SPECIFICATIONS

GENERAL		
Number of cylinders	2	
Type	4-cycle, 45°V Twin	
Horsepower	91 @ 5800 RPM	
Torque (foot-pounds)	87 @ 5200 RPM	
Compression ratio	10.0 to 1	
Bore	3.500 in.	88.9 mm
Stroke	3.812 in.	96.82 mm
Piston displacement	73.4 $in.^3$	1203 cc
Oil tank capacity with filter	2.1 quarts	1.90 liters

ENGINE IGNITION SPECIFICATIONS		
Timing during engine cranking	5° BTDC	
Timing with engine at RPM listed below and V.O.E.S. connected	20° BTDC	
Regular idle	950-1050 RPM (49 State)	1150-1250 RPM (Calif.)
Fast idle (all models)	2000 RPM	
Spark plug gap	0.038-0.045 in.	0.96-1.14 mm

NOTE

Service wear limits are given as a guideline for measuring components that are not new. For measurements not given under SERVICE WEAR LIMITS, see NEW COMPONENTS.

ITEM		NEW COMPONENTS		SERVICE WEAR LIMITS	
VALVE					
Fit in guide	Exhaust	0.0015-0.0033 in.	0.038-0.084 mm	0.0040 in.	0.102 mm
	Intake	0.008-0.0026 in.	0.020-0.066 mm	0.0035 in.	0.089 mm
Seat width		0.040-0.062 in.	1.02-1.57 mm	0.090 in.	2.29 mm
Stem protrusion from cylinder valve pocket		1.975-2.011 in.	50.17-51.08 mm	2.031 in.	51.59 mm
OUTER VALVE SPRING					
Free length		2.105-2.177 in.	53.47-55.30 mm	2.105 in. (min)	53.47 mm (min)
Intake	1.751-1.848 in. (closed)	72-92 lbs	32.6-41.7 kg		
	1.286-1.383 in. (open)	183-207 lbs	82.9-93.8 kg		
Exhaust	1.751-1.848 in. (closed)	72-92 lbs	32.6-41.7 kg		
	1.332-1.429 in. (open)	171-195 lbs	77.5-88.3 kg		
INNER VALVE SPRING					
Free length		1.926-1.996 in.	48.92-50.70 mm	1.926 in. (min)	48.92 mm (min)
Intake	1.577-1.683 in. (closed)	38-49 lbs	17.2-22.2 kg		
	1.112-1.218 in. (open)	98-112 lbs	44.4-50.7 kg		
Exhaust	1.577-1.683 in. (closed)	38-49 lbs	17.2-22.2 kg		
	1.158-1.264 in. (open)	91-106 lbs	41.2-48.0 kg		

ITEM		NEW COMPONENTS		SERVICE WEAR LIMITS	
ROCKER ARM					
Shaft fit in bushing (loose)		0.0005-0.0020 in.	0.013-0.051 mm	0.0035 in.	0.089 mm
End clearance		0.003-0.013 in.	0.08-0.33 mm	0.025 in	0.64 mm
Bushing fit in rocker arm (tight)		0.004-0.002 in.	0.10-0.05 mm		
ROCKER ARM SHAFT					
Shaft fit in rocker cover (loose)		0.0007-0.0022 in.	0.018-0.056 mm	0.0035 in.	0.089 mm
PISTON					
Compression ring gap (top and 2nd)		0.007-0.020 in.	0.18-0.51 mm	0.032 in.	0.81 mm
Oil control ring rail gap		0.009-0.052 in.	0.23-1.32 mm	0.065 in	1.65 mm
Compression ring side clearance	Top	0.0020-0.0045 in.	0.051-0.114 mm	0.0065 in.	0.165 mm
	2nd	0.0016-0.0041 in.	0.041-0.104 mm	0.0065 in.	0.165 mm
Oil control ring side clearance		0.0016-0.0076 in.	0.041-0.193 mm	0.0094 in.	0.239 mm
Pin fit (loose, at room temperature)		0.00005-0.00045 in.	0.0013-0.0114 mm	0.00100 in.	0.0254 mm
CYLINDER HEAD					
Valve guide in head (tight)		0.0033-0.0020 in.	0.084-0.051 mm		
Valve seat in head (tight)		0.0035-0.0010 in.	0.089-0.025 mm		
Head gasket surface (flatness)		0.006 in. total	0.15 mm total	0.006 in. total	0.15 mm total
CYLINDER					
Taper				0.002 in.	0.05 mm
Out of round				0.003 in.	0.08 mm
Warpage (gasket surfaces)	Top			0.006 in.	0.15 mm
	Base			0.008 in.	0.20 mm
Bore diameter ± 0.0002 in. OS=over size	Standard	3.4978 in.	88.844 mm	3.5008 in.	88.920 mm
	0.005 OS	3.502 in.	88.95 mm	3.505 in.	89.03 mm
	0.010 OS	3.507 in.	89.08 mm	3.510 in.	89.15 mm
	0.020 OS	3.517 in.	89.33 mm	3.520 in.	89.41 mm
	0.030 OS	3.527 in.	89.59 mm	3.530 in.	89.66 mm
CONNECTING ROD					
Piston pin fit (loose)		0.00125-0.00175 in.	0.0318-0.0445 mm	0.00200 in.	0.0508 mm
Side play between flywheels		0.005-0.025 in.	0.13-0.64 mm	0.030 in.	0.76 mm
Fit on crankpin (loose)		0.0004-0.0017 in.	0.010-0.043 mm	0.0027 in.	0.069 mm
TAPPET					
Fit in guide		0.0008-0.0023 in.	0.020-0.058 mm	0.003 in.	0.08 mm
Roller fit		0.0006-0.0013 in.	0.015-0.033 mm		
Roller end clearance		0.008-0.022 in.	0.203-0.599 mm	0.026 in.	0.660 mm
OIL PUMP					
Oil pressure at normal operating temperature	1000 RPM	7-12 PSI	0.5-0.8 kN/cm^2		
	2500 RPM	10-17 PSI	0.7-1.2 kN/cm^2		
Shaft to pump clearance		0.0025 in.	0.064 mm		
Feed/scavenge inner/outer gerotor clearance		0.003 in.	0.08 mm	0.004 in.	0.10 mm

ITEM		NEW COMPONENTS		SERVICE WEAR LIMITS	
GEARCASE					
Cam gear shaft in bushing (loose)		0.0007-0.0022 in.	0.018-0.056 mm	0.003 in.	0.08 mm
Cam gear shaft end play (min) (except rear intake)		0.005-0.024 in.	0.13-0.61 mm	0.025 in.	0.64 mm
Rear intake cam gear shaft end play (min)		0.006-0.024 in.	0.15-0.61 mm	0.040 in.	1.02 mm
FLYWHEEL					
Runout	Flywheels at rim	0.000-0.010 in.	0.00-0.25 mm	0.010 in.	0.25 mm
	Shaft at flywheel end	0.000-0.002 in.	0.00-0.05 mm	0.002 in.	0.05 mm
End play		0.001-0.005 in.	0.025-0.13 mm	0.005 in.	0.13 mm
SPROCKET SHAFT BEARING					
Outer race fit in crankcase (tight)		0.0004-0.0024 in.	0.010-0.061 mm		
Bearing inner race fit on shaft (tight)		0.0002-0.0015 in.	0.005-0.038 mm		
PINION SHAFT BEARINGS					
Pinion shaft jounal diameter		1.2496-1.2500 in.	31.740-31.750 mm	1.2496 in. (min)	31.375 mm (min)
Outer race diameter in right crankcase		1.5646-1.5652 in.	39.741-39.756 mm	1.5672 in. (max)	39.807 mm (max)
Bearing running clearance		0.00012-0.00088 in.	0.0030-0.0224 mm		
Fit in cover bushing (loose)		0.0023-0.0043 in.	0.058-0.109 mm	0.0050 in.	0.127 mm

ITEM	TORQUE		NOTES
Crank pin nut	150-185 ft-lbs	203-251 Nm	LOCTITE 620 RETAINING COMPOUND, page 3-59
Crankcase 1/4 in. screws	70-110 **in-lbs**	7.9-12.4 Nm	page 3-63
Crankcase 5/16 in. screws	15-18 ft-lbs	20-24 Nm	page 3-63
Crankcase cover screws	80-110 **in-lbs**	9.0-12.4 Nm	special pattern to tighten, page 3-46
Cylinder head screws	See note		special pattern to tighten, page 3-20
Cylinder studs	10 ft-lbs	13.6 Nm	install shoulder end down, page 3-63
Front isolator to cylinder head bolt	73-78 ft-lbs	98.9-105.7 Nm	LOCTITE THREADLOCKER 262 (red), page 3-19
Front sprocket nut	150-165 ft-lbs	203-224 Nm	LOCTITE THREADLOCKER 262 (red), page 3-63
Isolator bolt, front	100-110 ft-lbs	135.6-149.1 Nm	page 3-10
Isolator bolts, side	100-110 ft-lbs	135.6-149.1 Nm	LOCTITE THREADLOCKER 262 (red), page 3-10
Oil filter adapter	8-12 ft-lbs	11-16 Nm	LOCTITE THREADLOCKER 242 (blue), page 3-37
Oil pressure signal light switch	5-7 ft-lbs	7-9 Nm	page 3-37
Oil pressure switch wire nut	4-10 **in-lbs**	0.4-1.1 Nm	page 3-37
Oil pump cover screws	125-150 **in-lbs**	14.1-16.9 Nm	page 3-36
Oil pump mounting screws	125-150 **in-lbs**	14.1-16.9 Nm	page 3-36
Pinion shaft nut	35-45 ft-lbs	47-61 Nm	LOCTITE THREAD-LOCKER 262 (red), page 3-46
Rocker box bolts	10-13 ft-lbs	13.6-18 Nm	page 3-21
Rocker box cover screws	10-13 ft-lbs	13.6-18 Nm	page 3-21
Rocker box screws	90-120 **in-lbs**	10.2-13.6 Nm	page 3-21
Rocker box to head bolts	15-18 ft-lbs	20-24 Nm	2 sizes, page 3-21
Swingarm mount block bolts, lower	68-75 ft-lbs	92.2-101.7 Nm	page 3-10
Swingarm mount block bolts, upper	41-45 ft-lbs	55.6-61.0 Nm	page 3-10
Tappet plate screw	80-110 **in-lbs**	9.0-12.4 Nm	page 3-20, page 3-39
Tappet retainer screw	11-15 ft-lbs	20-24 Nm	page 3-20, page 3-39
Tie bar bolts	30-33 ft-lbs	40.7-44.7 Nm	front tie bar uses LOCITITE PST SEALANT, page 3-10

ENGINE

GENERAL

The V^2 Evolution^{TM} engine is a two-cylinder, four-cycle, air-cooled, overhead-valve V-twin. It has three major component assemblies.

Cylinder

The cylinder assembly includes cylinder head, valves, rocker arm cover, rocker arms and piston. Cylinders mount on the crankcase in a 45 degree “V” with both connecting rods connected to a single crank pin.

Crankcase

The up-and-down motion of the piston in the cylinder is converted to circular motion in the crankcase. The multi-piece crankshaft consists of a crank pin mounted between two counterweighted flywheels, which rotate on two end shaft 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 crank pin connection to the flywheel.

