CHECKING AND ADDING OIL

Check engine oil level in oil reservoir at least once every 500 miles (800 km). Check level more frequently if engine uses more oil than normal or if vehicle is operated under harsh conditions. Check oil when engine is warmed up to operating temperature (see Hot Check).

CHANGING OIL AND FILTER

After a new engine has run its first 1000 miles (1600 km) and at 5000 mile (8000 km) intervals or annually thereafter, completely drain oil reservoir of used oil. If riding habits include severe dust conditions, operation at temperature above 80 ° F, extensive idling, speeds in excess of 65 m.p.h. and /or extensive two up riding or similar loads the oil should be changed at 2,500 mile (4000 km) intervals. Refill with fresh oil. Always change oil filter when changing engine oil.

NOTE

See 1.5 ENGINE LUBRICATION SYSTEM for more information on checking oil level and changing oil and filter.

WINTER LUBRICATION

Normal fuel combustion in a gasoline engine produces water vapor and carbon dioxide along with other gases and particulates. When first starting and warming an engine, some of the water vapor that gets into the engine crankcase condenses to form liquid water. If the engine is driven long enough to thoroughly warm the crankcase, most of this liquid water is again vaporized and exhausted through the crankcase breather system.

A moderately driven vehicle making short runs may not be able to vacate water vapors allowing liquid water to accumulate in the oil reservoir. This is especially true if the vehicle is operated in cold weather. In freezing weather, an accumulation of water in the engine oil may become slush or ice, which can block oil lines and lead to severe engine damage. Water remaining in the engine oil for long periods of time can form an acidic sludge that is corrosive to metal engine parts and causes accelerated wear of moving components.

In winter the oil change interval should be shorter than normal. The colder the weather, the shorter the recommended oil change interval. A vehicle used only for short runs in cold weather must have the engine oil drained frequently.

OIL HOSE ROUTING 3.8

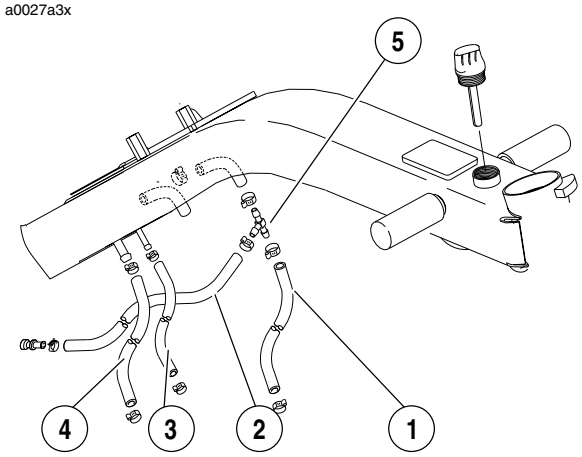
GENERAL

See Figure 3-83. Engine oil runs through the frame backbone which serves as the oil reservoir. From the bottom of the reservoir, the vent hose and the return hose run downward below the battery tray. A rubberized clamp secure the hoses in place.

See Figure 3-83. A T-fitting on the bottom left side of the oil reservoir, supplies the feed hose and the oil drain hose. See Figure 3-84. The drain hose attaches to the left side of the footpeg support bracket frame.

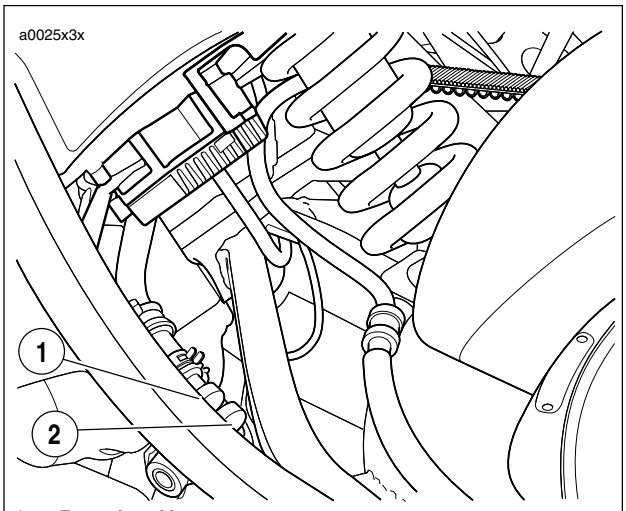
See Figure 3-85. The feed and return hoses run together alongside the engine and forward to the oil pump. The feed hose attaches to the rear most oil pump fitting; the return hose connects forward and above.

See Figure 3-86. After diverging from the feed and return hoses, the vent hose continues on to the right side of the motorcycle. Here the vent hose connects to an elbow fitting on the gearcase cover.



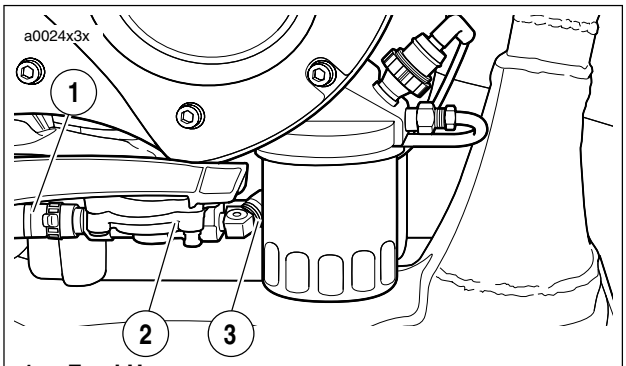
1. Feed Hose
2. Drain Hose
3. Vent Hose
4. Return Hose
5. T-fitting

Figure 3-83. Oil Reservoir Hose Assembly



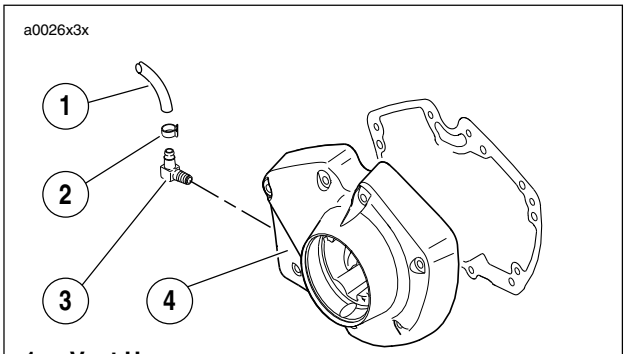
1. Breather Hose
2. Drain Hose

Figure 3-84. Drain Hose



1. Feed Hose
2. Oil Pump
3. Steel line connection

Figure 3-85. Oil Pump Connections



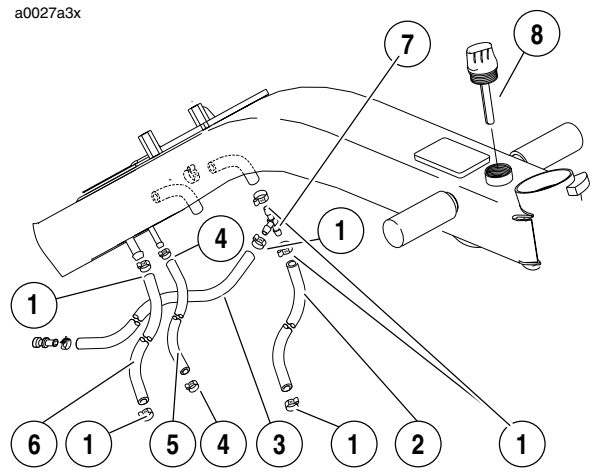
1. Vent Hose
2. Clamp
3. Elbow Fitting
4. Gearcase Cover

Figure 3-86. Vent Hose Connection

OIL RESERVOIR 3.9

GENERAL

See Figure 3-87. Engine oil is stored in the frame backbone which acts as an oil reservoir. From the bottom of the reservoir, the vent hose and the return hose run downward below the battery tray. A rubberized clamp secure the hoses in place.



1. 3/8 inch Clamp
2. Feed Hose
3. Drain Hose
4. 1/4 inch Clamp
5. Vent Hose
6. Return Hose
7. T-fitting
8. Dipstick

Figure 3-87. Oil Reservoir (Frame Backbone)

OIL PRESSURE INDICATOR SWITCH 3.10

GENERAL

The oil pressure indicator switch is a pressure-actuated diaphragm-type switch. When oil is not circulating through the system or when oil pressure is low, spring tension holds the switch contacts closed, thereby completing the signal light circuit and causing the indicator lamp to illuminate.

OIL PRESSURE SIGNAL LIGHT

The oil pressure signal light turns ON when:

- Ignition switch is turned on prior to starting engine.
- Oil is not circulating through the running engine.
- Oil pressure is abnormally low in the running engine.
- Engine is idling below 1000 RPM.

The oil pressure signal light turns OFF when:

- Oil is circulating with adequate pressure through the engine running at 1000 RPM or greater.

Troubleshooting information is listed in Table 3-11.

NOTE

If the ignition is turned back on immediately after the engine is stopped, the oil light may not turn on right away because of oil pressure retained in the filter housing.

OIL PRESSURE

See Figure 3-88. The oil pump is non regulatory and delivers its entire volume of oil under pressure to the oil filter mount. When an engine is cold, the engine oil will be more viscous (i.e., thicker).

When an engine is operated at high speeds, the volume of oil circulated through the oiling system increases, resulting in higher oil pressure. As engine speed is reduced, the volume of oil pumped is also reduced, resulting in lower oil pressure.

To check oil pressure, use OIL PRESSURE GAUGE (Part No. HD-96921-52B) and OIL PRESSURE GAUGE ADAPTER (Part No. HD-96940-58). Remove oil pressure indicator switch and insert pressure gauge fitting.

Ride motorcycle at least 20 miles (32 km) at or above 50 MPH (80 KM/H) until engine oil reaches normal operating temperature. At 2500 RPM, oil pressure will vary from 10-12 psi (69-83 KPa). At idle speed (950-1050 RPM), oil pressure will vary from 6-8 psi (42-55 KPa).

Figure 3-88. Oil Pressure Indicator Switch

Table 3-11. Troubleshooting Oil Pressure Signal Light

OIL PRESSURE SIGNAL LIGHT	PROBABLE CAUSES
Stays on at speeds above idle.	● Empty oil reservoir. ● Clogged feed line (ice and sludge, freezing temperatures). ● Air-bound oil line. ● Grounded oil switch wire. ● Malfunctioning signal switch. ● Diluted oil. ● Malfunctioning check valve (see 3.14 OIL FILTER MOUNT).
Flickers at idle.	● Incorrect idle speed. Malfunctioning or improperly installed check valve (see 3.14 OIL FILTER MOUNT).
Does not glow when ignition is turned on (prior to operating engine).	● Malfunctioning signal switch. ● Malfunction in wiring. ● Burned-out signal bulb. ● Dead battery (see NOTE).

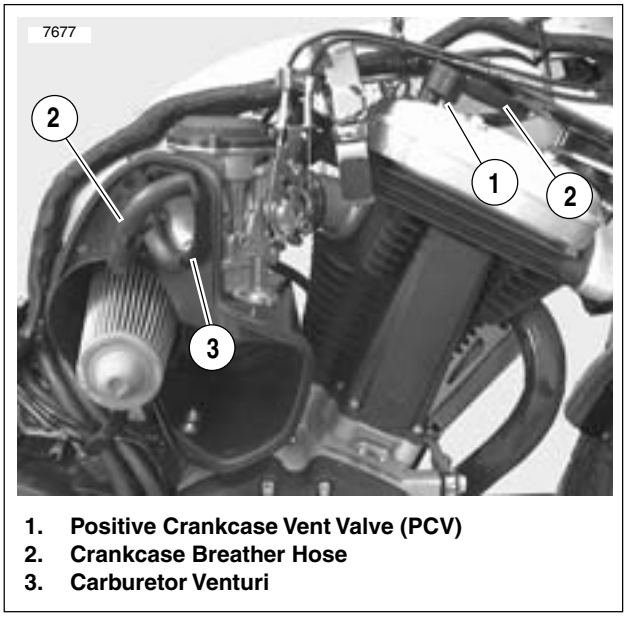
CRANKCASE BREATHING SYSTEM 3.11

GENERAL

See Figure 3-89. On piston downstroke, a mixture of crankcase air and oil mist is vented up the push rod covers to the upper rocker box. Air is allowed to escape the rocker box by exiting the positive crankcase vent valve located on top of the rocker box.

The oil mist collects and eventually returns to the crankcase through oil passageways in the cylinder head.

The crankcase air passes through the breather assembly to the positive crankcase vent valve (PCV) located on top of the rocker box cover. From the PCV the air enters the crankcase breather hose. The crankcase breather hose splits with one hose (crankcase breather hose) going to the air cleaner and the other hose (crankcase breather drain hose) going to the footrest support bracket. Crankcase air is routed to the air cleaner box where it is directed into the carburetor's venturi. Any residual oil drains to the crankcase breather drain hose located behind the right footrest support (located by the oil tank drain hose). The crankcase breather drain hose should be drained at each oil change.



1. **Positive Crankcase Vent Valve (PCV)**
2. **Crankcase Breather Hose**
3. **Carburetor Venturi**

Figure 3-89. Crankcase Breathing System,

OILING SYSTEM 3.12

GENERAL

1. Oil is gravity-fed from the oil reservoir to the gerotor-style oil pump through a **feed hose.** Oil enters the **feed section** and fills a cavity located under the feed pump.

NOTE

See 3.13 OIL PUMP for a complete explanation of the gerotor pump sets.

2. The feed pump transfers oil from the inlet cavity through the **external steel line** to the oil filter mount.
3. Oil flows through the **filter mount cavity** to the oil filter.
4. Oil enters the peripheral cavity of the **oil filter,** passes through the filtering medium into the central cavity of the oil filter, and flows into the filter adapter (fitting which connects filter to filter mount).
5. Adequate oil pressure in the filter mount cavity activates the **oil pressure signal light switch** and shuts off the oil pressure signal light.
6. Oil flowing from the filter adapter opens the **check ball.** The check ball opens at 4-6 psi (28-41 kPa) oil pressure.
7. With the check ball open, oil flows into the **crankcase feed galley.**
8. Oil flows through the feed galley in the crankcase to the tappet blocks and hydraulic lifters. **Cross-drilled passages** intersect the main feed galley and carry oil to both hydraulic lifters.
9. Oil also enters an **intersecting passage** in the gearcase cover. Oil flow is then routed to the crankshaft area.
10. Oil enters a hole in the end of the **pinion gear shaft** and travels to the right flywheel where it is routed through the flywheel to the **crankpin.** Oil is forced through the crankpin to properly lubricate the rod bearing assembly.
11. Oil flows up passages in the **push rods** to the rocker arm shafts and bushings.
12. The valve stems are lubricated by oil supplied through drilled oil holes in the **rocker arms.**
13. Oil collected in the push rod areas of the cylinder heads flows down the **push rod cover,** through drain holes in the **tappet blocks** and into the gearcase. After providing lubrication to the gearcase components, the oil flows to the left side of the oil pump.
14. Feed oil to the rocker area is returned to the crankcase through a **passage** in the head and cylinder.
15. Oil collected in the **sump** is splash-fed to the pistons, cylinder walls and flywheel components.
16. A single piston oil jet cools the bottom of the piston with a spray of oil.
17. Oil collected in the sump area returns to the scavenge section of the oil pump through a **passage** located in the rear section of the sump. Oil flow to the pump is accomplished by the scavenging effect of the pump and by the pressure created by the downward stroke of the pistons.
18. Return oil fills a **cavity** above the pump's return gears. The return gears pump oil back to the oil reservoir.

OIL PUMP 3.13

GENERAL

See Figure 3-90. The oil pump consists of two gerotor gear sets, feed and return, housed in one pump body. The feed set distributes oil to the engine, the scavenge set returns oil to the tank/frame reservoir.

