CYLINDER AND PISTON

REMOVAL/DISASSEMBLY

1. Strip motorcycle as described under DISASSEMBLING ENGINE FOR CYLINDER HEAD REPAIR on page 3-8.
2. Remove cylinder head as described under CYLINDER HEAD, REMOVAL on page 3-11.
3. Clean crankcase around base of cylinder to prevent dirt and debris from entering crankcase while removing cylinder.
4. See Figure 3-27. Turn engine over until one piston (3) is at bottom of its stroke.
5. Carefully raise cylinder just enough to permit placing clean towel under piston to prevent any foreign matter from falling into crankcase.

NOTE

If cylinder does not come loose, tap lightly with plastic hammer. Never try to pry cylinder up.

6. Carefully lift cylinder over piston and studs. Do not allow piston to fall against cylinder studs. Discard cylinder base gasket (5).

⚠CAUTION

With cylinder removed, be careful not to bend the studs. The slightest bend could cause a stress riser and lead to stud failure.

7. Install a 6 in. (150 mm) length of 1/2 in. (12.7 mm) ID plastic or rubber hose over each stud. This will protect the studs and the pistons.

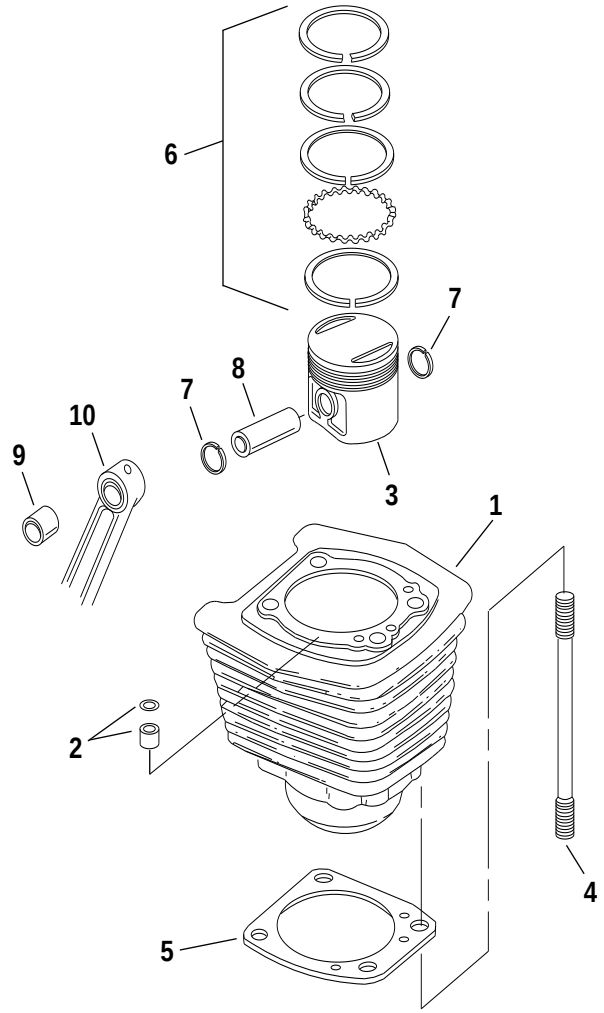
⚠WARNING

The next step covers removing the piston pin retaining rings. These rings are highly compressed in the ring groove and may "fly out" with considerable force when pried out of the groove. Safety glasses or goggles must be worn while removing or installing retaining rings or personal injury may occur.

⚠CAUTION

The piston pin retaining rings must not be reused. Removal may weaken retaining rings and they may break or dislodge. Either occurrence may damage engine.

8. Insert an awl in the recessed area below the piston pin bore, and pry out the piston pin retaining rings. To prevent the ring from flying out, place your thumb over the retaining ring.



1. Cylinder
2. Dowel (2) and O-ring (2)
3. Piston
4. Stud (4)
5. Gasket
6. Ring set
7. Retaining ring (2)
8. Piston pin
9. Piston pin bushing
10. Connecting rod

Figure 3-27. Cylinder and Piston

NOTE

Since the piston pin is a loose fit in the piston, the pin will easily slide out. The pins have tapered ends to help seat the round retaining rings. See Figure 3-28. 1200cc piston pins are stamped with a V-groove at one end.

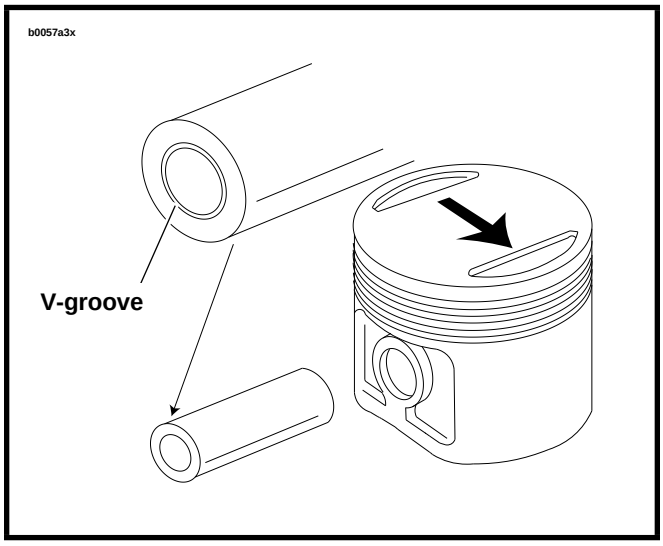


Figure 3-28. Piston Pin and Piston Identification

9. Mark each pin boss with either an “F” or an “R” to indicate front or rear cylinder, respectively. See Figure 3-28. The arrow at the top of 1200cc pistons must always point toward the front of the engine.

⚠CAUTION

Handle the piston with extreme care. The alloy used in these pistons is very hard. Any scratches, gouges or other marks in the piston could score the cylinder during engine operation and cause engine damage.

10. Spread piston rings (6) outward until they clear grooves in piston (3) and lift off.

CLEANING, INSPECTION AND REPAIR

1. Soak cylinder and piston in an aluminum-compatible cleaner/solvent until deposits are soft, then clean with a brush. Blow off loosened carbon and dirt particles and wash in solvent.
2. Clean oil passage in cylinder with compressed air.
3. Clean piston ring grooves with a piece of compression ring ground to a chisel shape.
4. Examine piston pin to see that it is not pitted or scored.
5. Check piston pin bushing to see that it is not loose in connecting rod, grooved, pitted or scored. A piston pin properly fitted to upper connecting rod bushing has a 0.00125 to 0.00175 in. (0.0317-0.0444 mm) clearance in bushing. If piston pin-to-bushing clearance exceeds 0.00200 in. (0.0508 mm), replace worn parts. See CONNECTING ROD BUSHING on page 3-26.
6. Clean piston pin retaining ring grooves.
7. Examine piston and cylinder for cracks, burnt spots, grooves and gouges.
8. Check connecting rod for up and down play in lower bearings. When up and down play is detected, lower bearing should be refitted. This requires removing and disassembling engine crankcase.

Checking Gasket Surface

⚠CAUTION

If either cylinder gasket surface does not meet flatness specifications, replace cylinder and piston. Proper tolerances will extend component life and prevent leaks.

1. See Figure 3-29. Check that cylinder top (head) gasket surface is flat within 0.006 in. (0.15 mm). Lay a straight edge across the surface, then try to insert a feeler gauge between the straightedge and the gasket surface.
2. Check that the cylinder base gasket surface is flat within 0.008 in. (0.20 mm). Lay a straightedge across the surface, then try to insert a feeler gauge between the straightedge and the gasket surface.

