6. Turn adjuster (4) on throttle control cable (2) until throttle cam stop (6) touches carburetor stop plate (7). Tighten jam nut on throttle control cable adjuster (4). Release throttle control grip (5).

7. Turn handlebars fully to right. Turn adjuster (4) on idle control cable (3) until end of cable housing just touches spring within carburetor cable guide (8).

8. With throttle friction screw (1) loosened, twist and release throttle control grip (5) a few times. Carburetor throttle must return to idle position each time throttle grip is released. If this is not the case, turn adjuster (4) on idle control cable (3) (shortening cable housing) until throttle control functions properly.

9. Tighten jam nut on idle control cable adjuster (4). Recheck operation of throttle control (Step 8).

10. Slide rubber boot over each cable adjuster (4). Recheck engine slow idle speed. Adjust if required.

REMOVAL/DISASSEMBLY (Figure 2-79)

1. Slide rubber boot off each cable adjuster (11). Loosen jam nut on each adjuster. Turn adjusters in direction which will shorten cable housings to minimum length.

2. Remove two screws (1) and separate upper housing (2) from lower housing (3).

3. Unhook ferrules (4) and cables (5) from throttle control grip (6) and lower housing (3).

4. Remove air cleaner assemby. See AIR CLEANER, REMOVAL in Section 4.

5. Disconnect cables from carburetor.

6. Remove friction spring (7), throttle friction screw (9) and spring (8) from lower housing (3).

CLEANING, INSPECTION, AND REPAIR

Clean all parts in a non-flammable cleaning solvent. Blow dry with compressed air. Replace cables if frayed, kinked or bent.

ASSEMBLY/INSTALLATION (Figure 2-79)

1. Apply a light coating of graphite to the handlebar (10) and the inside surface of the switch housings (2 and 3).

2. Install throttle spring (8), throttle friction screw (9) and friction spring (7) in lower housing (3).

3. Attach cable assemblies (5) to lower housing (3). See Figure 2-80. Throttle control cable (2) has a 5/16 in. (7.9 mm) fitting end and is positioned to front of lower housing. Idle control cable (3) has a 1/4 in. (6.3 mm) fitting end and is positioned to rear of lower housing.

4. See Figure 2-79. Install throttle control grip (6) over end of right handlebar (10). Position lower housing (3) onto right handlebar, engaging lower housing with throttle control grip. Position ferrules (4) over cable (5) ball ends, then seat ferrules (with cables attached) in their respective notches of the throttle control grip.

5. Install upper housing (2) over right handlebar (10) and secure to lower housing (3) using screws (1). Tighten screws to 18-24 ft-lbs (24-33 Nm) torque.

6. See Figure 2-81. Route control cables forward from throttle control grip, forward of front fork upper bracket, downward between right slider tube and headlamp, rearward along right side of frame steering head, rearward along right side of frame backbone into retaining clip on ignition switch housing, downward to carburetor.

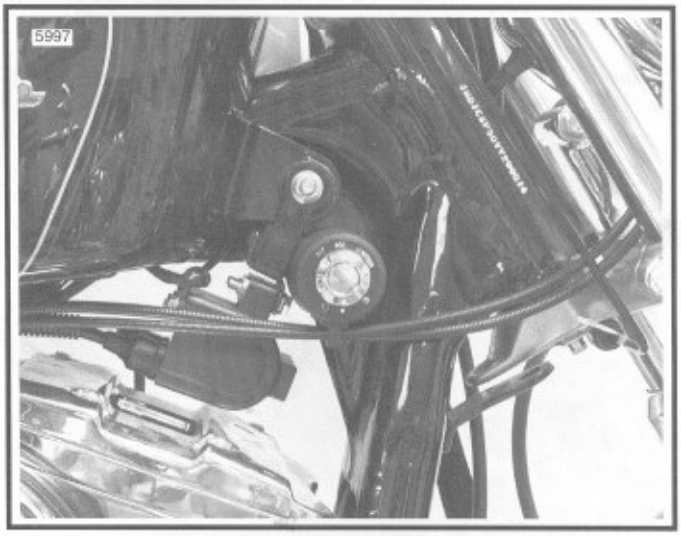


Figure 2-81. Control Cable Routing

7. See Figure 2-80. Install idle control cable (3) housing and spring into longer, inboard cable guide (8) on carburetor.

8. Install throttle control cable (2) housing into shorter, outboard cable guide (9) on carburetor.

⚠WARNING

Throttle cables must not pull tight when handlebars are turned fully to left or right fork stops. Be sure wires and throttle cables are clear of fork stops at steering head so they will not be pinched when fork is turned against stops. Steering must be smooth and free with no binding or interference. Improperly adjusted and/or positioned throttle cables could result in loss of control of vehicle resulting in possible personal injury.

