SPECIFICATIONS 3.1

GENERAL		
Type	Single cylinder, air cooled, four-stroke	
Horsepower @RPM	30 @ 6500	
Torque ft-lbs @ RPM	27 @ 3200	
Compression Ratio	9.2: 1	
Bore	3.50 in.	88.8 mm
Stroke	3.125 in.	79.375 mm
Engine Displacement	30 cu. in.	492 cc
Oil Capacity (with filter change)	2.0 quarts	1.89 liters

ENGINE IGNITION SPECIFICATIONS	
Timing Advance (during engine cranking)	11° BTDC
Timing Advance (at 1200 RPM)	20° BTDC
Regular Idle	1200 RPM
Fast Idle	2000 RPM

NOTE

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

VALVE		NEW COMPONENTS		SERVICE WEAR LIMITS	
Fit in guide	Exhaust	0.0015-0.0033 in.	0.0381-0.0838 mm	0.0040 in.	0.1016 mm
	Intake	0.0008-0.0026 in.	0.0200-0.0700 mm	0.0035 in.	0.0889 mm
Seat width		0.040-0.062 in.	1.016-1.575 mm	0.090 in.	2.286 mm
Stem protrusion from cylinder valve pocket		1.975-2.011 in.	50.165-51.079 mm	2.031 in.	51.587 mm

OUTER VALVE SPRING		NEW COMPONENTS		SERVICE WEAR LIMITS	
Free length		2.105-2.177 in.	53.467-55.296 mm	2.105 in. (min)	53.467 mm (min)
Intake	1.751-1.848 in. (closed)	72-92 lbs	33-42 kg		
	1.286-1.383 in. (open)	183-207 lbs	83-94 kg		
Exhaust	1.751-1.848 in. (closed)	72-92 lbs	33-42 kg		
	1.332-1.429 in. (open)	171-195 lbs	78-88 kg		

INNER VALVE SPRING		NEW COMPONENTS		SERVICE WEAR LIMITS	
Free length		1.926-1.996 in.	48.920-50.698 mm	1.926 in. (min)	48.920 mm (min)
Intake	1.577-1.683 in. (closed)	38-49 lbs	17-22 kg		
	1.112-1.218 in. (open)	98-112 lbs	44-51 kg		
Exhaust	1.577-1.683 in. (closed)	38-49 lbs	17-22 kg		
	1.158-1.264 in. (open)	91-106 lbs	41-48 kg		

ROCKER ARM	NEW COMPONENTS		SERVICE WEAR LIMITS	
Shaft fit in bushing (loose)	0.0005-0.0020 in.	0.0127-0.0508 mm	0.0035 in.	0.0889 mm
End clearance	0.003-0.013 in.	0.076-0.330 mm	0.025 in	0.635 mm
Bushing fit in rocker arm (tight)	0.004-0.002 in.	0.102-0.0559 mm		
Rocker arm shaft fit in rocker cover (loose)	0.0007-0.0022 in.	0.018-0.056 mm	0.0035 in.	0.0889 mm

PISTON		NEW COMPONENTS		SERVICE WEAR LIMITS	
Compression ring gap (top and 2nd)		0.007-0.020 in.	0.178-0.508 mm	0.032 in.	0.813 mm
Oil control ring rail gap		0.009-0.052 in.	0.229-1.321 mm	0.065 in	1.651 mm
Compression ring side clearance	Top	0.0020-0.0045 in.	0.0508-0.1143 mm	0.0065 in.	0.1651 mm
	2nd	0.0016-0.0041 in.	0.0406-0.1041 mm	0.0065 in.	0.1651 mm
Oil control ring side clearance		0.0016-0.0076 in.	0.0406-0.1930 mm	0.0094 in.	0.2388 mm
Pin fit (loose, at room temperature)		0.00005-0.00045 in.	0.00127-0.01143 mm	0.00100 in.	0.02540 mm

CYLINDER HEAD	NEW COMPONENTS		SERVICE WEAR LIMITS	
Valve guide in head (tight)	0.0033-0.0020 in.	0.0838-0.0508 mm		
Valve seat in head (tight)	0.0035-0.0010 in.	0.0889-0.0254 mm		
Head gasket surface (flatness)	0.006 in. total	0.152 mm total	0.006 in. total	0.152 mm total

CYLINDER		NEW COMPONENTS		SERVICE WEAR LIMITS	
Taper				0.002 in.	0.051 mm
Out of round				0.003 in.	0.076 mm
Warpage (gasket surfaces)	Top			0.006 in.	0.152 mm
	Base			0.008 in.	0.203 mm
Bore diameter ± 0.0002 in. OS=over size	Standard	3.4978 in.	88.8441 mm	3.5008 in.	88.9203 mm
	0.005 OS	3.502 in.	88.951 mm	3.5050 in.	89.0270 mm
	0.010 OS	3.507 in.	89.078 mm	3.5100 in.	89.1540 mm
	0.020 OS	3.517 in.	89.332 mm	3.5200 in.	89.4080 mm
	0.030 OS	3.527 in.	89.586 mm	3.5300 in.	89.6620 mm

CONNECTING ROD	NEW COMPONENTS		SERVICE WEAR LIMITS	
Piston pin fit (loose)	0.00125-0.00175 in.	0.03175-0.04445 mm	0.00200 in.	0.05080 mm
Side play between flywheels	0.005-0.025 in.	0.127-0.635 mm	0.030 in.	0.762 mm
Fit on crankpin (loose)	0.0004-0.0017 in.	0.0102-0.0432 mm	0.0027 in.	0.0686 mm
Connecting rod race ID	1.6245-1.6250 in.	41.2623-41.2750 mm	1.6270 in.	41.3258 mm

HYDRAULIC LIFTER	NEW COMPONENTS		SERVICE WEAR LIMITS	
Fit in guide	0.0008-0.0020 in.	0.0203-0.0508 mm	0.0030 in.	0.0762 mm
Roller fit	0.0006-0.0010 in.	0.0152-0.0254 mm	0.0015 in.	0.0381 mm
Roller end clearance	0.008-0.022 in.	0.203-0.559 mm	0.026 in.	0.660 mm

OIL PUMP		NEW COMPONENTS		SERVICE WEAR LIMITS	
Oil pressure	1000 RPM	7-12 PSI	48-83 KPa		
	2500 RPM	10-17 PSI	69-117 KPa		
Shaft to pump clearance		0.0025 in.	0.0635 mm		
Feed/scavenge inner/outer gerotor clearance		0.003 in.	0.076 mm	0.004 in.	0.102 mm

GEARCASE	NEW COMPONENTS		SERVICE WEAR LIMITS	
Cam gear shaft in bushing (loose)	0.0007-0.0022 in.	0.0178-0.0559 mm	0.003 in.	0.076 mm
Cam gear shaft end play (min)	0.005-0.024 in.	0.127-0.610 mm	0.025 in.	0.635 mm
Intake cam gear shaft end play (min)	0.006-0.024 in.	0.152-0.610 mm	0.040 in.	1.016 mm

FLYWHEEL		NEW COMPONENTS		SERVICE WEAR LIMITS	
Runout	**Flywheels at rim**	0.000-0.010 in.	0.000-0.254 mm	0.010 in.	0.254 mm
	Shaft at flywheel end	0.000-0.002 in.	0.000-0.051 mm	0.002 in.	0.051 mm
End play		0.001-0.005 in.	0.025-0.127 mm	0.005 in.	0.127 mm

SPROCKET SHAFT BEARING	NEW COMPONENTS		SERVICE WEAR LIMITS	
Outer race fit in crankcase (tight)	0.0004-0.0024 in.	0.0102-0.0610 mm		
Bearing inner race fit on shaft (tight)	0.0002-0.0015 in.	0.0051-0.0381 mm		

PINION SHAFT BEARINGS	NEW COMPONENTS		SERVICE WEAR LIMITS	
Pinion shaft journal diameter	1.2496-1.2500 in.	31.7398-31.7500 mm	1.2496 in. (min)	31.7398 mm (min)
Outer race diameter in right crankcase	1.5646-1.5652 in.	39.7408-39.7561 mm	1.5672 in. (max)	39.8069 mm (max)
Bearing running clearance	0.00012-0.00088 in.	0.00305-0.02235 mm		
Fit in cover bushing (loose)	0.0023-0.0043 in.	0.0584-0.1092 mm	0.0050 in.	0.1270 mm

TORQUE VALUES

ITEM	TORQUE		NOTES
Anti-rotation screws (lifter)	55-65 **in-lbs**	6-7 Nm	Page 3-54
Crankcase 5/16 in. screws	15-19 ft-lbs	20-26 Nm	Page 3-75
Crankcase, 3/8 in. screw	22-27 ft-lbs	30-37 Nm	Page 3-75
Cylinder head screws	See NOTES	See NOTES	Special pattern to tighten, Page 3-33
Cylinder studs	10-20 ft-lbs	14-27 Nm	Special method to tighten, Page 3-75
Flywheel - sprocket nut (for measuring fly-wheel end play)	190-210 ft-lbs	258-285 Nm	Page 3-64
Frame to rear isolator fastener	30-33 ft-lbs	41-45 Nm	LOCTITE® thread locker 262 (red), Page 3-17
Front isolator mounting bolt	63-70 ft-lbs	86-95 Nm	LOCTITE® thread locker 262 (red), Page 3-22
Front tie bar	30-33 ft-lbs	41-45 Nm	LOCTITE® thread locker 262 (red), Page 3-21
Gearcase cover screws	80-110 **in-lbs**	9-12 Nm	Special pattern to tighten, page 3-63
Master cylinder mounting screws	4-6 ft-lbs	5-8 Nm	LOCTITE® thread locker 243 (blue), Page 3-19
Oil filter adapter	8-12 ft-lbs	11-16 Nm	LOCTITE® thread locker 243 (blue), Page 3-52
Oil pressure signal light switch	50-70 **in-lbs**	6-8 Nm	Page 3-52
Oil pump cover screws	70-80 **in-lbs**	8-9 Nm	TORX, page 3-51
Oil pump mounting screws	125-150 **in-lbs**	14-17 Nm	Page 3-51
Pinion shaft nut	19-21 ft-lbs	26-29 Nm	Page 3-62
Pushrod cover screw	30-40 **in-lbs**	3-5 Nm	Page 3-54
Rear engine isolator engine to crankcase	23-27 ft-lbs	31-37 Nm	LOCTITE® thread locker 243 (blue), Page 3-16
Rocker box cover screws	10-13 ft-lbs	13.6-17.6 Nm	Page 3-34
Rocker box to head bolts	11-13 ft-lbs	15-18 Nm	Different sizes, Page 3-34
Rocker box to head bolts	135-155 **in-lbs**	15-18 Nm	Different sizes, Page 3-34
Rocker box to head bolts	18-22 ft-lbs	24-30 Nm	Different sizes, Page 3-34
Side stand bracket	38-41 ft-lbs	51-55 Nm	LOCTITE® thread locker 262 (red), Page 3-15
Swing arm pinch bolt	17-19 ft-lbs	23-26 Nm	LOCTITE® thread locker 243 (blue), Page 3-15
Swing arm pivot shaft	24-26 ft-lbs	32-35 Nm	Page 3-15
Top rear tie bar	30-33 ft-lbs	41-45 Nm	LOCTITE® thread locker 262 (red), Page 3-21
Upper front tie bar	30-33 ft-lbs	41-45 Nm	LOCTITE® thread locker 262 (red), Page 3-21

FUEL

Gasoline/alcohol Blends

The Buell Blast P3 motorcycle has been designed to obtain the best performance and efficiency using unleaded gasoline (**87 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.
- Gasolines containing ETHANOL: Gasoline/ethanol blends are 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 that 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 wall, piston, piston pin, timing gears, 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. 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 3.7 LUBRICATION SYSTEM for more 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 head, cylinder and piston 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/ENGINE REMOVAL. under 3.3 STRIPPING MOTORCYCLE FOR ENGINE REPAIR/REMOVAL to strip motorcycle for removal of cylinder head, cylinder, and piston.

After disassembling “upper end” only, it may be found that crankcase repair is necessary. In this situation, remove the engine crankcase from the chassis.

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.

See 1.24 TROUBLESHOOTING section. 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. 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 wire. Clean around plug base and remove plug.
2. Connect compression tester to 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. Compression is normal if final readings are 120 psi (827 kPa) or more.
6. Inject approximately 1/2 oz. (15 ml) of SAE 30 oil into cylinder and repeat the compression test. 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-35667A) 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 plug and remove spark plug.
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. See Table 3-2. Listen for air leaks at carburetor intake, exhaust, head gasket and timing inspection hole.

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 TEST PROCEDURE or Cylinder Leakage 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.

STRIPPING MOTORCYCLE FOR ENGINE REPAIR/ REMOVAL 3.3

DISASSEMBLING ENGINE FOR CYLINDER HEAD REPAIR/ENGINE REMOVAL

1. Lift and secure the motorcycle by placing the vehicle on a lift and anchor rear wheel in place. Raise lift so the top of the cylinder head is easy to access.
2. Remove seat. See 2.28 SEAT.

⚠WARNING

To protect against shock and accidental start-up of vehicle, disconnect the negative battery cable before proceeding. Inadequate safety precautions could result in death or serious injury.

⚠WARNING

Always disconnect the negative first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

3. Disconnect **both** battery cables, negative cable first. See 7.16 BATTERY.
4. Remove fuel tank. See 7.16 BATTERY.
5. Remove muffler. See 2.20 EXHAUST SYSTEM.
6. Place jack under the motor. Use jack to lower motor.
7. Remove Horn. See 7.22 HORN.
8. See Figure 3-1. Remove crankcase breather hose and crankcase breather from rocker box grommet.

CAUTION

See Figure 3-2. Do not attempt to remove isolator mount from 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.

NOTES:

- *Remove the isolator mount ONLY to replace the engine, cylinder head or servicing of exhaust valve components. For all other disassembly and servicing do not remove mount from cylinder head.*
- *Proceed to step 9. for engine removal, cylinder head replacement or complete cylinder head servicing including exhaust valve components.*
- *For all other disassembly and related servicing procedures proceed to step 10.*

9. See Figure 3-2. Remove the two mounted cylinder head bolts from the front isolator/engine bracket marked “DO NOT REMOVE”. See note above.

NOTES:

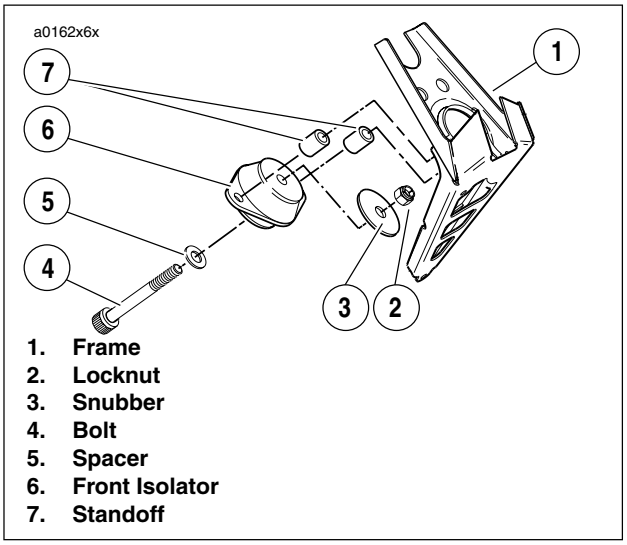
- For top end service proceed to step 11.
- For engine removal proceed to step 12.

