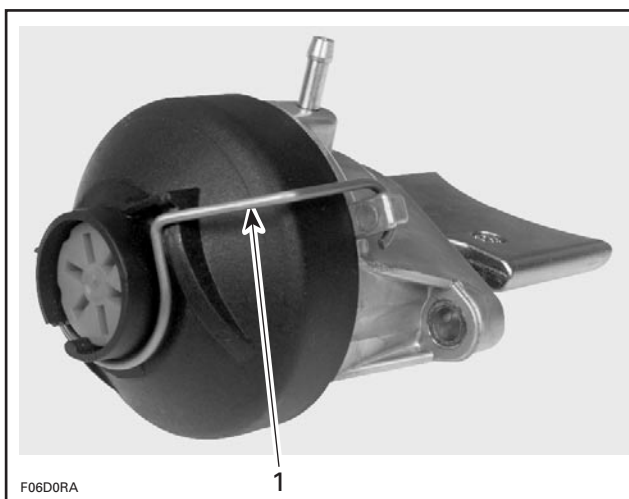
1. Remove screws

Remove RAVE valve **no. 15**.

Remove the cover **no. 18** of the valve by releasing the spring **no. 16**.

#### WARNING

Firmly hold cover to valve base. The compression spring inside the valve is applying pressure against the cover.

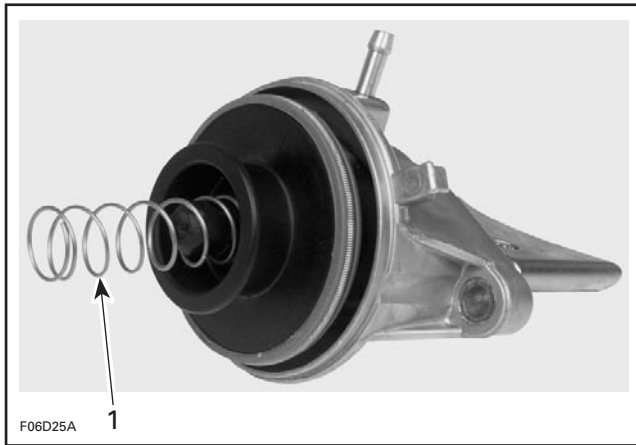


1. Spring

Remove the compression spring **no. 19**.

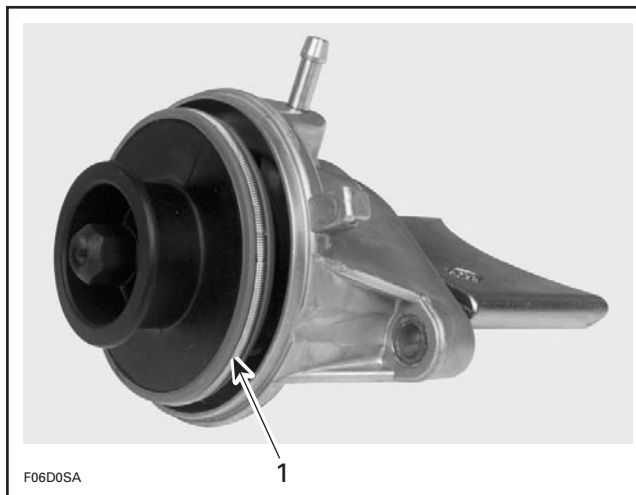
## Section 03 787 RFI ENGINE

### Subsection 03 (TOP END)



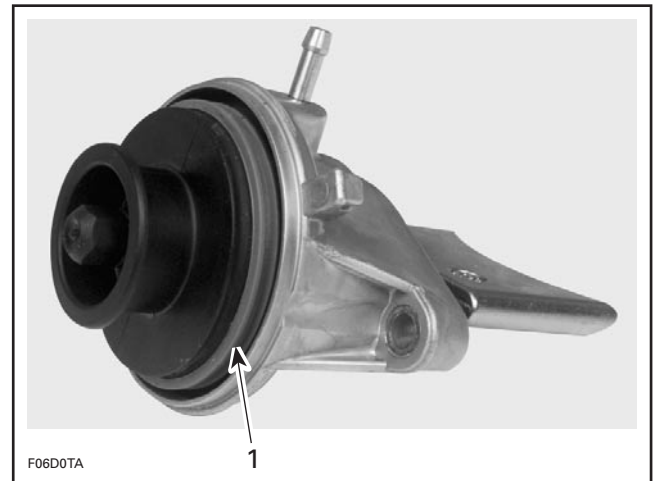
1. Remove spring

Remove spring **no. 30** retaining bellows **no. 21** to valve piston **no. 20**.



1. Spring

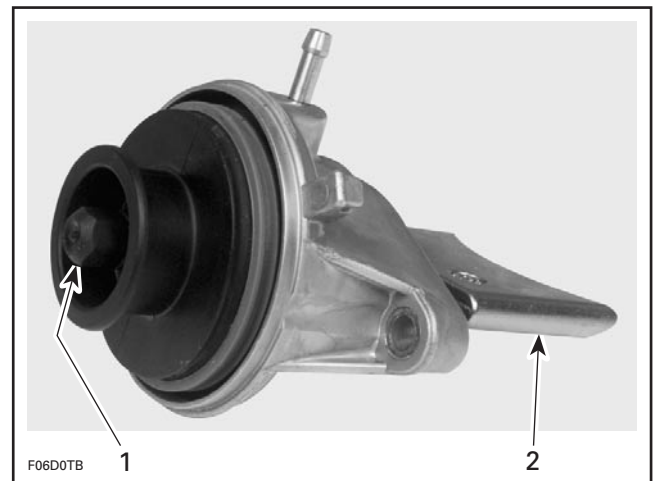
Free bellows **no. 21** from valve piston **no. 20**.



1. Bellows removed from piston

Unscrew valve piston **no. 20** from sliding valve **no. 22**.

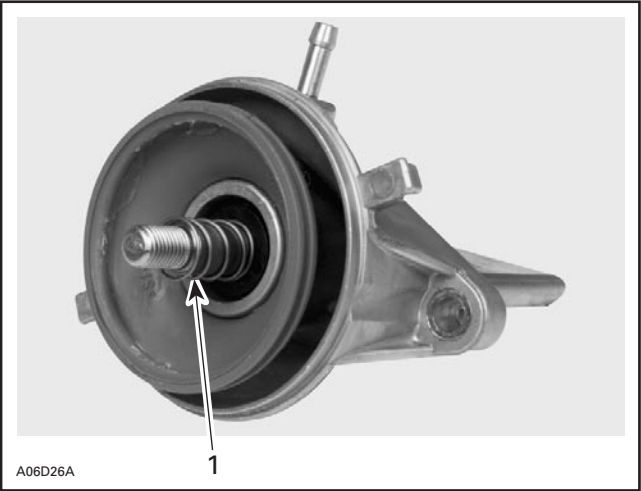
**NOTE:** Hold the sliding valve to prevent it from turning.



1. Unscrew piston  
2. Hold sliding valve

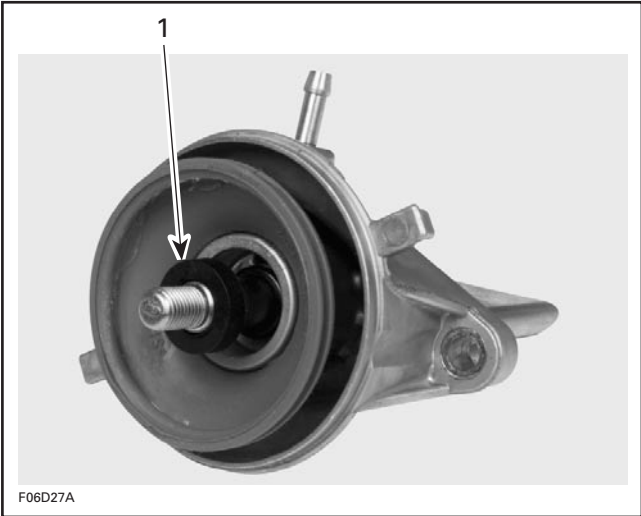
Remove compression spring **no. 29**.

**Section 03 787 RFI ENGINE**  
**Subsection 03 (TOP END)**



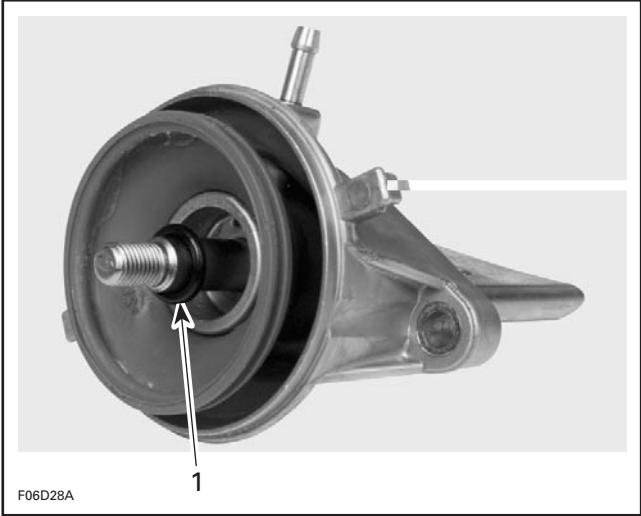
1. Remove spring

Remove supporting ring no. 28.



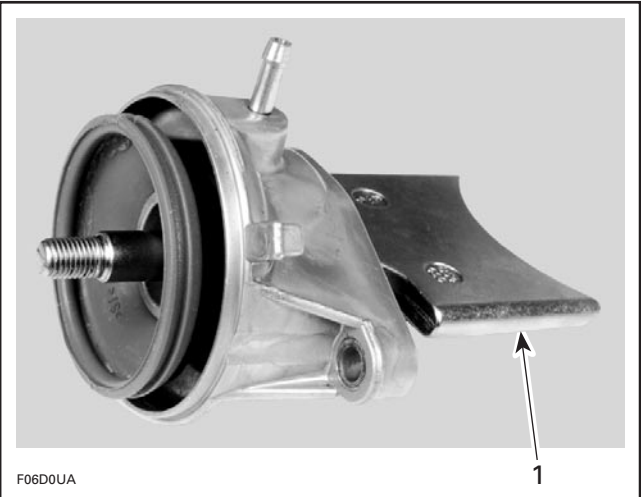
1. Remove supporting ring

Remove O-ring no. 23.



1. Remove O-ring

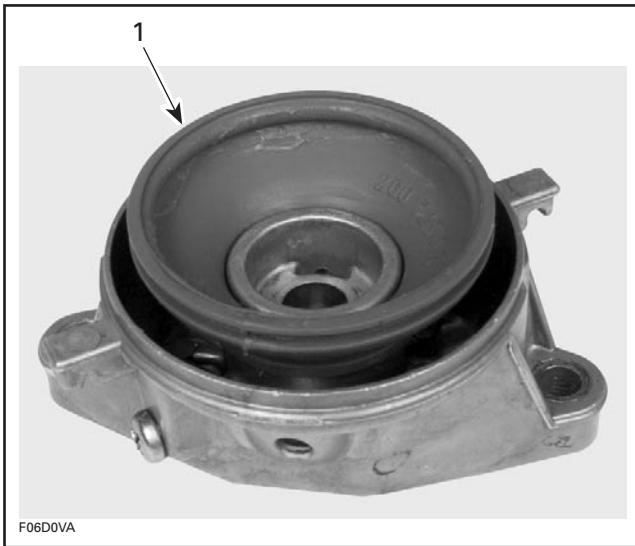
Remove sliding valve no. 22.



1. Remove sliding valve

Remove bellows no. 21.





1. Remove bellows

## Cylinder Head Cover and Cylinder Head

### Engine in Watercraft

Disconnect temperature sensor wire and spark plug cables.

Connect spark plug cables on grounding device.

Proceed with ENGINE ON BENCH WORK below.

### Engine on Bench Work

Remove cylinder head cover screws **no. 14**.

Remove cylinder head cover **no. 1**.

If shells, sand, salt or any other particles are present in cylinder head, clean with a vacuum cleaner.

Remove cylinder head **no. 2**.

If shells, sand, salt water or any other particles are present in cylinder cooling jacket, clean with a vacuum cleaner.

### Exhaust Manifold

Remove 8 Allen screws and lock washers then withdraw exhaust manifold.

### Cylinder

**NOTE:** When removing cylinder, make sure connecting rods do not hit crankcase edge.

### Engine in Watercraft

Remove air intake silencer and support, refer to the appropriate *VEHICLE SHOP MANUAL*.

Remove tuned pipe, refer to the appropriate *VEHICLE SHOP MANUAL*.

Proceed with ENGINE ON BENCH WORK.

### Engine on Bench Work

Remove cylinder screws **no. 13**.

Remove cylinders **no. 9**, while making sure connecting rods do not hit crankcase edge.

### WARNING

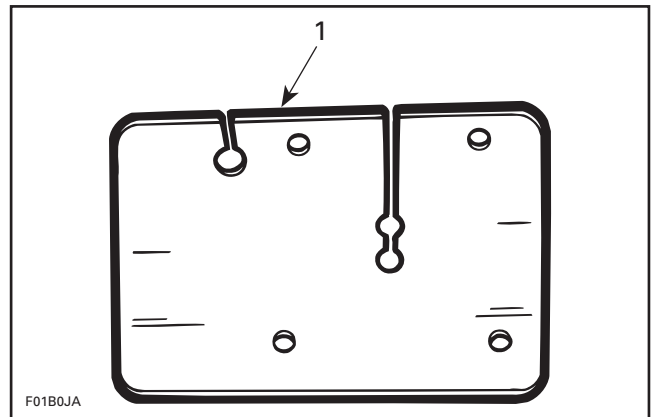
If screws need to be heated for removal when engine is in watercraft, fuel system pressurization must be done first. Do not use open flame; use a heat gun.

**NOTE:** Even if only 1 cylinder needs repair, both cylinders should be lifted to allow 1-piece cylinder base gasket replacement.

### Piston

**NOTE:** Engine features cageless piston pin bearings.

Bring piston to Top Dead Center (TDC) and install the rubber pad (P/N 295 000 101) over crankcase opening. Secure with screws. Lower piston until it sits on pad.

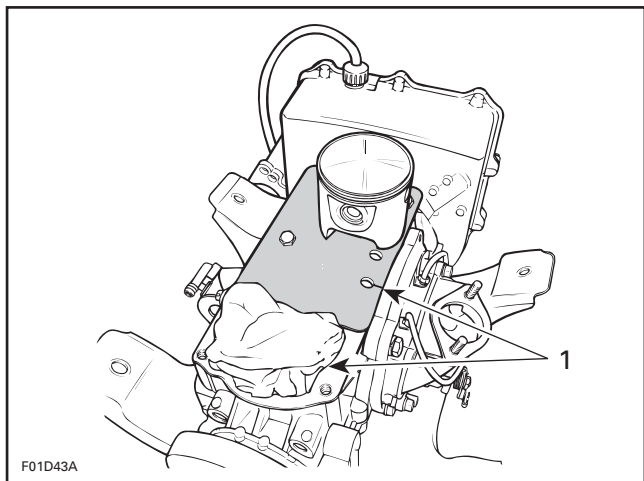


1. Rubber pad

If the other cylinder has been removed, completely cover its opening with a clean rag.

## Section 03 787 RFI ENGINE

### Subsection 03 (TOP END)

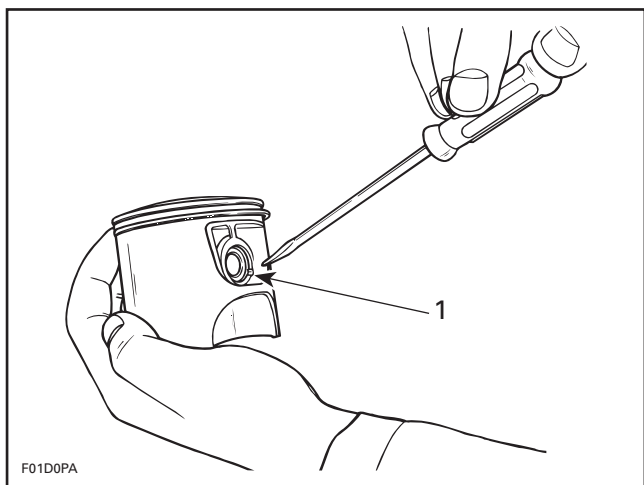


1. Openings covered with rag and rubber pad

To remove circlip **no. 5**, insert a pointed tool in piston notch then pry it out and discard.

#### **WARNING**

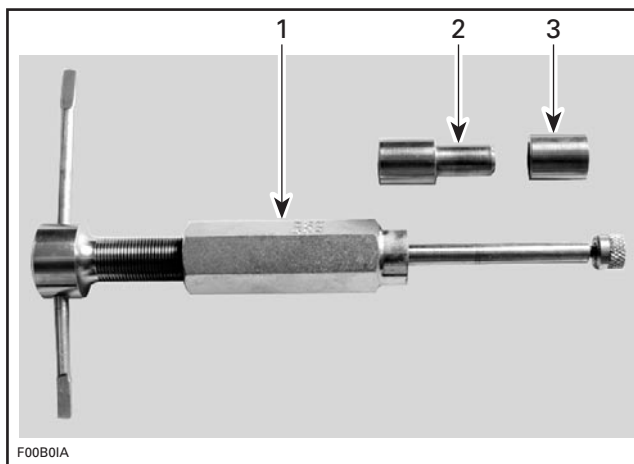
Always wear safety glasses when removing piston circlips.



**TYPICAL**

1. Piston notch

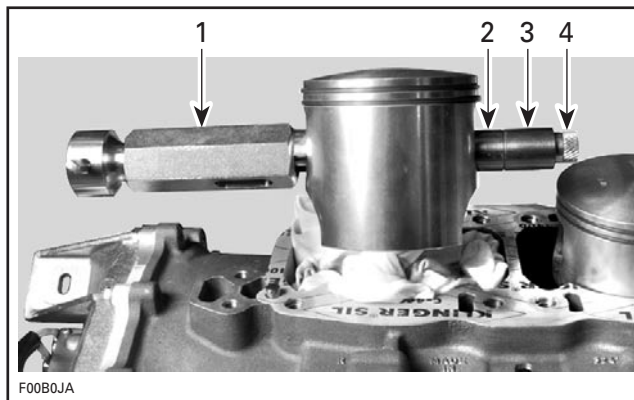
To extract piston pin **no. 4**, use the piston pin puller (P/N 529 035 503) with the set of sleeves (P/N 529 035 542).