Gearcase

The gearcase is located on the right side of the crankcase. The gearcase houses the gear train, which operates and times the valves and ignition. The cam gear train, consisting of four cam shafts with 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. Hydraulic lifters, located in the tappets, automatically compensate for heat expansion to maintain the no-lash fit of valve train components. Tappets serve to transmit the cam action to the valve linkage. Valve timing is obtained by aligning timing marks when installing cam gears.

Ignition spark is produced by the operation of a microprocessor-controlled electronic ignition module, ignition coil, and spark plugs. Spark timing is determined by a trigger rotor, magnetic sensing unit and vacuum-operated electric switch.

The trigger rotor has two openings which time the cylinders.

Both spark plugs fire simultaneously each crankshaft revolution. The spark plug in the front cylinder will fire at the end of that cylinder’s compression stroke, igniting the air/fuel mixture in the front cylinder. At the same instant, however, the spark in the rear cylinder will fire ineffectually during the end of that cylinder’s exhaust stroke. During the next engine revolution, the simultaneous firing of the spark plugs will occur during the middle of the front cylinder’s exhaust stroke and at the end of the rear cylinder’s compression stroke (igniting the air/fuel mixture in the rear cylinder).

FUEL

Gasoline/alcohol Blends

Buell motorcycles were designed to obtain the best performance and efficiency using unleaded gasoline (91 pump octane or higher). Some fuel suppliers sell gasoline/alcohol blends as a fuel. The type and amount of alcohol added to the fuel is important.

- DO NOT USE GASOLINES CONTAINING METHANOL. Using gasoline/methanol blends will result in starting and driveability deterioration and damage to critical fuel system components.
- ETHANOL is a mixture of 10% ethanol (Grain alcohol) and 90% unleaded gasoline. Gasoline/ethanol blends can be used in your motorcycle if the ethanol content does not exceed 10%.
- Gasolines containing ETHER: Gasoline/ether blends are a mixture of gasoline and as much as 15% ether. Gasoline/ether blends can be used in your motorcycle if the ether content does not exceed 17%.
- REFORMULATED OR OXYGENATED GASOLINES (RFG): “Reformulated gasoline” is a term used to describe gasoline blends that are specifically designed to burn cleaner than other types of gasoline, leaving fewer “tailpipe” emissions. They are also formulated to evaporate less when you are filling your tank. Reformulated gasolines use additives to “oxygenate” the gas. Your motorcycle will run normally using this type of gas. Buell recommends you use it when possible, as an aid to cleaner air in our environment.

Because of their generally higher volatility, these blends may adversely affect the starting, driveability and fuel efficiency of your motorcycle. If you experience these problems, Buell recommends you operate your motorcycle on straight, unleaded gasoline.

LUBRICATION

The engine has a force-feed (pressure) type oiling system, incorporating oil feed and return pumps 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, rocker arm bushings, valve stems, valve springs, push rods and tappets. Cylinder walls, pistons, piston pins, timing gears and bushings and main bearings are lubricated by oil spray thrown off connecting rods and crankshaft, and by oil draining from each rocker box through an internal drain passage in each cylinder and each tappet guide. A small amount of oil is sprayed through an oil galley jet onto the rear intake cam gear in the gearcase; oil is transferred to the teeth of all the cam gears by way of the gear meshing action. The oil-scavenging section of the pump returns oil to the tank from the engine. See LUBRICATION SYSTEM on page 3-28 for further information.

ADJUSTMENT/TESTING

General

When an engine needs repair, it is not always possible to determine definitely beforehand whether repair is possible with only cylinder heads, cylinders and pistons disassembled or whether complete engine disassembly is required for crankcase repair.

Most commonly, only cylinder head and cylinder repair is needed (valves, rings, piston, etc.) and it is recommended procedure to service these units first, allowing engine crankcase to remain in frame.

See DISASSEMBLING ENGINE FOR CYLINDER HEAD REPAIR on page 3-8 to strip motorcycle for removal of cylinder heads, cylinders, and pistons.

After disassembling “upper end” only, it may be found that crankcase repair is necessary. In this situation, remove the engine crankcase from the chassis. See REMOVING ENGINE CRANKCASE OR COMPLETE ENGINE on page 3-8.

⚠CAUTION

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

Symptoms indicating a need for engine repair are often misleading, but generally, if more than one symptom is present, possible causes can be narrowed down to make at least a partial diagnosis. An above-normal consumption of oil, for example, could be caused by several mechanical faults. See TROUBLESHOOTING in Section 1. However, when accompanied by blue-gray exhaust smoke and low engine compression, it indicates the piston rings need replacing. Low compression by itself, however, may indicate improperly seated valves, in addition to or in lieu of worn piston rings.

Most frequently, valves, rings, pins, bushings, and bearings need attention at about the same time. If the possible causes can be narrowed down through the process of elimination to indicate any one of the above components is worn, it is best to give attention to all of the cylinder head and cylinder parts.

Compression Test Procedure

Combustion chamber leakage can result in unsatisfactory engine performance. A compression test can help determine the source of cylinder leakage. Use CYLINDER COMPRESSION GAUGE (Part No. HD-33223-1).

A proper compression test should be performed with the engine at normal operating temperature when possible. Proceed as follows:

⚠CAUTION

After completing the compression test(s), make sure that the throttle plate is in the closed position before starting engine. Engine will start at an extremely high RPM if throttle plate is left open.

1. Disconnect spark plug wires. Clean around plug base and remove plugs.
2. Connect compression tester to front cylinder.
3. With carburetor throttle plates in wide open position, crank engine continuously through 5-7 full compression strokes.
4. Note gauge readings at the end of the first and last compression strokes. Record test results.
5. Connect compression tester to rear cylinder.
6. Repeat Steps 3 and 4 on rear cylinder.
7. Compression is normal if final readings are 120 psi (8.4 kgN/cm^2) or more and do not indicate more than a 10 psi (0.7 kgN/cm^2) variance between cylinders. See Table 3-1.
8. Inject approximately 1/2 oz. (15 ml) of SAE 30 oil into each cylinder and repeat the compression tests on both cylinders. Readings that are considerably higher during the second test indicate worn piston rings.

Table 3-1. Compression Test Results

DIAGNOSIS	TEST RESULTS
Ring trouble.	Compression low on first stroke; tends to build up on the following strokes but does not reach normal; improves considerably when oil is added to cylinder.
Valve trouble.	Compression low on first stroke; does not build up much on following strokes; does not improve considerably with the addition of oil.
Head gasket leak.	Same reaction as valve trouble.

Cylinder Leakage Test

The cylinder leakage test pinpoints engine problems including leaking valves, worn, broken or stuck piston rings and blown head gaskets. The cylinder leakage tester applies compressed air to the cylinder at a controlled pressure and volume, and measures the percent of leakage from the cylinder.

Use a CYLINDER LEAKDOWN TESTER (Part No. HD-35667) and follow the specific instructions supplied with the tester.

The following are some general instructions that apply to Buell motorcycle engines:

1. Run engine until it reaches normal operating temperature.
2. Stop engine. Clean dirt from around spark plugs and remove spark plugs.
3. Remove air cleaner and set carburetor throttle in wide open position.
4. Remove timing inspection plug from crankcase.
5. The piston, in cylinder being tested, must be at top dead center of compression stroke during test.
6. To keep engine from turning over when air pressure is applied to cylinder, engage transmission in fifth gear and lock the rear brake.
7. Following the manufacturer's instructions, perform a cylinder leakage test on the front cylinder. Make a note of the percent leakdown. Any cylinder with 12% leakdown, or more, requires further attention.
8. Listen for air leaks at carburetor intake, exhaust, head gasket and timing inspection hole. See Table 3-2.

NOTE

If air is escaping through valves, check push rod length.

9. Repeat procedure on rear cylinder.

⚠CAUTION

After completing the compression test(s), make sure that the throttle plate is in the closed position before starting engine. Engine will start at an extremely high RPM if throttle plate is left open.

Table 3-2. Air Leakage Test

AIR LEAK LOCATION	POSSIBLE CAUSES
Carburetor intake.	Intake valve leaking.
Exhaust pipe.	Exhaust valve leaking.
Timing inspection hole.	Piston rings leaking. Worn or broken piston. Worn cylinder.
Head gasket.	Leaking gasket.

Diagnosing Smoking Engine or High Oil Consumption

Perform Compression or Cylinder Leakdown Test as described previously. If further testing is needed, remove suspect head(s) and inspect the following:

- Valve guide seals.
- Valve guide-to-valve stem clearance.
- Gasket surface of both head and cylinder.
- Oil return passages for clogging.

STRIPPING MOTORCYCLE FOR ENGINE REPAIR

DISASSEMBLING ENGINE FOR CYLINDER HEAD REPAIR

1. Lift and secure the motorcycle.
   a. Place vehicle on a lift and anchor front wheel in place. Raise lift so the top of the cylinder head is easy to access.
   b. Raise rear wheel off lift using REAR WHEEL SUPPORT STAND (Part No. B-41174).

⚠WARNING

To avoid accidental start-up of vehicle and possible personal injury, disconnect the battery cables before proceeding. Always disconnect the negative cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion producing personal injury.

⚠CAUTION

Hold battery cable when loosening battery terminal hardware. Failure to hold cable may cause battery damage.

2. Disconnect both battery cables, negative cable first.
3. Remove seat and fuel tank. See FUEL TANK in Section 4.
4. Remove air cleaner assembly. See AIR CLEANER, REMOVAL in Section 4.
5. Remove exhaust header. See EXHAUST SYSTEM in Section 2.
6. Remove carburetor and manifold. See CARBURETOR, REMOVAL in Section 4.
7. If removing front cylinder, remove ignition coil and horn. See IGNITION COIL in Section 7.
8. Disconnect spark plug cables.

NOTE

At this stage, the lower rocker boxes, the cylinder heads and the cylinders may be removed. See CYLINDER HEAD on page 3-11.

REMOVING ENGINE CRANKCASE OR COMPLETE ENGINE

1. Perform the steps listed above.
2. Remove tail section. See TAIL SECTION, REMOVAL in Section 2.
3. See Figure 3-1. Place a floor hoist behind the lift. Attach straps to frame and hoist. Raise hoist until straps tighten.
4. Detach clutch cable from handgrip.
5. Remove REAR FENDER/LOWER BELT GUARD and SPROCKET COVER. See Section 2.
6. Remove rear caliper. See REAR BRAKE CALIPER in Section 2.
7. Detach belt from rear sprocket and remove rear wheel. See REAR WHEEL in Section 2.

