

GENERAL

Table 3-1. Engine—General

ITEM	SPECIFICATION
Number of cylinders	2
Type	4-cycle, 45° V-twin, air-cooled
Torque	100 ft-lbs (138 Nm) @ 4000 RPM
Bore	3.875 in. (98.425 mm)
Stroke	4.375 in. (111.125 mm)
Piston displacement (approx.)	103 cu. in. (1690 cc)
Compression ratio	9.0:1
Combustion chamber	Hemispherical
Cam system	Twin cams, chain driven with spring loaded tensioners
Max. sustained engine speed	5800 RPM
Idle speed	1000 RPM ± 50
Weight	165 lbs (74.8 kg)

Table 3-2. Ignition System

ITEM	SPECIFICATION
Type	Sequential, non waste spark, MAP-N control
Ignition timing: 1050 RPM (hot idle)	20°-30°
Spark plug size	12 mm
Spark plug type	Harley-Davidson 6R12
Spark plug gap	0.038-0.043 in. (0.97-1.09 mm)
Spark plug torque	12-18 ft-lbs (16.3-24.4 Nm)

Table 3-3. Oiling System

ITEM	SPECIFICATION
Pump	Twin gerotor, dual scavenge, crank mounted and driven, internal oil pump, dry sump
Pressure	30-38 psi (207-262 kN/m ²) at 2000 RPM and normal operating temperature of 230° F (110° C)
Filtration	10 micron media, filtered between pump and engine
Cooling	Thermostat controlled oil cooler

MANUFACTURING TOLERANCES

Table 3-4. Rocker Arms

ITEM	INCHES	MM
Shaft fit in bushing (loose)	0.0005-0.0020	0.013-0.051
End clearance	0.003-0.013	0.08-0.033
Bushing fit in rocker arm (tight)	0.002-0.004	0.051-0.102

Table 3-5. Rocker Arm Shafts

ITEM	INCHES	MM
Shaft fit in rocker arm support plate (loose)	0.0007-0.0022	0.018-0.056

Table 3-6. Hydraulic Lifters

ITEM	INCHES	MM
Fit in crankcase (loose)	0.0008-0.0020	0.02-0.05

Table 3-7. Cylinder Heads

ITEM	INCHES	MM
Valve guide in head (tight)	0.0020-0.0033	0.051-0.084
Valve seat in head (tight)	0.003-0.0045	0.076-0.114
Head gasket surface (flatness)	0.0-0.006	0.0-0.0152

Table 3-8. Valves

ITEM	INCHES	MM
Fit in guide (exhaust)	0.0015-0.0033	0.038-0.084
Fit in guide (intake)	0.0008-0.0026	0.020-0.066
Seat width	0.040-0.062	1.02-1.58
Stem protrusion from cylinder head boss	1.990-2.024	50.55-51.41

Table 3-9. Valve Spring Assembly

ITEM	PRESSURE	DIMENSION
Closed	165 lbs (75 kg).	1.820 in (46.2 mm).
Open	416 lbs (189 kg)	1.290 in. (32.7 mm)
Free length	n/a	2.210 in (56.1 mm)

Table 3-10. Pistons

ITEM	INCHES	MM
Fit in cylinder	0.0014-0.0025	0.036-0.064
Ring end gap:		
Top compression ring	0.010-0.020	0.254-0.508
2nd compression ring	0.014-0.024	0.3556-0.6096
Oil control ring	0.010-0.050	0.25-1.27
Ring side clearance:		
Top compression ring	0.0012-0.0037	0.030-0.094
2nd compression ring	0.0012-0.0037	0.030-0.094
Oil control ring	0.0031-0.0091	0.079-0.231
Piston pin fit (loose)	0.0002-0.0005	0.005-0.013

Table 3-11. Connecting Rods

ITEM	INCHES	MM
Piston pin fit (loose)	0.0003-0.0007	0.008-0.018
Side play between flywheels	0.005-0.015	0.13-0.38
Connecting rod to crankpin (loose)	0.0004-0.0017	0.0102-0.0432

Table 3-12. Flywheels

ITEM	INCHES	MM
Runout (flywheels at rim)	0.000-0.010	0.0-0.254
Runout (shaft at flywheel)	0.000-0.002	0.0-0.051
End play	0.003-0.010	0.076-0.254

Table 3-13. Crankshaft Sprocket Shaft Bearing

ITEM	INCHES	MM
Roller bearing fit (loose)	0.0002-0.0015	0.005-0.038
Crankshaft runout	0.0-0.003	0.0-0.076
Bearing fit in crankcase (tight)	0.0038-0.0054	0.097-0.137
Bearing inner race on crankshaft (tight)	0.0001-0.0010	0.0025-0.0254

GENERAL

Wear limits can be used as a guide when deciding whether to reuse engine parts. Replace used parts whenever the following wear limits are exceeded.

Table 3-14. Rocker Arm/Rocker Shafts

ITEM	REPLACE IF WEAR EXCEEDS	
	INCHES	MM
Shaft fit in bushing (loose)	0.0035	0.089
End clearance	0.025	0.635
Shaft fit in rocker arm support plate (loose)	0.0035	0.089

Table 3-15. Hydraulic Lifters

ITEM	REPLACE IF WEAR EXCEEDS	
	INCHES	MM
Fit in crankcase	0.003	0.08
Roller fit	0.0015	0.038
Roller end clearance	0.015	0.38

Table 3-16. Cam Support Plate

ITEM	REPLACE IF WEAR EXCEEDS	
	INCHES	MM
Cam chain tensioner shoe	0.080-0.090	2.03-2.29
	1/2 thickness of shoe	
Warpage	0.010	0.25
Crankshaft bushing fit	0.0008-0.001	0.0203-0.0254

Table 3-17. Cylinder Heads

ITEM	REPLACE IF	
	INCHES	MM
Valve guide (tight)	Less than 0.002	Less than 0.051
Valve seat (tight)	Less than 0.002	Less than 0.051
Head warpage	Greater than 0.006	Greater than 0.152

Table 3-18. Cylinders

ITEM	REPLACE IF WEAR EXCEEDS	
	INCHES	MM
Taper	0.002	0.051
Out of round	0.002	0.051
Warpage of gasket or O-ring surfaces: top	0.006	0.152
Warpage of gasket or O-ring surfaces: base	0.004	0.102

Table 3-19. Cylinder Bore

ITEM	REPLACE IF WEAR EXCEEDS	
	INCHES	MM
Standard	3.877	98.48
0.005 in. oversize	3.882	98.60
0.010 in. oversize	3.887	98.73

Table 3-20. Pistons

ITEM	REPLACE IF WEAR EXCEEDS		
	INCHES	MM	
Fit in cylinder (loose)	0.003	0.076	
Piston pin fit (loose)	0.0008	0.020	
Ring end gap	Top compression	0.030	0.762
	2nd compression	0.034	0.863
	Oil control ring rails	0.050	1.27
Ring side clearance	Top compression	0.0045	0.11
	2nd compression	0.0045	0.11
	Oil control ring rails	0.010	0.25

Table 3-21. Connecting Rods

ITEM	REPLACE IF WEAR EXCEEDS	
	INCHES	MM
Piston pin fit (loose)	0.001	0.025
Side play between flywheels	0.020	0.51
Fit on crankpin (loose)	0.002	0.05

Table 3-22. Flywheels

ITEM	REPLACE IF WEAR EXCEEDS	
	INCHES	MM
Flywheel runout at rim	0.015	0.381
Shaft runout at flywheel	0.003	0.076
End play	0.010	0.254

Table 3-23. Crankshaft Sprocket Shaft Bearing

ITEM	REPLACE IF	
	INCHES	MM
Bearing fit (loose)	Greater than 0.0015	Greater than 0.038
Crankshaft runout	Greater than 0.003	Greater than 0.076
Bearing fit in crankcase (tight)	0.0038-0.0054	0.097-0.137
Bearing inner race on crankshaft (tight)	Less than 0.0001	Less than 0.0254

Table 3-24. Breather Assembly

ITEM	REPLACE IF WEAR EXCEEDS	
	INCHES	MM
Breather cover warpage	0.005	0.13
Breather baffle warpage	0.005	0.13

Table 3-25. Valve Stem to Guide Clearance

ITEM	REPLACE IF WEAR EXCEEDS	
	INCHES	MM
Intake	0.0035	0.089
Exhaust	0.0040	0.102

TORQUE VALUES

ITEM	TORQUE		NOTES
Chrome oil vent line nut	60-80 in-lbs	6.8-9.0 Nm	page 3-30
Oil cooler to mounting bracket	80-110 in-lbs	9.1-12.4 Nm	page 3-34
Oil filter adapter	12-16 ft-lbs	16.3-21.7 Nm	page 3-36
Oil filter mount screw	130-150 in-lbs	14.7-16.9 Nm	page 3-36
Oil pressure switch	96-144 in-lbs	10.8-16.3 Nm	LOCTITE Thread Sealant, page 3-34
Oil spout fitting	130-150 in-lbs	14.7-16.9 Nm	page 3-30
Oil vent line crankcase fitting	130-150 in-lbs	14.7-16.9 Nm	page 3-30
Rocker housing bolts	120-168 in-lbs	13.6-19.0 Nm	page 3-9
Thermostat plug	15-20 ft-lbs	20.4-27.1 Nm	page 3-36, 3-37
Transfer passage cover	90-120 in-lbs	10.2-13.6 Nm	page 3-36

REMOVAL

See TOP END OVERHAUL in the Touring Models Service Manual.

NOTE

If breather style is different from that illustrated, see BREATHER ASSEMBLY under TOP END under SUBASSEMBLY SERVICE AND REPAIR, in the Touring Models Service Manual.

DISASSEMBLY

1. See Figure 3-1. Remove two fasteners from breather assembly.
2. Remove breather cover and gasket. Discard cover gasket.
3. Remove the breather baffle and gasket. Discard gasket.
4. Pull filter element from bore on inboard side of breather baffle. Discard filter element.
5. Pull stem of umbrella valve from hole at top of breather baffle. Discard umbrella valve.

CLEANING AND INSPECTION

⚠ WARNING

Compressed air can pierce the skin and flying debris from compressed air could cause serious eye injury. Wear safety glasses when working with compressed air. Never use your hand to check for air leaks or to determine air flow rates. (00061a)

1. Clean all parts in a non-volatile cleaning solution or solvent.
2. Thoroughly dry all parts with low pressure compressed air.

ASSEMBLY

1. See Figure 3-1. Insert stem of **new** umbrella valve through center hole at top of breather baffle. Use denatured alcohol or glass cleaner to lubricate stem. Carefully pull rubber bead on stem through hole in baffle. Verify that rubber bead is pulled completely through hole and resides on bottom side of baffle.
2. Press **new** filter element into bore at bottom of baffle. Hole in filter element accommodates umbrella valve stem.
3. Place breather baffle gasket on a clean flat surface. Aligning holes, place breather baffle, cover gasket and breather cover on top. Slide two screws through stackup to keep assembly together until time of installation.

INSTALLATION

See TOP END OVERHAUL in the Touring Models Service Manual.

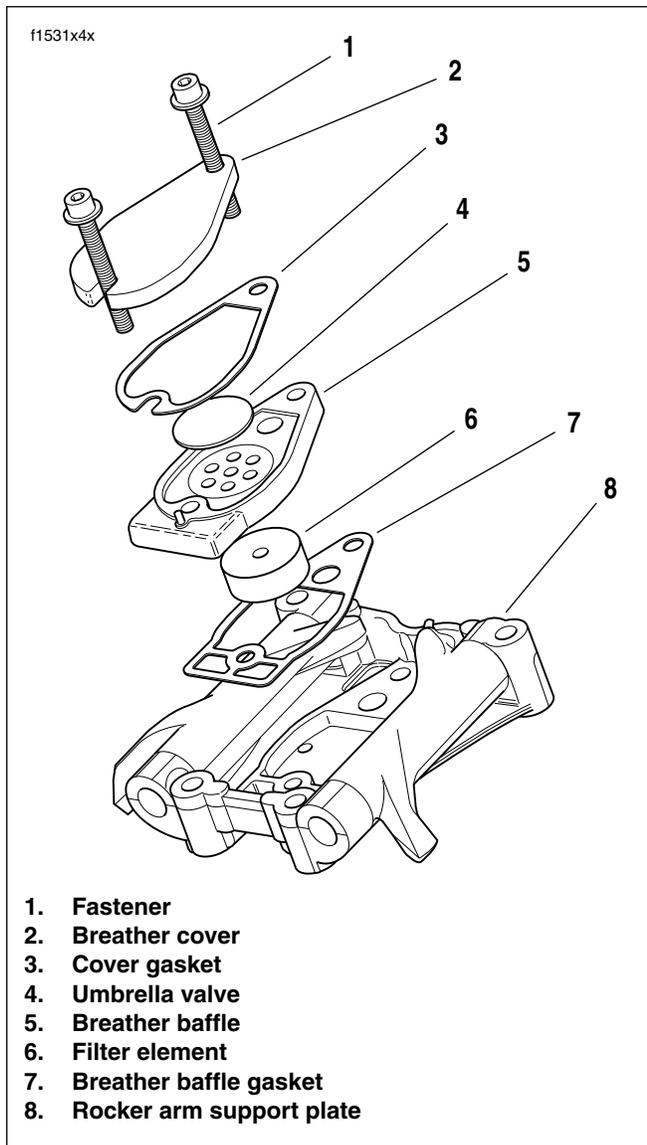


Figure 3-1. Breather Components

VALVE SPRING TO ROCKER HOUSING CLEARANCE

1. After torquing cylinder head bolts, continue top end overhaul by installing the rocker housings. See ASSEMBLY under TOP END OVERHAUL in the Touring Models Service Manual.
2. Install a **new** rocker housing gasket on the cylinder head flange.

CAUTION

Even though all bolt holes (rocker housing, rocker arm support plate and breather assembly) may appear to be in alignment, the rocker housing gasket may be installed upside down. An upside down gasket will result in an open breather channel causing an oil leak when the vehicle is started, possibly resulting in engine and/or property damage.

3. See [Figure 3-2](#). Verify that the rocker housing gasket is installed correctly by noting that the breather channel is concealed.
4. With the indent facing forward, place the rocker housing into position aligning the holes in the housing with those in the gasket.

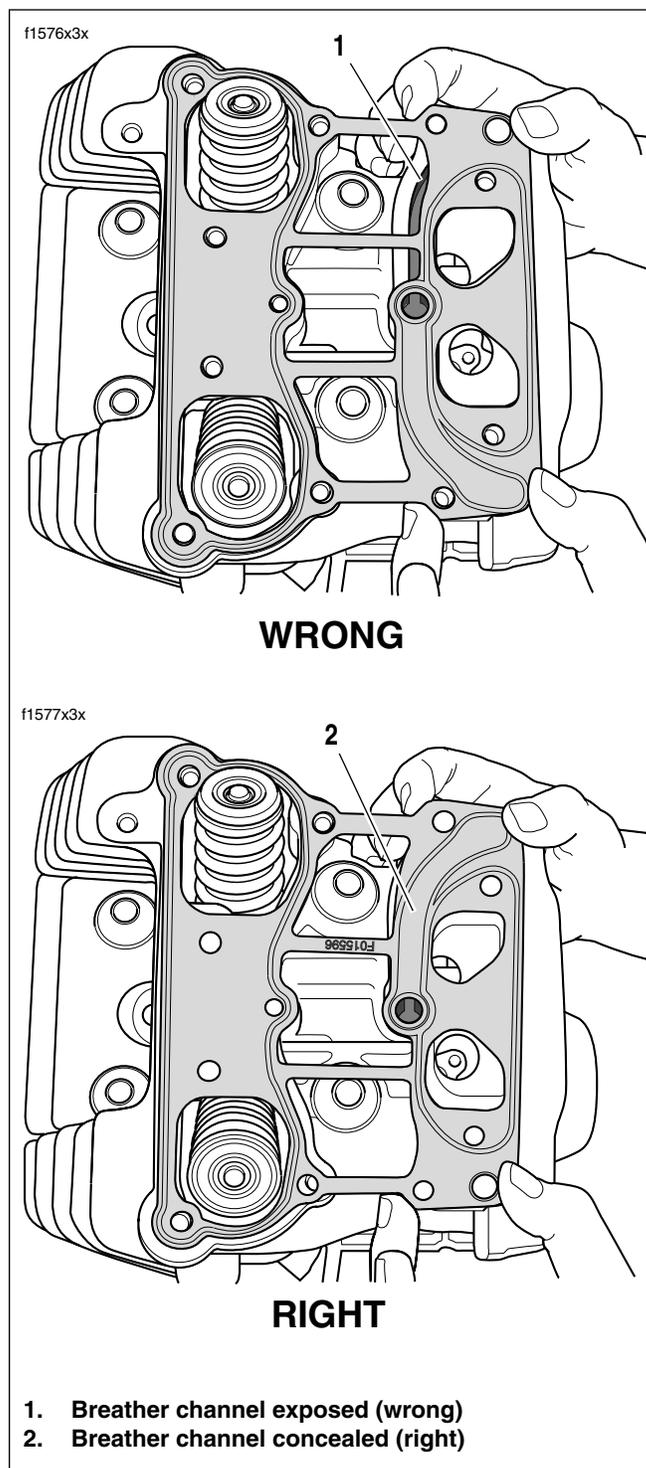


Figure 3-2. Rocker Housing Gasket

5. Apply a small dab of LOCTITE THREADLOCKER 243 (blue) (HD-99642-97) to threads of six rocker housing bolts.
6. See [Figure 3-3](#). Start the rocker housing bolts, two long bolts on the left side of the engine, four intermediate bolts in the interior.

