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GENERAL

SPECIFICATIONS

VALVES
Fit in guide (EX) .......................... .0025-.0045 in.
Fit in guide (IN) .......................... .0015-.0035 in.
Spring (Outer) ................. 50-66 lbs at 1-9/32 in. (valve closed)
                          152-168 lbs at 15/16 in. (valve open)
Spring (Inner) .................. 30-36 lbs at 1-3/32 in. (valve closed)
                          76-88 lbs at 3/4 in. (valve open)
Spring free length .............. 1-1/2 in. (outer)
                          1-23/64 in. (inner)

ROCKER ARM
Fit in bushing .......................... .001-.0025 in. loose

PISTON
Fit in cylinder .................... .003-.004 in. loose
Ring gap .......................... .015-.025 in.
Ring side clearance ................ .0035-.005 in.
Piston pin fit .................. Light hand press fit at 70°F

CONNECTING ROD
Piston pin fit .............. .0008-.001 in. loose
End play between flywheels ........ .005-.015 in.
Fit on crank pin ............. .0005-.0015 in. loose

OIL PUMP PRESSURE
At 60 mph in high gear (oil hot)
Minimum .................. 4 lbs/sq in.
Maximum .................. 15 lbs/sq in.

TAPPETS
Guide fit .......................... .0005-.001 in. press
Fit in guide .......................... .0005-.001 in. loose
Roller fit .......................... .0005-.001 in.
Roller end clearance .............. .008-.010 in.
Tappet clearance .......... Just free (no lash)

VALVE TIMING (At .050 tappet lift)
Intake opens .............. 35.4°±3° BTC,
                          Intake closes 41.2°±3° ABC
Exhaust opens .............. 44.3°±4° BBC,
                          Exhaust closes 20.2°±4° ATC

GEARCASE
Intermediate gear shaft
in bushing .................. .0005-.001 in.
Cam gear shaft in bushing .... .0005-.002 in.
Cam gear shaft
in needle bearing ........ .0005-.003 in.
Cam gear end play 
(1976 & earlier) .... .001-.005 in.
(1977 & later) ........ .005-.012 in. except rear intake which is .004 to .010 in.
Cam gear backlash ........ .000-.0005 in.

FLYWHEEL ASSEMBLY
Gear shaft nut torque ........ 100-120 ft-lbs
Sprocket shaft nut torque .... 100-120 ft-lbs
Crank pin nuts torque .... 150-175 ft-lbs
Pinion gear nut torque .... 50-60 ft-lbs
Runout (flywheels) ........ .003 in. maximum at rim
Runout (mainshafts) .... .002 in. maximum

SPROCKET SHAFT BEARING
Cup fit in crankcase ........ .0005-.0025 in. tight
Cone fit on shaft ........ .0002-.0015 in. tight
End play ................ .001-.007 in.

PINION GEAR SHAFT BEARING
Shaft fit in roller bearing .... .0005-.0015 in.
Shaft fit in cover bushing .... .0005-.0015 in.

IGNITION TIMING
Breaker point gap setting ........ 1970 .020 in.
                          1971 to 1978 .018 in.
Dwell 1970-71 .................. 90° @ 2000 rpm
                          1972 & later .................. 140° @ 2000 rpm
Spark plug gap setting .... .025-.030 in.
Ignition timing (advanced)
1971 & earlier ............... 45° (11/16 in. BTC)
                          1972 & later .................. 40° (17/32 in. BTC)
Ignition timing (retarded)
1971 & earlier ............... 15° (5/64 in. BTC)
                          1972 & later .................. 10° (1/32 in. BTC)

DESCRIPTION

GENERAL
The engine is a two-cylinder, four-cycle, air cooled, overhead-valve, V-type engine. It has three major component assemblies: cylinder, crankcase and gearcase.

Cylinder assemblies include cylinder head, valves, rocker arms and piston. Cylinders mount on the engine crankcase in a 45 degree "V", with both connecting rods connected to a single crank pin.

The reciprocating, linear motion of the piston in the cylinder is converted to circular motion in the crankcase. The built-up crankshaft consists of an off-center crank pin interposed between two counterweighted flywheels which rotate on two end shafts (pinion gear shaft and sprocket shaft) supported by anti-friction roller bearings. The lower end of the rear cylinder connecting rod is forked to fit around the single-end front cylinder connecting rod, allowing a single connecting rod-crankpin connection to the flywheel.
Hywwheel rotation is clockwise (viewing engine from right side). Using the front cylinder firing position as a starting point, the rear cylinder fires at 315 degrees rotation (360 degrees minus the 45 degrees between cylinders). The front fires in an additional 405 degrees (360 degrees plus the 45 degrees between cylinders), completing the 720 degrees of flywheel rotation necessary for the four piston strokes.

The gearcase is located on the right side of the crankcase and houses a gear train which operates and times the valves, ignition and generator.

The rotary crankcase breather valve is located between the crankcase and gearcase compartments and functions to relieve crankcase pressure caused by downstroke of pistons, and controls the flow of oil in the lubrication system.

A cam gear train consists of four cam shafts. One cam lobe on each shaft is gear driven. The engine valves are opened and closed through the mechanical linkage of tappets, push rods and rocker arms. Tappets serve to transmit the cam action to the valve linkage. Valve and breather timing are obtained by meshing gearcase gears with timing marks aligned.

Ignition spark is produced by operation of circuit breaker, ignition coil and spark plugs. The breaking of a single set of breaker points by a double lobe cam on the timer shaft determines the spark timing. The narrow lobe times the front cylinder. The wide lobe times the rear cylinder. Both spark plugs fire on each breaker point opening (twice per complete cycle of 720 degrees flywheel rotation since cam shaft operates at 1/2 engine speed). The valves are timed to produce combustion conditions in only one cylinder at a time so the spark in the other cylinder occurs ineffectually during its exhaust stroke.

Most other engine components function similar to usual internal combustion engine design. For further description of part function, see pertinent manual sections.

GASOLINE

CAUTION — Use a good quality "Premium" grade leaded gasoline. If "Premium" grade is unavailable, "Regular" grade may be used temporarily. Do not use unleaded grades such as "No-Leads."

LUBRICATION

GENERAL

The Sportster engine has a force-feed (pressure) type oiling system incorporating oil feed and return in one pump body, with one check valve on the oil feed side. The feed pump forces oil to the engine, lubricating lower connecting rod bearings, and rocker arm bushings. Valve stems, valve springs, push rods and tappets are lubricated by return oil from rocker arm bushings. Cylinder walls, pistons, piston pins and main bearings are lubricated by oil spray thrown off from connecting rods and crankshaft, and oil draining from rocker arm boxes through two holes in the base of each cylinder. The oil scavenging section of the pump returns oil to the tank from the engine. An oil slinger on the generator drive gear, located in the gear case compart-

ment, separates oil from air escaping through the breather system.

