

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 Information

Type	2 cylinder, air cooled, four-stroke 45 Degree V-twin	
Compression Ratio	10:1	
Bore	3.50 in.	88.8 mm
Stroke	3.125 in.	79.375 mm
Engine Displacement	60 cu. in.	984 cc
Oil Capacity (with filter change)	2.5 quarts	2.37 liters

Table 3-2. Engine Ignition Specifications

Type	Sequential, non waste spark	
Regular Idle	1050-1150 RPM	
Spark Plug Size	12 mm	
Spark Plug Type	Harley-Davidson No. 10R12A	
Spark Plug Gap	0.035 in.	0.8890 mm
Spark Plug Torque	11-18 ft-lbs	15-24 Nm

Table 3-3. Valve and Valve Seat Specifications

VALVE		NEW COMPONENTS		SERVICE WEAR LIMITS	
Fit in guide	Exhaust	0.001-0.003 in.	0.0254-0.0762 mm	0.0038 in.	0.1016 mm
	Intake	0.001-0.003 in.	0.0254-0.0762 mm	0.0038 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		2.028-2.064 in.	51.511-52.426 mm	2.082 in.	52.8828 mm

Table 3-4. Valve Spring Specifications

VALVE SPRING		NEW COMPONENTS		SERVICE WEAR LIMITS	
Free length		2.325 in.	59.1 mm	2.2-3.25. (min)	59.1 mm (min)
Intake	1.850 in. (closed)	135 lbs	61.2 kg		
	1.300 in. (open)	312 lbs	141.5 kg		
Exhaust	1.850 in. (closed)	135 lbs	61.2 kg		
	1.300 in. (open)	312 lbs	141.5 kg		

Table 3-5. Rocker Arm Specifications

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

Table 3-6. Piston Ring and Piston Pin Specifications

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.
	2nd	0.0016-0.0041 in.	0.0406-0.1041 mm	0.0065 in.
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

Table 3-7. Cylinder Head Specifications

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

Table 3-8. Cylinder Specifications

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 \pm 0.0002 in.	Standard	3.4978 in.	88.8441 mm	3.5008 in.
				88.9203 mm

Table 3-9. Connecting Rod Specifications

CONNECTING ROD	NEW COMPONENTS		SERVICE WEAR LIMITS	
Piston pin fit (loose)	0.00145-0.00155 in.	0.03683-0.03937 mm	0.00180 in.	0.04572 mm
Side play between flywheels	0.005-0.031 in.	0.1-0.8 mm	0.036 in.	0.9 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

Table 3-10. Hydraulic Lifter Specifications

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

Table 3-11. 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 3-12. Gearcase Specifications

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

Table 3-13. Flywheel Specifications

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

Table 3-14. Sprocket Shaft Bearing Specifications

SPROCKET SHAFT BEARING	NEW COMPONENTS		SERVICE WEAR LIMITS	
Bearing outer race fit in crankcase (tight)	0.006 in. Interference fit	0.2 mm		
Bearing inner race fit on shaft (tight)	0.006 in. Interference fit	0.2 mm		

Table 3-15. Pinion Shaft Bearing Specifications

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
"V" bracket to main frame	120-144 in-lbs	13.6-16.3 Nm	page 3-14, 3-32
All tie bars	25-27 ft-lbs	33.9-36.6 Nm	page 3-14
Anti-rotation screws (lifter)	55-65 in-lbs	6-7 Nm	page 3-84
Crankcase 5/16 in. screws	15-19 ft-lbs	20-26 Nm	page 3-102
Cylinder head screws	See NOTES	See NOTES	Special pattern to tighten, page 3-60
Cylinder studs	10-20 ft-lbs	14-27 Nm	Special method to tighten, page 3-103
Exhaust header nuts	72-96 in-lbs	8.1-10.8 Nm	page 3-14
Feed oil line at oil reservoir	20-22 ft-lbs	27.1-29.8 Nm	page 3-35
Feed oil line at pump to oil cooler	18-20 ft-lbs	24.4-27.1 Nm	page 3-39
Feed oil line at rear of oil pump	18-20 ft-lbs	24.4-27.1 Nm	page 3-36
Feed oil line at the oil cooler	15-17 ft-lbs	20.3-23 Nm	page 3-39
Front isolator bolt	49-51 ft-lbs	66-69 Nm	page 3-14
Front isolator bracket mounting fastener	49-51 ft-lbs	66-69 Nm	page 3-14, 3-32
Front muffler strap fastener	108-120 in-lbs	12.2-13.6 Nm	page 3-16
Gearcase cover screws	80-110 in-lbs	9-12 Nm	Special pattern to tighten, page 3-89
Oil cooler feed line at the oil pump	18-20 ft-lbs	24.4-27.1 Nm	page 3-39
Oil cooler return line fitting at crankcase	15-17 ft-lbs	20.3-23 Nm	page 3-39
Oil cooler return line fitting at the oil cooler	15-17 ft-lbs	20.3-23 Nm	page 3-39
Oil cooler return oil line	15-17 ft-lbs	20.3-23 Nm	page 3-15
Oil filter adapter	96-144 in-lbs	11-16 Nm	LOCTITE 243, page 3-82
Oil pressure signal light switch	50-70 in-lbs	6-8 Nm	page 3-82
Oil pump cover screws	70-80 in-lbs	8-9 Nm	TORX, page 3-81
Oil pump mounting screws	125-150 in-lbs	14-17 Nm	Page 3-81
Pinion shaft nut	19-21 ft-lbs	26-29 Nm	page 3-88
Piston jet TORX screws	25-35 in-lbs	2.8-4 Nm	Loctite 222, page 3-91
Pushrod cover screw	30-40 in-lbs	3-5 Nm	page 3-84
Rear isolator assembly fasteners	25-27 ft-lbs	33.9-36.6 Nm	page 3-29
Rear isolator bolt	49-51 ft-lbs	66.4-69.1 Nm	page 3-14

ITEM	TORQUE		NOTES
Rear muffler bracket	32-36 ft-lbs	43.4-48.8 Nm	page 3-33
Rear muffler straps	48-60 in-lbs	5.4-6.8 Nm	page 3-16
Reed valve fasteners	25-30 in-lbs	3.4-4.5 Nm	page 3-77
Return oil line at oil reservoir	19-21 ft-lbs	25.8-28.5 Nm	page 3-35
Return oil line at top front oil pump	18-20 ft-lbs	24.4-27.1 Nm	page 3-36
Rocker box cover screws	120-156 in-lbs	13.6-17.6 Nm	page 3-62
Rocker box to head bolts	135-155 in-lbs	15-18 Nm	Small fasteners (2), page 3-62
Rocker box to head bolts	135-155 in-lbs	15-18 Nm	Small fasteners (3), page 3-62
Rocker box to head bolts	18-22 ft-lbs	24-30 Nm	Large fasteners, page 3-62
Sprocket cover fastener	12-36 in-lbs	1-4 Nm	page 3-18, 3-44
Swingarm pivot shaft pinch bolt	17-19 ft-lbs	23-25.8 Nm	page 3-30
Swingarm pivot shaft	24-26 ft-lbs	32.5-35.2 Nm	page 3-30
Torca clamp	40-45 ft-lbs	54.2-61 Nm	page 3-16
Vent oil line at gearcase cover	120-132 in-lbs	13.6-14.9 Nm	page 3-36
Vent oil line at oil reservoir	14-16 ft-lbs	19-21.7 Nm	page 3-35

Table 3-16. Electrical Items for Engine Removal and Replacement

Description	Location
Ignition Coil	Beneath air box on the left side between cylinders
Throttle position sensor (TP) [88]	Located on the right side of engine between cylinders.
Head temperature sensor [90]	Beneath air box
Oxygen sensor	Behind rear cylinder head (Note: connection under air box)
Front and rear fuel injectors	Beneath air box on the right side of engine
Speedo sensor [65]	Located under sprocket cover.
Cam position sensor	Located under sprocket cover.
Neutral switch [131]	Located under sprocket cover.
Oil pressure switch [120]	Disconnect at oil pressure switch, right front side of engine.
Alternator stator [46]	Located under sprocket cover.
Starter solenoid wire [128B]	Disconnect at bottom of starter.
Positive battery at starter [128A]	Disconnect at rear of starter
Side stand switch [60]	Cable strapped under vehicle to sidestand.

FUEL

Gasoline/alcohol Blends

The Buell XB9S motorcycle has been designed to obtain the best performance and efficiency using a good quality unleaded gasoline. Buell recommends using at least 91 pump octane (RON). Octane rating is usually found on the pump. 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 through the oil cooler 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 [3.8 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 [3.4 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 [1.21 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 induction module throttle plate 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 induction module throttle plate 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 3-18](#). Listen for air leaks at induction 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 3-18. Air Leakage Test

AIR LEAK LOCATION	POSSIBLE CAUSES
Induction Module 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.

The following process allows you to rotate engine down, pivoting on rear isolator mount, in order to service components in the top end. The engine does not need to be removed from chassis in order to perform top end repairs.

DISASSEMBLY

NOTE

Vehicle should be placed onto the lift with rear tire placed in the wheel vise in order to successfully perform this procedure.

1. Disconnect fuel pump and run vehicle until it is out of fuel.

NOTES

- This step is always performed in order to purge fuel lines.
- The connection for fuel pump is just above the pump located at the rear of the fuel tank on the left side of the vehicle.

⚠ WARNING

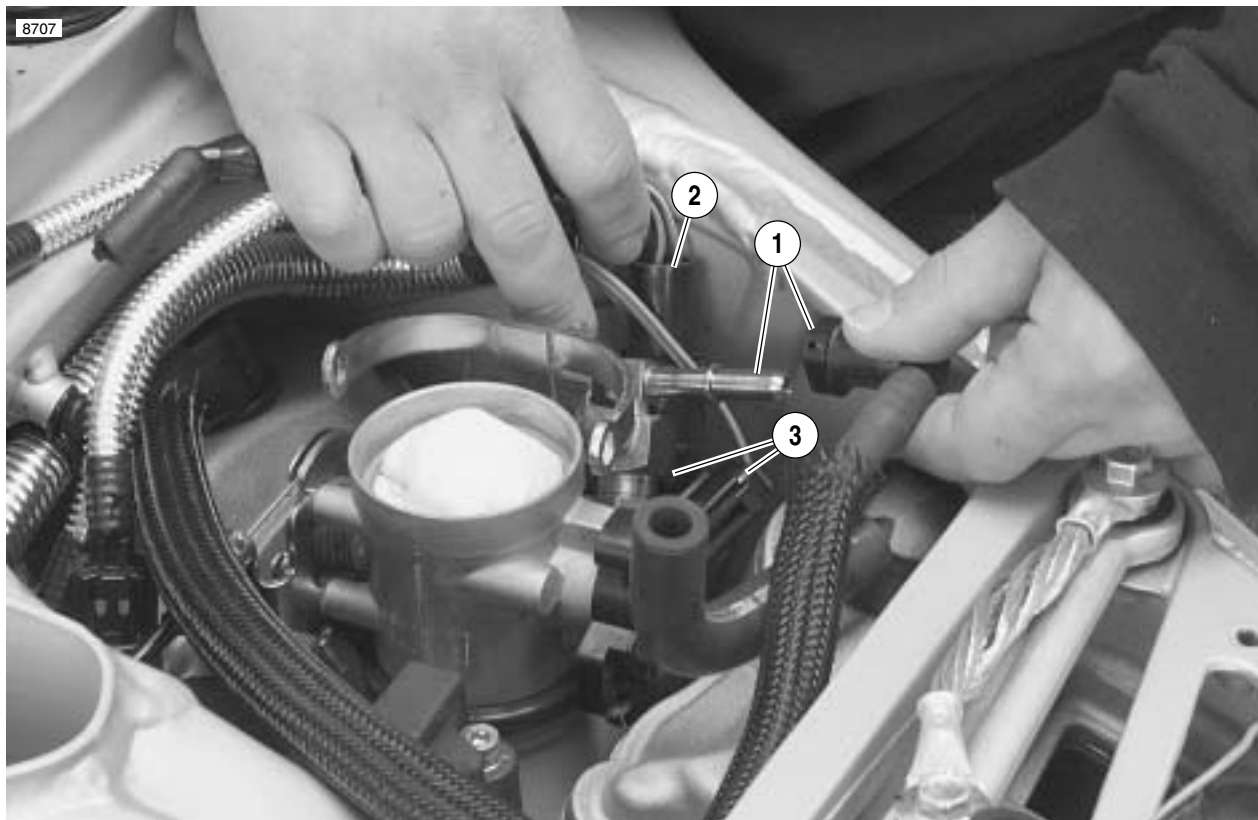
To protect against shock and accidental start-up of vehicle, disconnect the negative battery cable before proceeding. Inadequate safety precautions could result in death or serious injury.

2. Remove seat and disconnect battery.
3. Remove intake cover and airbox assembly.
4. Remove throttle body velocity stack.

NOTE

Cover velocity stack to prevent objects from falling into the induction module.

5. See [Figure 3-1](#). Disconnect fuel line.
6. Disconnect the throttle position sensor (2) [88].
7. Disconnect the fuel injector leads (3) [84 & 85].



1. Fuel line connection
2. Connection for throttle position sensor [88]
3. Connections for fuel injectors [84 & 85]

Figure 3-1. Fuel Line and DDFI Electrical Connections

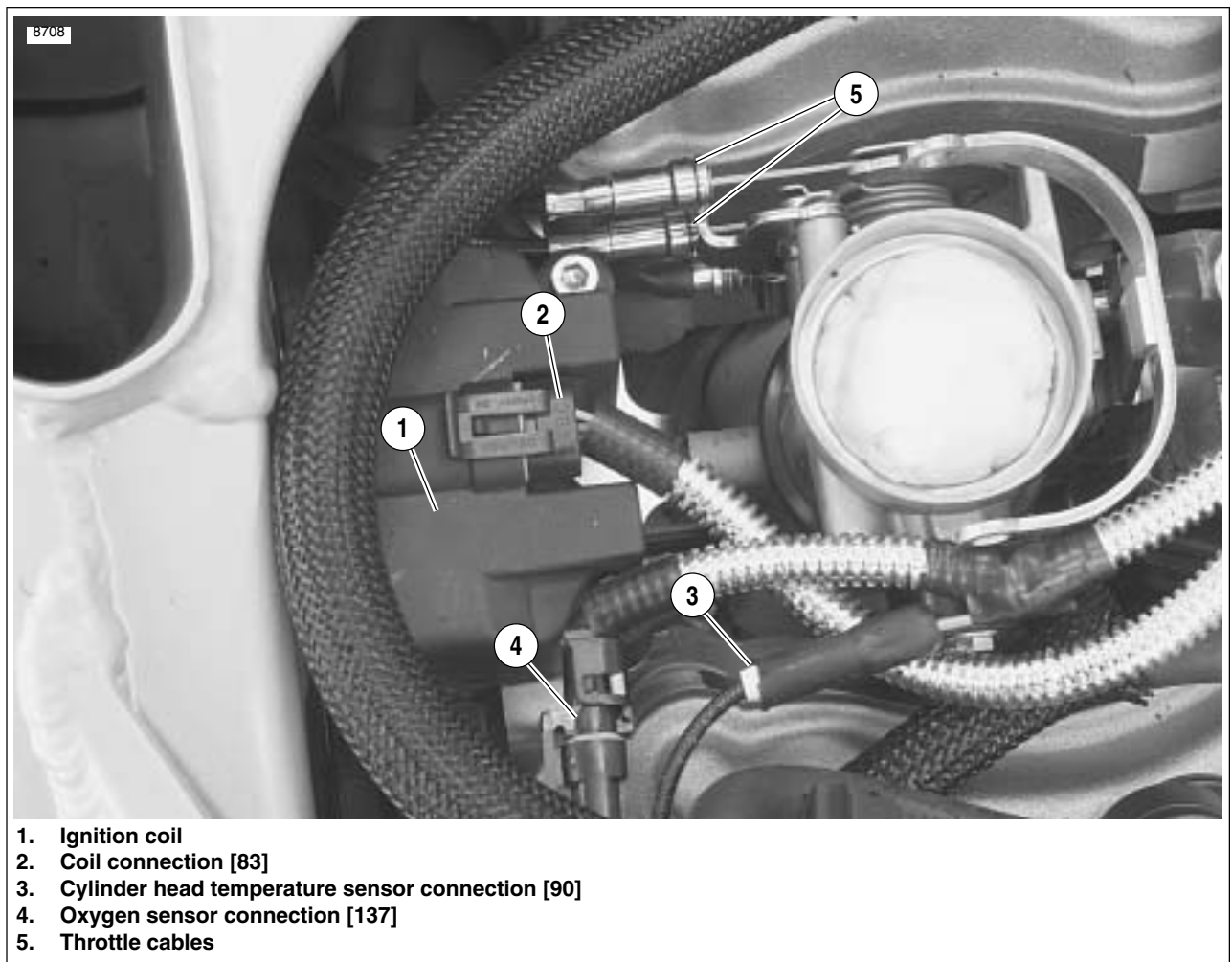
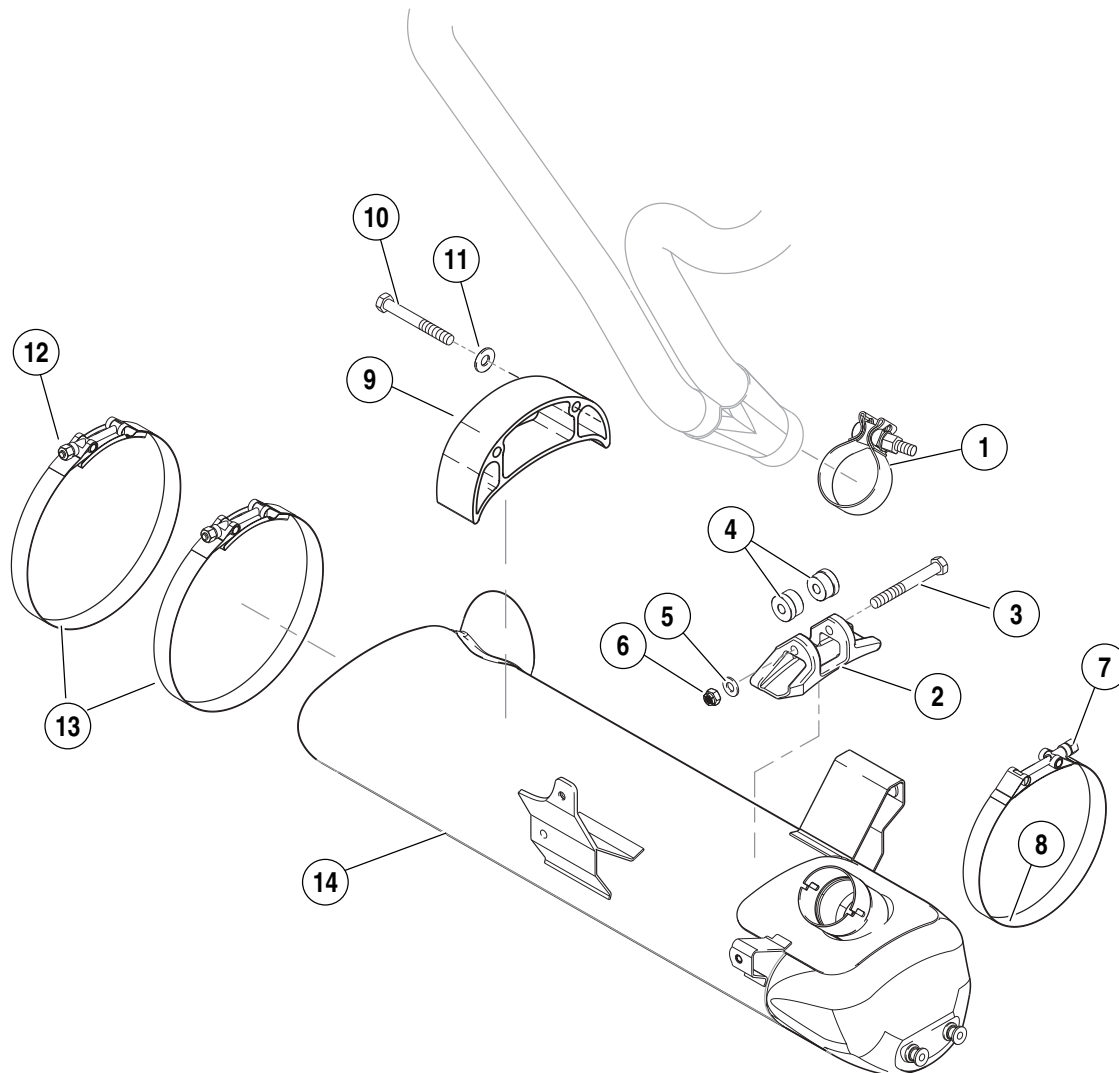


Figure 3-2. Electrical Connections and Throttle Cables

8. See [Figure 3-2](#). Disconnect the ignition coil (2) [83] and remove.
9. See [Figure 3-2](#). Disconnect the following sensors:
 - a. Temperature sensor (3) [90].
 - b. Oxygen sensor (4) [137].

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- | | |
|---|---|
| 1. Clamp, Torca | 8. Muffler strap, front |
| 2. Muffler mount, front | 9. Muffler bracket, rear |
| 3. Screw, front muffler mount (1) | 10. Screw, rear muffler bracket (2) |
| 4. Bushings, front muffler mount (2) | 11. Flat washer, rear muffler bracket (2) |
| 5. Flat washer, front muffler mount (1) | 12. Rear muffler strap fastener |
| 6. Nut, front muffler mount (1) | 13. Muffler strap, rear (2) |
| 7. Front muffler strap fastener | 14. Muffler |

Figure 3-3. Muffler and Mounting System

- | | |
|--|--|
| 10. Disconnect and remove air scoops, right and left sides. | 14. See Figure 3-3 . Remove muffler: |
| 11. Remove complete chin fairing. | a. Remove front muffler strap (8). |
| 12. Remove transmission sprocket side cover. | b. Remove rear muffler straps (13). |
| 13. Remove rear belt and idler pulley. See 1.10 DRIVE BELT | c. Loosen Torca clamp (1) and remove muffler (14). |
| and 2.13 REAR BRAKE MASTER CYLINDER . | d. Loosen front muffler mount (2). |

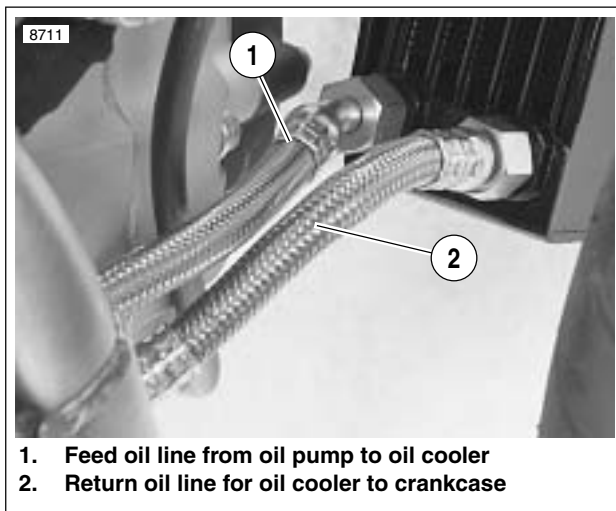


Figure 3-4. Oil Line Connections at Oil Cooler

15. See [Figure 3-4](#). Disconnect oil lines at oil cooler only.
16. Remove left side rider footrest and support plate.
17. See [Figure 3-5](#). Disconnect clutch cable.
 - a. Remove p-clamp (1) from front isolator.
 - b. Slide clutch cable adjuster boot (2) up to access clutch adjuster.
 - c. Loosen clutch adjuster to release tension from hand lever.
 - d. Remove clutch cable ferrule from hand lever.

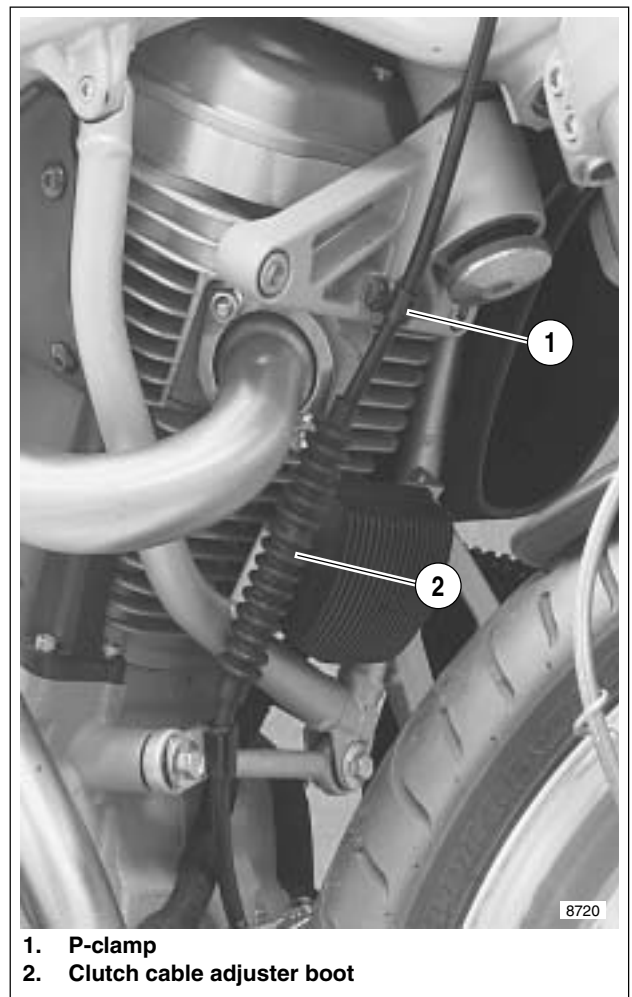
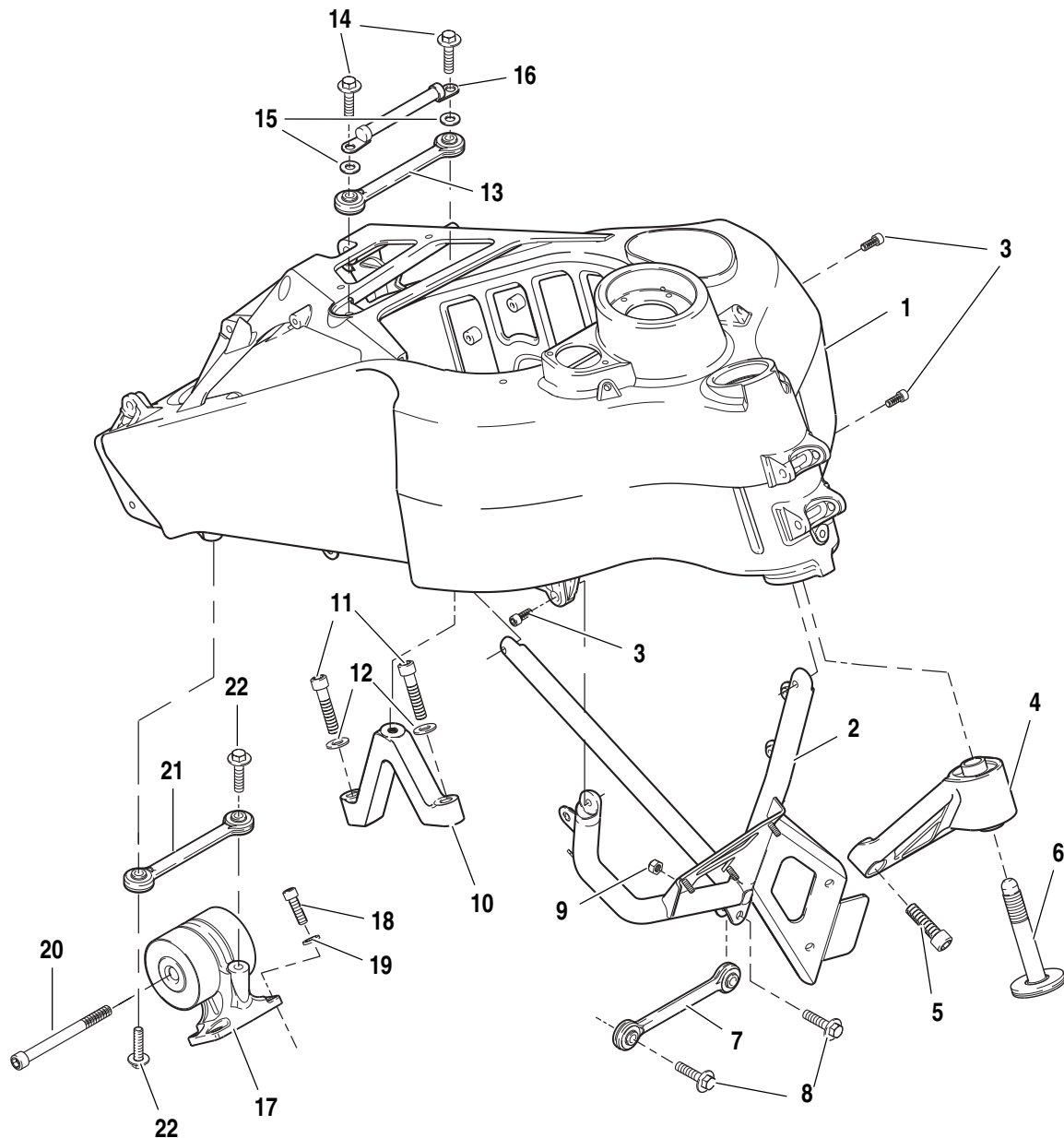


Figure 3-5. Clutch Cable Retaining Clamp and Adjuster Boot

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- | | |
|--|---|
| 1. Frame assembly | 12. Washers for center tie bar mount (2) |
| 2. "V" bracket | 13. Tie bar assembly, center |
| 3. Fasteners for "V" bracket (3) | 14. Fasteners for center tie bar assembly (2) |
| 4. Isolator assembly, front | 15. Washers for center tie bar assembly (2) |
| 5. Fasteners for front isolator (2) | 16. Cable, negative battery |
| 6. Bolt, front isolator | 17. Isolator assembly, rear |
| 7. Tie bar assembly, front | 18. Fasteners for rear isolator assembly (4) |
| 8. Fasteners for front tie bar assembly (2) | 19. Washers for rear isolator assembly (4) |
| 9. Nut for one fastener for front tie bar assembly | 20. Bolt, rear isolator |
| 10. Mount, center tie bar | 21. Tie bar assembly, rear |
| 11. Fasteners for center tie bar mount (2) | 22. Fasteners for rear tie bar assembly (2) |

Figure 3-6. Engine Mounting System

18. Support engine with wide scissors jack.
19. See [Figure 3-6](#). Remove front “V” bracket with oil cooler from main frame:
 - a. Remove cable strap securing the remote idle adjustment cable.
 - b. Remove the three cable straps holding regulator wiring harness in order to extend the harness to remove “V” bracket.
 - c. Unplug regulator harness, (2 plugs).
 - d. Remove front tie bar from “V” bracket only.
 - e. Unbolt “V” bracket from main frame and remove from left side.
20. Remove center tie-bar from engine.