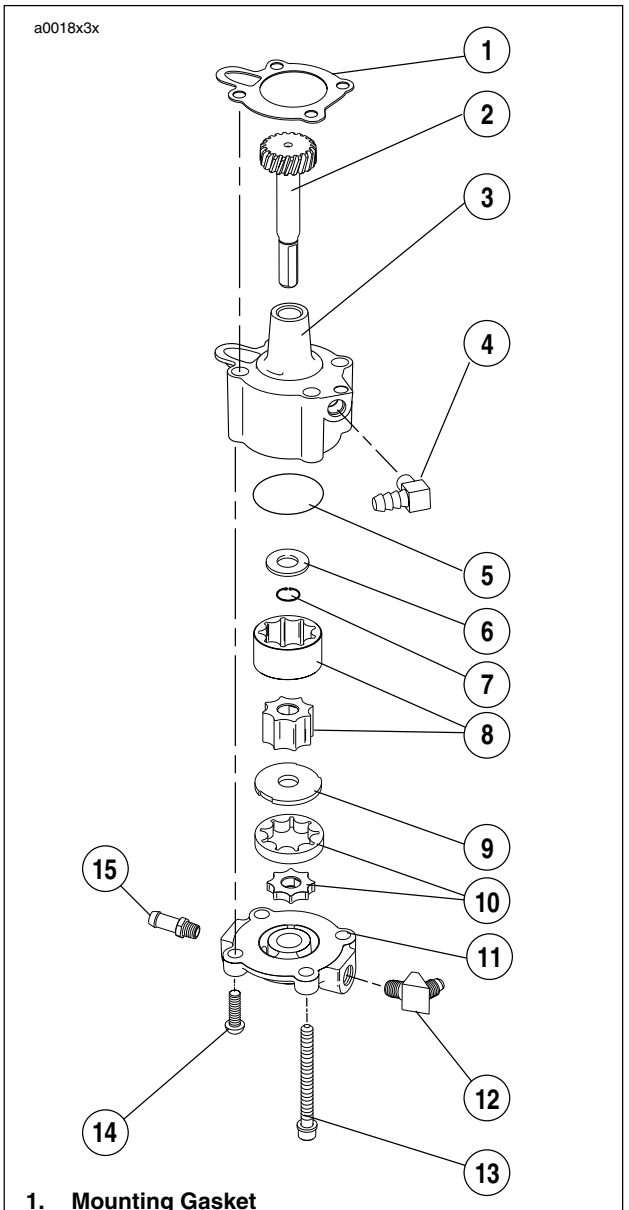
A gerotor-type gear set has two parts — an inner and an outer gerotor. The inner gerotor has one less tooth than the outer gerotor. Both gerotors have fixed centers which are offset to each other.

In a gerotor gear set, oil is transferred from inlet to outlet as it is trapped between the rotating inner and outer gerotors.

See Figure 3-90. Gravity-fed oil from the oil reservoir enters the pump through the feed hose connector. It is forced by the gerotor feed set through a hose to the oil filter. Return oil from the flywheel compartment is drawn back into the pump and is forced by the gerotor scavenge set back to the oil reservoir.

The oil pump seldom needs servicing. Before you disassemble an oil pump suspected of not producing adequate oil pressure, be sure that all possible related malfunctions have been eliminated:

1. Make sure all oil hose clamps are tight and that hoses are not pinched or damaged.
2. Check level and condition of oil in tank. Pressure will be affected if oil is diluted. In freezing weather, proper circulation of oil can be affected if the oil feed hose becomes clogged with ice or sludge.
3. Check for a grounded oil pressure switch wire or faulty switch if oil indicator light fails to go out with engine running.



1. **Mounting Gasket**
2. **Gear shaft**
3. **Oil Line Assembly**
4. **90° Fitting**
5. **O-ring**
6. **Thrust Washer**
7. **Retaining Ring**
8. **Gerotor Return Set**
9. **Separator Plate**
10. **Gerotor Feed Set**
11. **Cover**
12. **45° Fitting**
13. **Sems Screw (2)**
14. **TORX Screw (2)**
15. **Rear Connector Fitting**

Figure 3-90. Oil Pump

REMOVAL/DISASSEMBLY

NOTE

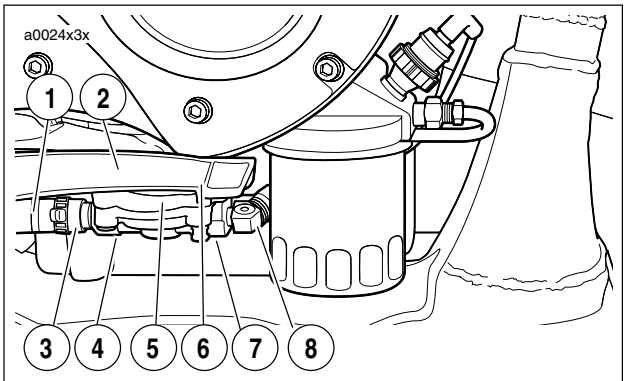
Oil pump can be removed with engine in frame and without removing gearcase cover.

1. See ENGINE LUBRICATION SYSTEM section. Drain oil reservoir.
2. Remove and discard oil filter.
3. See Figure 3-91. Disconnect feed hose and oil filter hose connection.

NOTE

Loosen nut on oil filter hose connection and then remove pressurized hose.

4. Carefully remove mounting screws and washers only. Pump will drop with screws removed. Discard mounting gasket.
5. Remove clamp and detach return hose connection.
6. See Figure 3-91. Remove cover TORX screws. Lift cover off body.
7. Remove and discard O-ring.
8. See Figure 3-90. Slide both pieces of gerotor feed set, separator plate and both pieces of gerotor scavenge set off gear shaft.
9. Remove and discard retaining ring. Remove thrust washer and gear shaft.



1. **Feed Hose Connection**
2. **Return Hose**
3. **Feed Hose Clamp**
4. **Cover TORX Screw (2)**
5. **Oil Pump**
6. **Return Hose Clamp**
7. **Mounting Screw and Washer (2)**
8. **Steel Line Connection**

Figure 3-91. Oil Pump Hardware

CLEANING AND INSPECTION

1. Clean all parts in cleaning solvent. Blow out holes and oil passages with compressed air.
2. See Figure 3-92. Inspect both gerotor sets for wear.
   a. Mesh pieces of each set together as shown.
   b. Use a feeler gauge to determine clearance.
   c. The SERVICE WEAR LIMIT between gerotors is 0.004 in. (0.102 mm). Replace gerotors as a set if clearance exceeds this dimension.
   d. Measure thickness of feed gerotors with a micrometer. Replace gerotors as a set if they are not the same thickness.
3. See Figure 3-93. Check gear shaft teeth for damage or wear. Replace if necessary.

ASSEMBLY/INSTALLATION

NOTE

Liberally coat all moving parts with clean engine oil to ensure easy assembly and smooth operation at start-up.

1. See Figure 3-90. Install gear shaft through body. Position thrust washer over end of shaft. Install **new** retaining ring into groove in shaft.
2. Insert inner gerotor of the gerotor scavenge set over gear shaft.
3. Place outer gerotor over inner gerotor to complete scavenge set.
4. See Figure 3-93. Install gerotor separator plate by lining up slots on perimeter with tabs inside oil pump body.
5. Install a **new** O-ring into groove in pump body.
6. See Figure 3-90. Place gerotor feed set over gear shaft.
7. Place cover onto pump body. Install cover TORX screws. Tighten to 70-80 **in-lbs** (8-9 Nm).
8. Place **new** mounting gasket in position.

NOTE

*Use **new** hose clamps. If fittings were removed, use TEFLON® PIPE SEALANT or HYLOMAR® on fitting threads.*

9. See Figure 3-91. Attach return hose connection.
10. Secure pump to crankcase with mounting screws. Tighten to 125-150 **in-lbs** (14-17 Nm).
11. Attach feed hose and oil filter hose connection.
12. Attach clamp to hose.
13. Install **new** oil filter. See 1.5 ENGINE LUBRICATION SYSTEM.
14. See 1.5 ENGINE LUBRICATION SYSTEM. Check engine oil level. Add oil to correct level if needed.

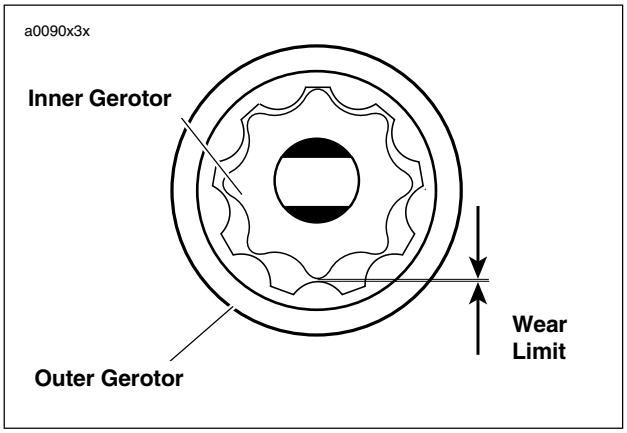
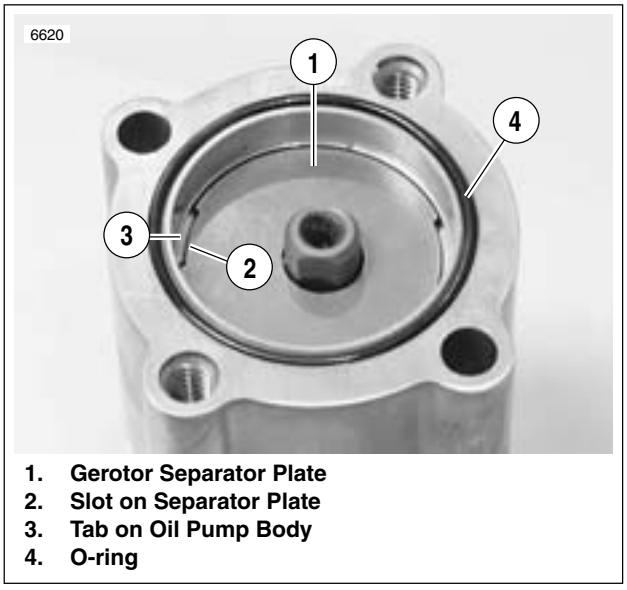


Figure 3-92. Gerotor Wear Limits



1. **Gerotor Separator Plate**
2. **Slot on Separator Plate**
3. **Tab on Oil Pump Body**
4. **O-ring**

Figure 3-93. Separator Plate Slots

OIL FILTER MOUNT 3.14

GENERAL

See Figure 3-94. Oil is pressure-fed from the oil pump to the filter mount via rigid external steel line. Oil travels through the filter mount into the filter through the outer filter holes.

Adequate oil pressure activates the oil pressure indicator switch in the filter mount, which turns off the oil pressure indicator lamp.

The check ball in the filter adapter “opens” at 4-6 psi (28-41 kPa) oil pressure. Filtered oil leaves the filter, flowing past the check ball.

DISASSEMBLY

1. Drain oil reservoir and remove filter. See 1.5 ENGINE LUBRICATION SYSTEM.
2. See Figure 3-94. Remove filter adapter from filter mount. Remove check ball and spring.
3. Detach indicator lamp wire from oil pressure indicator switch. Remove switch using OIL PRESSURE SENDING UNIT WRENCH (Part No. HD-41675).

CLEANING AND INSPECTION

Thoroughly clean all parts in cleaning solvent. Blow out holes and passages using compressed air.

ASSEMBLY

NOTE

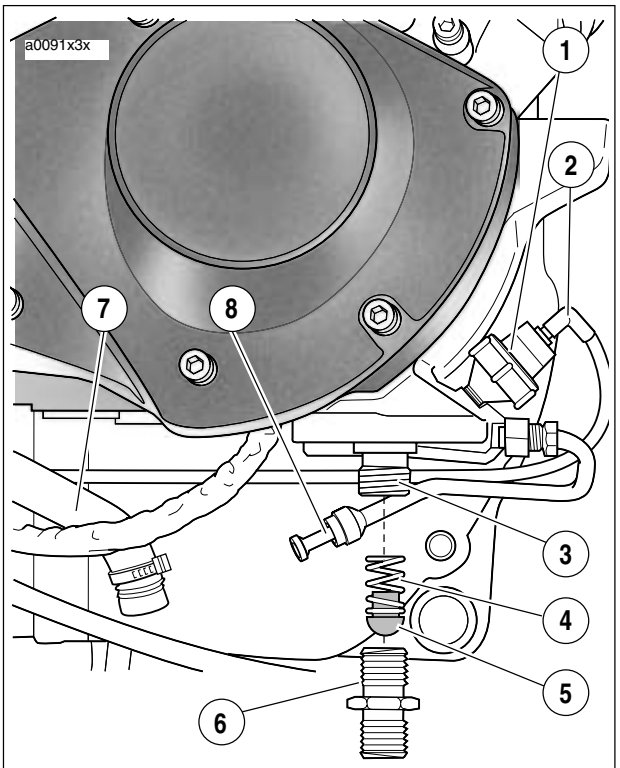
Use TEFLON PIPE SEALANT or HYLOMAR on all fittings installed to oil filter mount.

1. See Figure 3-94. Install oil pressure indicator switch using OIL PRESSURE SENDING UNIT WRENCH (Part No. HD-41675). Tighten to 50-70 **in-lbs** (6-8 Nm).
2. Attach indicator lamp wire.

NOTE

The filter adapter has identical ends; either end may be installed into the filter mount.

3. Apply several drops of LOCTITE® thread locker 243 (blue) to last few threads on that end of the filter adapter which is installed into filter mount. Do not apply LOCTITE to adapter threads on filter element side.
4. Install filter mount components.
   a. Place spring and check ball into threaded hole at center of mount.
   b. Push threaded end of filter adapter (with LOCTITE) against check ball to compress spring.
   c. Screw adapter into threaded hole. Tighten to 8-12 ft-lbs (11-16 Nm).
5. Install a **new** filter and fill oil reservoir with proper oil. See 1.5 ENGINE LUBRICATION SYSTEM.



1. **Oil Pressure Indicator Switch**
2. **Indicator Lamp Wire**
3. **Oil Filter Mount (part of right crankcase half)**
4. **Spring**
5. **Check Ball**
6. **Filter Adapter**
7. **Hose to Oil Pump**
8. **Hose from Oil Pump**

Figure 3-94. Oil Filter Mount Assembly

HYDRAULIC LIFTERS 3.15

GENERAL

See Figure 3-95. The lifter assembly consists of a hydraulic lifter and roller. The lifter and roller, under compression force from valve spring, follow the surface of the revolving cam. The up-and-down motion produced is transmitted to the valve by the push rod and rocker arm. The lifter contains a piston (or plunger) and cylinder; it also contains a check valve, which allows the unit to fill with engine oil, thereby reducing clearance in the valve train.

When a lifter is functioning properly, the assembly operates with minimal lifter clearance. The unit automatically compensates for heat expansion to maintain a no-clearance condition.

It is normal for lifters to click when engine is started after standing for some time. Hydraulic lifters have a definite leakdown rate which permits the oil in the lifters to escape. This is necessary to allow units to compensate for various expansion conditions of parts and still maintain correct clearance operation. Lifters are functioning properly if they become quiet after a few minutes of engine operation.

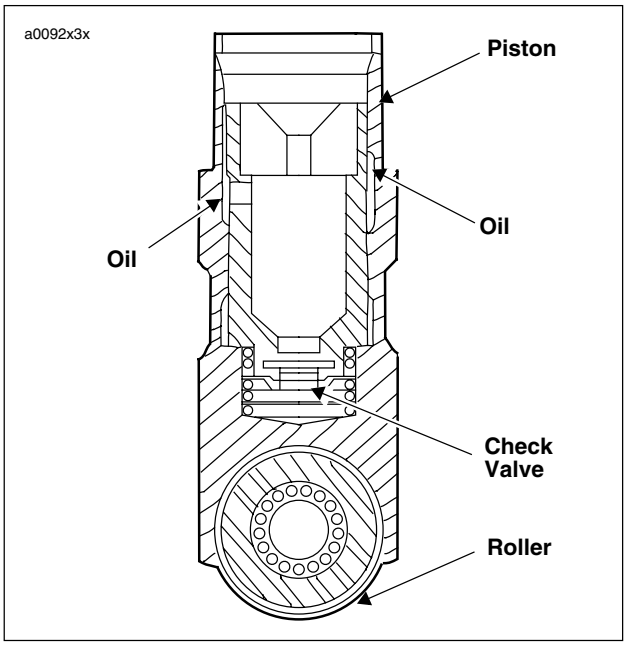


Figure 3-95. Lifter Assembly (Typical)

REMOVAL

1. Clean all dirt from around crankcase. Blow loose particles from area with compressed air.
2. Remove the lower rocker cover. Pull each push rod upward through top of cylinder head. See 3.5 CYLINDER HEAD.
3. Remove cylinder head assembly. See 3.5 CYLINDER HEAD.
4. See Figure 3-96. Remove push rod cover.
   a. Remove screws.
   b. Remove push rod cover.
   c. Remove gasket and o-rings. Discard parts.
5. Remove both valve hydraulic lifters.
   a. Remove anti-rotation screws.
   b. Remove lifters from crankcase bore using a thin-bladed screwdriver. Mark the location and orientation (front/back) of each lifter.