CHECKING AND CHANGING OIL

Oil mileage normally varies from 250 to 500 miles per quart depending on the nature of service, fast or moderate driving.

Remove tank cap and dipstick and check oil supply at least every 300 miles after each complete refill, or more often depending on condition of engine. Oil tank capacity is 3 quarts ("FULL" mark on dipstick). Do not fill above "FULL" mark, as the tank needs some air space. When oil is down to "REFILL" or "ADD" mark on dipstick, one quart can be added. Never allow oil level to go down to "DANGER" mark on dipstick. XLCH Model: Dip stick has two marks. One quart should be added when level is near lower mark. Capacity of tank at upper full mark is 3 quarts. Tighten the cap securely to prevent leakage. Oil runs cooler and oil mileage is somewhat higher with oil level well up in the tank. Furthermore, unless oil tank is kept well filled, frequent checking of oil level will be necessary to avoid any chance of running dry.

Use proper grade of oil for the lowest air temperature expected before the next oil change period as follows:

<table>
<thead>
<tr>
<th>Use</th>
<th>Use Grade</th>
<th>Air Temperature (Cold Temperature)</th>
</tr>
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<tbody>
<tr>
<td>Harley-Davidson Oil</td>
<td>58</td>
<td>Below 40°F</td>
</tr>
<tr>
<td>Medium Heavy</td>
<td>75</td>
<td>Above 40°F</td>
</tr>
<tr>
<td>Regular Heavy</td>
<td>105</td>
<td>Severe operating conditions at high air temperatures (above 90°F).</td>
</tr>
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After a new engine has run its first 500 and 1000 miles, and at 2000-mile intervals thereafter, completely drain oil tank of used oil and refill with fresh oil. If the engine is driven extremely hard, or used on dusty roads or in competition, drain and refill at shorter intervals. Draining should be done while oil is hot. It is not necessary to drain the crankcase as it does not accumulate used oil. At the time of the first 500 mile oil change, and at least every second oil change thereafter, thoroughly flush and clean out tank with kerosene to remove any sediment and sludge that may have accumulated.

CAUTION — Oil pump may lose prime because of air trapped in lines after system has been drained and refilled with oil. Be sure oil pressure signal light goes out within 3 minutes with engine operating at fast idle. If light does not go out, start up the engine and loosen plug in fitting (1976 and earlier) or pressure switch (1977 and later) at front of oil pump to allow about 3 ounces of oil to drain into can. This will allow any air in the oil feed line and passages to bleed out through the oil pump. Retighten plug or pressure switch to 12-16 in-lbs torque after air has been bled.
WINTER LUBRICATION

Combustion in any engine produces water vapor. When starting and warming up in cold weather, much of the vapor that gets into the crankcase condenses to water before the crankcase is hot enough to exhaust the vapor through the breather system. If engine is driven enough to get the crankcase thoroughly warmed up, most of this water is again vaporized and exits the crankcase through the breather system. However, a moderately driven engine making short runs, does not thoroughly warm up and is likely to accumulate water in the oil tank.

In freezing weather, this water will become slush or ice, and if allowed to accumulate too long, may block the oil lines and cause damage to the engine. Water mixed with oil for some time also forms sludge that is harmful to the engine and causes undue wear of working parts.

In winter the oil change interval should be shorter than normal, and any engine used only for short runs, must have oil drained frequently along with a thorough tank flush-out, before new oil is put in tank. The further below freezing the temperature drops, the shorter the oil change interval should be.

OIL PRESSURE SIGNAL LIGHT

When the “OIL” signal light lights or stays on, oil pressure is abnormally low or oil is not circulating through the engine. Proper operation is indicated when the light is off. The “OIL” signal will light when the ignition is turned on preparatory to starting engine. The light should be off when engine speed is approximately 1200 rpm. If the oil pressure signal light fails to go off at speeds above idling it is usually due to one of the following causes:

Empty oil tank, oil feed line clogged with ice and sludge (freezing weather) or air bound, grounded oil signal switch wire, defective signal switch, gear pin sheered in oil feed pump, diluted oil, defective oil pump check valve.
If the oil pressure signal light does not work when ignition is turned on, preparatory to starting engine, it is usually due to one of the following causes:

Defective signal switch, defective wiring, dead battery or turned out bulb.

PRESSURE SIGNAL LIGHT SWITCH

The oil pressure signal light switch is a pressure actuated diaphragm-type switch. The diaphragm is spring-loaded. When oil pressure is zero or too low to open switch contacts, diaphragm is held against its contact by spring tension closing the circuit (indicator light "ON").

When engine is started, and as engine speed is increased, oil pressure is raised a sufficient amount to counteract the diaphragm spring and open the circuit (indicator light "OFF"). Oil signal light switch cannot be repaired. Defective switches must be replaced.

OIL PRESSURE

The oil pump is non-regulatory and delivers its entire volume of oil to the engine. When a cold engine is started, engine oil will be thick or viscous, restricting circulation through the oiling system and causing high oil pressure; as engine becomes hot and oil thins, pressure will correspondingly drop. Similarly, 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, volume of oil pumped is also reduced resulting in lower oil pressure.

To check oil pressure, use an accurate oil pressure gauge. Remove oil pressure switch from motorcycle as described in "DISASSEMBLING OIL PUMP CHECK VALVE." Insert pressure gauge hose fitting in oil switch connection of pump nipple.

Run the engine until oil becomes hot. Under normal riding conditions of oil pressure will vary from 4-15 psi at idle. Idle down and check the gauge. Oil pressure will vary from 3 to 7 lbs. To ensure that the oil is hot prior to checking, motorcycle should be driven 20 miles at or above 50 mph (see specifications).

SERVICING OIL FILTER (Figure 3-1)

Thoroughly wash filter element (3) in clean solvent at least every 2000 miles or whenever engine oil is changed. Renew filter element every 5000 miles. To disassemble filter, follow order of disassembly under Figure 3-1. Assembly is essentially the reverse order of disassembly. Be sure O-ring (8) is positioned in filter cup (7) flange.

