

3. ENGINE

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Components which are identical for both cylinders/cylinder heads are identified in the two exploded views by the same number. Components which are different or which are, for instance, present on one of the cylinders/cylinder heads but not on the other, have different numbers. The information given below always relates as a general rule.

Special reference is made in the text to work instructions which are not the same for cylinder no. 1 and cylinder no. 2.



1. Cylinder 1
2. Cylinder 2

! 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

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

Always place the vehicle on level surface.

NOTE: For a better understanding, the many illustrations are taken with engine out of vehicle. To perform the following instructions, it is not necessary to remove engine from vehicle.

Always disconnect BLACK (-) cable from the battery, then RED (+) cable before working on the engine. Even if the removal of many parts is not necessary to reach another part, it is recommended to remove these parts in order to check them.

When disassembling parts that are duplicated in the engine, (e.g.: valves), it is a strongly recommended to note their position (PTO/MAG side, front/rear cylinder) and keep them as a “group”. If you find a defective component, it would be must easier to find the cause of the failure among it 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). Also, since used pars have matched together during the engine operation, they will keep their matched fit when you reassemble them together within their “group”.

ENGINE REMOVAL

To avoid potential burns, let engine and exhaust system cool down before performing any servicing.

Place vehicle on a work station that will have access to an engine-lifting hoist. Then start with initial preparation of vehicle.

Disconnect the BLACK(-) cable from battery, then the RED(+) cable.

Drain coolant from engine cooling system. Drain engine oil only if engine overhaul is necessary. To work on gearbox the removal is necessary but do not drain engine oil.

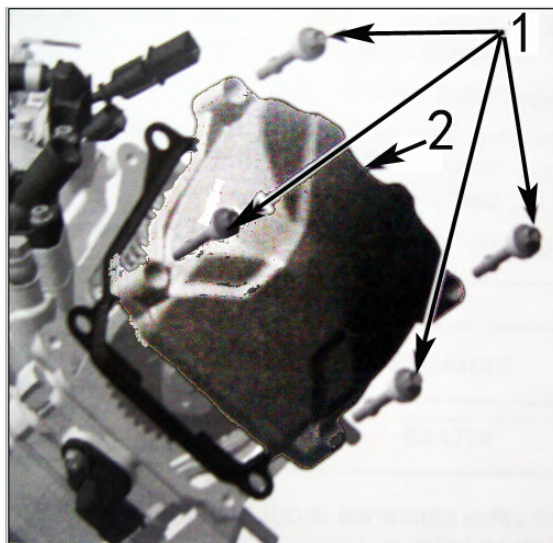
VALVE COVER

Cover Removal

Remove:

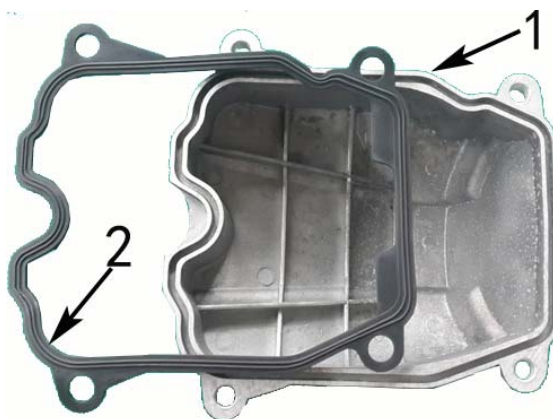
- distance screws of valve cover

1. Distance screws
2. Valve cover



- valve cover and gasket.

1. Valve cover
2. Gasket



Repeat the procedure for the other valve cover if required.

Cover Inspection

Check the gasket on the valve cover if it is brittle, cracked or hard. If so, replace the gasket.

Cover Installation

For installation, reverse the removal procedure.

Torque the valve cover distance screws in a criss-cross sequence.

TIMING CHAIN TENSIONER

NOTE: Before removal and installation, make sure that the respective cylinder is set to TDC ignition. Refer to CAMSHAFT.

Tensioner removal

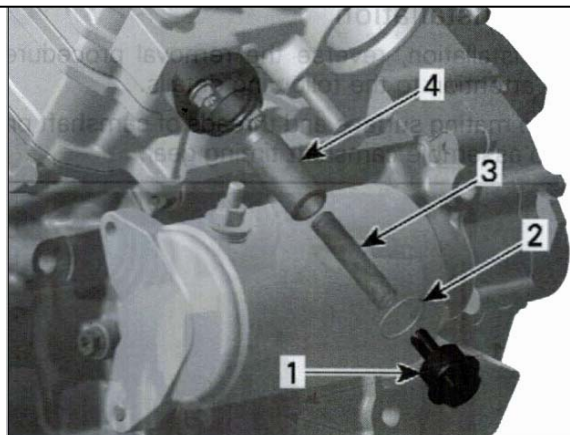
! WARNING

Timing chain tensioner is spring loaded. Never perform this operation immediately after the engine has been turned 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

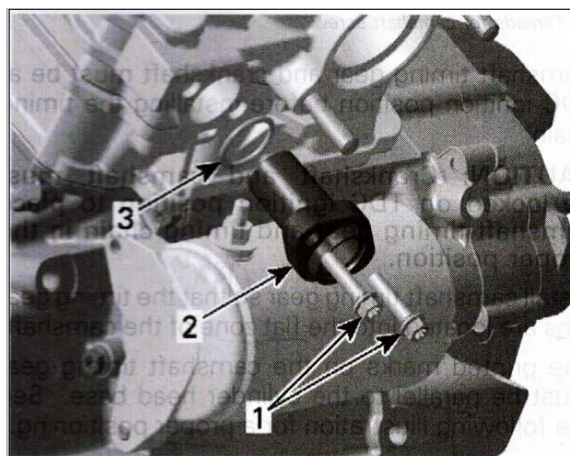
1. Chain tensioner plug
2. O-ring
3. Spring
4. Chain tensioner plunger



Screws retaining chain tensioner housing

- Chain tensioner housing with O-ring

1. Chain tensioner screws
2. Chain tensioner housing
3. O-ring

**Tensioner Inspection**

Check the housing for cracks or other damages.

Replace if necessary.

Check chain tensioner plunger for free movement and/or scoring.

Check if O-rings are brittle, cracked or hard.

Replace if necessary.

Check spring condition. Replace if broken or worn.

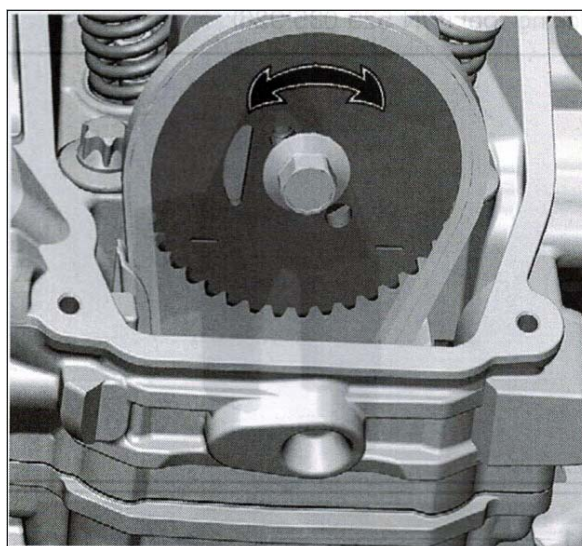
Tensioner Installation

For installation, reverse the removal procedure.

However, pay attention to the following.

NOTE: Before installing the chain tensioner make sure, that the camshaft timing gear can be moved back and forth.

Apply engine oil on the plunger before installing.



NOTE: Slightly screw in the plunger until the timing chain allows no more back and forth movement of the camshaft timing gear. Then screw in the plunger an additional 1/8 turn to reach the required torque of 0.1 N.m.

CAUTION: Improper adjustment of the timing chain will lead to severe engine damage.

Fit the spring on one side into the slot of the plug screw and on the other side into the plunger. Turn spring only clockwise in order to fit the spring end into the notch of the plunger and to avoid loosening the plunger during

spring installation. Do not preload the spring.

NOTE: Do not forget to place the O-ring on chain tensioner plug.

Then compress the spring and screw in plug screw.

Finally, tighten the plug screw to 4.5 N.m.

CAMSHAFT TIMING GEAR

Gear Removal

Turn crankshaft to TDC ignition of the respective cylinder.

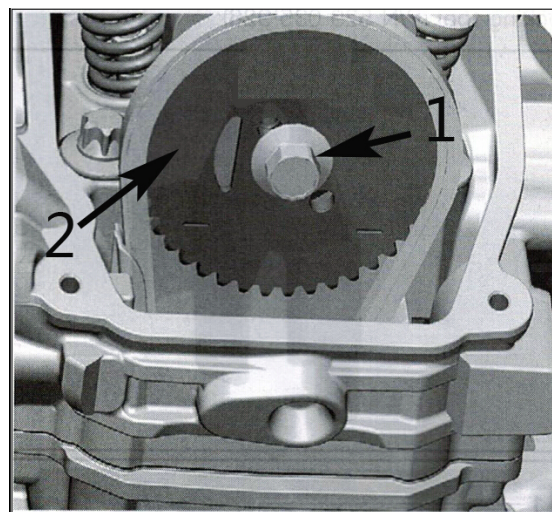
Unscrew timing chain tensioner.

Remove camshaft timing gear screw.

1. Camshaft timing gear screw
2. Camshaft timing gear

Remove the camshaft timing gear.

NOTE: Secure timing chain with a retaining wire.



Gear Inspection

Check camshaft timing gear for wear or deterioration.

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

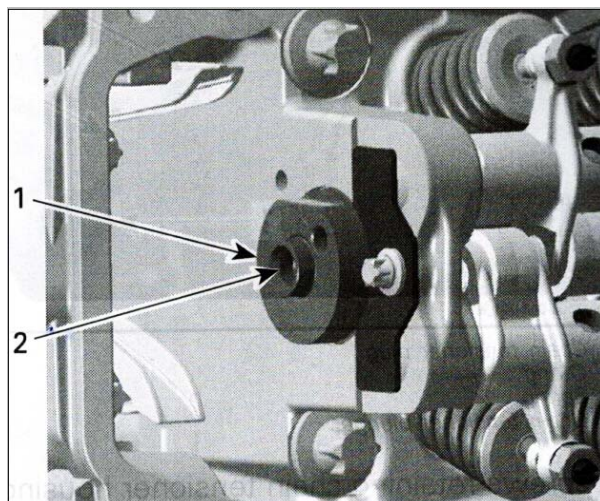
Gear Installation

For installation, reverse the removal procedure.

Pay attention to the following details.

Clean mating surface and threads of camshaft, prior to assemble camshaft timing gear.

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

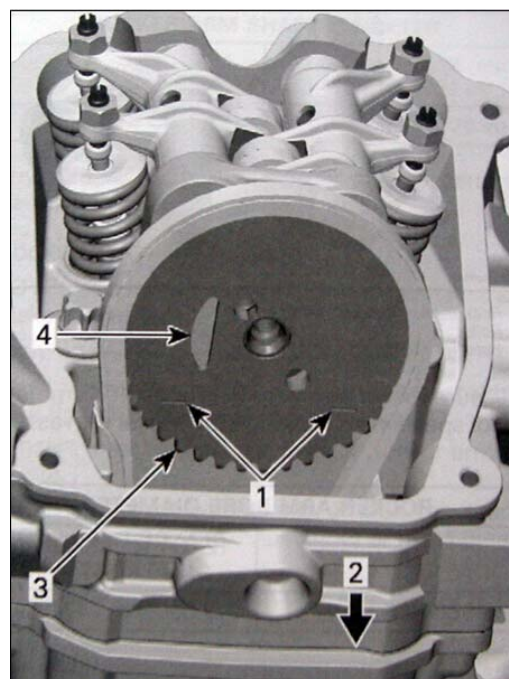


Camshaft timing gear and crankshaft must be at TDC ignition position before installing the timing chain.

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

Install camshaft timing gear so that the timing gear tabs are located into the flat zone of the camshaft.

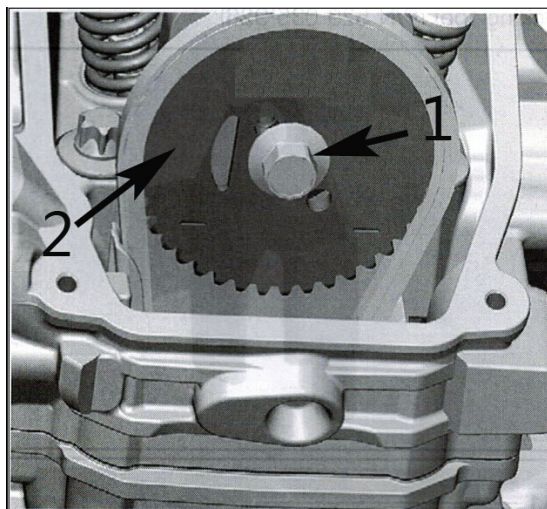
The printed marks on the camshaft timing gear must be parallel to the cylinder head base. See the following illustration for a proper positioning.



1. Printed marks on camshaft timing gear
2. Cylinder head base
3. Camshaft timing gear
4. Timing gear tab

Install trigger wheel on camshaft timing gear of cylinder 1.

1. Camshaft timing gear screw
2. Camshaft timing gear



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

NOTE: Before installing the camshaft screw adjust the chain tension and check again if marks on the timing gear are parallel to cylinder head base.

Reinstall all other removed parts.

ROCKER ARM

Rocker Arm Removal

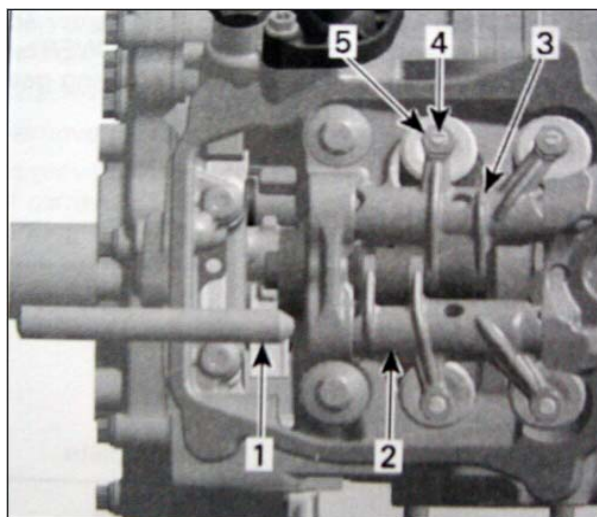
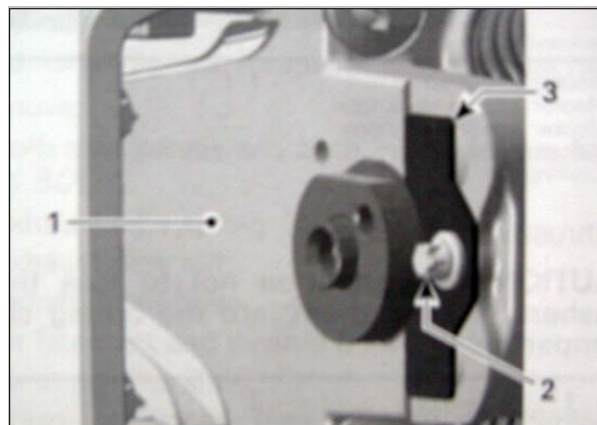
Remove:

- valve cover
- chain tensioner
- camshaft timing gear
- Allen screw and camshaft retaining plate

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

- Rocker arm shafts
- Rocker arm assembly (exhaust side and intake side) with adjustment screws and nuts.

1. Rocker arm shaft
2. Rocker arm (exhaust side)
3. Rocker arm (intake side)
4. adjustment screw



5. Locking nut

■ Thrust washer

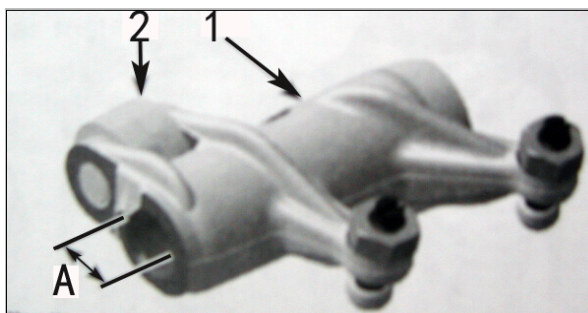
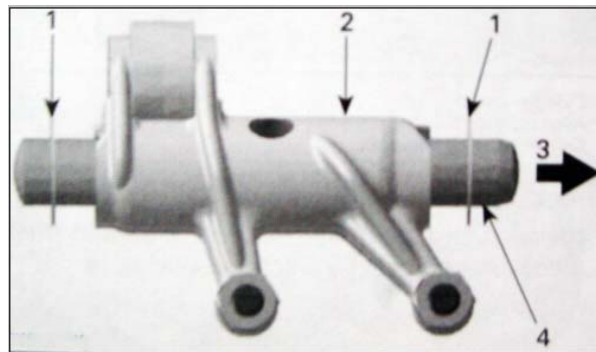
CAUTION: Pay attention not to lose thrust washers or drop them into the timing chain compartment.

Rocker Arm Inspection

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
3. Bore for rocker arm shaft

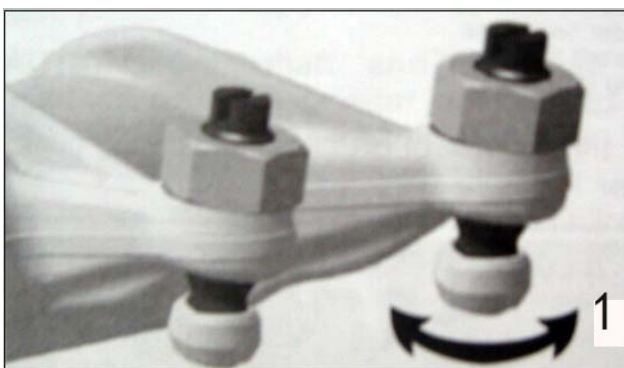


Measure rocker arm bore diameter. If diameter is out of specification, change the rocker arm assembly.

Rocker arm bore diameter	
new	12.000 to 12.018 mm
Service limit	12.030 mm

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

1. Free movement of adjustment screw top

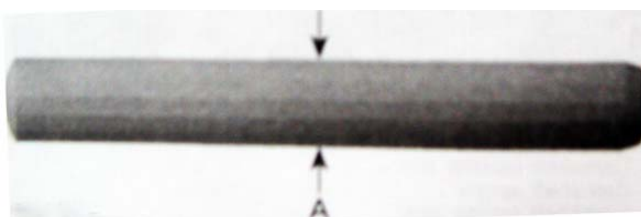


Rocker arm shaft

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

Measure rocker arm shaft diameter.

A: Measure rocker arm shaft diameter here



Rocker arm shaft diameter	
New	11.983 to 11.994 mm

Service limit	11.970 mm
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Any area worn excessively will require parts replacement.

Rocker Arm Installation

NOTE: use the same procedure for exhaust and intake rocker arm.

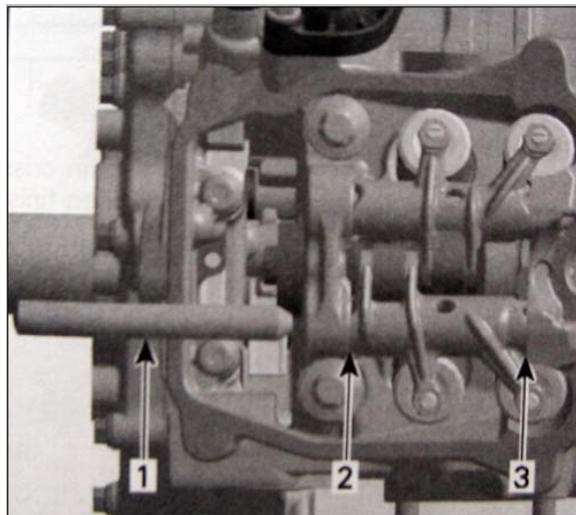
Apply engine oil on rocker arm shaft.

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

- Insert a rocker arm pin through rocker arm pin bore.
- Install a thrust washer then the proper rocker arm.
- Push in rocker arm shaft until its chamfer reaches the end of rocker arm bore.

1. Rocker arm shaft
2. Thrust washer (timing chain side)
3. Thrust washer (spark plug side)

- Place the other thrust washer and push rocker arm shaft to end position.
- Install the camshaft retaining plate no. 5.



CYLINDER HEAD

Cylinder Head Removal

The removal procedure is the same for both cylinder heads.

Drain coolant.

CAUTION

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:

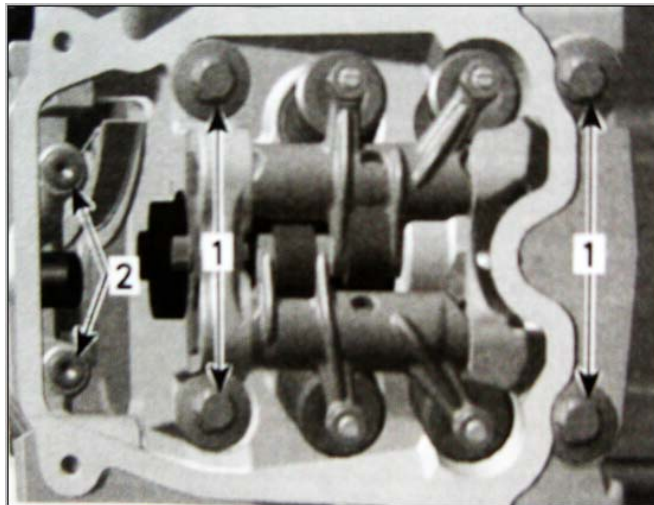
- spark plug wire
- temperature sensor connector, located at rear cylinder head

Remove:

- exhaust pipe spring
- exhaust pipe nuts

- radiator inlet hose
- air filter box and throttle body
- air intake manifold
- chain tensioner
- valve cover and gasket
- camshaft timing gear
- cylinder head screws M6
- cylinder head screws M10 retaining cylinder head and cylinder to cylinder base.

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

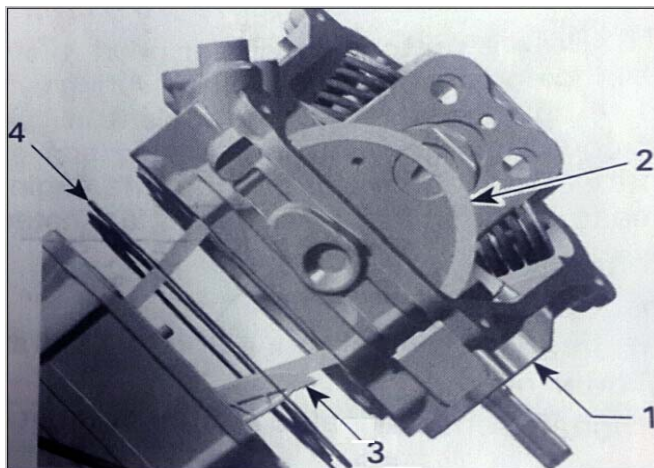


Pull up cylinder head.

Remove:

- chain guide
- cylinder head gasket and scrap it.

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



Cylinder Head Inspection

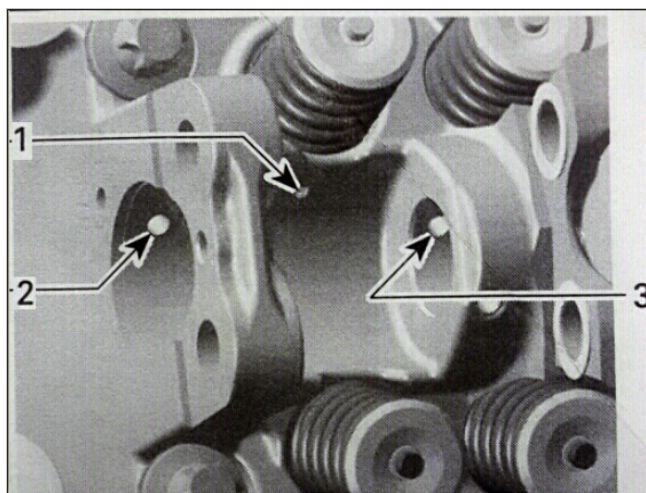
Inspect timing chain guide for wear, cracks or other damages. Replace if necessary.

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 supply through the cylinder head from contamination.

1. Oil port to lubricate camshaft lobes intake/exhaust
2. Oil supply to camshaft bearing journal timing chain side
3. Oil supply to camshaft bearing journal spark plug side



Cylinder Head Installation

NOTE: The cylinder heads are not identical in design. Do not invert the cylinder heads at assembly.

For installation, reverse the removal procedure.

Pay attention to the following details.

Ensure dowel pins are in place.

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)

Install a new cylinder head gasket.

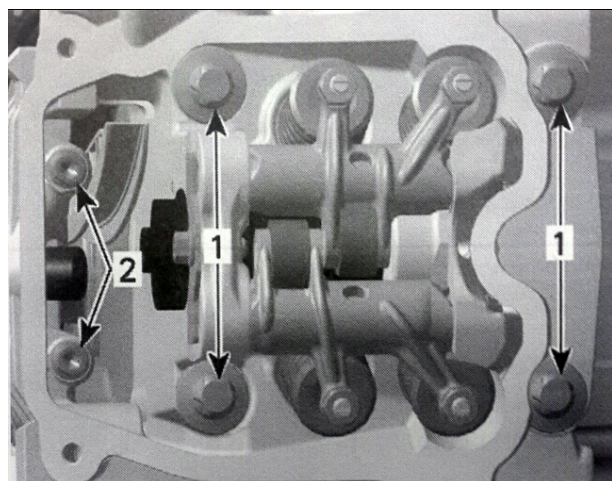
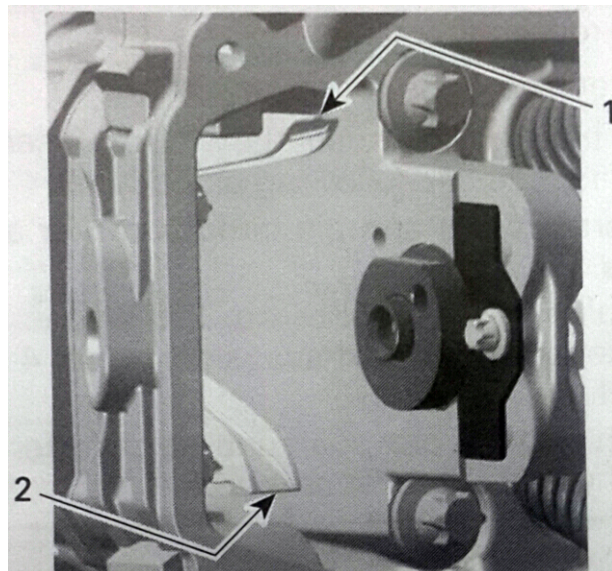
First, torque cylinder head screws M 10 in crisscross sequence to 20 N.m then finish by tightening to 60 N.m.

Install cylinder head screws M6.

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

Check chain guide for movement.

Remove crankshaft locking bolt and reinstall plug screw with sealing ring.



CAMSHAFT

NOTE: The engine is equipped with two different camshafts.

1. Camshaft of cylinder 1
2. Camshaft of cylinder 2



Camshaft timing cylinder 2

Turn crankshaft until piston is at TDC ignition as follows.