CLEANING AND INSPECTION

1. Clean all parts, except roller/lifter assembly, thoroughly in solvent. Blow dry with compressed air.

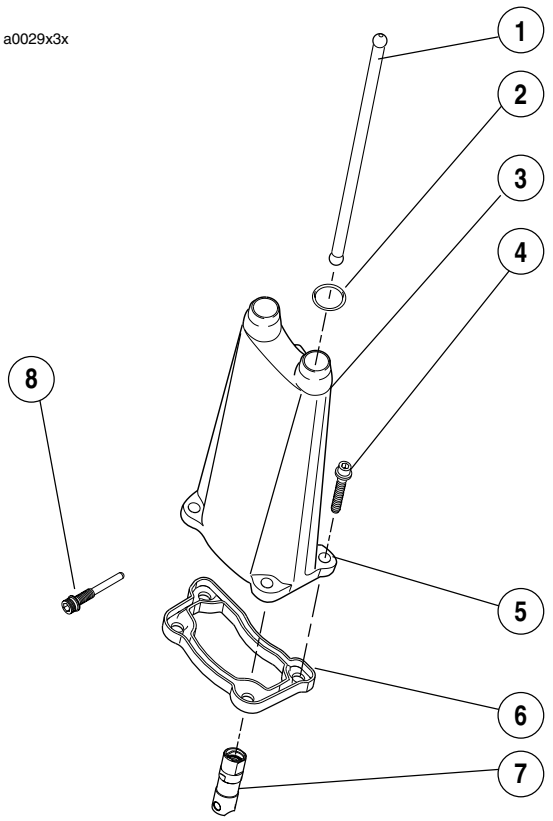
NOTE

Inside and outside micrometers used for measuring tappets and tappet guides must be calibrated to ensure accurate readings.

2. Inspect valve lifters for excessive clearance in guide. Accurately measure lifter bore inner diameter with a gauge.
   a. Clearance should be within 0.0008-0.0020 in. (0.0203-0.0508 mm).
   b. Fit a **new** lifter and/or replace crankcases if clearance exceeds SERVICE WEAR LIMIT of 0.0030 in. (0.076 mm).
3. Check lifter roller freeplay.
   a. Roller clearance on pin should be within 0.0006-0.0010 in. (0.0152-0.0254 mm).
   b. Replace lifters if clearance exceeds SERVICE WEAR LIMIT of 0.0015 in. (0.0381 mm).
4. Check lifter roller end clearance.
   a. End clearance should be within 0.008-0.022 in. (0.203-0.559 mm).
   b. Replace lifters if clearance exceeds SERVICE WEAR LIMIT of 0.026 in. (0.660 mm).
5. Soak lifters in clean engine oil. Keep covered until assembly.

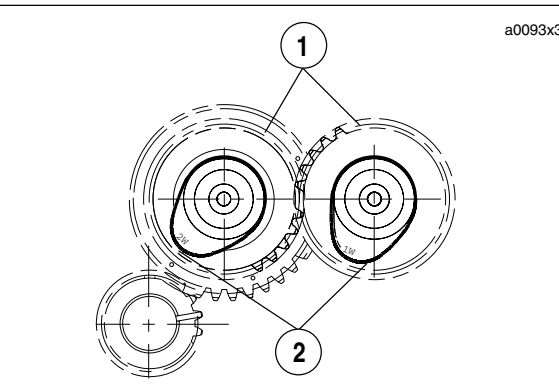
INSTALLATION

1. See Figure 3-97. Rotate engine so that both lifters, from the cylinder will be installed on the base circle of the cam.
2. Apply a liberal amount of engine oil to each lifter assembly (especially the roller needles) for smooth initial operation.
3. See Figure 3-96. Insert lifter into bore in crankcase. Rotate lifter so that flats at upper end of lifter face the front and rear of the engine. If the lifter is installed incorrectly, anti-rotation screws cannot be inserted.
4. Secure lifters in place.
   a. Install anti-rotation screws with washers in the holes in lifter block.
   b. Tighten anti-rotation screws to 55-65 **in-lbs** (6-7 Nm).
5. Install push rod cover.
   a. Slide **new** gasket cover over bottom of push rod cover.
   b. Position push rod cover onto crankcase.
   c. Install screws through holes in push rod cover into tapped holes in crankcase. Tighten screws evenly to 30-40 **in-lbs** (3-5 Nm).
   d. Place **new** o-rings on top of push rod cover.
6. Install push rods, cylinder head, lower and upper rocker covers. See 3.5 CYLINDER HEAD.



1. **Push Rod (exhaust)**
2. **O-ring**
3. **Push Rod Cover**
4. **Screws (4)**
5. **Push Rod Cover**
6. **Push Rod Cover gasket**
7. **Hydraulic Lifter (tappet)**
8. **Anti- Rotation Screw**

Figure 3-96. Valve Lifter Service



1. **Base Circle (lowest position)**
2. **Cam Lobe (maximum lift)**

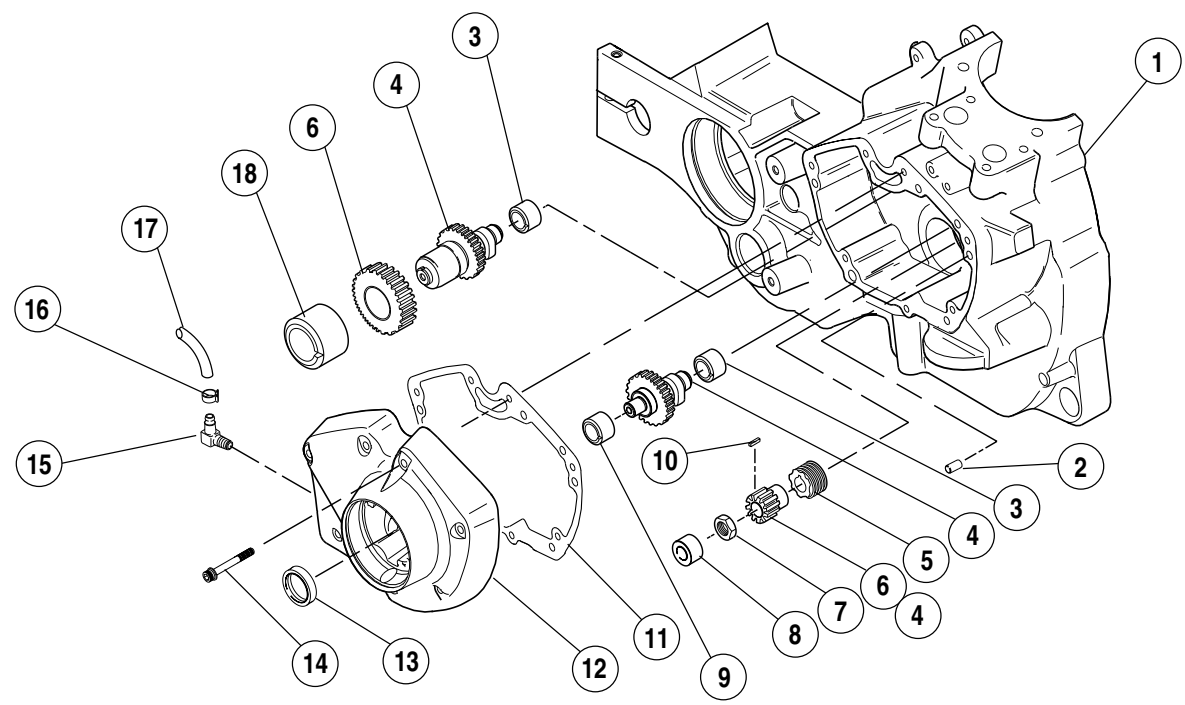
Figure 3-97. Base Circle

GEARCASE COVER AND CAM GEARS 3.16

GENERAL

Read the complete gearcase section carefully before you begin any service work.

For the gearcase components to operate at their optimum, all components must be properly fitted and matched. Changing one component can affect many others. It is important to know and understand all inspection procedures and how components interact.



1. Crankcase Half
2. Dowel Pin
3. Inner Camshaft Gear Bushing
4. “W’ Cam Gear Set
5. Oil Pump Drive Gear
6. “W” Cam Pinion and Drive Gear Set
7. Nut
8. Gear Shaft Pinion Bushing
9. Cam Gear Shaft Outer Bushing
10. Key
11. Camshaft Cover Gasket
12. Gear Cover
13. Seal
14. Sems Screw
15. Oil vent hose fitting
16. Clamp
17. Vent Hose
18. Outer Bushing

Figure 3-98. Gearcase Cover & Cam Assembly

REMOVAL/DISASSEMBLY

1. See Figure 3-98. Thoroughly clean area around gearcase cover and tappets. Blow loose dirt from crankcase with compressed air.
2. Remove any parts that will interfere with gearcase disassembly.
3. See 3.5 CYLINDER HEAD. Remove push rods.
4. See 3.15 HYDRAULIC LIFTERS. Remove hydraulic lifters.
5. Check for minimum cam gear end play. Record readings.
6. See 7.8 IGNITION MODULE/ CAM POSITION SENSOR. Remove cam position sensor and rotor from gearcase cover.
7. Place a pan under gearcase to collect oil. Remove cover screws. Carefully remove gearcase cover. Discard old gasket.

NOTE

If cover does not come loose on removal of screws, tap lightly with a plastic hammer. Never pry cover off.

8. Remove cam gears.

NOTE

Nut is secured by LOCTITE® thread locker 262 (red) on the nut threads.

9. Remove nut. Slide pinion gear and oil pump drive gear off pinion shaft.

CLEANING AND INSPECTION

1. Thoroughly clean gearcase compartment, gearcase cover and gears in solvent to remove oil and carbon deposits.
2. Blow out all cover oil passages and bushings with compressed air.
3. Clean old gasket material from gearcase and cover faces with cleaning solvent.

Cam and Pinion Gear Identification, Inspection, and Selection

See Figure 3-99. Cam lobes are stamped with a number (1 or 2) followed by a letter ("W"). The number (1 or 2) identifies the cam location/function and the letter ("W") indicates model year application:

2W=Intake
1W = Exhaust

See Figure 3-100. Measure the gear diameter with a micrometer over 0.108 in. (2.743 mm) diameter gauge pins on opposite sides of the gear. The pins are of the proper size to fit between the contacting surfaces of the gear teeth. Gear diameter should be measured in at least two places 90° apart. Use GAUGE PIN SET (Part No. HD-38361) when measuring pinion and cam gear sizes.

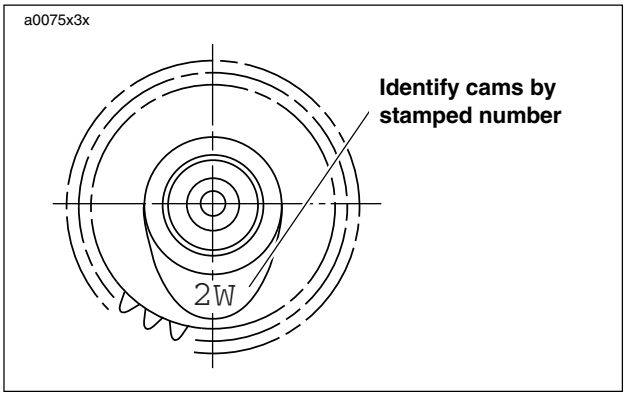


Figure 3-99. Cam Identification

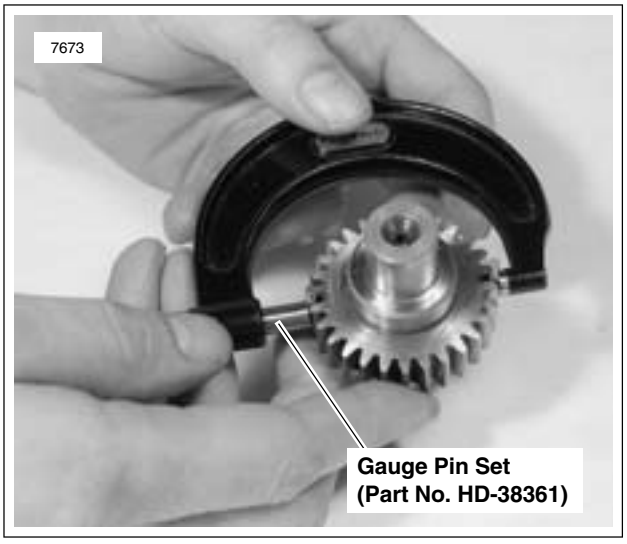


Figure 3-100. Measuring Gear Size

Cam gears are individually selected for each specific gear cover through sophisticated computer-aided measuring techniques in a controlled environment. Each gear is assigned an individual color code based on its diameter (measured with gauge pins). When cam gears are replaced, always use the same color code as found on gears being replaced to ensure that the gear operation remains as quiet as possible. For location of cam gear color codes, see Figure 3-101. Pinion gear and large gear on intake cam are one size only. No selective sizing is possible. If damaged, replace both gears as a pair.

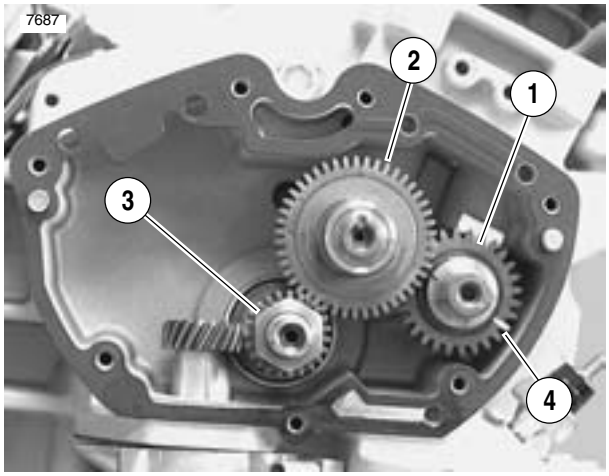
NOTE

On flywheel pinion shaft, a paint dot is located on the shaft perimeter near the centerline of the keyway. This dot identifies the pinion shaft inner race size. Do not use this dot to select pinion gear size.

See Table 3-12. Compare the previously measured diameter of each gear with the specifications (listed in inches) shown in the table to determine amount of wear on gear teeth.

NOTE

Prior to changing any cam gears, check gear shaft fit within corresponding bushings. Worn bushings can cause excessive backlash.



1. **Exhaust Cam Gear (1W)**
2. **Intake Cam Gear (2W)**
3. **Pinion Gear**
4. **Color Code**

Figure 3-101. Cam and Pinion Gear Color Code Location and Timing Mark Indexing

Table 3-12. Cam and Pinion Gear Color Code and Diameter

GEAR NO. & POSITION	2 INBOARD	2 OUTBOARD	1	3
COLOR CODE (1 paint dot)	**Intake**	**Intake**	**Exhaust**	**Pinion**
RED	1.9025-1.9029 (48.323-48.333)		1.9025-1.9029 (48.323-48.333)	
WHITE	1.9020-1.9024 (48.310-48.321)		1.9020-1.9024 (48.310-48.321)	
GREEN	1.9015-1.9019 (48.298-48.308)		1.9015-1.9019 (48.298-48.308)	

Bushing Inspection and Removal

1. See Figure 3-98. Bushings are press fit in gearcase cover and crankcase. Inspect each bushing against its corresponding cam gear shaft or pinion gear shaft. See Table 3-13.

