

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**.

Table 3-1. General Specifications

GENERAL		
Type	Single cylinder, air cooled, four-stroke	
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

Table 3-2. Ignition Specifications

ENGINE IGNITION SPECIFICATIONS	
Timing Advance (during engine cranking)	1° BTDC
Timing Advance (at 1200 RPM)	20° BTDC
Regular Idle	1200 RPM
Fast Idle	2000 RPM

Table 3-3. Valve and Valve Seat Specifications

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

Table 3-4. Outer Valve Spring Specifications

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		

Table 3-5. Inner Valve Spring Specifications

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		

Table 3-6. Rocker Arm Specifications

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

Table 3-7. Piston Specifications

PISTON		NEW COMPONENTS		SERVICE WEAR LIMITS	
		inches	mm	inches	mm
Compression ring gap (top and 2nd)		0.007-0.020	0.178-0.508	0.032	0.813
Oil control ring rail gap		0.009-0.052	0.229-1.321	0.065	1.651
Compression ring side clearance	Top	0.0020-0.0045	0.0508-0.1143	0.0065	0.1651
	2nd	0.0016-0.0041	0.0410-0.1041	0.0065	0.1651
Oil control ring side clearance		0.0016-0.0076	0.0410-0.1930	0.0094	0.2390
Pin fit (loose, at room temperature)		0.0005-0.00045	0.0130-0.0110	0.00100	0.02500

Table 3-8. Cylinder Head Specifications

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

Table 3-9. Cylinder Specifications

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

Table 3-10. Connecting Rod Specifications

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

Table 3-11. Hydraulic Lifter Specifications

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

Table 3-12. Oil Pump Specifications

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

Table 3-13. Gearcase Specifications

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

Table 3-14. Flywheel Specifications

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

Table 3-15. Sprocket Shaft Bearing Specifications

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

Table 3-16. Pinion Shaft Bearing Specifications

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

TORQUE VALUES

ITEM	TORQUE		NOTES
Air cleaner bracket fasteners to air cleaner	36-60 in-lbs	4.1-6.8 Nm	page 3-21
Anti-rotation screws (lifter)	55-65 in-lbs	6-7 Nm	Page 3-62
Crankcase 5/16 in. screws	15-19 ft-lbs	20-26 Nm	Page 3-86
Crankcase, 3/8 in. screw	22-27 ft-lbs	30-37 Nm	Page 3-86
Cylinder studs	10-20 ft-lbs	14-27 Nm	Special method to tighten, Page 3-87
Flywheel - sprocket nut (for measuring flywheel end play)	190-210 ft-lbs	258-285 Nm	Page 3-73
Frame to rear isolator fastener	30-33 ft-lbs	41-45 Nm	LOCTITE 262 (red), Page 3-17
Front isolator mounting bolt	63-70 ft-lbs	86-95 Nm	LOCTITE 262 (red), Page 3-23
Front tie bar	30-33 ft-lbs	41-45 Nm	LOCTITE 262 (red), Page 3-22
Gearcase cover screws	80-110 in-lbs	9-12 Nm	Special pattern to tighten, page 3-72
Ground strap bolt to engine	30-33 ft-lbs	41-45 Nm	Page 3-22
Master cylinder mounting screws	48-72 in-lbs	5-8 Nm	LOCTITE 243 (blue), Page 3-20
Oil filter adapter	96-144 in-lbs	11-16 Nm	LOCTITE 243 (blue), Page 3-60
Oil pressure signal light switch	50-70 in-lbs	6-8 Nm	Page 3-60
Oil pump cover screws	70-80 in-lbs	8-9 Nm	TORX, page 3-59
Oil pump mounting screws	125-150 in-lbs	14-17 Nm	Page 3-59
Pinion shaft nut	19-21 ft-lbs	26-29 Nm	Page 3-71
Piston jet TORX screws	25-35 in-lbs	2.8-4 Nm	Loctite 222, page 3-82
Pushrod cover screw	30-40 in-lbs	3-5 Nm	Page 3-62
Rear engine isolator engine to crankcase	23-27 ft-lbs	31-37 Nm	LOCTITE 243 (blue), Page 3-16
Rocker box cover screws	120-168 in-lbs	13.6-17.6 Nm	Page 3-39
Rocker box to head bolts	135-155 in-lbs	15-18 Nm	Different sizes, Page 3-39
Rocker box to head bolts	135-155 in-lbs	15-18 Nm	Different sizes, Page 3-39
Rocker box to head bolts	18-22 ft-lbs	24-30 Nm	Different sizes, Page 3-39
Sidestand bracket	38-41 ft-lbs	51-55 Nm	LOCTITE 262 (red), Page 3-16
Swing arm pinch bolt	17-19 ft-lbs	23-26 Nm	LOCTITE 243 (blue), Page 3-16
Swing arm pivot shaft	24-26 ft-lbs	32-35 Nm	Page 3-16
Top rear tie bar	30-33 ft-lbs	41-45 Nm	LOCTITE 262 (red), Page 3-22

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%.
- **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 [DISASSEMBLY](#) under [3.3 STRIPPING MOTORCYCLE FOR ENGINE SERVICE](#) 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 [1.26 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 3-17. 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. Refer to [Table 3-18](#). 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.

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 3-18. 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.

DISASSEMBLY

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 prevent accidental vehicle start-up, which could cause death or serious injury, disconnect negative (-) battery cable before proceeding. (00048a)

WARNING

Disconnect negative (-) battery cable first. If positive (+) cable should contact ground with negative (-) cable connected, the resulting sparks can cause a battery explosion, which could result in death or serious injury. (00049a)

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](#).



Figure 3-1. Remove Crankcase Breather Hose

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.



Figure 3-2. Cylinder Head Bolts

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.

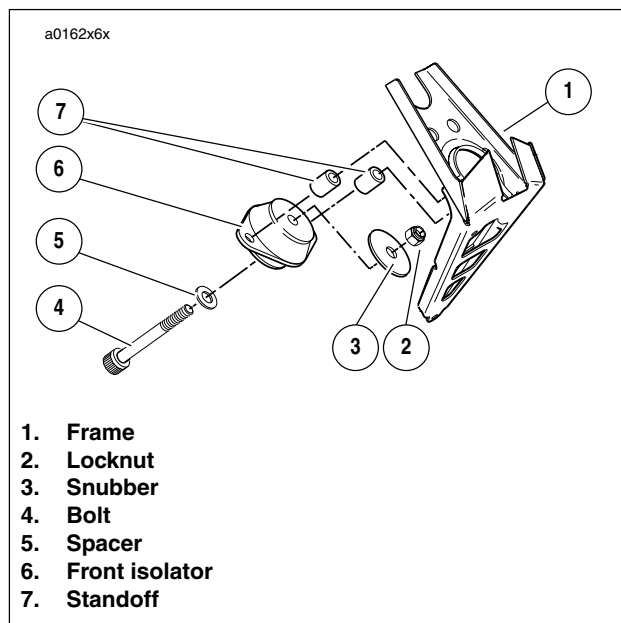


Figure 3-3. Front Isolator Mount

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.



Figure 3-4. Remove Top Rear Tie Bar

13. See [Figure 3-4](#). Remove top rear tie bar at frame.

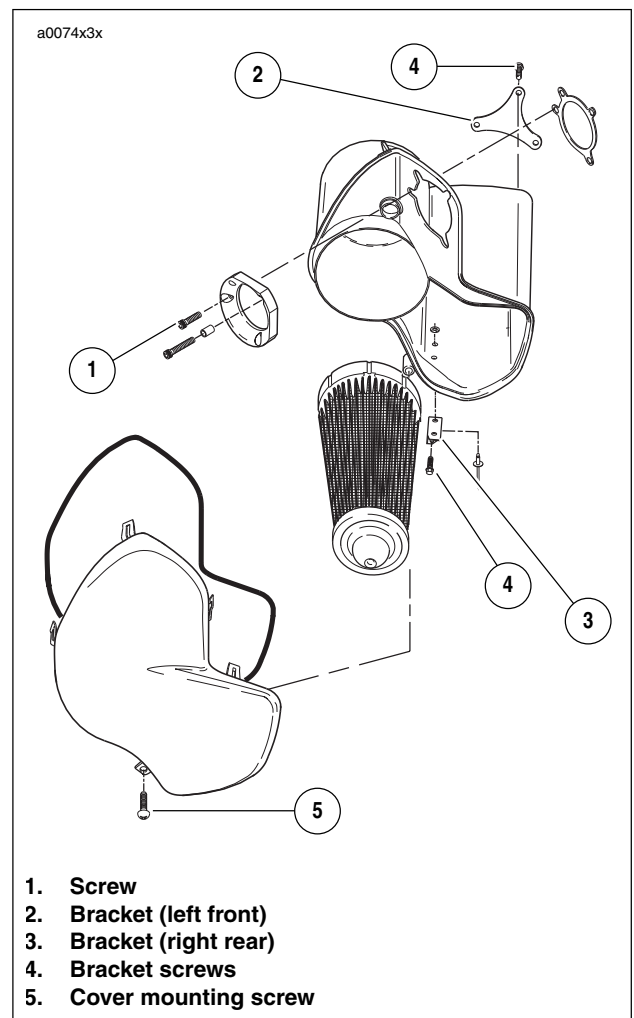


Figure 3-5. Air Cleaner Assembly

NOTE

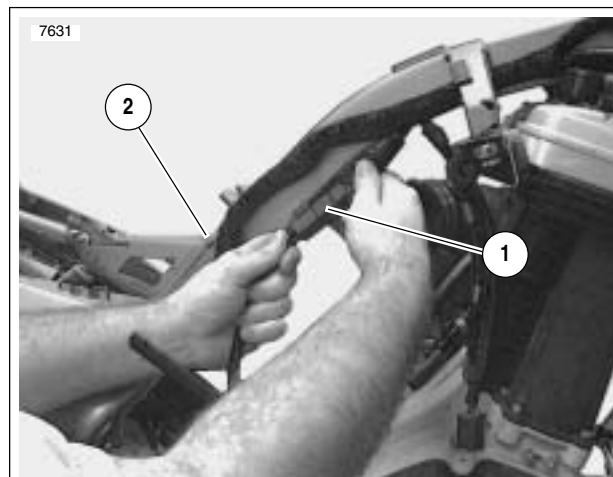
Remove entire air cleaner and carburetor as an assembly.

14. See [Figure 3-5](#). Remove screws (4) on both air cleaner brackets (2,3).



Figure 3-6. Hose Clamp

15. See [Figure 3-6](#). Loosen hose clamp.



1. Auto-enrichener plug
2. Frame

Figure 3-8. Auto-Enrichener Plug

17. See [Figure 3-8](#). Disconnect auto-enrichener plug.
18. Place air cleaner and carburetor as an assembly on top of frame.

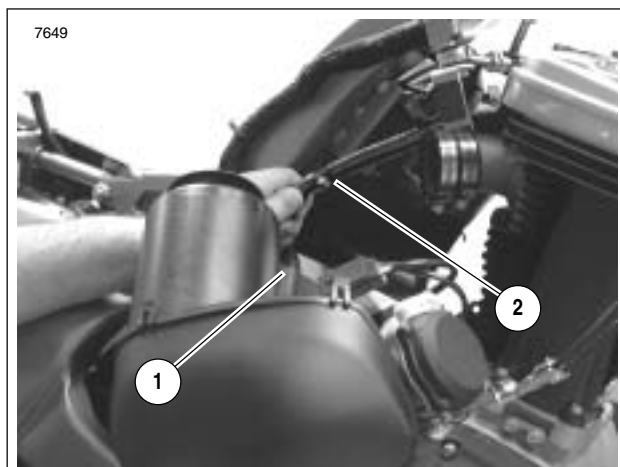
NOTES

- For more details about the air cleaner see [4.3 AIR CLEANER](#).
- The steps mentioned previously complete disassembly preparation for top end servicing. You may now proceed with **TOP END DISASSEMBLY PROCEDURES**. See [3.5 CYLINDER HEAD](#).
- If continuing engine removal proceed to step 20.

NOTE

The remaining steps are required to complete engine removal.

19. Place jack under the motor. Use jack to lower motor.
20. Move jack forward.
21. Place wooden cradle under engine.



1. Breather hose
2. Three-way connector

Figure 3-7. Crankcase Breather Hose

16. See [Figure 3-7](#). Remove crankcase breather hose.

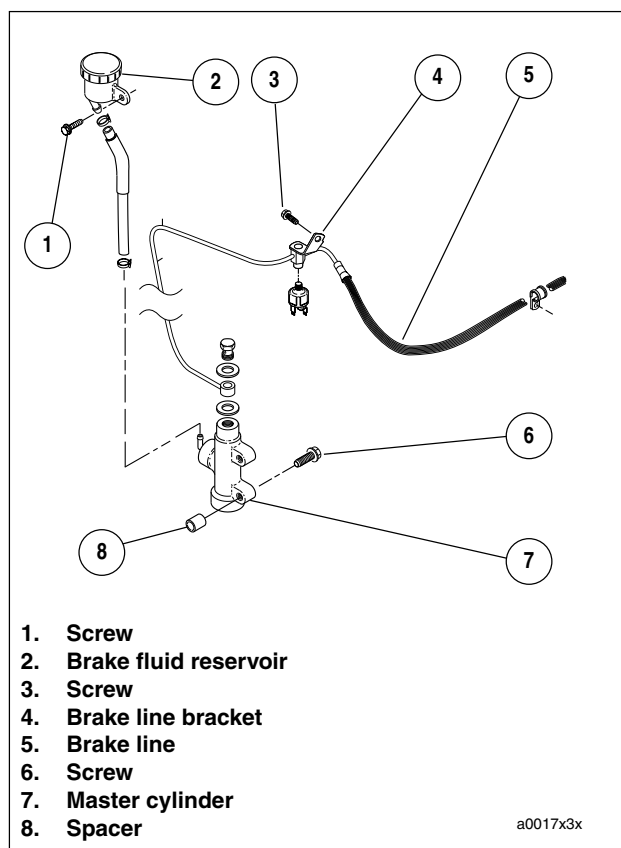


Figure 3-9. Rear Master Cylinder and Brake Line Assembly

NOTE

See [Figure 3-9](#). Remove rear master cylinder before removing sprocket cover.

22. Remove sprocket cover. See [2.22 SPROCKET COVER](#).
23. See [Figure 3-9](#). Disconnect screws (1, 3, 6) at brake fluid reservoir, master cylinder and brake line bracket.
24. Move belt on rear sprocket off pulley toward inside of motorcycle.

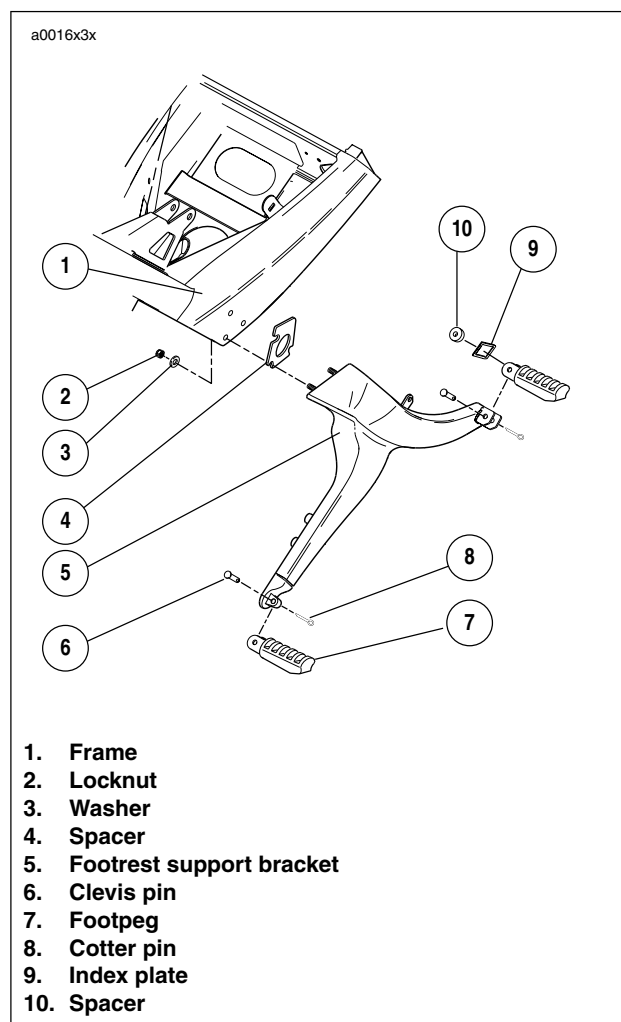


Figure 3-10. Footpeg Bracket Assembly

25. See [Figure 3-10](#). Remove right side rider footpeg bracket assembly. See [2.21 FOOTPEGS AND FOOTPEG SUPPORT BRACKETS](#).
26. Introduce freeplay and remove clutch cable at hand lever location. See [1.10 CLUTCH](#).