SERVICING OIL TANK CAP AND OPENING (Figure 3-1)

Clean and inspect all parts replacing any that are worn or damaged. Pay particular attention to the oil tank cap gasket (10) and the cap washer (13). To disassemble tank cap follow order of disassembly under Figure 3-1. Assembly is a reverse order of disassembly.

It oil leakage should occur between the tank cap and the opening (and the cap and gasket are in good condition), check the lip of the opening. A tank cap drawn too tight will bend the lip of the opening resulting in a poor seat between gasket and lip.

Using a mallet as a driver and a piece of wood as a cushion, bend the lip down until flush with sealing surface of tank cap. Use emery cloth to remove any nicks or rough spots from lip.

IMPORTANT

Before refilling oil tank, thoroughly flush and clean tank with kerosene to remove any foreign material that may have fallen into tank.

OILING AND BREATHER SYSTEM (1976 AND EARLIER) (Figure 3-2)

1. Gravity feed to oil pump.
2. Feed section of oil pump.
3. Check valve prevents gravity oil drainage from tank to engine. Builds up oil pressure to operate oil signal switch.
4. Oil is forced through pinion gear shaft to lubricate lower connecting rod bearings from which oil splashes to cylinder walls, piston, piston pin and main bearings.
5. Oil is forced through oil lines to lubricate rocker arm bearings and rods, valve stems, valve springs and push rod sockets.
6. Oil drains from cylinder head through passages in each cylinder, then flows through two holes in the base of each cylinder, lubricating cylinder walls, piston, piston rings and main bearings.
7. Oil flows from the rocker arm boxes into the gearbox compartment, lubricating push rods, tappets, tappet guides and tappet rollers.
8. Oil accumulated in crankcase base is scavenged by the flywheels to the breather oil trap.
9. The rotary breather valve is timed to open on the downward stroke of pistons, allowing crankcase exhaust air pressure to expel scavenged oil from crankcase breather oil trap into timing gearcase. Breather valve closes on upward stroke of pistons, creating vacuum in crankcase.
10. Oil blown and drained into timing gearcase (steps 7 and 9), lubricates generator drive gear, timing gears, gear shaft bearings, and also supplies oil to the rear chain oiler.
11. Crankcase exhaust air escapes from timing gearcase through outside breather tube. Any oil still carried by exhaust air is separated from the air by an oil slinger on the generator drive gear.
12. Gearcase oil flows through fine mesh oil strainer preventing foreign particles from entering scavenger section of pump.
13. Scavenge (return) section of oil pump.
14. Engine oil returns to tank.
15. Vent line from oil tank.
OILING SYSTEM (1977 AND LATER) (Figure 3-3)

1. Oil is supplied to the gerotor type oil pump by gravity feed from the oil tank. Oil enters the feed section and fills a cavity located under the feed pump.

NOTE

A complete explanation of the gerotor pump is given in "GEARCASE" section. See "OIL PUMP – 1977 AND LATER."

2. The feed pump transfers oil from the inlet cavity to the check valve located in the outlet line.

3. The one way check valve is preset to open at 4-6 psi oil pressure. This valve prevents gravity oil drainage from tank to engine and acts as a restriction to activate pressure switch.

4. When adequate pressure is produced, the oil pressure indicator light sending unit is activated and the check valve opens.

5. With the check valve open, oil flows into the right crankcase through a hole located in the oil pump gasket surface. Oil enters gearcase cover passage through hole in gearcase cover gasket.

6. Oil flow is then routed to both the crank shaft and the cylinder head areas. 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 crank pin. Oil is forced out of the crank pin through three holes located to properly lubricate the rod bearing assembly.

7. Oil which does not enter the pinion gear shaft travels upward through the gearcase cover to the right crankcase. Oil flow continues through a channel in the crankcase to the overhead oil lines to both front and rear intake rocker arm shafts. The oil provides lubrication to the rocker arm shafts, bushings, intake valves and pushrods.

8. Oil flow continues around a groove machined in the outside diameter of the large end of the rocker arm shaft and through the rocker arm cover to the exhaust rocker arm shaft. The exhaust rocker arm bushings, valves and pushrods are lubricated in the same manner as described for the intake shafts.

9. Oil collected in the pushrod area of the cylinder heads flows down the pushrod covers to lubricate the tappets. Tappet rollers are lubricated by oil draining into gearcase through two drain holes in tappet.

10. Oil collected in the intake and exhaust valve spring pockets drains to the flywheel compartment through holes drilled in each cylinder. Oil returning from the heads, rod assembly and gearcase collects in the sump area below the flywheels.

11. Oil collected in the sump area returns to the scavenger 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.

12. Return oil fills a cavity just above the scavenge pump. The pump transfers return oil to the outlet side of the pump and back to oil tank.

13. All engine breathing is accomplished through the gearcase into the breather system. Any oil still carried by the exhaust air is centrifugally separated from the air by an oil slinger on the end of the generator drive gear shaft.

14. Crankcase exhaust air is routed through a one way check valve to the air cleaner.

15. Scavenge pump.

16. Return oil to tank.

REPAIR PROCEDURE

GENERAL

When an engine needs repair, it is not always possible to definitely determine beforehand whether repair can be made with only cylinder head, cylinders and pistons removed from engine or whether engine must be completely disassembled for crankcase repair.

Most commonly, only cylinder head and cylinder repair is needed (valves, rings, pistons, etc.) and it is recommended procedure to service these units first, allowing engine crankcase to remain in frame. Follow the procedure under "STRIPPING MOTORCYCLE FOR ENGINE REPAIR," steps 1-5, 20-21, to strip motorcycle for removal of cylinder head, cylinder and pistons.

After disassembling "upper end" only, it may be found that crankcase repair is necessary; this requires removal of engine crankcase from chassis outlined under "STRIPPING MOTORCYCLE FOR ENGINE REPAIR," steps 6-19, 22-29.

In cases where it has been definitely determined beforehand that crankcase repair is necessary, the engine, completely assembled, should be removed from chassis as outlined under "STRIPPING MOTORCYCLE FOR ENGINE REPAIR," steps 1-29.

NOTE

The following stripping procedure applies directly to 1974 and earlier models. Models 1975 and later are similar, except that the brake and gear foot shift lever positions have been reversed on the motorcycle. The brake lever is now on the right side; the gear shift lever, on the left.

STRIPPING MOTORCYCLE FOR ENGINE REPAIR (See Figure 3-4 or 3-5)

1. Clean engine thoroughly with "Gunk" to remove all road dirt. Remove "Gunk" and dirt with water spray and blow engine dry with compressed air. Drain gasoline and oil. Remove battery cover and disconnect battery cables. Disconnect hoses from carburetor and remove bolts securing gasoline tank. Tank can then be removed from motorcycle.