Table 3-13. Gear Shaft Specifications

GEAR SHAFT	CORRECT CLEARANCE	SERVICE WEAR LIMIT
Cam	0.0007-0.0022 in. (0.0178-0.0559 mm)	0.003 in. (0.076 mm)
Pinion	0.0023-0.0043 in. (0.0584-0.1092 mm)	0.0050 in. (0.1270 mm)

2. See Figure 3-102. Use a BUSHING AND BEARING PULLER (Part No. HD-95760-69A) to remove bushings from gearcase cover and crankcase.

Bushing Installation

NOTE

Installing and reaming crankcase and gearcase cover bushings may alter the center distances between mating gears and may result in an increase in gear noise. For quiet-running gears, the gears should be matched to the center distances.

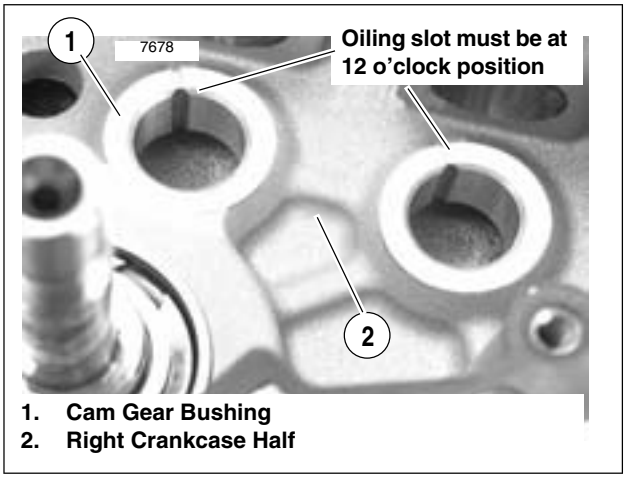
CAM GEAR BUSHINGS IN RIGHT CRANKCASE HALF

1. See Figure 3-103. Each cam gear bushing, to be installed in right crankcase half, must be positioned in crankcase bore with its oiling slot at crankcase slot.
2. Using an arbor press, UNIVERSAL DRIVER HANDLE (Part No. HD-33416), and CAMSHAFT NEEDLE BEARING (Part No. HD-97273-60) install each bushing in its crankcase bore so that bushing shoulder contacts crankcase boss.
3. See Bushing Reaming. After you install a **new** bushing in right crankcase half, ream the bushing to correct size.

CAM GEAR BUSHINGS (EXCEPT INTAKE BUSHING) IN GEARCASE COVER

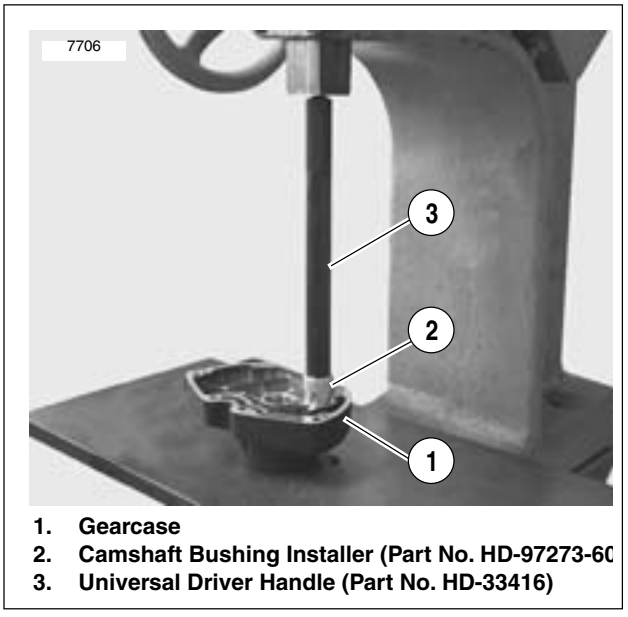
1. See Figure 3-104. Using an arbor press, install each bushing in its gearcase cover bore so that bushing shoulder contacts cover boss. Position each bushing so the oiling slot is at the 3 o'clock position within the gearcase cover bore.
2. See Bushing Reaming. After you install a **new** bushing in gearcase cover, line-ream the bushing to correct size.

Figure 3-102. Removing Bushing



1. Cam Gear Bushing
2. Right Crankcase Half

Figure 3-103. Cam Gear Bushing Installed in Crankcase



1. Gearcase
2. Camshaft Bushing Installer (Part No. HD-97273-60
3. Universal Driver Handle (Part No. HD-33416)

Figure 3-104. Arbor Press

INTAKE CAM GEAR BUSHING IN GEARCASE COVER.

See Figure 3-98. The intake cam gear bushing must be installed in its gearcase cover bore using an arbor press. You will need to orient the bushing in a specific position of rotation within the cover bore according to the following procedures:

1. See Figure 3-105. Position bushing over bore of gearcase cover with chamfered edge downward and slot upward. Align slot in bushing with slot in gearcase cover boss. Press bushing into cover bore until bushing is flush with cover boss.
2. See Bushing Reaming. After you install a **new** bushing in gearcase cover, line-ream the bushing to the correct size.

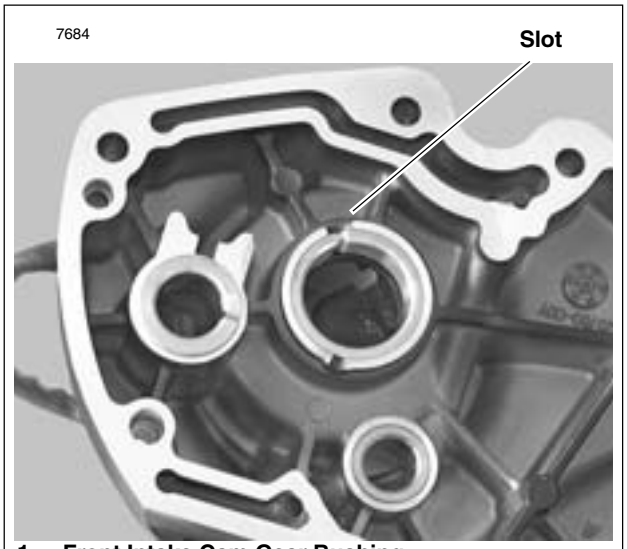
PINION SHAFT BUSHING IN GEARCASE COVER

1. See Figure 3-98. Using an arbor press, install pinion shaft bushing in its gearcase cover so that bushing is flush with cover boss. There is no need to orient this particular bushing in any specific position of rotation within the gearcase cover bore.
2. Although the original pinion shaft bushing is not “pinned,” the replacement bushing must be secured, from possible rotation within the cover bore, by installation of a dowel pin. See Figure 3-106. Drill a No. 31 hole, 0.281 in. (7.137 mm) deep, at top side of boss (side toward top of gearcase cover), centering the drill bit on the cover bore circle (hole is drilled half in bushing OD and half in cover bore ID).
3. Drive a **new** dowel pin no more than 0.20 in. (5.08 mm) below the bushing face. Carefully peen edges of hole to lock the pin in place.
4. See Bushing Reaming. After you install a **new** bushing in gearcase cover, line-ream the bushing to the correct size.

Bushing Reaming

NOTE

- *Installing and reaming crankcase and gearcase cover bushings may alter the center distances between mating gears and may result in an increase in gear noise. For quiet-running gears, the gears should be matched to the center distances.*
- *Bushings in right crankcase half serve as pilots for reaming gearcase cover bushings and must, therefore, be reamed to size first.*
- *After reaming any bushing, check shaft fit in the bushing. It may be necessary to make a second pass with reamer to attain proper fit.*



1. **Front Intake Cam Gear Bushing**
2. **Gearcase Cover**

Figure 3-105. Rear Intake Cam Gear Bushing Installed in Gearcase Cover

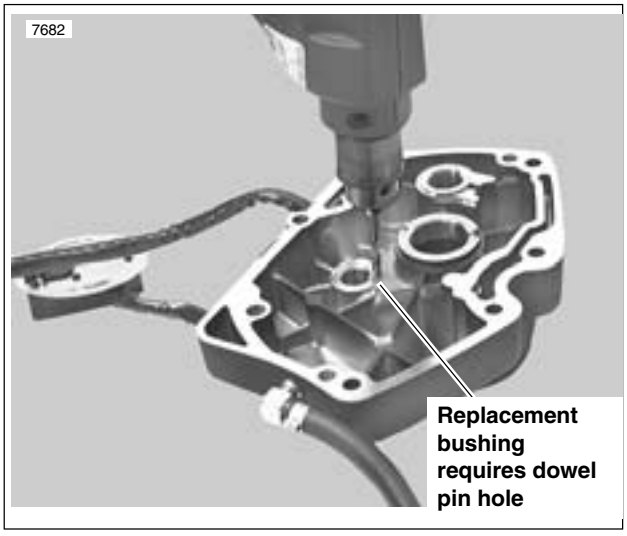


Figure 3-106. Drilling Dowel Pin Hole

CAM GEAR BUSHINGS IN RIGHT CRANKCASE HALF

1. Separate two halves of crankcase, if not already accomplished. Place right crankcase half on flat surface with gearcase side upward. Bushing to be reamed must be oriented as shown in Figure 3-103.
2. See Figure 3-107. Position CAMSHAFT BUSHING REAMER PILOT (Part No. B-43988) onto gearcase side of crankcase half; upper right and lower left indexing holes in pilot must be placed over dowels in crankcase half. Insert two bolts (supplied with pilot) through two remaining holes in pilot, and into threaded holes of crankcase half. Tighten bolts securely.
3. Insert REAMER (Part No. HD-38871-2) through pilot hole and into bushing while turning reamer clockwise. Continue turning reamer clockwise through bushing until smooth shank of reamer passes through hole in pilot.
4. Detach reamer from handle. Pull reamer out opposite side of crankcase half.
5. Thoroughly clean right crankcase half, removing all metal chips/shavings. Blow out all oil passages using compressed air.

EXHAUST GEAR BUSHING IN GEARCASE COVER

NOTE

Newly installed cam gear bushings in the gearcase cover must be line reamed, using the right crankcase half as a pilot for the reamer, to establish correct clearance and to ensure perfect alignment. If crankcase halves are not separated on your motorcycle, use a spare right crankcase half to perform the following line reaming procedures.

1. See Figure 3-98. Bushings to be reamed must be installed in gearcase cover as described in BUSHING INSTALLATION. Attach gearcase cover to right crankcase half, which has been disassembled from left crankcase half, securing with a minimum of three mounting screws.
2. Insert REAMER (Part No. HD-38871-2) through the previously reamed cam gear bushing in right crankcase half, which is in line with exhaust bushing to be reamed in gearcase cover.
3. Turn reamer clockwise through bushing in cover until reamer bottoms. Then give reamer one complete clockwise turn to size the bushing. Continue turning reamer clockwise while extracting reamer from bushing.
4. Separate gearcase cover from right crankcase half. Inspect bushings for proper cam gear shaft fit. Repeat line reaming operation if necessary.

Safety glasses or goggles must be worn while removing metal chips/shavings. Failure to wear safety glasses or goggles could result in death or serious injury.

5. Thoroughly clean gearcase cover, removing all metal chips/shavings. Blow out all oil passages using compressed air.

INTAKE CAM GEAR BUSHING IN GEARCASE COVER

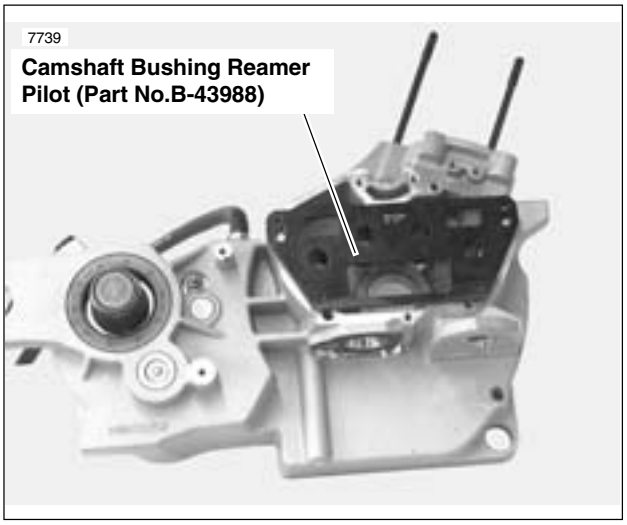


Figure 3-107. Reaming Cam Gear Bushing in Right Crankcase Half

NOTE

A newly installed intake cam gear bushing in the gearcase cover must be line reamed, using the right crankcase half as a pilot for the reamer, to establish correct clearance and to ensure perfect alignment. If crankcase halves are not separated on your motorcycle, use a spare right crankcase half to perform the following line reaming procedures.

1. See Figure 3-98. Intake cam gear bushing must be installed in gearcase cover as described in BUSHING INSTALLATION.
2. Identify the previously reamed intake cam gear bushing in right crankcase half, which has been disassembled from left crankcase half. Insert the shank end of REAR INTAKE CAMSHAFT BUSHING REAMER (Part No. HD-94804-67) through gearcase side of this bushing.
3. With reamer inserted into bushing in right crankcase half, attach gearcase cover to right crankcase half, securing with a minimum of three mounting screws.
4. Turn reamer clockwise through bushing in gearcase cover until reamer bottoms. Then give reamer one complete clockwise turn to size the bushing. Continue turning reamer clockwise while extracting reamer from bushing.
5. Separate gearcase cover from right crankcase half. Inspect bushing for proper cam gear shaft fit. Repeat line reaming operation if necessary.

Safety glasses or goggles must be worn while removing metal chips/shavings. Failure to wear safety glasses or goggles could result in death or serious injury.

6. Thoroughly clean gearcase cover, removing all metal chips/shavings. Blow out all oil passages using compressed air.

PINION SHAFT BUSHING IN GEARCASE COVER

NOTE

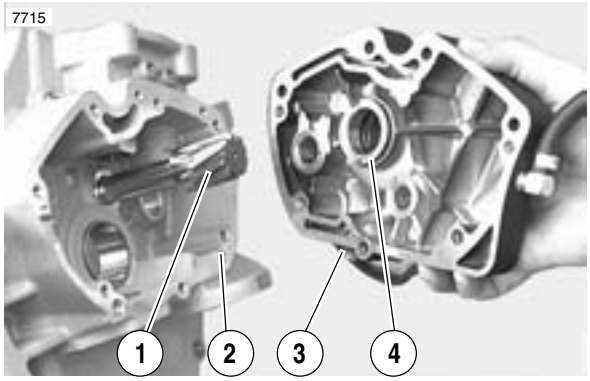
*A **newly** installed pinion shaft bushing in the gearcase cover must be line reamed, using both the right crankcase half and Part No. HD-94812-87 as pilots for the reamer, to establish correct clearance and to ensure proper alignment. If crank-*

case halves are not separated on your motorcycle, use a spare right crankcase half to perform the following line reaming procedures.

1. See Figure 3-98. Pinion shaft bushing must be installed in gearcase cover as described in BUSHING INSTALLATION. Attach gearcase cover to right crankcase half, which has been disassembled from left crankcase half, securing with a minimum of three mounting screws.
2. See Figure 3-108. Install PINION SHAFT BUSHING REAMER PILOT (Part No. HD-94812-87) into right crankcase roller bearing. Insert PINION SHAFT BUSHING REAMER (Part No. HD-94812-1) through the pilot.
3. Turn reamer clockwise through bushing in gearcase cover until reamer bottoms. Then give reamer one complete clockwise turn to size the bushing. Continue turning reamer clockwise while extracting reamer from bushing.
4. See Figure 3-109. Separate gearcase cover from right crankcase half. Inspect bushing for proper pinion shaft fit. Repeat line reaming operation if necessary.