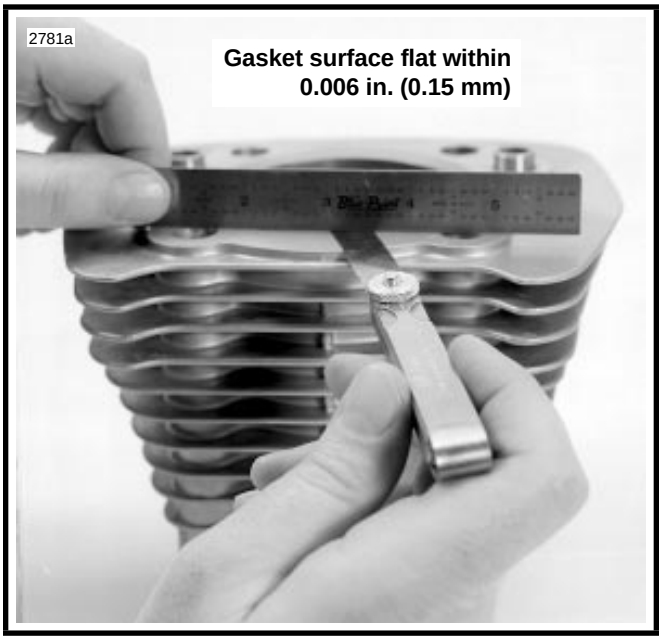


Figure 3-29. Checking Gasket Surfaces

Measuring Cylinder Bore

1. Remove any burrs from the cylinder gasket surfaces.

2. See Figure 3-30. Install a head and base gasket, and CYLINDER TORQUE PLATES (Part No. HD-33446A) and TORQUE PLATE BOLTS (Part No. HD-33446-86). Tighten the bolts using the same method used when installing the cylinder head screws. See CYLINDER HEAD, INSTALLATION on page 3-20.

NOTE

Torque plates, properly tightened and installed with gaskets, simulate engine operating conditions. Measurements will vary as much as 0.001 in. (0.025 mm) without torque plates.

3. Take cylinder bore measurement in ring path, starting about 1/2 in. (13 mm) from top of cylinder, measuring from front to rear and then side to side. Record readings.

4. Repeat measurement at center and then at bottom of ring path. Record readings. This process will determine if cylinder is out-of-round (or “egged”) and will also show any cylinder taper or bulge.

5. See Table 3-6. If cylinder is not scuffed or scored and is within service limit, see FITTING CYLINDER TO PISTON on page 3-25.

NOTE

If piston clearance exceeds service limit, cylinders should be rebored and/or honed to next standard oversize, and refitted with the corresponding piston and rings. Do not fit piston tighter than 0.0007 in. (0.018 mm) See SPECIFICATIONS.

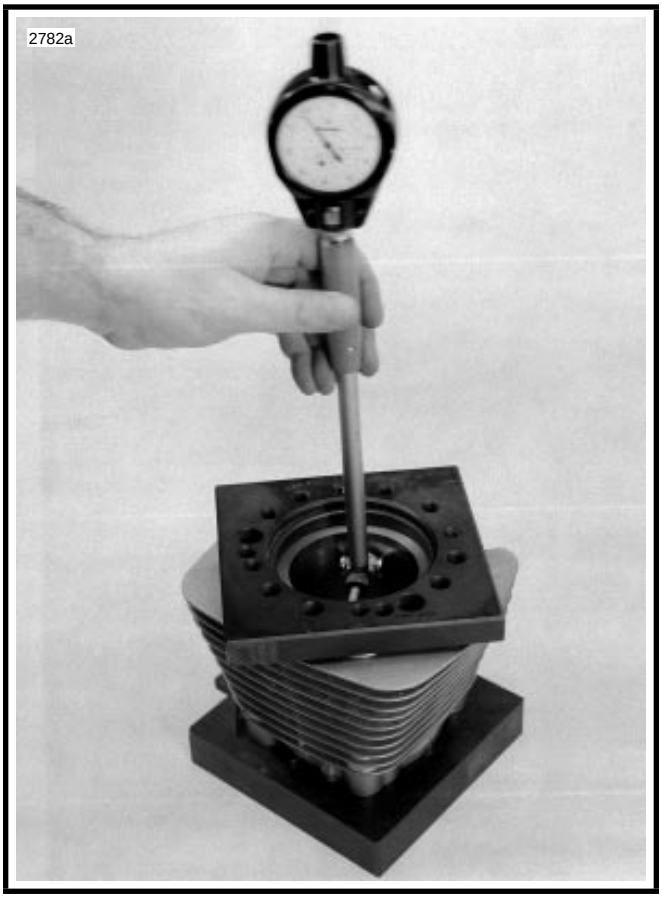


Figure 3-30. Measuring Cylinder Bore Using Torque Plates (Part No. HD-33446A)

Table 3-6. 1200cc Cylinder Bore Service Wear Limits

BORE SIZES	IN.	MM
Standard Bore	3.5008	88.920
0.005 in. OS bore (0.13 mm)	3.5050	89.027
0.010 in. OS bore (0.25 mm)	3.5100	89.154
0.020 in. OS bore (0.51 mm)	3.5200	89.408
0.030 in. OS bore (0.76 mm)	3.5300	89.662

Measuring Piston

Because of their complex shape, the pistons cannot be accurately measured with standard measuring instruments.

The pistons have the typical elliptical shape when viewed from the top. However, they also are barrel-shaped when viewed from the side. This barrel shape is not symmetrical.

Any damage to the piston will change its shape, which will lead to problems.

Fitting Cylinder to Piston

Since pistons cannot be accurately measured with standard measuring instruments, the bore sizes must be observed. Bore sizes are listed in Table 3-7. Example: A 0.005 in. (0.13 mm) oversize piston will have the proper clearance with a bore size of 3.502 in. ± 0.0002 in. (88.95 mm ± 0.005 mm) for the 1200cc engine.

Boring and Honing Cylinder

1. The cylinder must be bored with gaskets and torque plates attached. Bore the cylinder to 0.003 in. (0.08 mm) under the desired finished size.
2. Hone the cylinder to its finished size using a 280 grit rigid hone followed by a 240 grit flexible ball hone. Honing must be done with the torque plates attached. All honing must be done from the bottom (crankcase) end of the cylinder. Work for a 60° crosshatch pattern.

Table 3-7. Final Cylinder Bore Sizes

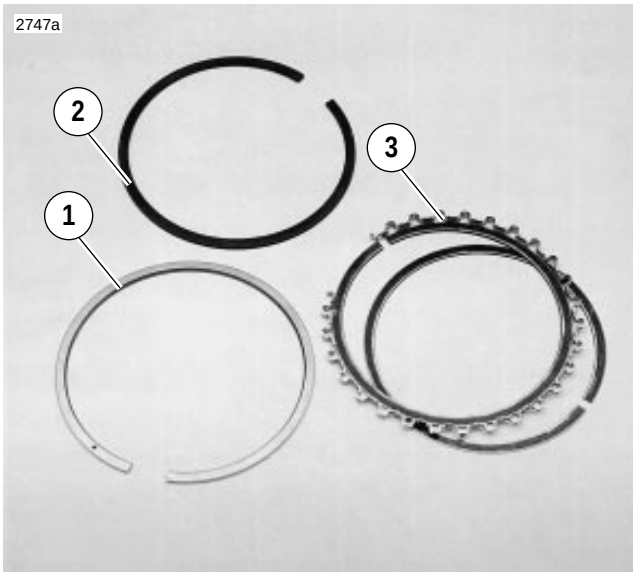
BORE SIZES	IN.	MM
Standard bore*	3.4978 in.	88.844 mm
0.005 in. OS bore (0.13 mm)	3.502 in.	88.95 mm
0.010 in. OS bore (0.25 mm)	3.507 in.	89.08 mm
0.020 in. OS bore (0.51 mm)	3.517 in.	89.33 mm
0.030 in. OS bore (0.76 mm)	3.527 in.	89.59 mm

*All bore sizes + 0.0002 in. (0.005 mm)

When cylinder requires oversize reboring to beyond 0.30 in. (0.76 mm), the oversize limit has been exceeded and cylinder must be replaced.

NOTE

The same piston may be used if cylinder bore was not changed, unless it is scuffed or grooved. However, replace rings and hone the cylinder walls with a No. 240 grit flexible hone to facilitate ring seating.



1. **Top compression ring – Install either side up**
2. **Second compression ring – Install dot toward top**
3. **Oil control rings**

Figure 3-31. Piston Rings

Fitting Piston Rings

NOTE

Ring sets and pistons, 0.040 in. (1.02 mm) oversize, are not available on 1200cc engines.

See Figure 3-31. Piston rings are of two types: compression and oil control. The two compression rings are positioned in the two upper piston ring grooves. The dot on the second compression ring must face upward. Ring sets are available to fit standard and oversize pistons.