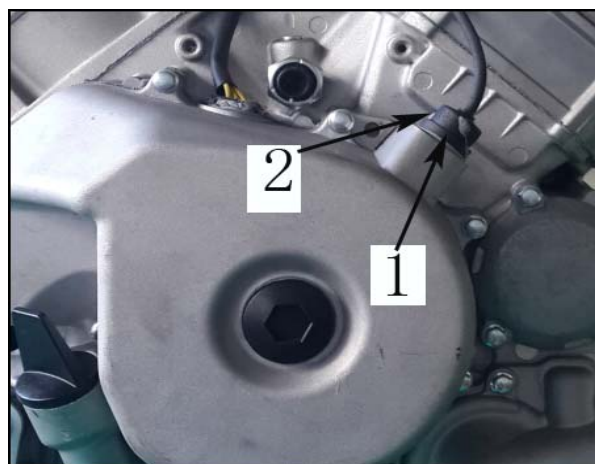
Remove:

- spark plug cable and spark plug of both cylinders
- valve cover of both cylinders
- plug screw and O-ring of magneto cover

1. Plug screw
2. O-ring



- crankshaft position sensor
1. Crankshaft position sensor
 2. Screw



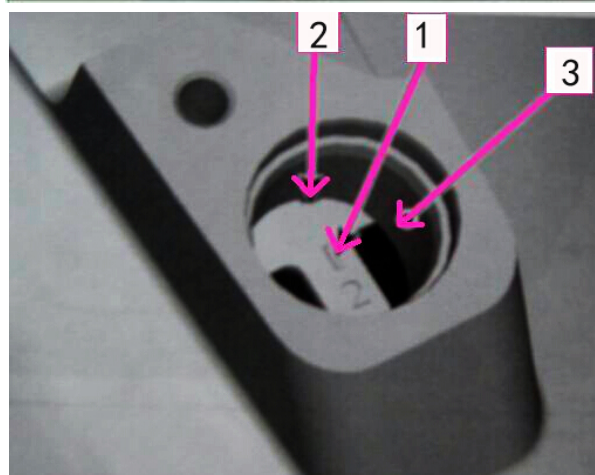
Use a 14 mm Allen key to turn crankshaft until piston 2, rear is at TDC ignition.

1. Allen key 14 mm



When rear piston is at TDC ignition, marks on magneto flywheel "2" and on the magneto cover are aligned.

1. Mark "2" on magneto flywheel
2. Notch on magneto cover
3. Crankshaft position sensor location



At TDC ignition, the printed marks on the camshaft timing gear have to be parallel to cylinder head base.

1. Printed marks on camshaft timing gear
2. Cylinder head base

To lock crankshaft at TDC ignition, proceed as follows.

Remove from crankcase plug screw with sealing ring.

- 1 Plug screw
- 2 Sealing ring
- 3 Crankcase PTO side, front side

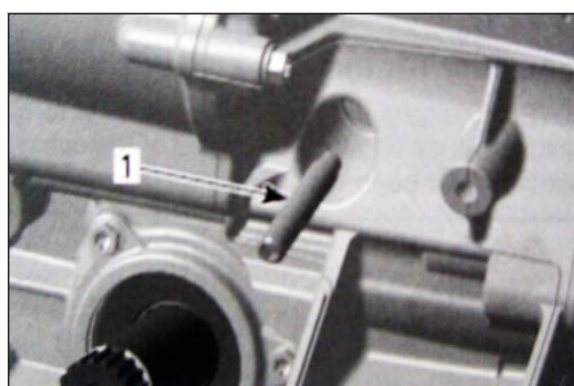
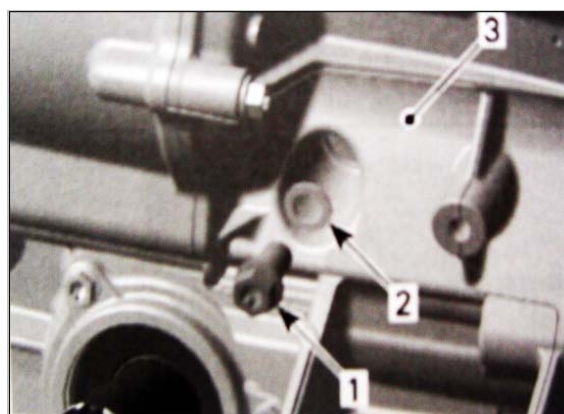
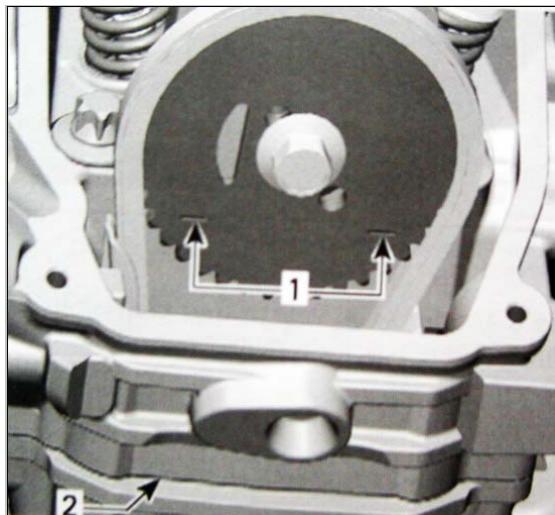
Lock crankshaft with crankshaft locking bolt.

1. Crankshaft locking bolt

NOTE: Make sure the locking bolt engages in the groove of the crankshaft.

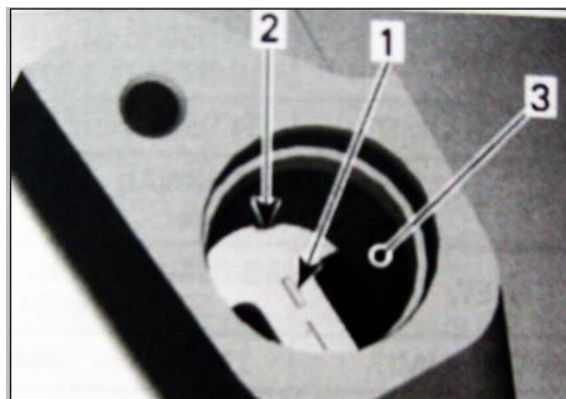
Camshaft Timing Cylinder 1

Using a 14 mm Allen key, turn crankshaft 280 ° counterclockwise, until marks on magneto flywheel "1" and magneto cover are aligned.



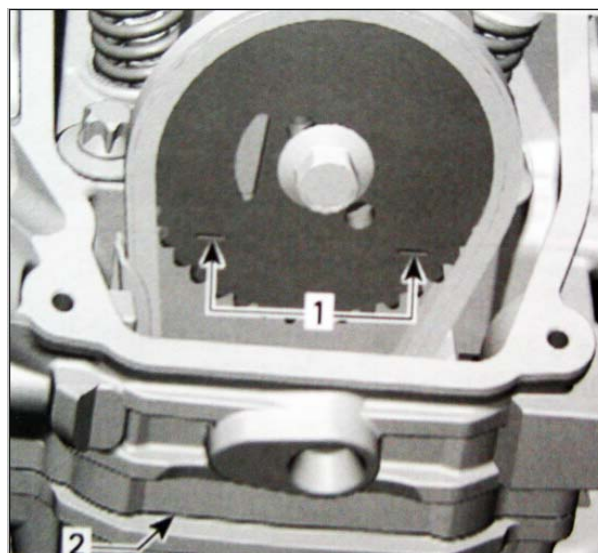
1. Allen key 14mm
2. Turn crankshaft 280° counterclockwise

1. Mark "1" on magneto flywheel
2. Notch on magneto cover
3. Location of crankshaft position sensor



NOTE: At TDC ignition, the printed marks on the camshaft timing gear have to be parallel to cylinder head base as per following illustration.

1. Printed marks on camshaft timing gear
2. Cylinder head base



CAUTION: Crankshaft can not be locked at cylinder 1 TDC ignition.

Camshaft Removal

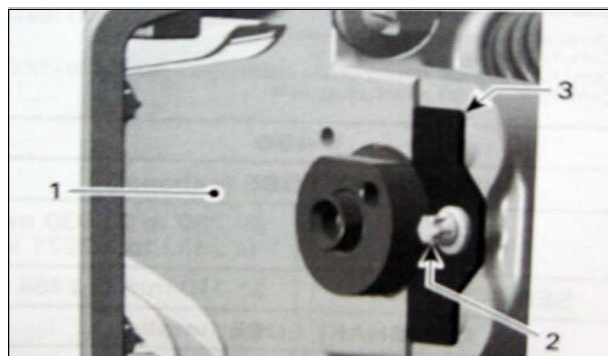
The removal procedure is the same for both camshafts.

Each camshaft is different in design. Thus, it is important not to mix up any parts of the camshaft assembly with that of the other cylinder. Keep parts as a group.

Remove:

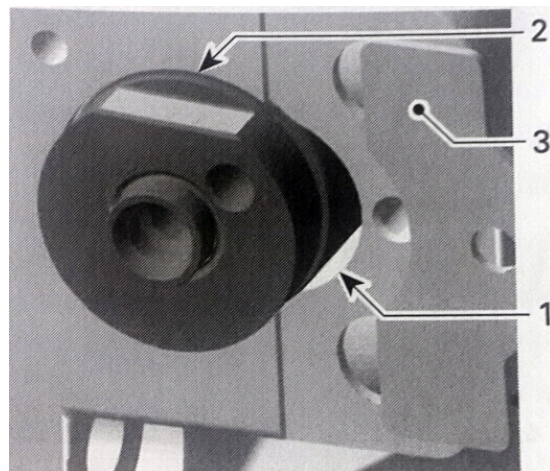
- valve cover (see VALVE COVER above)
- chain tensioner (see CHAIN TENSIONER above)
- camshaft timing gear (see CAMSHAFT TIMING GER above)
- camshaft retaining plate

1. Cylinder head



- 2. Allen screw
- 3. Camshaft retaining plat
- rocker arms (see ROCKER ARM above)
- camshaft.

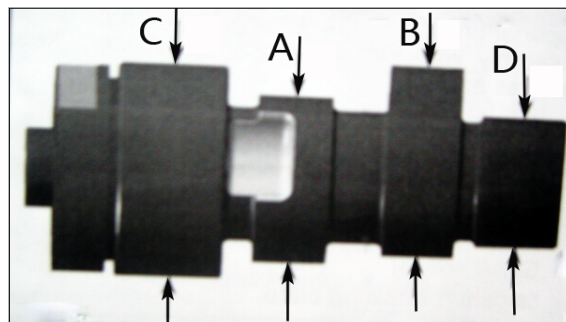
NOTE: For removal rotate camshaft so that intake/exhaust lobe shows to upper side of cylinder head.



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

Camshaft 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.

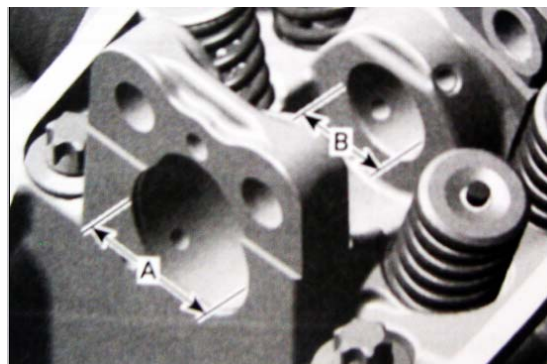


- A. Camshaft lobe (exhaust valves)
- B. Camshaft lobe (intake valves)
- C. Camshaft journal timing chain side
- D. Camshaft journal spark plug side

Camshaft lobe (exhaust)	
New	31.95 to 32.05mm
Service limit	31.92mm
Camshaft lobe (intake)	
New	32.15 to 32.25 mm
Service limit	32.09 mm

Camshaft journal(timing chain side)	
New	34.95 to 34.975 mm
Service limit	34.94mm
Camshaft journal (spark plug side)	
New	35 to 35.025 mm
Service limit	35.04 mm

Measure clearance between both ends of camshaft and cylinder head. Replace parts that are not within specifications.



- A. Cylinder head camshaft bearing timing chain side
- B. Cylinder head camshaft bearing spark plug side

Cylinder head camshaft bearing(timing chain side)	
New	35.000 to 35.025 mm
Service limit	35.040 mm

Cylinder head camshaft bearing(spark plug side)	
New	22.000 to 22.021 mm
Service limit	22.040 mm

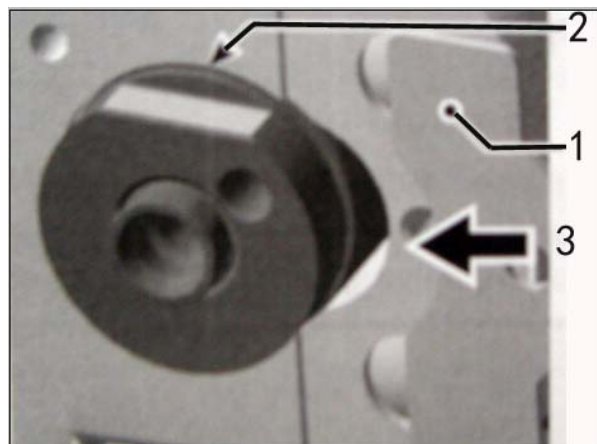
Camshaft Installation

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

CAUTION: the camshafts are not identical in design. Do not invert the camshafts during assembly. Any mix-up of the components will lead to engine damage.

Place the camshaft retaining plate in the slot of the camshaft.

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



For other parts, refer to proper installation procedure.

VALVE SPRING

Valve Spring Removal

Remove:

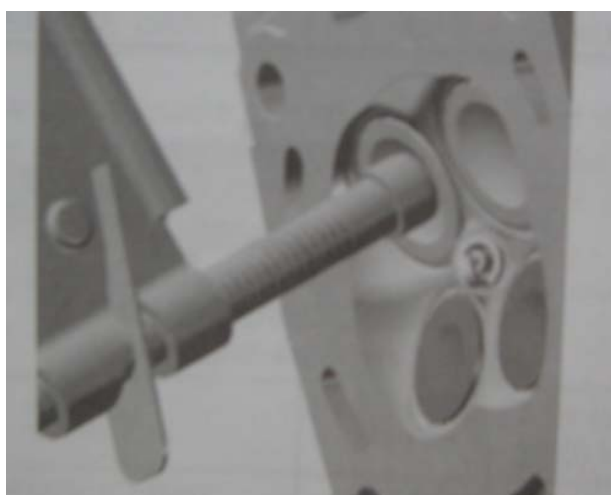
- rocker arms (see **ROCKER ARM** above)
- cylinder head (see **CYLINDER HEAD** above).

Compress valve spring; use valve spring compressor clamp and valve spring compressor cup.



! WARNING

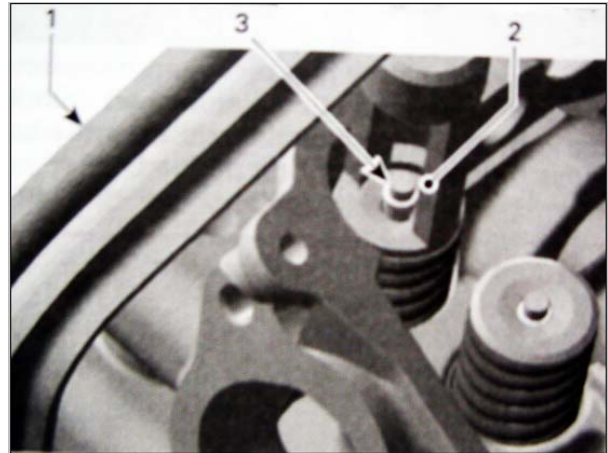
Always wear safety glasses when disassembling valve springs. Be careful when unlocking valves. Components could fly away because of the strong spring preload .



Remove valve cotters.

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

Withdraw valve spring compressor, valve spring retainer and valve spring .



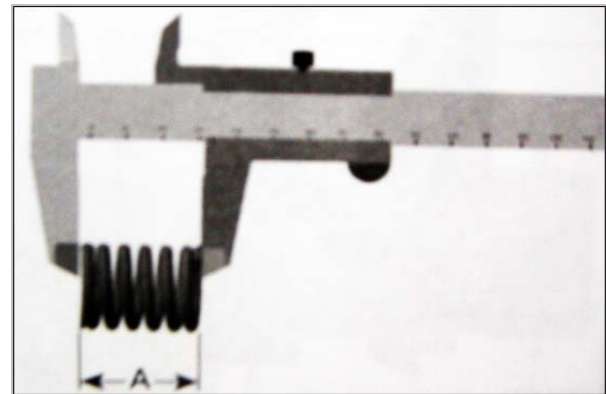
Valve Spring Inspection

Check valve spring for visible damages. If so, replace valve spring.

Check valve spring for free length and straightness. Replace valves springs if not within specifications.

A. Valve spring length

Valve spring free length		
Nominal	New	40.5 mm
	Service limit	39.00 mm



Valve Spring Installation

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

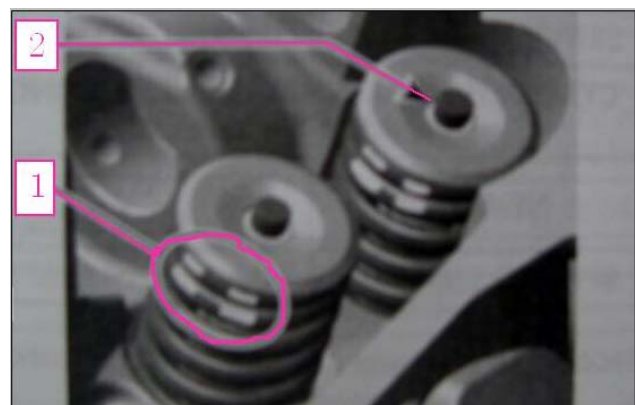
Colored area of the valve spring must be placed on top.

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

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

1. Position of the spring
2. Valve cotter

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

VALVE Removal

Remove valve spring, see VALVE SPRING above. Push valve stem, then pull valves (intake and exhaust) out of valve guide.

1. Intake valves 31mm
2. Exhaust valve 27mm

Remove valve stem seal with Snap-On pliers and discard it.

Valve Inspection

Valve Stem seal

Always install new seals whenever valves are removed.

Valve

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

Valve Stem and Valve Guide Clearance

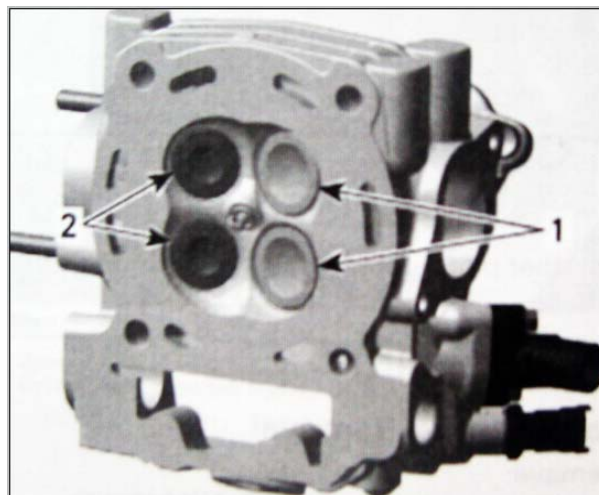
Measure valve stem and valve guide in three places using a micrometer and a small bore gauge.

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

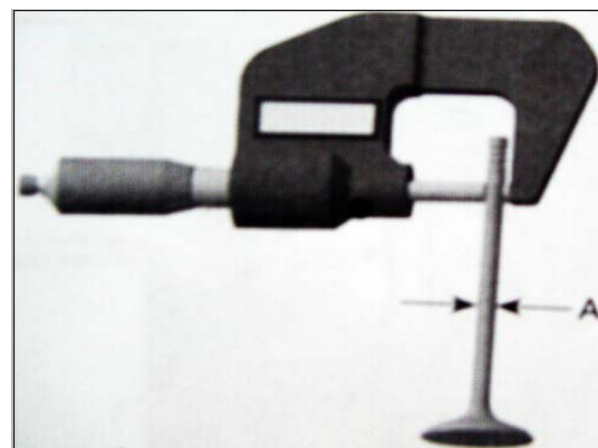
Change valve if valve stem is out of specification or has other damages such as wear or friction surface.

A. Valve stem diameter

Valve stem diameter	
Exhaust valve	
New	4.945 to 4.965 mm
Service limit	4.930 mm
Intake valve	
New	4.960 to 4.975 mm
Service limit	4.930 mm



Valve out of round(intake and exhaust valves)	
New	0.006 mm
Service limit	0.06 mm



Valve guide diameter(intake and exhaust valves)

New	5.006 to 5.015 mm
Service limit	5.050 mm

Replace valve guide out of cylinder head if valve guide or out of specification or has other damages such as wear or friction surface (see VALVE GUIDE PROCEDURE below)

Valve Face and Seat

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

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

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

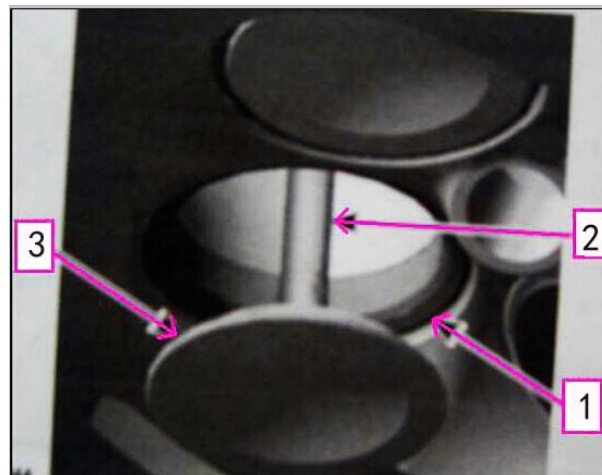
Measure valve face contact width.

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

Measure valve seat width using a caliper.

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



Valve seat contact width	
Exhaust valve	
New	1.25 to 1.55 mm
Service limit	2.00 mm
Intake valve	
New	1.05 to 1.35 mm
Service limit	1.80 mm



Valve installation

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

Install a NEW valve stem seal. Make sure thrust washer is installed before installing 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.

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

To ease installation of cotters, 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

Valve Guide Removal

Remove:

- cylinder head (see *CYLINDER HEAD* above)
- valve spring (see *VALVE SPRING* above)
- valves (see *VALVE* above)

NOTE: Clean valve guide area from contamination before removal.

Using valve guide remover, remove valve guide with a hammer.

1. Valve guide remover
2. Valve guide

Valve Guide Inspection

Always replace valve stem seals whenever valve guides are removed.

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

Valve Guide Installation

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

Use valve guide installer to install valve guide.

NOTE: Apply LOCTITE 767 on valve guide prior to install it into the cylinder head.

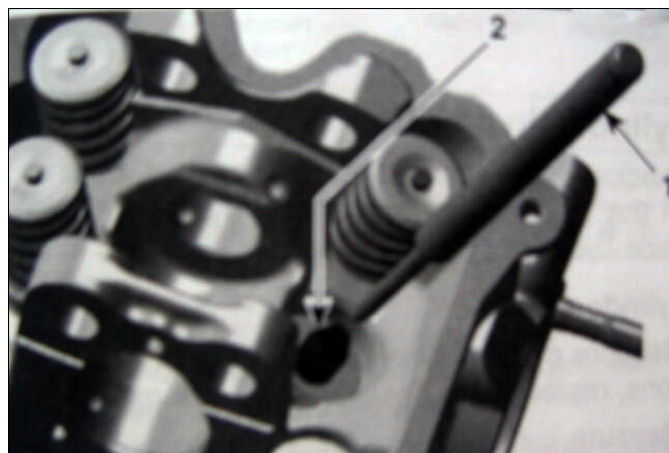
Valve guide to be adjusted in diameter by using a reamer.

NOTE: Ensure to turn reamer in the right direction.

Using cutting oil and make strokes 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



Valve guide diameter (intake and exhaust valves)	
new	5.006 to 5.015 mm
Service limit	5.050mm



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 pater. Repeat procedure until valve seat/valve face fits together.

CYLINDER

Cylinder removal

Remove:

- Chain tensioner (see CHAIN TENSIONER)
- camshaft timing gear (see CAMSHAFT TIMING GEAR)
- cylinder head (see CYLINDER HEAD)

Pull cylinder.

Discard cylinder base gaskets.

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

Cylinder Inspection

Check cylinder for cracks, scoring and wear, ridge on the top and bottom of the cylinder. If so, replace cylinder.

Cylinder taper

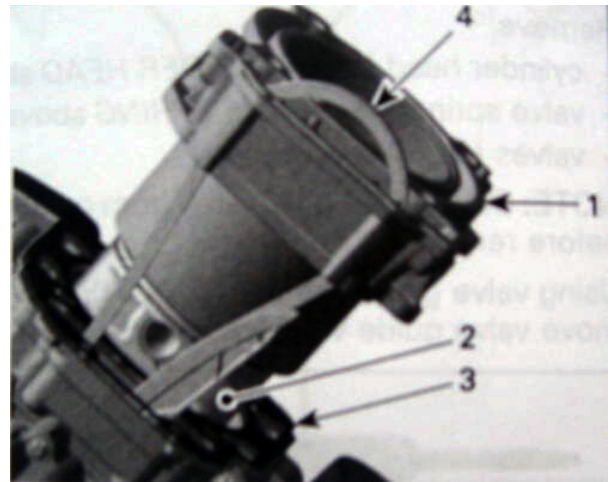
Measure cylinder bore and if it is out of specifications, replace cylinder and piston rings.

Measure cylinder bore at 3 recommended positions. See the following illustration.

1. First measuring of diameter
 - A. 7mm from cylinder bottom
 - B. 68mm
 - C. 32mm
2. Second measuring of diameter
3. Third measuring of diameter

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

Cylinder out of Round



Cylinder taper in diameter	
New (maximum)	0.033-0.048 mm
Service limit	0.090 mm



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 (maximum)	0.003 mm
Service limit	0.020 mm

Cylinder Installation

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

CAUTION: Always replace cylinder base gasket before installing the cylinder.

First mount cylinder 2. then remove crankshaft locking bolt. Crank the engine further and position piston 1 at TDC. Mount cylinder 1. The cylinder can not be pushed fully over the piston unless the piston is located at TDC.

Apply engine oil in the bottom area of cylinder bore and also on the band of the piston ring compressor tool.

1. Piston ring compressor
2. Piston
3. Cylinder

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

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

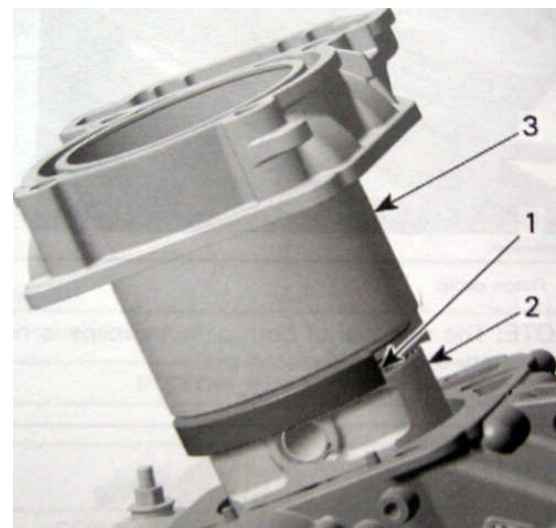
NOTE: After both cylinders are installed, turn crankshaft until piston of cylinder 2 is at TDC ignition and lock crankshaft. Install cylinder head and the other parts in accordance with the proper installation procedures.