Figure 3-1. Remove Crankcase Breather Hose

Figure 3-2. Cylinder Head Bolts

10. See Figure 3-3. Loosen and remove front isolator mount bolt, spacer, snubber and locknut.
11. For top end service loosen, but do not remove lower front tie bar bolts at engine and frame.
12. For engine removal, loosen and remove lower front tie bar from engine.

13. See Figure 3-4. Remove top rear tie bar at frame.



1. **Frame**
2. **Locknut**
3. **Snubber**
4. **Bolt**
5. **Spacer**
6. **Front Isolator**
7. **Standoff**

Figure 3-3. Front Isolator Mount

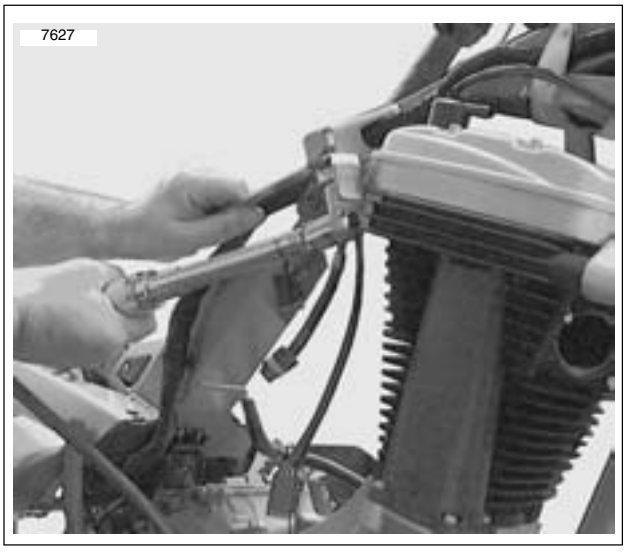
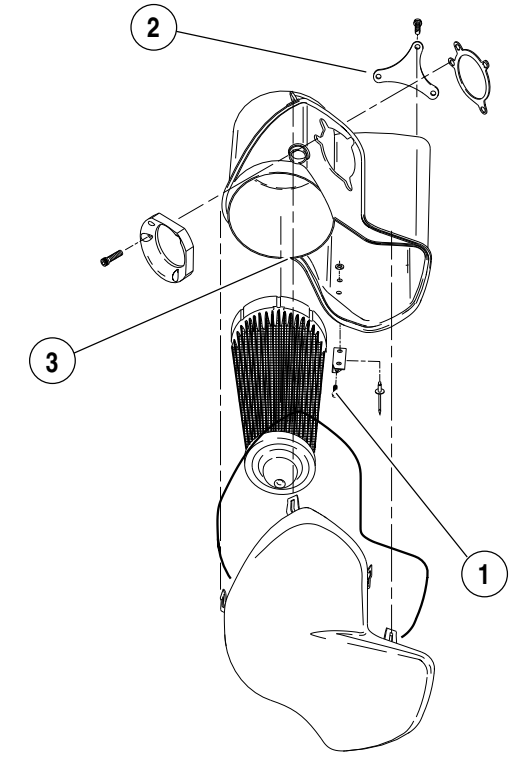


Figure 3-4. Remove Top Rear Tie Bar

14. See Figure 3-5. Remove entire air cleaner and carburetor as an assembly.
    a. Remove screws on both air cleaner brackets.
    b. See Figure 3-6. Loosen hose clamp.
    c. See Figure 3-7. Remove crankcase breather hose.
    d. See Figure 3-8. Disconnect auto enrichener plug.
    e. See Figure 3-8. Place air cleaner and carburetor as an assembly on top of frame.

NOTES:

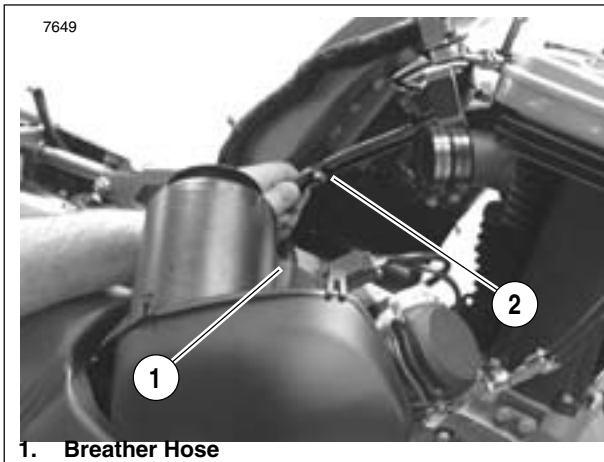
- See 4.3 AIR CLEANER for more details about the air cleaner.
- See 3.5 CYLINDER HEAD. The steps mentioned previously complete disassembly preparation for top end servicing. You may now proceed with TOP END DISASSEMLY PROCEDURES.
- If continuing engine removal proceed to step 16.



1. **Air cleaner bracket (left front)**
2. **Air cleaner bracket (right rear)**
3. **Air cleaner screw**

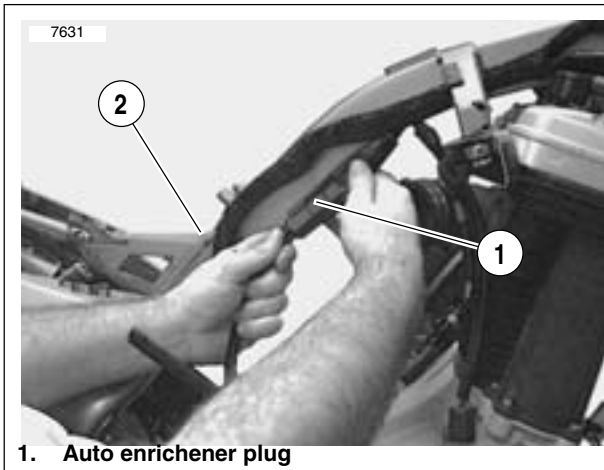
Figure 3-5. Air Cleaner Assembly

Figure 3-6. Hose Clamp



1. **Breather Hose**
2. **Three-way Connector**

Figure 3-7. Crankcase Breather Hose



1. **Auto enrichener plug**
2. **Frame**

Figure 3-8. Auto Enrichener Plug

NOTE

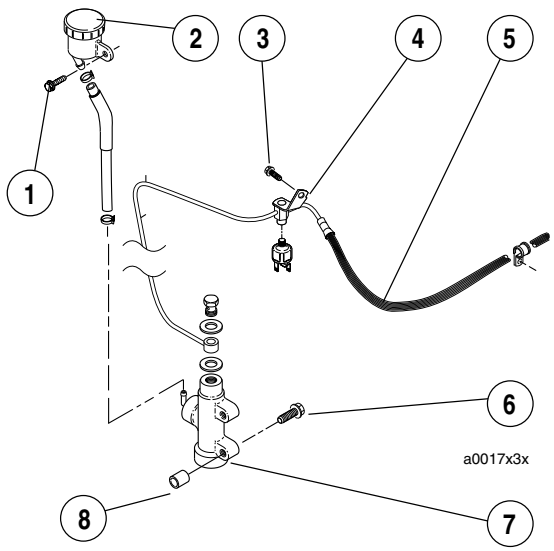
The remaining steps are required to complete engine removal.

15. Place jack under the motor. Use jack to lower motor.
16. Move jack forward.
17. Place wooden cradle under engine.

NOTE

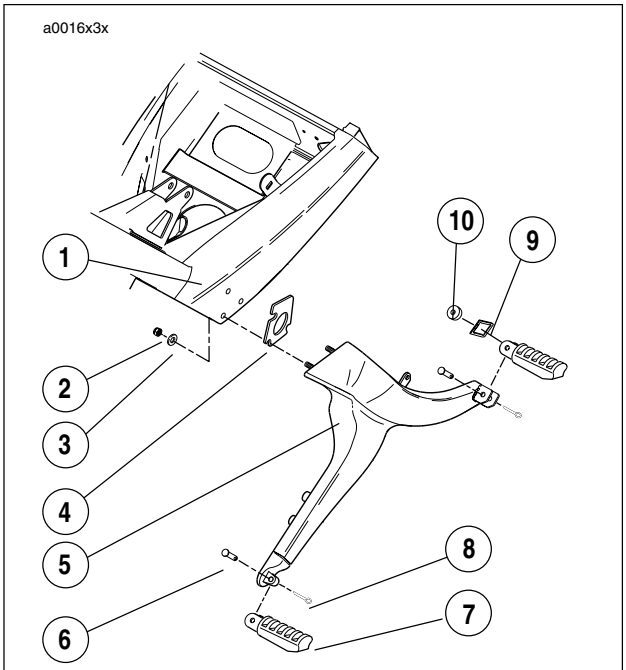
See Figure 3-9. Remove rear master cylinder before removing sprocket cover.

18. Remove sprocket cover. See 2.22 SPROCKET COVER.
19. See Figure 3-9. Disconnect screws at brake fluid reservoir, master cylinder and brake line bracket (items 1, 3 and 6).
20. Move belt on rear sprocket off pulley toward inside of motorcycle.
21. See Figure 3-10. Remove right side rider footpeg bracket assembly. See 2.21 FOOTPEGS AND FOOTPEG SUPPORT BRACKETS.
22. Introduce freeplay and remove clutch cable at hand lever location. See 6.4 CLUTCH.



1. **Screw**
2. **Brake fluid reservoir**
3. **Screw**
4. **Brake line bracket**
5. **Brake line**
6. **Screw**
7. **Master cylinder**
8. **Spacer**

Figure 3-9. Brake Line Assembly



1. **Frame**
2. **Locknut**
3. **Washer**
4. **Spacer**
5. **Footrest support bracket**
6. **Clevis pin**
7. **Footpeg**
8. **Cotter pin**
9. **Index plate**
10. **Spacer**

Figure 3-10. Footpeg Bracket Assembly

23. See Table 3-3. Disconnect the following electrical items:

Table 3-3. Electrical Items Disconnected for Engine Disassembly

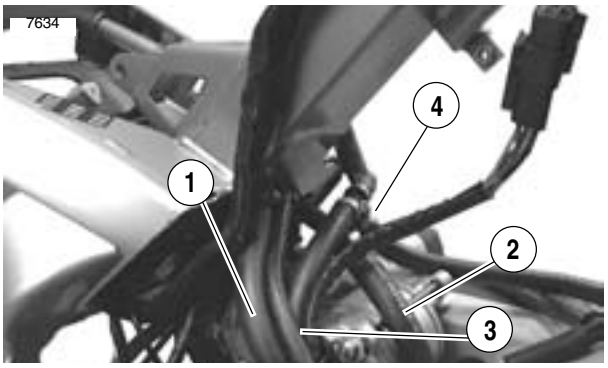
Item no.	Description	Location
1	Ignition module [10]	Located on frame backbone.
2	Speedo sensor [65]	Located under seat (right side-tucked in under cavity).
3	Side stand switch [60]	Tie wrapped to rear brake line.
4	Neutral switch [131]	Disconnect at neutral switch.
5	Oil pressure switch [120]	Disconnect at oil pressure switch.
6	Alternator stator [46]	Located under seat (left side).
7	Starter solenoid wire [128]	Disconnect at starter.
8	Spark plug wire	Located on spark plug.
9	Battery—positive wire	Disconnect at main circuit breaker.
10	Rear brake light switch [121]	Located under frame by shock absorber.

24. See Figure 3-11. Place a floor hoist behind the lift. Attach straps to frame and hoist. Raise hoist until straps tighten.
25. Remove rear shock. See 2.15 REAR SHOCK ABSORBER.
26. See Figure 3-12. Loosen nut on hose routing clamp.

Figure 3-11. Hoisting Bike

Figure 3-12. Loosen Clamp

27. See Figure 3-13. Disconnect feed, return, transmission and crankcase vent lines.



1. **Oil Return**
2. **Transmission Vent**
3. **Crankcase Vent**
4. **Oil Feed**

Figure 3-13. Disconnect Lines

28. See Figure 3-14. Remove rear motor mount bolts.

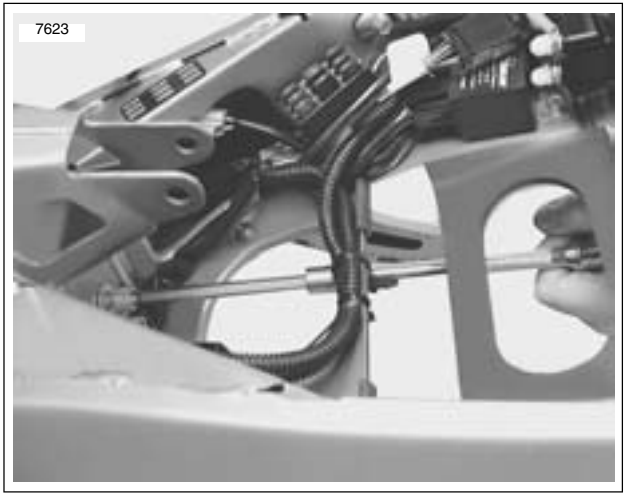


Figure 3-14. Removing Rear Motor Mount Bolts

29. Remove chassis from engine by performing the steps below.
    a. Lower chassis.
    b. Disconnect hoist from chassis.
    c. Lower lift.
    d. See Figure 3-15. Lift chassis and roll away from engine.