**TYPICAL**

1. Puller  
2. Shoulder sleeve  
3. Sleeve

- Fully thread on puller handle.
- Insert extractor spindle into the piston pin.
- Slide the sleeve and shoulder sleeve onto the spindle.
- Screw in extracting nut with the movable extracting ring toward spindle.



**TYPICAL**

1. Puller  
2. Sleeve  
3. Shoulder sleeve  
4. Extracting nut

**NOTE:** The tool cutout must be positioned toward the bottom of the piston.

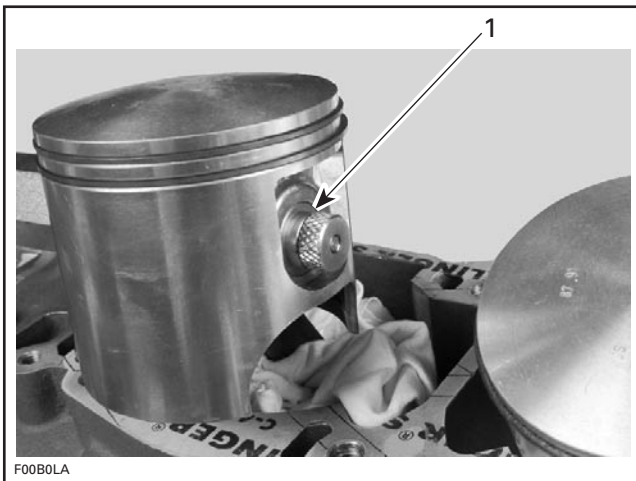




**TYPICAL**

1. Tool cut-out toward bottom of piston

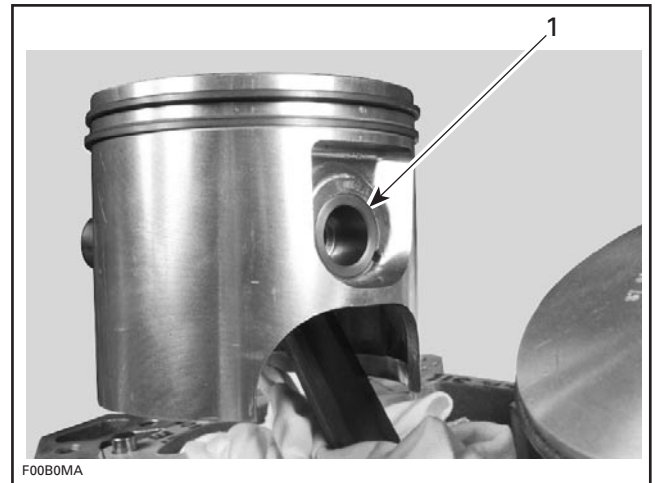
- Firmly hold puller and rotate handle to pull piston pin **no. 4**.
- Rotate spindle until the shoulder sleeve is flushed with the piston recess.



**TYPICAL**

1. Shoulder sleeve flush with piston recess

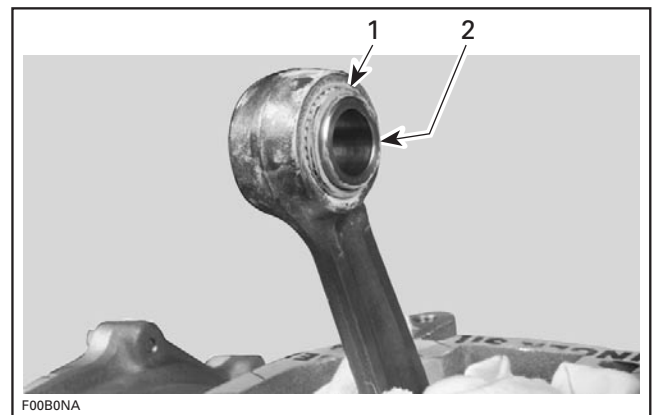
- Loosen the extracting nut and remove puller.
- Remove the shoulder sleeve from piston.



**TYPICAL**

1. Remove shoulder sleeve

- Carefully remove the piston **no. 3**.
- The needles, thrust washers and the sleeve remain in the connecting rod bore and may be used again.



1. Needles and thrust washer
2. Sleeve

## CLEANING

Discard all gaskets and O-rings.

Clean all metal components in a solvent.

Clean water passages and make sure they are not clogged.

Remove carbon deposits from cylinder exhaust port, RAVE valve, cylinder head and piston dome.

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

Section 03 787 RFI ENGINE

Subsection 03 (TOP END)

INSPECTION

Refer to table below to find top end engine dimension specifications. For dimension measurement procedures, refer to ENGINE MEASUREMENT.

Visually inspect all parts for corrosion damage.

Inspect piston for damage. Light scratches can be sanded with a fine sand paper.

**NOTE:** When repairing a seized engine, connecting rods should be checked for straightness and crankshaft for deflection/misalignment.

Inspect plane surfaces for warpage. Small deformation can be corrected by grinding surface with a fine sand paper. Install sand paper on a surface plate and rub part against oiled sand paper.

ENGINE MEASUREMENT	TOLERANCES		
	NEW PARTS (min.)	(max.)	WEAR LIMIT
Combustion chamber volume	34.7 cc	37.9 cc	N.A
Cylinder taper	N.A.	0.05 mm (.002 in)	0.1 mm (.004 in)
Cylinder out of round	N.A.	0.008 mm (.0003 in)	0.08 mm (.003 in)
Piston skirt	N.A.	N.A.	0.12 mm (.005 in)
Piston/cylinder wall clearance	0.13 mm (.005 in)	N.A	0.24 mm (.009 in)
Ring/piston groove clearance	0.025 mm (.001 in)	0.070 mm (.0027 in)	0.24 mm (.009 in)
Ring end gap	0.40 mm (.016 in)	0.55 mm (.022 in)	1.0 mm (.039 in)

N.A.: NOT APPLICABLE

**NOTE:** Replacement cylinder sleeves are available if necessary. Also, oversize pistons of 0.25 mm (.010 in) are available.

RAVE Valve

Check RAVE valve bellows no. 21 for cracks.

Check sliding valve for wear, bent or other damages.

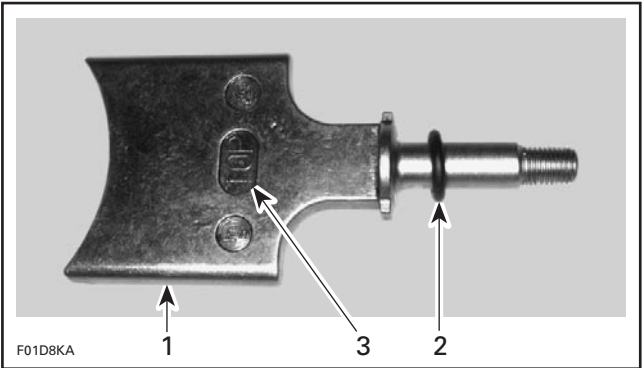
ASSEMBLY

Assembly is essentially the reverse of disassembly procedures. However pay particular attention to the following.

RAVE Valve

Make sure to insert O-ring no. 23 onto rod of sliding valve no. 22.

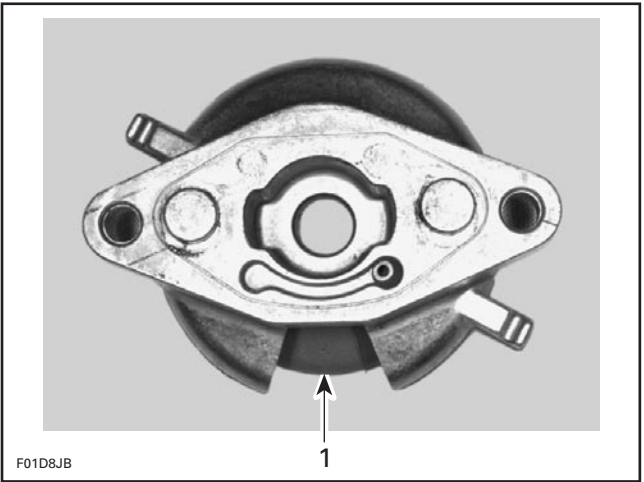
The TOP position of the sliding valve no. 22 is indicated on one side.



- 1. Sliding valve
- 2. O-ring
- 3. TOP

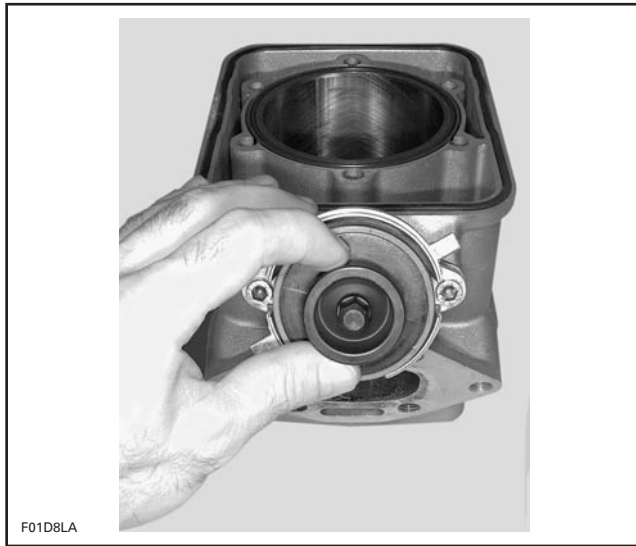
Install a new gasket no. 24. It must be installed at the same time as the sliding valve no. 22.

Position the valve housing no. 25 onto the cylinder so that its opening is toward the bottom.



- 1. Bottom of valve housing

When the valve is mounted onto the cylinder, move the valve piston no. 20 to ensure the sliding valve no. 22 moves easily and does not stick.

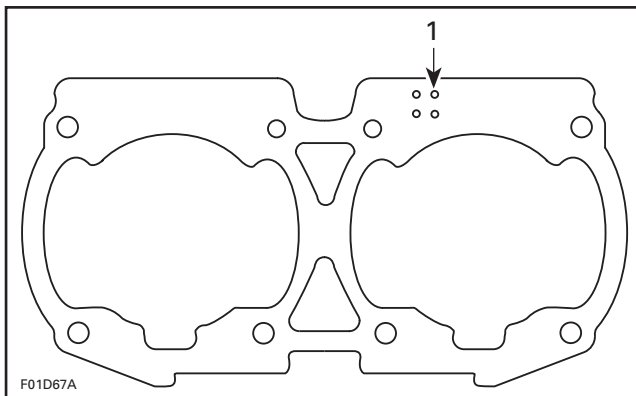


### Cylinder Base Gasket

**NOTE:** The general procedure is to install a new gasket of the same thickness. However, if you do not know the gasket thickness that was installed or if a crank repair has involved replacement of connecting rods, refer to COMBUSTION CHAMBER VOLUME MEASUREMENT in ENGINE MEASUREMENT section to properly determine the required gasket thickness.

Different thicknesses of cylinder base gaskets are used for a precise adjustment of the combustion chamber volume.

To identify gasket thickness, refer to the identification holes on the gasket.



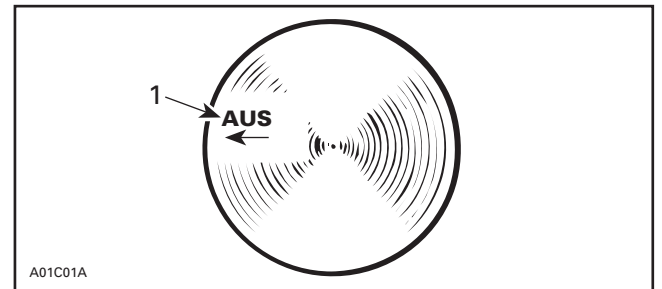
**TYPICAL**

1. Identification holes

GASKET THICKNESS	IDENTIFICATION HOLES
0.3 mm (.012 in)	3
0.4 mm (.016 in)	4
0.5 mm (.020 in)	5
0.6 mm (.024 in)	6
0.8 mm (.031 in)	8

### Piston

At assembly, place the pistons **no. 3** with the letters "AUS" (over an arrow on the piston dome) facing in direction of the exhaust port.



1. Exhaust side

**NOTE:** The exhaust ports are located on the same side as the intake.

Carefully cover crankcase opening as for disassembly.

### Piston Pin and Roller Bearing

To install roller bearing **no. 4** and piston pin **no. 6** use the piston pin puller (P/N 529 035 503) with the set of sleeves (P/N 529 035 542).

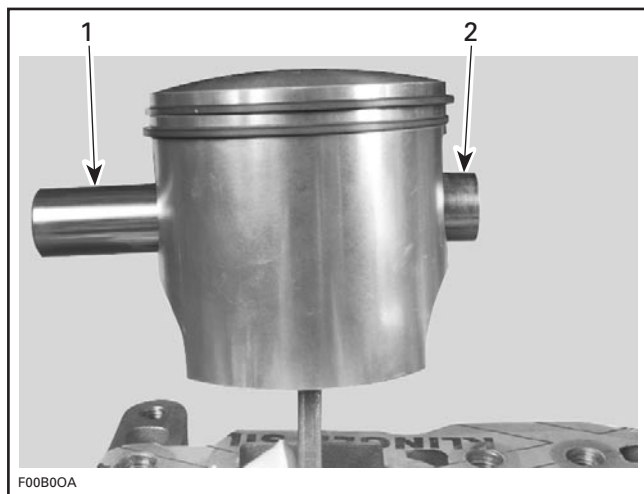
- Replacement bearings are held in place by a locating sleeve outside and 2 plastic cage halves inside.
- Push needle bearing together with inner halves out of the locating sleeve into the connecting rod bore.
- Replace the inner halves by the appropriate sleeve tool in the connecting rod bore.
- Insert piston pin into piston until it comes flush with inward edge of piston hub.
- Warm piston to approximately 50 - 60°C (122 - 140°F) and install it over connecting rod.

## Section 03 787 RFI ENGINE

### Subsection 03 (TOP END)

**NOTE:** Make sure thrust washers are present each side of needles.

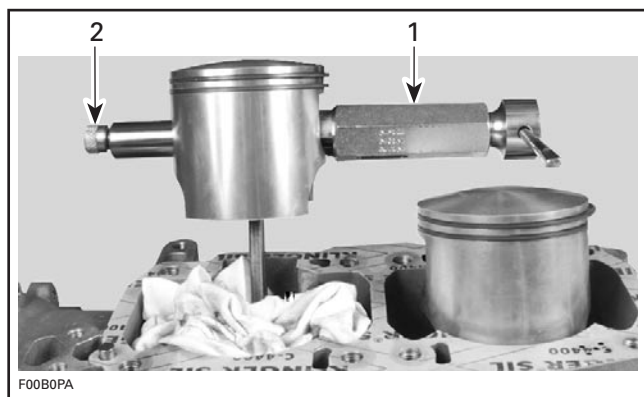
- Install the shoulder sleeve tool on the opposite side of the piston pin.



**TYPICAL**

1. Piston pin
2. Shoulder sleeve

- Insert extractor spindle into the piston pin, screw on extracting nut.



**TYPICAL**

1. Puller installed on the opposite side of the piston pin
2. Tighten extracting nut

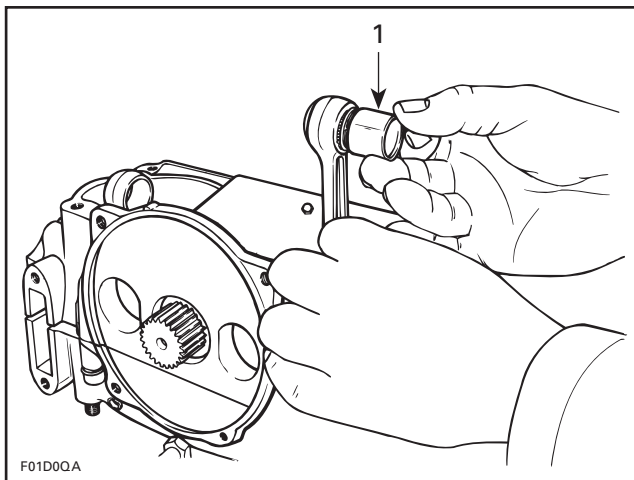
- Rotate handle to pull piston pin carefully into the piston.

#### Plastic Mounting Device Method

This is an alternate method when no service tool is available.

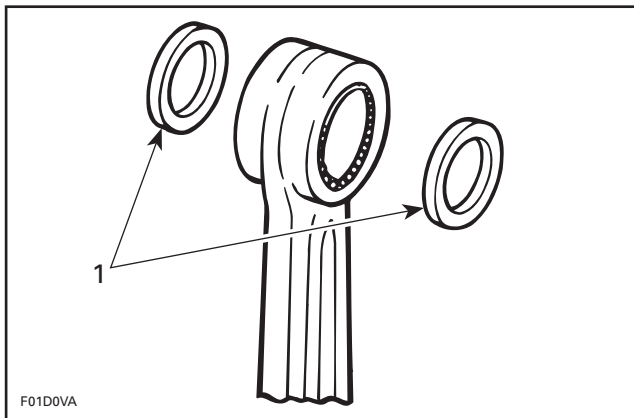
Replacement roller bearings are delivered in a convenient plastic mounting device. For installation, proceed as follows:

- Align replacement roller bearing with connecting rod bore.
- Carefully push inner plastic sleeve into connecting rod bore; outer plastic ring will release rollers.