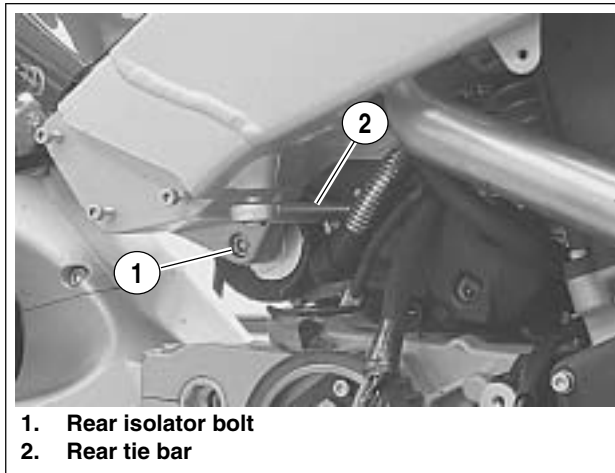


Figure 3-7. Rear Isolator Bolt and Rear Tie Bar

21. See [Figure 3-7](#). Remove rear tie bar from frame only.
22. Loosen rear isolator bolt. DO NOT REMOVE.

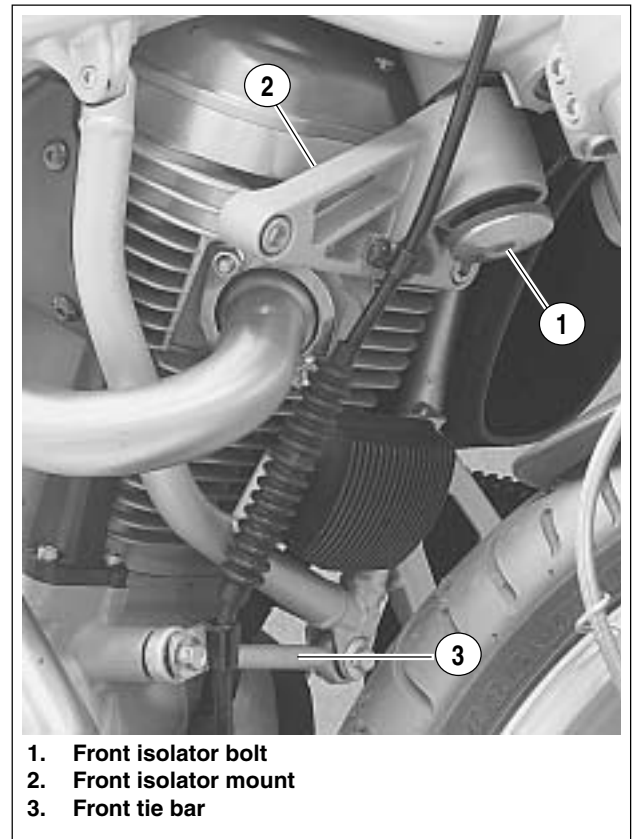


Figure 3-8. Front Isolator and Tie Bar Assemblies

23. See [Figure 3-8](#). Remove front isolator bolt (1).
24. Remove front isolator mount (2) from engine.
25. Rotate engine down.

REASSEMBLY

NOTE

- If exhaust header was removed during service it must be torqued with the engine rotated in the down position. It is not possible to reach fasteners on the rear exhaust at the head with engine rotated in the up position.
 - Tighten header nuts gradually, alternating between studs to insure that exhaust rings are flush with engine. Tighten fasteners to 72-96 **in-lbs** (8.1-10.8 Nm).
1. When repairs have been completed, rotate engine back up into frame.

NOTE

When installing and tightening front isolator bolt it is important to keep load off of isolator bolt for installation purposes. Alternate between tightening front isolator bolt and raising engine with scissors jack.

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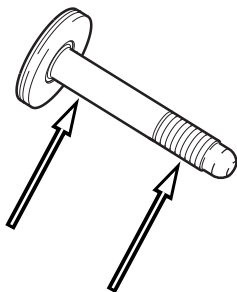
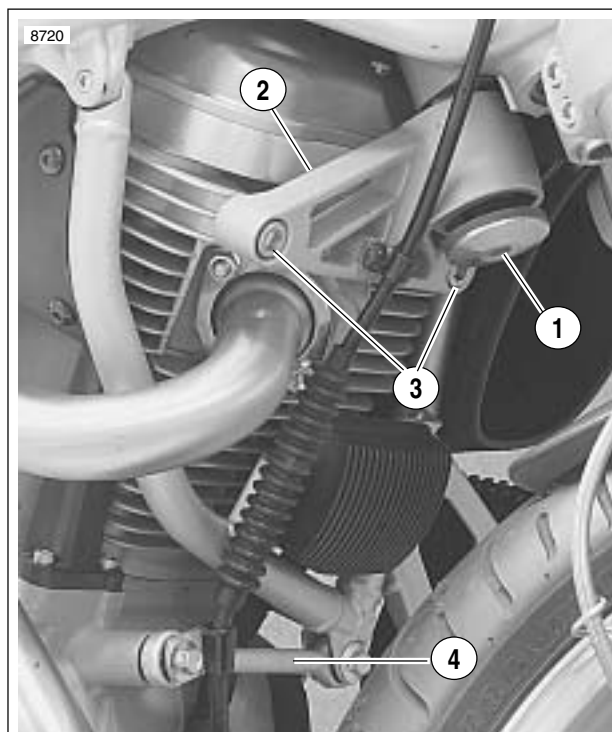


Figure 3-9. Lubrication Points on Front Isolator Bolt

NOTE

See [Figure 3-9](#). Always coat shaft and threads of front isolator bolt with anti-seize before installing.



1. Front isolator bolt
2. Front isolator mount
3. Front isolator mount fasteners (2)
4. Front tie bar

Figure 3-10. Front Isolator and Tie Bar Assemblies

2. See [Figure 3-10](#). Insert front isolator bolt (1) through front isolator (2) and loosely thread into frame. Do not tighten at this point.
3. See [Figure 3-10](#). Install isolator mounting fasteners (3) and tighten to 49-51 ft-lbs (66.4-69.1 Nm).
4. Tighten front isolator bolt to 49-51 ft-lbs (66.4-69.1 Nm).
5. See [Figure 3-6](#). Torque rear isolator bolt to 49-51 ft-lbs (66.4-69.1 Nm).
6. See [Figure 3-6](#). Install rear tie bar to frame and tighten to 25-27 ft-lbs (33.9-36.6 Nm).
7. See [Figure 3-6](#). Install center tie bar to engine and tighten to 25-27 ft-lbs (33.9-36.6 Nm).
8. See [Figure 3-6](#). Install front "V" bracket with oil cooler to main frame.
 - a. Install "V" bracket to main frame from the left side of the vehicle and tighten to 120-144 **in-lbs** (13.6-16.3 Nm).
 - b. [Figure 3-10](#). Install front tie-bar to "V" bracket and tighten to 25-27 ft-lbs (33.9-36.6 Nm).
 - c. Attach regulator wiring harness to bracket nylon cable straps.
9. Remove scissors jack.



Figure 3-11. Clutch Cable Retaining Clamp

10. See [Figure 3-11](#). Pull clutch cable back up into the proper position.

- a. Connect clutch cable to handlebars and adjust to specifications. See [3.1 SPECIFICATIONS](#).
- b. Install retaining clamp.

NOTE

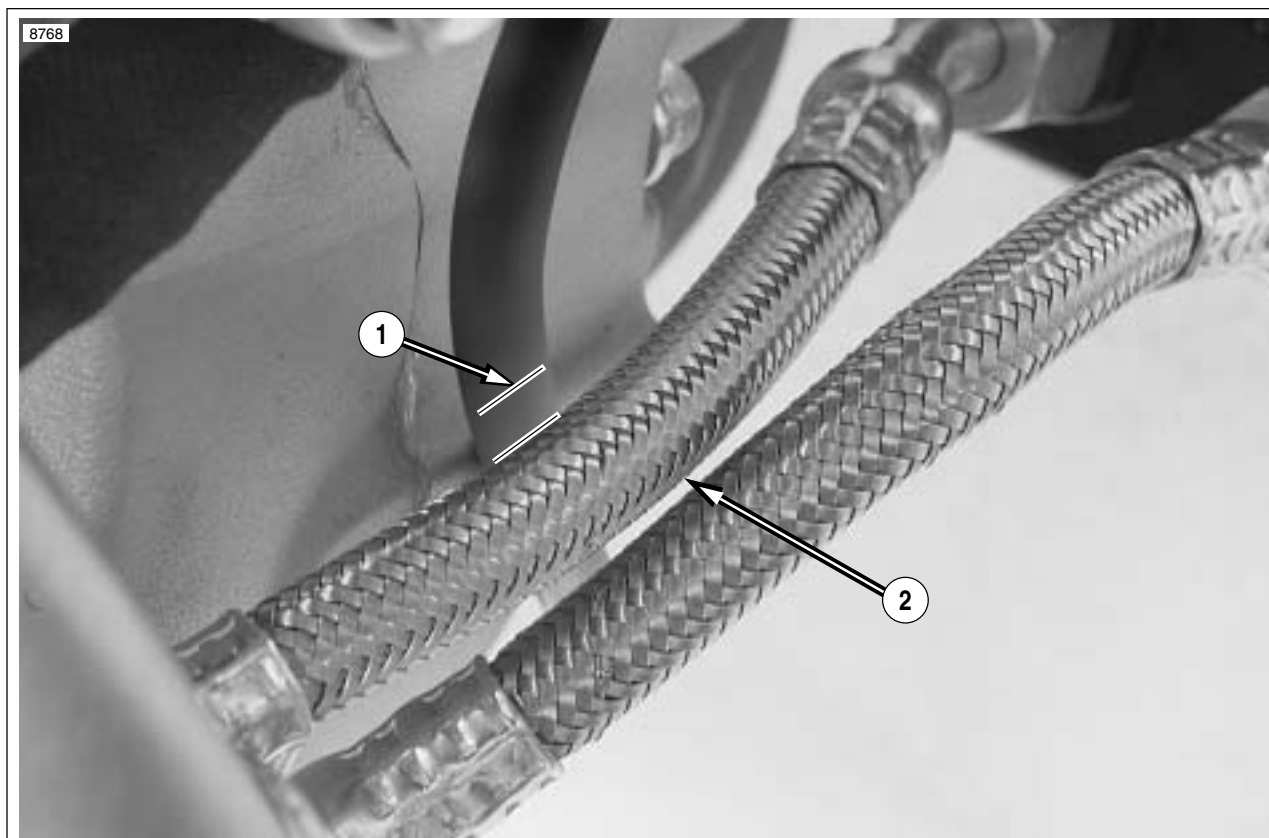
When torquing the feed oil line from the pump to the oil cooler it is necessary to torque the fitting at the oil pump first.

11. See [Figure 3-12](#). Install oil cooler oil feed line first and tighten to 15-17 ft-lbs (20.3-23 Nm).

NOTE

When installing the oil cooler return oil line it is necessary to install the end at the crankcase first.

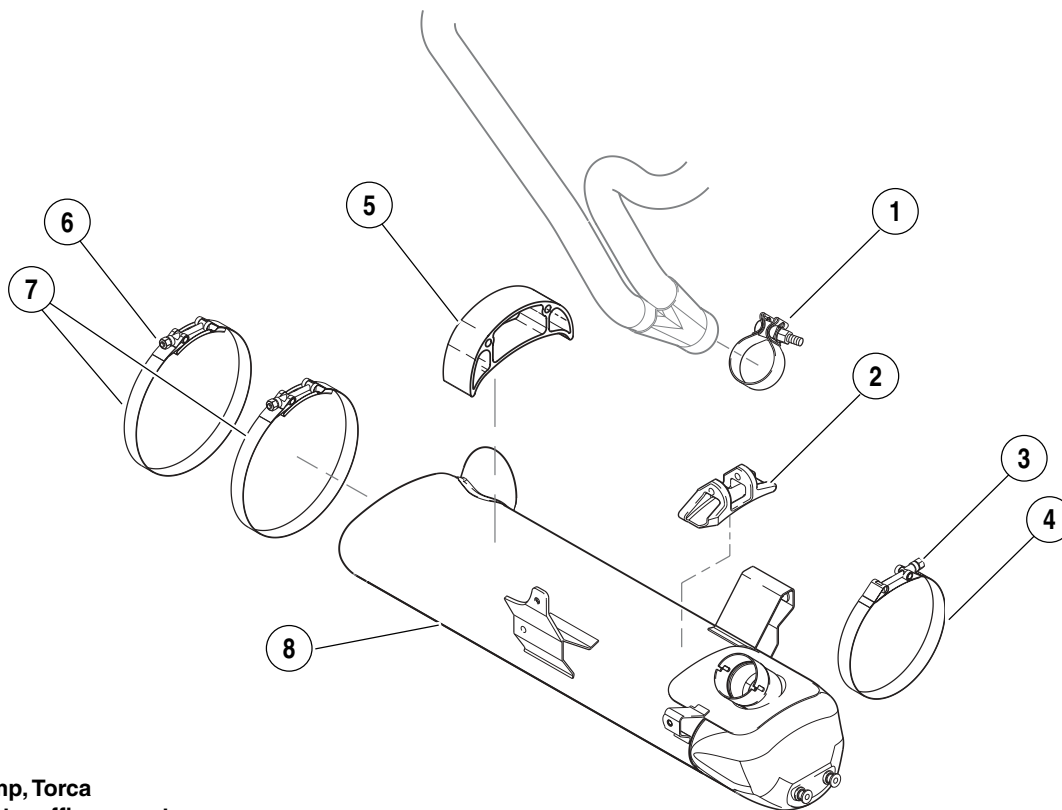
12. See [Figure 3-12](#). Install the oil cooler return oil line and tighten to 15-17 ft-lbs (20.3-23 Nm).



1. Verify that the clutch cable and feed line have a clearance of 1/8-1/4 in. (3.175-6.35 mm) between them.
2. Verify that oil lines have a minimum clearance of 1/8 in. (3.175 mm) between them.

Figure 3-12. Oil Cooler Feed and Return Oil Line Orientation and Clearances

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1. Clamp, Torca
2. Front muffler mount
3. Front muffler strap fastener
4. Muffler strap, front
5. Rear muffler bracket
6. Rear muffler strap fastener
7. Muffler strap, rear (2)
8. Muffler

Figure 3-13. Muffler and Mounting System

CAUTION

It is important that the front muffler mount is tightened last in order to ensure proper alignment of the exhaust system.

CAUTION

When rear muffler straps have been installed, it is important that strap fasteners do not contact idler pulley bracket.

13. See [Figure 3-13](#). Install muffler with **new** Torca clamp but do not tighten:
 - a. Install rear muffler straps and alternately tighten rear strap fasteners (6) to **48-60 in-lbs** (5.4-6.8 Nm).
 - b. Install front muffler strap fastener (3) and tighten to **108-120 in-lbs** (12.2-13.6 Nm).
 - c. Tighten Torca clamp to **40-45 ft-lbs** (54.2-61 Nm).
14. Tighten front muffler mount to **22-25 ft-lbs** (29.8-33.9 Nm).

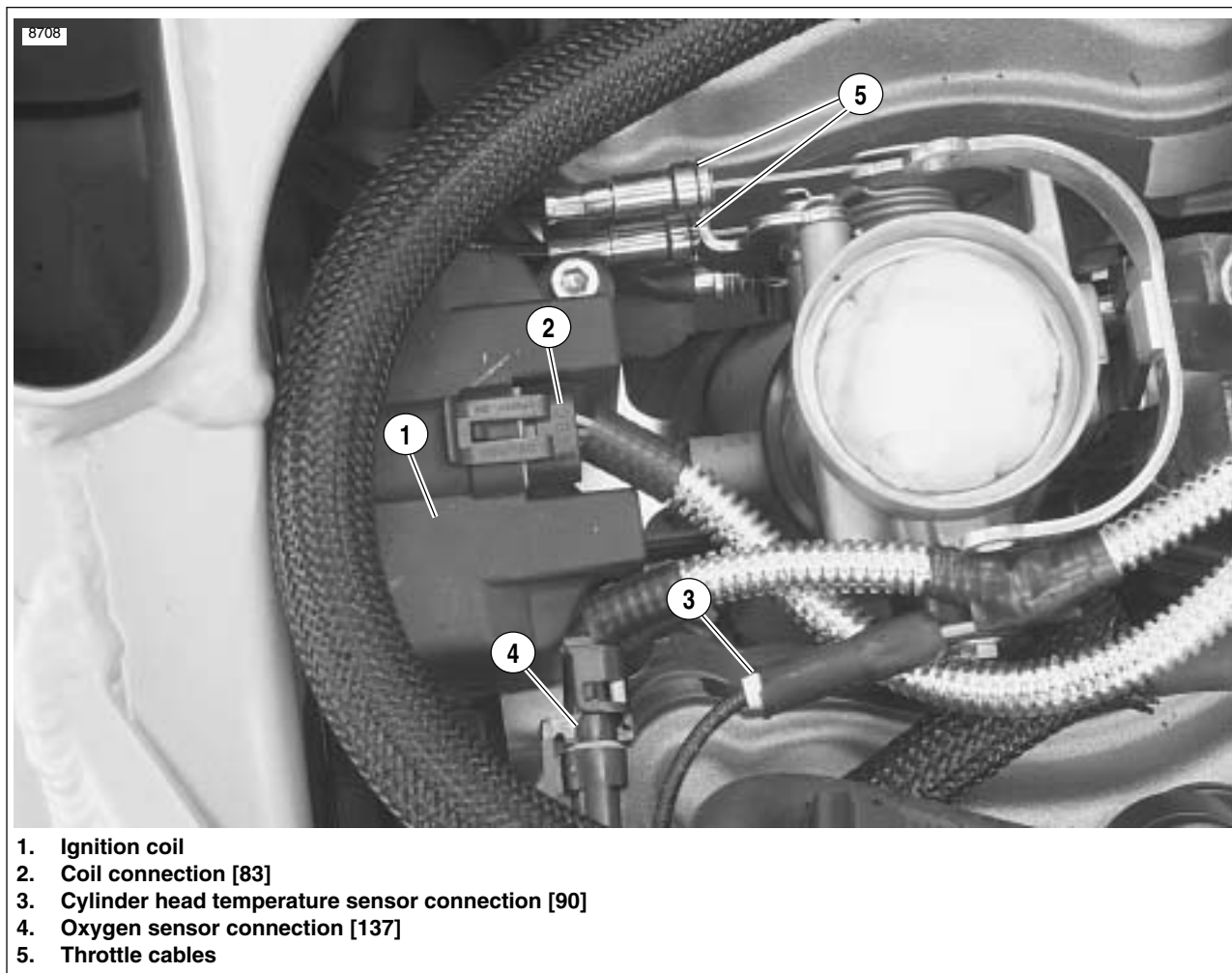


Figure 3-14. Electrical Connections and Throttle Cables

15. See [Figure 3-14](#). Connect throttle cables from induction module/throttle body.
16. Connect the following sensors:
 - a. Temperature sensor (3) [90].
 - b. Oxygen sensor (4) [137].
17. See [Figure 3-14](#). Install the ignition coil and connect (2) [83] and tighten fasteners to 120-144 **in-lbs** (13.6-16.3 Nm).

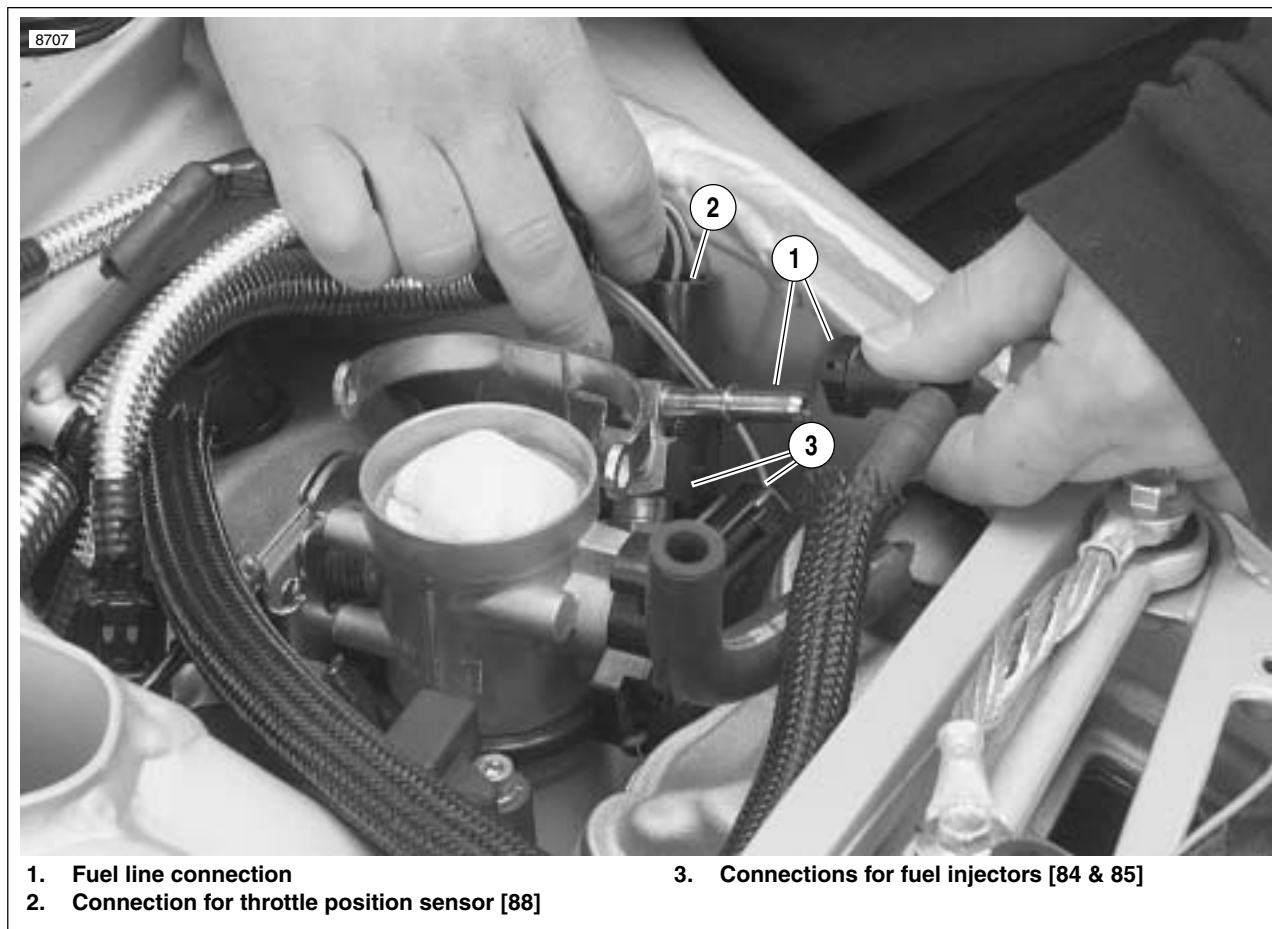


Figure 3-15. Fuel Line and DDFI Electrical Connections

CAUTION

Remove shop towel from entrance of throttle body to ensure proper operation of induction module.

18. See [Figure 3-15](#). Connect throttle position sensor (2) [88].
19. Connect fuel injector leads (3) [84 & 85].
20. Connect fuel line.
21. Install throttle body velocity stack (tighten).
22. Install airbox assembly and intake cover and tighten fasteners to 84-120 **in-lbs** (9.5-13.6 Nm).
23. Install rear belt and idler pulley. See [1.10 DRIVE BELT](#) and [2.13 REAR BRAKE MASTER CYLINDER](#).
24. Install left side rider footrest and support plate and tighten fasteners to 120-144 **in lbs** (13.56-16.27 Nm).
25. Install sprocket cover and tighten fasteners and washers to 12-36 **in-lbs** (1-4 Nm).
26. Install chin fairing. See [2.34 CHIN FAIRING](#).
27. Install air scoops, right and left sides. See [2.36 AIR SCOOPS](#).

28. Connect fuel pump.

NOTE

The connection for fuel pump is just above the pump located at the rear of the fuel tank on the left side of the vehicle.

⚠ 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.

29. Connect negative ground cable to battery and install seat (tighten).

⚠ WARNING

Pull up on seat to verify that it is properly secured, front and rear. A loose seat may shift during vehicle operation and startle the rider, possibly causing loss of vehicle control resulting in death or serious injury.

DISASSEMBLY

NOTE

Vehicle should be placed onto the lift with rear tire in the wheel vise in order to successfully perform this procedure.

1. Disconnect fuel pump and run vehicle until it is out of fuel. See 4.40 FUEL PUMP.

NOTES

- This step is always performed in order to purge fuel lines.
 - The connection for fuel pump is just above the pump located at the rear of the fuel tank on the left side of the vehicle.
2. Drain oil tank.

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.

3. Remove seat and disconnect battery.
4. Remove intake cover and airbox assembly.
5. Remove throttle body velocity stack.

NOTE

Install shop towel in entrance to throttle body to prevent objects from falling into the induction module.

6. See Figure 3-16. Disconnect fuel line.
7. Disconnect throttle position sensor (2) [88].
8. Disconnect fuel injector leads (3) [84 & 85].