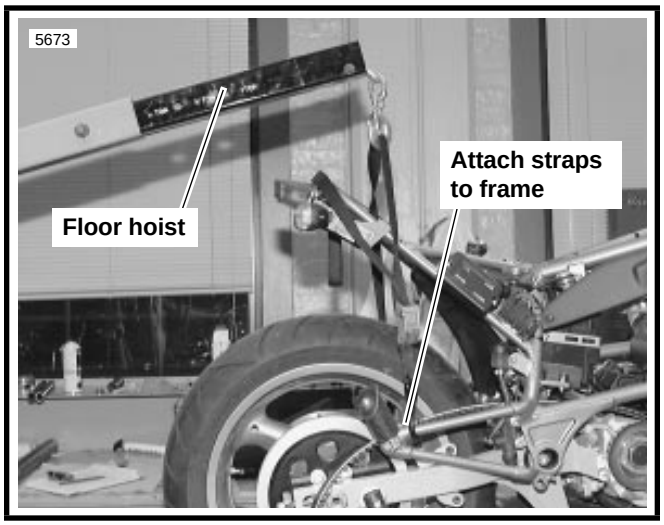


Figure 3-1. Floor Hoist

8. Drain oil tank and remove oil filter. See ENGINE LUBRICATION SYSTEM in Section 1.
9. Disconnect wire to oil pressure signal light switch. See OIL PRESSURE SIGNAL LIGHT SWITCH on page 3-31.
10. Detach feed, vent and return hoses from oil tank. See OIL TANK on page 3-30.
11. Remove both rider footrests from frame. See FOOTRESTS in Section 2.
12. Remove rear shock mounting bolt (metric) from swingarm. Allow rear shock to hang from front mount.
13. Disconnect wiring. See Section 7.
    a. Disconnect neutral switch wire from crankcase.
    b. Unplug ignition timer plate wires from wiring harness.
    c. Disconnect 18-gauge green wire from starter motor.
    d. Disconnect regulator/rectifier from the alternator stator at the plug near the regulator. See VOLTAGE REGULATOR in Section 7.
    e. Disconnect V.O.E.S. wire from ignition module.
14. Remove muffler. See EXHAUST SYSTEM in Section 2.
15. See Figure 3-2. Place a wooden cradle underneath the crankcase.
16. Place a crating strap between the engine cylinders and around the lift. Tighten crating strap until snug.
17. See Figure 3-3. Remove engine ground strap (1) from swingarm mount block.
18. Detach tie bars from frame mounts.
    a. Remove rear tie bar using a swivel socket.
    b. See Figure 3-4. Remove front tie bar (1) and clutch cable clamp.
19. Remove front isolator bolt (6), nut (9), D-washer (8) and washers (7).

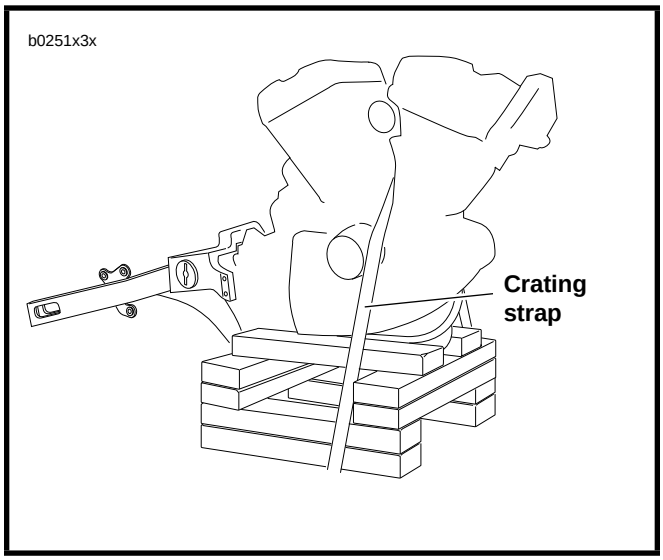


Figure 3-2. Supporting the Engine

20. See Figure 3-3. Remove isolator bolt (7) and lockwasher (6) on each side.

21. Slowly raise floor hoist until rubber isolators (5) can be removed. Frame will rise while engine remains secured to lift by crating strap.

NOTE

Rubber isolators align with a frame mounted metal pin.

22. Raise frame and walk forward over and away from the engine.

23. If necessary, remove rear swingarm. See SWINGARM in Section 2.

24. If necessary, detach swingarm mount block from power-train by removing bolts (3, 4), washers and locknuts.

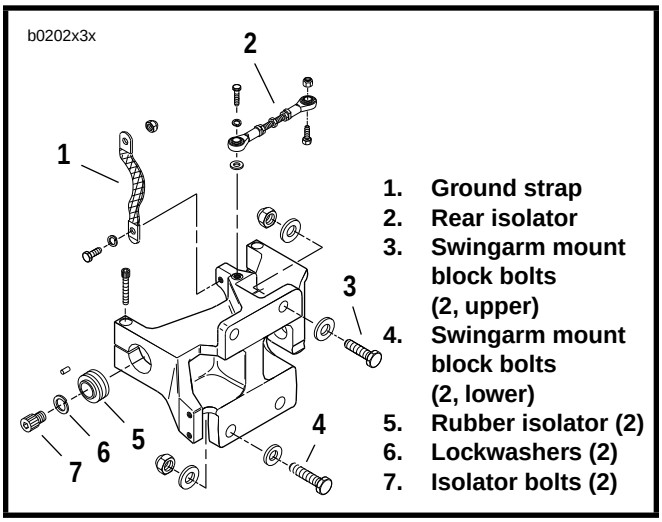


Figure 3-3. Rear Tie Bar Assembly

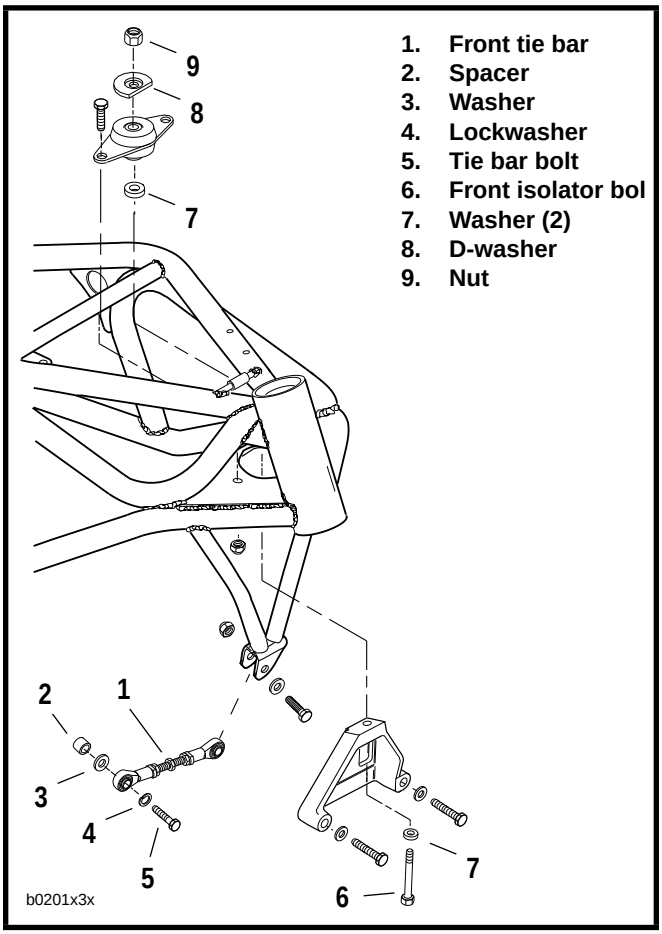


Figure 3-4. Front Tie Bar Assembly

INSTALLING THE ENGINE

ENGINE CRANKCASE INSTALLATION

1. See Figure 3-2. Place engine crankcase on supports so frame may be installed over the top of the engine.
2. See Figure 3-3. If removed, attach swingarm mount block to engine. Install upper bolts (3), washers and locknuts finger tight. Install lower bolts (4), washers and locknuts finger tight. Tighten upper bolts to 41-45 ft-lbs (55.6-61.0 Nm) and lower bolts to 68-75 ft-lbs (92.2-101.7 Nm).
3. If removed, install swingarm. Adjust swingarm bearing preload. See SWINGARM in Section 2.
4. Remove oil filter (if installed). Walk frame over powertrain.
5. See Figure 3-4. Install front isolator bolt. Attach front isolator mount with bolt (6), washers (7), D-washer (8) and locknut (9). Tighten bolt finger tight.

⚠CAUTION

Isolator bolts must be tightened within 30 minutes of applying LOCTITE THREADLOCKER. Failure to tighten bolts within 30 minutes may cause LOCTITE to set.

6. See Figure 3-3. Apply LOCTITE THREADLOCKER 262 (red) to side isolator bolts (7). Align pins on frame into holes in rubber isolators. Install bolts (7) and lockwashers (6) finger tight.

⚠CAUTION

Do not adjust tie bar assemblies. Tie bar tension is set at the factory. Any attempt at adjusting tension will cause damage to tie bars. Damaged tie bars must be replaced.

7. See Figure 3-3. Attach rear tie bar assembly (2). Install bolt, lockwasher, and washer on swingarm mount block. Install bolt and locknut on frame. Tighten bolts to 30-33 ft-lbs (40.7-44.7 Nm).
8. Attach top center tie bar assembly. Install bolt, washer, front tie bar spacer and locknut on ignition mount. Install bolt and locknut on frame. Tighten bolts to 30-33 ft-lbs (40.7-44.7 Nm).
9. See Figure 3-4. Attach front tie bar assembly to engine. Install bolt (5), lockwasher (4), washer (3) and front tie bar spacer (2).
10. See Figure 3-3. Tighten the two side isolator bolts (7) to 100-110 ft-lbs (135.6-149.1 Nm).
11. See Figure 3-4. Tighten front isolator bolt (6) to 100-110 ft-lbs (135.6-149.1 Nm).
12. Connect feed, return and vent lines to oil tank. See OIL HOSE ROUTING on page 3-29. Use **new** hose clamps.
13. Attach battery ground strap to swingarm mount block.
14. Attach clutch cable to handlebar lever.
15. Remove strap from between engine cylinders. Using a floor hoist, lift motorcycle by the frame and remove the wooden cradle from underneath the crankcase.
16. Install rear shock. See REAR SHOCK ABSORBER, INSTALLATION in Section 2. Remove floor hoist straps.
17. Install rear wheel and attach secondary drive belt. See REAR WHEEL, INSTALLATION in Section 2.
18. Install rear brake caliper. See REAR BRAKE CALIPER in Section 2.
19. Attach disconnected wires. See Section 7.
    a. Connect 18-gauge green wire to starter motor.
    b. Plug ignition switch assembly into main harness plug.
    c. Plug regulator/rectifier into stator connection.
    d. Attach ignition sensor to wire harness.
    e. Connect V.O.E.S. to ignition module.
    f. Connect neutral switch.
    g. Connect oil pressure switch wire.
20. Install REAR FENDER/LOWER BELT GUARD and SPROCKET COVER. See Section 2.
21. Install footrests. See FOOTRESTS in Section 2.
22. Continue with the steps listed below.

ENGINE INSTALLATION AFTER CYLINDER HEAD REPAIR

1. Install **new** oil filter, engine oil, and primary chaincase lubricant as necessary. See Section 1.
2. Install carburetor with intake manifold. See CARBURETOR, INSTALLATION in Section 4.
3. Install exhaust system as described under EXHAUST SYSTEM in Section 2.
4. Install air cleaner assembly. See AIR CLEANER, INSTALLATION in Section 4.
5. If removed, install horn and ignition coil. See Section 7.
6. Connect spark plug cables. See SPARK PLUG CABLES in Section 7.

⚠WARNING

Always connect positive battery cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion producing personal injury.