27. Refer to [Table 3-19](#). Disconnect the following electrical items.

Table 3-19. Electrical Items Disconnected for Engine Disassembly

DESCRIPTION	LOCATION
Ignition module [10]	Located on frame backbone.
Speedo sensor [65]	Located under seat (right side-tucked in under cavity).
Sidestand switch [60]	Tie wrapped to rear brake line.
Neutral switch [131]	Disconnect at neutral switch.
Oil pressure switch [120]	Disconnect at oil pressure switch.
Alternator stator [46]	Located under seat (left side).
Starter solenoid wire [128]	Disconnect at starter.
Spark plug wire	Located on spark plug.
Battery—positive wire	Disconnect at main circuit breaker.
Rear brake light switch [121]	Located under frame by shock absorber.



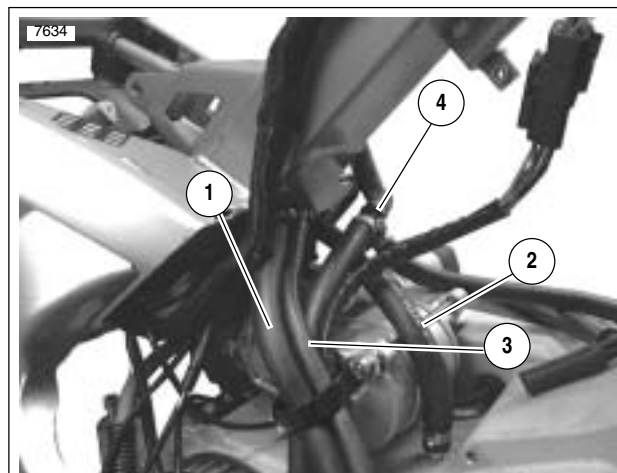
Figure 3-11. Hoisting Bike

28. See [Figure 3-11](#). Place a floor hoist behind the lift. Attach straps to frame and hoist. Raise hoist until straps tighten.
29. Remove rear shock. See [2.15 REAR SHOCK ABSORBER](#).



Figure 3-12. Loosen Clamp

30. See [Figure 3-12](#). Loosen nut on hose routing clamp.



1. Oil return
2. Transmission vent
3. Crankcase vent
4. Oil feed

Figure 3-13. Disconnect Lines

31. See [Figure 3-13](#). Disconnect feed, return, transmission and crankcase vent lines.

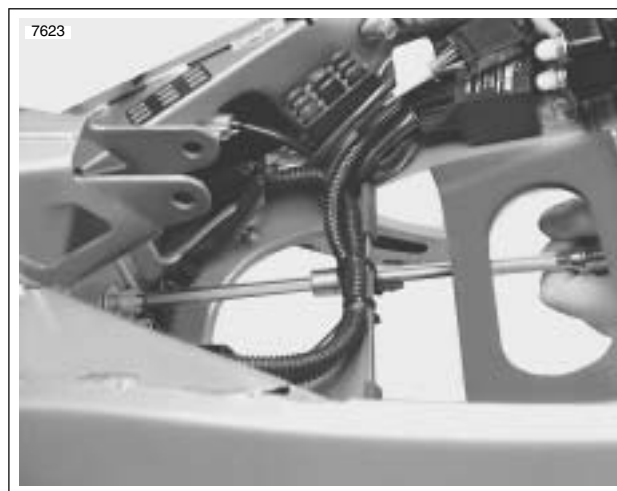


Figure 3-14. Removing Rear Motor Mount Bolts

32. See [Figure 3-14](#). Remove rear motor mount bolts.



Figure 3-15. Move Chassis From Engine

33. Remove chassis from engine by performing the steps below.
- Lower chassis.
 - Disconnect hoist from chassis.
 - Lower lift.
 - See [Figure 3-15](#). Lift chassis and roll away from engine.



Figure 3-16. Air Cleaner Bracket

34. See [Figure 3-16](#). Remove air cleaner box bracket.



Figure 3-17. Rear Engine Mount

35. See [Figure 3-17](#). Remove rear engine mount.

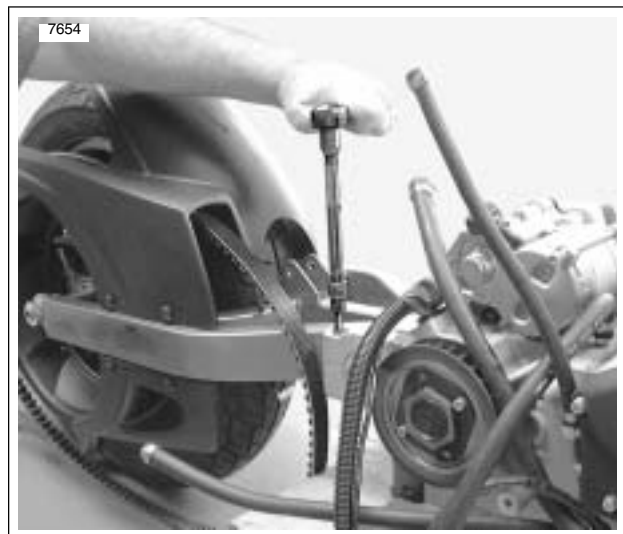


Figure 3-18. Swingarm Pivot Shaft Pinch Bolt

36. See [Figure 3-18](#). Loosen swingarm pinch bolt.

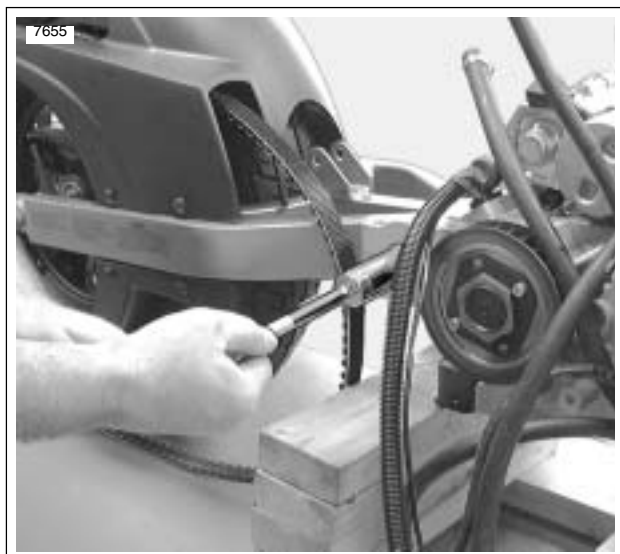


Figure 3-19. Swingarm Pivot Shaft

37. See [Figure 3-19](#). Remove swingarm pivot shaft and rear wheel as an assembly. See [2.19 SWINGARM](#).

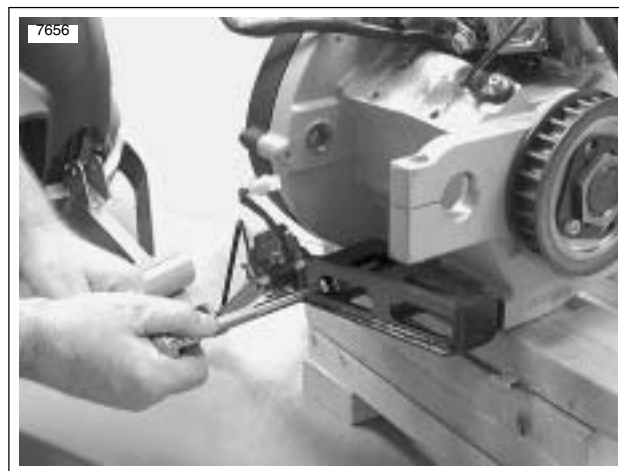


Figure 3-20. Sidestand Bracket

38. See [Figure 3-20](#). Remove sidestand and bracket assembly. See [2.29 SIDE STAND](#).

INSTALLING ENGINE

1. Verify cradle is secured under engine.

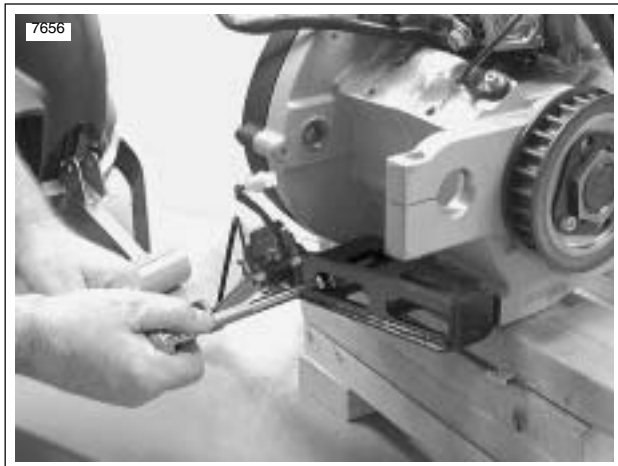


Figure 3-21. Sidestand Bracket

2. See [Figure 3-21](#). Install sidestand and bracket assembly. See [2.29 SIDESTAND](#).
 - a. Apply several drops of LOCTITE 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](#).

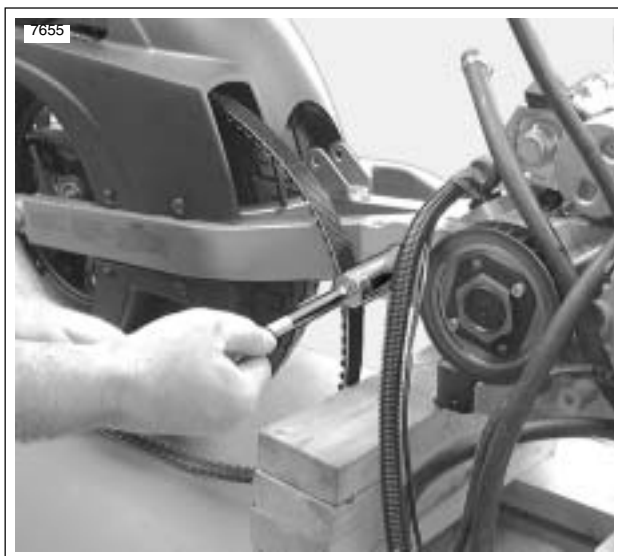


Figure 3-22. Swingarm Pivot Shaft

4. See [Figure 3-22](#). Install swingarm, pivot shaft and rear wheel as an assembly and tighten pivot shaft to 24-26 ft-lbs (32-35 Nm). See [2.19 SWINGARM](#).

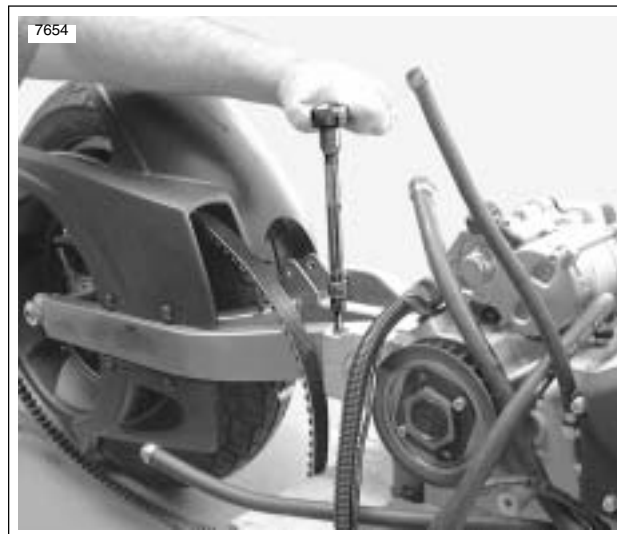


Figure 3-23. Pinch Bolt

5. See [Figure 3-23](#). Install swingarm pinch bolt.
 - a. Apply several drops of LOCTITE 243 (blue) to last few threads.
 - b. Tighten to 17-19 ft-lbs (23-26 Nm).



Figure 3-24. Rear Engine Mount

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



Figure 3-25. Bracket, Left Side Air Cleaner

7. See [Figure 3-25](#). Loosely install air cleaner box bracket.



Figure 3-26. Move Chassis to Engine

8. See [Figure 3-26](#). Roll chassis toward engine.
 - a. Lift chassis onto engine.
 - b. Raise lift.



Figure 3-27. Hoisting Bike

9. See [Figure 3-27](#). Attach hoist to frame using straps and raise hoist until straps tighten.
10. Place jack under the motor. Use jack to raise motor.
11. Move jack backward.

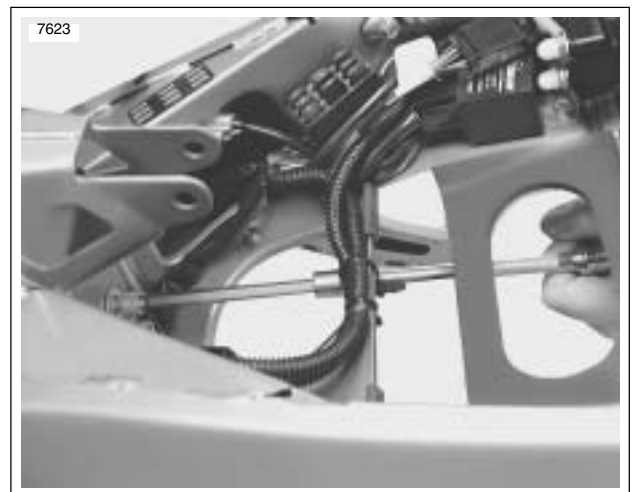
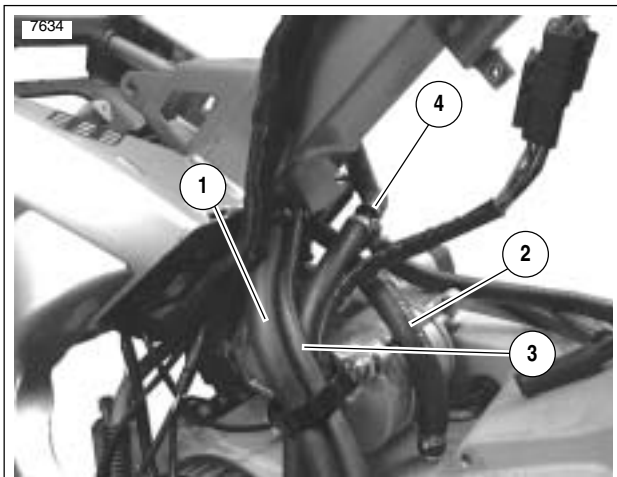


Figure 3-28. Installing Rear Motor Mount Bolts

12. See [Figure 3-28](#). Install rear motor mount bolts.
 - a. Apply several drops of LOCTITE 262 (red) to last few threads.
 - b. Tighten to 30-33 ft-lbs (41-45 Nm).



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

Figure 3-29. Connect Lines

13. See [Figure 3-29](#). Connect feed, return, transmission and crankcase vent lines.



Figure 3-30. Tighten Hose Clamps

14. See [Figure 3-30](#). Tighten hose clamps using Hose Clamp Pliers (Part No. HD-41137).



Figure 3-31. Tighten Clamp

15. See [Figure 3-31](#). Tighten nut on hose routing clamp.
16. Install rear shock. See [2.15 REAR SHOCK ABSORBER](#).

17. Refer to [Table 3-20](#). Connect the following electrical items:

Table 3-20. Electrical Items for Engine Assembly

DESCRIPTION	LOCATION
Ignition module [10]	Located on frame backbone.
Speedo sensor [65]	Located under seat (right side-tucked in under cavity).
Sidestand switch [60]	Tie wrapped to rear brake line.
Neutral switch [131]	Disconnect at neutral switch.
Oil pressure switch [120]	Disconnect at oil pressure switch.
Alternator stator [46]	Located under seat (left side).
Starter solenoid wire [128]	Disconnect at starter.
Spark plug wire	Located on spark plug.
Battery—positive wire	Disconnect at main circuit breaker.
Rear brake light switch [121]	Located under frame by shock absorber.