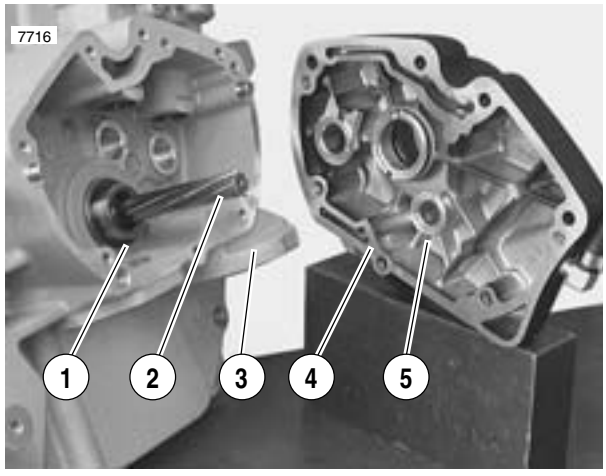
Safety glasses or goggles must be worn while removing metal chips/shavings. Failure to wear safety glasses or goggles could result in death or serious injury.

5. Remove pilot from right crankcase roller race. Thoroughly clean gearcase cover, removing all metal chips/shavings. Blow out all oil passages using compressed air.



1. **Reamer (Part No. HD-94804-67)**
2. **RIght Crankcase Half**
3. **Gearcase**
4. **Intake Cam**

Figure 3-108. Line Reaming Intake Camshaft Bushing



1. **Pilot (Part No. HD-94812-87)**
2. **Reamer (Part No. HD-94812-1)**
3. **RIght Crankcase**
4. **Gearcase**
5. **Pinion Bushing**

Figure 3-109. Line Reaming Pinion Shaft Bushing

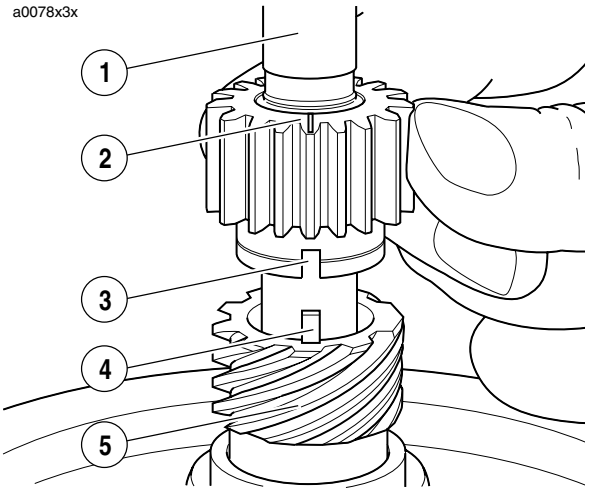
ASSEMBLY/INSTALLATION

1. See Figure 3-110. Install oil pump drive gear and pinion gear on pinion shaft.
   a. Install shaft key into pinion shaft slot.
   b. Slide oil pump gear drive gear over pinion shaft. Drive gear must align with shaft key.
   c. Align keyway in ID of pinion gear with shaft key.
   d. Slide pinion gear over shaft key and against oil pump drive gear.
2. See Figure 3-98. Install nut.
   a. Clean threads on pinion shaft and nut.
   b. See Figure 3-111. Install CRANKSHAFT LOCKING TOOL (Part No. HD-43984) to gearcase with “Side B” facing out, over pinion shaft, with two screws.
   c. Apply several drops of LOCTITE® thread locker 262 (red) to last few threads of nut.
   d. Install nut to pinion shaft. Tighten nut to 19-21 ft-lbs (26-29 Nm) plus an additional 15° to 17° rotation.
3. See Figure 3-101. Liberally apply engine oil to bushings, shafts, and gears. Install all cam gears into bushings of right crankcase half, properly aligning timing marks of cam gears and pinion gear.

NOTE

Because of the larger diameter additional gear (which meshes with the pinion gear) on the outboard end of the cam, the exhaust cam gear must be installed before the intake cam gear is installed.

4. See Figure 3-98. Install a **new** seal and **new** dry gear-cover gasket on crankcase.



1. **Pinion Shaft**
2. **Timing Mark on Pinion Gear**
3. **Keyway**
4. **Shaft Key**
5. **Oil Pump Drive Gear**

Figure 3-110. Aligning Pinion Gear

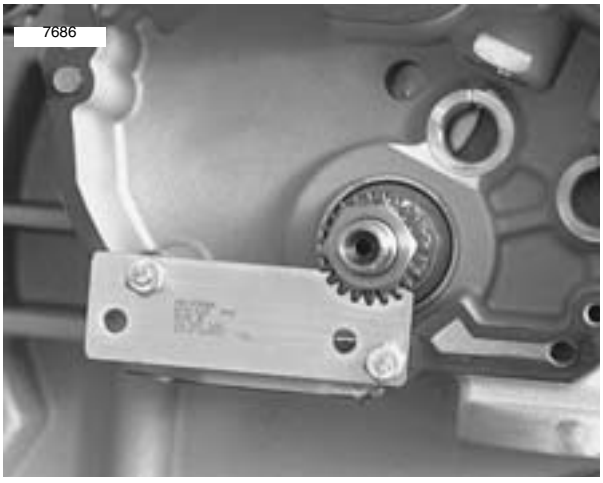


Figure 3-111. Crankshaft Locking Tool (HD-43984)

5. See Figure 3-112. Install gearcase cover over all gears and onto right crankcase half. Secure cover to crankcase half with 7 socket head screws. Tighten screws evenly to 80-110 **in-lbs** (9-12 Nm). Use torque sequence as shown in Figure 3-112.
6. See Figure 3-113. Check cam gear end play for each cam gear as follows:
   a. Turn engine over until lobe of cam gear being checked is pointing toward its respective tappet guide hole.
   b. Gently pry the cam gear toward the gearcase cover using a flat blade screwdriver.
   c. Measure gap between bushing (in crankcase half) and cam gear shaft thrust face (shoulder) using a feeler gauge. This is cam gear end play.
   d. Compare cam gear end play measurements with the SERVICE WEAR LIMITS. Make repairs as required if end play does not meet specifications.
7. See 3.15 HYDRAULIC LIFTERS. Install hydraulic lifters and push rods.
8. Install cam position sensor and rotor in gearcase cover. 7.8 IGNITION MODULE/ CAM POSITION SENSOR.
9. Install any components removed to gain access to gearcase (i.e. exhaust system components, air cleaner, etc.).

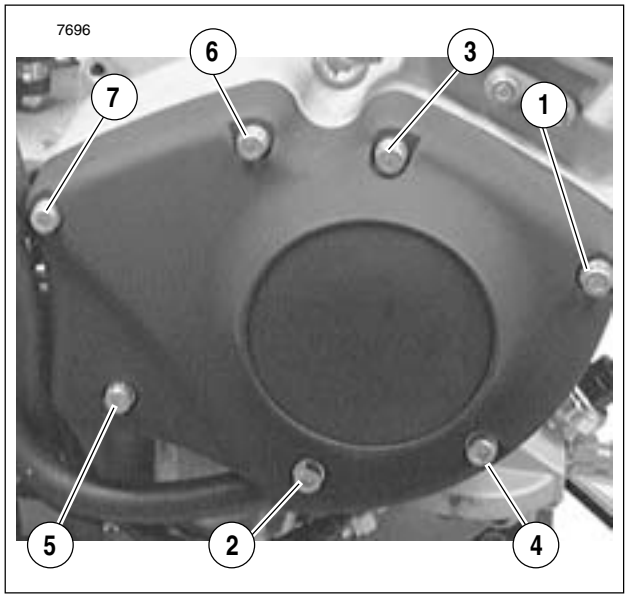


Figure 3-112. Gearcase Cover Mounting Screw Torque Sequence

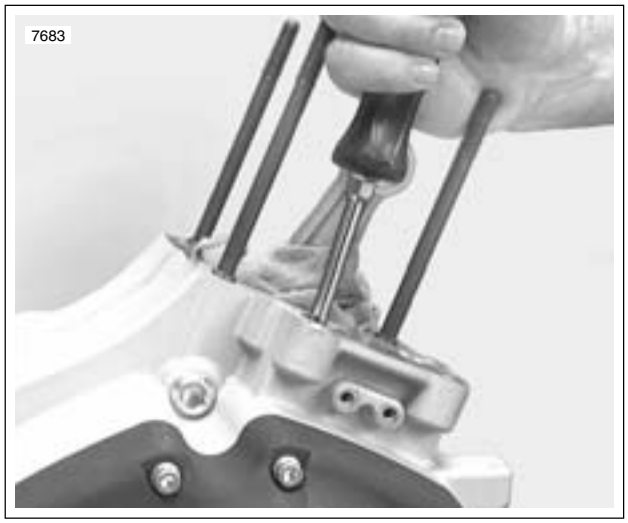


Figure 3-113. Checking Cam Gear End Play

GENERAL

If engine is removed from chassis, do not lay engine on primary side. Placing engine on primary side will damage clutch cable end fitting. If fitting is damaged, clutch cable must be replaced.

See 3.3 STRIPPING MOTORCYCLE FOR ENGINE REPAIR/REMOVAL. Remove engine from chassis to repair pinion shaft bearing or sprocket shaft bearing.

It is recommended procedure to overhaul engine if removed. This includes inspecting and repairing cylinder head, cylinder, gearcase and transmission.

ADJUSTMENT/TESTING

Flywheel End Play

Before completely disassembling crankcases, check flywheel end play.

1. After engine has been removed from chassis, securely fasten it to a stand or workbench.
2. See 3.16 GEARCASE COVER AND CAM GEARS. Remove gearcase cover.
3. See Figure 3-114. Attach a dial indicator to gear side crankcase with indicator stem on end of gearshaft.
4. To obtain an accurate flywheel end play reading, preload sprocket shaft bearings. Create a suitable tool by welding two handles to an old engine sprocket nut. Install the nut and sprocket. Tighten to 190-210 ft-lbs (258-285 Nm).
5. Check flywheel end play.
   a. Rotate and **push** on sprocket shaft while reading dial indicator.
   b. Then rotate and **pull** on sprocket shaft while reading dial indicator.
   c. Replace bearing inner shim if difference (end play) in indicator readings is not 0.001-0.005 in. (0.025-0.127 mm). Choose shim from Table 3-14.

NOTE

Use a thinner shim for less end play; use a thicker shim for more end play.

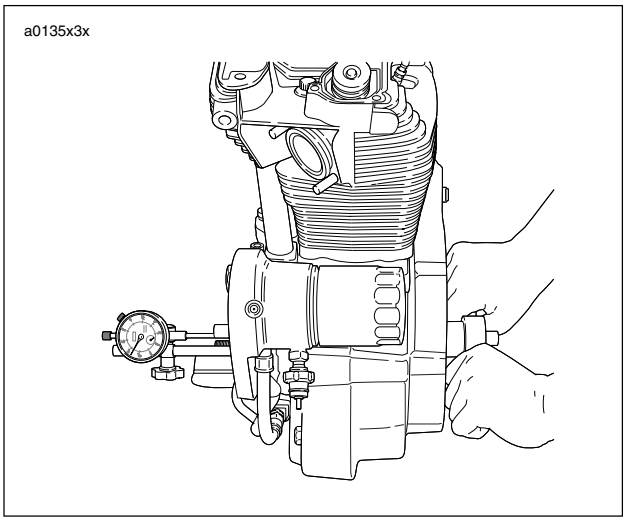


Figure 3-114. Checking Flywheel End Play

Table 3-14. Flywheel End Play Shims

PART NUMBER	THICKNESS	
	IN.	MM
9155	0.0975-0.0985	2.4765-2.5019
9142	0.0995 - 0.1005	2.5273-2.5527
9143	0.1015-0.1025	2.5781-2.6035
9144	0.1035 - 0.1045	2.6289-2.6543
9145	0.1055 - 0.1065	2.6797-2.7051
9146	0.1075 - 0.1085	2.7305-2.7559
9147	0.1095 - 0.1105	2.7813-2.8067
9148	0.1115 - 0.1125	2.8321-2.8575
9149	0.1135 - 0.1145	2.8829-2.9083

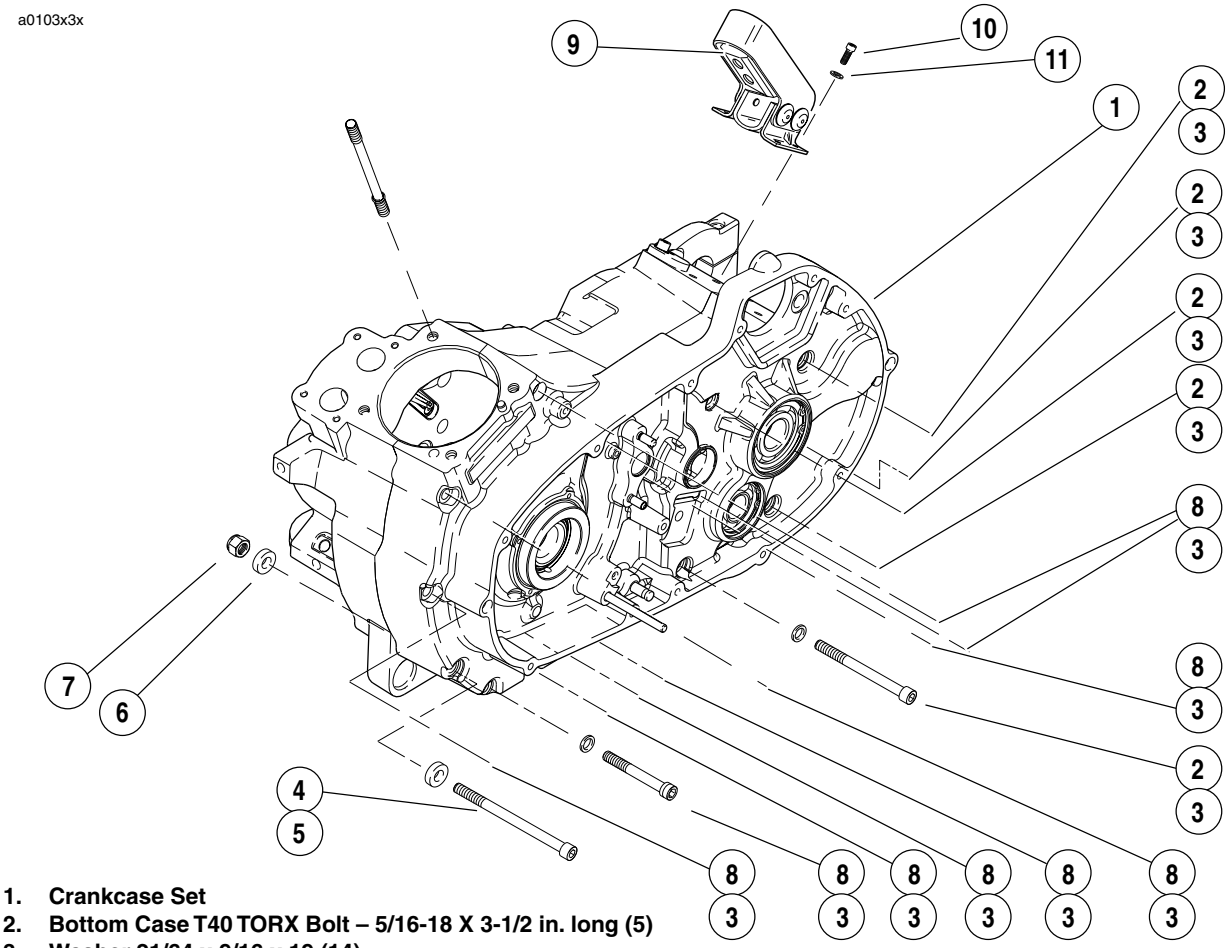
DISASSEMBLY

Crankcase Halves

1. See 3.5 CYLINDER HEAD. Remove cylinder head.

After removing cylinder, install plastic or rubber hose over cylinder studs. Lifting or moving crankcase by grasping studs will cause cylinder stud damage.