⚠CAUTION

Hold battery cable when tightening battery terminal hardware. Failure to hold cable may cause battery damage.

7. Install battery. Connect battery cables, positive first.
8. Install tail section, fuel tank and seat. See TAIL SECTION in Section 2.
9. If engine crankcase installation was performed:
    a. Adjust belt according to REAR BELT DEFLECTION in Section 1.
    b. Adjust rear shock spring preload. See REAR PRELOAD ADJUSTMENT in Section 1.
    c. Adjust clutch lever. See CLUTCH in Section 1.
    d. Check rear brake pedal freeplay. See BRAKES in Section 1.
10. Check all electrical components for proper operation.

CYLINDER HEAD

REMOVAL

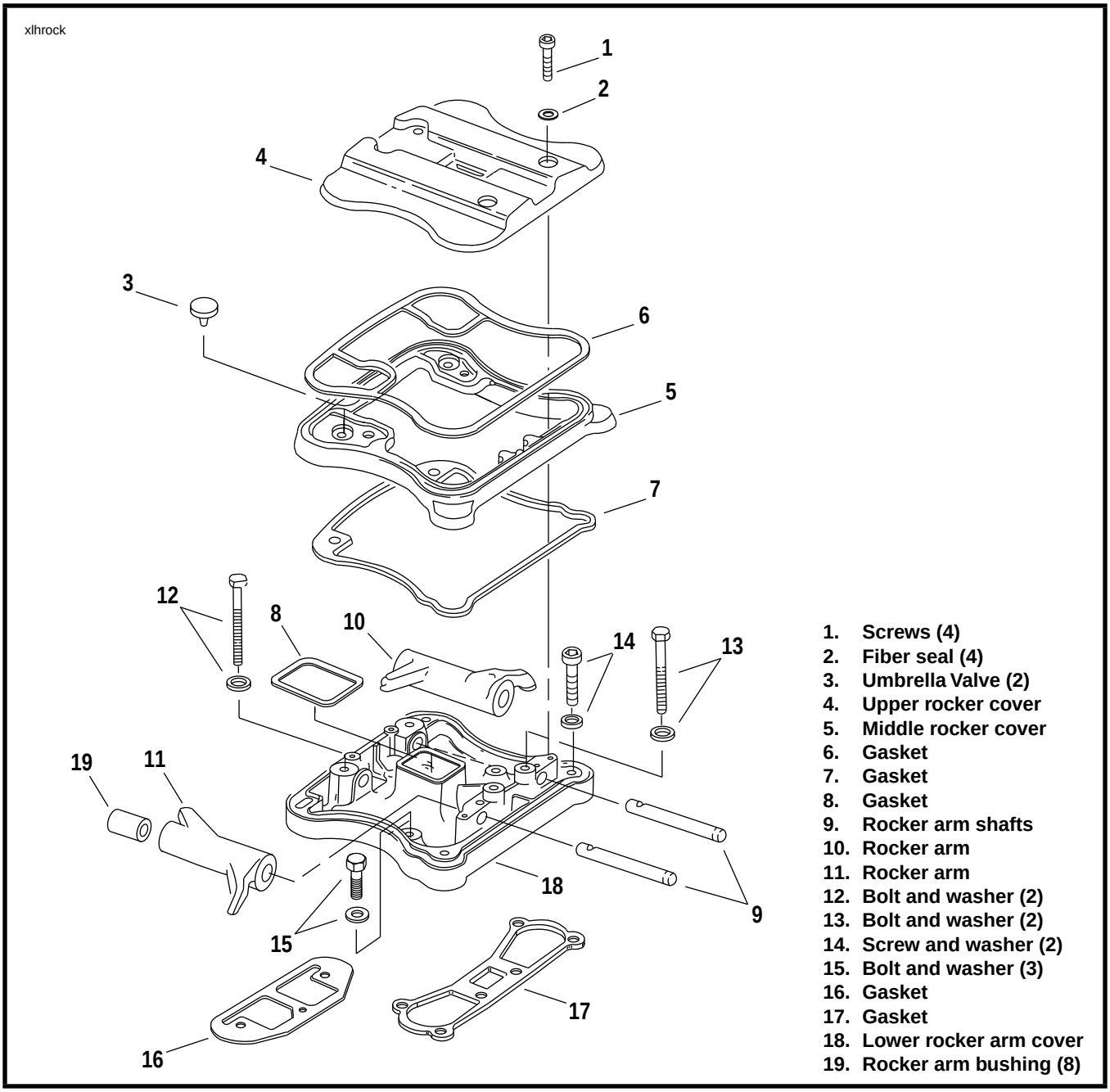
Before removing the cylinder head assembly, see DISASSEMBLING ENGINE FOR CYLINDER HEAD REPAIR on page 3-8. The rocker arm covers and internal components must be removed before removing cylinder heads.

1. See Figure 3-5. Remove screws (1) and fiber seals (2). Discard fiber seals.

CAUTION

All washers and fasteners used in the V^2_{TM} engine are hardened. Do not mix or replace hardened washers and fasteners with unhardened parts. Do not reuse fiber cover seals. These actions may result in accelerated wear and increased noise.

2. Remove top (4) and middle (5) sections of rocker box. Remove and discard gaskets (6, 7 and 8).



1. Screws (4)
2. Fiber seal (4)
3. Umbrella Valve (2)
4. Upper rocker cover
5. Middle rocker cover
6. Gasket
7. Gasket
8. Gasket
9. Rocker arm shafts
10. Rocker arm
11. Rocker arm
12. Bolt and washer (2)
13. Bolt and washer (2)
14. Screw and washer (2)
15. Bolt and washer (3)
16. Gasket
17. Gasket
18. Lower rocker arm cover
19. Rocker arm bushing (8)

Figure 3-5. Rocker Arm Cover

3. Rotate crankshaft until both valves are closed on head being repaired.
4. Remove two 5/16 in. rocker arm retaining bolts (12) at push rod end.
5. Remove remaining fasteners and washers (13, 14 and 15) holding lower rocker arm cover to cylinder head.
6. Remove lower rocker cover (18).

NOTE

Remove lower rocker boxes as an assembly; then disassemble as required.

⚠CAUTION

Mark rocker arm shafts for reassembly in their original positions. Valve train components must be reinstalled in their original positions to prevent accelerated wear and increased valve train noise.

7. See Figure 3-6. Remove rocker arm shafts by tapping them out using a hammer and a soft metal punch.
8. See Figure 3-5. Remove rocker arms (10, 11); mark them for reassembly in their original locations.

⚠CAUTION

Distortion to the head, cylinder and crankcase studs may result if head screws are not loosened (or tightened) gradually in the sequence shown in Figure 3-8.

9. See Figure 3-8. Loosen each head screw 1/8-turn following the sequence shown.

⚠CAUTION

See Figure 3-7. Do not attempt to remove the front isolator mount from front cylinder head. Isolator mount is an integral component and is not meant to be removed unless absolutely necessary. Repeated removals and installations will damage cylinder head threads.