Piston ring sets must be properly fitted to piston and cylinder:

1. See Figure 3-32. Place piston in cylinder about 1/2 in. (12.7 mm) from top. Set ring to be checked squarely against piston as shown. Check end gap with thickness gauge. See SPECIFICATIONS for tolerance.

NOTE

See SERVICE WEAR LIMITS for end gap dimensions. Do not file rings to obtain proper gap.

2. See Figure 3-33. Apply engine oil to piston grooves. Use TRANSMISSION SHAFT RETAINING RING PLIERS (Part No. J-5586) to slip compression rings over piston into their respective grooves. Be extremely careful not to over expand, twist rings, or damage piston surface when installing rings.

NOTE

Install second compression ring with dot towards top.

3. See Figure 3-34. Install rings so end gaps of adjacent rings are a minimum of 90° apart. Ring gaps are not to be within 10° of the thrust face centerline.
4. See Figure 3-35. Check for proper side clearance with thickness gauge, as shown. See SPECIFICATIONS for tolerance.

NOTE

If the ring grooves are clean and the side play is still not correct, replace the rings, the piston or both.

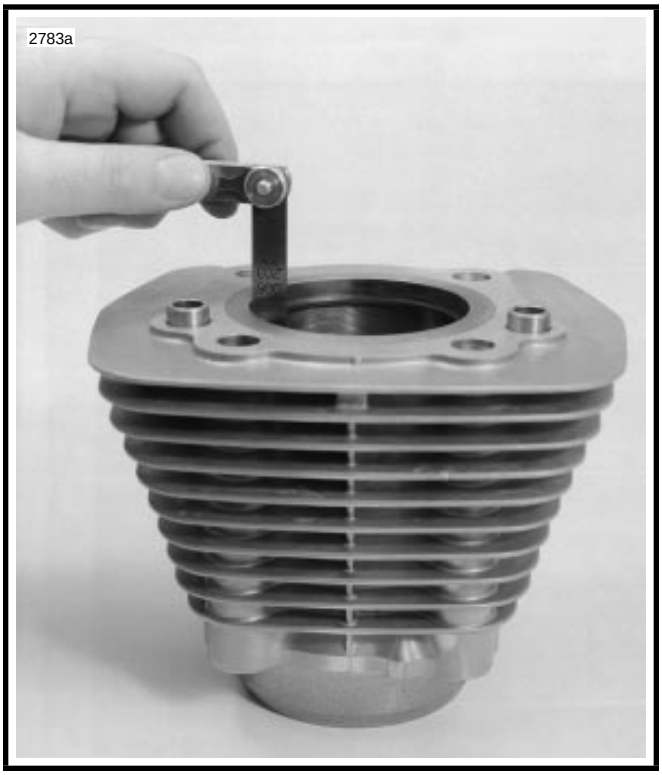


Figure 3-32. Measuring Ring End Gap

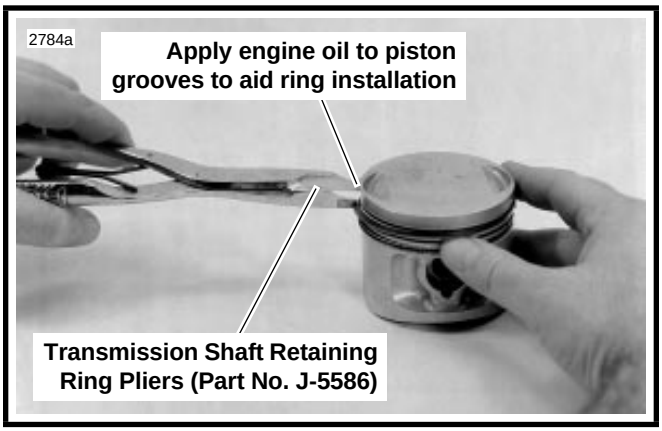


Figure 3-33. Installing Piston Rings

Connecting Rod Bushing

REMOVAL/INSTALLATION

When connecting rod bushing is worn to excessive pin clearance (0.002 in. or more) (0.05 mm) it must be replaced.

1. See Figure 3-37. Install plastic hoses over studs.
2. Secure connecting rod with CONNECTING ROD CLAMPING TOOL (Part No. HD-95952-33A).

NOTE

If CONNECTING ROD CLAMPING TOOL holes are too small, enlarge the holes in the tool.

3. See Figure 3-36. Attach PISTON PIN BUSHING TOOL (Part No. HD-95970-32C) to the connecting rod (receiver cup on one side of the rod and the driver on the opposite side) as shown.

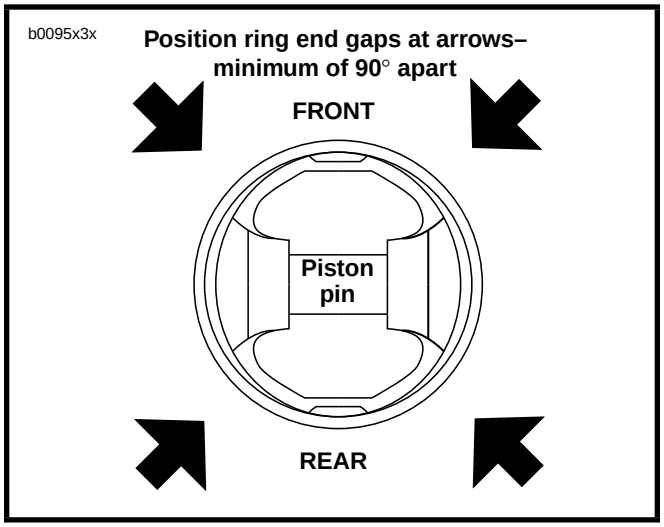


Figure 3-34. Ring End Gap Position

Figure 3-35. Measuring Ring Clearance in Groove

4. Use two box wrenches and push worn bushing from connecting rod.
5. Remove piston pin bushing tool from connecting rod.
6. Remove bushing from receiver cup.
7. See Figure 3-37. Attach PISTON PIN BUSHING TOOL (Part No. HD-95970-32C) to connecting rod; place **new** bushing between connecting rod and driver.

NOTE

The driver must be attached facing the opposite direction as it was for removal of the bushing.

8. Clean up and size bushing to 0.0010-0.0005 in. (0.025-0.013 mm) undersize using REAMER (Part No. HD-94800-26A). Sizing bushing with less than 0.00125 in. (0.0317 mm) clearance can result in a bushing loosening and/or seized pin in rod.
9. Hone bushing to final size using WRIST PIN BUSHING HONE (Part No. HD-35102). Use a liberal amount of honing oil to prevent damage to hone or bushing. Use care to prevent foreign material from falling into the crankcase.

