

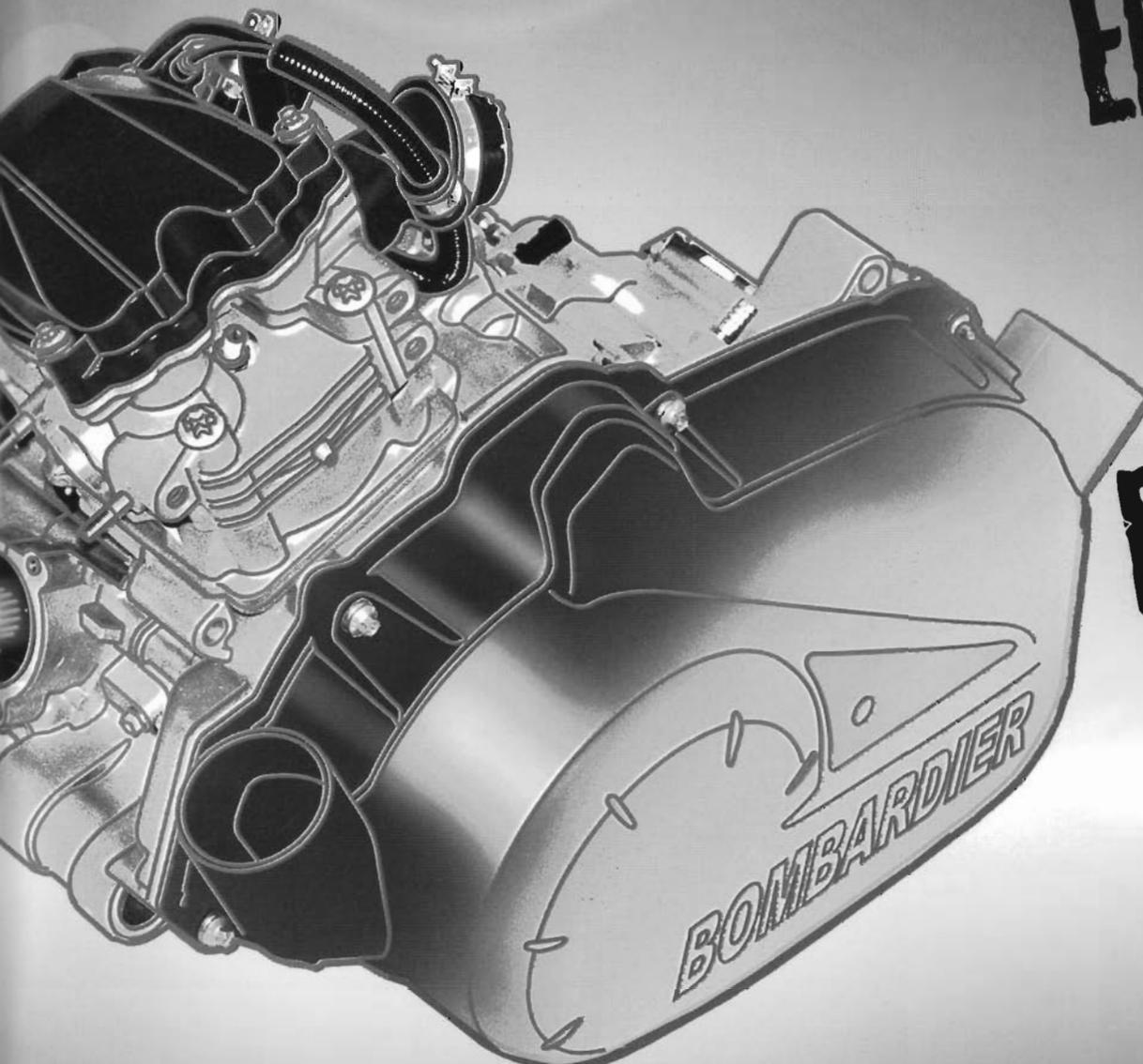
# ROTAX®



2006

ENGINE  
SHOP  
MANUAL

ROTAX®  
400



219 100 232

# **2006 Engine Shop Manual**

**ROTAX® 400  
ENGINE**

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## SAFETY NOTICE

This manual has been prepared as a guide to correctly service and repair the Rotax® 400 engine.

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. It does not include dealer modifications, whether authorized or not by BRP, after manufacturing the product.

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 engine and the corresponding components 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 Rotax 400 engine. 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.

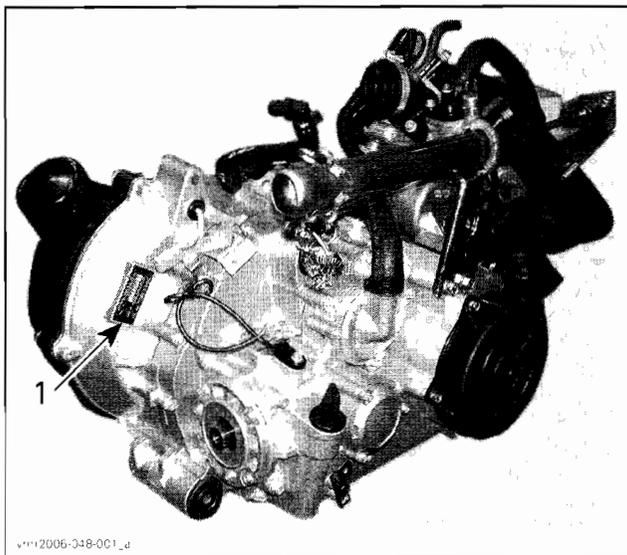
This Shop Manual uses technical terms which may be different from the ones of the *PARTS CATALOGS*.

When ordering parts always refer to the specific model *PARTS CATALOGS*.

## ENGINE EMISSIONS INFORMATION

Refer to the appropriate *VEHICLE SHOP MANUAL*.

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



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

## 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.

Each section is divided in various subsections, and again, each subsection has one or more division.

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.

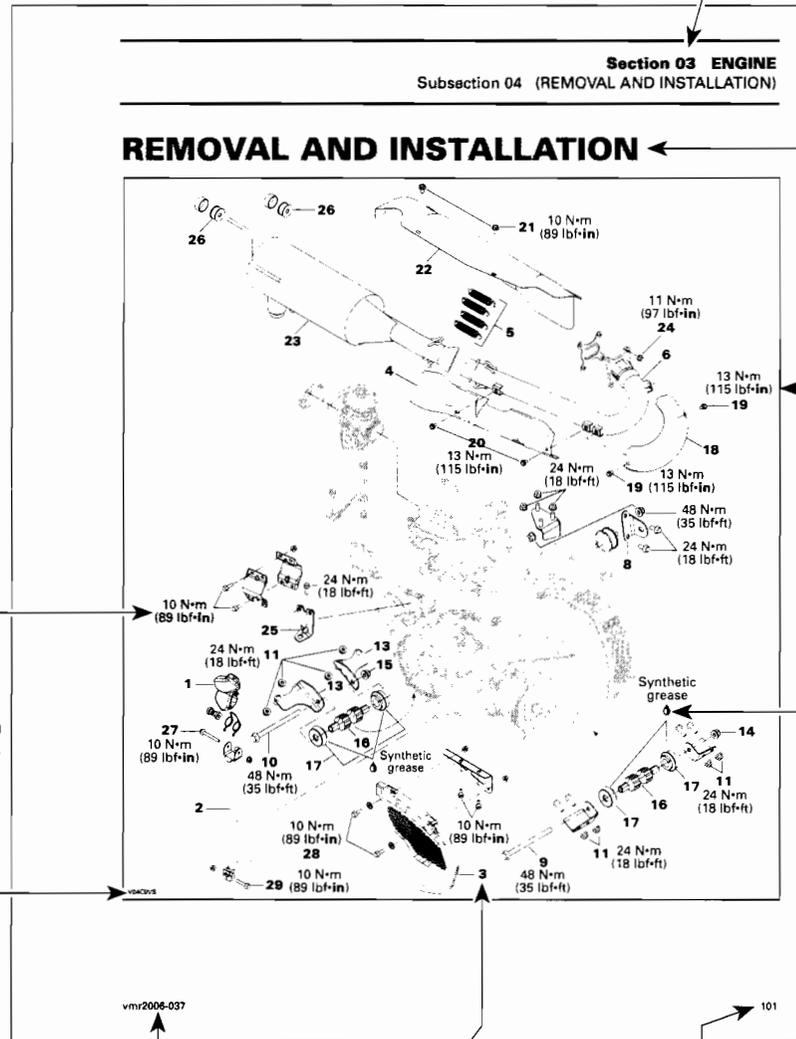
**CAUTION:** These engines are designed with parts dimensioned mostly in the metric system. However some components may be from the imperial system. When replacing fasteners, make sure to use only those recommended by BRP.

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.

This *Shop Manual* uses technical terms which may be slightly different from the ones in the parts catalog.

TYPICAL PAGE



Page heading indicates section and subsection detailed.

**Section 03 ENGINE**  
Subsection 04 (REMOVAL AND INSTALLATION)

**REMOVAL AND INSTALLATION**

Subsection title indicates beginning of the subsection.

Exploded view assists you in identifying parts and related positions.

Tightening torque nearby fastener. In this case, nut must be torqued to 10 N·m or 89 lbf·in.

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

Drop represents a liquid product to be applied to a surface.

Illustration number for publishing process.

vmr2006-037

Document number for publishing process.

Bold face number indicates special procedure concerning this part.

Page number

# INTRODUCTION

## TYPICAL PAGE

**Section 03 ENGINE**  
Subsection 06 (MAGNETO SYSTEM)

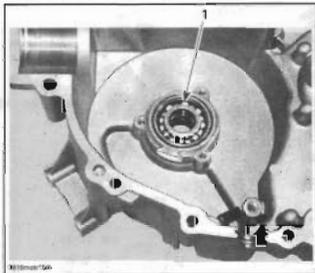
**BEARING**

**Inspection**

Ball bearing no. 10 must rotate freely. Otherwise, replace it.

**Removal**

Heat up the magneto housing cover to about 100°C (212°F) for an easy ball bearing removal.



1. Ball bearing

**Installation**

For installation also heat the magneto housing up to about 100°C (212°F) to put ball bearing in place.

Place new ball bearing in freezer for 10 minutes approximately.

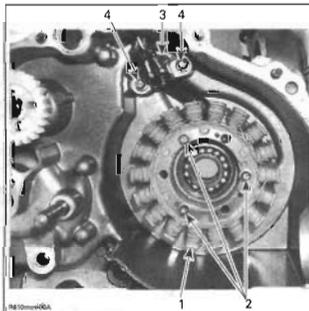
Reinstall other removed parts in the reverse order.

**STATOR AND TRIGGER COIL**

**Removal**

Remove.

- magneto housing cover no. 7
- screw no. 11 and 12
- stator with trigger coil no. 13.



5. Stator  
2. Stator screws  
3. Trigger coil  
4. Trigger coil screws

**Inspection**

Check stator and trigger coil condition. If damaged replace the faulty part.

For electrical inspection, refer to CHARGING SYSTEM for the stator and IGNITION SYSTEM for the trigger coil.

Title indicates main procedure to be carried-out.

Call-outs for above illustration.

Bold face number following part name refers to exploded view at beginning of subsection.

Reference to look up a certain section and subsection. In this case it concerns IGNITION SYSTEM.

# LEAK TEST

## SERVICE TOOLS

Description	Part Number	Page
camshaft locking tool.....	529 035 926 .....	2
crankshaft locking bolt.....	529 035 617 .....	2
dial gauge .....	414 104 700 .....	2

## GENERAL

Before performing the cylinder leak test, verify the following:

- clamp(s) tightness
- radiator and hoses.

**NOTE:** For best accuracy, the leak test should be done with the engine at normal operating temperature.

### Repair Tips

- blue exhaust gas means damaged/worn piston rings
- oily contamination on leak indicator hole (speed sensor area) means a damaged oil seal on water pump shaft
- coolant out of leak indicator hole means a damaged rotary seal on water pump shaft (refer to *COOLING SYSTEM*)
- coolant escaping from water pump housing means damaged gasket(s) and/or loosened screws (refer to *COOLING SYSTEM*).

**NOTE:** For all the checkpoints mentioned above see the appropriate engine section to diagnose and repair the engine.

## PROCEDURES

### PREPARATION

Disconnect battery.

**⚠ WARNING**

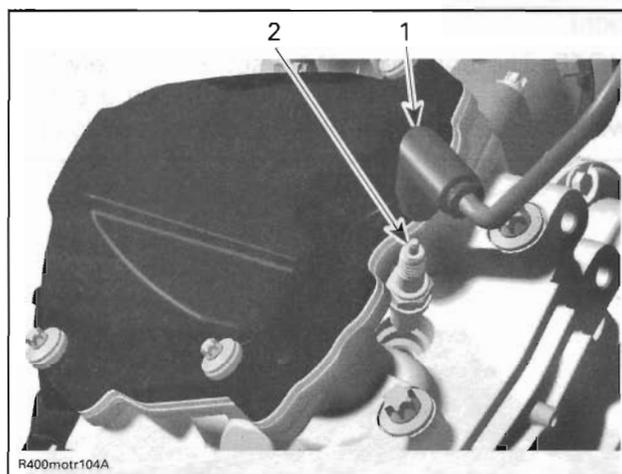
Always respect this order for disassembly; disconnect BLACK (-) cable first.

Remove:

- radiator cap
- any parts to have access to engine cylinder head. Refer to appropriate *VEHICLE SHOP MANUAL*.

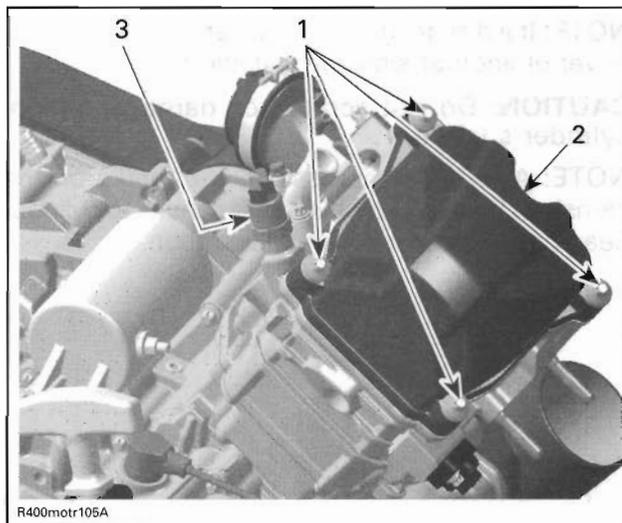
Unplug and remove spark plug cable.

Remove spark plug from cylinder head.



1. Spark plug cable  
2. Spark plug

Remove valve cover (refer to *CYLINDER AND HEAD*).



1. Valve cover screws  
2. Valve cover  
3. Coolant temperature switch

## Section 01 ENGINE

### Subsection 01 (LEAK TEST)

#### How to Turn Crankshaft

To turn crankshaft, there are two possible procedures.

**First Procedure:**

- Turn the drive pulley.

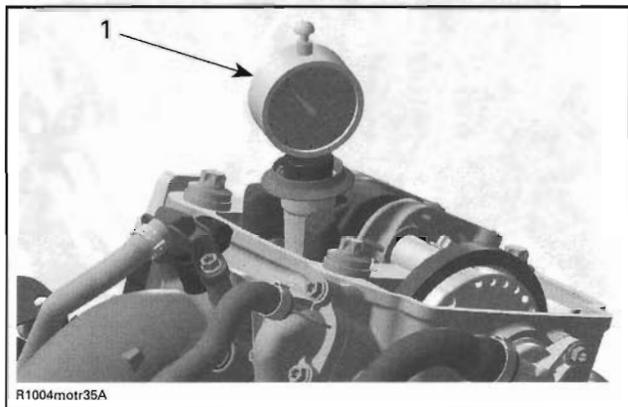
**Second Procedure:**

- Using rewind starter.

#### How to Position Piston at TDC (compression)

Using a dial gauge (P/N 414 104 700), turn the crankshaft and set the piston to TDC (compression).

**NOTE:** The engine must be set to precisely TDC (compression); if this is not ensured the engine will continue to rotate when pressure builds up.

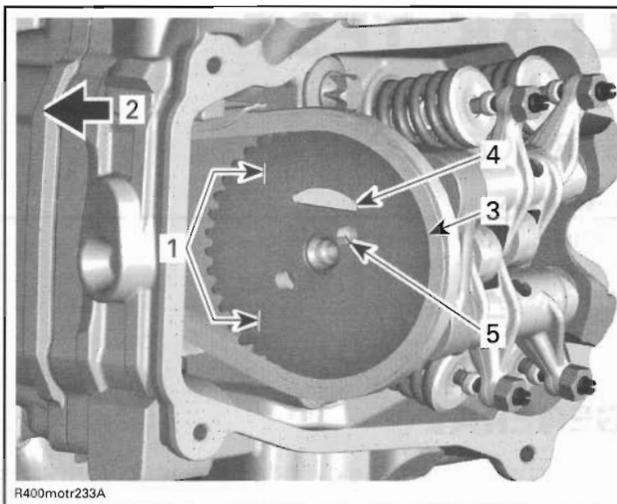


TYPICAL  
1. Dial gauge

**NOTE:** If a dial gauge is not available, use a screwdriver or another similarly suitable tool.

**CAUTION:** Do not scratch or damage piston/cylinder surface.

**NOTE:** At TDC (compression), the marks on the camshaft timing gear have to be parallel to cylinder head base as per following illustration.



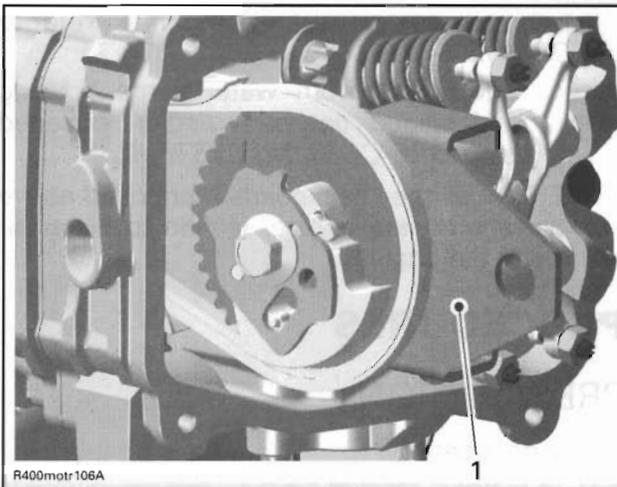
1. Marks on camshaft timing gear  
2. Cylinder head base  
3. Camshaft timing gear  
4. Timing gear tab  
5. Decompressor shaft bore

#### How to Lock Piston at TDC (compression)

To lock piston at TDC (compression), there are two possible procedures.

**First Procedure**

Lock camshaft using camshaft locking tool (P/N 529 035 926).



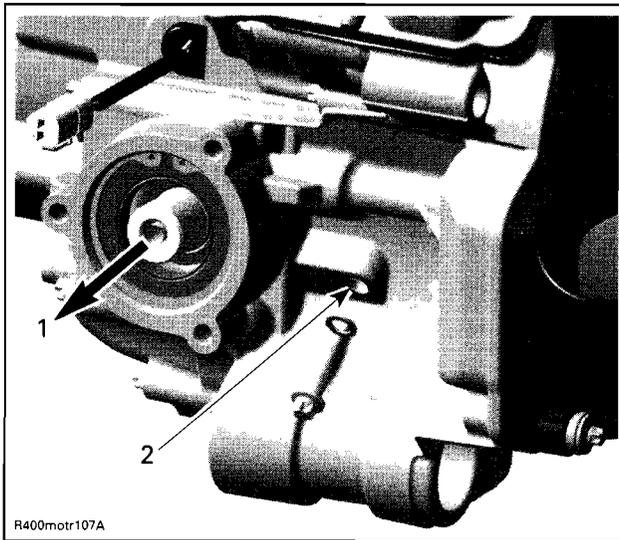
1. Camshaft locking tool

**Second Procedure**

Lock crankshaft using crankshaft locking bolt (P/N 529 035 617).

## Section 01 ENGINE

### Subsection 01 (LEAK TEST)



1. Vehicle front side
2. Position for crankshaft locking bolt

## LEAK TEST

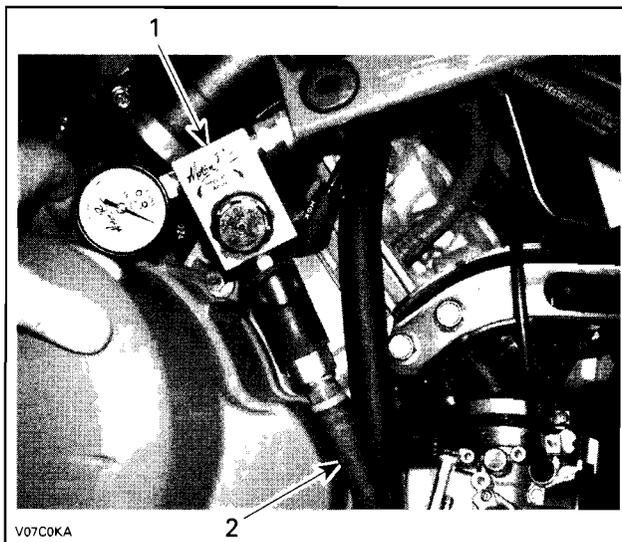
Connect to adequate air supply.

Set needle of measuring gauge to zero.

**NOTE:** Each tester will have specific instruction on the gauge operation and required pressure.

Install gauge adapter into previously cleaned spark plug hole.

Supply combustion chamber with air pressure.



1. Leak tester
2. Air supply hose

Note the amount of leaking or percentage (depending on tester).

LEAKAGE PERCENTAGE	ENGINE CONDITION
0% to 15%	Excellent condition
16% to 25%	Good condition
26% to 40%	Fair condition; engine will run and in some cases, performance might be affected.
41% and higher	Poor condition, diagnose and repair engine.

## Diagnosis

Listen for air leaks.

- air escaping on intake port/carburetor means leaking intake valve(s)
- air escaping on exhaust port means leaking exhaust valve(s)
- air bubbles out of radiator means leaking cylinder head gasket
- air/oil escaping from crankcase means damaged gasket and/or loosened screws
- air/coolant escaping from cylinder/head means damaged gasket(s) and/or loosened screws
- air escaping into crankcase area means excessively worn cylinder and/or broken piston rings.

**NOTE:** For all the checkpoints mentioned above see the appropriate engine section to diagnose and repair the engine.

## REASSEMBLY

**NOTE:** Always replace the valve cover gasket.

Torque valve cover screws to 7 N•m (62 lbf•in).

Torque spark plug to 20 N•m (177 lbf•in).

For other components, reverse the preparation procedure. Ensure to respect torque values and use of appropriate products/lubricants. Refer to exploded views of other sections of this manual or to the appropriate *VEHICLE SHOP MANUAL* as required.

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# REWIND STARTER

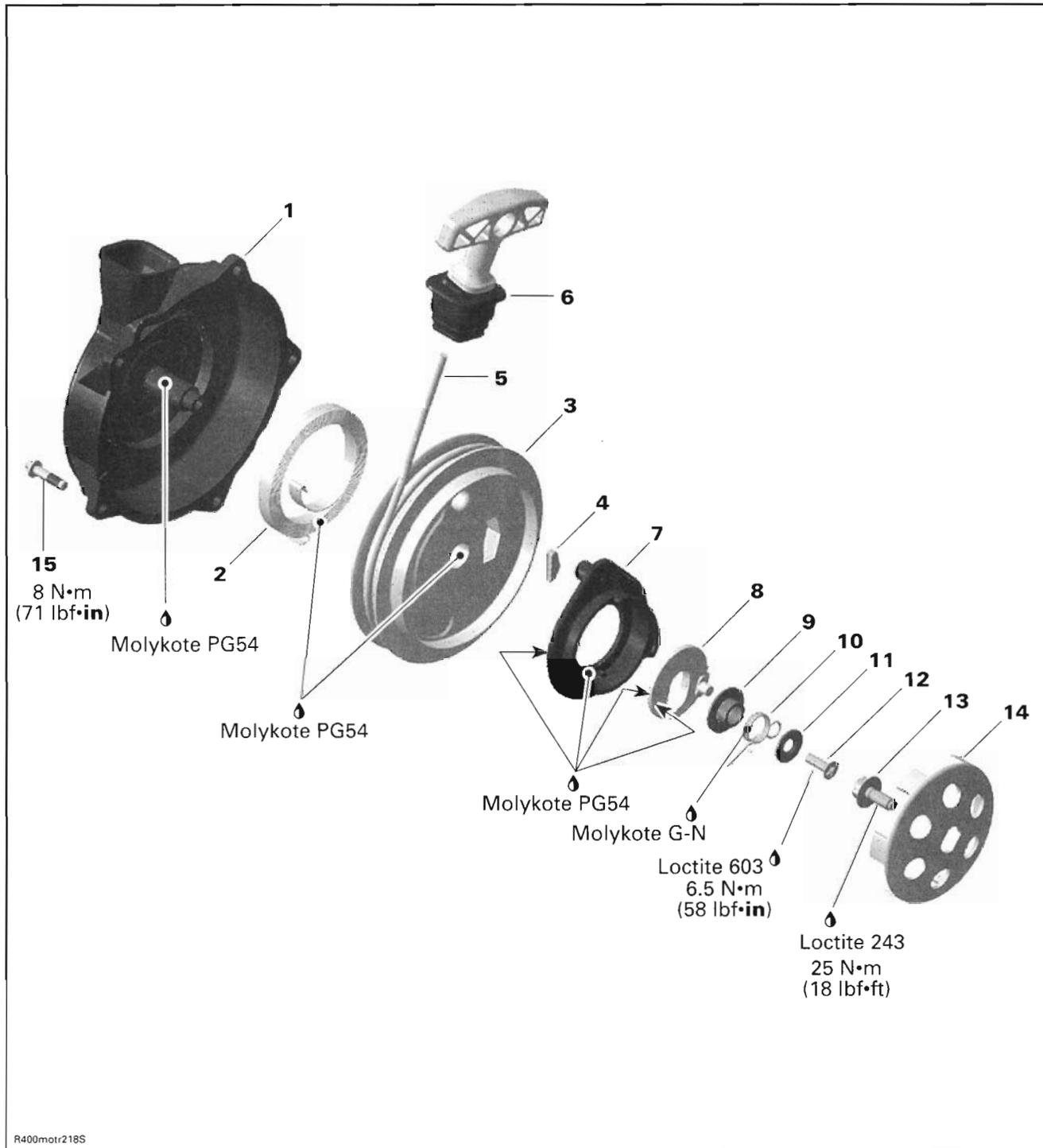
## SERVICE PRODUCTS

<u>Description</u>	<u>Part Number</u>	<u>Page</u>
Loctite 243 (blue).....	293 800 060 .....	10
Molykote PG 54.....	420 899 763 .....	8

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**Section 01 ENGINE**

**Subsection 02 (REWIND STARTER)**



R400motr218S

## GENERAL

During assembly/installation, use the torque values and service products as in the exploded views.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

### ⚠ 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.

## PROCEDURES

### REWIND STARTER

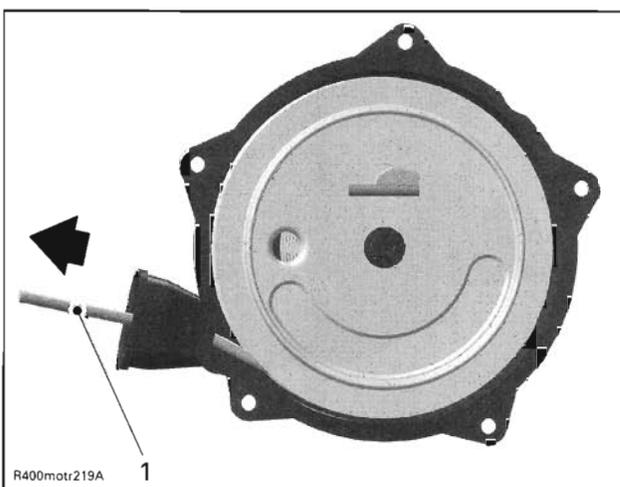
#### Removal

Remove RH side panel and engine cover.

Remove rewind starter mounting bolts no. 15 and pull rewind starter.

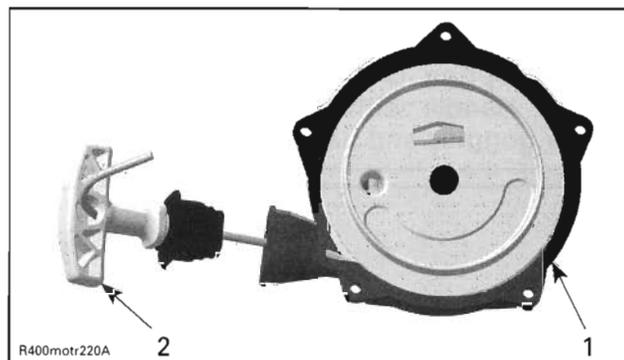
To release tension from torsion spring no. 2:

- First pull grip no. 6 and tie a knot more than 20 cm (8 in) below it.



1. Rope

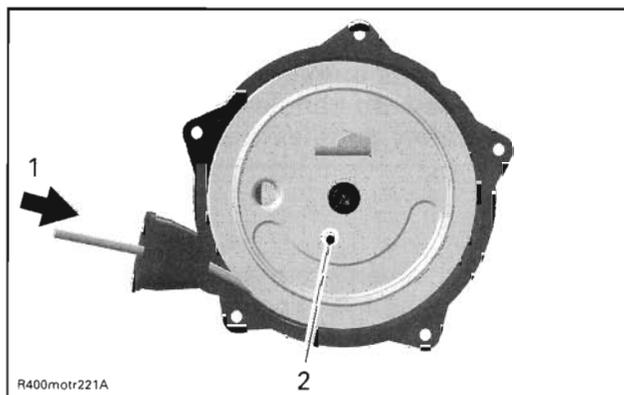
- Untie knot holding rewind starter grip and remove grip.



1. Starter housing  
2. Rewind starter grip

- Finally untie other knot and slowly release rope into starter housing to release spring tension.

**CAUTION:** Hold rope sheave reactive to spring tension while releasing the rope into starter housing.



1. Direction to release spring tension  
2. Rope sheave

#### Disassembly

### ⚠ WARNING

Spring tension has to be released prior to withdraw the rewind starter sheave.

To remove rope no. 5 from rewind starter mechanism:

- First remove flat washer no. 11 and screw no. 12, locking spring no. 10, locking spring washer no. 9, pawl lock no. 8 and pawl no. 7.

**NOTE:** Use two flat screwdrivers to withdraw locking spring washer no. 9.

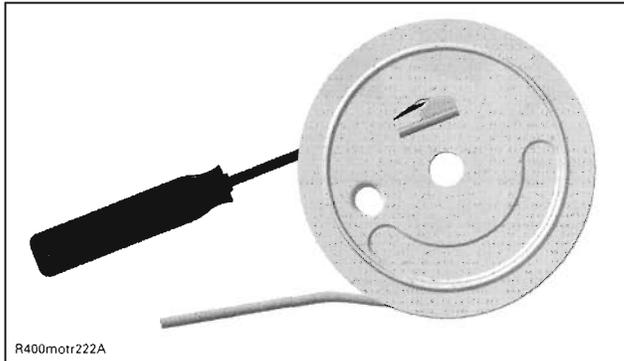
- Remove sheave no. 3 from starter housing no. 1.
- Disengage key no. 4 and pull out rope no. 5.

**Section 01 ENGINE**

**Subsection 02 (REWIND STARTER)**

**⚠ WARNING**

Torsion spring is tightly wound inside the guide. Handle with care and always wear safety goggles and hand gloves.



TYPICAL — GENTLY TAP ON KEY

**⚠ WARNING**

Never remove spring out of starter housing except if spring is damaged. Torsion spring is spring loaded, so handle with care and always wear safety goggles and hand gloves.

**Assembly**

For installation, reverse the removal procedure. Pay attention to the following details.

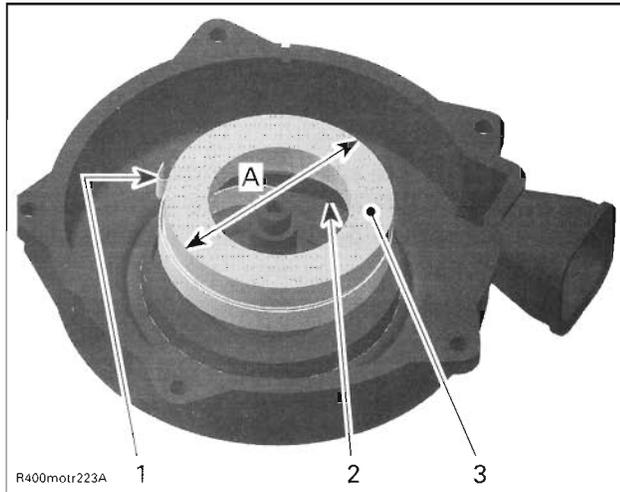
**⚠ WARNING**

Always install new spring into starter housing. Torsion spring is spring loaded, so handle with care during installation. Always wear safety goggles and hand gloves.

At assembly, position spring no. 2 outer end into spring guide notch. Use appropriate ring to push spring into starter housing as illustrated.

**⚠ WARNING**

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

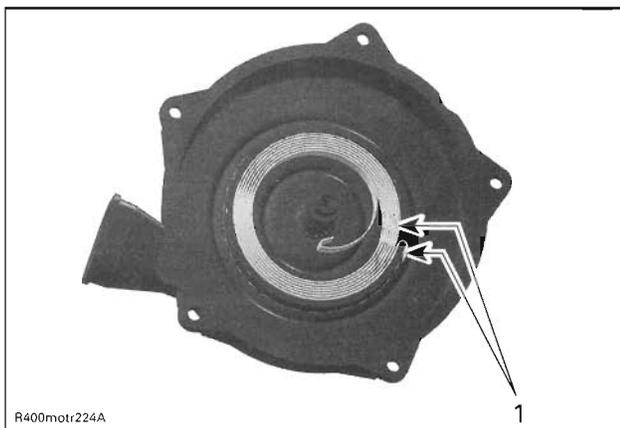


TYPICAL  
 1. Outer end into guide notch  
 2. Apply Molykote PG 54 inside spring guide  
 3. Ring for spring installation  
 A.  $82 + .2 \text{ mm } (3.23 + .008 \text{ in})$

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

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

Lubricate spring assembly with Molykote PG 54 (P/N 420 899 763) and position into starter housing as illustrated.



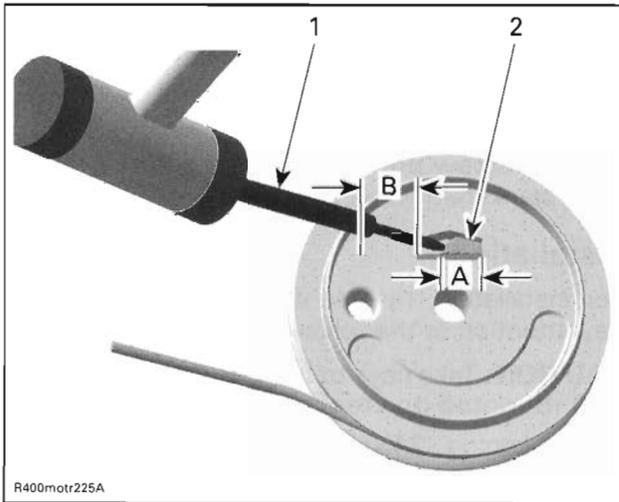
TYPICAL  
 1. Apply Molykote PG 54 in spring area

**CAUTION:** The use of standard multipurpose grease could result in rewind starter malfunction.

To install a new rope no. 5, insert rope into sheave orifice and lock it with the key no. 4 as illustrated.

**Section 01 ENGINE**

**Subsection 02 (REWIND STARTER)**



**TYPICAL**

- 1. Punch
- 2. Key
- A. Maximum 14 mm (.55 in)
- B. Rope overstand 20 to 25 mm (.787 to .984 in)

**To adjust rope tension:**

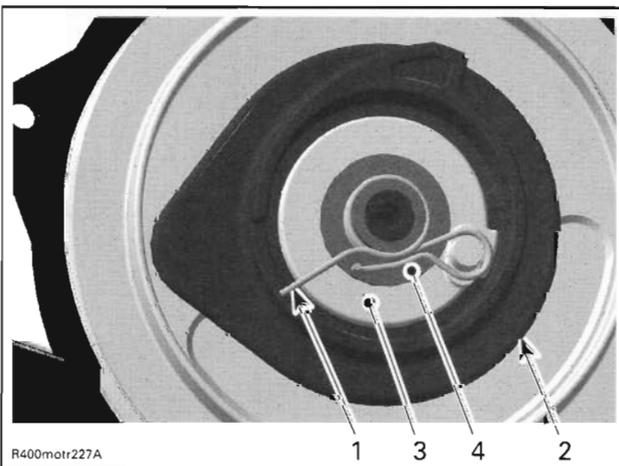
Wind rope on sheave and place rope sheave into starter housing making sure that the sheave hub notch engages in the rewind spring hook.

**⚠ WARNING**

To prevent spring from flying out of the guide, it is mandatory to secure rope sheave in place. Always handle with care and use safety goggles and hand gloves.

Position pawl no. 7, pawl lock no. 8 and locking spring washer no. 9.

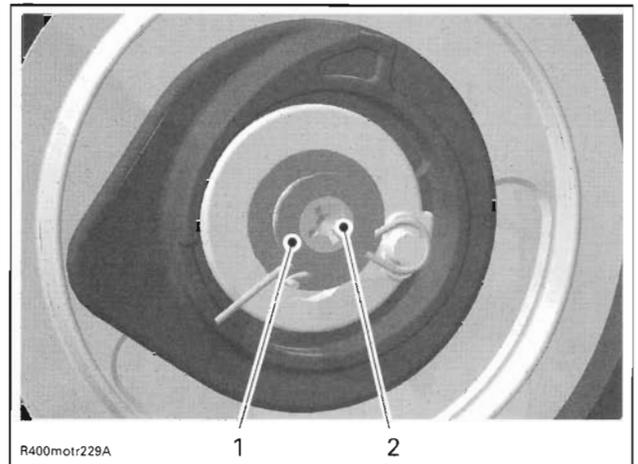
Install locking spring no. 10.



**TYPICAL**

- 1. Locking spring
- 2. Pawl
- 3. Pawl lock
- 4. Locking spring washer

Install washer no. 11 and torque screw no. 12.

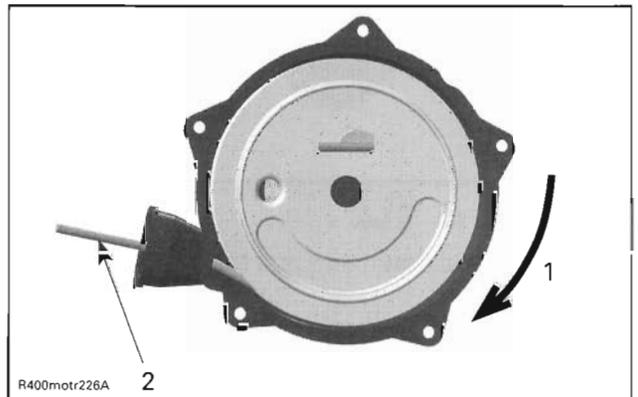


- 1. Washer
- 2. Screw

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

**Pull Rope Out of the Starter Housing and Temporarily Hold It**

**NOTE:** It is recommended to use a hose clamp to fix rope in place. A knot can get too tight.

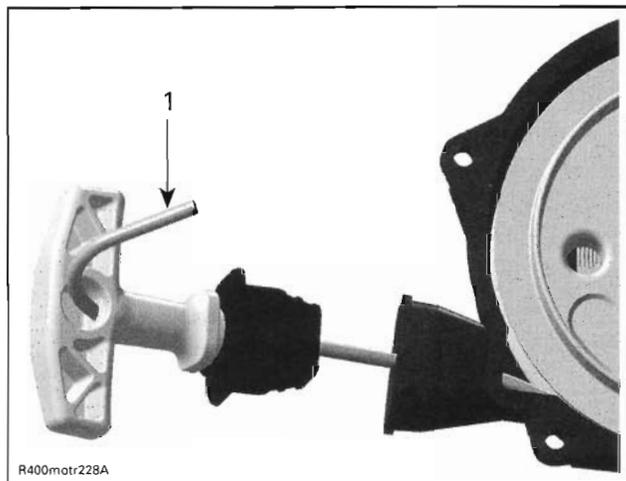


**TYPICAL**

- 1. Turn clockwise
- 2. Position to fix rope in place

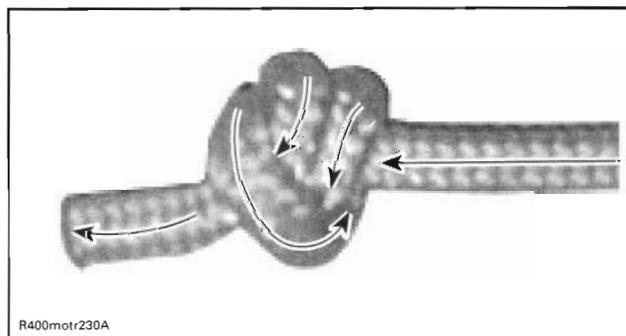
Thread starter rope no. 5 through rope guide when applicable.

Prior to installing starter grip on new rope, it is first necessary to fuse the rope end with a lit match.

**Section 01 ENGINE****Subsection 02 (REWIND STARTER)**

*TYPICAL*  
1. Fuse end of starter rope

Pass rope through starter grip, tie a knot in the rope end.



*TYPICAL*

Insert rope end down and pull the starter grip over the knot.

**Installation**

For installation, reverse the removal procedure. Pay attention to the following details.

Prior to reinstalling rewind starter on engine, clean threads from Loctite deposits.

**NOTE:** Before torquing mounting bolts no. 15, apply Loctite 243 (blue) (P/N 293 800 060) on threads.

**STARTING PULLEY****Removal**

Remove rewind starter.

Remove screw no. 13 and starting pulley no. 14 from crankshaft MAG side.

**Installation**

For installation, reverse the removal procedure. Pay attention to the following details.

**CAUTION:** Take care to have the starting pulley well mounted on crankshaft end.

Apply Loctite 243 (blue) (P/N 293 800 060) on threads and torque the screw to 25 N•m (18 lbf•ft).