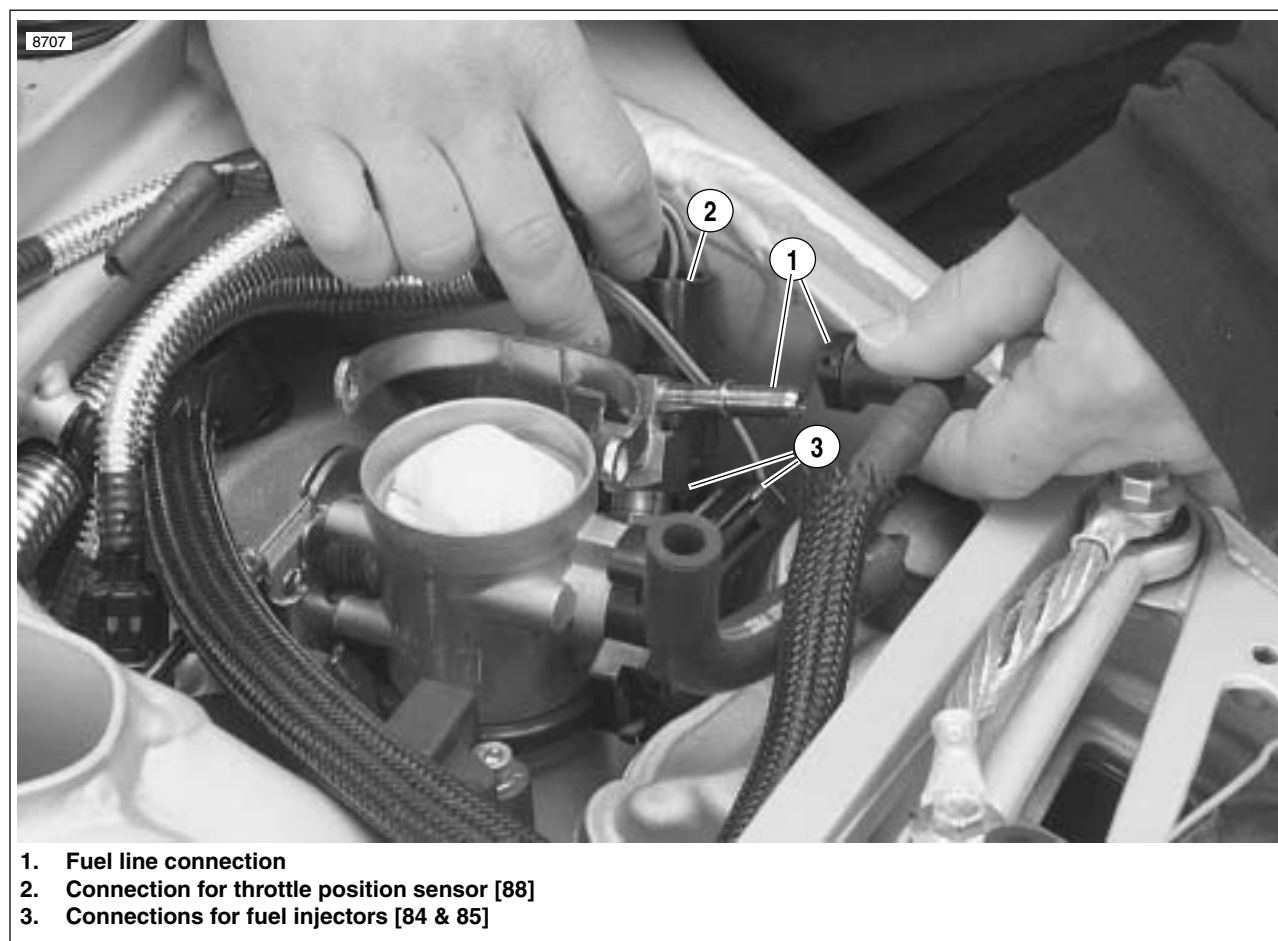


Figure 3-16. Fuel Line and DDFI Electrical Connections

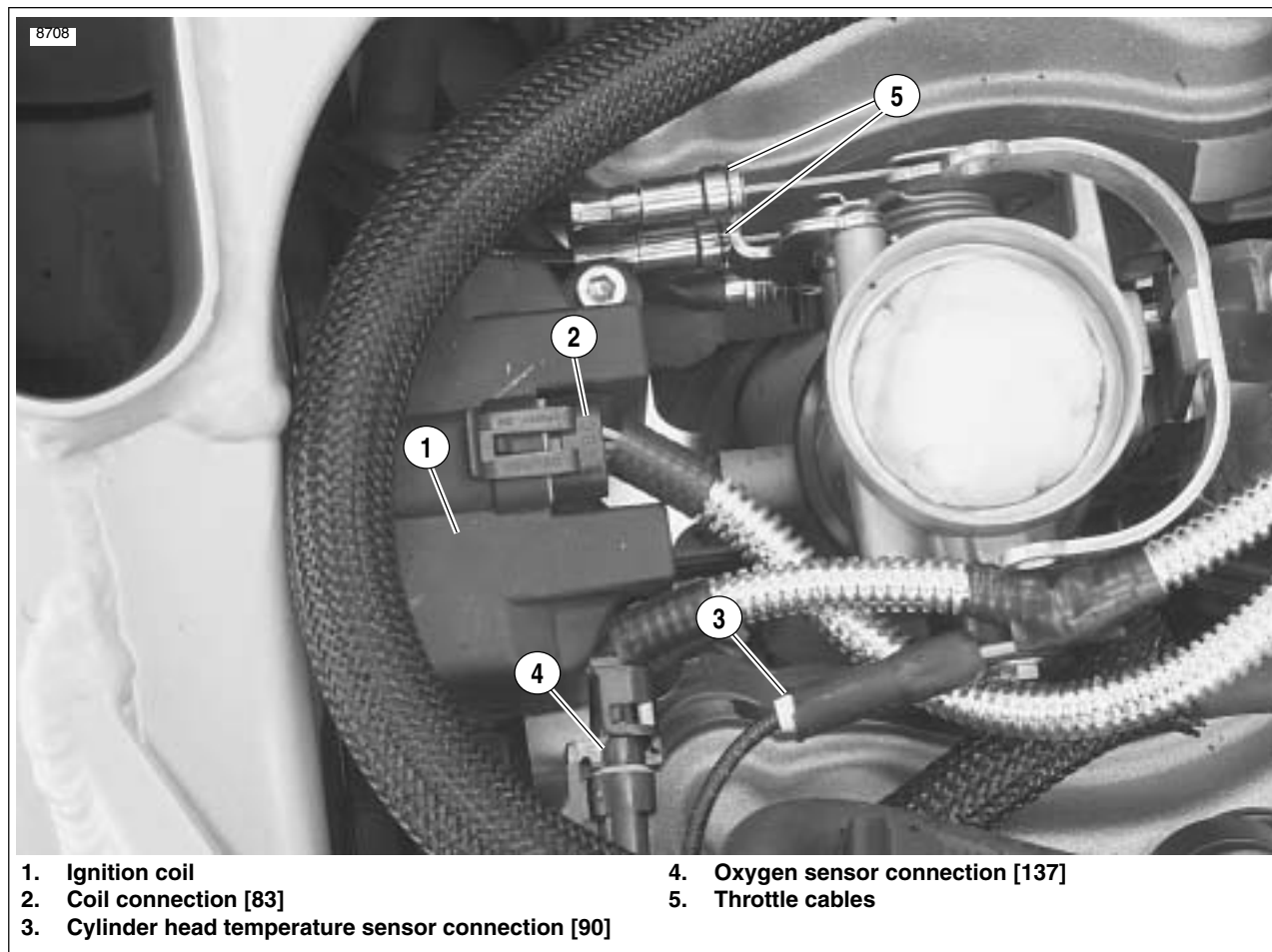
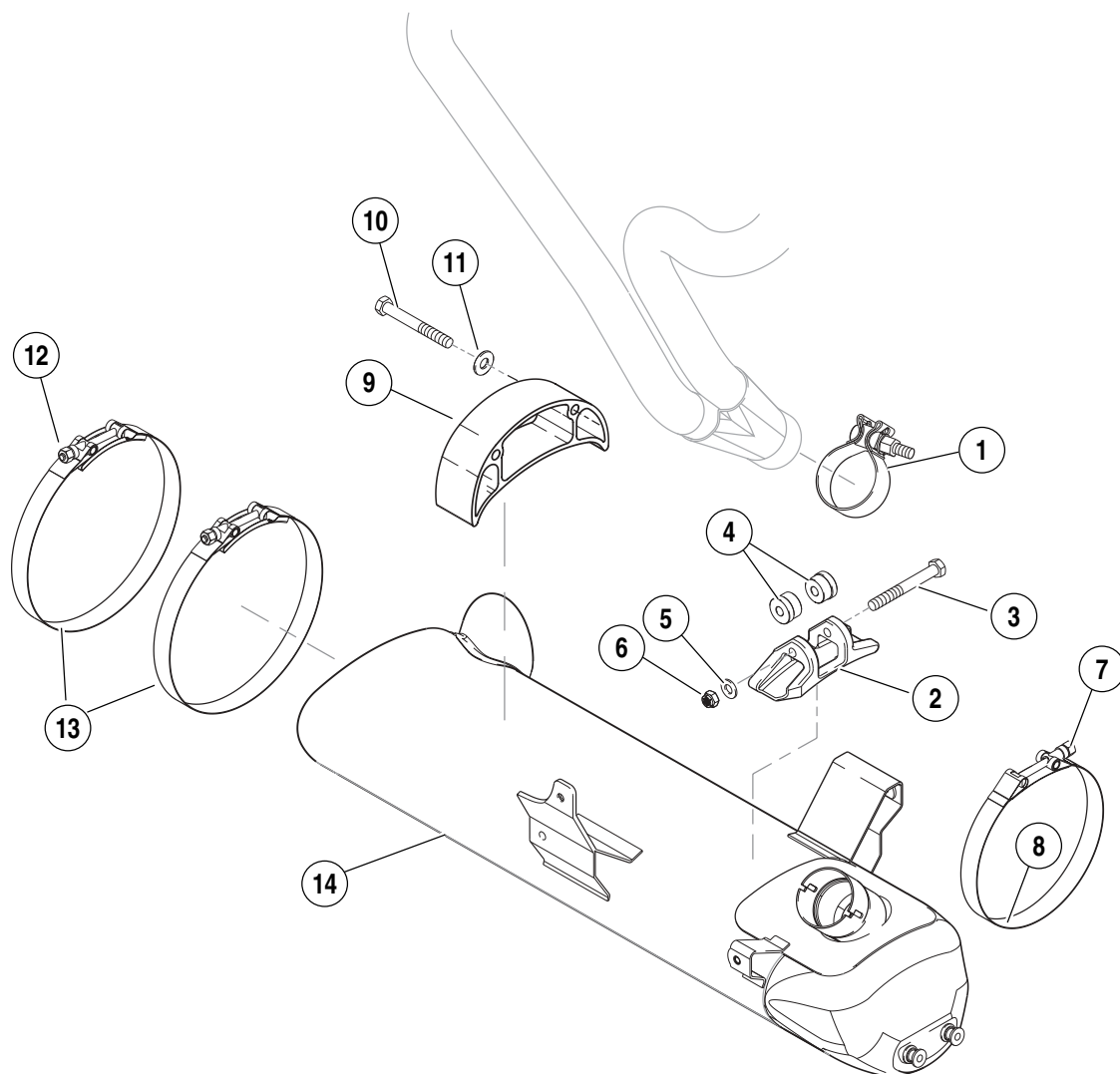


Figure 3-17. Electrical Connections and Throttle Cables

9. See [Figure 3-17](#). Disconnect the ignition coil connector (2) and remove.
10. Disconnect the following sensors:
 - c. Temperature sensor (3) [90].
 - d. Oxygen sensor (4) [137].
11. Disconnect throttle cables from induction module/throttle body.

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- | | |
|---|---|
| 1. Clamp, Torca | 8. Muffler strap, front |
| 2. Muffler mount, front | 9. Muffler bracket, rear |
| 3. Screw, front muffler mount (1) | 10. Screw, rear muffler bracket (2) |
| 4. Bushings, front muffler mount (2) | 11. Flat washer, rear muffler bracket (2) |
| 5. Flat washer, front muffler mount (1) | 12. Rear muffler strap fastener |
| 6. Nut, front muffler mount (1) | 13. Muffler strap, rear (2) |
| 7. Front muffler strap fastener | 14. Muffler |

Figure 3-18. Muffler and Mounting System

12. Disconnect and remove air scoops, right and left sides.
13. Remove complete chin fairing, (7) bolts.
14. Remove transmission sprocket side cover.
15. Remove rear belt and idler pulley. See [1.10 DRIVE BELT](#) and [2.13 REAR BRAKE MASTER CYLINDER](#).
16. See [Figure 3-18](#). Remove muffler:
 - a. Remove front muffler strap fastener (7). Front strap will not be removed.
 - b. Alternately loosen rear strap fasteners (12) and remove rear muffler straps.
 - c. Loosen Torca clamp and remove muffler.
 - d. Loosen front muffler mount.

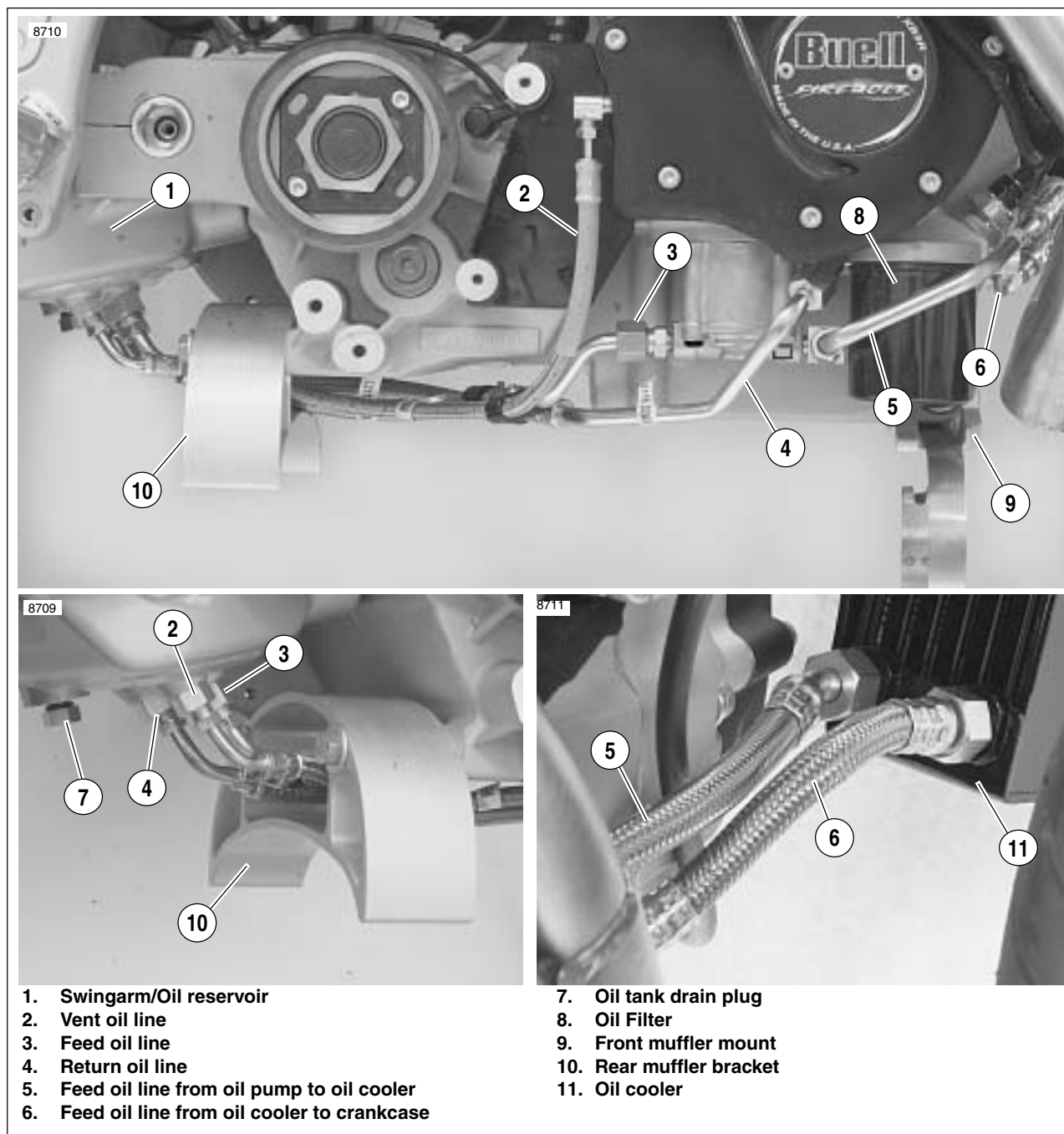


Figure 3-19. Oil Lines and Connections

17. See [Figure 3-19](#). Remove oil filter.

19. Remove front and rear muffler brackets.

18. Remove all oil lines (including lines to oil cooler).

20. Remove left and right side rider footrests and support plates. See [2.30 FOOTPEG, HEEL GUARD AND MOUNT](#).

NOTE

When removing the right side rider footrest and support plate, also remove rear brake pedal assembly and remote reservoir and secure towards rear of vehicle.

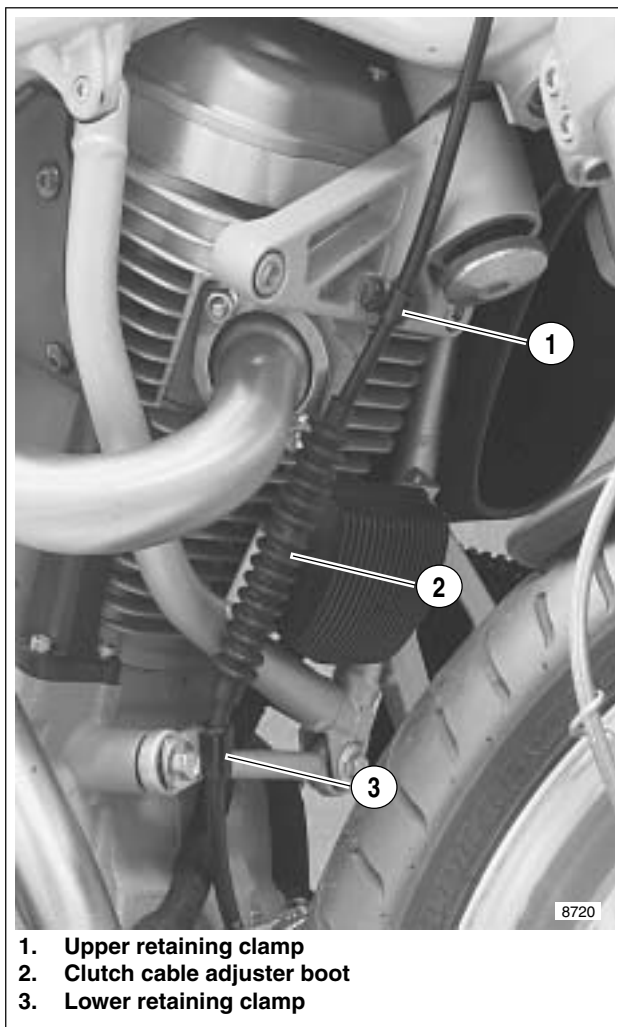


Figure 3-20. Clutch Cable Retaining Clamps and Adjuster Boot

21. See [Figure 3-20](#). Disconnect clutch cable.
- Remove upper retaining clamp (1) from front isolator.
 - Slide clutch cable adjuster boot (2) up to access clutch adjuster.
 - Loosen clutch adjuster to release tension from hand lever.
 - Remove clutch cable ferrule from hand lever.

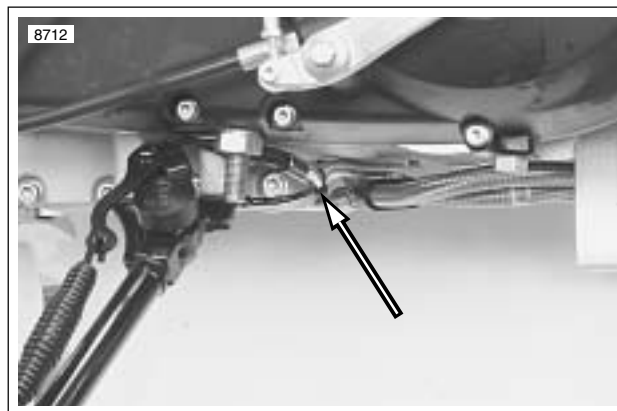


Figure 3-21. Sidestand Switch with Cable Strap

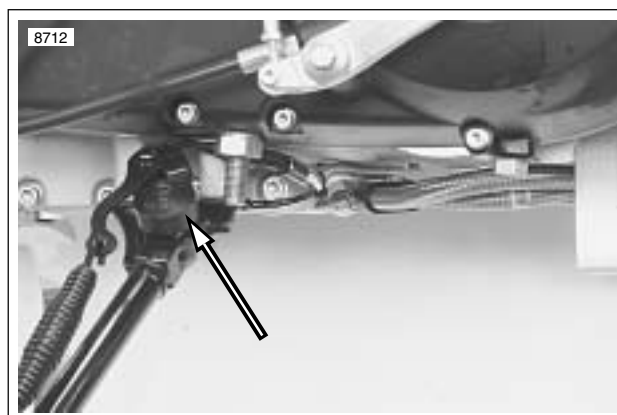
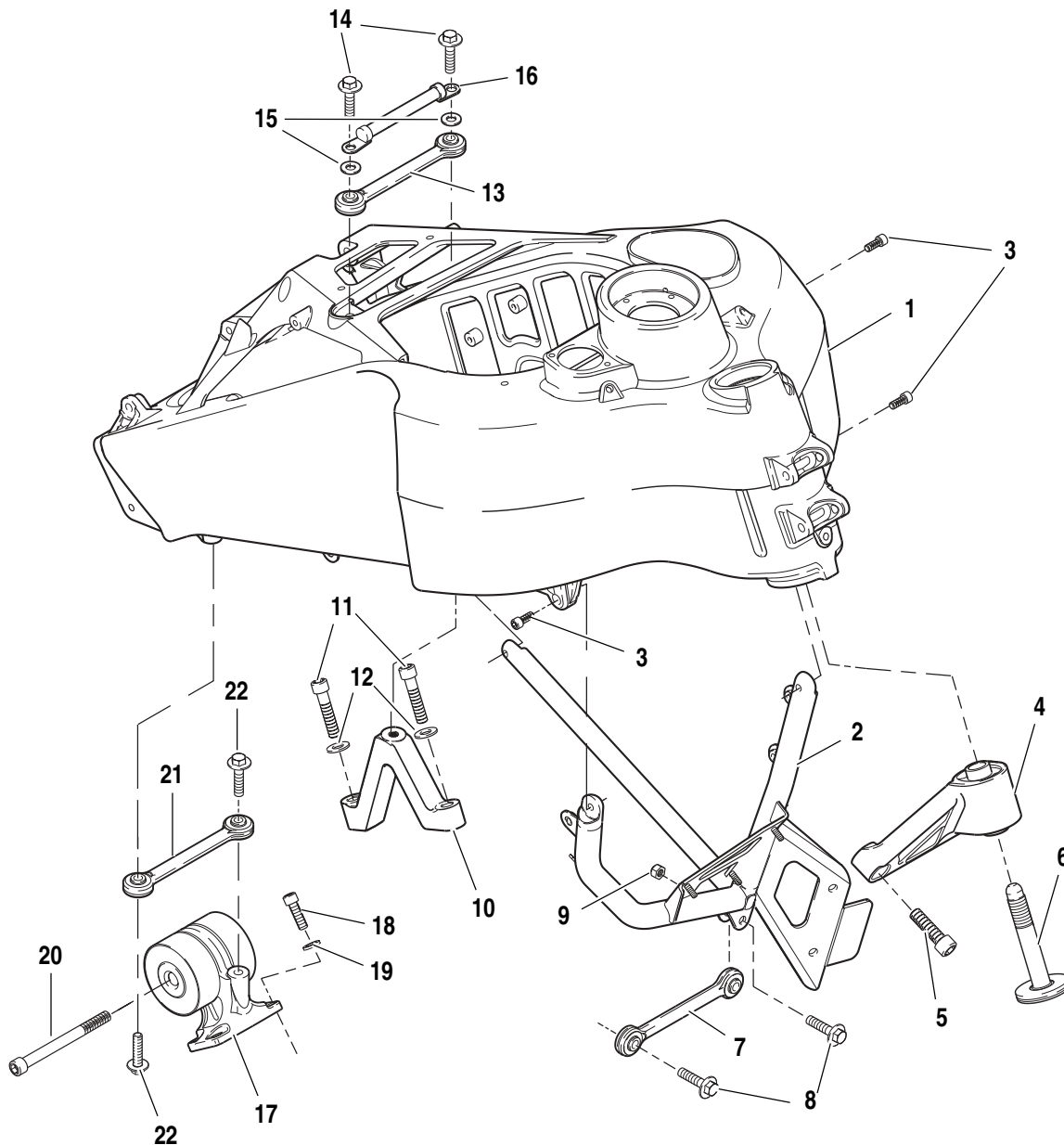


Figure 3-22. Sidestand Switch

- See [Figure 3-21](#). Cut cable strap securing sidestand switch harness.
- See [Figure 3-22](#). Remove sidestand switch, leaving wire attached. Pull switch assembly and wire harness through to right side of vehicle.
- Remove sidestand assembly.

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- | | |
|--|---|
| 1. Frame assembly | 12. Washers for center tie bar mount (2) |
| 2. "V" bracket | 13. Tie bar assembly, center |
| 3. Fasteners for "V" bracket (3) | 14. Fasteners for center tie bar assembly (2) |
| 4. Isolator assembly, front | 15. Washers for center tie bar assembly (2) |
| 5. Fasteners for front isolator (2) | 16. Cable, negative battery |
| 6. Bolt, front isolator | 17. Isolator assembly, rear |
| 7. Tie bar assembly, front | 18. Fasteners for rear isolator assembly (4) |
| 8. Fasteners for front tie bar assembly (2) | 19. Washers for rear isolator assembly (4) |
| 9. Nut for one fastener for front tie bar assembly | 20. Bolt, rear isolator |
| 10. Mount, center tie bar | 21. Tie bar assembly, rear |
| 11. Fasteners for center tie bar mount (2) | 22. Fasteners for rear tie bar assembly (2) |

Figure 3-23. Engine Mounting System

CAUTION

Anytime front tie-bar is removed, it must first be removed from the “V” bracket and then the engine. When reinstalling the tie bar, first mount to engine and then to “V” bracket in order to prevent damage to threaded area of crankcase.

25. Support engine with wide scissors jack.

26. See [Figure 3-23](#). Remove front “V” bracket with oil cooler from main frame.

- a. Remove cable strap securing the remote idle adjustment cable
 - b. Remove the three cable straps holding regulator wiring harness in order to extend the harness to remove “V” bracket.
 - c. See [Figure 3-24](#). Unplug regulator harness, (2 plugs).
- Alternator [46].
 - Voltage regulator [77].

d. Remove front tie-bar from “V” bracket.

e. Unbolt “V” bracket from main frame and remove from left side.

27. See [Figure 3-20](#). Remove front tie-bar from engine along with lower retaining clamp.

28. See [Figure 3-23](#). Remove center tie-bar from engine.

29. Remove rear tie bar from frame.

30. Loosen rear isolator bolt.

31. Remove front isolator bolt.

32. Remove front isolator mount from engine.

33. See [Figure 3-24](#). Disconnect electrical components:

- a. Neutral switch [131].
- b. Speedometer sensor [65] (remove cable strap).
- c. Cam position sensor [14].
- d. Positive battery cable at starter.
- e. Starter solenoid [128].
- f. Oil pressure switch [120].

34. Rotate engine down to remove exhaust header.

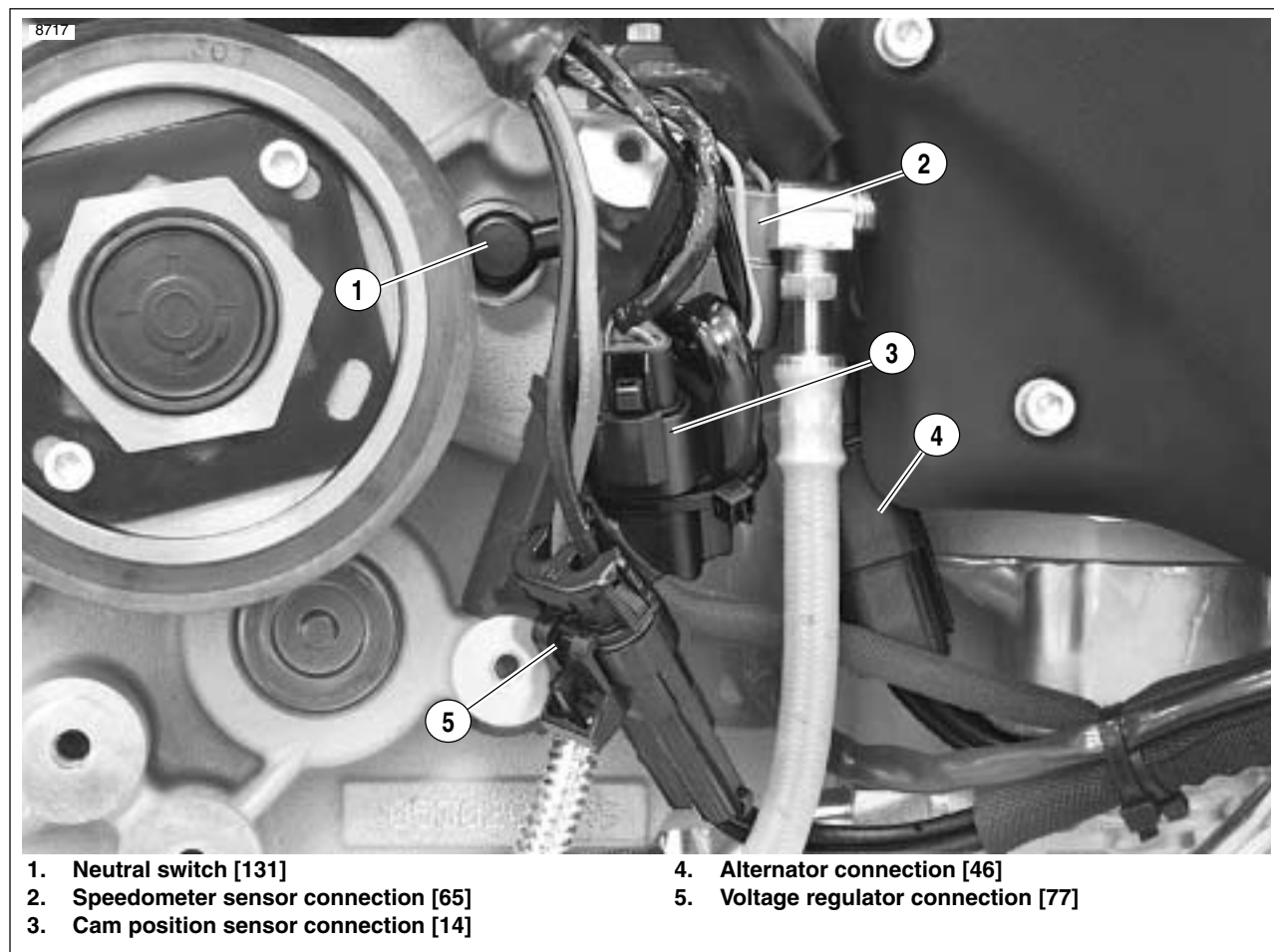


Figure 3-24. Electrical Connections

CAUTION

See [Figure 3-25](#). At this point it is necessary to support main frame with overhead hoist in order to remove rear isolator bolt. Failure to do this will result in main frame dropping slightly.



Figure 3-25. Supporting Vehicle for Disassembly (Typical)

35. See [Figure 3-26](#). After rotating engine back up into frame, continue to remove:

- a. Rear isolator bolt.
- b. Swingarm pivot shaft.

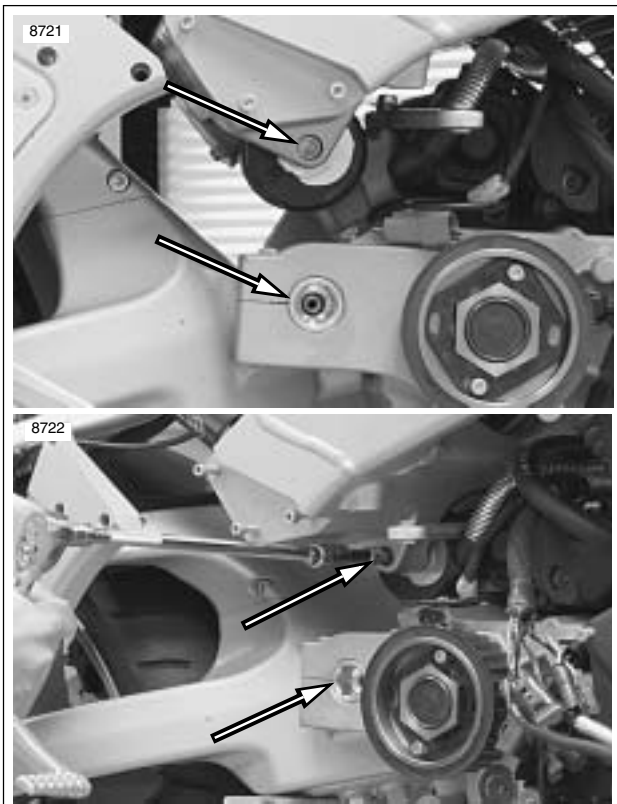


Figure 3-26. Rear Isolator Bolt and Swingarm Pivot Shaft



Figure 3-27. Supporting the Swingarm

36. See [Figure 3-27](#). Support swingarm/oil tank with wooden blocks, jack, etc.



Figure 3-28. Transmission Vent Line

37. See [Figure 3-28](#). Cut the cable strap holding transmission vent line and pull vent line out of frame leaving it attached to engine.