PISTON AND RINGS

Piston removal

Remove:

- cylinder head (see *CYLINDER HEAD* above)
- cylinder (see *CYLINDER* above).



Place a rag under piston and in the area of timing chain compartment.

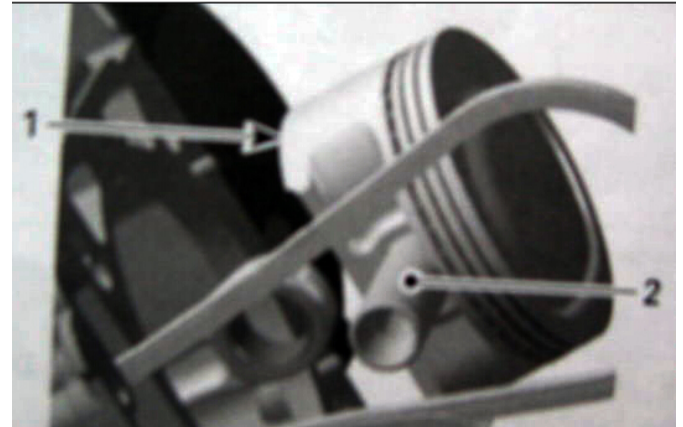
Remove one piston circlip and discard it.

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.



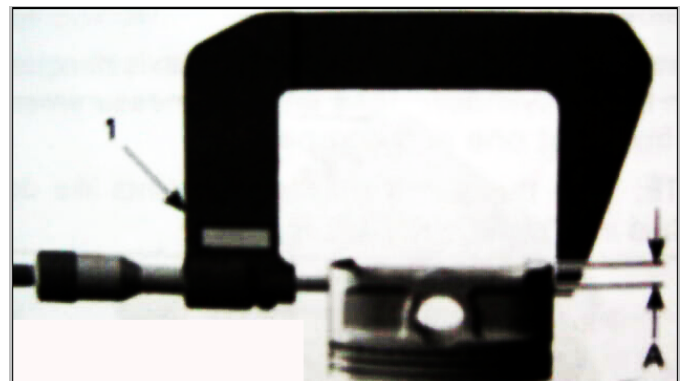
Piston Inspection

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

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

1. Measuring perpendicularly to piston pin
 - A. 8 mm

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



Piston measurement	
Size "A"	
New	90.955 to 90.962mm
Service limit	90.930mm
Size "B"	
New	90.962 to 90.970 mm
Service limit	90.940mm

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

1. Indicator set to 0

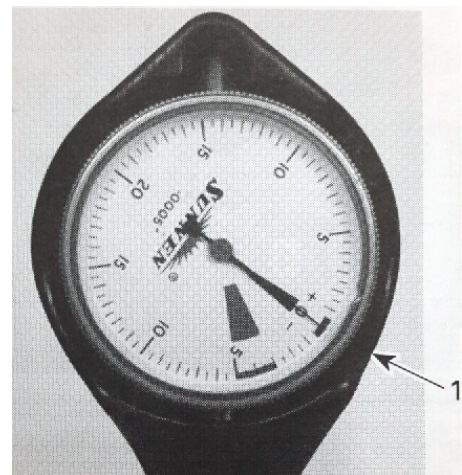
Position the dial bore gauge 20 mm above cylinder base, measuring perpendicularly (90°) to piston pin axis.

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

Piston/cylinder clearance	
v-800	
New	0.033 to 0.048 mm
Service limit	0.09 mm

NOTE: Make sure used piston is not worn.

If clearance exceeds specified tolerance; replace piston by a new one and measure piston/cylinder clearance again. Make sure the cylinder bore gauge indicator is set exactly at the same position as the micrometer, otherwise the reading will be false.



Connecting Rod/Piston Pin clearance

Using synthetic abrasive woven clean piston pin from deposits .

Inspect piston pin for scoring, cracking or other damages.

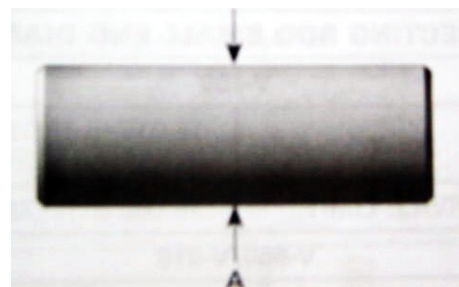
Measure piston pin. See the following illustration for the proper measurement positions.

A. Piston pin diameter

Piston pin diameter	
New	19.996 to 20.000 mm
Service limit	19.980 mm

Replace piston pin if diameter is out of specifications.

Measure inside diameter of connecting rod small end bushing .



1. Bore gauge
2. Connecting rod

Connecting rod small end diameter	
New	20.010 to 20.020 mm
Service limit	20.060 mm

Replace connecting rod if diameter of connecting rod small end is out of specifications.

Piston Installation

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

Apply engine oil on the piston pin.

Insert piston pin into piston and connecting rod.

1. Piston of cylinder 1
2. Mark on piston must show to exhaust side of cylinder1
3. Piston of cylinder2
4. Mark on piston must show to exhaust side of cylinder 2

CAUTION: Take care that pistons will be installed with the punched arrow on piston top direction to the rear side of the engine.

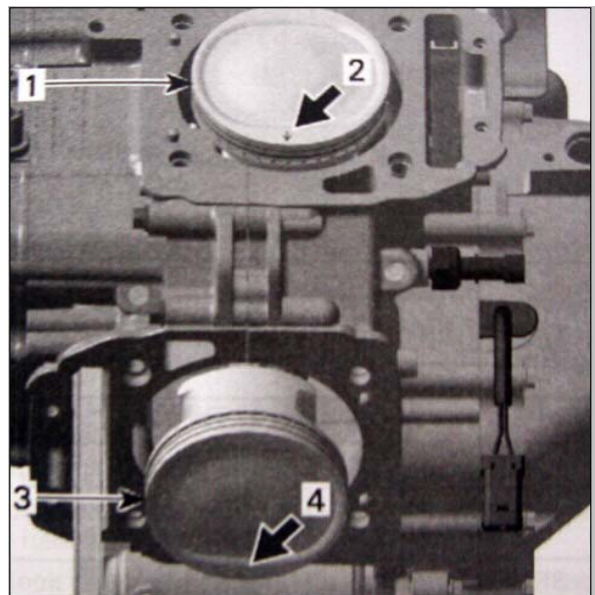
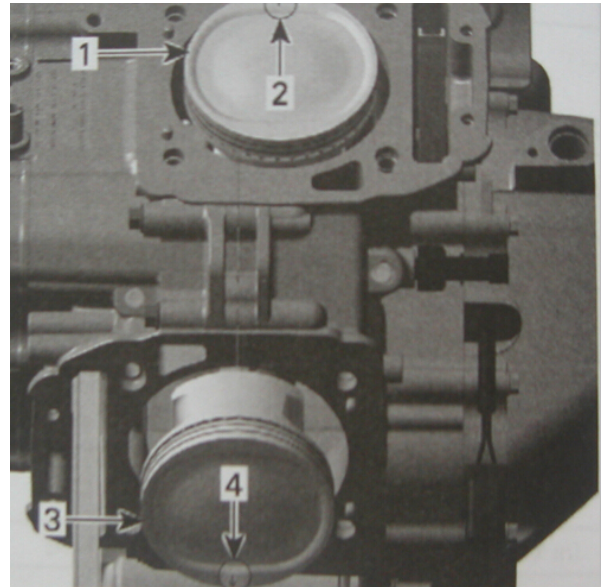
Front cylinder: Mark on top of piston must show to intake side.

Rear cylinder: Mark on top of piston must show to exhaust side.

1. Piston of cylinder 1
2. Mark on piston must show to intake side of cylinder 1
3. Piston of cylinder 2
4. Mark on piston must show to exhaust side of cylinder 2

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

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



PISTON RINGS

Ring Removal

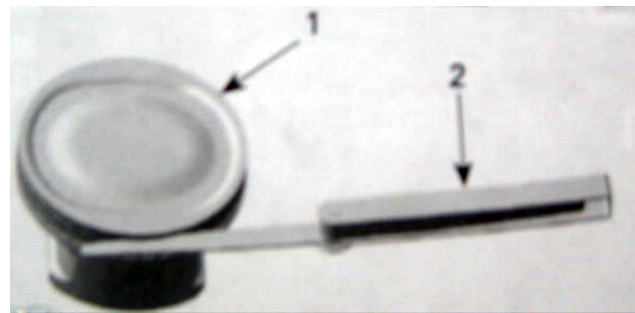
Remove:

- cylinder head
- cylinder
- piston pin.

Ring Inspection

Ring/piston Groove Clearance

1. Piston
2. Feeler gauge



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	
Upper compression ring	
New	0.030 to 0.070 mm
Service limit	0.150 mm
Lower compression ring	
New	0.020 to 0.060 mm
Service limit	0.150 mm
Oil scraper ring	
New	0.010 to 0.045 mm
Service limit	0.150 mm

Ring end gap	
Upper compression ring	
New	0.25 to 0.40 mm
Service limit	1.50 mm
Lower compression ring	
New	0.35 to 0.50 mm
Service limit	1.50 mm
Oil scraper ring	
New	0.20 to 0.80 mm
Service limit	1.50 mm

To measure the ring end gap place the ring in the cylinder in the area of 8 to 16 mm from top of cylinder.

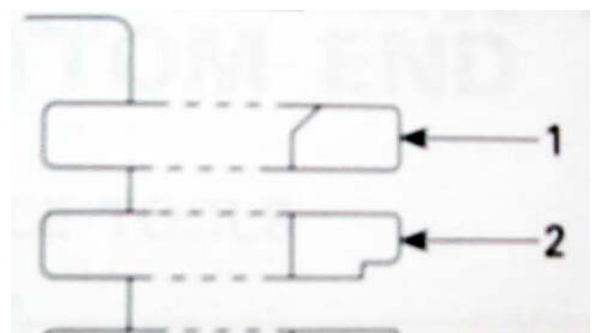
NOTE: In order to correctly position the ring in the cylinder, use piston as a pusher.

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

Ring Installation

For installation, reverse the removal procedure.

Pay attention to the following details.



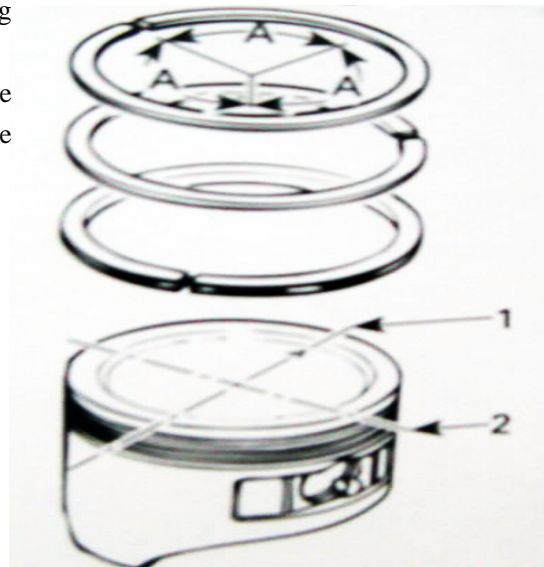
NOTE: First install spring and then rings of oil scraper ring. Install the oil scraper ring first, then the lower compression ring with the word “N and TOP” facing up, then the upper compression ring with the word “N and TOP” facing up.

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

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



DRIVE SHAFT

Oil Seal Removal

To remove the front oil seal, no need to remove the engine. Lift the front of vehicle to avoid engine oil spillage. Separate the front propeller shaft from engine. For the rear oil seal the gearbox removal is necessary.

Engine Drive Shaft Removal

NOTE: The engine drive shaft is located inside the engine and comes through it to drive the front differential.

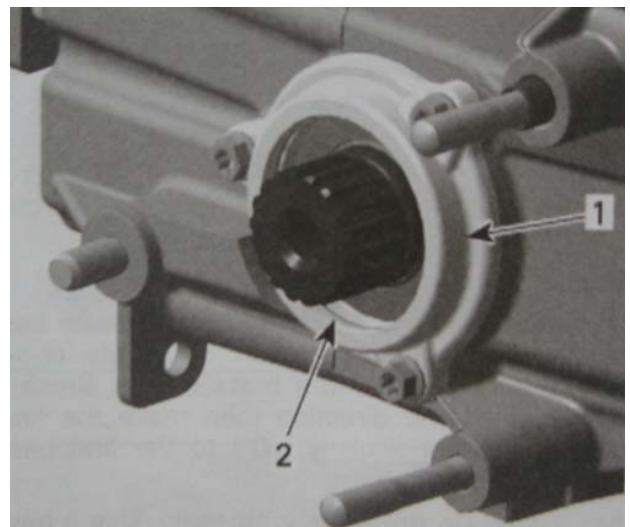
Separate gearbox from engine.

To the rear of engine, remove the bearing cover and its O-ring.

1. bearing cover
2. o-ring

Pull out drive shaft.

CAUTION: check ends of the circlip for sharp edges or burr before removing the drive shaft, to avoid damaging the oil seal.



1. bearing cover gearbox side
2. drive shaft
3. circlip

Remove the other bearing cover at the front of engine.

Engine Drive Shaft Inspection

Replace oil seals and/or O-ring if they are brittle, hard or damaged.

Check drive shaft bearings for contamination and/or metal shavings. Check if bearings turn freely and smoothly. Replace if necessary.

Check drive shaft for cracks, bend, pitting or other visible damages.

Check drive shaft splines for wear or damages.

Check oil seal running surface of the drive shaft for scratches. Replace if necessary.

Engine Drive Shaft Installation

The installation is reverse of removal procedure. Pay attention to the following details.

Clean all metal components in a solvent.

Crankcase surface and bearing covers are best cleaned using a combination of LOCTITE chisel 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.

Then install drive shaft oils with the oil seal installer.

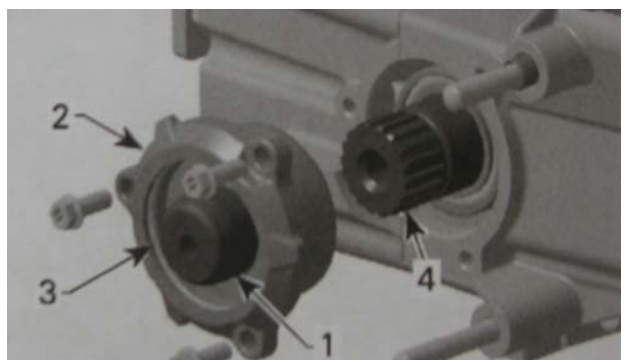
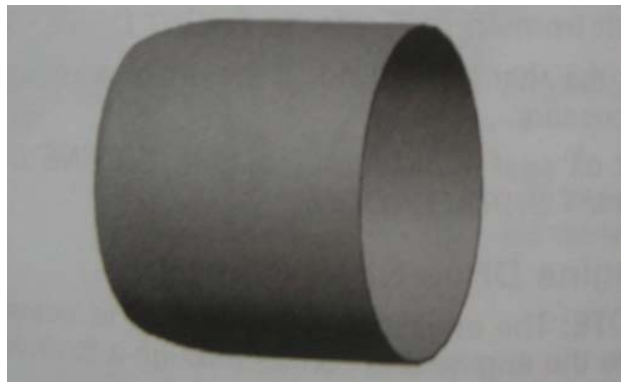
Use a suitable installer for installing bearings. Use LOCTITE 5910 on mating surfaces.

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

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

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

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).

To install bearing cover no. 6, fit oil seal protection sleeve into oil seal.

1. Protection sleeve
2. Bearing cover
3. O-ring
4. Drive shaft

Install bearing cover then place O-ring inside cover.

Finally check for axial play of the drive shaft.

PTO COVER

Cover Removal

Remove

- CVT and air guide. Refer to TRANSMISSION
- Disconnect vent hose
- PTO cover screws and pull PTO cover.

1. PTO cover
2. PTO cover screws
3. vent hose nipple

Cover Inspection

Check the PTO cover for cracks or other damage.

Replace PTO cover if damaged.

Clean oil breather bore in PTO cover from contaminations with part cleaner then use an air gun to dry it.

1. oil breather bore

Check oil seal running surface of crankshaft PTO side for grooves. Replace if necessary.

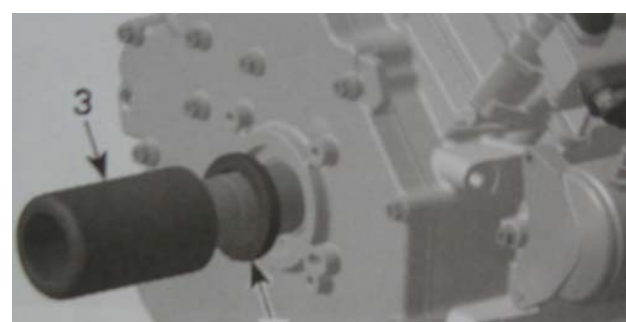
Oil Seal Installation

The installation is the reverse of the removal procedure.

Pay attention to the following details.

CAUTION: Oil seal must be installed with sealing lip toward the engine.

Push oil seal in place by using the oil seal installer.



1. PTO cover
2. oil seal
3. oil seal installer

Check plain bearings for scorings or other damages.

NOTE: Measure plain bearing inside diameter and compare to crankshaft journal diameter (PTO support bearing). Refer to CRANKSHAFT in this section. Replace if the measurement is out of specification.

1. plain bearing
2. oil bore
- A. measure plain bearing inside diameter

Plain bearing inside diameter (PTO side support bearing)	
Service limit	34.080 mm



Plain Bearing Replacement Procedure

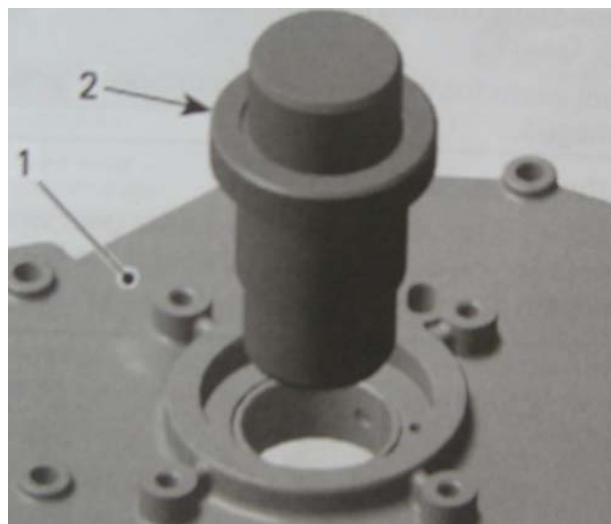
Plain Bearing Removal

Carefully remove the oil seal **no. 9** with a screwdriver, without damaging the PTO cover.

Push-out the plain bearings from the outside towards the inside using the plain bearing remover/installer.

The PTO cover has to be supported from below with suitable support with straight surface, in order to prevent damage of the sealing surface.

1. PTO cover
2. plain bearing remover/installer



Plain Bearing Installation

CAUTION: Unless otherwise instructed, never use hammer to install plain bearings. Use press only.

Install plain bearings with the proper plain bearing remover/installer in a cool PTO cover. Do not lubricate plain bearings and/or PTO cover for installation.

Carefully press-in the plain bearings in the same direction as during disassembly, from the outside towards the inside. Support PTO cover with suitable support with straight surface, in order to prevent damage of the sealing surface.

CAUTION: Mark position of oil bore on PTO cover and on plain bearing remover/installer. Align mark on plain bearing remover/installer with mark on PTO cover.



1. mark position of oil bore on PTO cover
2. mark position of oil bore on plain bearing remover/installer

NOTE: Wrong oil bore position will stop oil supply to plain bearings and will damage the engine.

CAUTION: The partition of the plain bearings must be positioned near to oil bore in counterclockwise direction (refer to no.3 in next illustration).

1. PTO cover (inside)
2. partition
3. oil bore

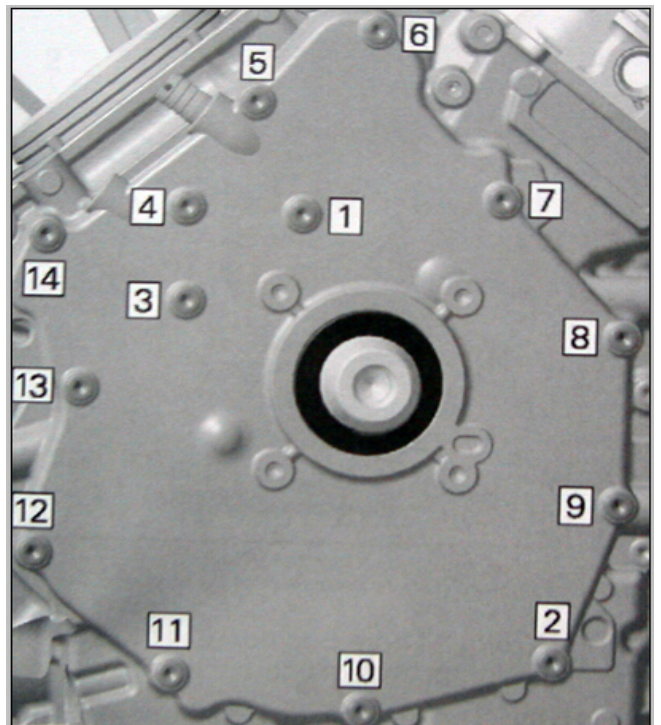
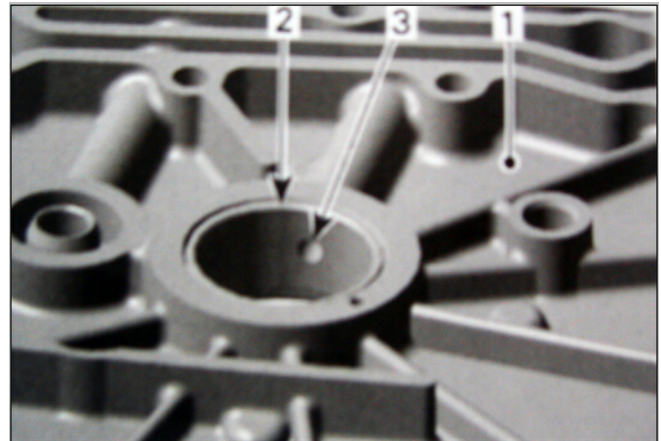
Cover Installation

For installation, reverse the removal procedure.

Pay attention to the following details.

NOTE: At installation, replace PTO cover gasket and oil seal.

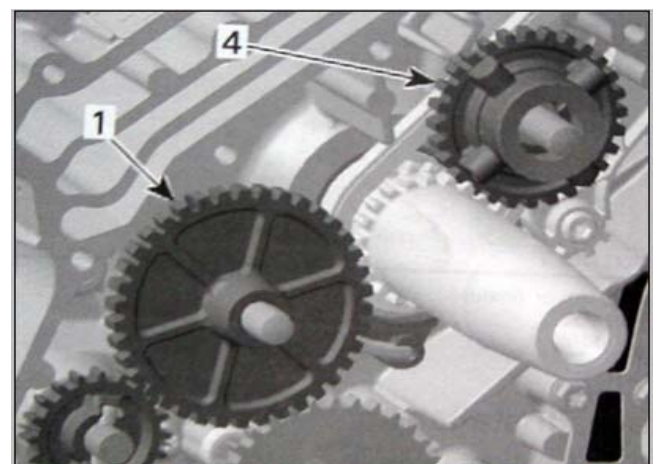
Tightening sequence for screws on PTO cover is as per following illustration.



DRIVE GEARS

The drive gears are located on the engine PTO side behind the PTO cover.

1. intermediate gear
2. oil pump gear



3. water pump gear
4. breather gear

Drive Gear Removal

Remove:

- PTO cover (refer to PTO COVER)
- Intermediate gear
- Oil pump gear
- Water pump gear

To remove water pump gear, pull the shaft assembly a bit out and turn it about one teeth until it stays out.

Now you can push water pump gear down. Remove needle pin and pull water pump gear out.

Remove breathe gear.

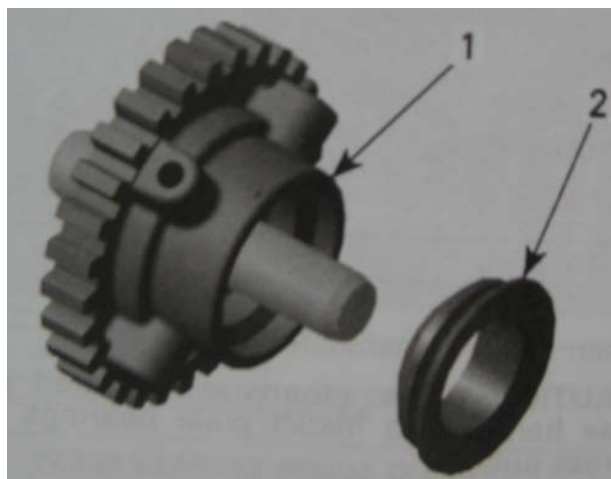
Drive Gear Inspection

Intermediate Gear/Oil Pump Gear/Water Pump Gear. Inspect gears for wear or other damage. Replace if damaged.

Breather Gear

The engine is equipped with a breather gear which prevents engine oil coming out through the breathing system into the air box.

1. breather gear
2. V-ring



Inspect gear for wear or other damage.

Check ball bearing for excessive play and smooth operation. Replace breather gear assembly if necessary.

Drive Gear Installation

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

NOTE: At installation replace the V-ring no. 16 of the breather gear.

Adequately oil the ball bearing of the breather gear.

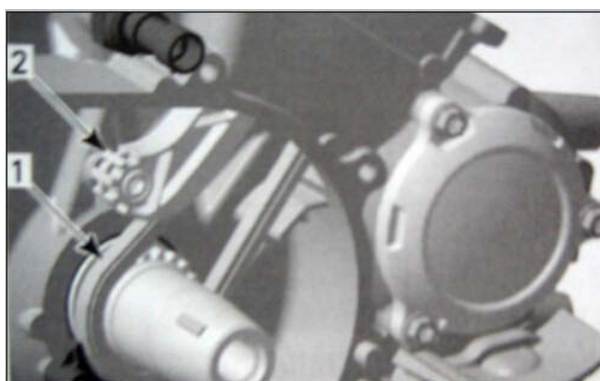
TIMING CHAIN

The engine is equipped with two timing chains. One of the timing chain is located on engine MAG side behind the magnet cover. The second timing chain is located on engine PTO side behind the PTO cover.

Removal of Magneto Side Timing Chain

Remove:

- valve cover, chain tensioner and camshaft timing gear (refer to CYLINDER AND HEAD)
- magneto cover and rotor (refer to MAGNETO SYSTEM)



■ timing chain guide and lower timing chain guide.

1. Timing chain
2. Timing chain guide
3. Lower timing chain guide

Carefully pull the timing chain sideward and down from the crankcase.

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

Removal of PTO Side Timing Chain

Remove:

- valve cover, chain tensioner and camshaft timing gear (refer to CYLINDER AND HEAD section)
- PTO cover (refer to PTO COVER)
- Intermediate gear and breather gear (refer to DRIVE GEARS)
- Timing chain guide and lower timing chain guide (see illustration above).

Carefully pull the timing chain sideward and down from the crankcase.