2. Remove the following parts from right side of motorcycle:
3. Disconnect throttle and choke control at carburetor. Free throttle cable and support bracket from carburetor. Remove cable from between the cylinders and position cable out of working area (to front of frame). Remove carburetor.

4. Remove top engine support bracket bolt. Be sure to note the number of shim washers between cylinder head bracket and frame lug; these will have to be refitted when installing the engine.

5. Loosen exhaust pipe port clamps (6). Remove exhaust system from motorcycle.

6. On XLCH Model, remove starter crank clamp bolt (9) and with a screwdriver pry crank from shaft. Press down on end of starter spring (10), and at the same time pry spring off shaft.

7. Models 1974 and earlier, shift into high gear and remove footrest (11) and foot shift lever (12). Models 1975 and later, remove right footrest (11) and brake foot lever (12A).

8. Remove transmission sprocket cover bolts (13). With a mallet, lightly tap cover at the same time pulling cover from shaft. On 1974 and earlier models, disengage clutch cable and from clutch release lever by moving lever forward (as positioned on motorcycle), and disengage cable from lever. On 1975 and later models, detach shifter link from arm of shifter pedal cross shaft.
10. Remove oil return line (15) at oil tank.
11. Free oil vent line (16) at oil tank and oil feed line (17) at engine.
12. Remove breather pipe (18) and disconnect oil pressure switch wire (1) from switch.
13. On 1970 models, pull clutch cable (2) forward (as positioned on motorcycle), until approximately 1 in. of cable remains in gearcase cover, at the same time press cable inward (towards oil pump), and down to free from gearcase cover. On 1971 and later models, disconnect clutch control cable at handlebar control lever.
14. Remove oil pressure switch from motorcycle.
15. Disconnect speedometer cable from speedometer drive unit (located under transmission sprocket cover). Disconnect tachometer cable.
16. Free speedometer cable from clip (4).
17. Remove lower front bar bolt.
Remove the following parts from left side of motorcycle.
18. Loosen, but do not remove, top front engine mounting bolt (20).
19. Remove three remaining engine mounting bolts (21) and lower front bar bolt (22).
20. Disconnect ground wire (2b) from battery terminal, and spark plug cables from spark plugs (26).

21. Disconnect horn wires and remove horn from engine mount bracket. Remove two engine support bracket bolts (30) and free bracket assembly from engine.

22. Disconnect circuit breaker to coil wire (not shown).

23. Remove battery (23), battery carrier (24), and oil tank (19).

24. Remove two top rear engine mounting bolts (32) and regulator ground strap (31).

25. Models 1974 and earlier, remove rear brake foot lever and spring (33). Models 1975 and later, remove gear shift foot lever (33A).

26. Remove left footrest (34) from motorcycle.

27. Remove two lower rear engine mounting bolts, (located directly above rear brake crossover shaft).

28. Remove front top engine mounting bolt (20).

29. Engine is now free to be removed from chassis. Install a spare engine support bracket and with a hoist centered directly over engine, attach hook securely to bracket. Lift engine up off the mounting pad. Then, slip engine from left side of chassis, top of engine tipped slightly towards center of chassis.

INSTALLING ENGINE IN CHASSIS (Figures 3-4 and 3-5)

To install an engine assembly into chassis, reverse the stripping procedure in the following order:

Left side of motorcycle:
Steps 29, 27, 24, 23, 28, 19, 18, 25, 24, 22, 21, 23 and 20.

Right side of motorcycle:
Steps 15, 13, 16, 14, 12, 9, 8, 8A, 11, 10, 7, 5, 17, 3, 4, 2 and 1.

IMPORTANT

Be sure to check engine and transmission oil level before starting engine.
REMOVING

Before removing cylinder head assembly, strip motorcycle as described in "STRIPPING MOTORCYCLE FOR ENGINE REPAIR," steps 1-5, 20-21. Free carburetor and manifold assembly from motorcycle by removing manifold clamps and carburetor support bracket nut at crankcase. Loosen two oil line nuts (2, Figure 3-7), and remove spark plugs.

See Figure 3-6, and proceed as follows: Open push rod covers as follows: Press push rod cover spring retainers (7) down and remove push rod cover keepers (2). Telescope upper push rod cover (8) into lower cover (4). To remove cylinder head assembly, turn engine over until both valves are closed in cylinder head (both push rods in lowest position). Remove cylinder head bolts (1, Figure 3-7). Remove cylinder head and rocker arm cover assembly (from left side of motorcycle), valve push rods and push rod covers and oil lines in one operation. If the cylinder head does not come loose on removal of head bolts, tap lightly with rawhide hammer. Never try to pry head off.

NOTE

With engine in chassis, the rear cylinder rocker arm cover and cylinder head must be removed from engine as an assembly. There is not enough clearance between rocker arm cover and frame to remove rocker arm cover only.

DISASSEMBLING (Figure 3-7)

Refer to Figure 3-7 and follow the order of disassembly. Remove the rocker arm cover (6) from cylinder head by removing cover bolts (4). Before further disassembly, carefully check the rocker arm pads and ball sockets for pitting and excessive wear. Also, check the rocker arm shaft (9) for appreciable play in the rocker arm bushings (13). If rocker arm assembly is noticeably worn, disassemble unit for further inspection and replacement of parts.

Remove rocker arm shaft screw and O-ring (7), acorn nut and washer (8). Discard shaft screw O-ring. Using a plastic or brass hammer, tap rocker arm shaft (9) from cover and remove the following parts: Spring (10), rocker arm (11) and spacer (12). Mark rocker arm shaft and arm in some manner so all parts may be returned to respective locations during assembly.

CAUTION — Rocker arms are not interchangeable. Exhaust rocker arms have extra oil hole to provide cooling on valve.

Compress valve springs using Valve Spring Compressor, Part No. 96600-36 (see Figure 3-8) and remove valve keys (14) from ends of valve stems. Remove valve spring collars (15 and 18), springs (16 and 17) and valves (19). It is customary to reassemble valves in same cylinder head from which they were removed; therefore, before removing, mark them in some manner to identify them with front and rear cylinder head.

CLEANING AND INSPECTING (Figure 3-7)

Thoroughly clean all parts and inspect them for wear and damage. Clean out oil passages with compressed air.

Inspect oil line nut rubber sleeve (2), if damaged or worn, replace when reassembling.