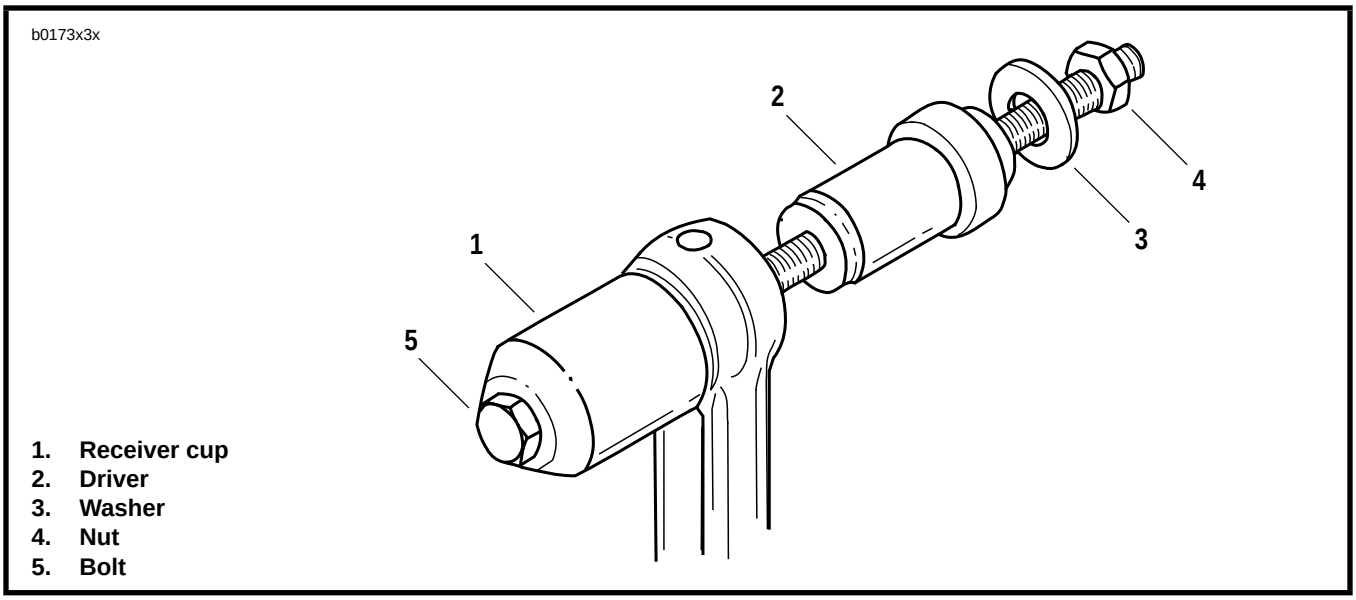


Figure 3-36. Piston Pin Bushing Tool Assembly for Bushing Removal

REPAIR

⚠CAUTION

Replace bent connecting rods. Do not attempt to straighten. Straightening rods by bending will damage the bearing on the crank pin and the piston pin bushing. Installing bent connecting rods will damage cylinder and piston beyond repair.

ASSEMBLY/INSTALLATION

1. Install piston assembly over connecting rod.

NOTE

New 1200cc pistons must be installed with the arrow, at the top of the piston, pointing towards the front of the engine.

2. Install piston pin.

⚠CAUTION

Always use new retaining ring. Make sure retaining ring groove is clean and that ring seats firmly in groove. If it does not, discard the ring. Never install a used retaining ring or a new one if it has been installed and then removed for any reason. A loosely installed ring will come out of the piston groove and damage cylinder and piston beyond repair.

3. Install **new** piston pin retaining rings with the PISTON PIN RETAINING RING INSTALLER (Part No. HD-34623A). Make sure the ring groove is clean and that the ring is fully seated in the groove with the gap away from the slot at the bottom.
4. See Figure 3-34. Make sure the piston ring end gaps are properly positioned as shown.
5. Lubricate cylinder wall, piston, pin and rod bushing with engine oil.
6. Turn engine until piston is at top dead center.

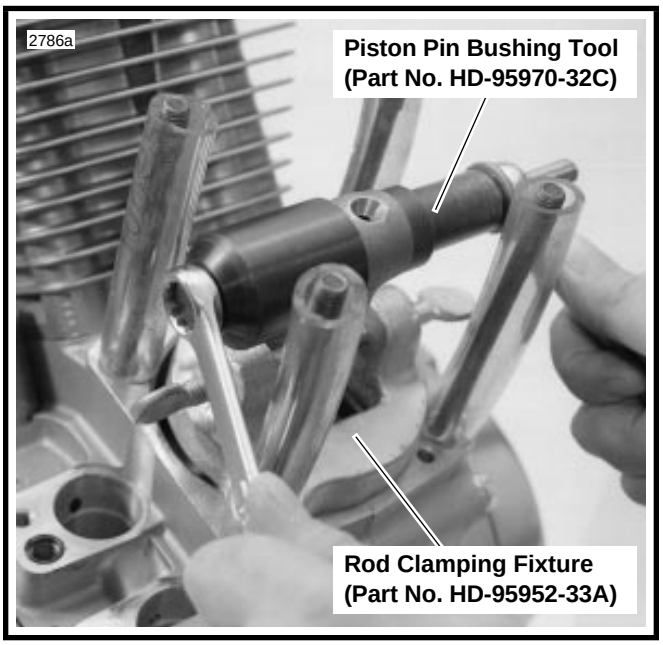


Figure 3-37. Installing New Piston Pin Bushing

7. Compress the piston rings using PISTON RING COMPRESSOR (Part No. HD-96333-51B).
8. Remove cylinder stud sleeves. Install a **new** cylinder base gasket. Make sure the piston does not bump the studs or crankcase.
9. Install cylinder over piston.
10. Remove piston ring compressor.
11. Assemble and install cylinder head. See CYLINDER HEAD, ASSEMBLY starting on page 3-19.
12. Install assembled engine. See INSTALLING THE ENGINE on page 3-10.

LUBRICATION SYSTEM

CHECKING AND ADDING OIL

Check engine oil level in oil tank 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. Oil tank capacity is 2.0 quarts (1.9 liters).

See ENGINE LUBRICATION SYSTEM in Section 1 for more information.

CHANGING OIL AND FILTER

After a new engine has run its first 500 miles (800 km) and at 5000 mile (8000 km) intervals or annually thereafter, completely drain oil tank of used oil. Refill with fresh oil. If vehicle is driven extremely hard, used in competition or driven on dusty roads, change engine oil at shorter intervals. Always change oil filter when changing engine oil.

See ENGINE LUBRICATION SYSTEM in Section 1 for more information.

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 accumulates in the oil tank. 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.

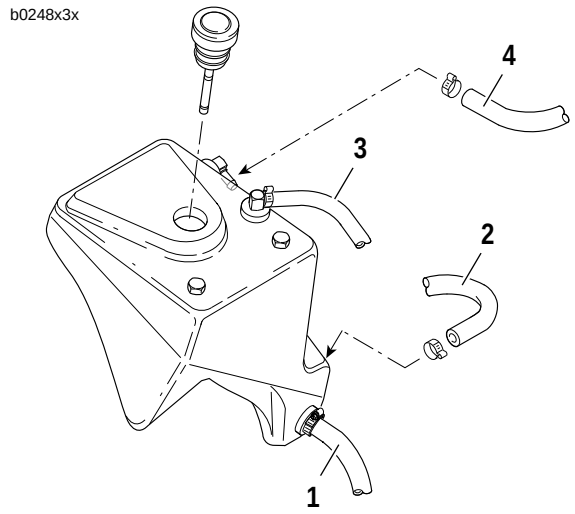
OIL HOSE ROUTING

GENERAL

See Figure 3-38. The oil tank has four hoses. The drain hose (2) attaches to a fitting on the left side of the frame. From the top of the tank, the vent hose (3) and the return hose (4) join the bottom feed hose (1) near the battery tray. Cable straps secure the hoses in place.

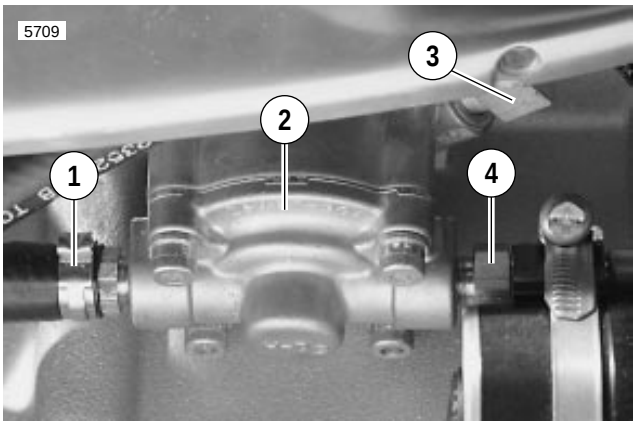
See Figure 3-39. The feed (1) and return hoses (3) run together between the swingarm mount block and crankcase, beneath the engine and forward to the oil pump. The feed hose attaches to the rear most oil pump fitting; the return hose connects forward and above.

After diverging from the feed and return hoses, the vent hose is routed beneath the starter. The vent hose continues on to the right side of the motorcycle and goes behind the gearcase cover assembly where it connects to an elbow fitting.