NOTE

The transmission vent line runs up the left side of the frame and exits underneath the left rear side of the intake cover assembly.

38. Lower engine with scissors lift all the way down.
39. Move the engine assembly from under the main frame to the right side of the lift.
40. Remove engine.

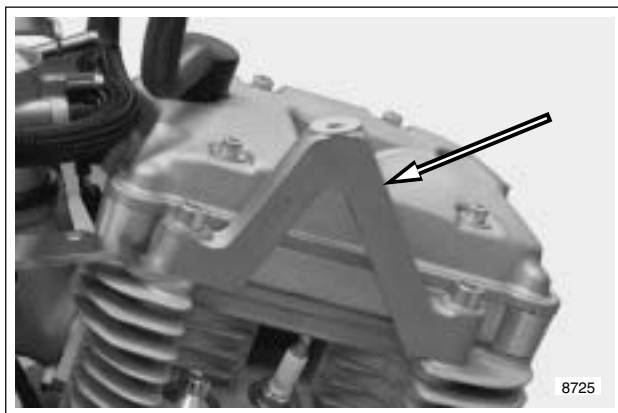


Figure 3-29. Center Tie Bar Mount

41. Once engine has been removed from vehicle finish removing the following items as required:
- Shifter assembly.
 - See [Figure 3-29](#). Center tie bar mount.
 - See [Figure 3-30](#). Swingarm pivot shaft pinch bolt threaded insert.
 - See [Figure 3-31](#). Aluminum bushings from front exhaust mount.
 - Timer cover.

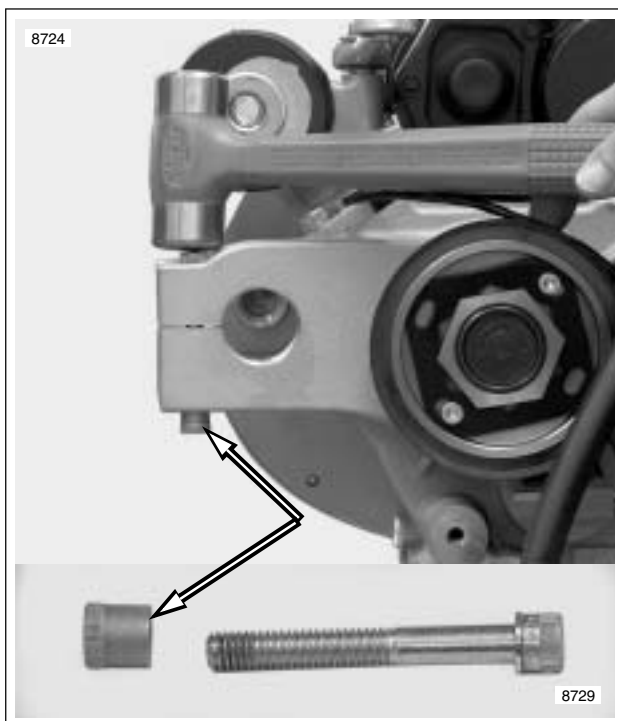


Figure 3-30. Removing Threaded Insert

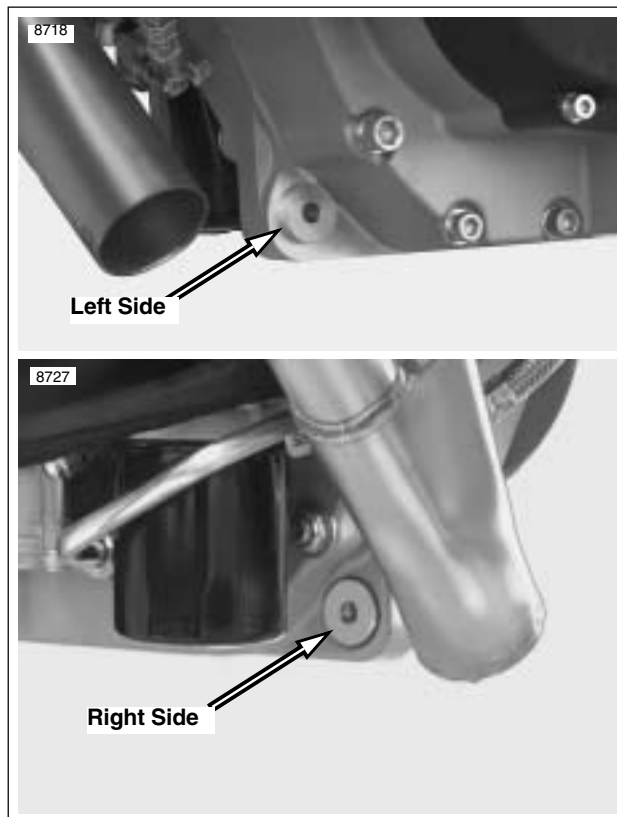


Figure 3-31. Front Exhaust Mount Bushings (2 piece)



Figure 3-32. Rear Isolator and Mounting Hardware

42. See [Figure 3-32](#). If the crankcases are being separated it will be necessary to remove rear isolator assembly by removing the forward two fasteners first and then the two rear fasteners (re-install with **new** fasteners).



Figure 3-33. Securing Vehicle for Relocation (Typical)

43. See [Figure 3-33](#). Place a block of wood between rear isolator mount on main frame and swingarm/oil tank.
44. Route a ratcheting tie down through the swingarm bearings, up over the main frame, through the top stabilizer area, back down to the ratchet mechanism and secure swingarm to main frame.

NOTE

See [Figure 3-34](#). This allows the vehicle to remain together as a rolling chassis and to be removed from the lift and stored if necessary.

45. Remove support from under swingarm/oil tank.
46. Remove overhead support.



Figure 3-34. Rolling Chassis (Typical)

ASSEMBLY

Engine Prep for Re-installation

NOTE

Install components that were removed from engine as were necessary for service prior to installing engine in frame.



Figure 3-35. Rear Isolator and Mounting Hardware

1. See [Figure 3-35](#). Install rear isolator assembly by installing the two rear fasteners first and then the two forward fasteners (re-install with new fasteners). Tighten to 25-27 ft-lbs (33.9-36.6 Nm).

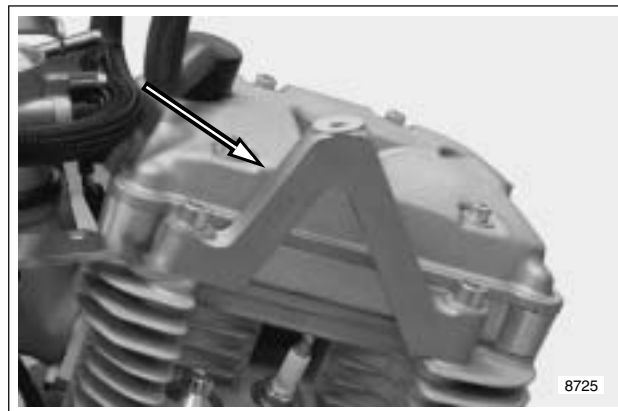


Figure 3-36. Center Tie Bar Mount

2. Install the following items on the engine assembly as required:
 - a. Shifter assembly.
 - b. See [Figure 3-36](#). Center tie bar mount 25-27 ft-lbs (33.9-36.6 Nm).
 - c. See [Figure 3-37](#). Swingarm pivot shaft pinch bolt threaded insert.
 - d. See [Figure 3-38](#). Aluminum bushings from front exhaust mount.

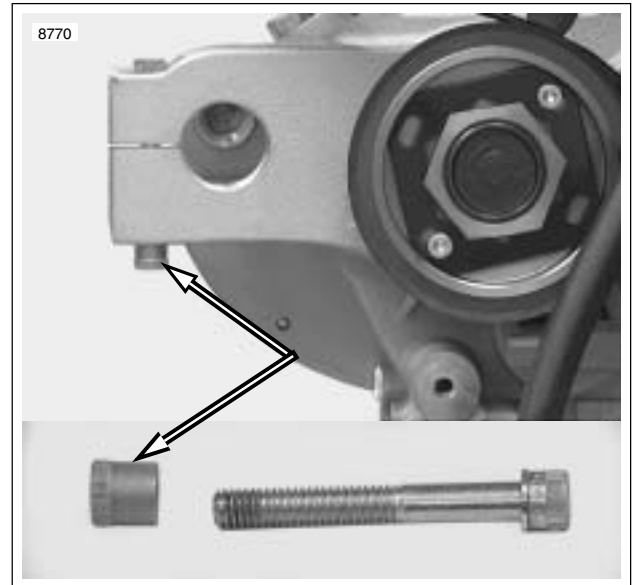
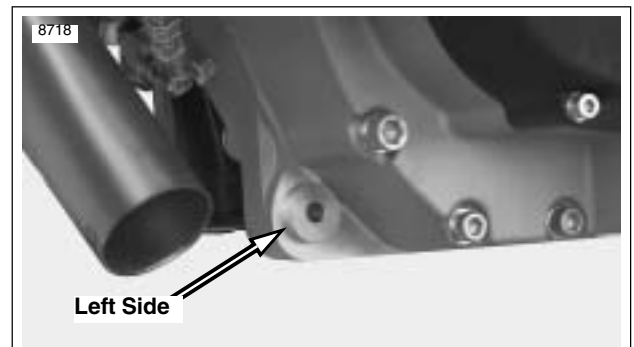
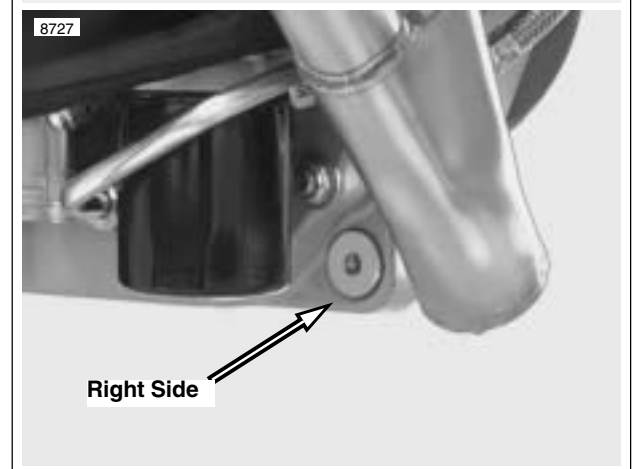


Figure 3-37. Installing Threaded Insert



Left Side



Right Side

Figure 3-38. Front Exhaust Mount Bushings (2 piece)

Installing Engine in Frame

NOTE

Vehicle should be placed onto the lift with rear tire in the wheel vise in order to successfully perform this procedure.



Figure 3-39. Supporting the Swingarm

1. See [Figure 3-39](#). Install bottle jack and wooden block under swingarm/oil tank to the rear of the oil line fittings.
2. Remove ratcheting tie down and block of wood between rear isolator mount on main frame and swingarm/oil reservoir.

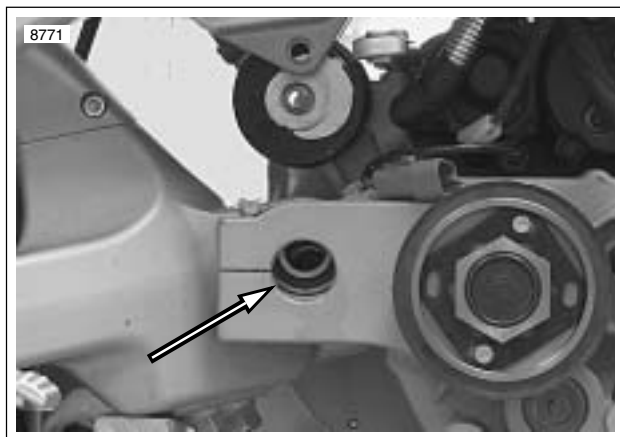


Figure 3-40. Aligning Swingarm to Crankcase for Pivot Shaft Installation

3. See [Figure 3-40](#). With engine on a flat scissors jack, raise engine and chassis until swingarm and rear isolator mount align and pivot shaft can be installed.
4. Torque swingarm pivot shaft to 24-26 ft-lbs (32.5-35.2 Nm).
5. Torque swingarm pivot shaft pinch bolt to 17-19 ft-lbs (23-25.8 Nm) using LOCTITE 272.
6. See [Figure 3-41](#). Route transmission vent line up through left side of frame exiting under the left rear side of the intake cover assembly. Install cable strap to secure transmission vent line in place. Inspect vent line to verify space between vent line and rear exhaust.



Figure 3-41. Transmission Vent Line

NOTE

See [Figure 3-42](#). At this point it is necessary to support main frame with overhead hoist in order to install rear isolator bolt.



Figure 3-42. Supporting Vehicle for Assembly (Typical)

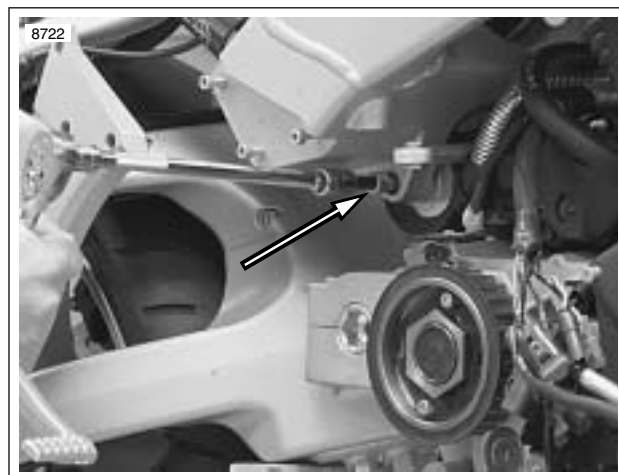
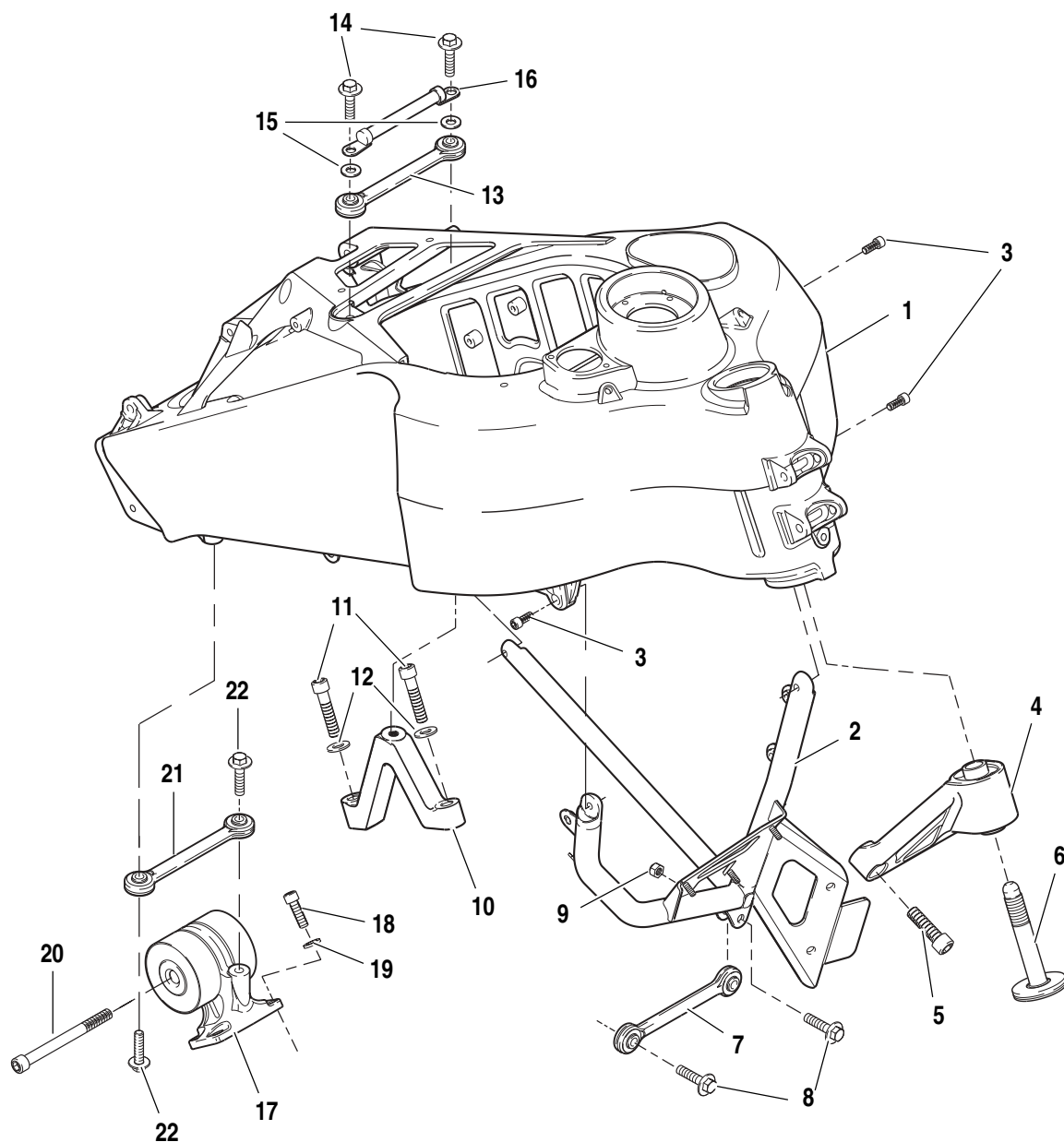


Figure 3-43. Installing Rear Isolator Bolt

7. See [Figure 3-43](#). Using the overhead hoist to align the frame to the rear isolator, install rear isolator bolt and leave loose at this time.

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- | | |
|--|---|
| 1. Frame assembly | 12. Washers for center tie bar mount (2) |
| 2. "V" bracket | 13. Tie bar assembly, center |
| 3. Fasteners for "V" bracket (3) | 14. Fasteners for center tie bar assembly (2) |
| 4. Isolator assembly, front | 15. Washers for center tie bar assembly (2) |
| 5. Fasteners for front isolator (2) | 16. Cable, negative battery |
| 6. Bolt, front isolator | 17. Isolator assembly, rear |
| 7. Tie bar assembly, front | 18. Fasteners for rear isolator assembly (4) |
| 8. Fasteners for front tie bar assembly (2) | 19. Washers for rear isolator assembly (4) |
| 9. Nut for one fastener for front tie bar assembly | 20. Bolt, rear isolator |
| 10. Mount, center tie bar | 21. Tie bar assembly, rear |
| 11. Fasteners for center tie bar mount (2) | 22. Fasteners for rear tie bar assembly (2) |

Figure 3-44. Engine Mounting System

8. Rotate engine down and install exhaust header only and tighten fasteners to 72-96 **in-lbs** (8.1-10.8 Nm).

NOTES

- Tighten header nuts gradually, alternating between studs to insure that exhaust rings are flush with engine.
 - Exhaust header must be torqued with the engine rotated in the down position. It is not possible to reach fasteners on the rear exhaust at the head with engine rotated in the up position.
9. When the exhaust header has been torqued, rotate engine back up into frame.

NOTE

When tightening front isolator bolt it is important to keep load off of isolator bolt for installation purposes. Alternate between tightening front isolator bolt and raising engine with scissors jack.

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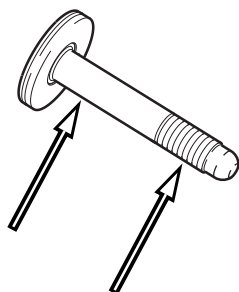
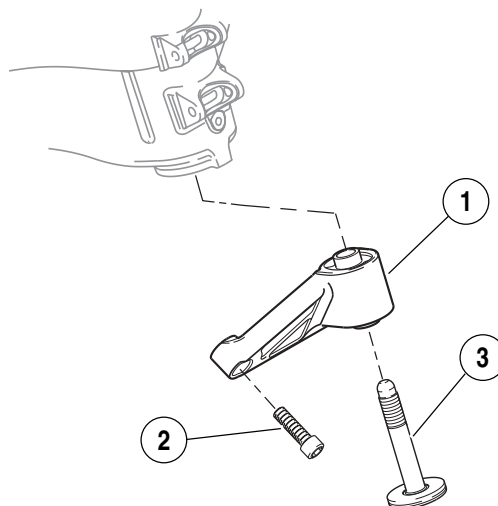


Figure 3-45. Lubrication Points on Front Isolator Bolt

NOTE

See [Figure 3-45](#). Always coat shaft and threads of front isolator bolt with anti-seize before installing.

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1. Front isolator
2. Front isolator fasteners (2)
3. Front isolator bolt

Figure 3-46. Front Isolator

10. See [Figure 3-46](#). Insert front isolator bolt (3) through front isolator (1) and loosely thread into frame. Do not tighten at this point.
11. See [Figure 3-46](#). Install isolator mounting fasteners (2) and tighten to 49-51 ft-lbs (66.4-69.1 Nm).
12. Tighten front isolator bolt to 49-51 ft-lbs (66.4-69.1 Nm).
13. See [Figure 3-44](#). Torque rear isolator bolt to 49-51 ft-lbs (66.4-69.1 Nm).
14. See [Figure 3-44](#). Install rear tie bar to frame and tighten to 25-27 ft-lbs (33.9-36.6 Nm).
15. See [Figure 3-44](#). Install center tie bar to engine and tighten to 25-27 ft-lbs (33.9-36.6 Nm).

CAUTION

When reinstalling the tie bar, first mount to engine and then to "V" bracket in order to prevent damage to threaded area of crankcase.

16. Install front tie-bar and clutch cable lower retaining clamp to engine and tighten to 25-27 ft-lbs (33.9-36.6 Nm).
17. See [Figure 3-44](#). Install front "V" bracket with oil cooler to main frame.
 - a. Install "V" bracket to main frame from the left side of the vehicle and tighten to 120-144 **in-lbs** (13.6-16.3 Nm).
 - b. Install front tie-bar to "V" bracket and tighten to 25-27 ft-lbs (33.9-36.6 Nm).
 - c. Attach regulator wiring harness to bracket nylon cable straps.
18. Remove scissors jack.

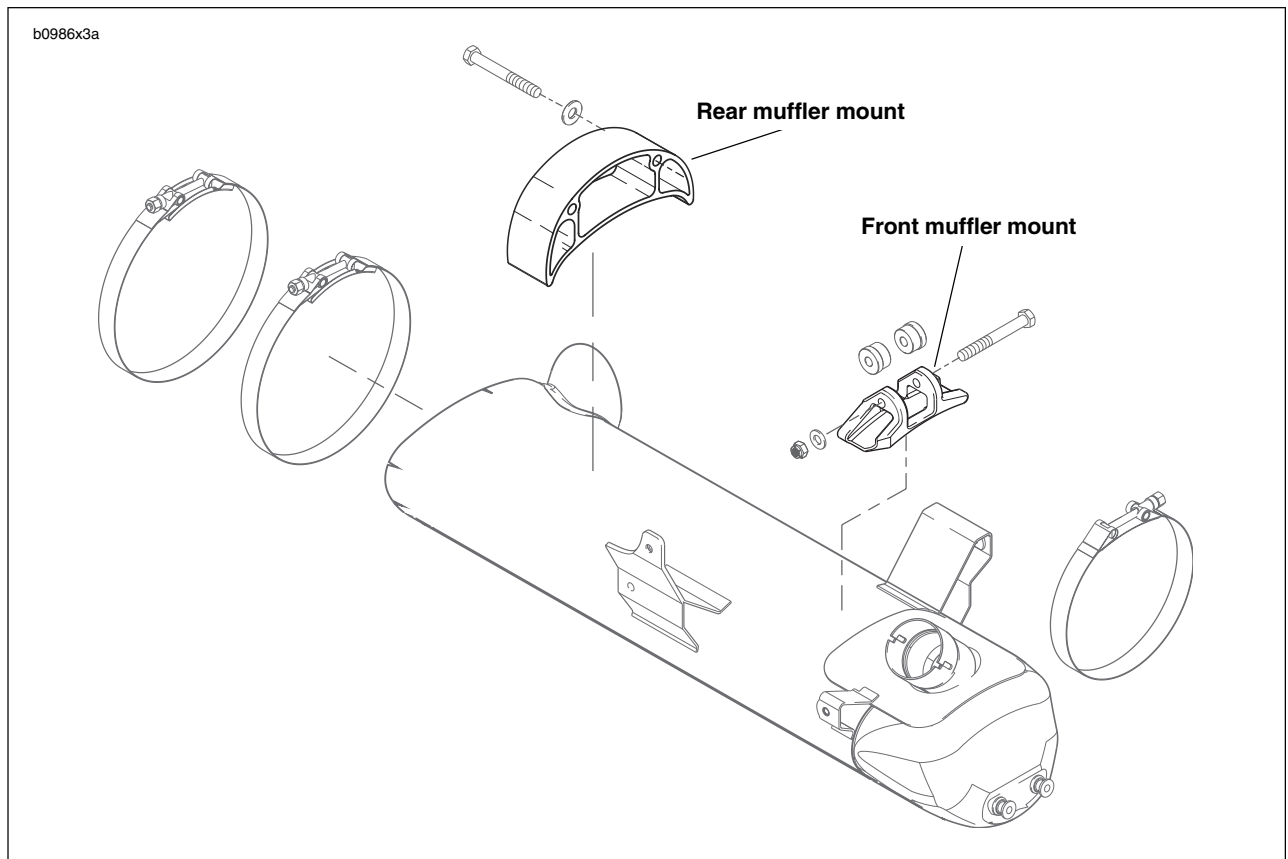


Figure 3-47. Muffler Mounting System

19. See [Figure 3-47](#). Install rear muffler bracket and torque to 32-36 ft-lbs (43.4-48.8 Nm).
20. Install front muffler mount and leave loose at this time.

NOTE

DO NOT install muffler at this time. It is necessary to install muffler mounts first in order to properly install oil lines.

CAUTION

At this point it will be necessary to install the oil lines. It is important to follow this procedure to ensure correct orientation of oil lines in order to establish the proper clearances needed between the oil lines and varied components on the vehicle.