2. See 3.6 CYLINDER AND PISTON. Remove cylinder and piston.
3. See 3.13 OIL PUMP. Remove oil pump.
4. See 3.16 GEARCASE COVER AND CAM GEARS. Remove gearcase components.
5. See 6.2 PRIMARY CHAIN. Remove primary cover and primary drive/clutch components.
6. See 5.7 STARTER. Remove starter motor.
7. See Figure 3-115. Remove screws and rear engine mount bolts securing crankcase halves together.
8. Tap crankcase with plastic mallet to loosen and separate the halves.



1. **Crankcase Set**
2. **Bottom Case T40 TORX Bolt – 5/16-18 X 3-1/2 in. long (5)**
3. **Washer 21/64 x 9/16 x 19 (14)**
4. **Hex Socket Head Screw – 3/8-16 X 4-1/2 in. long (1)**
5. **Spacer (1)**
6. **Washer - 3/8 I.D. X 13/16 O.D. (1)**
7. **Nyloc, Hex Locknut - 3/8-16**
8. **Hex Socket Head Screw – 5/16-18 X 2-1/2 in. long (9)**
9. **Rear Isolator**
10. **Screw (4)**
11. **Washer (4)**

Figure 3-115. Crankcase Hardware

The next step requires using a press. Wear eye protection and make certain set-up is stable. The pressure

involved could cause parts to "fly out" with considerable force. Inadequate safety precautions could result in death or serious injury.

9. See Figure 3-116. Mount the left crankcase half and flywheel assembly on a press table, supporting crankcase on parallel bars. Press on end of sprocket shaft with arbor press until flywheel assembly is free from crankcase half. Do not drive flywheel assembly from crankcase half as flywheels may be knocked out of alignment.

NOTE

See Figure 3-117. If it is necessary to remove either the pinion shaft bearing or sprocket shaft bearing, proceed as follows:

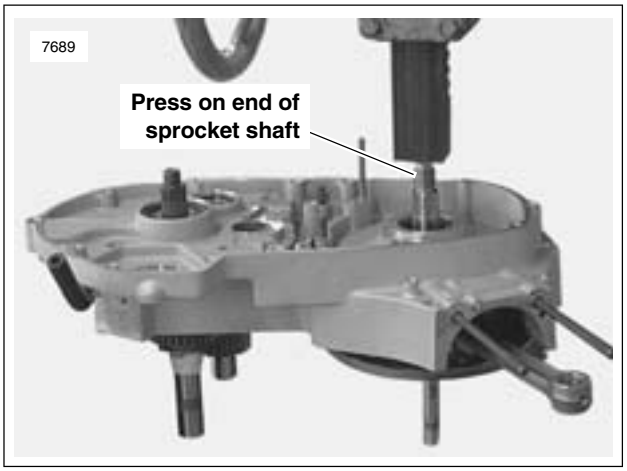
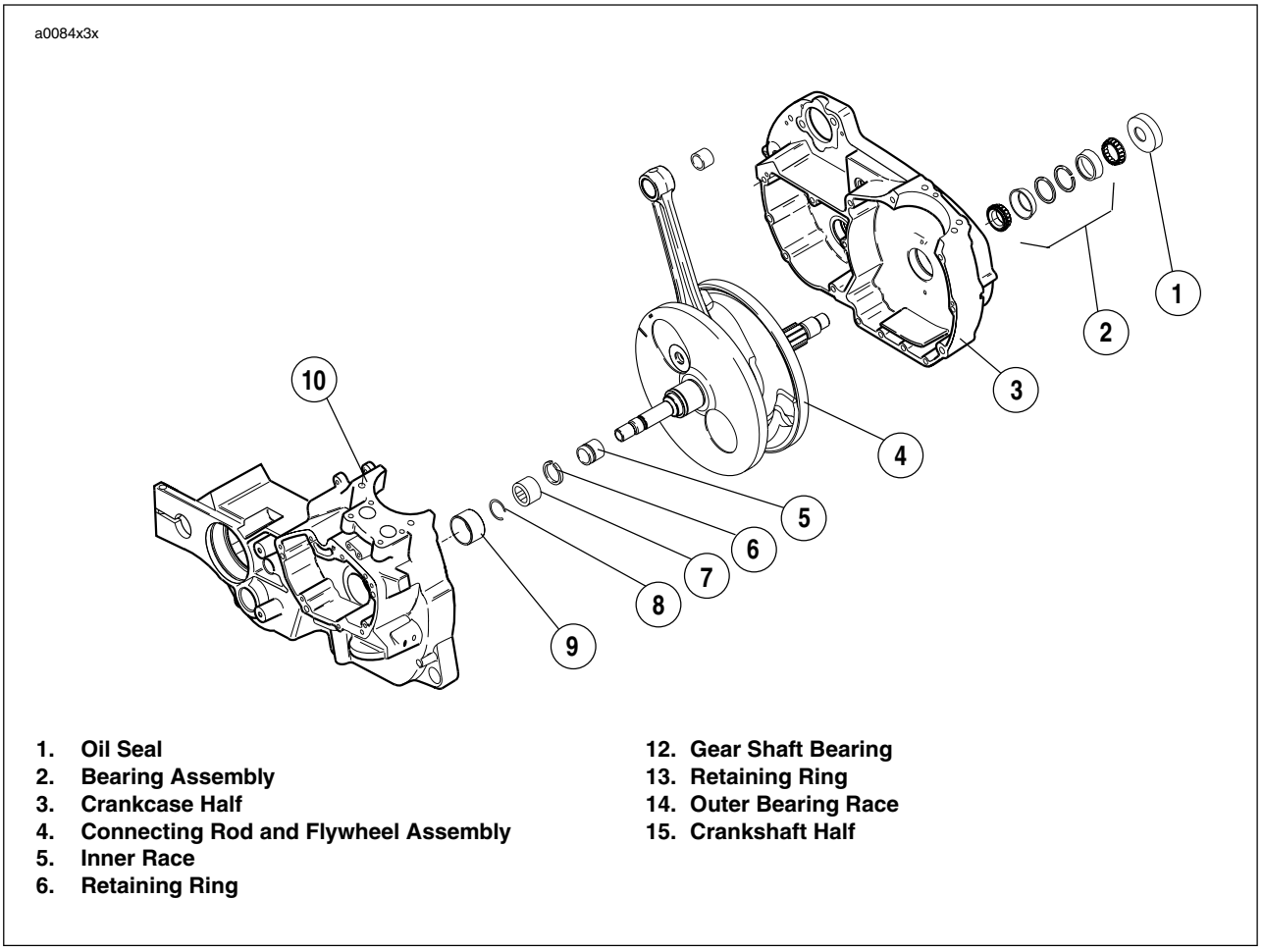


Figure 3-116. Pressing Flywheel from Crankcase



1. **Oil Seal**
2. **Bearing Assembly**
3. **Crankcase Half**
4. **Connecting Rod and Flywheel Assembly**
5. **Inner Race**
6. **Retaining Ring**
12. **Gear Shaft Bearing**
13. **Retaining Ring**
14. **Outer Bearing Race**
15. **Crankshaft Half**

Figure 3-117. Crankcase and Flywheel Assembly

10. Gearshaft bearing will remain on flywheel pinion shaft. Remove retaining ring, and bearing may be slipped off pinion shaft.

11. See Figure 3-118. Place flywheel assembly in FLYWHEEL SUPPORT FIXTURE (Part No. HD-44385). Pull sprocket shaft bearing with SPROCKET SHAFT INNER

TIMKIN BEARING REMOVER (Part No. HD-44404) and BEARING RACE REMOVER/INSTALLER (Part No. HD-34902B).

12. See Figure 3-119. Use CRANKSHAFT BEARING TOOL (Part No. HD-94547-101) to remove sprocket shaft outer races.
13. See Figure 3-120. To remove pinion shaft inner race, use WEDGE ATTACHMENT for CLAW PULLER (Part No. HD-95637-46A) with BEARING RACE REMOVER/INSTALLER (Part No. HD-34902B) and END CAP (Part No. HD-34902-7). Apply heat to race to aid removal. Four sizes of pinion bearings are available. Pinion bearing selection at the factory, during engine rebuild, or replacement of crankcase set or flywheel assembly is based on the largest measured outside diameter (OD) of the inner race and the smallest measured inside diameter (ID) of the outer race (crankcase bushing). A running clearance of 0.0002-0.0008 in. (0.0051-0.0203 mm) is established during crankcase set or flywheel assembly replacement and engine rebuild.

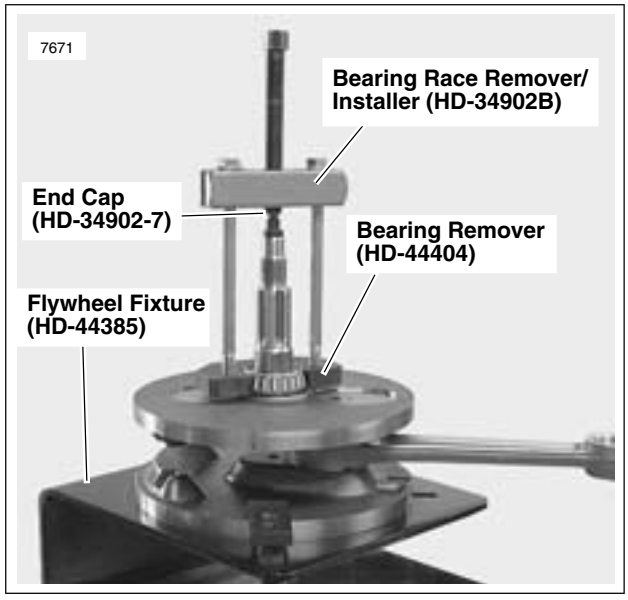
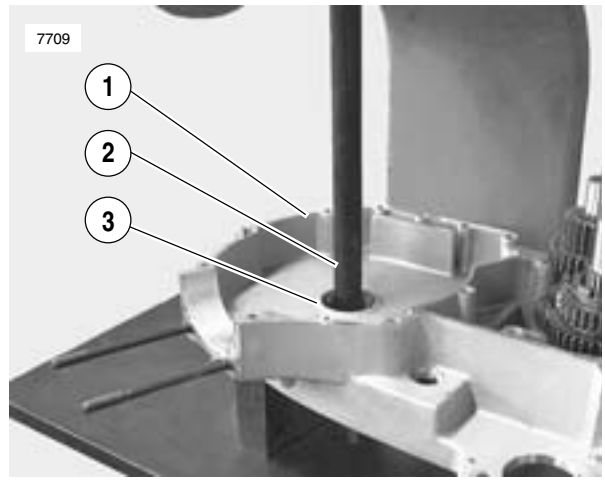
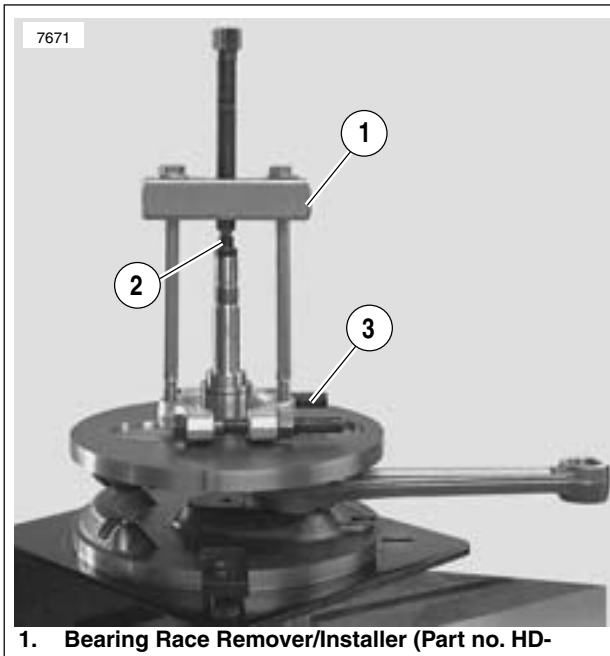


Figure 3-118. Removing Sprocket Shaft Roller Bearing



1. **Left Crankcase Half**
2. **Universal Driver (Part No. HD-33416)**
3. **Crankshaft Bearing Tool (Part No. HD-94547-101)**

Figure 3-119. Sprocket Outer Shaft Race Removal



1. **Bearing Race Remover/Installer (Part no. HD-34902B**
2. **End Cap (Part No. HD-34902-7)**
3. **Wedge Attachment for Claw Puller (Part No. HD-95637-46A)**

Figure 3-120. Pulling Pinion Shaft Inner Race

14. See Figure 3-121. Installed inner races are identified at the factory as shown.
15. See Figure 3-122. Outer races are identified at the factory as shown.

NOTE

The different sizes of crankcase sets and flywheel assemblies will not have separate part numbers. That is, a replacement crankcase set may have a class 1, 2 or 3 pinion outer race. Replacement flywheel assemblies will have either a class A or B inner race.

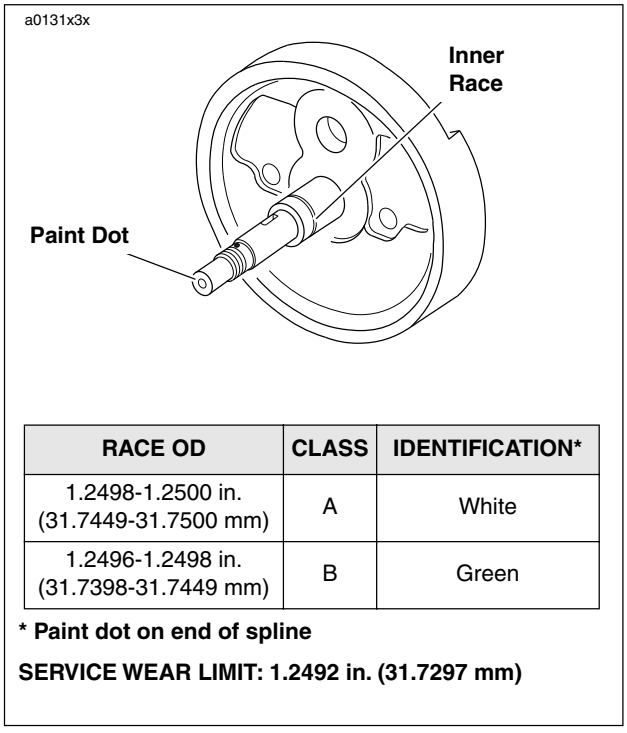
16. See Figure 3-123. Pinion bearings are identified as shown.

BEARING SELECTION

See Table 3-15. Pinion Shaft Bearing Selection. Select bearings using the identification information given for inner and outer races and bearings.

NOTE

If either inner or outer race show wear, measure both races to confirm correct bearing fit.