Figure 3-15. Move Chassis From Engine

30. See Figure 3-16. Remove air cleaner box bracket.

Figure 3-16. Bracket

31. See Figure 3-17. Remove rear engine mount.

Figure 3-17. Rear Engine Mount

32. See Figure 3-18. Loosen swingarm pinch bolt.

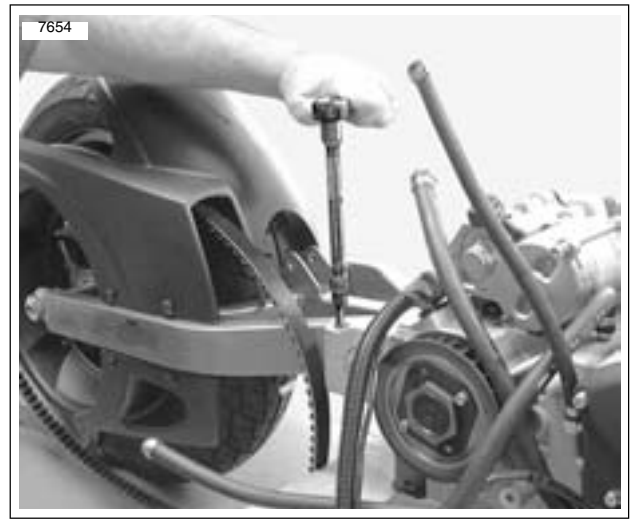


Figure 3-18. Pinch Bolt

33. See Figure 3-19. Remove swingarm pivot shaft and rear wheel as an assembly. See 2.19 SWINGARM.

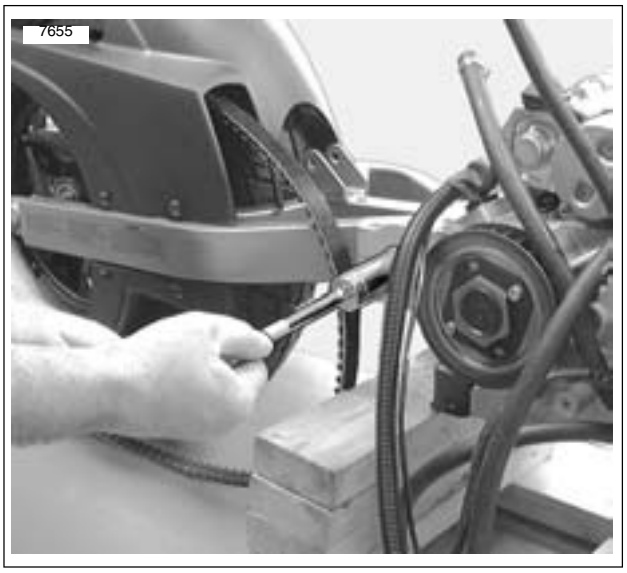


Figure 3-19. Swingarm Pivot Shaft

34. See Figure 3-20. Remove side stand and bracket assembly. See 2.29 SIDE STAND

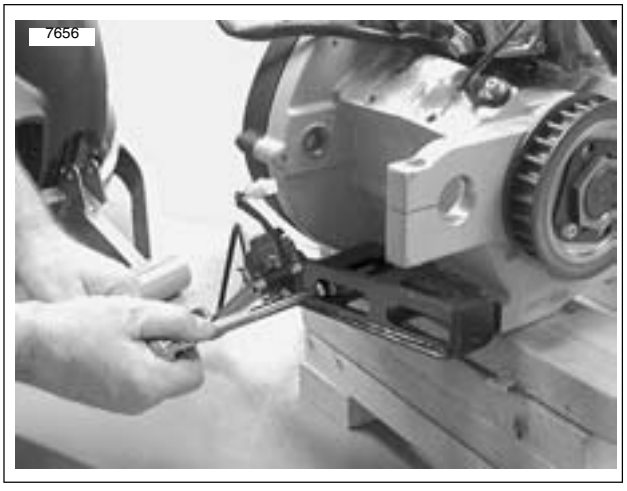


Figure 3-20. Side Stand Bracket

INSTALLING ENGINE

1. Ensure cradle is secured under engine.
2. See Figure 3-21. Install side stand and bracket assembly. See 2.29 SIDE STAND.
   a. Apply several drops of LOCTITE® THREADLOCKER 262 (red) to last few threads.
   b. Tighten to 38-41 ft-lbs (51-55 Nm).
3. Install rear wheel. See 2.6 REAR WHEEL.

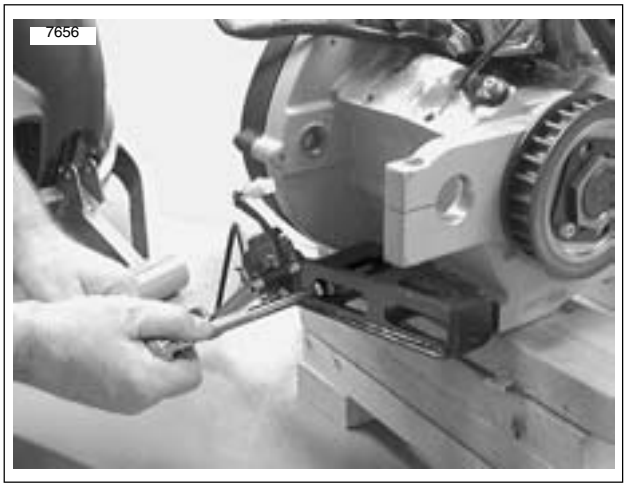


Figure 3-21. Side Stand Bracket

See Figure 3-22. Install swingarm pivot shaft and rear wheel as an assembly. See 2.19 SWINGARM.
   a. Tighten to 24-26 ft-lbs (32-35 Nm).

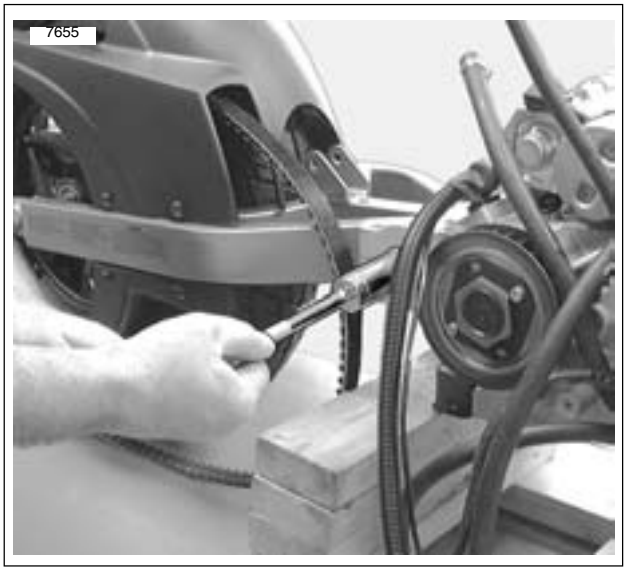


Figure 3-22. Swingarm Pivot Shaft

4. See Figure 3-23. Install swingarm pinch bolt.
   a. Apply several drops of LOCTITE® THREADLOCKER 243 (blue) to last few threads.
   b. Tighten to17-19 ft-lbs (23-26 Nm).

Figure 3-23. Pinch Bolt

5. See Figure 3-24. Install rear engine mount.
   a. Apply several drops of LOCTITE® THREAD-LOCKER 243 (blue) to last few threads.
   b. Tighten to 23-27 ft-lbs (31-37 Nm).

Figure 3-24. Rear Engine Mount

6. See Figure 3-25. Loosely install air cleaner box bracket.
7. Install chassis onto engine by performing the steps below.
   a. See Figure 3-26. Roll chassis toward engine.
   b. Lift chassis onto engine.
   c. Raise lift.
   d. See Figure 3-27. Attach hoist to frame; Place a floor hoist behind the lift. Attach straps to frame and hoist. Raise hoist until straps tighten.
8. Place jack under the motor. Use jack to raise motor.
9. Move jack backward.

Figure 3-25. Bracket

Figure 3-26. Move Chassis to Engine

10. See Figure 3-28. Install rear motor mount bolts.
    a. Apply several drops of LOCTITE® THREAD-LOCKER 262 (red) to last few threads.
    b. Tighten to 30-33 ft-lbs (41-45 Nm).
11. See Figure 3-29. Connect feed, return, transmission and crankcase vent lines.

Figure 3-27. Hoisting Bike

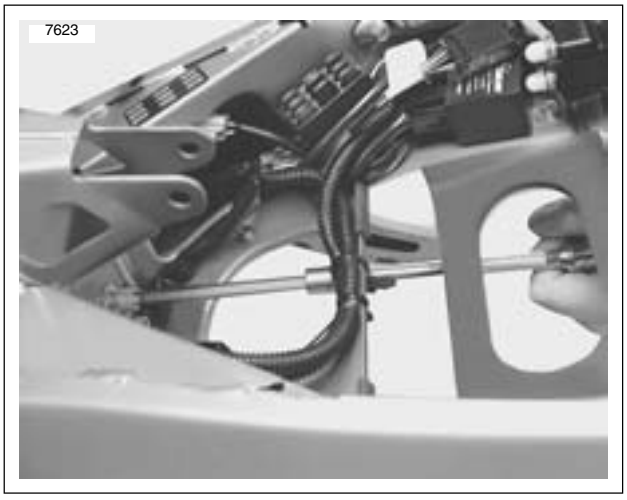
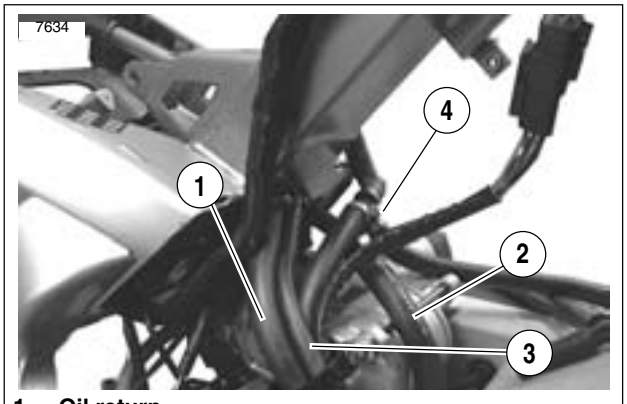


Figure 3-28. Installing Rear Motor Mount Bolts



1. **Oil return**
2. **Transmission vent**
3. **Crankcase vent**
4. **Feed**

Figure 3-29. Connect Lines

12. See Figure 3-30. Tighten hose clamps using Hose Clamp Pliers, part no. HD-41137.

Figure 3-30. Tighten Hose Clamps

13. See Figure 3-31. Tighten nut on hose routing clamp.
14. Install rear shock. See 2.15 REAR SHOCK ABSORBER.
15. See Table 3-4. Electrical Items for Engine Assembly Connect the following electrical items:

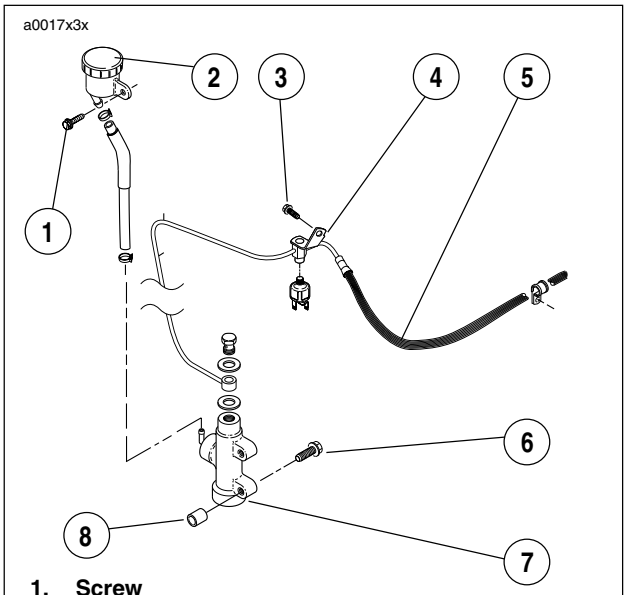
Figure 3-31. Tighten Clamp

Table 3-4. Electrical Items for Engine Assembly

Item no.	Description	Location
1	Ignition module [10]	Located on frame backbone.
2	Speedo sensor [65]	Located under seat (right side-tucked in under cavity).
3	Side stand switch [60]	Tie wrapped to rear brake line.
4	Neutral switch [131]	Disconnect at neutral switch.
5	Oil pressure switch [120]	Disconnect at oil pressure switch.
6	Alternator stator [46]	Located under seat (left side).
7	Starter solenoid wire [128]	Disconnect at starter.
8	Spark plug wire	Located on spark plug.
9	Battery—positive wire	Disconnect at main circuit breaker.
10	Rear brake light switch [121]	Located under frame by shock absorber.

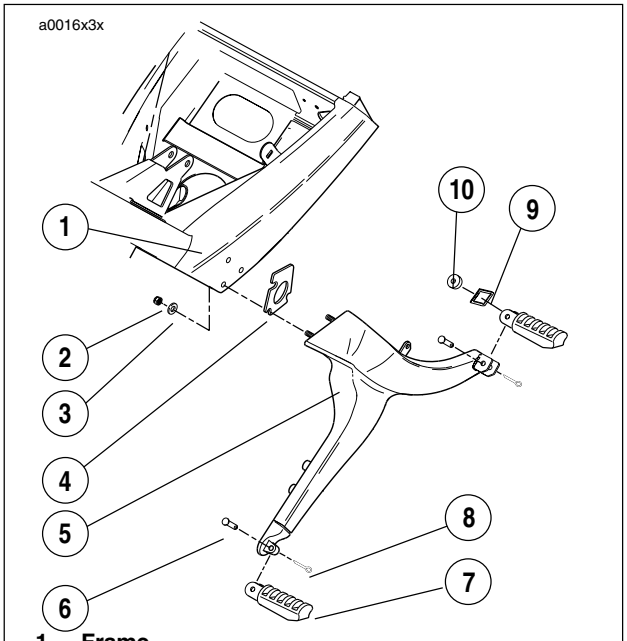
16. Install clutch cable at hand lever location. See 6.4 CLUTCH.
17. Install drive belt. See 1.11 DRIVE BELT AND REAR SPROCKET.
18. Install front sprocket cover. See 2.22 SPROCKET COVER.
19. Install master cylinder onto footpeg bracket. See 2.21 FOOTPEGS AND FOOTPEG SUPPORT BRACKETS.
    a. Apply several drops of LOCTITE® THREADLOCKER 243 (blue) to last few threads.
    b. Tighten to 4-6 ft-lbs (5-8 Nm).

NOTE:
SEE TOP END ASSEMBLY SECTION. The steps mentioned previously complete Assembly preparation for top end servicing. You may now proceed with TOP END ASSEMBLY PROCEDURES. Then proceed to step 22.



1. **Screw**
2. **Brake Fluid Reservoir**
3. **Screw**
4. **Brake Line Bracket**
5. **Screw**
6. **Brake Line**
7. **Master Cylinder**
8. **Spacer**

Figure 3-32. Brake Line Assembly



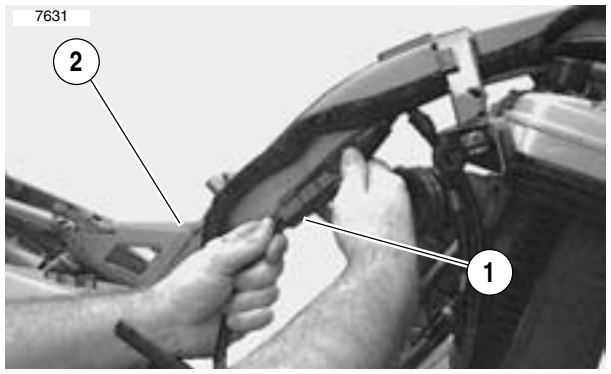
1. **Frame**
2. **Locknut**
3. **Washer**
4. **Spacer**
5. **Footrest Support Bracket**
6. **Clevis Pin**
7. **Footpeg**
8. **Cotter Pin**
9. **Index Plate**
10. **Spacer**

Figure 3-33. Footpeg Bracket Assembly

20. See Figure 3-34. Connect auto enrichener plug.
21. See Figure 3-36. Install entire air cleaner assembly. See 4.3 AIR CLEANER.
    c. See Figure 3-35. Connect crankcase breather hose to three-way connector.
    d. See Figure 3-37.Install hose clamp.
    e. See Figure 3-36. Install and tighten screws on both air cleaner brackets.
    f. Install screw on air cleaner cover.