Carefully check the rocker arm (11) and shaft (9) for wear. Replace rocker arm bushings if shaft is over .002 in. loose in bushings. Examine the rocker arm pads. If rocker arm and ball sockets are worn and elongated, the rocker arms must be replaced.

Place cylinder head in "Gunk Hydro-Seal" until deposits are soft. Using a wire brush, clean carbon from cylinder head combustion chamber, inlet and exhaust valve ports. When cleaning carbon, be careful not to scratch or nick cylinder head face, as leakage will result. Blow off loosened carbon and dirt particles and wash head in solvent.
Figure 3-7. Cylinder Head Assembly - Exploded View

1. Cylinder head bolt and washer (4)
2. Oil line nut and rubber sleeve (2)
3. Rocker arm cover to crankcase oil line
4. Rocker arm cover bolt, washer (7)
5. Rocker arm cover gasket (2)
6. Rocker arm cover
7. Rocker arm shaft screw and O-ring (2)
8. Rocker arm shaft acorn nut and washer (2 each)
9. Rocker arm shaft (2)
10. Rocker arm spring (2)
11. Rocker arm (2)
12. Rocker arm spacer (2)
13. Rocker arm bushing (4)
14. Valve key (4)
15. Valve spring upper collar (2)
16. Inner valve spring (2)
17. Outer valve spring (2)
18. Valve spring lower collar (2)
19. Intake and exhaust valve
20. Intake and exhaust valve guide
21. Cylinder head
22. Cylinder head gasket

Force air through all oil holes in cylinder head to make sure passages are clean.

If the valve seat is pitted, burned, corroded or has any indication of improper valve seating, recondition the seat as described in “RECONDITIONING OR REPLACING VALVE SEATS.” Replace any valve seat inserts that are cracked or loose in the cylinder head.

Check length and tension of each valve spring (16 and 17) using Valve Spring Tester, Part No. 96796-47. Replace spring if 1/8 in. or more shorter than a new spring, or compression shows 5 lbs, below low limit tension of new spring. Refer to engine “SPECIFICATIONS” for free length, compressed length and poundage of new valve springs.
Remove carbon from valve head and stem using a knife and wire wheel—never a file or other hardened tool that will scratch or nick valve. Polish valve stem with fine emery cloth or steel wool. Replace valves that are badly scored, warped or in bent condition. Reface valves that are slightly pitted, burned or in corroded condition as described in "GRINDING VALVE FACES AND SEATS."

Clean intake valve guide with a 5/16 in. reamer and exhaust valve guide with a 11/32 in. reamer, and examine for wear and valve stem clearance. Check the valve guide to make sure it is not loose in cylinder head. Replace guide, or possibly both valve and guide if either part is not within tolerances, described in engine "SPECIFICATIONS."

Inspect push rod (1, Figure 3-6) for damage and wear. Pay particular attention to the ball ends. If the ball ends are worn and flattened replace the push rod.

REPLACING ROCKER ARM AND BUSHINGS (Figure 3-7)

To replace worn bushings (13), press or drive them from rocker arm. If bushing is difficult to remove, insert a tap (5/8-11 thread) into bushing. From opposite side of rocker arm, drift out bushing and tap. Press or drive replacement bushing into rocker arm, flush with arm end, oil hole correctly aligned and split portion of bushing towards the top of arm. New bushings should be line reamed using Reamer, Part No. 94804-57. Repeat for other end of rocker arm. When reassembling rocker arm housing, install new O-Rings (7).

If the rocker arm pads show uneven wear or pitting, dress on a grinder, maintaining original curve. If possible, compare with a new unit during this operation to ensure a correctly contoured surface.

REPLACING VALVE GUIDES

Replacing valve guides if necessary, must be done before valve seat and face are ground since the valve stem hole in valve guide is the basis from which all face and seat grinding is done. Valve stem-valve guide clearance is as follows: Exhaust valves, .0025 in. to .0045 in. loose; intake valves, .0015 in. to .0035 in. loose. If valve stems and/or guides are worn to exceed the maximum tolerances by more than .002 in., new parts must be installed.

Tap out valve guides with shouldered drift pin (from chamber side) and insert replacement guide on arbor press. Be particularly careful to press replacement guide squarely into hole.

New valve guides are reamed to correct size. However, when guides are pressed into cylinder heads, they may close up slightly; also the ends may be burrred. Therefore, after new guides are in place, they should be sized and cleaned with an expansion reamer.

It is of prime importance that valve guides fit tightly in cylinder heads, or valves may not seat properly. If original guide or new standard guide is not a tight press fit, an oversize guide must be installed. Oversize guides can be obtained .001 in. and .002 in. oversize. The number of grooves on O.D. indicates number of thousandths of an inch press diameter is oversize.

RECONDITIONING OR REPLACING VALVE SEATS

After installing valve guides, valve seats must be refaced to true them with guides.

If valves have been seated several times, valve seats may have become too wide and/or valve may be seating itself too deeply in head. When valve seat becomes wider than 1/16 in. (see Figure 3-8) valve seat relief must be counterbored or ground to reduce seat to 1/16 in. Counterebore dimensions are shown. Tools for this purpose are available commercially. To determine if valve is seating itself too deeply in head, measure distance from shoulder of valve guide to end of valve stem. See dimension in Figure 3-8. When valve stem extends through guide in excess of maximum shown, valve seat inserts must be replaced.

A special gauge is available under Part No. 96489-63, which is used to measure this dimension. The tool consists of gauge valves and gauge which is placed over the valve stem as shown. If top end of gauge valve stem is between steps on gauge, the valve seat location is satisfactory.

Replacement inserts are available from the factory. Installation requires accurate boring equipment to machine correct counterbore in head for installation with .004 to .006 in. interference fit.

GRINDING VALVE FACES AND SEATS

Valve seat tools and fixtures are available commercially. Seat each valve in same port from which it was disassembled.
Valve face angle is 45° for both intake and exhaust valves, and if a valve refacing grinder is used, it must be adjusted exactly to this angle. It is important to not remove any more metal than is necessary to clean up and true valve face. If grinding leaves the edge of valve very thin or sharp, install a new valve. A valve in this condition does not seat normally, will burn easily and may cause pre-ignition. There is also danger of cracking. Valves that do not clean up quickly are probably warped or too deeply pitted to be used. If end of valve stem shows uneven wear, true end of stem on a valve refacing grinder equipped with suitable attachment.

Intake valves are marked "IN" on head; exhaust valves are marked "EX."