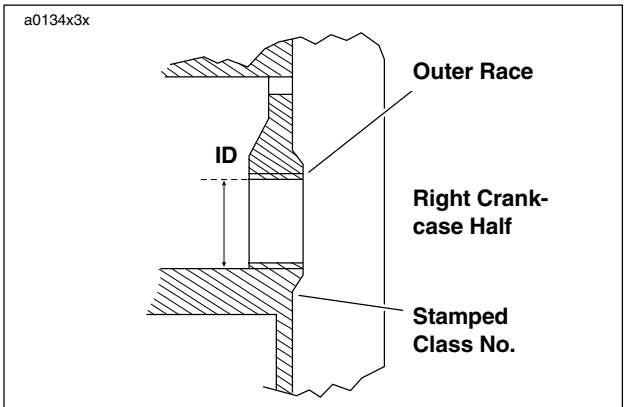


RACE OD	CLASS	IDENTIFICATION*
1.2498-1.2500 in. (31.7449-31.7500 mm)	A	White
1.2496-1.2498 in. (31.7398-31.7449 mm)	B	Green

*** Paint dot on end of spline**

SERVICE WEAR LIMIT: 1.2492 in. (31.7297 mm)

Figure 3-121. Factory Inner Race Sizes

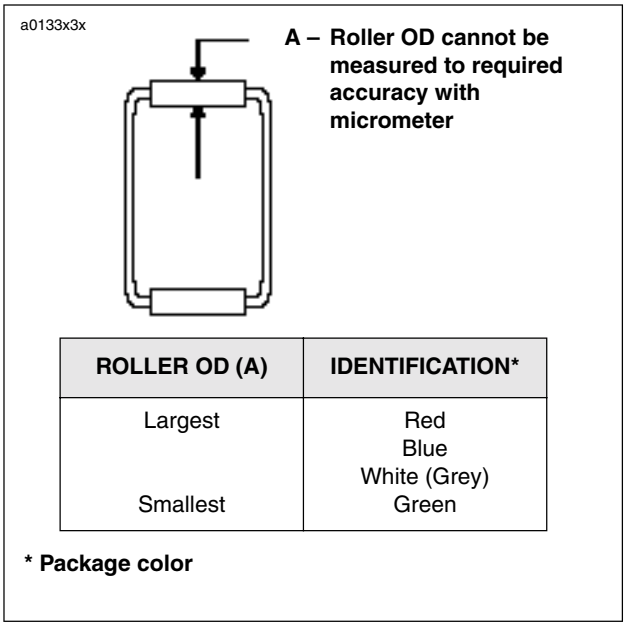


RACE ID	CLASS NO.	STAMPED IDENTIFICATION*
1.5646-1.5648 in. (39.7408-39.7459 mm)	1	1
1.5648-1.5650 in. (39.7459-39.7510 mm)	2	2
1.5650-1.5652 in. (39.7510-39.7561 mm)	3	3

*** Stamped number inside crankcase near race**

SERVICE WEAR LIMIT: 1.5672 in. (39.8069 mm)

Figure 3-122. Factory Outer Race Sizes



ROLLER OD (A)	IDENTIFICATION*
Largest	Red
	Blue
	White (Grey)
Smallest	Green

*** Package color**

Figure 3-123. Bearing Identification

1. Use a dial bore gauge to measure and record ID of outer race. Take four measurements on ID where bearing rollers ride.
   a. If the largest measurement is larger than 1.5672 in. (39.8069 mm) or the required lapping to remove wear marks would enlarge bore beyond 1.5672 in., continue at Step 5.
   b. If largest measurement is 1.5672 in. (39.8069 mm) or less, cover the cam bearings with masking tape to prevent debris from entering bearings. Assemble crankcase halves.

NOTE

The next step requires lapping the outer race. To keep sprocket shaft and pinion shaft bearings aligned the lap must be supported by an adaptor or pilot in the left crankcase half.

2. See LAPPING ENGINE MAIN BEARING RACES. Lap race until all wear marks are removed.
3. Measure and record ID of race at four places.
4. Check measurements against these specifications:

   Largest ID measured: 1.5672 in. (39.8069 mm) or less

   Roundness of ID: within 0.0002 in. (0.0051 mm)

   Taper: within 0.0002 in. (0.0051)
   a. If lapping increased bore ID to larger than 1.5672 in. (39.8069 mm), go to Step 5.
   b. If roundness or taper do not meet specifications, continue lapping until specifications are met.
   c. If all specifications are met, continue at Step 7 to remove and size inner race.
5. Press the outer race from the right crankcase. Press **new** outer race into crankcase flush with inside edge of cast-in insert.

   See Figure 3-124. Dimensions are shown for fabrication of tools used in pressing the outer race into or out of crankcase.
6. See LAPPING ENGINE MAIN BEARING RACES. The **new** outer race must be lapped slightly to true and align with left case bearing and to meet the following specifications.

   ID: 1.5646 - 1.5652 in. (39.7408 - 39.7561 mm)

   Roundness: within 0.0002 in. (0.0051 mm)

   Taper: within 0.0002 in. (0.0051 mm)

   Surface finish: 16 RMS

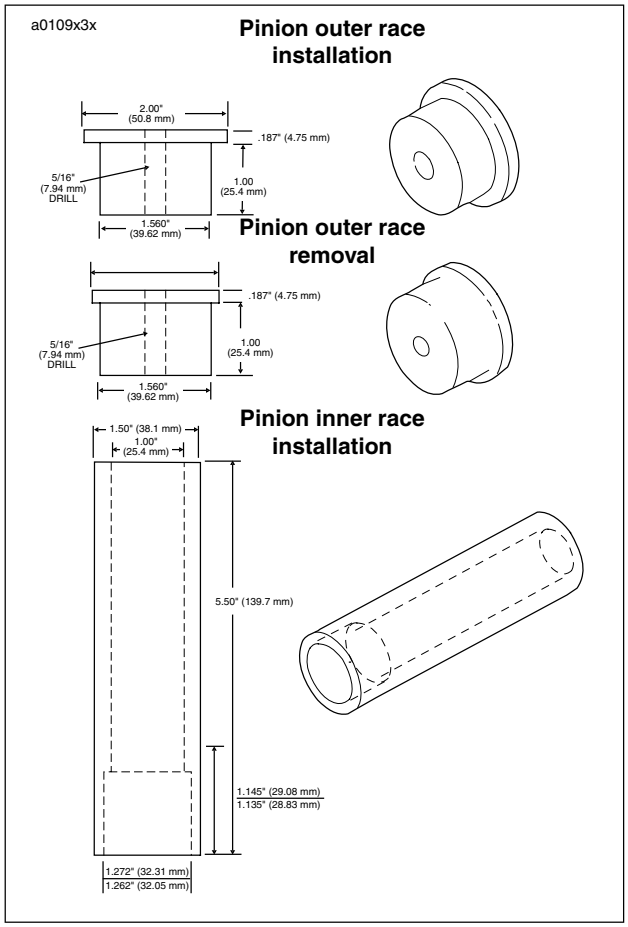


Figure 3-124. Pinion Shaft Bearing Tools

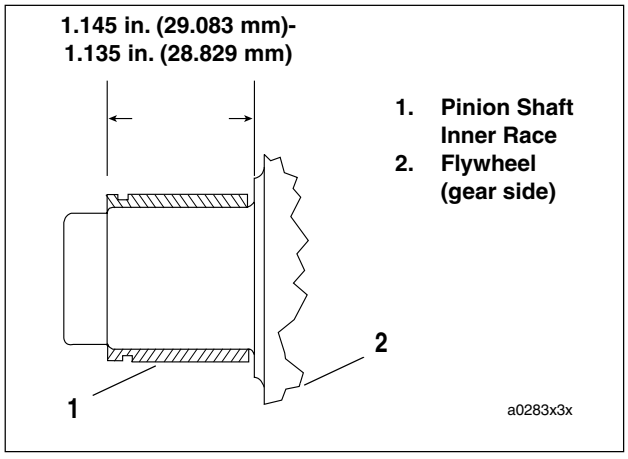


Figure 3-125. Inner Race Location

7. See Figure 3-125. Pull inner race from pinion shaft using WEDGE ATTACHMENT for CLAW PULLER (Part No. HD-95637-46A) with BEARING RACE REMOVER/INSTALLER (Part No. HD-34902B) and END CAP (Part No. HD-34902-7). Apply heat to race to aid removal.
8. See Figure 3-125. Press **new** inner race on pinion shaft as shown. The **new** inner race must be ground by a competent machinist to OD dimension range for the finished lapped ID of the outer race. See Table 3-15. The finished inner race must meet these specifications. For necessary dimensions for constructing a press-on tool see Figure 3-124. When the tool bottoms against the flywheel, correct inner race location is automatically established.

   Roundness: within 0.0002 in. (0.0051 mm)

   Taper: within 0.0002 in. (0.0051 mm)

   Surface finish: 16 RMS

NOTE

Always use the smallest outer race ID measurement and the largest OD inner race measurement when selecting bearings.

9. The following example illustrates how to determine the required inner race OD.
   a. See Table 3-15. For example purposes, suppose the smallest outer race ID measurement is 1.5651 in. (39.754 mm). This requires an inner race OD range of 1.2496-1.2504 in. (31.740 - 31.760 mm).

NOTE

Have machinist grind outer race to center or middle of required OD range. This will prevent grinding outer race undersize and gives a more easily achieved tolerance range.

b. Grind inner race. Measure OD at four places. Check that specifications in Step 8 are met.

c. For example purposes, suppose the largest inner race OD measurement after grinding is 1.2499 in. (31.747 mm) OD.

d. With a 1.5651 in. (39.754 mm) ID outer race and a 1.2499 in. (31.747 mm) OD inner race, a blue bearing is required.

Table 3-15. Pinion Shaft Bearing Selection

FACTORY STAMPED NUMBER	OUTER RACE ID	BEARING SIZE AS IDENTIFIED BY COLOR CODING										
	over 1.5672 in. 39.807 mm	Service Wear Limit Exceeded – Replace Outer Race and Resize										
	1.5670-1.5672 in. 39.802-39.807 mm											Red
	1.5668-1.5670 in. 39.797-39.802 mm										Red	Blue
	1.5666-1.5668 in. 39.792-39.797 mm									Red	Blue	White-Gray
	1.5664-1.5666 in. 39.787-39.792 mm								Red	Blue	White-Gray	Green
	1.5662-1.5664 in. 39.781-39-787 mm							Red	Blue	White-Gray	Green	
	1.5660-1.5662 in. 39.776-39.781 mm						Red	Blue	White-Gray	Green		
	1.5658-1.5660 in. 39.771-39.776 mm					Red	Blue	White-Gray	Green			
	1.5656-1.5658 in. 39.766-39.771 mm				Red	Blue	White-Gray	Green				
	1.5654-1.5656 in. 39.761-39.766 mm			Red	Blue	White-Gray	Green					
	1.5652-1.5654 in. 39.756-39.761 mm		Red	Blue	White-Gray	Green						
3	**1.5650-1.5652 in. 39.751-39.756 mm**	**Red**	**Blue**	White-Gray	Green							
2	**1.5648-1.5650 in. 39.746-39.751 mm**	**Blue**	**White-Gray**	Green								
1	**1.5646-1.5648 in. 39.741-39.746 mm**	**White-Gray**	**Green**									
INNER RACE OD (In)		**1.2496-1.2498 in.**	**1.2498-1.2500 in.**	1.2500 - 1.2502 in.	1.2502 - 1.2504 in.	1.2504-1.2506 in.	1.2506 - 1.2508 in.	1.2508 - 1.2510 in.	1.2510 - 1.2512 in.	1.2512 - 1.2514 in.	1.2514 - 1.2516 in.	1.2516 - 1.2518 in.
		31.740 31.745 mm	31.745 31.750 mm	31.750 - 31.755 mm	31.755 - 31.760 mm	31.760-31.765 mm	31.765 - 31.770 mm	31.770 - 31.755 mm	31.775 - 31.780 mm	31.780 - 31.786 mm	31.786 - 31.791 mm	3.791-31.796 mm
FACTORY COLOR CODE		**Green**	**White**									

Lapping Engine Main Bearing Races

1. Secure right and left crankcase halves with three crankcase stud bolts (top center and bottom left and right). The sprocket shaft bearing outer races and large spacer must be installed in left crankcase.
2. See Figure 3-126. Obtain CRANKCASE MAIN BEARING LAPPING TOOL (Part No. HD-96710-40B). Assemble CRANKCASE MAIN BEARING LAP (Part No. HD-96718-87) to lapping handle. Assemble guide sleeve to sprocket shaft bearing bushing. Sleeves, for use with tapered bearing, are assembled to case with bearings and small spacer collar. Finger-tighten the sleeve parts.
3. Insert lap shaft with arbor assembled through pinion bearing bushing and into guide sleeve. Tighten arbor expansion collars using a length of 0.156 in. (3.962 mm) rod as spanner until arbor begins to drag. Do not adjust arbor snug in bushing or bushing will “bell,” a condition where hole is larger at ends than it is in the center.
4. Withdraw arbor far enough to coat lightly with 220 grit lapping compound. Do not apply a heavy coat. Reposition lap in bushing and turn handle at moderate hand speed. Work lap back and forth in bushing, as it is revolved, to avoid grooving and tapering.

At frequent intervals, remove lap from crankcase, wash and inspect bushing. Lapping is completed when entire bushing surface has a dull, satin finish rather than a glossy, smooth appearance. If necessary, flush off lap in cleaning solvent, air dry and apply fresh, light coat of fine lapping compound.

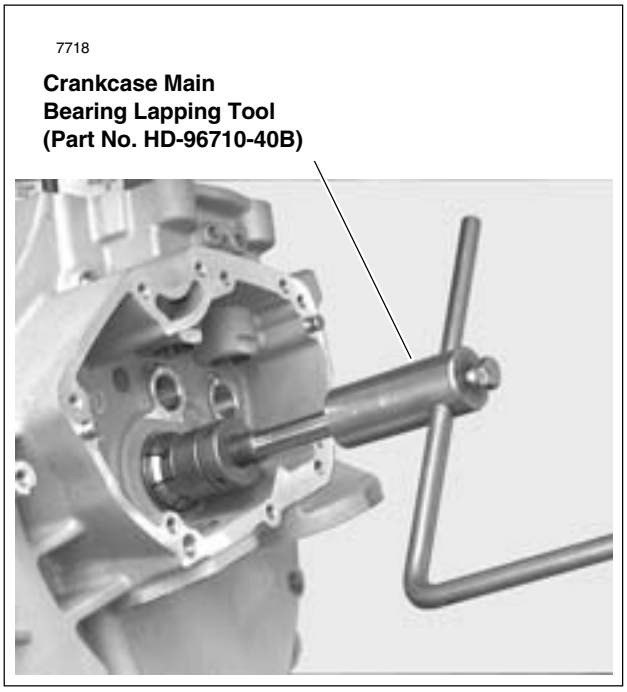


Figure 3-126. Lapping Pinion Shaft Main Bearing

Checking Connecting Rod Side Play

1. See Figure 3-127. Check connecting rod side play with a thickness gauge as shown.
2. If side play measurement is greater than service wear limit listed below, replace flywheel/connecting rod assembly.
   - 0.030 in. (0.762 mm)

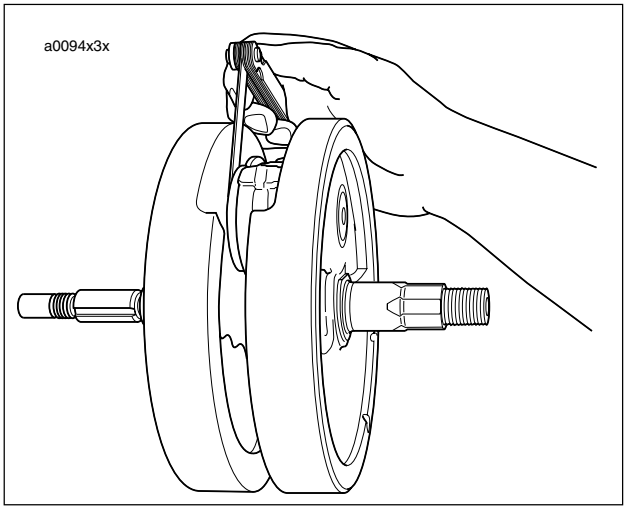


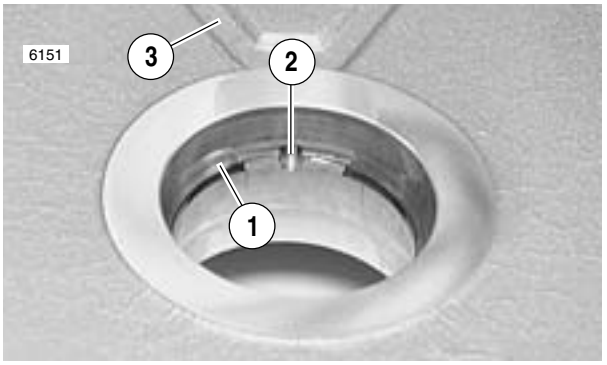
Figure 3-127. Checking Connecting Rod Side Play