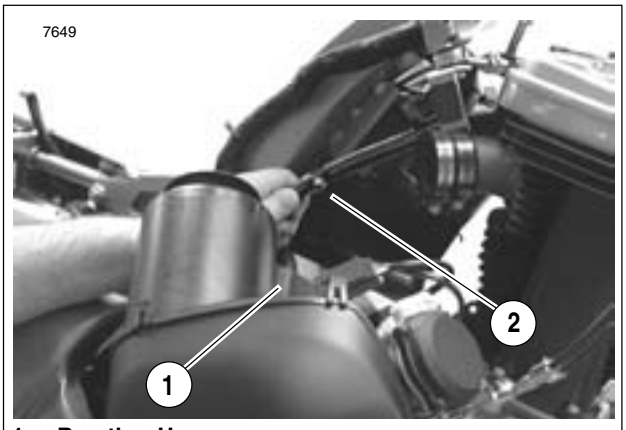
NOTE

See 4.3 AIR CLEANER for more details on the air cleaner.



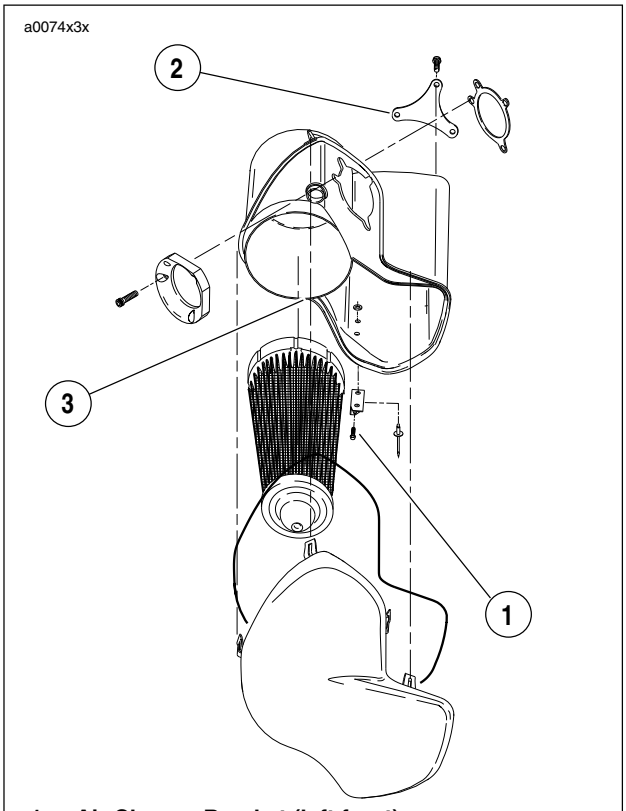
1. **Auto Enrichener Plug**
2. **Frame**

Figure 3-34. Auto Enrichener Plug



1. **Breather Hose**
2. **Three-way Connector**

Figure 3-35. Crankcase Breather Hose



1. **Air Cleaner Bracket (left front)**
2. **Air Cleaner Bracket (right rear)**
3. **Air Cleaner Screw**

Figure 3-36. Air Cleaner Assembly

Figure 3-37. Hose Clamp

22. See Figure 3-38. Install top rear tie bar at frame.
23. Tighten tie bar bolt to 30-33 ft-lbs (41-45 Nm).
24. Install ground strap bolt to engine. Tighten ground strap bolt to 30-33 ft-lbs (41-45 Nm).
25. See Figure 3-39. Install front tie bar onto engine.
    a. Apply several drops of LOCTITE® THREAD-LOCKER 262 (red) to last few threads.
    b. Tighten to 30-33 ft-lbs (41-45 Nm).
26. See Figure 3-40. Install the two mounted cylinder head bolts from the front isolator/engine bracket marked “DO NOT REMOVE”.
    a. Apply several drops of LOCTITE® THREAD-LOCKER 262 (red) to last few threads of **new** bolts.
    b. Apply a thin film of clean HD 20W50 engine oil to both sides of **new** thick washers and to bottom of bolt heads. Exercise caution to avoid mixing oil on washers with LOCTITE on bolts.
    c. Tighten bolts to 60 ft-lbs (27 Nm) initially and then loosen each bolt one full turn. Tighten bolts again to 60 ft-lbs (27 Nm).

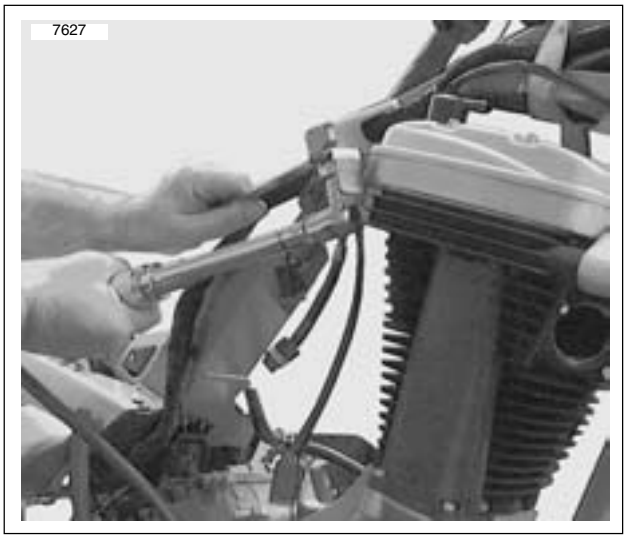
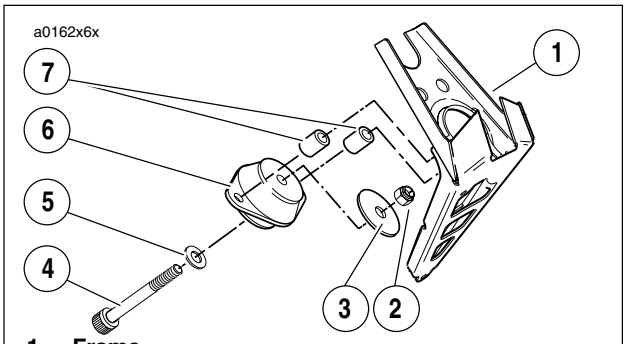


Figure 3-38. Install Top Rear Tie Bar

Figure 3-39. Install Front Tie Bar

Figure 3-40. Cylinder Head Bolt

27. See Figure 3-41. Install front isolator mounting bolt, spacer snubber and **new** nut.
28. Tighten front isolator mounting bolt to 63-70 ft-lbs (86-95 Nm).



1. **Frame**
2. **Locknut**
3. **Snubber**
4. **Bolt**
5. **Spacer**
6. **Front Isolator**
7. **Standoff**

Figure 3-41. Front Isolator Mount

29. See Figure 3-42. Install crankcase breather hose and crankcase breather into rocker box grommet.
30. Install horn. See 7.22 HORN.
31. Remove jack from under the motor.
32. Install muffler. See 2.20 EXHAUST SYSTEM.
33. Install fuel tank. See 4.2 FUEL TANK COVER/FUEL TANK.
34. Install new oil filter, engine oil and primary chaincase fluid as necessary.
35. See Figure 3-33. Install right side rider footpeg bracket assembly. See 2.21 FOOTPEGS AND FOOTPEG SUPPORT BRACKETS.

Figure 3-42. Install Crankcase Breather Hose

⚠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 which could result in death or serious injury.

36. Connect **both** battery cables, positive cable first. See 7.16 BATTERY.
37. Install seat. See 2.28 SEAT.

REMOVAL

Before removing the cylinder head assembly, see 3.3 STRIPPING MOTORCYCLE FOR ENGINE REPAIR/REMOVAL. The rocker arm covers and internal components must be removed before removing cylinder head.

1. See Figure 3-43. Remove screws with washers and fiber seals. Discard fiber seals.

CAUTION

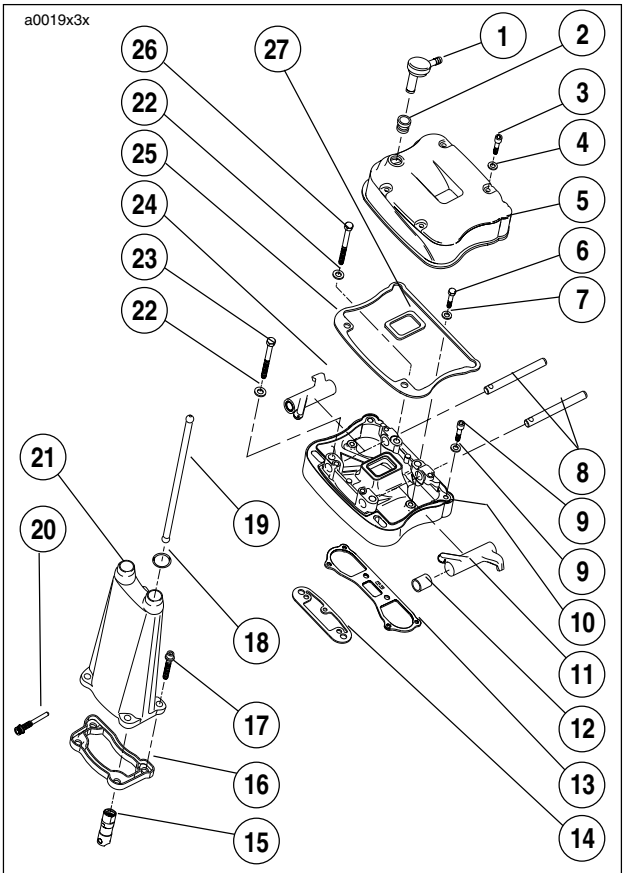
Do not mix or replace hardened washers and fasteners with unhardened parts. Do not reuse fiber cover seals. These actions may result in accelerated wear and increased noise.

2. Remove rocker cover.
3. Remove and discard gaskets.
4. Rotate crankshaft until piston on head reaches top dead center of compression stroke.
5. Remove spark plug.

NOTE

Both valves in the cylinder head will be closed when viewed through the spark plug hole.

6. Remove the two rocker arm retaining bolts near the push rods.
7. Remove remaining hardware holding lower rocker cover to cylinder head in the following order.
   a. Remove two screws and washers.
   b. Remove three bolts and washers.
   c. Remove the remaining two rocker arm retaining bolts.



1. Crankcase Breather
2. Grommet
3. Screw (4)
4. Gasket
5. Rocker Cover (top)
6. Bolt (3)
7. Washer (3)
8. Rocker Arm Shafts
9. Bolt w/washer (2)
10. Rocker Cover (lower)
11. Rocker Arm (exhaust)
12. Bushing (rocker arm)
13. Gasket (valve side)
14. Gasket (push rod side)
15. Hydraulic Lifter
16. Gasket (push rod cover)
17. Screw (4)
18. O-ring (push rod cover)
19. Push Rod (exhaust)
20. Anti-Rotation Screw (2)
21. Push Rod cover
22. Washer (4)
23. Bolt (2)
24. Rocker Arm (intake)
25. Gasket (lower)
26. Bolt (2)
27. Gasket (inner)

Figure 3-43. Rocker Arm Cover

8. See Figure 3-43. Remove lower rocker cover.

NOTE

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

9. Mark the location and orientation (top/bottom) of each push rod. Remove push rods.

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.

10. See Figure 3-44. Remove rocker arm shafts by tapping them out using a hammer and a soft metal punch.

11. See Figure 3-43. Remove rocker arms; **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 3-45.

12. See Figure 3-45. Loosen each head screw 1/8-turn following the sequence shown.

13. Support motorcycle under crankcase. Do not allow engine to drop when performing the next Step.

14. Continue loosening in 1/8-turn increments until screws are loose. Remove head screws.

15. Remove cylinder head, head gasket, and O-rings.

16. Discard head gasket.

17. See Figure 3-43. Remove push rod cover, gasket and valve tappets.

DISASSEMBLY

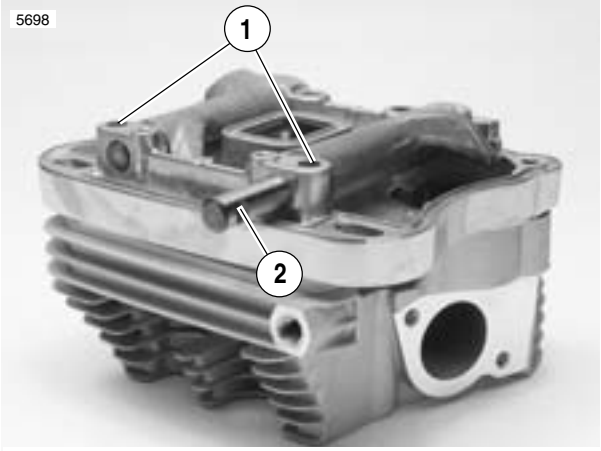
1. See Figure 3-46. Compress valve springs with VALVE SPRING COMPRESSOR (Part No. HD-34736B).

2. See Figure 3-47. Remove valve keepers, upper collar and valve springs. Mark valve keepers for reassembly in their original locations.

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, valve stem seal and lower collar.