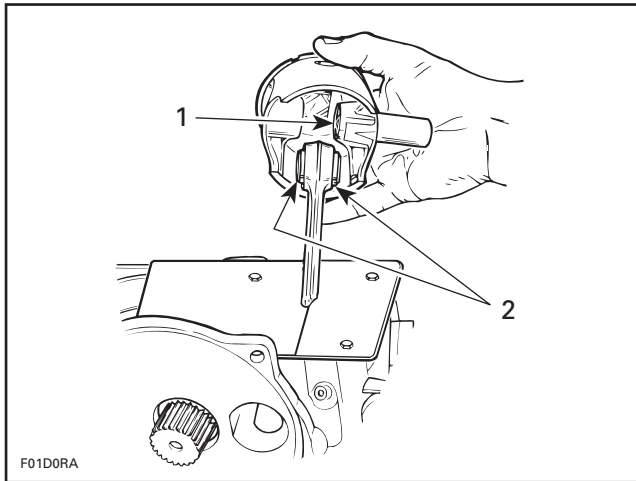
1. Outer ring removal after inner sleeve insertion into bore

- Make sure thrust washers are present each side of rollers.



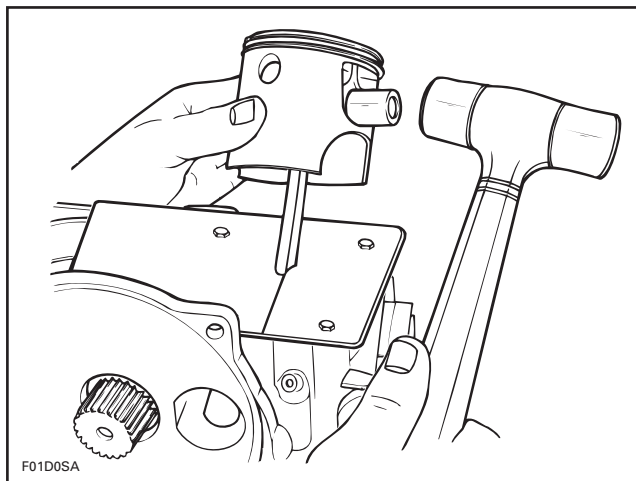
1. Thrust washer each side

- Insert piston pin into piston until it comes flush with inward edge of piston hub.

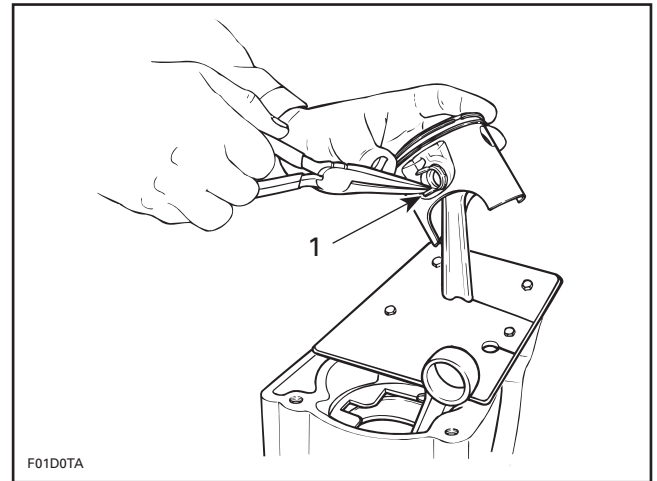


1. Piston pin flush here
2. Thrust washers

- Place piston over connecting rod and align bores, then gently tap piston pin with a fiber hammer to push out inner plastic ring on opposite side. Support piston from opposite side.



- As necessary, pull halves of inner sleeve with long nose pliers.



1. Pulling inner sleeve half

### Circlip

Always use new circlips.

#### **⚠ WARNING**

Always wear safety glasses when installing piston circlips.

**CAUTION:** Always use new circlips. At installation, take care not to deform them. Circlips must not move freely after installation.

Secure circlip with its opening located at the bottom of the piston.

**CAUTION:** To minimize the stress on the circlips, it is important to install them as described.



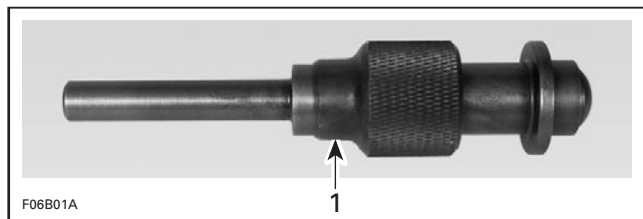
1. Circlip opening at 6 o'clock (at bottom)

To easily insert circlip into piston, use the circlip installer (P/N 529 035 562).



## Section 03 787 RFI ENGINE

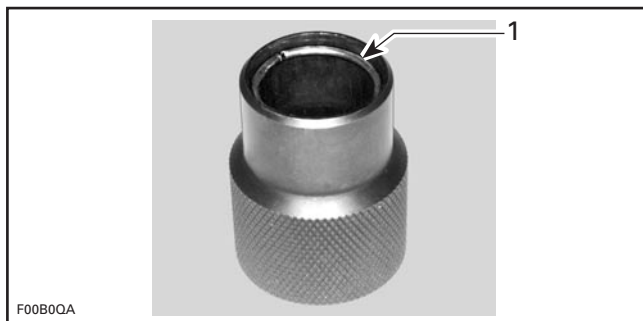
### Subsection 03 (TOP END)



#### TYPICAL

1. Circlip installer

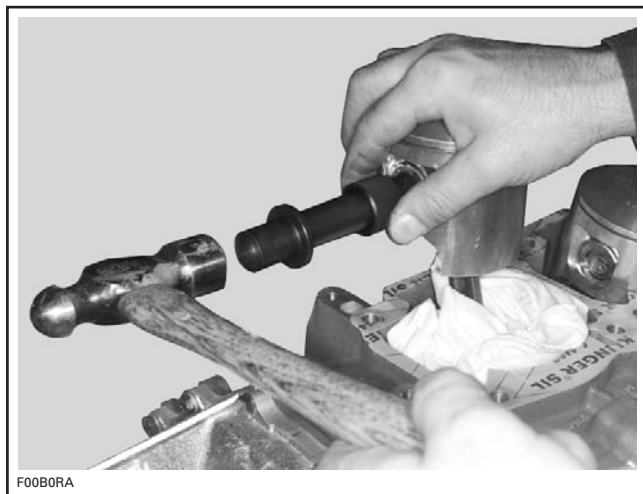
- Remove sleeve from pusher then insert circlip into its bore.
- Reinstall sleeve onto pusher and push until circlip comes in end of tool.



#### TYPICAL

1. Circlip near end of tool

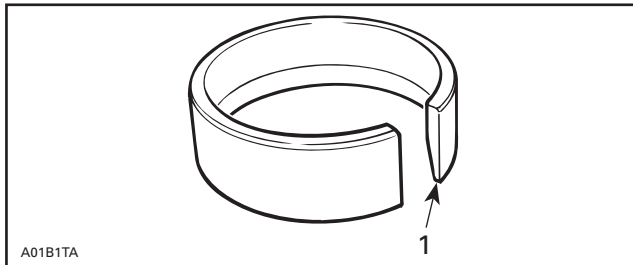
- Position end of tool against piston pin opening.
- Firmly hold piston against tool and tap tool with a hammer to insert circlip into its groove.



**CAUTION:** The hand retaining the piston should absorb the energy to protect the connecting rod.

## Cylinder

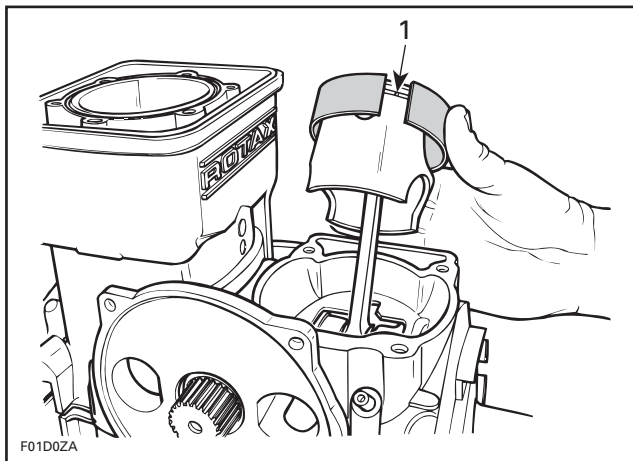
To easily slide cylinder **no. 9** over piston, use the piston ring compressor (P/N 420 876 979).



1. Slide this edge

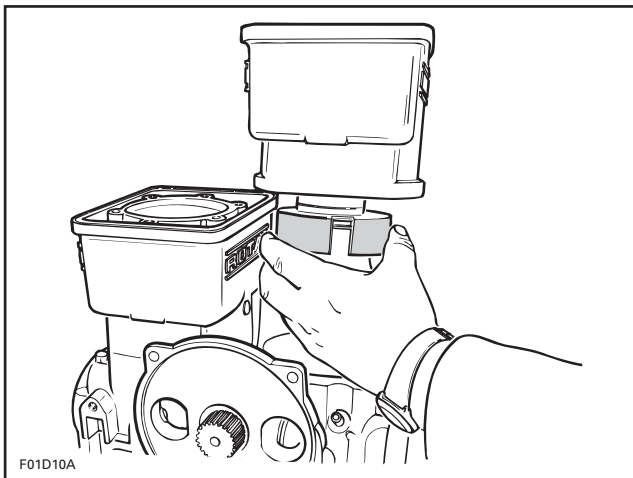
**NOTE:** Ring compressor will not fit on oversize parts.

Make sure to align ring end gap with piston locating pin. Slide tool over rings.



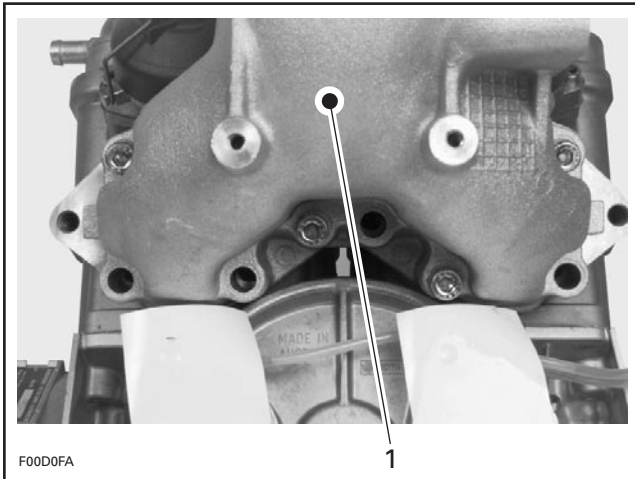
1. Ring end gap aligned with piston locating pin

Slide cylinder over piston.



When reassembling cylinders to crankcase, it is important to have them properly aligned so that exhaust flanges properly match up with exhaust manifold.

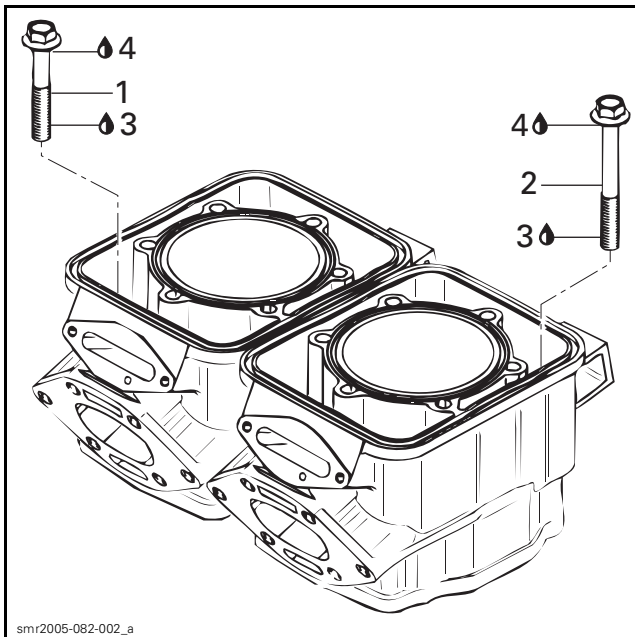
The exhaust manifold is used to align cylinders.



1. Aligning cylinders using exhaust manifold

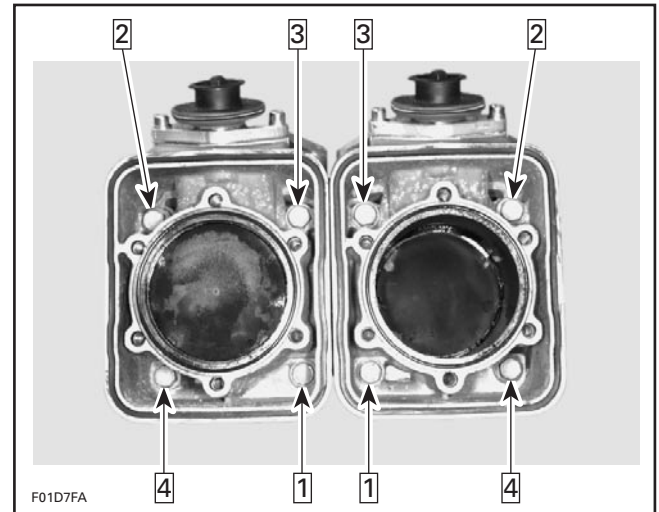
Apply Molykote 111 (P/N 413 707 000) below screw head and Loctite 518 (P/N 293 800 038) on screw threads.

Install M10 x 73.5 screws on exhaust side and the M10 x 105 on opposite side.



1. M10 x 73.5
2. M10 x 105
3. Loctite 518
4. Molykote 111

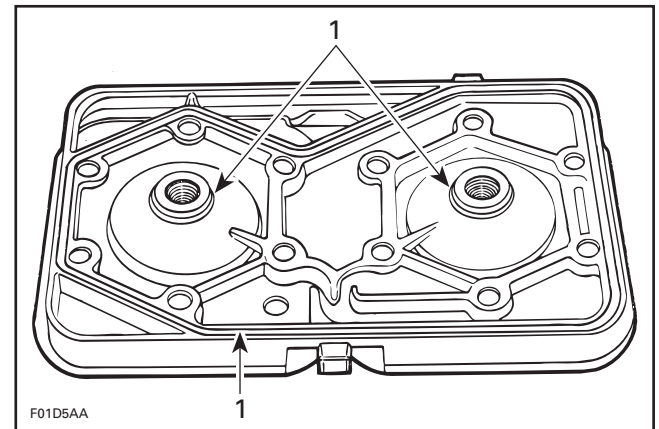
Torque screws in a criss-cross sequence for each cylinder to 20 N•m (15 lbf•ft). Repeat the procedure, retightening all cylinder screws to 40 N•m (30 lbf•ft).



## Cylinder Head

Install cylinder head gasket.

Make sure to install O-rings **no. 12** around spark plug holes and O-ring **no. 11** of cylinder head as shown in the following illustration.



1. O-rings

Apply Loctite 518 (P/N 293 800 038) in O-ring groove of cylinder sleeves.

## Cylinder Head Cover

Install cylinder head cover **no. 1**.

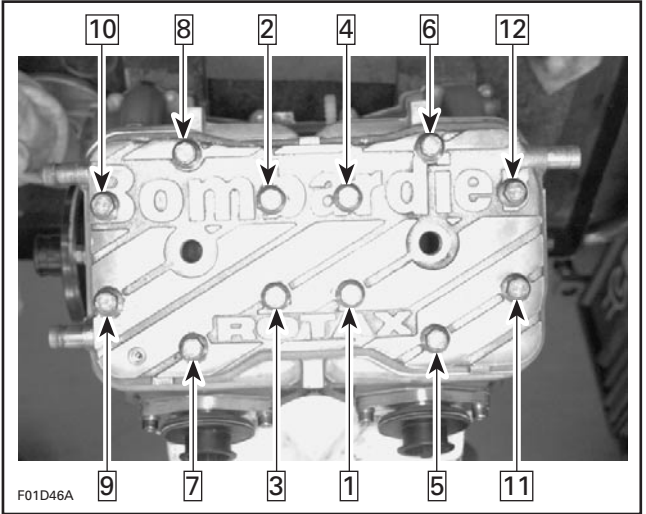
Apply Loctite 243 (blue) (P/N 293 800 060) below head of screws **no. 14**.



**Section 03 787 RFI ENGINE**  
**Subsection 03 (TOP END)**

Apply also Molykote 111 (P/N 413 707 000) on threads of screws **no. 14**.

Torque cylinder head screws **no. 14** to 12 N•m (106 lbf•in) as per following illustrated sequence. Repeat the procedure, retightening all screws to 24 N•m (17 lbf•ft).

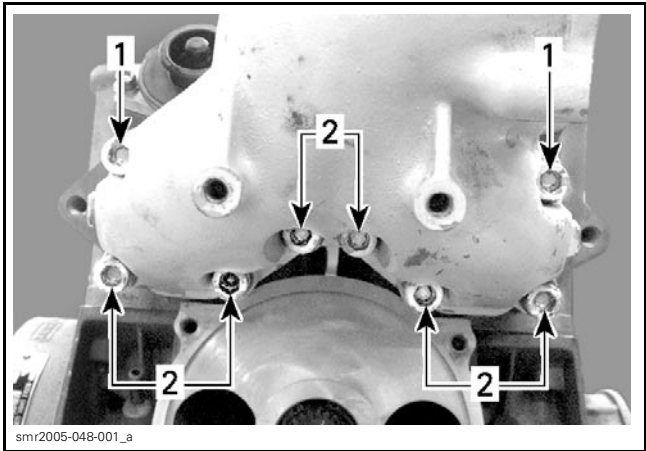


TORQUING SEQUENCE

**Exhaust Manifold**

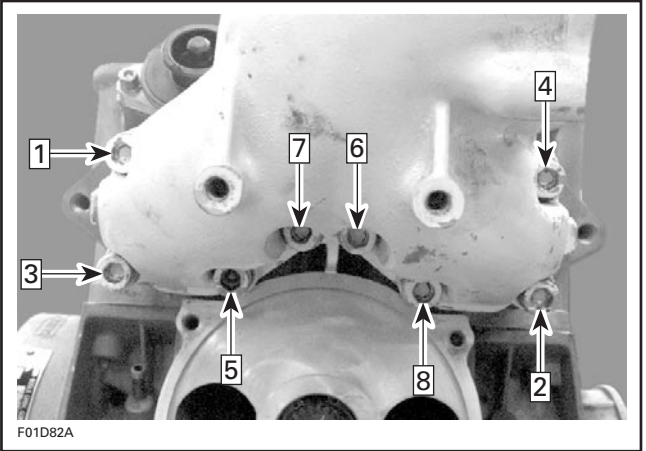
Make sure gaskets are properly positioned prior to finalizing manifold installation.