NOTE

Rocker housing and rocker cover bolts have both an internal and external hex, which allows the bolts to be installed with either a short 3/16 inch allen wrench (tight spaces), or a 7/16 inch socket or open end/box wrench (open spaces). If the engine is left in the chassis for service, the short 3/16 inch allen wrench is indispensable when installing the rocker housing and rocker cover bolts on the left side of the engine (particularly the rear) where there is close proximity to the frame.

7. From the cam cover side, press rocker cover diagonally toward the intake valve.
8. See [Figure 3-5](#). Snug bolts in torque sequence to hold housing in position. Do not torque.
9. See [Figure 3-4](#). Using a feeler gauge, check for clearance around both valve spring assemblies and the rocker housing.
10. If spring assembly contacts rocker housing at any point around springs, loosen rocker cover bolts and press on side of cover opposite contact point to produce noticeable clearance between housing and valve assembly.

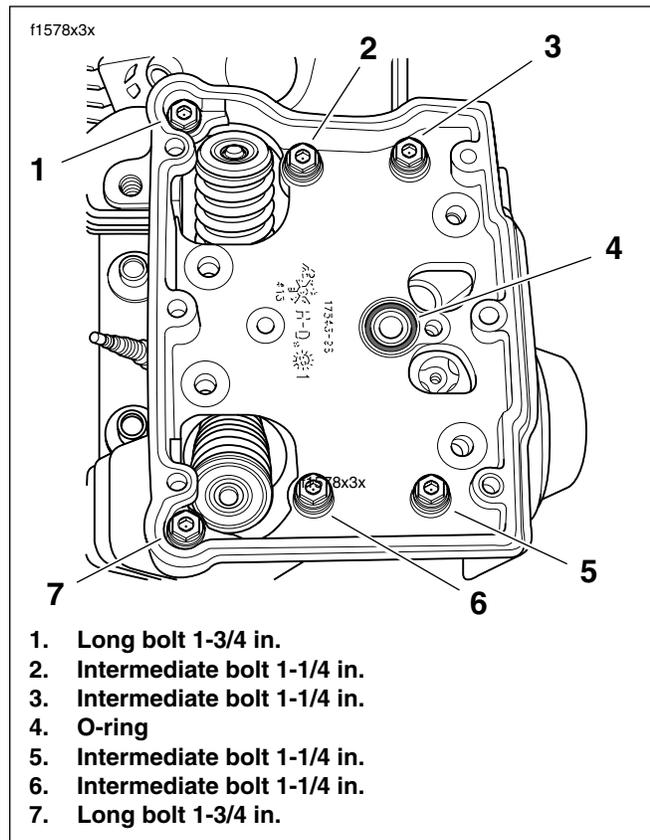


Figure 3-3. Rocker Housing Bolt Lengths

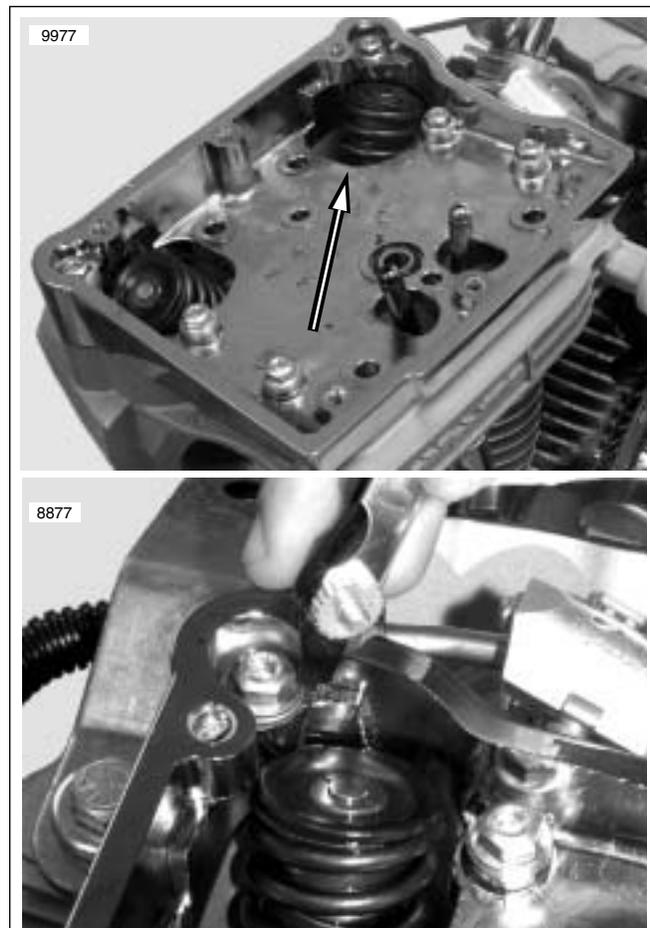


Figure 3-4. Valve Spring to Rocker Housing Clearance

11. Tighten rocker housing bolts to 120-168 **in-lbs** (13.6-19.0 Nm) in the pattern shown in [Figure 3-5](#).

NOTE

*If the engine was left in the chassis for service, final tighten the rear left rocker housing bolt (rear cylinder) using a torque wrench with a 1/4 inch drive. Since this tool may not be available in foot-pounds, tighten the bolt to 120-168 **in-lbs** (13.6-19.0 Nm).*

12. Re-check clearance at both valve spring assemblies and repeat until there is sufficient clearance between spring assemblies and rocker housing with the bolts torqued.

CAUTION

O-rings that are missing, distorted, pinched or otherwise damaged will result in either oil leakage or low oil pressure. Use of the wrong o-ring will have the same results. Since many o-rings are similar in size and appearance, always use new o-rings keeping them packaged until use to avoid confusion.

13. Install **new** o-ring in groove around breather baffle hole in rocker housing. Apply a thin film of clean SYN3 engine oil to o-ring before installation.
14. Continue the top end overhaul by installing the hydraulic lifters in the crankcase bores. See ASSEMBLY under TOP END OVERHAUL in the Touring Models Service Manual.

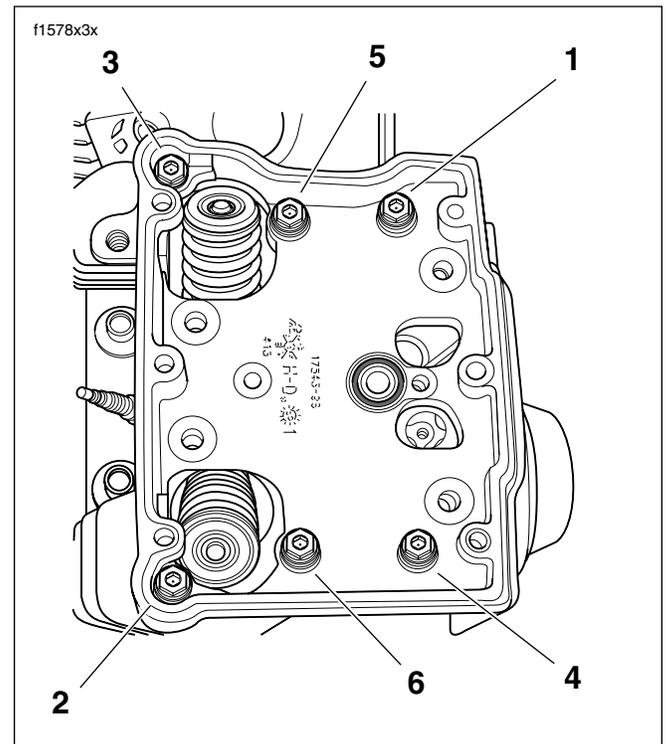


Figure 3-5. Rocker Housing Torque Sequence

GENERAL

For service wear limits, refer to [Table 3-17](#).

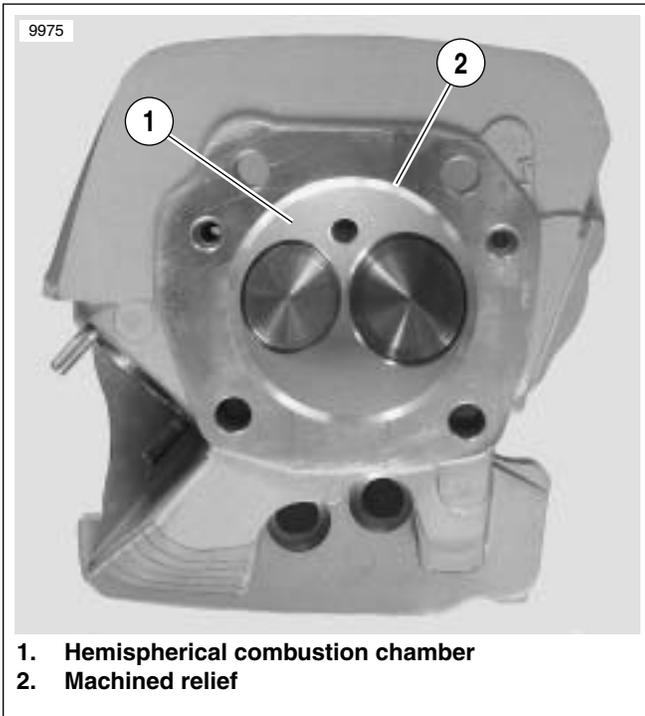


Figure 3-6. FLHTCUSE Front Cylinder Head

REMOVAL

See Touring Models Service Manual for removal of cylinder heads.

DISASSEMBLY

1. Before proceeding with the disassembly procedure, determine if cylinder head reconditioning is necessary. Proceed as follows:
 - a. Raise valve ports of cylinder head to strong light source. If light is visible around edges of seats, then move to step 2 to recondition cylinder head.
 - b. Fill ports at top of cylinder head with solvent. Wait ten full seconds and then check for leakage into combustion chamber. If solvent leakage into combustion chamber is evident, then move to step 2 to recondition cylinder head.

2. See [Figure 3-7](#). Obtain the CYLINDER HEAD HOLDING FIXTURE (HD-39786) and proceed as follows:
 - a. Note that both ends of the fixture are threaded, one end at 14mm and the other at 12mm. Thread the 12mm end of the tool into the spark plug hole of the cylinder head.
 - b. See [Figure 3-8](#). Clamp tool in vise at a 45 degree angle (or one that offers a comfortable working position).

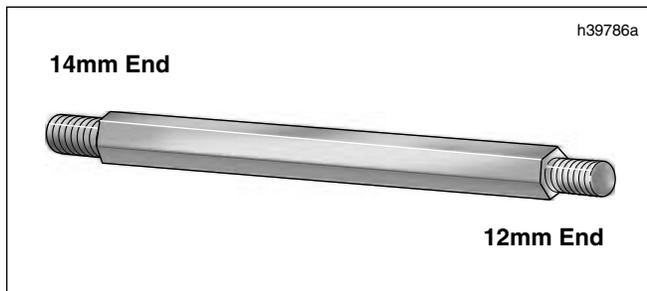


Figure 3-7. Cylinder Head Holding Fixture (Part No. HD-39786)

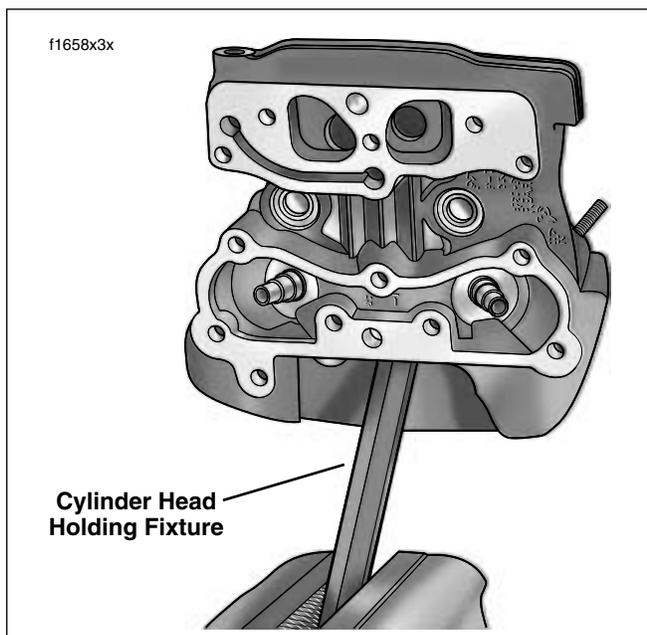
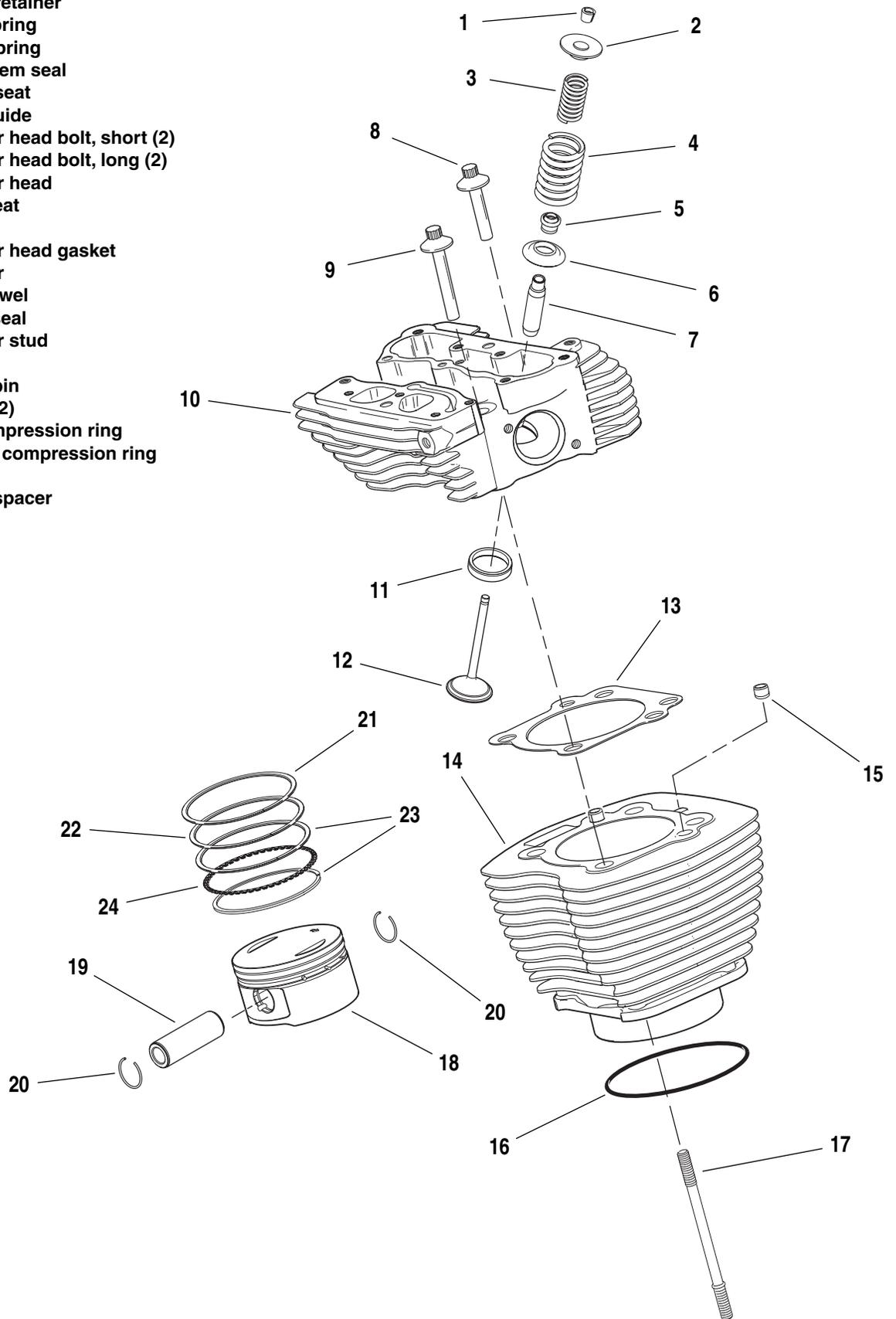


Figure 3-8. Install Cylinder Head Holding Fixture in Vise

1. Tapered keepers
2. Spring retainer
3. Inner spring
4. Outer spring
5. Valve stem seal
6. Spring seat
7. Valve guide
8. Cylinder head bolt, short (2)
9. Cylinder head bolt, long (2)
10. Cylinder head
11. Valve seat
12. Valve
13. Cylinder head gasket
14. Cylinder
15. Ring dowel
16. O-ring seal
17. Cylinder stud
18. Piston
19. Piston pin
20. Circlip (2)
21. Top compression ring
22. Second compression ring
23. Oil rail
24. Oil rail spacer



f21332x3x

Figure 3-9. Cylinder Head/Cylinder/Piston Assemblies (Exploded View)

3. See [Figure 3-10](#). Obtain the VALVE SPRING COMPRESSOR (HD-34736B) and proceed as follows:
 - a. See [Figure 3-11](#). Place tool over cylinder head so that the blunt end is centered on the valve head and adapter at end of forcing screw is seated on the valve spring retainer.
 - b. Rotate forcing screw to compress valve springs.
 - c. If spring retainer has not broken free of tapered keepers, give head of tool a sharp tap with a soft mallet. Using magnetic rod or small screwdriver, remove the keepers from the valve stem groove.
 - d. Rotate forcing screw to release the valve spring compression.
4. Remove the spring retainer and inner and outer valve springs.
5. Slide the valve from the valve guide.
6. Using pliers, twist and remove the valve stem seal from the top of the valve guide. Discard the valve stem seal.
7. Remove the spring seat from the cylinder head.
8. Mark the bottom of the valve "F(ront)" or "R(ear)" to indicate the cylinder head from which it was removed. Also, separate and tag tapered keepers, valve springs, spring retainers and spring seats so that they are installed on the same valve at time of assembly.
9. Repeat steps 3-8 to remove the other valve components.
10. Release the cylinder head holding fixture from the vise and then remove the tool from the spark plug hole.