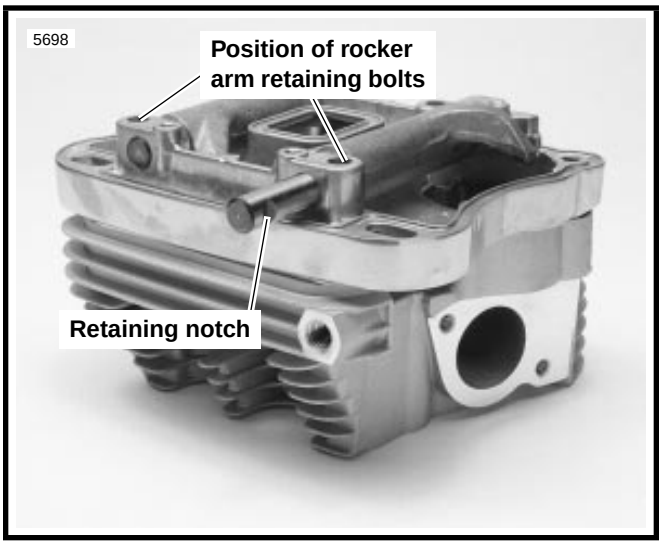


Figure 3-6. Removing Rocker Arm Shafts

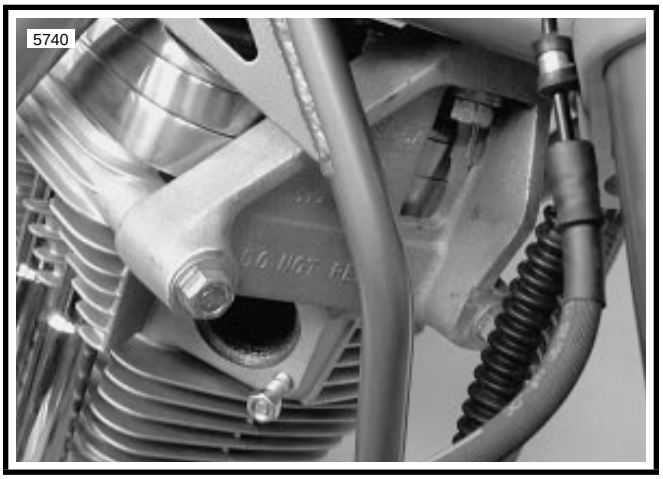


Figure 3-7. Front Isolator Mount Warning

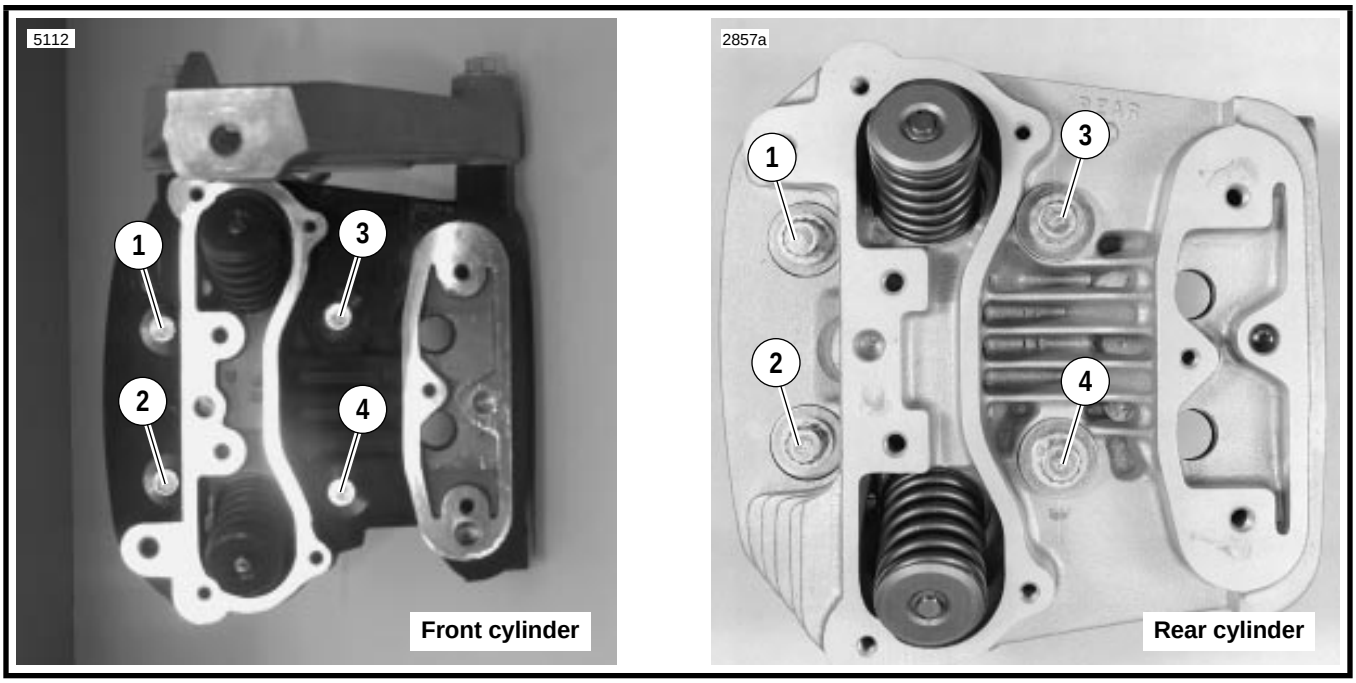


Figure 3-8. Head Screw Loosening/Tightening Sequence

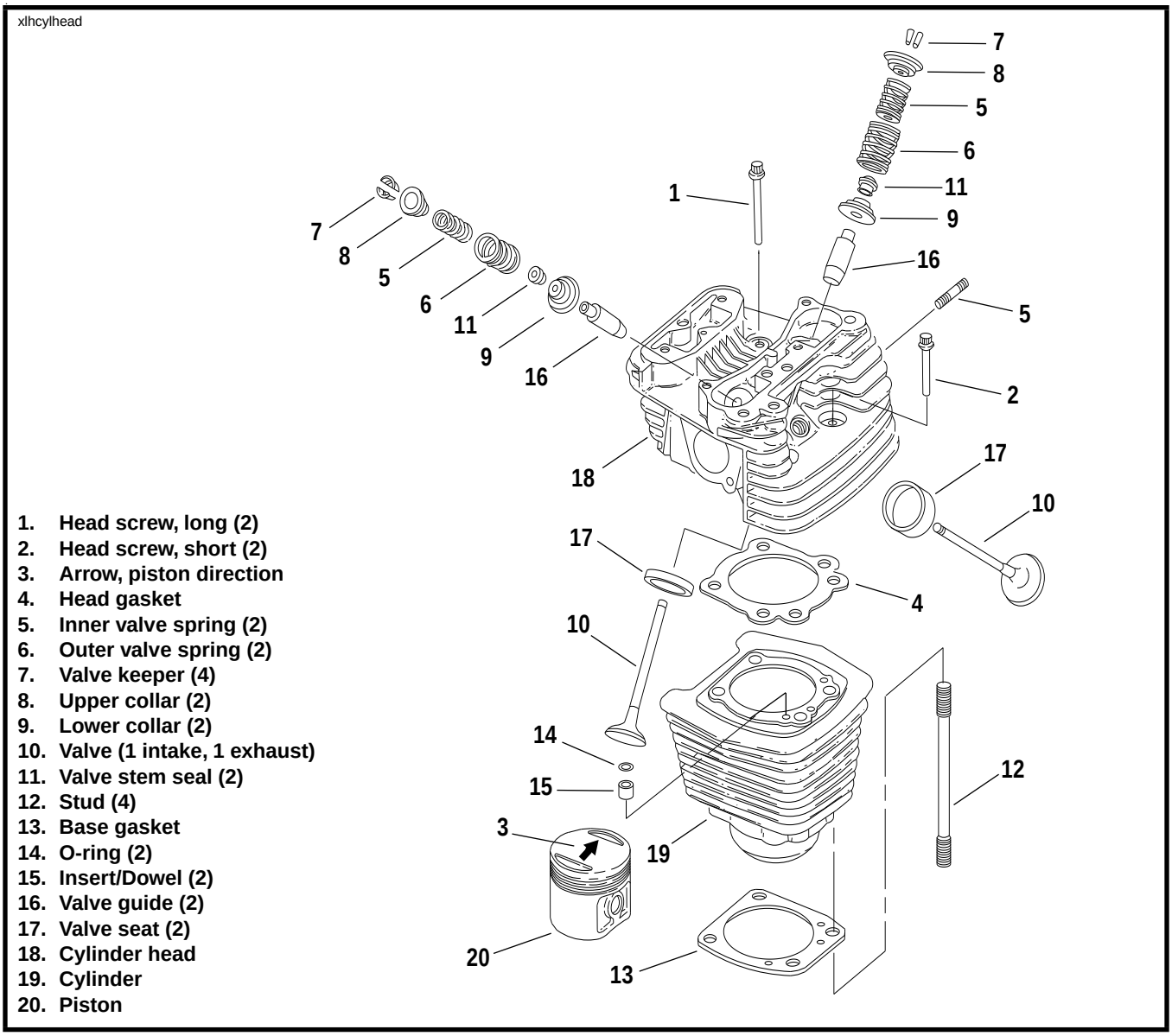


Figure 3-9. Cylinder Head, Cylinder and Piston

10. Support motorcycle under front header mount. Do not allow engine to drop when performing Step 11.
11. Continue loosening in 1/8-turn increments until screws are loose. Remove screws and thick washers.
12. See Figure 3-9. Remove cylinder head (18), head gasket (4), and O-rings (14).

NOTE

Front cylinder must be removed through upper triangular frame members with front isolator mount attached.

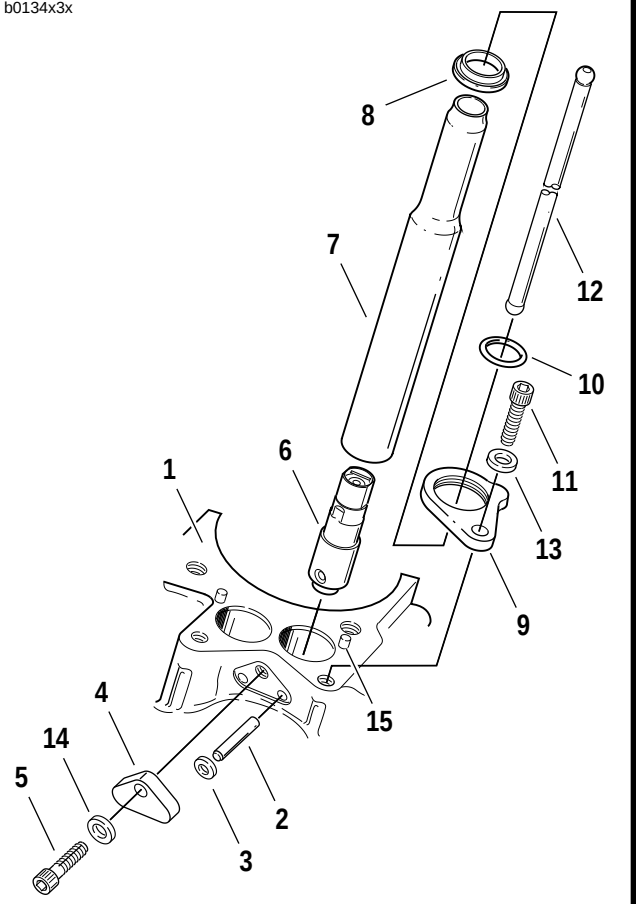
13. See Figure 3-10. Remove socket screws (11), washers (13), and retainers (9). Remove push rod covers (7), seals (8), O-rings (10) and push rods (12). Mark the location and orientation (top and bottom) of each push rod.
14. Remove socket screw (5), washer (14) and plate (4). Remove O-rings (3) from ends of pins (2). Grasp pins (2) and pull from crankcase. Use a pliers if necessary. Remove lifter from crankcase bore.
15. Repeat Steps 1-13 for the other head.

DISASSEMBLY

NOTE

Disassembly of front cylinder exhaust valve components requires front isolator mount removal.

1. See Figure 3-9. Compress valve springs (5, 6) with VALVE SPRING COMPRESSOR (Part No. HD-34736B) (as shown in Figure 3-11.)
2. Remove keepers (7), upper collar (8) and springs (5, 6). Mark keepers for reassembly in original position.
3. Use a fine tooth file to remove any burrs on the valve stem at the keeper groove.
4. Mark valve to ensure that it will be reassembled in the same head. Remove valve (10), valve stem seal (11) and lower collar (9).
5. Repeat Steps 1-5 for the other valve.
6. Disassemble the other head following Steps 1-6.



1.	Right crankcase half	8.	Seal (2)
2.	Pin (2)	9.	Retainer (2)
3.	O-ring (2)	10.	O-ring (2)
4.	Plate	11.	Screw (2)
5.	Screw	12.	Push rod (2)
6.	Tappet lifter (2)	13.	Washer (2)
7.	Push rod cover (2)	14.	Washer
		15.	Locating pin (2)

Figure 3-10. Middle Valve Train Components (Quantities per Engine Cylinder)

CLEANING, INSPECTION AND REPAIR

1. Bead blast or scrape carbon from head, top of cylinder and valve ports. Be careful to avoid scratching or nicking cylinder head and cylinder joint faces. Blow off loosened carbon or dirt with compressed air.
2. Soak cylinder head in an aluminum-compatible cleaner/solvent to loosen carbon deposits.
3. Wash all parts in non-flammable solvent, followed by a thorough washing with hot, soapy water. Blow out oil passages in head. Be sure they are free of sludge and carbon particles. Remove loosened carbon from valve head and stem using a wire wheel. Never use a file or other hardened tool which could scratch or nick valve. Polish valve stem with very fine emery cloth or steel wool.
4. Check each rocker arm, at pad end and push rod end, for uneven wear or pitting. Replace rocker arm if either condition exists.

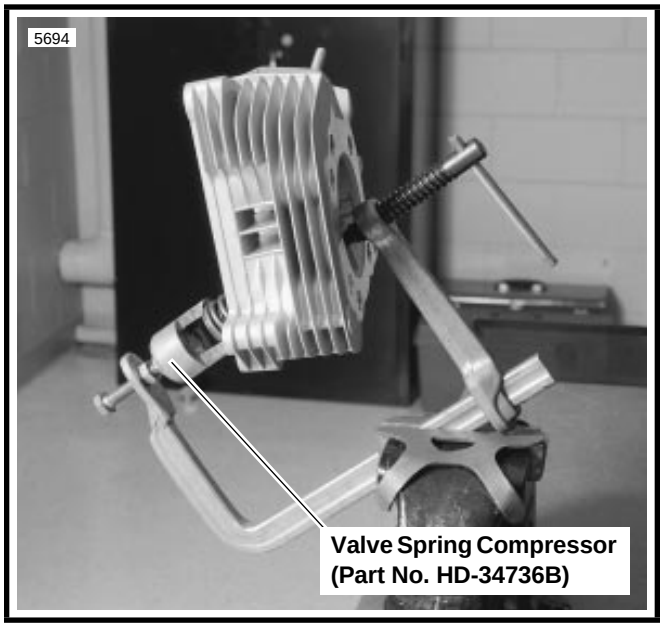


Figure 3-11. Compressing Valve Springs

Figure 3-12. Measuring Rocker Arm Shaft Diameter (Rocker Cover Position)

5. See Figure 3-12 and Figure 3-13. Measure rocker arm shaft diameter at the positions where shaft fits in lower rocker arm cover and where rocker arm bushings ride. Record the measurements.
6. See Figure 3-14 and Figure 3-15. Measure rocker arm shaft bore diameter in lower rocker cover and rocker arm bushing inner diameter. Record the measurements.
7. Check the clearances and measurements obtained in Steps 5 and 6 against the SERVICE WEAR LIMITS. Repair or replace parts exceeding the SERVICE WEAR LIMITS.
8. Assemble rocker arms and rocker arm shafts into lower rocker cover.