9. Adjust control cables. See THROTTLE CONTROL, ADJUSTMENT.

HANDLEBARS

REMOVAL

1. Disconnect battery negative cable.
2. See Figure 2-82. Remove left hand controls and switches. Let wires carefully support the switches.
3. Remove left handlebar grip
4. Remove right side master cylinder. Loosen switch housing screws but do not remove.
5. Remove instrument cluster and screws.
6. Remove remaining two screws holding upper clamp.
7. Right hand control assembly may now be removed from detached handlebar.
8. On XL Custom:
   - Remove riser cover screws (9) and front and rear covers (10 and 11).
   - Detach indicator lamp socket from bezel.
9. Loosen riser bolts (7). Remove cup washers (3), rubber bushings (4) and spacers (6).
10. Remove ground wire (8) from triple clamp.

INSTALLATION

1. See Figure 2-82. Install cup washers (3), rubber bushings (4) and spacers (6).
2. Insert riser bolts (7) (Finger tight only).
3. Slide right handlebar switch housing onto right handlebar end.
4. Position handlebar on lower riser clamp (2).
5. Place upper riser clamp in position and thread the two rear (front on XL Custom) screws in place.
6. Using the remaining two screws, install instrument bracket.
7. See Figure 2-83. Adjust the handlebars to the desired position and torque rear screws (front screws on XL Custom) to 12-15 ft-lbs (16-20 Nm) until cast-in spacers of upper clamp contact the lower clamp.
8. See Figure 2-83. Final tighten front screws (rear screws on XL Custom) to 12-15 ft-lbs (16-20 Nm)
9. Torque lower riser bolts (7) to 25-30 ft-lbs (34-41 Nm).