18. Install clutch cable at hand lever location. See [1.10 CLUTCH](#).
19. Install drive belt. See [1.12 DRIVE BELT AND REAR SPROCKET](#).
20. Install front sprocket cover. See [2.22 SPROCKET COVER](#).

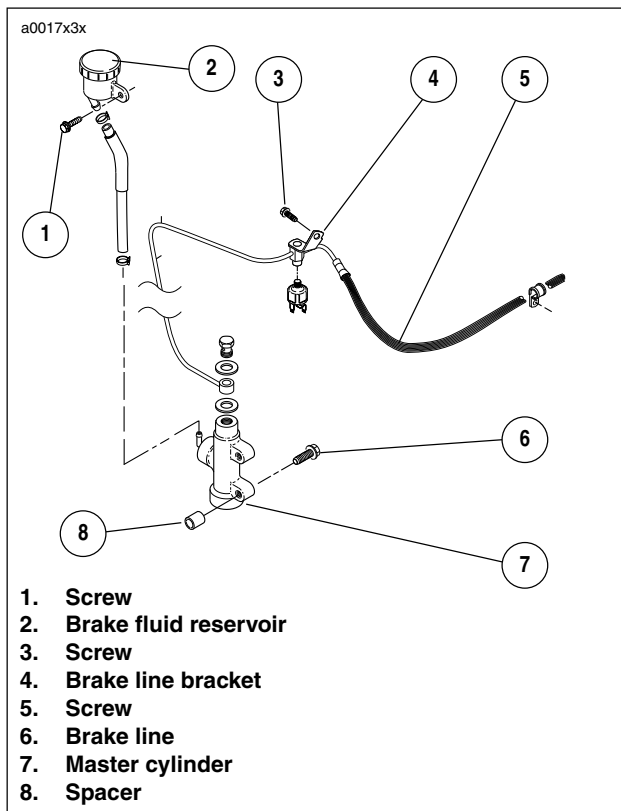


Figure 3-32. Rear Master Cylinder and Brake Line Assembly

21. See [Figure 3-32](#). Install master cylinder onto footpeg bracket. See [2.21 FOOTPEGS AND FOOTPEG SUPPORT BRACKETS](#).
 - a. Apply several drops of LOCTITE 243 (blue) to last few threads.
 - b. Tighten to 48-72 **in-lbs** (5-8 Nm).

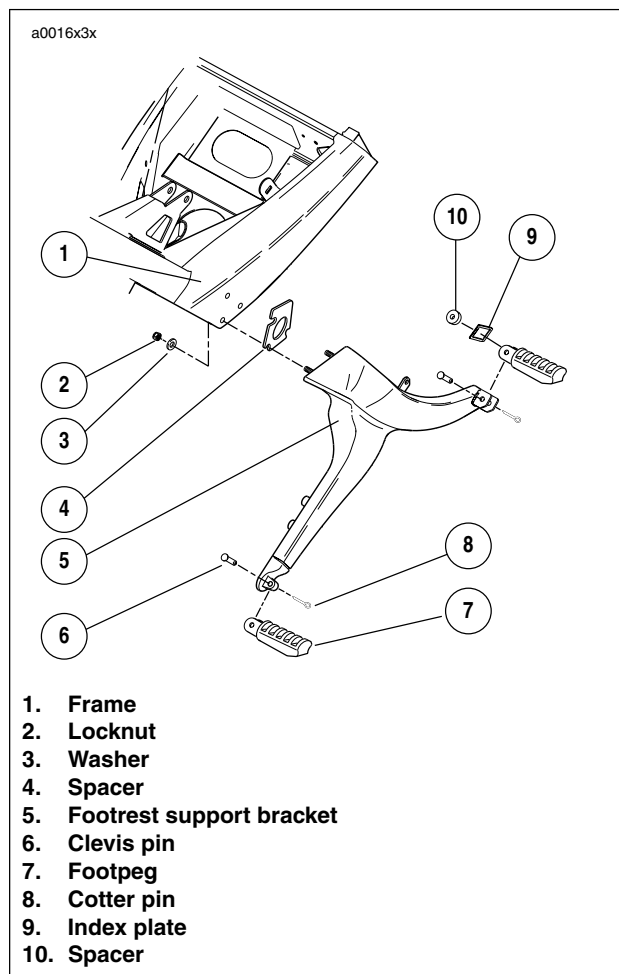


Figure 3-33. Footpeg Bracket Assembly

22. See [Figure 3-33](#). Install right side rider footpeg bracket assembly. See [2.21 FOOTPEGS AND FOOTPEG SUPPORT BRACKETS](#).

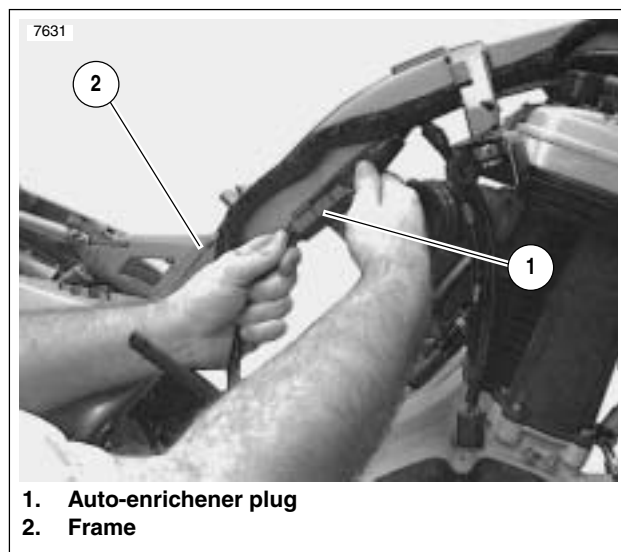


Figure 3-34. Auto-Enrichener Plug

23. See [Figure 3-34](#). Connect auto-enrichener plug.

NOTE

Install entire air cleaner and carburetor as an assembly. See [4.3 AIR CLEANER](#).

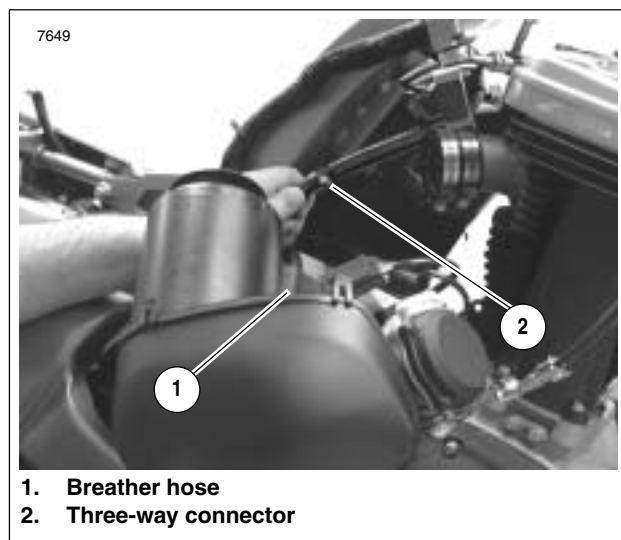


Figure 3-35. Crankcase Breather Hose

24. See [Figure 3-35](#). Connect crankcase breather hose to three-way connector.



Figure 3-36. Hose Clamp

25. See [Figure 3-36](#). Install hose clamp.

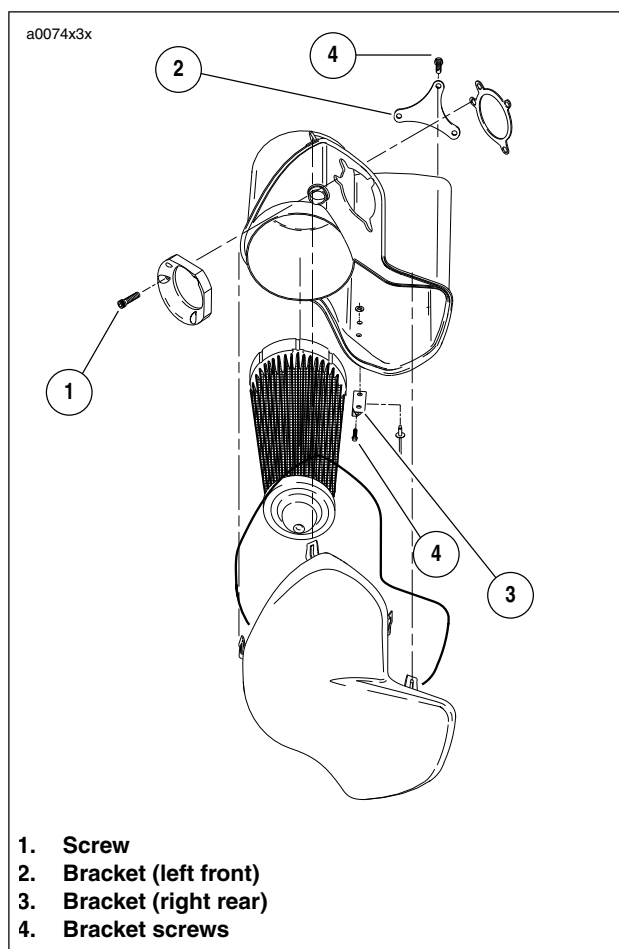


Figure 3-37. Air Cleaner Assembly

26. See [Figure 3-37](#). Install and tighten screws on both air cleaner brackets.

- Right bracket to air cleaner, 36-60 **in-lbs** (4.1-6.8 Nm).
- Left bracket to crankcases, 120-144 **in-lbs** (13.6-16.3 Nm).
- Install screw on air cleaner cover.



Figure 3-38. Install Top Rear Tie Bar

27. See [Figure 3-38](#). Install top rear tie bar at frame.
28. Tighten tie bar bolt to 30-33 ft-lbs (41-45 Nm).
29. Install ground strap bolt to engine. Tighten ground strap bolt to 30-33 ft-lbs (41-45 Nm).



Figure 3-39. Install Front Tie Bar

30. See [Figure 3-39](#). Install front tie bar onto engine.
 - a. Apply several drops of LOCTITE 262 (red) to last few threads.
 - b. Tighten to 30-33 ft-lbs (41-45 Nm).



Figure 3-40. Cylinder Head Bolt

31. 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 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 (81.3 Nm) initially and then loosen each bolt one full turn. Tighten bolts again to 60 ft-lbs (81.3 Nm).

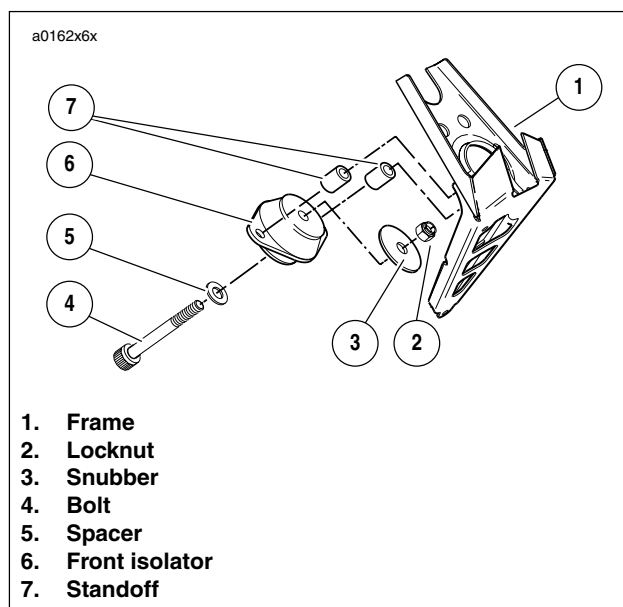


Figure 3-41. Front Isolator Mount

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

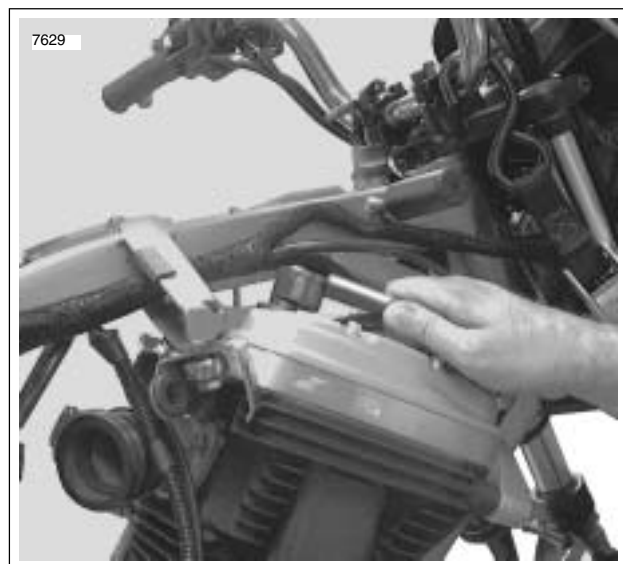


Figure 3-42. Install Crankcase Breather Hose

34. See [Figure 3-42](#). Install crankcase breather hose and crankcase breather into rocker box grommet.
35. Install horn. See [7.22 HORN](#).
36. Remove jack from under the motor.
37. Install muffler. See [2.20 EXHAUST SYSTEM](#).
38. Install fuel tank. See [4.2 FUEL TANK COVER/FUEL TANK](#).
39. Install **new** oil filter, engine oil and primary chaincase fluid as necessary.

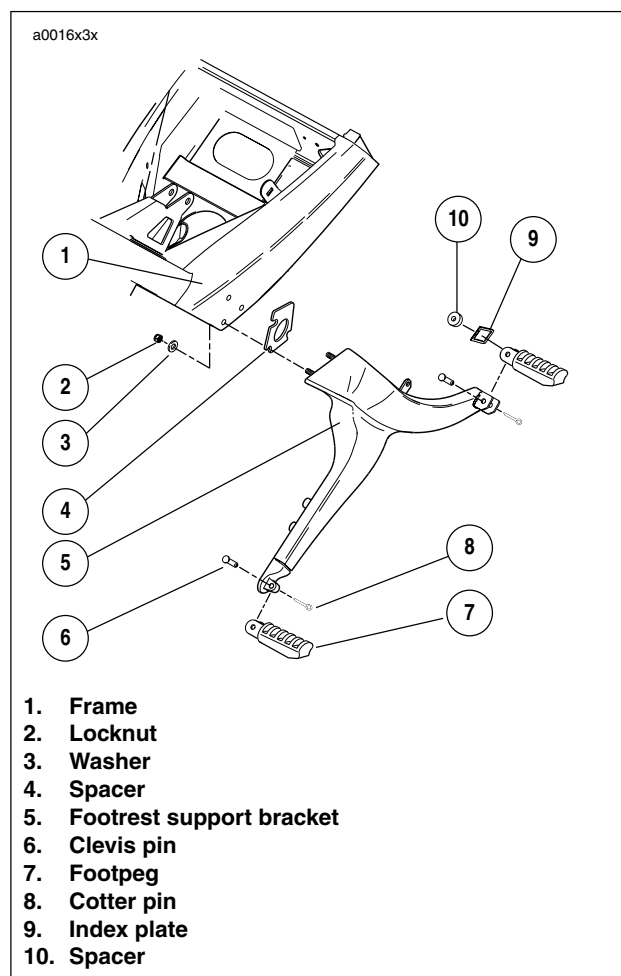


Figure 3-43. Footpeg Bracket Assembly

40. See [Figure 3-43](#). Install right side rider footpeg bracket assembly. See [2.21 FOOTPEGS AND FOOTPEG SUPPORT BRACKETS](#).

⚠ WARNING

Connect positive (+) battery cable first. If positive (+) cable should contact ground with negative (-) cable connected, the resulting sparks can cause a battery explosion, which could result in death or serious injury. (00068a)

41. Connect **both** battery cables, positive cable first. See [7.16 BATTERY](#).

⚠ WARNING

After installing seat, pull upward on front of seat to be sure it is in locked position. While riding, a loose seat can shift causing loss of control, which could result in death or serious injury. (00070a)

42. Install seat. See [2.28 SEAT](#).

REMOVAL

The rocker arm covers and internal components must be removed before removing cylinder heads.