1. **Feed hose (3/8 in. ID by 5/8 in. OD)**
2. **Drain hose (3/8 in. ID by 5/8 in. OD)**
3. **Vent hose (1/4 in. ID by 1/2 in. OD)**
4. **Return hose (3/8 in. ID by 5/8 in. OD)**

Figure 3-38. Oil Tank Hoses



1. **Feed hose**
2. **Oil pump**
3. **Return hose**
4. **Oil filter connection**

Figure 3-39. Oil Pump Connections

OIL TANK

REMOVAL/DISASSEMBLY

1. Remove seat, fuel tank and tail section. See TAIL SECTION, REMOVAL in Section 2.
2. Remove rear fender. See FENDERS in Section 2.
3. Drain oil tank. See ENGINE LUBRICATION SYSTEM, CHANGING ENGINE OIL AND FILTER in Section 1. The oil filter need not be removed unless it is due to be replaced.
4. See Figure 3-40. Disconnect hoses from oil tank. Label each hose upon removal.
   a. Remove worm clamp (3) from feed hose (4).
   b. Remove clamp (5) from drain hose (6).
   c. Remove clamp (8) from vent hose (7).
   d. Remove clamp (10) from return hose (9)
5. Remove bolts and lockwashers from well nuts.
6. Detach oil tank from frame.

ASSEMBLY/INSTALLATION

1. See Figure 3-40. Place oil tank on frame and align mounts. Loosely install bolts and lockwashers (1) at all four mounting points.

NOTE

Starting at the top mounting points will simplify installation.

2. Connect the four oil tank hoses. Tighten **new** clamps (5, 8 and 10) using HOSE CLAMP PLIERS (Part No. HD-41137).

NOTE

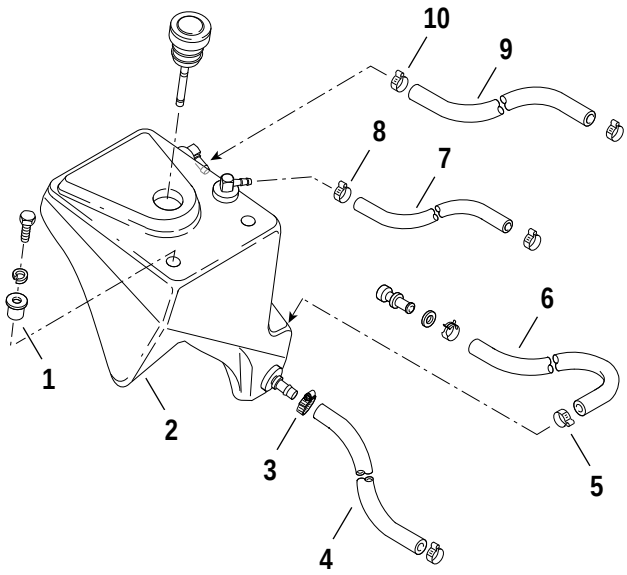
Worm clamp (3) may be reused on feed hose (4).

3. Fill oil tank. See ENGINE LUBRICATION SYSTEM, CHANGING ENGINE OIL AND FILTER in Section 1.
4. Install rear fender. See FENDERS in Section 2.

⚠WARNING

After installing seat, pull upward on front of seat to be sure it is locked in position. If seat is loose, it could shift during vehicle operation and startle the rider, causing loss of control and personal injury.

5. Install tail section, fuel tank and seat. See TAIL SECTION in Section 2.



1.	**Bolt, lockwasher and well nut (4)**	**6.**	**Drain hose**
2.	**Oil tank**	**7.**	**Vent hose**
3.	**Worm clamp, 3/8 in.**	**8.**	**Hose clamp, 1/4 in.**
4.	**Feed hose**	**9.**	**Return hose**
5.	**Hose clamp, 3/8 in.**	**10.**	**Hose clamp, 3/8 in.**

Figure 3-40. Oil Tank

OIL PRESSURE SIGNAL LIGHT SWITCH

GENERAL

The oil pressure signal light switch is a pressure-actuated diaphragm-type switch. When oil is not circulating through the system or when oil pressure is abnormally 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 on the running engine.
- Engine is idling far 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 3-8.

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 3-41. The oil pump is nonregulatory 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). During start-up of a cold engine, oil pressure will be higher than normal and oil circulation will be somewhat restricted within the oiling system. As the engine warms to normal operating temperature, the engine oil will warm up and become less viscous — oil pressure decreases.

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-96921-52A) and OIL PRESSURE GAUGE ADAPTER (Part No. HD-96940-52A). Remove oil pressure switch and insert pressure gauge fitting. See Figure 3-42.

Run engine until oil reaches normal operating temperature (motorcycle should be driven at least 20 miles (32 km) at or above 50 MPH (80 KM/H)). At 2500 RPM, oil pressure will vary from 10-17 psi (69-117 kN/m^2). At idle speed (950-1050 RPM), oil pressure will vary from 7-12 psi (48-83 kN/m^2).