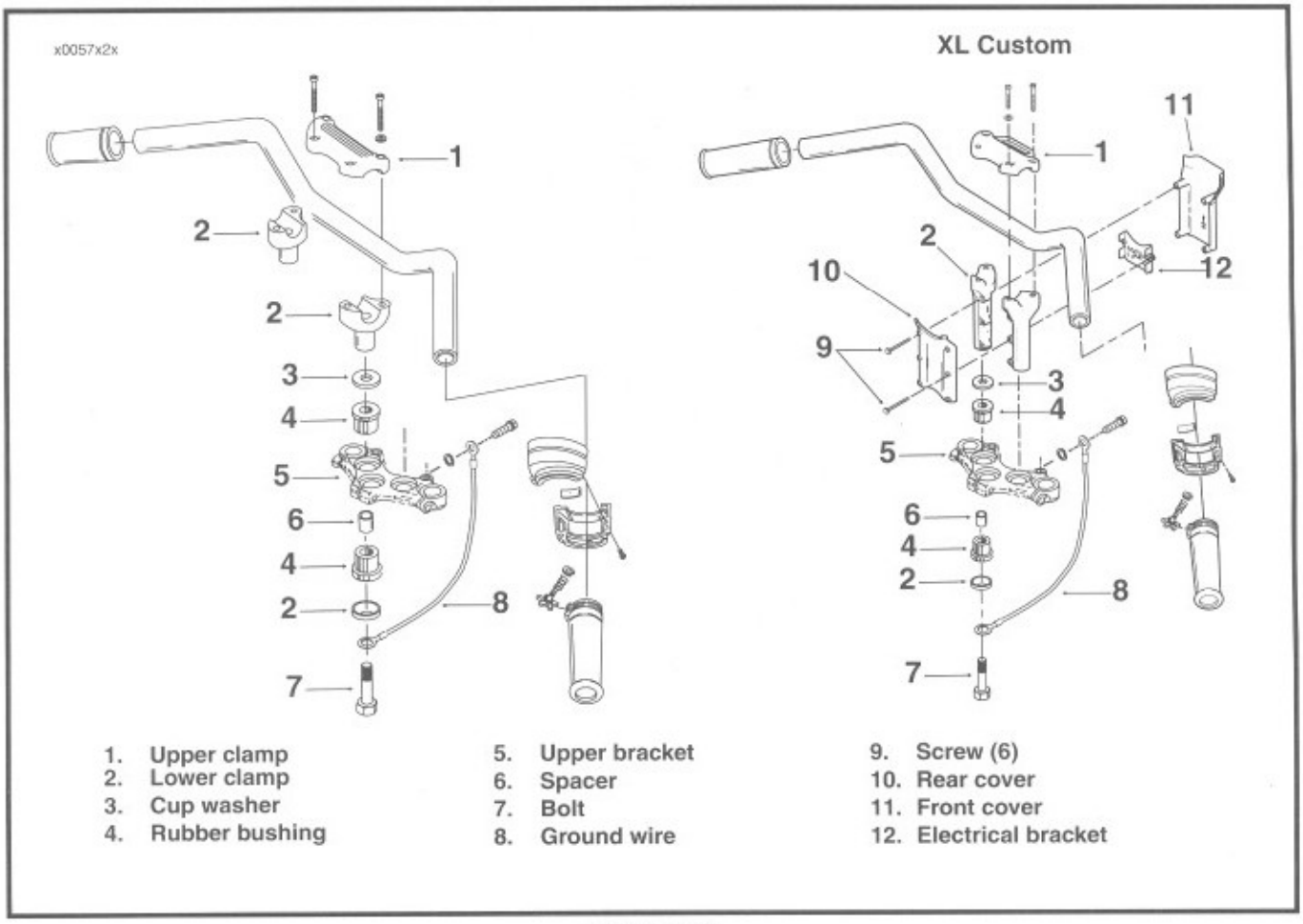


Figure 2-82.

10. On XL Custom:
    - Position indicator lamp socket and clip in position under bezel.
    - Install front and rear riser covers (10 and 11) and torque screws (9) to 8-12 **in-lbs** (.9-1.4 Nm).
11. Install new left hand grip in place as follows:
    - Using a piece of emery cloth, rough grip end of left handlebar.

NOTE

Before applying adhesive in the next step, clean the left handlebar with acetone.

- Apply LOCTITE PRISM PRIMER (770) to inside of handgrip. Remove any excess PRISM PRIMER with a clean cloth. Wait two minutes for PRISM PRIMER to set before attempting the next step.
- Apply LOCTITE PRISM SUPERBONDER (411) to inside of handgrip. Install new handgrip on left handlebar.

NOTE

SUPERBONDER will set in four minutes and be fully cured in 24 hours

12. Position left hand control and loosly install hand control clamp screws.
13. Attach clutch control and torque fastener. Torque hand control in position.
14. Push new wire harness retainers in handlebar holes
15. Attach brake hand control in place and tighten torx screws to
16. Push new wire harness retainers in handlebar holes
17. Connect negative battery cable.
18. Verify the following:
    - cable adjustment/operation.
    - proper throttle cable operation.
    - all electrical switch functions.
    - proper brake operation and brake light function.