Apply Loctite 518 (P/N 293 800 038) on 2 screws. On the other screws, apply Molykote 111 (P/N 413 707 000) on threads. Install screws. Refer to the following illustration for proper position of screws.



- 1. Screw with Loctite 518
- 2. Screw with Molykote 111

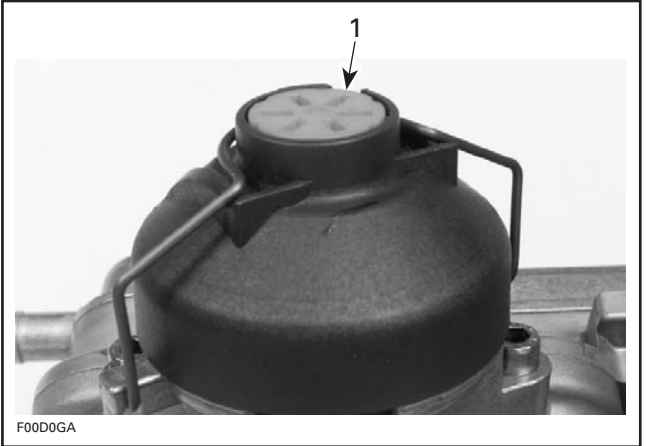
Torque exhaust manifold screws to 24 N•m (17 lbf•ft) as per following illustrated sequence. Repeat the procedure, retightening screws to 40 N•m (30 lbf•ft).



**ADJUSTMENT**

**RAVE Valve**

Turn the red plastic knob **no. 17** until it is flush to the valve cover.



- 1. Knob flush with the cover

# BOTTOM END

## SERVICE TOOLS

Description	Part Number	Page
bearing heater.....	529 035 969 .....	94
distance gauge .....	529 034 900 .....	96
Distance ring.....	420 876 569 .....	91
extension handle .....	295 000 125 .....	89
gear/bearing puller.....	290 877 665 .....	91
Protective cap.....	420 876 557 .....	91–92
PTO flywheel extractor.....	295 000 156 .....	89
Puller .....	420 877 635 .....	91–92
Ring .....	420 977 480 .....	92
Ring .....	420 977 490 .....	91
Ring halves .....	420 876 330 .....	92
Ring halves .....	420 977 475 .....	91
Screw M8 x 40 .....	420 840 681 .....	91–92
Screw M8 x 70 .....	420 841 201 .....	91
temperature indicator stick.....	529 035 970 .....	95

## SERVICE PRODUCTS

Description	Part Number	Page
chisel gasket remover .....	413 708 500 .....	93
Loctite 518.....	293 800 038 .....	99
Loctite 5910 .....	293 800 081 .....	97
Loctite 767 (anti-seize lubricant) .....	293 800 070 .....	95, 100
Molykote 111.....	413 707 000 .....	99
pulley flange cleaner.....	413 711 809 .....	93

### Subsection 04 (BOTTOM END)



## GENERAL

Engine has to be removed from watercraft to take apart bottom end. Refer to appropriate *VEHICLE SHOP MANUAL*.

Engine top end has to be disassembled to take apart bottom end. Refer to TOP END section in this manual.

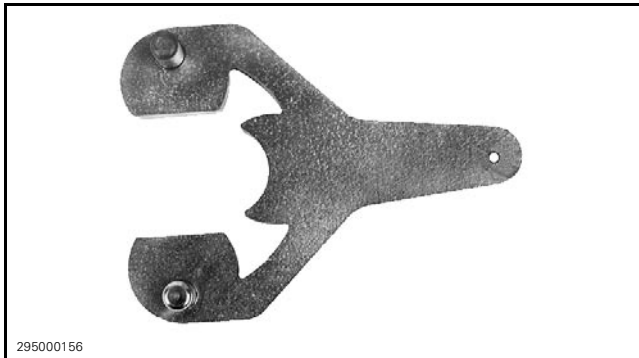
**NOTE:** Crankcase halves are factory matched and therefore, are not interchangeable or available as single halves.

## DISASSEMBLY

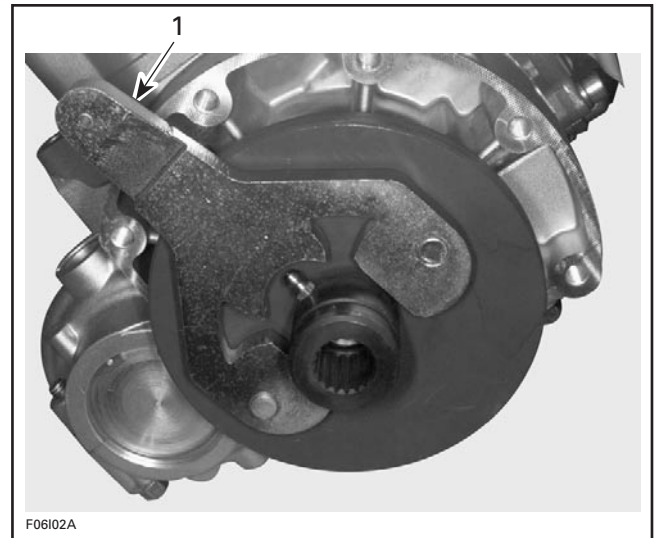
### PTO Flywheel

To remove PTO flywheel **no. 1**, the crankshaft must be locked. Refer to MAGNETO SYSTEM and follow the procedure to lock the magneto flywheel.

PTO flywheel is loosened using PTO flywheel extractor (P/N 295 000 156).

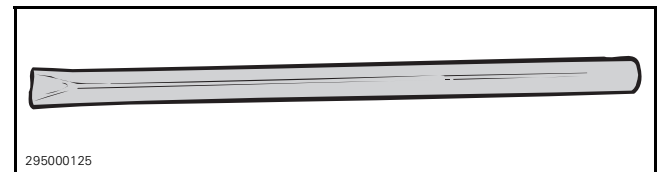


Install special tool.



1. PTO flywheel extractor

Install the extension handle (P/N 295 000 125) on the PTO flywheel extractor.



Loosen PTO flywheel COUNTERCLOCKWISE when facing it.

### MAG Crankshaft Seal

MAG crankshaft seal is retained by the magneto housing. For replacement procedure, refer to MAGNETO SYSTEM section.

### PTO Crankshaft Seal

If PTO crankshaft seal **no. 5** has to be replaced, bottom end must be opened. Refer to CRANKCASE and CRANKSHAFT END BEARINGS below.

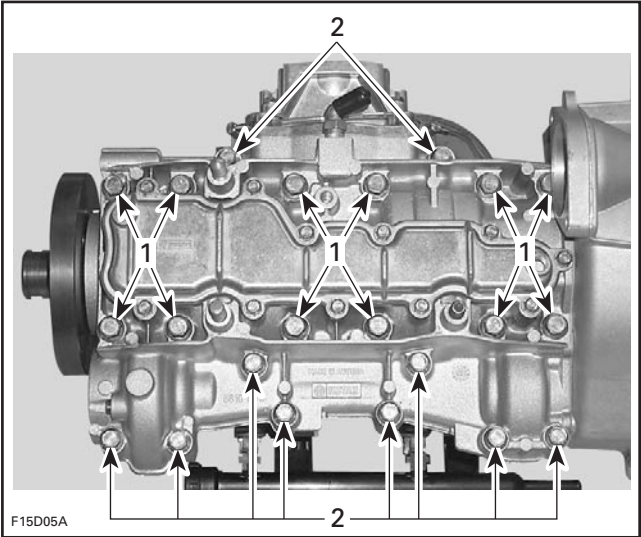
### Crankcase

Before opening the crankcase, remove the following parts:

- magneto flywheel and housing, refer to MAGNETO SYSTEM section
- starter, refer to appropriate *VEHICLE SHOP MANUAL*
- rotary valve cover and valve, refer to ROTARY VALVE section
- engine top end, refer to TOP END section.

**Section 03 787 RFI ENGINE**  
**Subsection 04 (BOTTOM END)**

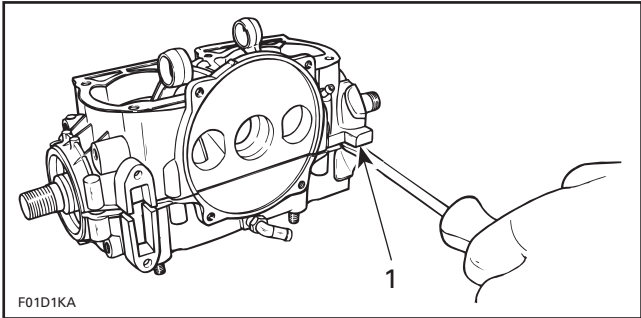
Put engine on a stand. Loosen crankcase screws.



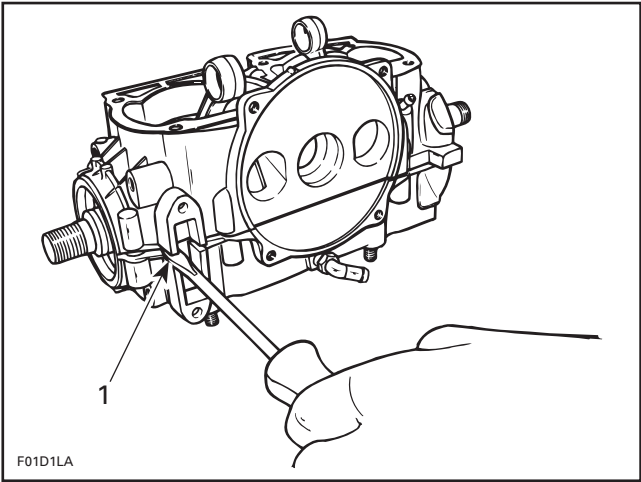
- 1. M10 x 73.5 flanged screws
- 2. M8 x 53.5 flanged screws

Put engine back on a support. Insert a pry bar between crankcase lugs to separate halves.

**CAUTION:** Be careful to precision machined surfaces.



- TYPICAL**
- 1. Separate halves by prying at provided lugs



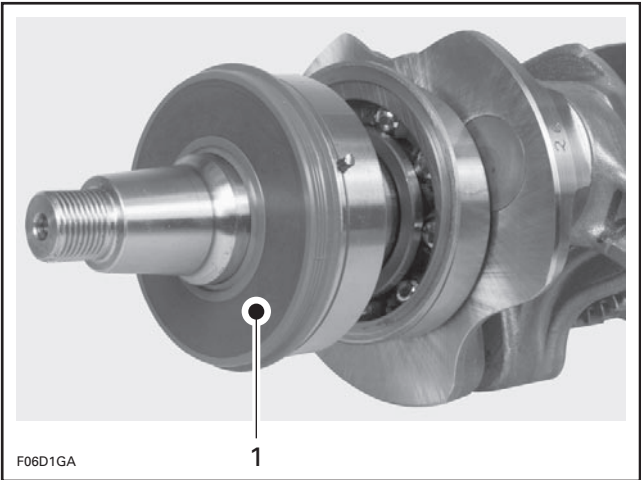
- TYPICAL**
- 1. Separate halves by prying at provided lugs

Remove crankshaft and counterbalance shaft.

**Crankshaft End Bearings**

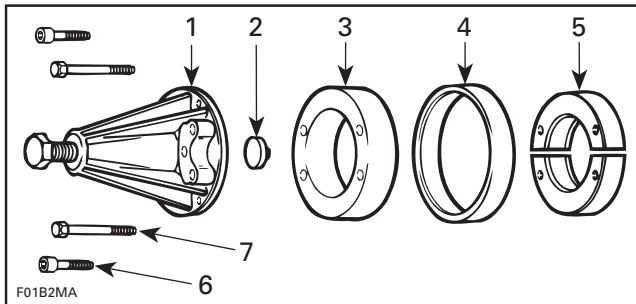
**NOTE:** Do not needlessly remove crankshaft bearings.

Take apart crankcase as per procedure above.  
Remove PTO seal.



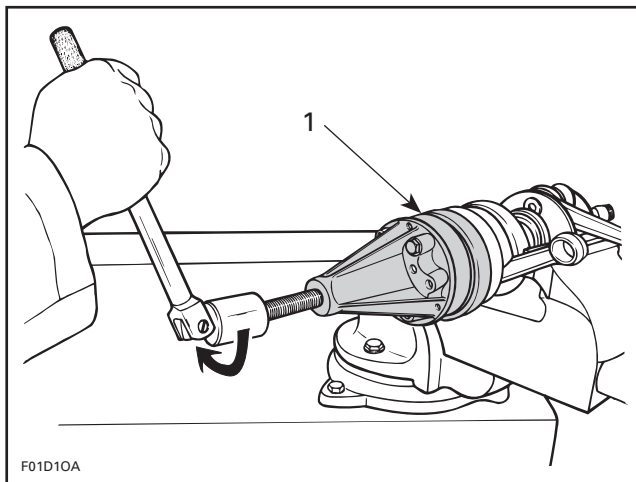
- TYPICAL**
- 1. PTO seal

To remove MAG and PTO end bearings no. 4 from crankshaft, use the following tools.



1. Puller (P/N 420 877 635)
2. Protective cap (P/N 420 876 557)
3. Distance ring (P/N 420 876 569)
4. Ring (P/N 420 977 490)
5. Ring halves (P/N 420 977 475)
6. Screw M8 x 40 (P/N 420 840 681)
7. Screw M8 x 70 (P/N 420 841 201)

**NOTE:** To facilitate ring or distance ring installation, lubricate their inside diameters.



**TYPICAL**

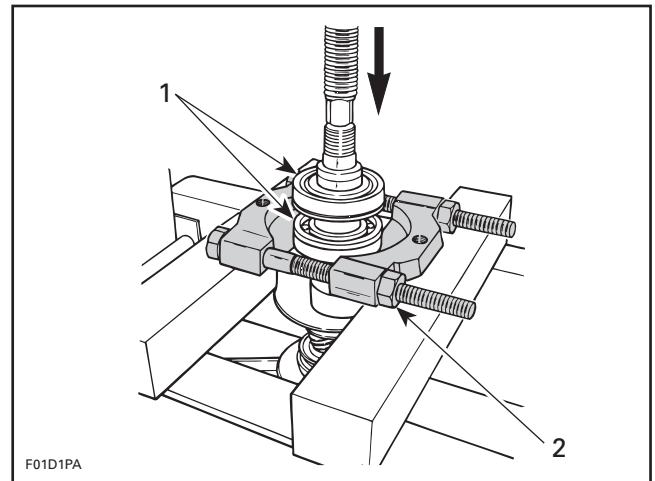
1. Removing crankshaft bearing

#### PTO End Crankshaft Bearing

As an alternate method, the outer PTO bearing and crankshaft gear can be removed in one step using another puller. See CRANKSHAFT GEAR no. 18 below

#### MAG End Crankshaft Bearing

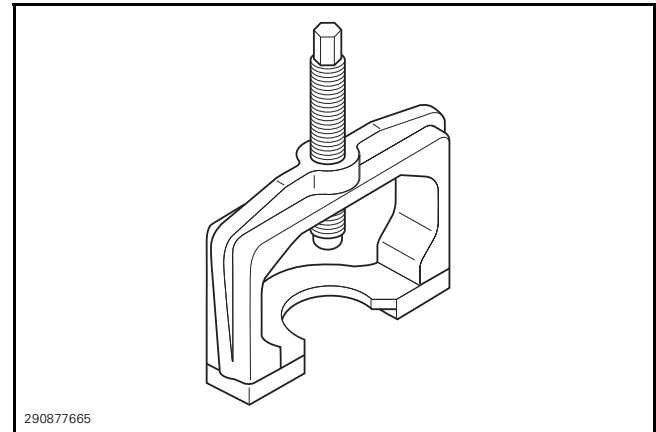
As an alternate method, use a bearing extractor such as Proto no. 4332 and a press to remove two bearings at a time.



1. Press bearings out
2. Bearing extractor

#### Crankshaft Gear

The crankshaft gear no. 18 and bearing no. 5 can be removed in one step using the gear/bearing puller (P/N 290 877 665).

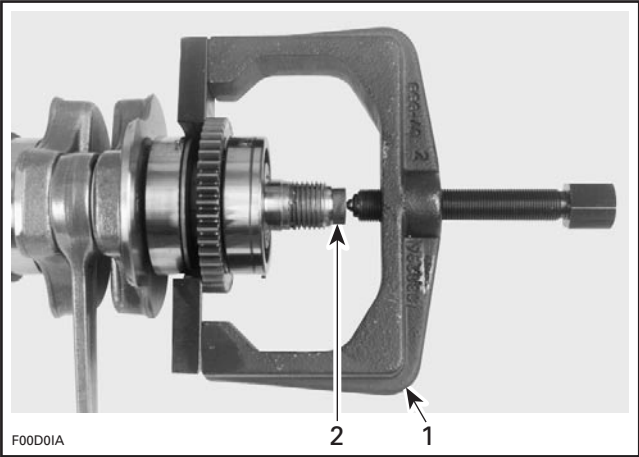


Install the puller as per following illustration.