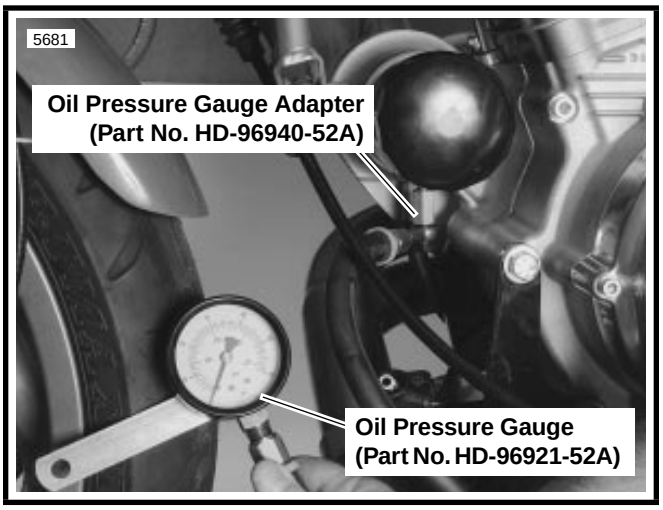


Figure 3-41. Checking Oil Pressure

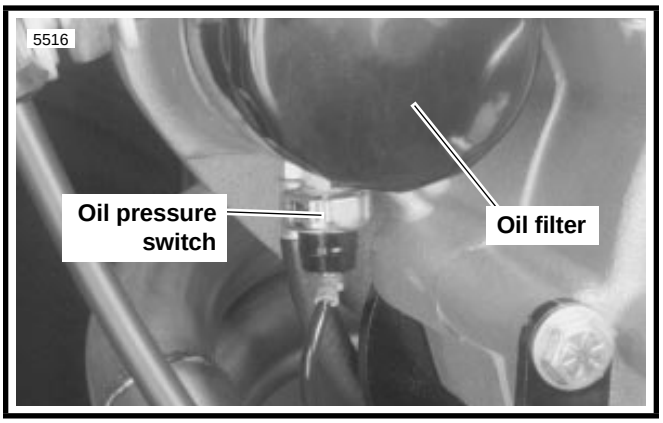


Figure 3-42. Oil Pressure Signal Light Switch

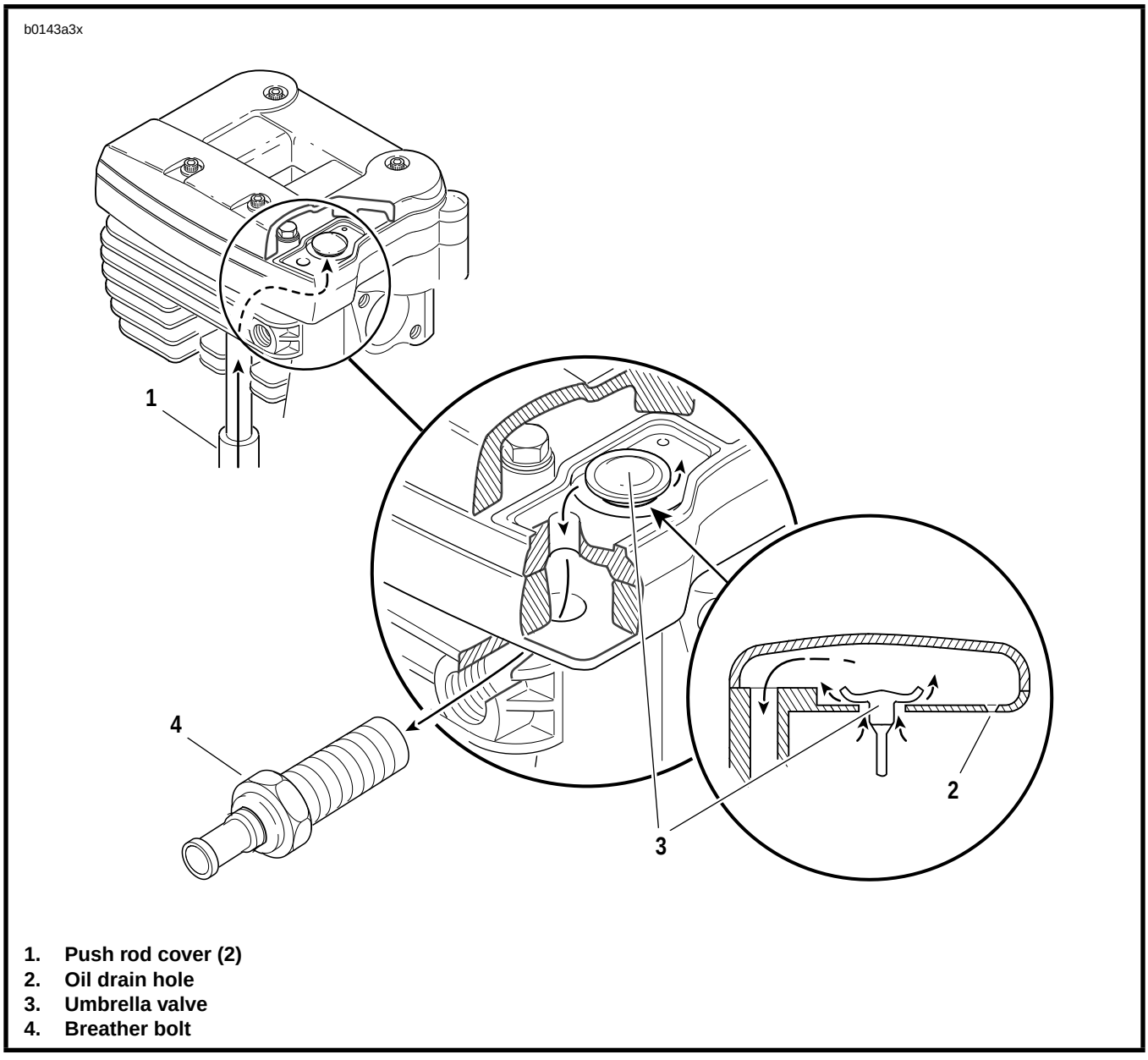
Table 3-8. Troubleshooting Oil Pressure Signal Light

OIL PRESSURE SIGNAL LIGHT	PROBABLE CAUSES
Stays on at speeds above idle.	● Empty oil tank. ● 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 OIL FILTER MOUNT on page 3-37).
Flickers at idle.	● Incorrect idle speed. Malfunctioning or improperly installed check valve (see 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 above).

CRANKCASE BREATHING SYSTEM

GENERAL

See Figure 3-43. On piston downstroke, a mixture of crankcase air and oil mist is vented up the push rod covers (1) through an umbrella valve (3) in each middle rocker box section. The oil mist separates from the crankcase air, collects and passes through a small drain hole (2) where it eventually returns to the crankcase. The crankcase air is routed through a passage in each cylinder head. The crankcase air then travels through each air cleaner breather bolt (4) into a hose leading into the air cleaner.



1. **Push rod cover (2)**
2. **Oil drain hole**
3. **Umbrella valve**
4. **Breather bolt**

Figure 3-43. Crankcase Breathing System – Typical Cylinder

OILING SYSTEM (COLOR FOLDOUT)

NOTE

The following paragraph numbers correspond with the numbered callouts in the INTERNAL ENGINE PASSAGES illustration.

1. Oil is gravity-fed from the oil tank 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

A complete explanation of the gerotor pump is given under OIL PUMP.

2. The feed pump transfers oil from the inlet cavity through the **feed hose** 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 kN/m^2) 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 each hydraulic lifter.
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 covers,** through drain holes in the **tappet blocks** and into the gearcase.
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. 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.
17. Return oil fills a **cavity** above the pump's return gears. The return gears pump oil back to the oil tank.
18. A small amount of oil flows from the feed galley in the right crankcase half through a **restricted orifice,** which sprays the oil onto the rear intake cam gear in the gearcase. Oil is transferred to the teeth of all the cam gears through the gear meshing action.

OIL PUMP

GENERAL

See Figure 3-44. The oil pump consists of two gerotor gear sets, feed and scavenge (return), housed in one pump body. The feed pump distributes oil to the engine, the scavenge pump returns oil to the tank.

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. The illustration below shows the principle of gerotor operation:

1. During the first 180° of rotation, the cavity between inner and outer gerotors gradually increases in size until it reaches its maximum size, equivalent to the full volume of the "missing tooth." The gradually enlarging cavity creates a vacuum into which oil flows from the inlet.
2. During the next 180° of rotation, the size of the cavity decreases forcing oil into the outlet. See Figure 3-46. Gravity-fed oil from the oil tank enters the pump through fitting (5). It is forced by gerotor set (7) through a hose to the oil filter. Return oil from the flywheel compartment is drawn back into the pump and is forced by gerotor set (9) back to the oil tank.

See INTERNAL ENGINE PASSAGES for oil passages within the engine.

The oil pump seldom needs servicing. Before you disassemble an oil pump suspected of not producing adequate oil pressure, be absolutely certain 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 oil 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 and sludge.
3. Check for a grounded oil pressure switch wire or faulty switch if oil indicator light fails to go out with engine running.