![Figure 3-9. Valve Seat Specifications](image)

**Figure 3-9. Valve Seat Specifications**

<table>
<thead>
<tr>
<th>Valve</th>
<th>Relief Dia.</th>
<th>Max.</th>
<th>Min.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Int.</td>
<td>2.120</td>
<td>1.420</td>
<td>1.375</td>
</tr>
<tr>
<td>Exh.</td>
<td>1.62</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**LAPPING VALVE FACES AND SEATS**

If valve faces and seats have been smoothly and accurately refaced, very little lapping will be required to complete seating operation. Apply a light coat of fine lapping compound to valve face, insert valve in guide and give it a few oscillations with Valve Grinding Tool, Part No. 96550-36, Lift valve and rotate it about 1/3 of a turn. Repeat lapping procedure as shown in Figure 3-10. After full turn, remove valve, wash valve face and seat, and dry with cloth that is immediately discarded so grinding compound cannot be transferred to engine parts. If inspection shows an unbroken lapped finish of uniform width around both valve and seat, valve is well seated. If lapped finish is not complete, further lapping, of grinding and lapping is necessary.

![Figure 3-10. Lapping Valve Face and Seat](image)

**ASSEMBLING CYLINDER HEAD (Figure 3-7)**

To install valve assemblies in cylinder head, reverse the disassembly procedure. Apply a light coat of oil to valve seats and stems. Be careful to insert marked valves (19) in their respective guides (20). Carefully seat lower valve spring collar (18) over valve guide. Install springs (17 and 16) and upper collar (15). Compress valve springs with Valve Spring Compressor, Part No. 96600-36. Position keys (14) in valve key groove using grease to hold them in place and slowly release compressor tool until keys are correctly locked in groove.

Position spacer (12) in countersunk hole in rocker arm cover. Install marked rocker arms (11) in their respective cover location. Compress spring (10) and position spring between rocker arm and washer. Apply a light film of oil to rocker arm shaft (9) and insert in cover assembly. Examine spring ends to be sure they are square with washer and rocker arm. Install and securely tighten acorn nut and washer (8) to 60-65 ft-lbs torque, shaft screw and new O-ring (7). Check rocker arm action to make sure it is not binding.

Carefully clean top of cylinder head and rocker arm cover faces, install a new gasket (5) and position rocker arm cover on cylinder head. Install rocker arm cover screws (4) with flat washer under head of each screw. Screws must be tightened evenly to attain a tight joint. First turn them snug; then tighten each one, 1/8 or 1/4 turn at a time until all are securely tightened to 20 ft-lbs.

**INSTALLING CYLINDER HEAD (Figure 3-7)**

To install the cylinder head assembly, reverse the order of disassembly. Clean top of cylinder and cylinder head faces and wipe them off with a clean rag.

Turn engine over so cylinder tappets are at their lowest position and install cylinder head, push rods and push rod covers in one operation. Install push rods in their original position in cylinder head. Be sure push rods register in tap-
pet screw sockets at bottom end and in push rod sockets at upper end. Install oil line (3) in head and crankcase connection using new rubber sleeves.

Install cylinder head bolts with flat washers under head of each bolt. Bolts must be tightened evenly to attain a tight joint. First turn bolts snug, then tighten each of them 1/8 or 1/ 4 turn at a time with a torque wrench until all are tightened to 65 ft-lbs. Follow same procedure for both cylinder heads. Make sure rubber sleeves are in place and tighten oil line nuts (2).

Before installing carburetor, replace intake manifold rubber O-rings. Assemble O-rings on manifold and then slip carburetor assembly into position aligning the hole in carburetor support bracket with top center crankcase stud. Just snug up stud nut. Carefully square manifold face with cylinder head intake port face and slip rubber O-ring onto its seat. Insert and tighten two manifold clamps. Tighten crankcase stud nut securely.

NOTE
There are likely to be air leaks around manifold-cylinder head joints, unless manifold is perfectly aligned with cylinder head intake port face, rubber O-rings are in good condition and manifold clamps securely tightened. Air leakage will affect carburetion, particularly at low speeds.

If all necessary steps have been taken and air continues to leak around manifold-cylinder head joints, it may be necessary to loosen the cylinder base nuts to allow final shifting and alignment of cylinder heads and manifold. Be sure to tighten base nuts after alignment.

Check tappet adjustment as described below and reassemble remaining parts.

ADJUSTING TAPPETS (Figure 3-11)
To get the maximum power and best all-around performance from an engine, keep valve tappets properly adjusted. They should be inspected and, if necessary, readjusted initially at 500 and 1000 miles and every 2000 miles thereafter.

Engine must be cold during tappet adjustment. As each tappet is readjusted, make sure it is at its lowest position, by turning engine ahead until the like tappet in the other cylinder is at its highest position (valve fully opened). The inlet valves are those nearest the carburetor.

To uncover tappets, press down on push rod cover spring retainer, and remove keeper at upper end. Raise lower cover. Loosen tappet adjusting screw locknut (3) and turn adjusting screw (2) downward (into tappet body) until push rod is just free and has noticeable up and down movement. Slowly turn adjusting screw upward (toward push rod) until nearly all play is removed. At this point, tighten tappet screw locknut 8-10 ft-lbs torque against tappet body (4) and recheck for correct tappet adjustment. A tappet is correctly readjusted when push rod has no up and down movement, and can be turned freely with finger tips, completely around, without trace of bind.

When reassembling push rod covers, make sure that both ends of covers are properly seated against cork washers.

REMOVING AND INSTALLING PUSH RODS ONLY (Figure 3-11)
Before attempting to remove push rod and cover assembly, turn engine over until tappet is at its lowest position. Turn adjusting screw locknut (3) all the way up to end of thread on adjusting screw (2). Turn adjusting screw (2) all the way down into tappet body. Remove push rod and cover assembly by lifting push rod upward and to one side, being careful not to bind push rod upper end in aluminum rocker arm housing. Doing so may result in a bent push rod. Install new cork washers (3, Figure 3-6) in aluminum rocker arm housing and in tappet guide, being careful not to damage them and making sure they are well seated. Replace cork washer (3, Figure 3-6) in push rod cover with a new one.

Reassemble push rod and push rod cover assembly in reverse order of disassembly. Check tappet adjustment as described in "ADJUSTING TAPPETS."
CYLINDER AND PISTON

REMOVING (Figure 3-12)

See "STRIPPING MOTORCYCLE FOR ENGINE REPAIR," steps 1-5, 20-21 and "REMOVING CYLINDER HEAD ASSEMBLY FROM ENGINE," this section.