5. Repeat the above procedure for the other valve.



1. Position of rocker arm retaining bolts
2. Retaining notch

Figure 3-44. Removing Rocker Arm Shafts (Typical)

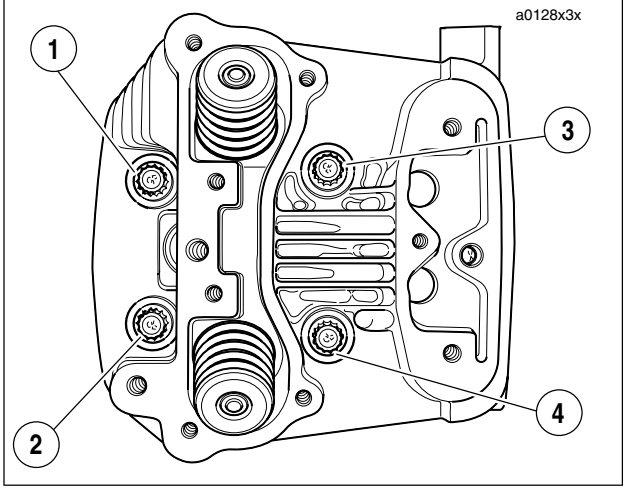


Figure 3-45. Head Screw Loosening/Tightening Sequence

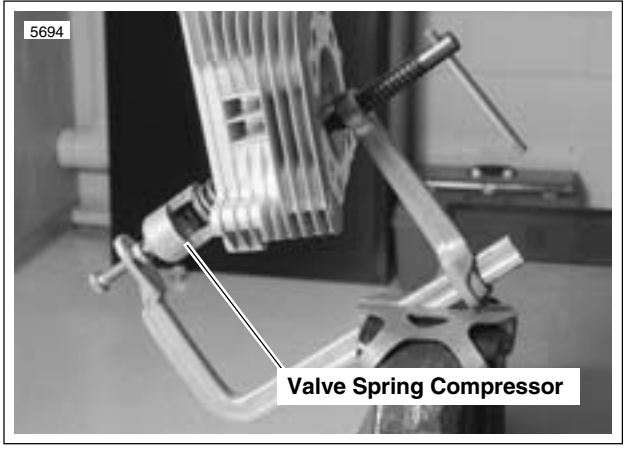
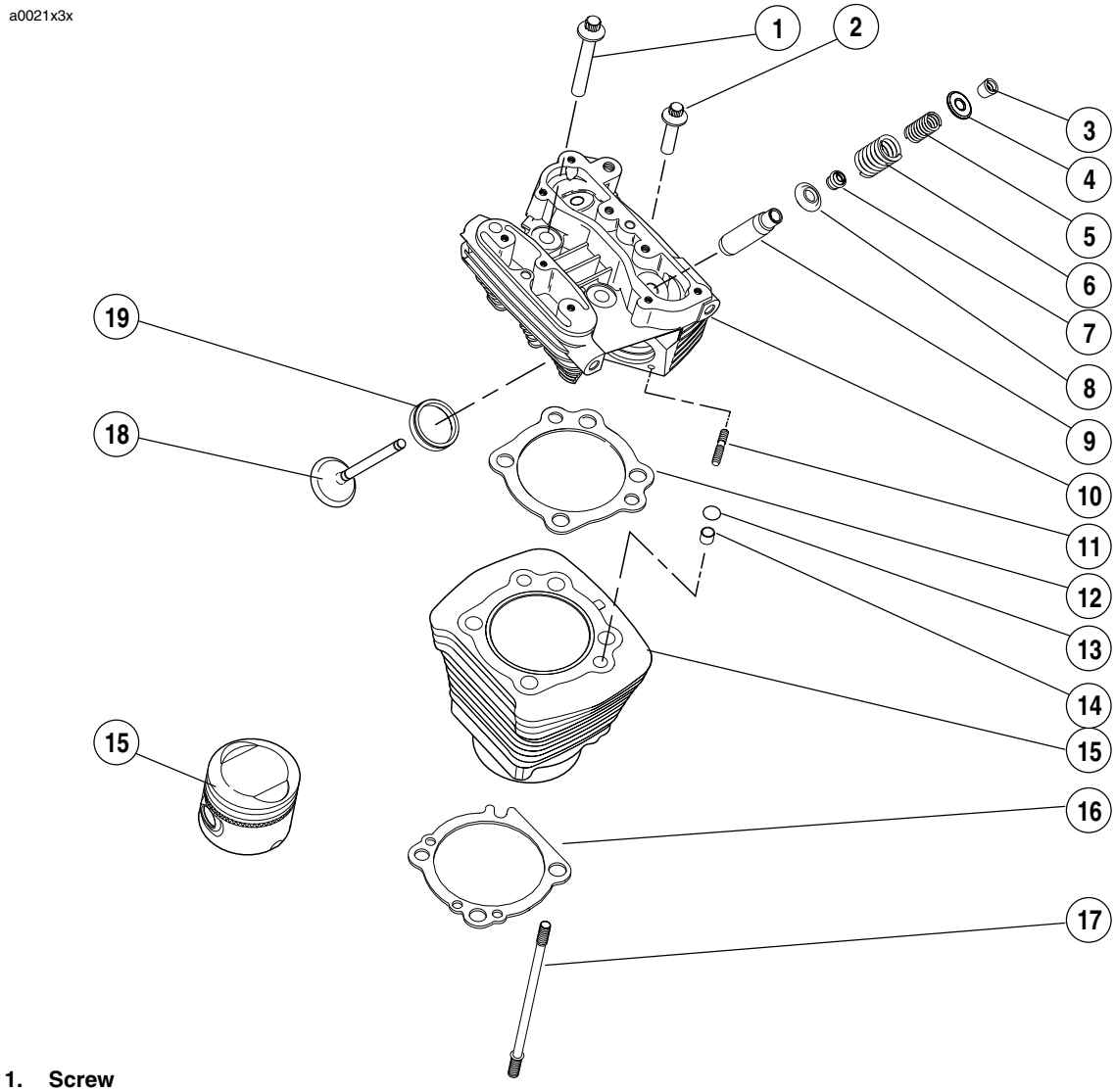


Figure 3-46. Valve Spring Compressor (Part No. HD-34736B)



1. Screw
2. Screw
3. Valve collar retainer
4. Upper valve spring collar
5. Inner valve spring
6. Outer valve spring
7. Valve seal
8. Lower valve spring collar
9. Valve guide intake & exhaust (2)
10. Cylinder head
11. Exhaust port stud
12. Cylinder head gasket
13. Cylinder O-ring (4)
14. Cylinder insert
15. Cylinder w/piston & rings
16. Cylinder base gasket
17. Cylinder base stud
18. Exhaust valve
19. Exhaust valve seat

Figure 3-47. Cylinder Head, Cylinder and Piston Assembly

CLEANING AND INSPECTION

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.
5. Measure and record rocker arm shaft diameter.
   a. See Figure 3-48. Measure where shaft fits in lower rocker arm cover.
   b. See Figure 3-49. Measure where rocker arm bushings ride.
6. Measure and record rocker arm shaft bore diameter.
   a. See Figure 3-50. Measure bore of lower rocker cover.
   b. See Figure 3-51. Measure rocker arm bushing inner diameter.

Figure 3-48. Measuring Rocker Arm Shaft Diameter (Rocker Cover Position)

Figure 3-49. Measuring Rocker Arm Shaft Diameter (Rocker Arm Bushing Position)

Figure 3-50. Measuring Rocker Arm Shaft Bore Diameter in Lower Rocker Cover

7. Check the measurements obtained in Steps 5-6 against the SERVICE WEAR LIMITS. Repair or replace parts exceeding limits.
8. Assemble rocker arms and rocker arm shafts into 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. (0.635 mm).
11. Valve heads should have a seating surface width of 0.040-0.062 in. (1.016-1.575 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. Resurface valve seats 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.
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 3-52. Check free length and compression force of each spring. Compare with SERVICE WEAR LIMITS. 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 3-53. Check head gasket surface on head for flatness. Machine or replace any head which exceeds SERVICE WEAR LIMIT of 0.006 in. (0.152 mm).

Figure 3-51. Measuring Rocker Arm Bushing Inner Diameter

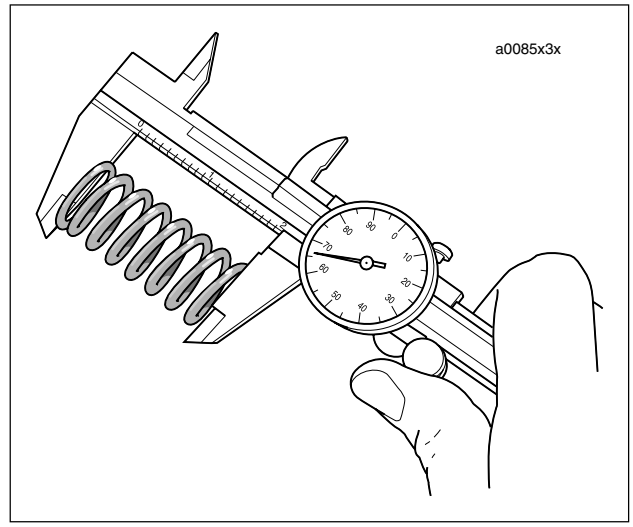


Figure 3-52. Checking Spring Free Length

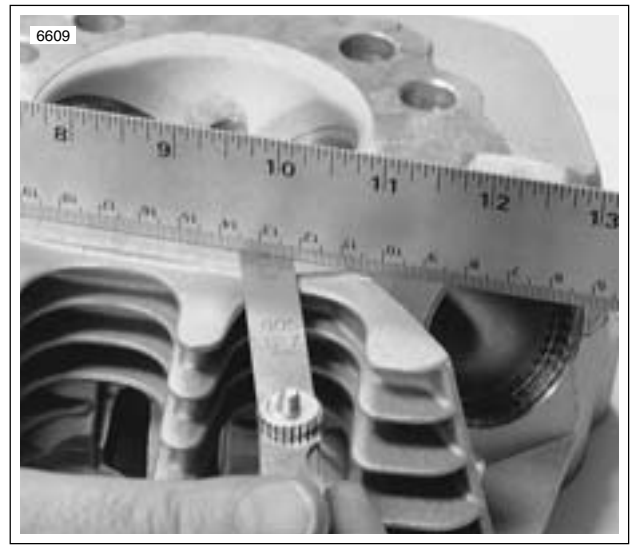


Figure 3-53. Checking Gasket Surface

Rocker Arms and Bushings

1. See Figure 3-54. 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.

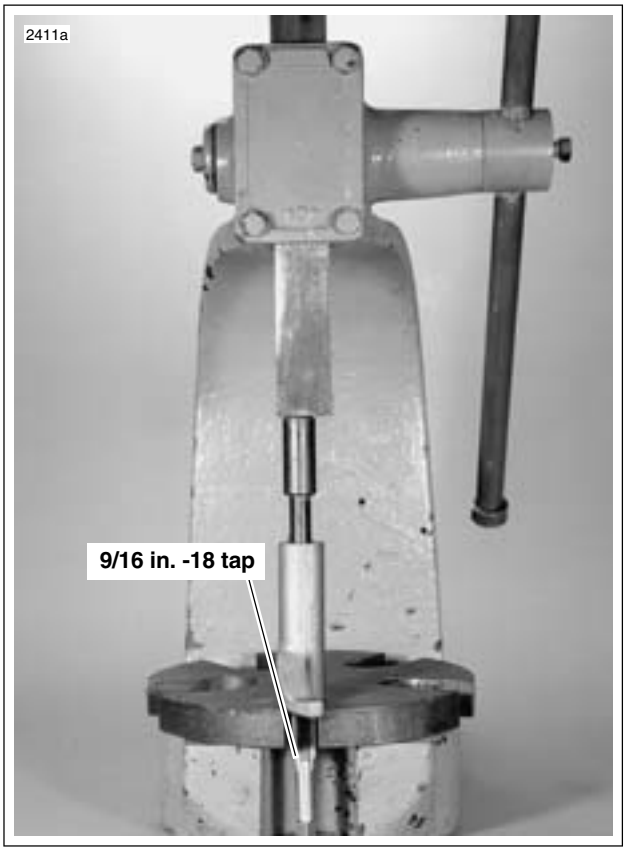


Figure 3-54. Removing Rocker Arm Bushing

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 3-5. If valve stems and/or guides are worn beyond limits, install **new** parts.

Table 3-5. Valve Stem Clearances and Service Wear Limits

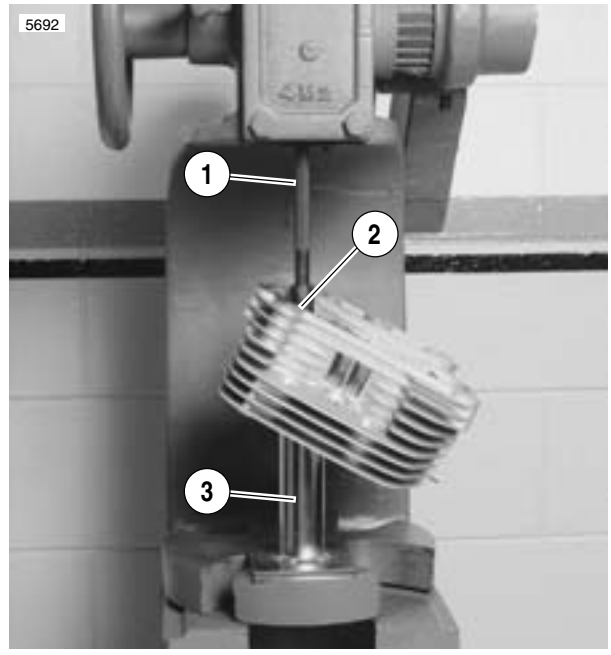
VALVE	CLEARANCE	SERVICE WEAR LIMIT
Exhaust	0.0015-0.0033 in. (0.0381-0.0838 mm)	0.0040 in. (0.1016 mm)
Intake	0.008-0.0026 in. (0.203-0.0660 mm)	0.0035 in. (0.0889 mm)

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.
3. Measure outer diameter of a new standard valve guide. The guide diameter should be 0.0020-0.0033 in. (0.0508-0.0838 mm). larger than bore in head. If it is not, select one of the following oversizes: +0.001 in. (+0.025 mm), +0.002 in. (+0.051 mm) or +0.003 in. (+0.076 mm) (intake and exhaust).
4. See Figure 3-55. 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. (0.0254 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.

NOTE

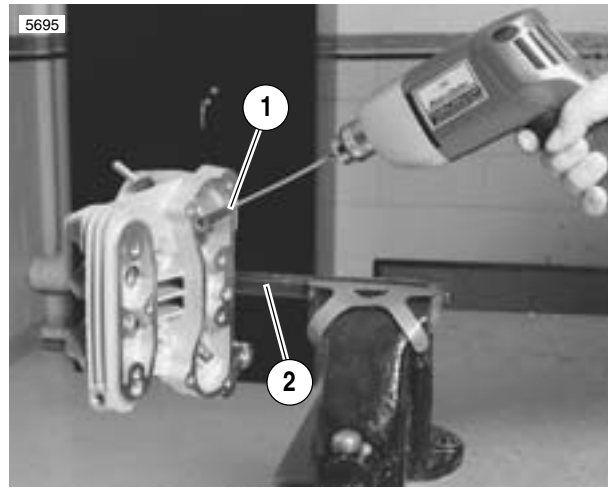
The hone is not intended to remove material.

6. 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°.
7. See Figure 3-56. Thoroughly clean valve guide bores using VALVE GUIDE BRUSH) (Part No. HD-34751) and hot soapy water.



1. **Driver Handle (Part No. HD-34740)**
2. **Valve Guide Installation tool (Part No. HD-34731)**
3. **Cylinder Head Stand (Part No. HD-39782)**

Figure 3-55. Installing Shoulderless Valve Guide



1. **Valve Guide Brush (Part No. HD-34751)**
2. **Cylinder Head Holding Fixture (Part No. HD-39786)**

Figure 3-56. Cleaning Valve Guides

Grinding Valve Faces and Seats

After installing valve guides, reface valve seats to make them concentric with guides.

See Figure 3-57. Valve face angle is 45° for both intake and exhaust valves. If a valve re-facing grinder is used, it must be adjusted exactly to this angle.

NOTES

- *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).**

CAUTION

Do not use valves with too thin of margins. Using 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.

See Table 3-6. 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 as shown. Use NEWAY VALVE SEAT CUTTER SET (Part No. HD-35758) to cut the seats. Always grind valves before cutting seats.

1. See Figure 3-58. 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 3-57. Check the contact pattern on valve face. It should be 0.040-0.062 in. (1.016-1.575 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 a 60° angle in order to raise seat. If pattern is too close to the edge of valve face, cut a 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. (1.016-1.575 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.