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

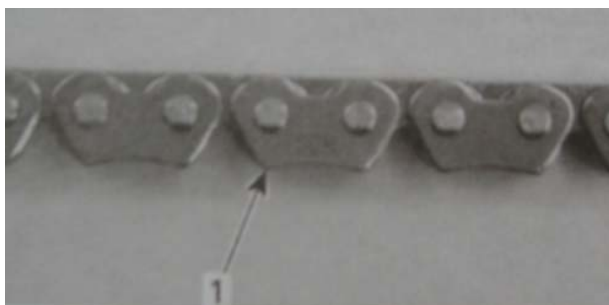
Timing Chain Inspection

Inspection is the same for both timing chains.

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

Check chain condition for wear and teeth condition.

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



Timing Chain Installation

Installation is the same for both timing chains.

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

NOTE: Ensure to perform proper valve timing. Lock crankshaft (see CRANKSHAFT) and camshaft at TDC ignition (refer to CYLINDER AND HEAD section).

Install timing chain with camshaft timing gear then, adjust chain tension (refer to CYLINDER AND HEAD section).

CAUTION: Improper valve timing will damage engine components.

CRANKCASE

Crankcase Disassembly

Remove:

- drive shaft (refer to ENGINE DRIVE SHAFT)
- PTO cover (refer to PTO COVER)
- Drive gears (refer to DRIVE GEARS)

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



■ electric starter

1. electric starter
2. screw

■ magneto cover and rotor (refer to MAGNETO SYSTEM section)

■ electric starter drive gears (refer to MAGNETO SYSTEM section)

■ water pump housing (refer to COOLING SYSTEM section)

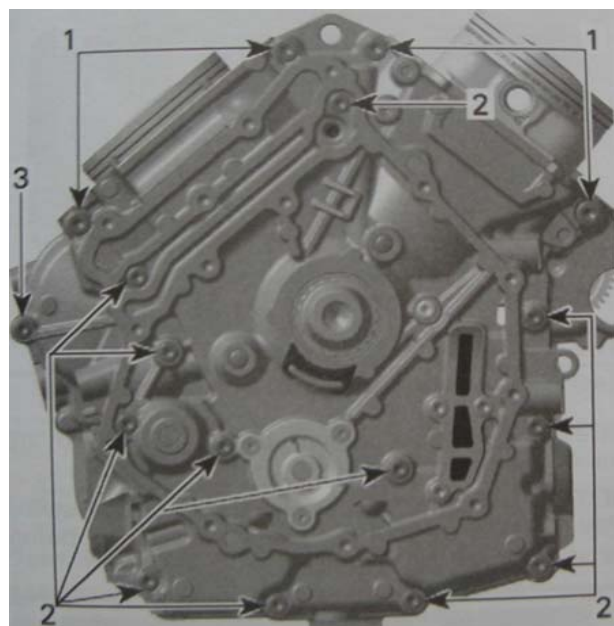
■ oil filter (refer to LUBRICATION SYSTEM section)

■ cylinder head and cylinder (refer to CYLINDER AND CYLINDER HEAD section)

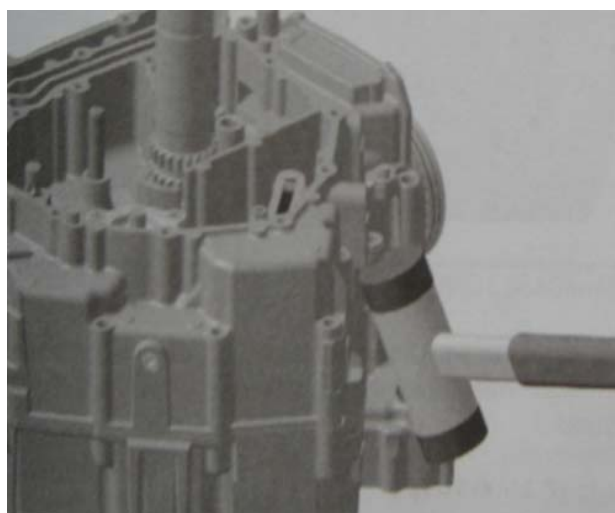
■ timing chains and timing chain guides (refer to TIMING CHAIN and TIMING CHAIN GUIDE).

Remove retaining screws of crankcase.

1. 4 screws M8 x 65
2. 12 screws M6 x 75
3. 1 screw M6 x 35



Carefully split crankcase halves by using a screw driver and a soft hammer.



NOTE: During disassembly, do not damage the sealing surfaces of the crankcase halves.

Pull crankshaft out of crankcase.

Remove the water pump intermediate shaft and the water pump gear.



1. water pump intermediate shaft
2. water pump gear

Remove engine oil strainer.

1. engine oil strainer
2. retaining plate
3. screws

Crankcase Inspection

NOTE: Remove all remaining parts from the crankcase halves; they could get damaged during repair work.

Clean crankcase halves from contaminations and blow the oil supply lines with compressed air.

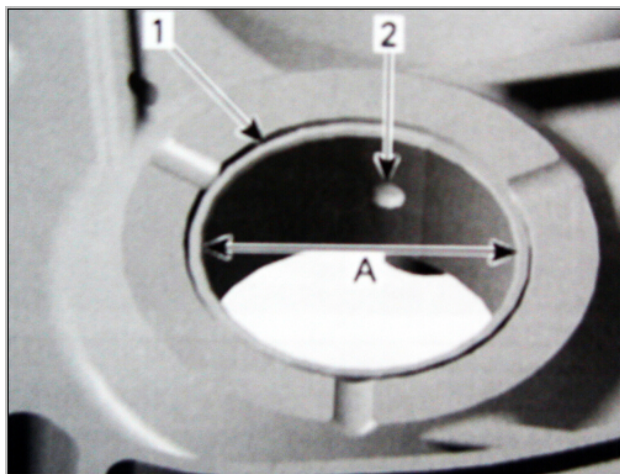
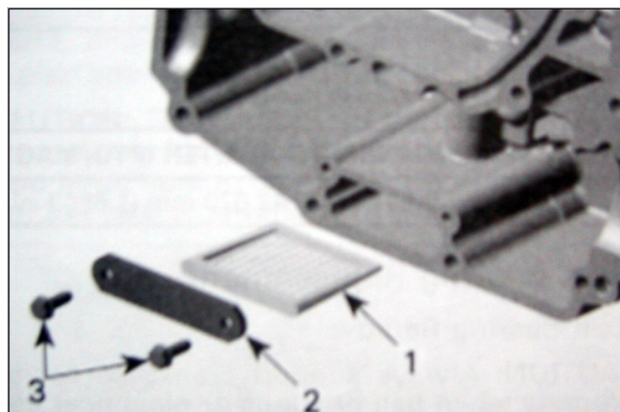
Check crankcase halves for cracks or other damage. Replace if damaged.

Check plain bearings no. 17 and no.18 for scorings or other damages.

NOTE: Measure plain bearing inside diameter and compare to PTO/MAG side journal diameters of crankshaft (refer to *CRANKSHAFT*). Replace if the measurements are out of specification.

1. plain bearing
 2. oil bore
- A. measure plain bearing inside diameter

plain bearing inside diameter	
service limit	42.070 mm

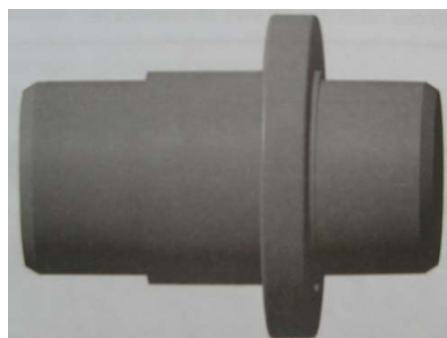


Plain Bearing Replacement

Plain bearing Removal

CAUTION: Always support crankcase halves properly when ball bearing or plain bearings are removed. Damages to crankcase halves may occur if this procedure is not performed correctly.

NOTE: Always use a press for removal of plain bearings.

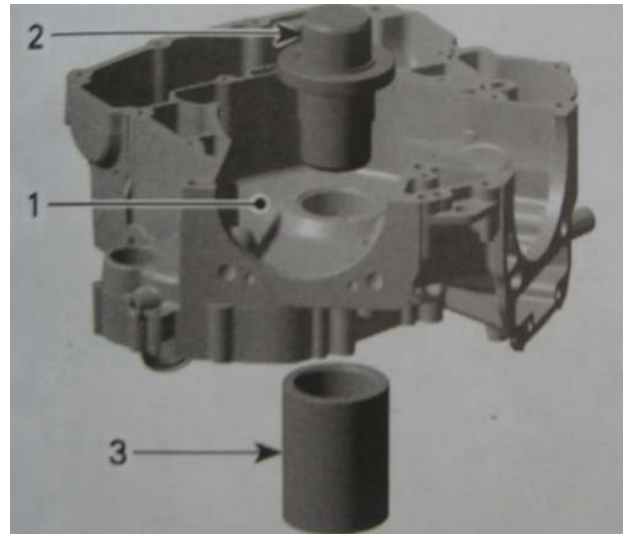


Remove plain bearings with the proper plain bearing remover/installer.

Carefully push the plain bearings out, from the crankcase half inside towards the outside.

NOTE: Place the proper crankcase support sleeve under crankcase halves before removing plain bearings. During disassembly, make sure not to damage the surfaces of the crankcase halves.

1. Crankcase half
2. Plain bear remover/installer
3. Crankcase support sleeve



Plain Bearing Installation

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

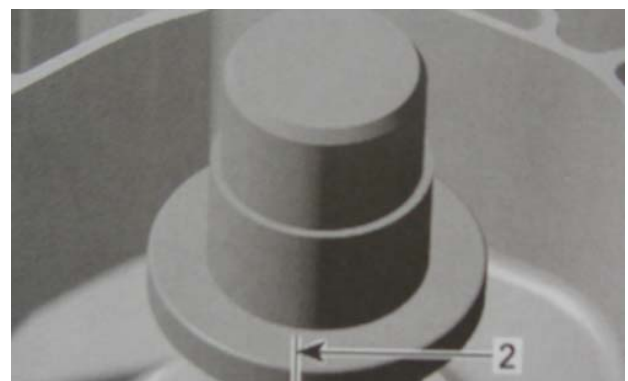
Install plain bearings with the proper plain bearing remover/installer in a cool crankcase. Do not lubricate plain bearings and/or crankcase for installation.

NOTE: Place the proper crankcase support sleeve under crankcase halves before installing the plain bearings.

Carefully press-in the plain bearings in the same direction as during disassembly, from the crankcase inside toward the outside.

During reassembly, make sure not to damage the sealing surface of the crankcase halves.

CAUTION: Mark position of oil bore on crankcase half and on plain bearing remover/installer. Align mark on plain bearing remover/installer with mark on crankcase half.



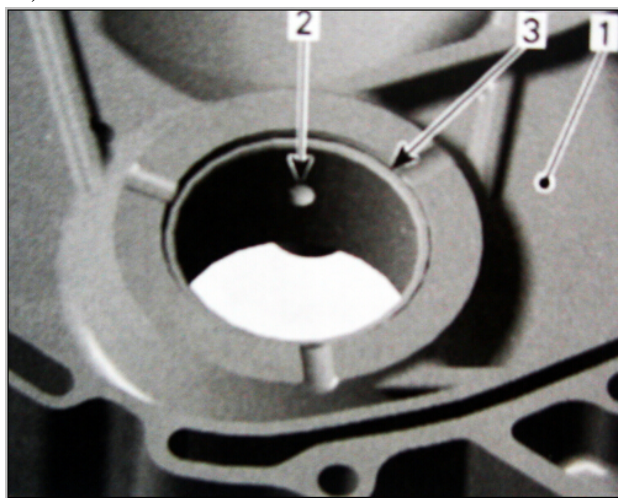
1. oil bore position marked on crankcase
2. oil bore position marked on plain bearing remover/installer

NOTE: Wrong oil bore position will stop oil supply to plain bearings and will cause engine damage.

CAUTION: the partition of the plain bearings in crankcase half MAG side must be positioned near to oil bore in clockwise direction (refer to no. 3 in next illustration).

CAUTION: The partition of the plain bearings in crankcase half PTO side must be positioned near to oil bore in counterclockwise direction (refer to no. 3 in next illustration).

1. crankcase half PTO (inside)
2. oil bore
3. partition



NOTE: Use an O-ring ($\phi 42 \times 1$ or 1.5 mm thickness) to hold plain bearings in place during installation. The O-ring will disappear in the groove, of the plain bearing remover/installer.

Crankcase Assembly

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

NOTE: Clean oil passages and make sure they are not clogged.

Clean all metal components in a solvent.

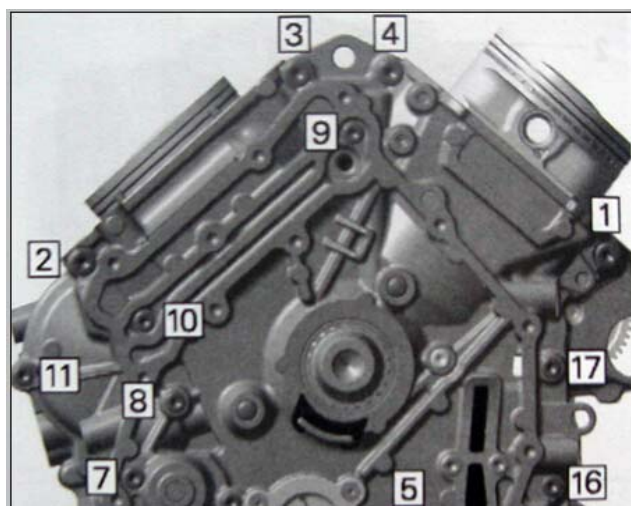
At installation, replace crankcase gasket.

Oil the plain bearings before mounting the crankshaft.

CAUTION: Correctly reinstall crankshaft (refer to CRANKSHAFT).

Reinstall engine oil strainer.

Reinstall water pump shaft shafts /gears.



Tightening sequence for screws on crankcase is as per following illustration.

CRANKSHAFT

Crankshaft Removal

Refer to CRANKCASE.

Crankshaft Inspection

NOTE: Check each bearing journal of crankshaft for scoring, scuffing, cracks or other signs of wear.

NOTE: Replace crankshaft if the gears are worn or otherwise damaged.

CAUTION: Components with less than the service limit always have to be replaced. If this is not observed, severe damage may be caused to the engine.

1. Crankshaft timing gears

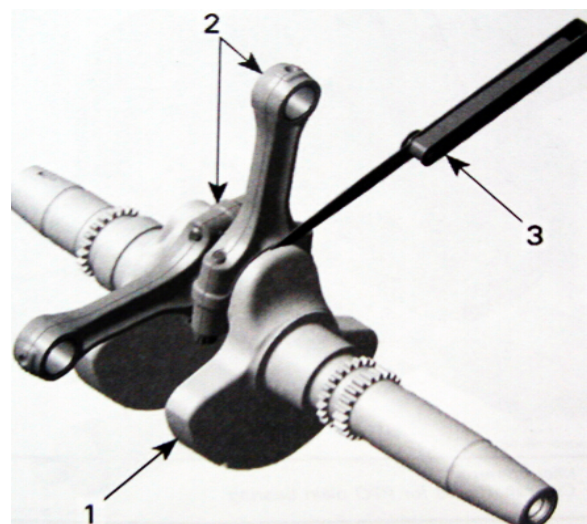


Connecting Rod Big End Axial Play

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

1. Crankshaft
2. Connecting rods
3. Feeler gauge

Connecting rod big end axial play	
New	0.200 to 0.500 mm
Service limit	0.6 mm



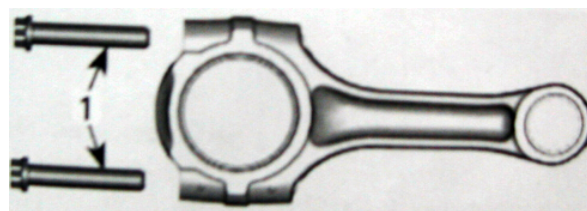
Connecting Rod/Piston Pin Clearance

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

position).

Remove connecting rods from crankshaft.

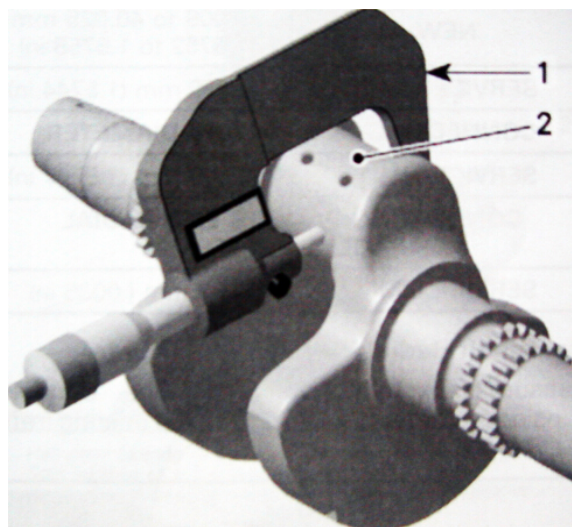
CAUTION: Always replace connecting rod screws no. 19 if removing the connecting rod. It is recommended to replace plain bearings no. 20, in case of installing the connecting rod.



1. Connecting rod screws.

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

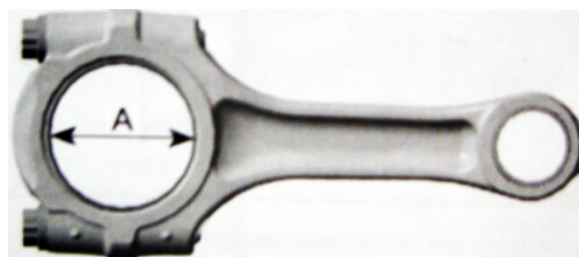
1. Micrometer
2. Crankpin area for plain bearing



To measure the rod big end diameter, use the OLD screws .

Install the OLD plain bearings as they were mounted initially.

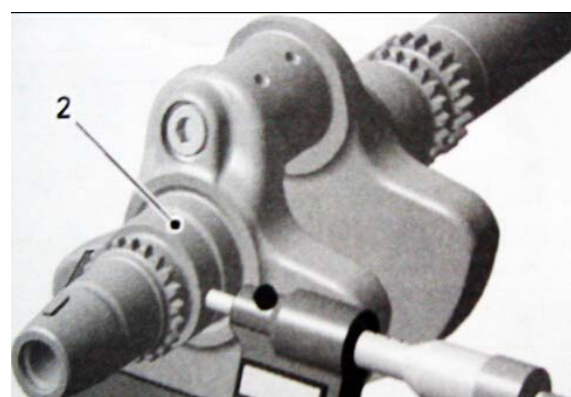
Do the torque procedure as described further.



Crankshaft pin diameter	
new	40.009 to 40.025 mm
Service limit	39.990 mm
Connecting rod big end diameter	
Service limit	40.100 mm
Connecting rod big end radial clearance	
Service limit	0.09 mm

Crankshaft Radial Play MAG/PTO Side

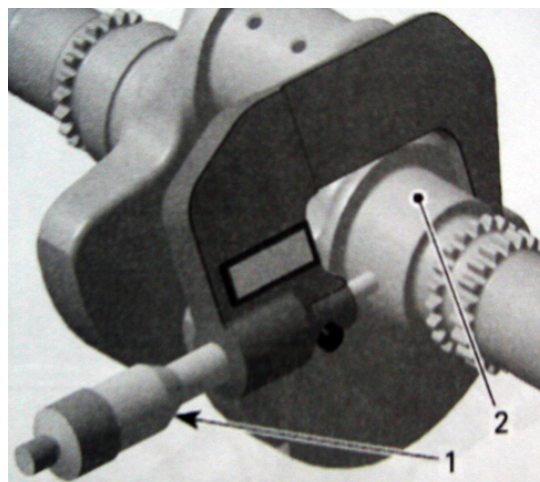
Measure crankshaft on MAG/PTO side. Compare to inside diameter of MAG/PTO plain bearing (refer to CRANKCASE).



1. Micrometer
2. Crankshaft area for MAG plain bearing

1. Micrometer
2. Crankshaft area for PTO plain bearing

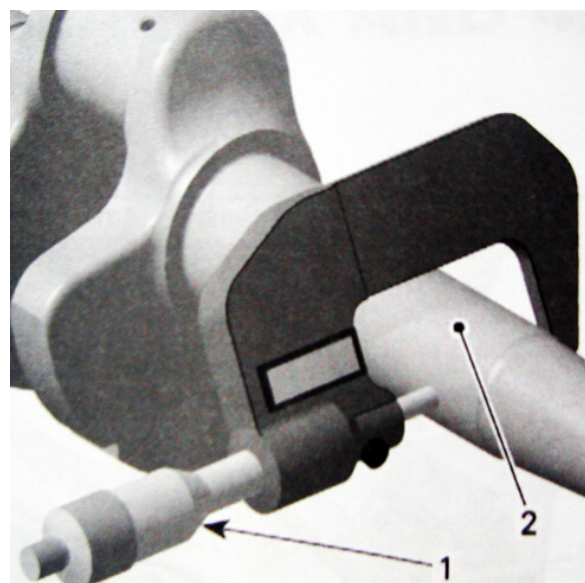
Crankshaft main journal diameter	
New	42.024 to 42.040 mm
Service limit	42.000 mm
Crankshaft deflection	
Service limit	0.07mm
Crankshaft radial clearance	
Service limit	0.06 mm



**Crankshaft Radial Play
(PTO side support bearing)**

Measure crankshaft journal of PTO support bearing. Compare to inside diameter of PTO support bearing in PTO cover (refer to PTO COVER).

Crankshaft pin journal diameter (PTO support bearing)	
new	34.024 to 34.040 mm
Service limit	34.010mm
Crankshaft PTO support bearing radial clearance	
Service limit	0.01 mm



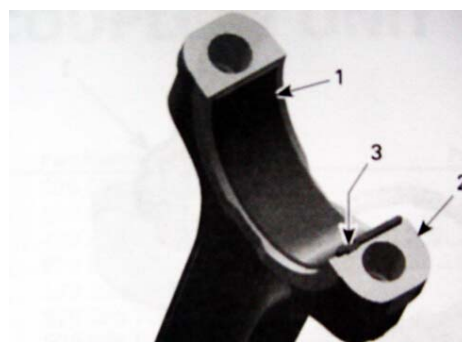
Crankshaft Assembly

For assembly, reverse the disassembly procedure.

Pay attention to following details.

NOTE: Use **NEW** plain bearings **no. 20**, 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 with



compressed air.

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

NOTE: Oil the plain bearing surface of the connecting rod and crank pin before installation.

Torque NEW connecting rod screws as per following procedure:

First, install screws with half of the recommended torque. Do not apply any thread locker.

Secondly, torque connecting rod screws to 20 N.m.

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 plain bearing tapered end must be against the counterweight. Besides, as the “crankpin” has been stretched from the previous installation, it is very important to use a new screw at assembly.

The running direction of big end bearings and of the piston pins must not change.

Crankshaft Installation

For installation of crankshaft in crankcase reverse the removal procedure. Pay attention to the following details.

CAUTION: Observe the correct installation position when fitting the crankshaft with the connecting rods. The connecting rod MAG side has to face to cylinder 1.

OIL PRESSURE REGULATOR

The oil pressure regulator is located the engine magneto side (inside magneto cover).

1. Engine pressure regulator

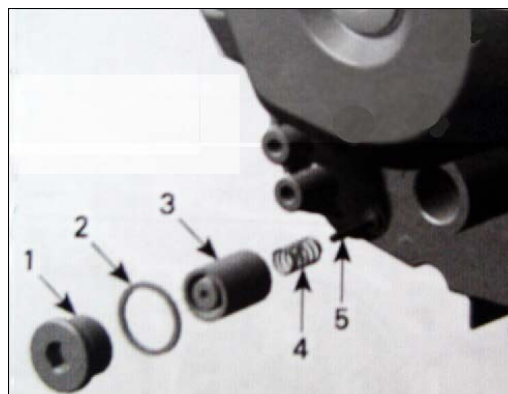
NOTE: The oil pressure regulator system works when the oil pressure exceeds 450kPa (65ps).



Removal

Remove plug screw and pull oil pressure regulator out.

1. Plug screw
2. Gasket ring
3. Pressure regulator housing
4. Spring
5. Pressure regulator valve



Inspection

Inspect pressure regulator hosing and valve for scoring or other damages.

Check spring for free length.

SPRING FREE LENGTH	
New nominal	39 mm(1.535 in)
Service limit	37 mm(1.457in)

NOTE: Replace worn or damaged components.

Clean bore and thread in the magneto housing from metal shavings and other contaminations.

Installation

For installation, reverse the removal procedure.

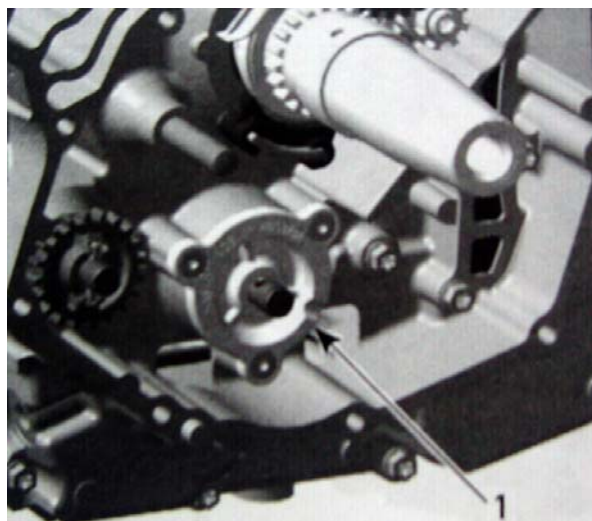
Pay attention to the following details.

NOTE: At installation, always replace the gasket ring no. 3 of the plug screw.

OIL PUMP

The oil pump is located on the engine PTO side (behind cover).

1. Oil pump



Removal

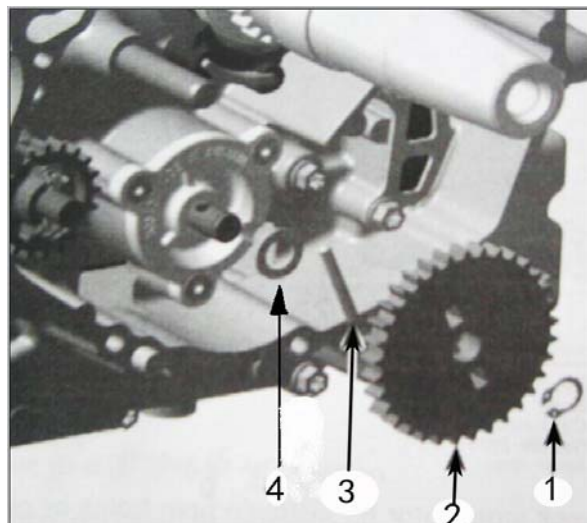
Remove parts to access the engine crankcase PTO cover.

Remove the engine crankcase PTO cover. .

Remove:

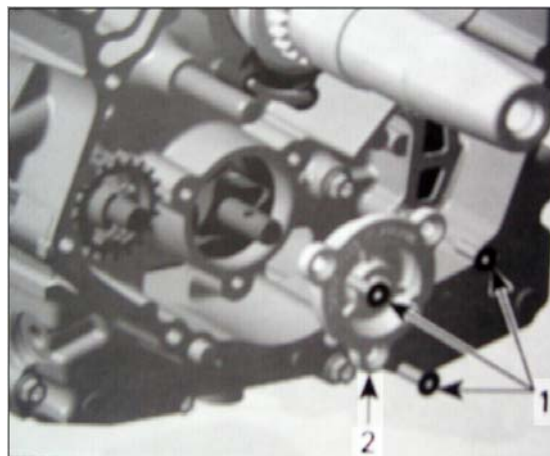
- retaining ring
- oil pump gear
- needle pin
- thrust washer
- oil pump cover screws and pull oil pump cover
- oil pump shaft with inner rotor and outer rotor.