CLEANING

1. Remove old gasket material from cylinder head. Gasket material left on sealing surfaces will cause leaks.
2. Remove all carbon deposits from combustion chamber and machined surfaces of cylinder head. Exercise caution to avoid removing any metal material. For best results, use an air tool with a **worn** wire brush. Scraping may result in scratches or nicks.
3. To soften stubborn deposits, soak the cylinder head in a chemical solution, such as GUNK HYDRO-SEAL or other carbon and gum dissolving agent. Repeat step 2 as necessary.

CAUTION

Do not use glass or sand to bead blast surfaces exposed to the engine oil. Bead blasting materials become lodged in the pores of the casting where they cannot be removed through ordinary cleaning methods. Only after the engine is put into use will heat expansion cause this material to be released, and the resulting oil contamination will accelerate wear and lead to engine failure. If bead blasting must be employed, use walnut shells or other soft non-damaging abrasive that can be digested in the engine oil.

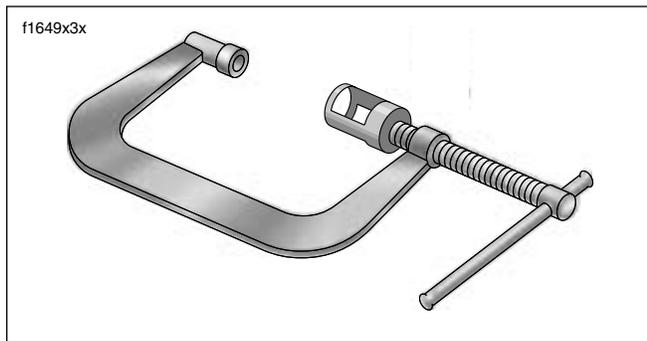


Figure 3-10. Valve Spring Compressor (Part No. HD-34736B)

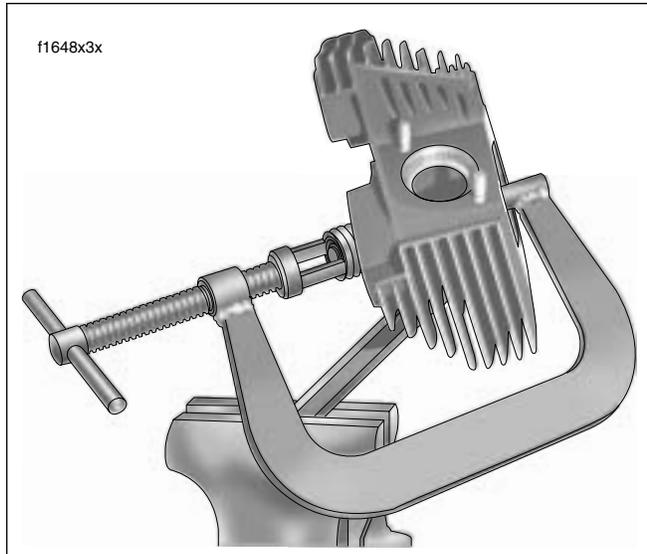


Figure 3-11. Compress Valve Springs

CAUTION

Be aware that bead blasting materials may also enter threaded holes adversely affecting fastener engagement and torque indication. Carefully cover all threaded holes if bead blasting is employed.

4. Thoroughly clean the cylinder head, spring retainers, tapered keepers, valves, inner and outer valve springs and spring seats in a non-volatile cleaning solution or solvent. Follow up with a thorough wash in hot soapy water. Blow dry with compressed air.

INSPECTION

Cylinder Head

1. Check for scratches and nicks on all gasket sealing surfaces.
2. With the combustion chamber side facing upward, set a straightedge diagonally across the length of the cylinder head intersecting the upper and lower corners of the gasket surface. Slide a feeler gauge beneath the straightedge to check the head for warpage. Checking the opposite diagonal, repeat the procedure to verify that the gasket surface is flat (especially if a head gasket was blown). Discard the head if any low spot is 0.006 inch (0.15 mm) or greater.

NOTE

For good results, use one of the CYLINDER TORQUE PLATES (HD-42324A) in lieu of the straightedge. Lay the upper plate flat on the machined surface of the head. As a preliminary check, see if the plate rocks from side to side. A head on which the plate rocks is immediately suspect. Insert a feeler gauge between the plate and head at various locations to see if warpage exceeds above specification.

3. Verify that oil passageways are open and clean.

Valve Guides

1. Inspect external surfaces for cracks (particularly the combustion chamber side). Replace the guide if any cracks are found.
2. To verify cleanliness of valve guides, lightly hone bore using the VALVE GUIDE HONE (HD-34723) and then scrub with the VALVE GUIDE CLEANING BRUSH (HD-34751) to remove any dust or debris. Polish the valve stem with fine emery cloth or steel wool to remove carbon buildup, and then check valve stem to guide clearance as follows:

Carefully measure the inside diameter of the valve guide using an inside ball micrometer. Measure the outside diameter of the valve stem with an outside micrometer. The valve stem and/or guide are excessively worn if the clearance exceeds the limits shown in [Table 3-26](#). Repeat measurements with a new valve to determine if the guide must be replaced.

Table 3-26. Service Wear Limits

Valve	Valve Stem to Guide Clearance
Intake	0.0035 in. (0.089 mm)
Exhaust	0.0040 in. (0.102 mm)

Valves

1. Replace the valve if there is evidence of burning or cracking.
2. Inspect the end of the valve stem for pitting or uneven wear. Replace the valve if either of these conditions are found.
3. Inspect for burrs around the valve stem keeper groove. Remove burrs with a fine tooth file if found.
4. To determine if the valve stem is excessively worn, see INSPECTION, VALVE GUIDES, step 2.

Valve Springs

1. Inspect springs for broken or discolored coils. Replace springs if either of these conditions are found.
2. Set the intake and exhaust valve springs on a level surface and use a straightedge to check for proper squareness and height.
3. Check free length of inner and outer springs using a dial vernier caliper or load test with the VALVE SPRING TESTER (HD-96796-47). Replace springs if free length or compression force do not meet specifications. See [Section 3.1 SPECIFICATIONS](#).

Tapered Keepers

1. Inspect parts for damage or rust pits. Replace as necessary.
2. Inspect inboard side of tapered keepers for excessive wear. Upraised center must be pronounced and fit snugly in valve stem groove. Place keepers into groove and verify that they grip tightly without sliding.

Valve Seats

1. Inspect seats for cracking, chipping or burning. Replace seats if any evidence of these conditions are found.
2. Check seats for recession by measuring valve stem protrusion. See [VALVE AND SEAT REFACING](#) in this section, steps 5-6.

VALVE GUIDE REPLACEMENT

Removal

NOTE

If valve guide replacement is necessary, always install new guide before refacing valve seat.

1. See [Figure 3-12](#). Obtain the CYLINDER HEAD SUPPORT STAND (HD-39782A) and proceed as follows:
 - a. Insert sleeve of intake or exhaust seat adapter into tube at top of support stand.
 - b. Position cylinder head so that valve seat is centered on seat adapter. Support stand ensures that valve guide and seat are perpendicular. If perpendicularity is not achieved, the cylinder head valve guide bore will be damaged during the press procedure.

CAUTION

Do not press out the valve guide from the bottom of the cylinder head. Carbon buildup on the combustion chamber side of the guide can deeply gouge the cylinder head bore diminishing the likelihood of achieving the proper interference fit and possibly requiring replacement of the cylinder head casting.

2. See [Figure 3-13](#). At the top of the cylinder head, insert VALVE GUIDE DRIVER (HD-34740) into valve guide bore until stopped by shoulder.
3. See [Figure 3-14](#). Center valve guide driver under ram of arbor press. Apply pressure until valve guide drops free of cylinder head. Discard the valve guide.

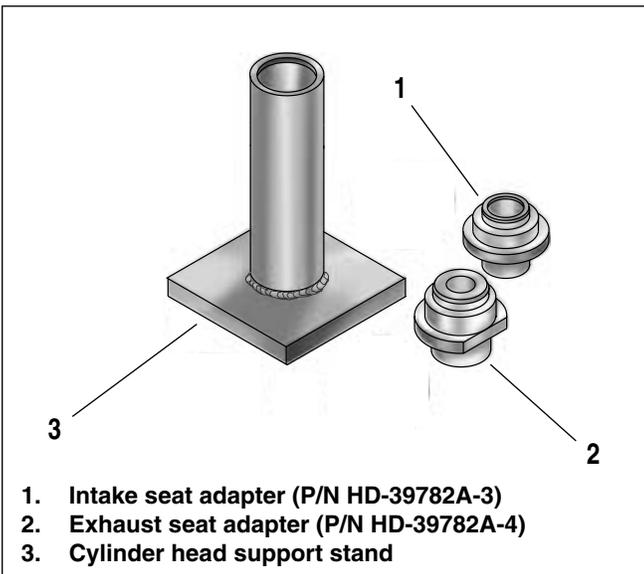


Figure 3-12. Cylinder Head Support Stand (Part No. HD-39782A)

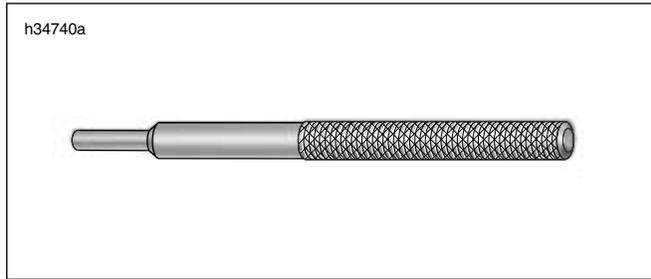


Figure 3-13. Valve Guide Driver (Part No. HD-34740)

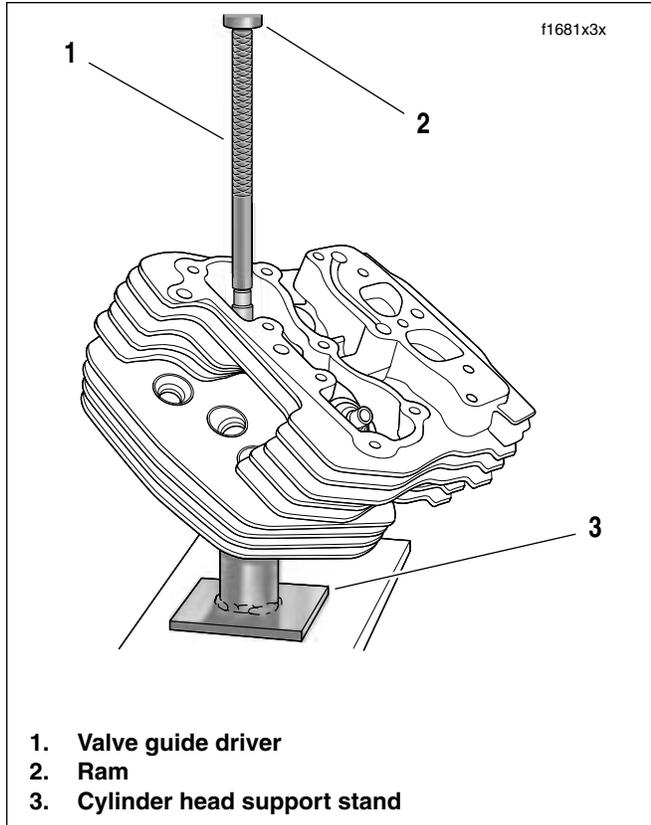


Figure 3-14. Remove Valve Guide

Installation

1. Measure the outside diameter of a **new** standard valve guide, and then measure the cylinder head valve guide bore. The valve guide should be 0.0020-0.0033 inch (0.051-0.084 mm) larger than the bore.

If clearance is not within specification, then select one of the following oversize guides - 0.001 inch (0.025 mm), 0.002 inch (0.05 mm) or 0.003 inch (0.08 mm).

NOTE

Since some material is typically removed when the guide is pressed out, it is normal to go to the next larger size for the proper interference fit.

2. Measure cylinder head bore and outside diameter of selected oversize guide to verify correct interference fit.
3. See [Figure 3-12](#). See [Figure 3-15](#). Obtain the CYLINDER HEAD SUPPORT STAND (HD-39782A), VALVE GUIDE DRIVER (HD-34740) and VALVE GUIDE INSTALLER SLEEVE (HD-34731). Proceed as follows:
 - a. See [Figure 3-16](#). Insert sleeve of intake or exhaust seat adapter into tube at top of support stand. Position cylinder head so that valve seat is centered on seat adapter. Support stand ensures that valve guide and seat are perpendicular. If perpendicularity is not achieved, cylinder head valve guide bore will be damaged during the press procedure.
 - b. Apply Vaseline to lightly lubricate external surfaces of valve guide. Spread lubricant so that thin film covers entire surface area.
 - c. At top of cylinder head, start valve guide into bore.
 - d. Place installer sleeve over valve guide, and then insert tapered end of valve guide driver into installer sleeve.
 - e. Center valve guide driver under ram of arbor press and apply pressure only until valve guide is started in bore and then back off ram slightly to allow guide to center itself.

CAUTION

Always back off ram to allow the valve guide to find center. Pressing guide into cylinder head in one stroke can bend driver, break guide, distort cylinder head casting and/or damage cylinder head valve guide bore.

- f. Verify that support stand and driver are square. Center driver under ram and press valve guide further into bore, but then back off ram again to allow valve guide to find center.
- g. Repeat previous step and then apply pressure to driver until installer sleeve contacts machined area of cylinder head.