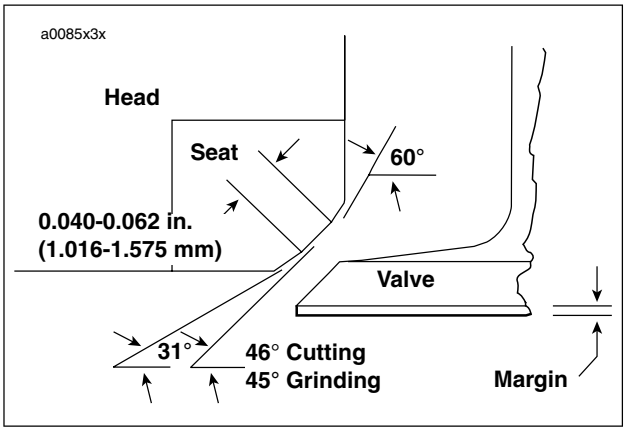


Figure 3-57. Valve Seat Angles

Table 3-6. Neway Valve Seat Cutters

VALVE SEAT	60° CUTTER	31° AND 46° CUTTERS
Exhaust	Part No. 205	Part No. 622
Intake	Part No. 293	Part No. 642

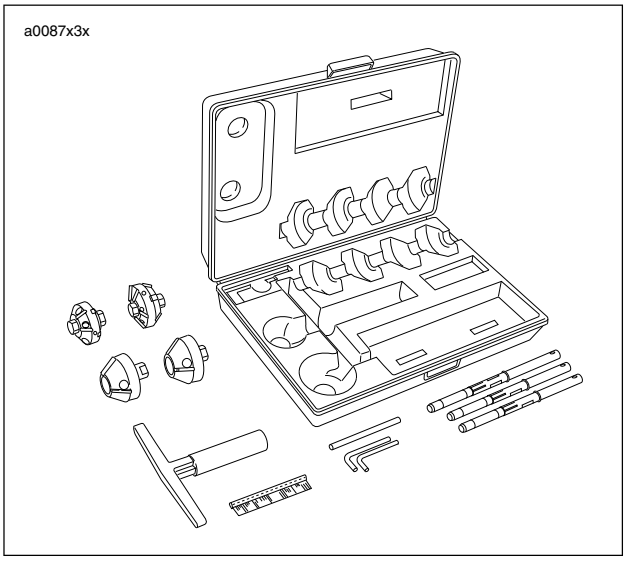


Figure 3-58. Valve Seat Cutter

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 3-59. Wipe valve seats and valve faces clean. Measure valve stem protrusion.
   a. If valve stem protrudes more than 2.031 in. (51.587 mm), replace valve seat or cylinder head.
   b. If valve stem protrusion is acceptable, 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 3.1 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 3-60. Use CYLINDER HEAD HOLDING FIXTURE (Part No. HD-39786) to secure cylinder head.
   a. Apply a light coat of fine lapping compound to valve face. Insert valve in guide.
   b. Place one rubber cup end of VALVE LAPPING TOOL (Part No. HD-96550-36A) onto head of valve.
   c. Holding lapping tool as shown, apply only very light pressure against valve head.
   d. 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 parts with a **new**, clean cloth or towel.
5. Inspect valve and seat.
   a. If inspection shows an unbroken lapped finish of uniform width around both valve and seat, valve is well seated.
   b. If lapped finish is not complete, further lapping (or grinding and lapping) is necessary.

Figure 3-59. Measuring Valve Stem Protrusion

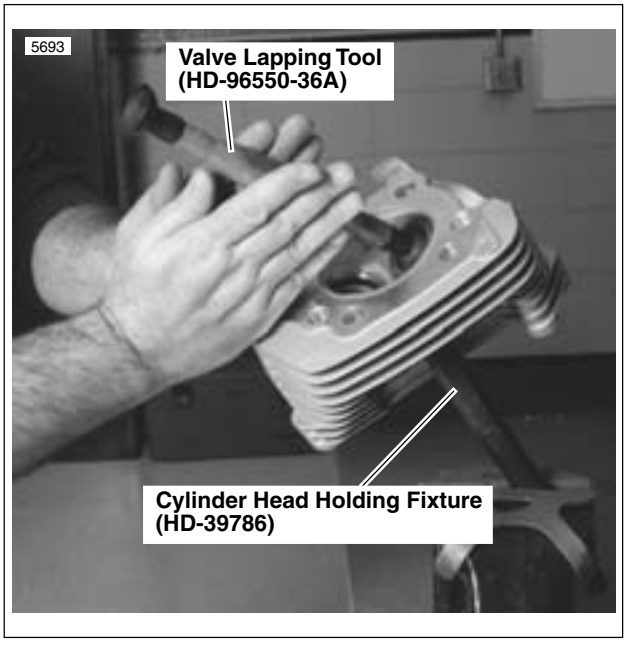


Figure 3-60. Lapping Valves

ASSEMBLY

CAUTION

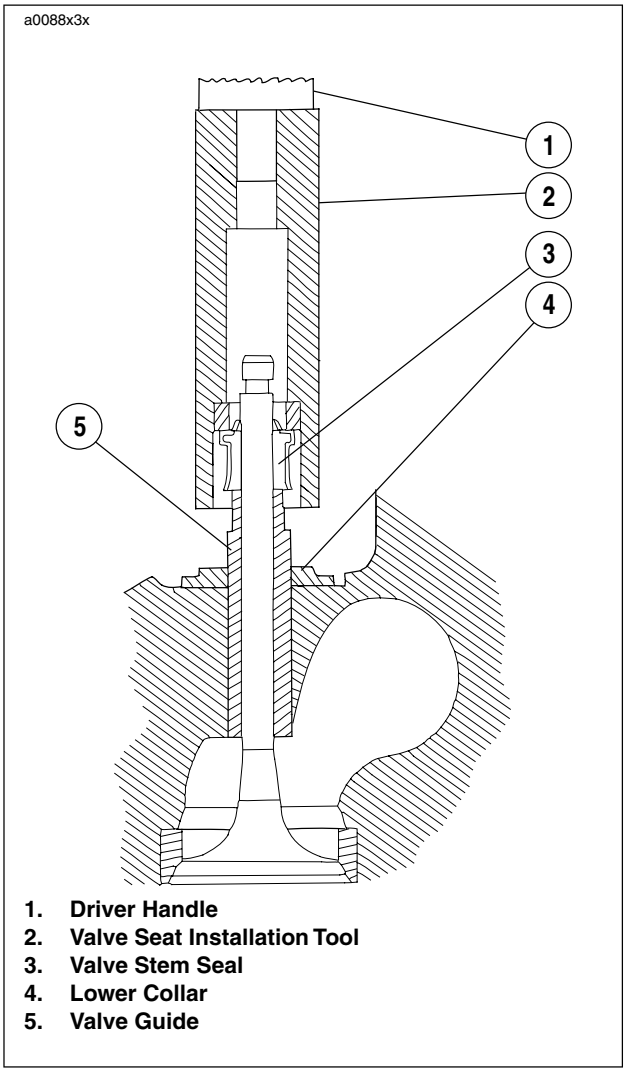
Make sure all lapping compound is removed from cylinder head and valves after lapping is completed. If lapping compound contaminates any internal engine components or engine oil, excessive engine wear and damage may result.

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 3-61. Insert valve into valve guide and install lower collar.
6. See Figure 3-62. 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 3-61. Tap the valve stem seal onto the valve 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.
8. See Figure 3-62. Install valve springs and upper collar.
9. Compress springs with VALVE SPRING COMPRESSOR (Part No. HD-34736B).
10. Insert valve keepers into upper collar, 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.



1. **Driver Handle**
2. **Valve Seat Installation Tool**
3. **Valve Stem Seal**
4. **Lower Collar**
5. **Valve Guide**

Figure 3-61. Valve Seal Installation

Figure 3-62. 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 3.6 CYLINDER AND PISTON.

1. Coat mating surfaces of cylinder studs and head screws 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 and cylinder head.
7. Install a **new** O-ring on each dowel.

CAUTION

O-rings help to properly position the head gasket. O-rings must be installed before the head gasket.

8. Install a **new** head gasket to cylinder.
9. Carefully lower cylinder head over studs and position on dowels. Use great care so as not to disturb head gasket.

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.

10. See Figure 3-45. For each cylinder head, start with screw numbered one, as shown. In increasing numerical sequence (i.e. – 1, 2, 3 and 4):
    a. Tighten bolts to 8-10 ft-lbs (11-14 Nm).
    b. Tighten bolts to 13-15 ft-lbs (18-20 Nm).
    c. Loosen all screws.
11. After screws are loosened from initial torque, tighten head screws in three stages. Tighten fasteners in increasing numerical sequence (i.e. – 1, 2, 3 and 4).
    a. Tighten each screw to 8-10 ft-lbs (11-14 Nm).
    b. Tighten each screw to 13-15 ft-lbs (18-20 Nm).
    c. See Figure 3-63. Mark cylinder head and head screw shoulder with a line as shown (View A).
    d. Turn all bolts an additional 85° -95° .
12. See 3.15 HYDRAULIC LIFTERS. Install hydraulic lifters and push rod cover.
13. See Figure 3-64. See Table 3-7.Identify push rod color coding, length and respective push rod positions in engine. Place intake and exhaust push rods onto seat at top of tappet.

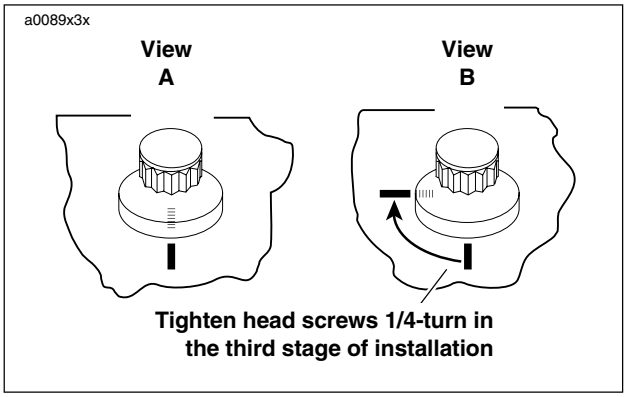


Figure 3-63. Tightening Head Screws

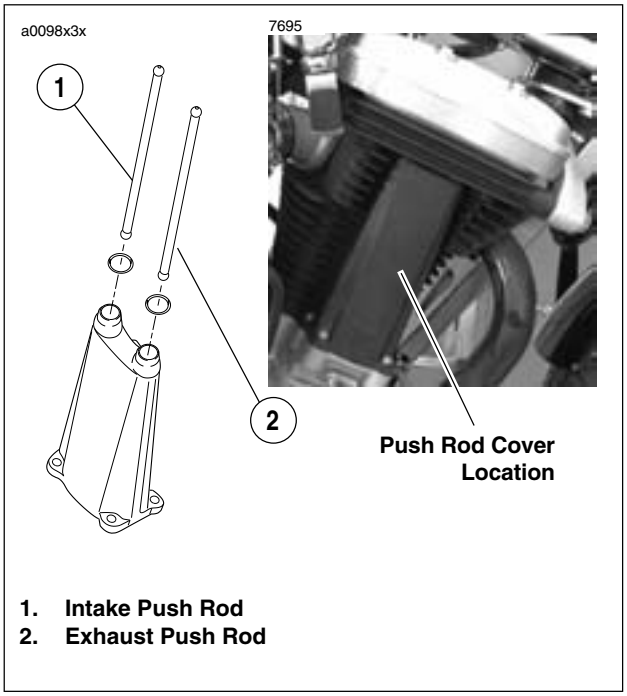


Figure 3-64. Push Rod Locations

Table 3-7. Push Rod Selection

Position	Color Code	Length	Part Number
Exhaust	1 Band-Black	10.800 in. (274.320 mm)	17895-00Y
Intake	1 Band-Orange	10.746 in. (272.948 mm)	17984-00Y

14. See Figure 3-65. Install **new** gaskets with the bead facing up. Place lower rocker box assembly (with rocker arms and shafts into position). Place push rods in rocker arm sockets.

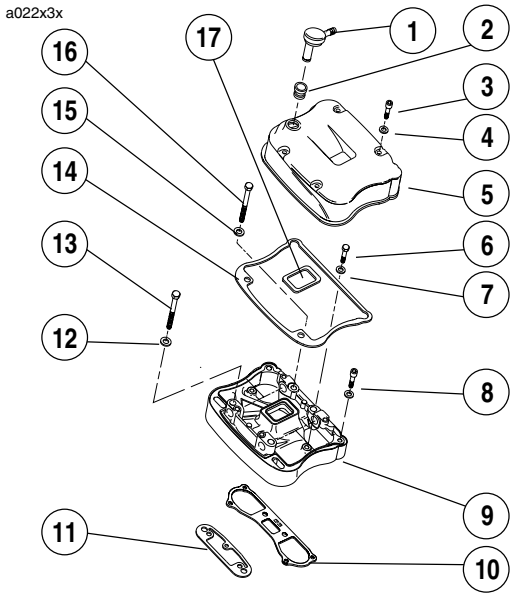
CAUTION

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

15. See Figure 3-66. Install fasteners. Slowly snug all fasteners in small increments (one turn at a time). Use a cross pattern on the four large bolts) that fasten the lower rocker box to head. This will bleed the tappets. Fastener sizes and torque specifications are listed in Table 3-8.
    a. Tighten bolts to 18-22 ft-lbs (24-30 Nm).
    b. Tighten bolts to 11-13 ft-lbs (15-18 Nm).
    c. Tighten bolts to 135-155 **in-lbs** (15-18 Nm).
16. See Figure 3-65. Install upper rocker covers.
    a. Place a **new** inner gasket on lower rocker box assembly.
    b. Place a **new lower** gasket on lower rocker cover.
    c. Install upper rocker cover using screws with washers and **new** fiber seals. Tighten screws to 10-14 ft-lbs (13.6-9 Nm).