# COOLING SYSTEM

## SERVICE TOOLS

Description	Part Number	Page
oil seal pusher.....	529 035 757 .....	16
water pump ceramic seal installer.....	529 035 766 .....	17

## SERVICE PRODUCTS

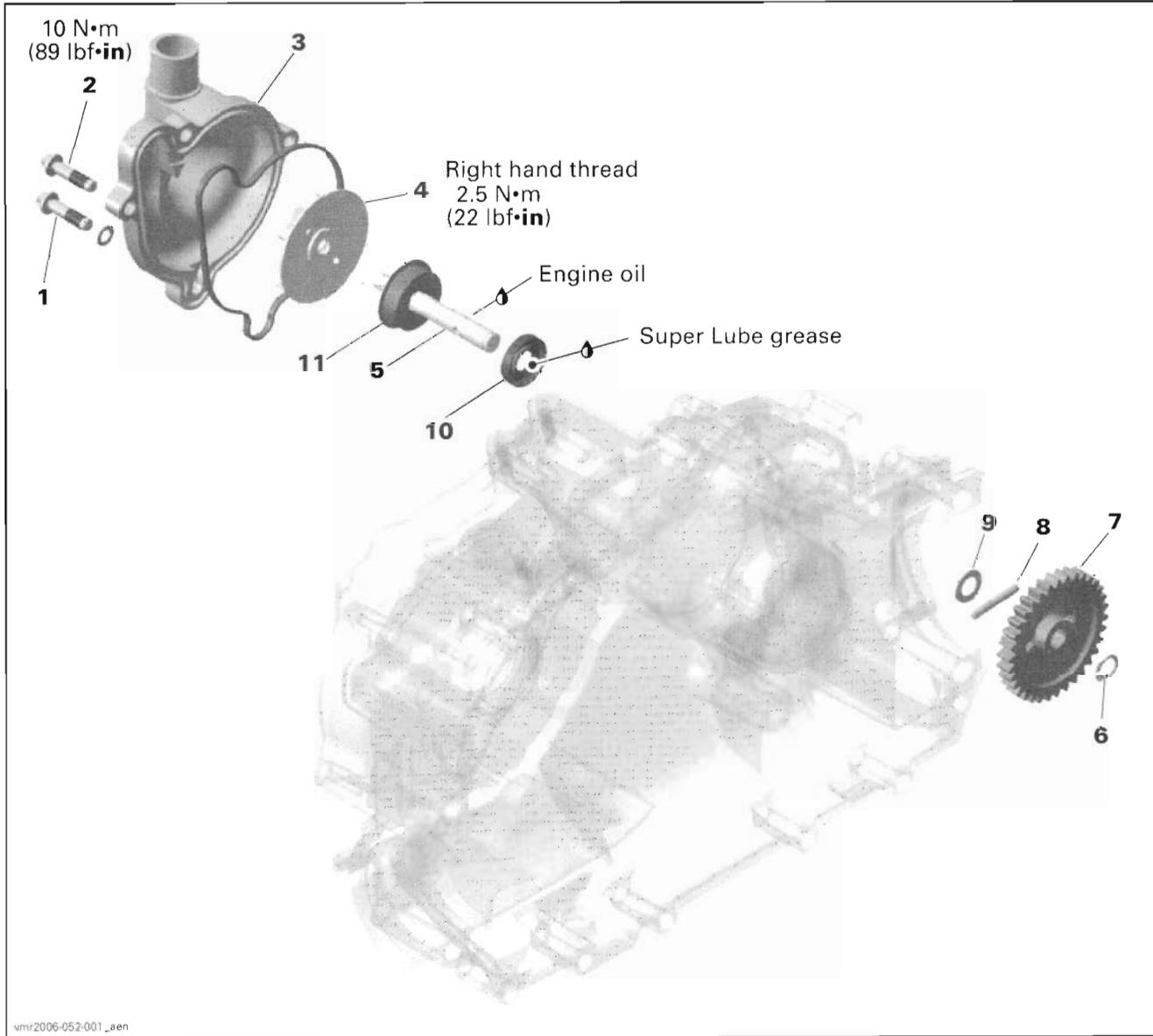
Description	Part Number	Page
super lube grease .....	293 550 030 .....	17

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**Section 01 ENGINE**

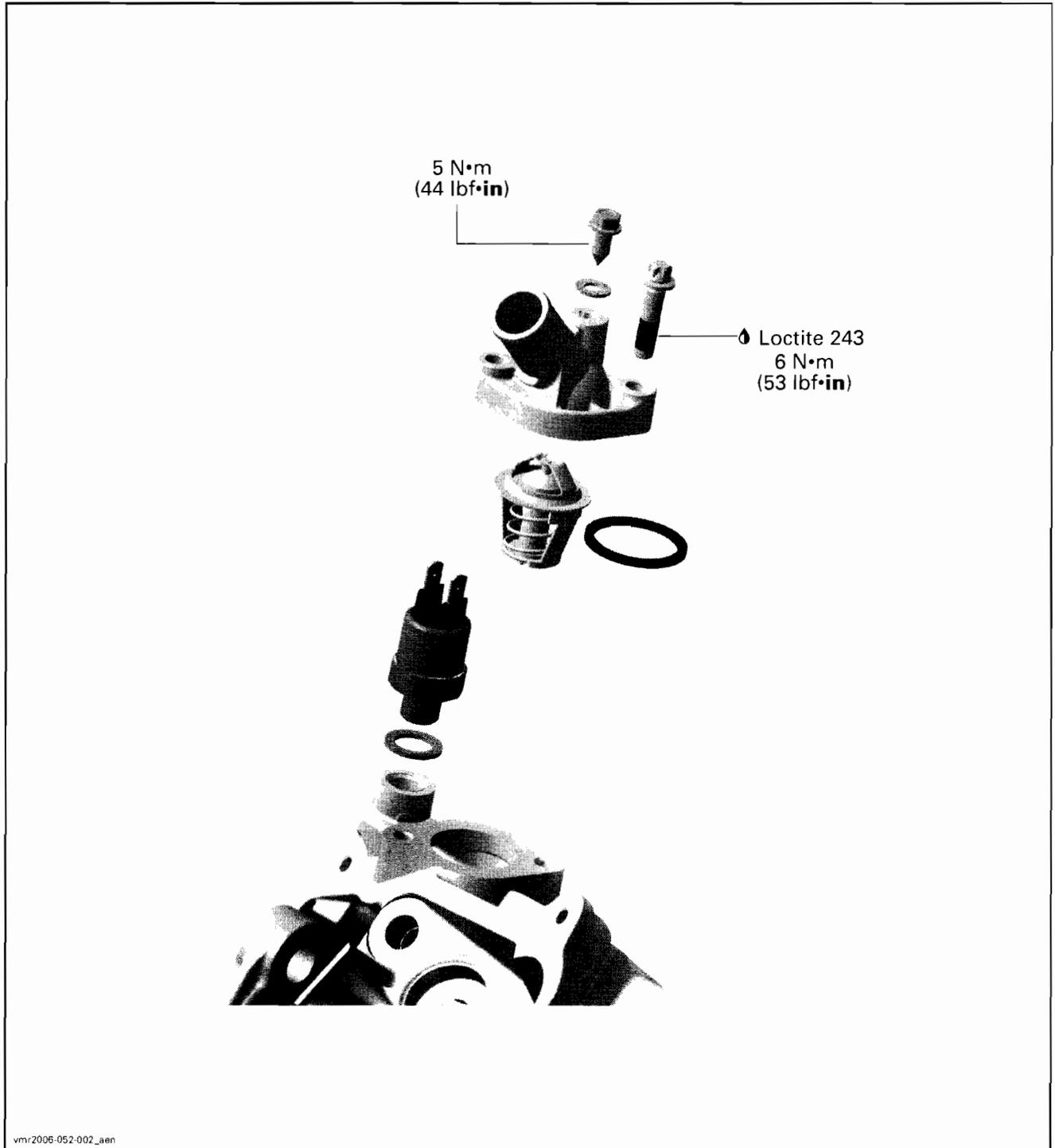
Subsection 03 (COOLING SYSTEM)

**WATER PUMP**



vmr2006-052-001\_a.en

**THERMOSTAT**



vmr2006-052-002\_aen

**Section 01 ENGINE****Subsection 03 (COOLING SYSTEM)****GENERAL**

During assembly/installation, use the torque values and service products as in the exploded views.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

**⚠ 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.

**PROCEDURE****THERMOSTAT**

**NOTE:** For thermostat removal, test and installation, refer to the appropriate *VEHICLE SHOP MANUAL*.

**COOLANT TEMPERATURE SWITCH**

**NOTE:** For coolant temperature switch removal, test and installation, refer to the appropriate *VEHICLE SHOP MANUAL*.

**WATER PUMP COVER**

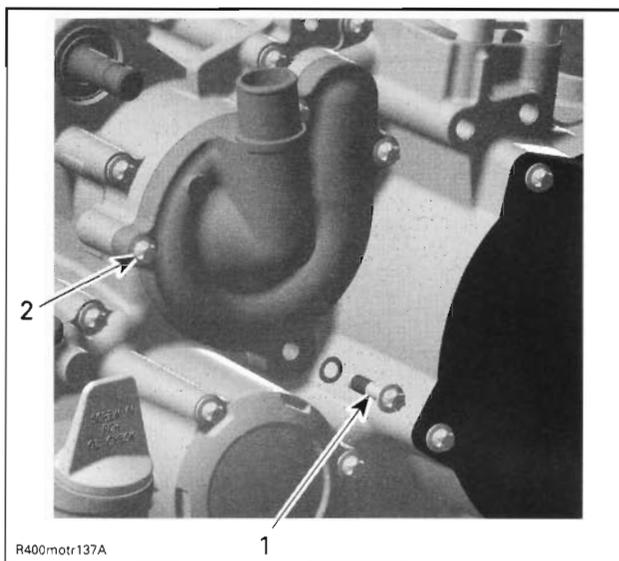
**NOTE:** It is located on the engine MAG side.

**Removal**

Drain cooling system.

Remove:

- radiator outlet hose
- screws no. 1 and no. 2 retaining water pump cover no. 3

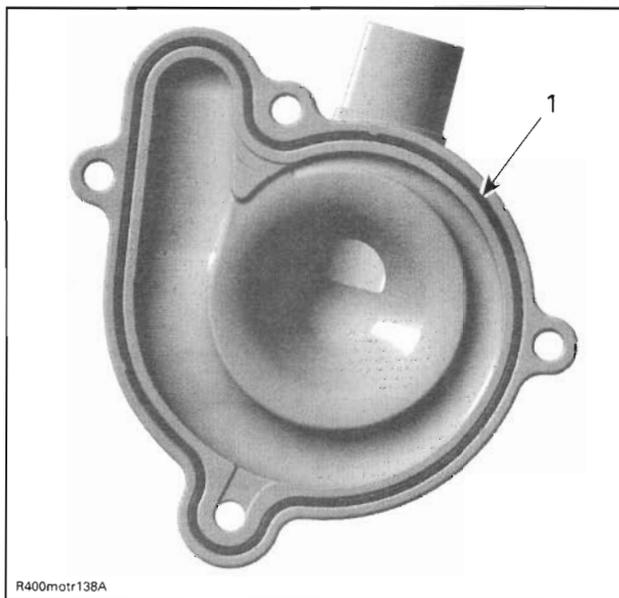


1. Screws M6 x 25 with sealing ring
2. Screws M6 x 25

– water pump cover no. 3.

**Inspection**

Check if gasket is brittle, hard or damaged and replace as necessary.



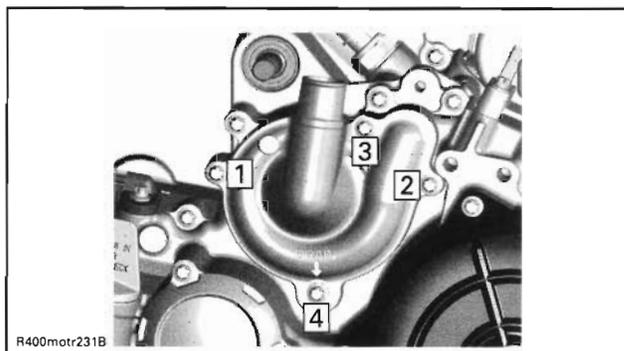
1. Gasket

**Installation**

The installation is the opposite of the removal procedure.

**CAUTION:** To prevent leaking, take care that the gasket is exactly in groove when you reinstall the water pump cover.

Tightening sequence for screws on water pump cover is as per following illustration (criss-cross).

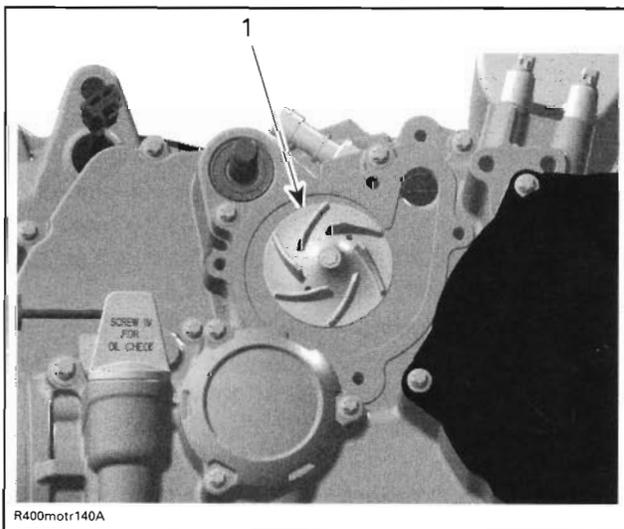


## WATER PUMP IMPELLER

### Removal

Remove:

- water pump cover no. 3
- impeller no. 4.



1. Impeller

**CAUTION:** Water pump shaft no. 5 and impeller no. 4 have right-hand threads. Remove by turning counterclockwise and install by turning clockwise.

### Inspection

Check impeller for cracks or other damage. Replace impeller if damaged.

### Installation

The installation is the opposite of the removal procedure. Pay attention to the following detail.

**CAUTION:** Be careful not to damage impeller wings during installation.

## WATER PUMP SHAFT

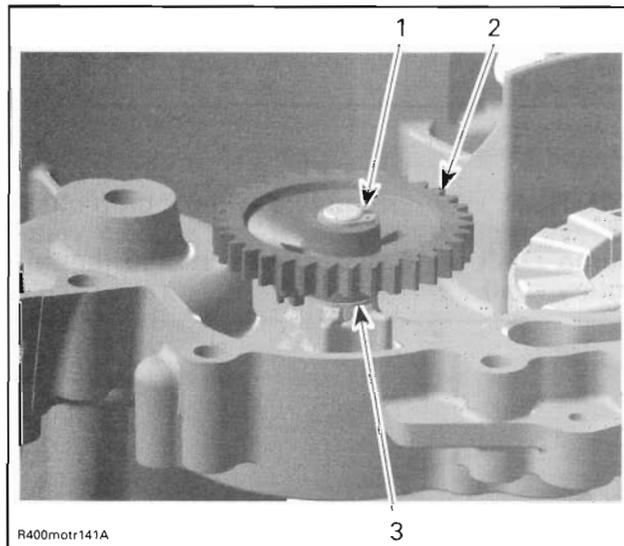
### Removal

Remove:

- water pump cover no. 3
- impeller no. 4
- magneto cover (refer to *MAGNETO SYSTEM*)
- retaining ring no. 6 with appropriate pliers

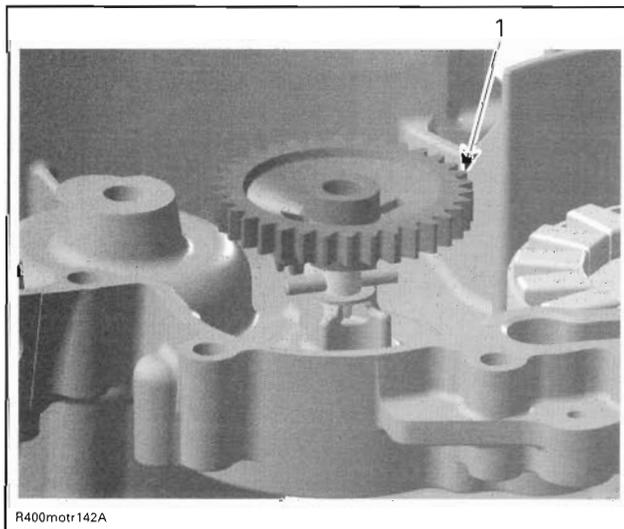
**CAUTION:** Never use the retaining ring a second time. Always install a new one.

- water pump gear no. 7



1. Retaining ring  
2. Water pump gear  
3. Thrust washer

**NOTE:** The water pump gear is held by a needle pin no. 8 on the water pump shaft.

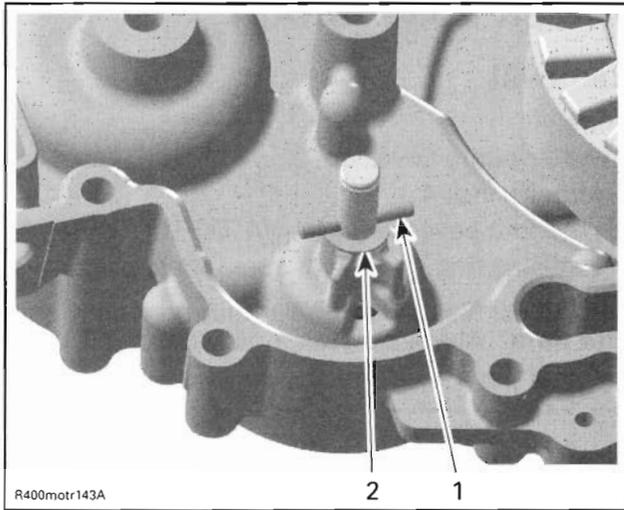


1. Water pump gear

- needle pin no. 8 and thrust washer no. 9.

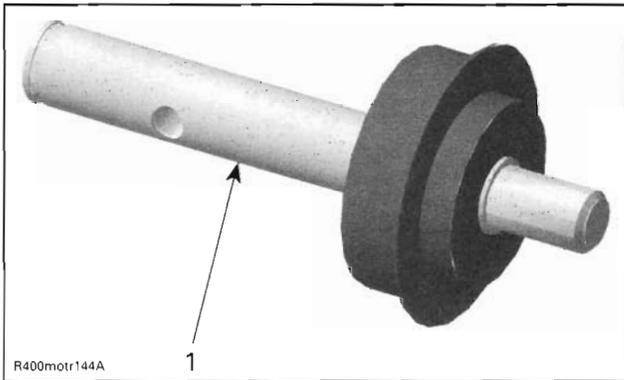
**Section 01 ENGINE**

**Subsection 03 (COOLING SYSTEM)**

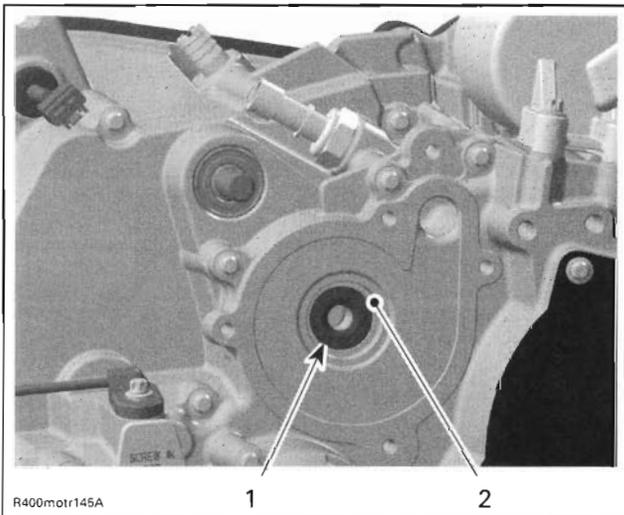


1. Needle pin  
2. Thrust washer

**CAUTION:** When removing water pump shaft, always replace rotary seal no. 11 with water pump shaft no. 5 and oil seal no. 10 (behind rotary seal).



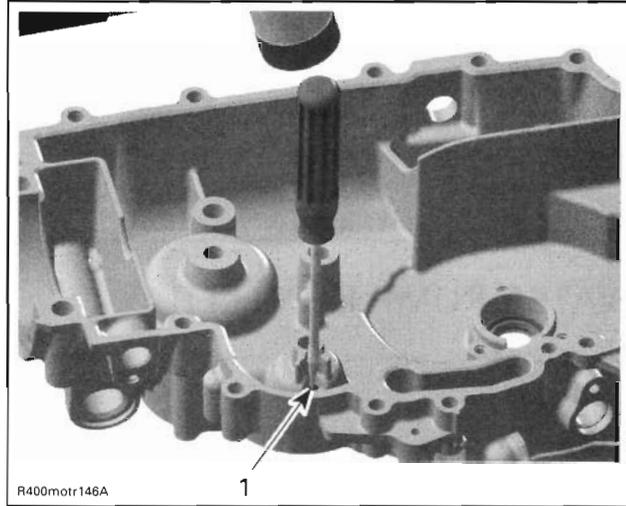
1. Water pump shaft with rotary seal



1. Oil seal behind the rotary seal  
2. Rotary seal bore

Extract the water pump shaft no. 5 with rotary seal no. 11 together with oil seal no. 10 from inside magneto cover with a pusher.

**CAUTION:** Be careful not to damage the surface of the rotary seal bore in magneto cover.



1. Special area for oil seal removal

**Inspection**

Inspect water pump gear for wear and damage on the snap mechanism to the needle pin. Replace if damaged.

Water pump shaft with rotary seal must rotate freely. Otherwise, replace it.

**NOTE:** When removing water pump shaft, always replace together retaining ring, oil seal, water pump shaft with rotary seal with new parts.

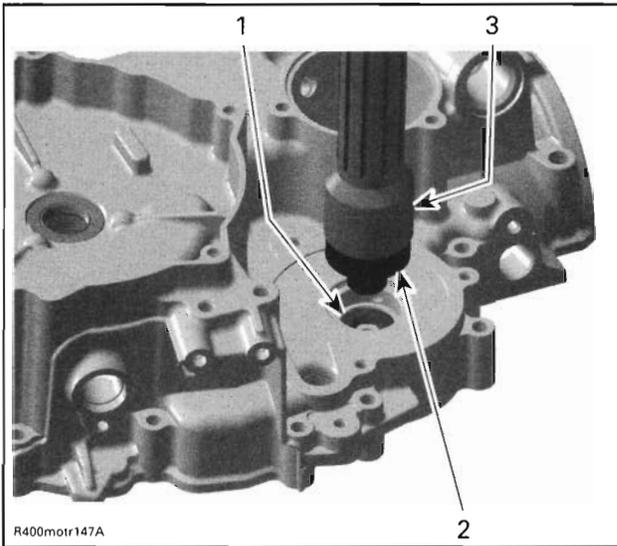
**Installation**

For installation, reverse the removal procedure. However, pay attention to the following.

**NOTE:** Never use oil in the press fit area of the oil seal and rotary seal.

Push water pump shaft oil seal in place by using the oil seal pusher (P/N 529 035 757).

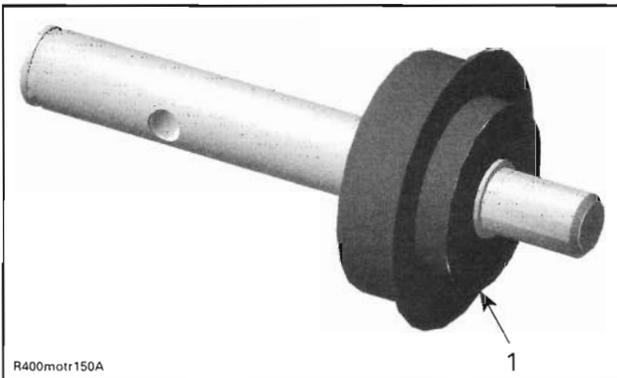
**Section 01 ENGINE**  
 Subsection 03 (COOLING SYSTEM)



1. Oil seal for the water pump shaft
2. Oil seal pusher (P/N 529 035 757)
3. Handle for insertion jig (P/N 420 877 650)

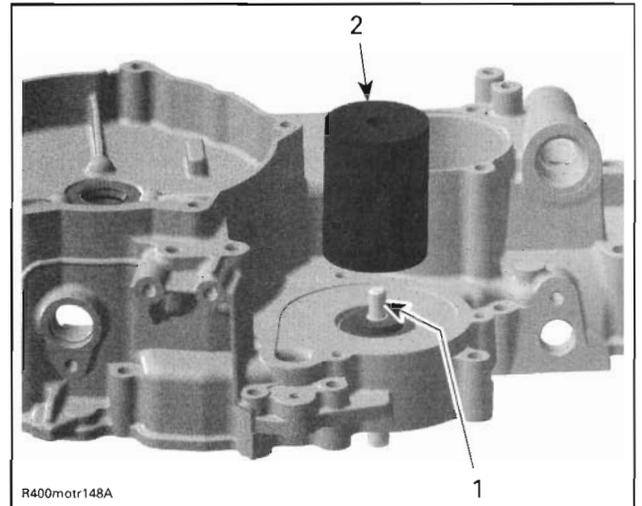
It is recommended to install the water pump shaft assembly using the water pump ceramic seal installer (P/N 529 035 766).

**NOTE:** The water pump shaft assembly has to be pushed using the outside area of the rotary seal.



1. Surface to push water pump shaft assembly in place

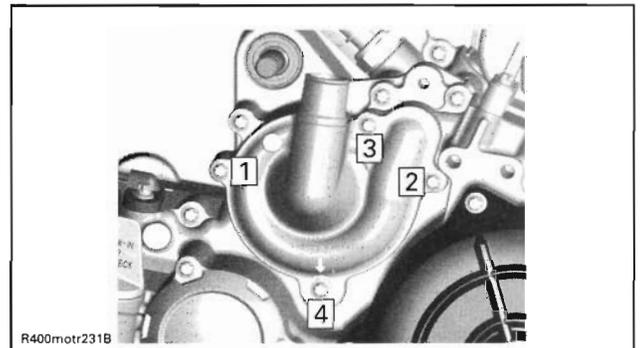
**CAUTION:** Never use a hammer for the rotary seal installation. Only use a press to avoid damaging the ceramic component.



1. Water pump shaft with rotary seal
2. Water pump ceramic seal installer (P/N 529 035 766)

**NOTE:** For installation use the torque values in the exploded view. Ensure to use super lube grease (P/N 293 550 030) for oil seal no. 10 and engine oil in water pump shaft bore/shaft no. 5.

Tighten screws in the following sequence.



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# MAGNETO SYSTEM

## SERVICE TOOLS

Description	Part Number	Page
crankshaft protector .....	420 876 557 .....	26
handle .....	420 877 650 .....	24
locking bolt .....	529 035 617 .....	25
magneto puller.....	529 035 748 .....	26
oil seal installer .....	529 035 759 .....	24
oil seal protector .....	529 035 935 .....	23-24

## SERVICE PRODUCTS

Description	Part Number	Page
Loctite 5910.....	293 800 081 .....	22
Loctite chisel (gasket remover) .....	413 708 500 .....	22

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## GENERAL

The engine removal is necessary to work on magneto components except for the CPS (Crankshaft Position Sensor) and oil seal.

Always perform the electric tests before removing or installing whatever component.

During assembly/installation, use the torque values and service products as in the exploded views.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

### WARNING

Torque wrench tightening specifications must strictly be adhered to.

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

## PROCEDURE

### MAGNETO COVER

#### Removal

Remove engine from vehicle.

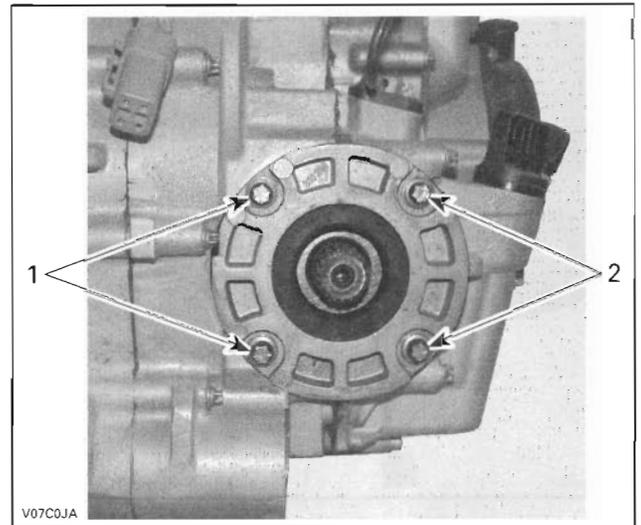
Remove 4WD coupling unit.

Lock crankshaft at TDC (refer to *CRANKSHAFT AND CRANKCASE*).

Remove:

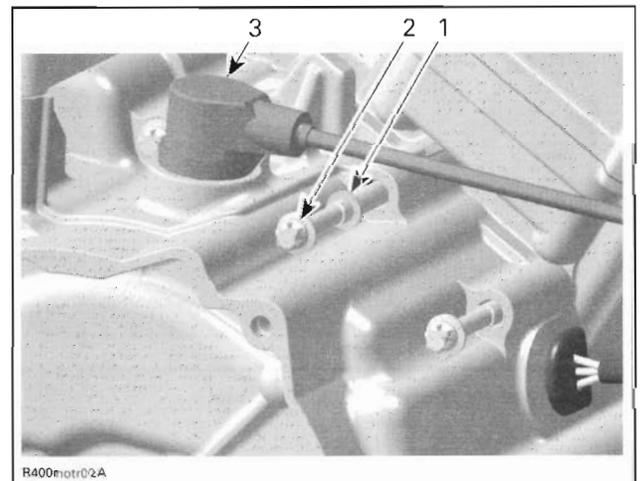
- rewind starter (refer to *REWIND STARTER*)
- water pump cover (refer to *COOLING SYSTEM*)
- electric starter screws no. 1
- screws no. 2 holding output shaft bearing flange in place

**NOTE:** Remove the screws on magneto cover side and loosen only the screws on the crankcase side if the output shaft is not removed. Remove all screws and bearing flange if output shaft is removed.



1. Loosen only these screws if output is not removed
2. Remove these screws

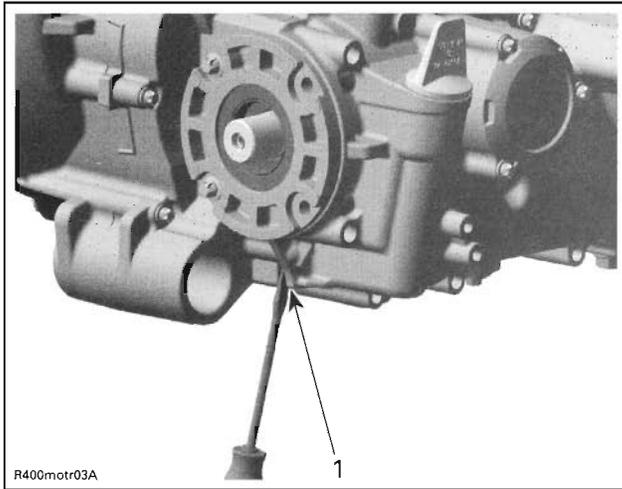
- screws no. 3, 4 and 5



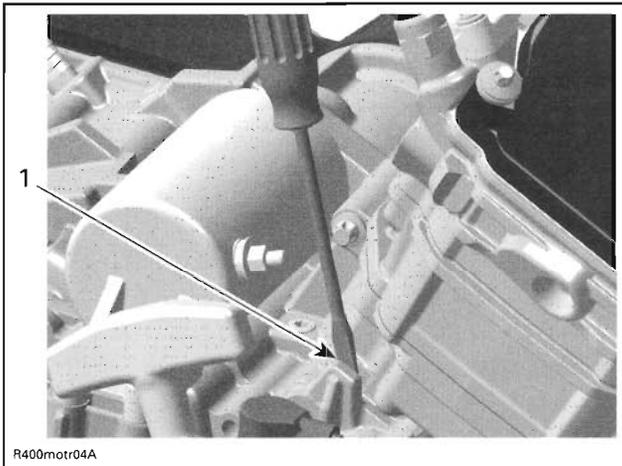
1. Gasket ring
2. Screw M6
3. CPS (Crankshaft Position Sensor)

- magneto cover no. 6.

**NOTE:** Lift the magneto cover from the provided area using two flat screwdrivers prying equally at the same time.

**Section 01 ENGINE****Subsection 04 (MAGNETO SYSTEM)**

1. Special area for removal of magneto cover



1. Special area for removal of magneto cover

**Inspection**

Check magneto cover for cracks or other damages. Replace if necessary.

**Installation**

**NOTE:** Clean all metal component in a non-ferrous metal cleaner. Use Loctite chisel (gasket remover) (P/N 413 708 500), or suitable equivalent. To remove remaining Loctite 5910 on the contact surface, use a copper brush.

**⚠ WARNING**

Wear safety glasses and work in a well ventilated area when working with strong chemical products. Also wear suitable non-absorbent gloves to protect your hands.

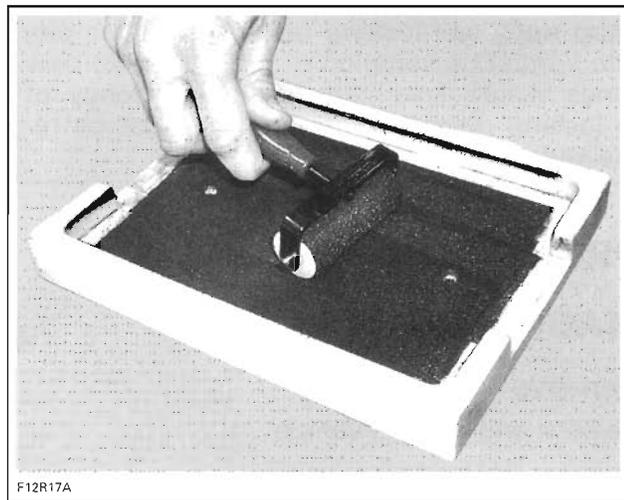
For installation, reverse the removal procedure. However, pay attention to the following.

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

**IMPORTANT:** When beginning the application of the 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.

Use a plexyglass 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 magneto mating surfaces.

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



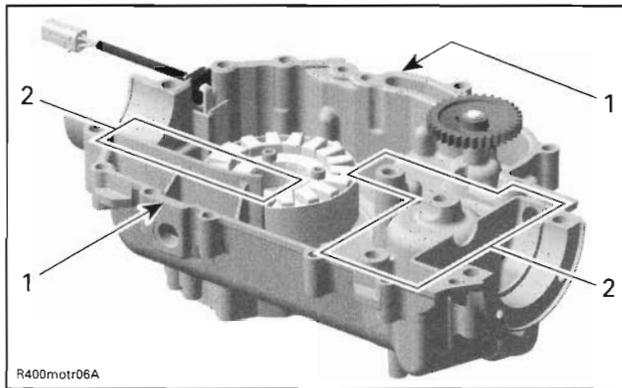
Apply Loctite 5910 all around the magneto cover slit surface except the areas described below

**NOTE:** Do not apply in excess as it will spread out inside cover.

**CAUTION:** Apply the product only in the shown areas.

**Section 01 ENGINE**

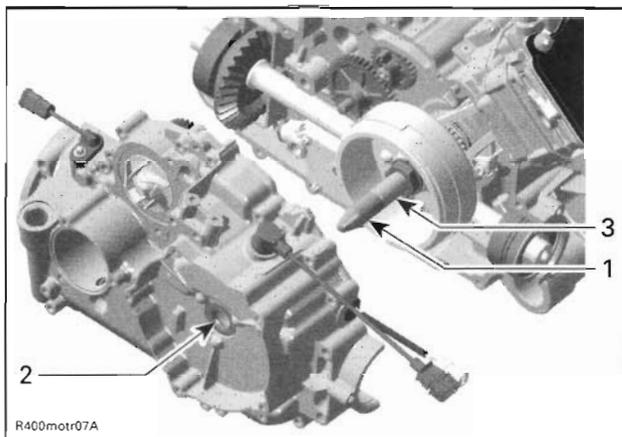
Subsection 04 (MAGNETO SYSTEM)



- 1. Mating surface on the magneto cover
- 2. No need to apply Loctite 5910

Install the magneto cover.

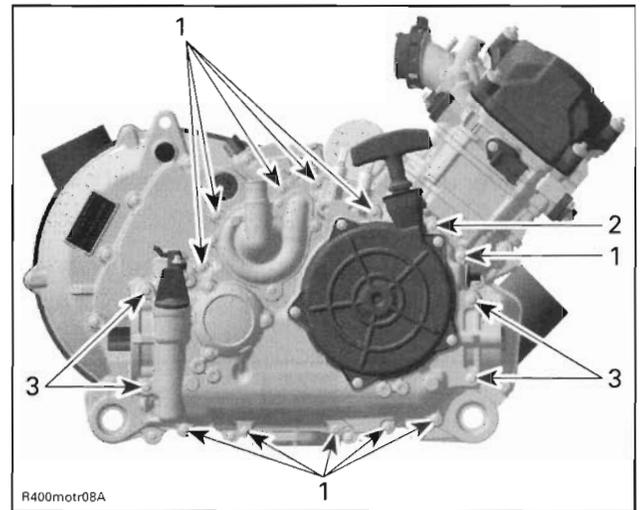
**CAUTION:** Ensure the oil seal is present on the magneto cover. Use oil seal protector (P/N 529 035 935) to avoid damaging the oil seal during reinstallation of the magneto cover.



- 1. Oil seal protector
- 2. Oil seal on magneto cover
- 3. Crankshaft MAG side

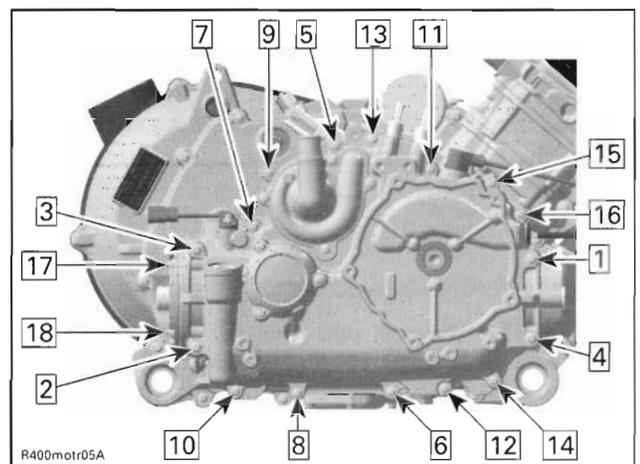
Refer to the following illustration for proper installation of screws.

**CAUTION:** Never use the gasket ring on screw no. 4 a second time. Always install a new one.



- 1. Screws M6 x 45
- 2. Screw M6 x 45 with sealing ring
- 3. Screws M8 x 65

Tightening sequence for screws on magneto cover is as per following illustration.



**NOTE:** Refer to the manufacturer's label for the sealant curing time.

**OIL SEAL**

Remove rewind starter (refer to *REWIND STARTER*).

**Inspection**

Check the oil seal no. 7 on the magneto cover. If brittle, hard or damaged, replace it.

**Removal**

**NOTE:** The oil seal no. 7 can be removed even if the cover is not removed.

Pry out oil seal with a screwdriver.

## Section 01 ENGINE

### Subsection 04 (MAGNETO SYSTEM)

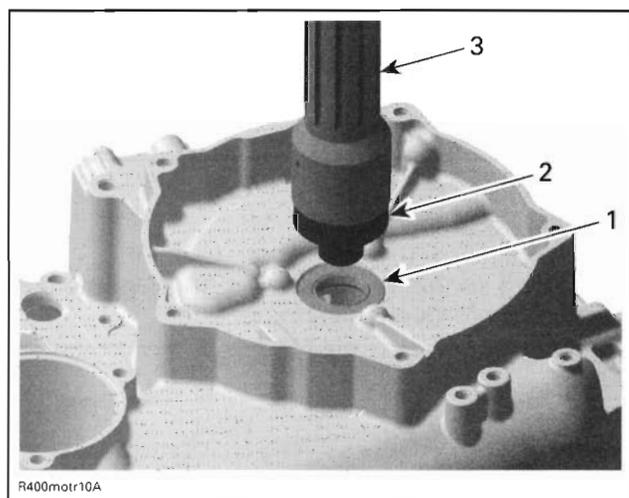
**CAUTION:** Be careful not to damage the oil seal bore of the magneto cover and/or the crankshaft when using a screwdriver.

#### Installation

**NOTE:** Never use oil in the press fit area of oil seal.

##### With Magneto Cover Removed

Using the oil seal installer (P/N 529 035 759) and the handle (P/N 420 877 650), install the oil seal in its location.



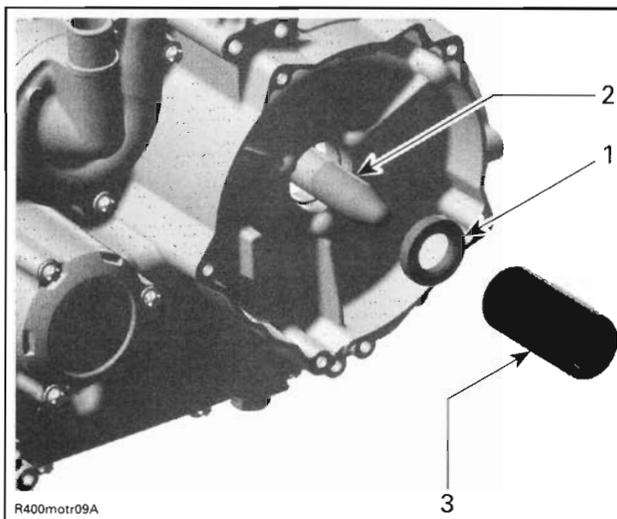
1. Oil seal
2. Oil seal installer (P/N 529 035 759)
3. Handle (P/N 420 877 650)

Reinstall other removed parts in the reverse order.

**CAUTION:** Always use the oil seal protector (P/N 529 035 935) to avoid damaging the oil seal during magneto cover installation.

##### Without Magneto Cover Removed

Using a suitable tube, with the proper diameter, install the oil seal as per following illustration.



1. Oil seal
2. Oil seal protector
3. Tube

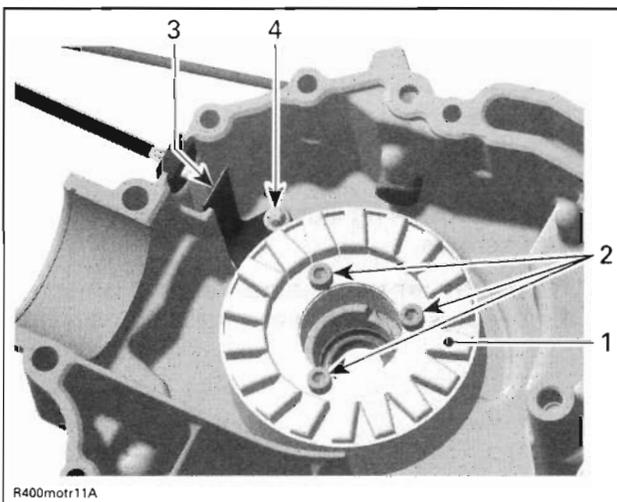
**CAUTION:** Use the oil seal protector (P/N 529 035 935) to avoid damaging the oil seal during installation.

## STATOR

#### Removal

Remove:

- magneto cover no. 6
- screws no. 8 and 9
- stator no. 11.



1. Stator
2. Stator screws
3. Holding strip
4. Holding strip screw

#### Inspection

Check stator condition. If damaged replace it.

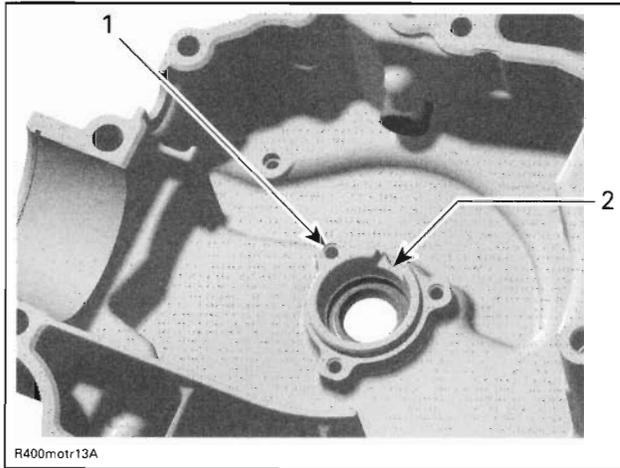
For electrical inspection, refer to *CHARGING SYSTEM* in the *VEHICLE SHOP MANUAL*.

### Installation

For installation, reverse the removal procedure. However, pay attention to the following.

**CAUTION:** When installing the stator take care that the cable is in place (guide for the wire).

**NOTE:** There is only one position for the stator (notch in the magneto cover).



1. Thread for cable holding strip
2. Notch for stator

## CPS (CRANKSHAFT POSITION SENSOR)

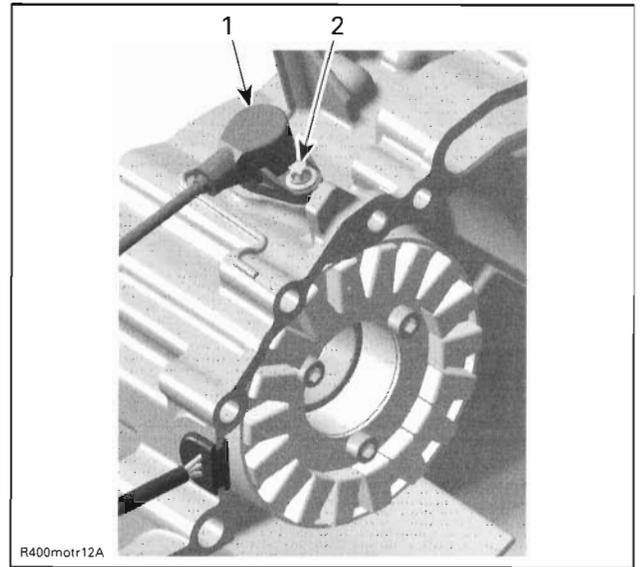
The CPS is located on the top of magneto cover, behind the exhaust pipe support.

### Removal

Lift up the console (refer to the *VEHICLE SHOP MANUAL*) then unplug the CPS connector.

Remove the RH side panel.

Unscrew the CPS screw no. 10.



1. Crankshaft position sensor
2. Screw

Remove the CPS no. 15.

### Inspection

Check the CPS condition and replace it if necessary.

To test the sensor refer to *IGNITION SYSTEM* in the *VEHICLE SHOP MANUAL*.

### Installation

For installation, reverse the removal procedure.

## ROTOR

### Removal

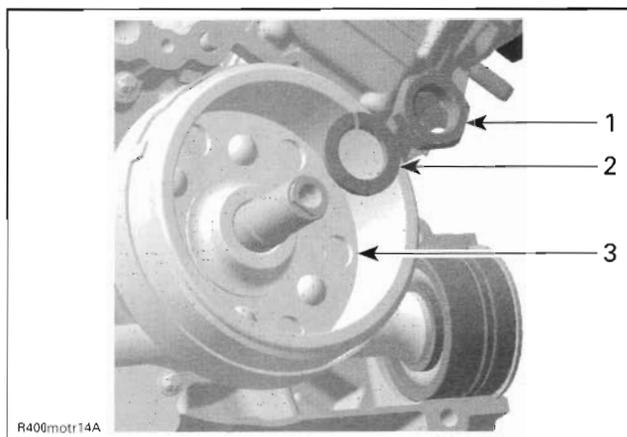
Lock crankshaft with locking bolt (P/N 529 035 617). Refer to *CRANKSHAFT AND CRANKCASE*.

Remove:

- magneto cover no. 6
- nut no. 12 retaining rotor no. 14
- serrated washer no. 13.

**Section 01 ENGINE**

## Subsection 04 (MAGNETO SYSTEM)



1. Nut
2. Serrated washer
3. Rotor

Install magneto puller (P/N 529 035 748) and crankshaft protector (P/N 420 876 557) then remove rotor.

**NOTE:** Use grease to place protector on crankshaft end prior to screw on the magneto puller.

**Inspection**

Check woodruff key and keyway on the crankshaft and the serrated washer for wear or damages. Replace as necessary.