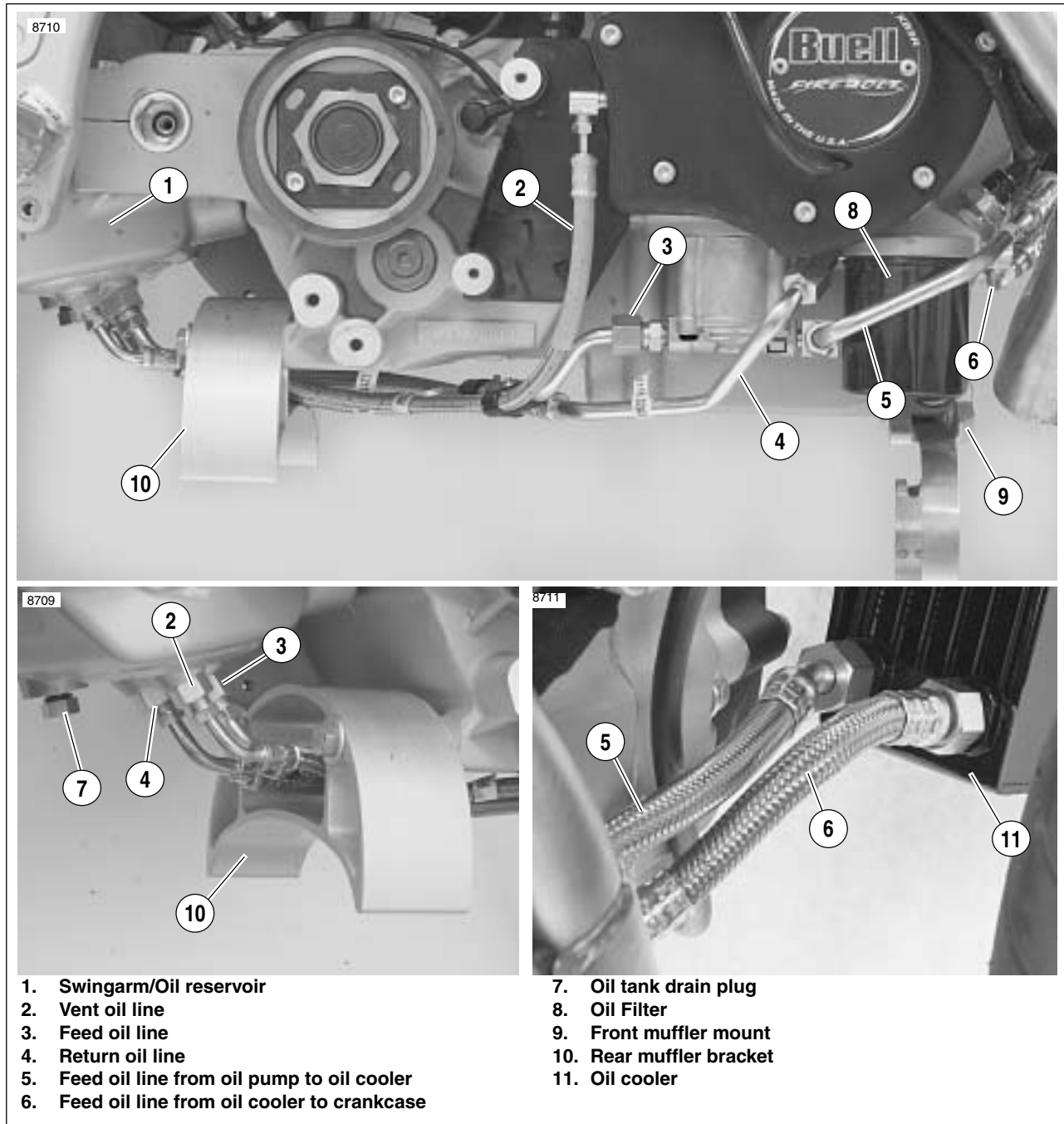


Figure 3-48. Oil Lines and Connections

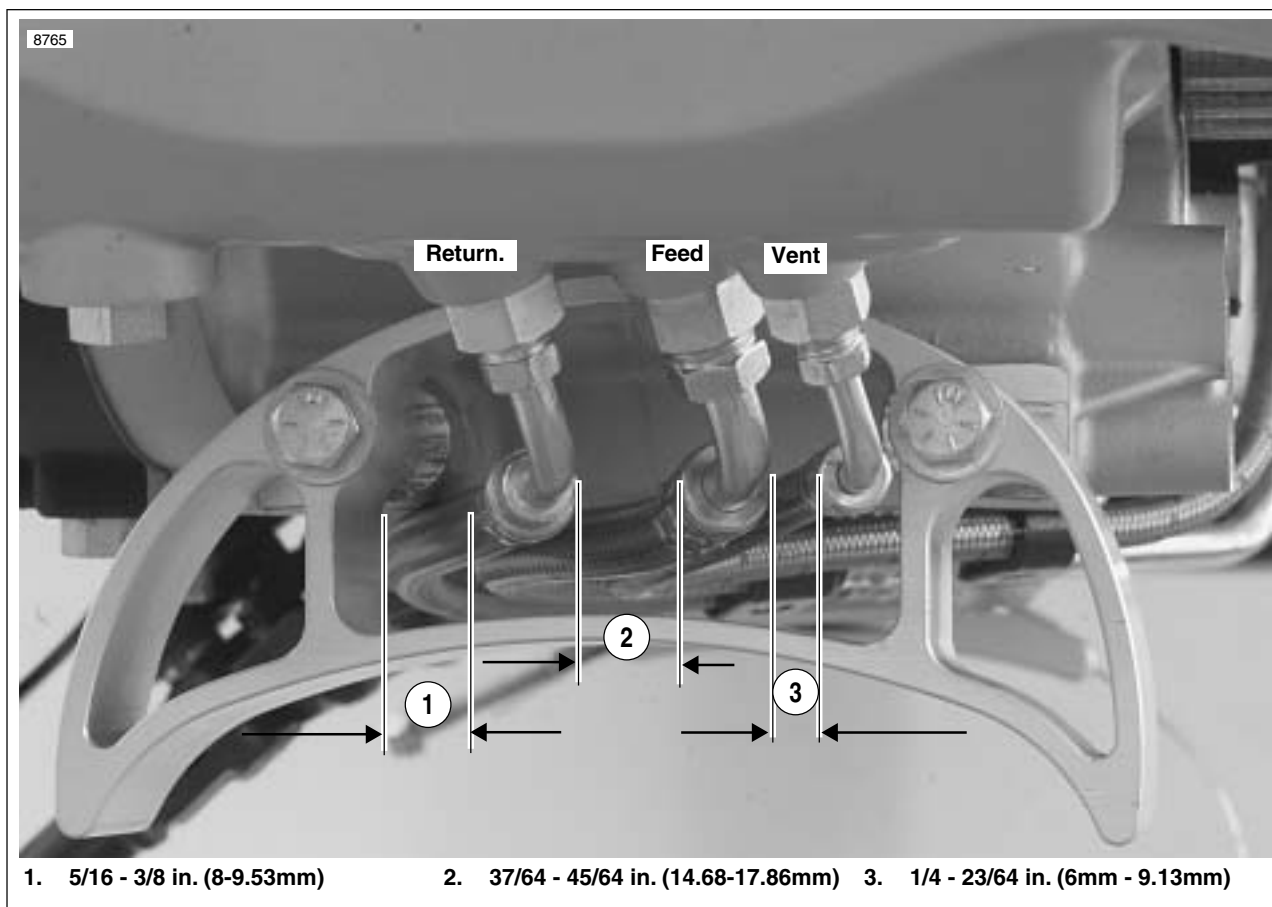


Figure 3-49. Oil Line Clearances and Torques

21. See [Figure 3-49](#). Install the return, feed and vent oil lines starting at the swingarm/oil reservoir and working towards the front of the vehicle. Leave all oil line fittings loose at this time.

NOTE

Once the three main oil lines are attached, it will be necessary to follow the proper torquing sequence. The three main oil lines must be torqued at the swingarm/oil reservoir first.

22. See [Figure 3-49](#). Torque the return oil line first making sure to maintain the proper clearance between the oil line and the rear muffler bracket. 19-21 ft-lbs (25.8-28.5 Nm.)

23. Torque the feed oil line next making sure the distance between the feed line and the return line is within specifications. 20-22 ft-lbs (27.1-29.8 Nm).
24. Torque the vent oil line next making sure the distance between the vent line and the feed line is within specifications. 14-16 ft-lbs (19-21.7 Nm).

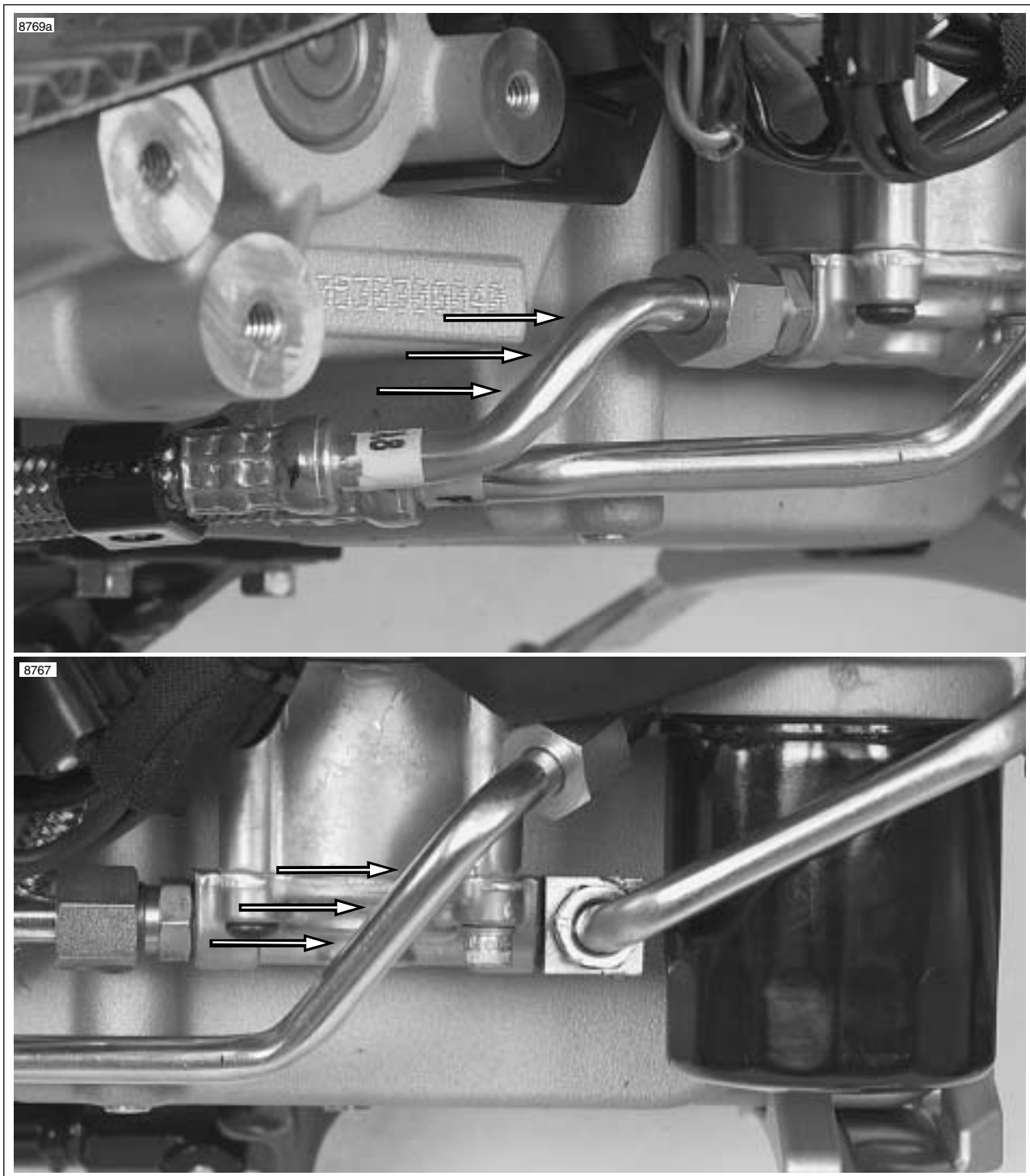


Figure 3-50. Approximate Seven O'Clock Orientation of Oil Feed Line and Oil Return Line at the Oil Pump

25. See [Figure 3-50](#). The feed oil line at the rear of the of the oil pump should be torqued to 18-20 ft-lbs (24.4-27.1 Nm). When the oil line has been properly torqued, the orientation of the line should be approximately 7 o'clock.
26. Also torque the return oil line at the top front oil pump fitting to 18-20 ft-lbs (24.4-27.1 Nm). When the oil line has been properly torqued, the orientation of the line should also be approximately 7 o'clock.

27. Torque the vent oil line at the gearcase cover to 120-132 **in-lbs** (13.6-14.9 Nm).

NOTE

When torquing the vent line, verify that the line does not twist down towards the muffler, but remains horizontal and aligned with the feed and return lines after torquing.

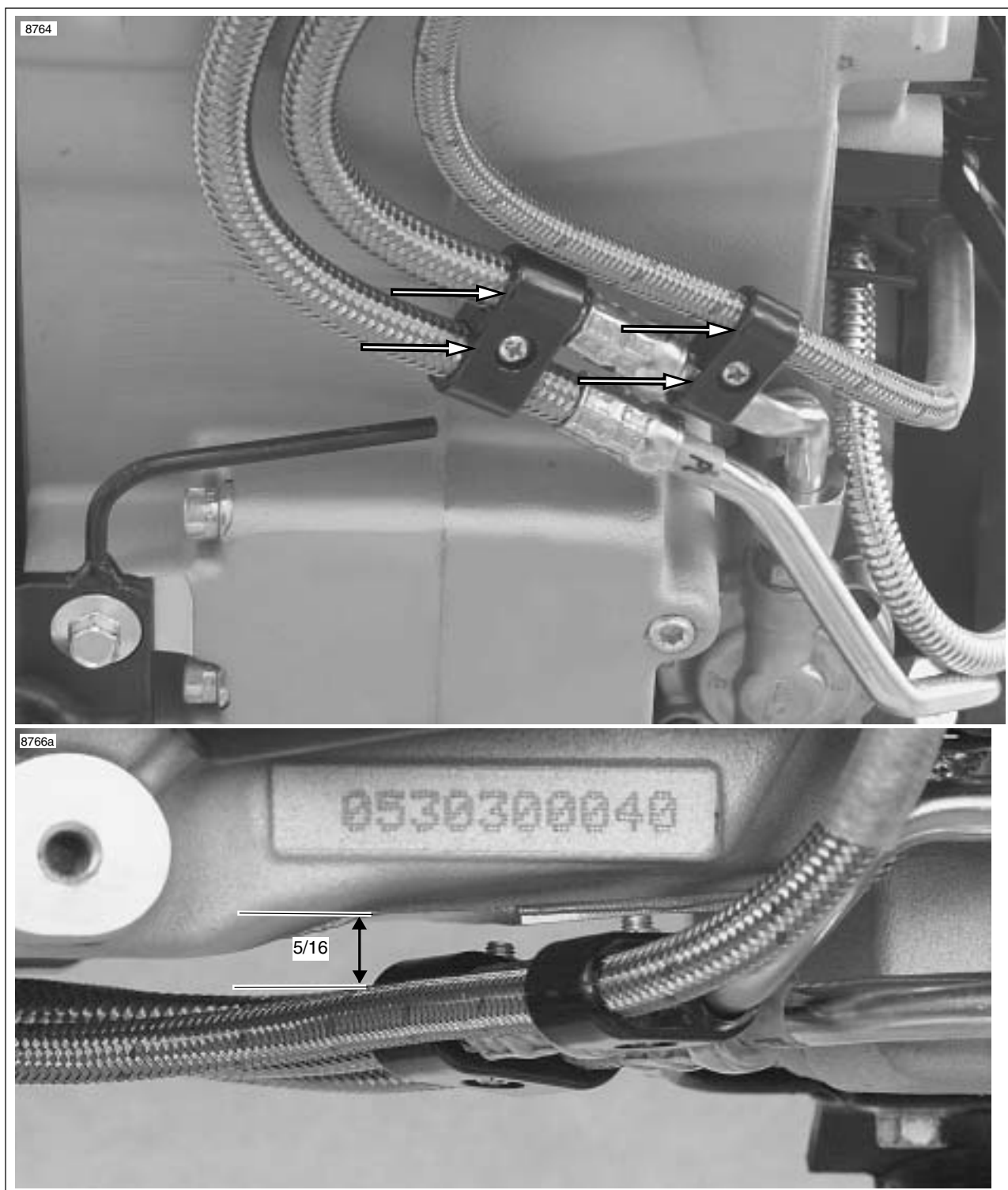


Figure 3-51. Clamp Orientation and Oil Line Spacing

CAUTION

The orientation of the oil lines is extremely important to the relation of the oil lines and certain components on the vehicle.

28. See [Figure 3-51](#). Verify that both black plastic oil line clamps are parallel to the crankcases and there is a clearance of 5/16 in. (7.9375 mm) between the bottom of the crankcases and the oil lines.

NOTE

The 5/16 in. clearance is between the crankcase and the steel oil line as shown. Not between the crankcase and the clamp.

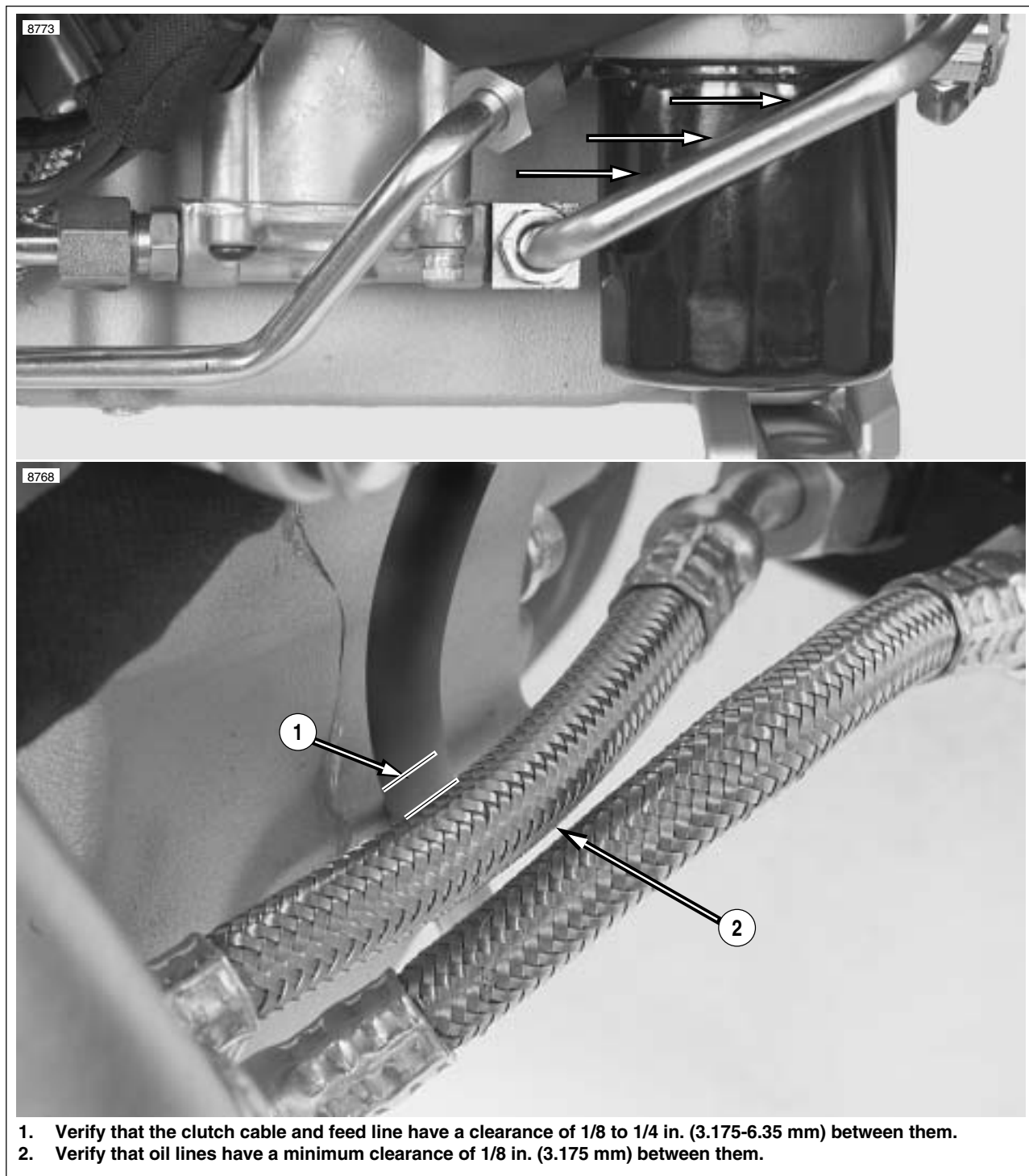


Figure 3-52. Oil Cooler Feed Oil Line Orientation (Approximately 2 O'Clock) and Oil Line Clearances

29. Loosely install the feed oil line that runs from the lower front oil pump fitting to the rear fitting on the oil cooler.

NOTE

Depending on the type of crowfoot being used to torque the oil lines it may be necessary to remove the oil filter in order to properly torque certain oil line fittings.

CAUTION

See [Figure 3-52](#). It is important to maintain an orientation of approximately 2 o'clock with the rigid part of the feed oil line running to the oil cooler. Also be aware of the 1/8-1/4 (3.175-6.35 mm) clearance specified between the feed oil line and the clutch cable at the front of the crankcase.

NOTE

When torquing the oil cooler feed and return lines to the oil cooler, verify that the lines do not twist while torquing.

30. See [Figure 3-54](#). When torquing the feed oil line from the pump to the oil cooler it is necessary to torque the fitting at the oil pump first, 18-20 ft-lbs (24.4-27.1 Nm), making sure to center the oil line between the oil sending switch and the return oil line fitting on the crankcase.

31. See [Figure 3-53](#). Torque the feed oil line at the oil cooler to 15-17 ft-lbs (20.3-23 Nm).

NOTE

When installing the oil cooler return oil line it is necessary to install the end at the crankcase first.

32. Install the oil cooler return oil line that runs from the crankcase fitting, which is located above and forward of the oil filter, to the front fitting on the oil cooler.

33. Torque the oil cooler return line fitting at the crankcase first to 15-17 ft-lbs (20.3-23 Nm).

NOTE

See [Figure 3-54](#). The orientation of the oil cooler return oil line where it enters the crankcase should be at approximately 4 o'clock to allow for proper alignment and clearance of other components on the vehicle.

34. See [Figure 3-53](#). Finally torque the oil cooler return line fitting on the front of the oil cooler to 15-17 ft-lbs (20.3-23 Nm).

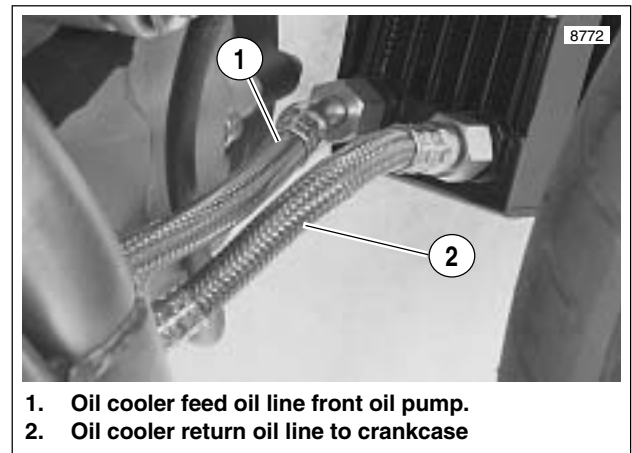


Figure 3-53. Oil Cooler Oil Lines

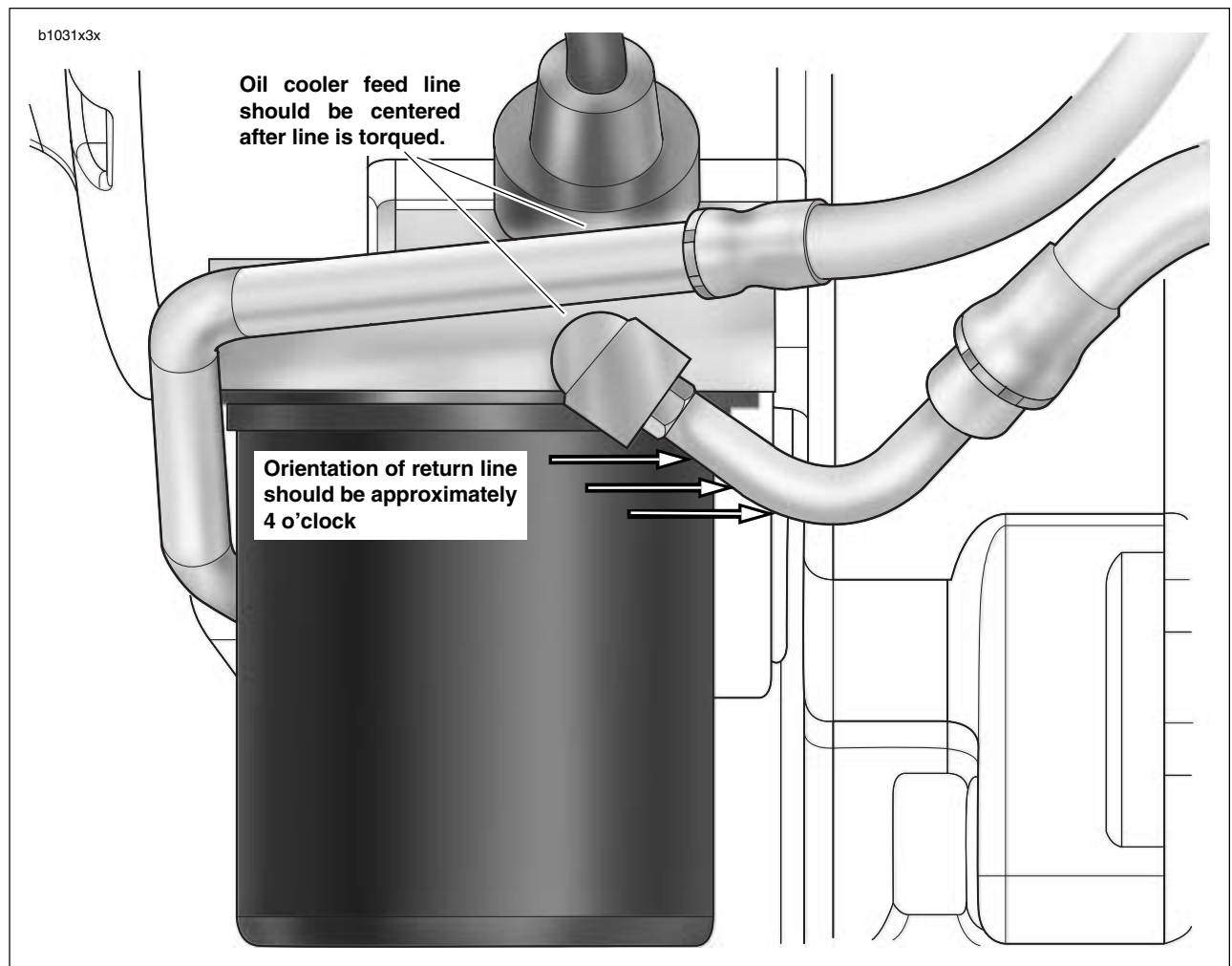


Figure 3-54. Oil Cooler Feed and Return Oil Lines Location and Orientation

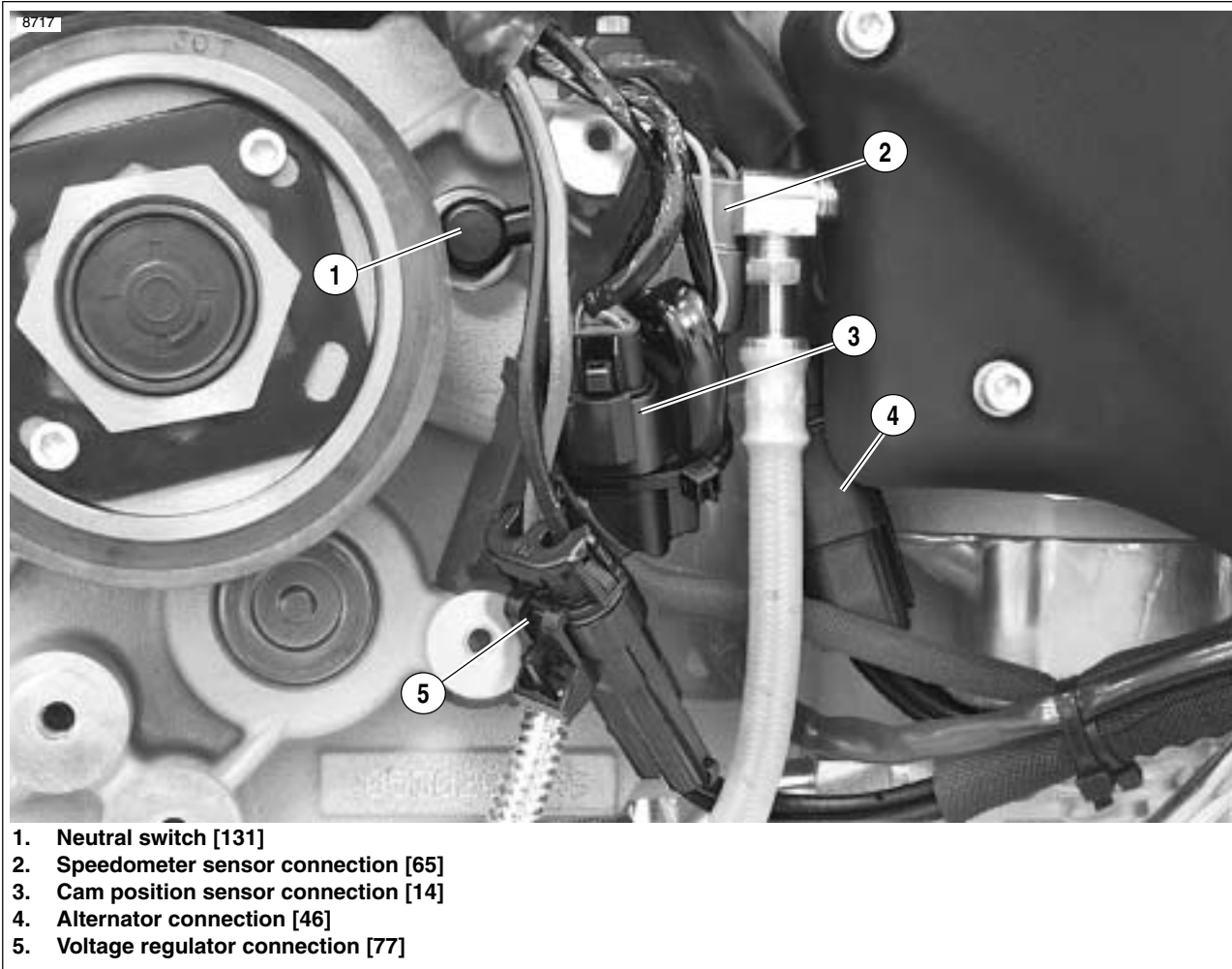


Figure 3-55. Electrical Connections

35. See [Figure 3-55](#). Connect the following electrical components:

- a. Neutral switch [131].
- b. Speedometer sensor [65] (install cable strap).
- c. Cam position sensor [14].
- d. Alternator [46].
- e. Voltage regulator [77].
- f. Positive battery cable at starter.
- g. Starter solenoid [128].
- h. Oil pressure switch [120].