Table 3-8. Lower Rocker Box Hardware

ITEM	SIZE	TORQUE
Bolt with washer (12)	5/16-18 X 2-3/4	18-22 ft-lbs (24-30 Nm)
Bolt with washer (13)	5/16-18 X 2-1/2	
Screw with washer (14)	1/4-20 X 1-1/2	135-155 **in-lbs** (15-18 Nm)
Bolt with washer (15)	1/4-20 X 1-1/4	11-13 ft-lbs (15-18 Nm)



1. **Crankcase Breather**
2. **Grommet**
3. **Screw (4)**
4. **Gasket**
5. **Rocker Cover (top)**
6. **Bolt (3)**
7. **Washer (3)**
8. **Bolt w/washer (2)**
9. **Rocker Cover (lower)**
10. **Gasket (valve side)**
11. **Gasket (push rod side)**
12. **Washer (4)**
13. **Bolt (2)**
14. **Gasket (lower)**
15. **Washer (4)**
16. **Bolt (2)**
17. **Gasket (inner)**

Figure 3-65. Rocker Arm Cover Gaskets

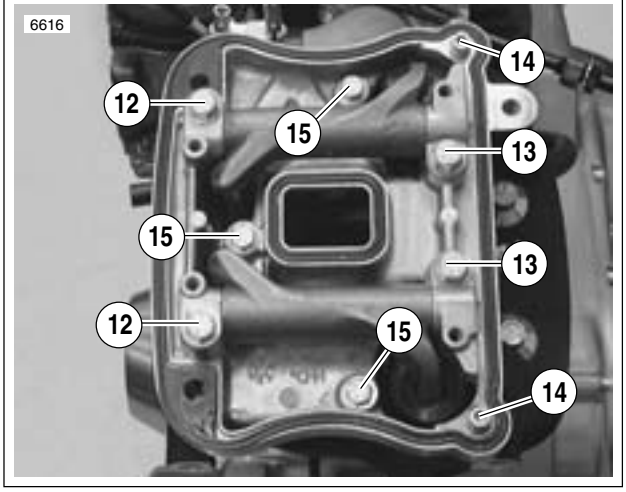


Figure 3-66. Lower Rocker Box Fasteners

REMOVAL/DISASSEMBLY

1. See 3.3 STRIPPING MOTORCYCLE FOR ENGINE REPAIR/REMOVAL. Strip motorcycle as described under this procedure.
2. Remove cylinder head. See 3.5 CYLINDER HEAD.
3. Clean crankcase around cylinder base to prevent dirt and debris from entering crankcase while removing cylinder.
4. See Figure 3-67. Turn engine over until piston of cylinder being removed is at bottom of its stroke.
5. Carefully raise cylinder just enough to permit placing clean towel under piston to prevent any foreign matter from falling into crankcase.

NOTE

If cylinder does not come loose, lightly tap a plastic hammer perpendicular to the cylinder fins. Never try to pry a cylinder up.

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

CAUTION

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

7. Install a 6.0 in. (152 mm) length of 1/2 in. (12.7 mm) ID plastic or rubber hose over each cylinder stud. This will protect the studs and the piston.

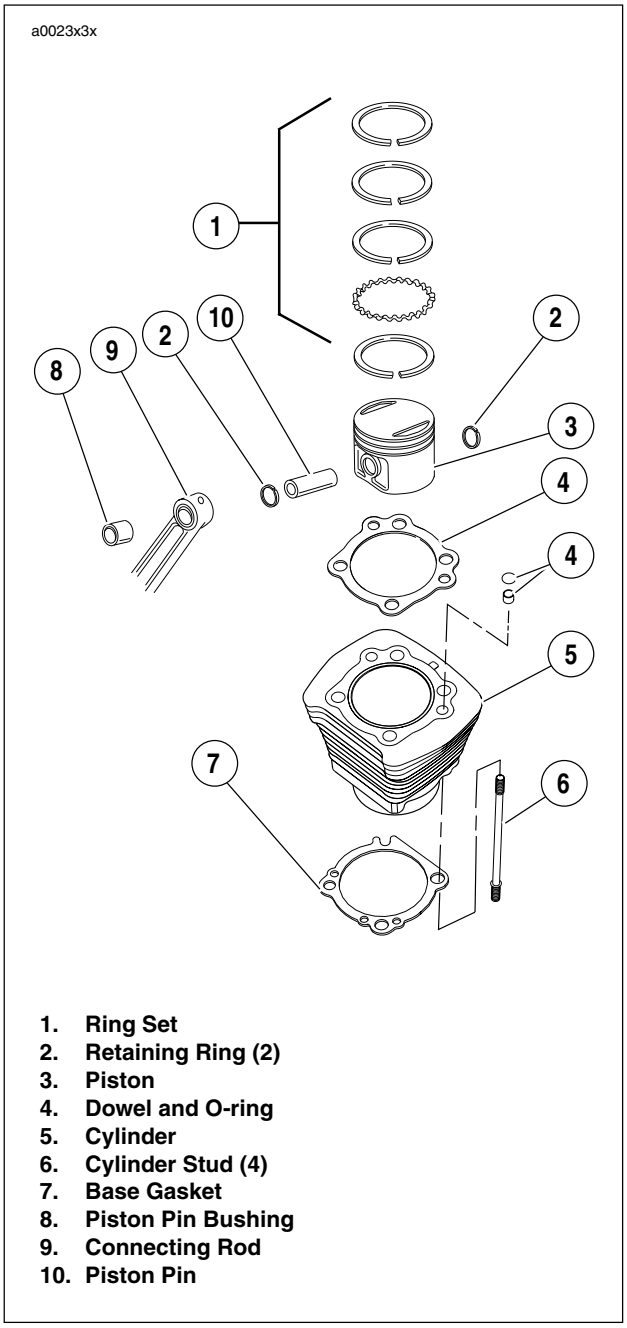
⚠WARNING

Retaining rings are highly compressed in the ring groove and may "fly out" with considerable force when pried out. Always wear safety glasses or goggles when removing or installing retaining rings. Failure to wear safety glasses or goggles could result in death or serious injury.

CAUTION

DO NOT re-use piston pin retaining rings. Removal may weaken retaining rings and they may break or dislodge if reinstalled resulting in engine damage.

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



1. **Ring Set**
2. **Retaining Ring (2)**
3. **Piston**
4. **Dowel and O-ring**
5. **Cylinder**
6. **Cylinder Stud (4)**
7. **Base Gasket**
8. **Piston Pin Bushing**
9. **Connecting Rod**
10. **Piston Pin**

Figure 3-67. Cylinder and Piston

NOTE

Since the piston pin is a loose fit in the piston, the pin will easily slide out. The pin has tapered ends to help seat the round retaining rings.

9. See Figure 3-68. The arrow at the top of pistons must always point toward the front of the engine.

CAUTION

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

10. See Figure 3-68. Spread piston rings outward until they clear grooves in piston and lift off.

CLEANING AND INSPECTION

1. Soak cylinder and piston in an aluminum-compatible cleaner/solvent until deposits are soft, then clean with a brush. Blow off loosened carbon and dirt particles and wash in solvent.
2. Clean oil passage in cylinder with compressed air.
3. Clean piston ring grooves with a piece of compression ring ground to a chisel shape.
4. Examine piston pin to see that it is not pitted or scored.
5. Check piston pin bushing to see that it is not loose in connecting rod, grooved, pitted or scored.
   a. A piston pin properly fitted to upper connecting rod bushing has a 0.00125 to 0.00175 in. (0.03175-0.04445 mm) clearance in bushing.
   b. See Connecting Rod Bushing section. If piston pin-to-bushing clearance exceeds 0.00200 in. (0.05080 mm), replace worn parts.
6. Clean piston pin retaining ring grooves.
7. Examine piston and cylinder for cracks, burnt spots, grooves and gouges.
8. Check connecting rod for up and down play in lower bearings. When up and down play is detected, lower bearing should be refitted. This requires removing and disassembling engine crankcase.

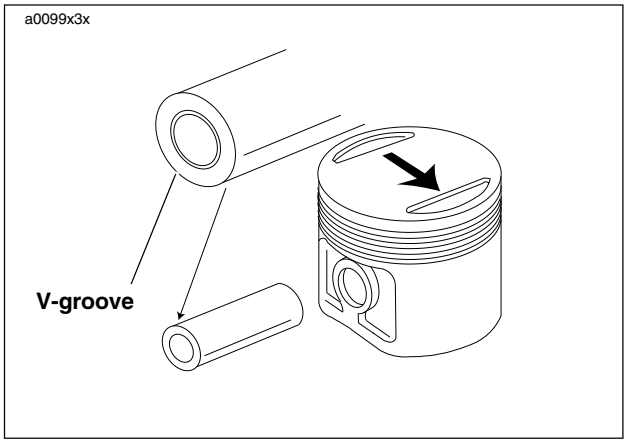


Figure 3-68. Piston Pin and Piston Identification

Checking Gasket Surface

CAUTION

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

1. See Figure 3-69. Check cylinder head gasket surface for flatness.
   a. Lay a straightedge across the surface.
   b. Try to insert a feeler gauge between the straightedge and the gasket surface.
   c. If cylinder head gasket surface is not flat within 0.006 in. (0.152 mm), replace cylinder and piston.
2. Check cylinder base gasket surface for flatness.
   a. Lay a straightedge across the surface.
   b. Try to insert a feeler gauge between the straightedge and the gasket surface.
   c. If cylinder base gasket surface is not flat within 0.008 in. (0.203 mm), replace cylinder and piston.

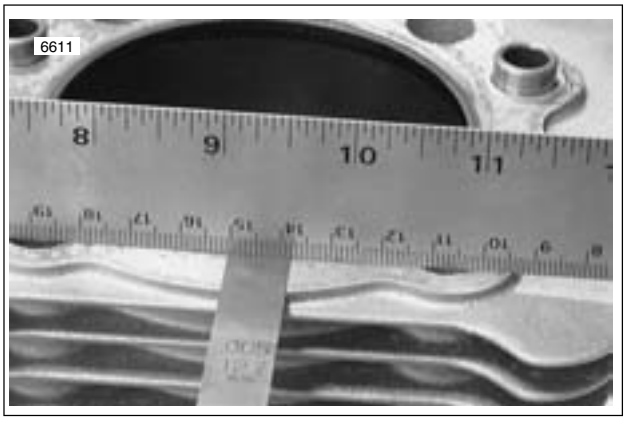


Figure 3-69. Checking Gasket Surfaces

Measuring Cylinder Bore

1. Remove any burrs from the cylinder gasket surfaces.
2. See 3.5 CYLINDER HEAD. See Figure 3-70. Install a head and base gasket, and CYLINDER TORQUE PLATES (Part No. HD-33446A) and XL EVOLUTION TORQUE PLATE BOLTS (Part No. HD-33446-86). Tighten the bolts using the same method used when installing the cylinder head screws.

NOTE

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

3. Take cylinder bore measurement in ring path, starting about 1/2 in. (12.7 mm) from top of cylinder, measuring from front to rear and then side to side. Record readings.
4. Repeat measurement at center and then at bottom of ring path. Record readings. This process will determine if cylinder is out-of-round (or “egged”) and will also show any cylinder taper or bulge.
5. See Table 3-9. If cylinder is not scuffed or scored and is within service limit, see FITTING CYLINDER TO PISTON section.

NOTE

See 3.1 SPECIFICATIONS. If piston clearance exceeds service wear limit, cylinders should be re-bored and/or honed to next standard oversize, and refitted with the corresponding piston and rings. Do not fit piston tighter than 0.0007 in. (0.0178 mm).

Measuring Piston

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

Pistons have an elliptical shape when viewed from the top and are barrel-shaped when viewed from the side. This barrel shape is not symmetrical.

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

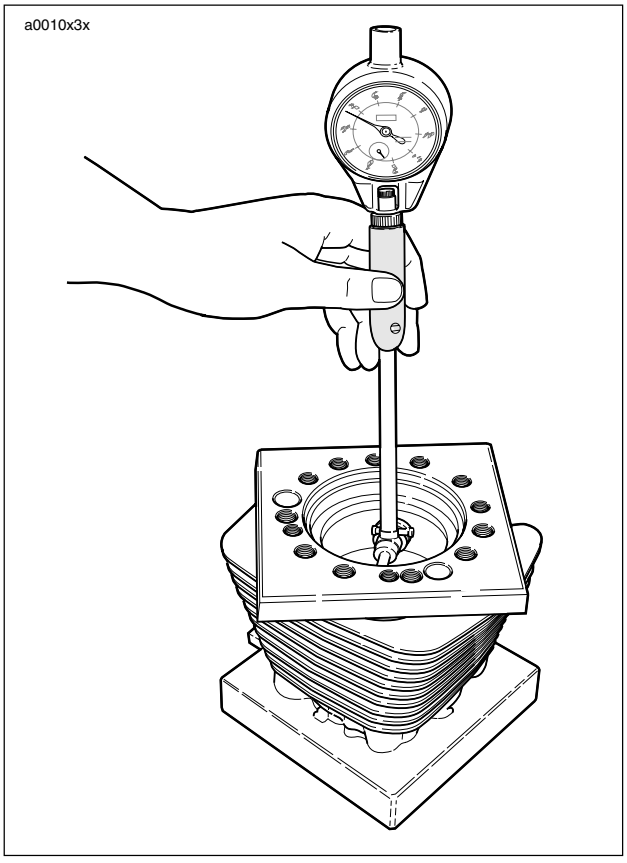


Figure 3-70. Measuring Cylinder Bore Using Torque Plates (Part No. HD-33446A)

Table 3-9. Cylinder Bore Service Wear Limits

BORE SIZES	IN.	MM
Standard Bore	3.5008	88.9203
0.005 in. OS bore (0.127 mm)	3.5050	89.0270
0.010 in. OS bore (0.254 mm)	3.5100	89.1540
0.020 in. OS bore (0.508 mm)	3.5200	89.4080
0.030 in. OS bore (0.762 mm)	3.5300	89.6620

Fitting Cylinder to Piston

Since pistons cannot be accurately measured with standard measuring instruments, the bore sizes must be measured. Bore sizes are listed in Table 3-10. Example: A 0.005 in. (0.127 mm) oversize piston will have the proper clearance with a bore size of 3.502 in. ± 0.0002 in. (88.951 mm ± 0.0051 mm).

Boring and Honing Cylinder

When cylinder requires oversize reboring to beyond 0.030 in. (0.762 mm), the oversize limit has been exceeded and cylinder must be replaced.

1. Bore cylinder with gaskets and torque plates attached. Bore to 0.003 in. (0.076 mm) under the desired finished size.
2. Hone the cylinder to its finished size using a 280 grit rigid hone followed by a 240 grit flexible ball hone. Honing must be done with the torque plates attached. All honing must be done from the bottom (crankcase) end of the cylinder. Work for a 60° crosshatch pattern.

Fitting Piston Rings

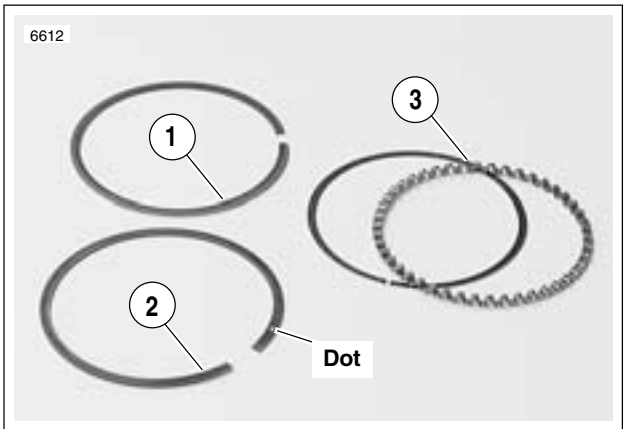
See Figure 3-71. Piston rings are of two types: compression and oil control. The two compression rings are positioned in the two upper piston ring grooves. The dot on the second compression ring must face upward. Ring sets are available to fit standard and oversize pistons.

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

1. See 3.1 SPECIFICATIONS. See Figure 3-72. Place piston in cylinder about 1/2 in. (12.7 mm) from top. Set ring to be checked squarely against piston as shown. Check end gap with thickness gauge.