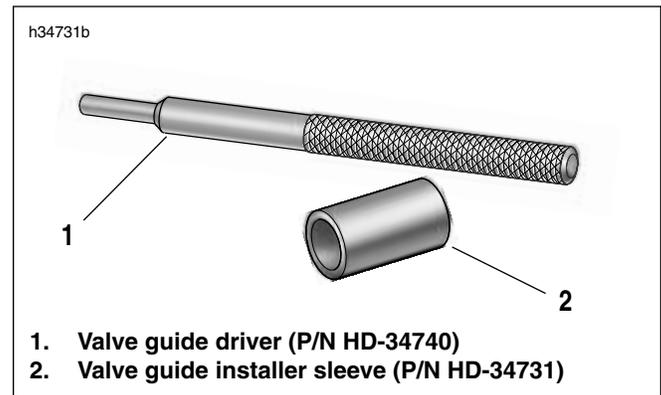


Figure 3-15. Valve Guide Driver and Installer Sleeve

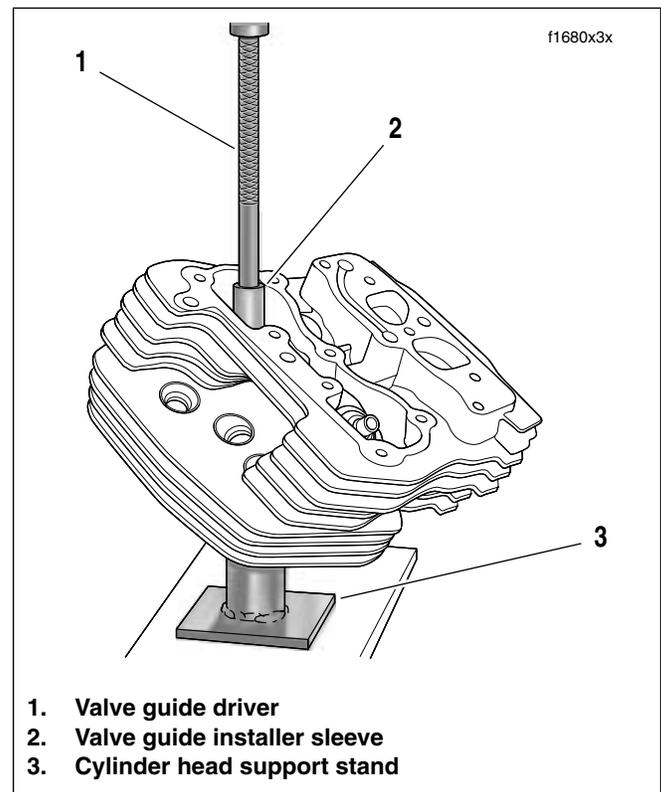


Figure 3-16. Install Valve Guide

4. See [Figure 3-7](#). Obtain the CYLINDER HEAD HOLDING FIXTURE (HD-39786) and proceed as follows:
 - a. Thread the 12mm end of the tool into the spark plug hole of the cylinder head.
 - b. Clamp tool in vise at a 45 degree angle (or one that offers a comfortable working position).

NOTE

Valve guides must be reamed to within 0.0005-0.0001 inch (0.013-0.0025 mm) of finished size.

5. See [Figure 3-17](#). Obtain the VALVE GUIDE REAMER (HD-39932), REAMER T-HANDLE (HD-39847) and REAMER LUBRICANT (HD-39964). Proceed as follows:
 - a. Install T-handle on reamer.
 - b. Apply a liberal amount of reamer lubricant to valve guide bore and bit of reamer. Start bit of reamer into bore at top of cylinder head.
 - c. See [Figure 3-18](#). Placing thumb on drive socket of reamer T-handle, apply slight pressure on reamer while rotating in a clockwise direction. Squirt additional lubricant onto reamer and into guide as necessary.

CAUTION

For best results, do not push on reamer or apply pressure to the reamer handle. While excessive pressure results in a rough cut, bore will be tapered if pressure is not centrally applied.

- d. Continue rotating reamer T-handle until entire bit has passed through valve guide bore and shank of reamer rotates freely.

CAUTION

Never back reamer out of valve guide or bore will be damaged.

- e. Remove T-handle from reamer, and carefully pulling on bit, draw shaft of reamer out combustion chamber side of valve guide.

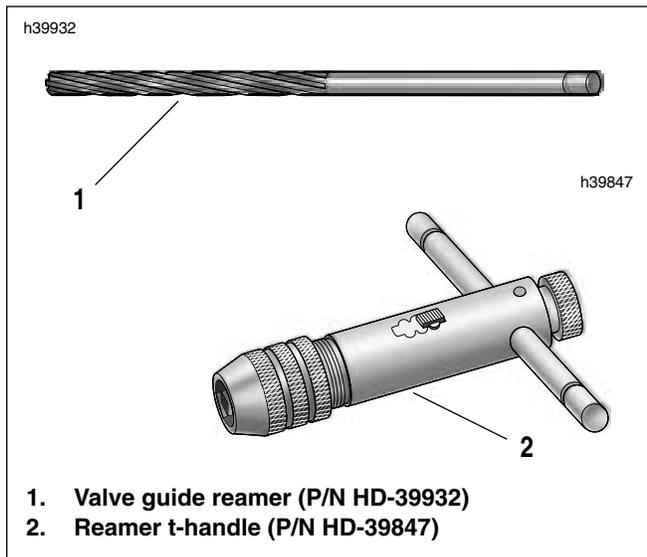


Figure 3-17. Valve Guide Reamer and T-Handle

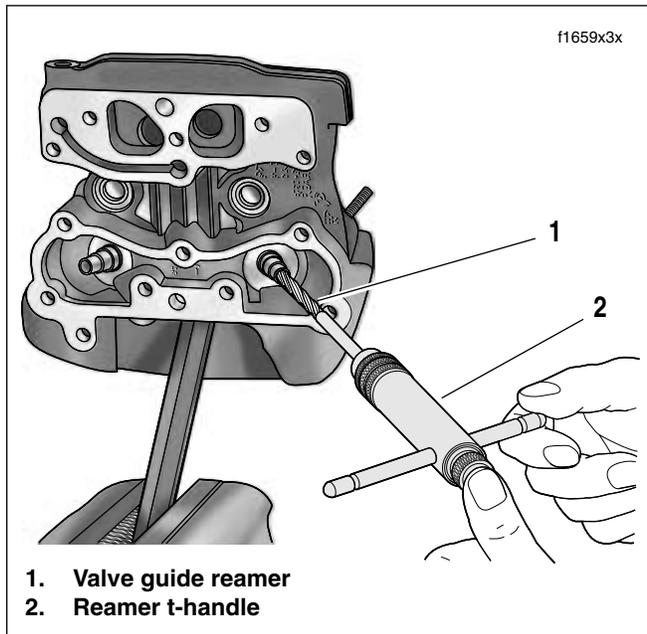


Figure 3-18. Ream Valve Guide Bore

CAUTION

Abrasive particles can damage machined surfaces and plug oil passageways possibly resulting in engine failure.

6. Direct compressed air into the valve guide bore to remove any metal shavings or debris.

7. See [Figure 3-19](#). Clean valve guide bore with the VALVE GUIDE CLEANING BRUSH (HD-34751).
8. See [Figure 3-20](#). Obtain the VALVE GUIDE HONE (HD-34723) and REAMER LUBRICANT (HD-39964). Proceed as follows:
 - a. Install hone in a high speed electric drill.
 - b. Apply reamer lubricant to finishing stones of hone and valve guide bore.
 - c. Start finishing stones of hone into bore.
 - d. See [Figure 3-21](#). Activating the drill, move the entire length of the finishing stone arrangement forward and backward through the bore for 10 to 12 complete strokes. Work for a crosshatch pattern of approximately 60°.

CAUTION

Abrasive particles can damage machined surfaces and plug oil passageways possibly resulting in engine failure.

9. Direct compressed air into the valve guide bore to remove any debris and then clean with the VALVE GUIDE CLEANING BRUSH (HD-34751). See [Figure 3-22](#).

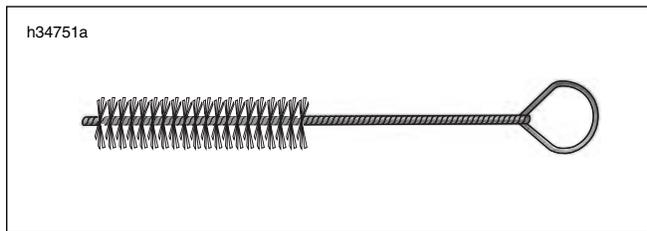


Figure 3-19. Valve Guide Brush (Part No. HD-34751)

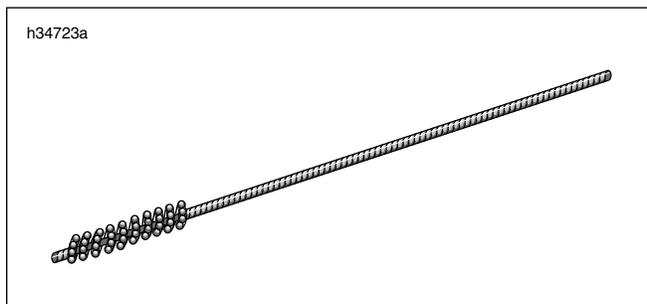


Figure 3-20. Valve Guide Hone (Part No. HD-34723)

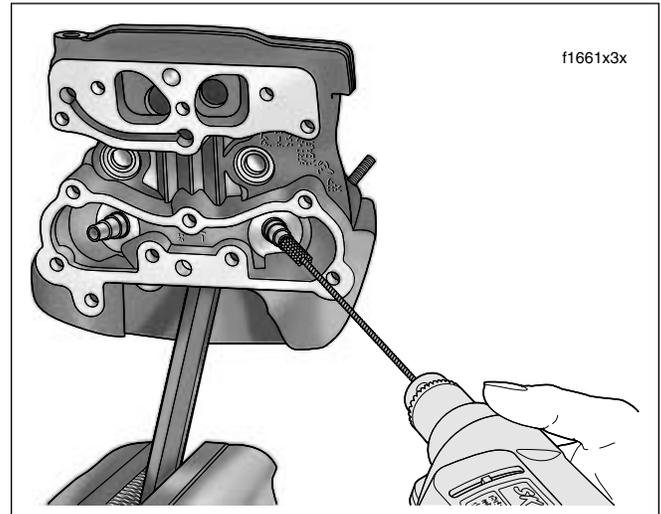


Figure 3-21. Hone Valve Guide Bore

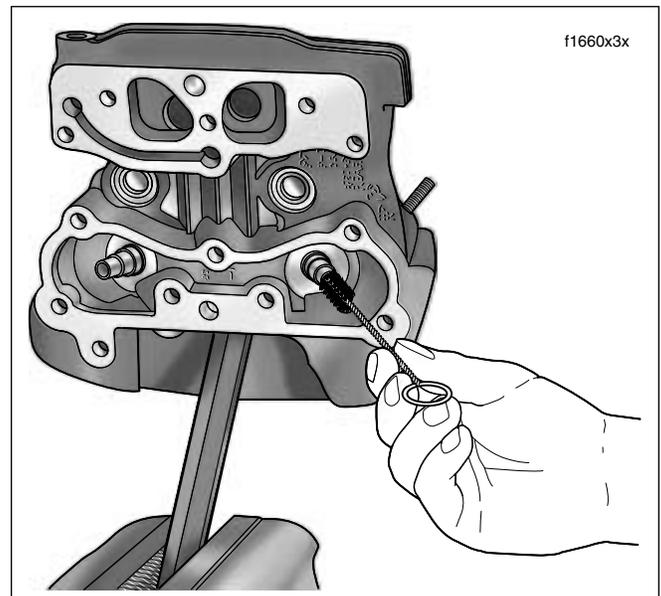


Figure 3-22. Scrub Valve Guide Bore

NOTE

Always verify valve stem to valve guide clearance after honing, since a worn reamer may cut the bore undersize.

10. Measure the inside diameter of the valve guide with an inside ball micrometer. Measure the outside diameter of the valve stem with an outside micrometer. The valve stem may be excessively worn or the valve guide bore undercut if the clearance is not within the limits (low end preferable) shown in Table 3-27.

Table 3-27. New Parts Limits

Valve	Valve Stem to Guide Clearance
Intake	0.0008-0.0026 in. (0.020-0.066 mm)
Exhaust	0.0015-0.0033 in. (0.038-0.084 mm)

11. Using cleaning solvent, thoroughly clean cylinder head and valve guide bore. Scrub valve guide bore with the VALVE GUIDE CLEANING BRUSH (HD-34751). For best results, use a thin engine oil and clean valve guide bore with the type of swabs or patches found in gun cleaning kits. Continue to wipe bore until clean cloth shows no evidence of dirt or debris. Follow up with a thorough wash in hot soapy water. Blow dry with compressed air.

VALVE AND SEAT REFACING

NOTE

Verify correct valve stem to valve guide clearance before refacing. Refer to Table 3-27. If new guides must be installed, complete that task before refacing valves and seats.

1. Hold the valve firmly against a wire wheel in a bench grinder. Remove all carbon deposits from the valve head, face and stem, but exercise caution to avoid removing any metal. Carbon left on the stem may affect alignment in the valve refacer. Polish the valve stem with steel wool or crocus cloth to remove any marks that might be left by the wire wheel.
2. Install valve (both intake and exhaust) in a valve refacer set to a 45 degree angle. The valve refacer is required equipment, since accuracy in matching the angle of the valve face with the angle of the valve seat is critical.

Do not remove any more metal than is necessary to clean up and true the valve face. Removing metal reduces the service life of the valve. The amount of grinding needed to retrue the valve is a clear indication of its condition. Discard the valve if it cannot be quickly refaced while maintaining a good margin. Valves that do not clean up quickly are either warped, excessively worn or too deeply pitted to be used.

Obtain a **new** valve if grinding leaves the margin less than 0.0313 inch (0.795 mm). A valve in this condition does not seat normally, burns easily and may crack or cause pre-ignition.

3. Obtain the CYLINDER HEAD HOLDING FIXTURE (HD-39786) and proceed as follows:
 - a. Thread the 12mm end of the tool into the spark plug hole of the cylinder head.
 - b. Clamp tool in vise at a 45 degree angle (or one that offers a comfortable working position).
4. Obtain the NEWAY VALVE SEAT CUTTER SET (HD-35758A) and cut valve seat angle to 46°.

NOTE

Do not remove any more metal than is necessary to clean up the seat (that is, to provide a uniform finish and remove pitting).

5. From the bottom of the cylinder head, insert the valve stem into the valve guide. Push on bottom of valve until it contacts the valve seat.
6. Placing finger at bottom of valve to keep valve seated, use a dial vernier caliper to check the distance from the top of the valve stem to the machined area on the cylinder head. See [Figure 3-23](#).
 - a. Seat wear and valve refacing causes the valve stem protrusion to change. If valve stem protrusion exceeds 2.034 inches (51.66 mm), but is less than 2.064 inches (52.43 mm), obtain the short service replacement valve. Service replacement valves are 0.030 inch (0.76 mm) shorter than the standard valve.
 - b. If protrusion exceeds 2.064 inches (52.43 mm), then use the existing valve, but replace the valve seat.
7. Remove valve from cylinder head. Apply magic marker or similar product to valve seat and allow to thoroughly dry.
8. Insert the valve stem into the valve guide. Push on bottom of valve until it contacts the valve seat.
9. See [Figure 3-24](#). Obtain the VALVE LAPPING TOOL (HD-96550-36A) and proceed as follows:
 - a. Attach suction cup at end of tool to valve head.
 - b. See [Figure 3-25](#). Holding shank of tool between the palms of both hands, oscillate the tool back and forth a few times.

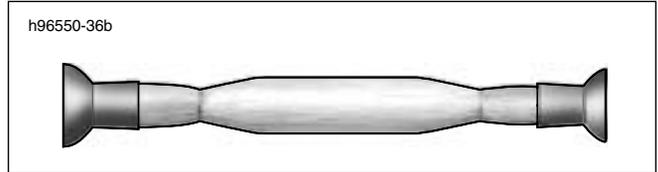


Figure 3-24. Valve Lapping Tool (Part No. HD-96550-36A)

CAUTION

Do not shorten the valve by grinding on the end of the stem. Grinding replaces the hardened case with mild steel which results in accelerated wear.