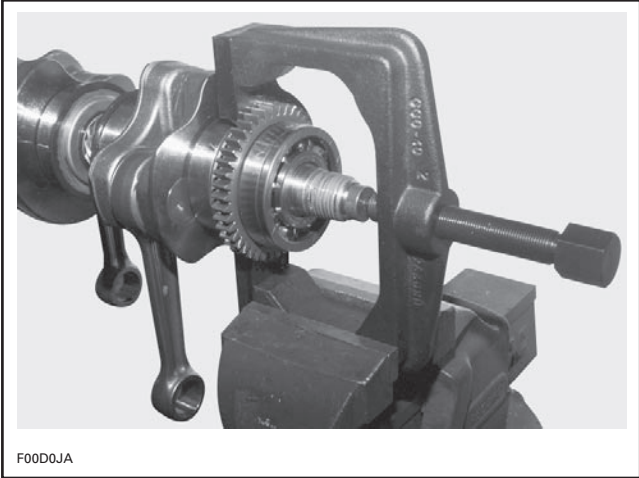
Section 03 787 RFI ENGINE

Subsection 04 (BOTTOM END)



- 1. Puller
- 2. Protective cap

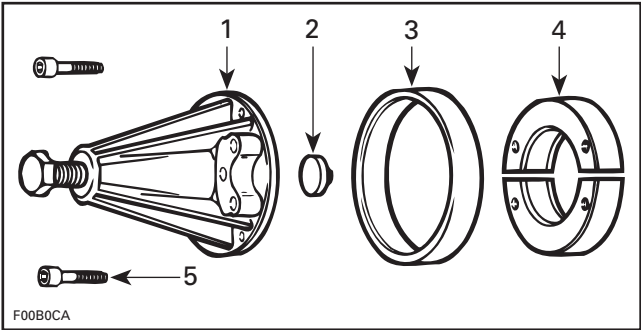
Secure puller in a vise and remove gear and bearing.



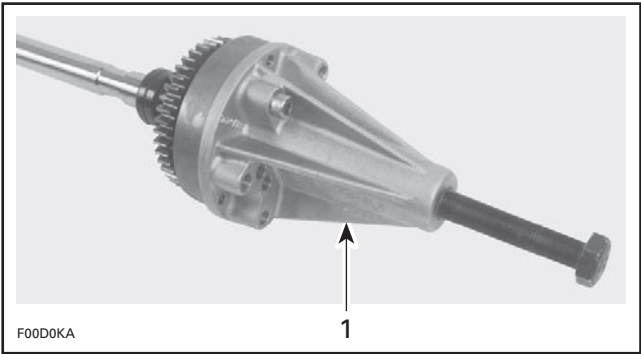
**NOTE:** If the inner PTO bearing needs to be replaced, remove the Woodruff key on the crankshaft.

Counterbalance Shaft Bearings

Bearings no. 15 on counterbalance shaft no. 13 can be removed by using the following tools:



- 1. Puller (P/N 420 877 635)
- 2. Protective cap (P/N 420 876 557)
- 3. Ring (P/N 420 977 480)
- 4. Ring halves (P/N 420 876 330)
- 5. Screw M8 x 40 (P/N 420 840 681)

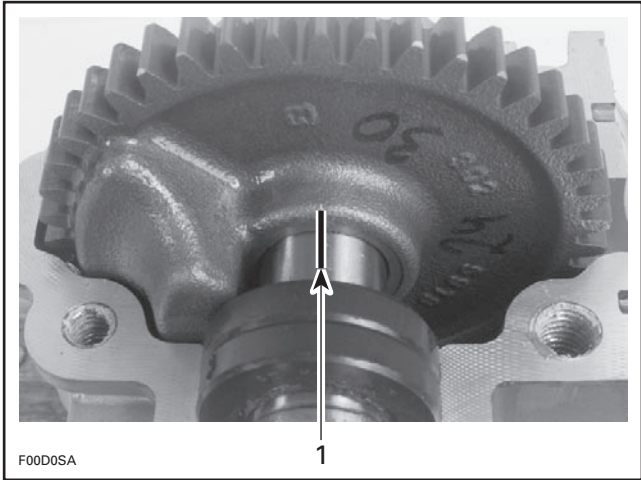


- 1. Tool installed

Counterbalance Shaft Gear

To remove gear no. 14, first trace an index mark on the gear and counterbalance shaft.

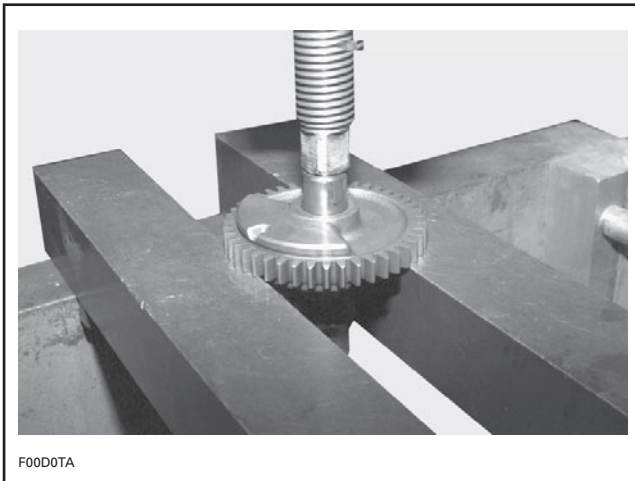
**NOTE:** There is no Woodruff key to position the gear on the counterbalance shaft. An index mark must be traced to ease assembly procedure.



- 1. Index mark



Use a press to remove the gear **no. 14** from the counterbalance shaft.



## CLEANING

### General

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

Clean oil passages and make sure they are not clogged.

Clean all metal components in a solvent.

### Crankshaft

Clean crankshaft end with sand paper no.180 and remove all residue using pulley flange cleaner (P/N 413 711 809).



TYPICAL

### Crankcase

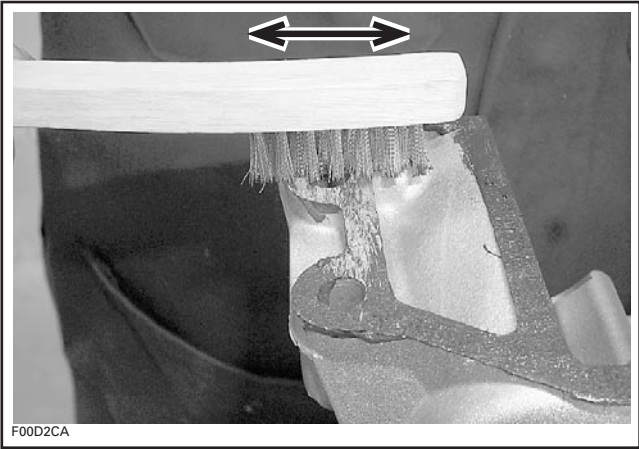
Crankcase mating surfaces are best cleaned using a combination of the chisel gasket remover (P/N 413 708 500) and a brass brush. Brush a first pass in one direction then make the final brushing perpendicularly (90°) to the first pass cross (hatch).

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

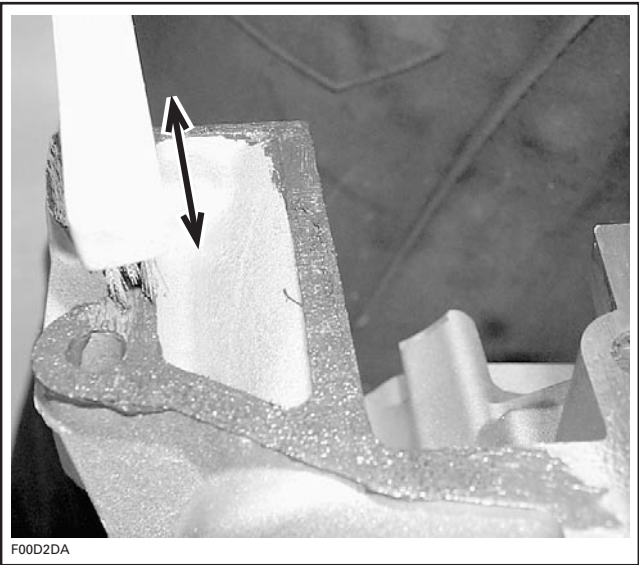


Section 03 787 RFI ENGINE

Subsection 04 (BOTTOM END)



FIRST PASS



SECOND PASS

Finish the cleaning with acetone.

**CAUTION:** Be careful not to spray cleaner on the painted surface of the engine. Do not wipe with rags. Use a new clean hand towel only.

INSPECTION

Refer to table below to find bottom end dimension specifications. For measurement procedures, refer to ENGINE MEASUREMENT.

MEASUREMENT	TOLERANCE	
	NEW PART	WEAR LIMIT
	mm (in)	
Crankshaft deflection MAG	N.A.	0.05 (.020)
Crankshaft deflection CENTER	N.A.	0.08 (.003)
Crankshaft deflection PTO	N.A.	0.03 (.001)
Connecting rod big end axial play	min. 0.230 (.008) max. 0.617 (.024)	1.2 (.047)

Crankcase

Inspect plane surfaces for warpage. Small deformation can be corrected by grinding surface with a fine sandpaper. Install sandpaper on a surface plate and rub part against oiled sand paper.

Bearing

Inspect crankshaft bearings **no. 4**. Check for corrosion, scoring, pitting, chipping or other evidence of wear. Make sure plastic cage is not melted. Rotate and make sure they turn smoothly.

ASSEMBLY

Assembly is essentially the reverse of disassembly procedures. However pay particular attention to the following.

**NOTE:** It is recommended to spray injection oil on all moving parts when reassembling the engine.

Crankshaft End Bearings

Heat up the bearing(s) using the bearing heater (P/N 529 035 969). This will expand bearings and ease installation.

## Section 03 787 RFI ENGINE

### Subsection 04 (BOTTOM END)



TYPICAL

**CAUTION:** Bearing should not be heated to more than 80°C (176°F). Do not heat bearing with direct flame or heat gun or heated oil. Inappropriate heating procedure(s) may cause inner seal failure.

Turn bearing(s) several times during heating process for heating it (them) properly.

**NOTE:** Normally it takes approximately 10 minutes to heat up a bearing so in the event of replacing bearing, it's recommended to start the bearing heating process prior to removal operation. Two bearings can be heated at the same time on one bearing heater.



TYPICAL  
1. Bearings

Touch the inner race of the bearing with the temperature indicator stick (P/N 529 035 970). Stick will liquefy when the bearing reach the proper temperature.

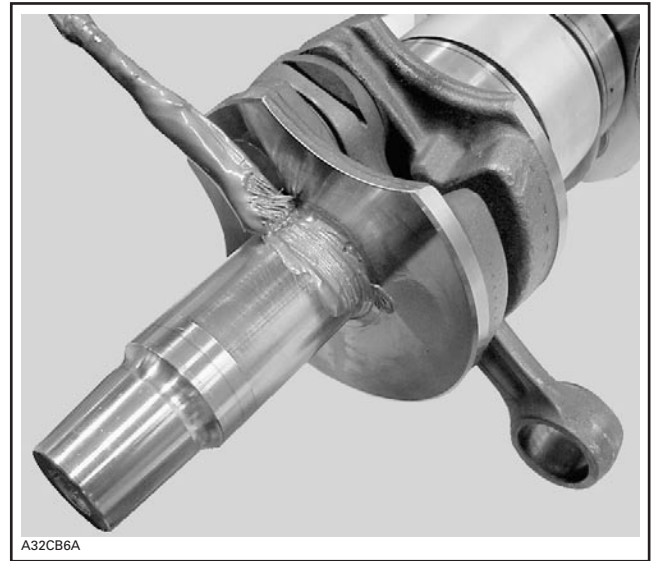


TYPICAL

#### WARNING

Do not touch heated bearing with bare handle. Wear heat resisting gloves before handling the heated bearing(s).

Smear Loctite 767 (anti-seize lubricant) (P/N 293 800 070) on part of crankshaft where bearing fits.



TYPICAL

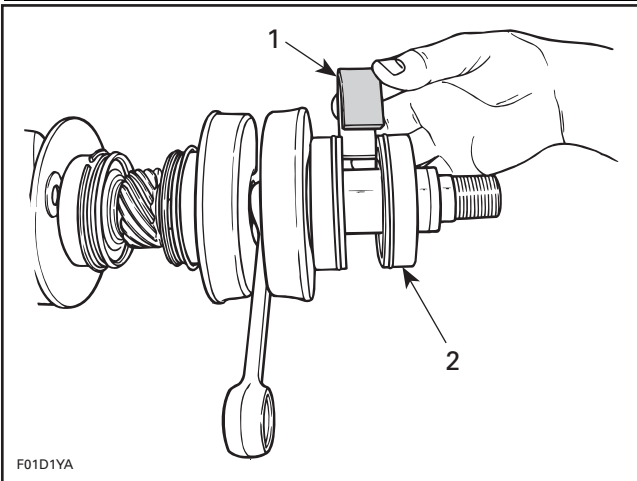
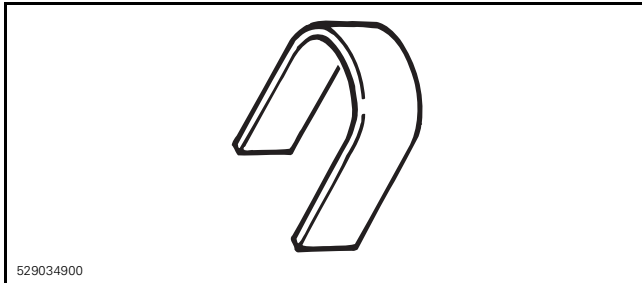
## Section 03 787 RFI ENGINE

### Subsection 04 (BOTTOM END)

Install distance ring **no. 12**. Position its chamfer toward crankshaft counterweight.

Slide inner bearing on crankshaft until it bottoms.

To properly position outer bearing, distance gauge (P/N 529 034 900) must be temporarily installed against inner bearing. Slide outer bearing until stopped by distance gauge, then remove distance gauge.

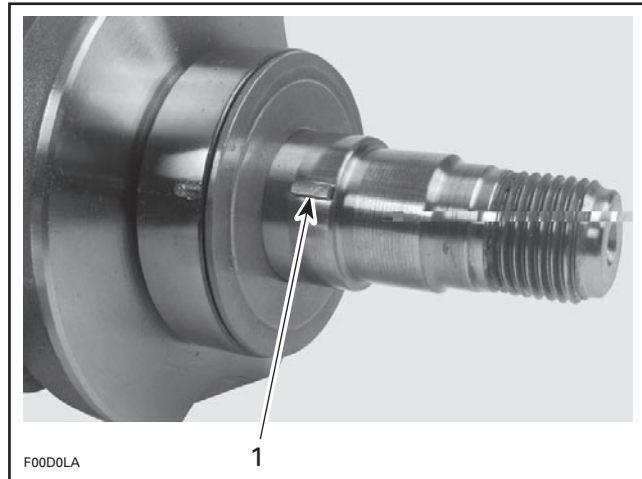


#### TYPICAL

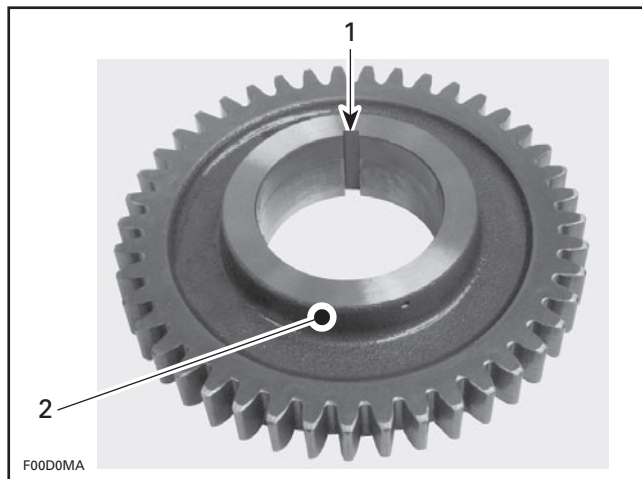
1. Distance gauge
2. Outer bearing

### Crankshaft Gear

Position the long flange of the gear **no. 18** toward the counterweight of the crankshaft. Also, make sure to align the gear keyway with the Woodruff key on the crankshaft.



1. Woodruff key on the crankshaft



1. Keyway
2. Long flange toward the crankshaft counterweight

### Counterbalance Shaft Gear

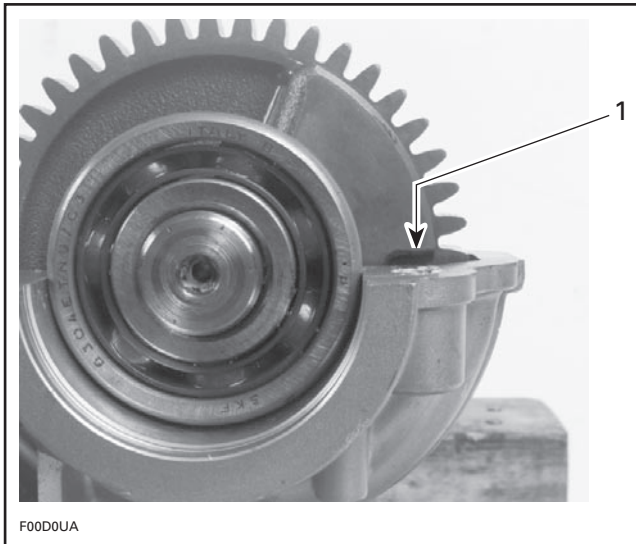
Press gear **no. 14** onto counterbalance shaft **no. 13** taking care to align both marks previously traced.

**CAUTION:** Counterbalance shaft must be properly assembled, otherwise engine will vibrate and premature wear will occur.

Proceed as follows to check if the gear **no. 14** is properly positioned on the counterbalance shaft:

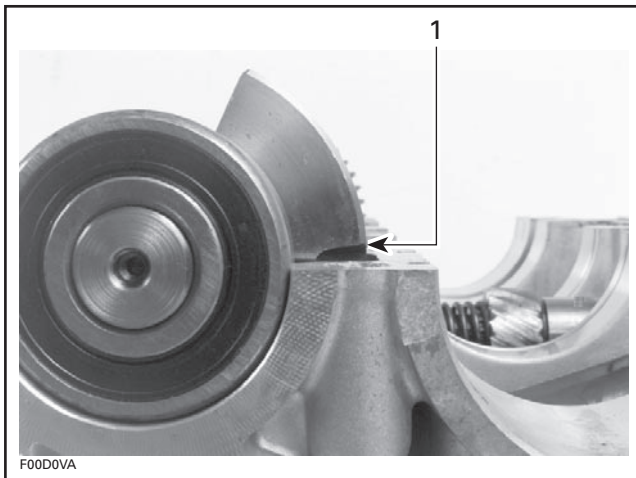
- Temporarily install the counterbalance shaft in the crankcase.
- Rotate the counterbalance shaft to align the notch of the gear with the crankcase.