**Installation**

For installation, reverse the removal procedure. However, pay attention to the following.

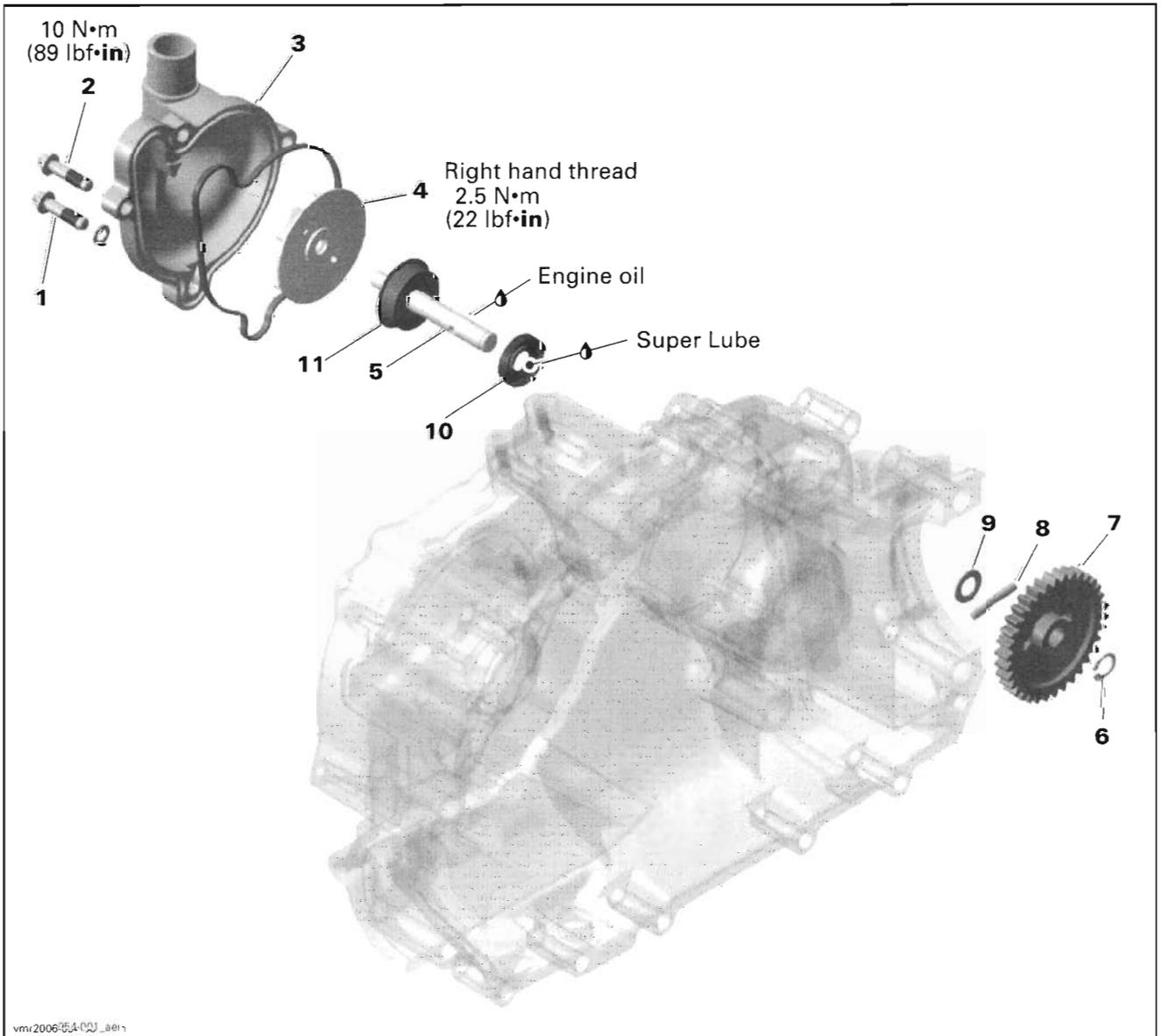
**CAUTION:** When installing the rotor, take care that the tapers are clean. Serrated washer no. 13 has to be put in place correctly.

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# LUBRICATION SYSTEM

## SERVICE TOOLS

Description	Part Number	Page
oil pressure gauge .....	529 035 652 .....	28



**Section 01 ENGINE****Subsection 05 (LUBRICATION SYSTEM)****GENERAL**

During assembly/installation, use the torque values and service products as in the exploded views.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

**⚠ WARNING**

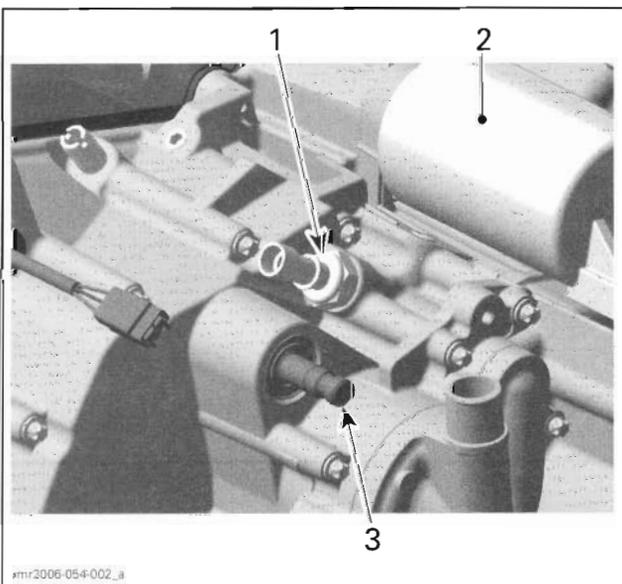
Torque wrench tightening specifications must strictly be adhered to.

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

**PROCEDURE****ENGINE OIL PRESSURE TEST**

**NOTE:** The engine oil pressure test should be done with a warm engine and the recommended oil.

Remove the oil pressure switch **no. 1** in the area between electrical starter and shift shaft, mounted on the crankcase MAG side and install the oil pressure gauge (P/N 529 035 652).



1. Oil pressure switch
2. Electrical starter
3. Shift shaft

**NOTE:** Oil pressure switch works between 30 kPa (4 PSI) and 60 kPa (9 PSI).

The engine oil pressure should be within the following values.

PRESSION/RPM	1300 RPM	6000 RPM
Minimal	70 kPa (10 PSI)	350 kPa (51 PSI)
Nominal	350 kPa (51 PSI)	500 kPa (73 PSI)
Maximal	550 kPa (80 PSI)	700 kPa (102 PSI)

If the engine oil pressure is out of specifications, check the points described in *TROUBLESHOOTING* section of the appropriate *VEHICLE SHOP MANUAL*.

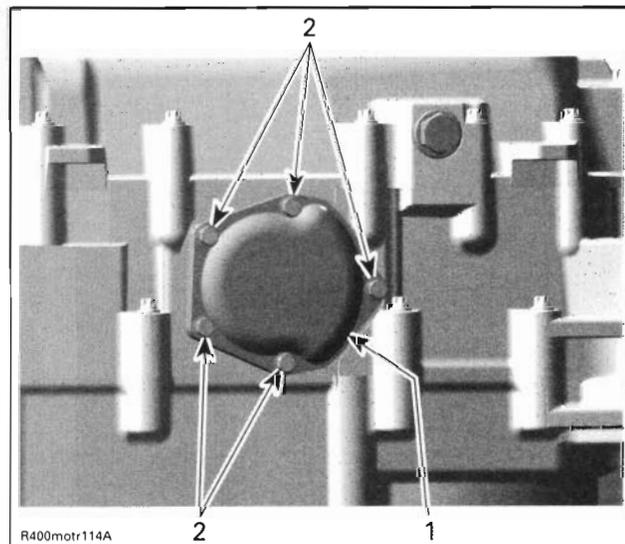
To install oil pressure switch, reverse the removal procedure.

**OIL STRAINER****Removal**

Engine must be lifted or removed to access the oil strainer. Refer to the appropriate *VEHICLE SHOP MANUAL*.

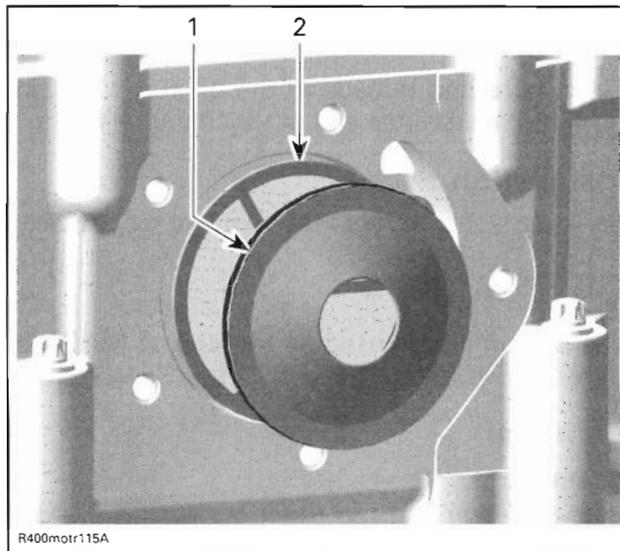
Remove:

- engine oil
- screws **no. 11** retaining oil strainer cover **no. 10**



1. Oil strainer cover
2. 5 screws

- oil collector **no. 8** and O-ring **no. 7**
- oil strainer **no. 6**.

**Section 01 ENGINE****Subsection 05 (LUBRICATION SYSTEM)**

1. Oil collector with O-ring
2. Oil strainer

**Cleaning and Inspection**

Clean oil strainer with a part cleaner then use an air gun to dry it.

**⚠ WARNING**

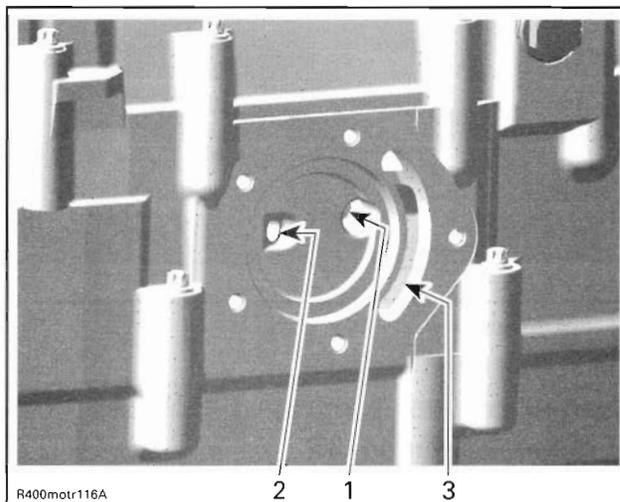
Always wear eye protector. Chemicals can cause a rash break out in and an injury to your eyes.

Inspect O-ring no. 7 and rubber ring no. 9.

If O-ring and/or rubber ring is (are) brittle, cracked or hard, replace the defective part(s).

Clean both contact surfaces of oil strainer cover.

Check and clean the oil inlet and outlet area for dirt and other contaminations.

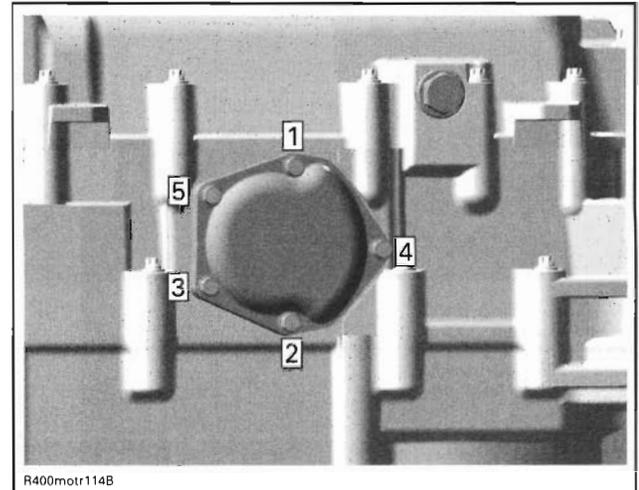


1. Oil inlet to the oil pump
2. Oil return from the oil pressure regulator system
3. Oil return from the engine oil circulation

**Installation**

For installation, reverse the removal procedure.

Torque oil strainer cover screws as per following sequence.



Reinstall engine in vehicle. Refill engine at the proper level with the recommended oil. Refer to appropriate *VEHICLE SHOP MANUAL*.

Start engine and let idle for a few minutes. Ensure oil filter and magnetic drain plug areas are not leaking.

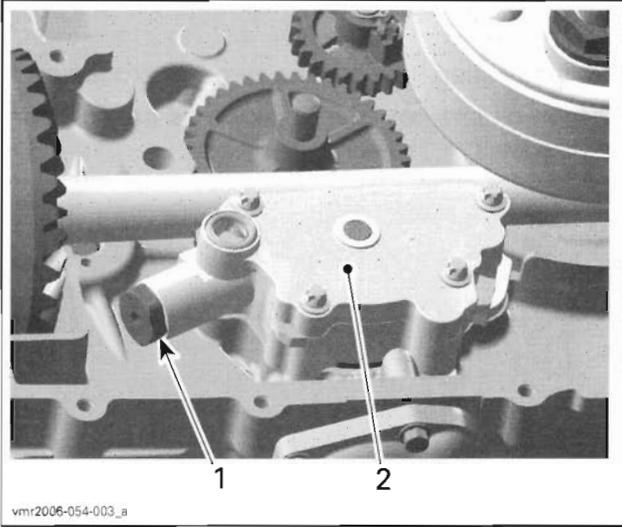
Stop engine. Wait a while to allow oil to flow down to crankcase then check oil level. Refill as necessary.

**ENGINE OIL PRESSURE REGULATOR**

The oil pressure regulator is located in the oil pump housing (engine MAG side, behind magneto cover).

**Section 01 ENGINE**

**Subsection 05 (LUBRICATION SYSTEM)**



1. Oil pressure regulator plug  
2. Oil pump housing

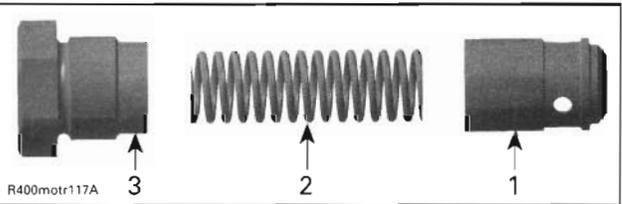
**NOTE:** The oil pressure regulator system works when the oil pressure exceeds 500 kPa (73 PSI).

**Removal**

- Remove:
- engine from vehicle (refer to *VEHICLE SHOP MANUAL*)
  - water pump cover (refer to *COOLING SYSTEM*)
  - magneto cover (refer to *MAGNETO SYSTEM*)
  - oil pressure regulator plug no. 20, compression spring no. 19 and valve piston no. 18.

**⚠ WARNING**

Oil pressure regulator plug on oil pump housing is spring loaded.



1. Valve piston  
2. Compression spring  
3. Oil pressure regulator plug

**Inspection**

Inspect valve piston for scoring or other damages. Check compression spring for free length.

COMPRESSION SPRING FREE LENGTH	
NEW NOMINAL	64 mm (2.519 in)
SERVICE LIMIT	62 mm (2.441 in)

Replace both parts if important wear or damage are present.

Clean bore and threads in the oil pump housing from metal shavings and other contaminations.

**Installation**

For installation, reverse the removal procedure.

**OIL PUMP**

The oil pump is located on the engine MAG side (refer to *ENGINE OIL PRESSURE REGULATOR*).

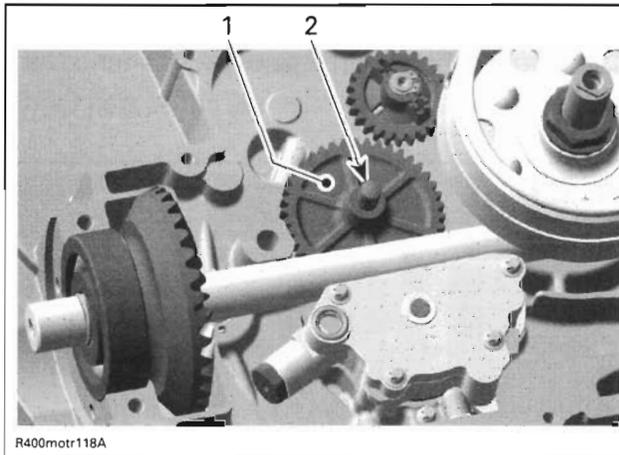
**Removal**

- Remove:
- engine from vehicle (refer to *VEHICLE SHOP MANUAL*)
  - water pump cover (refer to *COOLING SYSTEM*)
  - magneto cover (refer to *MAGNETO SYSTEM*)
- NOTE:** The following steps to remove the gears no. 13 and no. 16 are not necessary to replace only the oil pump.
- retaining ring no. 14 then drive gear no. 13

**CAUTION:** Never use the retaining ring a second time. Always replace by a new one.

**NOTE:** Drive gear is snapped on a needle pin. This needle pin passes through the balancing shaft.

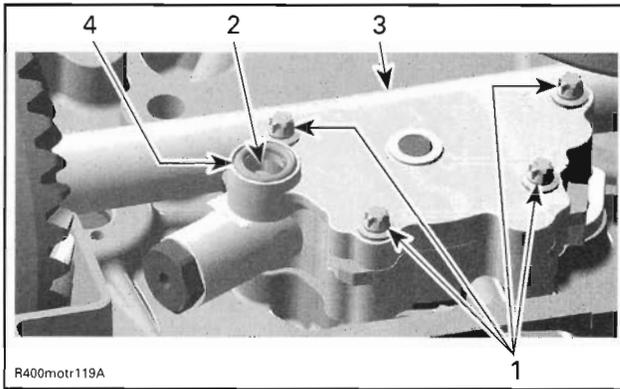
- needle pin no. 12
- pin no. 15
- intermediate gear no. 16



1. Intermediate gear  
2. Pin

- screws no. 26
- oil pump cover no. 23

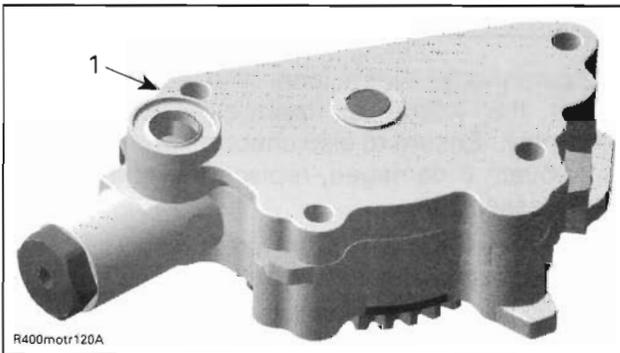
**Section 01 ENGINE**  
Subsection 05 (LUBRICATION SYSTEM)



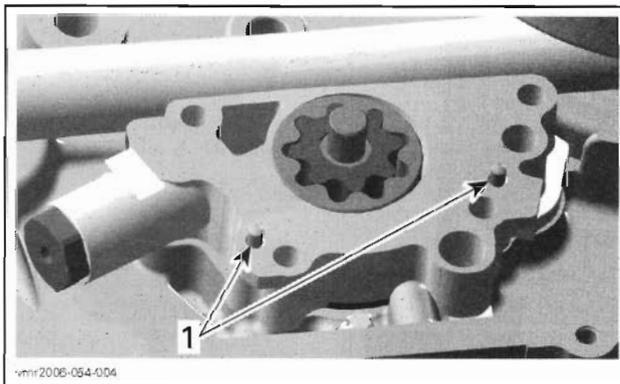
1. 4 screws
2. Oil from the pump to the oil filter in the magneto cover
3. Oil pump cover
4. Oil seal to crankcase MAG side

**NOTE:** To remove oil pump system, lift the dowel pins no. 22 a bit. The oil pump housing with oil pump shaft assembly will be easier to remove.

**CAUTION:** Pay attention not to drop the dowel pins inside the engine.



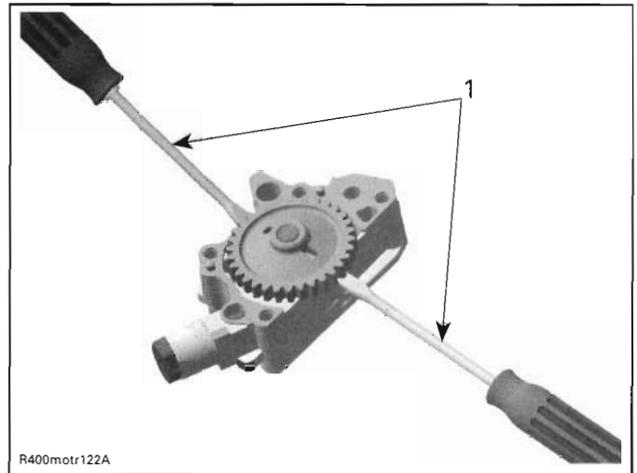
1. Oil pump system



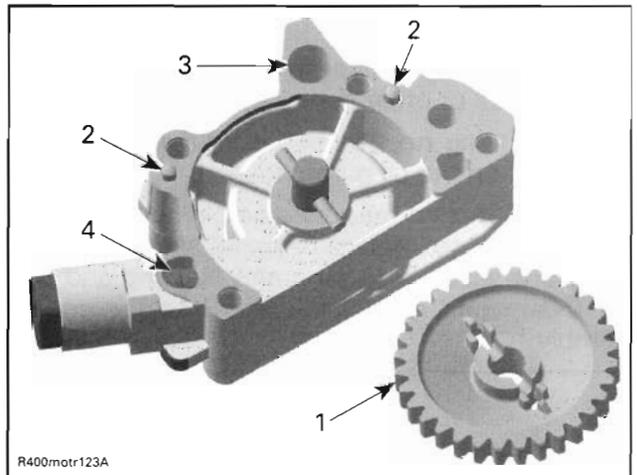
1. Dowel pins

- oil pump gear no. 25

**NOTE:** Oil pump gear is snapped on needle pin. This needle pin passes through the oil pump shaft. Use screwdrivers to remove this gear.

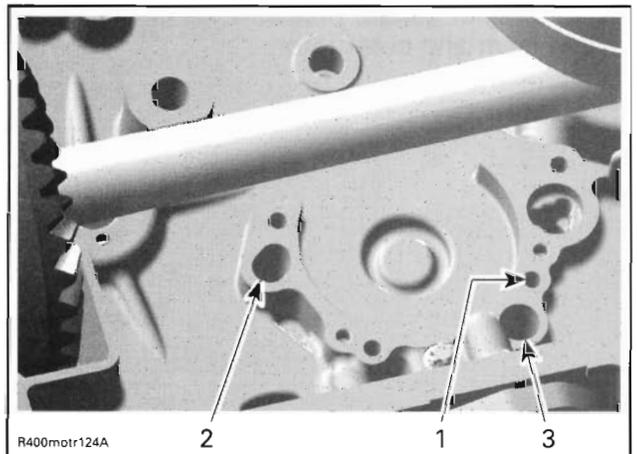


1. Flat screwdrivers



1. Oil pump gear
2. Dowel pins
3. Suction side of the oil pump
4. Outlet from the engine oil pressure regulator valve

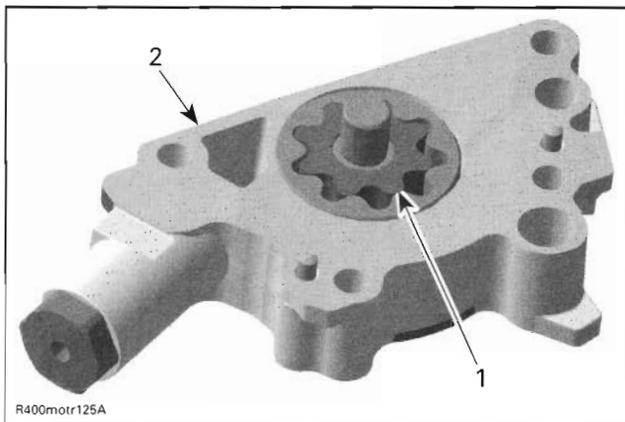
- needle pin no. 24
- oil pump shaft assembly no. 21
- oil pump housing no. 17.



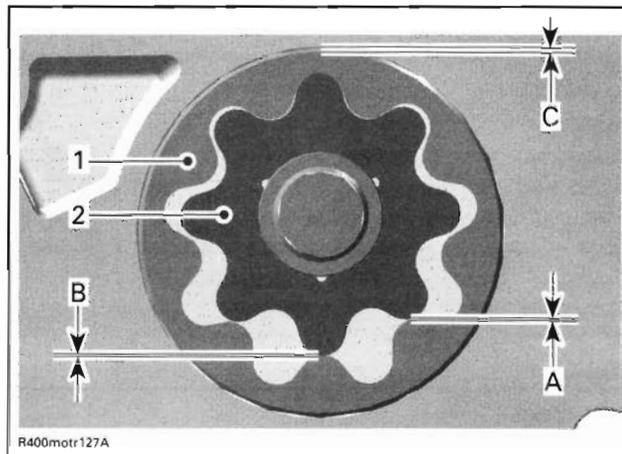
1. Oil inlet to the oil pump (leads to strainer on engine bottom)
2. Oil return from the oil pressure regulator system
3. Bore for dowel pin support

**Section 01 ENGINE**

**Subsection 05 (LUBRICATION SYSTEM)**



1. Oil pump shaft assembly  
2. Oil pump housing



1. Outer rotor  
2. Inner rotor

**Inspection**

Inspect oil pump shaft assembly, housing and cover for marks or other damages.

Replace O-ring no. 27 if brittle or hard. This O-ring is located on the oil pump housing.

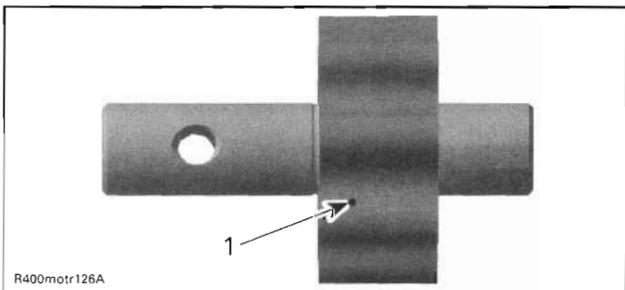
Check inner rotor for corrosion pin-holes or other damages. If so, replace oil pump shaft assembly. Ensure to also check oil pump housing and cover. If damaged, replace the complete oil pump assembly.

OUTER AND INNER ROTOR CLEARANCE	
SERVICE LIMIT	
A	0.25 mm (.009 in)
B	
C	

If clearance between inner and outer rotor exceeds the tolerance, replace oil pump shaft assembly. Ensure to also check oil pump housing and cover. If damaged, replace the complete oil pump assembly.

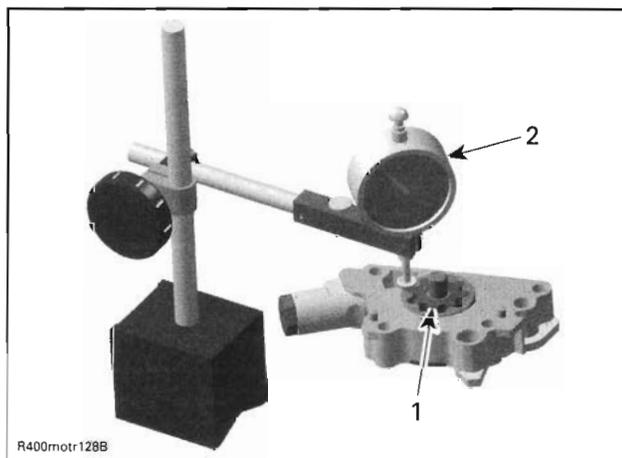
If clearance between outer rotor and its bore in oil pump exceeds the tolerance, replace the complete oil pump assembly.

Using a dial indicator, measure side wear as shown.

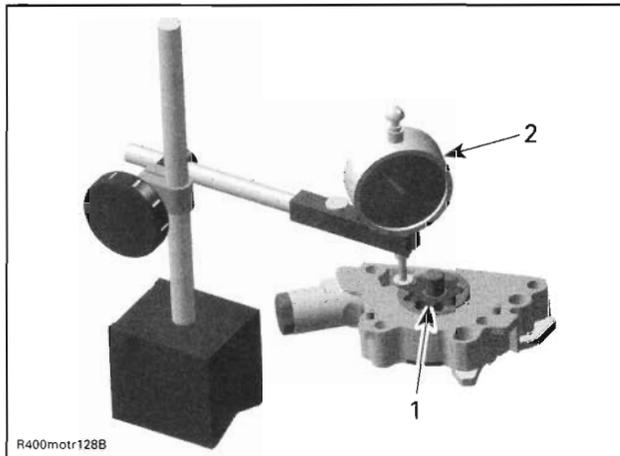


1. Pittings on the teeth

Using a feeler gauge, measure the clearance between inner and outer rotor.



1. Oil pump housing surface  
2. Dial indicator



1. Oil pump outer rotor surface
2. Dial indicator

Difference between pump housing and outer rotor should not exceed 0.1 mm (.004 in). If so, replace the complete oil pump assembly.

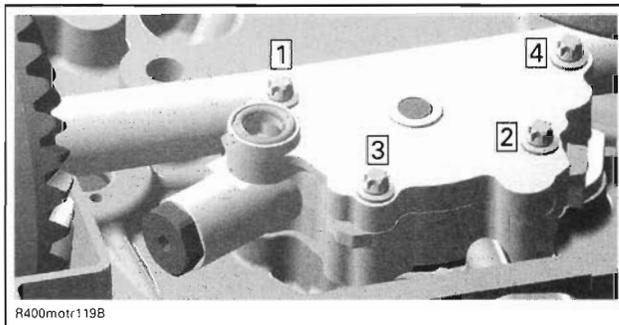
**NOTE:** When the axial clearance of the oil pump shaft assembly increases, the oil pressure decreases.

Check the inside of oil pump housing and its cover for scoring or other damages. If so, change the complete oil pump assembly.

### Installation

For installation, reverse the removal procedure.

Tightening oil pump housing screws as per following sequence.



Install the O-ring no. 27 on oil pump cover.

**CAUTION:** Never apply any sealing compound on split surfaces of oil pump.

### Final Test

After engine is completely reassembled, start engine and make sure oil pressure is within specifications.

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# CYLINDER AND HEAD

## SERVICE TOOLS

<b>Description</b>	<b>Part Number</b>	<b>Page</b>
camshaft locking tool.....	529 035 926 .....	42, 54
piston circlip installer .....	529 035 921 .....	57
piston ring compressor tool.....	529 035 919 .....	55
valve guide installer .....	529 035 853 .....	53
valve guide remover .....	529 035 924 .....	52
valve spring compressor clamp.....	529 035 724 .....	49
valve spring compressor cup.....	529 035 725 .....	49
valve stem seal installer .....	529 035 687 .....	52

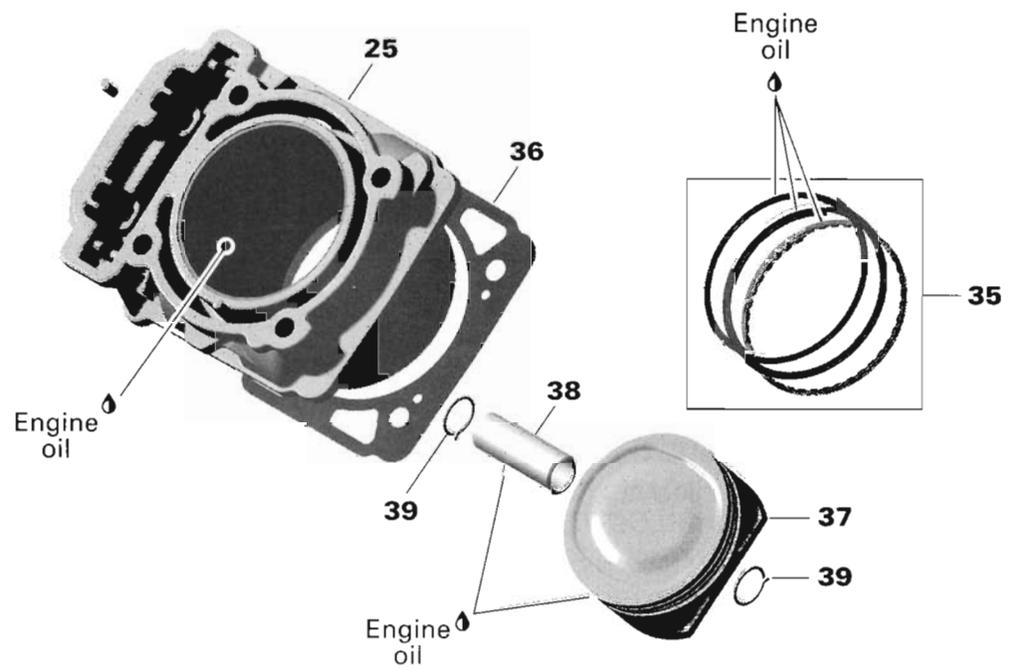
## SERVICE TOOLS – OTHER SUPPLIER

<b>Description</b>	<b>Part Number</b>	<b>Page</b>
valve stem seal pliers .....	Snap-ON YA 8230 .....	50

## SERVICE PRODUCTS

<b>Description</b>	<b>Part Number</b>	<b>Page</b>
Loctite 243 (blue).....	293 800 060 .....	41
Loctite 243.....	293 800 060 .....	44
Loctite 767 (antiseize lubricant) .....	293 800 070 .....	53





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**Section 01 ENGINE****Subsection 06 (CYLINDER AND HEAD)****GENERAL**

To work on cylinder head, cylinder and piston, the engine removal is not necessary.

Always place the vehicle on level surface.

**NOTE:** For a better understanding, the many illustrations are taken with engine out of vehicle.

**NOTE:** When diagnosing an engine problem, always perform a cylinder leak test. This will help pinpoint a problem. Refer to the instructions included with your leak tester and *LEAK TEST* section for procedures.

Always disconnect BLACK (-) cable from the battery, then RED (+) cable before working on the engine.

**⚠ WARNING**

Always disconnect battery or starter cables exactly in the specified order, BLACK (-) cable first.

During assembly/installation, use the torque values and service products as in the exploded views.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

**⚠ WARNING**

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

When disassembling parts that are duplicated in the engine, (e.g.: valves), it is a strongly recommended to note their position (PTO, MAG side) and to keep them as a "group". If you find a defective component, it would be much easier to find the cause of the failure among its group of parts (e.g.: you found a worn valve guide. A bent spring could be the cause and it will be easy to know which one among the springs is the cause to replace it if you grouped them at disassembly). Besides, since used parts have matched together during the engine operation, they will keep their matched fit when you reassemble them together within their "group".

Intake port/air filter contaminated (clogged) with dirt, sand, etc. (leads to worn valves, piston rings and finally to leak of power).

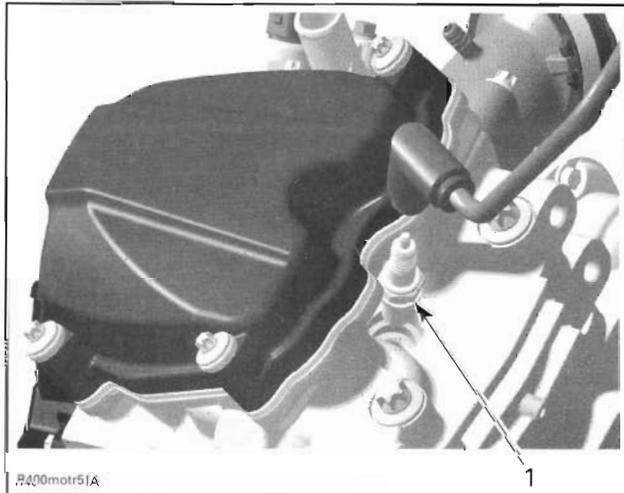
**CAUTION:** In case of piston rings and/or valve replacement, always clean the whole engine and change oil and oil filter.

**PROCEDURES****SPARK PLUG****Removal**

Unplug the spark plug wire.

Clean spark plug area before disassembly.

Unscrew spark plug.



1. Spark plug on engine PTO side

**Inspection**

Check spark plug condition (refer to *IGNITION SYSTEM* section of the *VEHICLE SHOP MANUAL*).

**Installation**

For installation, reverse the removal procedure. Pay attention to the following details.

Check spark plug gap (refer to *TECHNICAL SPECIFICATIONS* section).

Screw spark plug. Torque it to 20 N•m (15 lbf•ft). Reinstall the spark plug wire.

**THERMOSTAT**

Refer to *COOLING SYSTEM* section.

**Section 01 ENGINE**

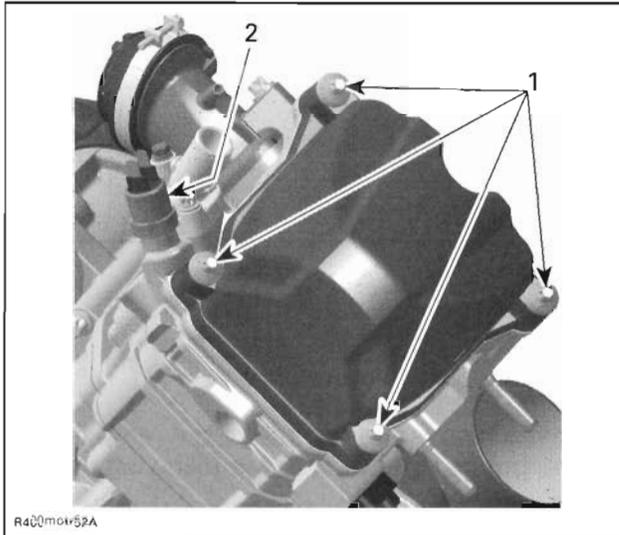
**Subsection 06 (CYLINDER AND HEAD)**

**VALVE COVER**

**Removal**

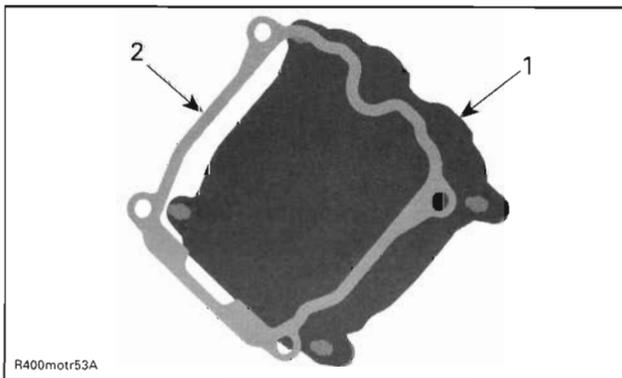
Remove:

- valve cover screws



1. Valve cover screws  
2. Water temperature switch

- valve cover and gasket.



1. Valve cover  
2. Gasket

**Inspection**

Check the gasket no. 1 on the valve cover no. 2 if it is brittle, cracked or hard. If so, replace the gasket.

**Installation**

For installation, reverse the removal procedure.

Install the valve cover screws no. 3 in a criss-cross sequence.

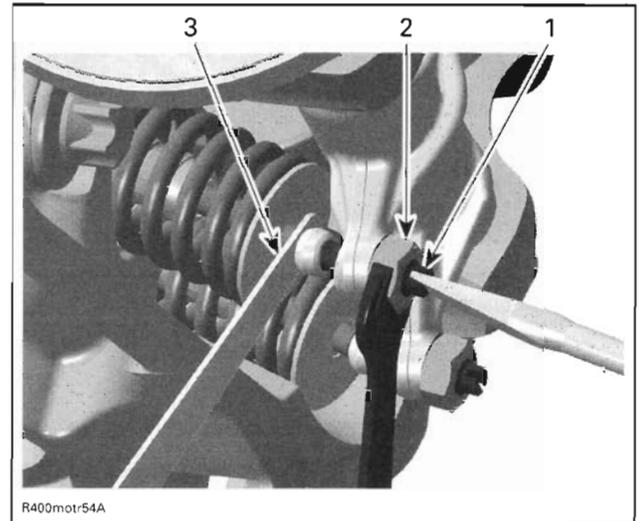
**VALVE ADJUSTMENT**

Lock crankshaft to TDC compression (refer to *CRANKSHAFT AND CRANKCASE* section).

Remove valve cover.

Hold adjusting screw and loosen locking nut.

Using feeler gauge, check the valve clearance.



1. Adjustment screws  
2. Locking nuts  
3. Feeler gauge

VALVE CLEARANCE	
Exhaust	0.11 to 0.19 mm (.0043 to .0075 in)
Intake	0.06 to 0.14 mm (.0024 to .0055 in)

**NOTE:** Use mean value of exhaust/intake to ensure a proper valve adjustment.

Hold the adjusting screw at the proper position and torque the locking nut.

Repeat the procedure for each valve.

Before installing valve cover, recheck all valve adjustments.

**DECOMPRESSOR**

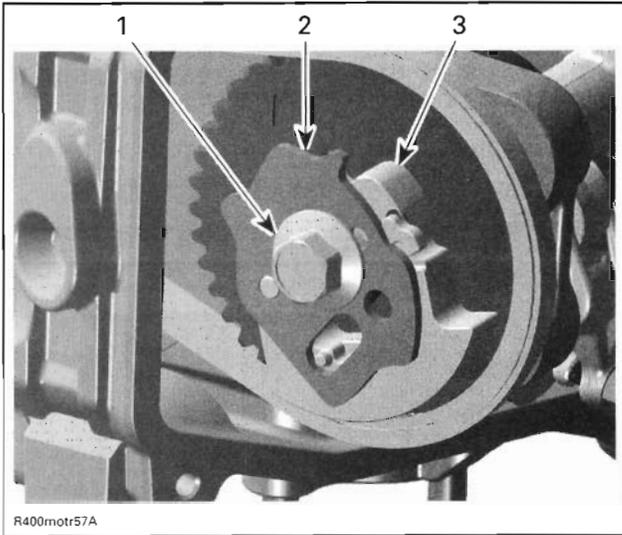
**Removal**

Remove:

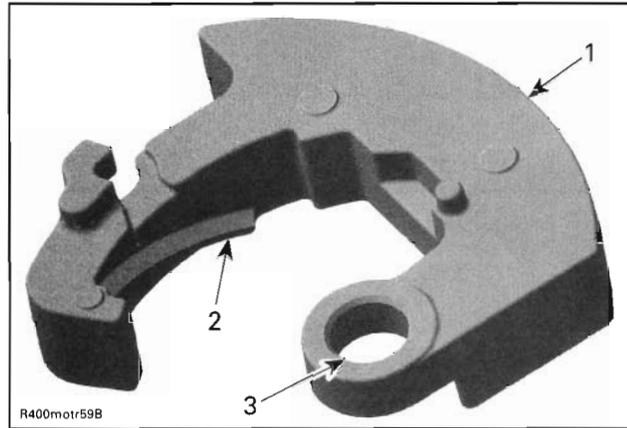
- valve cover
- camshaft sprocket screw
- decompressor washer
- centrifugal weight with torsion spring no. 11 and spacer no. 12
- decompressor shaft no. 13.

**Section 01 ENGINE**

**Subsection 06 (CYLINDER AND HEAD)**



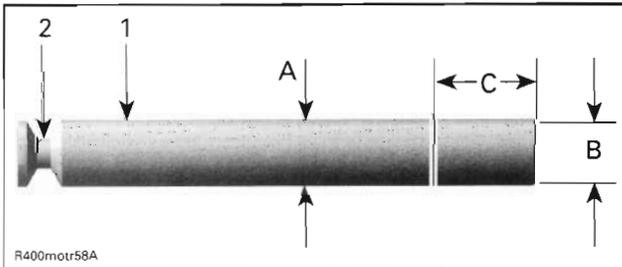
- 1. Camshaft sprocket screw
- 2. Decompressor washer
- 3. Centrifugal weight



- 1. Centrifugal weight
- 2. Edge of centrifugal weight
- 3. Bearing bore

**Inspection**

Check decompressor shaft for service limit, replace if out of specifications.



- 1. Decompressor shaft
- 2. Groove for centrifugal weight
- A. Measure here the bearing seat to cylinder head
- B. Measure top end (contact to camshaft lobe exhaust)
- C. 7 mm (.276 in)

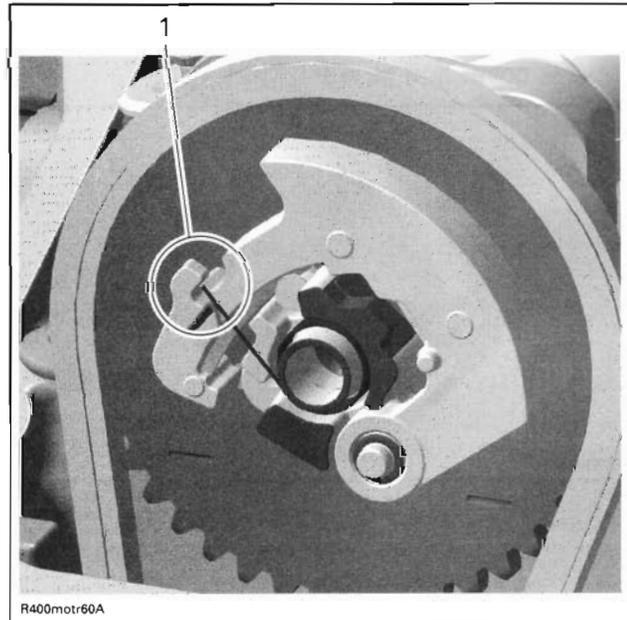
DECOMPRESSOR SHAFT MEASUREMENT A	
NEW	5.578 to 5.590 mm (.219 to .220 in)
SERVICE LIMIT	5.450 mm (.215 in)
DECOMPRESSOR SHAFT MEASUREMENT B	
NEW	5.300 to 5.350 mm (.210 to .211 in)
SERVICE LIMIT	5.050 mm (.199 in)

Check torsion spring, edge and bearing bore of centrifugal weight for visible wear. If so, replace them together.