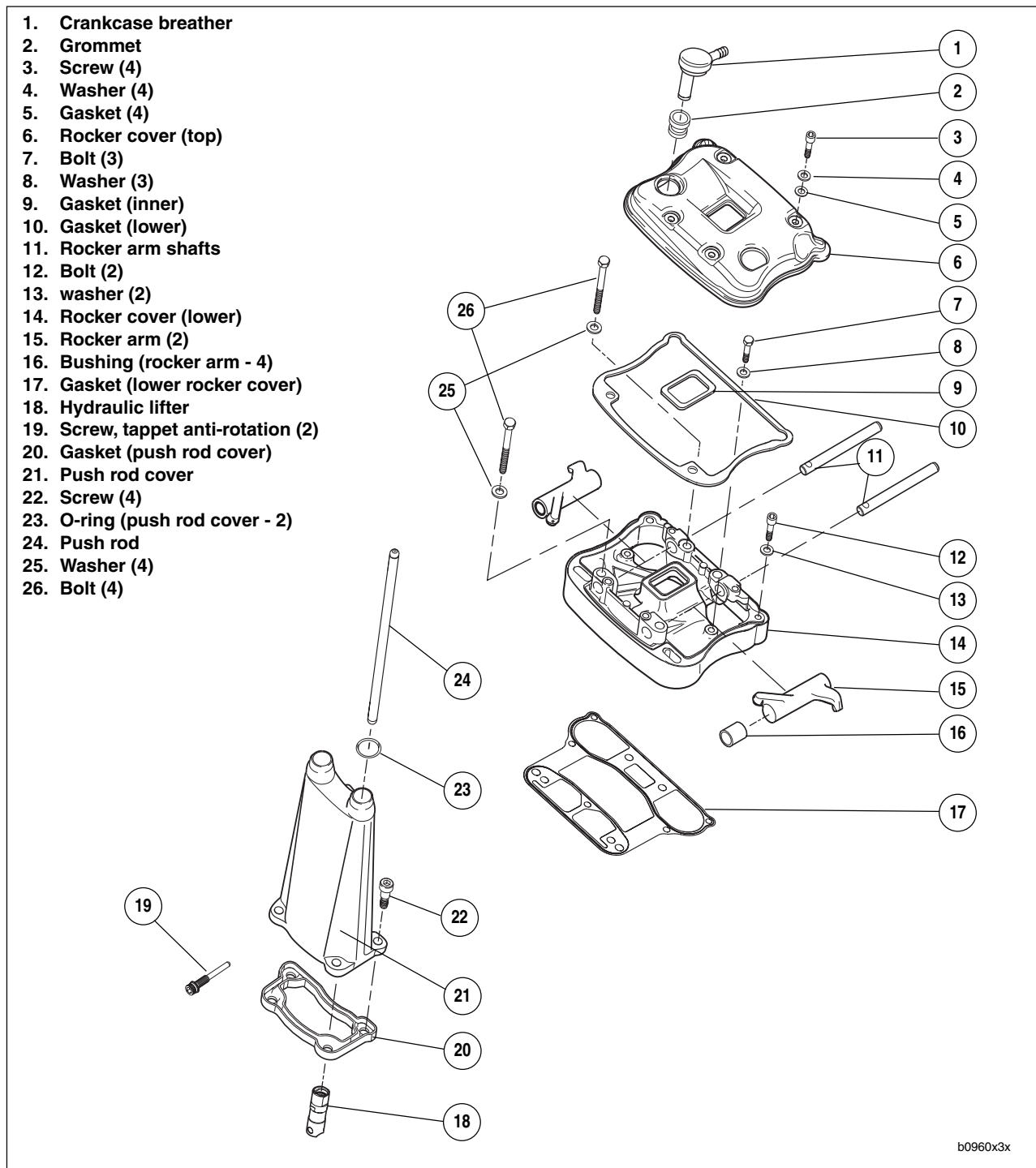


Figure 3-44. Rocker Arm and Push Rod Cover Assemblies

[Rocker Box Assemblies]

CAUTION

All washers and fasteners used in the engine are hardened. Do not mix or replace hardened washers and fasteners with unhardened parts. Do not reuse fiber cover seals. Engine damage may result.

1. Remove spark plug.
2. See [Figure 3-44](#). Remove screws with washers and fiber cover seals. Discard fiber seals.
3. Remove top rocker cover.
4. Remove and discard gaskets.
5. Rotate crankshaft until both valves are closed.
6. See [Figure 3-45](#). Remove hardware holding lower rocker cover to cylinder head in the following order.
 - a. Remove two screws and washers (1).
 - b. Remove three bolts and washers (2).
 - c. Loosen the four rocker arm fasteners (3) in 1/4-1/2 turn increments using a cross pattern in order to relieve valve spring pressure on the lower rocker box.
7. See [Figure 3-44](#). Remove lower rocker cover.

NOTE

Remove lower rocker box 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.

8. See [Figure 3-46](#). Remove rocker arm shafts by tapping them out using a hammer and a soft metal punch.
9. Remove rocker arms, **mark them for reassembly** in their original locations.
10. Mark the location and orientation (top/bottom) of each push rod. Remove push rods.

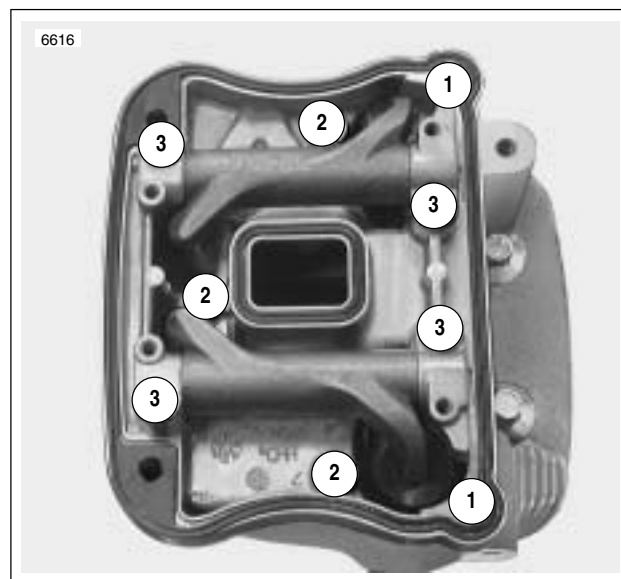


Figure 3-45. Lower Rocker Box Fasteners



Figure 3-46. Removing Rocker Arm Shafts

Cylinder Head Assembly

CAUTION

See [Figure 3-47](#). Distortion to the head, cylinder and crankcase studs may result if head screws are not loosened (or tightened) gradually in the sequence shown.

11. See [Figure 3-47](#). Loosen each head screw 1/8-turn following the sequence shown.
 - a. Continue loosening in 1/8-turn increments until screws are loose. Remove head screws.
 - b. Remove cylinder head, head gasket, and o-rings.
12. Discard head gasket.
13. See [Figure 3-44](#). Remove push rod cover, gasket and valve tappets.

DISASSEMBLY

1. See [Figure 3-48](#). Clamp VALVE SPRING COMPRESSOR TOOL (Part No. HD-34736B) in vise.
2. Compress valve springs with VALVE SPRING COMPRESSOR.
3. See [Figure 3-49](#). Remove valve keepers, upper collar and valve springs. Mark valve keepers for reassembly in their original locations.
4. Use a fine tooth file to remove any burrs on the valve stem at the keeper groove.
5. Mark valve to ensure that it will be reassembled in the same guide. Remove valve, valve stem seal and lower collar assembly.
6. Repeat the above procedure for the other valve.

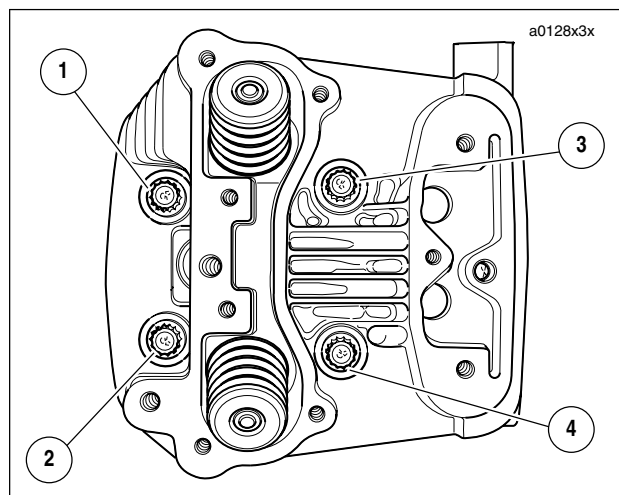


Figure 3-47. Head Screw Loosening/Tightening Sequence

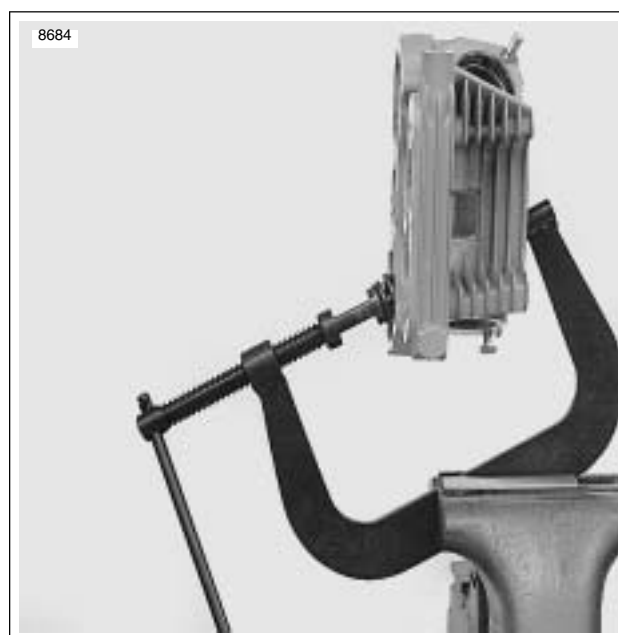
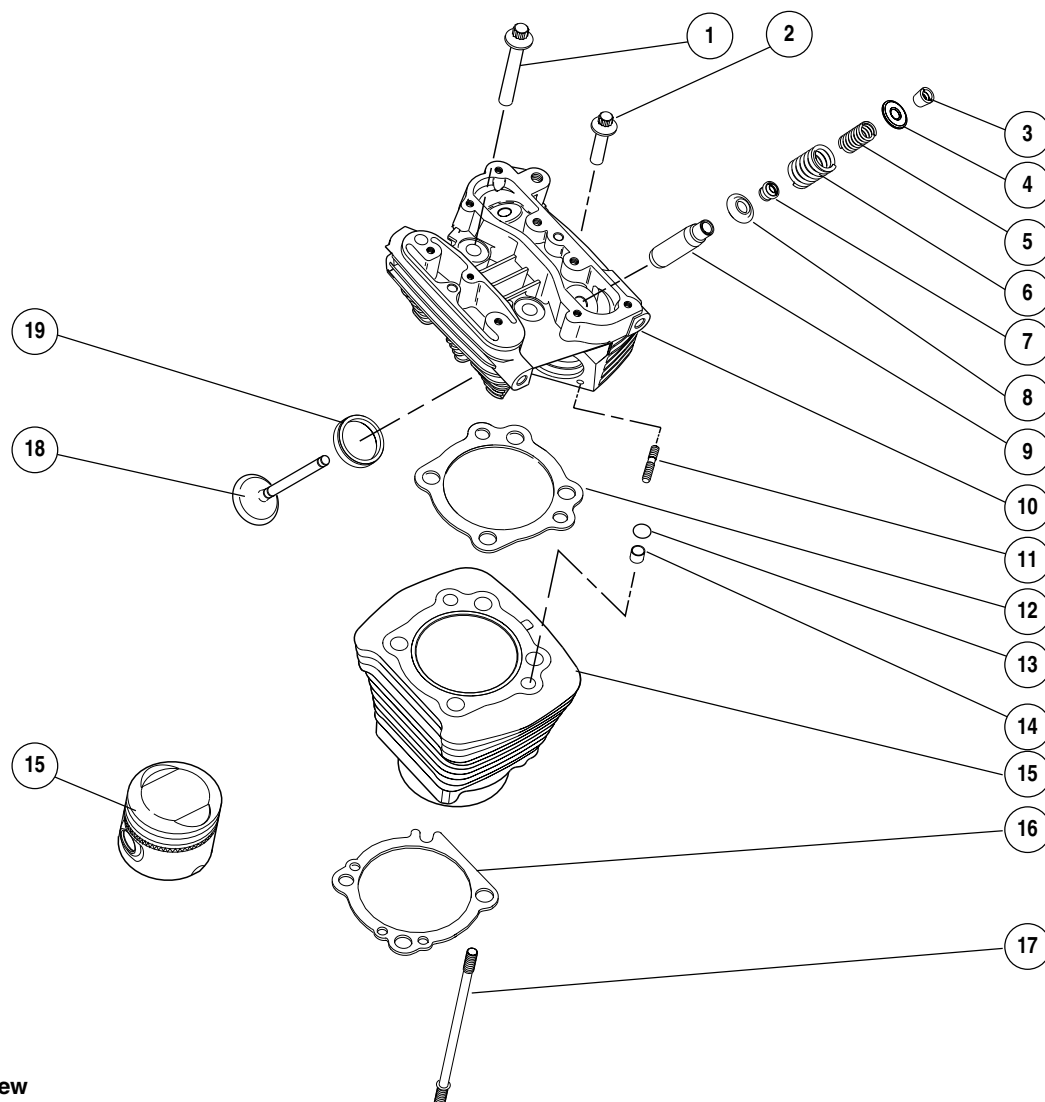


Figure 3-48. Valve Spring Compressor
(Part No. HD-34736B)

a0021x3x



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 3-49. Cylinder Head, Cylinder and Piston Assembly

CLEANING AND INSPECTION

Cylinder Head

WARNING

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

1. 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.

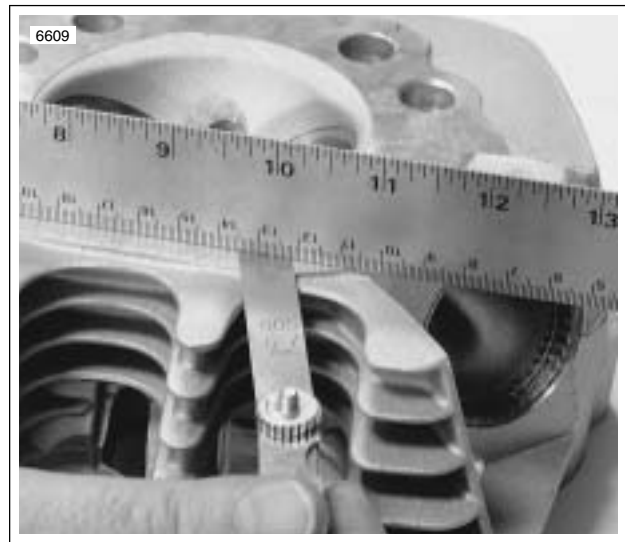


Figure 3-50. Checking Gasket Surface

4. See [Figure 3-50](#). 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).

Rocker Arm Assemblies

1. Check each rocker arm, at pad end and push rod end, for uneven wear or pitting. Replace rocker arm if either condition exists.



Figure 3-51. Measuring Rocker Arm Shaft Diameter (Rocker Cover Position)



Figure 3-52. Measuring Rocker Arm Shaft Diameter (Rocker Arm Bushing Position)

2. Measure and record rocker arm shaft diameter.
 - a. See [Figure 3-51](#). Measure where shaft fits in lower rocker arm cover.
 - b. See [Figure 3-52](#). Measure where rocker arm bushings ride.