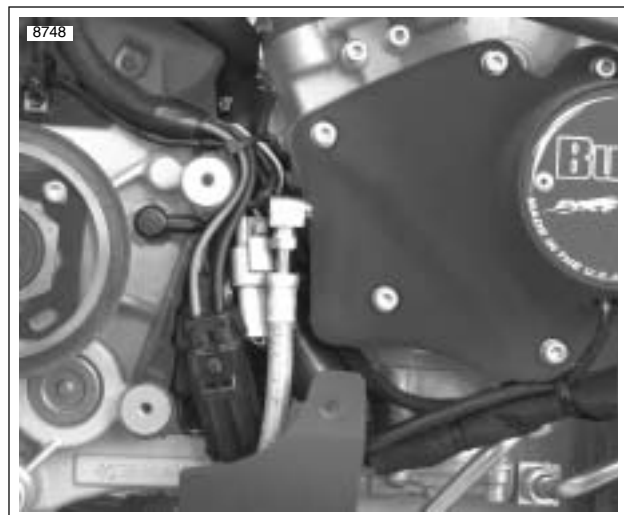


Figure 3-56. Correct Routing of Wiring Harnesses

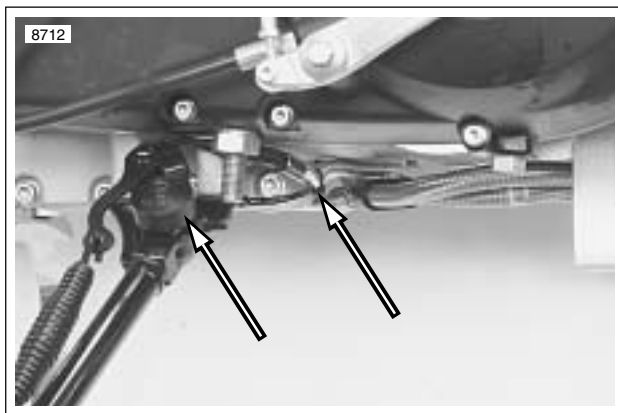


Figure 3-57. Sidestand Assembly and Switch with Cable Strap

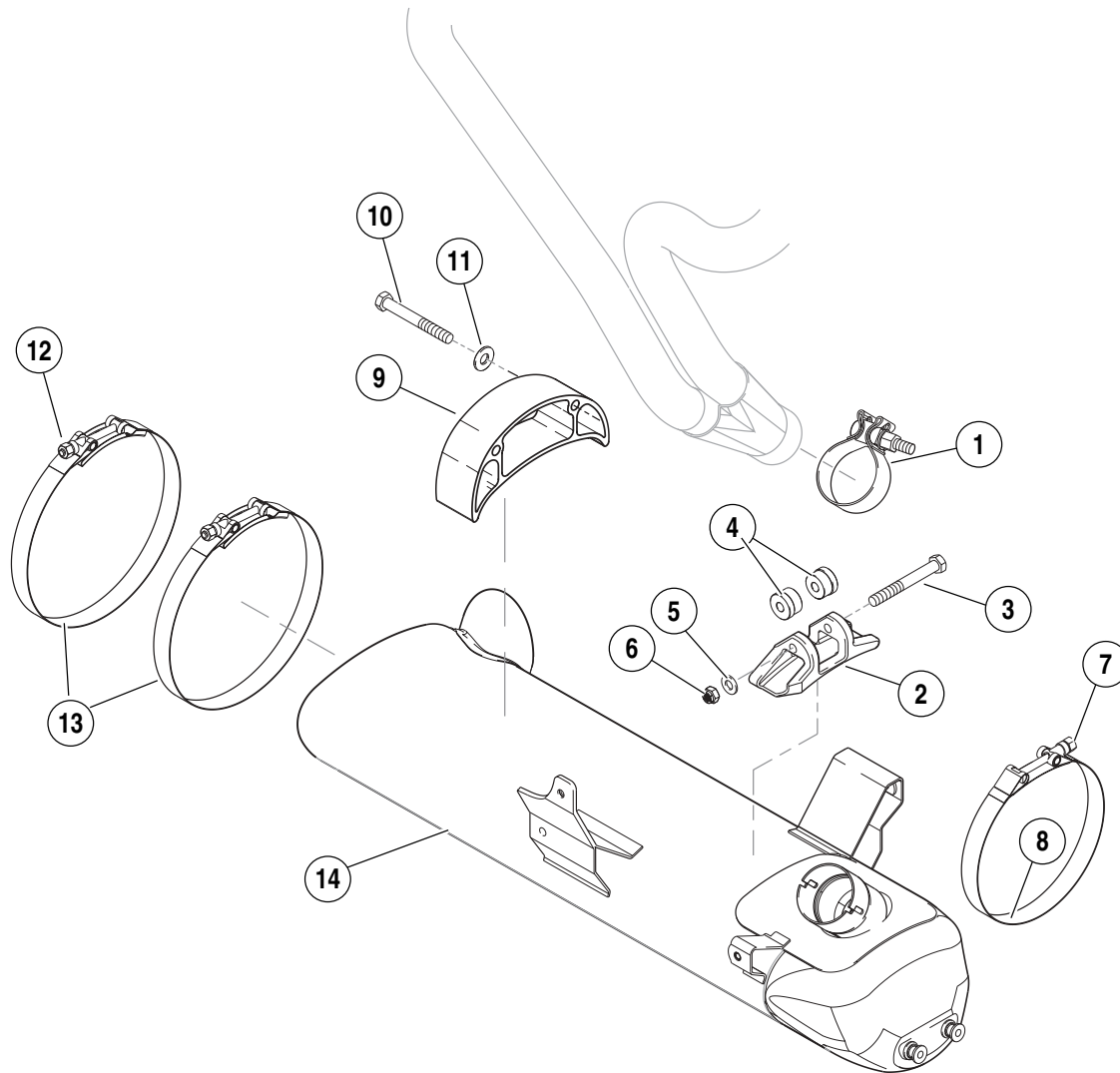
36. See [Figure 3-57](#). Install sidestand assembly. See [2.43 SIDESTAND ASSEMBLY](#).
37. Pull wire harness and sidestand switch through from right side of vehicle.
38. Install sidestand switch to sidestand assembly and install cable strap.



Figure 3-58. Clutch Cable Upper Retaining Clamp

39. See [Figure 3-58](#). Pull clutch cable back up into the proper position.
 - a. Connect clutch cable to handlebars and adjust to specifications. See [3.1 SPECIFICATIONS](#).
 - b. Install upper retaining clamp.

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- | | |
|---|---|
| 1. Clamp, Torca | 8. Muffler strap, front |
| 2. Muffler mount, front | 9. Muffler bracket, rear |
| 3. Screw, front muffler mount (1) | 10. Screw, rear muffler bracket (2) |
| 4. Bushings, front muffler mount (2) | 11. Flat washer, rear muffler bracket (2) |
| 5. Flat washer, front muffler mount (1) | 12. Rear muffler strap fastener |
| 6. Nut, front muffler mount (1) | 13. Muffler strap, rear (2) |
| 7. Front muffler strap fastener | 14. Muffler |

Figure 3-59. Muffler and Mounting System

CAUTION

It is important that the front muffler mount is tightened last in order to ensure proper alignment of the exhaust system.

CAUTION

When rear muffler straps have been installed, it is important that strap fasteners do not contact idler pulley bracket.

40. See [Figure 3-59](#). Install muffler with Torca clamp but do not tighten:
- Install rear muffler straps (13) and alternately tighten rear strap fasteners (12) until properly torqued to 48-60 **in-lbs** (5.4-6.8 Nm).
 - Install front muffler strap fastener (7) and torque to 108-120 **in-lbs** (12.2-13.6 Nm).
 - Tighten Torca clamp (1) to 40-45 **ft-lbs** (54.2-61 Nm).
 - Tighten front muffler mount (2) to 22-25 **ft-lbs** (29.8-33.9 Nm).

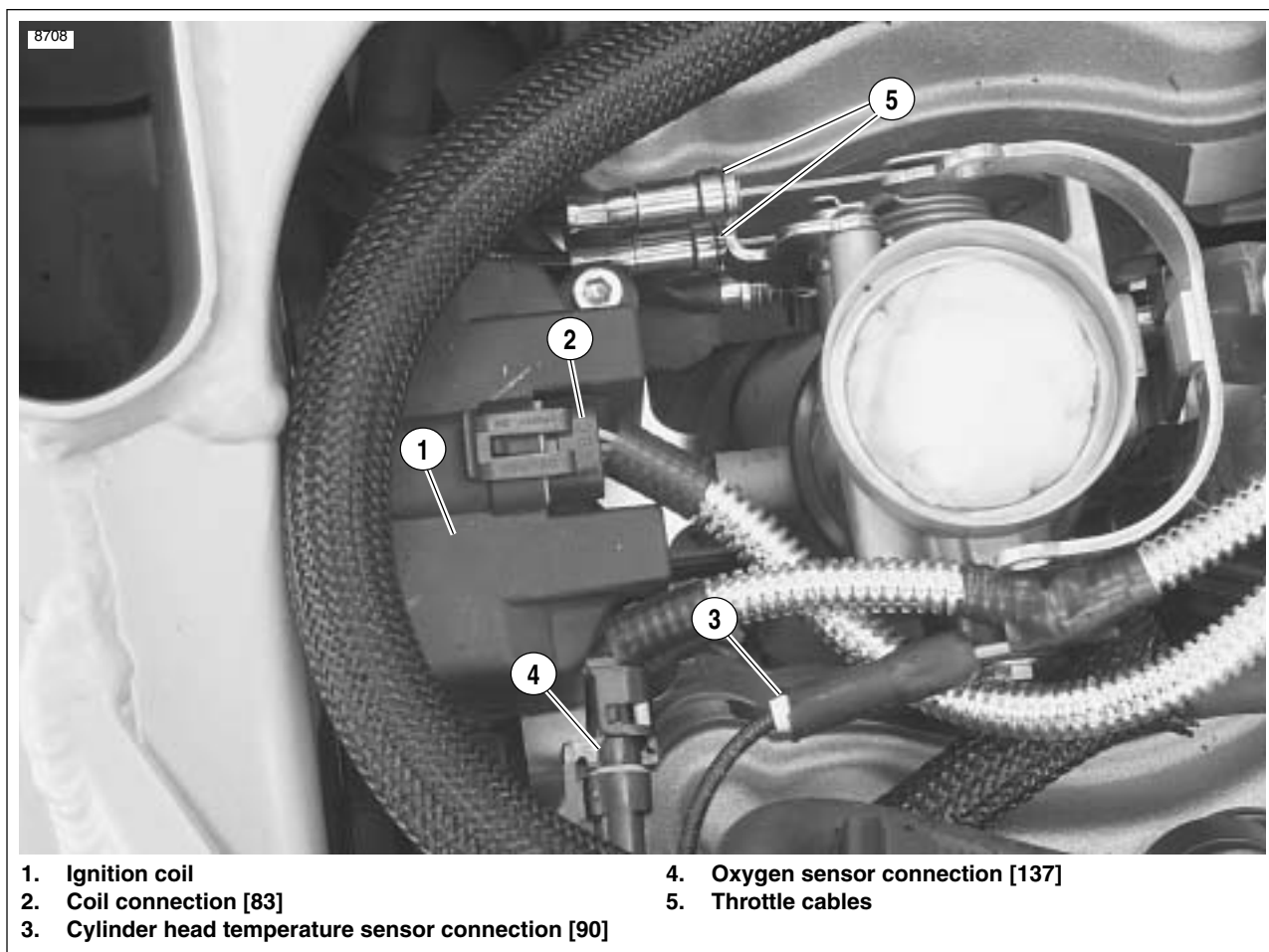
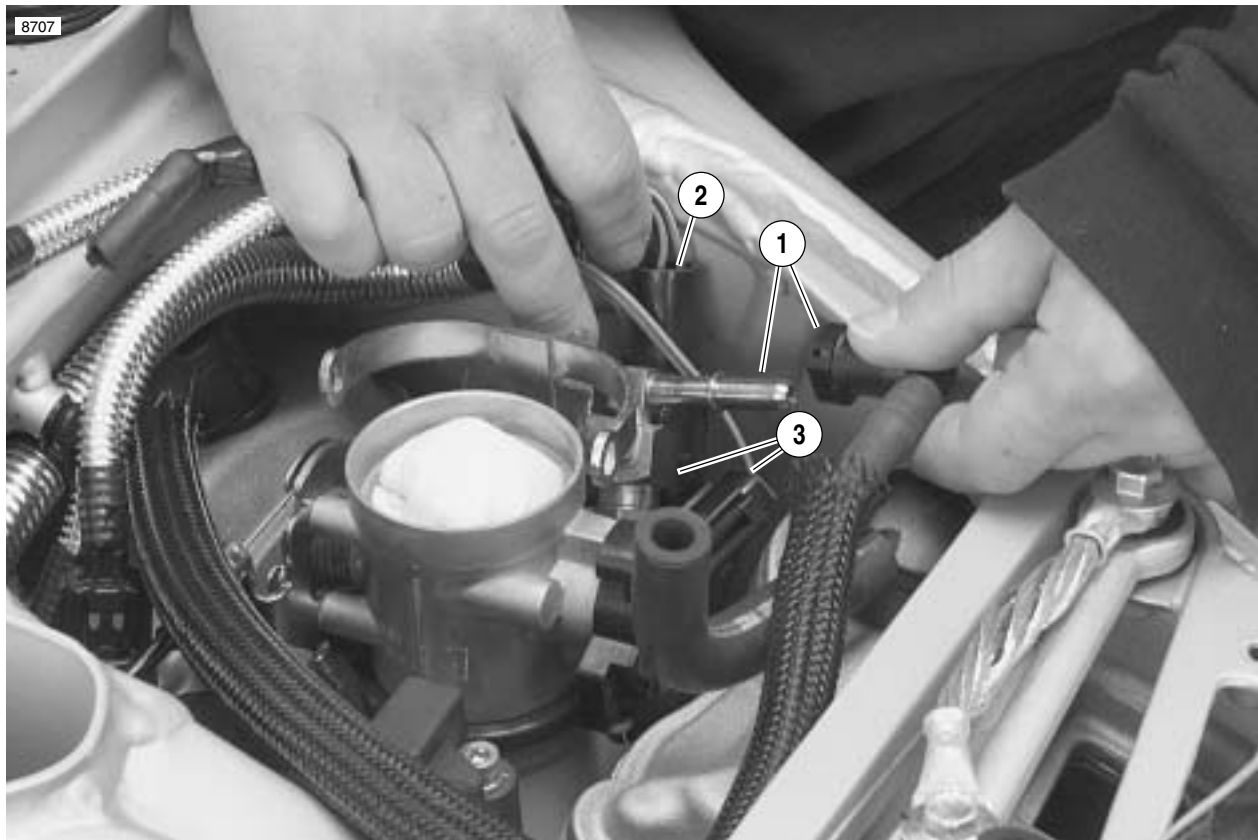


Figure 3-60. Electrical Connections and Throttle Cables

41. See [Figure 3-60](#). Connect throttle cables to induction module/throttle body.
42. Connect the following sensors:
 - a. Temperature sensor [90].
 - b. Oxygen sensor [137] (Install wire tire on harness).
43. See [Figure 3-60](#). Install the ignition coil and spark plug wires and connect [83]. Tighten ignition coil fasteners to 120-144 **in-lbs** (13.6-16.3 Nm).



1. Fuel line connection
2. Connection for throttle position sensor [88]
3. Connections for fuel injectors [84 & 85]

Figure 3-61. Fuel Line and DDFI Electrical Connections

CAUTION

Remove shop towel from entrance of throttle body to ensure proper operation of induction module.

44. See [Figure 3-61](#). Connect throttle position sensor [88].
45. Connect fuel injector leads [84 & 85].
46. Connect fuel line.
47. Install throttle body velocity stack and tighten to 12-36 **in-lbs** (1.356-4.064 Nm).
48. Install air box cover and assembly. Tighten fasteners to 84-120 **in-lbs** (9.49-13.56 Nm).
49. Fill oil tank.
50. Connect fuel pump.
51. Install rear belt and idler pulley. See [1.10 DRIVE BELT](#) and [2.13 REAR BRAKE MASTER CYLINDER](#).
52. Install left and right side rider footrests and support plates and torque to 108-132 **in-lbs** (12.20-14.91 Nm).

NOTE

When re-installing the right side rider footrest and support plate, also install rear brake pedal assembly and remote reservoir.

53. Install sprocket cover and tighten fasteners and washers to 12-36 **in-lbs** (1-4 Nm).

54. Install chin fairing. See [2.34 CHIN FAIRING](#).

55. Install air scoops, right and left sides. See [2.36 AIR SCOOPS](#).

NOTE

The connection for fuel pump is just above the pump located at the rear of the fuel tank on the left side of the vehicle.

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.

56. Connect negative ground cable to battery and install seat (tighten).

WARNING

Pull up on seat to verify that it is properly secured, front and rear. A loose seat may shift during vehicle operation and startle the rider, possibly causing loss of vehicle control resulting in death or serious injury.

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.

REMOVAL

Before removing the cylinder head assembly, it is necessary to rotate engine down as described in [3.3 ENGINE ROTATION FOR SERVICE](#). The rocker arm covers and internal components must be removed before removing cylinder heads.

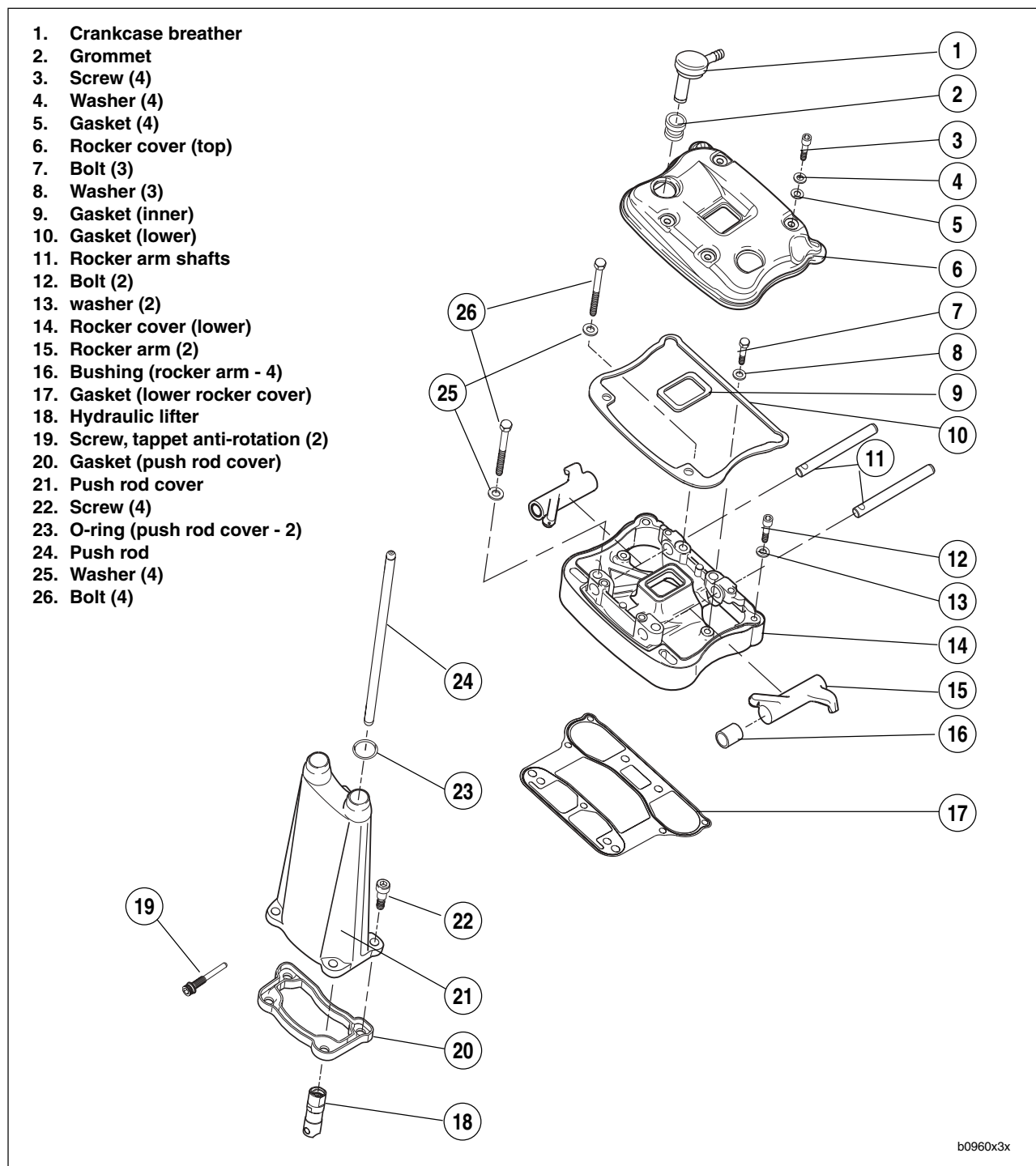


Figure 3-62. Rocker Arm and Push Rod Cover Assemblies

Rocker Box Assemblies

1. Remove spark plugs.
2. See [Figure 3-62](#). Remove screws with washers and fiber cover seals. Discard fiber seals.
3. Remove top rocker covers.
4. Remove and discard gaskets.
5. Rotate crankshaft until both valves are closed on head being removed.
6. See [Figure 3-63](#). 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 3-62](#). 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 3-64](#). 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.

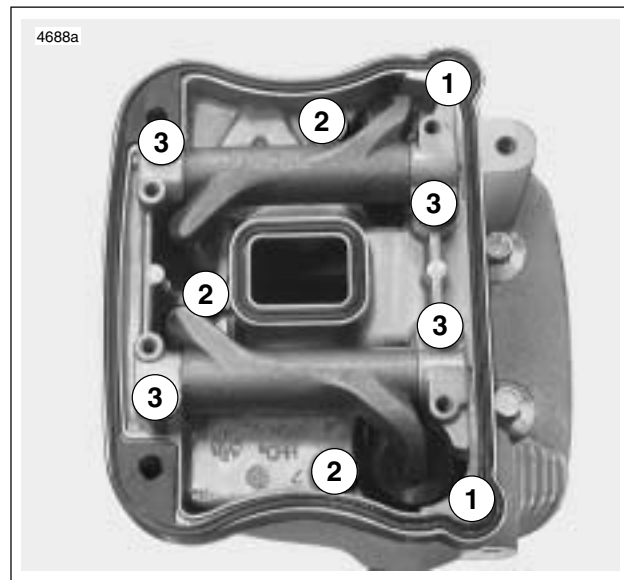


Figure 3-63. Lower Rocker Box Fasteners



Figure 3-64. Removing Rocker Arm Shafts

Cylinder Head Assemblies

CAUTION

See [Figure 3-65](#). 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 3-65](#). 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 3-62](#). Remove push rod cover, gasket and valve tappets.

DISASSEMBLY

1. See [Figure 3-66](#). Clamp VALVE SPRING COMPRESSOR TOOL (Part No. HD-34736B) in vise.
2. See [Figure 3-66](#). Compress valve spring with VALVE SPRING COMPRESSOR.
3. See [Figure 3-67](#). Remove valve keepers, upper collar and valve spring. 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 head. Remove valve, valve stem seal and lower collar assembly by hand. No special tools are required to remove valve stem seal and lower collar assembly.
6. Repeat the above procedure for the other valves.

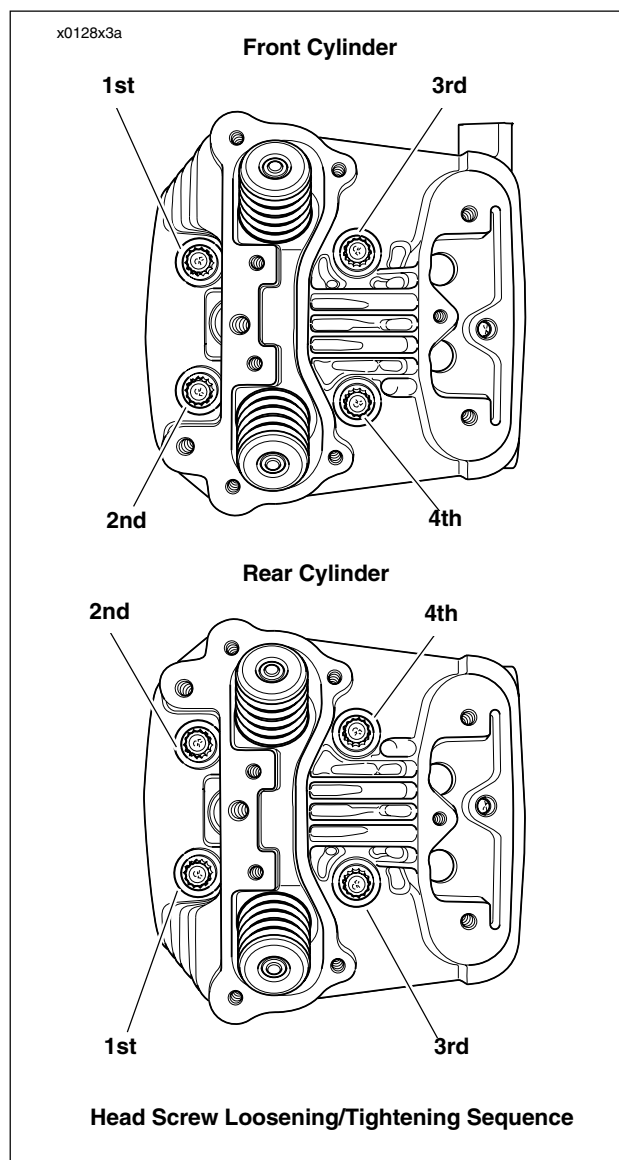
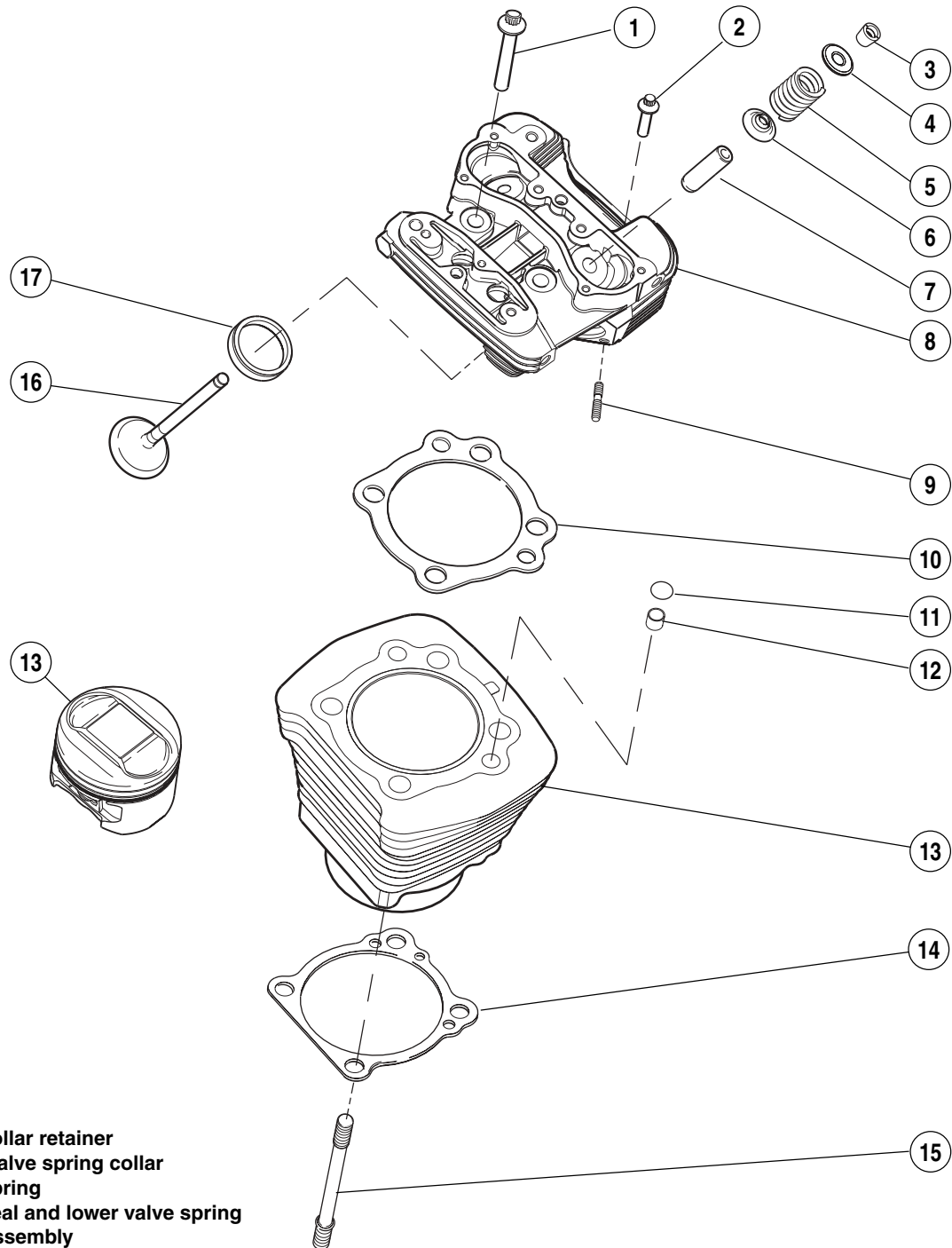


Figure 3-65. Head Screw Loosening/Tightening Sequence



Figure 3-66. Valve Spring Compressor
(Part No. HD-34736B)

b1024x3x



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

Figure 3-67. Cylinder Head, Cylinder and Piston Assembly

CLEANING AND INSPECTION

Cylinder Heads

WARNING

Low pressure compressed air can blow debris into your face and eyes. Always wear eye protection or a face shield when using pressurized air. Failure to take adequate safety precautions could result in death or serious injury.

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.

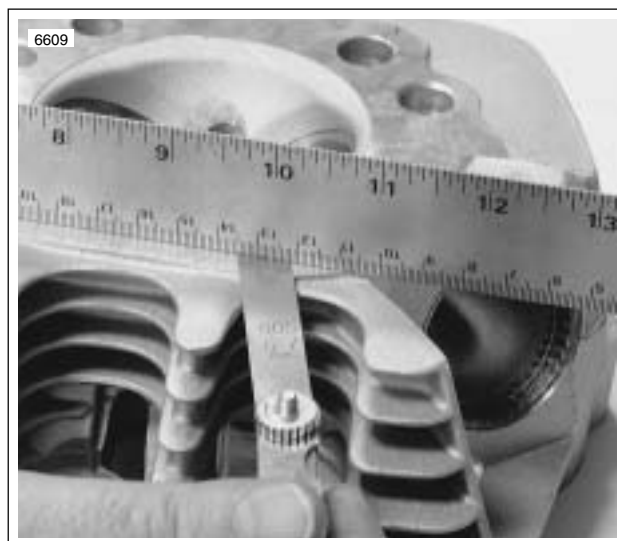


Figure 3-68. Checking Gasket Surface

4. See [Figure 3-68](#). 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 3-69. Measuring Rocker Arm Shaft Diameter (Rocker Cover Position)



Figure 3-70. Measuring Rocker Arm Shaft Diameter (Rocker Arm Bushing Position)

2. Measure and record rocker arm shaft diameter.
 - a. See [Figure 3-69](#). Measure where shaft fits in lower rocker arm cover.
 - b. See [Figure 3-70](#). Measure where rocker arm bushings ride.