**Installation**

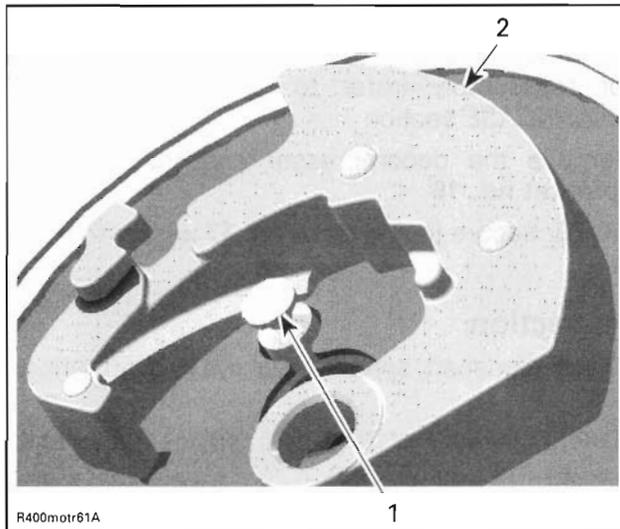
The installation is the reverse of the removal procedure, but pay attention to the following details.

Position the end of torsion spring properly in the centrifugal weight location.



- 1. Position of torsion spring end

Engage the edge of centrifugal weight no. 14 into the decompressor shaft groove then put the parts in place.



1. Decompressor shaft groove
2. Centrifugal weight

Apply Loctite 243 (blue) (P/N 293 800 060) on threads of camshaft sprocket screw no. 15.

**CAUTION:** Take care before and after cover installation that the centrifugal system moves (slides) easily.

## TIMING CHAIN TENSIONER

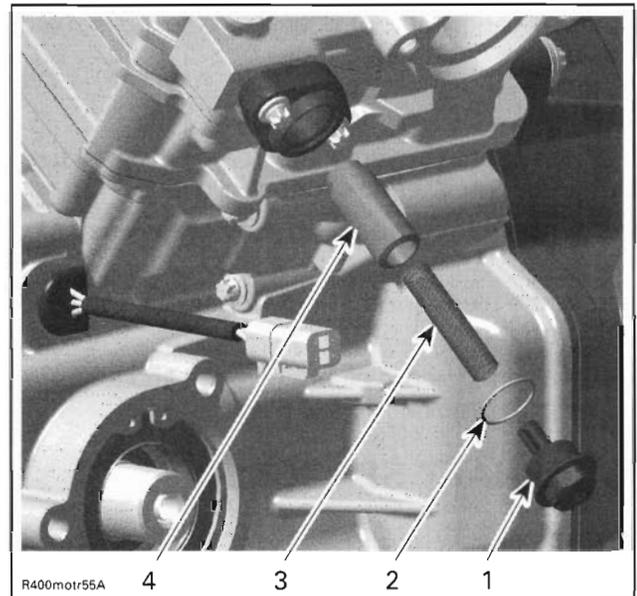
### Removal

#### **WARNING**

Chain tensioner is spring loaded. Never perform this operation immediately after the engine has been run because the exhaust system can be very hot. Wait until exhaust system is warm or cold.

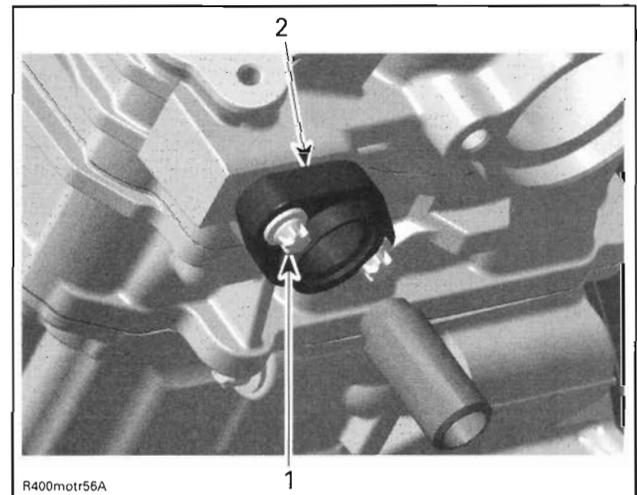
Remove:

- chain tensioner plug
- O-ring
- spring
- chain tensioner plunger.



1. Chain tensioner plug
2. O-ring
3. Spring
4. Chain tensioner plunger

- chain tensioner housing with its O-ring.



1. Chain tensioner screw
2. Chain tensioner housing

### Inspection

Check chain tensioner plunger no. 4 for free movement and/or scoring.

Check if possible chain guides for wear. Replace as necessary.

Check if O-ring no. 5 is brittle, cracked or hard. Replace as necessary.

Check condition of spring no. 6. Replace if broken or worn.

Check the housing no. 9 for cracks or other damages. Replace it if necessary.

**Section 01 ENGINE****Subsection 06 (CYLINDER AND HEAD)**

Check if O-ring no. 10 is brittle, cracked or hard. Replace as necessary.

**Installation**

For installation, reverse the removal procedure. However, pay attention to the following.

Install the O-ring no. 5 on chain tensioner plug no. 7.

Screw the plunger no. 4 until it touches the chain guide no. 8.

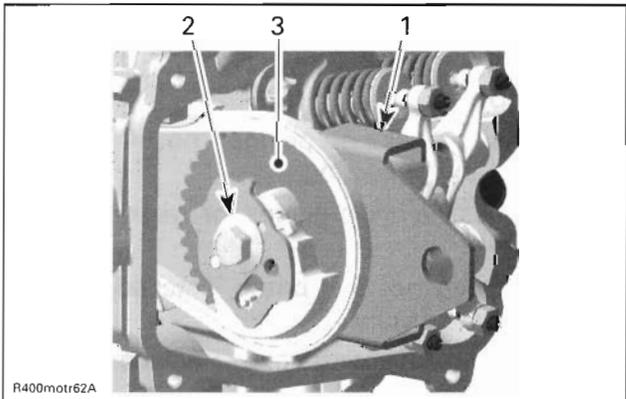
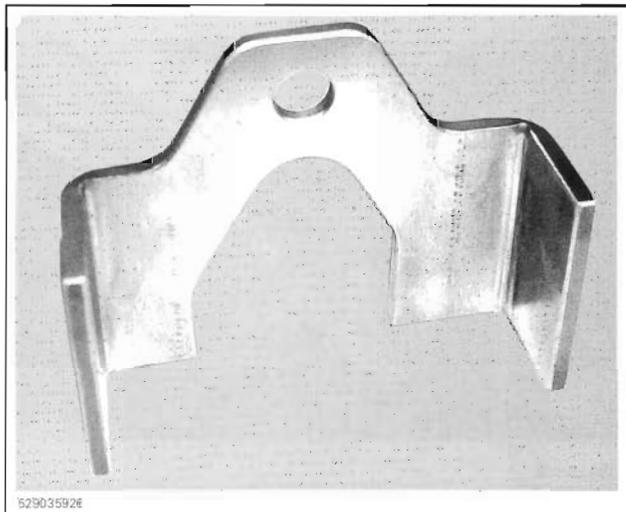
Install a spring end in plunger groove and the other in the plug groove. Screw plug.

**CAMSHAFT SPROCKET****Removal**

Remove:

- valve cover
- chain tensioner.

Using the camshaft locking tool (P/N 529 035 926), lock the camshaft at TDC compression position to prevent timing chain stretching.



1. Camshaft locking tool
2. Camshaft sprocket screw
3. Camshaft sprocket

Lock crankshaft at the TDC compression position to have the crankshaft position defined for reassembly (refer to *CRANKSHAFT AND CRANKCASE* section).

Remove the decompressor and the camshaft sprocket no. 16.

**NOTE:** Secure timing chain no. 17 with a retaining wire.

**Inspection**

Check camshaft sprocket for wear or deterioration.

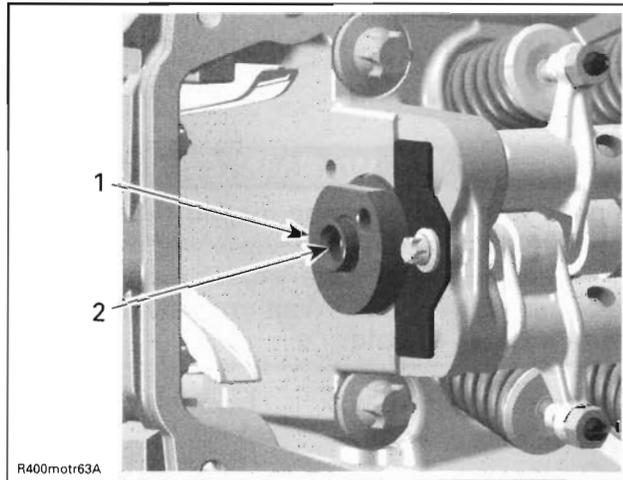
If teeth are worn or damaged, replace sprocket as well as the timing chain.

**NOTE:** For crankshaft gear, refer to *CRANKSHAFT AND CRANKCASE*.

**Installation**

For installation, reverse the removal procedure. Pay attention to the following details.

Clean mating surface and threads of camshaft prior to assemble camshaft sprocket.



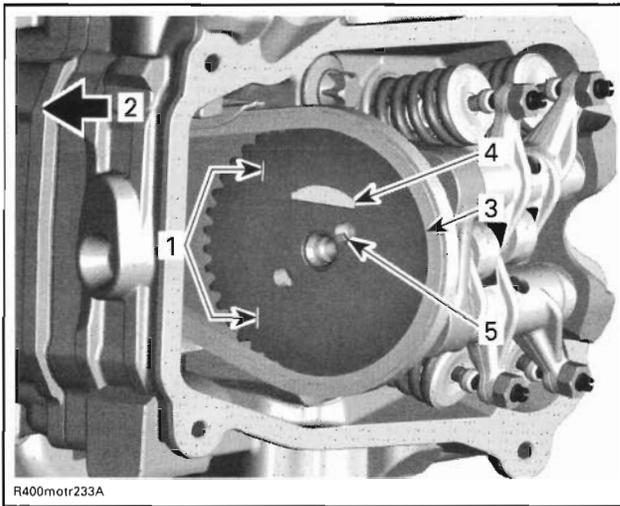
1. Mating surface on camshaft
2. Threads for camshaft sprocket screw

Camshaft sprocket must be at TDC compression before installing the timing chain.

Install camshaft sprocket so that the tabs are located into the flat zone of the camshaft. The printed marks on the camshaft sprocket have to be parallel to the cylinder head base. See the following illustration for a proper positioning.

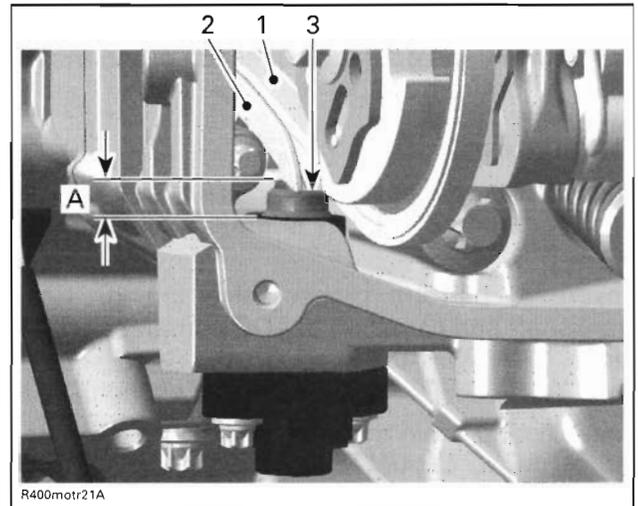
**Section 01 ENGINE**

Subsection 06 (CYLINDER AND HEAD)



1. Printed marks on camshaft sprocket
2. Cylinder head base
3. Camshaft sprocket
4. Tab
5. Decompressor shaft bore

**CAUTION:** Crankshaft and camshaft must be locked on TDC position to place camshaft sprocket and timing chain in the proper position.



1. Sprocket
2. Chain tensioner guide
3. Chain tensioner plunger
- A. Chain tensioner plunger protrusion

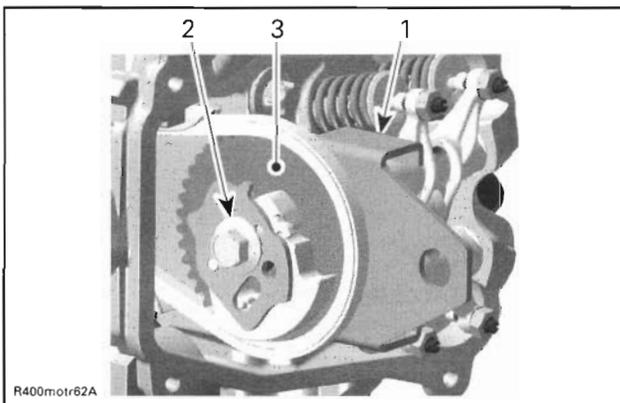
**CHAIN TENSIONER PLUNGER PROTRUSION**

SERVICE LIMIT	18.5 mm to 20 mm (.71 in to .79 in)
---------------	--

If protrusion exceeds service limit, replace timing chain, camshaft timing gear, chain guide and chain tensioner guide at the same time.

Check timing chain on camshaft timing gear for excessive radial play.

Check chain condition for wear and teeth condition.



1. Camshaft locking tool
2. Camshaft sprocket screw
3. Camshaft sprocket

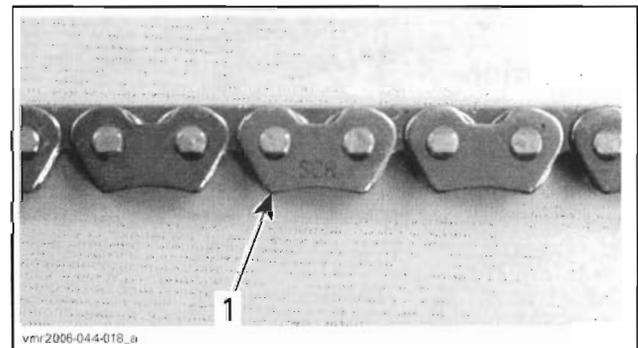
When the camshaft sprocket and the timing chain are installed, remove the crankshaft locking bolt as well as the camshaft locking tool.

Reinstall all other removed parts.

**TIMING CHAIN**

**Inspection**

Distance between chain tensioner guide and end of chain tensioner housing is a general information about the valve train (chain) condition.



1. Timing chain

If chain is excessively worn or damaged, replace it as a set (camshaft sprocket and timing chain).

**Removal**

Remove:

- engine from vehicle (refer to *VEHICLE SHOP MANUAL*)
- valve cover, chain tensioner and camshaft sprocket
- magneto cover and rotor (refer to *MAGNETO SYSTEM* section)

## Section 01 ENGINE

### Subsection 06 (CYLINDER AND HEAD)

– output shaft (refer to *GEARBOX* section).

**NOTE:** Mark the operating direction of the timing chain before removal.

#### Installation

The installation is essentially the reverse of the removal procedure but, pay attention to the following details.

Ensure to perform proper valve timing. Lock crankshaft and camshaft at TDC compression (refer to *CRANKSHAFT AND CRANKCASE* section and *CAMSHAFT SPROCKET* in this section).

Install timing chain then, adjust chain tension (refer to *TIMING CHAIN TENSIONER* in this section).

**CAUTION:** Improper valve timing will damage engine components.

## TIMING CHAIN GUIDE

#### Removal

Remove:

- engine from vehicle (refer to *VEHICLE SHOP MANUAL*)
- magneto and rotor (refer to *MAGNETO* section)
- bearing screw at the bottom of chain guide.

Pull the chain guide downward to remove it.

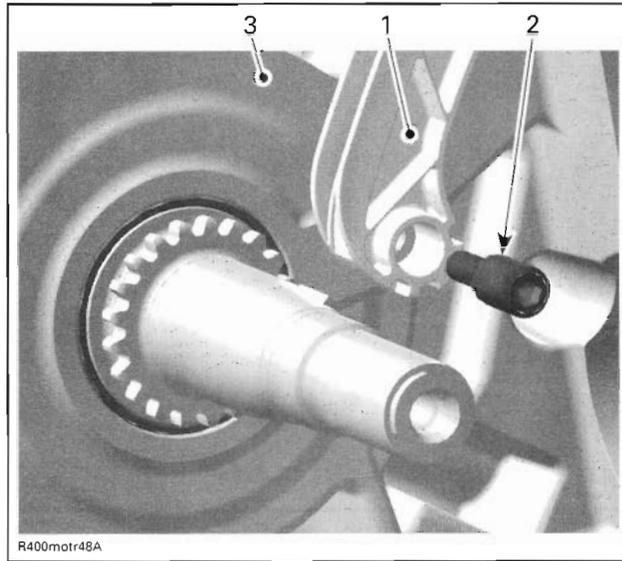
#### Inspection

Check chain tensioner guide for wear, cracks or other damages. Replace if necessary.

#### Installation

Clean bearing screw threads then apply Loctite 243 (P/N 293 800 060) on the screw threads.

Install the guide in crankcase housing then torque bearing screw to 10 N•m (89 lbf•in).



1. Chain tensioner guide
2. Bearing screw
3. Crankcase MAG side

Reinstall all removed parts in accordance with the proper installation procedures.

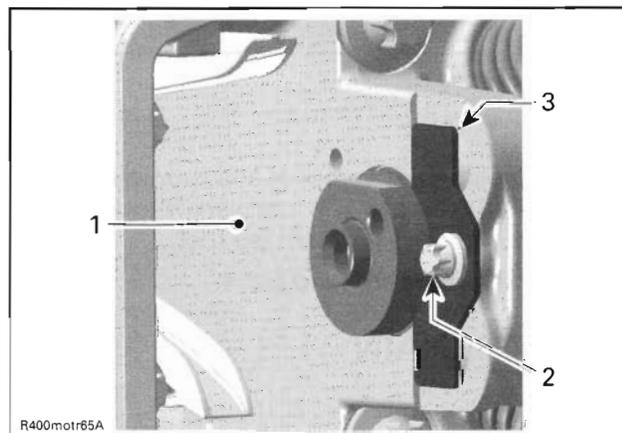
## ROCKER ARM

#### Removal

Lock crankshaft to TDC compression, refer to *CRANKSHAFT AND CRANKCASE*.

Remove:

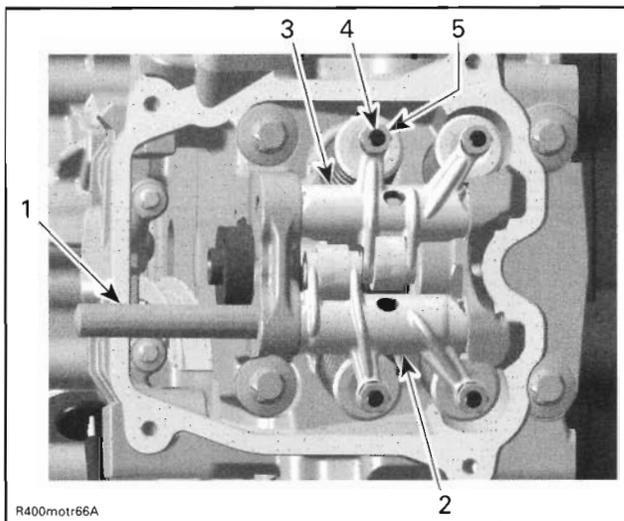
- valve cover
- chain tensioner
- camshaft sprocket no. 16
- camshaft retaining plate



1. Cylinder head
2. Camshaft retaining plate screw
3. Camshaft retaining plate

- rocker arm shafts
- rocker arms (exhaust side and intake side)

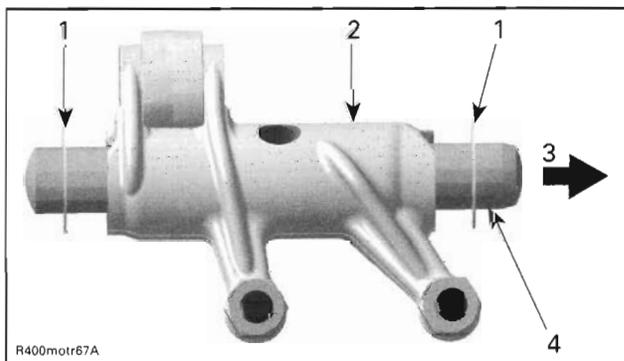
**Section 01 ENGINE**  
Subsection 06 (CYLINDER AND HEAD)



- 1. Rocker arm shaft
- 2. Rocker arm (exhaust side)
- 3. Rocker arm (intake side)
- 4. Adjusting screw
- 5. Locking nut

– thrust washers.

**CAUTION:** Pay attention not to lose thrust washers or drop them into the timing chain compartment.

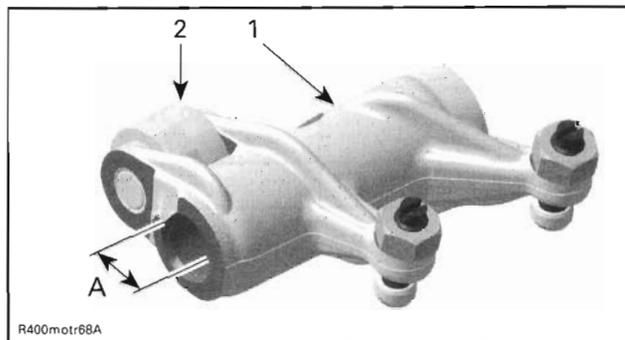


- 1. 2 thrust washers
- 2. Rocker arm (exhaust side)
- 3. Cylinder head — spark plug side
- 4. Big taper to PTO side

**Inspection**

**Rocker Arm**

Inspect each rocker arm for cracks and scored friction surfaces. If so, replace rocker arm assembly. Check the rocker arm rollers for free movement, wear and excessive radial play. Replace rocker arm assembly if necessary.

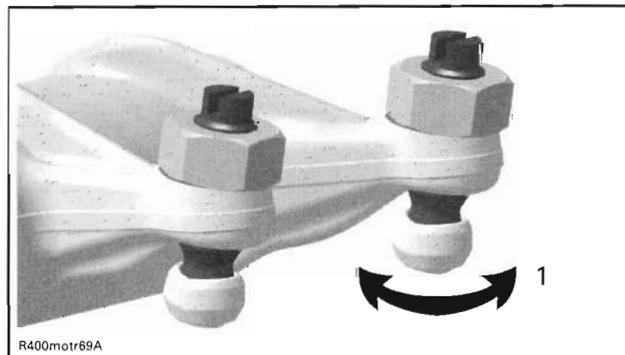


- 1. Rocker arm (exhaust side)
- 2. Roller
- A. Bore for rocker arm shaft

Measure rocker arm bore diameter. If diameter is out of specification, change the rocker arm assembly.

ROCKER ARM BORE DIAMETER	
NEW	12.036 to 12.050 mm (.4739 to .4744 in)
SERVICE LIMIT	12.060 mm (.4748 in)

Check adjustment screws for free movement, cracks and/or excessive play.

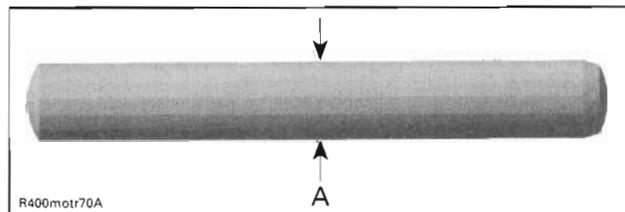


- 1. Free movement of adjustment screw top

**Rocker Arm Shaft**

Check for scored friction surfaces; if so, replace parts.

Measure rocker arm shaft diameter.



- A. Measure rocker arm shaft diameter here

**Section 01 ENGINE****Subsection 06 (CYLINDER AND HEAD)**

ROCKER ARM SHAFT DIAMETER	
NEW	12.007 to 12.018 mm (.4727 to .4731 in)
SERVICE LIMIT	11.990 mm (.4720 in)

Any area worn excessively will require parts replacement.

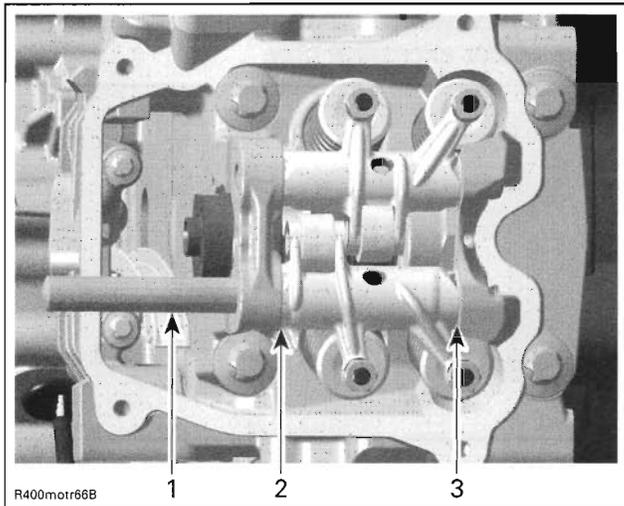
**Installation**

**NOTE:** Use the same procedure for exhaust or intake rocker arm.

Apply engine oil on rocker arm shafts **no. 18**.

Install the rocker arm shafts with the chamfered edge first and use following procedure:

- Insert a rocker arm shaft through rocker arm shaft bore.
- Install thrust washer **no. 19** then the proper rocker arm (exhaust **no. 20** or intake **no. 21**).
- Push in rocker arm shaft until its chamfer reaches the end of rocker arm bore.



1. Rocker arm shaft
2. Thrust washer (MAG side)
3. Thrust washer (PTO side)

- Place the other thrust washer **no. 22** and push rocker arm shaft to end position.

Install the other rocker arm by using the previous procedure.

Install the camshaft retaining plate **no. 23**.

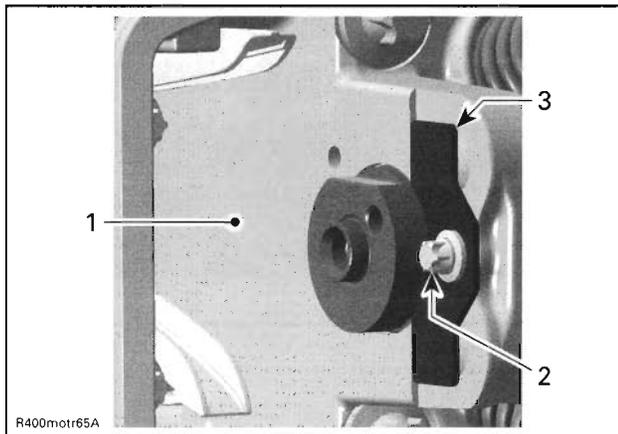
Install all other removed parts.

**CAMSHAFT****Removal**

The camshaft **no. 28** can be removed with the cylinder head installed.

Remove:

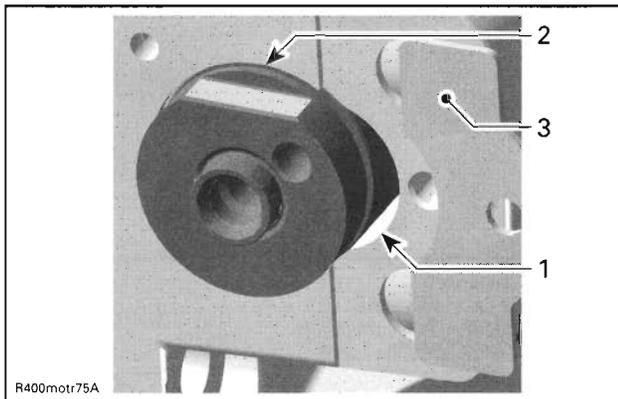
- valve cover
- chain tensioner
- camshaft sprocket
- camshaft retaining plate



1. Cylinder head
2. Camshaft retaining plate screw
3. Camshaft retaining plate

- rocker arms
- camshaft.

**NOTE:** Rotate camshaft so that intake/exhaust lobe shows to upper side of cylinder head to ease removal of the camshaft.



1. Area for camshaft lobes
2. Camshaft
3. Camshaft retaining plate

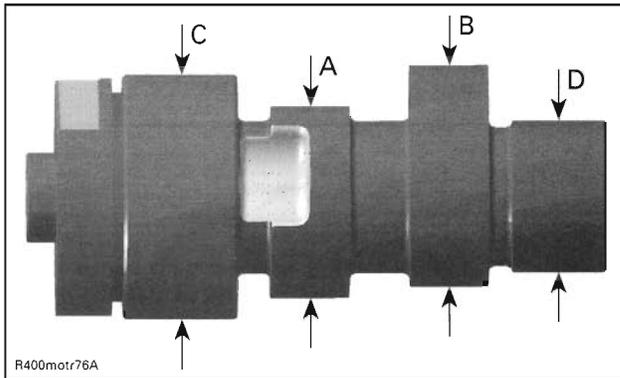
**Inspection**

Check each lobe and bearing journal of camshaft for scoring, scuffing, cracks or other signs of wear.

Measure camshaft bearing journal diameter and lobe height using a micrometer.

**Section 01 ENGINE**

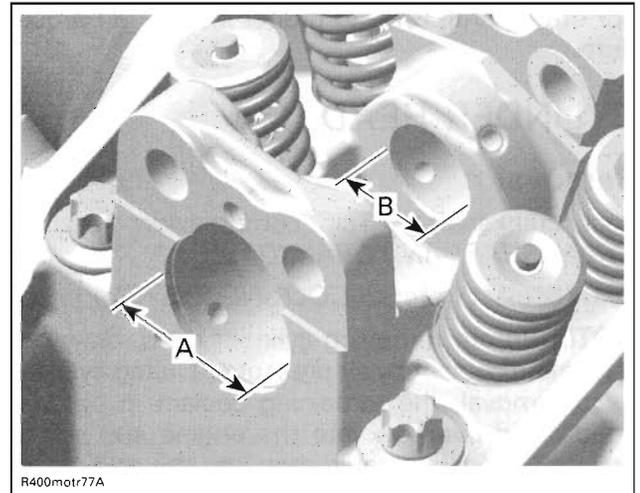
**Subsection 06 (CYLINDER AND HEAD)**



A. Camshaft lobe (exhaust valves)  
 B. Camshaft lobe (intake valves)  
 C. Camshaft bearing journal MAG side  
 D. Camshaft bearing journal PTO side

CAMSHAFT LOBE — EXHAUST VALVES	
NEW	32.027 to 32.047 mm (1.2609 to 1.2617 in)
SERVICE LIMIT	32.000 mm (1.2598 in)
CAMSHAFT LOBE — INTAKE VALVES	
NEW	32.343 to 32.363 mm (1.2733 to 1.2741 in)
SERVICE LIMIT	32.300 mm (1.2717 in)
CAMSHAFT BEARING JOURNAL — MAG SIDE	
NEW	34.959 to 34.975 mm (1.3763 to 1.3770 in)
SERVICE LIMIT	34.950 mm (1.3760 in)
CAMSHAFT BEARING JOURNAL — PTO SIDE	
NEW	21.959 to 21.980 mm (.8645 to .8654 in)
SERVICE LIMIT	21.950 mm (.8642 in)

Measure clearance between both ends of camshaft and cylinder head.



A. Cylinder head — camshaft bore MAG side  
 B. Cylinder head — camshaft bore PTO side

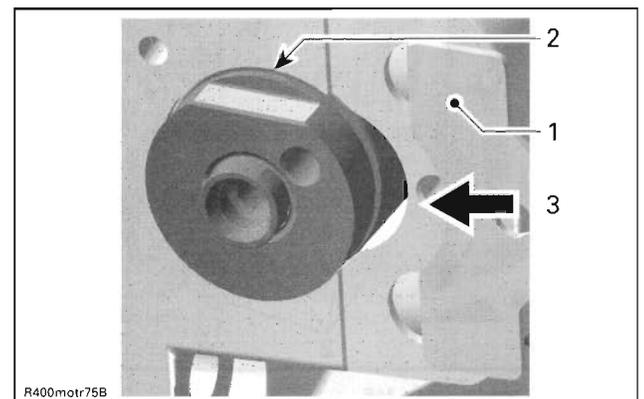
CAMSHAFT BORE — MAG SIDE MEASURED IN DIAMETER	
NEW	35.000 to 35.025 mm (1.3780 to 1.3789 in)
SERVICE LIMIT	35.040 mm (1.3795 in)
CAMSHAFT BORE — PTO SIDE MEASURED IN DIAMETER	
NEW	22.000 to 22.021 mm (.8661 to .8670 in)
SERVICE LIMIT	22.040 mm (.8677 in)

Replace parts that are not within specifications.

**Installation**

For installation, reverse the removal procedure. Pay attention to the following details.

Install camshaft in the opposite way of the removal then place the camshaft retaining plate no. 23 in the slot.



1. Camshaft retaining plate position  
 2. Slot retaining camshaft  
 3. Direction of movement

**Section 01 ENGINE****Subsection 06 (CYLINDER AND HEAD)**

For other parts, refer to proper installation procedure.

**CYLINDER HEAD****Removal**

Lock crankshaft at TDC compression, refer to *CRANKSHAFT AND CRANKCASE*.

Drain coolant (refer to *COOLING SYSTEM*).

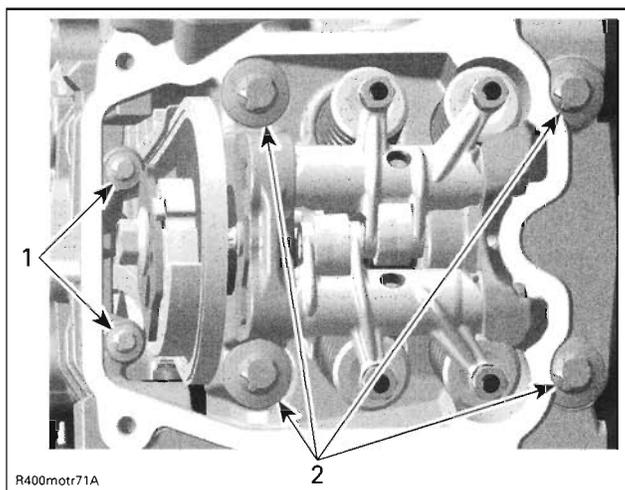
**NOTE:** Before removing cylinder head, blow out remaining coolant by air pressure. During cylinder head removal, the remaining coolant in cylinder head could overflow into the engine and a little quantity of coolant could drop into the engine. In this case, the engine oil will be contaminated.

Disconnect:

- spark plug wire
- temperature switch connectors.

Remove:

- both side panels and both inner fenders (refer to *BODY*)
- exhaust pipe spring
- exhaust pipe nuts
- radiator inlet hose
- carburetor clamp (cylinder head side only)
- chain tensioner
- valve cover
- camshaft sprocket
- cylinder head screws M6
- cylinder head screws M10 retaining cylinder head no. 24 and cylinder no. 25 to crankcase housings.

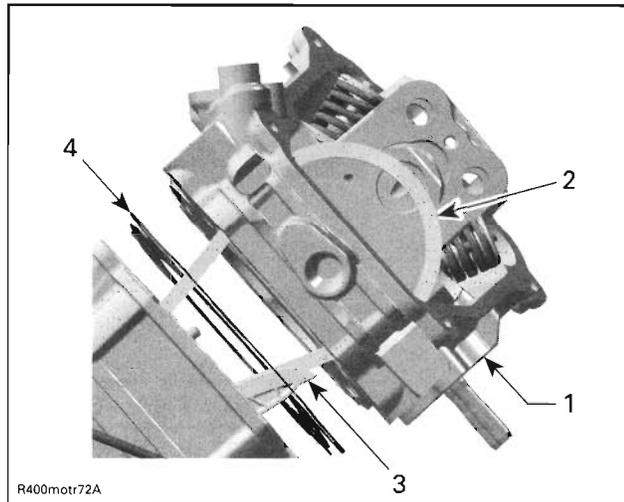


1. Cylinder head screws M6
2. Cylinder head screws M10

Pull up cylinder head.

Remove:

- chain guide
- cylinder head gasket (discard).



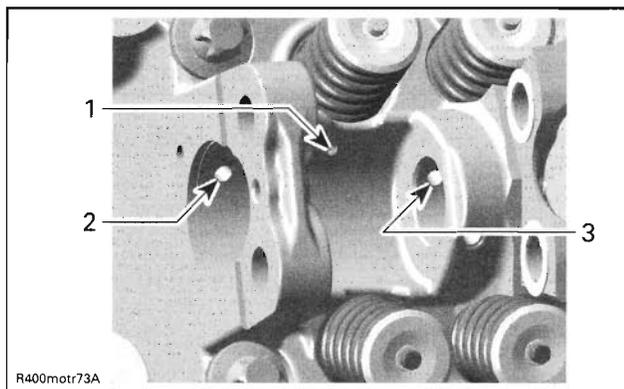
1. Cylinder head
2. Timing chain
3. Chain guide
4. Cylinder head gasket

**Inspection**

Check for cracks between valve seats, if so, replace cylinder head.

Check mating surface between cylinder and cylinder head for contamination. If so, clean both surfaces.

Clean oil support through the cylinder head from contamination.



1. Oil port to lubricate camshaft lobes intake/exhaust
2. Oil supply to camshaft bearing journal MAG side
3. Oil supply to camshaft bearing journal PTO side

**Installation**

For installation, reverse the removal procedure. Pay attention to the following details.

Ensure dowel pins are in place.

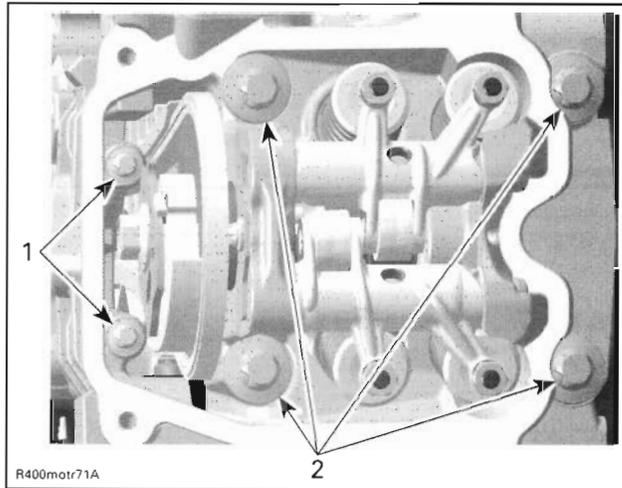
Install a new cylinder head gasket no. 26.

## Section 01 ENGINE

### Subsection 06 (CYLINDER AND HEAD)

First, torque cylinder head screws M10 in criss-cross sequence to 20 N•m (15 lbf•ft) then finish tightening to 60 N•m (44 lbf•ft).

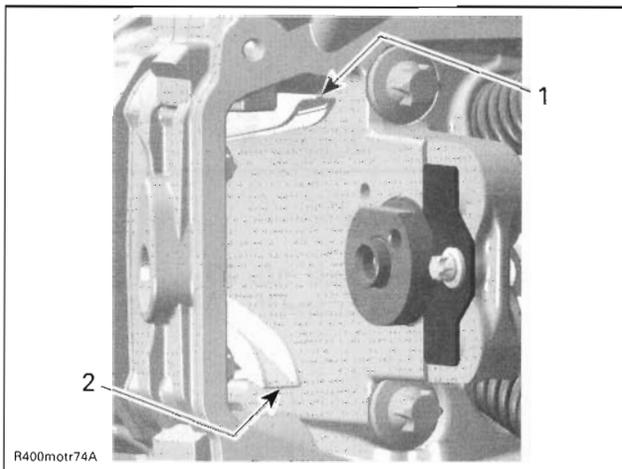
Torque cylinder head screws M8 to 10 N•m (89 lbf•in).



1. Cylinder head screws M6
2. Cylinder head screws M10

Check chain guide no. 27 for movement.

**CAUTION:** Chain guide has to be fixed between cylinder and cylinder head.



1. Chain guide (fixed between cylinder and cylinder head)
2. Chain tensioner guide (mounted in crankcase)

Remove crankshaft locking bolt then reinstall all other removed parts.

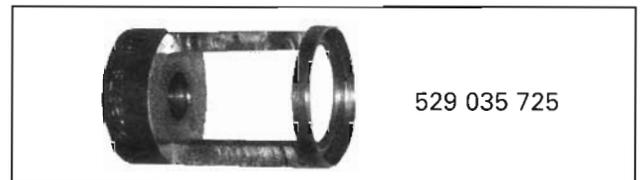
## VALVE SPRING

### Removal

Remove:

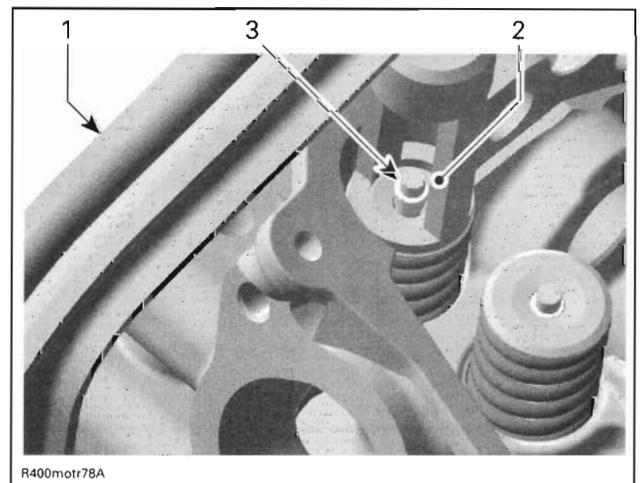
- rocker arms no. 20 and no. 21
- cylinder head no. 24.

Compress valve spring no. 29; use the valve spring compressor clamp (P/N 529 035 724) and the valve spring compressor cup (P/N 529 035 725).



### **⚠ WARNING**

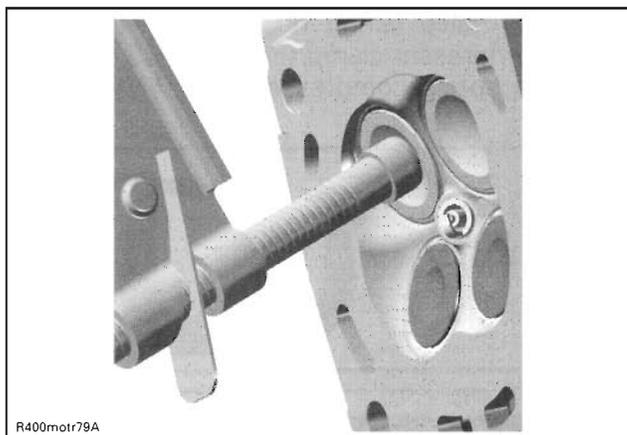
Always wear safety glasses when disassembling valve springs. Be careful when unlocking valves. Components could fly away because of the strong spring preload.



1. Valve spring compressor clamp
2. Valve spring compressor cup
3. Valve cotter

## Section 01 ENGINE

### Subsection 06 (CYLINDER AND HEAD)



LOCATE VALVE SPRING COMPRESSOR CLAMP IN CENTER OF THE VALVE

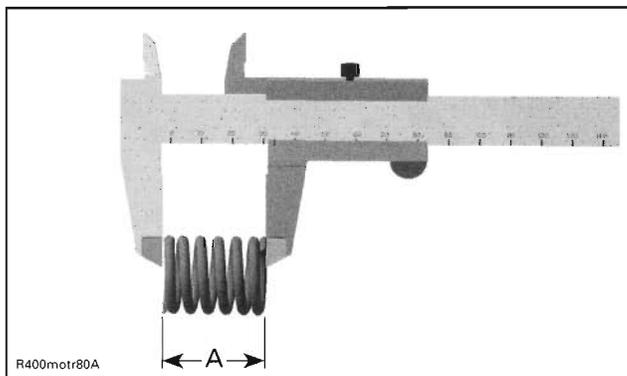
Remove valve cotters no. 30.

Withdraw valve spring compressor, valve spring retainer no. 34 and valve spring no. 29.

#### Inspection

Check valve springs for visible damages. If so, replace them.

Check valve springs for free length and straightness.



A. Valve spring length

VALVE SPRING FREE LENGTH	
NEW	40.81 mm (1.607 in)
SERVICE LIMIT	39.00 mm (1.535 in)

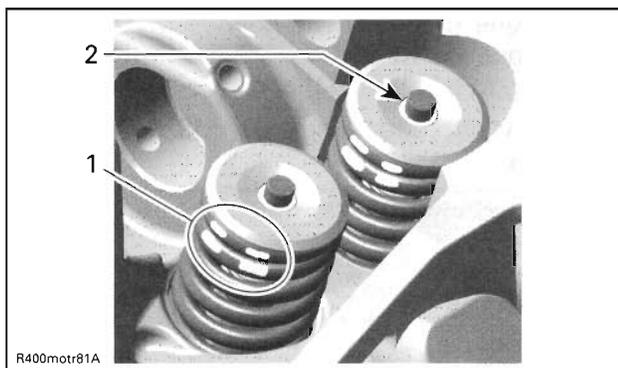
Replace valve springs if not within specifications.