Figure 3-53. Measuring Rocker Arm Shaft Bore Diameter in Lower Rocker Cover



Figure 3-54. Measuring Rocker Arm Bushing Inner Diameter

3. Measure and record rocker arm shaft bore diameter.
 - a. See [Figure 3-53](#). Measure bore of lower rocker cover.
 - b. See [Figure 3-54](#). Measure rocker arm bushing inner diameter.
4. Check the measurements obtained in Steps 2-3 against the SERVICE WEAR LIMITS. Repair or replace parts exceeding limits.
5. Assemble rocker arms and rocker arm shafts into lower rocker cover.
6. Check end play of rocker arm with feeler gauge.
7. Replace rocker arm or lower cover or both if end play exceeds 0.025 in. (0.635 mm).

Valves

1. Replace the valve if there is evidence of burning or cracking.
2. Inspect the end of the valve stem for pitting or uneven wear. Replace the valve if either of these conditions are found.
3. Inspect for burrs around the valve stem keeper groove. Remove burrs with a fine tooth file if found.

Valve Seats

NOTE

Valve seats are also subject to wear. Resurface valve seats whenever valves are refinished.

1. Inspect seats for cracking, chipping or burning. Replace seats if any evidence of these conditions are found.



Figure 3-55. Measuring Valve Stem Protrusion

2. See [Figure 3-55](#). Check seats for recession by measuring valve stem protrusion.
 - a. Wipe valve seats and valve faces clean.
 - b. Measure valve stem protrusion.
 - c. If valve stem protrudes more than 2.031 in. (51.587 mm), replace valve seat or cylinder head.

NOTE

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.

Valve Guides

1. Clean valve guides by lightly honing with VALVE GUIDE HONE (Part No. HD-34723).
2. 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 [3.1 SPECIFICATIONS](#).

Valve Springs

1. Inspect valve springs for broken or discolored coils.

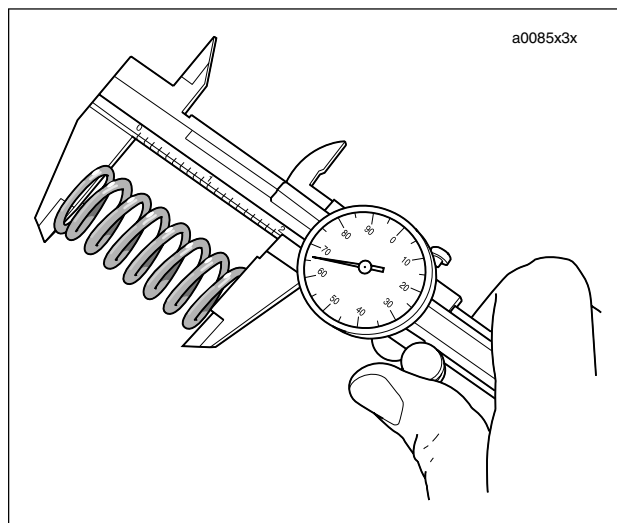


Figure 3-56. Checking Spring Free Length

2. See [Figure 3-56](#). Check free length and compression force of each spring. Compare with [3.1 SPECIFICATIONS](#). If spring length is shorter than specification or if spring compression force is below specification, replace spring.

Spark Plug Threads

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.

Push Rods

Examine push rods, particularly the ball ends. Replace any rods that are bent, worn, discolored or broken.

Replacing Rocker Arm Bushings

1. See [Figure 3-57](#). 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 using a discarded rocker arm shaft.
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.

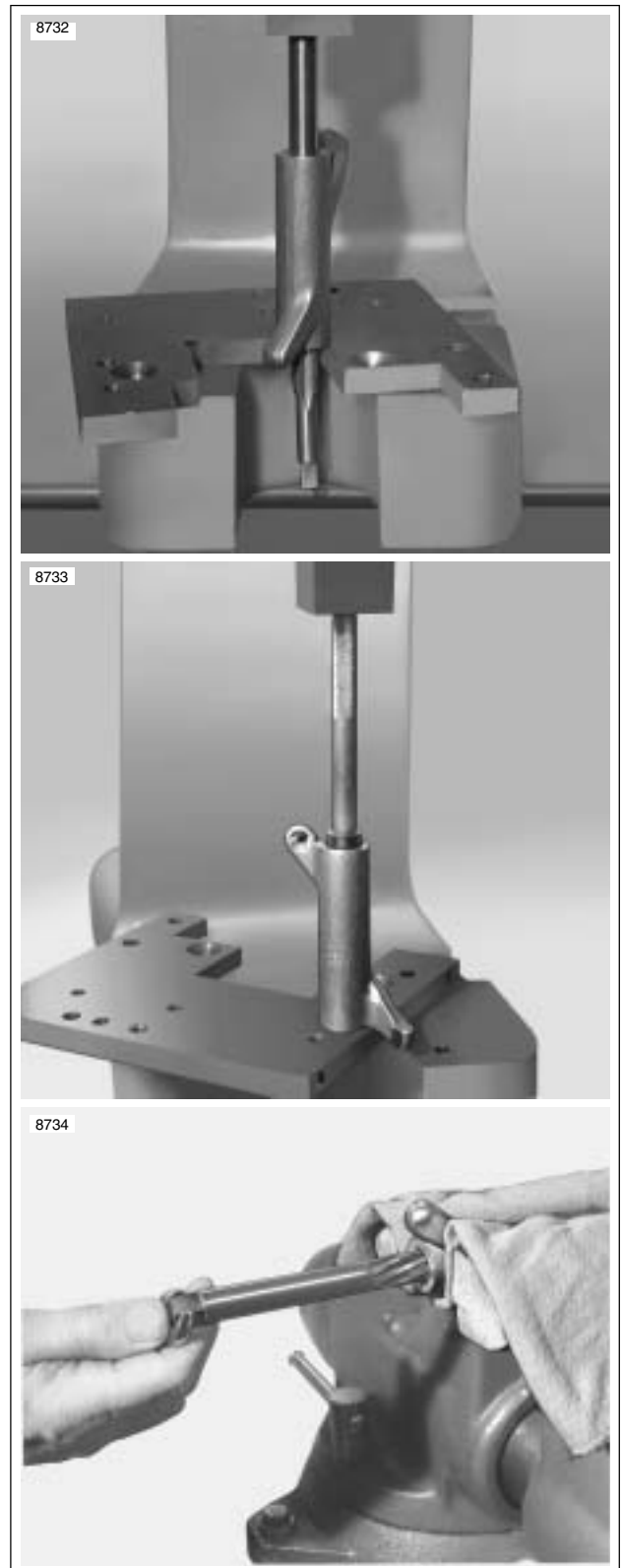


Figure 3-57. Replacing Rocker Arm Bushings

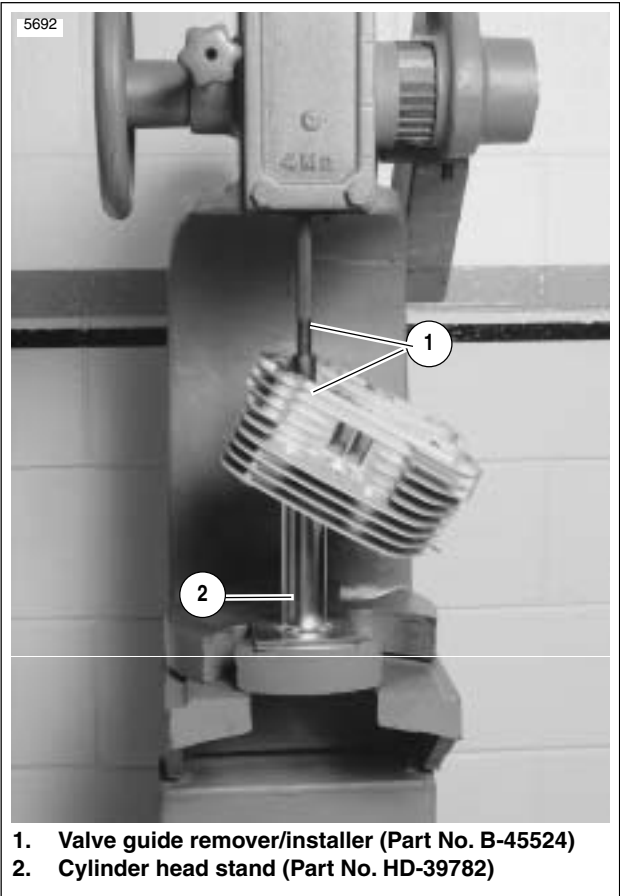
Replacing Valve Guides

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 3-21. If valve stems and/ or guides are worn beyond limits, install **new** parts.

Table 3-21. 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	0.0008-0.026 in. (0.025-0.076 mm)	0.0035 in. (0.0889 mm)

- 1. To remove shoulderless guides, press or tap guides toward combustion chamber using VALVE GUIDE REMOVER/INSTALLER (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).



1. Valve guide remover/installer (Part No. B-45524)
2. Cylinder head stand (Part No. HD-39782)

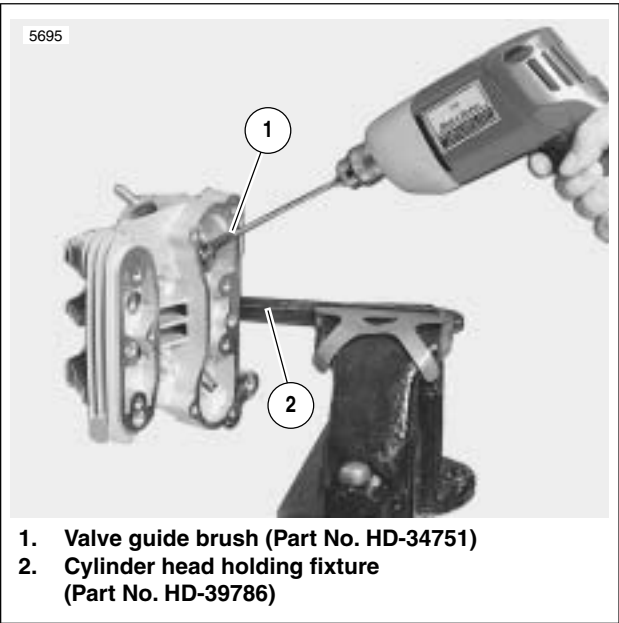
Figure 3-58. Installing Shoulderless Valve Guide

- 4. See Figure 3-58. 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°.



1. Valve guide brush (Part No. HD-34751)
2. Cylinder head holding fixture (Part No. HD-39786)

Figure 3-59. Cleaning Valve Guides

- 7. See Figure 3-59. Thoroughly clean valve guide bores using VALVE GUIDE BRUSH (Part No. HD-34751) and hot soapy water.

PROCEDURE FOR USING THE NEWAY VALVE SEAT CUTTER

Table 3-22. Neway Valve Seat Cutter

PART NO.	SPECIALTY TOOL
HD-35758A	Neway valve seat cutter
HD-39786	Cylinder head holding fixture

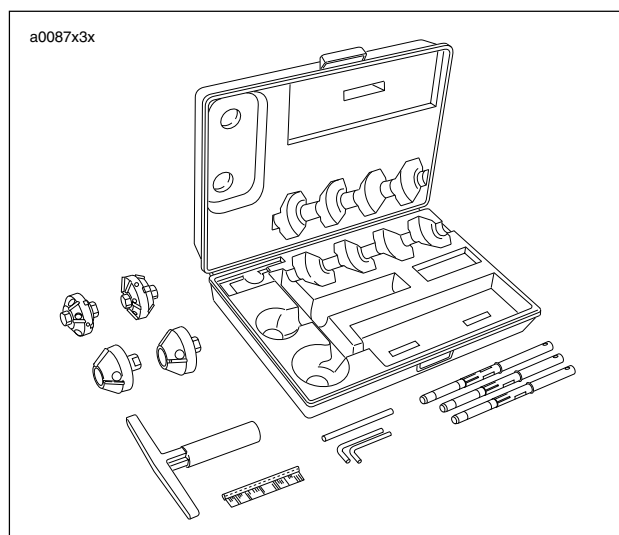


Figure 3-60. Neway Valve Seat Cutter

NOTES

- Verify correct valve stem to valve guide clearance before refacing. See [Table 3-21](#). If **new** guides must be installed, complete that task before refacing valves and seats.
 - This procedure is not based on the lapping of valves. The end result is an interference fit between the valve of 45° and the valve seat which will be 46°.
1. Secure cylinder head for service.
 - a. Thread 12 mm end of CYLINDER HEAD HOLDING FIXTURE (Part No. HD-39786) into cylinder head spark plug hole.
 - b. Clamp tool in vise and further tighten cylinder head onto the fixture to prevent any movement during operation.
 - c. Place cylinder head at a 45° angle or one that offers a comfortable working position.

2. Obtain the NEWAY VALVE SEAT CUTTER SET (HD-35758A) and cut valve seat angle to 46°. Do not remove any more metal than is necessary to clean up the seat (that is, to provide a uniform finish and remove pitting).
3. In order to determine the correct location of the 46° valve seat in the head, measure the width of the valve to be used and subtract 0.080" (2.032 mm) from that number.
4. Set your dial caliper to the lesser measurement and lock down for quick reference. This is the location of your valve seat.
5. Use a permanent magic marker to highlight the valve seat area that is going to be cut and be sure to highlight all 3 angles. Allow marker to dry before proceeding.

NOTES

- Always ensure cutter blades and cutter pilot are clean before beginning the cutting process. The correct cleaning brush is supplied with the Neway tool set.
 - Also ensure the inside of the valve guide is clean by using Kent-Moore cleaning brush (Part No. HD-34751).
6. Choose the cutter pilot that fits properly into the valve guide hole and securely seat the pilot by pushing down and turning using the installation tool supplied in the tool set.
 7. Choose the proper 46° cutter (intake or exhaust) and gently slide the cutter onto the pilot being careful not to drop the cutter onto the seat.
 8. While applying a constant and consistent pressure, remove just enough material to show a complete clean-up on the 46° angle.

NOTES

- If the width of the clean-up angle is greater on one side of the seat than the other, the guide may need to be replaced due to improper installation.
- After making the 46° cut, if you discover a groove cut completely around the seat this means the blades of the cutter are in alignment and need to be staggered. This is accomplished by loosening all of the blades from the cutter body and moving each blade slightly in it's cradle in opposite directions on the cutter. The tool needed to loosen the blades is supplied in the tool set. A permanent magic marker mark every 90° will help in determining where new angles are.

9. Next, with your dial caliper locked to the predetermined setting, measure the 46° cut at the outer most edge at the widest point of the circle to determine what cut needs to be made next.
 - a. If the 46° cut is too high (towards the combustion chamber), use the 31° cutter to lower the valve seat closer to the port.
 - b. If the 46° cut is too low, use the 60° cutter to raise the valve seat or move it away from the port.

NOTE

- *Due to using the top measurement of our valve seat as a reference point it will usually be necessary to use the 31° cutter following the initial 46° cut.*
 - *Always highlight the valve seat with the permanent magic marker in order to ensure the location of the 46° valve seat.*
10. If the location of the valve seat is not correct, repeat steps 8 and 9.
 11. When you accomplish a complete clean-up of the 46° angle and the width is at least .062 in. (1.575 mm), proceed to the next step.

12. Select the proper 60° cutter and gently slide the cutter down the cutter pilot to the valve seat.
13. Remove just enough material to provide an even valve seat width of .040-.062 in. (1.016-1.575 mm).
14. Remove cutter pilot and wash head thoroughly and dry completely.
15. Repeat the process on any valve seat that needs service.
16. Insert valve to be used in the valve guide and bottom on the valve seat. Positioning the cylinder head port upwards and with slight thumb pressure against the valve, completely fill the port with solvent to verify proper seal between the valve and the valve seat.

NOTE

Hold pressure against the valve for a minimum of 10 seconds. If any leakage occurs, examine the valve seat for irregularities or defects and if necessary repeat the above cutting process.