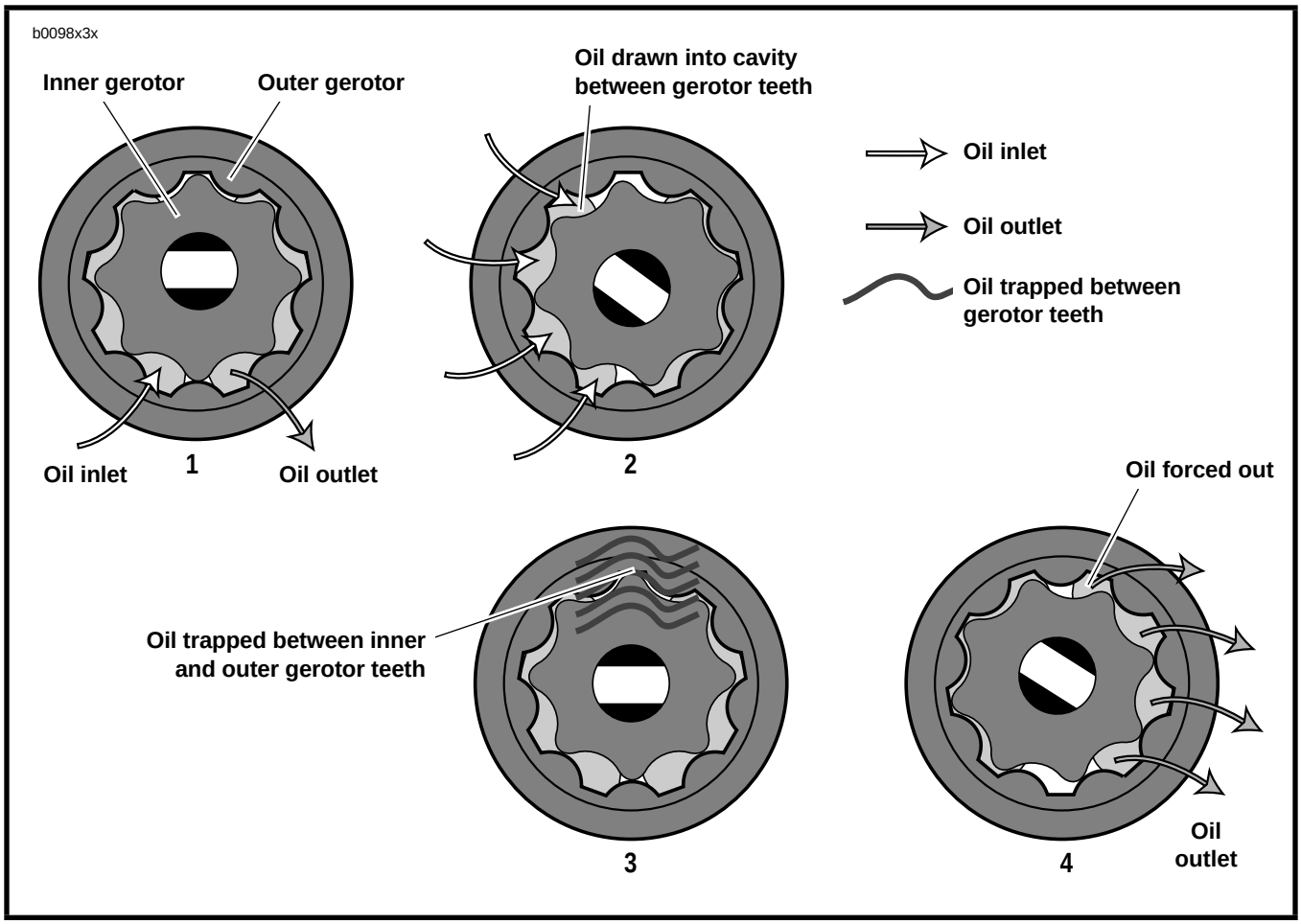


Figure 3-44. Principle of Gerotor Operation

REMOVAL/DISASSEMBLY

NOTE

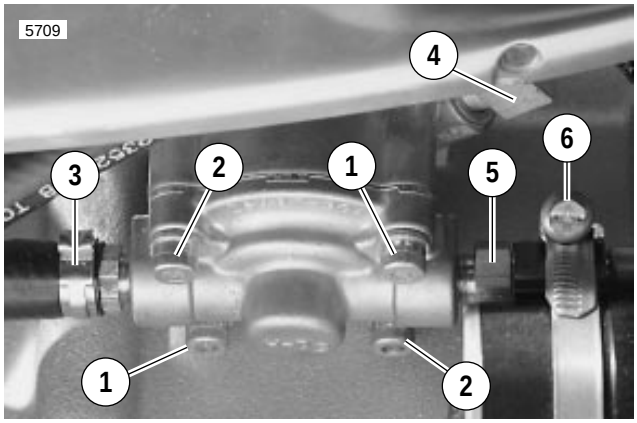
Oil pump can be removed with engine in frame and without removing gearcase cover.

1. Drain oil from oil tank.
2. See Figure 3-45. Detach clamp (6) from oil hose. Move rear shock rebound canister aside.
3. Disconnect feed hose (3) and oil filter mount connection (5).

NOTE

Loosen nut on oil filter mount connection (5) and then remove pressurized hose.

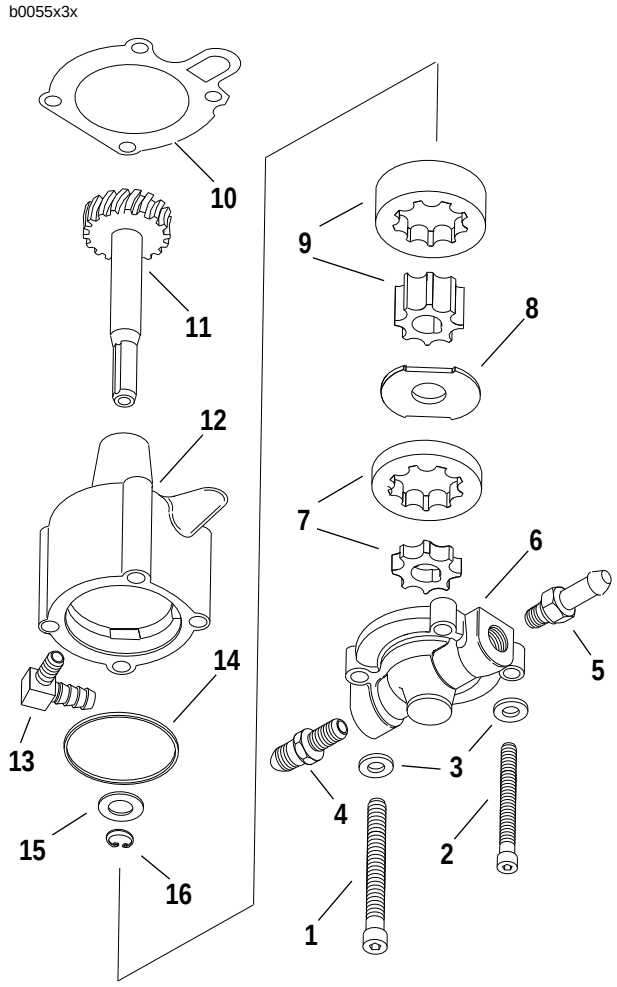
4. Carefully remove screws (1) and washers that secure pump to crankcase. Pump will drop with screws removed. Discard mounting gasket.
5. Remove clamp and return hose connection (4).



1.	Mounting screw and washer (2)	4.	Return hose connection
2.	Cover screw and washer (2)	5.	Oil filter mount connection
3.	Feed hose connection	6.	Clamp

Figure 3-45. Oil Pump Hardware

6. See Figure 3-46. Remove cover screws (2) and washers (3). Lift cover (6) off body (12). Remove and discard O-ring (14).
7. Slide both pieces of feed gerotor set (7), separator plate (8) and both pieces of scavenge gerotor set (9) off gear shaft (11).
8. Remove and discard retaining ring (16). Remove thrust washer (15) and gear shaft (11).



1.	Mounting screw, long (2)	9.	Gerotor assembly, scavenge pump
2.	Cover screw, short (2)	10.	Mounting gasket
3.	Washer (4)	11.	Gear shaft
4.	Connector	12.	Body, oil pump
5.	Hose fitting	13.	Elbow
6.	Cover, oil pump	14.	O-ring
7.	Gerotor assembly, feed pump	15.	Washer, thrust
8.	Gerotor separator plate	16.	Retaining ring

Figure 3-46. Oil Pump

CLEANING, INSPECTION AND REPAIR

1. Clean all parts in cleaning solvent. Blow out holes and oil passages with compressed air.
2. See Figure 3-47. Inspect both gerotor sets for wear. Mesh pieces of each set together as shown. Use a feeler gauge to determine clearance.

NOTE

The maximum allowable clearance between gerotors is 0.004 in. (0.10 mm). Replace gerotors as a set if clearance exceeds this dimension.

3. Measure thickness of feed gerotors with a micrometer. If they are not the same thickness, replace as a set.
4. Check gear shaft (11) teeth for damage or wear. Replace if necessary.

ASSEMBLY/INSTALLATION

1. See Figure 3-46. Install gear shaft (11) through body (12). Position thrust washer (15) over end of shaft. Install **new** retaining ring (16) into groove in shaft.

NOTE

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

2. Insert inner gerotor of the scavenge gerotor set (9) over gear shaft.
3. Place outer gerotor over inner to complete scavenge set (9).
4. Position separator plate (8) into case and line up slots on perimeter with tabs inside oil pump body (12).
5. Place feed gerotor set (7) over gear shaft (11).
6. Install a **new** O-ring (14) into groove in cover (6). Place cover onto pump body. Install cover screws (2) with washers (3). Tighten cover screws (2) to 125-150 **in-lbs** (14.1-16.9 Nm).

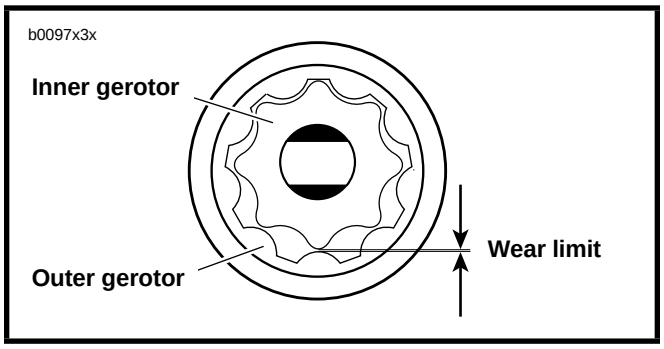


Figure 3-47. Gerotor Wear Limits

7. Place **new** mounting gasket (10) in position.
8. See Figure 3-45. Attach return hose (4) to oil pump.
9. Secure pump to crankcase with screws (1) and washers. Tighten mounting screws to 125-150 **in-lbs** (14.1-16.9 Nm).
10. Connect feed hose (3) and oil filter mount connection (5) to oil pump.