#### Installation

For installation, reverse the removal procedure. Pay attention to the following details.

Colored area of the valve springs must be placed on top.

**NOTE:** Valve cotters must be properly engaged in valve stem grooves.



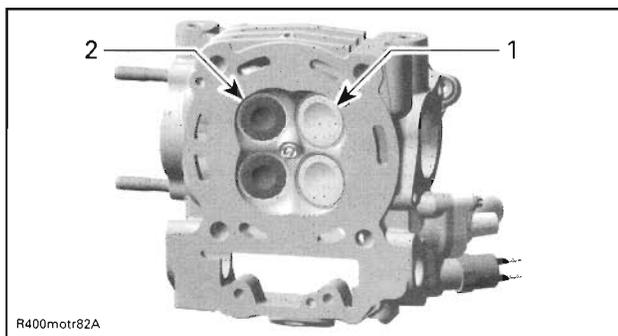
1. Position of the valve spring  
2. Valve cotters

## VALVE

### Removal

Remove valve spring (s) no. 29.

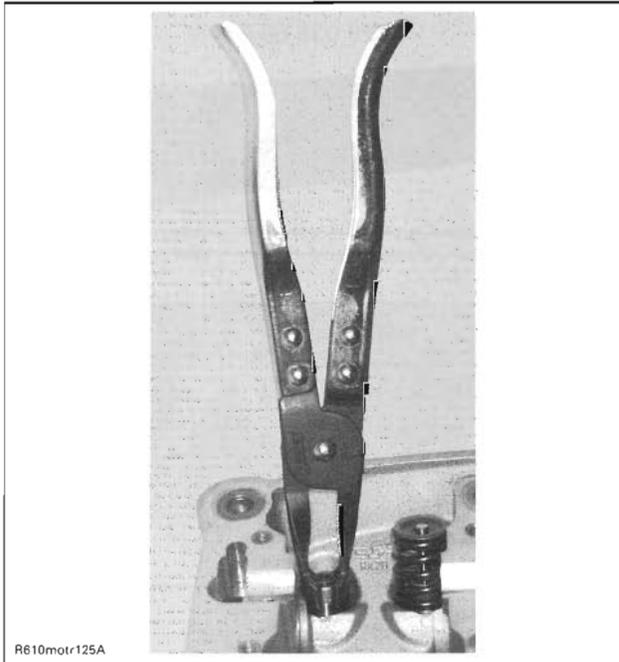
Push valve stem then pull valves out of valve guide no. 32.



1. Intake valve 31 mm (1.22 in)  
2. Exhaust valve 27 mm (1.06 in)

Remove valve stem seal no. 33 with the valve stem seal pliers (P/N Snap-ON YA 8230).

**Section 01 ENGINE**  
 Subsection 06 (CYLINDER AND HEAD)



R610motr125A

**Inspection**

**Valve Stem Seal**

Inspection of valve stem seals is not needed because new seals should always be installed whenever cylinder head is removed.

**Valve**

Inspect valve surface, check for abnormal stem wear and bending. If out of specification, replace by a new one.

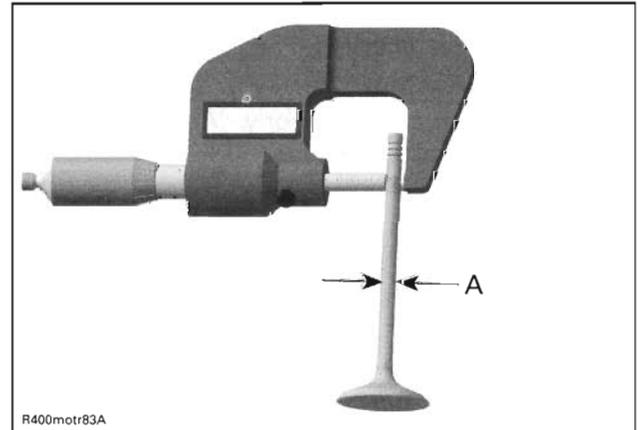
VALVE OUT OF ROUND	
NEW	
Exhaust	0.005 mm (.0002 in)
Intake	
SERVICE LIMIT	
Exhaust	0.06 mm (.0024 in)
Intake	

**Valve Stem and Valve Guide Clearance**

Measure valve stem and valve guide in three places using a micrometer and a small bore gauge.

**NOTE:** Clean valve guide to remove carbon deposits before measuring.

Change valve if valve stem is out of specification or has other damages such as wear or friction surface.



R400motr83A

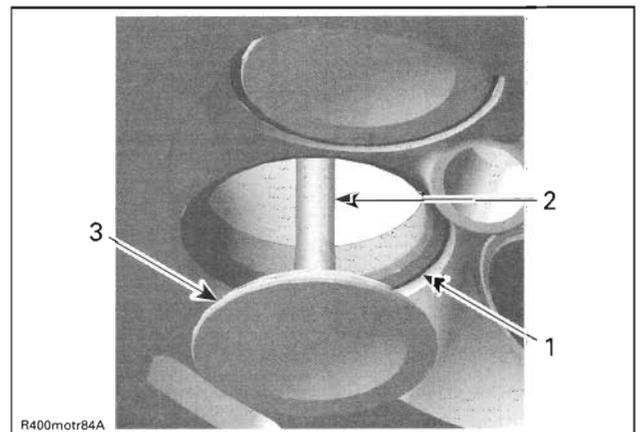
A. Valve stem diameter

VALVE STEM DIAMETER	
NEW	
Exhaust	4.956 to 4.970 mm (.1951 to .1957 in)
Intake	4.966 to 4.980 mm (.1955 to .1960 in)
SERVICE LIMIT	
Exhaust	4.930 mm (.1941 in)
Intake	

Replace valve guide no. 32 if it is out of specification or has other damages such as wear or friction surface.

VALVE GUIDE DIAMETER	
SERVICE LIMIT	
Exhaust	5.050 mm (.1988 in)
Intake	

**Valve Face and Seat**



R400motr84A

1. Valve seat
2. Exhaust valve contaminated area
3. Valve face (contact surface to valve seat)

**Section 01 ENGINE****Subsection 06 (CYLINDER AND HEAD)**

Check valve face and seat for burning or pittings and replace valve or cylinder head if there are signs of damage.

Ensure to seat valves properly. Apply some lapping compound to valve face and work valve on its seat with a lapping tool (see *VALVE GUIDE PROCEDURE* below).

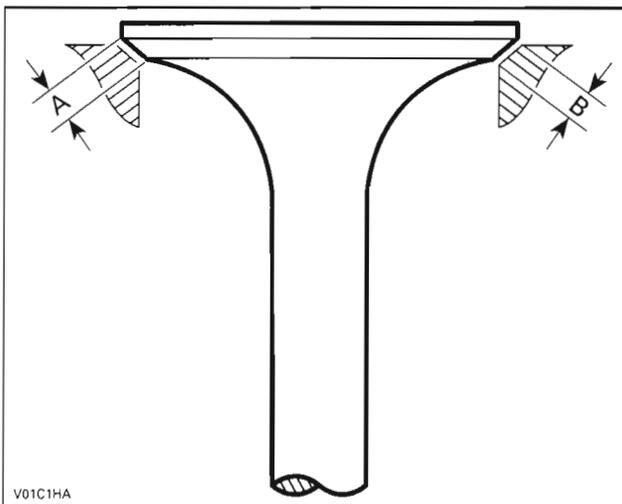
Measure valve face contact width.

**NOTE:** The location of contact area should be in center of valve seat.

Measure valve seat width using a caliper.

VALVE SEAT CONTACT WIDTH	
NEW	
Exhaust	1.25 to 1.55 mm (.049 to .061 in)
Intake	1.15 to 1.35 mm (.045 to .053 in)
SERVICE LIMIT	
Exhaust	2 mm (.078 in)
Intake	1.8 mm (.07 in)

If valve seat contact width is too wide or has dark spots, replace the cylinder head.

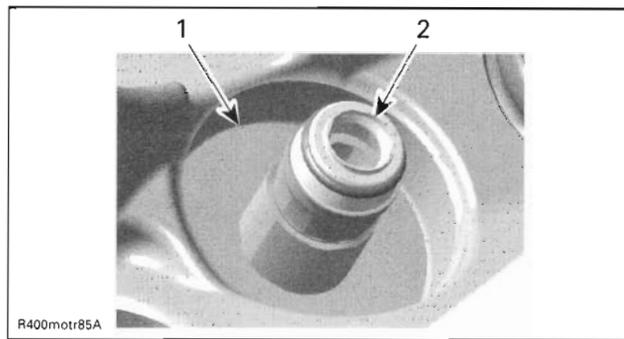
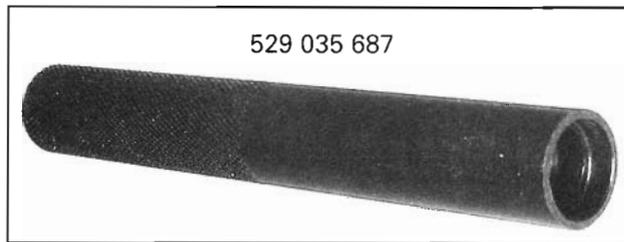


A. Valve face contact width  
B. Valve seat contact width

**Installation**

For installation, reverse the removal procedure. Pay attention to the following details.

Install thrust washer no. **34** then using the valve stem seal installer (P/N 529 035 687), install valve stem seal no. **33**.



1. Thrust washer  
2. Sealing lips of valve stem seal

Apply engine oil on valve stem and install it.

**CAUTION:** Be careful when valve stem is passed through sealing lips of valve stem seal.

To ease installation of valve cotter, apply oil or grease on them so that they remain in place while releasing the spring.

After spring is installed, ensure it is properly locked by tapping on valve stem end with a soft hammer so that valve opens and closes a few times.

**CAUTION:** An improperly locked valve spring will cause engine damage.

**VALVE GUIDE PROCEDURE****Removal**

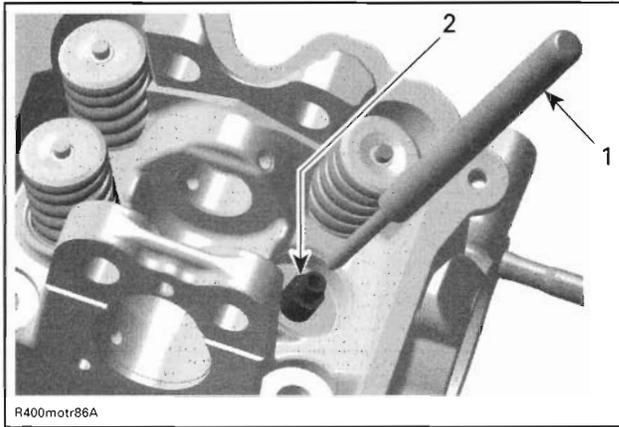
Remove:

- cylinder head
- valve spring
- valves.

**NOTE:** Clean valve guide area from contamination before removal.

Using the valve guide remover (P/N 529 035 924) and a hammer, remove valve guide.

**Section 01 ENGINE**  
**Subsection 06 (CYLINDER AND HEAD)**



1. Valve guide remover  
 2. Valve guide

**Inspection**

Always replace valve stem seals whenever cylinder head is removed.

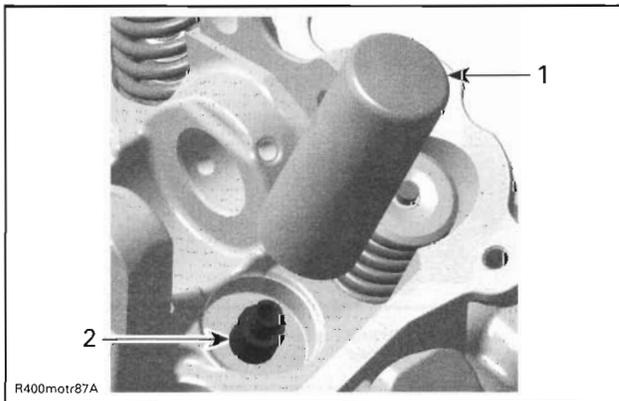
Clean the valve guide bore before reinstalling the valve guide into cylinder head.

**Installation**

For installation, reverse the removal procedure. Pay attention to the following details.

Apply Loctite 767 (antiseize lubricant) (P/N 293 800 070) on valve guide no. 32 prior to install it into the cylinder head no. 24.

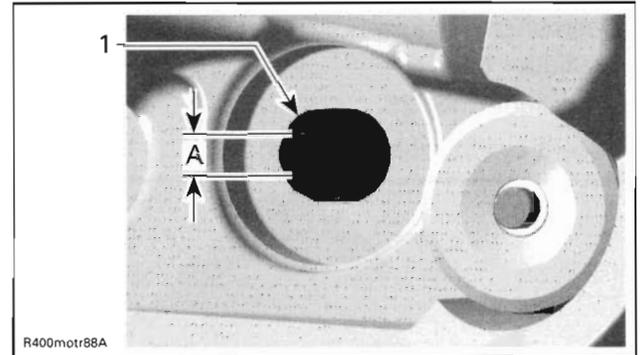
Use the valve guide installer (P/N 529 035 853) to install valve guide in the cold cylinder head.



1. Valve guide installer  
 2. Valve guide

Valve guide must be adjusted in diameter by using a reamer.

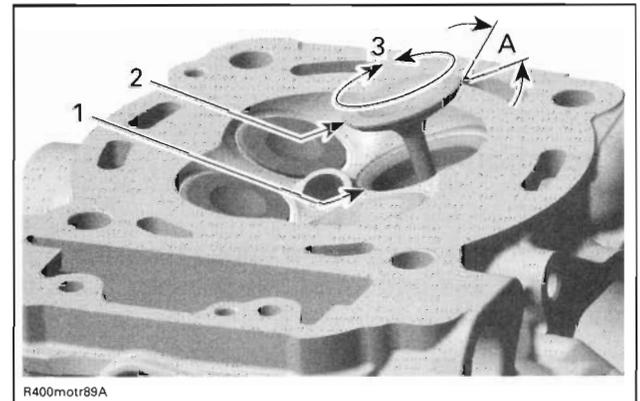
VALVE GUIDE DIAMETER	
NEW	
Exhaust	5.006 to 5.018 mm (.1971 to .1976 in)
Intake	



1. Valve guide  
 A. Valve guide diameter

**NOTE:** Ensure to turn reamer in the right direction. Use cutting oil and make brakes to clean reamer/valve guide from metal shavings.

Apply some lapping compound to valve face and work valve on its seat with a lapping tool.



1. Valve seat  
 2. Valve face (contact surface to valve seat)  
 3. Turn valve while pushing against cylinder head  
 A. Valve seat angle 45°

**NOTE:** Ensure to seat valves properly. Apply marking paste to ease checking contact pattern.

Repeat procedure until valve seat/valve face fits together.

**CYLINDER**

**Removal**

Lock crankshaft at TDC compression position, refer to *CRANKSHAFT AND CRANKCASE*.

**Section 01 ENGINE**

**Subsection 06 (CYLINDER AND HEAD)**

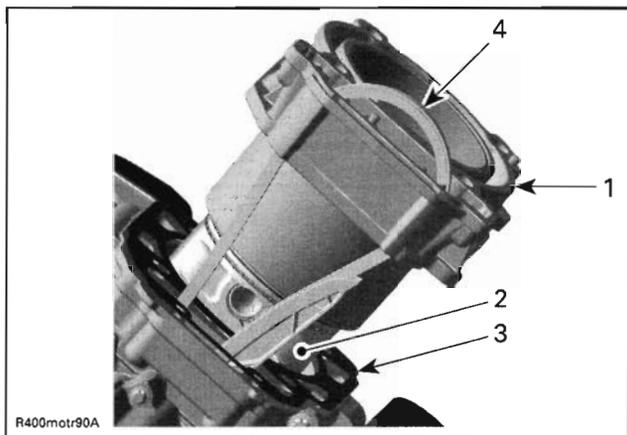
Using the camshaft locking tool (P/N 529 035 926), lock the camshaft at TDC compression position to prevent timing chain stretching.

Remove:

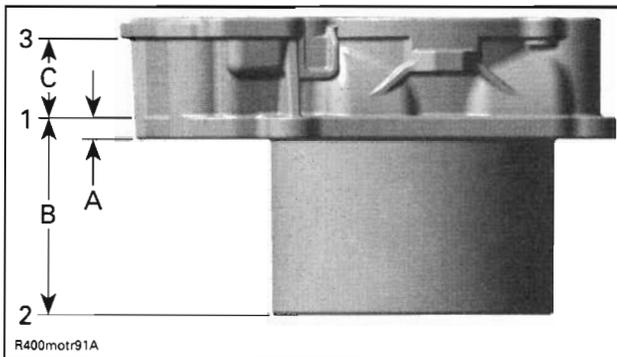
- chain tensioner
- decompressor
- camshaft sprocket
- cylinder head.

Pull cylinder no. 25.

Discard cylinder base gasket.



1. Cylinder
2. Piston assembly
3. Cylinder base gasket
4. Camshaft timing chain



1. First measuring of diameter
2. Second measuring of diameter
3. Third measuring of diameter
- A. 7 mm (.276 in) from cylinder bottom
- B. 68 mm (2.68 in)
- C. 32 mm (1.260 in)

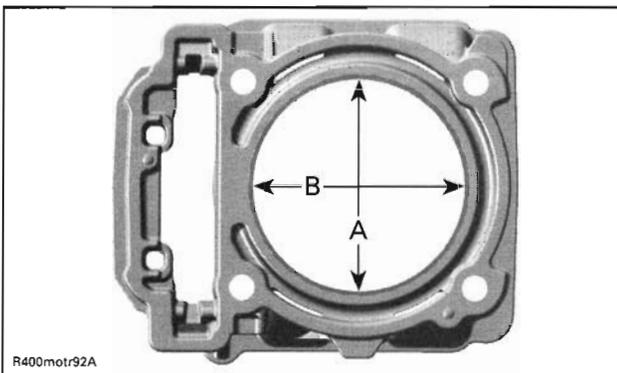
CYLINDER TAPER IN DIAMETER	
NEW	0.038 mm (.0015 in)
SERVICE LIMIT	0.090 mm (.004 in)

Distance between measurements should not exceed the service limit mentioned above.

**Cylinder Out of Round**

Measure cylinder diameter in piston axis direction from top of cylinder. Take another measurement 90° from first one and compare.

**NOTE:** Take the same measuring points like described in *CYLINDER TAPER* above.



- A. Perpendicular to crankshaft axis
- B. Parallel to crankshaft axis

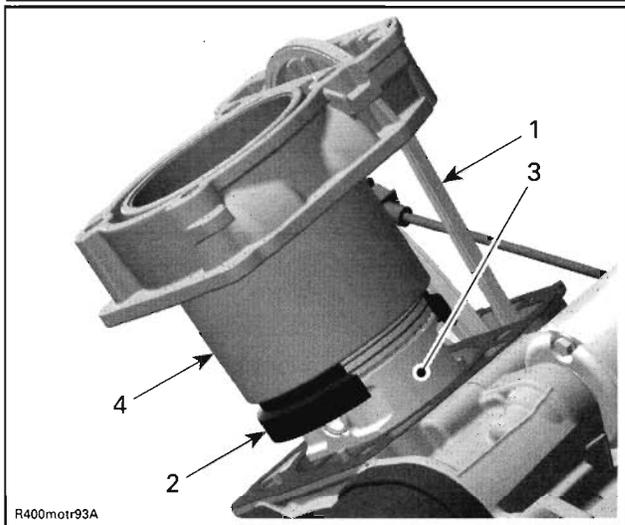
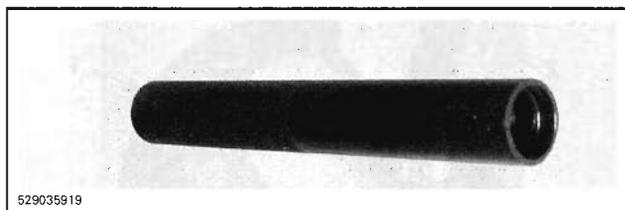
CYLINDER OUT OF ROUND	
NEW	0.015 mm (.0006 in)
SERVICE LIMIT	0.02 mm (.0008 in)

**Installation**

For installation, reverse the removal procedure. Pay attention to the following details.

Install a new cylinder base gasket no. 36.

Apply engine oil in the bottom area of the cylinder bore and also on the band of the piston ring compressor tool (P/N 529 035 919).



1. Timing chain
2. Piston ring compressor tool
3. Piston
4. Cylinder

**NOTE:** Put timing chain through the chain pit then put the cylinder in place.

Install cylinder head and the other parts in accordance with the proper installation procedures.

## PISTON

### Removal

Remove:

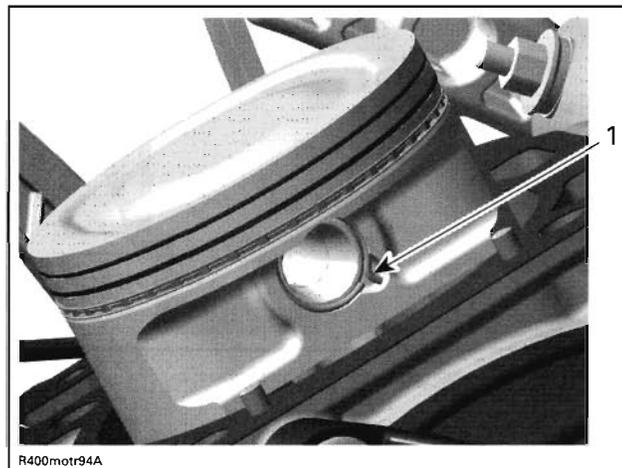
- cylinder head no. 24
- cylinder no. 25.

Place a rag under piston no. 37 and in the area of timing chain compartment.

### ⚠ WARNING

Piston circlips are spring loaded.

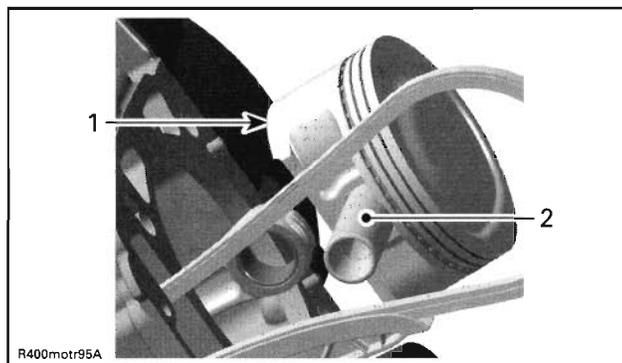
Remove one piston circlip and discard it.



1. Piston circlip

**NOTE:** The removal of both piston circlips is not necessary to remove piston pin.

Push piston pin out of piston.



1. Piston
2. Piston pin

Detach piston from connecting rod.

## Inspection

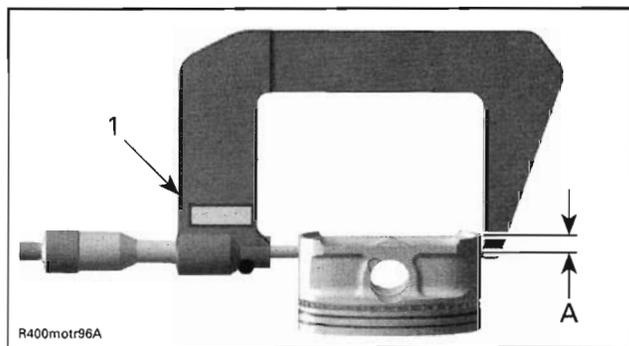
### Piston

Inspect piston for scoring, cracking or other damages. Replace piston and piston rings if necessary.

Using a micrometer, measure piston at 8 mm (.315 in) perpendicularly (90°) to piston pin.

**Section 01 ENGINE**

**Subsection 06 (CYLINDER AND HEAD)**



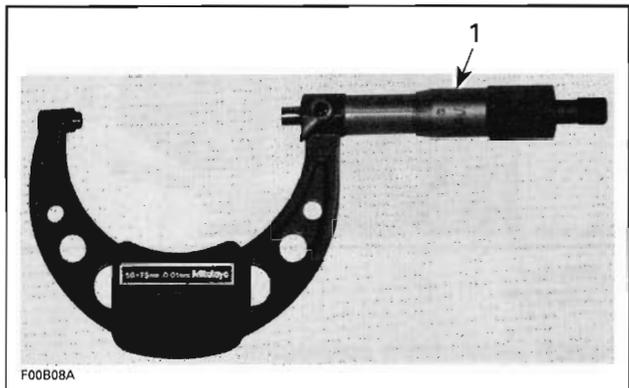
1. Measuring perpendicularly (90°) to piston pin  
A. 8 mm (.315 in)

The measured dimension should be as described in the following table. If not, replace piston.

PISTON MEASUREMENT	
NEW	90.950 to 90.966 mm (3.5807 to 3.5813 in)

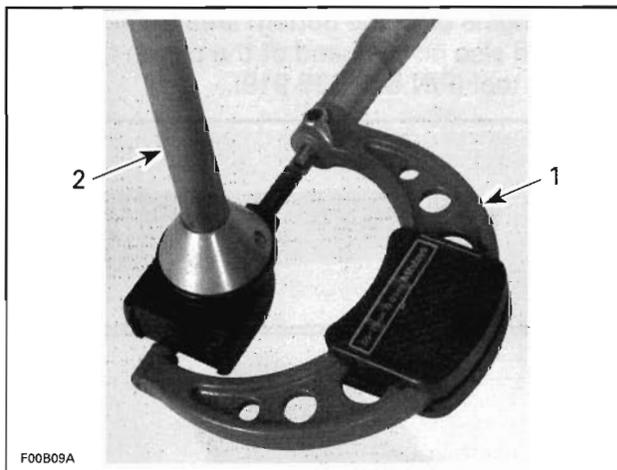
**Piston/Cylinder Clearance**

Adjust and lock a micrometer to the piston dimension.

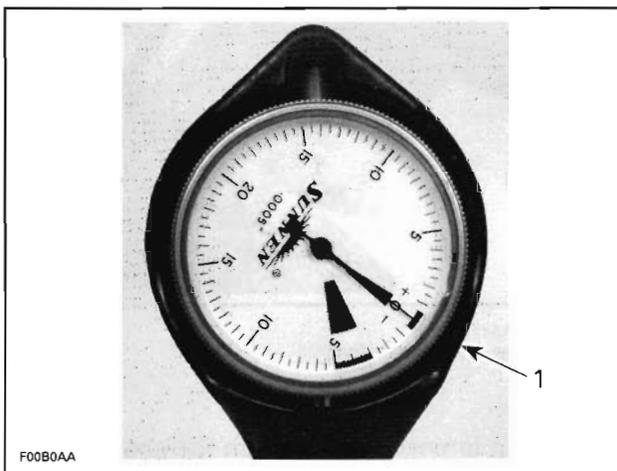


1. Micrometer set to the piston dimension

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



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



TYPICAL  
1. Indicator set to 0 (zero)

Position the dial bore gauge 20 mm (.787 in) above cylinder base, measuring perpendicularly (90°) to piston pin axis.

Read the measurement on the cylinder bore gauge. The result is the exact piston/cylinder wall clearance.

PISTON/CYLINDER CLEARANCE	
NEW	0.027 to 0.057 mm (.0011 to .0022 in)
SERVICE LIMIT	0.010 mm (.004 in)

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

If clearance exceeds specified tolerance, replace cylinder.

**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.

**Section 01 ENGINE**

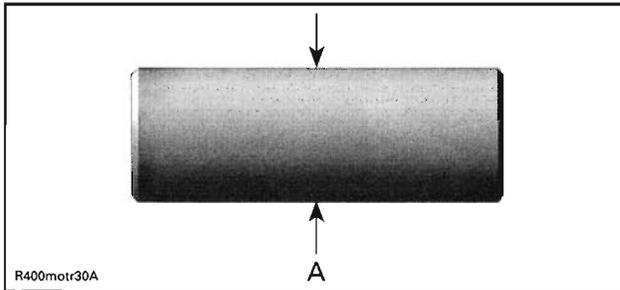
**Subsection 06 (CYLINDER AND HEAD)**

**Piston Pin**

Using synthetic abrasive woven, clean piston pin no. 38 from deposits.

Inspect piston pin for scoring, cracking or other damages.

Measure piston pin. See the following illustration for the proper measurement position.



A. Piston pin diameter

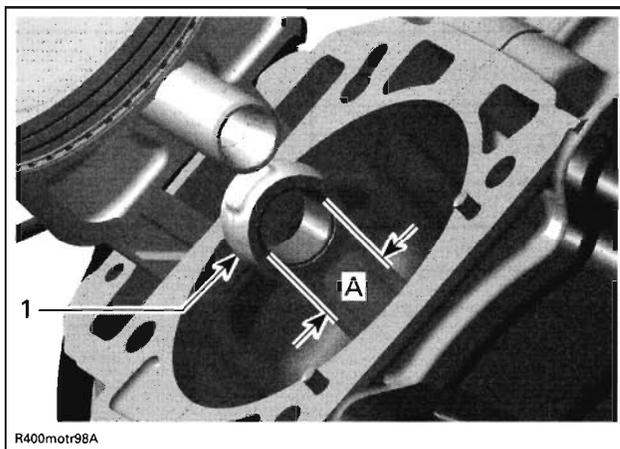
PISTON PIN DIAMETER	
NEW	19.996 to 20.000 mm (.7872 to .7874 in)
SERVICE LIMIT	19.980 mm (.7866 in)

Replace piston pin if diameter is out of specifications.

**Piston Pin/Connecting Rod Bushing Clearance**

Measure inside diameter of connecting rod.

CONNECTING ROD SMALL END DIAMETER	
NEW	20.010 to 20.020 mm (.7878 to .7881 in)
SERVICE LIMIT	20.060 mm (.7898 in)



1. Connecting rod small end  
A. Connecting rod small end diameter

Replace connecting rod if diameter of connecting rod small end is out of specifications. Refer to *CRANKSHAFT AND CRANKCASE* for removal procedure.

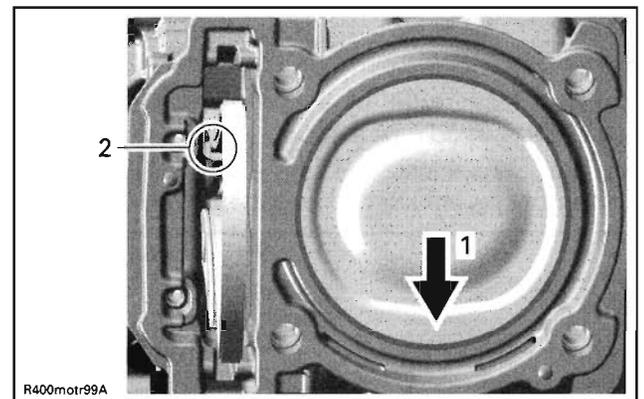
**Installation**

For installation, reverse the removal procedure. Pay attention to the following details.

Apply engine oil on the piston pin.

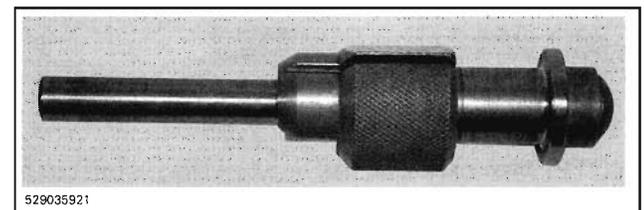
Place piston no. 37 over connecting rod. Position the piston with the punched arrow towards the exhaust side.

Insert piston pin no. 38 into piston and connecting rod.



1. Arrow should indicate to the exhaust side  
2. Area of timing chain compartment

Use the piston circlip installer (P/N 529 035 921) to assemble the new piston circlip no. 39 as per following procedure:

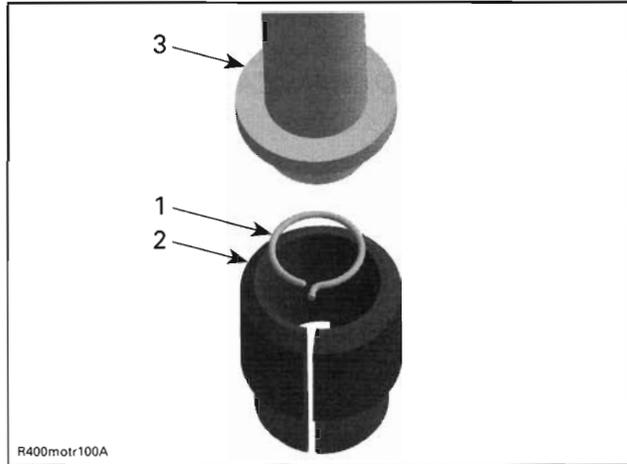


**CAUTION:** Always replace disassembled piston circlip(s) by new ones. Place a rag on cylinder base to avoid dropping the circlip inside the engine.

– Place circlip in sleeve as per following illustration.

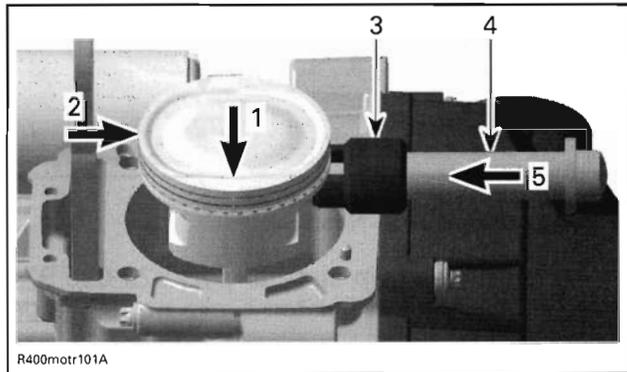
**Section 01 ENGINE**

**Subsection 06 (CYLINDER AND HEAD)**



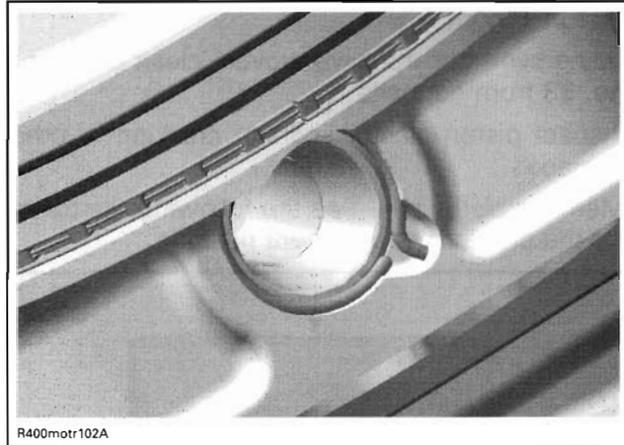
1. Circlip
2. Sleeve
3. Assembly jig from piston clip installer

- Push taper side of assembly jig until circlip reaches middle of sleeve.
- Align sleeve with piston pin axis and push assembly jig until circlip engages in piston.



1. Arrow should indicate to the exhaust side
2. Hold piston while pushing circlip in place
3. Sleeve
4. Assembly jig
5. Direction to push circlip

**NOTE:** Take care that the hook of the piston circlip is positioned properly.



**CORRECT POSITION OF THE PISTON CIRCLIP**

**PISTON RINGS**

**Removal**

Remove:

- cylinder head no. 24
- cylinder no. 25
- piston pin no. 37.

**Inspection**

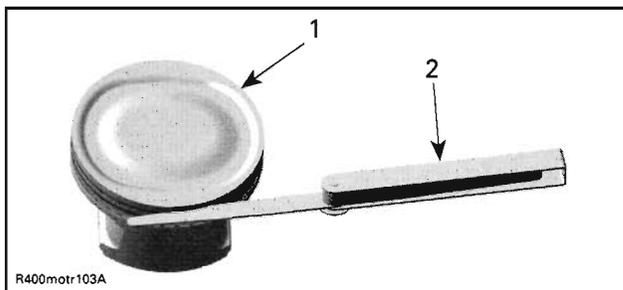
**Ring/Piston Groove Clearance**

Using a feeler gauge measure each ring/piston groove clearance. If the clearance is too large, the piston and the piston rings should be replaced.

RING/PISTON GROOVE CLEARANCE	
NEW	
Upper compression ring	0.03 to 0.070 mm (.0012 to .0028 in)
Lower compression ring	0.02 to 0.060 mm (.0008 to .0026 in)
Oil scraper ring	0.01 to 0.045 mm (.0004 to .0018 in)
SERVICE LIMIT	
All	0.15 mm (.0059 in)

**Section 01 ENGINE**

**Subsection 06 (CYLINDER AND HEAD)**



- 1. Piston
- 2. Feeler gauge

**Ring End Gap**

RING END GAP	
NEW	
Upper compression ring	0.20 to 0.40 mm (.008 to .014 in)
Lower compression ring	0.20 to 0.40 mm (.008 to .014 in)
Oil scraper ring	0.20 to 0.70 mm (.008 to .028 in)
SERVICE LIMIT	
All	1.5 mm (.059 in)

Measure position for ring end gap in the area of 8 to 16 mm (.315 to .630 in) from top of cylinder.

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

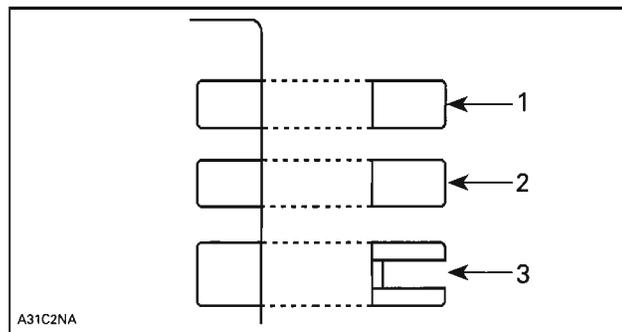
Using a feeler gauge, check ring end gap. Replace ring if gap exceeds above described specified tolerance.

**Installation**

For installation, reverse the removal procedure. Pay attention to the following details.

**NOTE:** First install spring and then rings of oil scraper ring.

Install the oil scraper ring first, then the lower compression ring with the word "N and TOP " facing up, then the upper compression ring with the word "N and TOP" facing up.

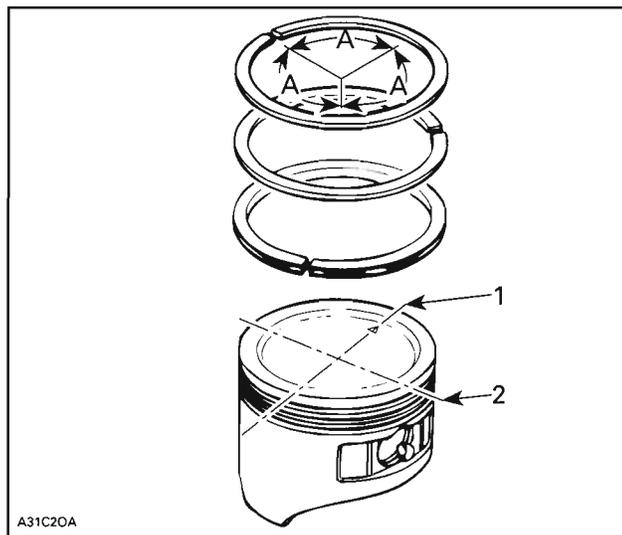


- 1. Upper compression ring
- 2. Lower compression ring
- 3. Oil scraper ring

**CAUTION:** Ensure that top and second rings are not interchanged.

**NOTE:** Use a ring expander to prevent breakage during installation. The oil ring must be installed by hand.

Check that rings rotate smoothly after installation. Space the piston ring end gaps 120° apart and do not align the gaps with the piston pin bore or the thrust side axis.



- 1. DO NOT align ring gap with piston thrust side axis
- 2. DO NOT align ring gap with piston pin bore axis
- A. 120°

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# CRANKSHAFT AND CRANKCASE

## SERVICE TOOLS

Description	Part Number	Page
crankcase support MAG .....	529 035 916 .....	70-71
crankcase support PTO .....	529 035 754 .....	70-71
crankshaft locking bolt.....	529 035 617 .....	64, 79
dial gauge .....	414 104 700 .....	64
insertion handle .....	420 877 650 .....	67-68, 72-73
needle bearing installer.....	529 035 762 .....	73
needle bearing installer.....	529 035 763 .....	72
needle bearing installer.....	529 035 943 .....	73
needle bearing remover.....	529 035 756 .....	73
oil seal installer .....	529 035 760 .....	68
oil seal installer .....	529 035 934 .....	67
oil seal installer .....	529 035 941 .....	67
plain bearing remover/installer.....	529 035 917 .....	70

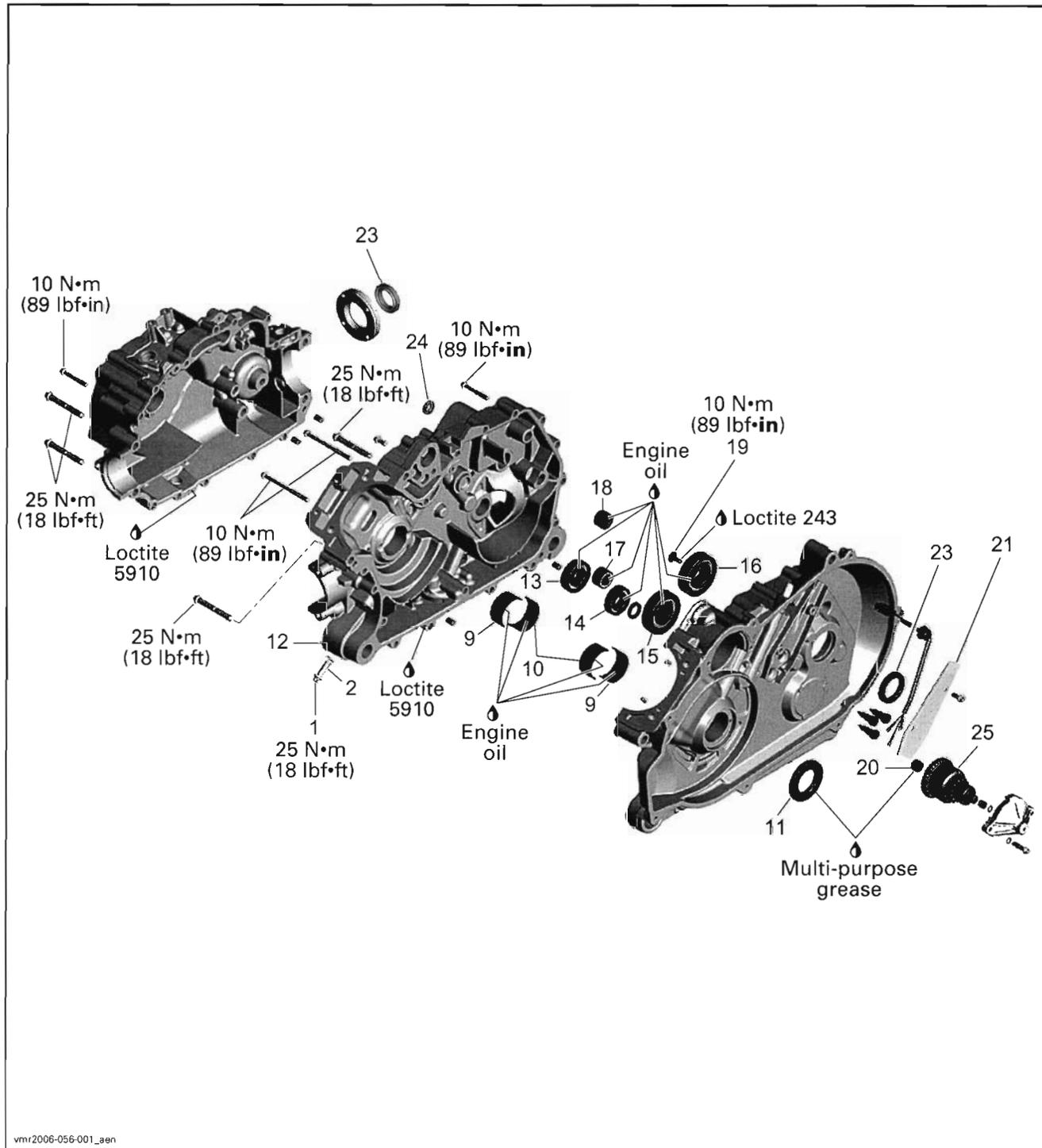
## SERVICE PRODUCTS

Description	Part Number	Page
Loctite 243 (blue).....	293 800 060 .....	66
Super Lube grease .....	293 550 030 .....	67-68

### Section 01 ENGINE

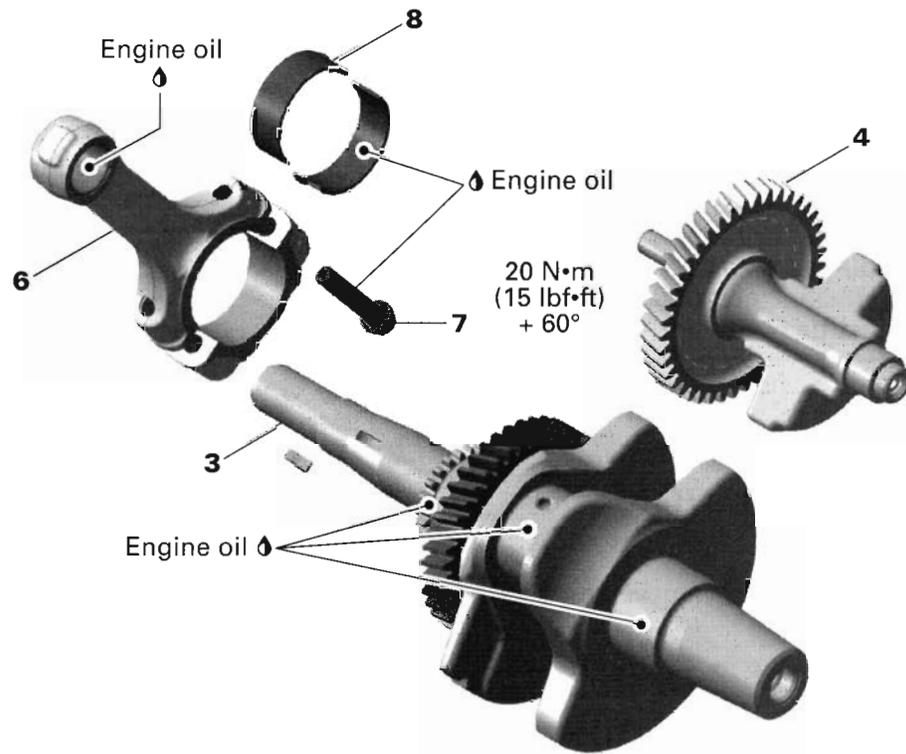
#### Subsection 07 (CRANKSHAFT AND CRANKCASE)

## CRANKCASE



vmr2006-056-001\_aen

**CRANKSHAFT/BALANCER SHAFT**



R400motr16S

**Section 01 ENGINE****Subsection 07 (CRANKSHAFT AND CRANKCASE)****GENERAL**

This section includes the procedures pertaining to the crankcase, crankshaft and balancer shaft. For the gearbox, follow the procedure for the *CRANKCASE* then refer to *GEARBOX* section.