1. Gear notch aligned with the crankcase

- The notch of the counterweight on the opposite end of the counterbalance shaft must also be aligned with the crankcase.



1. Counterweight notch aligned with the crankcase

If notches are not aligned with the crankcase, remove the gear and repeat the procedure until the notches are properly aligned.

## Crankcase

**NOTE:** Rotary valve shaft must be installed in crankcase before closing halves.

**CAUTION:** Before joining crankcase halves, make sure that crankshaft gear is well engaged with rotary valve shaft gear.

## Crankcase Sealant Application

**IMPORTANT:** When beginning the application of the crankcase sealant, the assembly and the first torquing should be done within 10 minutes. It is suggested to have all you need on hand to save time.

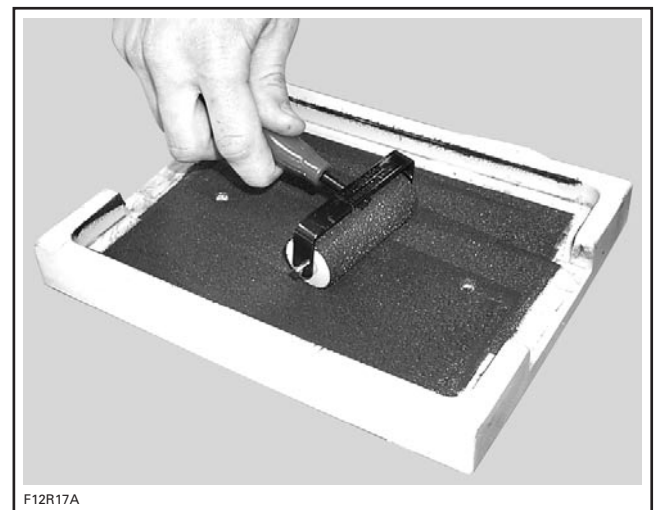
**NOTE:** It is recommended to apply this specific sealant as described here to get an uniform application without lumps. If you do not use the roller method, you may use your finger to uniformly distribute the sealant.

Use the silicone-based Loctite 5910 (P/N 293 800 081) on mating surfaces.

**NOTE:** Refer to the product label for the curing time.

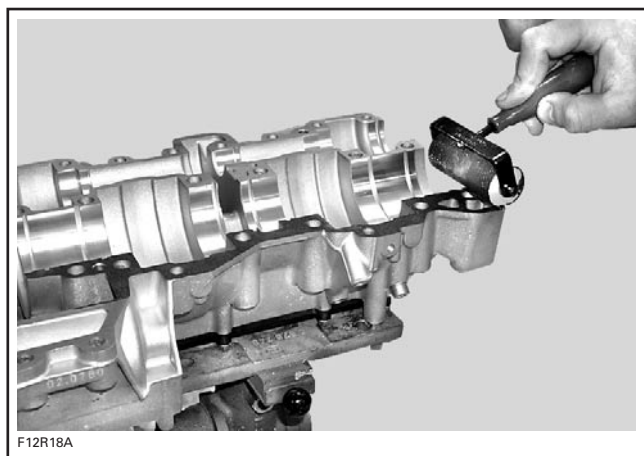
**CAUTION:** Do not use other products to seal crankcase. Do not use an activator with the Loctite 5910. Using a non silicone-based sealant over a previously sealed crankcase with Loctite 5910 will lead to poor adhesion and possibly a leaking crankcase. Even after cleaning, the Loctite 5910 would leave incompatible microscopic particles.

Use a plexiglass plate and apply some sealant on it. Use a soft rubber roller (50 - 75 mm (2 - 3 in)) (available in arts products suppliers for printmaking) and roll the sealant to get a thin uniform coat on the plate (spread as necessary). When ready, apply the sealant on crankcase mating surfaces.



## Section 03 787 RFI ENGINE

### Subsection 04 (BOTTOM END)

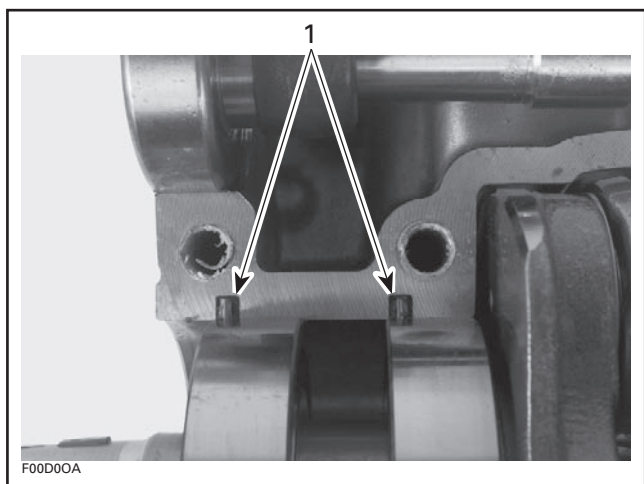


Do not apply in excess as it will spread out inside crankcase.

#### Crankshaft and Counterbalance Shaft

Install crankshaft **no. 3** in crankcase.

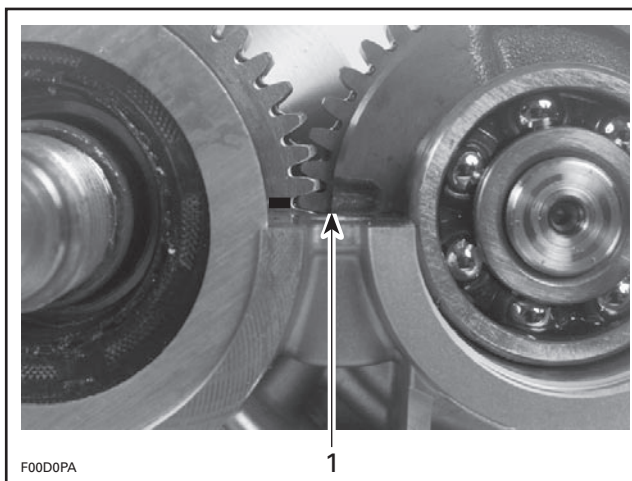
**NOTE:** When installing crankshaft in crankcase, make sure drive pins **no. 6** of bearings are properly installed in crankcase recesses.



1. Drive pins

After crankshaft installation, install counterbalance shaft **no. 13**. Make sure to properly index crankshaft and counterbalance shaft by gear aligning marks.

**CAUTION:** Marks on the crankshaft and counterbalance shaft must be aligned, otherwise engine will vibrate and premature wear will occur.



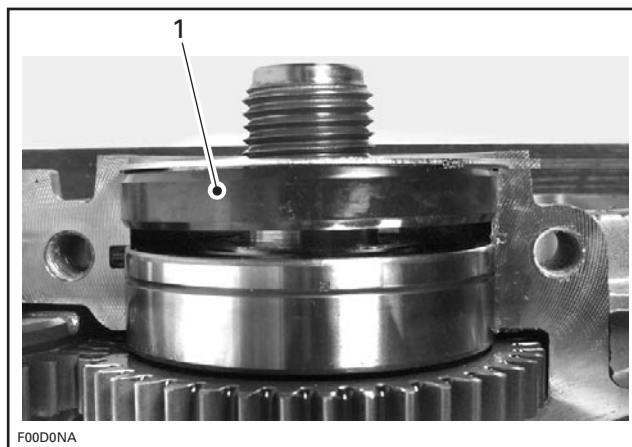
1. Marks must be aligned

Turn by hand the crankshaft and counterbalance shaft. Make sure they do not interfere with the crankcase.

#### PTO Crankshaft Seal

When installing seal **no. 5**, apply a light coat of lithium grease on seal lips.

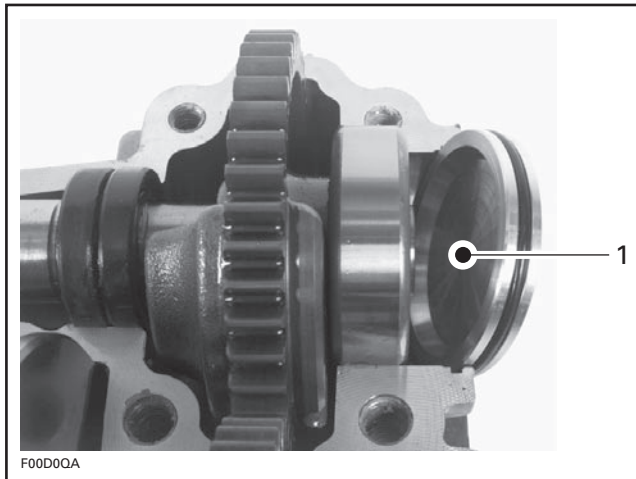
Position PTO seal against the retaining shim; the gap between the seal **no. 5** and bearing **no. 4** will ensure proper lubrication of the bearing.



1. Seal against the retaining shim

#### Counterbalance Shaft Bearing Cover

Install the bearing cover **no. 19** with its hollow side toward the bearing.



1. Hollow side facing bearing

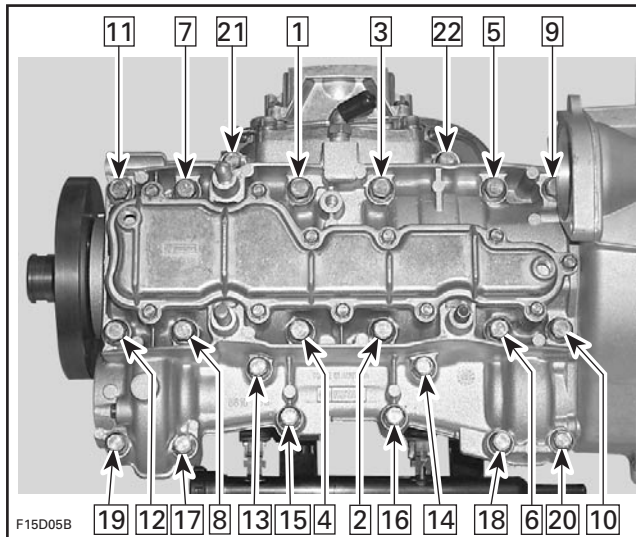
### Crankcase Halves

Assemble crankcase halves.

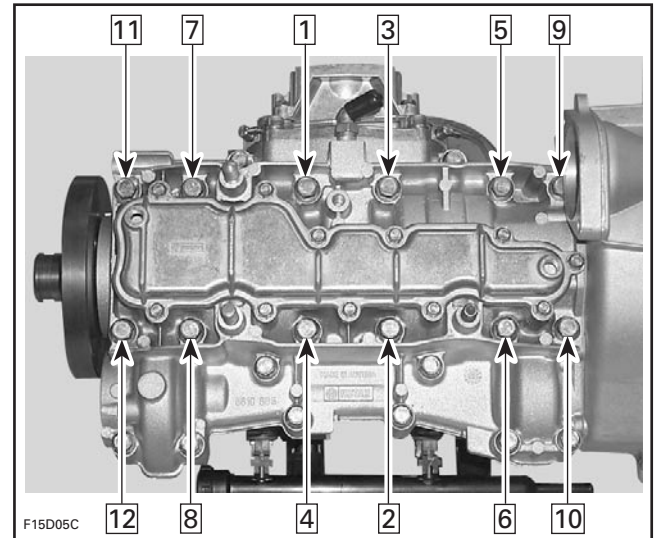
### Crankcase Screws

Apply Loctite 518 (P/N 293 800 038) on screw threads and Molykote 111 (P/N 413 707 000) below head screws.

Torque crankcase screws to 12 N•m (106 lbf•in) as per following sequence. Repeat procedure, retightening all screws to 24 N•m (17 lbf•ft).

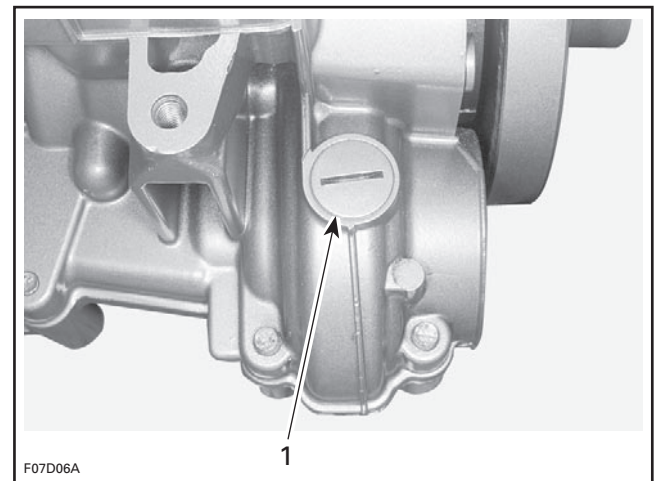


As a final step, torque only M10 screws **no. 8** of crankcase to 40 N•m (30 lbf•ft) as per following sequence.



### Counterbalance Shaft Gear Oil

When crankcase assembly is completed, add 30 mL (1 oz) of motor oil SAE 30 to the counterbalance shaft gear through the crankcase filler plug.



1. Remove plug and add SAE 30 motor oil

### Oil Fittings

If inlet and outlet oil fittings **no. 11** of rotary valve shaft have been removed from crankcase, reinstall them with their end pointing toward ignition housing. Apply Loctite 518 (P/N 293 800 038) on threads of fittings.

### PTO Flywheel

Install O-ring onto crankshaft.

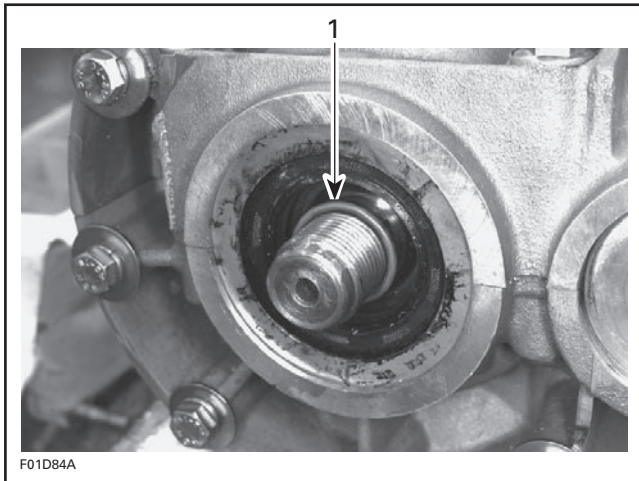


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## Section 03 787 RFI ENGINE

### Subsection 04 (BOTTOM END)

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1. O-ring

Apply Loctite 767 (anti-seize lubricant) (P/N 293 800 070) to crankshaft threads.

Using the same tools as for disassembly procedure, torque PTO flywheel to 110 N•m (81 lbf•ft).

# ROTARY VALVE

## SERVICE TOOLS

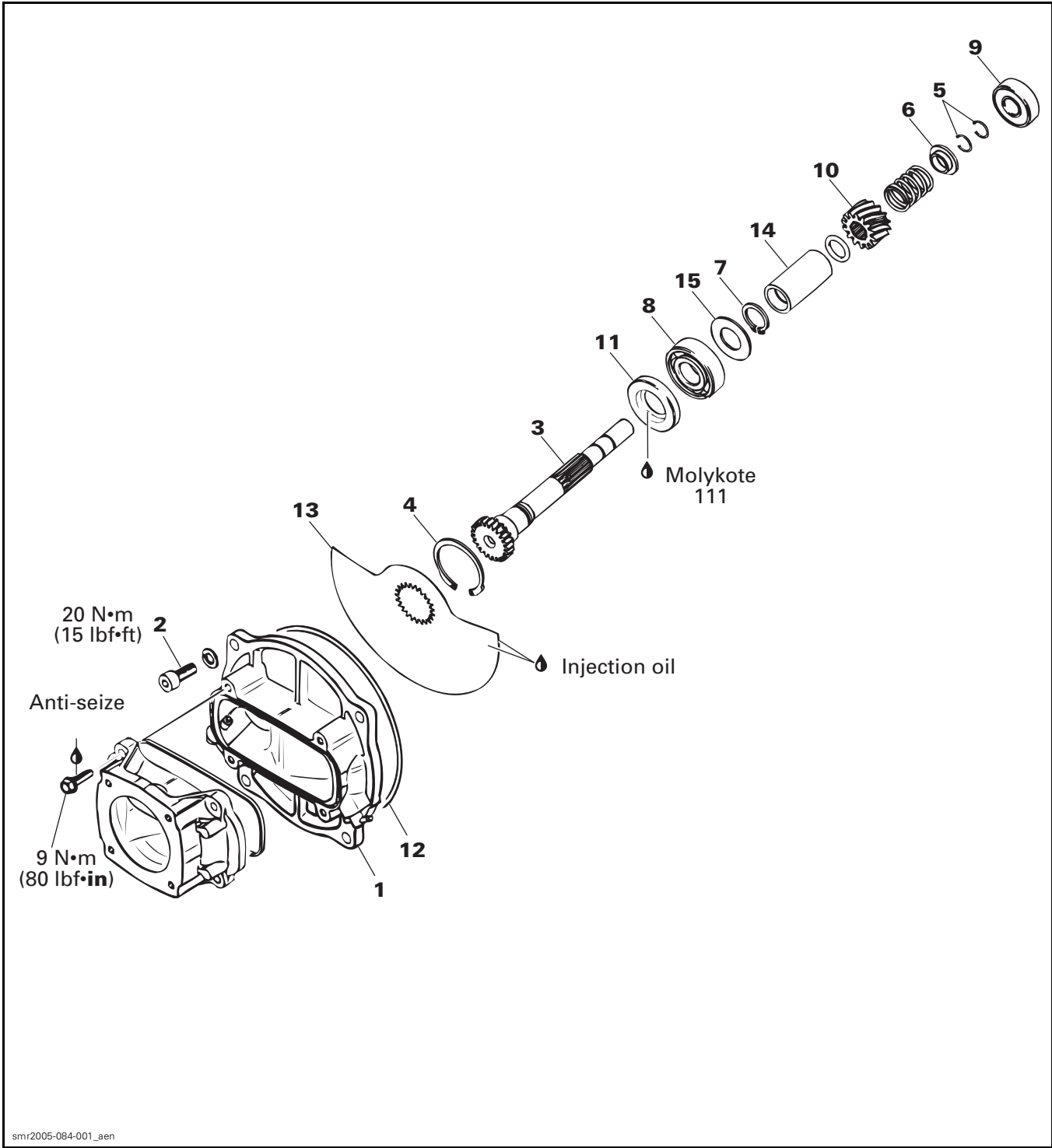
<b>Description</b>	<b>Part Number</b>	<b>Page</b>
Degree wheel.....	529 035 607 .....	109
handle .....	420 877 650 .....	106
puller.....	290 876 488 .....	103
pusher.....	290 876 609 .....	106
pusher.....	420 876 501 .....	105
TDC gauge (short).....	295 000 143 .....	109

## SERVICE PRODUCTS

<b>Description</b>	<b>Part Number</b>	<b>Page</b>
Molykote 111 grease.....	413 707 000 .....	106

**Section 03 787 RFI ENGINE**  
Subsection 05 (ROTARY VALVE)

**787 RFI Engines**



## GENERAL

The clearance of rotary valve cover or rotary valve shaft gear backlash can be performed without taking apart engine.