ASSEMBLY

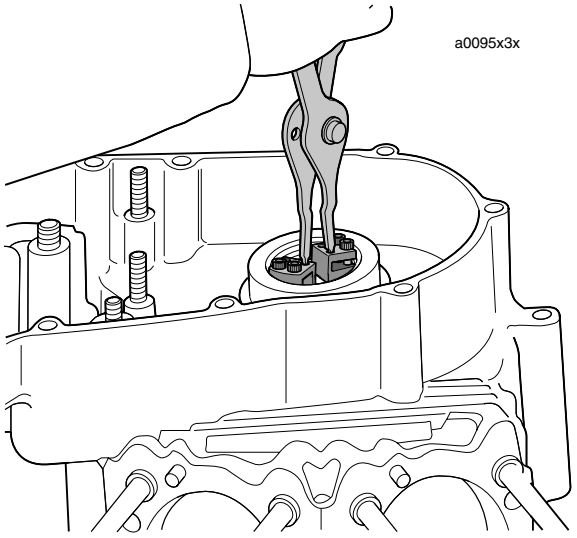
Crankcase Halves

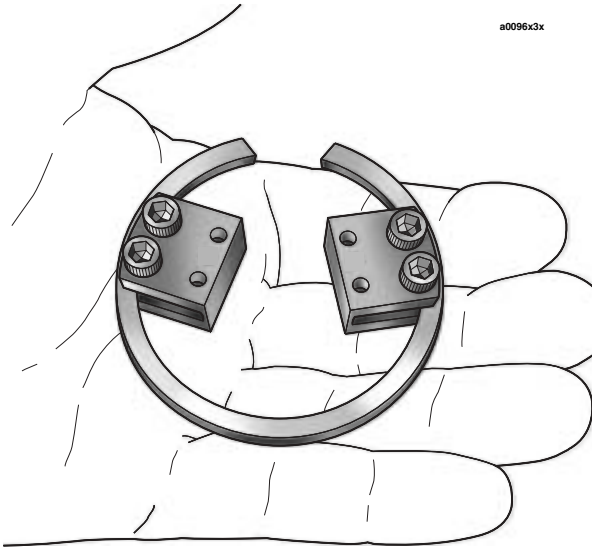
Lubricate all parts with Harley-Davidson 20W50 engine oil, and proceed as follows:

1. See Figure 3-128. Install **new** snap ring to crankcase bore (if bearings were replaced).
   a. Place the crankcase half on a flat surface with the outboard side facing up.
   b. Obtain the TIMKEN SNAP RING REMOVER/ INSTALLER (HD-44069).
   c. With the gap in the snap ring being the 12 o'clock position, place the two claws so that the slotted sides engage the inside edge of the snap ring at the 10 and 2 o'clock positions.
   d. Using a 9/64 inch allen head bit, tighten the screws to fix the position of the claws on the snap ring.
   e. Inserting the tips of a large retaining ring pliers (Snap-On PR-56A) into one hole in each claw, compress the snap ring and install in groove of crankcase bore.
   f. Verify that the gap in the snap ring is centered below the oil hole at the top of the ring groove. Move snap ring if not properly centered.
   g. Loosen allen head screws and remove claws from snap ring



1. Retaining Ring
2. Oil Supply Hole
3. Oil Supply Channel





HD-44069 Retaining Ring Remover/Installer

Figure 3-128. Snap Ring Installation

NOTE

See Figure 3-129. Use SPROCKET SHAFT BEARING OUTER RACE INSTALLATION TOOL (Part No. HD-39458) to install left and right outer races of sprocket shaft tapered roller bearings into left crankcase half. Always install left outer race prior to installing right outer race because the installer base is usable only when you follow this sequence of race installation.

2. Insert “SPORTSTER” end of installer base into inboard side of left crankcase half bearing bore until base contacts installed retaining ring.
3. Position left outer race over bearing bore on outboard side of left crankcase half.
4. Insert shaft of installer plug through left outer race and into installer base. Press race into bore until firmly seated against retaining ring.
5. Insert “SPORTSTER” end of installer base into outboard side of left crankcase half bearing bore until base contacts outboard surface of installed left outer race.
6. Position right outer race over bearing bore on inboard side of left crankcase half.
7. See Figure 3-129. Insert shaft of installer plug through right outer race and into installer base. Press race into bore until firmly seated against retaining ring.

NOTE

See Figure 3-129. Use SPROCKET SHAFT BEARING/SEAL INSTALLATION TOOL (Part No. HD-42579) to install sprocket shaft tapered roller bearings and seal.

8. See Figure 3-129. Install inner bearing.
   a. Place **new** bearing, small end upward, over end of sprocket shaft.
   b. Thread pilot onto sprocket shaft until pilot bottoms on sprocket shaft shoulder.
   c. Sparingly apply graphite lubricant to threads of pilot shaft to ensure smooth operation.
   d. Slide sleeve over pilot until sleeve contacts inner bearing race. Install Nice bearing, washer and handle on top of sleeve.
   e. Rotate handle clockwise until bearing contacts flywheel shoulder. Remove tool from sprocket shaft.

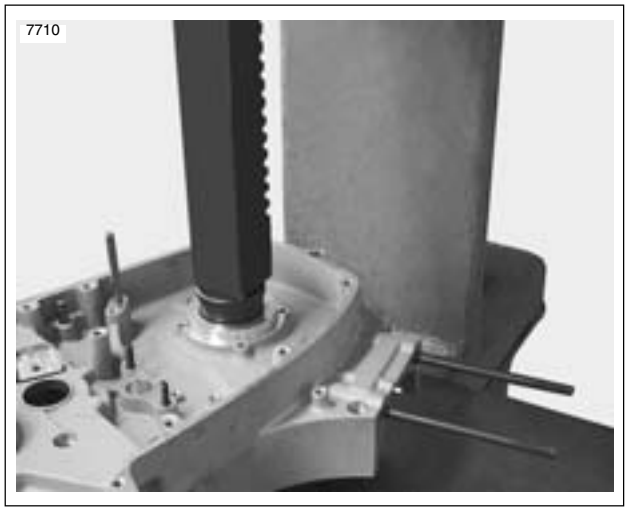


Figure 3-129. Left Outer Race Bearing Installation

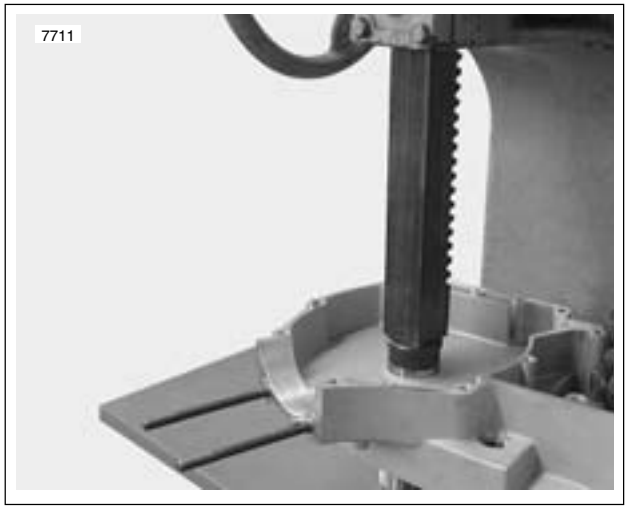
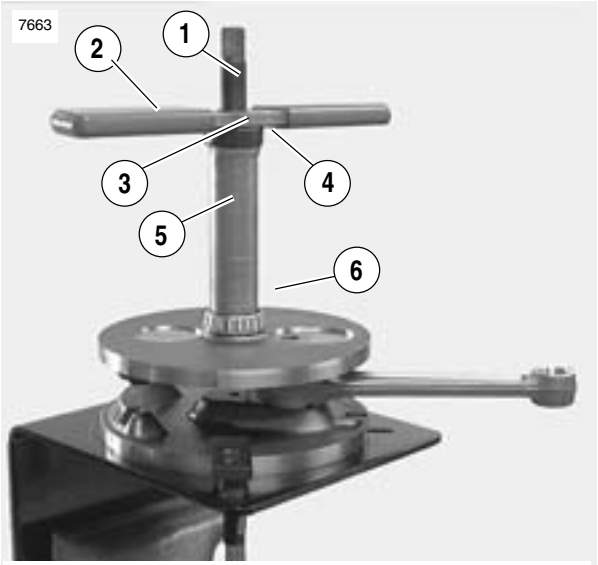


Figure 3-130. Right Outer Race Bearing Installation

9. See Figure 3-132. Install shim and outer bearing.
   a. Carefully place crankcase half over sprocket shaft so that it rests flat on inner bearing.
   b. Slide **new** inner spacer over sprocket shaft until it contacts inner bearing race.
   c. Place **new** outer bearing, small end downward, over sprocket shaft.
   d. Assemble Sprocket Shaft Bearing/Seal Installation Tool (Part No. HD-42579) onto sprocket shaft. Follow procedure in Step 8.
   e. Rotate handle clockwise until bearing firmly contacts inner spacer. Inner and outer bearings must be tight against inner spacer for correct bearing clearance. Remove tool from sprocket shaft.
   f. Spin crankcase half to verify that flywheel assembly is free.
10. See Figure 3-133. Install **new** spacer in seal ID. With the open (lipped) side facing outward, center seal/spacer assembly over bearing bore.

Do not remove the spacer after installation or the new seal will have to be discarded and the procedure repeated.

11. See Figure 3-133. Install bearing seal and spacer.
    a. Center seal/spacer driver over seal, so that the sleeve (smaller OD) seats between seal wall and garter spring.
    b. Assemble Sprocket Shaft Bearing/Seal Installation Tool (1) (Part No. HD-42579) and SPROCKET SHAFT SEAL/SPACER INSTALLER (Part No. HD-42774) onto sprocket shaft. Follow procedure in Step 8.
    c. Rotate handle clockwise until the spacer makes contact with the bearing. Remove tool from sprocket shaft.



1. **Pilot**
2. **Handle**
3. **Washer**
4. **Nice Bearing**
5. **Sleeve**
6. **Inner Bearing**

Figure 3-131. Inner Bearing Installation

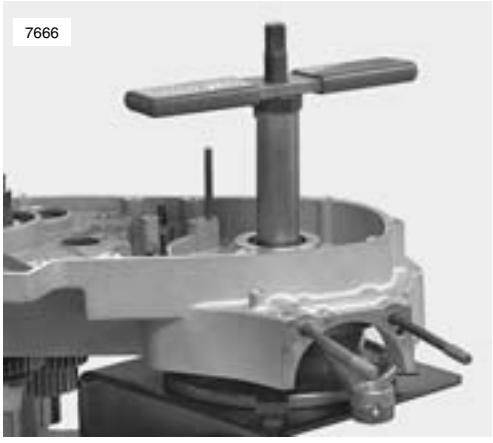


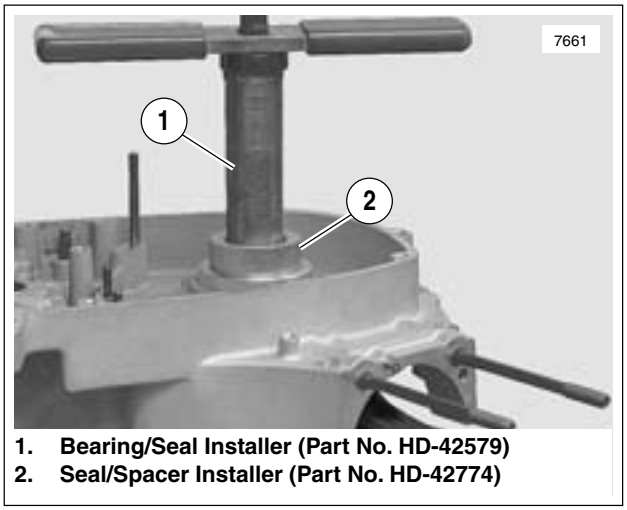
Figure 3-132. Installing Flywheel Spacer and Outer Bearing

12. See Figure 3-134. Install pinion shaft bearing.
    a. Lubricate pinion shaft bearing with engine oil.
    b. Slip bearing on pinion shaft.
    c. Install **new** retaining ring in groove of pinion shaft bearing inner race.
13. Install transmission. See 6.14 TRANSMISSION INSTALLATION.
14. Assemble crankcase halves together.
    a. Apply a thin coat of DOW CORNING SILASTIC or 3-M 800 sealant to crankcase joint faces.
    b. Slide pinion shaft through outer race in right crankcase.
    c. Attach crankcase halves using hardware shown in Figure 3-115.
    d. Tighten the 5/1618 X 3-1/2 in. fasteners to 15-19 ft-lbs (20-26 Nm).
    e. Tighten the 5/1618 X 2-1/2 in fasteners to 15-19 ft-lbs (20-26 Nm).
    f. Tighten 3/8-in. fastener to 22-27 ft-lbs (30-37 Nm).
15. See Figure 3-135. Install cylinder studs.
    a. Pack clean towels into crankcase opening.
    b. Place a steel ball into a head screw.
    c. The cylinder studs have a shoulder at the lower end. Place the end of the stud without the shoulder into the head screw.
    d. Install the stud in the crankcase with the shoulder end down. Use an air gun to drive the stud until the shoulder reaches the crankcase.
    e. Remove air gun. Use a torque wrench to tighten stud to 10-20 ft-lbs (14-27 Nm).
16. Install piston and cylinder. See 3.6 CYLINDER AND PISTON.
17. Install oil pump. See 3.13 OIL PUMP.
18. See 3.16 GEARCASE COVER AND CAM GEARS. Install cam gears, gearcase cover, lifter guides and lifters.
19. Install cylinder head. See 3.5 CYLINDER HEAD.
20. Install starter. See 5.7 STARTER.
21. Install shift linkage.
22. Install all primary drive components. This includes engine sprocket, primary chain, complete clutch assembly, engine sprocket nut and mainshaft nut. See 6.6 PRIMARY DRIVE/CLUTCH.
23. Install primary cover. See 6.2 PRIMARY CHAIN.

NOTE

See 1.10 TRANSMISSION/PRIMARY FLUID. Be sure to refill transmission to proper level with fresh lubricant.

24. See 3.4 ENGINE INSTALLATION and perform the applicable steps.



1. Bearing/Seal Installer (Part No. HD-42579)
2. Seal/Spacer Installer (Part No. HD-42774)

Figure 3-133. Install Bearing Seal/Spacer

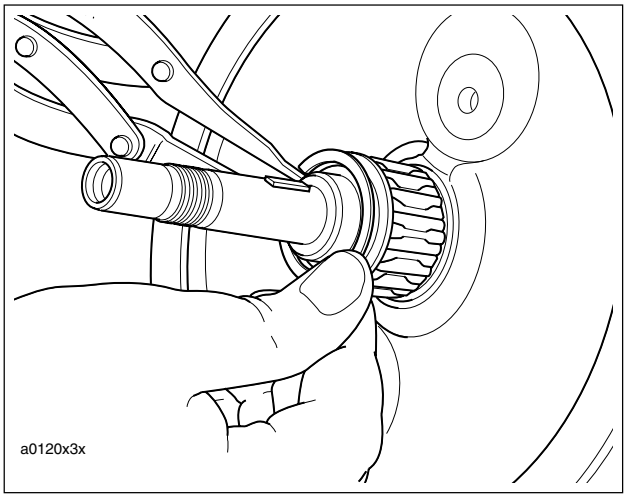
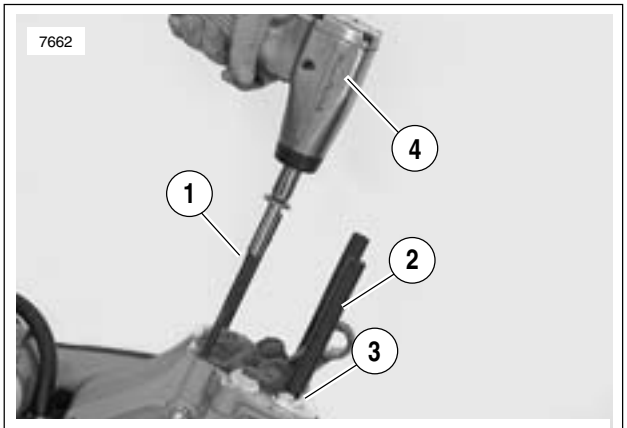


Figure 3-134. Pinion Shaft Bearing



1. Head Screw with Ball Inside
2. Cylinder Stud
3. Shoulder on Cylinder Stud
4. Air Gun

Figure 3-135. Cylinder Studs

NOTES