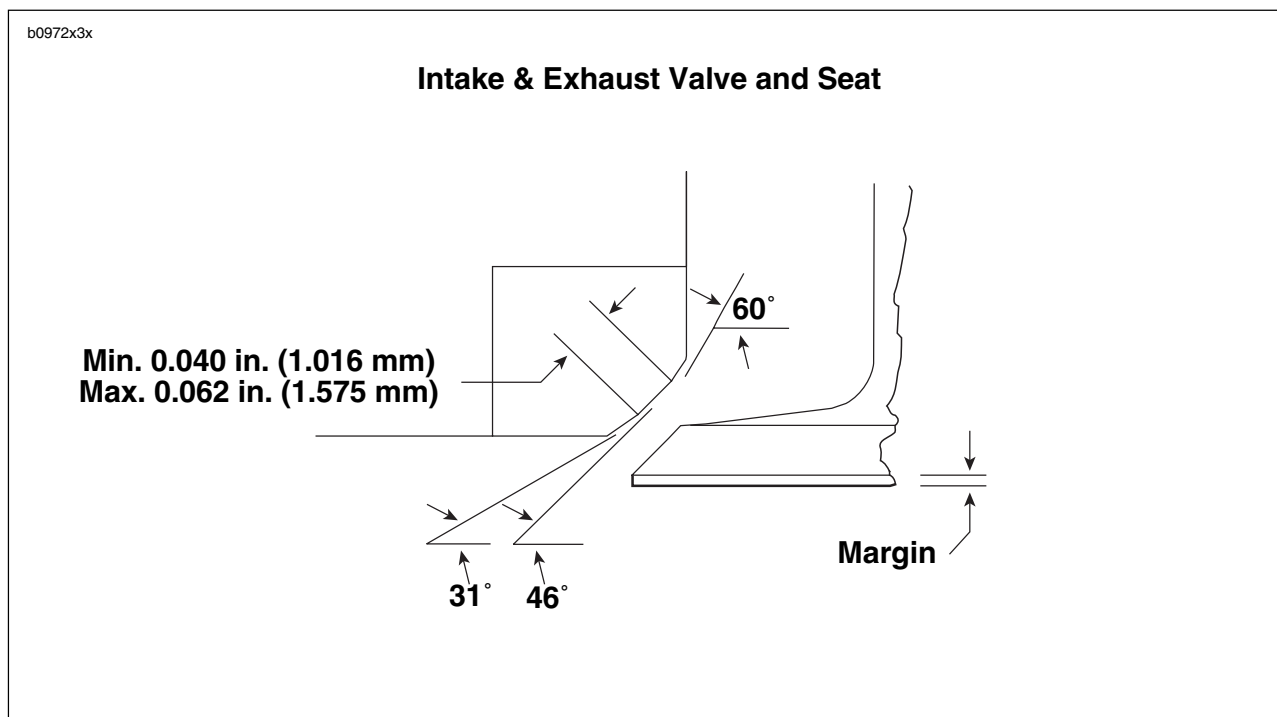


Figure 3-61. Valve and Seat Dimensions

ASSEMBLY

1. Wash cylinder head and valves in warm, soapy water to remove all debris.
2. Scrub valve guide bores with VALVE GUIDE BRUSH (Part No. HD-34751) and hot, soapy water.

WARNING

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

3. Blow dry with compressed air.
4. Apply a liberal amount of engine oil to the valve stem.
5. Insert valve into valve guide and install lower collar.

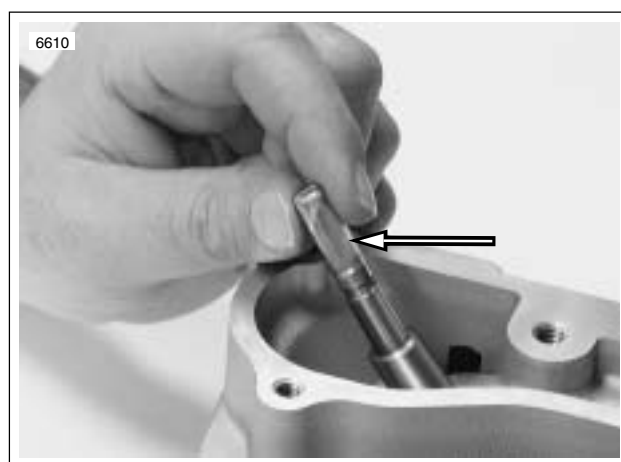


Figure 3-62. Valve Guide Seal Protector Sleeve

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.

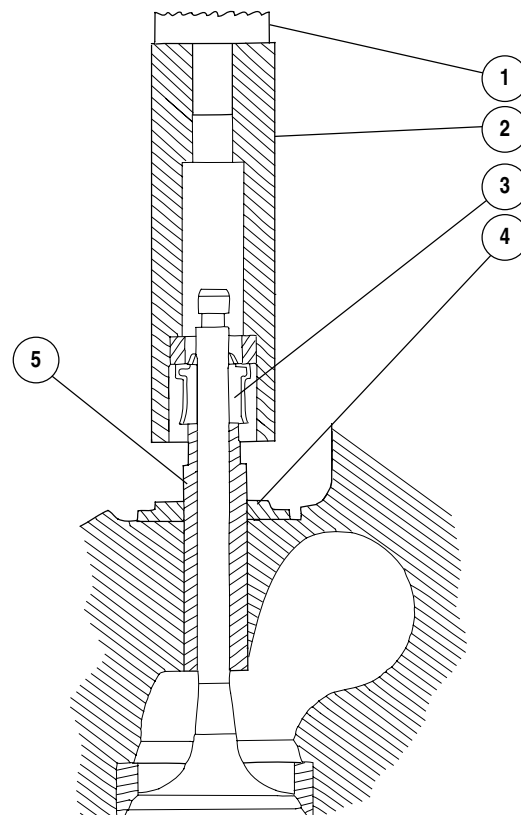
CAUTION

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.

CAUTION

Do not remove valve after seal is installed. Otherwise, sharp edges on keeper groove will damage seal.

a0088x3x



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

Figure 3-63. Valve Seal Installation

7. See Figure 3-63. 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 3-49. 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.

PUSH ROD COVER INSTALLATION

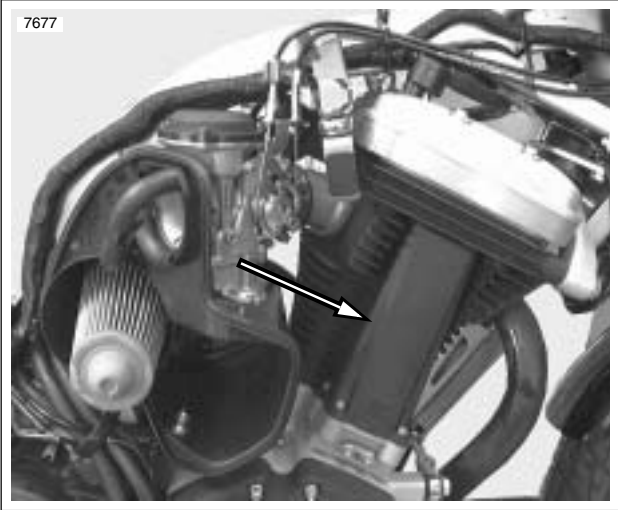


Figure 3-64. Push Rod Location

NOTE

Push rod cover must be installed prior to installing cylinder head.

1. See Figure 3-64. Install push rod cover.
 - a. Install **new** o-rings (2) on top of each push rod cover (3).
 - b. Install **new** push rod cover gasket (5) onto bottom of each push rod cover.
 - c. Install push rod cover assembly and start the four fasteners (4) securing bottom of cover to crankcase.
 - d. Tighten fasteners to 30-40 in lbs (3.4-4.5 Nm).
2. Refer to Table 3-23. 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.

Table 3-23. Push Rod Selection

POSITION	COLOR CODES	LENGTH	PART NO.
Exhaust	1 Band-Black	10.969 in. (278.613 mm)	17985-00Y
Intake	1 Band-Orange	10.915 in. (277.241 mm)	17984-00Y

CAUTION

After head has been installed do not turn engine over until both push rods can be turned with fingers. Otherwise, damage to push rods or rocker arms may result.

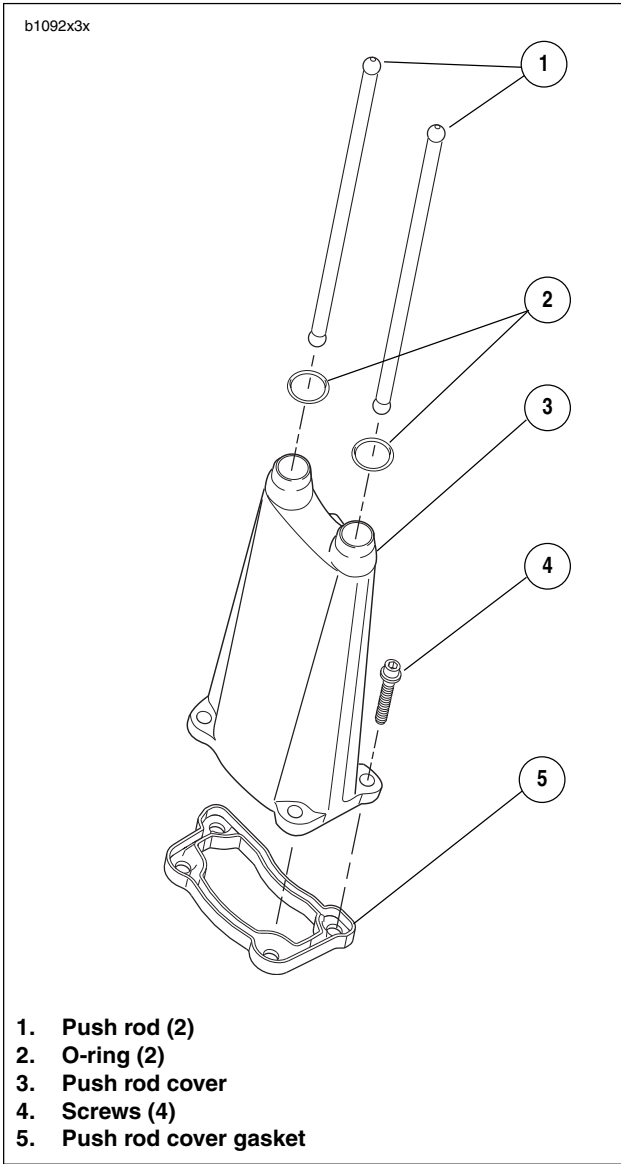


Figure 3-65. Push Rods and Push Rod Cover Assembly

CYLINDER HEAD INSTALLATION

CAUTION

Thoroughly clean and lubricate the threads of the cylinder head screws before installation. Friction caused by dirt and grime will result in a false torque indication.

1. Thoroughly clean and dry the gasket surfaces of cylinder and cylinder head.
2. Install **new** o-rings over two ring dowels at the top of the cylinder. Apply a very thin film of clean H-D 20W50 engine oil to o-rings before installation.

CAUTION

To ensure proper head gasket alignment, install new o-rings over cylinder ring dowels before installing the head gasket. Improper head gasket alignment will cause leaks.

3. Install a **new** head gasket to cylinder.
4. Carefully lower cylinder head over studs and position on dowels. Use great care so as not to disturb head gasket.
5. Lightly coat the threads and bottom face of the cylinder head bolts in clean H-D 20W50 engine oil. Wipe off any excess oil.

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.

6. Start the cylinder head screws onto the cylinder studs, two short bolts on the left side of the engine, two long bolts on the right.
7. See [Figure 3-66](#). Always start with screw numbered one, as shown. In increasing numerical sequence (i.e. – 1, 2, 3 and 4):
 - a. Tighten bolts to 96-120 **in-lbs** (11-14 Nm).
 - b. Tighten bolts to 13-15 **ft-lbs** (18-20 Nm).
 - c. Loosen all screws.
8. 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 96-120 **in-lbs** (11-14 Nm).
 - b. Tighten each screw to 13-15 **ft-lbs** (18-20 Nm).
 - c. See [Figure 3-67](#). Mark cylinder head and head screw shoulder with a line as shown (View A).
 - d. Turn all bolts an additional 85° -95° .

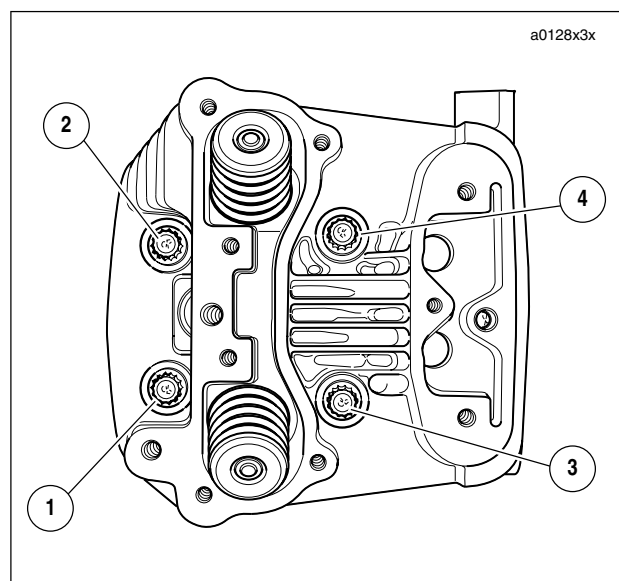


Figure 3-66. Head Screw Loosening/Tightening Sequence

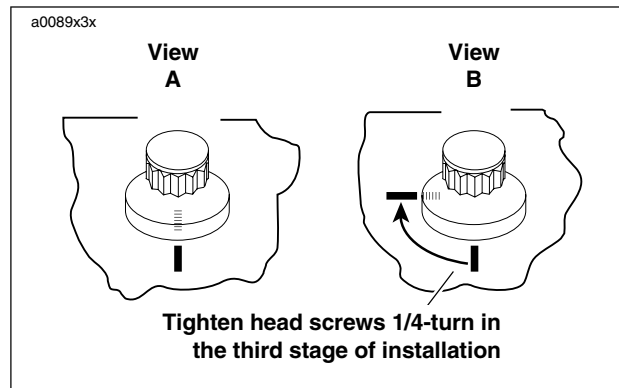
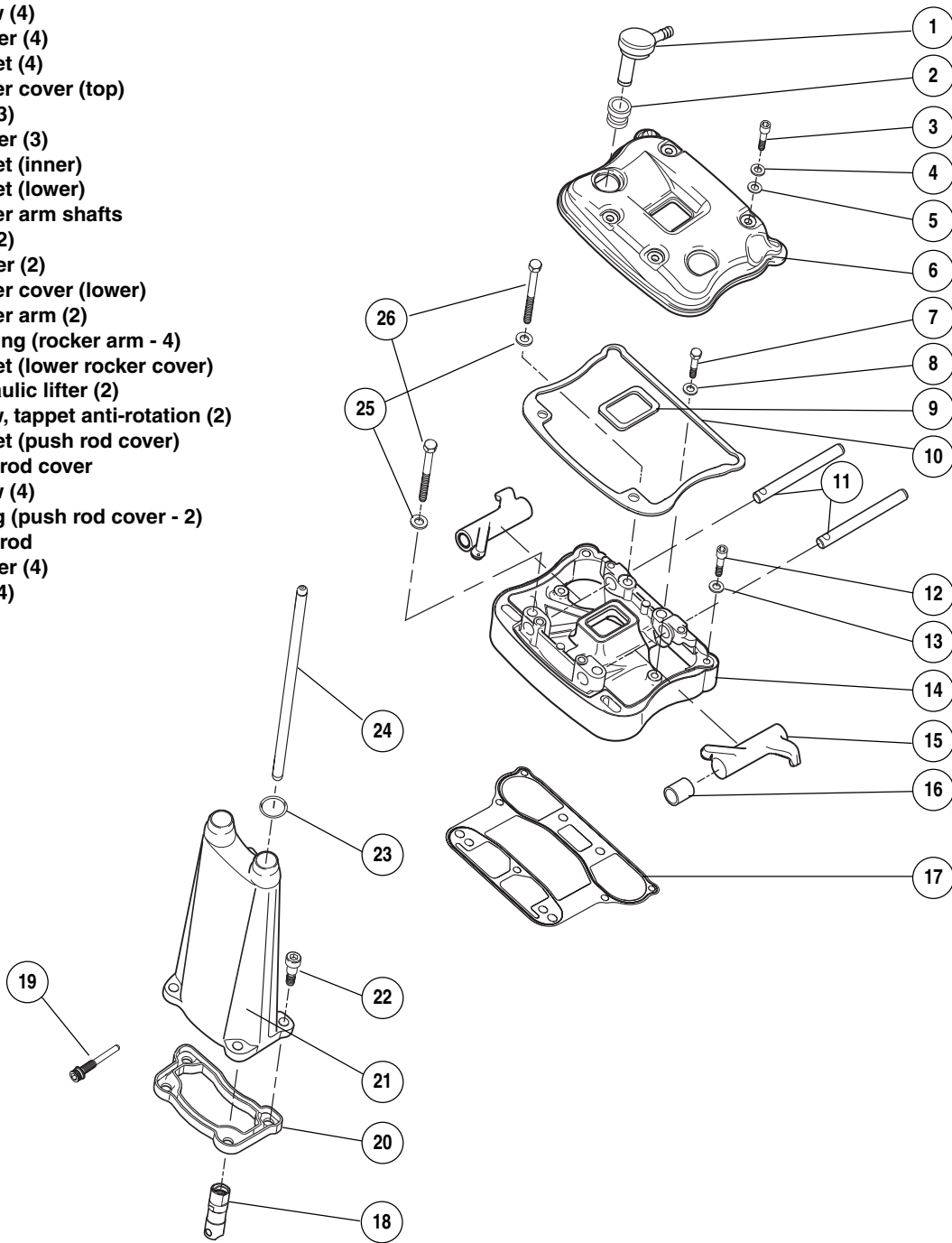


Figure 3-67. Tightening Head Screws

1. Crankcase breather
2. Grommet
3. Screw (4)
4. Washer (4)
5. Gasket (4)
6. Rocker cover (top)
7. Bolt (3)
8. Washer (3)
9. Gasket (inner)
10. Gasket (lower)
11. Rocker arm shafts
12. Bolt (2)
13. washer (2)
14. Rocker cover (lower)
15. Rocker arm (2)
16. Bushing (rocker arm - 4)
17. Gasket (lower rocker cover)
18. Hydraulic lifter (2)
19. Screw, tappet anti-rotation (2)
20. Gasket (push rod cover)
21. Push rod cover
22. Screw (4)
23. O-ring (push rod cover - 2)
24. Push rod
25. Washer (4)
26. Bolt (4)



b0960x3x

Figure 3-68. Rocker Arm and Push Rod Cover Assemblies

9. See [Figure 3-68](#). Install **new** gasket with the bead facing up. Place lower rocker box assembly, with rocker arms and shafts, into position. Place push rods in rocker arm sockets.