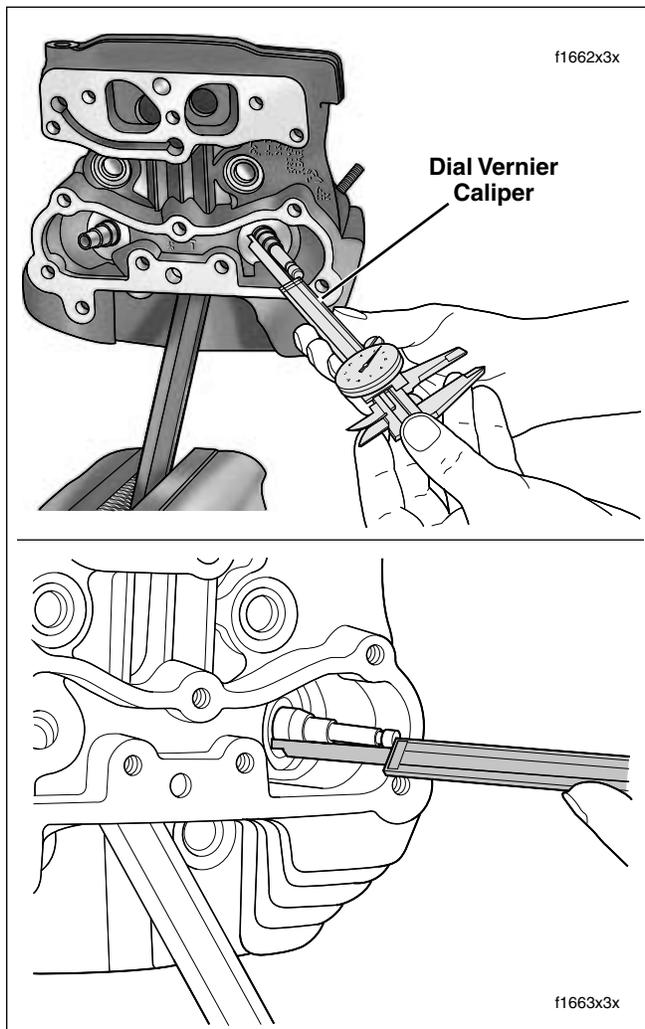


Figure 3-23. Measure Valve Stem Protrusion



Figure 3-25. Oscillate Valve Lapping Tool to Create Contact Area

10. Remove the valve from the cylinder head and carefully inspect the mating surfaces under a good light.

NOTES

- *Inspection of the valve seat should show an unbroken contact area of uniform width. If the seat is not concentric with the valve guide, the cutter will remove more material in one spot than another. Carbon deposits may have caused the guide to be pressed in crooked, the guide may be cracked, or the cutter blade or cutter pilot may not have been properly cleaned.*
 - *If the results are not acceptable, recut the valve seat or replace the valve guide.*
11. See Figure 3-26. Inspect the contact pattern on the valve seat to be sure area is 0.040-0.062 inch (1.02-1.57 mm) wide and contacts the valve two-thirds of the way towards the outer edge of the valve face. If necessary, modify the seat pattern as follows:
 - a. Use the 31° angle cutter to lower the valve seat surface and reduce its width.
 - b. Use the 60° angle cutter to raise the valve seat surface and reduce its width.
 - c. Use the 46° angle cutter to widen the valve seat surface.

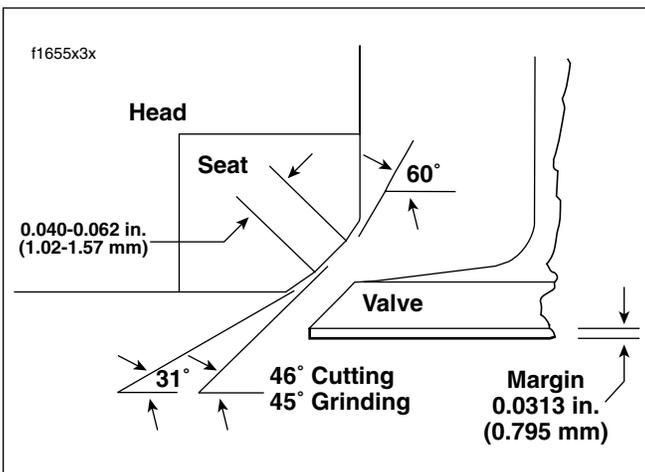


Figure 3-26. Valve Seat Angles

12. Using a magic marker, mark three equally spaced vertical lines across the valve face and then insert the valve back into the cylinder head.
13. Attach suction cup of VALVE LAPPING TOOL (HD-96550-36A) to valve head, and holding shank of tool between the palms of both hands, oscillate the tool back and forth a few times.
14. Remove the valve and perform a final inspection of the contact pattern. If necessary, return to step 11.
15. Remove the valve from the cylinder head. Use contact cleaner to thoroughly clean magic marker and/or dye from valve face and seat, if present.
16. Release the cylinder head holding fixture from the vise and then remove the tool from the spark plug hole.
17. To confirm quality of valve and seat refacing work, proceed as follows:
 - a. Insert valve in guide, and holding valve to seat, raise port to strong light source. If light is visible around edge of seat, then valves and seats must be reconditioned.
 - b. Holding valve to seat, fill port at top of cylinder head with solvent. Wait ten full seconds and then check for leakage into combustion chamber. If solvent leakage into combustion chamber is evident, then valves and seats must be reconditioned.

⚠ WARNING

Compressed air can pierce the skin and flying debris from compressed air could cause serious eye injury. Wear safety glasses when working with compressed air. Never use your hand to check for air leaks or to determine air flow rates. (00061a)

18. Clean valves, cylinder head and valve seats in solvent. Follow up with a thorough wash in hot soapy water. Blow dry with low pressure compressed air.

ASSEMBLY

1. Obtain the CYLINDER HEAD HOLDING FIXTURE (HD-39786) and proceed as follows:
 - a. Thread the 12mm end of the tool into the spark plug hole of the cylinder head.
 - b. Clamp tool in vise at a 45 degree angle (or one that offers a comfortable working position).
2. Slide spring seat over valve guide until it contacts the machined area on the cylinder head casting. Use a little grease to hold the spring seat in position, if necessary.

NOTE

At the time of disassembly, all parts should have been marked or tagged so that they are installed on the same valve (and in the same head).

3. Run the VALVE GUIDE CLEANING BRUSH (HD-34751) through the valve guide bore to verify cleanliness.
4. Using TORCO MPZ or another suitable product, apply a liberal amount of engine assembly lube to valve stem.
5. From the bottom of the cylinder head, insert the valve stem into the valve guide.
6. To distribute the assembly lube evenly around the valve stem and guide, hand spin the valve as it is installed. Work the valve back and forth in the bore to verify that it slides smoothly and seats properly.
7. Remove the valve and apply a second coat of assembly lube to the valve stem. Install the valve in the valve guide.
8. Retract the valve so that the stem is not visible above the top of the valve guide.
9. Using isopropyl alcohol or other suitable degreaser, thoroughly clean external surface of valve guide until completely free of grease and oil.

CAUTION

Do not apply Loctite to inside of valve stem seal or top of valve guide or valve may stick to seal resulting in loss of compression and valve sticking.

10. Obtain tube of Loctite RC/620 (green) High Temperature Retaining Compound. Carefully apply Loctite to valve stem seal seating surface on outside diameter of valve guide. Exercise caution to keep compound out of valve guide bore.

CAUTION

Failure to install plastic capsule will cause the valve stem seal to catch the edge of the valve stem keeper groove. The resulting damage will lead to leakage around the valve stem, excessive oil consumption and valve sticking.

11. See [Figure 3-27](#). Push on bottom of valve until it contacts the valve seat. Placing finger at bottom of valve to keep valve seated, slide plastic capsule over valve stem tip and keeper groove.

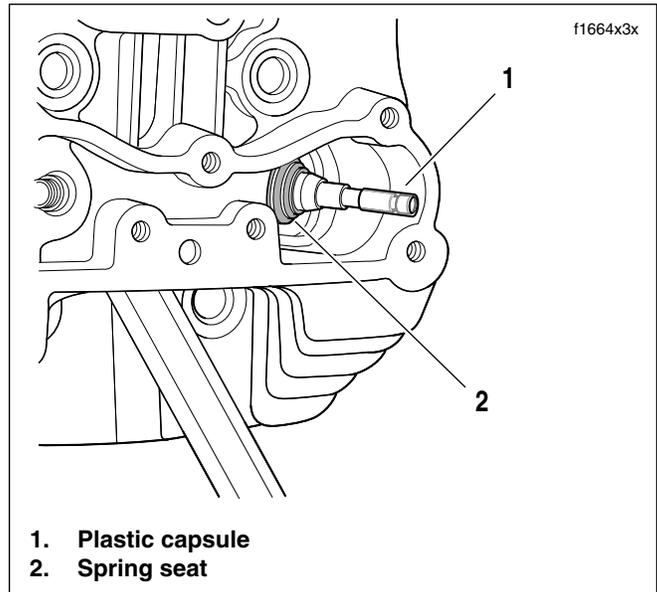


Figure 3-27. Install Plastic Capsule on Valve Stem

12. See [Figure 3-28](#). Apply a very thin film of clean H-D 20W50 engine oil to capsule. Slide **new** valve stem seal over capsule and down valve stem until contact is made with top of valve guide. Remove capsule from valve stem tip.

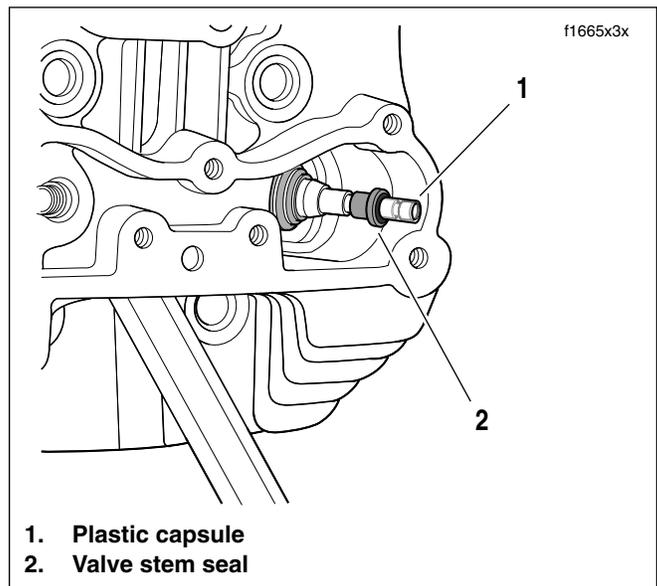


Figure 3-28. Install Valve Stem Seal

CAUTION

To avoid damaging the valve stem seal and/or cracking the valve guide, always use the proper valve stem seal installer tool. Use of an ordinary socket will damage the seal or guide, resulting in leakage around the valve stem, excessive oil consumption and valve sticking.

13. See [Figure 3-29](#). Obtain the VALVE STEM SEAL INSTALLER (HD-34643A) and proceed as follows:

- a. Slide the installer tool over the valve stem seal using valve stem as pilot. The tool bore allows insertion of the valve stem, while the counterbore fits over the valve stem seal.

CAUTION

Repeated blows on installer after seal is in place will cause seal distortion resulting in leakage around the valve stem, excessive oil consumption and valve sticking.

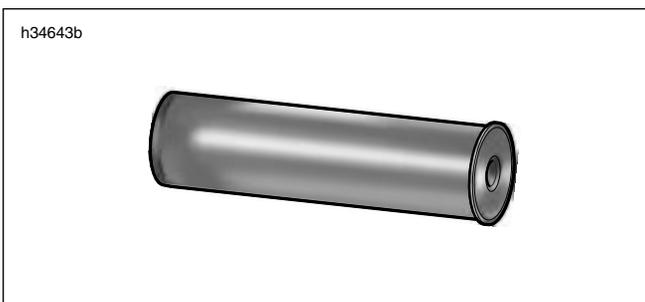
- b. See [Figure 3-30](#). Using a small hammer, gently tap the end of the tool until it lightly bottoms on the installed spring seat. For best results, brace the cylinder head with chest area to prevent movement during seal installation.

NOTE

See [Figure 3-31](#). If an arbor press is the preferred method of valve stem seal installation, use the VALVE STEM SEAL INSTALLER (HD-34643A) with the VALVE GUIDE DRIVER (HD-34740).

CAUTION

Removing the valve after seal installation will cause the valve stem seal to catch the edge of the valve stem keeper groove. The resulting damage will lead to leakage around the valve stem, excessive oil consumption and valve sticking.



**Figure 3-29. Valve Stem Seal Installer
(Part No. HD-34643A)**

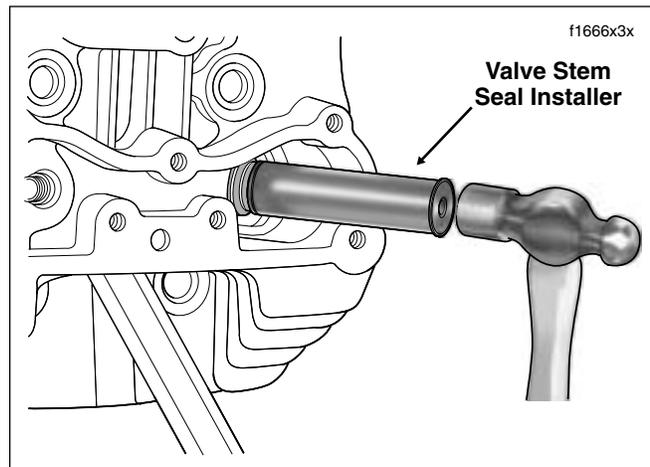
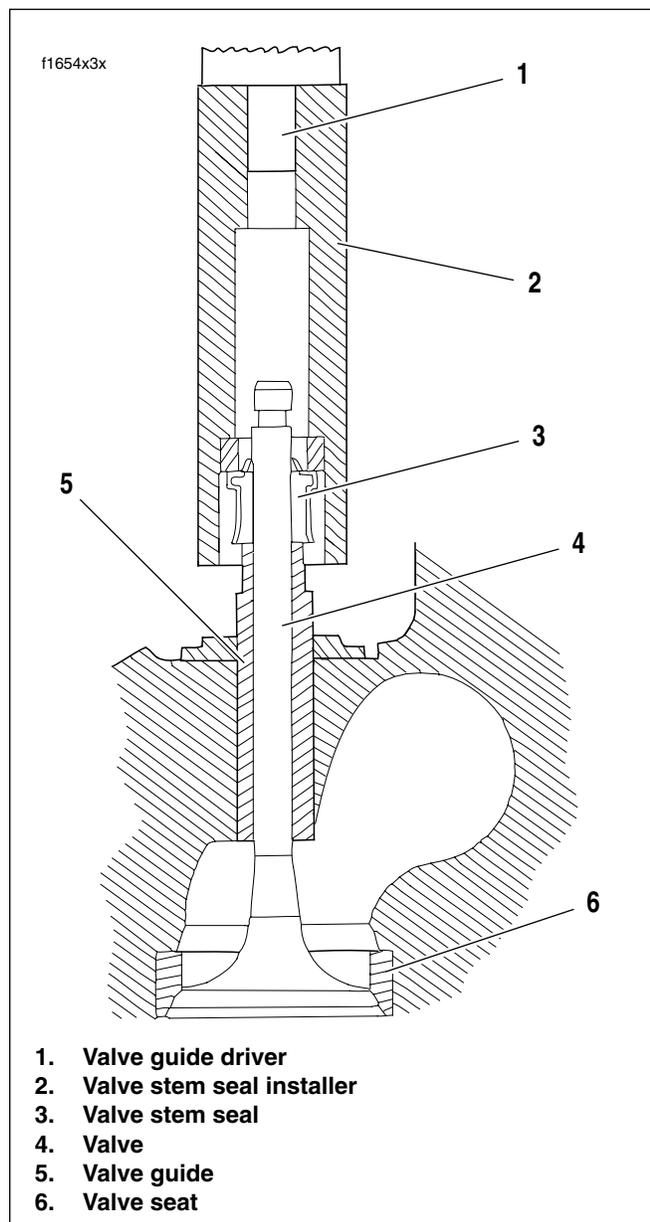


Figure 3-30. Tap Installer to Seat Valve Stem Seal



1. Valve guide driver
2. Valve stem seal installer
3. Valve stem seal
4. Valve
5. Valve guide
6. Valve seat

Figure 3-31. Using Arbor Press to Install Valve Stem Seal

14. Apply a liberal amount of assembly lube to valve stem tip and keeper groove.
15. Install the inner and outer valve springs over the valve guide. Fit the spring retainer on top of the inner and outer valves springs. Like the spring seat, the smaller diameter flange fits inside the inner valve spring. The larger diameter flange separates the inner and outer springs.
16. Obtain the VALVE SPRING COMPRESSOR (HD-34736B) and proceed as follows:
 - a. Place tool over cylinder head so that the blunt end is centered on the valve head and adapter at end of forcing screw is seated on the valve spring retainer.

CAUTION

Over-compressing the valve spring can damage the valve stem seal resulting in leakage around the valve stem, excessive oil consumption and valve sticking.

- b. Rotate forcing screw to compress valve springs.
 - c. With the tapered side down, fit the keepers into the valve stem groove. For best results, apply a dab of grease to the inboard side of the keepers before installation and use a magnetic rod for easy placement.
 - d. Arranging tapered keepers so that the gaps are evenly spaced, turn forcing screw to release valve spring compression.
17. Tap the end of the valve stem once or twice with a soft mallet to ensure that tapered keepers are tightly seated in the valve stem groove.
18. Repeat all previous steps to install the other valve components.
19. Release the cylinder head holding fixture from the vise and then remove the tool from the spark plug hole.
20. Cover the cylinder head to protect it from dust and dirt until time of installation.

INSTALLATION

See Touring Models Service Manual for cylinder head installation procedure.

GENERAL

FLHTCUSE pistons differ from those of other touring models in specification and appearance. However, piston service procedures are the same as those found in the Touring Models Service Manual. See PISTON on SUBASSEMBLY SERVICE AND REPAIR in the Touring Models Service Manual.

For service wear limits, refer to [Table 3-20](#). and [Table 3-19](#).