1. Retaining ring
2. Oil pupm gear



- 3. Needle pin
- 4. Thrust washer

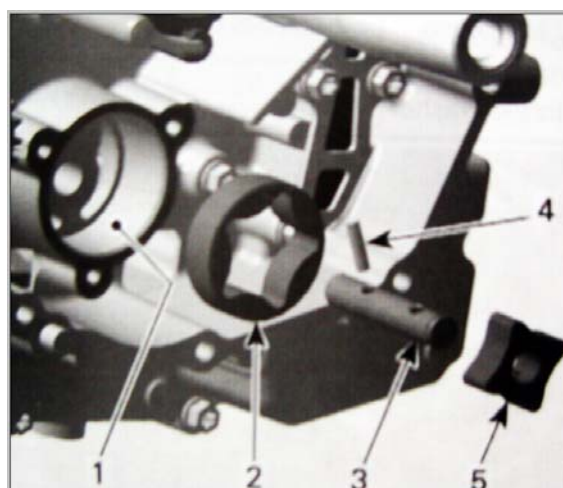
- 1. Retaining screws
- 2. Oil pump cover



Inspection

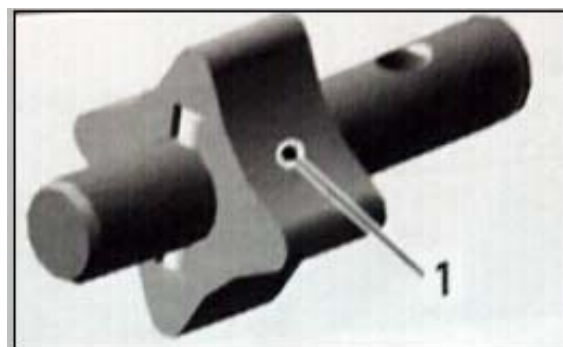
Inspect oil pump for marks or other damages.
Check for scratches in crankcase between outer rotor and oil pump bore. If so, replace damaged parts.

- 1. Oil pump bore
- 2. outer rotor
- 3. Oil pump shaft
- 4. Needle pin
- 5. Inner rotor

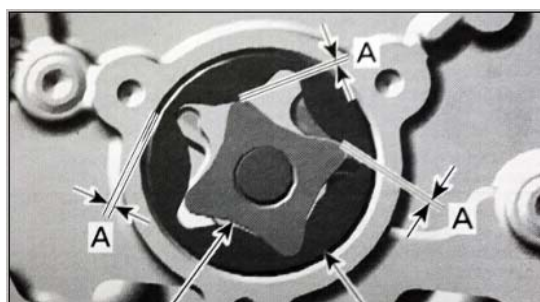


Check inner rotor for corrosion
pin holes or other damages. If so, replace oil pump
shaft assembly.

- 1. Pitting on the teeth



Using a feeler gauge, measure the clearance of inner and
outer rotors as shown.



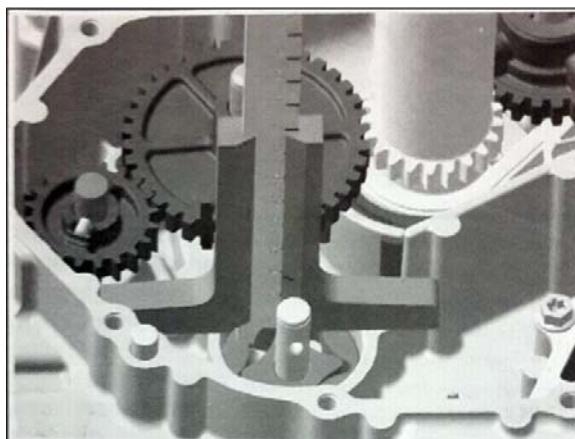
1. Outer rotor
 2. inner rotor
- A. SERVICE LIMIT:0.25mm(0.09in)**

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

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

Using a depth gauge, measure the axial clearance of the oil pump as shown..

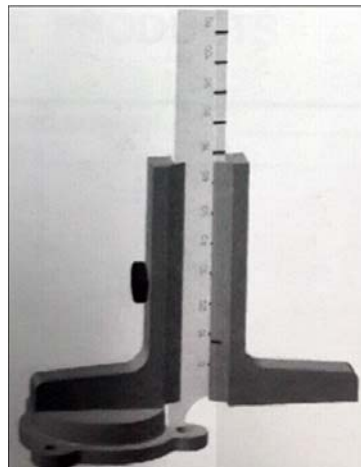
Oil PUMP-MEASUREMENT "A"



Oil PUMP COVER - MEASUREMENT "B"

Difference between measurements should not exceed 0.2 mm. if so, replace the complete oil pump assembly.

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



Installation

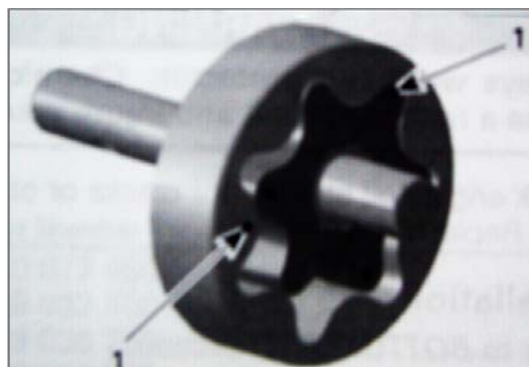
For installation, reverse the removal procedure.

Pay attention to the following details.

NOTE: The outer rotor and inner rotor are marked.

When installing, make sure both markings are on the upper side.

1.Markings



After reinstallation of the remaining parts, check for smooth

operation of the oil pump assembly.

Final Test

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

MAGNETO COVER

Magneto Cover Removal

Lock crankshaft at TDC.

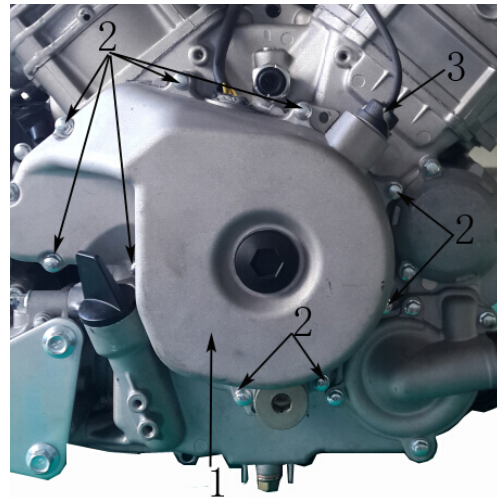
Drain engine oil.

Disconnect crankshaft position sensor (CPS) connector and cut tie rap.

Remove magneto cover retaining screws.

1. magneto cover
2. retaining screws
3. crankshaft position sensor

Pull magneto cover.



Magneto Cover Inspection and Cleaning

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

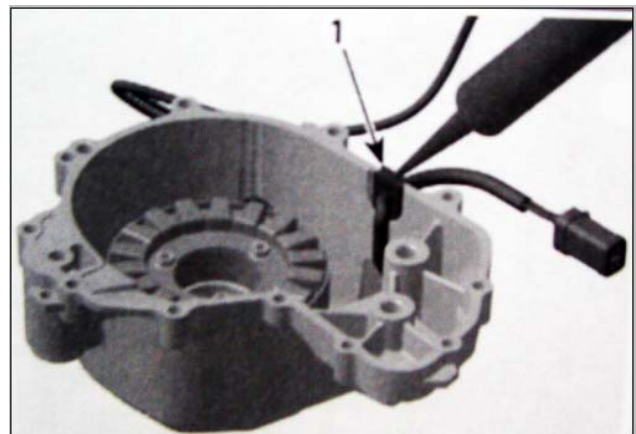
Magneto Cover Installation

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

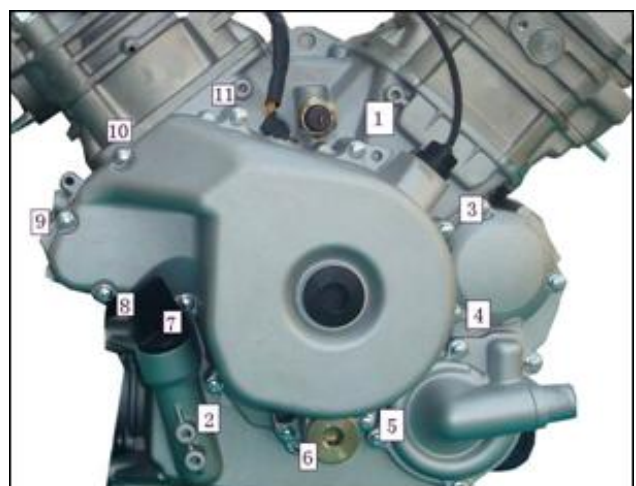
NOTE: At installation replace magneto cover gasket.

Apply Drei Bond sealing compound on stator cable grommet as shown in the illustration.

1. Apply drei bond sealing compound



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



STATOR

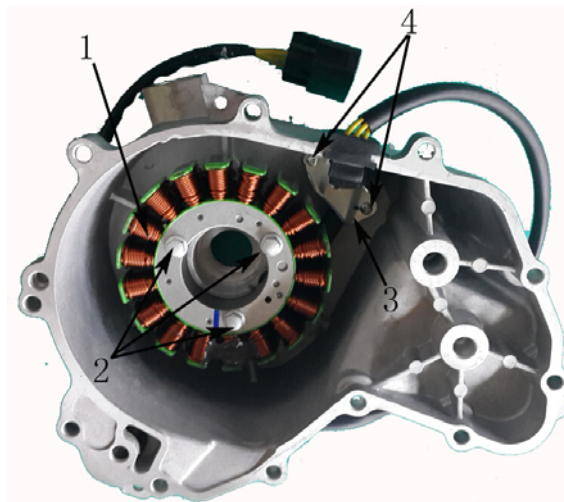
Stator Removal

Remove magneto cover.

Remove screws securing holding strip.

Remove stator retaining screws then the stator.

1. Stator
2. Stator retaining screws
3. holding strip
4. holding strip screws



Stator Inspection

Check stator condition. If damaged replace it.

Check if stator wires are brittle, bard or otherwise damaged.

For electrical inspection, refer to CHARGING SYSTEM.

Stator Installation

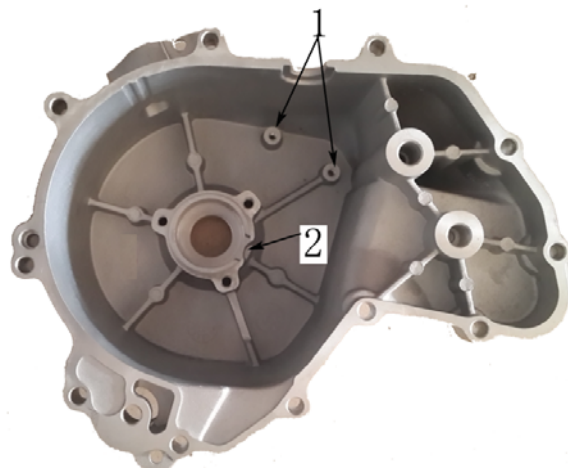
For installation, reverse the removal procedure.

However, pay attention to the following.

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

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

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



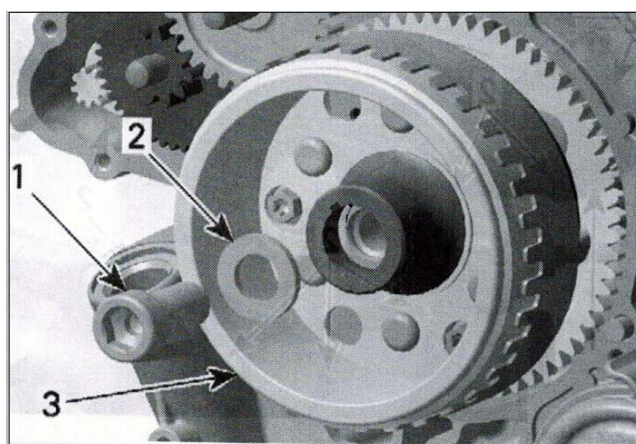
ROTOR

Rotor Removal

Lock crankshaft with crankshaft locking bolt.

Remove magneto cover. Refer to *MAGNETO COVER* above.

Remove screw and washer securing rotor to crankshaft.



1. Screw M16
2. Washer
3. Rotor

Install magneto puller and crankshaft then remove rotor.

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

1. Rotor
2. Magneto puller

Screw magneto puller bolt to remove rotor.



Rotor Inspection

Check inner side of rotor for scratches or other damage.

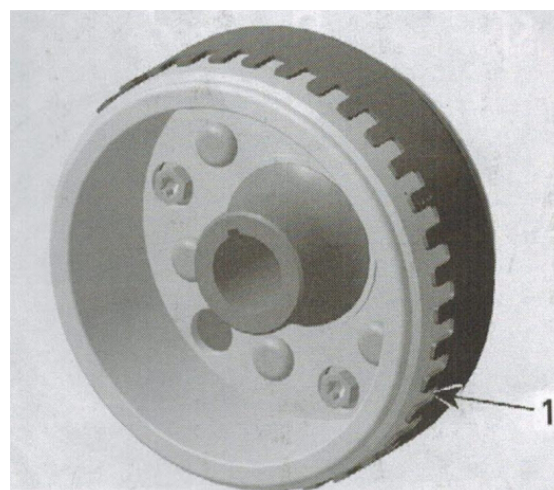
Check keyway of the rotor for wear or damages.

Check if trigger wheel teeth are bent or otherwise damaged.

1. Rotor with trigger wheel

Check woodruff and keyway on the crankshaft for wear or damages.

Replace parts as necessary.



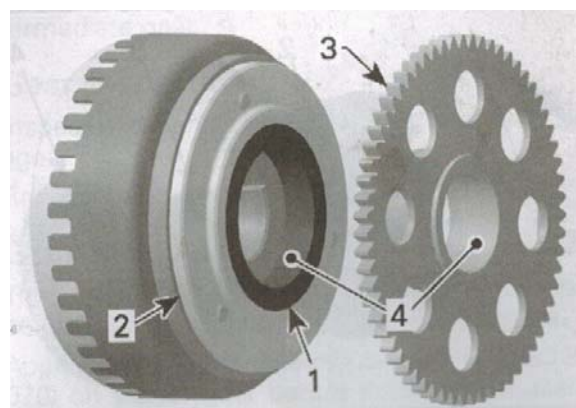
Rotor Installation

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

Clean crankshaft taper and rotor with pulley flange cleaner.

CAUTION: Taper on crankshaft and rotor must be free of grease.

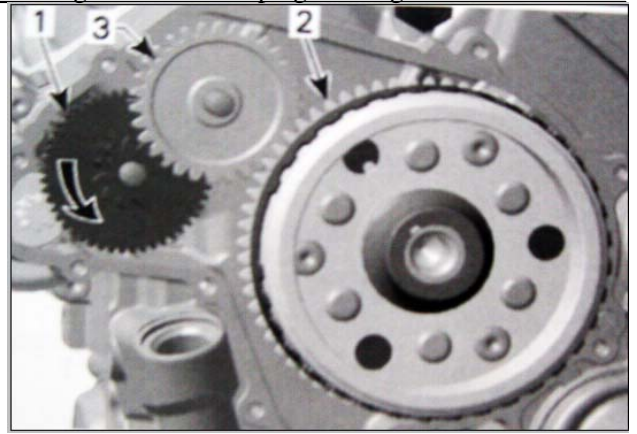
Oil sprag clutch in sprag clutch housing and install sprag clutch gear.



1. Sprag clutch
2. Sprag clutch housing
3. Sprag clutch gear
4. Apply engine oil here

Slide rotor onto crankshaft. The woodruff key and the keyway must be aligned.

1. Starter double gear
2. Sprag clutch gear
3. intermediate gear



SPRAG CLUTCH

Sprag Clutch Removal

Remove magneto cover

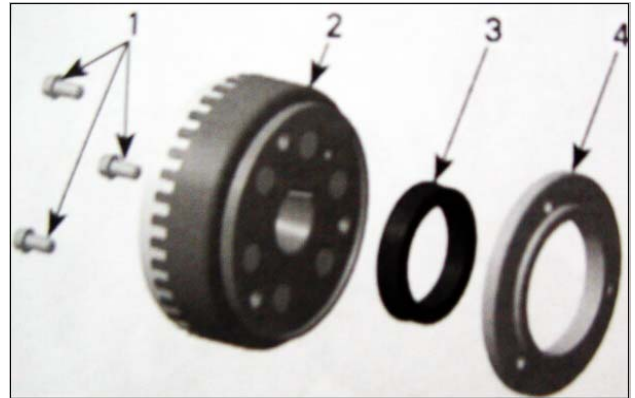
Loosen sprag clutch housing screws located inside rotor.

Remove rotor (refer to ROTOR above)

Remove sprag clutch gear.

Remove sprag clutch housing screws and sprag clutch housing.

1. Sprag clutch housing screws
2. Rotor
3. Sprag clutch
4. Sprag clutch housing



Sprag Clutch Inspection

Inspect sprag clutch and sprag clutch housing for wear and damage.

Also check the collar of the sprag clutch gear.

Perform a functional test of the sprag clutch. To do so, rotate sprag clutch gear in sprag clutch.

NOTE: Sprag clutch must lock in counterclockwise direction.

1. Lock



NOTE: Sprag clutch, housing and gear must be replaced at the same time, if damaged.

Sprag Clutch Installation

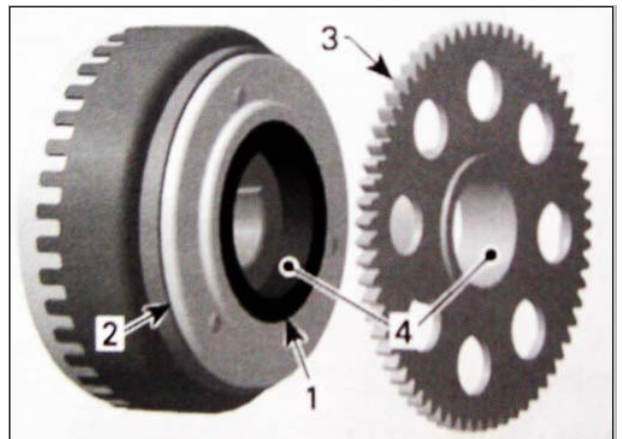
For installation, reverse the removal procedure. Pay attention to the following details.

Apply LOCTITE 648 (green) on threads of sprag clutch housing screws.

Install screw but do not torque yet.

Apply engine oil on sprag clutch and inside sprag clutch gear hole.

1. Sprag clutch
2. sprag clutch housing



Install rotor then torque sprag clutch housing screws to 30 **N.m.**

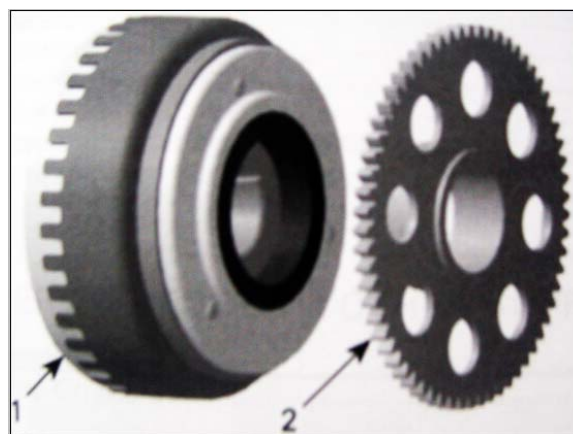
SPRAG CLUTCH GEAR

Sprag Clutch Gear removal

Remove rotor .

Pull sprag clutch gear from rotor.

1. Rotor
2. Sprag clutch gear



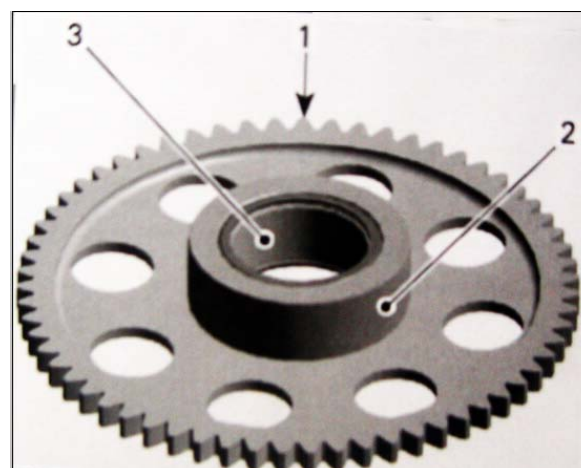
Sprag Clutch Gear Inspection

Inspect gear, especially teeth and sprag clutch collar, for wear and other damage.

Check needle bearing condition. Replace sprag clutch gear if necessary.

INSPECT

1. Teeth
2. Collar
3. Needle bearing

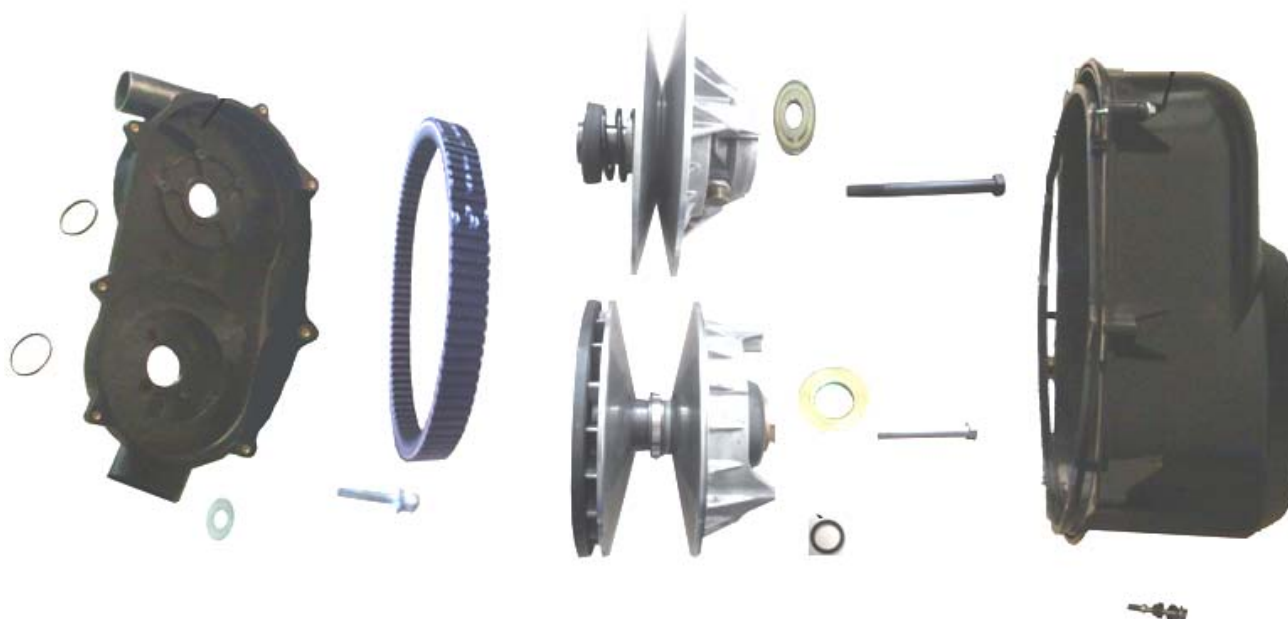


Sprag Clutch Gear Installation

The installation is the reverse of the removal procedure.

NOTE: Apply engine oil on needle bearing and collar of sprag clutch gear.

TRANSMISSION



Never touch CVT while engine is running.

never drive vehicle when *variator* cover is removed.

Subcomponent installation and assembly tolerances require strict adherence to procedures detailed.

Never use any type of impact wrench at drive pulley removal and installation.

The clutch assembly is a precisely balanced unit. Never replace parts with used parts from another clutch assembly

These pulleys have metric threads. Do not SAE threads puller. Always tighten puller by hand to ensure that the drive pulley has the same type of threads prior to fully tightening.

DRIVE BELT

Removal

Remove:

- Distance screws
- remove *variator* cover and gasket.

1. *Variator cover*

2. *Distance screw*

3. *Gasket*

NOTE:

Remove the center top screw last. This screw allows to support the cover during removal.

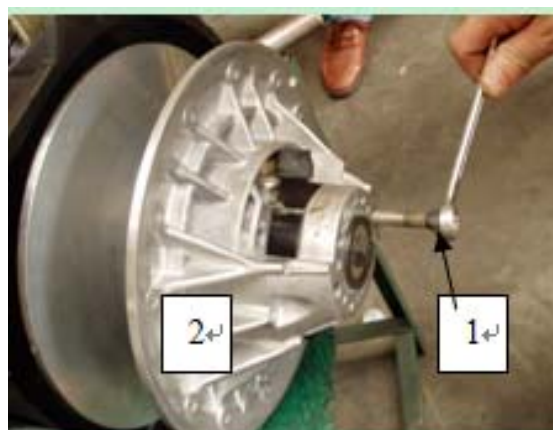
Open driven pulley with the driven pulley expander.

Screw tool in the threaded hole of driven pulley and tighten to open the pulley.

1. *Driven pulley expander*

2. *Fixed sheave of driven pulley*

To remove belt, slip the belt over the edge of fixed sheave as shown.



INSPECTION

Inspect belt for cracks, fraying or abnormal wear.
Replace if necessary.

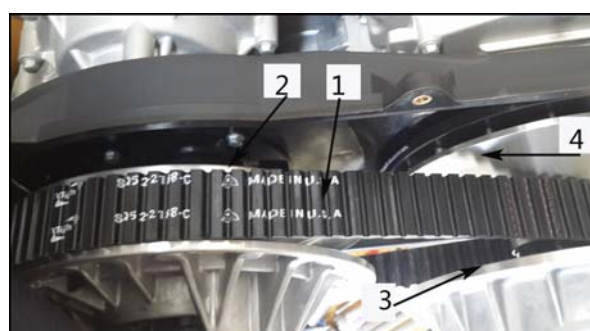
Drive belt width	
Service limit	30.00mm(1.181 in)

**Installation**

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

1. Word printed on belt
2. Drive pulley (front)
3. Driven pulley (rear)
4. Rotation direction

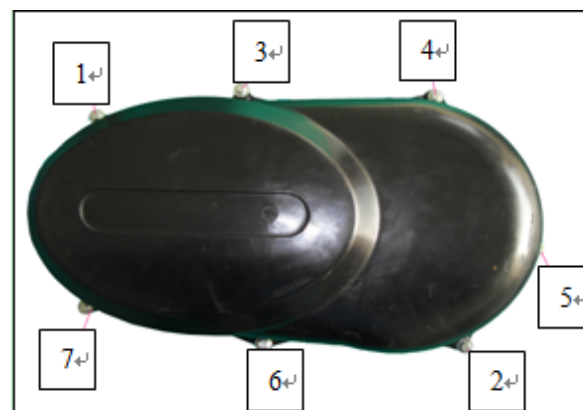
The maximum drive belt life span is obtained when the drive belt has the proper rotation direction. Install it so that the arrow printed on belt is pointing towards front of the vehicle, viewed from top.