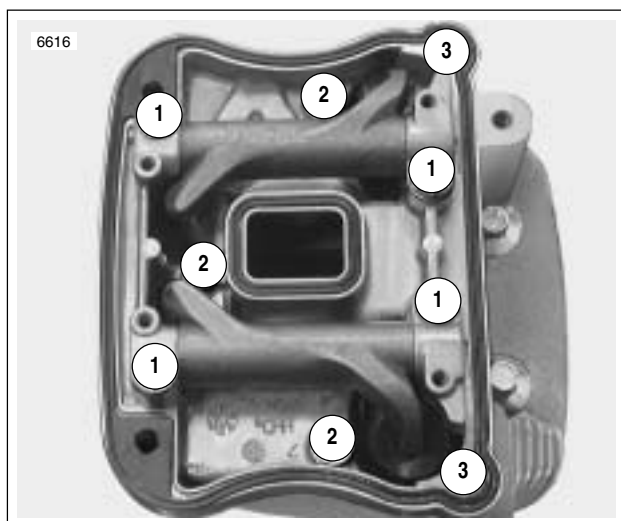


Figure 3-69. Lower Rocker Box Fasteners

10. See [Figure 3-69](#). Install hardware attaching lower rocker cover to cylinder head in the following order. After loosely installing all fasteners, use a cross pattern on the four large bolts that fasten the lower rocker box to head to tighten and then torque to specifications. This will bleed the tappets. Finish tightening remaining fasteners. Fastener sequences, sizes and torque specifications are listed in [Table 3-24](#).
- Tighten bolts (1) to 18-22 ft-lbs (24-30 Nm).
 - Tighten bolts (2) to 135-155 **in-lbs** (15-18 Nm).
 - Tighten bolts (3) to 135-155 **in-lbs** (15-18 Nm).

11. See [Figure 3-68](#). Install upper rocker covers.
- Place a **new** inner gasket on lower rocker box assembly.
 - Place a **new** lower gasket on lower rocker cover.
 - Install upper rocker cover using screws with washers and **new** fiber seals. Tighten screws to 120-168 **in-lbs** (13.6-18.9 Nm).

Table 3-24. Lower Rocker Box Hardware

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

REMOVAL/DISASSEMBLY

1. Strip motorcycle as described under this procedure. See [3.3 STRIPPING MOTORCYCLE FOR ENGINE SERVICE](#).
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 3-70](#). 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

Wear safety glasses or goggles when removing or installing piston pin retaining rings. Piston pin retaining rings are compressed in the ring groove and can fly out when removed from the groove, which could result in serious eye injury. (00293a)

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.

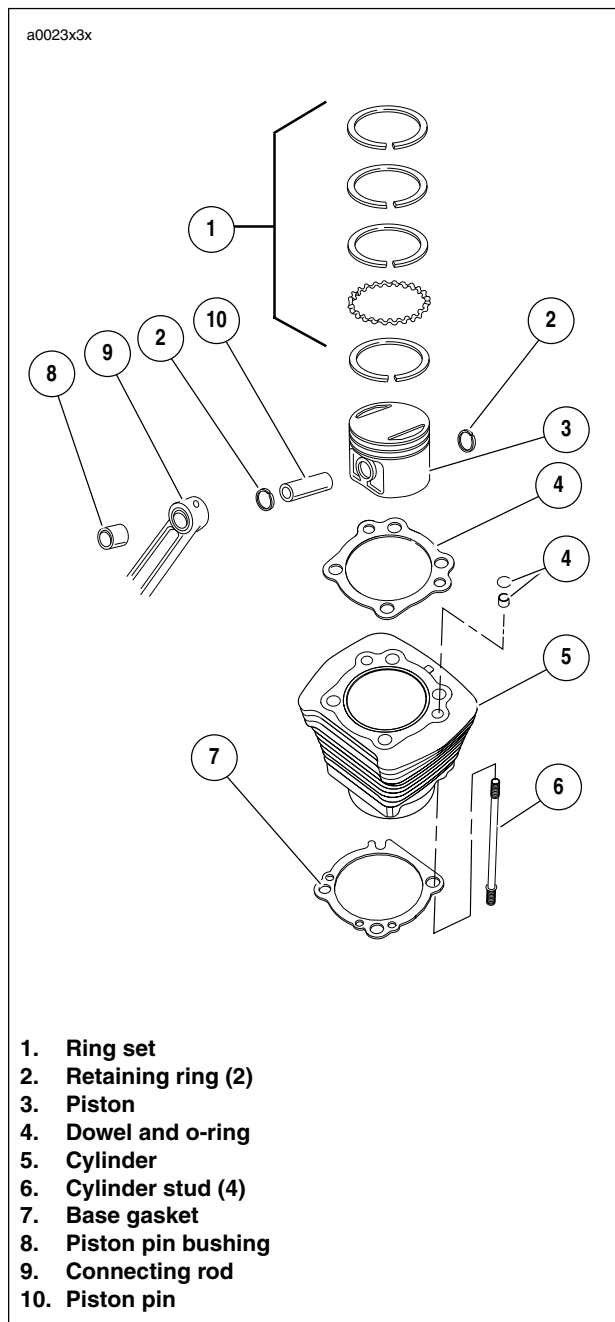


Figure 3-70. Cylinder and Piston

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.

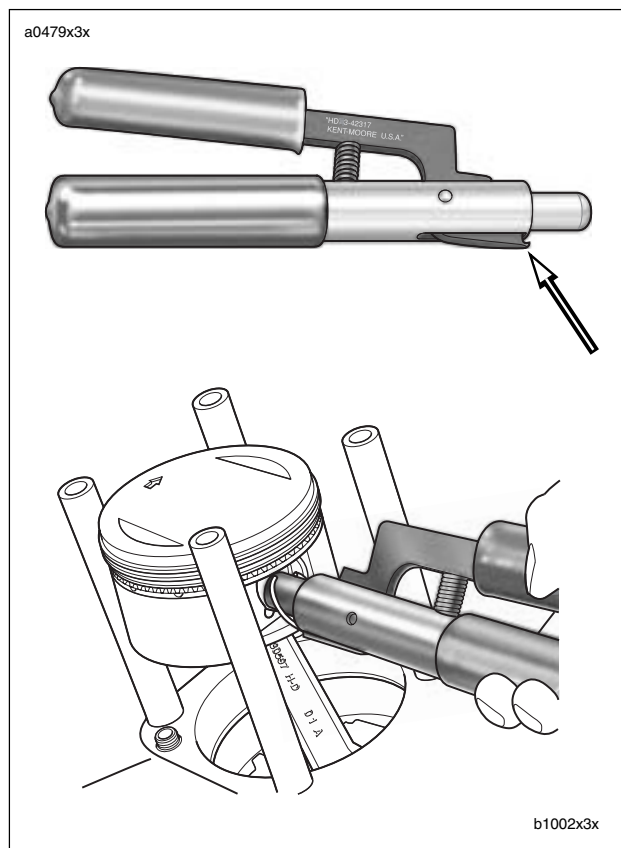


Figure 3-71. Removing Piston Pin Circlip Using Piston Pin Circlip Remover/Installer (Part No. HD-42317)

8. Remove the piston pin circlip as follows:
 - a. See [Figure 3-71](#). Insert the PISTON PIN CIRCLIP REMOVER/INSTALLER (HD-42317) into the piston pin bore until claw on tool is positioned in slot of piston (directly under circlip).
 - b. Squeeze the handles of the tool together and pull from bore. In the event that the circlip should fly out, hold a shop towel over the bore during removal. Remove circlip from claw and discard.

NOTE

It is not necessary to remove both piston pin circlips during piston removal. Leave the second circlip in the pin bore.

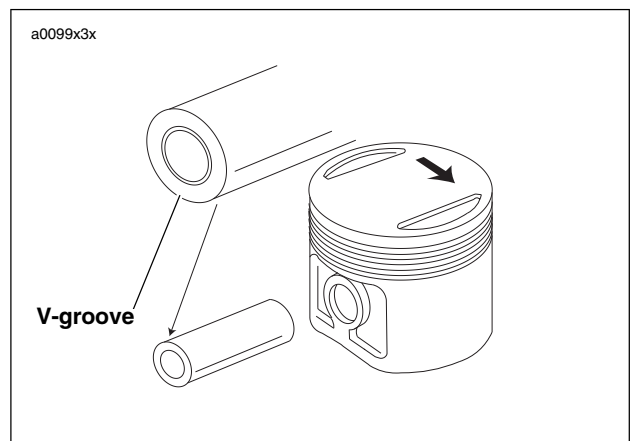


Figure 3-72. Piston Pin and Piston Identification

9. See [Figure 3-72](#). 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. Spread piston rings outward until they clear grooves in piston and lift off.

CLEANING AND INSPECTION

WARNING

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

1. 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.

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.

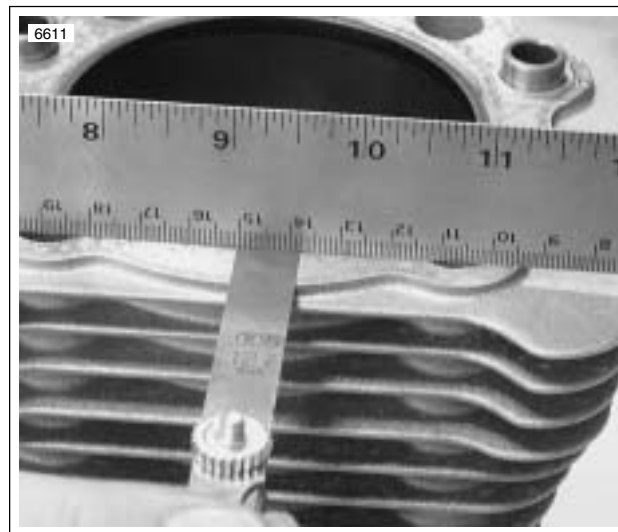


Figure 3-73. Checking Gasket Surfaces

1. See [Figure 3-73](#). Check cylinder head gasket surface for flatness.
 - a. Lay a straightedge across the surface.
 - b. Try to insert a feeler gauge between the straight-edge 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 straight-edge and the gasket surface.
 - c. If cylinder base gasket surface is not flat within 0.008 in. (0.203 mm), replace cylinder and piston.

Measuring Cylinder Bore

1. Remove any burrs from the cylinder gasket surfaces.
2. See [Figure 3-74](#). Install a head gasket, base gasket and o-rings, and CYLINDER TORQUEPLATES (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. See [3.5 CYLINDER HEAD](#).

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.

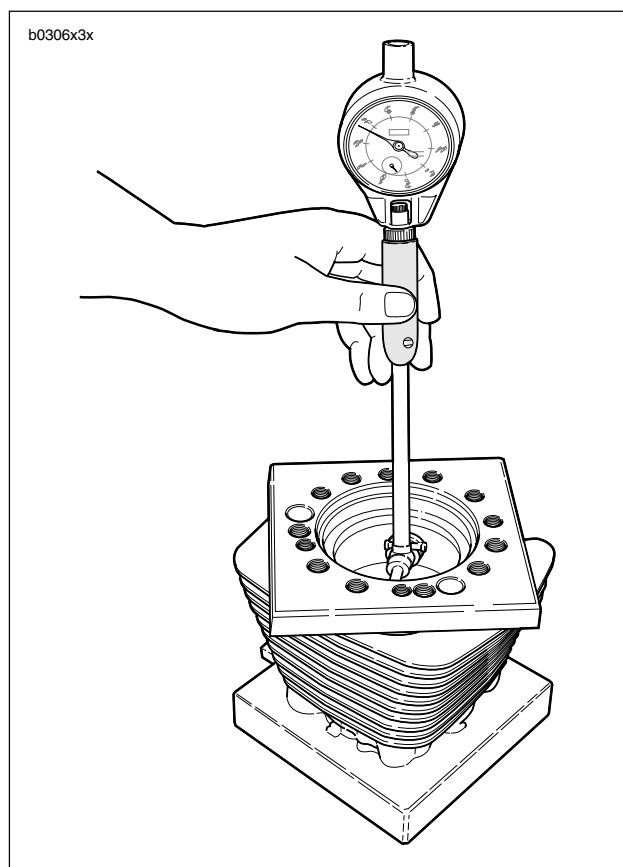


Figure 3-74. Measuring Cylinder Bore Using Torque Plates (Part No. HD-33446A)

3. See [Figure 3-74](#). Take cylinder bore measurement in ring path, starting about 0.50 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 and will also show any cylinder taper or bulge.
5. Refer to [Table 3-25](#). If cylinder is not scuffed or scored and is within service limit, see next section, [FITTING PISTON RINGS](#).

NOTE

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). See [3.1 SPECIFICATIONS](#).

Table 3-25. 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

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.

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 3-26](#). Example: A 0.005 in. (0.127 mm) oversize piston will have the proper clearance with a bore size of 3.502 in. \pm 0.0002 in. (88.951 mm \pm 0.0051 mm).

Table 3-26. Final Cylinder Bore Sizes

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

*All bore sizes + 0.0002 in. (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.

CAUTION

Failure to remove all abrasive particles may result in premature cylinder, piston and ring wear and possible engine failure.

3. Thoroughly wash the cylinder bore with liquid dishwashing soap and warm water to remove all abrasive particles and residual grit. Continue cleaning until a clean cloth shows no evidence of dirt or debris.

⚠ WARNING

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

4. Hot rinse the cylinder and dry with moisture free compressed air.
5. Immediately apply a thin film of clean engine oil to a clean white paper towel and thoroughly wipe the inside of the cylinder.