During assembly/installation, use the torque values and service products as in the exploded views.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

**⚠ WARNING**

Torque wrench tightening specifications must strictly be adhered to.

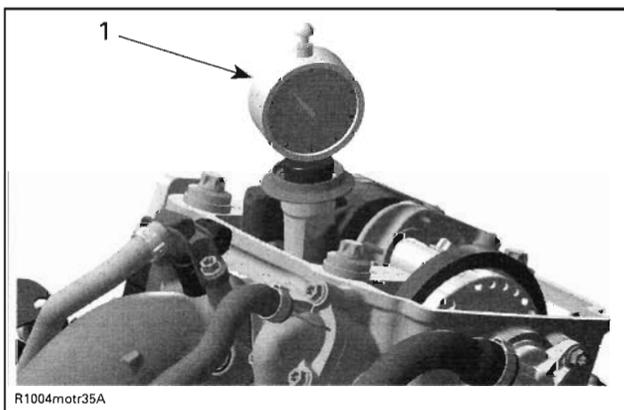
Locking devices (e.g.: locking tabs, elastic stop nuts, self-locking fasteners, etc.) must be installed or replaced with new ones where specified. If the efficiency of a locking device is impaired, it must be renewed.

**PROCEDURE****CRANKSHAFT LOCKING PROCEDURE**

Unplug spark plug cable then remove the spark plug.

Remove valve cover (refer to *CYLINDER AND HEAD*).

Install a dial gauge (P/N 414 104 700).

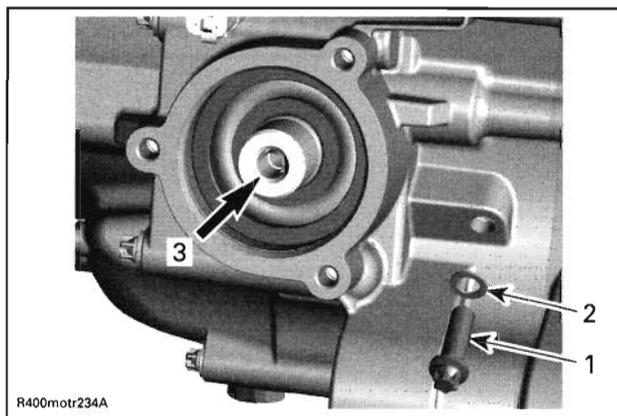


*TYPICAL*

1. Dial gauge

Pull rewind starter to rotate crankshaft until piston is at TDC compression.

Remove screw no. 1 and sealing washer no. 2.

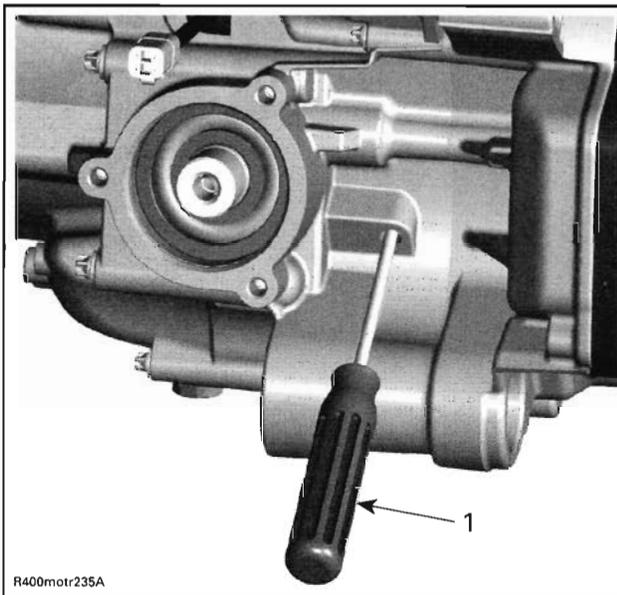


1. Screw

2. Sealing washer

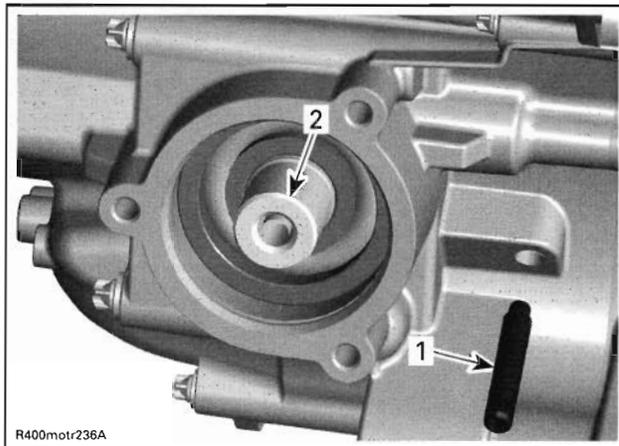
3. Output shaft on front side of vehicle

Use a screwdriver to check if groove in crankshaft is aligned with the hole.



1. Screwdriver

Lock crankshaft with crankshaft locking bolt (P/N 529 035 617).

**Section 01 ENGINE****Subsection 07 (CRANKSHAFT AND CRANKCASE)**

- R400motr236A
1. Crankshaft locking bolt
  2. Front output shaft area

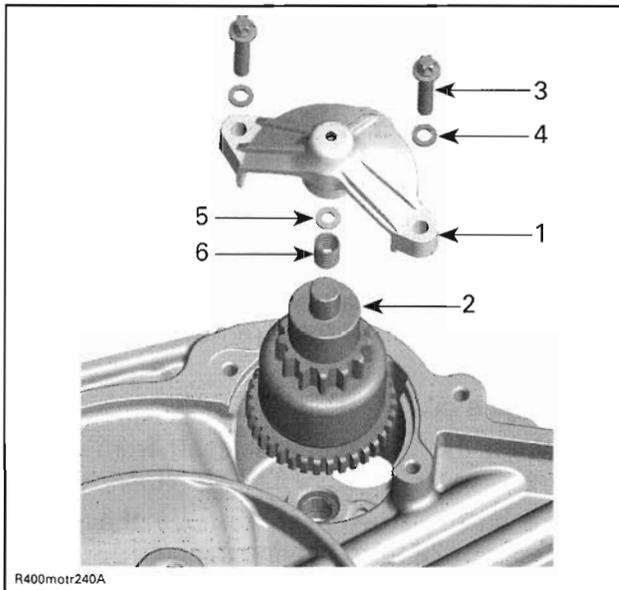
**STARTER DRIVE PINION****Removal**

Remove:

- drive pulley (refer to *VEHICLE SHOP MANUAL*)
- screws retaining starter drive pinion cover

**NOTE:** Do not lose shims and/or spring during removal of starter pinion cover.

- starter drive pinion cover
- starter drive pinion no. 25.

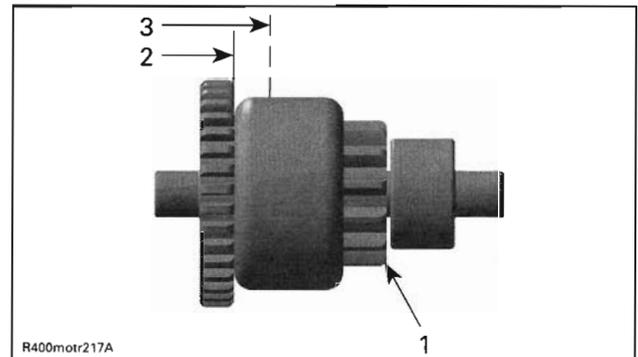


- R400motr240A
1. Starter drive pinion cover
  2. Starter drive pinion
  3. Screw
  4. Shim
  5. Shim
  6. Spring

**Inspection**

Check if starter drive pinion is free of movement.

**NOTE:** Centrifugal weights avoid disengaging of the pinion while starting the engine.



- R400motr217A
1. Starter drive pinion
  2. Starting position (spring released)
  3. Gear is engaged drive pulley fixed half (spring loaded)

Replace needle bearing if damaged (see *CRANKCASE*).

Check starter drive pinion cover for crack and clean it before reinstallation.

Check bore inside starter drive pinion cover if damaged, worn or otherwise damaged. Replace as necessary.

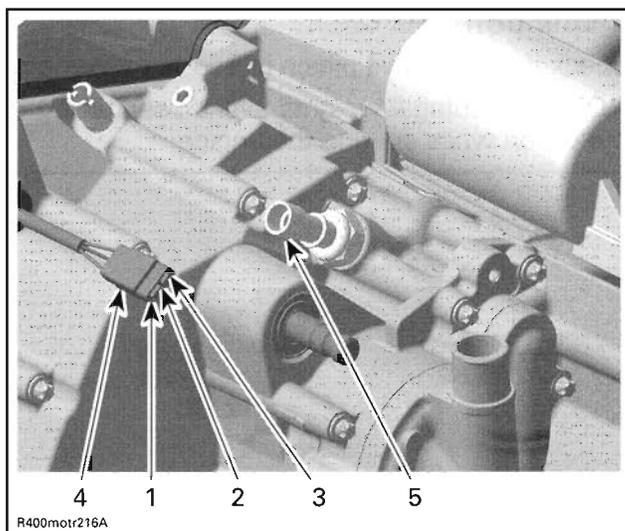
**Installation**

For installation, reverse the removal procedure.

**NOTE:** Apply multi-purpose grease inside starter drive pinion cover.

**SHIFTING INDICATOR SWITCH****Test**

- Unplug connector from vehicle wire harness.

**Section 01 ENGINE****Subsection 07 (CRANKSHAFT AND CRANKCASE)**

1. Blue wire for contact to parking gear
2. Brown wire for contact to reverse gear
3. Green/yellow wire for contact to neutral gear
4. Shifting indicator connector
5. Oil pressure switch

– Put vehicle in park, reverse or neutral position and use a multimeter to measure the resistance from connector (specific wire) to engine ground.

**NOTE:** For example, shift gear to park position and measure from blue wire of connector to engine ground. Resistance should be close to 0 ohm.

**Removal**

**NOTE:** The engine removal is not necessary to reach the shifting indicator switches.

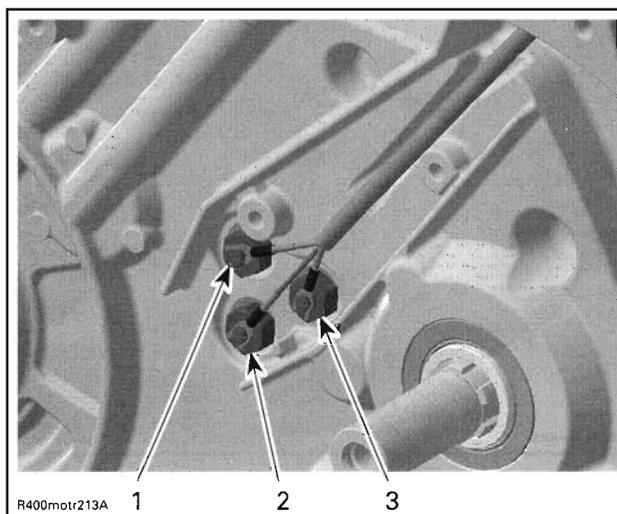
To reach the shifting indicator switches, remove:

- CVT cover
- driven pulley.

Remove:

- protection plate no. 21.

**NOTE:** Clean area from dirt and belt dust before removing shifting indicator switch(es).



1. Parking switch (blue wire)
2. Reverse switch (brown wire)
3. Neutral switch (green/yellow wire)

Remove screw retaining shifting indicator switch wire.

Unscrew the shifting indicator switch.

**Installation**

For installation, reverse the removal procedure. Pay attention to the following details.

If all switches are removed, take care to put back wires at the proper location.

Take care do not damage shifting indicator switches threads during installation.

Apply Loctite 243 (blue) (P/N 293 800 060) on switch threads then torque to 4 N•m (36 lbf•in).

**OUTPUT SHAFT OIL SEAL****Removal**

**NOTE:** The output shaft oil seal no. 22 can be removed and installed without removing the engine from vehicle.

Drain engine oil.

Disconnect the rear propeller shaft from output shaft, refer to *VEHICLE SHOP MANUAL*.

Using a small screwdriver, remove the output shaft seal no. 22 from bearing flange.

**Inspection**

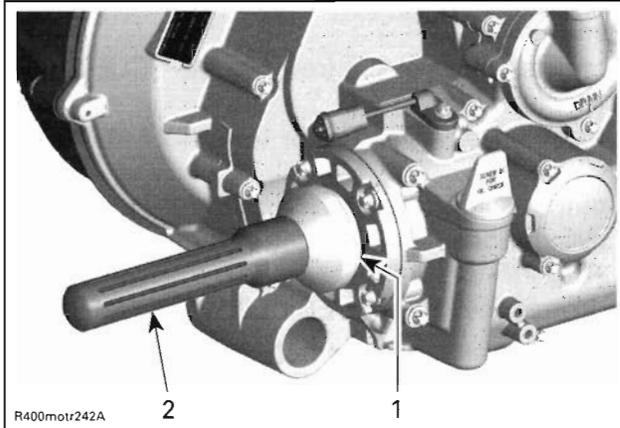
Check bearing behind oil seal for contamination and/or metal shavings.

Check oil seal seating surface for grooves. Replace bearing flange if necessary.

**Installation**

Apply Super Lube grease (P/N 293 550 030) on seal.

Use the oil seal installer (P/N 529 035 941) and insertion handle (P/N 420 877 650) for installation of the oil seal.



1. Oil seal installer
2. Insertion handle

Install all removed parts.

**MAIN SHAFT OIL SEAL****Removal**

**NOTE:** The main shaft oil seal no. 23 can be removed without removing the engine from vehicle.

Remove the driven pulley. Refer to the appropriate *VEHICLE SHOP MANUAL*.

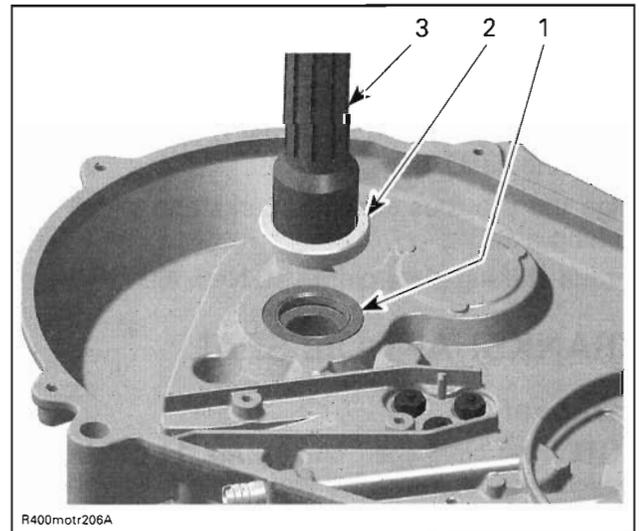
Using a small screwdriver, remove the main shaft seal. Be careful to avoid scratching crankcase.

**Installation**

Apply Super Lube grease (P/N 293 550 030) on seal.

Using a suitable tube with the proper diameter, install the seal.

If the engine is removed and crankcase is split, use the oil seal installer (P/N 529 035 934) and the insertion handle (P/N 420 877 650) to install seal.



1. Main shaft seal
2. Seal installer
3. Insertion handle

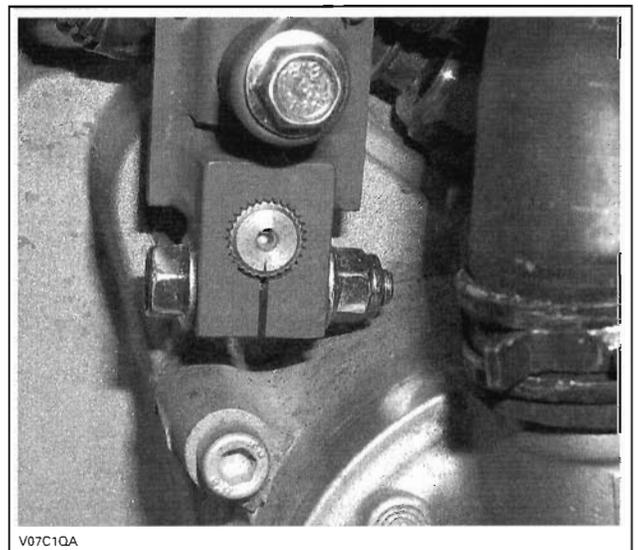
Install all removed parts.

**SHIFT SHAFT OIL SEAL****Removal**

**NOTE:** The shift shaft oil seal no. 24 can be removed without removing the engine from vehicle.

Scribe a mark on the end of shift shaft and on shifting plate.

Unscrew shifting plate bolt then remove shifting plate.



Using a small screwdriver, remove the shift shaft seal. Be careful to avoid scratching housing.

**Section 01 ENGINE**

**Subsection 07 (CRANKSHAFT AND CRANKCASE)**

**Installation**

Apply Super Lube grease (P/N 293 550 030) on seal.

Using a suitable tube, with the proper diameter, install the seal.

Align the previous scribing marks and install the shifting plate.

Torque shifting plate bolt to 10 N•m (89 lbf•in).

**CRANKSHAFT OIL SEAL**

**Removal**

**NOTE:** The crankshaft oil seal no. 11 can be removed without removing the engine from vehicle.

Remove the drive pulley. Refer to the appropriate *VEHICLE SHOP MANUAL*.

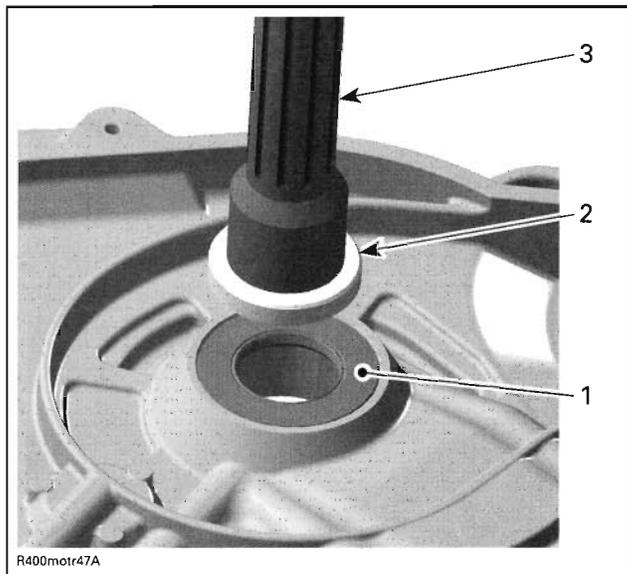
Using a small screwdriver, remove the crankshaft oil seal. Be careful to avoid scratching crankcase.

**Installation**

Apply Super Lube grease (P/N 293 550 030) on seal.

Using a suitable tube with the proper diameter, install the seal.

If the engine is removed and crankcase is split, use the oil seal installer (P/N 529 035 760) and the insertion handle (P/N 420 877 650).



1. Oil seal (crankcase PTO side)  
2. Oil seal installer  
3. Insertion handle

**CRANKCASE**

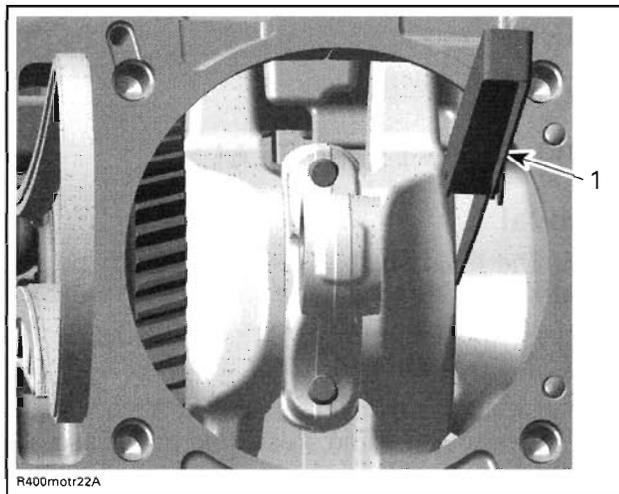
**Disassembly**

**NOTE:** Oil pump removal from crankcase MAG side not necessary, but recommended to see condition of oil pump (refer to *LUBRICATION SYSTEM*).

Remove:

- engine from vehicle (refer to *VEHICLE SHOP MANUAL*)
- magneto cover and rotor (refer to *MAGNETO SYSTEM*)
- output shaft (refer to *GEARBOX*)
- cylinder head and cylinder (refer to *CYLINDER AND HEAD*)
- drive pulley (refer to *VEHICLE SHOP MANUAL*).

Measure axial clearance between the crankshaft no. 3 and crankcase PTO no. 5 with a feeler gauge.



1. Feeler gauge

CRANKSHAFT AXIAL CLEARANCE	
MINIMUM (new)	0.1 mm (.0039 in)
MAXIMUM (new)	0.4 mm (.0157 in)

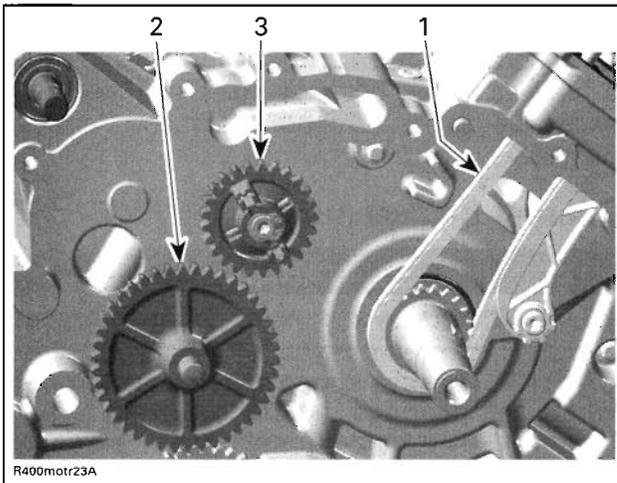
If measurement is out of specification, inspect butting faces of crankshaft and crankcase (MAG/PTO side) for excessive wear.

Remove:

- drive and intermediate gear of water and oil pump.

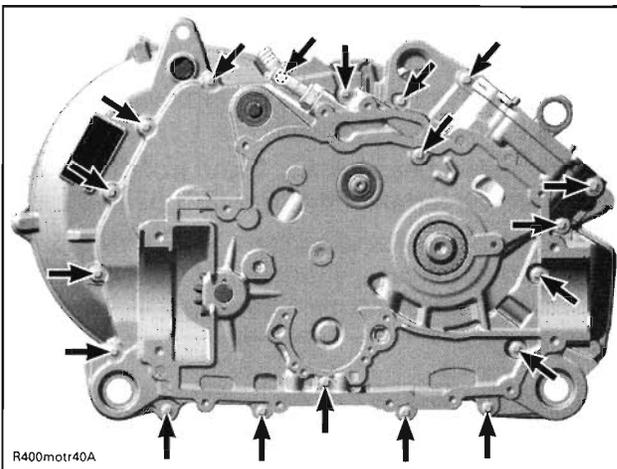
**Section 01 ENGINE**

**Subsection 07 (CRANKSHAFT AND CRANKCASE)**



1. Timing chain
2. Intermediate gear
3. Drive gear

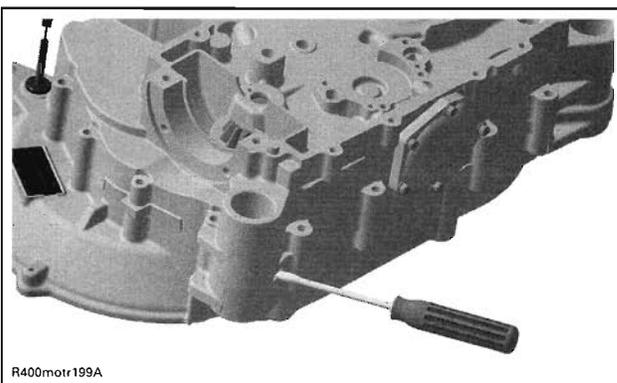
– Remove crankcase retaining screws.



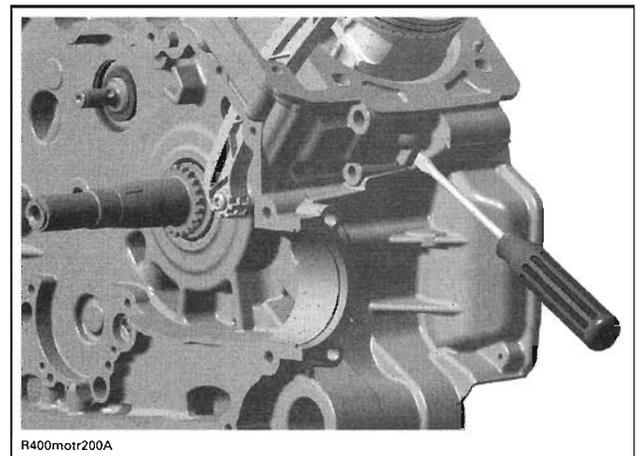
**19 SCREWS**

Place the crankcase on a wood stand, MAG side upwards.

Split crankcase no. 12 with 2 screwdrivers.



POSITION FOR BIG FLAT SCREWDRIVER



POSITION FOR BIG FLAT SCREWDRIVER

**Cleaning**

Clean all metal components in a solvent.

Clean oil passages and make sure they are not clogged.

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:** Do not wipe with rags. Use a new clean hand towel only.

**Inspection**

**NOTE:** To check some parts, it is recommended to remove all components from crankcase.

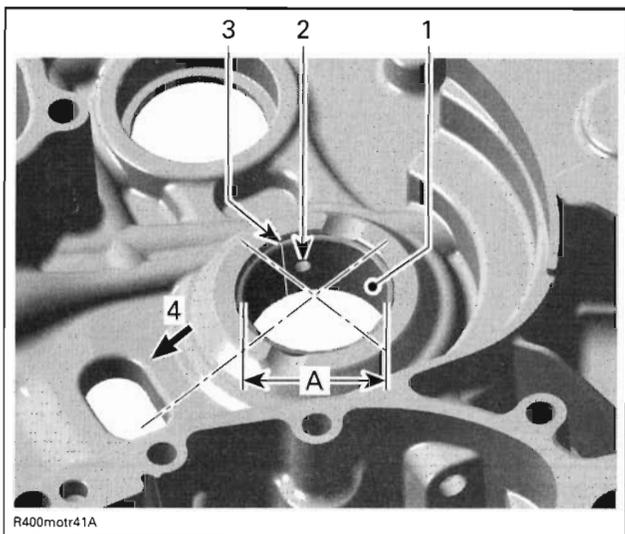
**Crankshaft Plain Bearing**

Check plain bearings no. 9 and no. 10 for scorings or other damages.

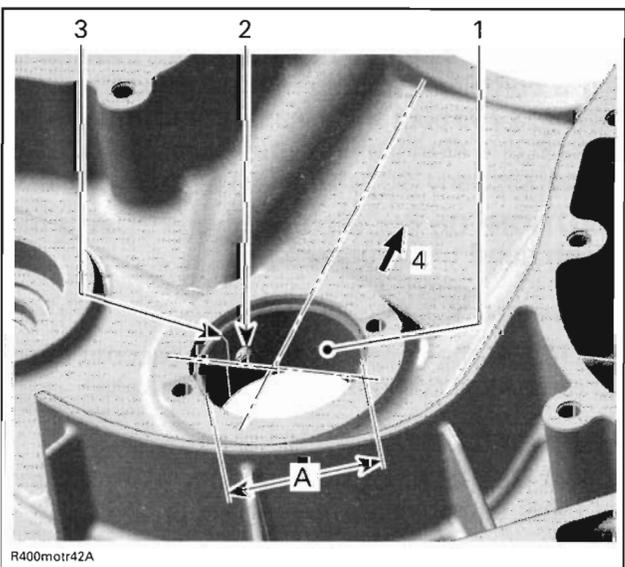
Measure plain bearing inside diameter. Replace if the measurement is out of specification (refer to PARTS REPLACEMENT) further in this section.

**Section 01 ENGINE**

**Subsection 07 (CRANKSHAFT AND CRANKCASE)**



- 1. MAG plain bearing without groove
- 2. Oil bore
- 3. Split of the plain bearing halves
- 4. Cylinder base direction
- A. Plain bearing inside diameter to be measured in area of oil bore



- 1. PTO plain bearing without groove
- 2. Oil bore
- 3. Split of the plain bearing halves
- 4. Cylinder base direction
- A. Plain bearing inside diameter to be measured in area of oil bore

PLAIN BEARING INSIDE DIAMETER (MAG/PTO)	
SERVICE LIMIT	42.070 mm (1.6563 in)

**Crankshaft Oil Seal**

Check oil seal no. 11 if brittle, hard or otherwise damaged. Replace if necessary.

**NOTE:** The oil seal is removed easily with a flat screwdriver.

**Main/Balancer Shaft and Bevel Gear Bearings**

Check bearings no. 13, no. 14, no. 15 and no. 16 as well as needle bearings no. 17 and no. 18 for excessive play and smooth operation. Replace if necessary.

**Bearing Replacement**

**⚠ WARNING**  
Clean oil, outside and inside, from crankcase.

**CAUTION:** Always support crankcase properly when ball bearings, needle bearings or plain bearings are removed; otherwise, crankcase could be damaged.

Unless otherwise instructed, never use hammer to install ball bearings, needle bearings or plain bearings. Use press machine only.

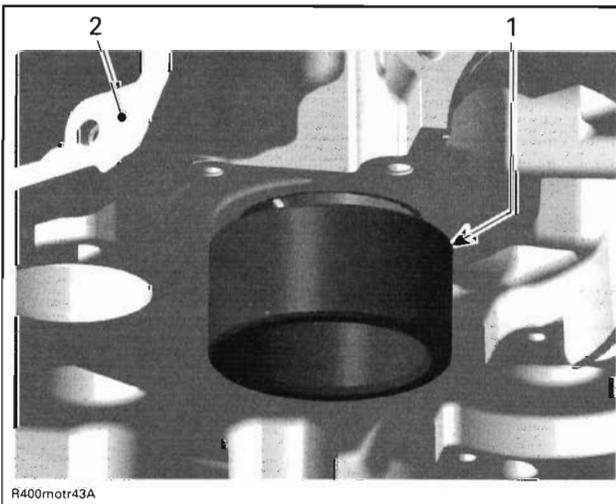
**CAUTION:** Ball bearings have to be installed with closed bearing cage to the engine outside.

**Crankshaft Plain Bearing Removal**

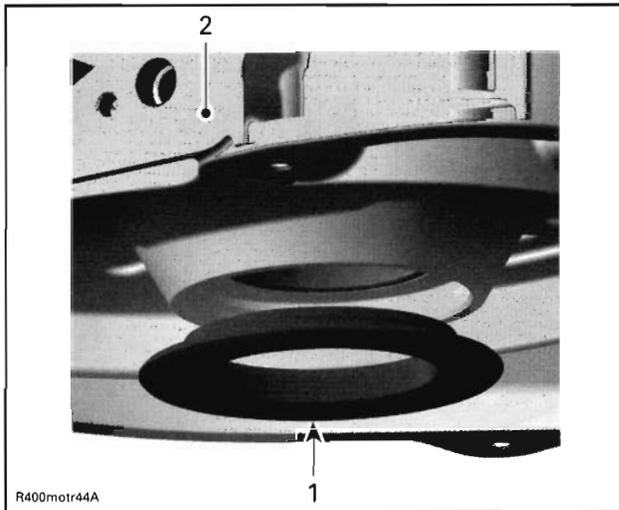
**NOTE:** Always use a press for removal or installation of plain bearing halves.

Remove plain bearings no. 9 and no. 10 with the plain bearing remover/installer (P/N 529 035 917).

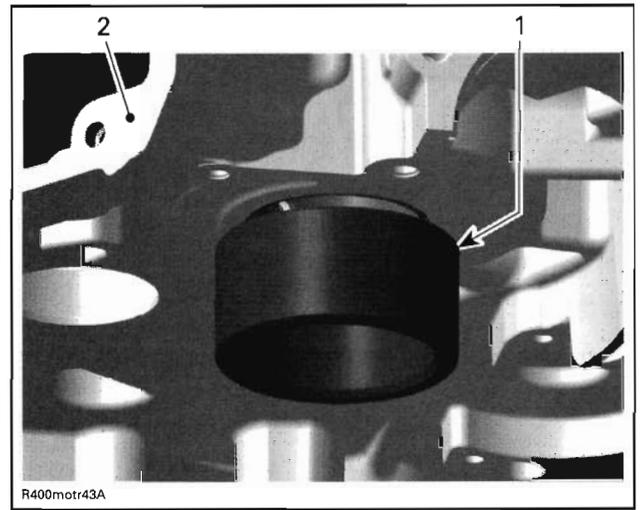
**NOTE:** Use crankcase support MAG (P/N 529 035 916) and crankcase support PTO (P/N 529 035 754) when removing plain bearings.



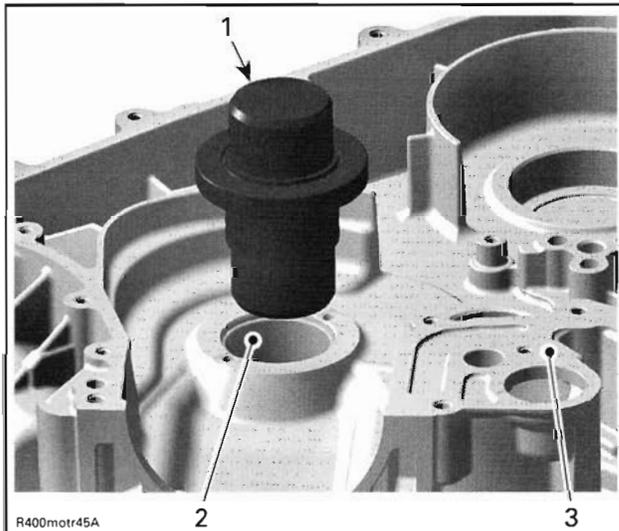
- 1. Crankcase support MAG
- 2. Crankcase MAG side



1. Crankcase support PTO  
2. Crankcase PTO side



1. Crankcase support MAG  
2. Crankcase MAG side



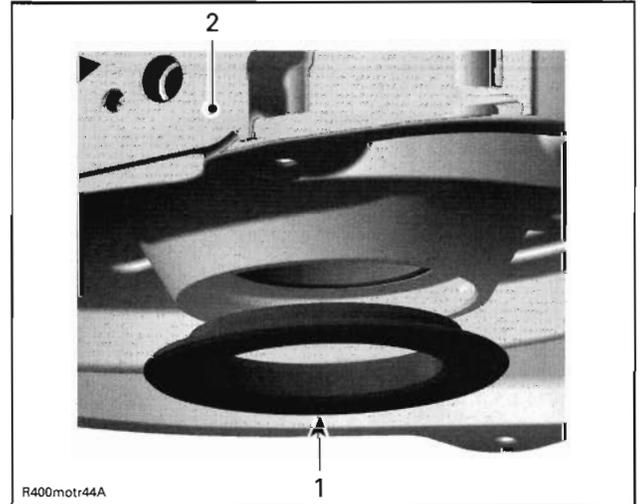
**PUSH PLAIN BEARINGS OUTSIDE**

1. Plain bearing remover/installer
2. Plain bearing
3. Crankcase PTO

**Crankshaft Plain Bearing Installation**

To install the plain bearing turn the plain bearing remover/installer up side down.

**NOTE:** Use crankcase support MAG (P/N 529 035 916) and crankcase support PTO (P/N 529 035 754) when pushing plain bearing in place.

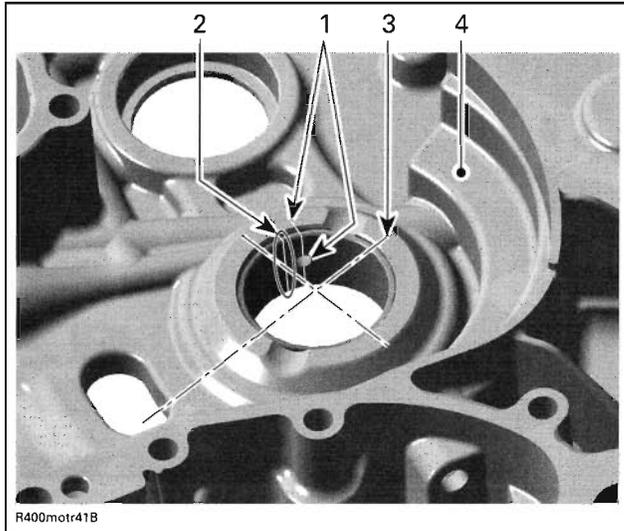


1. Crankcase support PTO  
2. Crankcase PTO side

**NOTE:** Mark oil bore position on crankcase to align new plain bearing with crankcase thrust surface.

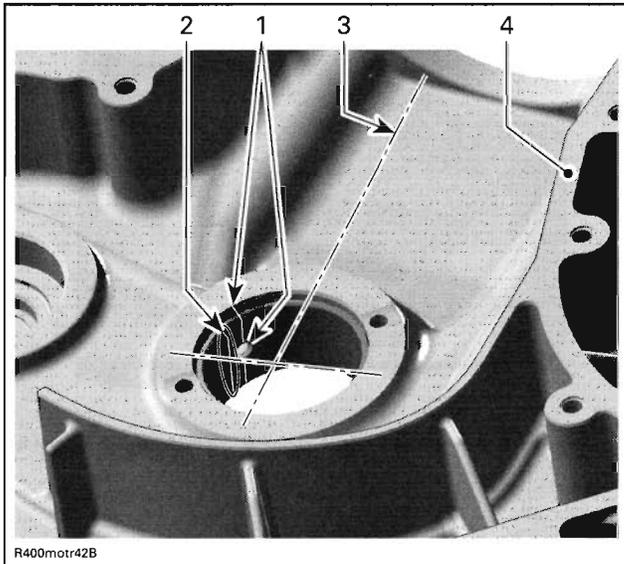
**Section 01 ENGINE**

**Subsection 07 (CRANKSHAFT AND CRANKCASE)**



R400motr41B

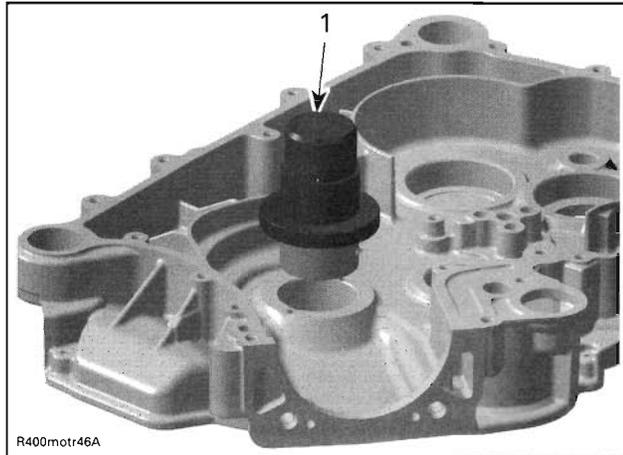
1. Mark on crankcase and oil bore position
2. Split between bearing halves
3. Perpendicular axle to cylinder base
4. Crankcase MAG



R400motr42B

1. Mark on crankcase and oil bore position
2. Split between bearing halves
3. Perpendicular axle to cylinder base
4. Crankcase PTO

**CAUTION:** Push plain bearings MAG/PTO correctly in place to ensure oil supply to crankshaft (oil bore and split between plain bearing halves).

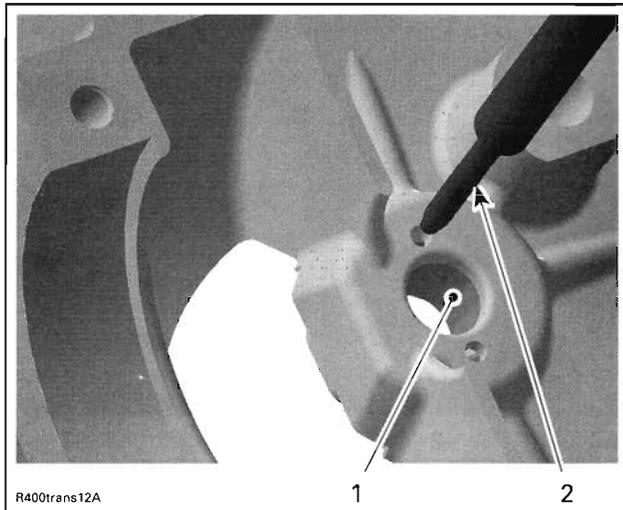


R400motr46A

**PUSH PLAIN BEARINGS INSIDE**  
 1. Plain bearing installer

**Bevel Gear Needle Bearing Removal**

To remove bevel gear needle bearing no. 17, use a punch as follows.



R400trans12A

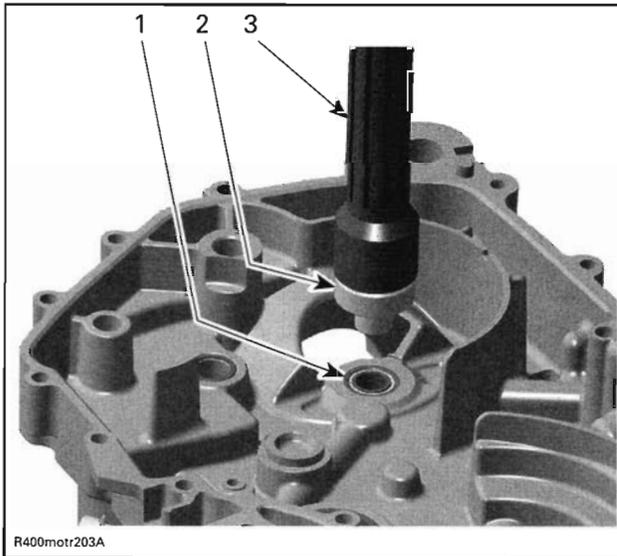
1. Bevel gear needle bearing
2. Punch

**Bevel Gear Needle Bearing Installation**

Install needle bearing no. 17 with the needle bearing installer (P/N 529 035 763) and insertion handle (P/N 420 877 650).

**Section 01 ENGINE**

**Subsection 07 (CRANKSHAFT AND CRANKCASE)**

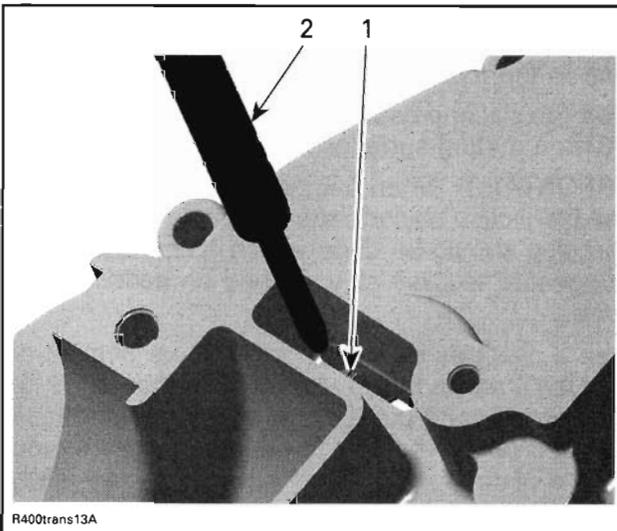


**BEVEL GEAR**

1. Bevel gear needle bearing
2. Needle bearing installer
3. Insertion handle

**Main Shaft Needle Bearing Removal**

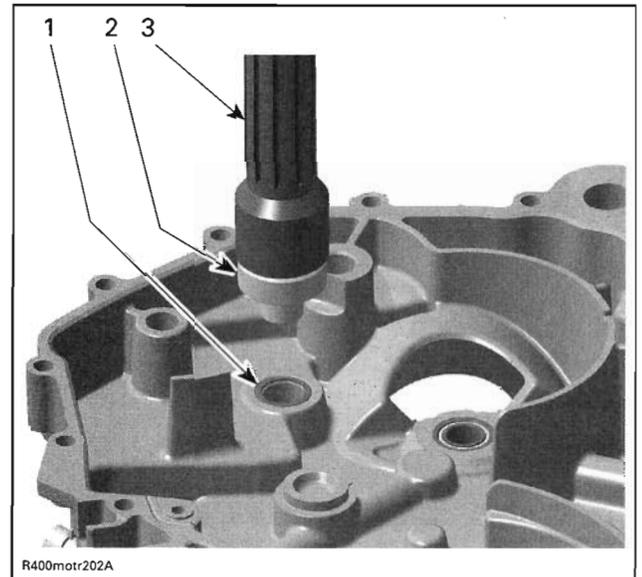
To remove main shaft needle bearing no. 18, use a punch as follows.