NOTE

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



1. **Top Compression Ring – Install either side up**
2. **Second Compression Ring – Install dot toward top**
3. **Oil Control Rings**

Figure 3-71. Piston Rings

Table 3-10. Final Cylinder Bore Sizes

BORE SIZES	IN.	MM
Standard bore*	3.4978 in.	88.8441 mm
0.005 in. OS bore (0.127 mm)	3.502 in.	88.951 mm
0.010 in. OS bore (0.254 mm)	3.507 in.	89.078 mm
0.020 in. OS bore (0.508 mm)	3.517 in.	89.332 mm
0.030 in. OS bore (0.762 mm)	3.527 in.	89.586 mm

*All bore sizes + 0.0002 in. (0.0051 mm)

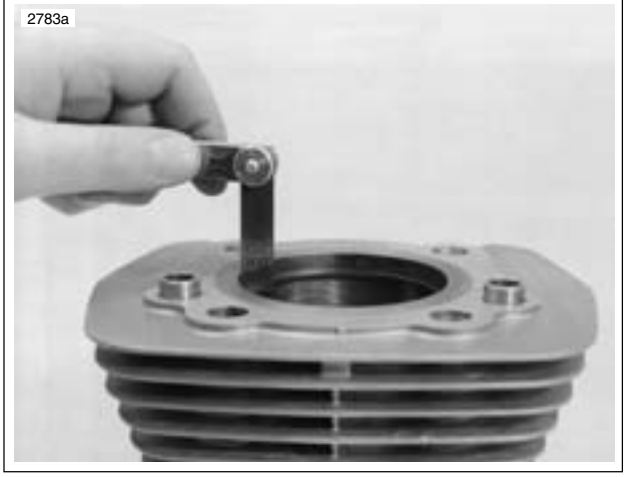


Figure 3-72. Measuring Ring End Gap

NOTE

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

2. See Figure 3-73. Apply engine oil to piston grooves. Use TRANSMISSION SHAFT RETAINING RING PLIERS (Part No. J-5586) to slip compression rings over piston into their respective grooves. Be extremely careful not to over expand, twist rings or damage piston surface when installing rings.

NOTE

Install second compression ring with dot towards top.

3. See Figure 3-74. Install rings so end gaps of adjacent rings are a minimum of 90° apart. Ring gaps are not to be within 10° of the thrust face centerline.
4. See 3.1 SPECIFICATIONS. See Figure 3-75. Check for proper side clearance with thickness gauge, as shown.

NOTE

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

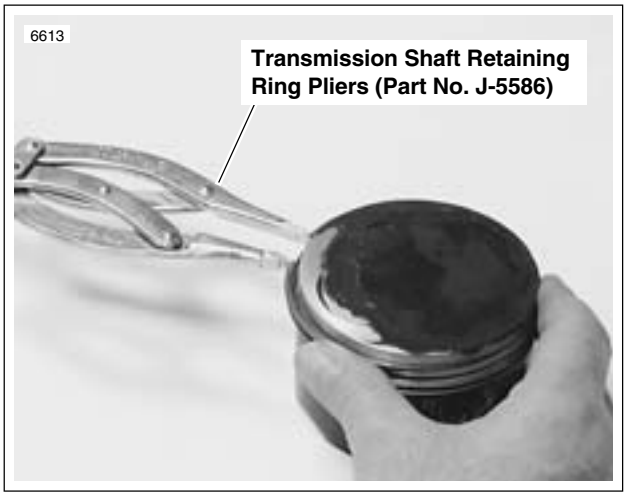


Figure 3-73. Installing Piston Rings

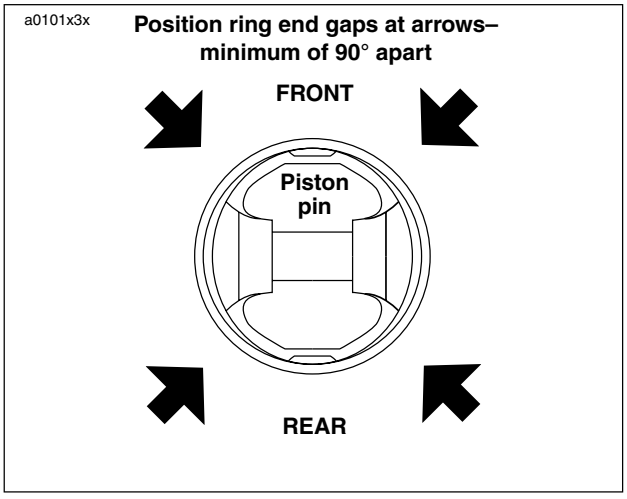


Figure 3-74. Ring End Gap Position

Figure 3-75. Measuring Ring Clearance in Groove

Connecting Rod Bushing

REMOVAL/INSTALLATION

When connecting rod bushing is worn to excessive pin clearance (0.002 in. or more) (0.051 mm) it must be replaced.

1. Secure connecting rod with CONNECTING ROD CLAMPING TOOL (Part No. HD-95952-33B).
2. See Figure 3-77. Attach PISTON PIN BUSHING TOOL (Part No. HD-95970-32D) to the connecting rod. The receiver cup fits on one side of the rod while the driver fits on the opposite side as shown.
3. Use two box wrenches and push worn bushing from connecting rod.
4. Remove piston pin bushing tool from connecting rod.
5. Remove bushing from receiver cup.
6. Place **new** bushing between connecting rod and driver.

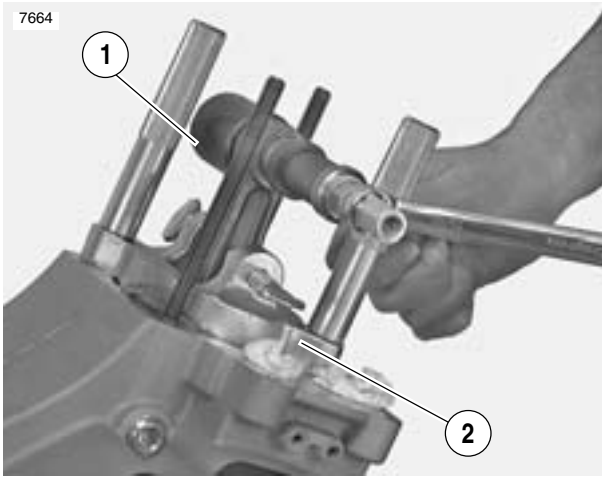
NOTE

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

7. Clean up and size bushing to 0.0010-0.0005 in. (0.0254-0.0127 mm) undersize using REAMER (Part No. HD-94800-26A). Sizing bushing with less than 0.00125 in. (0.03175 mm) clearance can result in a bushing loosening and/or seized pin in rod.
8. Hone bushing to final size using WRIST PIN BUSHING HONE (Part No. HD-35102). Use a liberal amount of honing oil to prevent damage to hone or bushing. Use care to prevent foreign material from falling into the crankcase.

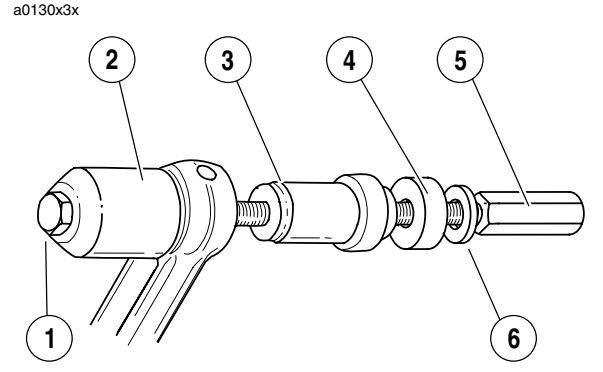
CAUTION

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



1. **Piston Pin Bushing Tool (Part No. HD-95970-32D)**
2. **Rod Clamping Tool (Part No. HD-95952-33B)**

Figure 3-76. Installing New Piston Pin Bushing



1. **Bolt**
2. **Body**
3. **Driver**
4. **Nice Bearing**
5. **Nut**
6. **Washer**

Figure 3-77. Piston Pin Bushing Tool Assembly for Bushing Removal

ASSEMBLY/INSTALLATION

1. See Figure 3-78. Place PISTON SUPPORT PLATE (Part No. HD-42322) in position as shown.
2. Install piston assembly over connecting rod.

NOTE

Piston must be installed with the arrow, at the top of the piston, pointing towards the front of the engine.

3. Install piston pin.

CAUTION

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

4. See Figure 3-79. Install **new** piston pin retaining rings (1) using PISTON PIN RETAINING RING INSTALLER (2) (Part No. HD-34623B). Place **new** retaining ring on tool with gap pointing up. See Figure 3-80.

NOTE

Make sure the ring groove is clean. Ring must be fully seated in the groove with the gap away from the slot at the bottom.

5. See Figure 3-74. Make sure the piston ring end gaps are properly positioned as shown.

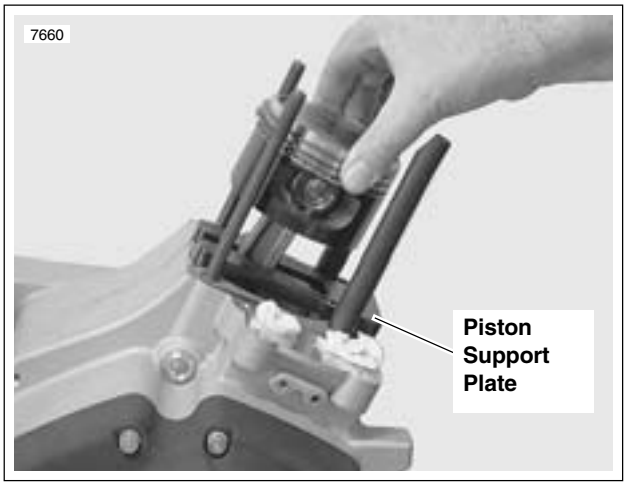
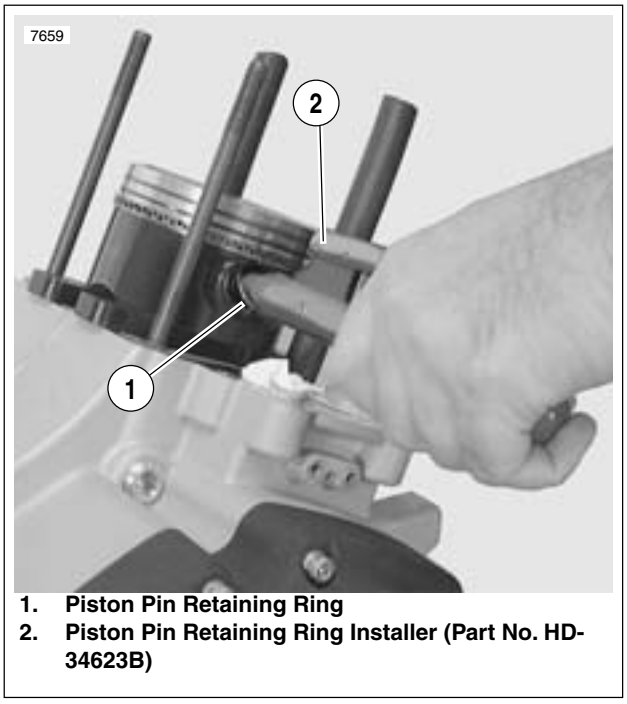


Figure 3-78. Piston Support Plate



1. **Piston Pin Retaining Ring**
2. **Piston Pin Retaining Ring Installer (Part No. HD-34623B)**

Figure 3-79. Installing Piston Retaining Rings

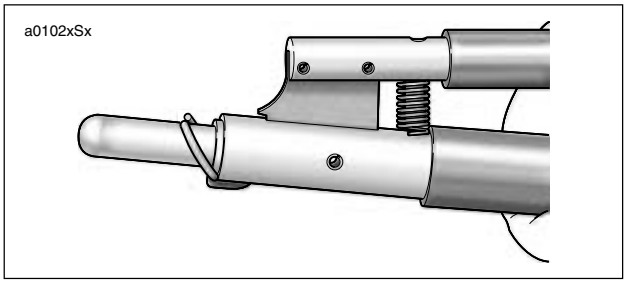
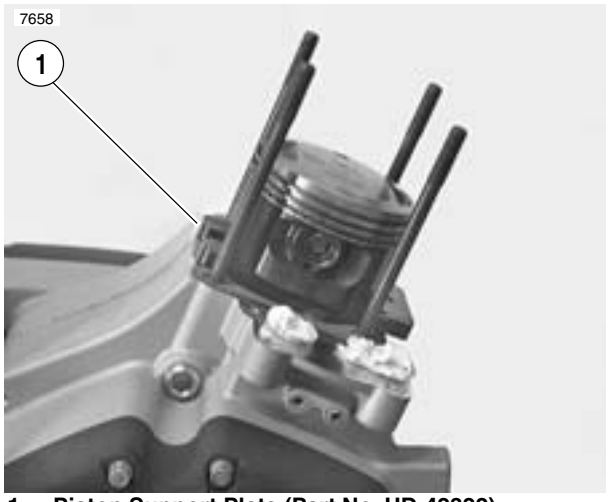


Figure 3-80. Installing Retaining Ring

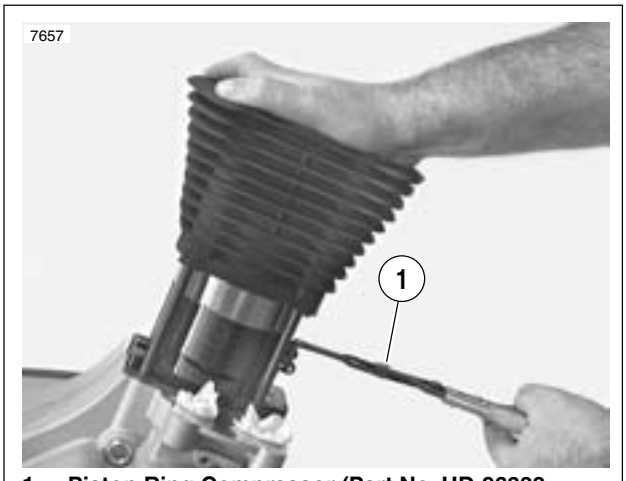
6. See Figure 3-81. Turn engine until piston is resting on top of PISTON SUPPORT PLATE (Part No. HD-42322) top dead center.

7. Lubricate cylinder wall, piston, pin and rod bushing with engine oil.
8. See Figure 3-82. Compress the piston rings using PISTON RING COMPRESSOR (Part No. HD-96333-51C).
9. Remove protective sleeves from cylinder studs. Install a **new** cylinder base gasket. Make sure the piston does not bump the studs or crankcase.
10. Install cylinder over piston.
11. Remove PISTON RING COMPRESSOR.
12. Assemble cylinder head. See 3.5 CYLINDER HEAD.
13. Install cylinder head. See 3.5 CYLINDER HEAD.
14. Install assembled engine. See 3.4 ENGINE INSTALLATION.



1. Piston Support Plate (Part No. HD-42322)

Figure 3-81. Piston Support Plate



1. Piston Ring Compressor (Part No. HD-96333-51C)

Figure 3-82. Compressing Piston Rings