However engine must be disassembled to work on rotary valve shaft/components.

## INSPECTION (ASSEMBLED ENGINE)

### Rotary Valve/Cover Clearance

Remove air intake silencer and throttle body. Refer to appropriate *VEHICLE SHOP MANUAL*.

Refer to table below to find dimension specifications. For measurement procedures, refer to ENGINE MEASUREMENT section.

ENGINE MEASUREMENT	TOLERANCES	
	NEW PARTS (min.)	(max.)
Rotary valve/cover clearance	0.25 mm (.010 in)	0.3 mm (.014 in)

**NOTE:** If the rotary valve/cover clearance is too small, this could create an overheating situation and if the clearance is too high, this could create a hard starting situation.

### Rotary Valve Shaft Gear Backlash

Verify rotary valve shaft gear backlash as follows:

Remove PTO flywheel guard.

Remove spark plugs, rotary valve cover and valve.

Manually feel backlash at one position, then turn crankshaft about 1/8 turn and recheck. Continue this way to complete one revolution.

Backlash must be even at all positions. Otherwise overhaul engine to find which part is faulty (gear, rotary valve shaft or crankshaft with excessive deflection).

## DISASSEMBLY

### Rotary Valve Cover

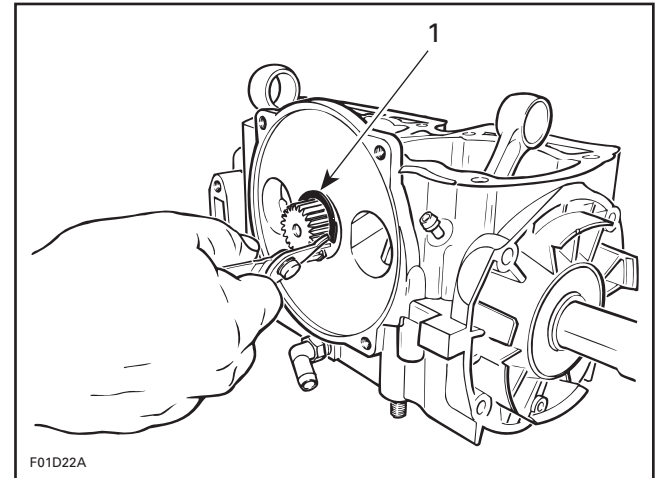
Remove air intake silencer and throttle body. Refer to appropriate *VEHICLE SHOP MANUAL*.

Unscrew 4 retaining screws and withdraw rotary valve cover **no. 1** and rotary valve **no. 13**.

### Rotary Valve Shaft

To remove the rotary valve shaft assembly, the engine must be removed from watercraft (refer to appropriate *VEHICLE SHOP MANUAL*).

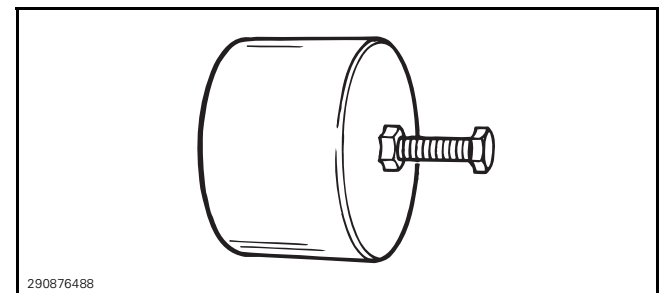
First remove snap ring **no. 4** from crankcase.



1. Removing snap ring

Open bottom end and remove crankshaft (refer to BOTTOM END section).

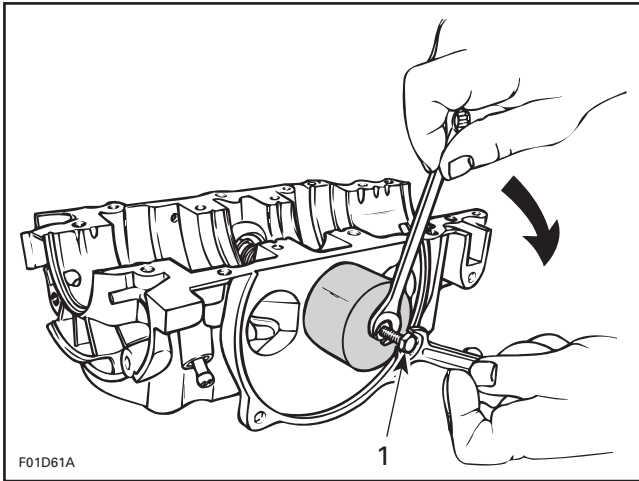
To remove rotary valve shaft assembly, use the appropriate puller (P/N 290 876 488).



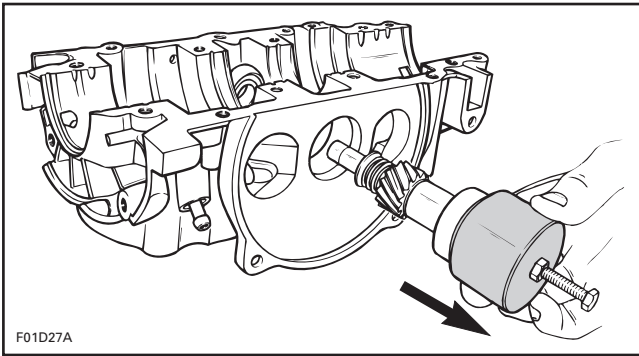
Place puller over rotary valve shaft end and screw on puller bolt into shaft. While retaining bolt with a wrench, turn puller nut **CLOCKWISE** until shaft comes out.

## Section 03 787 RFI ENGINE

### Subsection 05 (ROTARY VALVE)

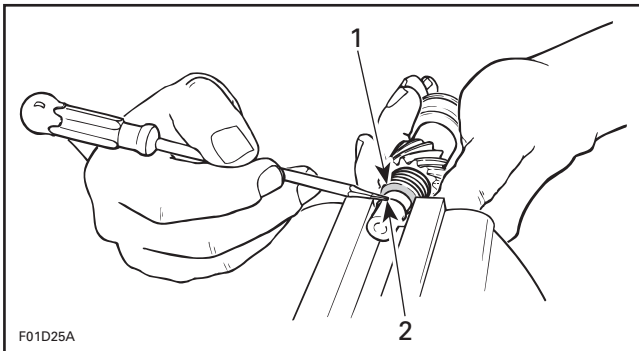


1. Hold bolt



### Circlip and Spring Seat

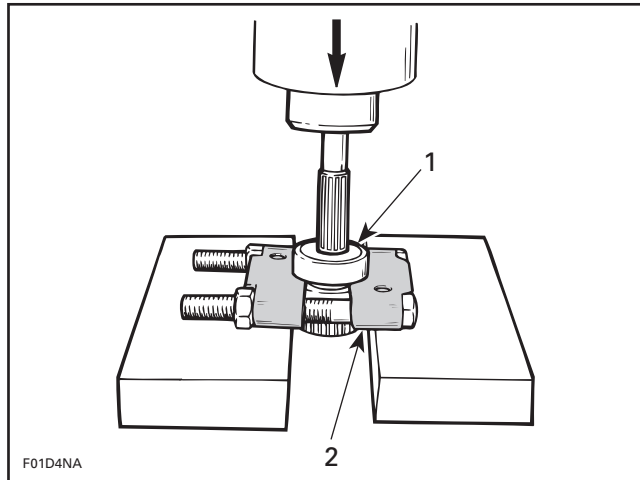
If it is necessary to disassemble components of rotary valve shaft assembly, use seat **no. 6** to compress spring and remove circlips **no. 5**.



1. Compress seat  
2. Remove circlips

### Shaft Bearing

To remove bearing **no. 8** use a bearing extractor such as Snap-on no. CJ-950 (or equivalent) as illustrated. Slide off distance sleeve **no. 14**, remove snap ring **no. 7** and washer **no. 15** then press shaft out.

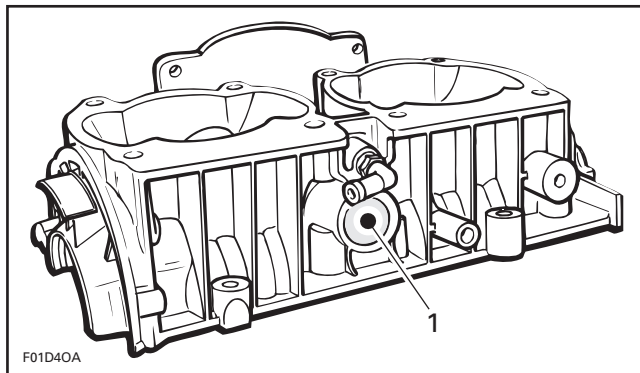


1. Bearing  
2. Bearing extractor

**CAUTION:** Ensure that rotary valve shaft is perfectly perpendicular with press tip.

### End Bearing

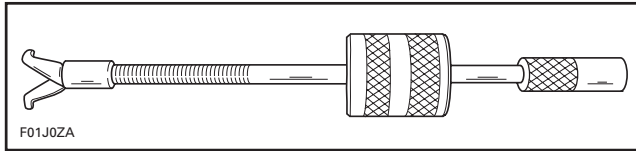
**CAUTION:** Do not remove plug against bearing in upper crankcase half.



1. Do not remove this plug

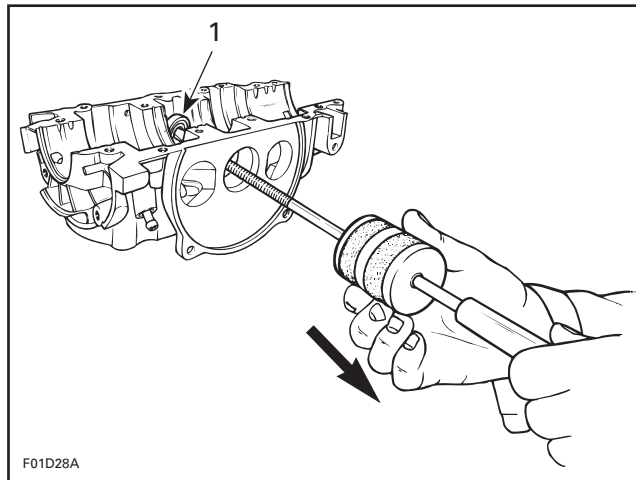
End bearing **no. 9** can be easily removed from upper crankcase half using the following suggested tool (or equivalent):

- Snap-on hammer puller including:
- handle CJ93-1
- hammer CJ125-6
- claws CJ93-4.



Close puller claws so that they can be inserted in end bearing. Holding claws, turn puller shaft clockwise so that claws open and become firmly tight against bearing.

Slide puller hammer outwards and tap puller end. Retighten claws as necessary to always maintain them tight against bearing. Continue this way until bearing completely comes out.



1. End bearing

## CLEANING

Discard all seals and O-rings.

Clean all metal components in a solvent.

Clean oil passages and make sure they are not clogged.

Clean rotary valve shaft and inside of distance sleeve **no. 14**.

## INSPECTION (DISASSEMBLED ENGINE)

### Rotary Valve Cover

Inspect rotary valve cover **no. 1** for warpage. Small deformation can be corrected by surfacing with fine sand paper on a surface plate. Surface part against oiled sand paper.

### Rotary Valve Shaft

Refer to table below to find dimension specifications. For measurement procedures, refer to ENGINE MEASUREMENT section.

ENGINE MEASUREMENT	TOLERANCES	
	NEW PARTS (min.)	(max.)
Rotary valve shaft deflection	N.A.	0.08 mm (.003 in)

### Gear

Visually check gear wear pattern. It should be even on tooth length all around. Otherwise it could indicate a bent shaft, check deflection. Replace gear if damaged.

Check for presence of brass filings in gear housing.

### Bearings

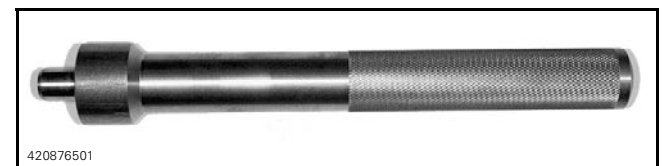
Inspect bearings **no. 8** and **no. 9**. Check for scoring, pitting, chipping or other evidence of wear. Make sure plastic cage (on bigger bearing) is not melted. Rotate them and make sure they turn smoothly.

## ASSEMBLY

Assembly is essentially the reverse of disassembly procedures. However pay particular attention to the following.

### End Bearing

To install end bearing **no. 9** in crankcase, use pusher (P/N 420 876 501).

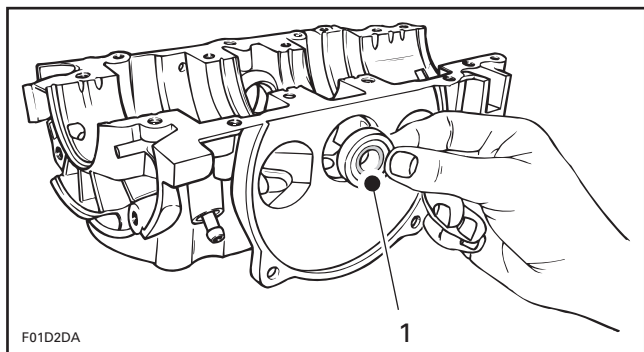


Position ball bearing shielded side towards rotary valve.



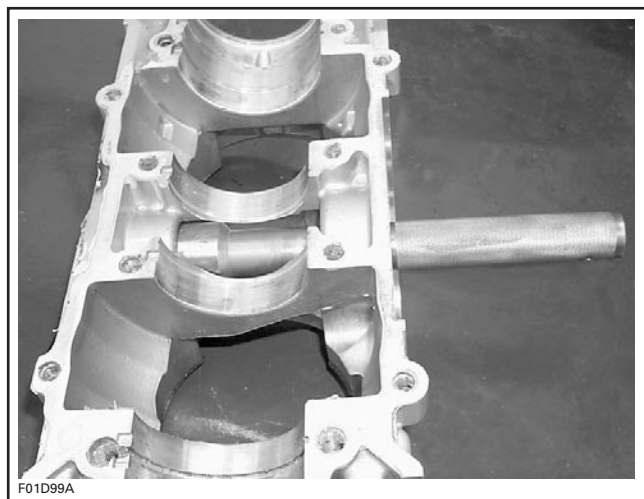
## Section 03 787 RFI ENGINE

### Subsection 05 (ROTARY VALVE)



1. Shield side (toward gear)

Push bearing until it stops on its seat.

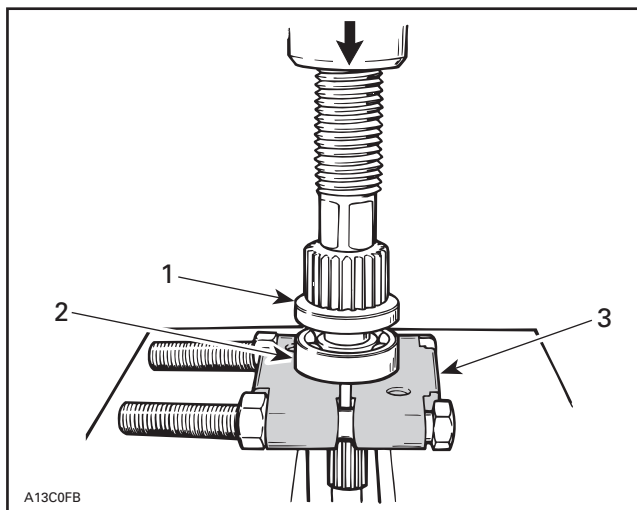


#### Seal

Apply Molykote 111 grease (P/N 413 707 000) on seal lips. Position seal no. 11 with shielded portion against shaft splines.

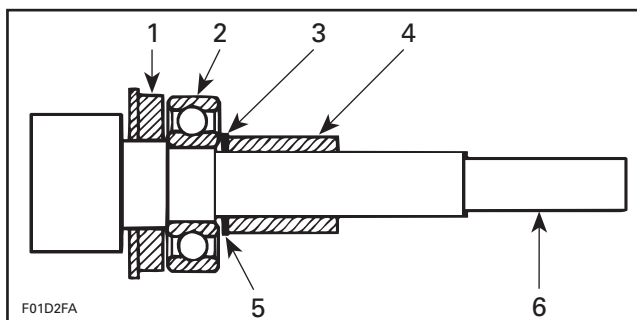
#### Shaft Bearing

Install ball bearing using bearing extractor as illustrated.



1. Seal  
2. Ball bearing  
3. Bearing extractor Snap-on CJ-950

Install washer no. 15, snap ring no. 7 and slide distance sleeve no. 14 on shaft.