Figure 3-71. Measuring Rocker Arm Shaft Bore Diameter in Lower Rocker Cover



Figure 3-72. Measuring Rocker Arm Bushing Inner Diameter

3. Measure and record rocker arm shaft bore diameter.
 - a. See [Figure 3-71](#). Measure bore of lower rocker cover.
 - b. See [Figure 3-72](#). Measure rocker arm bushing inner diameter.
4. Check the measurements obtained in Steps 5-6 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 3-73. Measuring Valve Stem Protrusion

2. See [Figure 3-73](#). 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.

NOTE

The XB9S utilizes a single valve spring for each valve. The inner and outer springs are combined into one tapered spring that is progressively wound.

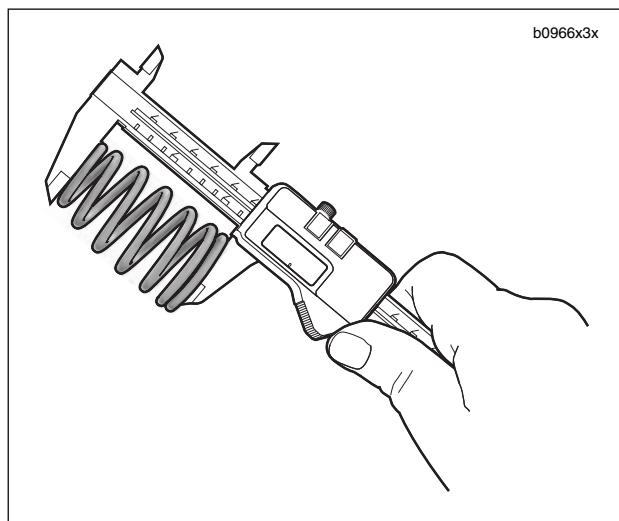


Figure 3-74. Checking Spring Free Length

2. See [Figure 3-74](#). 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 3-75](#). 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.

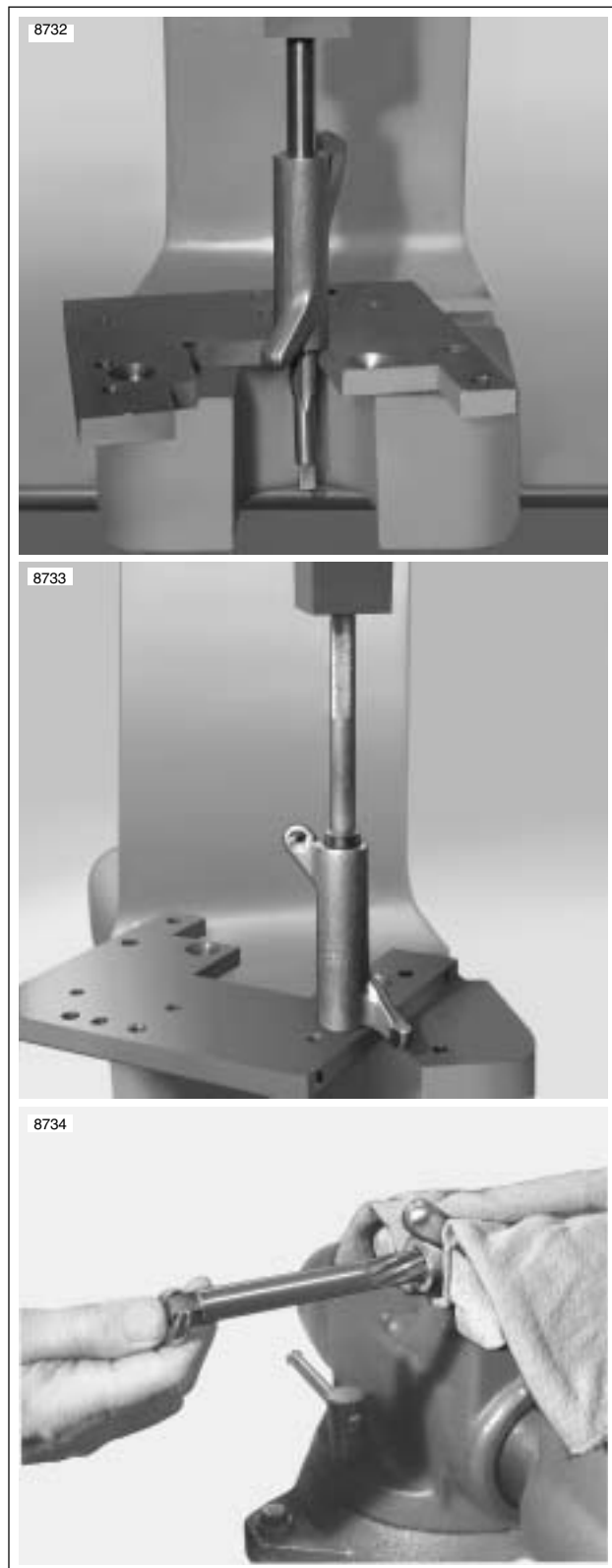


Figure 3-75. Replacing Rocker Arm Bushings

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 3-19](#). If valve stems and/or guides are worn beyond limits, install **new** parts.

Table 3-19. Valve Stem Clearances and Service Wear Limits

VALVE	CLEARANCE	SERVICE WEAR LIMIT
Exhaust	0.001-0.003 in. (0.025-0.076 mm)	0.0035 in. (0.0889 mm)
Intake	0.001-0.003 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. B-45524).
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 3-76](#). Install shoulderless guides using VALVE GUIDE REMOVER/INSTALLER TOOL (Part No. B-45524). 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 (Part No. B-45523). 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. B-45525). Lubricate hone with honing oil. Driving hone with an electric drill, work for a crosshatch pattern with an angle of approximately 60°.

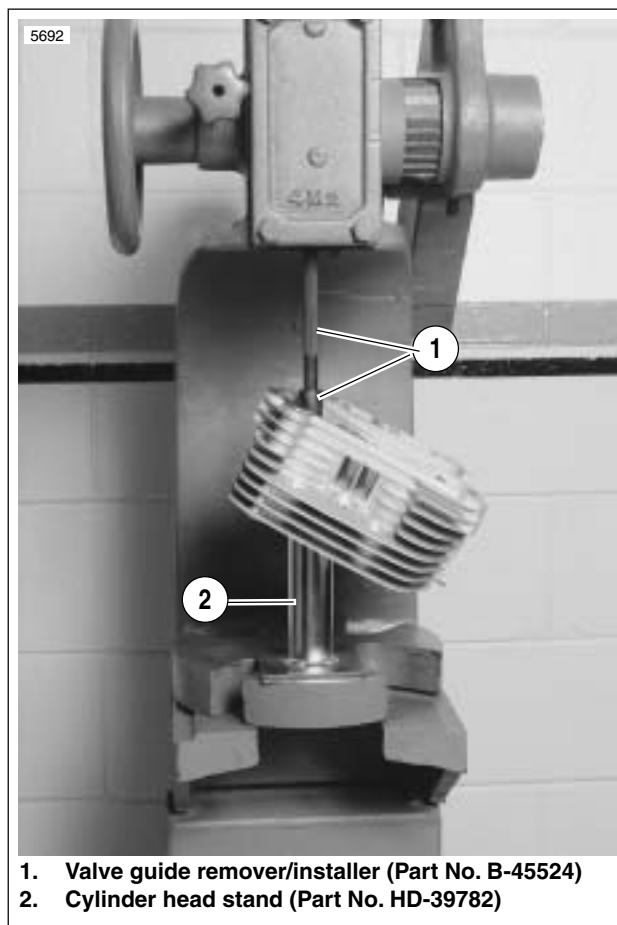


Figure 3-76. Installing Shoulderless Valve Guide

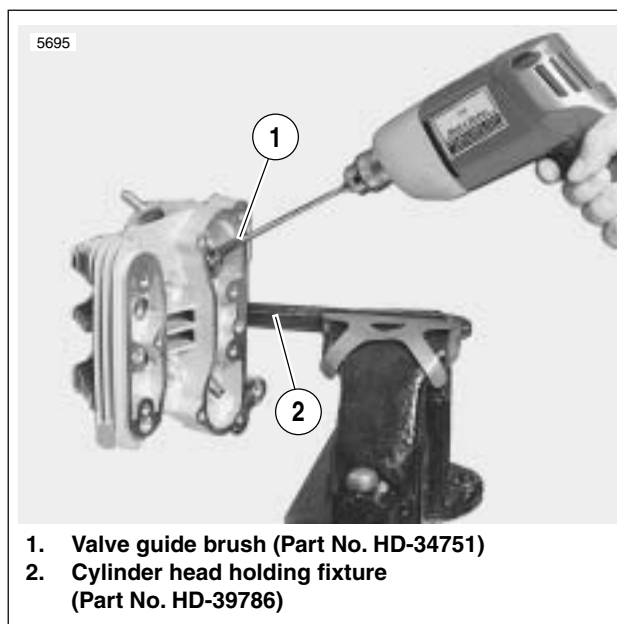


Figure 3-77. Cleaning Valve Guides

7. See [Figure 3-77](#). 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 3-20. Neway Valve Seat Cutter

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

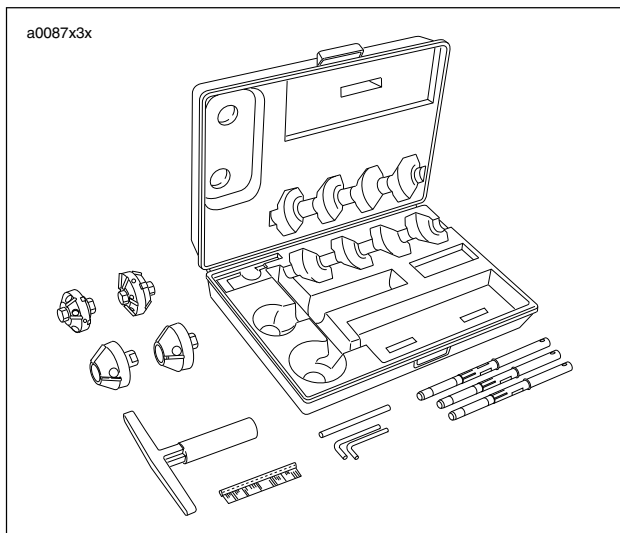


Figure 3-78. Neway Valve Seat Cutter

NOTE

- Verify correct valve stem to valve guide clearance before refacing. See [Table 3-19](#). 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.

NOTE

- 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.

NOTES

- *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 0.062 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 0.040-.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.

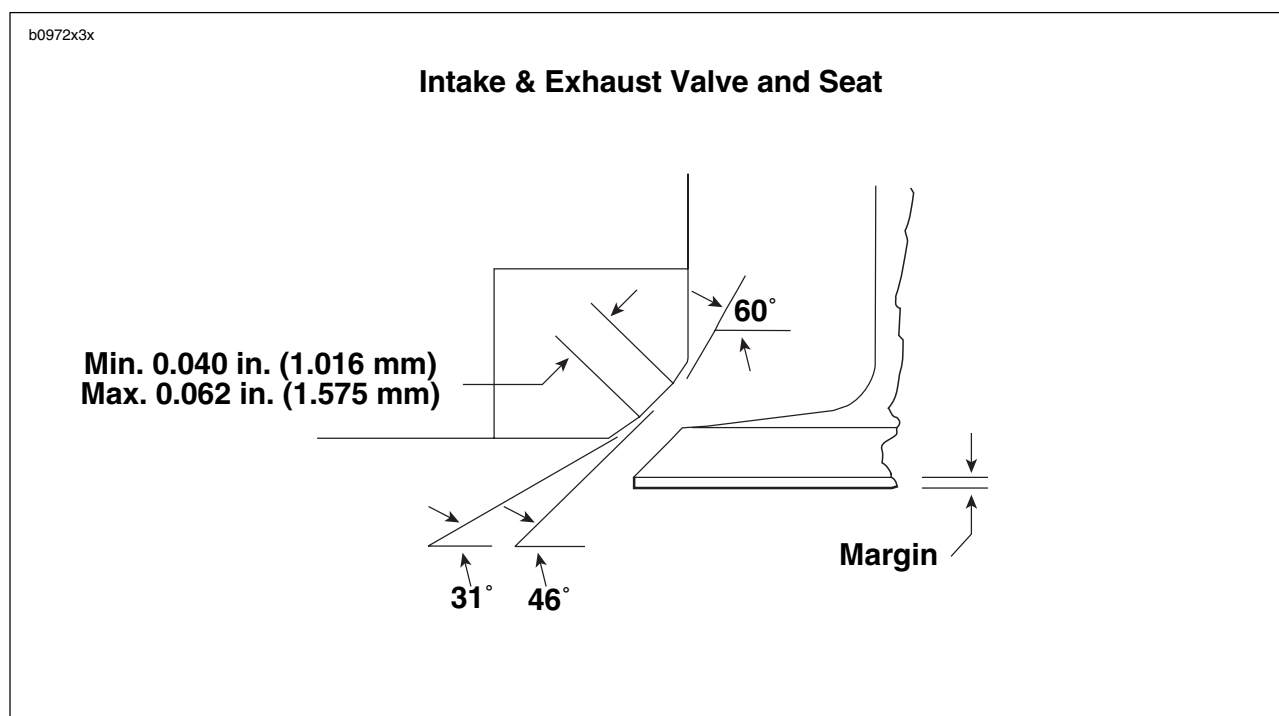
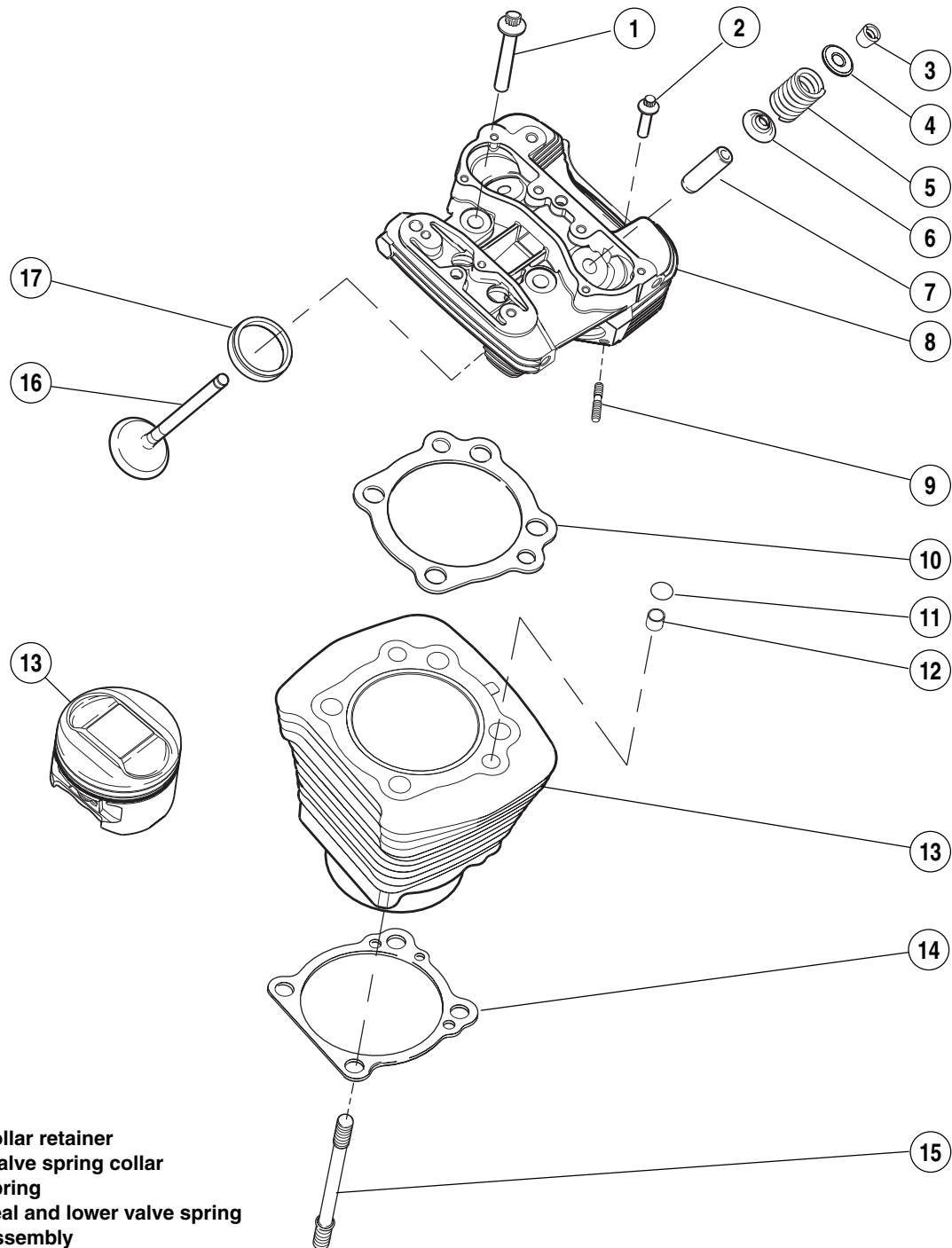


Figure 3-79. Valve and Seat Dimensions

b1024x3x



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

Figure 3-80. Cylinder Head, Cylinder and Piston Assembly

ASSEMBLY

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

⚠ WARNING

Low pressure compressed air can blow debris into your face and eyes. Always wear eye protection or a face shield when using pressurized air. Failure to take adequate safety precautions could result in death or serious injury.

3. Blow dry with compressed air.
4. Apply a liberal amount of engine oil to the valve stem.
5. See [Figure 3-80](#). Insert valve into valve guide and bottom valve on valve seat.

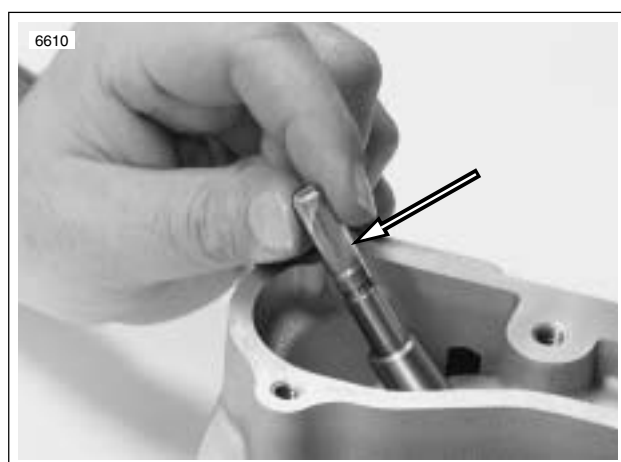


Figure 3-81. Valve Guide Seal Protector Sleeve

6. See [Figure 3-81](#). Place a protective sleeve over the valve stem keeper groove.

CAUTION

Failure to use a protective sleeve on the valve stem keeper groove when installing the valve stem seal and collar assembly will result in damage to the seal causing leakage around the valve stem, excessive oil consumption and valve sticking.

8702



8703



8704



Figure 3-82. Valve Seal and Lower Collar Assembly (seal and lower collar replaced as assembly only)



Figure 3-83. Valve Seal and Lower Collar Assembly Installation

7. See [Figure 3-83](#). Coat the sleeve with oil and place a **new** seal and lower collar assembly over the valve stem and onto valve guide.

NOTE

- See [Figure 3-82](#). The valve seal is now incorporated into the lower collar and is installed by hand. **NO SPECIAL TOOLS ARE REQUIRED.**
- The seal is completely installed when the lower collar contacts the machined surface of the head.

CAUTION

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



Figure 3-84. Valve Spring Compressor (Part No. HD-34736B)

8. Install valve spring and upper collar.
9. See [Figure 3-84](#). Compress spring with VALVE SPRING COMPRESSOR (Part No. HD-34736B).

NOTE

The XB9S utilizes a single valve spring for each valve. The inner and outer springs are combined into one tapered spring that is progressively wound.

10. Insert valve keepers into upper collar, making sure they engage grooves in valve stem. The keeper gaps should be equal.
11. Release and remove from VALVE SPRING COMPRESSOR.
12. Repeat Steps 4-11 for the remaining valve.

PUSH ROD COVER INSTALLATION

NOTE

Push rod covers must be installed prior to installing cylinder heads.



Figure 3-85. Push Rod Locations

1. See Figure 3-86. Install push rod covers.
 - 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 each push rod cover assembly and start the fasteners (4) securing the bottom of each cover to the crankcase.
 - d. Tighten fasteners to 30-40 **in lbs** (3.4-4.5 Nm).
2. Refer to Table 3-21. 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.

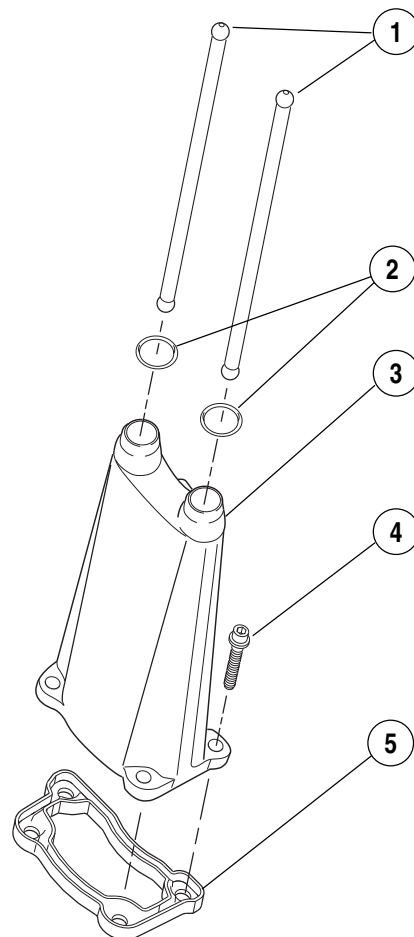
Table 3-21. Push Rod Selection

POSITION	COLOR CODES	LENGTH	PART NO.
Exhaust	1 Band-Pink/Purple	10.780 in. (274.320 mm)	17908-02
Intake	1 Band-Orange/Brown	10.726 in. (272.948 mm)	17909-02

CAUTION

After head(s) have 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.

b1092x3x



1. Push rod (2)
2. O-ring (2)
3. Push rod cover
4. Screws (4)
5. Push rod cover gasket

Figure 3-86. 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 cylinders and cylinder heads.
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 3-87](#). 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 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 3-88](#). Mark cylinder head and head screw shoulder with a line as shown (View A).
 - d. Turn all bolts an additional 85° -95° .

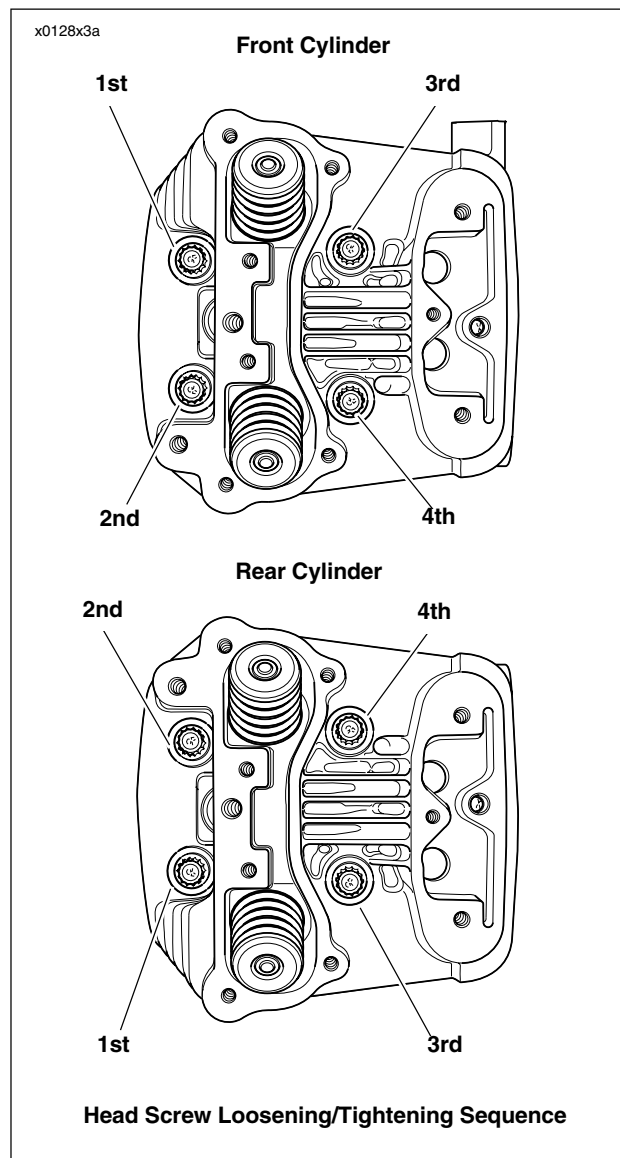


Figure 3-87. Head Screw Loosening/Tightening Sequence

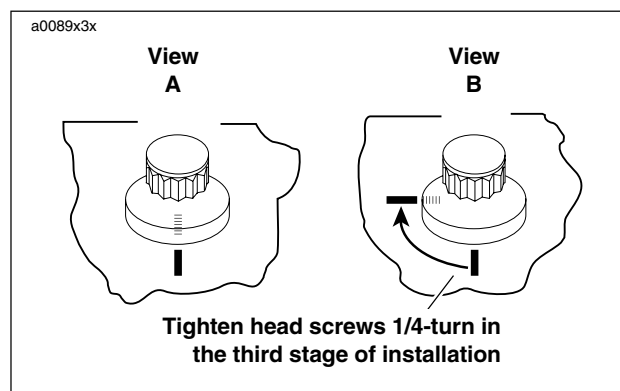


Figure 3-88. Tightening Head Screws

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

19. Screw, tappet anti-rotation (2)

20. Gasket (push rod cover)

21. Push rod cover

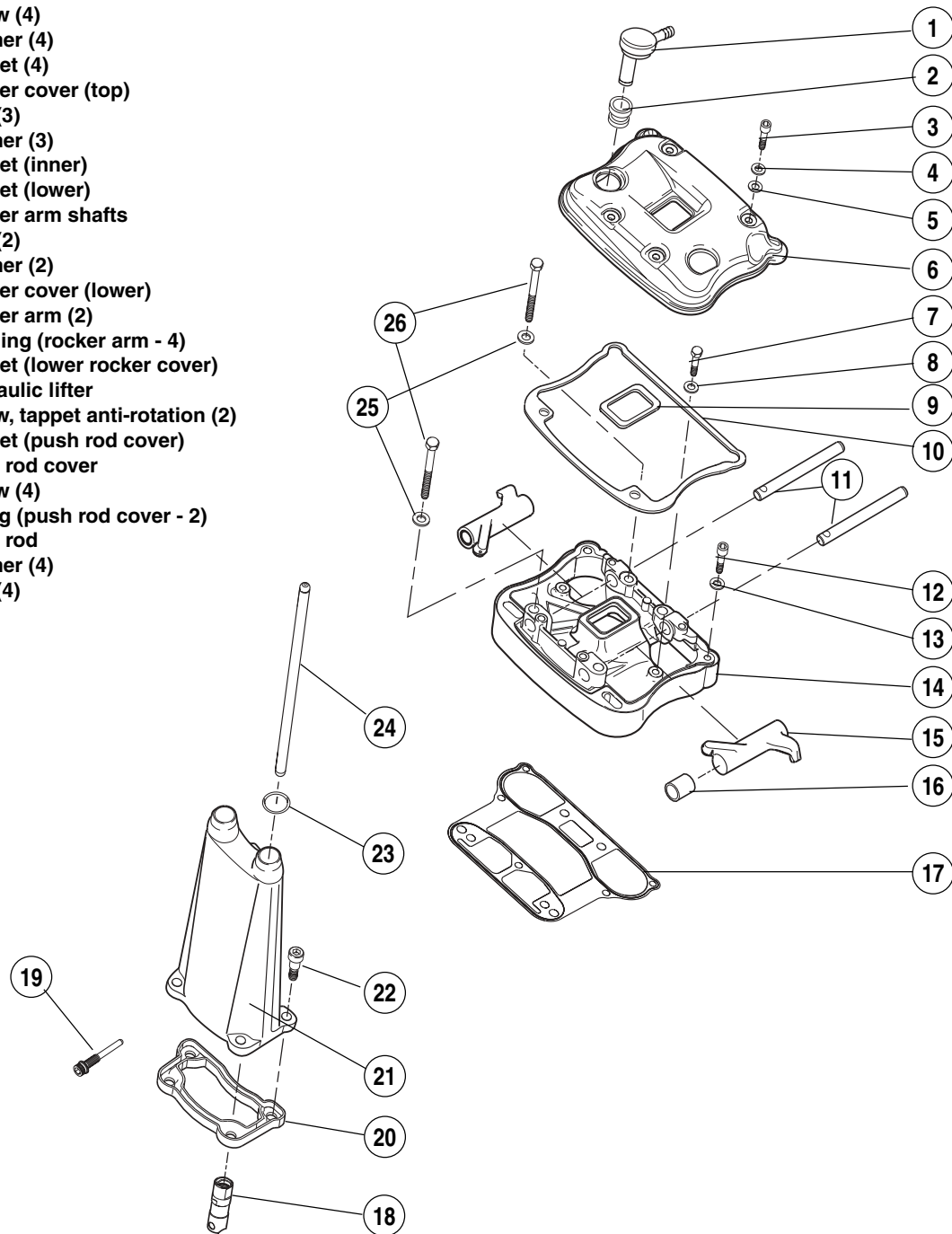
22. Screw (4)

23. O-ring (push rod cover - 2)

24. Push rod

25. Washer (4)

26. Bolt (4)



b0960x3x

Figure 3-89. Rocker Arm and Push Rod Cover Assemblies

9. See [Figure 3-90](#). 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.

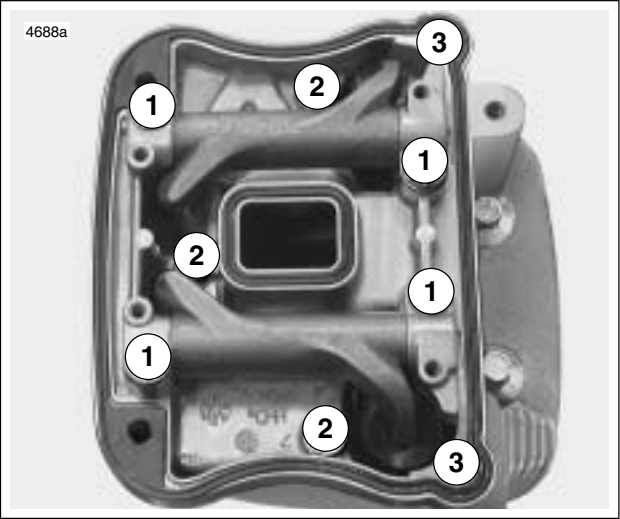


Figure 3-90. Lower Rocker Box Fasteners

10. See [Figure 3-90](#). 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 3-22](#).
- a. Tighten bolts (1) to 18-22 ft-lbs (24-30 Nm).
 - b. Tighten bolts (2) to 135-155 **in-lbs** (15-18 Nm).
 - c. Tighten bolts (3) to 135-155 **in-lbs** (15-18 Nm).
11. See [Figure 3-89](#). Install upper rocker covers.
- a. Place a **new** inner gaskets on lower rocker box assemblies.
 - b. Place a **new lower** gaskets on lower rocker cover.
 - c. Install upper rocker cover using screws with washers and **new** fiber seals. Tighten screws to 10-14 ft-lbs (13.6-19 Nm).