NOTE

The piston is measured on the bare aluminum to avoid measuring errors. An oval-shaped spot is present on each side of the piston for proper placement of the micrometer. See upper frame of [Figure 3-33](#). Since the oval openings are too small for a standard flat anvil micrometer, which would result in measuring errors, use a 4-5 inch micrometer with spherical ball anvil adapters. See lower frame of [Figure 3-33](#).



Figure 3-32. FLHTCUSE Piston Orientation Arrow (arrow points to front of engine)

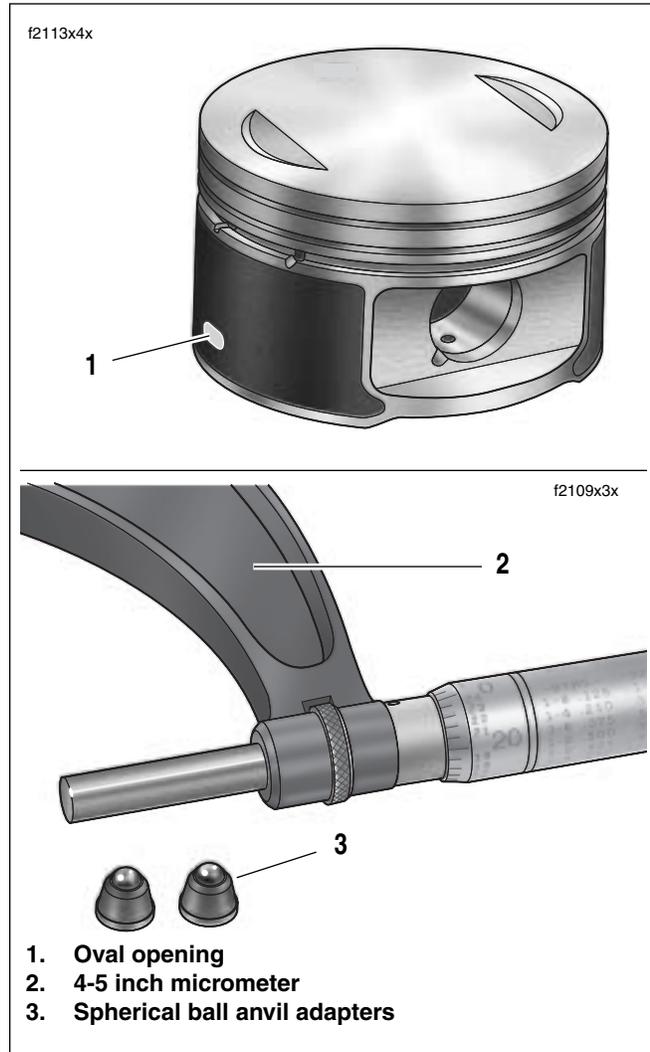


Figure 3-33. FLHTCUSE Piston Measurement

CYLINDER BORE FINISHED SIZE

1. For cylinder removal, cleaning, inspection, boring and honing and installation, see CYLINDER in the Touring Models Service Manual.
2. Refer to [Table 3-28](#). Bore the cylinder to 0.003 in. (0.08 mm) under the desired finished size. See BORING and HONING CYLINDER in the Touring Models Service Manual. Refer to [Table 3-28](#).

CAUTION

An improper crosshatch pattern or too fine a hone will result in insufficient oil retention and possible piston seizure and/or high oil consumption.

3. 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.
4. Stop frequently to examine the cylinder bore and/or take measurements. Remember, a precise 60° cross hatch pattern in the piston travel area is important.

5. Thoroughly wash the cylinder bore with liquid dish soap and warm water to remove all abrasive particles and residual girt. Continue cleaning until a clean cloth shows no evidence or dirt or debris.
6. Immediately apply a thin film of clean engine oil to a clean white paper towel and thoroughly wipe the inside of the cylinder. This prevents the cylinder bore from rusting.

NOTE

After wiping the cylinder with a clean, oiled paper towel, the towel will be dark with contamination. Repeat this process using a new lightly oiled paper towel each time until the towel remains white. The cylinder is now clean.

7. With the cylinder at room temperature, check the piston clearance in the cylinder in which the piston will run. See INSPECTION under PISTON in Touring Models Service Manual.
8. For cylinder installation, see CYLINDER in Touring Models Service Manual.

Table 3-28. Oversize Pistons/Cylinder Bores

PISTON		CYLINDER BORE FINISHED SIZE	
TYPE	SIZE	MINIMUM	MAXIMUM
Standard	STD	3.8750 in. (98.4250 mm)	3.8755 in. (98.438 mm)
Oversize	0.005 in. (0.13 mm)	3.8800 in. (98.552 mm)	3.8805 in. (98.565 mm)
	0.010 in. (0.25 mm)	3.8850 in. (98.679 mm)	3.8855 in. (98.692 mm)

GENERAL

FLHTCUSE cams differ from those of other touring models in specification and appearance. However, cam service procedures are the same as those found in the Touring Models Service Manual. See Camshafts and Camshaft Bearings under CAM SUPPORT PLATE under SUBASSEMBLY SERVICE AND REPAIR in the Touring Models Service Manual.

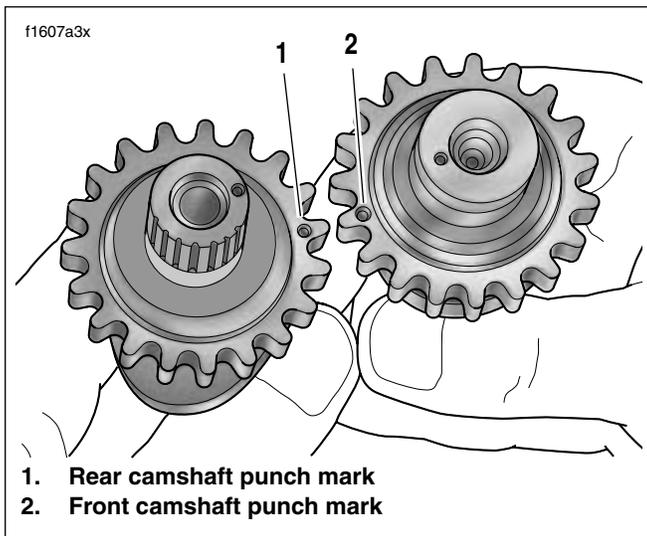


Figure 3-34. FLHTCUSE Cam Timing Marks

GENERAL

For removal, inspection, and installation, see FLYWHEEL/CONNECTING ROD ASSEMBLY under SUBASSEMBLY SERVICE AND REPAIR in the Touring Models Service Manual.

For service wear limits, refer to [Table 3-21](#). and [Table 3-22](#).

NOTE

If the flywheel or connecting rods need to be replaced, then they must be replaced together as one assembly.

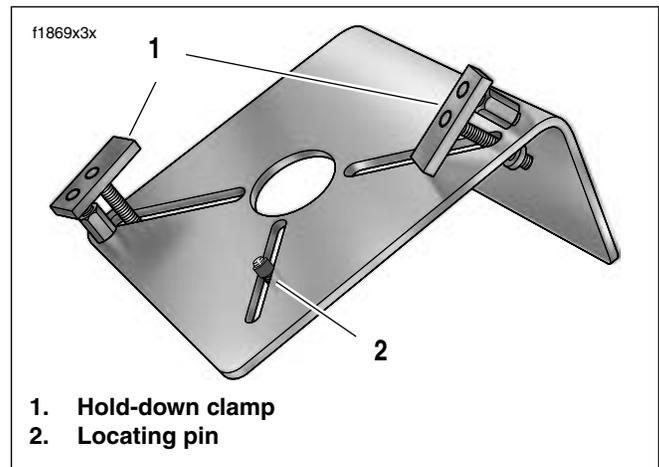


**Figure 3-35. FLHTCUSE
Flywheel/Connecting Rod Assembly**

SPROCKET SHAFT BEARING INNER RACE REPLACEMENT

PART NO.	SPECIALTY TOOL
HD-44358	Flywheel support fixture
HD-95637-46A	Wedge attachment
HD-34902B	Mainshaft bearing inner race puller/installer
HD-25070	Robinair heat gun

1. If reusing flywheel, remove bearing inner race and thrust washer as follows:
 - a. Obtain FLYWHEEL SUPPORT FIXTURE (HD-44358). See [Figure 3-36](#). Install brass jaws or shop towels around teeth of vise to prevent damage to tool. Clamp tool in vise with the round hole topside.
 - b. Insert crankshaft end through hole resting flywheel assembly on fixture. Slide knurled locating pin down slot in tool to engage crank pin hole. Hand tighten locating pin.
 - c. Slide hold-down clamp down slot to engage inboard side of right flywheel half, and then hand tighten knurled nut at bottom to secure. Repeat step to secure hold-down clamp on opposite side of flywheel.



1. Hold-down clamp
2. Locating pin

**Figure 3-36. Flywheel Support Fixture
(Part No. HD-44358)**

NOTE

For proper clamping force, hold-down clamp must not be tilted. Rotate hex on outboard stud until clamp is level.

- d. Position WEDGE ATTACHMENT (HD-95637-46A) on inboard side of thrust washer and turn hex nuts an equal number of turns to draw halves of wedge together.

CAUTION

Install wedge attachment only so far as necessary to ensure positive contact with thrust washer. Installing tool with more contact than absolutely necessary will result in damage to flywheel.

- e. Obtain two 3/8-16 inch bolts 6-1/2 inches long (with flat washers). Install flat washers on bolts. Obtain bridge, forcing screw and hardened plug from MAINSHAFT BEARING INNER RACE PULLER/INSTALLER (HD-34902B).
- f. Slide one bolt into channel on each side of bridge so that flat washer is between bridge and bolt head. Thread bolts into wedge attachment an equal number of turns.
- g. Sparingly apply graphite lubricant to threads of forcing screw to prolong service life and ensure smooth operation. Start forcing screw into center hole of bridge.

CAUTION

Failure to use hardened plug may result in damage to forcing screw and/or sprocket shaft.

- h. Place cupped side of hardened plug against end of sprocket shaft. Thread forcing screw into bridge until the steel ball at the end of the screw makes firm contact with hardened plug.
- i. Using the ROBINAIR HEAT GUN (HD-25070), uniformly heat the bearing inner race for about 30 seconds using a circular motion.

NOTE

To facilitate removal without heat, apply a light penetrating oil to shaft and leading edge of bearing inner race.

WARNING

Never use both heat and penetrating oil. Use only one or the other. Excessive heat can cause the penetrating oil to ignite resulting in flames or fire. Inadequate safety precautions can result in death or serious injury.

- j. Turn forcing screw until thrust washer and bearing inner race move approximately 1/8 inch (3.2 mm).
- k. Turn hex nuts an equal number of turns to separate halves of WEDGE ATTACHMENT.

- l. After bottoming thrust washer on shaft, reposition WEDGE ATTACHMENT (HD-95637-46A) on inboard side of bearing inner race. Turn hex nuts an equal number of turns to draw halves of wedge together.

CAUTION

Install wedge attachment only so far as necessary to ensure positive contact with bearing inner race. Installing tool with more contact than absolutely necessary will result in damage to flywheel.

- m. Verify that the tool assembly is square, so that the bearing inner race is not cocked during removal. See Figure 3-37.
- n. Using the ROBINAIR HEAT GUN (HD-25070), uniformly heat the bearing inner race for about 30 seconds using a circular motion.

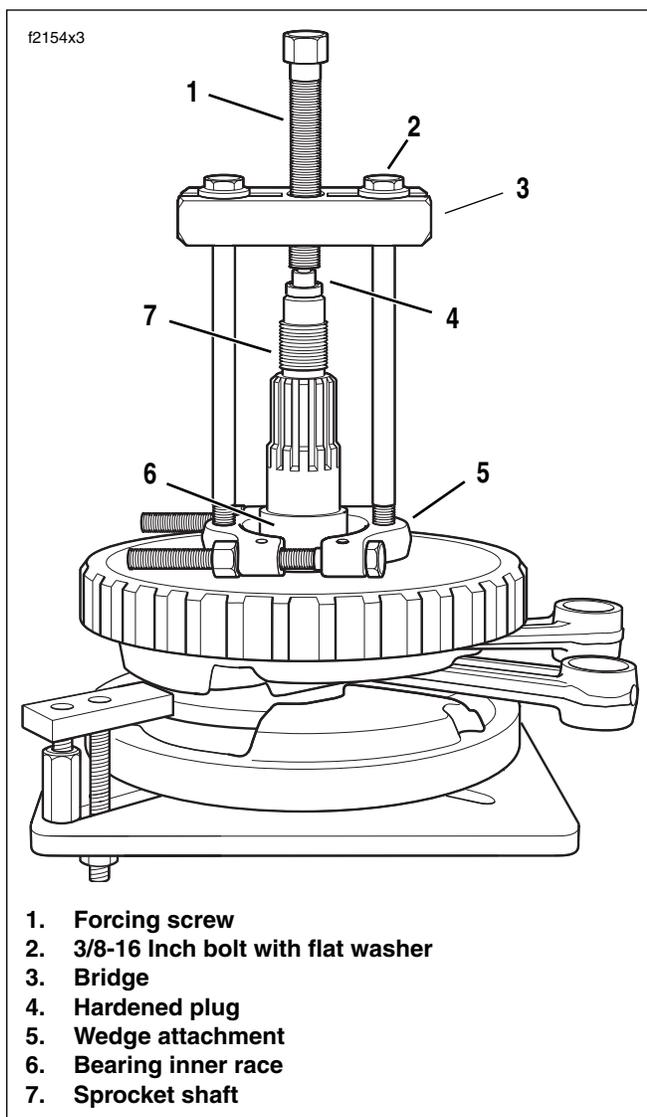


Figure 3-37. Remove Inner Race From Sprocket Shaft

NOTE

To facilitate removal without heat, apply a light penetrating oil to shaft and leading edge of bearing inner race.

- o. Turn forcing screw until bearing inner race is pulled free of sprocket shaft.
 - p. Remove thrust washer from sprocket shaft.
 - q. Discard thrust washer and bearing inner race.
2. Place **new** thrust washer over sprocket shaft with the ink stamp facing outside (and the chamfer on the ID inboard).
 3. Place **new** bearing inner race on bench top. Using the ROBINAIR HEAT GUN (HD-25070), uniformly heat bearing inner race for about 60 seconds using a circular motion.
 4. Wearing suitable gloves to protect hands from burns, place heated bearing inner race over sprocket shaft.

NOTE

To facilitate installation without heat, apply a light penetrating oil to shaft and leading edge of bearing inner race.

WARNING

Never use both heat and penetrating oil. Use only one or the other. Excessive heat can cause the penetrating oil to ignite resulting in flames or fire. Inadequate safety precautions can result in death or serious injury.

5. See Figure 3-38. Obtain the SPROCKET SHAFT TIMKEN BEARING CONE INSTALLER (HD-97225-55B). Assemble tool as described below.
 - a. See Figure 3-39. Thread pilot shaft onto sprocket shaft until contact is made with shoulder.
 - b. Sparingly apply graphite lubricant to threads of pilot shaft to prolong service life and ensure smooth operation.
 - c. Slide sleeve over pilot until it contacts bearing inner race.
 - d. Slide Nice bearing and large flat washer over pilot until contact is made with sleeve.
 - e. Thread handle onto pilot shaft. See upper frame of Figure 3-39.
6. Rotate handle of tool in a clockwise direction until bearing inner race bottoms against thrust washer. See lower frame of Figure 3-39.
7. Remove handle, flat washer, Nice bearing, sleeve and pilot from sprocket shaft.