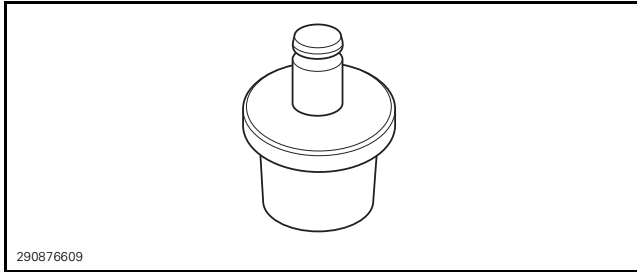


1. Seal  
2. Ball bearing  
3. Snap ring  
4. Distance sleeve  
5. Washer 0.5 mm (.020 in)  
6. Rotary valve shaft

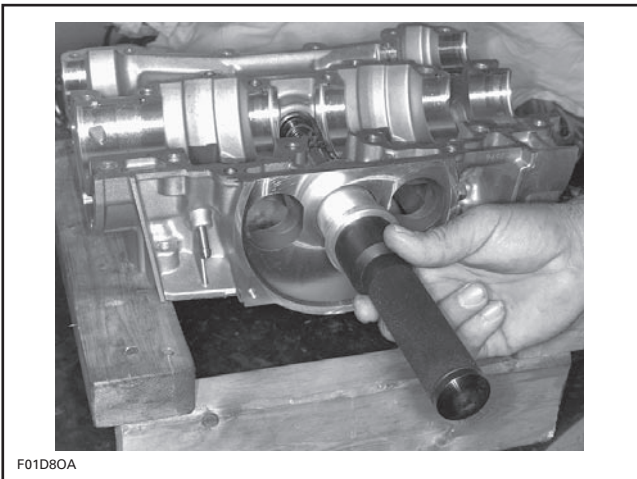
#### Rotary Valve Shaft Assembly

**CAUTION:** Crankcase halves must be separated and crankshaft must not be present to install rotary valve shaft assembly in crankcase.

To install rotary valve shaft in crankcase, use a pusher (P/N 290 876 609) and handle (P/N 420 877 650).



Push shaft until it stops on bearing seat.



### Snap Ring

Position snap ring **no. 4** so that its sharp edge faces outwards.

### Rotary Valve

The rotary valve **no. 13** controls the opening and closing of the inlet ports. Therefore its efficiency will depend on the precision of its installation.

#### IDENTIFICATION OF THE ROTARY VALVE

ENGINE	ROTARY VALVE P/N	DURATION
787 RFI	420 924 502	159°

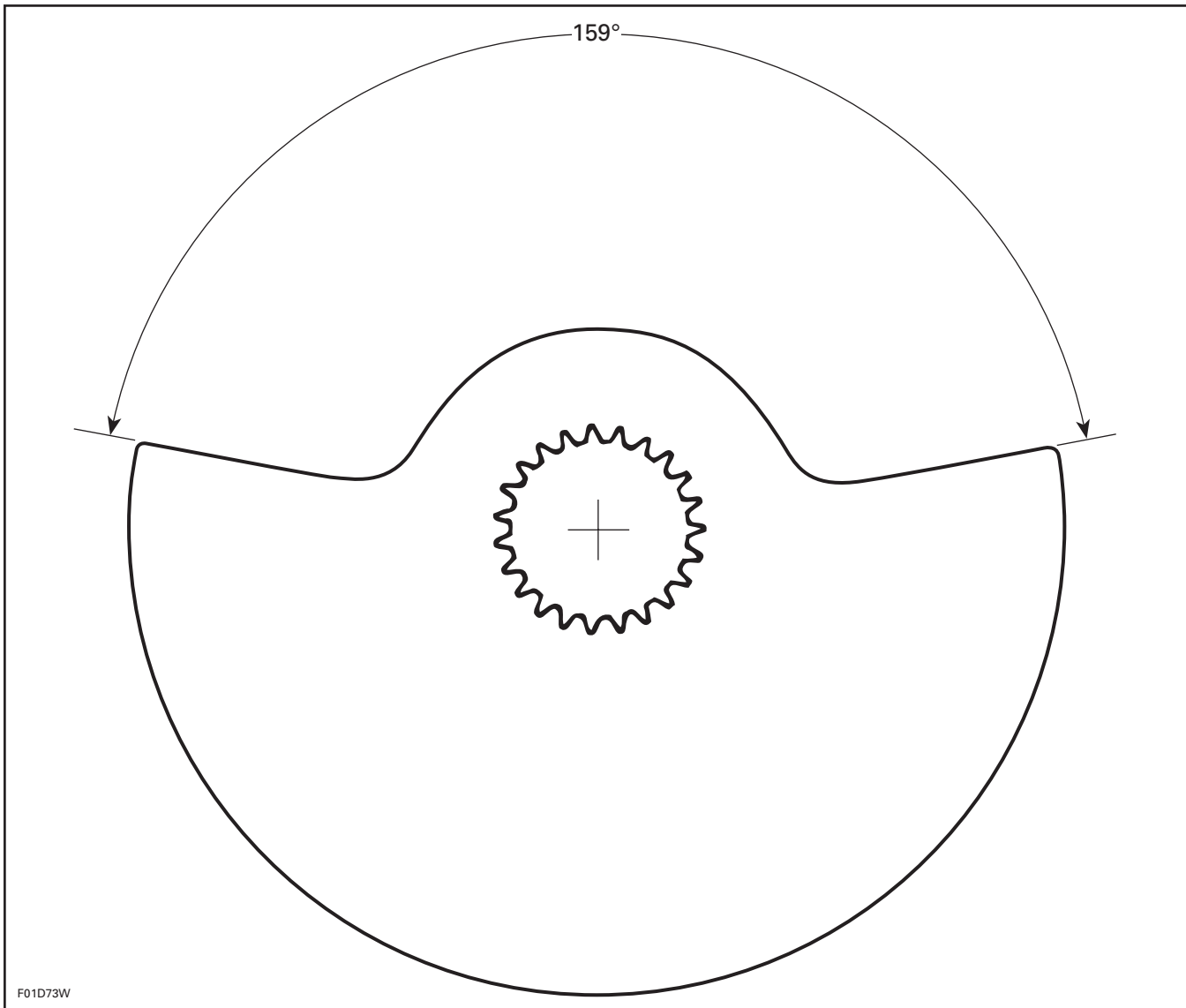
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## Section 03 787 RFI ENGINE

### Subsection 05 (ROTARY VALVE)

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There is no identification code on the valve. To find out the duration, place an angle finder on the valve and measure the valve cut-out angle or use the following template.

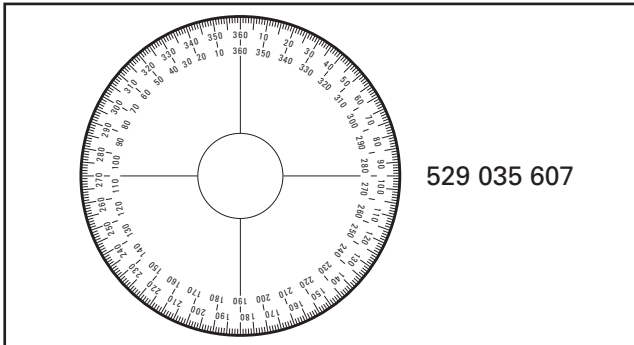


## ROTARY VALVE TIMING

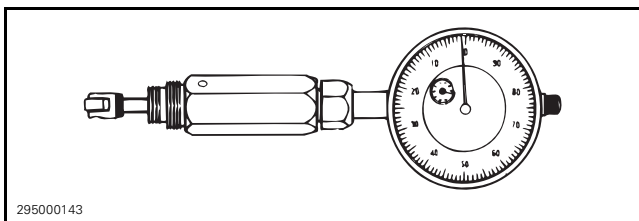
**CAUTION:** Never use the ridge molded in crankcase as a timing mark.

The following tools are required to measure rotary valve opening and closing angles in relation with MAG side piston.

Degree wheel (P/N 529 035 607)



TDC gauge (short) (P/N 295 000 143)



Rotary valve must be set so that timing occurs as follows:

ENGINE	TIMING	
	OPENING BTDC	CLOSING ATDC
787 RFI	147° ± 5	63.5° ± 5

### Timing Procedure

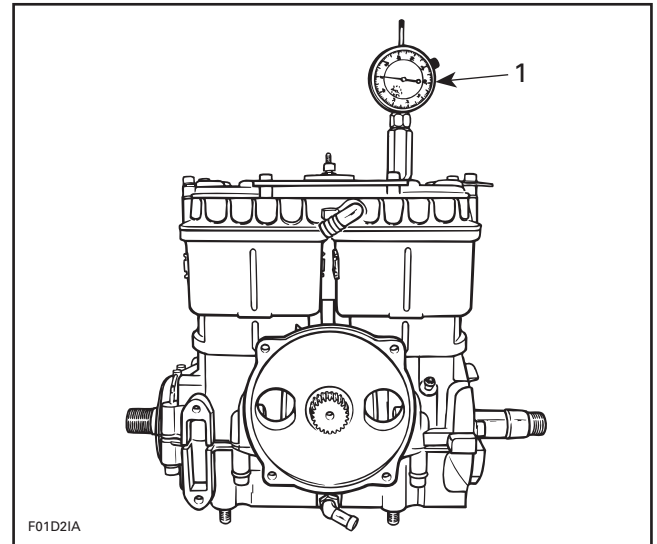
The following timing procedure example uses these specifications:

OPENING: 147° BTDC

CLOSING: 65° ATDC

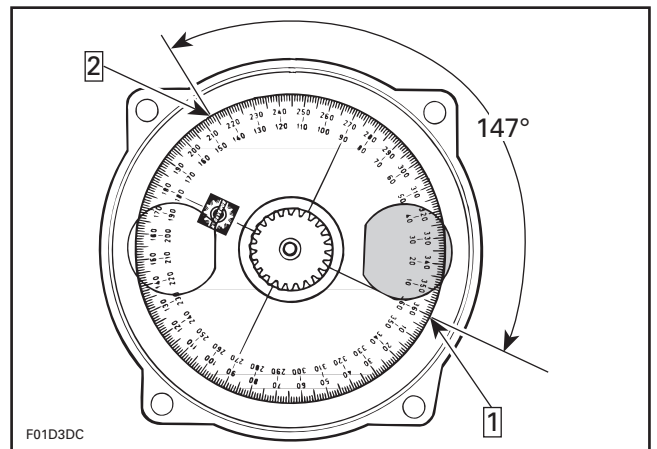
Proceed as follows:

- Turning crankshaft, bring MAG side piston to Top Dead Center using a TDC gauge.



1. Bring piston to TDC

- For opening mark, first align 360° line of degree wheel with BOTTOM of MAG side inlet port. Then, find 147° line on inner scale of degree wheel and mark crankcase at this point.



#### OPENING MARK

- Step 1: Bottom of MAG inlet port. Align 360° line of degree wheel  
 Step 2: Find 147° on inner scale of degree wheel and mark here

**NOTE:** Do not rotate the crankshaft.

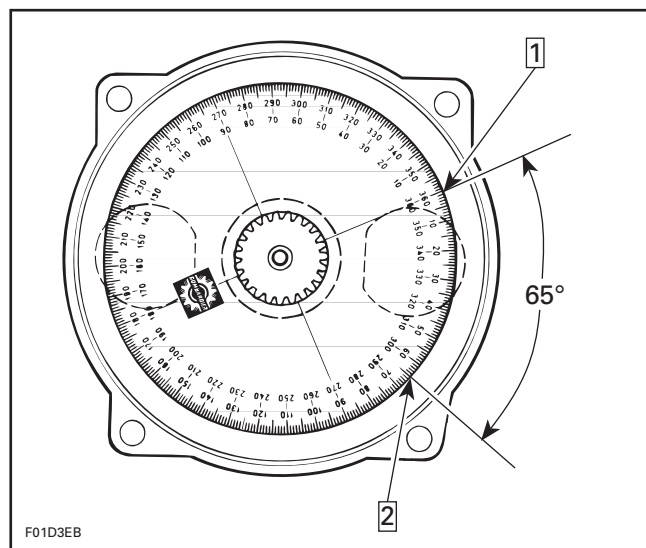
- For closing mark, first align 360° line of degree wheel with TOP of MAG side inlet port. Then, find 65° line on outer scale of degree wheel and mark crankcase at this point.

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## Section 03 787 RFI ENGINE

### Subsection 05 (ROTARY VALVE)

---



#### **CLOSING MARK**

Step 1: Top of MAG inlet port. Align 360° line of degree wheel

Step 2: Find 65° on outer scale of degree wheel and mark here

- Remove degree wheel.
- Position rotary valve on shaft splines to have edges as close as possible to these marks with the MAG piston at TDC.

**NOTE:** Rotary valve is asymmetrical. Therefore, try flipping it over then reinstall on splines to obtain best installation position.

Apply injection oil on rotary valve before reassembling rotary valve cover.

- Remove TDC gauge.

#### **Rotary Valve Cover**

Install O-ring **no. 12** and rotary valve cover **no. 1** then torque screws **no. 2** to 20 N•m (15 lbf•ft) in a criss-cross sequence.

# TECHNICAL SPECIFICATIONS

ENGINE		GTI RFI	GTI RFI LE
Engine type		ROTAX 787 RFI, 2-stroke	
Induction type		Rotary valve	
Exhaust system	Type	Water cooled, water injected with regulator	
	Water injection fitting (head)	4.0 mm (.157 in)	
	Water injection fitting (cone)	Not applicable	
	Water injection fitting (muffler)	4.5 mm (.177 in)	
Exhaust valve		Rotax Adjustable Variable Exhaust (RAVE)	
Starting system		Electric start	
Lubrication	Fuel/oil mixture	VROI (Variable Rate Oil Injection)	
	Oil injection pump	Direct driven	
	Oil injection type	XP-S™ synthetic 2-stroke	
Number of cylinders		2	
Bore	Standard	82 mm (3.228 in)	
	First oversize	82.25 mm (3.238 in)	
	Second oversize	Not applicable	
Stroke		74 mm (2.91 in)	
Displacement		781.6 cm³ (47.7 in³)	
Corrected compression ratio		6.0:1	
Cylinder head volume		47.7 ± 0.4 cc	
Cylinder head warpage (maximum)		0.05 mm (.002 in)	
Piston ring type and quantity		1 semi-trapez -- 1 rectangular	
Ring end gap	New	0.40 - 0.55 mm (.016 - .022 in)	
	Wear limit	1.00 mm (.039 in)	
Ring/piston groove	New	0.025 - 0.070 mm (.001 - .003 in)	
	Wear limit	0.24 mm (.009 in)	
Piston/cylinder wall clearance	New (minimum)	0.13 mm (.005 in)	
	Wear limit	0.22 mm (.009 in)	
Cylinder taper (maximum)		0.10 mm (.004 in)	
Cylinder out of round (maximum)		0.08 mm (.003 in)	
Connecting rod big end axial play	New	0.230 - 0.617 mm (.009 - .024 in)	
	Wear limit	1.2 mm (.047 in)	
Crankshaft deflection		MAG: 0.050 mm (.002 in); PTO: 0.030 mm (.001 in)	
Rotary valve timing	Opening	147° ± 5° BTDC	
	Closing	63.5° ± 5° ATDC	
Rotary valve duration		159°	
Rotary valve/cover clearance		0.25 - 0.35 mm (.010 - .014 in)	
Connecting rod/crankshaft pin radial clearance	New	0.023 - 0.034 mm (.0009 - .0013 in)	
	Wear limit	0.050 mm (.002 in)	
Connecting rod/piston pin radial clearance	New	0.02 - 0.033 mm (.0008 - .00013 in)	
	Wear limit	0.05 mm (.002 in)	
Counterbalance shaft oil	Type	SAE 30 motor oil	
	Capacity	30 mL (1 U.S. oz)	
ADDITIONAL INFORMATION:			



## Section 03 787 RFI ENGINE

### Subsection 06 (TECHNICAL SPECIFICATIONS)

ENGINE		3D RFI	3D RFI PREMIUM
Engine type		ROTAX 787 RFI, 2-stroke	
Induction type		Rotary valve	
Exhaust system	Type	Water cooled (water jacket), water injection in muffler only	
	Water injection fitting (head)	Not applicable	
	Water injection fitting (cone)	Not applicable	
	Water injection fitting (muffler)	3 x 3.5 mm (.138 in)	
Exhaust valve		Rotax Adjustable Variable Exhaust (RAVE)	
Starting system		Electric start	
Lubrication	Fuel/oil mixture	VROI (Variable Rate Oil Injection)	
	Oil injection pump	Direct driven	
	Oil injection type	XP-S™ synthetic 2-stroke	
Number of cylinders		2	
Bore	Standard	82 mm (3.228 in)	
	First oversize	82.25 mm (3.238 in)	
	Second oversize	Not applicable	
Stroke		74 mm (2.91 in)	
Displacement		781.6 cm³ (47.7 in³)	
Corrected compression ratio		6.0:1	
Cylinder head volume		47.7 ± 0.4 cc	
Cylinder head warpage (maximum)		0.05 mm (.002 in)	
Piston ring type and quantity		1 semi-trapez – 1 rectangular	
Ring end gap	New	0.40 - 0.55 mm (.016 - .022 in)	
	Wear limit	1.00 mm (.039 in)	
Ring/piston groove clearance	New	0.025 - 0.070 mm (.001 - .003 in)	
	Wear limit	0.24 mm (.009 in)	
Piston/cylinder wall clearance	New (minimum)	0.13 mm (.005 in)	
	Wear limit	0.22 mm (.0087 in)	
Cylinder taper (maximum)		0.10 mm (.004 in)	
Cylinder out of round (maximum)		0.08 mm (.003 in)	
Connecting rod big end axial play	New	0.230 - 0.617 mm (.009 - .024 in)	
	Wear limit	1.2 mm (.047 in)	
Crankshaft deflection		MAG side: 0.050 mm (.002 in); PTO side: 0.030 mm (.001 in)	
Rotary valve timing	Opening	147° ± 5° BTDC	
	Closing	63.5° ± 5° ATDC	
Rotary valve duration		159°	
Rotary valve/cover clearance		0.25 - 0.35 mm (.010 - .014 in)	
Connecting rod/crankshaft pin radial clearance	New	0.023 - 0.034 mm (.0009 - .0013 in)	
	Wear limit	0.050 mm (.002 in)	
Connecting rod/piston pin radial clearance	New	0.020 - 0.033 mm (.0008 - .0013 in))	
	Wear limit	0.050 mm (.002 in)	
Counterbalance shaft oil	Type	SAE 30 motor oil	
	Capacity	30 mL (1 U.S. oz)	
ADDITIONAL INFORMATION:			



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