Table 3-22. 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	11-13 ft-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 [3.4 STRIPPING MOTORCYCLE FOR ENGINE SERVICE](#).
2. Remove cylinder head. See [3.6 CYLINDER HEAD](#).
3. Clean crankcase around cylinder base to prevent dirt and debris from entering crankcase while removing cylinder.
4. See [Figure 3-91](#). 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 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.

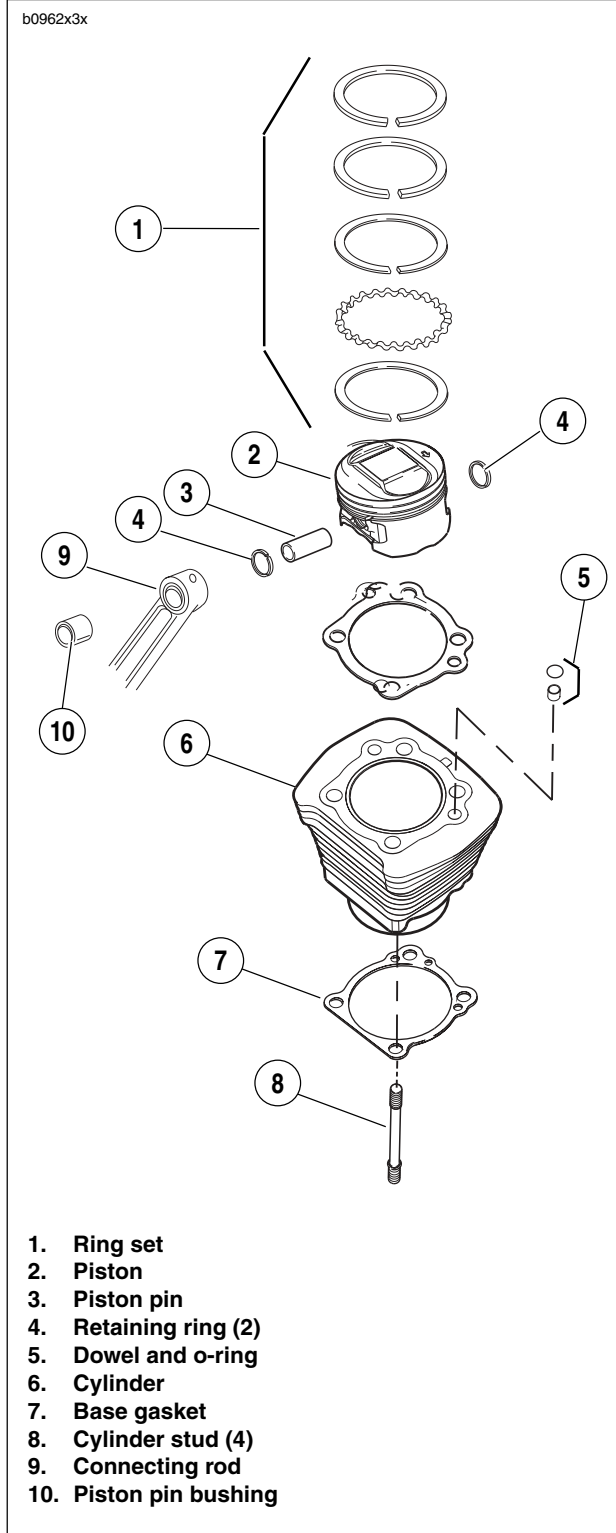


Figure 3-91. Cylinder and Piston

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.

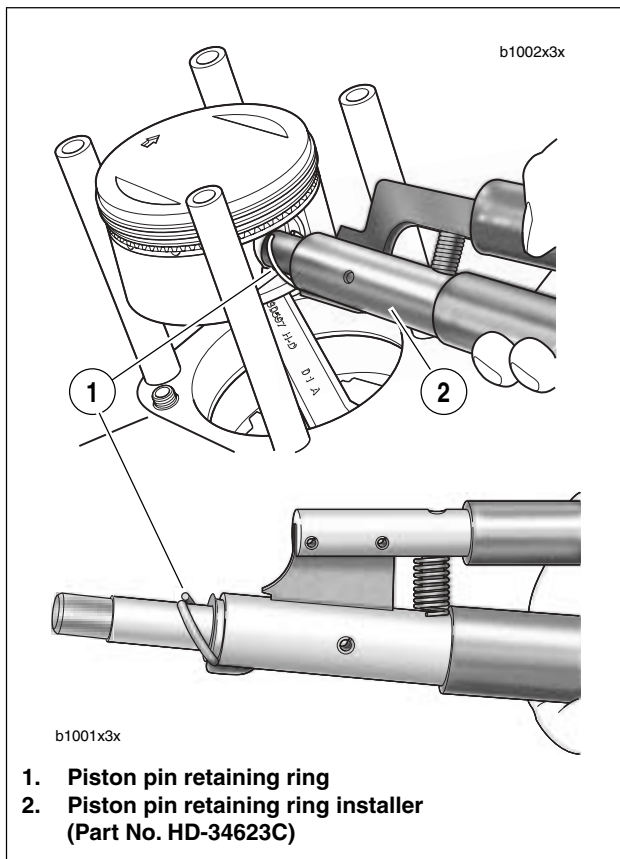


Figure 3-92. Removing Piston Pin Circlip

8. See [Figure 3-92](#). Remove the piston pin circlip as follows:
 - a. Insert the PISTON PIN CIRCLIP REMOVER/INSTALLER (Part No. HD-34623C) 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.

NOTES

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

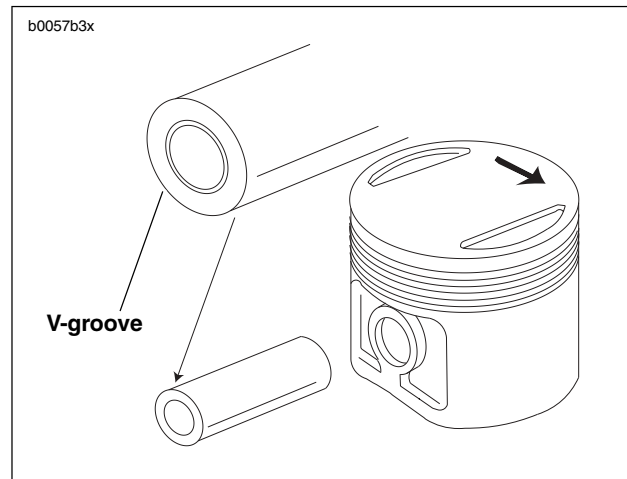


Figure 3-93. Piston Pin and Piston Identification

NOTE

See [Figure 3-93](#). The arrow at the top of pistons must always point toward the front of the engine.



Figure 3-94. Removing Piston Rings

9. See [Figure 3-94](#). To remove piston rings spread outward until they clear grooves in piston and lift off.

CLEANING AND INSPECTION

⚠ WARNING

Low pressure compressed air can blow debris into your face and eyes. Always wear eye protection or a face shield when using pressurized air. Failure to take adequate safety precautions could result in death or serious injury.

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 0.00125-0.00175 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.

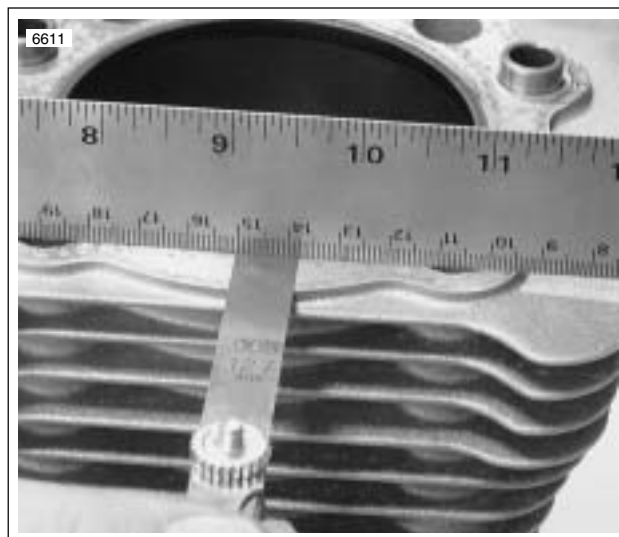


Figure 3-95. Checking Gasket Surfaces

1. See [Figure 3-95](#). 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.

Measuring Cylinder Bore

- 1. Remove any burrs from the cylinder gasket surfaces.
- 2. See Figure 3-96. Install a head gasket, base gasket and O-rings, and CYLINDER TORQUEPLATES (Part No. HD-33446B) 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 3.6 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.

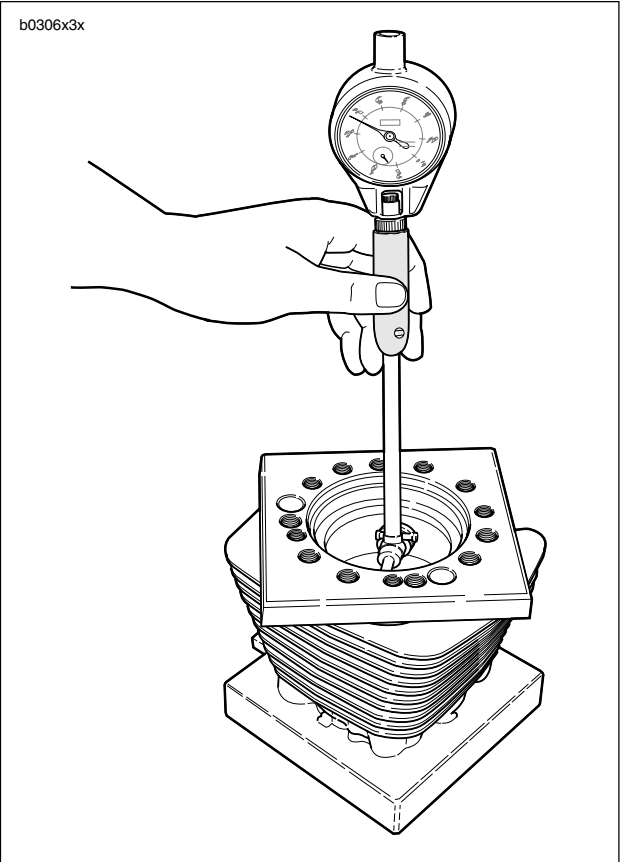


Figure 3-96. Measuring Cylinder Bore Using Torque Plates (Part No. HD-33446B)

- 3. See Figure 3-96. 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. See Table 3-23. If cylinder is not scuffed or scored and is within service limit, see next section, DEGLAZING CYLINDER.

NOTE

If piston clearance exceeds service wear limit, cylinders and pistons should be replaced with new components. See 3.1 SPECIFICATIONS.

Table 3-23. Cylinder Bore Service Wear Limit

BORE SIZES	IN.	MM
Standard Bore	3.5008	88.9203

Deglazing Cylinder

NOTE

Deglazing removes wear patterns, minor scuff marks and scratches without enlarging the bore diameter.

- 1. Lightly swab the cylinder bore with a cloth dipped in clean engine oil.
- 2. Obtain a 240 grit flexible ball-type deglazing tool with a bristle tip or finishing stone arrangement able to produce a 60° cross hatch pattern.
- 3. Install the deglazing tool in a slow-speed drill. The speed at which the tool rotates determines the speed at which it must be stroked up and down the bore to produce the desired cross hatch pattern.
- 4. Starting at the bottom of the cylinder, move the deglazing tool up and down the entire length of the cylinder bore for 10 to 12 complete strokes.

NOTE

Stop to examine the cylinder bore and/or take measurements. A precise 60° cross hatch pattern in the piston travel area is the most important.

CAUTION

The angular cross hatch pattern ensures an even flow of oil onto the cylinder walls and promotes longer cylinder, piston and ring life. An Improper crosshatch pattern will result in insufficient oil retention and possible piston seizure and/or high oil consumption.

CAUTION

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

- 5. 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 or dirt or debris.
- 6. Hot rinse the cylinder and dry with moisture free compressed air.
- 7. 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.

- 8. With the cylinder at room temperature, check the piston clearance in the cylinder in which the piston will run. See 3.1 SPECIFICATIONS.

Fitting Piston Rings

See [Figure 3-97](#). 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.

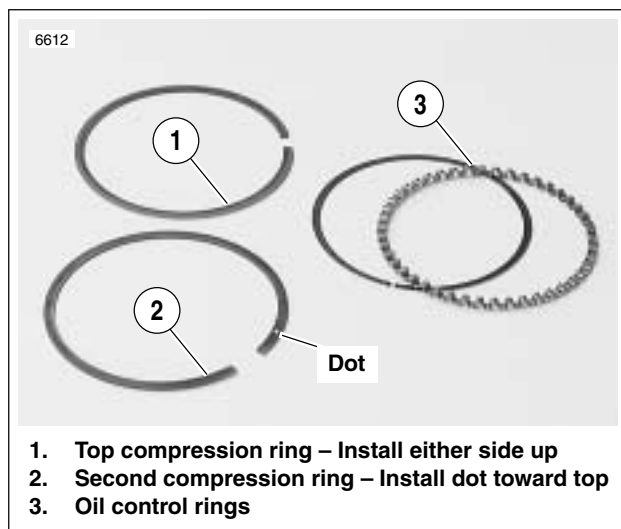


Figure 3-97. Piston Rings

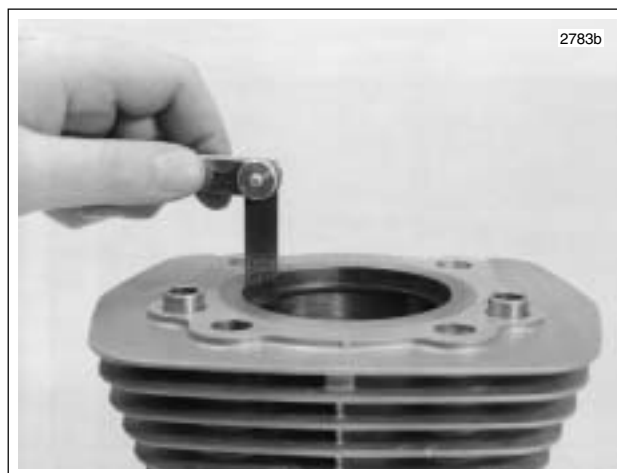


Figure 3-98. Measuring Ring End Gap

See [Figure 3-98](#). Piston ring sets must be properly fitted to piston and cylinder:

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, See [Table 3-24](#).

Table 3-24. Piston Ring End Gap

Ring Type	Ring End Gap	
	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.

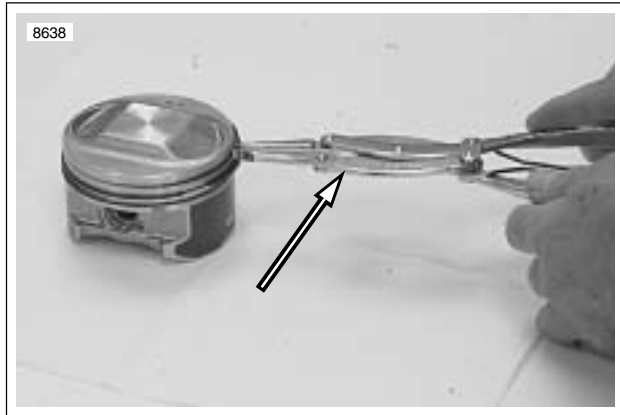


Figure 3-99. Installing Piston Rings Transmission Shaft Retaining Ring Pliers (Part No. J-5586)

9. See [Figure 3-99](#). 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.

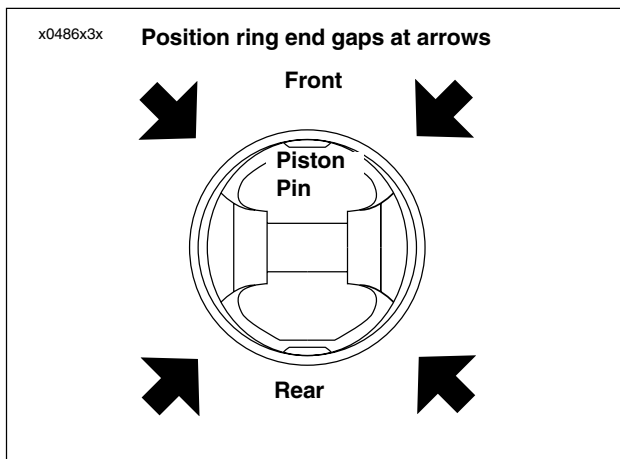


Figure 3-100. Ring End Gap Position

10. See [Figure 3-100](#). 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 3-101. Measuring Ring Clearance in Groove

11. See [Figure 3-101](#). 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 (0.002 in. or more) (0.051 mm) it must be replaced.

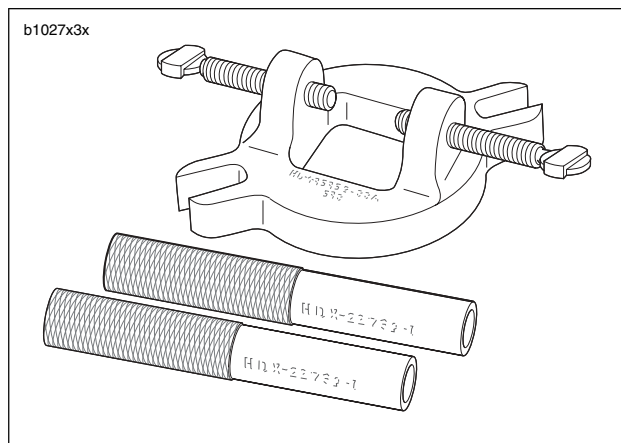


Figure 3-102. Connecting Rod Clamping Tool (Part No. HD-95952-33B)

1. See [Figure 3-102](#). Secure connecting rod with CONNECTING ROD CLAMPING TOOL (Part No. HD-95952-33B).

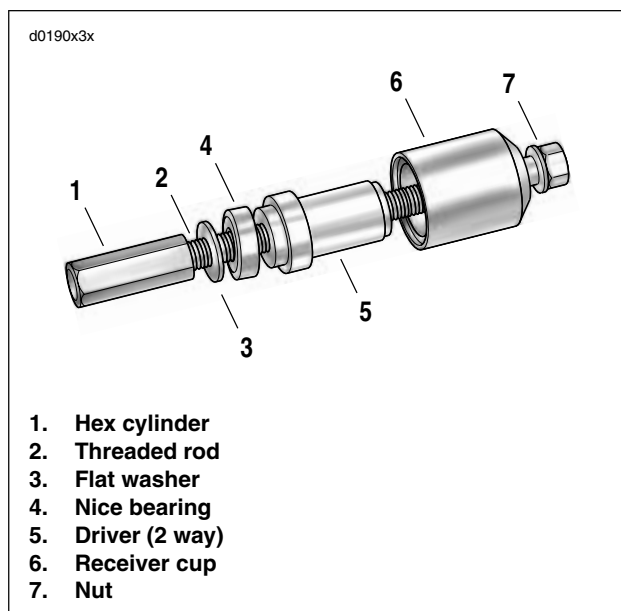


Figure 3-103. Connecting Rod Bushing Remover/Installer (Part No. HD-95970-32D)

2. See [Figure 3-103](#). Attach PISTON PIN BUSHING TOOL (Part No. HD-95970-32D) to the connecting rod.

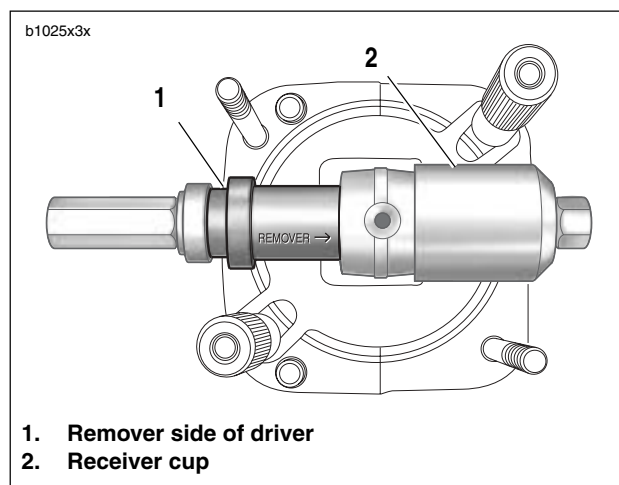


Figure 3-104. Removing Wrist Pin Bushing

NOTE

See [Figure 3-104](#). 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.

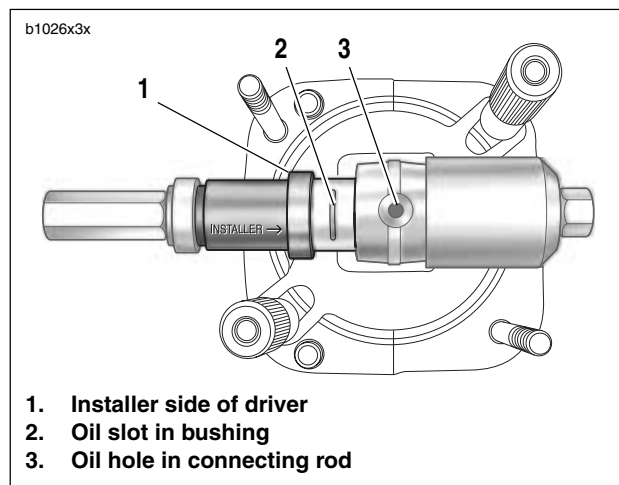


Figure 3-105. Installing New Wrist Pin Bushing

6. See [Figure 3-105](#). Place **new** bushing between connecting rod and driver.

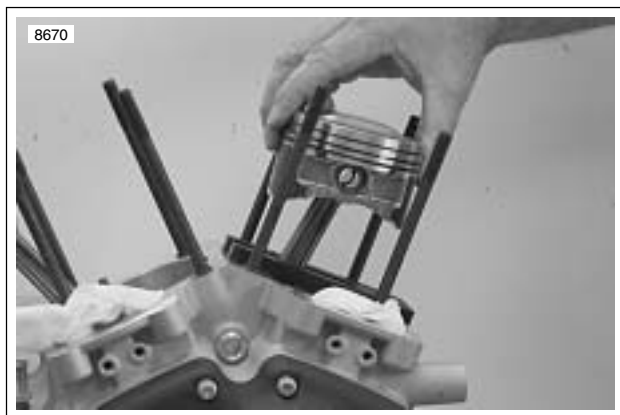
NOTE

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

1. See [Figure 3-106](#). Place PISTON SUPPORT PLATE (Part No. HD-42322) in position as shown.



**Figure 3-106. Piston Support Plate
(Part No. HD-42322)**

2. Install piston assembly over connecting rod.

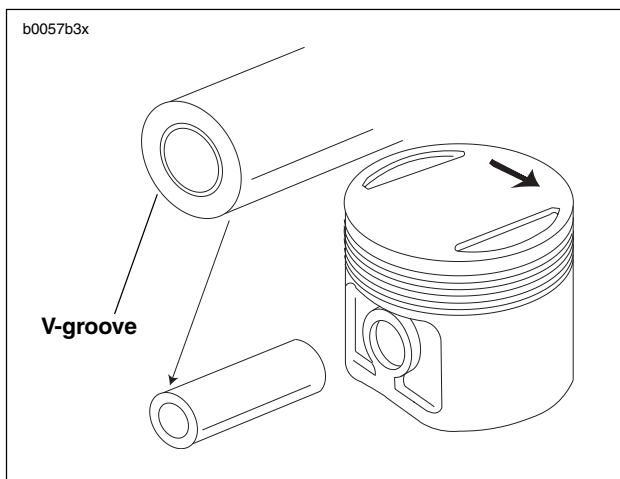


Figure 3-107. Piston Pin and Piston Identification

NOTE

See [Figure 3-107](#). 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.

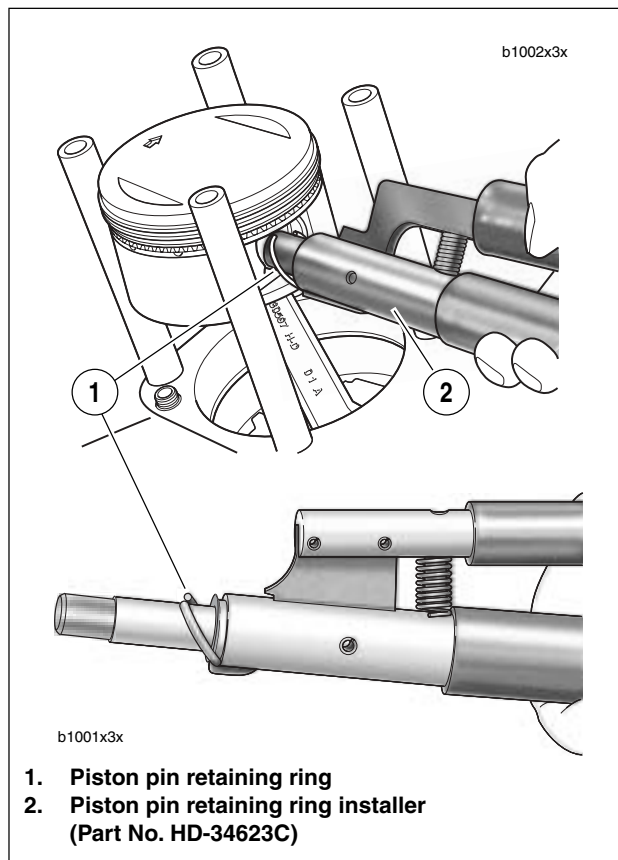


Figure 3-108. Installing Piston Pin Circlip

4. See [Figure 3-108](#). Install **new** piston pin retaining rings (1) using PISTON PIN RETAINING RING INSTALLER (2) (Part No. HD-34623C). Place **new** retaining ring on tool with gap pointing up.

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.

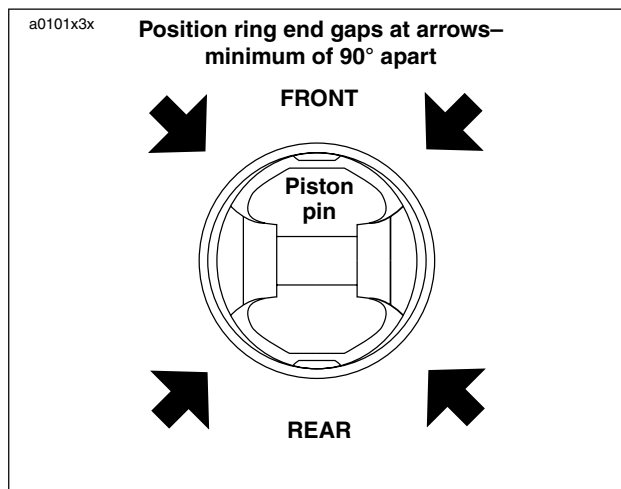


Figure 3-109. Ring End Gap Position

5. See [Figure 3-109](#). Make sure the piston ring end gaps are properly positioned as shown.



Figure 3-110. Piston Support Plate

6. See [Figure 3-110](#). Turn engine until piston is resting on top of PISTON SUPPORT PLATE (Part No. HD-42322).
7. Lubricate cylinder wall, piston, pin and rod bushing with engine oil.
8. Remove protective sleeves from cylinder studs. Install a **new** cylinder base gasket. Make sure the piston does not bump the studs or crankcase.

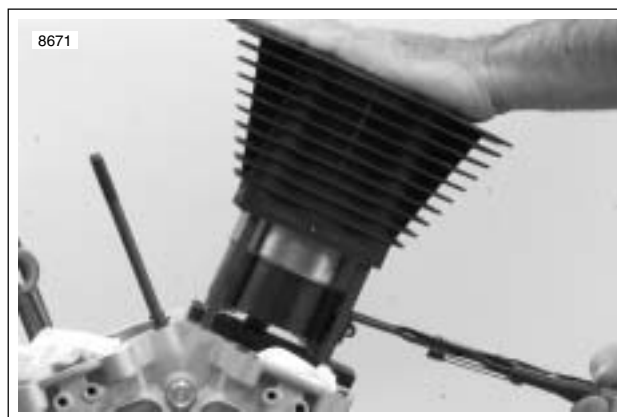


Figure 3-111. Compressing Piston Rings Using Piston Ring Compressor (Part No. HD-96333-51C)

9. See [Figure 3-111](#). Compress the piston rings using PISTON RING COMPRESSOR (Part No. HD-96333-51C).
10. Install cylinder over piston.
11. Remove PISTON RING COMPRESSOR.
12. Assemble and install cylinder head. See [3.6 CYLINDER HEAD](#).
13. Install assembled engine. See [3.4 STRIPPING MOTOR-CYCLE FOR ENGINE SERVICE](#).

NOTES