See Figure 3-12, and proceed as follows: Clean crankcase around cylinder base to prevent dirt from falling into crankcase when lifting cylinders. Remove cylinder base stud nuts (1). Raise cylinder and piston just high enough to permit placing a rag over crankcase opening; this will prevent dirt and possibly pieces of broken ring from falling into crankcase. With piston at bottom of stroke, remove cylinder (2), discard cylinder base gasket (3). Using a piston ring expander (Figure 3-19) spring piston rings (4) outward until they clear grooves in piston (7) and lift off. Remove piston pin lock rings (5, 5A) from piston (7) groove. For 1976 and earlier models, use two sharp pointed instruments such as awls to remove ring. For 1977 and 1978 models, use Internal Lock Ring Pliers, Part No. 96215-49. Support piston and tap out piston pin (6) with a suitable drift.

Remove piston pin bushing (8) if necessary (see "CLEANING AND INSPECTION") using Piston Pin Bushing Tool, Part No. 95970-32A. Do not drive bushing out with a drift.

CLEANING AND INSPECTING

Place piston and cylinder in solvent or other carbon and gum dissolving agent until deposits are soft. Then thoroughly scrub piston and cylinder in solvent to remove deposits. Where carbon deposit is thick or hard, it is advisable to use a wire wheel to scrape carbon before cleaning. Use extreme care to avoid scraping into aluminum of pistons.

After parts are thoroughly washed, blow dry with compressed air. Force air through oil holes in cylinder. Clean piston ring grooves with a tool for cleaning ring grooves. Avoid scratching or damaging sides of ring grooves.

Examine piston pin to see that it is not loose in connecting rod, grooved, pitted or scored. If necessary, remove bushing as described in "DISASSEMBLING CYLINDER AND PISTON."

A piston pin, properly fitted, is a light hand press fit in piston and has .001 in. clearance in connecting rod upper bearing.

If difference in diameter of hole in piston pin bushing and diameter of piston pin exceeds a .002 in. fit, replace worn parts.

Replace piston pin lock ring with a new ring whenever it is removed from piston groove. If opposite side ring has not been removed and is undamaged, it is not necessary to disturb it.

Examine piston and cylinder for cracks, burrs, burned spots on piston dome, grooves and gouges.

On motorcycles using rod bearings with steel retainers (1976 and Earlier) check rods for end side shake (Figure 3-13). To make this check with accuracy, pistons should first be removed. When side shake (rod tip) at extreme upper end is 3/64 in. or more for front rod or 1/64 in. or more for rear rod, lower bearing should be refitted.

On motorcycles using rod bearings with aluminum retainers (1977 and 1978) side shake cannot be used to determine bearing wear. Instead, carefully check rod for up-and-down movement. To make this check accurately, pistons should be removed first. When appreciable up-and-down movement is found, lower bearing should be refitted.

These two procedures require removing and disassembling engine crankcase. See "CRANKCASE."

REFINISHING CYLINDERS

Piston and cylinders must be measured to see if they are worn to the point where cylinders must be refinished and oversize pistons installed.

Inside and outside micrometers used for cylinder-piston fitting should be checked together to be sure they are adjusted to read exactly the same. By subtracting piston measurement from bore measurement, amount of piston-cylinder clearance is obtained.

Figure 3-12. Cylinder and Piston - Exploded View
Bore measurement of a used and worn cylinder should be taken in ring path, starting about 1/2 in. from the top of cylinder, measuring front to rear then side to side. Repeat procedure at the center and at the bottom of the ring travel (see Figure 3-14). This process will determine if cylinder is out-of-round or "egged" and will also show any cylinder taper.

Piston measurement should be taken at extreme bottom of skirt, measured front to rear, 90° from center line of piston pin (see Figure 3-15).

If cylinders are not scored and above measurements do not vary more than .002 in., it is not usual practice to refinish oversize. If the total piston clearance is more than .006 in., a new standard piston, or piston of the same oversize to which the cylinder was last refinished, should be fitted to reduce clearance and effect reasonably quiet operation.

If cylinders show more than .002 in. variance, they should be refinished to the next oversize step and fitted with new corresponding pistons and rings.

Exact final size of the cylinder bore is determined by size of the piston to be used in that cylinder. Measure piston diameter accurately as described previously, then add desired piston clearance in cylinder. This will equal the exact final size to which cylinder bore should be refinished. Example: The .020 inch oversize 1971 piston to be used measures 3.0190 inches, adding .0025 inch (desired clearance) equals 3.0215 inches (finish-honed size). When cylinders require reboring to beyond oversize limit to clean up (.030 in. for 1972 to early 1973 models; .070 in. for all other models) cylinder oversize limit has been exceeded and the cylinder must be replaced.

Pistons are available in the following oversizes: .010, .020, and .030 for 1972 to early 1973 models, .010, .020, .030, .040, .050, .060, .070 for other year models. Oversize pistons have their size stamped on head; for example: 10, 20, etc.

In general practice only cylinders not scored and not badly worn are refinished using only a hone. Cylinders badly worn or deeply scored are first rebored to nearly the required oversize and then are finish-honed to exact size.
FITTING PISTON RINGS

If cylinders are worn less than the .002 in. maximum and refinishing is not necessary (unless they are scuffed or grooved), the same pistons may be used with the replacement of rings. However, before reassembling it is a good practice to rough up the cylinder wall with No. 150 Carborundum emery paper or a No. 300 hone. This will remove any high spots, carbon or foreign material from the cylinder wall and at the same time provide a surface suitable for proper lubrication and ring seating.

Piston rings are of two types – Compression (plain face) and oil control. The two compression rings are positioned in the two upper piston ring grooves, chamfered side up. Rings are available in following oversizes to fit standard oversize pistons: .010, .020, .030, .040, .050, .060 and .070 in.

The rings must have proper side clearance in ring grooves. See “SPECIFICATIONS.” Check with thickness gauge as shown in Figure 3-16. Gap between ends of rings when inserted squarely in cylinder bore must also be as specified under “SPECIFICATIONS.”

![Figure 3-16. Measuring Ring Clearance in Grooves](image)

The oil control ring is a full width slotted ring using a spring expander.

To check ring gap place a piston in cylinder with top end of piston about 1/2 in. from top end of cylinder.

Set the ring to be checked in cylinder bore squarely against piston. With a thickness gauge, check ring gap as shown in Figure 3-17.

Use only standard size rings and piston in standard bore, and only matching oversize rings and pistons in same oversize bore.

If cylinder has been refinshed oversize, use the correct oversize rings, fitting rings to give standard gap.