NOTE

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

11. Attach clamp (6) and canister to oil hose.
12. Prime oil pump. Loosen feed hose connection and start engine. Operate at idle and allow about 2.0 ounces (0.06 liter) of engine oil to be forced through hose connection. Stop engine and tighten hose connection.
13. Check engine oil level in tank. Add oil to correct level if needed. See ENGINE LUBRICATION SYSTEM in Section 1.

OIL FILTER MOUNT

GENERAL

See Figure 3-48. Oil is pressure-fed from the oil pump to the oil filter mount (4) via a hose connection (5). Oil travels through the filter mount into the filter via outer filter holes.

Adequate oil pressure activates the oil pressure signal light switch (6) in the filter mount, which turns off the oil pressure indicator lamp.

The check ball (2) in the filter adapter (1) “opens” at 4-6 psi (28-41 kN/m^2) oil pressure. Filtered oil leaves the filter, flowing past the check ball.

DISASSEMBLY

1. Remove oil filter adapter (1) from oil filter mount (4). Remove check ball (2) and spring (3).
2. Remove oil pressure signal light switch (6).

CLEANING/INSPECTION

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

ASSEMBLY

NOTE

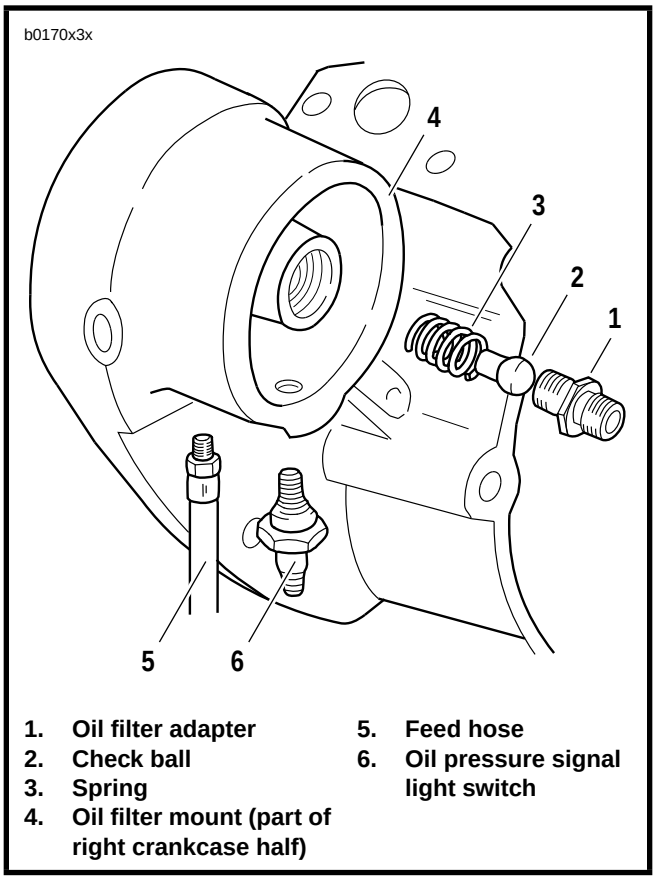
Use TEFLON PIPE SEALANT or HYLOMAR on all fittings installed to oil filter mount.

1. Install oil pressure signal light switch (6). Tighten to 5-7 ft-lbs (7-9 Nm).
2. Apply LOCTITE THREADLOCKER 242 (blue) to the threads on that end of the oil filter adapter (1) which is installed into oil filter mount (4). Do not apply LOCTITE to adapter threads on oil filter element side.

NOTE

The oil filter adapter (1) has identical ends; either end may be installed into the oil filter mount.

3. Place spring (3) and check ball (2) into threaded hole at center of mount (4). Push adapter (1) against ball to compress spring. Install threaded end (with LOCTITE) into threaded hole at center of mount (4). Tighten adapter to 8-12 ft-lbs (11-16 Nm).



1. Oil filter adapter
2. Check ball
3. Spring
4. Oil filter mount (part of right crankcase half)
5. Feed hose
6. Oil pressure signal light switch

Figure 3-48. Oil Filter Mount

4. Connect pressure switch wire. Tighten nut which secures wire to 4-10 **in-lbs** (0.4-1.1 Nm).
5. Pour about 4.0 ounces (0.12 liter) of clean engine oil into filter. Apply a light coat of oil to oil filter gasket. Install oil filter onto oil filter mount/adapter assembly; tighten filter an additional 1/2-3/4 turn after gasket contacts filter mount surface.
6. Fill oil tank with proper oil. See ENGINE LUBRICATION SYSTEM, CHANGING ENGINE OIL AND FILTER in Section 1.

VALVE TAPPETS

GENERAL

See Figure 3-49. The tappet assembly consists of tappet and roller. The tappet 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 tappet 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 tappet is functioning properly, the assembly operates with minimal tappet clearance. The unit automatically compensates for heat expansion to maintain a no-clearance condition.

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

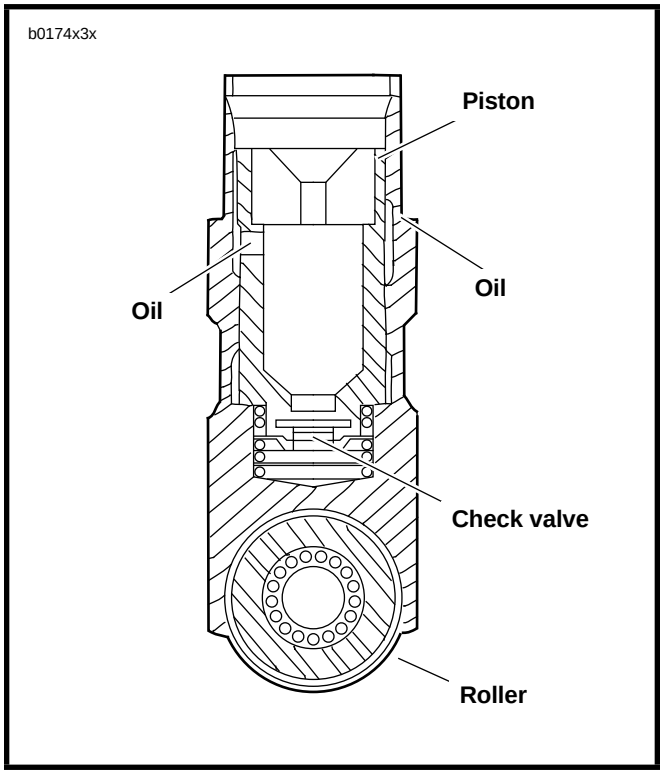


Figure 3-49. Tappet Assembly

REMOVAL

1. Clean all dirt from around crankcase. Blow loose particles from area with compressed air.

2. Remove the upper, middle, and lower rocker covers. See CYLINDER HEAD, REMOVAL on page 3-11. Pull the push rod upward through top of cylinder head.

3. See Figure 3-50. Remove screw (11) and washer (13). Lift retainer (9) and seal (8) upward a few inches on push rod cover (7). Push upward on push rod cover while pulling bottom of cover (7) clear of crankcase. Remove cover (7).

4. Remove screw (5), washer (14), and plate (4). Pull O-rings (3) off ends of pins (2) and discard. Grasp ends of pins (2) and pull outward free of crankcase. A pliers is a handy tool to free pins (2). With a thin-bladed screwdriver in the retainer groove at the top of the tappet, pry upward on the tappet until it extends above the gearcase and can be pulled out by hand.

CLEANING/INSPECTION

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

2. Inspect valve tappets for excessive clearance in guide. Clearance should be 0.0008-0.0020 in. (0.020-0.051 mm). Accurately measure tappet bore inner diameter with a gauge. Service wear limit is 0.0030 in. (0.076 mm). Excessive tappet guide clearance is corrected by fitting a **new** tappet and/or replacing crankcases.

NOTE

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

3. Check tappet roller freeplay. Roller clearance on pin should be within 0.0006-0.0010 in. (0.015-0.025 mm). Recommended service practice is tappet replacement. Service wear limit is 0.0015 in. (0.038 mm).

4. Check tappet roller end clearance. Clearance should be 0.008-0.022 in. (0.203-0.559 mm). Service wear limit is 0.026 in. (0.660 mm).

5. Tappets should be soaked in clean engine oil and kept covered until assembly.