NOTE

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

Fitting Piston Rings

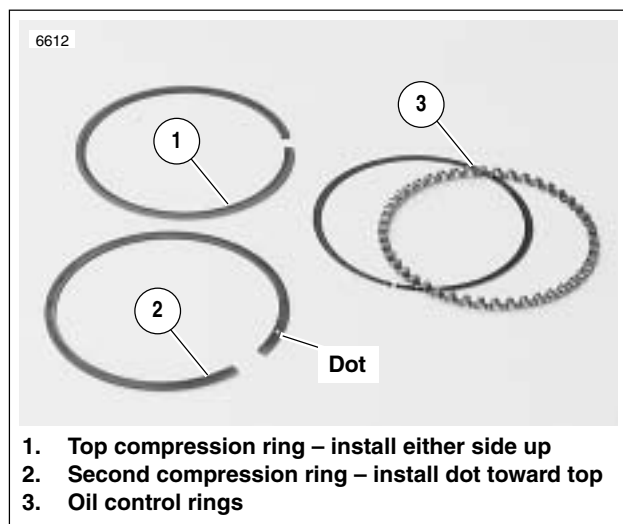


Figure 3-75. Piston Rings

See [Figure 3-75](#). 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.

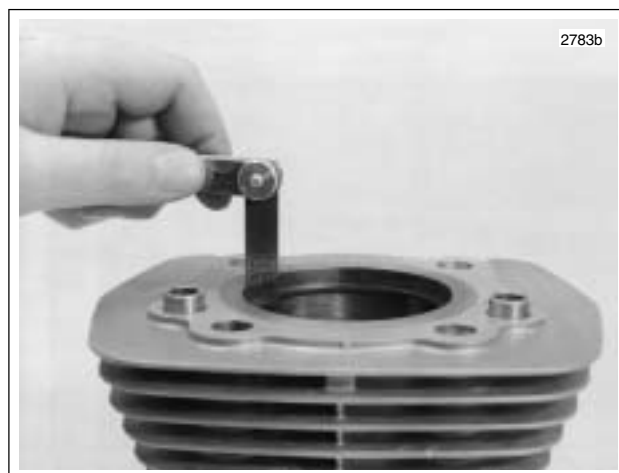


Figure 3-76. Measuring Ring End Gap

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

1. See [Figure 3-76](#). Insert the **new** ring into the cylinder, square it in the bore using the top of the piston and measure the ring end gap with a feeler gauge. Do not use the ring if the end gap does not fall within the following specifications. Refer to [Table 3-27](#).

NOTE

Ring end gap dimensions also apply to oversize rings. Replace ring if end gap exceeds specification. If end gap is under specification, filing is permissible.

Table 3-27. Piston Ring End Gap

Ring Type	inches	mm
Top compression ring	0.010-0.020	0.25-0.51
2nd compression ring	0.014-0.024	0.36-0.61
Oil control ring rails	0.010-0.050	0.25-1.27

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.



Figure 3-77. Installing Piston Rings using Transmission Shaft Retaining Ring Pliers (Part No. J-5586)

2. See [Figure 3-77](#). 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.

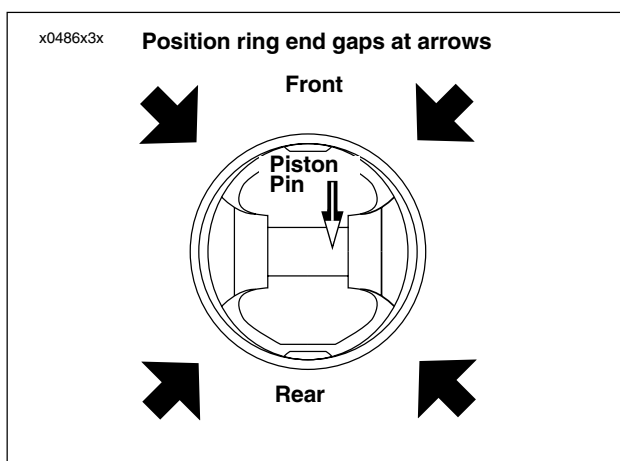


Figure 3-78. Ring End Gap Position

3. See [Figure 3-78](#). 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.



Figure 3-79. Measuring Ring Clearance in Groove

4. See [Figure 3-79](#). Check for proper side clearance with thickness gauge, as shown. See [3.1 SPECIFICATIONS](#).

NOTE

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

Connecting Rod Bushing

REMOVAL/INSTALLATION

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

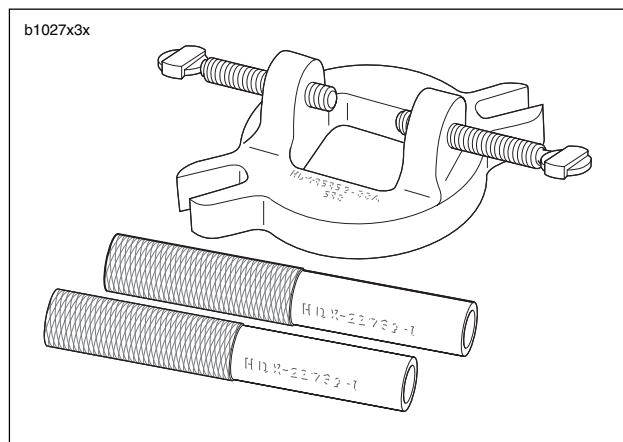


Figure 3-80. Connecting Rod Clamping Tool (Part No. HD-95952-33B)

1. See [Figure 3-80](#). Secure connecting rod with CONNECTING ROD CLAMPING TOOL (Part No. HD-95952-33B).

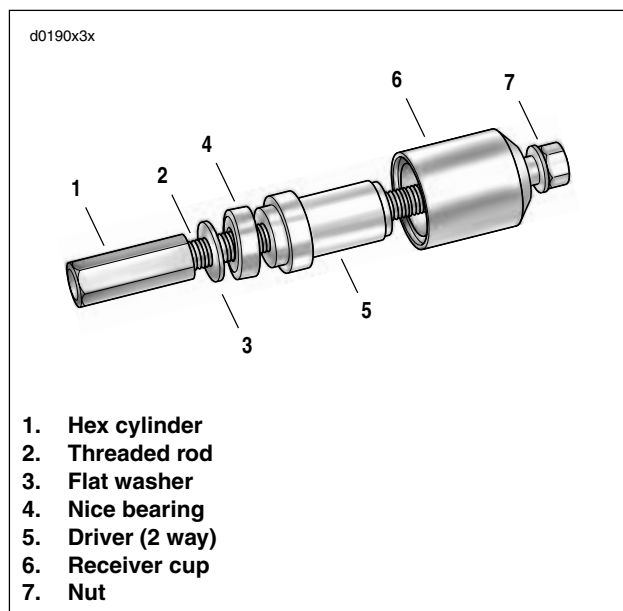


Figure 3-81. Connecting Rod Bushing Remover/Installer (Part No. HD-95970-32D)

2. See [Figure 3-81](#). Attach PISTON PIN BUSHING TOOL (Part No. HD-95970-32D) to the connecting rod.

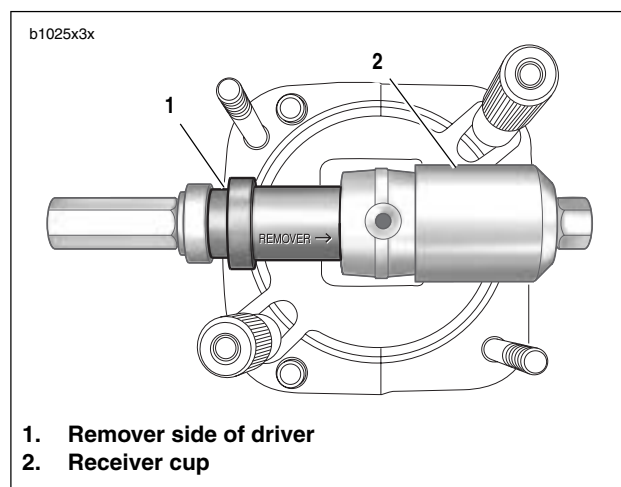


Figure 3-82. Removing Wrist Pin Bushing

NOTE

See [Figure 3-82](#). 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.

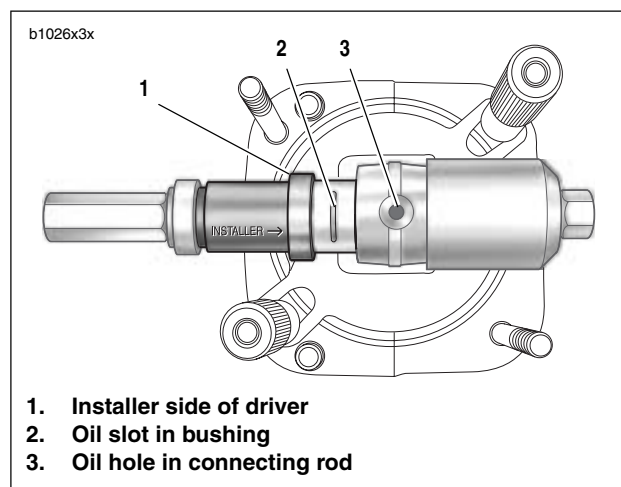


Figure 3-83. Installing New Wrist Pin Bushing

6. See [Figure 3-83](#). 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.

ASSEMBLY/INSTALLATION

NOTE

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

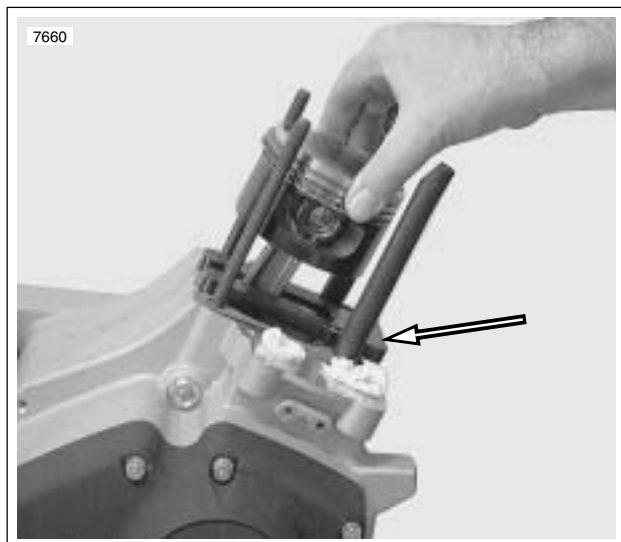


Figure 3-84. Piston Support Plate

1. See [Figure 3-84](#). Place PISTON SUPPORT PLATE (Part No. HD-42322) in position as shown.
2. Install piston assembly over connecting rod.
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.

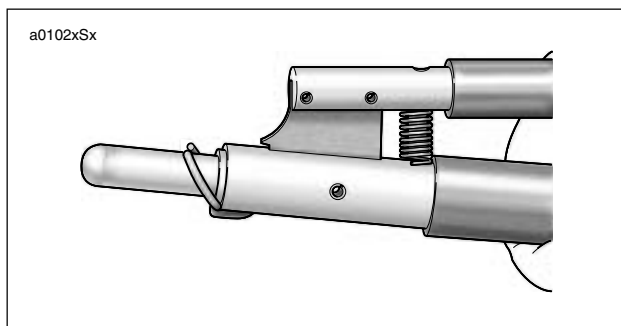
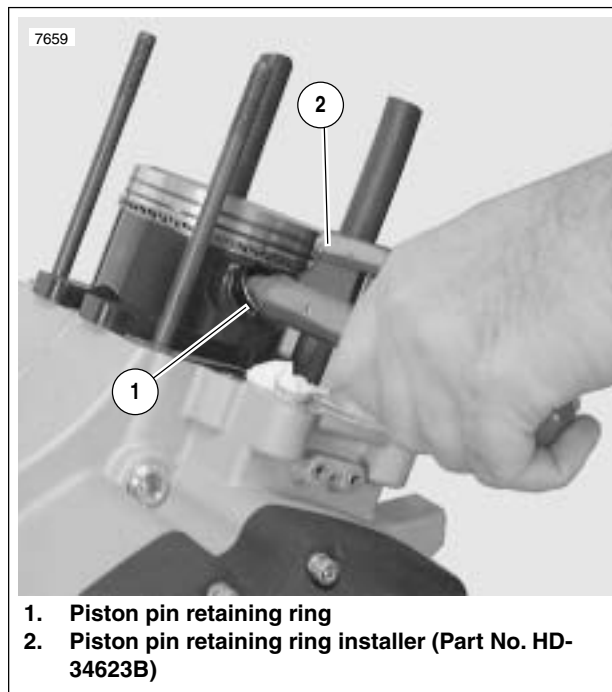


Figure 3-85. Installing Piston Pin Retaining Ring



1. Piston pin retaining ring
2. Piston pin retaining ring installer (Part No. HD-34623B)

Figure 3-86. Installing Piston Retaining Rings

4. See [Figure 3-86](#). 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 3-85](#).

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.

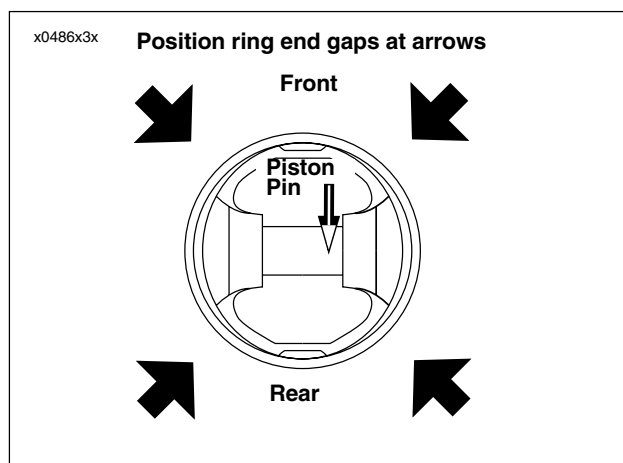


Figure 3-87. Ring End Gap Position

5. See [Figure 3-87](#). Make sure the piston ring end gaps are properly positioned as shown.

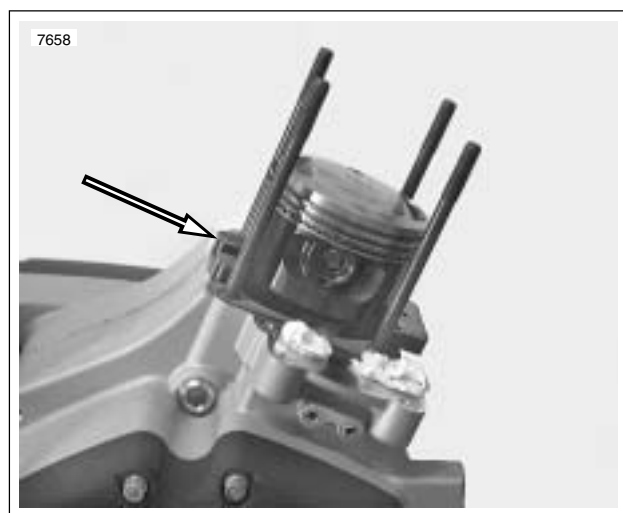


Figure 3-88. Piston Support Plate (Part No. HD-42322)

6. See [Figure 3-88](#). 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.

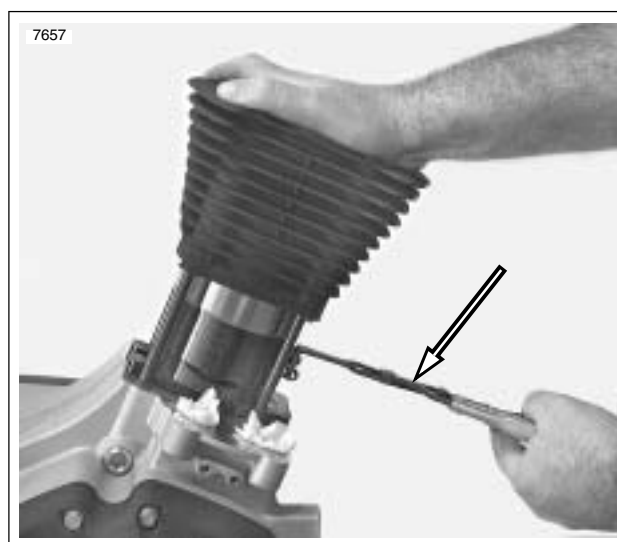


Figure 3-89. Compressing Piston Rings Using Piston Ring Compressor (Part No. HD-96333-51C)

8. See [Figure 3-89](#). 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](#).

NOTES