Install variator cover gasket.

Install the center top screw in first.

Tighten the distance screw as per following sequence.

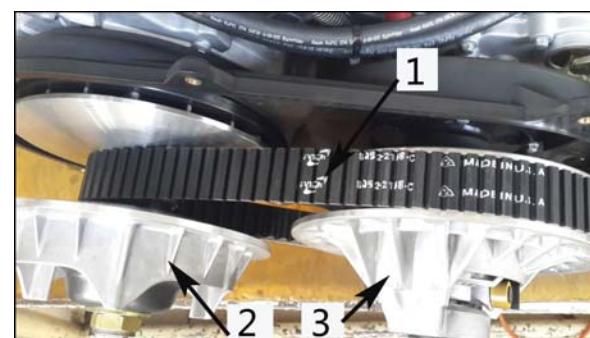
**DRIVE PULLEY**

1. Belt
2. Drive pulley
3. Driven pulley

Removal

- remove *variator* cover and gasket.
- Remove belt

Block the drive pulley as followed.

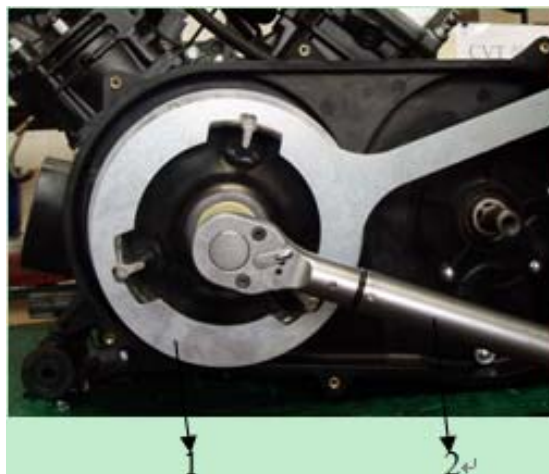


Block drive pulley with the pulley holding tool.

1. Pulley holding tool
2. Torque wrench

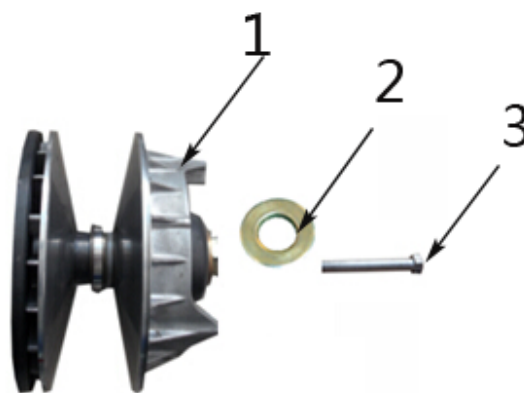


When the drive pulley is blocked, mark sliding sheave and governor cup to ensure correct reinstallation.



Unscrew the drive pulley screw (right hand thread), then remove it as well as the conical spring washer and thrust washer.

1. Drive pulley
2. Thrust washer
3. Drive pulley screw



Inspection

Drive pulley should be inspected annually for wear or damages.

Check drive pulley for cracks and sliding contact surface for excessive wear. Replace it if necessary.

Check one-way clutch bearing for excessive play and smooth operation. Replace one-way clutch if necessary.

Installation

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

Do not apply any lubricant on crankshaft and drive pulley tapers.

Clean pulley faces and shaft with dry cloth.

Install drive pulley on crankshaft extension.

Do not forget to place thrust washer

Never substitute conical spring washer and/ or screw with jobber ones. Always use genuine parts for this

particular case.

Install thrust washer with its concave side towards drive pulley then install drive pulley screw.

To torque the drive pulley screw, block the drive pulley. Refer at the beginning of this section.

When the drive pulley is blocked, torque screw to 100N.m.

DRIVEN PULLEY

Removal

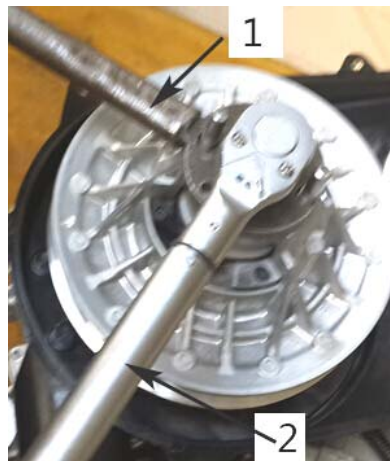
- remove *variator* cover and gasket.
- Remove belt



Using the pulley holding tool, hold the driven pulley during the removal of the driven pulley screw, do not remove screw completely.

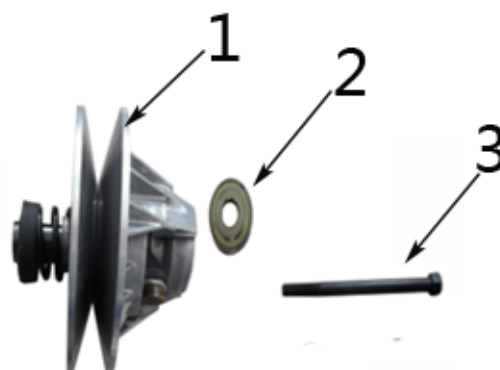


Put in tow STUD to Driven Pulley



1. Driven Pulley holding tool
2. Torque wrench

When the driven pulley is blocked, unscrew the driven pulley screw.



1. Driven pulley
2. Thrust washer
3. Driven pulley screw

Inspection

Driven pulley should be inspected annually for wear or damages.

Check sliding and fixed sheave for cracks and sliding contact surface for excessive wear. Replace sliding sheave if necessary.

Check sliding sheave bushings for cracks, scratch and for free movement when assembled to sliding sheave.

Check ball bearing for free play and smooth operation. Replace if necessary.

Installation

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

Chamfer on inside diameter of the spacer must face engine side.

Clean pulley faces and shaft with dry cloth.

Driven pulley is a spring loaded system.

Always place washer at the time of driven pulley installation.

When the driven pulley is blocked, torque screw to 60N.m.

CVT AIR GUIDE**Removal**

Remove:

- Variator cover
- Drive belt
- Drive pulley
- Driven pulley

Unscrew the clamps retaining the CVT air hoses

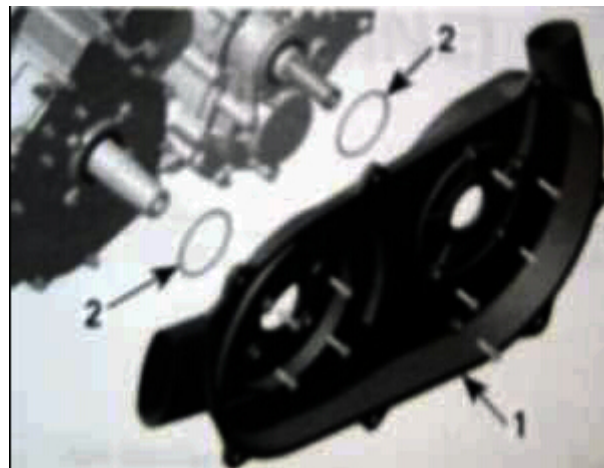
Remove CVT air guide.

Inspection

Clean CVT air guide from contamination.

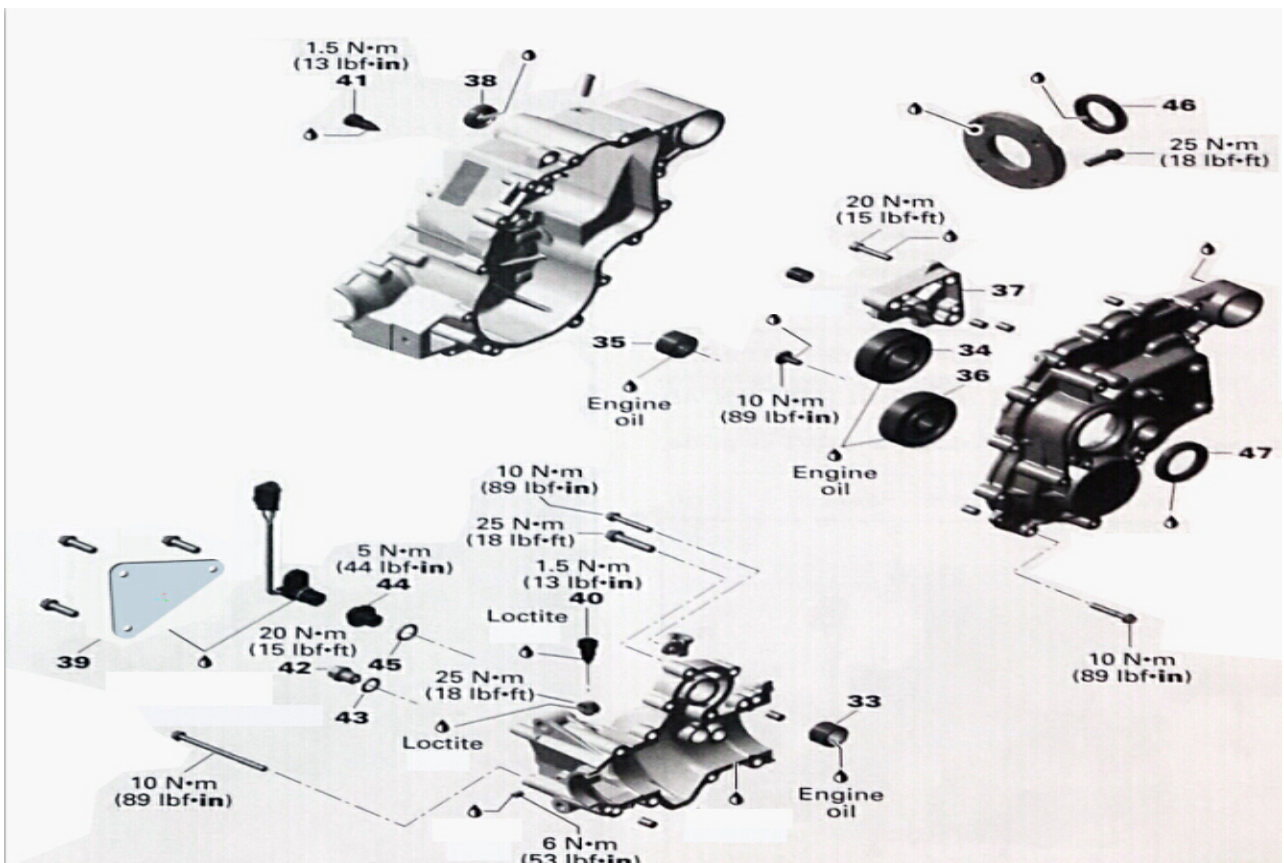
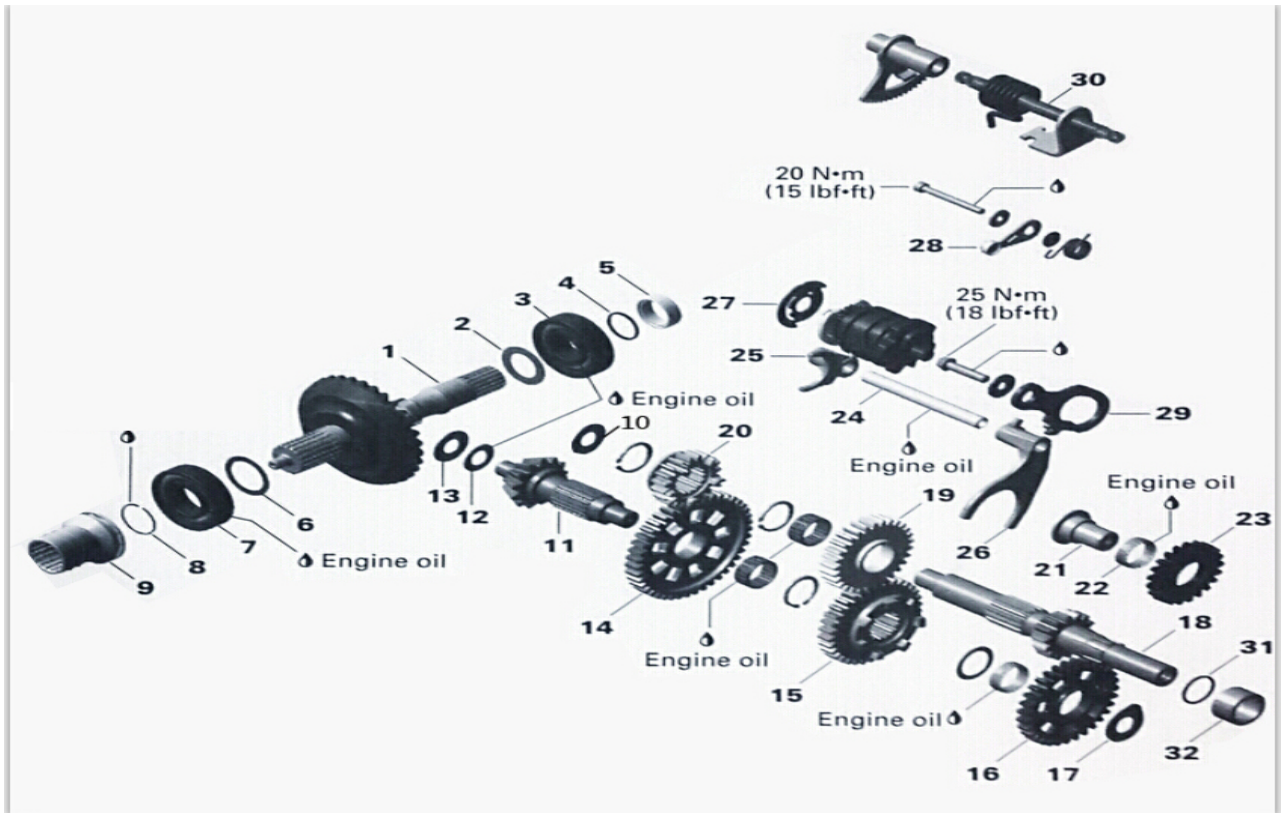
Check O-rings if brittle, hard or damaged. Replace if necessary.

1. CVT air guide
2. O-rings

**Installation**

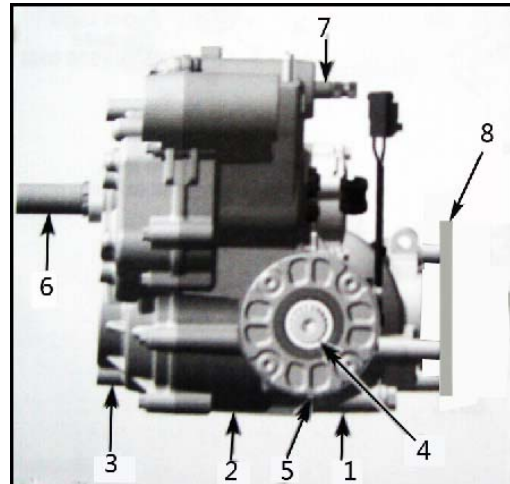
For installation, reverse the removal procedure.

GEARBOX



To remove gearbox, the engine removal is necessary. First remove drive and driven pulley and CVT air guide. After unscrew the three (3) nuts attach the gearbox to the engine. Then pull gearbox to separate it from engine. Always drain the gearbox oil before working on.

1. Right housing
2. Center housing
3. Left housing
4. Output shaft
5. Bearing cover
6. Countershaft
7. Shift shaft
8. Cover



GEARBOX OIL DRAIN

Prior to change the oil, ensure gearbox is on a level surface.

Place a drain pan under the gearbox drain plug area.

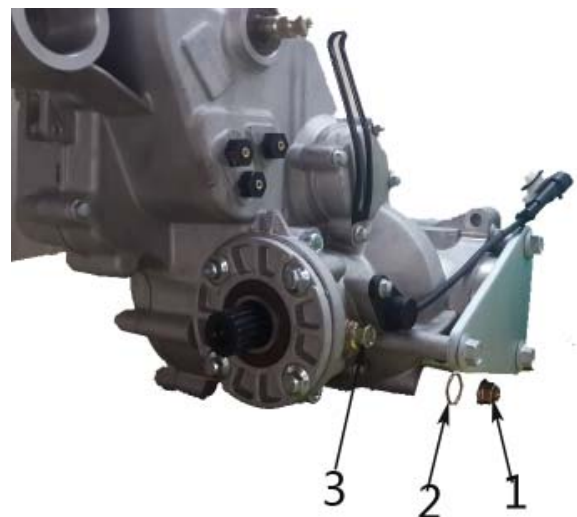
Clean drain plug area and remove magnetic drain plug with its sealing ring to drain gearbox oil.

Remove oil filler screw including its o-ring.

CAUTION: Pay attention not to loose O-ring on drain plug screw.

Wait a while to allow oil flow out of gearbox.

1. Magnetic drain plug
2. Sealing ring
3. Oil filler screw



Dispose gearbox oil as per your local environmental regulations.

Inspection

Oil condition gives information about the teeth condition inside the gearbox.

Clean the magnetic drain plug from metal shavings and dirt. Presence of debris gives an indication of failure inside the gearbox. Check gearbox to correct problem.

Change gasket ring on the magnetic drain plug if damaged.

Replace o-ring if brittle, hard or otherwise damaged.

POSTION INDICATOR SWITCHES

NOTE: The gearbox removal is not necessary to reach the gearbox position indicator switches.

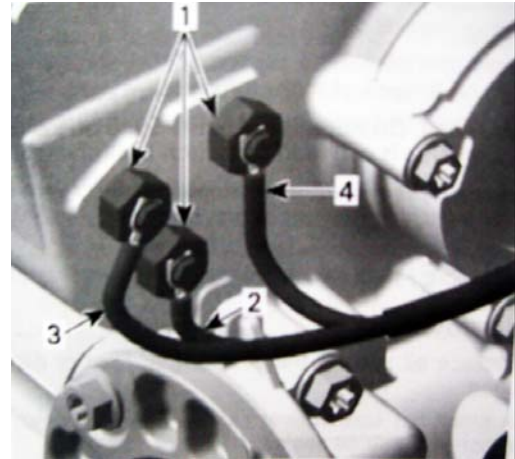
Removal

To reach the gearbox position indicator switches, remove the rear engine cover.

Remove screw retaining indicator switch wire.

1. Gearbox position indicator switches
2. BROWN/ GREY wire
3. WHITE/ GREY wire
4. ORANGE/ GREY wire

Unscrew switch.

**Test**

Check if gearbox position indicator switches work properly as per following procedure:

NOTE: Remove insulating paint to obtain correct readings.

Put gearbox in park, reverse, neutral, high and low position.

Use a multi meter to measure the resistance from the indicator switch to engine ground. Compare results with the logic table below.

An "x" indicates switch is making ground contact, thus there should be continuity (R is close to 0 ohms)

A blank space indicates switch is not making contact, there should be no continuity (R = infinite). If the indicator switch is good, check the vehicle harness and /or indicator lights.

Shifter position	Corresponding switch wires		
	Brown/grey	White/grey	Orange/grey
L	x		x
H			x
N		x	x
R		x	
P	x	x	

Installation

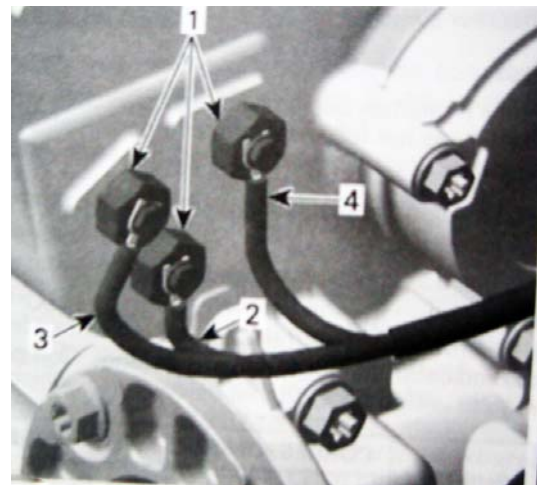
For installation, reverse the removal procedure.

Pay attention to the following details.

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

If all switches are removed, make sure to put the wires back in the right location.

1. Gearbox position indicator switches
2. BROWN/ GREY wire
3. WHITE/ GREY wire
4. ORANGE/ GREY wire



Spray a layer of electrical insulating paint or varnish over switches to prevent shorts and corrosion.

OIL SEALS

Removal

Replace oil seals if they are brittle, hard or damaged.

A small flat screwdriver can be used to remove most of these oil seals.

CAUTION: Avoid scoring housings, bearing cover, shift shaft, distance sleeve of countershaft or output shaft during oil seal removal.

Countershaft oil seal

The countershaft oil seal can be removed without removing gearbox from vehicle. Remove drive and driven pulley and CVT air guide.

NOTE: When oil seal is removed also inspect O-ring

1. Countershaft oil seal
2. Distance sleeve

Shift shaft oil seal

The shift shaft oil seal can be removed without removing the gearbox from the vehicle.

Remove side panel and the shifting plate from shift shaft to reach the oil seal.

Output shaft oil seal

Removal of output shaft oil seal requires that the rear propeller shaft is separated from the output shaft. The removal of the gearbox or bearing cover is not necessary.

NOTE: When oil seal is removed also inspect O-ring

1. Shift oil seal
2. Output shaft oil seal

Inspection

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

Check oil seal running surfaces for scratches. Replace if necessary.

Check if the countershaft O-ring and the output shaft O-ring are brittle, hard or damaged. Replace if necessary.

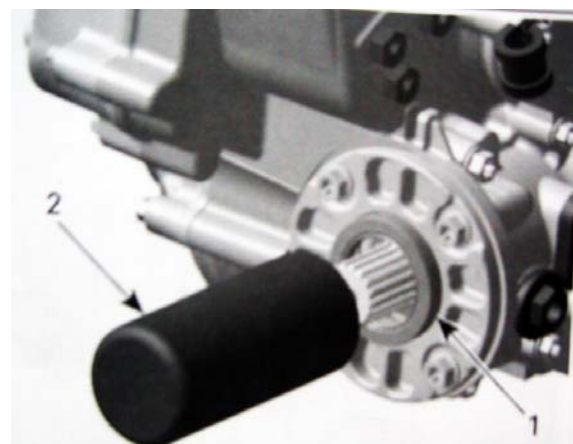
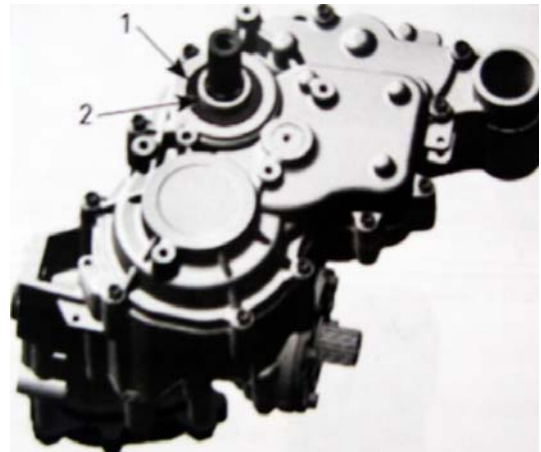
Installation

The installation is the reverse of removal procedure. Pay attention to the following details.

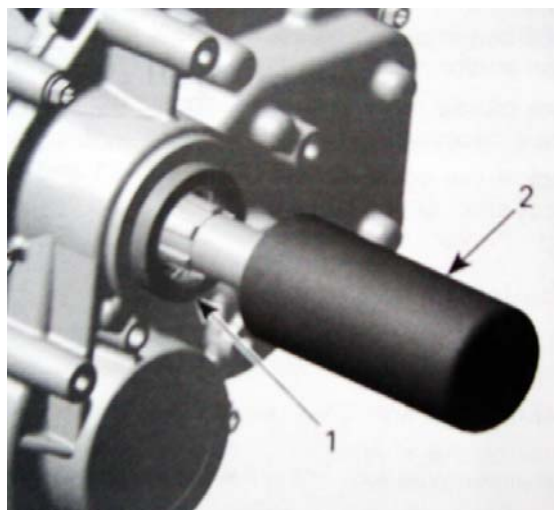
Output shaft and countershaft oil seal

Install output shaft oil seal and countershaft oil seal with the oil seal installer.

1. output shaft oil seal
2. oil seal installer



1. countershaft oil seal
2. oil seal installer



Shift shaft oil seal

Using a suitable tube with the proper diameter to install the shift shaft oil seal.

If gear housing is apart, the oil seal installer and installer handle can be used for shift shaft oil installation.

CUTION: Oil seal must be installed with sealing lip toward gearbox.



OUTPUT SHAFT

Remove gearbox.

Before removing the right housing and output shaft measure the back lash on output shaft. This measure will indicate if output shaft adjustment is necessary.

Output Shaft Back lash Procedure

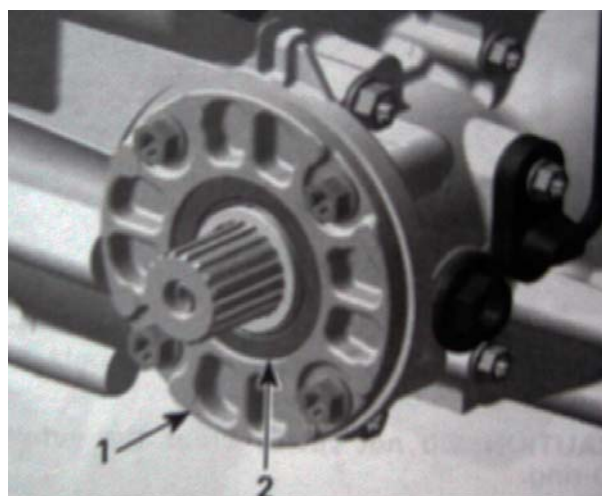
Engage PARK position on the gear shaft to block gearbox.

Remove:

- bearing cover with oil seal

1. bearing sleeve
2. oil seal

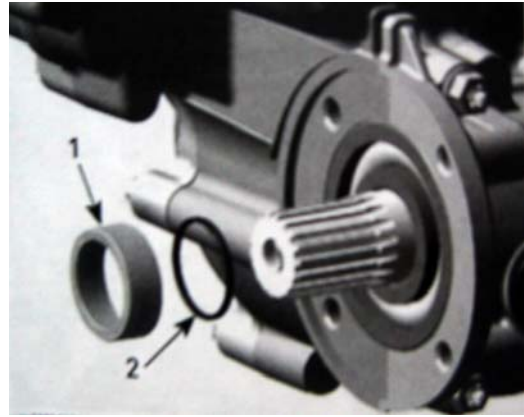
- distance sleeve
- o-ring



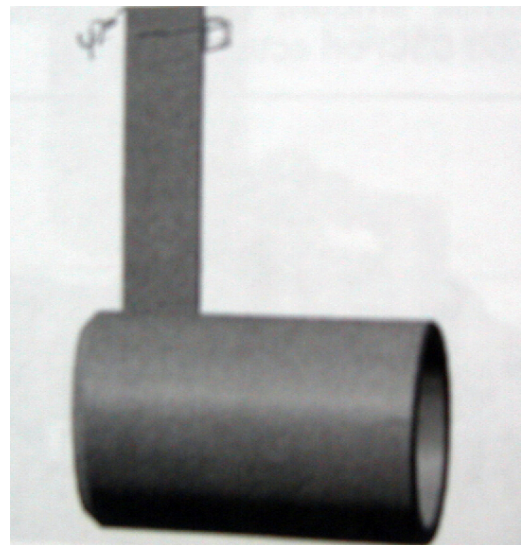
NOTE: It is recommended to apply this specific sealant as described here to get a uniform application without lumps. If you do not use the roller method, you may use your finger to uniformly distribute the sealant (using a finger will not affect the adhesion).