Figure 3-13. Measuring Rocker Arm Shaft Diameter (Rocker Arm Bushing Position)

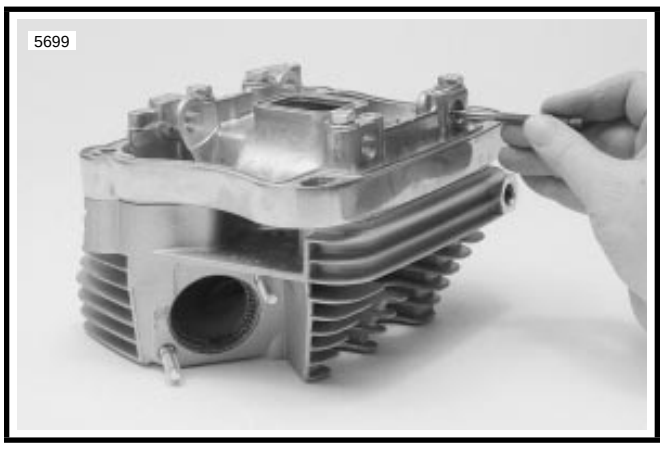


Figure 3-14. Measuring Rocker Arm Shaft Bore Diameter in Lower Rocker Cover

9. Check end play of rocker arm with feeler gauge.
10. Replace rocker arm or lower cover or both if end play exceeds 0.025 in. (0.63 mm).
11. Valve heads should have a seating surface width of 0.040-0.062 in. (1.02-1.57 mm), and should be free of pit marks and burn spots. The color of carbon on exhaust valves should be black or dark brown. White or light buff carbon indicates excessive heat and burning.
12. Valve seats are also subject to wear, pitting, and burning. They should be resurfaced whenever valves are refinished.
13. Clean valve guides by lightly honing with VALVE GUIDE HONE (Part No. HD-34723).
14. Scrub guides with VALVE GUIDE BRUSH (Part No. HD-34751) and hot soapy water. Measure valve stem outer diameter and valve guide inner diameter. Check measurements against SERVICE WEAR LIMITS.

Figure 3-15. Measuring Rocker Arm Bushing Inner Diameter

15. Inspect spark plug threads for damage. If threads in head are damaged, a special plug type insert can be installed using a 12 mm spark plug repair kit.
16. Inspect valve springs for broken or discolored coils.
17. See Figure 3-16. Check free length and compression force of each spring. Compare with SPECIFICATIONS. If spring length is shorter than specification, or if spring compression force is below specification, replace spring.
18. Examine push rods, particularly the ball ends. Replace any rods that are bent, worn, discolored, or broken.
19. See Figure 3-17. Check head gasket surface on head for flatness. Machine or replace any head which exceeds SERVICE WEAR LIMIT of 0.006 in. (0.15 mm).

Rocker Arms and Bushings

1. See Figure 3-18. To replace worn bushings, press or drive them from the rocker arm. If bushing is difficult to remove, turn a 9/16-18 tap into bushing. From opposite side of rocker arm, press out bushing and tap.
2. Press replacement bushing into rocker arm, flush with arm end, and split portion of bushing towards top of arm.
3. Using remaining old bushing as a pilot, line ream new bushing with ROCKER ARM BUSHING REAMER (Part No. HD-94804-57).
4. Repeat for other end of rocker arm.

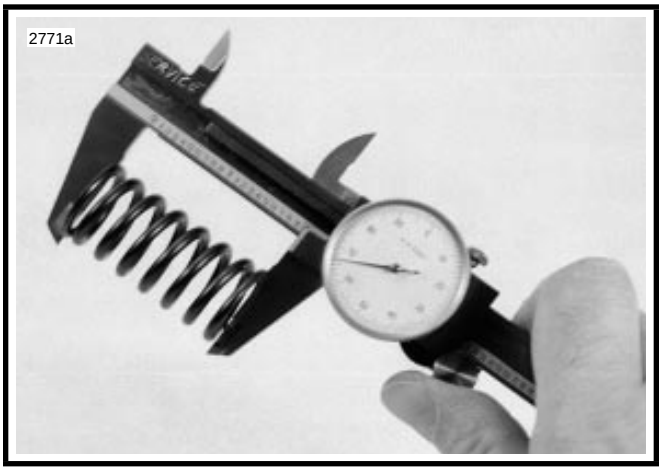


Figure 3-16. Checking Spring Free Length

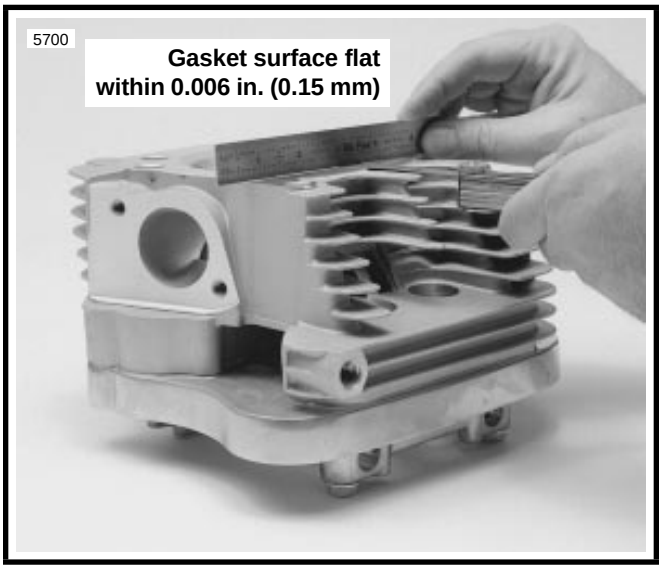


Figure 3-17. Checking Gasket Surface

Replacing Valve Guides

Valve guide replacement, if necessary, must be done before valve seat is ground. It is the valve stem hole in valve guide that determines seat grinding location. Valve stem-to-valve guide clearances are listed in Table 3-3. If valve stems and/or guides are worn beyond service wear limits, install **new** parts.

Table 3-3. Valve Stem Clearances and Service Wear Limits

VALVE	CLEARANCE	SERVICE WEAR LIMIT
Exhaust	0.0015-0.0033 in.	0.0040 in.
Intake	0.008-0.0026 in.	0.0035 in.

1. To remove shoulderless guides, press or tap guides toward combustion chamber using DRIVER HANDLE AND REMOVER (Part No. HD-34740).
2. Clean and measure valve guide bore in head.

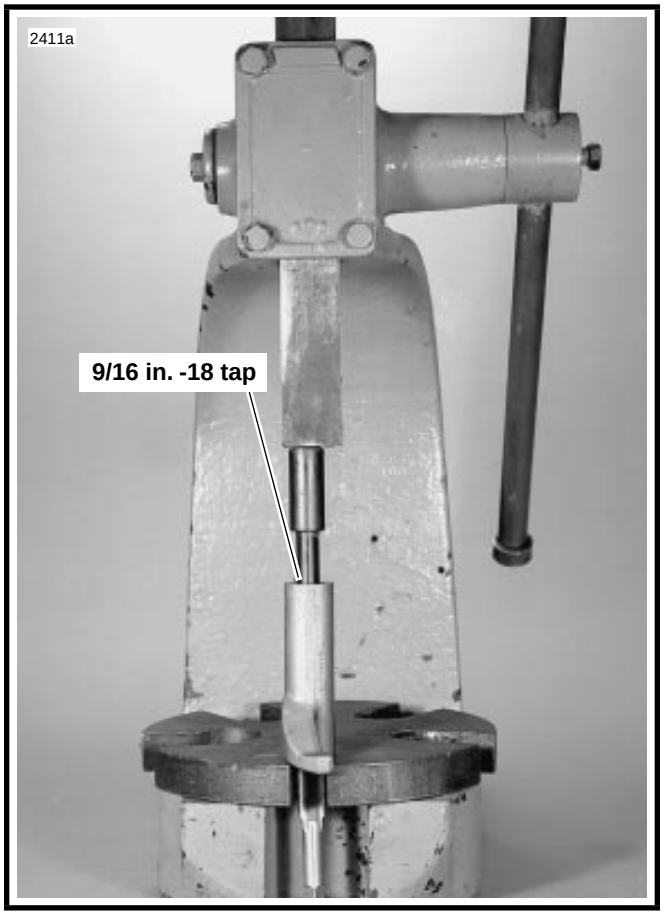


Figure 3-18. Removing Rocker Arm Bushing

3. Measure outer diameter of a new standard valve guide. The guide diameter should be 0.0020-0.0033 in. (0.051-0.084 mm). larger than bore in head. If it is not, select one of the following oversizes: +0.001 in., +0.002 in., or +0.003 in. (+0.025, +0.05 +0.08 mm) (intake and exhaust).
4. See Figure 3-19. Install shoulderless guides using VALVE GUIDE INSTALLATION TOOL (Part No. HD-34731) and DRIVER HANDLE (Part No. HD-34740). Press or drive guide until the tool touches the machined surface surrounding the guide. At this point, the correct guide height has been reached.
5. Ream guides to final size or within 0.0010 in. (0.025 mm) of final size using VALVE GUIDE REAMER (Steel, Part No. HD-39932 or Carbide, Part No. HD-39932-CAR). Use REAMER LUBRICANT (Part No. HD-39964) or liberal amounts of suitable cutting oil to prevent reamer chatter.
6. See Figure 3-20. Apply the proper surface finish to the valve guide bores using the VALVE GUIDE HONE (Part No. HD-34723). Lubricate hone with honing oil. Driving hone with an electric drill, work for a crosshatch pattern with an angle of approximately 60°.

NOTE

The hone is not intended to remove material.