1. Main shaft needle bearing location
2. Punch

**Main Shaft Needle Bearing Installation**

Install needle bearing no. 18 with the needle bearing installer (P/N 529 035 762) and insertion handle (P/N 420 877 650).

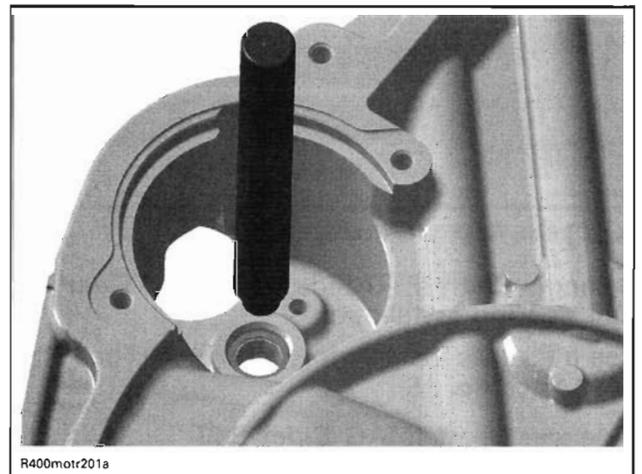


**MAIN SHAFT**

1. Main shaft needle bearing
2. Needle bearing installer
3. Insertion handle

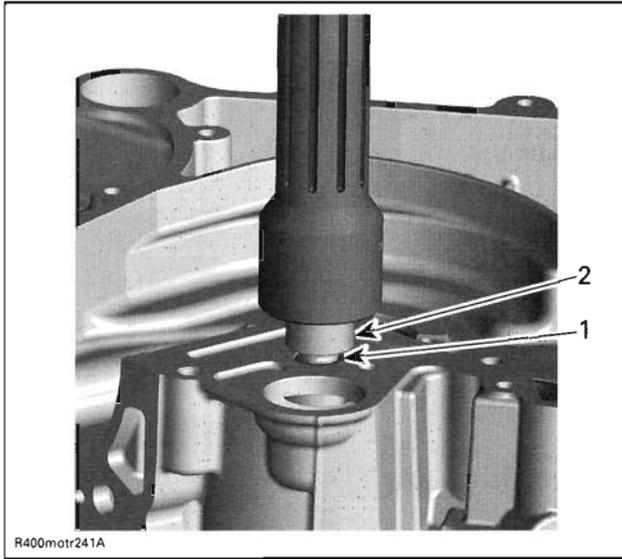
**Starter Drive Pinion Needle Bearing Removal**

Use needle bearing remover (P/N 529 035 756) to remove needle bearing no. 20.



**Starter Drive Pinion Needle Bearing Installation**

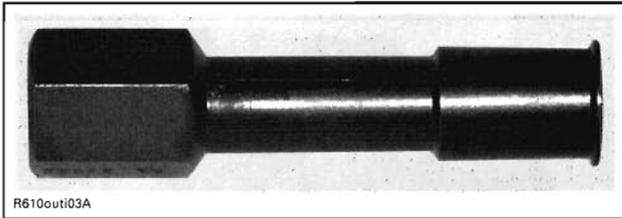
Install needle bearing no. 20 with the needle bearing installer (P/N 529 035 943) and insertion handle (P/N 420 877 650).

**Section 01 ENGINE****Subsection 07 (CRANKSHAFT AND CRANKCASE)****STARTER DRIVE PINION**

1. Starter drive needle bearing PTO side
2. Needle bearing installer

**Balancer Shaft (PTO Side) and Bevel Gear Ball Bearing Removal**

To remove ball bearings no. 14 and no. 15, use a blind hole bearing puller.

**BLIND HOLE BEARING PULLER****Balancer Shaft (PTO Side) and Bevel Gear Ball Bearing Installation**

Use a suitable installer for installing ball bearings no. 14 and no. 15.

**Balancer Shaft (MAG Side) Ball Bearing Removal**

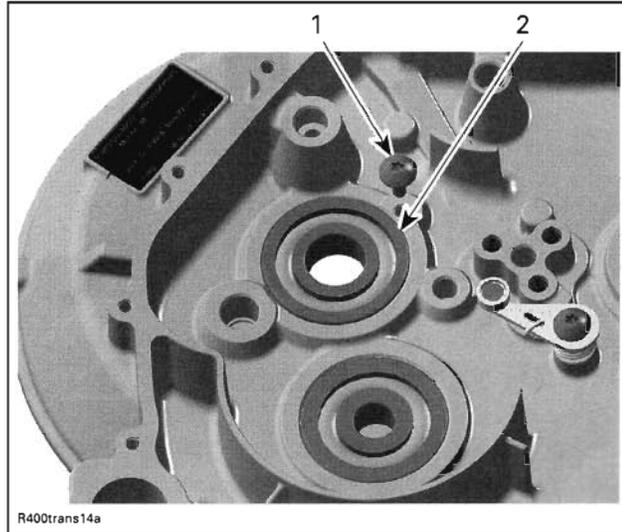
Ball bearing no. 13 can be easily removed with a suitable pusher from outside in.

**Balancer Shaft (MAG Side) Ball Bearing Installation**

Use a suitable installer for installing ball bearing no. 13.

**Main Shaft (PTO Side) Ball Bearing Removal**

For main shaft ball bearing no. 16, remove screw no. 19 then push bearing from outside in with a punch.



1. Screw M6
2. Main shaft ball bearing (PTO side)

**Main Shaft (PTO Side) Ball Bearing Installation**

Use a suitable installer for installing ball bearing no. 16.

**Assembly**

The assembly of crankcase is essentially the reverse of removal procedure. However, pay attention to the following details.

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

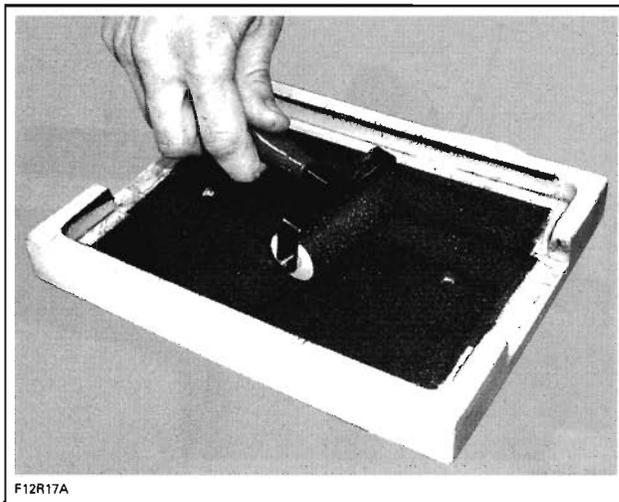
**IMPORTANT:** When beginning the application of the crankcase sealant, the assembly and the first torquing should be done within 10 minutes. It is suggested to have all you need on hand to save time.

Use a plexiglas 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.

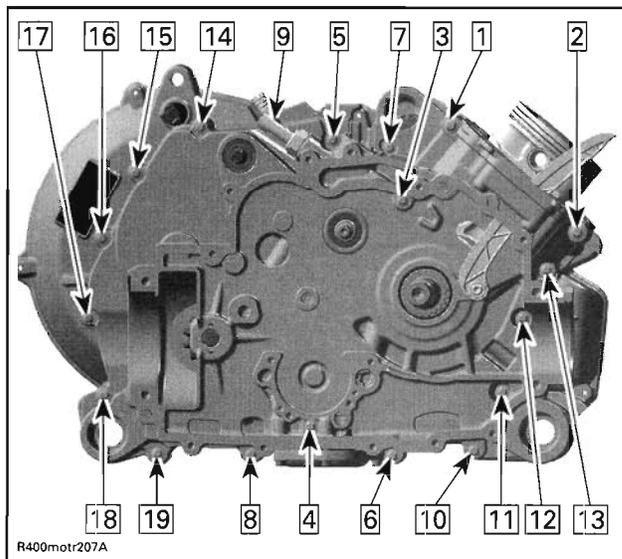
**NOTE:** It is recommended to apply this specific sealant as described here to get a uniform application without lumps. If you do not use the roller method, you may use your finger to uniformly distribute the sealant (using a finger will not affect the adhesion). Do not apply in excess as it will spread out inside crankcase.

**Section 01 ENGINE**

**Subsection 07 (CRANKSHAFT AND CRANKCASE)**



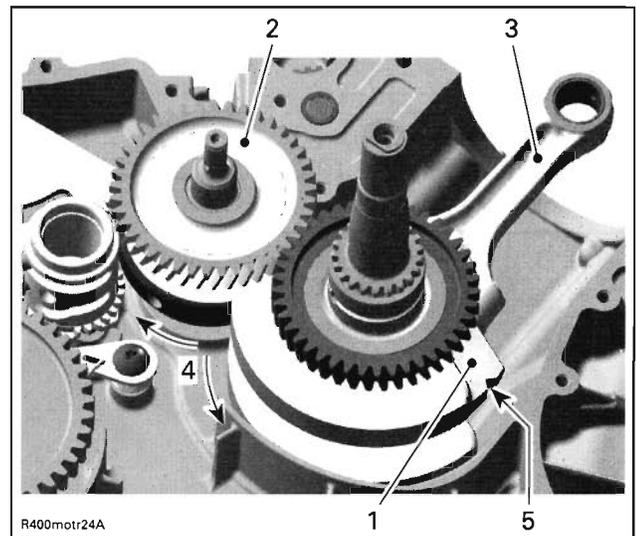
Torque crankcase screws by hand as per following sequence. Repeat procedure, retightening all screws to 10 N•m (89 lbf•in).



**BALANCER SHAFT**

**Removal**

Split crankcase (refer to *CRANKCASE*).  
 Remove the crankshaft locking bolt.  
 Align the dot of crankshaft gear with the balancer shaft gear dot then remove balancer shaft no. 4.



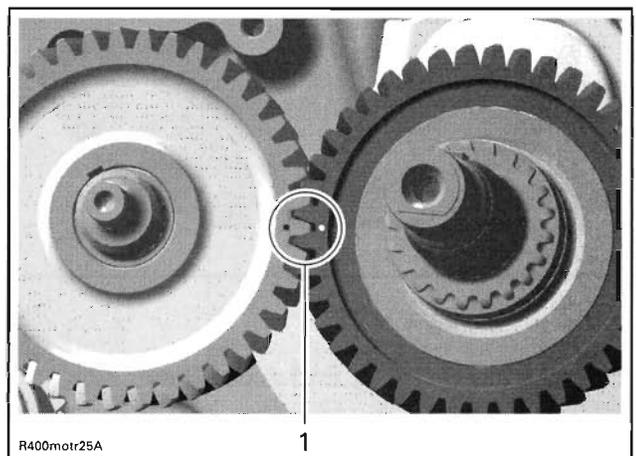
1. Crankshaft
2. Balancer shaft
3. Connecting rod
4. Rotate crankshaft for balancer shaft removal
5. Groove for fixation at TDC

**Inspection**

Check balancer shaft and replace if damaged.  
 Check ball bearings on MAG and PTO side for excessive play and smooth operation. Replace if necessary.  
 If the gear on the balancer shaft is damaged, replace balancer shaft.  
 Check gears on the crankshaft and replace crankshaft if necessary (refer to *CRANKSHAFT* below).

**Installation**

For installation, reverse the removal procedure. Pay attention to following detail.  
 Align the dot on crankshaft gear with the balancer shaft gear dot.



1. Punched marks located in the gears

**Section 01 ENGINE**

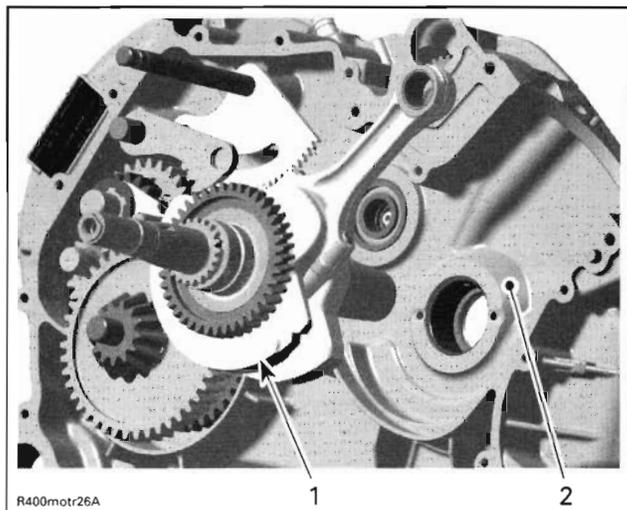
**Subsection 07 (CRANKSHAFT AND CRANKCASE)**

**CRANKSHAFT**

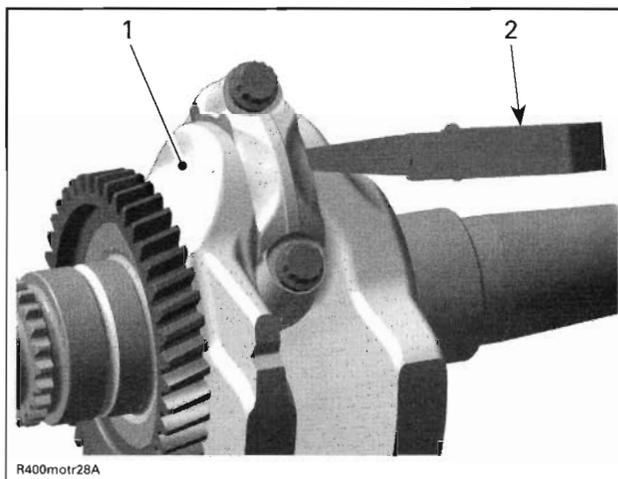
**Removal**

Remove:

- balancer shaft (see *BALANCER SHAFT*)
- crankshaft no. 3.



1. Crankshaft  
2. Crankcase PTO

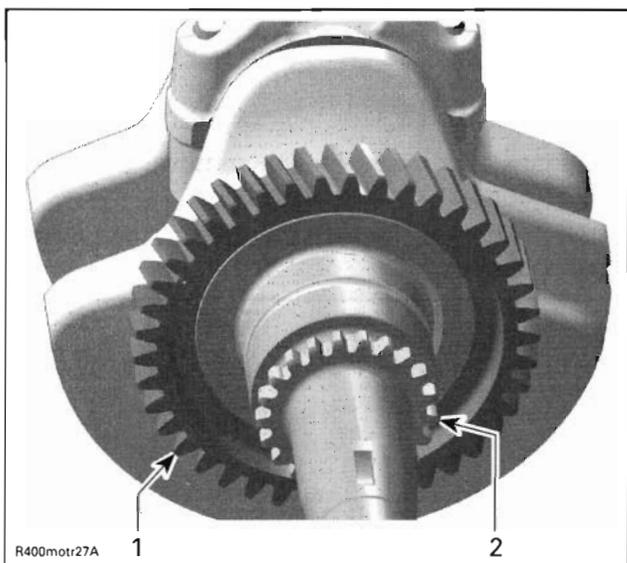


1. Crankshaft  
2. Feeler gauge

CONNECTING ROD BIG END AXIAL PLAY	
MINIMUM (new)	0.100 mm (.004 in)
MAXIMUM (new)	0.352 mm (.014 in)
SERVICE LIMIT	0.5 mm (.02 in)

**Inspection and Disassembly**

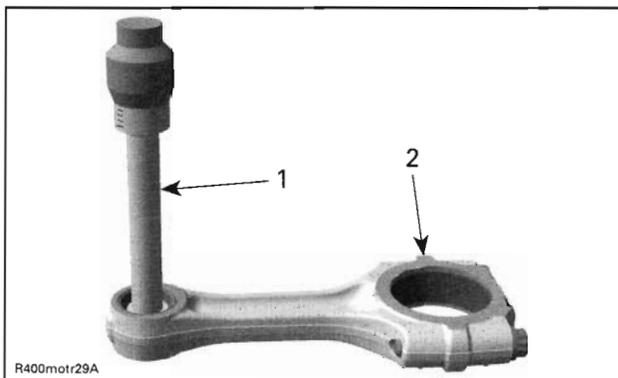
Replace crankshaft if the gears are worn or otherwise damaged.



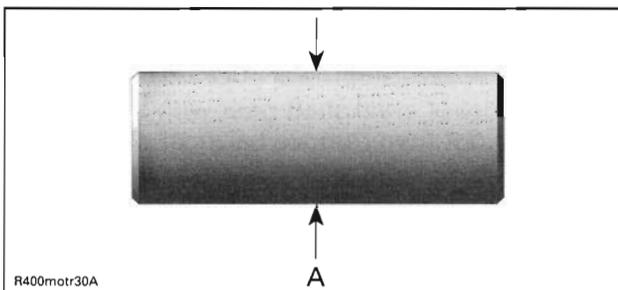
1. Balancer gear  
2. Crankshaft timing gear

**Connecting Rod/Piston Pin Clearance**

Measure piston pin. Compare to inside diameter of connecting rod no. 6.



1. Bore gauge  
2. Connecting rod



A. Piston pin diameter in the area of the plain bearing

**Connecting Rod Big End Axial Play**

Using a feeler gauge, measure distance between butting face of connecting rod and crankshaft counterweight. If the distance exceeds specified tolerance, replace the crankshaft.

**Section 01 ENGINE**

**Subsection 07 (CRANKSHAFT AND CRANKCASE)**

CONNECTING ROD SMALL END DIAMETER	
MINIMUM (new)	20.010 mm (.7878 in)
MAXIMUM (new)	20.020 mm (.7882 in)
SERVICE LIMIT	20.060 mm (.7898 in)
PISTON PIN DIAMETER	
MINIMUM (new)	19.996 mm (.7872 in)
MAXIMUM (new)	20.000 mm (.7874 in)
SERVICE LIMIT	19.980 mm (.7866 in)
PISTON PIN BORE CLEARANCE	
SERVICE LIMIT	0.080 mm (.0035 in)

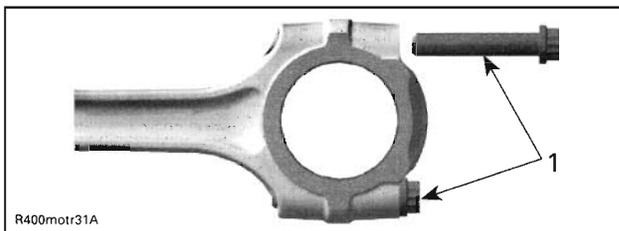
If the connecting rod small end diameter is out of specification, replace connecting rod.

**Connecting Rod Big End Radial Play**

**NOTE:** Prior to remove connecting rod from the crankshaft, mark big end halves together to ensure a correct reinstallation (cracked surface fits in only one position).

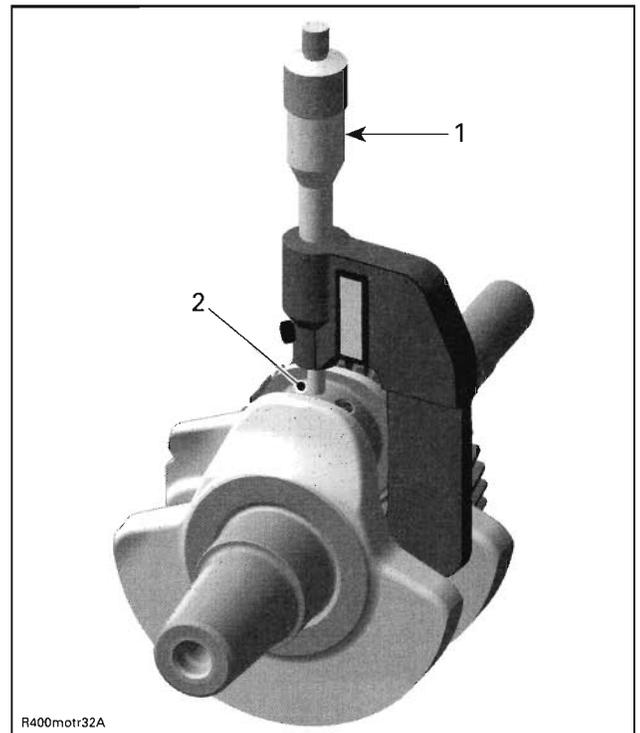
Remove connecting rod no. 6 from crankshaft no. 3.

**CAUTION:** Always replace connecting rod screws no. 7 if removing the connecting rod. It is also recommended to replace plain bearings no. 8.



1. Connecting rod screw

Measure crankpin. Compare to inside diameter of connecting rod big end.

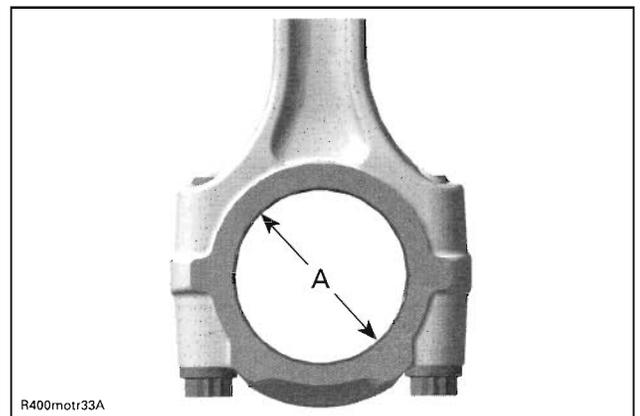


1. Micrometer  
2. Crankpin area for plain bearings

To measure the connecting rod big end diameter, use the OLD screws no. 7.

Install the OLD plain bearings no. 8 as they were mounted initially.

Do the torque procedure as described further.



A. Connecting rod big end plain bearing

CRANKSHAFT PIN DIAMETER	
MINIMUM (new)	40.009 mm (1.575 in)
MAXIMUM (new)	40.025 mm (1.576 in)
SERVICE LIMIT	39.980 mm (1.574 in)
CONNECTING ROD BIG END DIAMETER	
SERVICE LIMIT	40.100 mm (1.579 in)

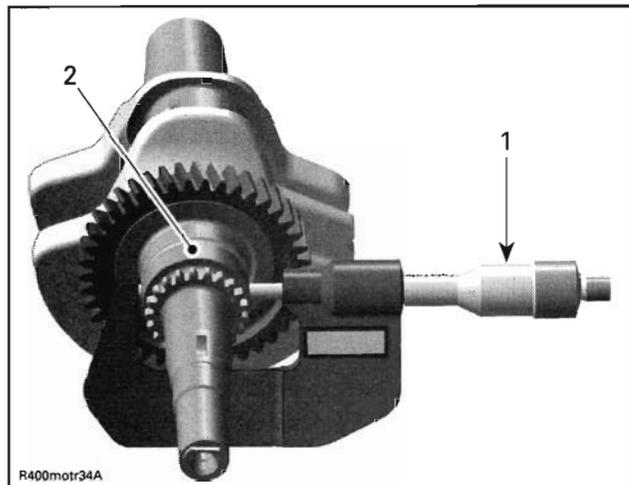
**Section 01 ENGINE**

**Subsection 07 (CRANKSHAFT AND CRANKCASE)**

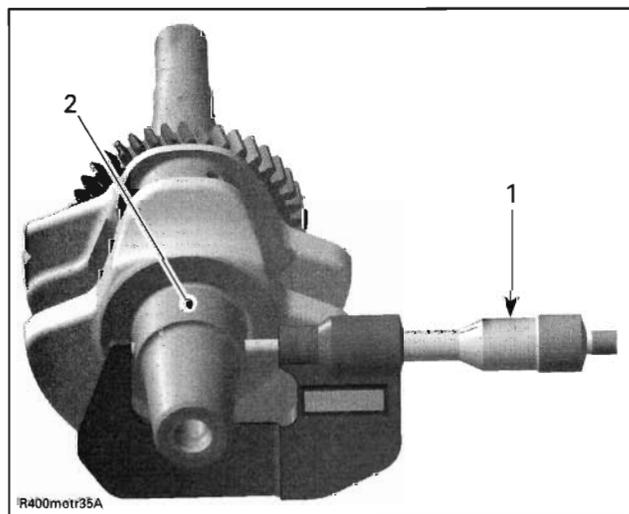
CONNECTING ROD BIG END CLEARANCE	
SERVICE LIMIT	0.09 mm (.0035 in)

**Crankshaft Radial Play MAG/PTO Side**

Measure crankshaft on MAG/PTO side. Compare to inside diameter of MAG/PTO plain bearings.



- 1. Micrometer
- 2. Crankshaft area for MAG plain bearing



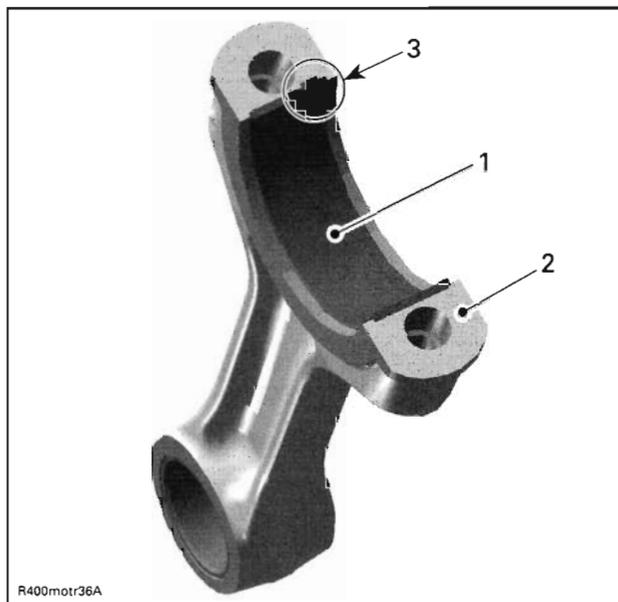
- 1. Micrometer
- 2. Crankshaft area for PTO plain bearing

CRANKSHAFT MAG/PTO DIAMETER	
MINIMUM (new)	42.024 mm (1.6545 in)
MAXIMUM (new)	42.040 mm (1.6551 in)
SERVICE LIMIT	42.000 mm (1.6535 in)
CRANKSHAFT MAG RADIAL CLEARANCE	
SERVICE LIMIT	0.07 mm (.0028 in)

**Assembly**

Use NEW bearings no.-8, when connecting rod big end diameter is out of specification.

Put plain bearings correctly in place and clean the split surface on both sides (cracked area) carefully.

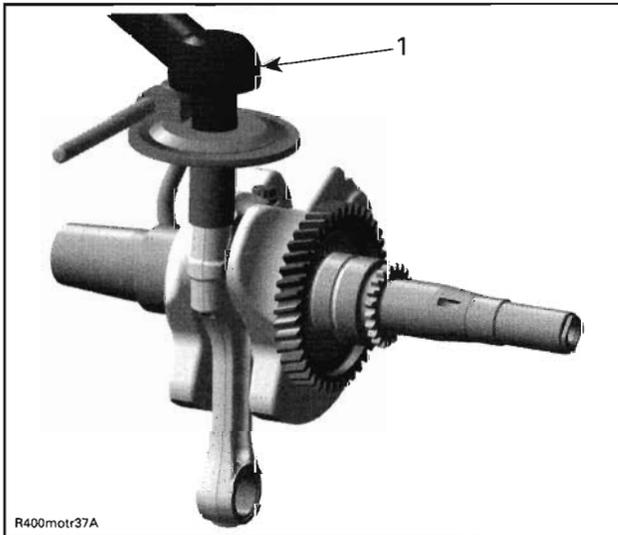


- 1. Half plain bearing of connecting rod big end
- 2. Split surface of the connecting rod
- 3. Nose of bearing in line with connecting rod groove

Torque NEW connecting rod screws no. 7 as per following procedure:

- Install screws with half of recommended torque in the exploded view. Do not apply any thread locker product.
- Torque with the recommended values in the exploded view.
- Finish tightening the screws with an additional 60° turn using an angle torque wrench.

**CAUTION:** Failure to strictly follow this procedure may cause screw to loosen and lead to engine damage. The bearing tapered end must be against the counterweight. Besides, as the "crankpin" screw has been stretched from the previous installation, it is very important to use a new screw at assembly.

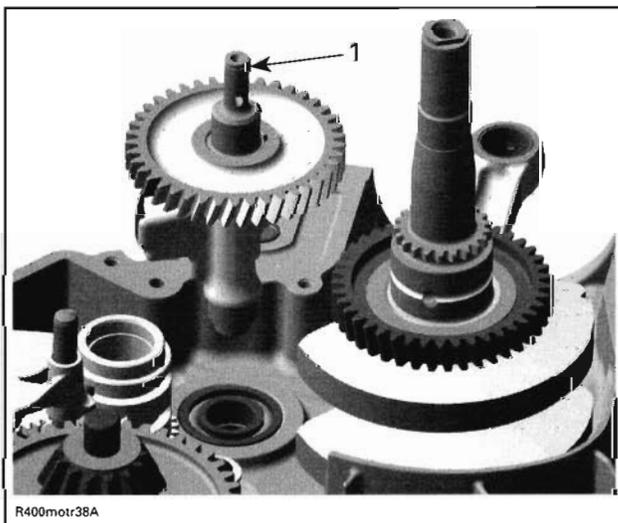


1. Angle torque wrench

**Installation**

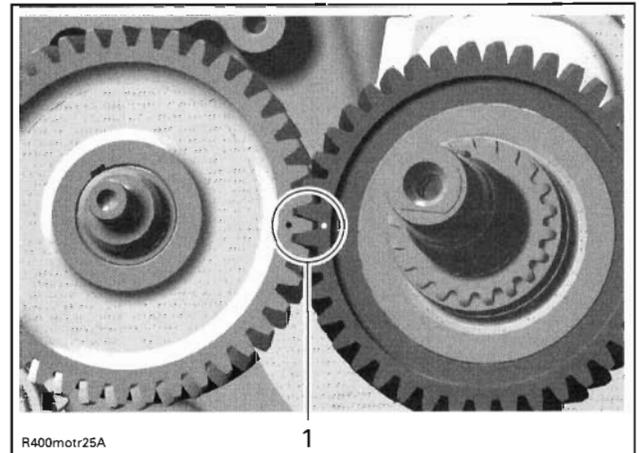
For installation, reverse the removal procedure. Pay attention to following details.

Install crankshaft first then balancer shaft.



1. Insertion of balancer shaft

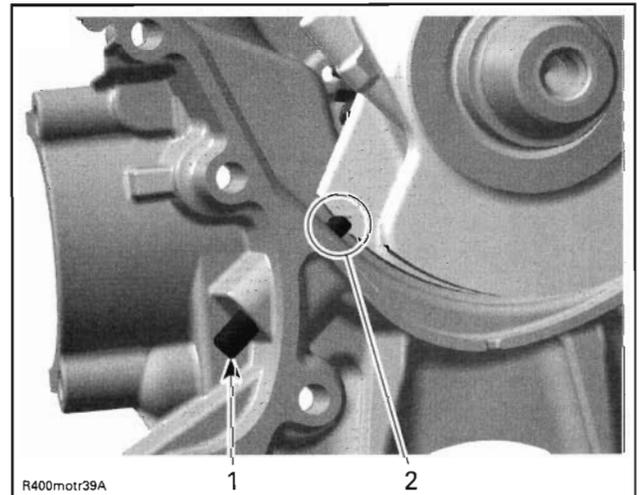
Align the marks of crankshaft and balancer shaft.



1. Punched marks located in the gears

After reinstalling of crankcase MAG, measure axial clearance of crankshaft with a feeler gauge on the PTO side between PTO crankcase and crankshaft thrust surface.

**CAUTION:** Install crankshaft locking bolt (P/N 529 035 617) to put crankshaft in TDC position.



1. Crankshaft locking bolt  
2. Engagement groove for TDC position of the piston

**NOTE:** Always degrease tapers on both sides of the crankshaft before reinstalling rotor or CVT.

**CAUTION:** Make sure the woodruff key on crankshaft MAG is present and correctly in place.

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**Section 01 ENGINE**

**Subsection 08 (GEARBOX AND OUTPUT SHAFT)**

**GENERAL**

During assembly/installation, use the torque values and service products as in the exploded view.

**⚠ 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.

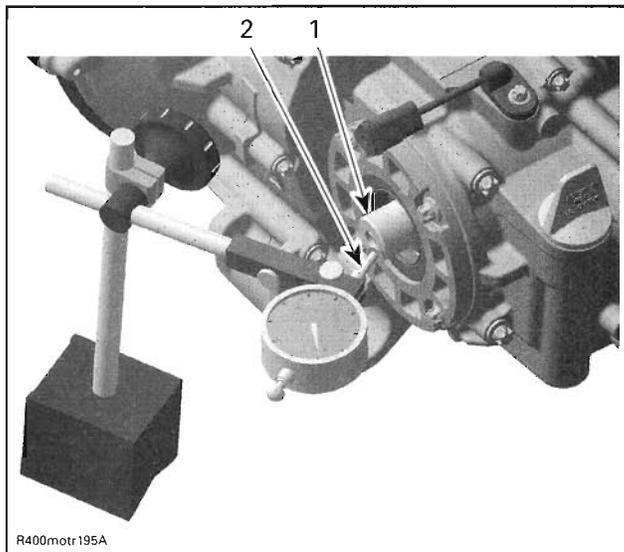
**PROCEDURES**

**OUTPUT SHAFT**

**Removal**

Remove the engine from the vehicle. Refer to the appropriate *VEHICLE SHOP MANUAL*.

Measure output shaft axial clearance prior to remove it.



1. Output shaft  
2. Dial indicator

OUTPUT SHAFT AXIAL CLEARANCE	
SERVICE LIMIT	0.30 mm (.012 in)

If the output shaft axial clearance is out of specification, crankcase must be split and perform the *BEVEL GEAR ADJUSTMENT* procedure. See *GEARBOX* in this section.

**CAUTION:** If the output shaft must be changed, always replace the bevel gear shaft at the same time.

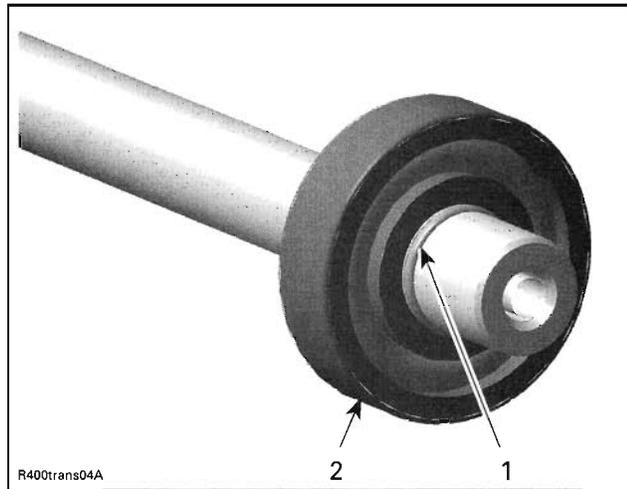
Remove:

- magneto cover and rotor (refer to *MAGNETO SYSTEM* in this shop manual)
- output shaft no. 6

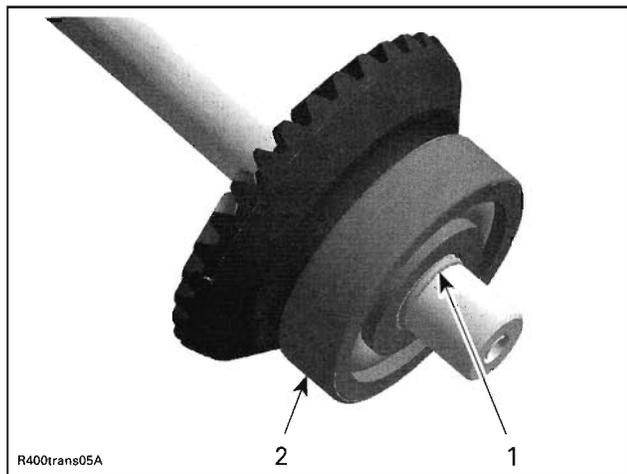
**CAUTION:** Use a soft hammer to remove output shaft from housing.

- both O-rings and both bearings

**NOTE:** Both bearings on output shaft have a transition fit.

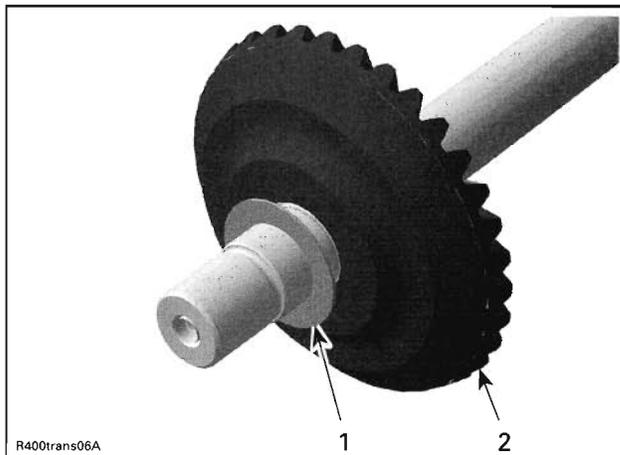


1. O-ring  
2. Bearing on front side



1. O-ring  
2. Bearing on rear side

- thrust washer.



1. Thrust washer
2. Output shaft ring gear

### Inspection

Check output shaft for bending, cracks and other visible damages.

**CAUTION:** Always replace output shaft and bevel gear shaft at the same time.

Check output shaft gear for wear and teeth damages.

Check if output shaft bearings no. 7 and no. 8 turn freely and smoothly. Replace if necessary.

Replace output shaft seal if brittle, hard or damaged. Refer to *CRANKSHAFT AND CRANKCASE* for replacement procedure.

Replace O-rings no. 9 and no. 10 if brittle, hard or damaged.

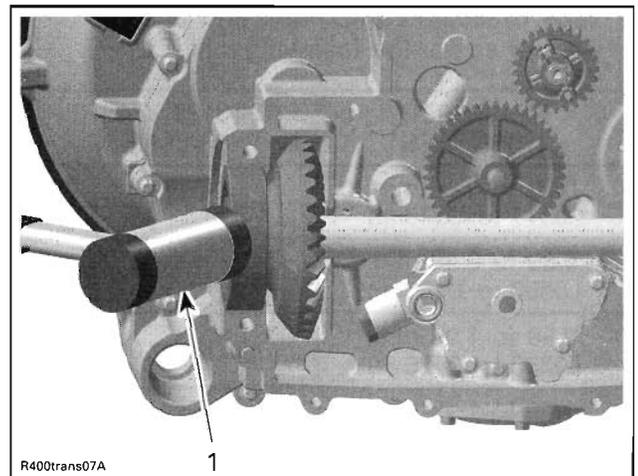
Clean crankcase and magneto cover mating surface and especially the bearing areas from metal particles or other contamination.

### Installation

For installation, reverse the removal procedure. Pay attention to following details.

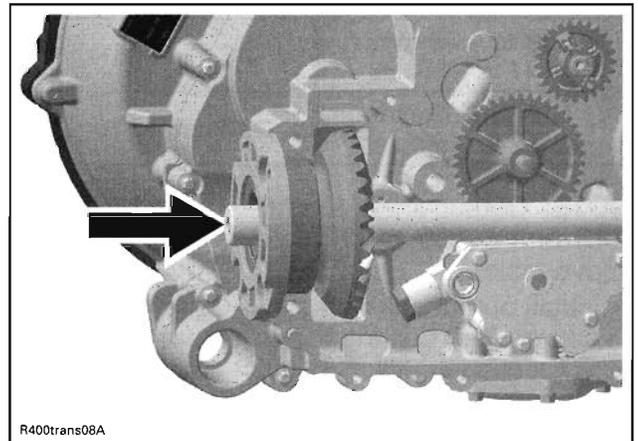
Adjust axial play as per following procedure:

- Install output shaft in housing without thrust washer no. 11.
- Use soft hammer to put bearings exactly in place against crankcase.



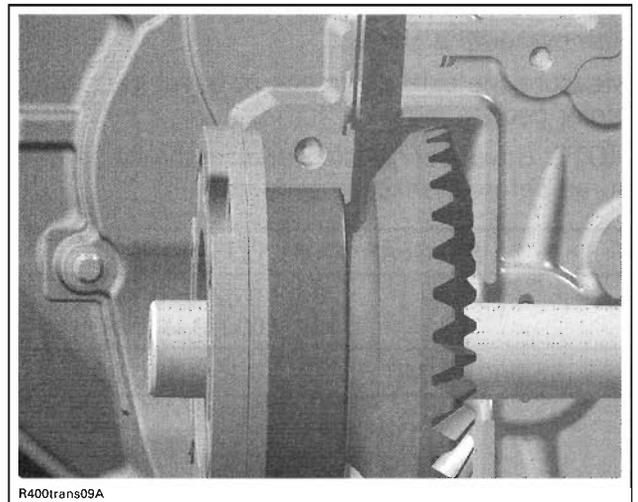
1. Soft hammer

- Push output shaft as per following illustration.



**WAY TO PUSH THE BEVEL GEARS TOGETHER**

- Install output shaft bearing flange and measure axial gap between bearing and output shaft gear with a feeler gauge.



- Remove output shaft again and rebuild it with proper thrust washer.

**Section 01 ENGINE**

**Subsection 08 (GEARBOX AND OUTPUT SHAFT)**

- Take measured thickness and choose thrust washer as per the following table.

MEASURED THICKNESS	THRUST WASHER THICKNESS
0.79 to 0.88 mm (.0311 to .0346 in)	0.70 mm (.0276 in)
0.89 to 0.98 mm (.0350 to .0386 in)	0.80 mm (.0315 in)
0.99 to 1.08 mm (.0390 to .0425 in)	0.90 mm (.0354 in)
1.09 to 1.18 mm (.0429 to .0465 in)	1.00 mm (.0394 in)
1.19 to 1.28 mm (.0469 to .0504 in)	1.10 mm (.0433 in)
1.29 to 1.38 mm (.0508 to .0543 in)	1.20 mm (.0472 in)
1.39 to 1.48 mm (.0547 to .0583 in)	1.30 mm (.0512 in)
1.49 to 1.58 mm (.0587 to .0622 in)	1.40 mm (.0511 in)

**NOTE:** Output shaft axial clearance of 0.09 to 0.18 mm (.0035 to .0071 in) is included in the above table.

- Install output shaft. Install magneto cover and output shaft bearing flange. Refer to *MAGNETO* section in this manual for procedure.

**GEARBOX**

**Disassembly**

Remove engine from vehicle.

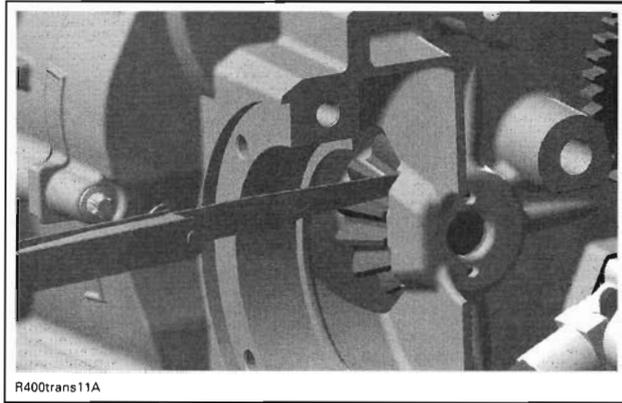
**NOTE:** During gearbox disassembly, inspect the condition of each part closely.

Remove output shaft.

Measure the axial clearance of bevel gear with a feeler gauge.

**NOTE:** Bevel gear axial clearance should be measured before crankcase separation.

BEVEL GEAR AXIAL CLEARANCE	
NEW	0.02 to 0.11 mm (.00079 to .00433 in)
SERVICE LIMIT	0.15 mm (.059 in)

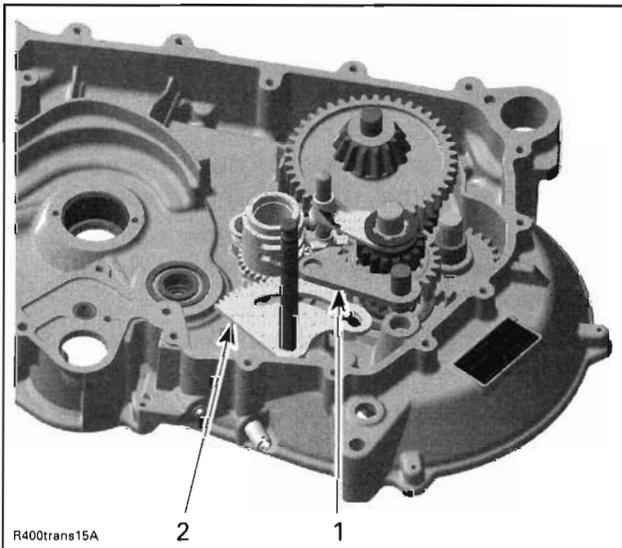


MEASURE AXIAL CLEARANCE OF BEVEL GEAR

Separate crankcase, refer to *CRANKSHAFT AND CRANKCASE*.