Install all the screws on right housing then the O-ring and the distance sleeve on end of output shaft. Chamfered bore of distance sleeve has to face the engine.

1. distance sleeve
2. O-ring



Install the backlash measurement tool at the end of output shaft.



From center of tool bolt, measure 47 mm and place a mark on the tab.

1. back lash measurement tool
 2. mark on tab
- A 47 mm

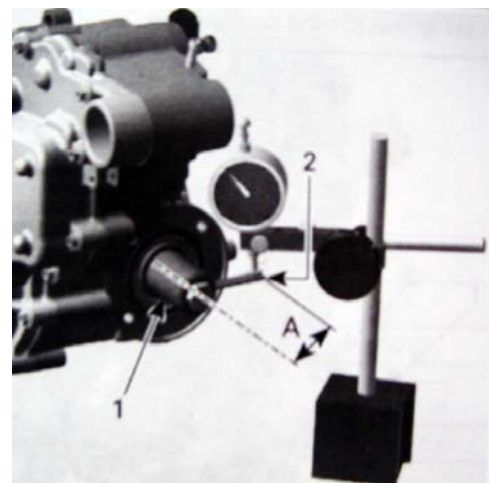
Position the head of the dial indicator, against the tab at a 90° angle and on the line. Then, gently rotate the output shaft.

This reading gives the back lash measurement.

Refer to the following table for backlash specifications.

Output shaft backlash	
New	0.10 to 0.20 mm
Service limit	0.25 mm

If back lash is not within the specification, remove the output shaft and select the next larger or smaller shim to meet the specifications.



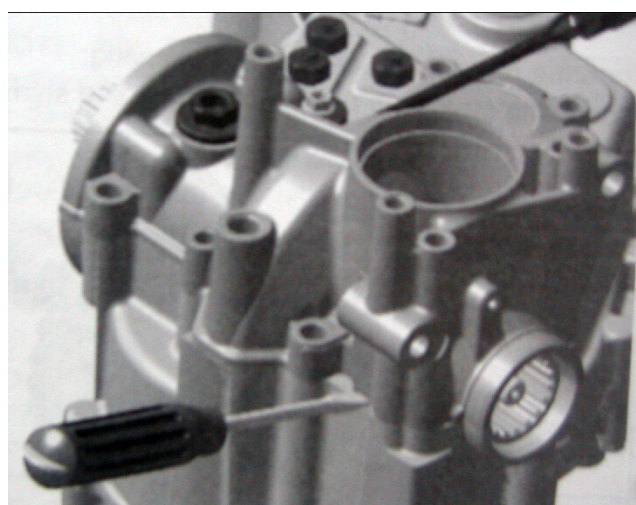
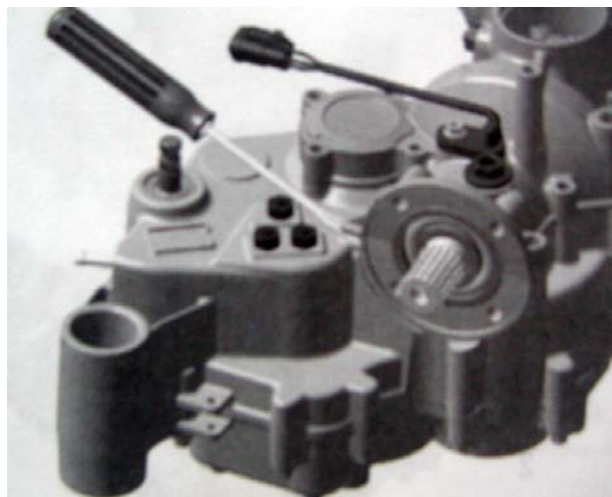
NOTE: Use next lager shim to increase back lash and next small shim to reduce backlash.

Removal

Remove the bearing cover with oil seal.

Unscrew all bolts retaining the right housing to the center housing.

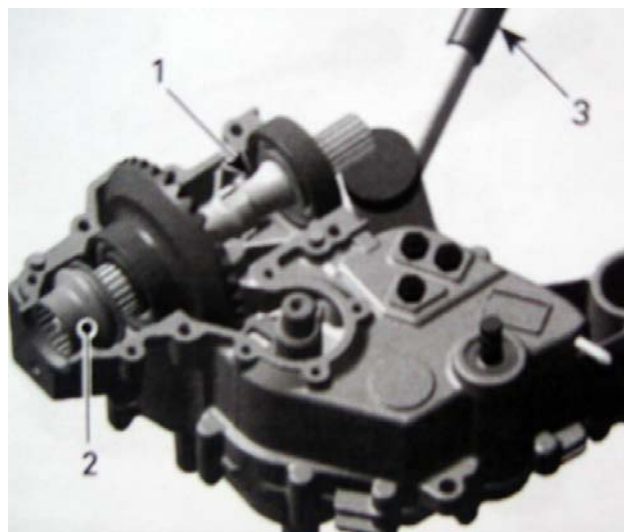
To remove right housing, use 2 big screwdrivers.



Remove output shaft.

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

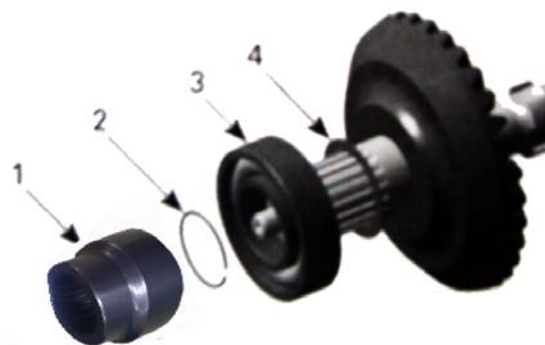
1. output shaft
2. coupling sleeve
3. soft hammer



Continue removal procedure by removing:

- coupling sleeve, O-ring, ball bearing and shim.

1. coupling sleeve
2. O-ring
3. ball bearing
4. shim



■ ball bearing and thrust washer

1. ball bearing
2. thrust washer



Inspection

Check output shaft and its gear for cracks, bend, pitting or other visible damages.

Check output shaft splines for wear or other damages.

CAUTION: Always replace output shaft and bevel gear shaft at the same time. Adjust these components upon replacement.

Check if the output shaft bearings and turn freely and smoothly. Replace if necessary.

Replace oil seal if brittle, hard or damaged.

Replace O-rings and if brittle, hard or damaged.

Check splines of coupling sleeve for wear or other damages.

1. inspect splines



Installation

Install shim, bearing, O-ring and coupling sleeve onto the output shaft.

Install thrust washer and ball bearing.

O-ring and distance sleeve are not installed at this time.

Place the output shaft into the center housing.

Use soft hammer to put bearing exactly in place against center housing.

Clean the bearing cover location then attach bearing cover with oil seal to the housing.

Temporarily install the right housing with the four (4) M8 screws beside bearing seats.

NOTE: prior to tightening the screws, tap on the gear end of output shaft with a soft hammer to take up all gear free play.

Verify output shaft backlash. Refer to OUTPUT SHAFT BACK LASH PROCEDURE in this section. Adjust as required.

If back lash is with in specifications, remove dial indicator, backlash measuring tool, bearing cover and right housing.

Clean all metal components in a solvent.

Housing mating surfaces are best cleaned using a combination of chisel (gasket remover) 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.

Important: When beginning the application of 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 LOTITE 5910 on mating surfaces.

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

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

NOTE: It is recommended to apply this specification 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).

Install all other screws on right housing then the O-ring no. 4 and the distance sleeve on end of output shaft. Chamfered bore of distance sleeve has to face the engine.

1. O-ring
2. distance sleeve

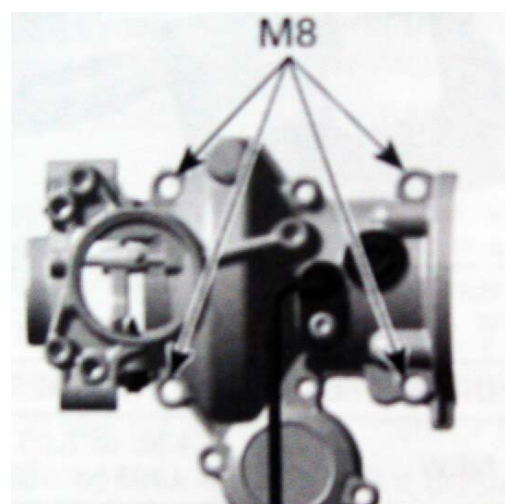
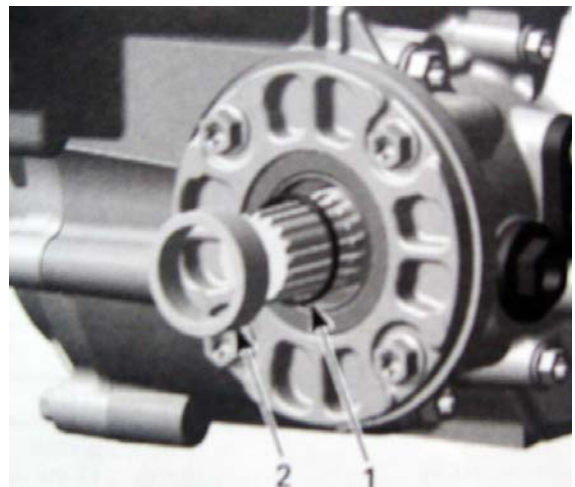
NOTE: To install the right housing align the coupling fork no. 10 with the groove in the coupling sleeve no. 9.

First, torque the four (4) M8 screws in a crisscross sequence by hand then retighten to 25 N.m.

Tighten all M 6 screws to 10 N.m.

Before installing bearing cover, apply Loctite 5910 on the housing and Super Lube grease on seal.

Once this is done, complete final assembly.



GEARS

Removal

Unscrew the three (3) nuts attach the gearbox to the engine.

Pull gearbox to separate it from engine.

Disassembly

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

Remove the output shaft..

Push bevel gear with a pin lightly down and measure the axial clearance of bevel gear with a feeler gauge.

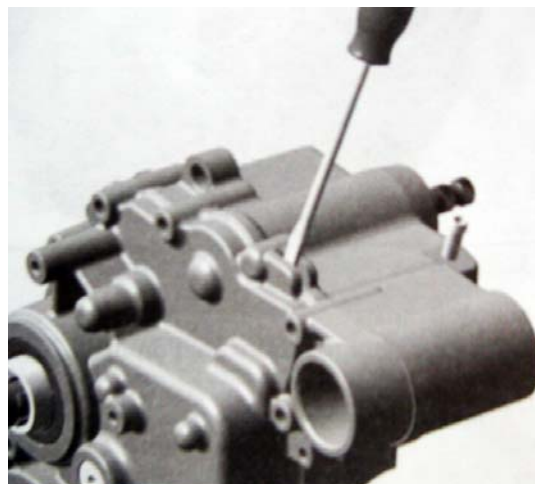
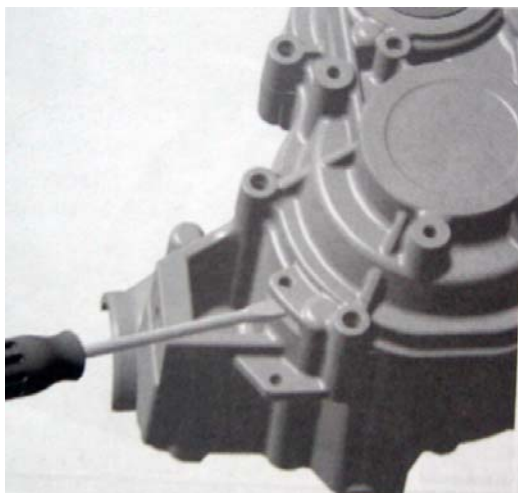
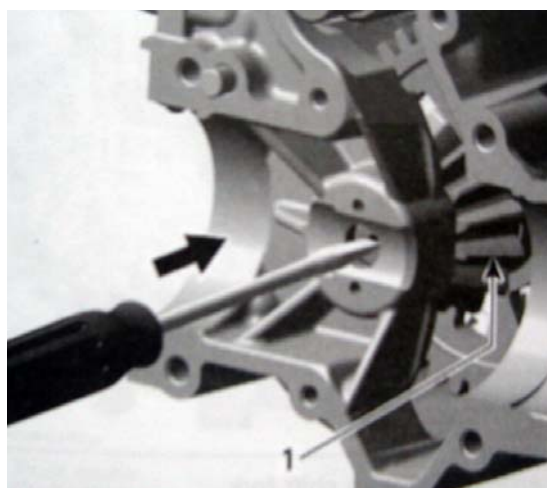
NOTE: Bevel gear axial clearance must be measured before center and left housings separation.

1. bevel gear

Unscrew the left housing screws.

Place the left housing on a wood stand, center housing pointing upwards.

Using 2 big flat screwdrivers, lift the center housing.



Remove center housing completely.

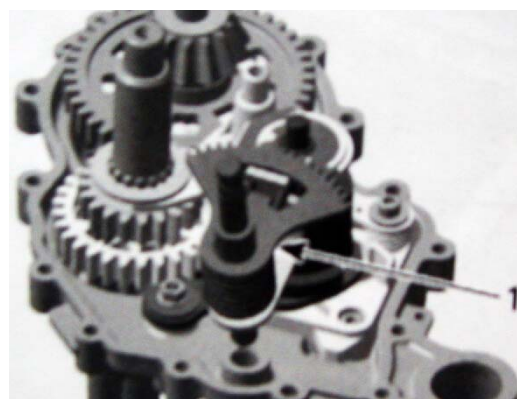
Remove:

- shift shaft assembly

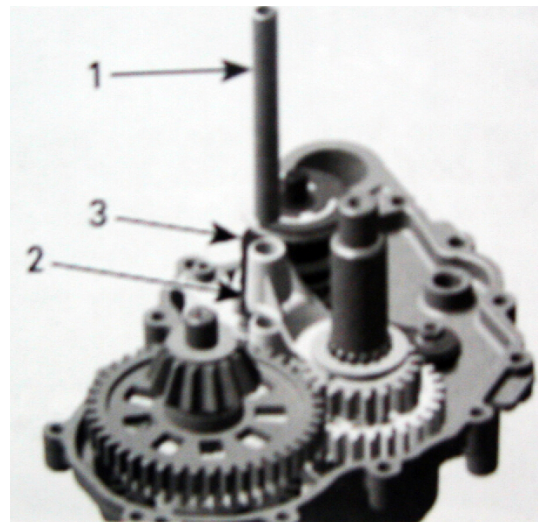
1. shift shaft assembly

- shift fork shaft

- disengage shift fork from shift drum

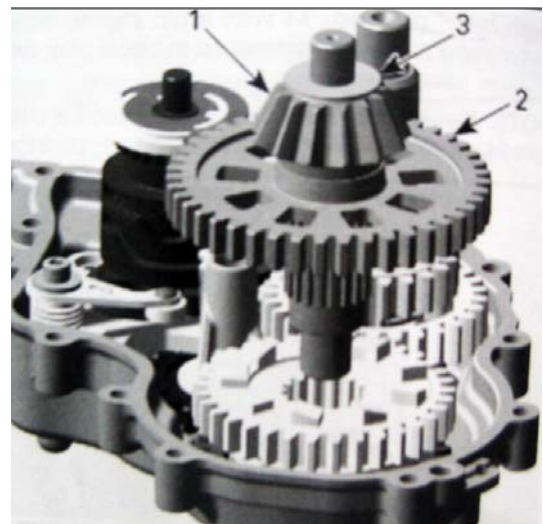


1. shift fork shaft
2. shift fork
3. shift drum



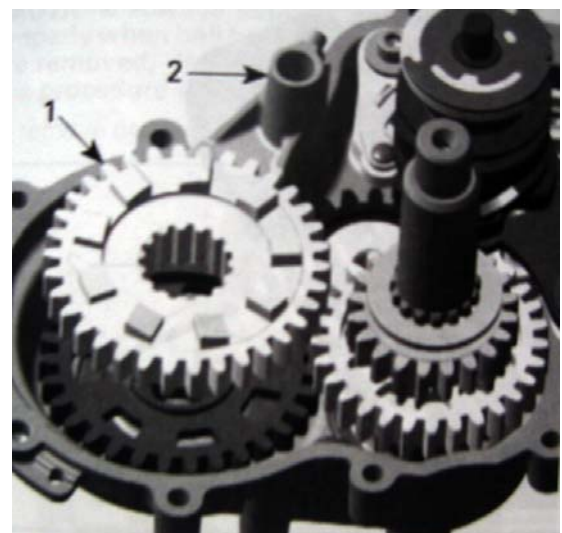
- bevel gear shaft with low range gear assembly and thrust washer

1. bevel gear
2. low range gear
3. thrust washer



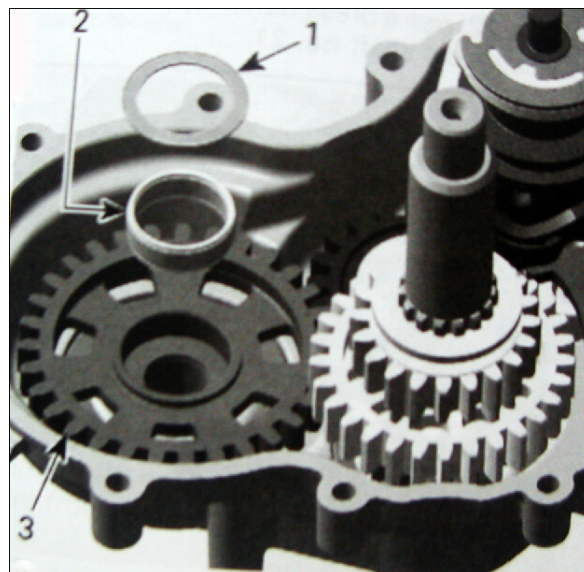
- sliding gear with shift fork

1. sliding gear
2. shift fork



- thrust washer, needle bearing and reverse gear

1. thrust washer
2. needle bearing
3. reverse gear



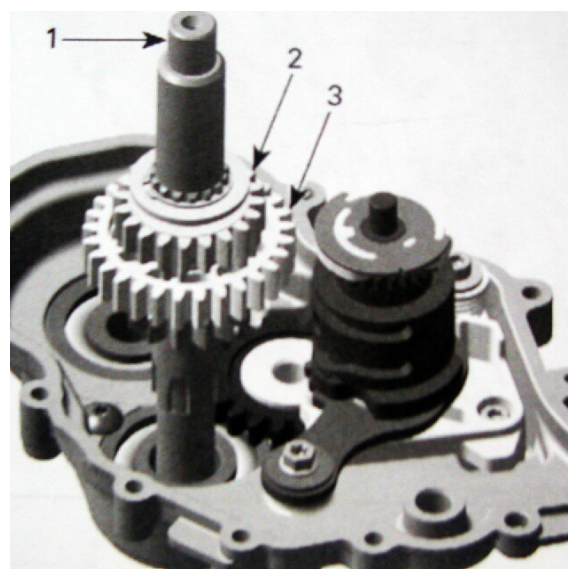
■ thrust washer CVT side

1. thrust washer CVT side



■ countershaft with low range gear and high range gear assembly.

1. countershaft
2. low range gear
3. high range gear



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

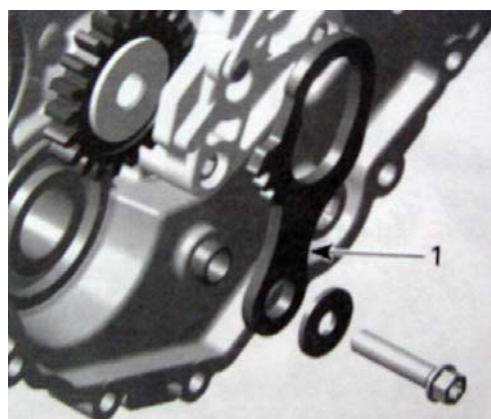
1. index level
2. shift drum



Continue by removing the following:

- parking lock lever

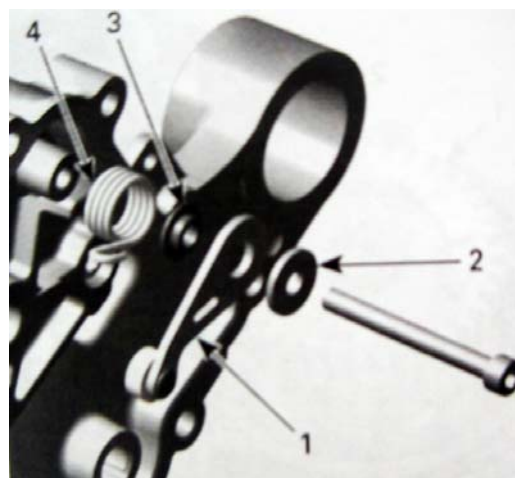
1. parking lock lever



- index lever with washer, step ring and spring

1. index lever
2. washer
3. step ring]
4. index spring

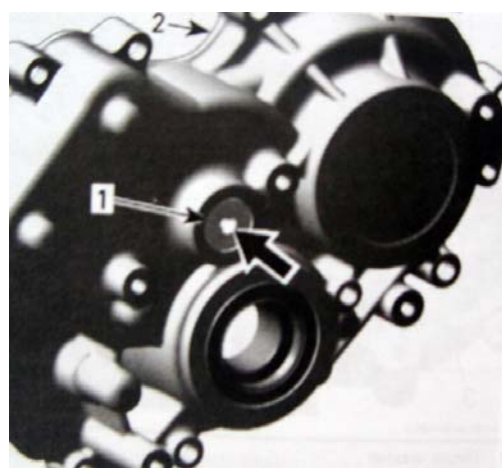
- support flange.



To remove intermediate gear and needle bearing, use a press bench to push out the intermediate gear shaft.

PRESS SHAFT IN THE DIRECTION AS SHOWN BY THE ARROW

1. intermediate gear shaft
2. left housing



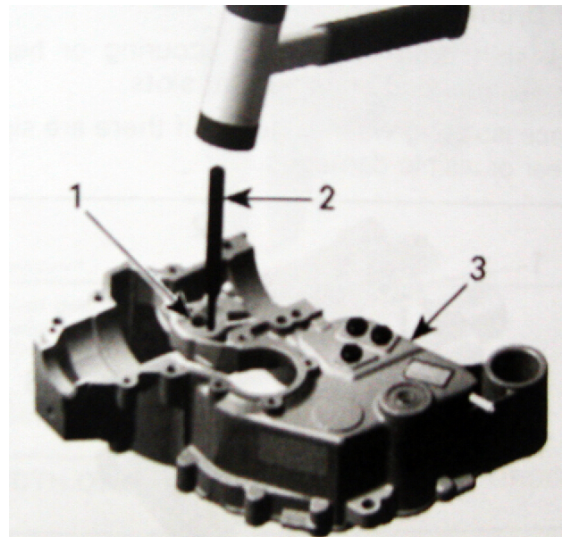
Bearing removal in Housing

If necessary heat housing up to 100°C before removing ball bearings or needle bearings.

CAUTION: Always support gearbox housings properly when ball bearings or needle bearings are removed. Housing damages may occur if this procedure is not performed correctly.

To remove bevel gear needle bearing use a punch.

1. bevel gear needle bearing
2. punch
3. center housing

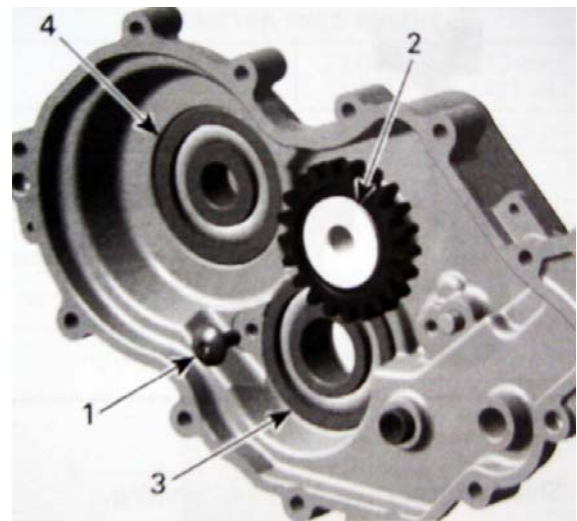


To remove ball bearings of bevel gear and needle bearing of countershaft, use a blind hole bearing puller.



For countershaft ball bearing, remove screw and intermediate gear shaft, then push with a suitable puller from outside in.

1. screw
2. intermediate gear shaft
3. ball bearing countershaft
4. bevel gear ball bearing



Inspection

Always verify for the following when inspecting gearbox components:

- gear teeth damage
- worn or scoured bearing surfaces
- worn or scoured shift fork
- worn or scoured shift fork shaft
- rounded engagement dogs and slots
- bent shift forks
- bent shift fork shaft
- worn shift fork engagement pins
- worn tracks on shift drum
- worn shift fork engagement groove
- worn splines on shafts and gears.

Bearing

Check if bearings as well as needle bearings turn freely and smoothly.

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

Shift Forks

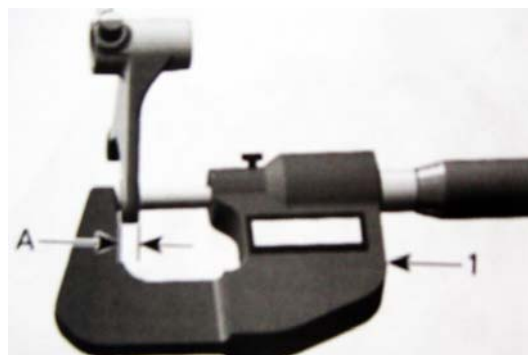
Check both shift forks for visible damage, wear or bent shift fork claws.

Measure the shift fork claw thickness.

1. micrometer

A. shift fork claw thickness

Shift fork claw thickness	
New	4.95 to 5.05 mm
Service limit	4.80mm

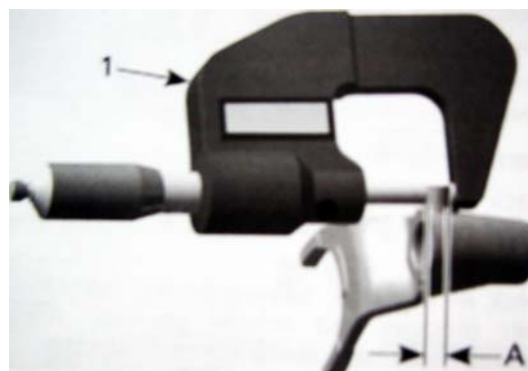


Measure shift fork pins.

1. micrometer

A. shift fork pin diameter

Shift fork pin diameter	
New	6.942 to 7.00 mm
Service limit	6.850 mm

**Shift Drum**

Check shift drum tracks for scouring or heavy wear, like rounded engagement slots.

Replace isolating washer 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

**Levers**

Check parking lever for cracks or other damages.

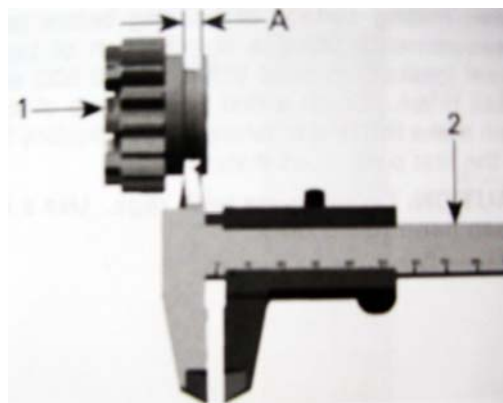
Index lever with roller must move freely.