If gap is less than specified, ring ends may butt under expansion, and rings may be scored or broken. Gap may be increased by filing with a fine-cut file.

The two chrome plated compression rings, recognized by bright finish, are used in top and second ring grooves, with chamfer on one edge of the inside diameter facing top of piston when installed. Slotted oil control ring is used in bottom ring groove.

![Figure 3-17. Measuring Piston Compression Ring Gap](image)

Slip compression rings over piston into their respective grooves as shown in Figure 3-18. Be extremely careful not to overexpand, twist rings or damage the finely finished piston surface when slipping them into place.

![Figure 3-18. Installing Piston Rings](image)
CONNECTING ROD BUSHING

When connecting rod bushing is found tight in rod but is worn to excessive pin clearance (.002 in. or more) it is, of course, possible to repair it by reaming oversize and fitting an oversize pin. However, it is better practice to install a new bushing and ream it to fit a standard pin, except when piston to be used had previously been fitted with oversize pin or pin is loose in bosses, necessitating fitting with larger pin. The principal objection to fitting upper end oversize is that considerably more time is required for the job.

New pistons obtained from factory are supplied correctly fitted with standard pin, and installing one is not difficult if the rod bushing is already reamed to standard size. If bushing has been reamed oversize, either new bushing must be installed and reamed to standard size or piston must be reamed oversize to fit an oversize pin, which involves extra time.

When removing bushings in connection with only a top overhaul, use special tools as shown in Figure 3-19, Bushing Tool, Part No. 95970-32A, and Connecting Rod Clamping Fixture, Part No. 96952-33.

CAUTION — Oil slot in bushing must be in alignment with oil slot in rod.

Ream new bushing to size, or preferably, ream nearly to size and finish to exact size with a hone (Reamer, Part No. 94800-26). A properly fitted pin should have .001 in. clearance; with this clearance, pin will have just noticeable shake in bushing. Fitting tighter is likely to result in a seized pin or bushing loosened in rod.

Oversize piston pins are available in .004 in. oversize. After installing new piston pin bushings connecting rod alignment must be checked.

Fig. 3-19. Installing New Connecting Rod Bushing

STRAIGHTENING CONNECTING RODS

In refitting and reassembling connecting rods, and finally fitting pistons, rods may possibly be bent or twisted, throwing upper bearing and lower bearing out of alignment with each other to some extent. Therefore, after pistons have been installed, rods must be checked and re-aligned as may be necessary. If a rod is left bent or twisted, piston has a "cocked" relation to cylinder bore and the result is excessive noise and rapid wear.

Check rod alignment by means of Piston Squaring Plate, Part No. 96181-26, as shown in Figure 3-20. Be sure crankcase face is clean and free from burrs so that squaring plate seats fully. On 1972 and later 61 OHV engine, use 2 spacers on studs to center the plate over cylinder hole in crankcase.

If a rod is in perfect alignment, piston bottom will rest squarely on plate with flywheels turned so that crank pin is in either forward or rear position. Keep in mind that this check, to be accurate, depends upon checking with crank pin in both forward and rear positions. It is the change of rod angle, resulting from changing crank pin from one position to the other, that influences the seat of piston on squaring plate and thus indicates whether or not rod is in alignment.

Insert narrow strips of very thin paper of equal thickness underneath piston, one on each side, below piston pin, as shown in Figure 3-20. Press piston down lightly with fingertips resting on center of piston head and pull first one paper, then the other, partially from underneath piston. If piston is perfectly square (rod in alignment), both will have the same amount of drag.

Fig. 3-20. Checking Connecting Rod Alignment
If rod proves to be out of alignment, it can be straightened by means of a bar inserted through piston pin, as shown in Figure 3-21. Use a bar with a diameter as close to the hole diameter in the piston pin as possible. The manner in which piston seats on squaring plate indicates as follows:

1. Piston high on same side, both crank pin positions; rod is bent.

Figure 3-21. Straightening Connecting Rod

2. Piston high on opposite sides as crank pin position is changed; rod is twisted.

3. Piston square or nearly square with crank pin in one position and high on one side with crank pin in other position; rod is bent and twisted.

Correct as follows:

1. To straighten a bent rod, insert straightening bar through piston pin hole on low side of piston and apply upward force.

2. To straighten a twisted rod, insert straightening bar through piston pin hole on high side of piston, and if crank pin position is to front, apply force to rear — if crank pin position is to rear, apply force to front.

3. To straighten a bent and twisted rod, remove bend first and then remove twist. See above paragraphs, Nos. 4 and 5.

After rods have been aligned, check to see that pistons center in crankcase cylinder opening, without side pressure on upper rod ends. If further realigning is necessary to center pistons, correct by dressing off end of rod bushing on interfering side with a file. This allows the piston to shift slightly on rod to find a more suitable alignment of rod, piston and cylinder.

ASSEMBLING CYLINDER AND PISTON (Figure 3-12)

When connecting rod is true, remove squaring plate and attach piston so relief on piston dome for intake valve is to-ward intake valve when head is installed. Be sure one piston pin lock ring is in place. If the piston is heated, the piston pin may be inserted into piston with a slip or light press fit.

After pin is in place, install new piston pin lock ring. Use special Lock Ring Tool, Part No. 96780-58A, as shown in Figures 3-22 and 3-23 for 1976 and earlier models. 1972 engine requires Part No. 96781-72 tool plug. 1977 and 1978 models require Internal Lock Ring Pliers, Part No. 96215-49. Make sure ring groove is clean and that ring seats firmly in groove. If it doesn't, discard the ring and install a new one. A lock ring loosely installed will rapidly loosen further in service and finally will come out of piston groove, resulting in both piston and cylinder soon being damaged beyond repair. Never install a used lock ring or a new one if it has been installed and then removed for any reason, always use a new lock ring.

Figure 3-22. Inserting Piston Pin Lock Ring in Tool (1976 and Earlier)

Figure 3-23. Installing Piston Pin Lock Ring in Piston (1976 and Earlier)
Lubricate cylinder walls, pistons, rings, pins and rod bushings with engine oil. Space ring gaps about equidistant around piston. Turn engine until crank pin is at bottom center. Install new cylinder base gasket. Position Piston Inserting Ring Tool, Part No. 96331-57, on piston and slip cylinder down over piston as shown in Figure 3-24. Install flat washers and nuts and torque nuts to 30 ft-lbs. Repeat process for other cylinder.

Assemble cylinder head and remaining parts of motorcycle as indicated in "INSTALLING CYLINDER HEAD ASSEMBLY."
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