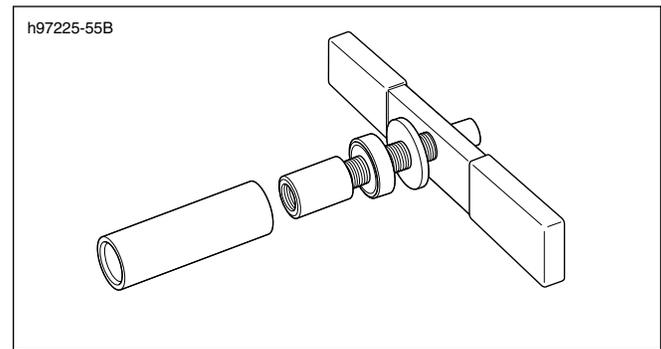


Figure 3-38. Sprocket Shaft Timken Bearing Cone Installer (Part No. HD-97225-55B)

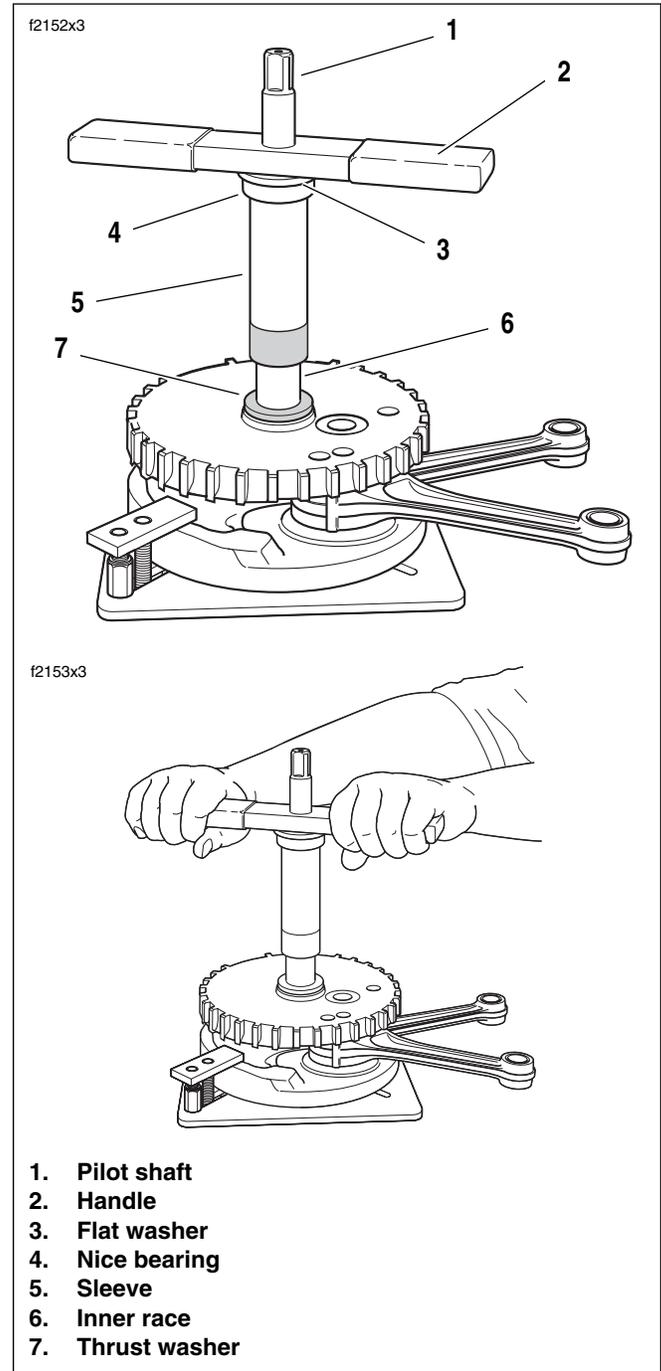


Figure 3-39. Press Inner Race Onto Sprocket Shaft

REPLACEMENT

PART NO.	SPECIALTY TOOL
HD-41137	Hose clamp pliers

NOTE

Dispose of oil in accordance with local regulations.

1. See Figure 3-40. Back the chrome nut off of the crankcase oil fitting.
2. Using side cutters, cut the clamps on the short length of hose at the oil spout end of the vent line.
3. Remove the oil vent line.
4. If necessary, remove both fittings and clean sealant from threads in crankcase and oil fill.

NOTE

The spout fitting is a nipple styled fitting.

5. If removed, identify the crankcase end fitting and using pipe sealant or TEFLON[®] tape, prepare the tapered threaded end of fitting. Thread fitting into crankcase and tighten to 130-150 **in-lbs** (14.7-16.9 Nm).
6. If removed, identify oil spout fitting and using pipe sealant or TEFLON[®] tape, prepare the tapered threaded end of fitting. Thread fitting into oil spout and tighten to 130-150 **in-lbs** (14.7-16.9 Nm).
7. Slide crankcase fitting nut and rubber ferrule on crankcase end of vent line.
8. Push **new** hose with **new** clamps on the oil spout end of chrome vent line.
9. Orient s-bend in vent line toward crankcase and slide chrome vent line into case fitting.
10. Push hose onto oil spout fitting.
11. Position line parallel with transmission cover and with clearance to other components.
12. Push rubber ferrule into crankcase fitting. Thread chrome nut over ferrule and hand tighten.
13. Tighten chrome nut to 60-80 **in-lbs** (6.8-9.0 Nm).
14. Using HOSE CLAMP PLIERS (HD-41137), crimp the clamps on the hose.
15. Operate motorcycle and inspect for leaks.

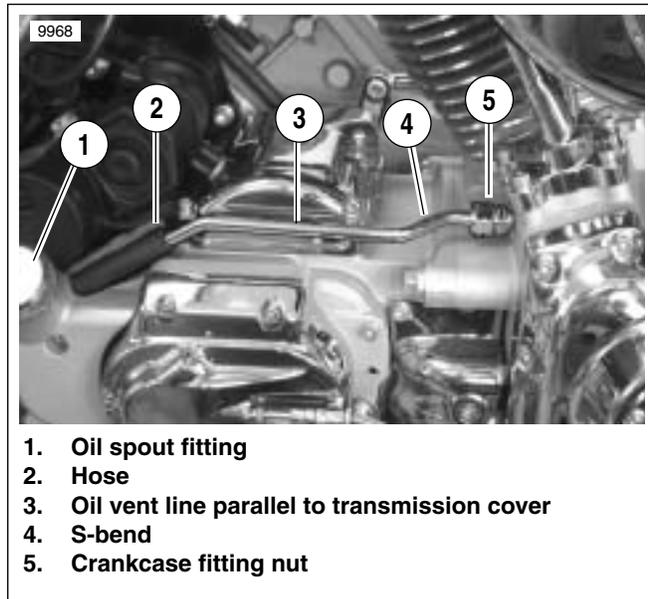


Figure 3-40. Oil Vent Line (clamps removed)

GENERAL

For engine oil flow through the engine, See ENGINE OIL FLOW under GENERAL INFORMATION in Touring Models Service Manual.

See Figure 3-41. The FLHTCUSE is equipped with a factory installed oil cooler controlled by a thermostat in the oil filter mount.

Engine oil flows from the crankcase through the oil filter mount to the oil cooler through a supply hose. The oil circulates through the finned tubes of the cooler to dissipate heat and returns to the oil filter mount through a return hose.

Under pressure from the crankcase, engine oil enters the lower port in the oil filter mount. A passage way directs oil to flow to the oil filter. The oil circulates through the oil filter element and out the oil filter threaded fitting.

From the oil filter, the filtered oil flows in two directions:

- From the oil filter adapter into the thermostat chamber.
- Through a side passage and out the supply oil fitting to the oil cooler.

See Figure 3-43. The thermostat chamber is located in line with the return port to the engine crankcase. The thermostat assembly consists of a temperature sensitive plunger compressed between a spring-loaded piston, spring and an open cage spreader.

While the engine oil temperature is below 180° F (82° C), the thermostat is in its closed position. See Closed Thermostat under 3.12 OIL COOLER OPERATION.

The filtered oil is circulated through the transfer passage where it returns to the crankcase. At the same time, oil is supplied under pressure to the oil cooler even though the oil cooler return port is blocked.

While the engine operates at average temperatures, approximately 195° F (91° C), the thermostat partially opens allowing cooler oil from the cooler to mix with warmer oil from the oil transfer passage as the oil returns to the crankcase. See Partially Open Thermostat under 3.12 OIL COOLER OPERATION.

When the engine oil exceeds 210° F (99° C), the thermostat is in its fully open position. See Fully Open Thermostat under 3.12 OIL COOLER OPERATION.

In this position, all the oil flows through the oil cooler and back through the oil filter mount before returning to the crankcase.

NOTE

Regardless of whether the thermostat is closed, partially open or fully open, oil is **always** pressurized in the transfer passage, the oil cooler supply hose, the oil cooler and the oil return hose.

The oil cooler should always be checked for dirt and debris to maintain cooler efficiency at every service interval.

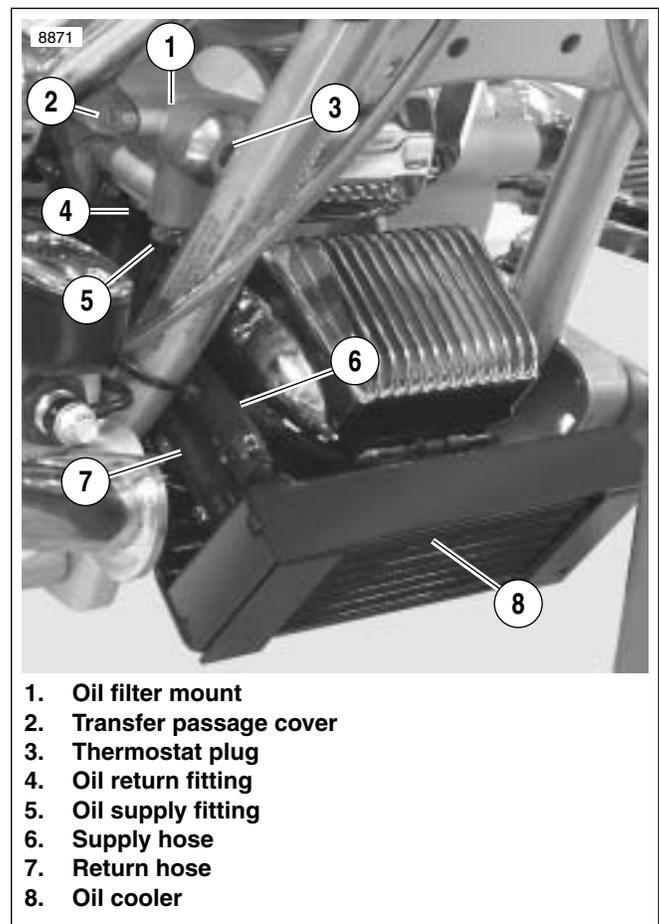


Figure 3-41. Oil Cooler and Bracket
(chrome cover removed for photo clarity)

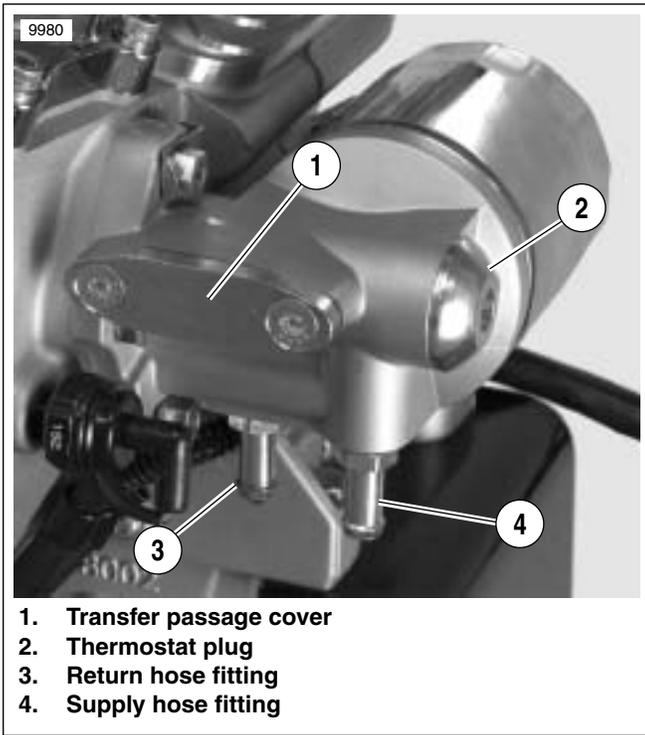


Figure 3-42. Oil Filter Mount on Engine

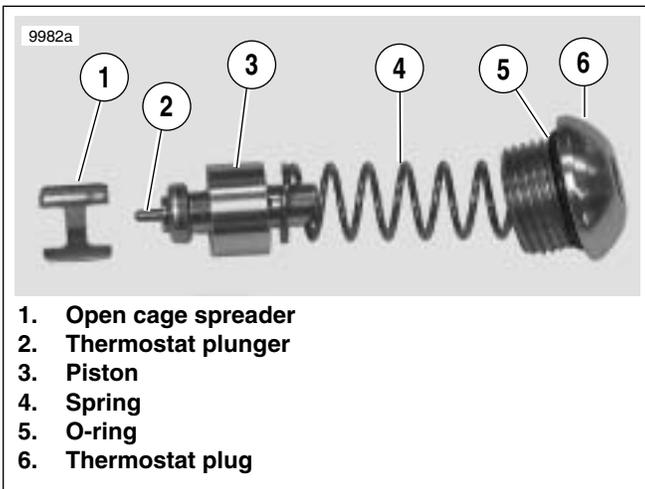


Figure 3-43. Thermostat Assembly

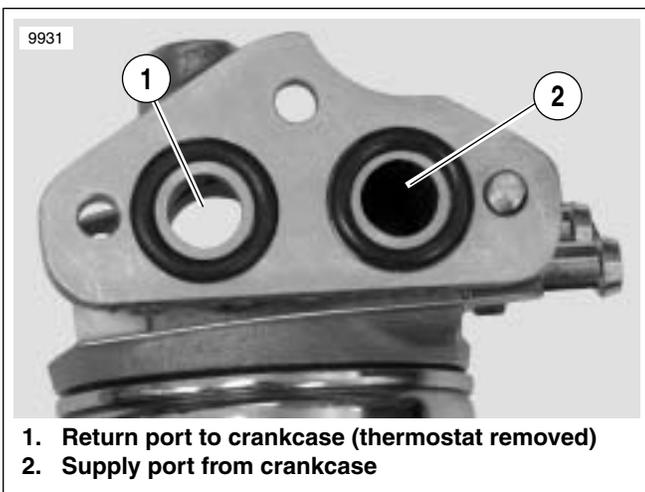
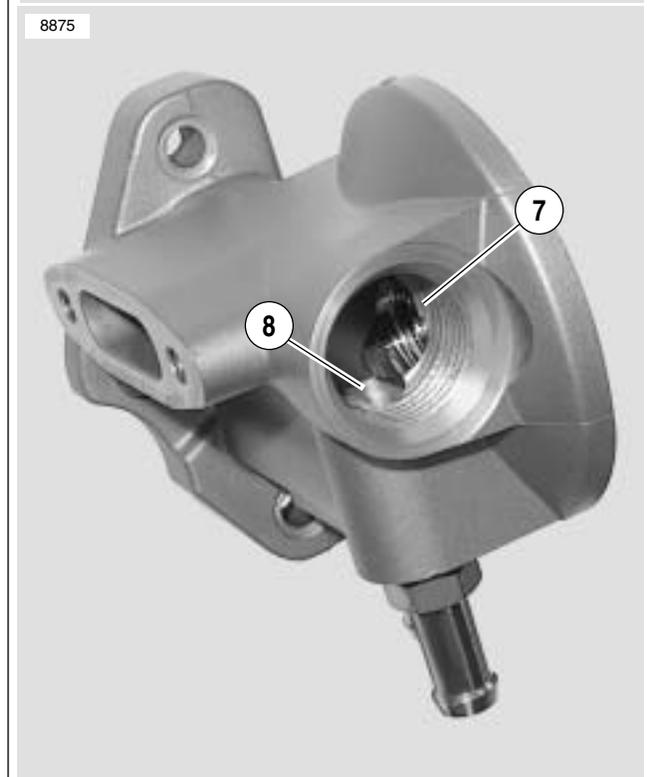
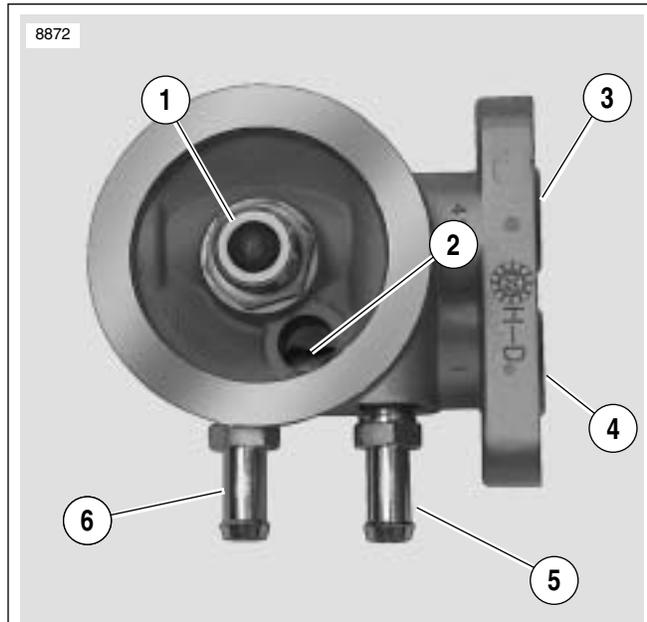


Figure 3-44. Oil Filter Mount Ports to Crankcase



1. Oil filter adapter
2. Passage to oil filter element
3. Return to crankcase
4. Supply from crankcase
5. Return hose fitting
6. Supply hose fitting
7. Open passage from oil filter
8. Open passage to oil cooler supply

Figure 3-45. Oil Filter Mount

Closed Thermostat

See [Figure 3-46](#). While the engine oil is cool, the thermostat is in its closed position. The spring holds the piston over the return passage from the oil cooler. Even though oil pressure is supplied to the oil cooler, oil is blocked from returning from the oil cooler.