Remove:

- balancer shaft
- parking lever
- shift shaft

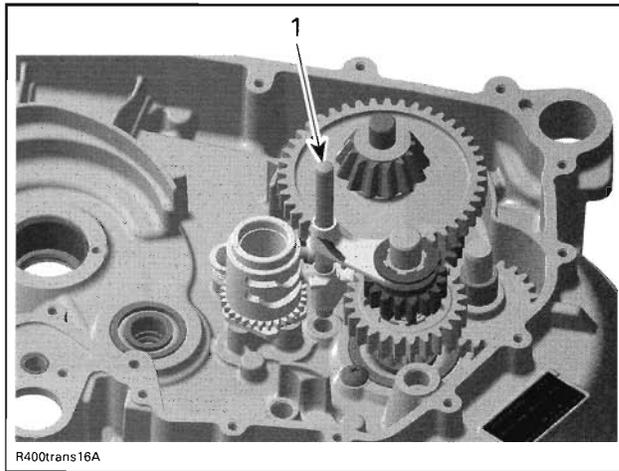


1. Parking lever  
2. Shift shaft

- shift fork shaft

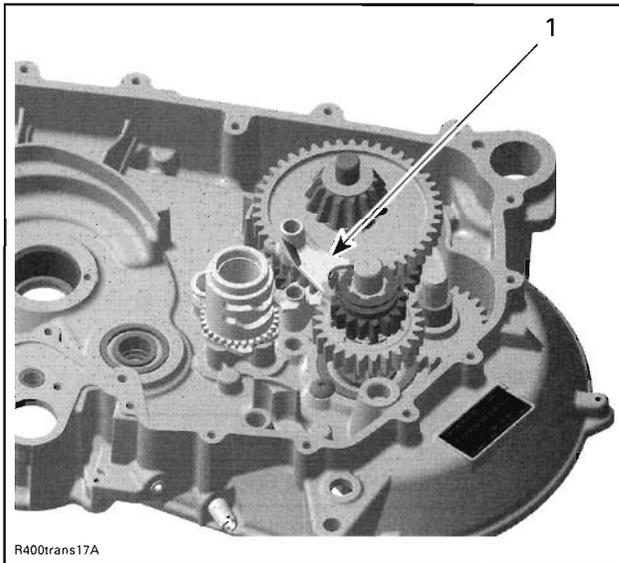
**Section 01 ENGINE**

**Subsection 08 (GEARBOX AND OUTPUT SHAFT)**



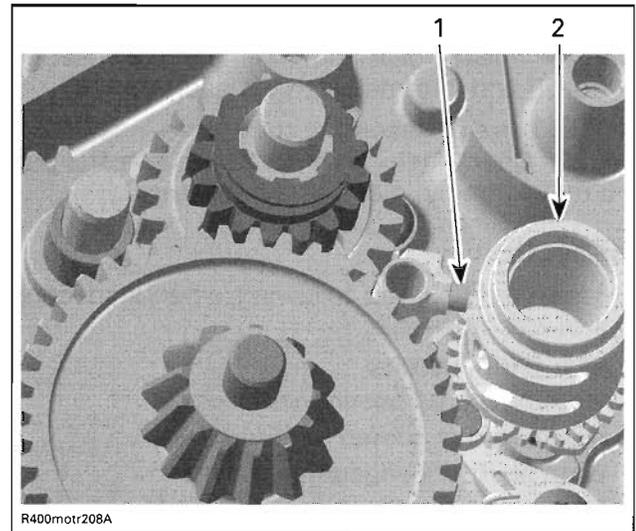
1. Shift fork shaft

– shift fork.



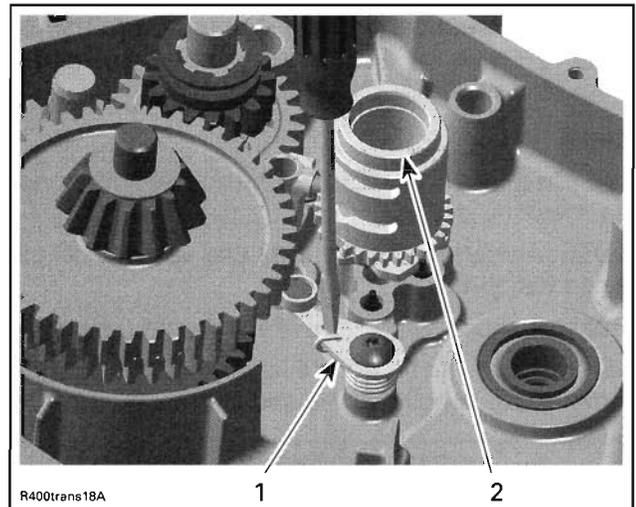
1. Shift fork (engaged in main shaft gear)

Disengage shift fork from shift drum.



1. Shift fork engagement pin  
2. Shift drum

Insert a flat screwdriver in the slot of index lever. Turn screwdriver counterclockwise and remove shift drum.



1. Index lever  
2. Shift drum

Remove:

- shift fork no. 12
- bevel gear shaft no. 13 with low range gear assembly
- main gear no. 14
- O-ring no. 15 including distance sleeve no. 16 from main shaft no. 17 on engine PTO side
- main shaft with high range gear no. 18 assembly
- gear selection no. 19, thrust washer no. 20, reverse gear no. 21, needle bearing no. 22 and thrust washer no. 23

**Section 01 ENGINE**

**Subsection 08 (GEARBOX AND OUTPUT SHAFT)**

- distance sleeve no. 24, thrust washer no. 25, intermediate gear no. 26, needle bearing no. 27 and intermediate gear shaft no. 28.

**NOTE:** It is not necessary to remove index lever no. 29. Check index lever for visible damage and if it moves freely. Replace if necessary.

**Inspection**

Always verify for the following when inspecting gearbox components:

- gear teeth damage
- worn or scored bearing surfaces
- bent, worn or scored shift fork
- worn shift fork engagement pins
- bent, worn or scored shift fork shaft
- rounded engagement dogs and slots of gears
- worn grooves on shift drum
- worn gear engagement groove
- worn splines on shafts and gears.

**Bearings**

Check all bearings, bearing points, tooth flanks, taper grooves and annular grooves. Annular grooves must have sharp edges.

**Gears**

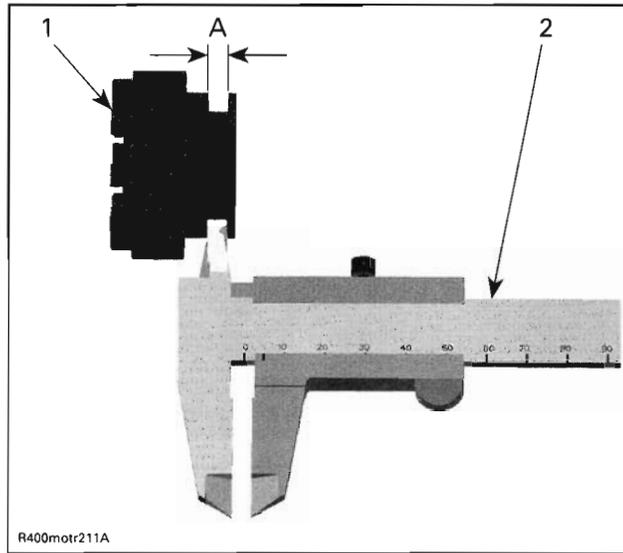
Replace gears only together with the corresponding meshing gears.

**NOTE:** Always replace circlips and use special pliers to install them.

Measure the engagement groove width of gears.

**NOTE:** Both gears no. 14 and no. 19 have the same width specifications and service limit.

GEAR GROOVE WIDTH	
NEW	5.00 to 5.10 mm (.197 to .201 in)
SERVICE LIMIT	5.20 mm (.205 in)



- 1. Main gear
- 2. Caliper
- A. Engagement groove width

**Levers**

Parking lever no. 30 for cracks or other damages.

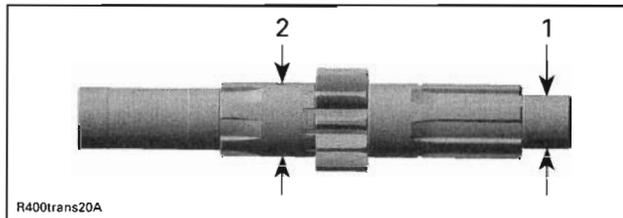
Roller of index lever no. 29 must have free movement.

**Shafts**

Check shift shaft no. 31 for worn splines and gears.

Check main shaft no. 17 for wear.

MAIN SHAFT	
SERVICE LIMIT	
MAG side	17.990 mm (.708 in)
PTO side	24.950 mm (.982 in)



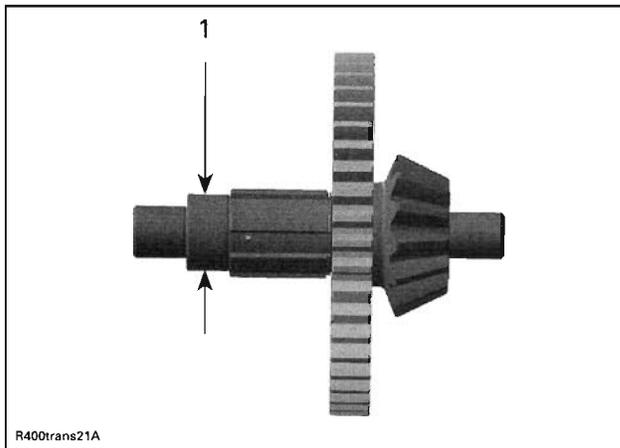
- 1. Mag side
- 2. PTO side

Check bevel gear shaft no. 13.

BEVEL GEAR SHAFT	
SERVICE LIMIT	
PTO side	24.990 mm (.984 in)

**Section 01 ENGINE**

**Subsection 08 (GEARBOX AND OUTPUT SHAFT)**



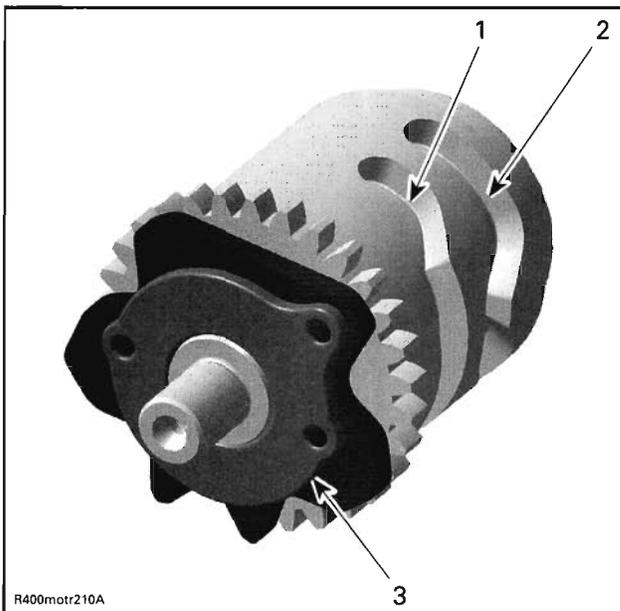
1. PTO side

**Shift Drum**

Check tracks of shift drum no. 32 for scoring or heavy wear like rounded engagement slots.

Check index washer on shift drum for scoring or visible damages.

Replace isolating washer no. 33 if there are signs of wear or visible damages.



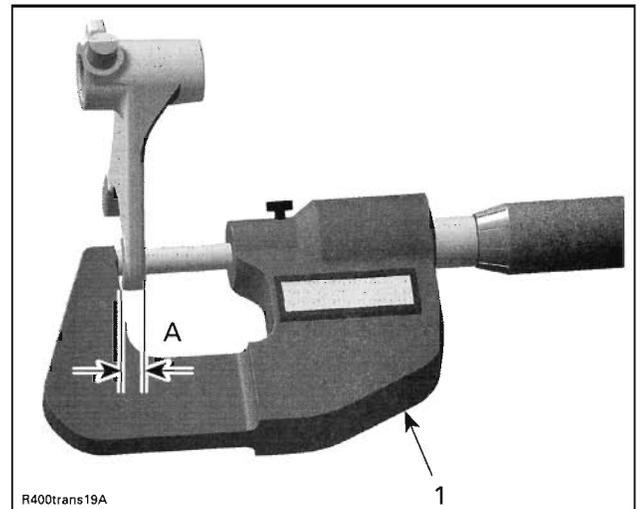
- 1. Track for the low/reverse gear shift fork
- 2. Track for the high gear shift fork
- 3. Isolating washer on the shift drum

**Shift Forks**

Check both shift forks no. 12 and no. 34 for visible damage, wear or bent shift fork claws.

Measure the shift fork claw thickness.

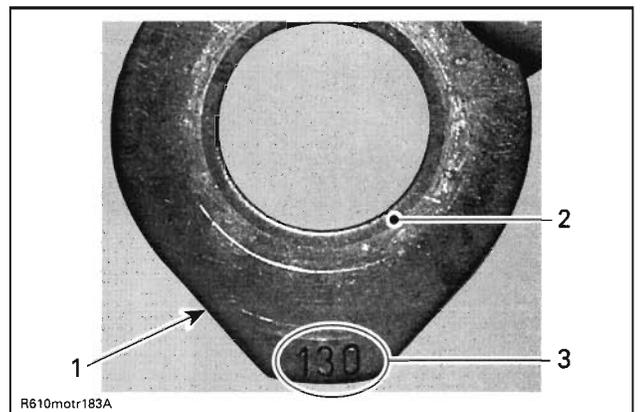
SHIFT FORK CLAW THICKNESS	
NEW	4.800 to 4.900 mm (.189 to .193 in)
SERVICE LIMIT	4.750 mm (.187 in)



- 1. Micrometer
- A. Shift fork claw thickness

**Thrust Washers**

Check thrust washers no. 23 and no. 35 for wear. Always replace thrust washer by a new one with the same thickness, when reassembling the gear-box with existing output shaft no. 6 and bevel gear no. 13.



- 1. Thrust washer for adjusting the bevel gear axial clearance on PTO side
- 2. Area where wear signs appear
- 3. Adjustment thickness of the washer

**Section 01 ENGINE**

**Subsection 08 (GEARBOX AND OUTPUT SHAFT)**

**Bevel Gear Adjustment**

**NOTE:** When the output shaft axial clearance is out of specification or if the following parts are changed (output shaft, bevel gear or crankcase), the bevel gear adjustment must be verified.

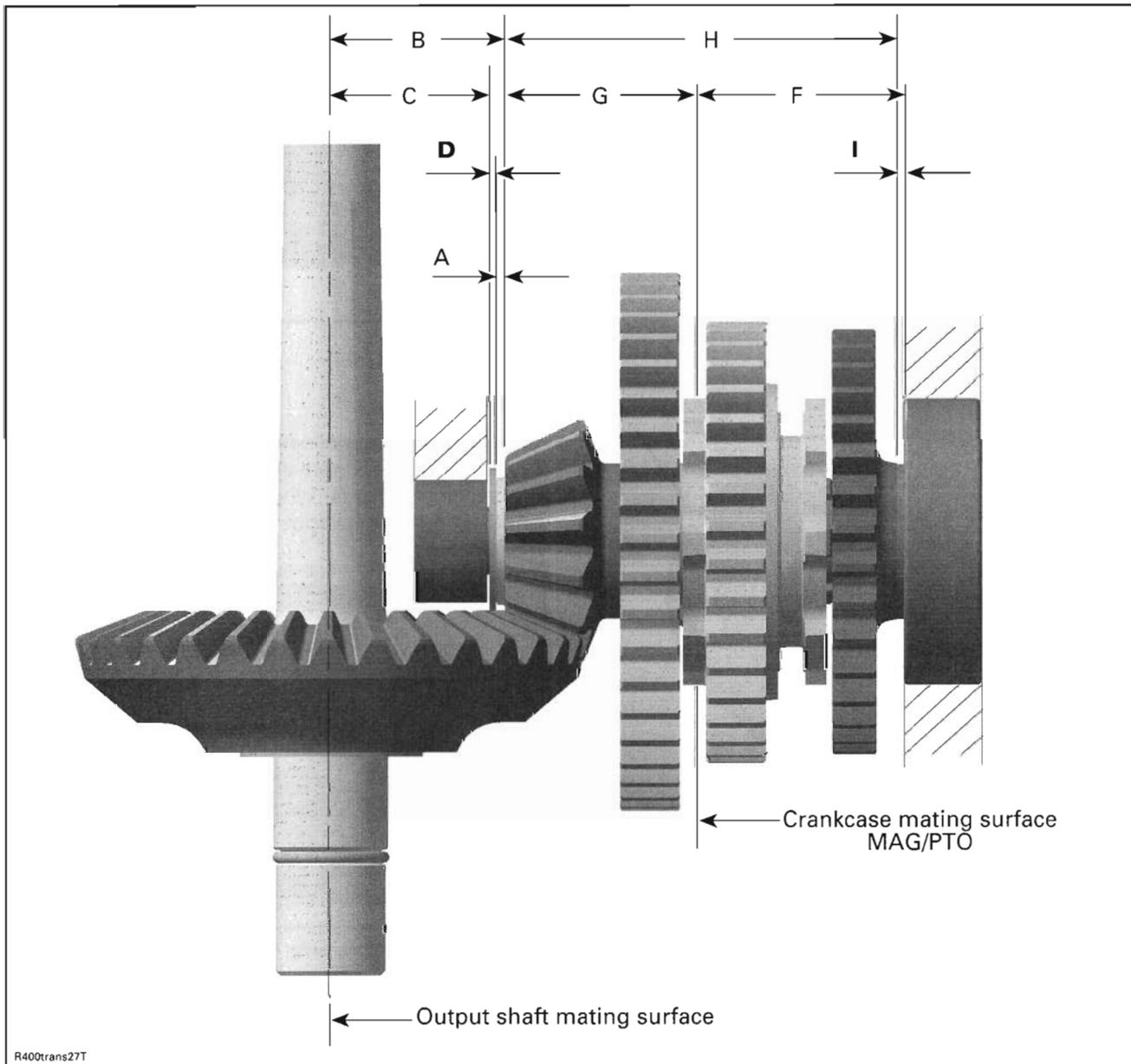
The bevel gear adjustment includes:

- bevel gear backlash on MAG side crankcase
- bevel gear axial clearance on PTO side crankcase.

The bevel gear backlash is adjusted by finding the distance **D** (see illustration) and using the corresponding thrust washer thickness.

The bevel gear axial clearance is adjusted by finding the distance **I** (see illustration) and using the corresponding thrust washer thickness.

**NOTE:** Clean mating surface of crankcase before taking measurements. Refer to *CRANKSHAFT AND CRANKCASE*.



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**BEVEL GEAR BACKLASH  
(MAG Side Crankcase)**

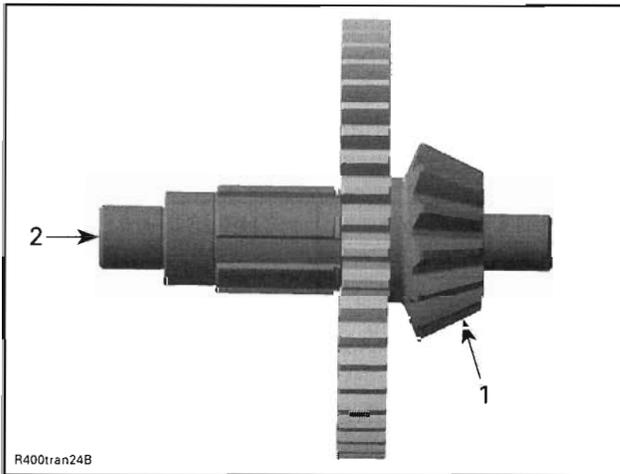
Use the following course of calculation to determine the theoretical thickness (D) of thrust washer no. 35 on MAG side crankcase:

$$D = B - C - A$$

- B = Distance between the thrust surface of bevel gear and the theoretical center of its taper. This is defined by manufacturer and written on the bevel gear shaft.

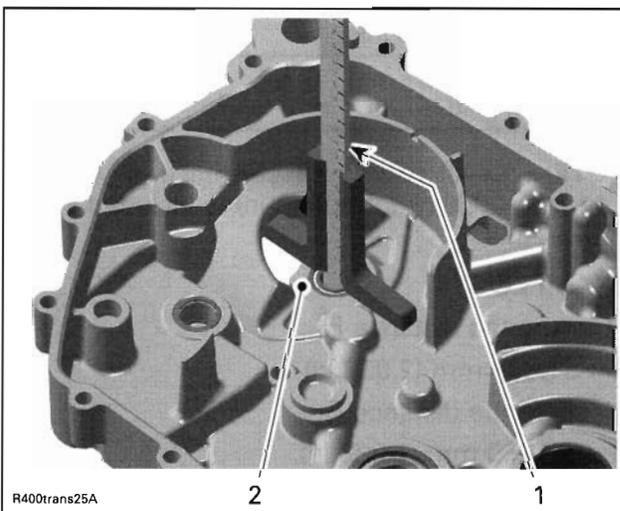
Use following course of calculation to find out value B.

$$B = \left( \frac{\text{bevel gear reference}}{100} \right) + 37.8$$



1. Bevel gear  
2. Area of written bevel gear reference number

- C = Distance between the shim thrust surface in the MAG side and the mating surface of crankcase MAG.



1. Depth gauge  
2. Shim thrust surface

- A = 2 mm (.0787 in) nominal thickness of needle bearing no. 36.

When all the measurements are taken, calculate the theoretical thickness D of thrust washer using the formula (D = B - C - A).

Take the obtained theoretical value D and choose the proper thrust washer according to table.

CALCULATED THICKNESS (D)	THRUST WASHER NUMBER
1.20 mm to 1.29 mm (.0472 to .0508 in)	120
1.30 mm to 1.39 mm (.0512 to .0547 in)	130
1.40 mm to 1.49 mm (.0551 to .0587 in)	140
1.50 mm to 1.59 mm (.0591 to .0626 in)	150
1.60 mm to 1.69 mm (.0630 to .0665 in)	160
1.70 mm to 1.79 mm (.0669 to .0705 in)	170
1.80 mm to 1.89 mm (.0709 to .0744 in)	180

**EXAMPLE**

Take the reference number on the bevel gear shaft: -3.

$$B = (-3/100) + 37.8$$

$$B = 37.77$$

Measure the distance C with a depth gauge, between the shim thrust surface in the MAG side and the mating surface of crankcase MAG.

$$C = 34.040 \text{ mm (1.340 in)}$$

The nominal thickness A of needle bearing is always 2 mm (.0787 in).

$$A = 2 \text{ mm (.0787 in)}$$

The theoretical shim thickness D is calculated as follows:

$$D = B - C - A$$

$$D = 37.77 - 34.040 - 2$$

$$D = 1.73 \text{ mm (.0681 in)}$$

**NOTE:** Take the obtained theoretical value D and choose the proper thrust washer according to table above.

In this example, the correct thrust washer number is 170.

**NOTE:** The thrust washer number 170 represents a value equal at 1.70 mm (.0669 in).

**Section 01 ENGINE**

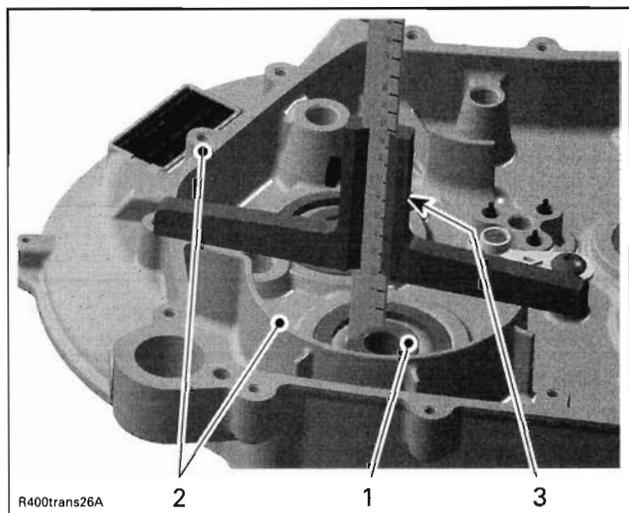
**Subsection 08 (GEARBOX AND OUTPUT SHAFT)**

**BEVEL GEAR AXIAL CLEARANCE  
(PTO Side Crankcase)**

Use the following course of calculation to determine the theoretical thickness (I) of thrust washer no. 23 on PTO side crankcase:

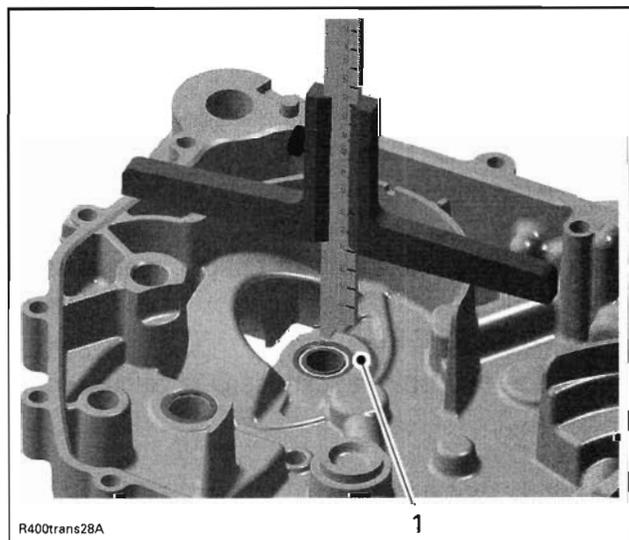
$$I = F + G - H - A - D$$

- F = Distance between mating surface (crankcase PTO) to ball bearing inner race.



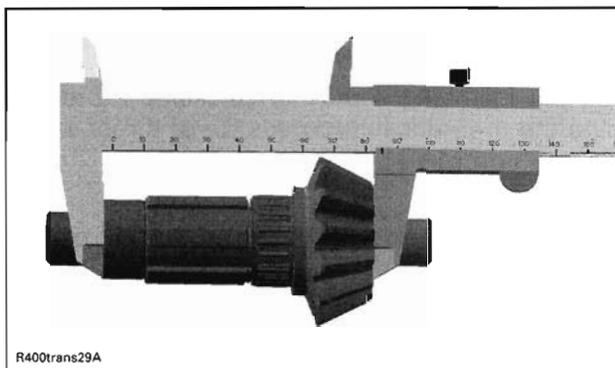
- 1. Ball bearing inner race
- 2. Mating surface of crankcase PTO
- 3. Depth gauge

- G = Distance between mating surface of crankcase MAG and butting face.



- 1. Butting surface

- H = Distance between thrust surfaces of bevel gear shaft.



R400trans29A

- A = 2 mm (.0787 in) nominal thickness of needle bearing no. 36.
- D = The theoretical shim thickness D as calculated in the *BEVEL GEAR BACKLASH (MAG SIDE CRANKCASE)*.

When all the measurements are taken, calculate the theoretical thickness I of thrust washer using the formula (I = F + G - H - A - D).

Take the obtained theoretical value I and choose the proper thrust washer according to table.

CALCULATED THICKNESS (I)	THRUST WASHER NUMBER
1.22 mm to 1.31 mm (.0480 to .0516 in)	120
1.32 mm to 1.41 mm (.0519 to .0555 in)	130
1.42 mm to 1.51 mm (.0559 to .0594 in)	140
1.52 mm to 1.61 mm (.0598 to .0634 in)	150
1.62 mm to 1.71 mm (.0638 to .0673 in)	160
1.72 mm to 1.81 mm (.0677 to .0713 in)	170
1.82 mm to 1.91 mm (.0717 to .0752 in)	180

**NOTE:** Bevel gear axial clearance of 0.02 to 0.11 mm (.00079 to .00433 in) is included in the above table.

**EXAMPLE**

Measure the distance F.

F = 51.800 mm (2.039 in).

Measure the distance G.

G = 39.080 mm (1.539 in).

Measure the distance H, between both butting surfaces of bevel gear shaft.

H = 85.680 mm (3.373 in).

The nominal thickness A of needle bearing is always 2 mm (.0787 in).

A = 2 mm (.0787 in)

Take the theoretical shim thickness D as calculated for the bevel gear backlash:

D = 1.73 mm (.0681 in)

The theoretical shim thickness I is calculated as follows:

$$I = F + G - H - A - D$$

$$I = 51.800 + 39.080 - 85.680 - 2 - 1.73$$

$$I = 1.47 \text{ mm}$$

**NOTE:** Take the obtained theoretical value I and choose the proper thrust washer according to table above.

In this example, the correct thrust washer number is 140.

**NOTE:** The thrust washer number 140 represents a value equal at 1.40 mm (.0551 in).

### Assembly

For installation, reverse the removal procedure. Pay attention to the following details.

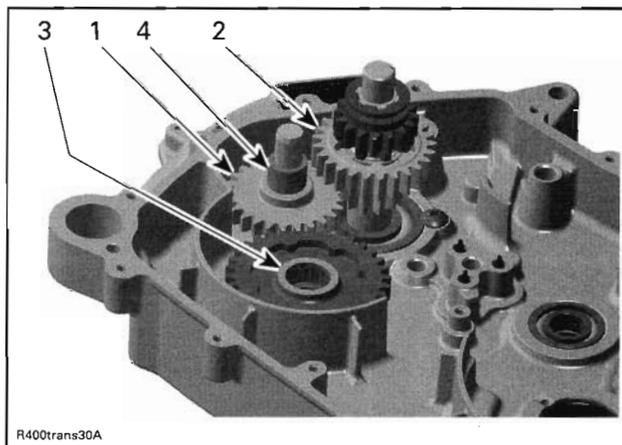
Install:

- intermediate gear shaft no. 28, needle bearing no. 27, intermediate gear no. 26, thrust washer no. 25 and distance sleeve no. 24
- thrust washer no. 23, needle bearing no. 22, reverse gear no. 21, thrust washer no. 20 and gear selection no. 19
- main shaft no. 17 with high range gear no. 18 assembly
- main gear no. 14
- bevel gear shaft no. 13 with low range gear no. 37 assembly

**NOTE:** If a new bevel gear is used, it is necessary to perform the *BEVEL GEAR ADJUSTMENT*. If the existing bevel gear is used, it is mandatory to use new thrust washers no. 23 and no. 35 with the same thickness and also a new needle bearing no. 36.

**CAUTION:** Do not forget thrust washer no. 20 and no. 25.

First install intermediate gear then main shaft and afterward the bevel gear.

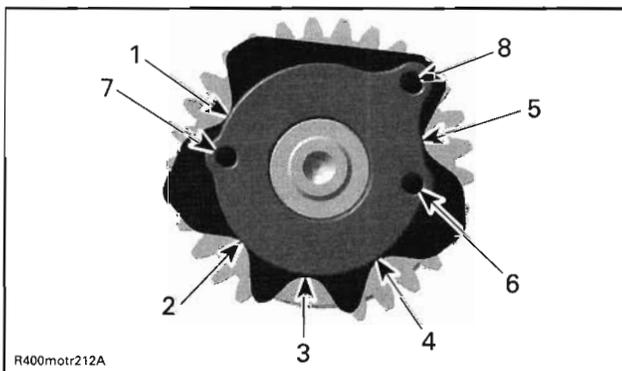


1. Intermediate gear
2. Main shaft
3. Thrust washer after gear selection on bevel gear
4. Thrust washer between distance sleeve and reverse gear

- shift forks no. 12 and no. 34.

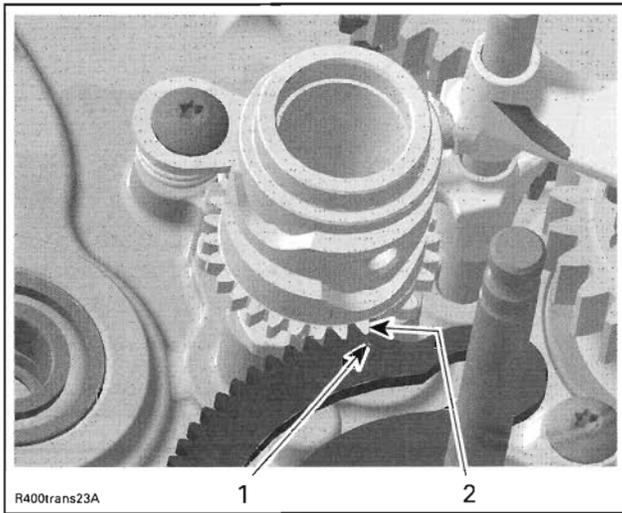
Put shift forks in place and afterward insert pin no. 38 with the chamfer on top for a better installation of crankcase MAG side.

Insert a flat screwdriver in the slot of index lever no. 29. Turn screwdriver counterclockwise and install shift drum on park position as per the following illustration.



1. Parking stop location
2. Reverse stop location
3. Neutral stop location
4. High gear stop location
5. Low gear stop location
6. Contact to stop location for neutral/park position
7. Contact to reverse stop location
8. Pin to align isolating and index washer

Insert shift shaft no. 31 with mark in line to first tooth on shift drum.

**Section 01 ENGINE****Subsection 08 (GEARBOX AND OUTPUT SHAFT)**

1. Mark on shift shaft
2. First tooth on shift drum

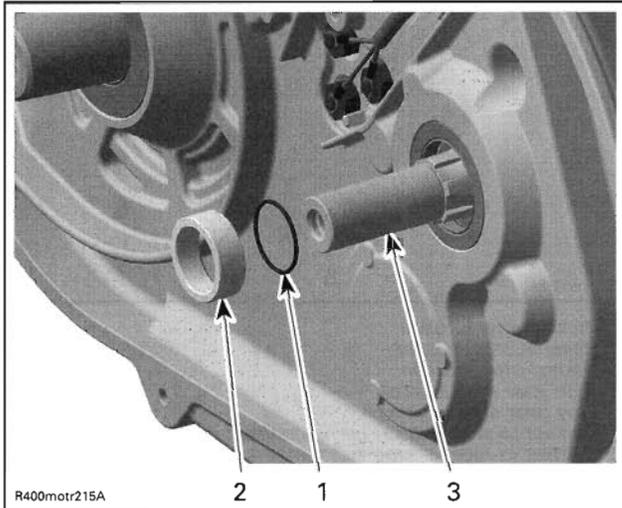
Install parking lever no. 30.

Run all gears as a final function check.

Install balancer shaft then close crankcase housings. Refer to *CRANKSHAFT AND CRANKCASE*.

Install O-ring no. 15 including distance sleeve no. 16 on main shaft end PTO side

**CAUTION:** Place O-ring including distance sleeve right away. Chamfered bore of distance sleeve has to face the engine.



1. O-ring
2. Distance sleeve
3. Main shaft end PTO side

Install all other removed parts.

# TECHNICAL SPECIFICATIONS

ENGINE			
Engine type		ROTAX 400 4-TEC, 4-stroke, Single Over Head Camshaft (SOHC), liquid cooled	
Number of cylinder(s)		1	
Number of valves		4 valves (mechanical adjustment)	
Bore	Standard	91 mm (3.58 in)	
Stroke		61.5 mm (2.42 in)	
Displacement		400 cm <sup>3</sup> (24.41 in <sup>3</sup> )	
Compression ratio		10.3 : 1	
Decompressor type		Automatic	
Maximum HP RPM		6750 RPM	
Starting system		Electric start and manual rewind starter. Start in any gear (with brakes applied)	
Lubrication		Type	Wet sump with replaceable oil filter
		Oil type	Refer to the appropriate <i>VEHICLE SHOP MANUAL</i>
Oil filter		BRP ROTAX paper type, replaceable	
Intake valve opening		15.00° BTDC	
Intake valve closing		45.00° ABDC	
Exhaust valve opening		50.00° BBDC	
Exhaust valve closing		10.00° ATDC	
Chain tensioner plunger protrusion		Service limit	20.0 mm (.7874 in)
Valve clearance	Intake		0.06 mm (.0024 in) to 0.14 mm (.0055 in)
	Exhaust		0.11 mm (.0043 in) to 0.19 mm (.0075 in)
Valve/valve stem diameter	Intake	Minimum new	4.966 mm (.1955 in)
		Maximum new	4.980 mm (.1960 in)
		Service limit	4.930 mm (.1940 in)
	Exhaust	Minimum new	4.956 mm (.1951 in)
		Maximum new	4.970 mm (.1957 in)
		Service limit	4.930 mm (.1940 in)
Valve guide diameter	Minimum new		5.006 mm (.1971 in)
	Maximum new		5.018 mm (.1976 in)
	Service limit		5.050 mm (.1988 in)
Valve spring free length	Nominal new		40.81 mm (1.607 in)
	Service limit		39.00 mm (1.535 in)
Valve seat contact width	Intake	New	1.05 mm (.041 in) to 1.35 mm (.053 in)
		Service limit	1.8 mm (.07 in)
	Exhaust	New	1.25 mm (.049 in) to 1.55 mm (.061 in)
		Service limit	2 mm (.078 in)
Piston measurement		Nominal new	90.950 mm (3.580 in) to 90.966 mm (3.581 in)
Piston/cylinder clearance	Nominal new		0.027 mm (.0011 in) to 0.057 mm (.0022 in)
	Service limit		0.1 mm (.004 in)
Piston ring type	Upper compression ring		Rectangular
	Lower compression ring		Taper-face
	Oil scraper ring		Standard

**Section 01 ENGINE****Subsection 09 (TECHNICAL SPECIFICATIONS)**

ENGINE			
Piston ring end gap	Upper compression ring	Minimum new	0.2 mm (.008 in)
	Lower compression ring		0.2 mm (.008 in)
	Oil scraper ring		0.2 mm (.008 in)
	Upper compression ring	Maximum new	0.40 mm (.016 in)
	Lower compression ring		0.40 mm (.016 in)
	Oil scraper ring		0.70 mm (.028 in)
	All	Service limit	1.5 mm (.06 in)
Piston/ring groove clearance	Upper compression ring	Minimum new	0.030 mm (.0012 in)
	Lower compression ring		0.020 mm (.0008 in)
	Oil scraper ring		0.010 mm (.0004 in)
	Upper compression ring	Maximum new	0.070 mm (.0028 in)
	Lower compression ring		0.060 mm (.0024 in)
	Oil scraper ring		0.045 mm (.0018 in)
	All	Service limit	0.15 mm (.006 in)
Rocker arm bore diameter	Minimum new	12.036 mm (.4739 in)	
	Maximum new	12.050 mm (.4744 in)	
	Service limit	12.060 mm (.4748 in)	
Rocker arm shaft diameter	Minimum new	12.000 mm (.4724 in)	
	Maximum new	12.018 mm (.4732 in)	
	Service limit	11.990 mm (.4720 in)	
Cylinder bore	Nominal new	90.993 mm (3.582 in) to 91.007 mm (3.583 in)	
Cylinder taper	Maximum new	0.038 mm (.0015 in)	
	Service limit	0.090 mm (.0035 in)	
Cylinder out of round	Maximum new	0.015 mm (.0006 in)	
	Service limit	0.02 mm (.0008 in)	
Camshaft bearing journal	PTO side	Minimum new	21.959 mm (.8645 in)
		Maximum new	21.980 mm (.8654 in)
		Service limit	21.950 mm (.8642 in)
	Magneto side	Minimum new	34.959 mm (1.3763 in)
		Maximum new	34.975 mm (1.3770 in)
		Service limit	34.950 mm (1.3760 in)
Camshaft bore	PTO side	Minimum new	22.000 mm (.8661 in)
		Maximum new	22.021 mm (.8670 in)
		Service limit	22.040 mm (.8677 in)
	Magneto side	Minimum new	35.000 mm (1.3780 in)
		Maximum new	35.025 mm (1.3789 in)
		Service limit	35.040 mm (1.3795 in)
Cam lobe	Intake	Minimum new	32.253 mm (1.2698 in)
		Maximum new	32.453 mm (1.2777 in)
		Service limit	32.233 mm (1.2690 in)
	Exhaust	Minimum new	31.937 mm (1.2574 in)
		Maximum new	32.137 mm (1.2652 in)
		Service limit	31.947 mm (1.2971 in)
Crankshaft axial clearance	Minimum new	0.1 mm (.0039 in)	

## Section 01 ENGINE

### Subsection 09 (TECHNICAL SPECIFICATIONS)

ENGINE			
Crankshaft deflection	MAG side	Nominal new	0.05 mm (.0020 in)
	PTO side	Nominal new	0.05 mm (.0020 in)
Crankshaft pin diameter		Minimum new	40.009 mm (1.5752 in)
		Maximum new	40.025 mm (1.5758 in)
		Service limit	39.980 mm (1.5740 in)
Crankshaft journal diameter	MAG/PTO side	Minimum new	42.024 mm (1.6545 in)
		Maximum new	42.040 mm (1.6551 in)
		Service limit	42.000 mm (1.6535 in)
Crankcase plain bearing	MAG side	Service limit	42.070 mm (1.6563 in)
	PTO side	Service limit	42.070 mm (1.6563 in)
Crankshaft radial clearance	MAG/PTO side	Service limit	0.07 mm (.0028 in)
Connecting rod big end diameter		Minimum new	40.020 mm (1.5756 in)
		Maximum new	40.051 mm (1.5768 in)
		Service limit	40.100 mm (1.5787 in)
Connecting rod big end clearance		Service limit	0.09 mm (.0035 in)
Connecting rod big end axial play		Minimum new	0.100 mm (.004 in)
		Maximum new	0.352 mm (.014 in)
		Service limit	0.5 mm (.02 in)
Connecting rod small end diameter		Minimum new	20.01 mm (.7878 in)
		Maximum new	20.02 mm (.7882 in)
		Service limit	20.06 mm (.7898 in)
Piston pin diameter		Minimum new	19.996 mm (.7872 in)
		Maximum new	20.000 mm (.7874 in)
		Service limit	19.980 mm (.7867 in)
Piston pin bore clearance		Service limit	0.080 mm (.0035 in)
Drive belt		Nominal new	32.00 mm (1.260 in)
		Service limit	30.00 mm (1.181 in)
Governor cup roller diameter		Minimum new	13.70 mm (.539 in)
		Maximum new	13.90 mm (.547 in)
		Service limit	13.20 mm (.519 in)
Centrifugal lever pivot bolt diameter		Minimum new	6.078 mm (.239 in)
		Maximum new	6.100 mm (.240 in)
		Service limit	6.000 mm (.236 in)
Centrifugal lever bore diameter		Service limit	6.200 mm (.244 in)
Centrifugal lever pivot bolt bore diameter		Minimum new	6.113 mm (.241 in)
		Maximum new	6.171 mm (.243 in)
		Service limit	6.300 mm (.248 in)
Drive pulley sliding half large bushing		Minimum new	55.000 mm (2.165 in)
		Maximum new	55.020 mm (2.166 in)
		Service limit	55.200 mm (2.173 in)
Drive pulley sliding half small bushing		Minimum new	30.000 mm (1.181 in)
		Maximum new	30.020 mm (1.182 in)
		Service limit	30.200 mm (1.189 in)

**Section 01 ENGINE****Subsection 09 (TECHNICAL SPECIFICATIONS)**

ENGINE		
One-way clutch bushing diameter	Minimum new	39.990 mm (1.574 in)
	Maximum new	40.085 mm (1.578 in)
	Service limit	40.100 mm (1.579 in)
Driven pulley sliding half bushing diameter	Minimum new	30.000 mm (1.181 in)
	Maximum new	30.020 mm (1.182 in)
	Service limit	30.200 mm (1.189 in)
Driven pulley fixed half bushing diameter	Minimum new	30.000 mm (1.181 in)
	Maximum new	30.020 mm (1.182 in)
	Service limit	30.200 mm (1.189 in)
Torque gear on driven pulley	Service limit	7.500 mm (.295 in)
Main shaft	MAG side	Service limit 17.990 mm (.708 in)
	PTO side	Service limit 24.950 mm (.982 in)
Bevel gear shaft	PTO side	Service limit 24.990 mm (.984 in)
ELECTRICAL		
Magneto generator output		400 W @ 6000 RPM
Ignition system type		C.D.I. (Capacitive Discharge Ignition)
Ignition timing		Not adjustable
Spark plug	Quantity	1
	Make and type	NGK DCP8E
	Gap	0.7 mm (.028 in) to 0.8 mm (.032 in)
Engine RPM limiter	Forward	8000 RPM
	Reverse	4000 ± 100 RPM
COOLING		
Type		Liquid cooled. Closed loop for engine
Coolant		Ethyl glycol/water mix (50% coolant, 50% water). Use coolant specifically designed for aluminum engines
Engine thermostat	Opening temperature	65°C (149°F)
CAPACITIES		
Engine oil		Refer to the appropriate <i>VEHICLE SHOP MANUAL</i>
Cooling system		