7. Thoroughly clean valve guide bores using VALVE GUIDE BRUSH (Part No. HD-34751) and hot soapy water.

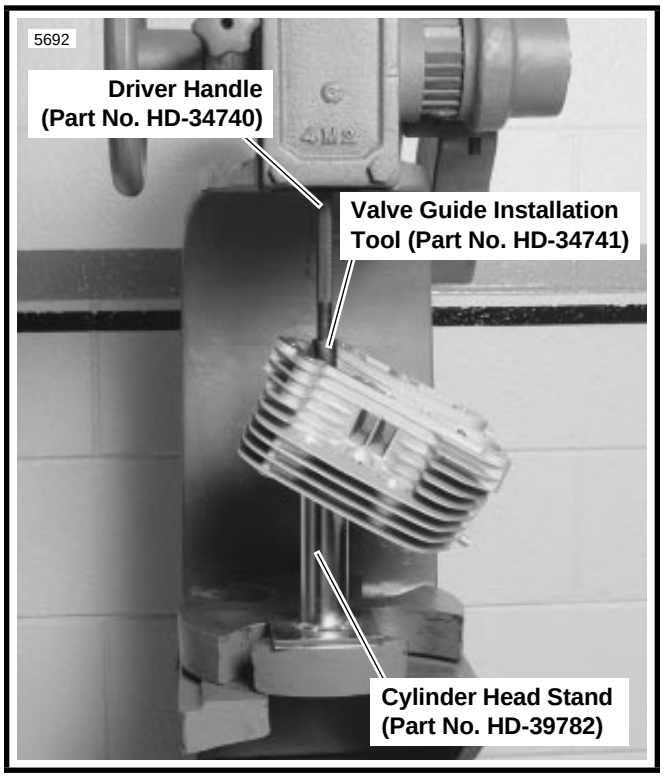


Figure 3-19. Installing Shoulderless Valve Guide

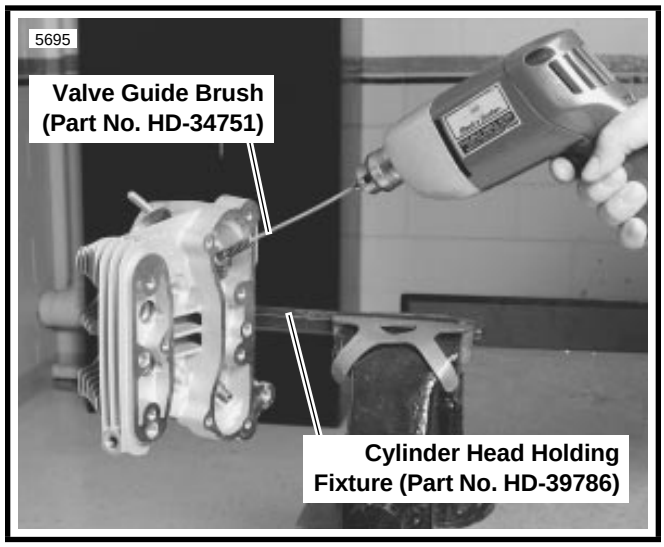


Figure 3-20. Honing Valve Guides

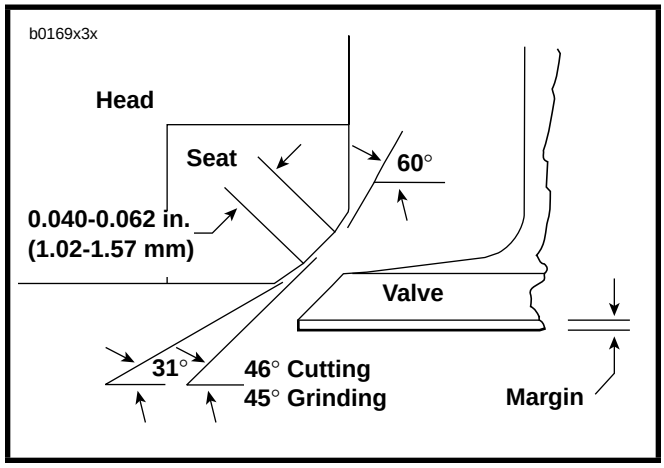


Figure 3-21. Valve Seat Angles

Grinding Valve Faces and Seats

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

Valve face angle is 45° for both intake and exhaust valves. If a valve refacing grinder is used, it must be adjusted exactly to this angle. It is important to remove no more metal than is necessary to clean up and true valve face. Install a **new** valve if grinding leaves the valve edge (the margin) with a width of less than 1/32 in. (0.8 mm). A valve with too thin a margin does not seat normally, burns easily, may cause pre-ignition and can also lead to valve cracking. Valves that do not clean up quickly are probably warped or too deeply pitted to be reused. Replace the valve if end of valve stem shows uneven wear. After valves have been ground, handle with care to prevent damage to the ground faces.

The valve seats may be refinished with cutters or grinders. Cut seats to a 46° angle or grind seats to a 45° angle. Valve seat tools and fixtures are available commercially. Seat each valve in the same position from which it was removed.

The correct 3-angle valve seat angles are shown in Figure 3-21. Use a NEWAY VALVE SEAT CUTTER (Part No. 444-HDF; part of NEWAY VALVE SEAT CUTTER SET, Part No. HD-35758) to cut the seats. Always grind valves before cutting seats.

1. Cut 46° (or grind 45°) valve seat angle first. Use cutting oil to avoid chatter marks. Cut or grind only enough to clean up the seat.
2. Apply a small amount of lapping compound to the valve face. Rotate valve against seat using VALVE LAPPING TOOL (Part No. HD-96550-36A).
3. See Figure 3-21. Check the contact pattern on valve face. It should be 0.040-0.062 in. (1.02-1.57 mm) wide, and its center should be positioned 2/3 of the way toward the outside edge of face.
4. If valve seat pattern is too close to the stem side of valve face, cut 60° angle in order to raise seat. If pattern is too close to the edge of valve face, cut 31° angle in order to lower seat.
5. After cutting either or both 31° or 60° angles to position seat, final cut 46° (or grind 45°) seat angle to obtain proper 0.040-0.062 in. (1.02-1.57 mm) width.
6. Recheck valve seat width and location with lapping compound as described in Step 2.
7. To achieve a smooth even finish, place a piece of 280 grit emery paper under the cutter head and rotate cutter.

⚠CAUTION

Do not grind valve to shorten. Grinding will remove the case hardening and expose the stem's mild steel core resulting in rapid end wear.

8. See Figure 3-22. Wipe valve seats and valve faces clean. Measure valve stem protrusion. If valve stem protrudes more than 2.034 in. (51.66 mm), replace valve seat or cylinder head. If valve stem protrusion is within the acceptable range, valves and seats are ready for lapping.

Replacing Valve Seats

Replacing a valve seat is a complex operation requiring special equipment. If the seat is loose or is not fully seated in the head, then seat movement will prevent the proper transfer of heat from the valve. The seat surface must be flush with (or below) the head surface. See SPECIFICATIONS for valve seat-to-cylinder head fit.

To remove the old seat, lay a bead of weld material around the inside diameter of the seat. This will shrink the seat outside diameter and provide a surface for driving the seat out the port side.

Lapping Valve Faces and Seats

NOTE

If valve faces and seats have been smoothly and accurately refaced, very little lapping will be required to complete the seating operation.

1. See Figure 3-23. Apply a light coat of fine lapping compound to valve face. Insert valve in guide. Position one rubber cup end of VALVE LAPPING TOOL (Part No. HD-96550-36A) onto head of valve. Holding lapping tool as shown, apply only very light pressure against valve head, and rotate lapping tool and valve alternately clockwise and counterclockwise a few times.
2. Lift valve and rotate it about 1/3 of a turn clockwise. Repeat lapping procedure in Step 1.
3. Repeat Step 2. Then, remove valve.
4. Wash valve face and seat; dry with a **new**, clean cloth or towel.
5. 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 (or grinding and lapping) is necessary.

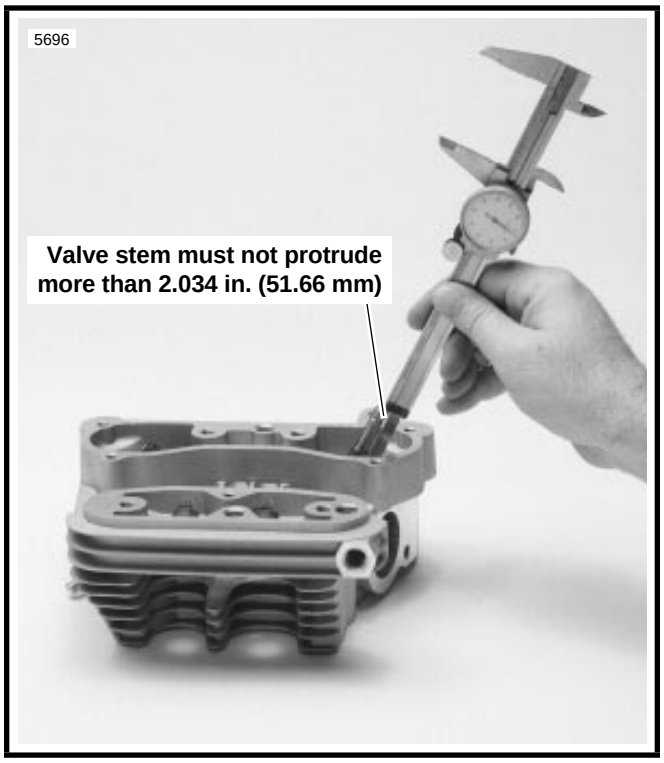


Figure 3-22. Measuring Valve Stem Protrusion

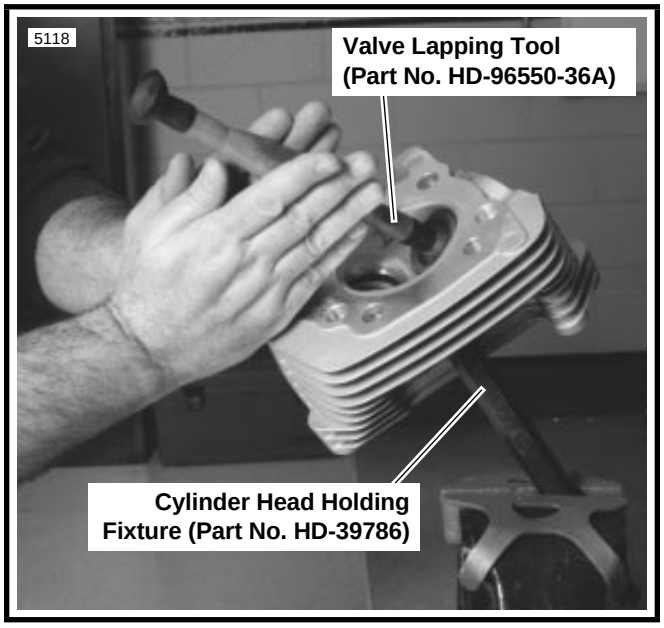


Figure 3-23. Lapping Valves

ASSEMBLY

⚠CAUTION

Make sure all lapping compound is removed from cylinder head and valves after lapping is completed. If lapping compound contaminates any internal engine components or engine oil, excessive engine wear and damage may result.

1. Wash cylinder head and valves in warm, soapy water to remove all lapping compound.
2. Scrub valve guide bores with VALVE GUIDE BRUSH (Part No. HD-34751) and hot, soapy water.
3. Blow dry with compressed air.
4. Apply a liberal amount of engine oil to the valve stem.
5. See Figure 3-24. Insert valve into guide and install lower collar (4).
6. See Figure 3-25. Place a protective sleeve over the valve stem keeper groove. Coat the sleeve with oil and place a **new** seal over the valve stem.