Gears

NOTE: Replace gears only together with the corresponding meshing gears. Always replace circlips and use special pliers to install them.

Measure the width of shift fork engagement groove.

1. main gear
 2. caliper
- A. width for engagement of shift fork



■ gear for high gear shifting.

Width of shift fork engagement groove (high gear shifting)	
New	5.10 to 5.17 mm
Service limit	5.20 mm

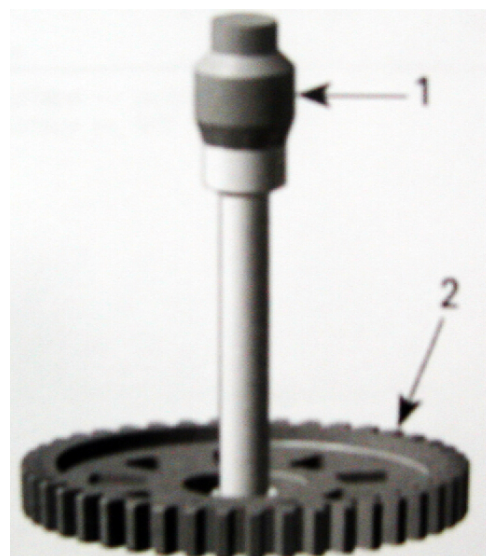
■ gear for low/ reverse gear shifting.

Width of shift fork engagement groove (low/reverse gear shifting)	
New	5.10 to 5.17 mm
Service limit	5.20 mm

Check free pinion for wear.

1. micrometer
2. free pinion

Diameter free pinion	
New	29.007 to 29.028 mm
Service limit	29.030 mm



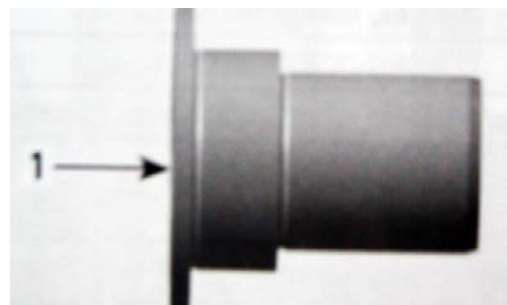
Shafts

Check shaft for worn splines and gears.

Check intermediate shaft for wear.

1. intermediate gear bearing

Intermediate gear shaft	
New	24.980 to 24.993 mm
Service limit	24.977 mm



Check countershaft for wear.

1. MAG side
2. free pinion bearing
3. CVT side



Countershaft	
Service limit	
MAG side	17.974 mm
Free pinion bearing	24.970 mm
CVT side	24.970

Check bevel gear shaft.

1. free pinion bearings

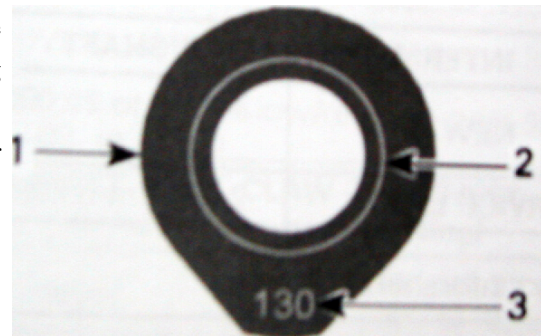
Bevel gear shaft	
Service limit	
Free pinion bearing	24.972 mm



Shims

Always replace shim by a new one with the same thickness, when reassembling the gearbox with existing output shaft and bevel gear shaft.

1. thrust washer for adjusting the bevel gear on center housing side
2. area where wear signs appear
3. thickness of the washer



Bevel Gear Adjustment

NOTE: Only necessary if backlash and axial clearance of the bevel gear is out of specification or if parts are changed (output shaft, bevel gear shaft or housing).

There are 2 adjustments to perform on the bevel gear.

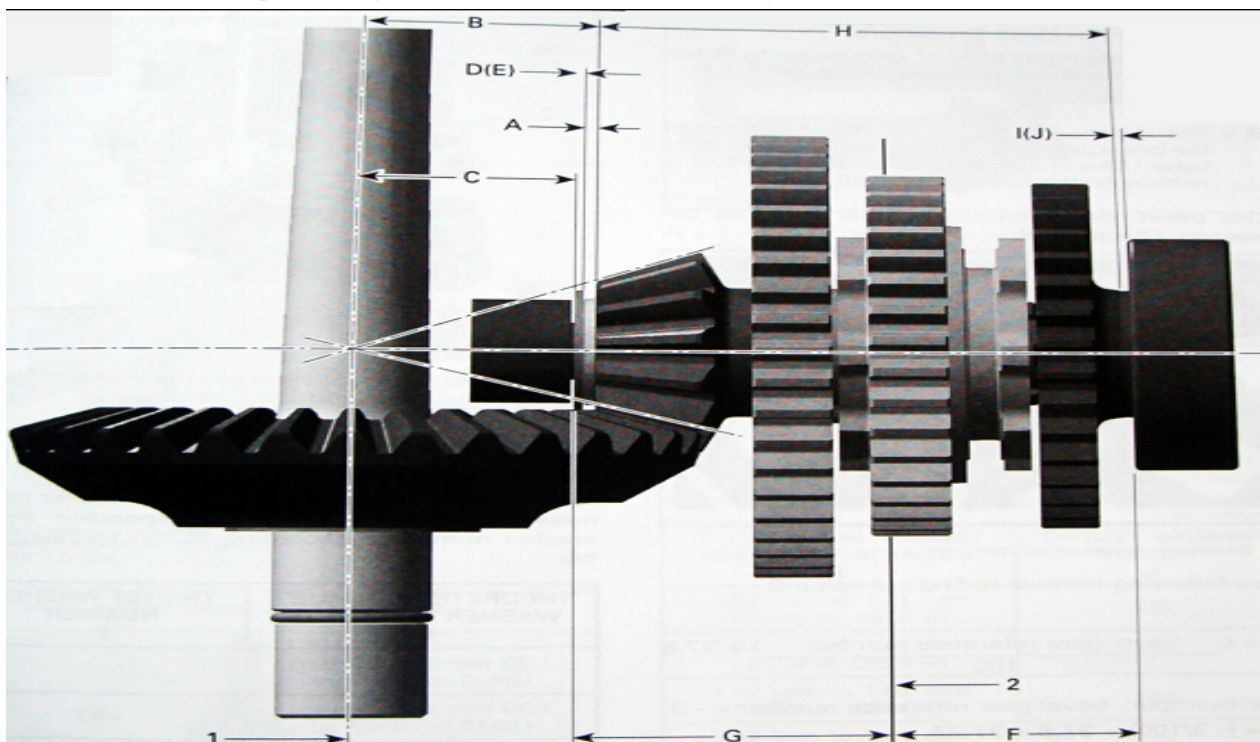
- bevel gear backlash on center housing
- bevel gear axial clearance on left housing.

The bevel gear backlash is adjusted by finding the proper thrust washer thickness E as per following illustration.

The bevel gear axial clearance is adjusted by finding the proper thrust washer thickness J as per following illustration.

Clean mating surface of housing before taking measurements.

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



Bevel Gear Back lash Procedure

Use the following course of calculation to determine the theoretical thrust washer thickness D:

$$D = B - C - A$$

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

This bevel gear reference number could be between -10 and + 10.



1. bevel gear
2. bevel gear reference number

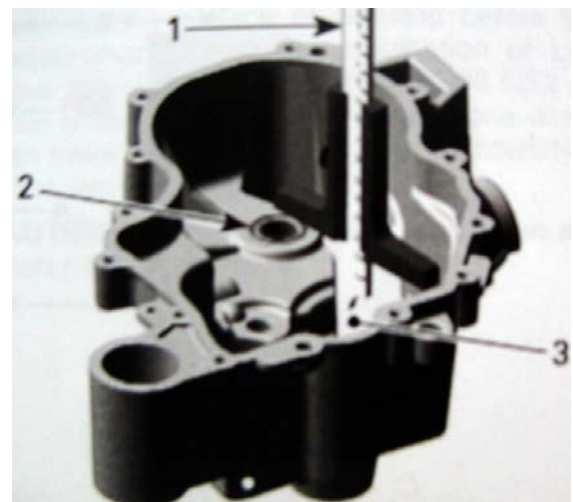
Use following formula to find out value **B**.

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

For example: Bevel gear reference number = -3.

$$B = \frac{(-3/100)}{100} + 37.8 = 37.77$$

C = Distance between the shim thrust surface in the center housing and the mating surface to left housing.



1. deep gauge – measurement C
2. thrust washer surface in center housing
3. mating surface to left housing

A = 2 mm nominal thickness of axial needle bearing .

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

Take the obtained theoretical thrust washer thickness **D** and choose the corresponding thrust washer number **E** according to the following table.

NOTE: For example, if the theoretical thrust washer thickness **D** is 1.53 mm, choose the corresponding thrust washer number 150 **E**. the thrust washer number 150 represents a nominal value equal to 1.50 mm.

Theoretical Thrust Washer Thickness D	Thrust Washer Number E
1.20 mm to 1.29 mm	120
1.30 mm to 1.39 mm	130
1.40 mm to 1.49 mm	140
1.50 mm to 1.59 mm	150
1.60 mm to 1.69 mm	160
1.70 mm to 1.79 mm	170
1.80 mm to 1.89 mm	180

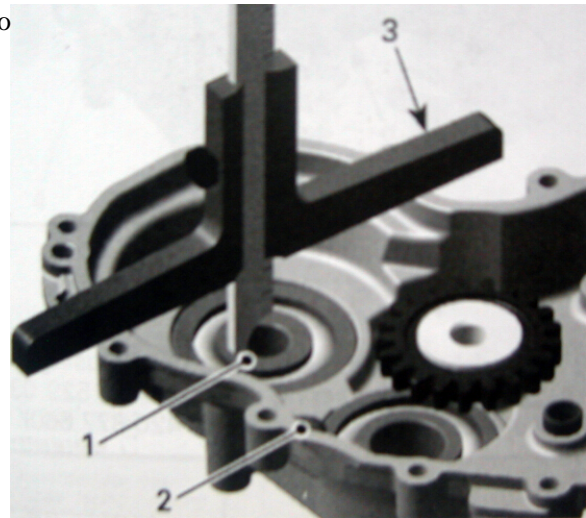
Bevel Gear Axial Clearance Procedure

Use the following course of calculation to determine the theoretical thrust washer thickness **I**:

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

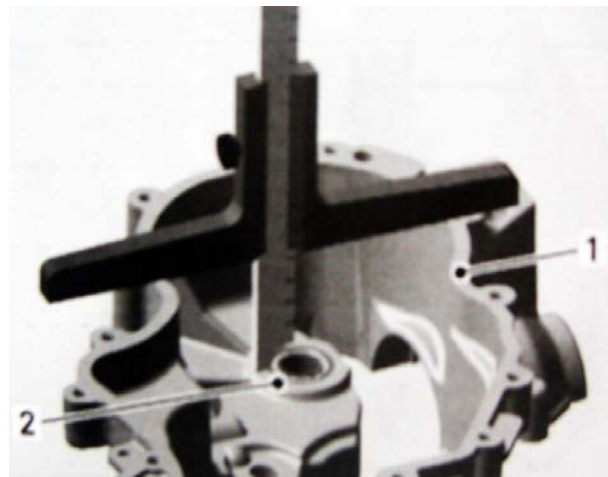
F = Distance between mating surface of left housing to ball bearing inner race.

1. ball bearing inner race
2. mating surface of left housing
3. depth gauge

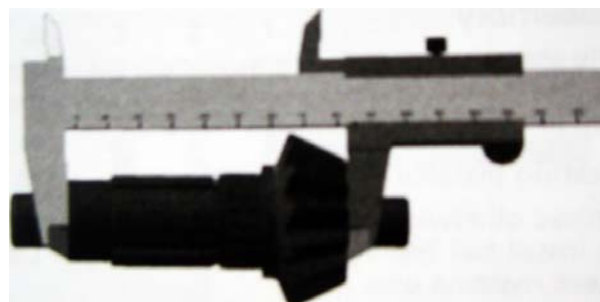


G = Distance between mating surface of center housing and thrust washer surface.

1. mating surface of center gear housing
2. thrust washer surface



H = Distance between thrust surface of bevel gear shaft.



A = 2mm nominal thickness of axial needle bearing no. 12 .

E = the thrust washer number nominal value as found in the *BEVEL GEAR BACKLASH PROCEDURE*. For example, thrust washer number 150 represents a value of 1.50 mm.

When the measurements are taken, calculate the theoretical thrust washer thickness I using the formula ($I = F + G - H - A - E$)

Take the obtained theoretical thrust washer thickness I and choose the corresponding thrust washer number J according to the following table.

For example, if the theoretical thrust washer thickness I is 1.53 mm, choose the corresponding shim number 150 J.

Bevel gear axial clearance of 0.02 to 0.11 mm is included in the table.

THEORETICAL THRUST WASHER THICKNESS I	THRUST WASHER NUMBER J
1.22 mm to 1.31 mm	120
1.32 mm to 1.41 mm	130
1.42 mm to 1.51 mm	140
1.52 mm to 1.61 mm	150
1.62 mm to 1.71 mm	160
1.72 mm to 1.81 mm	170
1.82 mm to 1.91 mm	180

Assembly

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

Bearing Installation in Housing

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

If necessary heat housings up to 100°C before installing ball bearings or needle bearings.

Place new bearing in freezer for 10 minutes before installation.

Use a suitable installer for installing ball bearings of countershaft and bevel gear.

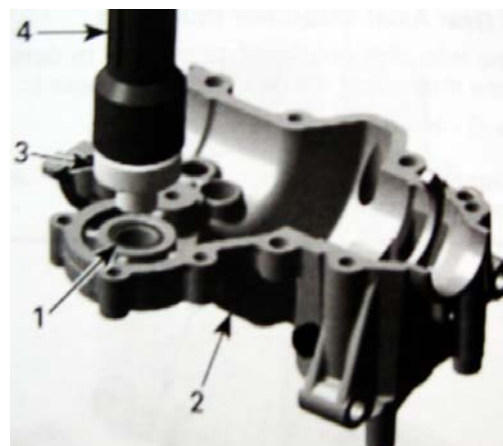
NOTE: Place gearbox housings on a wood stand before installing bearings.

Install countershaft needle bearing with the main shaft needle bearing installer and the installer handle in right housing.

1. needle bearing installer
2. installer handle

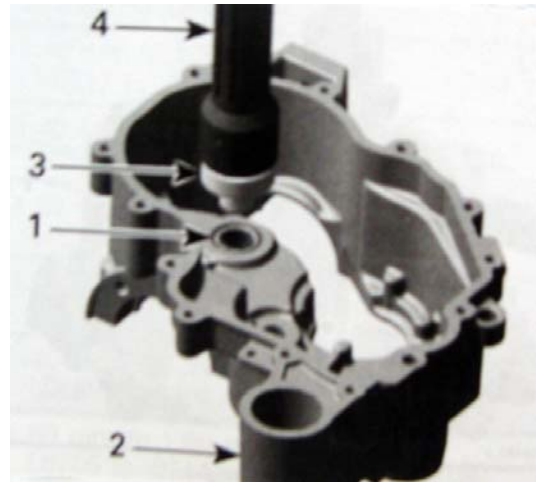


1. countershaft needle bearing
2. right housing
3. needle bearing installer
4. installer handle



Install bevel gear needle bearing using the bevel gear needle bearing installer and the installer handle.

1. bevel gear needle bearing
2. center housing
3. needle bearing installer
4. installer handle



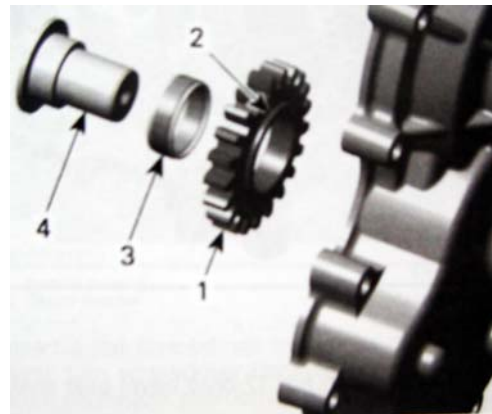
Install new oil seals with the proper installer.

Other Gearbox Components

Fit intermediate gear with needle bearing on intermediate gear shaft.

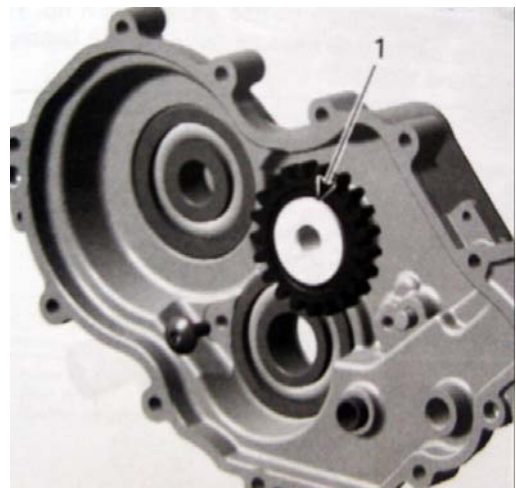
NOTE: Fit gear with collar face to housing side on the intermediate shaft.

1. intermediate gear
2. collar facing housing
3. needle bearing
4. intermediate gear shaft



Press intermediate gear shaft in the left housing.

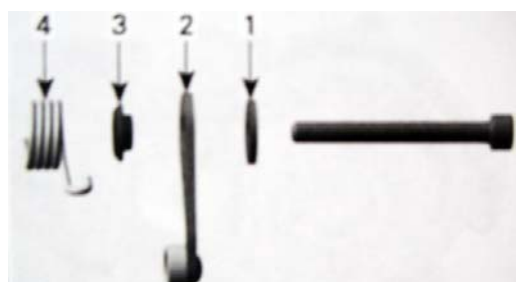
1. intermediate gear shaft



Fit support flange in the left housing and install index lever.

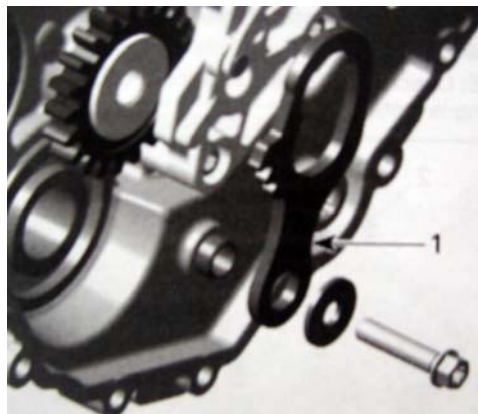
NOTE: Fit step ring into index lever.

1. shim
2. index lever
3. step ring
4. index spring



Install parking lock level, teeth showing to countershaft.

1. parking lock lever



Place thrust washer CVT side on bearing.

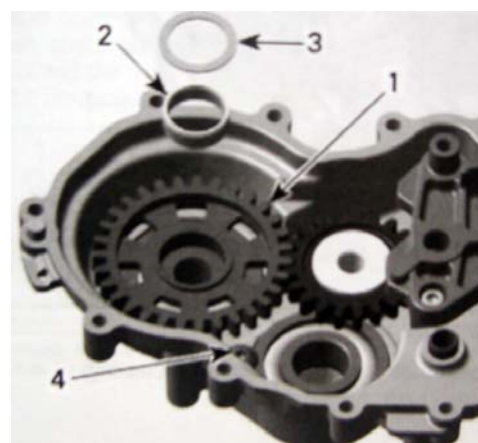
1. thrust washer CVT side



Place reverse gear with needle bearing and thrust washer.

NOTE: Check if the screw to secure countershaft bearing is installed.

1. reverse gear
2. needle bearing
3. thrust washer
4. countershaft bearing screw



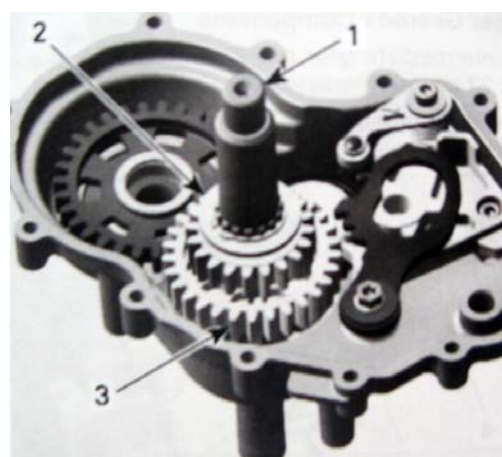
Install countershaft with low gear and high gear assembly.

1. countershaft
2. low gear
3. high gear

Install a new shim onto bevel gear shaft, fork side.

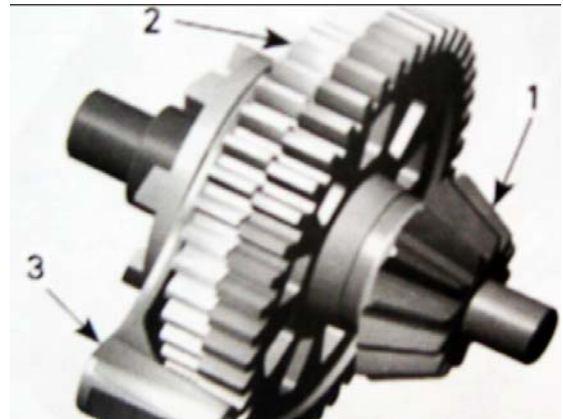
Install bevel gear with sliding gear assembly together with shift fork.

NOTE: If a new bevel gear and output shaft are used, it is necessary to verify the shim adjustment prior to



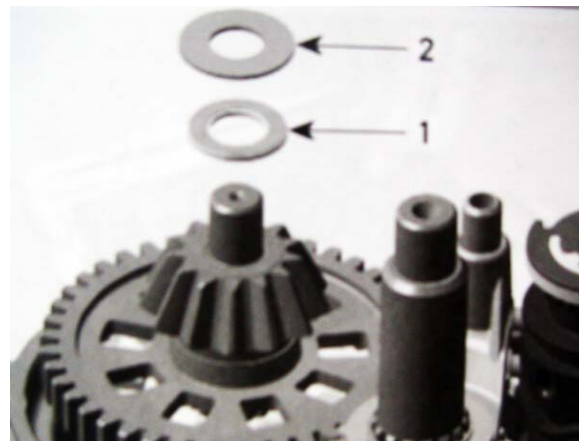
finalize assembly. Refer to *ADJUSTMENT* above in this section. If the existing bevel gear is used, it is mandatory to use a new shim with the same thickness, a new needle bearing and thrust washer .

1. bevel gear
2. sliding gear
3. shift fork



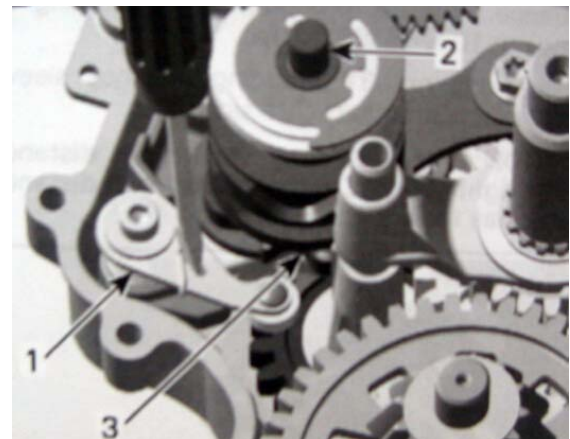
Install a new needle bearing and thrust washer.

1. needle bearing
2. thrust washer

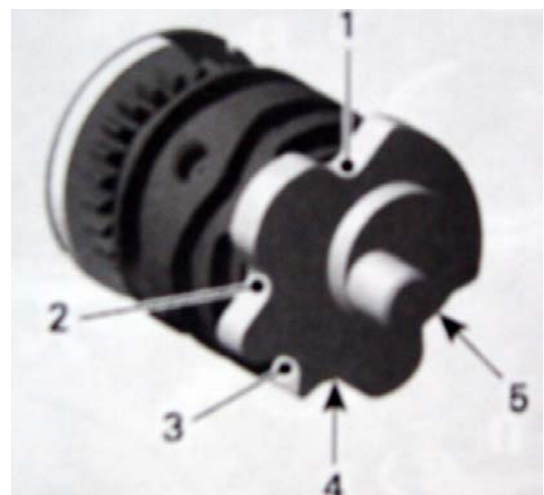


Insert a flat screwdriver in the slot of the index lever, turn screwdriver clockwise and install shift drum on neutral position as per following illustration.

1. index lever
2. shift drum
3. neutral position



1. parking stop location
2. reverse stop location
3. neutral stop location
4. high gear stop location
5. low gear stop location



Install shift shaft assembly.

NOTE: Marks on shift drum/isolating washer and shift shaft must align.

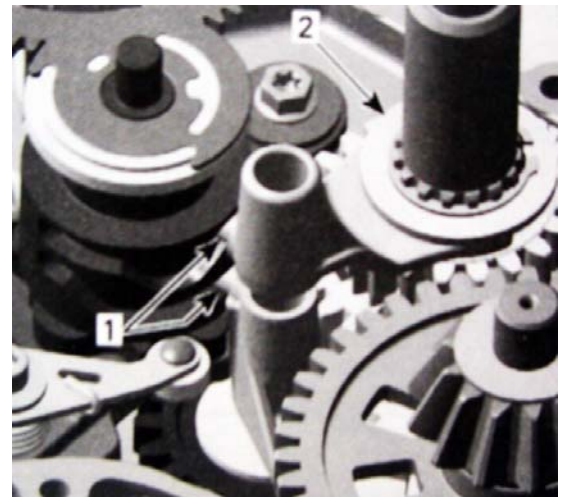
1. shift shaft assembly
2. isolating washer
3. marks



Install shift fork then engage both shift fork pins in their corresponding groove on the shift drum.

NOTE: move sliding gears to facilitate engagement of pins inside grooves.

1. shift fork pin
2. sliding gear



Install shift fork.

NOTE: Run all gears as a final function check before installing center housing.

Now, close the housings by doing the following:

Clean all metal components in a solvent.

Gearbox housing mating surfaces are best cleaned.

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

IMPORTANT: When beginning the application of the gear housing 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 Loctite 5910 on mating surfaces.

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

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

NOTE: It is recommended to apply this specification 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).

Hand-torqued gear housing screws in a crisscross sequence. Repeat procedure, retightening all screws to **10 N.m.**

Install O-ring including distance sleeve on countershaft CVT side.

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

Installation

The installation is the reverse of the removal procedure.

Filling Procedure

Make sure that magnetic drain plug is reinstalled and tight.

With the gearbox on a level surface, fill the gearbox through the oil filler hole with GL-4-90 or with an equivalent product until the oil reaches the lower threads of the oil filler hole (about 420 ml).

ENGINE INSTALLATION

The engine installation is the reverse of the removal procedure. However, pay attention to the following.

1. Prior to install engine, inspect condition of engine mounts. If necessary, replace the engine mounts, you can insert a punch in hole of engine mount bushing and push the other bushing out of the housing.
2. Make sure coolant and oil drain plugs are reinstalled and tight.

Refill engine oil and check the oil level with the dipstick.