See [Figure 3-47](#). When closed, the piston opens a port in the transfer passage along the side of the thermostat chamber. The filtered oil is circulated around the piston through the transfer passage and into a port in the thermostat chamber where it flows through the open cage spreader and returns to the crankcase.

Partially Open Thermostat

As the engine oil exceeds 180° F (82° C), the thermostat plunger begins to expand and compresses the spring pushing against the piston. The piston partially opens the return passage from the oil cooler and partially closes the port from the chamber to the transfer passage.

While the engine operates at an average temperature, 195° F (91° C), the thermostat remains partially open allowing cooler oil from the cooler to mix with warmer oil from the oil filter.

Fully Open Thermostat

See [Figure 3-48](#). The thermostat fully opens when the engine oil temperature exceeds 210° F (99° C). The piston fully closes the port to the transfer passage and opens the return passage from the oil cooler.

In this position, all the oil flows from the oil filter through the oil cooler and back through the return passage before returning to the crankcase. The oil from the oil cooler return will back up under pressure in the transfer passage even though the port from the oil filter is closed.

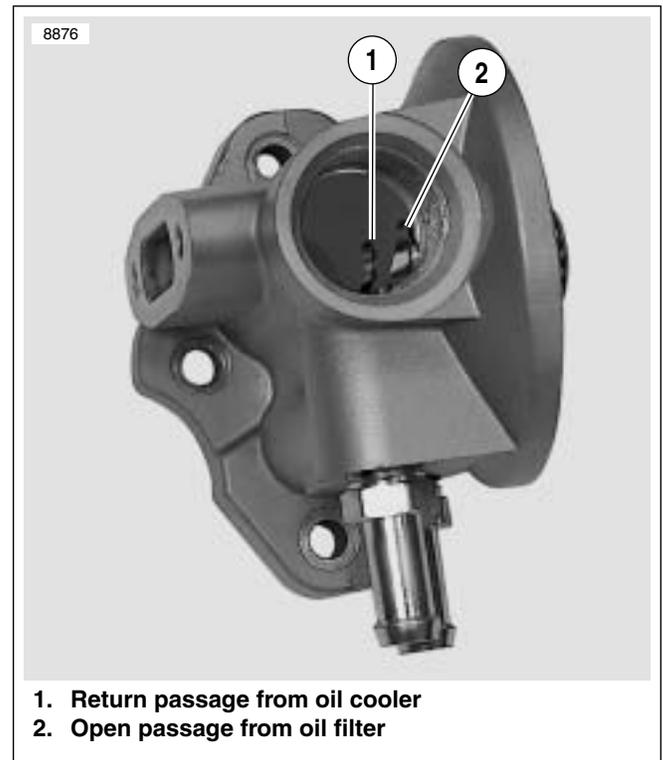


Figure 3-46. Thermostat Chamber

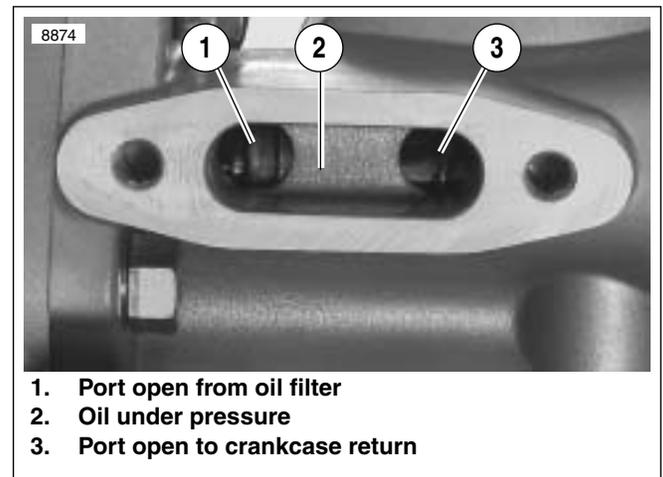


Figure 3-47. Closed Thermostat

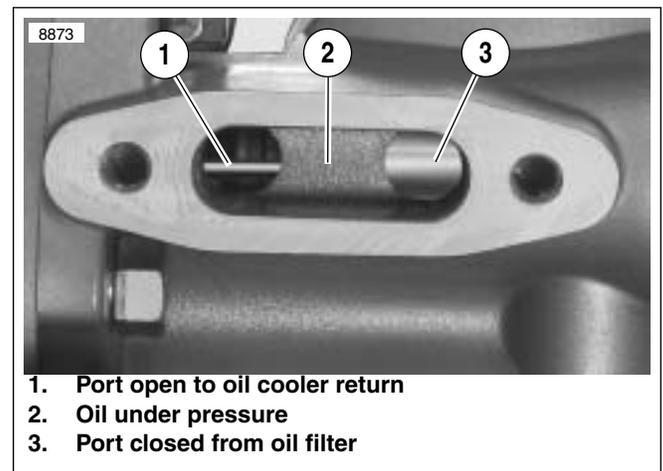


Figure 3-48. Fully Open Thermostat

REMOVAL

1. Cover the front fender to protect finish.

NOTE

Dispose of oil in accordance with local regulations.

2. Place a container under the motorcycle to catch excess oil.
3. Remove the fasteners holding the oil cooler and cover to mounting bracket.
4. Pull the cooler and cover forward and, using side cutters, cut the clamps on the supply and return hoses.
5. Remove the oil cooler with cover.

NOTE

The oil cooler guard is held in place with adhesive tape.

6. If replacing the oil hoses, remove oil pressure switch to gain access to clamps. Cut clamps at oil filter mount. Remove oil hoses.
7. The oil cooler should be checked for dirt and debris.

INSTALLATION

PART NO.	SPECIALTY TOOL
HD-41137	Hose clamp pliers

1. If replacing the hoses, install **new** hoses with clamps at the oil filter mount. Using HOSE CLAMP PLIERS (HD-41137), clamp the supply and return hoses at the oil filter mount.
2. Apply LOCTITE Thread Sealant to threads of oil pressure switch and install oil pressure switch. Tighten to 96-144 **in-lbs** (10.8-16.3 Nm).
3. Connect oil pressure switch wire lead.
4. Attach hoses to oil cooler. Using HOSE CLAMP PLIERS (HD-41137), clamp the supply and return hoses at the oil cooler.
5. Install oil cooler and cover to mounting bracket. Tighten fasteners to 80-110 **in-lbs** (9.1-12.4 Nm).
6. Operate motorcycle and inspect for leaks.

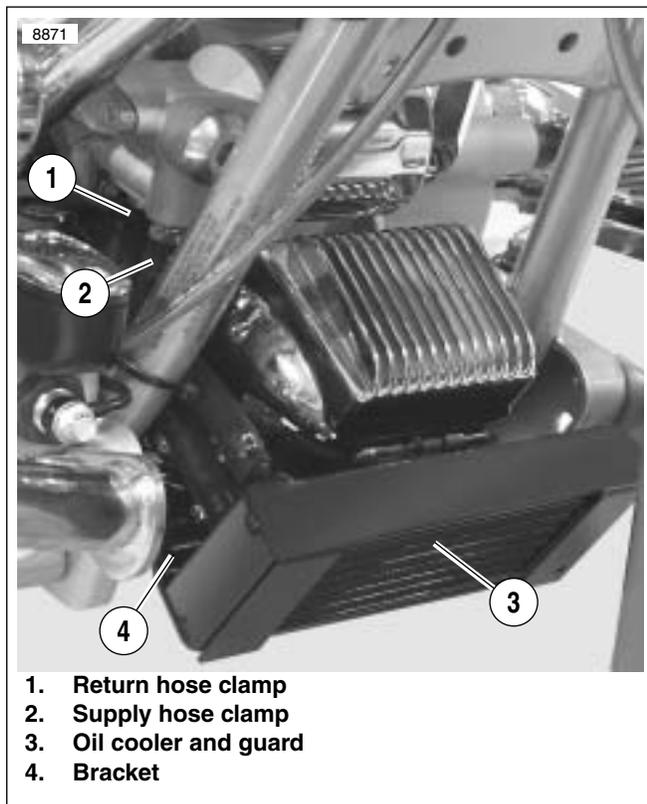


Figure 3-49. Oil Cooler and Mount
(chrome cover removed for photo clarity)

REMOVAL

PART NO.	SPECIALTY TOOL
HD-42311 or HD-44067	Oil filter wrench

1. Place a container under motorcycle to catch excess oil.
2. Bend a cardboard funnel and fit to motorcycle to route fluid away from regulator and oil cooler to container.
3. Using OIL FILTER WRENCH (HD-42311 or HD-44067), remove oil filter. Discard oil filter

NOTE

Dispose of oil in accordance with local regulations.

4. If necessary, remove the threaded oil filter adapter and oil pressure switch.
5. Using side cutters, cut the clamps and remove oil cooler hoses.
6. If necessary, loosen but do not remove thermostat plug.
7. Bend tabs of the lockplate away from bolt heads.
8. Remove oil filter mount lockplate fasteners and flat washers. Discard lockplate.
9. Remove middle bolt with flat washer and remove oil filter mount.

DISASSEMBLY

1. If necessary, remove the thermostat. See [3.15 THERMOSTAT](#).
2. See [Figure 3-51](#). Remove the o-rings in the oil filter mount.
3. Remove the transfer passage cover.
4. Remove the transfer passage cover gasket.
5. Remove the two oil cooler line fittings.
6. Clean the oil passages in a cleaning solution or solvent.
7. Remove thread locking adhesive from the threads of the oil filter adapter.
8. Inspect the oil passages and the oil filter mount.



Figure 3-50. Oil Filter Mount (engine removed from frame)

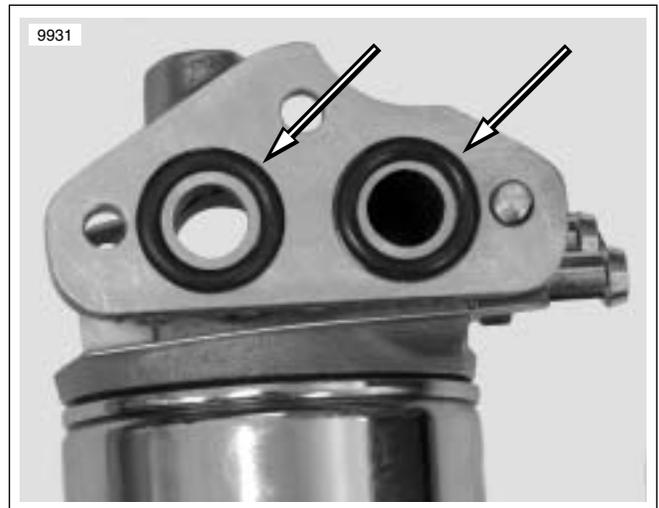


Figure 3-51. Oil Filter Mount O-rings (thermostat removed)

ASSEMBLY

1. See [Figure 3-52](#). Install a **new** gasket on the transfer passage cover.
2. Install the transfer passage cover. Tighten to 90-120 **in-lbs** (10.2-13.6 Nm).
3. Using pipe sealant or TEFLON tape, prepare the tapered threaded end of oil supply and return fittings and install fittings.
4. If removed, replace the thermostat components:
 - a. Replace the spreader.
 - b. Replace the thermostat plunger and piston.
 - c. Replace the spring.
 - d. Install a **new** o-ring and loosely install thermostat plug.

INSTALLATION

PART NO.	SPECIALTY TOOL
HD-41137	Hose clamp pliers

1. Install the oil cooler oil hoses to the filter mount with **new** clamps.
2. Using HOSE CLAMP PLIERS (HD-41137), crimp the clamps.
3. Place flat washers in recessed bolt holes at top and bottom of filter mount flange.
4. Align holes in lockplate with holes in flat washers.
5. Slide two fasteners through lockplate, flat washers and filter mount flange. Apply LOCTITE 243 (blue) (HD-99642-97) to threads of installed bolts.
6. See [Figure 3-51](#). Install **new** o-rings into grooves in oil filter mount.

CAUTION

To avoid cross threading tapped holes, exercise care when starting hex head bolts in crankcase.

7. Align holes in filter mount flange with holes in crankcase and tighten bolts until snug.
8. Install flat washer on remaining fastener, apply LOCTITE to threads and install in middle hole of mount flange.
9. Starting at the top, alternately tighten the fasteners to 130-150 **in-lbs** (14.7-16.9 Nm).
10. Bend the ends of the lockplate to capture the top and bottom fasteners.
11. If disassembled, tighten the thermostat plug to 15-20 ft-lbs (20.4-27.1 Nm).
12. Apply LOCTITE THREADLOCKER 243 (blue) to tapered threads of oil filter adapter. Install oil filter adapter and tighten to 12-16 ft-lbs (16.3-21.7 Nm).
13. Install a **new** oil filter. See SCHEDULED MAINTENANCE in Touring Models Service Manual.

NOTE

*If removed, install oil pressure switch using LOCTITE Thread Sealant and tighten to 96-144 **in-lbs** (10.9-16.3 Nm).*



Figure 3-52. Transfer Passage Cover and Gasket

TEST PROCEDURE

1. Using an infrared thermometer, measure the temperature at the oil pan and at the oil cooler while operating motorcycle.
2. Compare temperatures.
 - a. If the temperature of the oil cooler follows the temperature of the oil pan at temperatures below 180° F (82° C), then the thermostat may be stuck open. Allow the engine to cool, remove the thermostat, and proceed.
 - b. If the temperature of the oil cooler is less than that of the oil pan below 180° F (82° C) but, above 180° F (82° C), follows the temperature of the oil pan, the thermostat is operating correctly.
 - c. If the oil pan exceeds 210° F (99° C) and the oil cooler is cooler, then the thermostat may be stuck closed. Allow the engine to cool, remove the thermostat and proceed.
3. Verify that thermostat plunger is fully retracted.
4. Place thermostat plunger in a container of water with a thermometer.
5. Refer to [Table 3-29](#). Heat water to START TO OPEN temperature. Verify that the plunger extends.
6. Heat water pass START TO OPEN temperature to FULL OPEN temperature and verify that plunger is fully extended.
7. If plunger does not extend per specifications, replace thermostat assembly.

Table 3-29. Thermostat Operating Range

ITEM	FAHRENHEIT	CELSIUS
START TO OPEN (closed)	180°	82°
AVERAGE (partially open)	195°	91°
FULL OPEN (fully open)	210°	99°

REMOVAL

1. Allow the motorcycle to cool.
2. Place a catch pan under motorcycle.
3. Bend a cardboard funnel and fit to motorcycle to route fluid away from regulator and oil cooler to container.

NOTE

Dispose of oil in accordance with local regulations.

4. See [Figure 3-53](#). With a ball Allen wrench, loosen and remove the thermostat plug.
5. Remove the spring.
6. Remove the thermostat plunger and piston with a pair of needle nosed pliers.
7. Remove the open cage spreader with a pick.

INSTALLATION

1. See [Figure 3-53](#). Insert the open cage spreader part way into thermostat chamber.
2. Install the thermostat plunger and piston together.
3. Locate the plunger in the spreader and push in to bottom of chamber.
4. Install the spring.
5. Fit a **new** o-ring and install thermostat plug. Tighten to 15-20 ft-lbs (20.4-27.1 Nm).

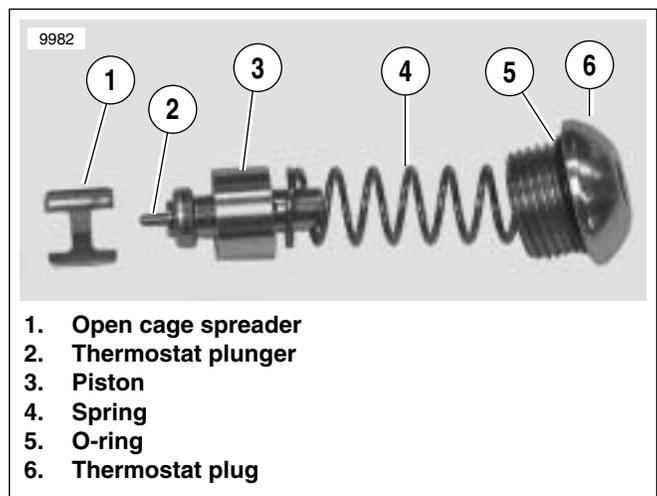


Figure 3-53. Thermostat Components

NOTES