⚠CAUTION

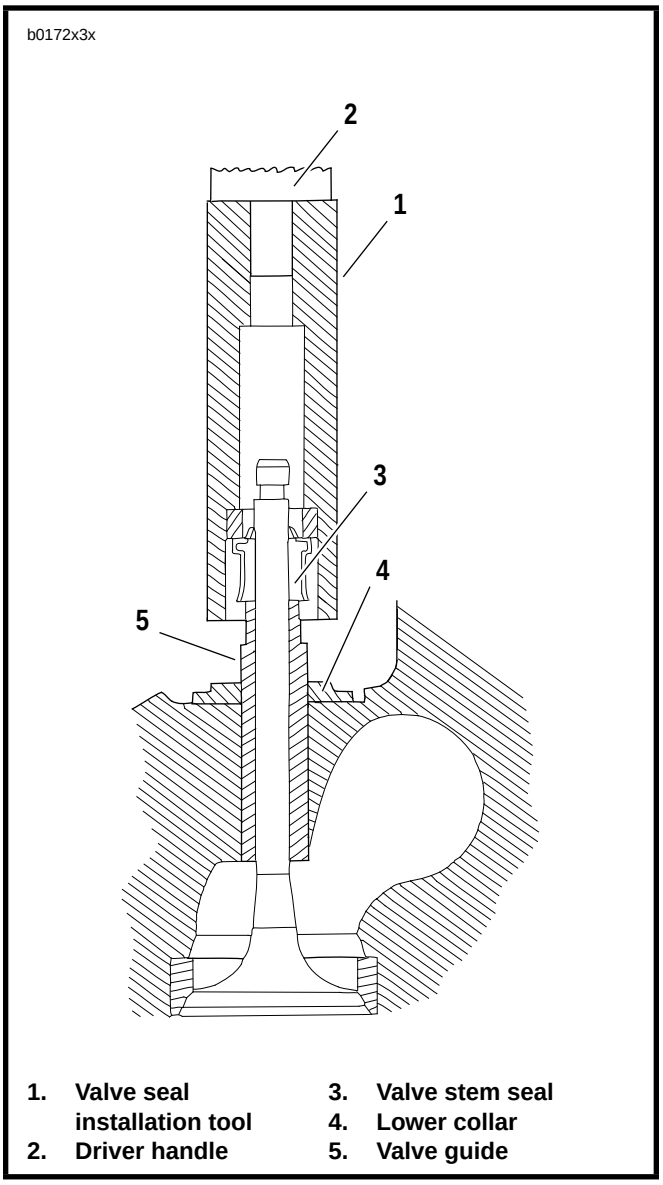
- **Always use a protective sleeve on the valve stem keeper groove when installing valve stem seal. If the seal is installed without using the protective sleeve, the seal will be damaged.**
- **Do not remove valve after seal is installed. Otherwise, sharp edges on keeper groove will damage seal.**

7. See Figure 3-24. Tap the seal onto the guide using the VALVE SEAL INSTALLATION TOOL (Part No. HD-34643A) and DRIVER HANDLE (Part No. HD-34740). The seal is completely installed when the tool touches the lower collar (4).
8. See Figure 3-9. Install valve springs (5, 6) and upper collar (8).
9. Compress springs with VALVE SPRING COMPRESSOR (Part No. HD-34736B).
10. Insert keepers (7) into upper collar (8), making sure they engage groove in valve stem. The keeper gaps should be equal.
11. Release and remove VALVE SPRING COMPRESSOR.
12. Repeat Steps 4-11 for the remaining valve(s).

NOTE

If front isolator mount was removed from front cylinder, reinstall in the following manner.

13. Coat **new** bolts with LOCTITE THREADLOCKER 262 (red). Tighten bolts to 73-78 ft-lbs (98.9-105.7 Nm).



1. **Valve seal installation tool**
2. **Driver handle**
3. **Valve stem seal**
4. **Lower collar**
5. **Valve guide**

Figure 3-24. Valve Seal Installation

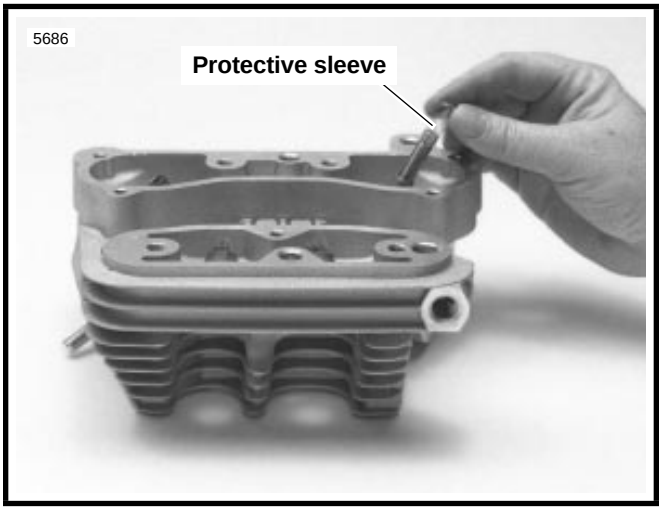


Figure 3-25. Valve Guide Seal Protector Sleeve

INSTALLATION

If only cylinder head work was needed, reinstall cylinder head following these instructions. If further repair is required, see CYLINDER AND PISTON on page 3-22.

1. See Figure 3-9. Coat mating surfaces of cylinder studs (12) and head screws (1, 2) with parts cleaning solution.
2. Scrape old oil and any carbon deposits from threads by using a back-and-forth motion, threading each head screw onto its mating cylinder stud.
3. Remove head screws from studs. Wipe or blow dry thread surfaces.
4. Apply oil to stud threads and to the underside of the head screw shoulder.

⚠CAUTION

Only oil film must remain on the head screw surfaces. Too much oil will pool in the head screw sleeve. Pooled oil may prevent proper torque application and full thread engagement.

5. Blow or wipe off excess oil from head screws.
6. Thoroughly clean and dry the gasket surfaces of cylinder (19) and cylinder head (18).
7. Install a **new** O-ring (14) on each dowel (15).

⚠CAUTION

O-rings (14) help to properly position the head gasket (4). O-rings must be installed before the head gasket.

8. Install a **new** head gasket (4) to cylinder.
9. Carefully lower cylinder head over studs and position on dowels. Use great care so as not to disturb head gasket.
10. Install head screws (1, 2) finger tight.

⚠CAUTION

The procedure for tightening the head screws is critical to proper distribution of pressure over gasket area. It prevents gasket leaks, stud failure, and head and cylinder distortion.

11. See Figure 3-8. For each cylinder head, start with screw numbered one, as shown. In increasing numerical sequence (i.e. – 1, 2, 3 and 4), tighten head screws in three stages:

FIRST STAGE: Tighten each screw to 7-9 ft-lbs (9-12 Nm).

SECOND STAGE: Tighten each screw to 12-14 ft-lbs (16-19 Nm).

THIRD STAGE: See Figure 3-26. Mark cylinder head and head screw shoulder with a line as shown (View A). Tighten each screw a 1/4-turn (90°) (View B).

12. See Figure 3-10. Rotate engine so that both tappets (6), from the cylinder being serviced, will be installed on the base circle (lowest position) of the cam.

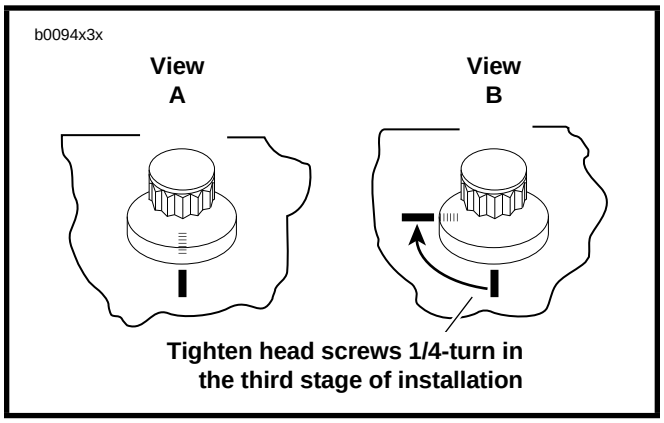


Figure 3-26. Tightening Head Screws

13. Apply a liberal amount of engine oil to tappet assembly (especially roller needles) for smooth initial operation.
14. Insert tappet (6) into bore in crankcase (1). Rotate tappet so that flats at upper end of tappet face the front and rear of the engine. If the tappet is installed incorrectly, pins (2) cannot be inserted.
15. Insert pins (2) in the holes in crankcase. Place **new** O-rings (3) over ends of pins. Install plate (4) using screw (5) with washer (14). Tighten screw (5) to 80-110 **in-lbs**. (9.0-12.4 Nm).
16. Slide **new** seal (8), and place retainer (9), over top of push rod cover (7). Position **new** O-ring (10) at top of push rod cover. Hold cover at an angle and insert top through hole in cylinder head. Push up on cover while aligning bottom of cover with tappet bore in crankcase. Lower retainer (9) with seal (8) onto crankcase, aligning locating pin (15) with hole in retainer.
17. Insert screw (11) with washer (13) through hole in retainer (9), and thread into tapped hole in crankcase. Tighten screw (11) to 15-18 ft-lbs (20-24 Nm).
18. Identify push rod color coding, length and respective push rod positions in engine. See Table 3-4. Place intake and exhaust push rods (1, 2) onto seat at top of tappet (6).

Table 3-4. Push Rod Selection Table

POSITION	COLOR CODE, PART NUMBER, LENGTH
Exhaust (Front & Rear)	3 Band - Pink, 17904-89, 10.800 in.
Intake (Front & Rear)	1 Band - Brown, 17897-89, 10.746 in.

19. See Figure 3-5. Install **new** gaskets (16, 17) with the bead facing up. Place lower rocker box assembly (with rocker arms and shafts) into position. Place push rods in rocker arm sockets.

⚠CAUTION

Do not turn engine over until both push rods can be turned with fingers. Otherwise, damage to push rods or rocker arms may result.

20. See Figure 3-5. Install fasteners (12, 13, 14 and 15). Slowly snug all fasteners in small increments (one turn at a time). Use a cross pattern on the four large bolts (12, 13) that fasten the lower rocker box to head. This will bleed the lifters. Tighten screws (14) to 90-120 **in-lbs** (10.2-13.6 Nm). Tighten bolts (15) to 10-13 ft-lbs (13.6-18 Nm). Tighten bolts (12, 13) to 15-18 ft-lbs (20-24 Nm). See Table 3-5.

Table 3-5. Rocker Arm Cover Hardware

ITEM (NUMBER)	QTY	SIZE	TORQUE
Bolt (12)	2	5/16-18 X 2-3/4	15-18 ft-lbs (20-24 Nm)
Bolt (13)	2	5/16-18 X 2-1/2	
Screw (14)	2	1/4-20 X 1-1/2	90-120 **in-lbs** (10.2-13.6 Nm)
Bolt (15)	3	1/4-20 X 1-1/4	10-13 ft-lbs (14-18 Nm)

NOTES

Tubular frame prohibits direct access to bolt (12) on right rear cylinder. Use TORQUE ADAPTOR (SNAP-ON Part No. FRDH 181) and TORQUE COMPUTER (Part No. SS-306G) to correctly assemble.

21. Place **new** gasket (7), middle rocker cover (5), (with breather valve on intake side) **new** gasket (6) and upper rocker cover (4) on lower rocker box. Install screws (1) with **new** fiber seals (2). Tighten screws (1) to 10-13 ft-lbs (14-18 Nm).

Repeat above procedures for other cylinder.