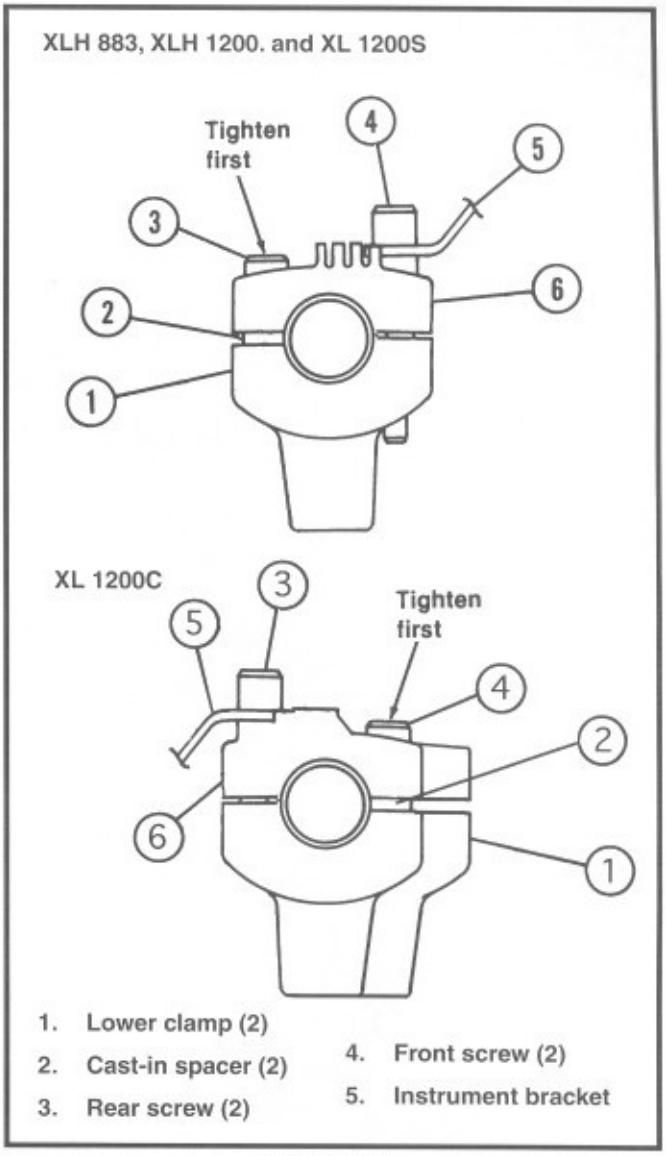
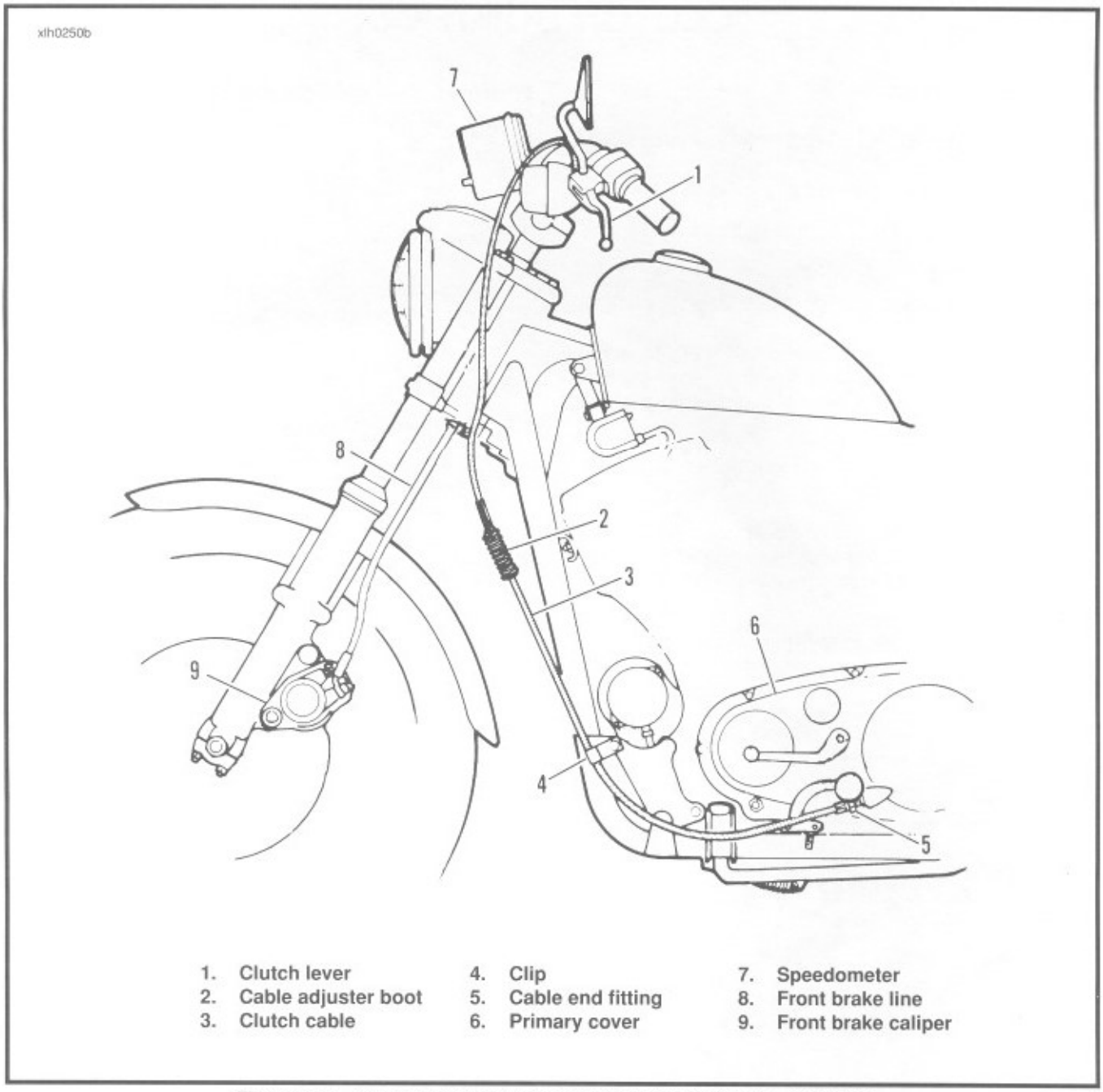


Figure 2-83.



1. Clutch lever
2. Cable adjuster boot
3. Clutch cable
4. Clip
5. Cable end fitting
6. Primary cover
7. Speedometer
8. Front brake line
9. Front brake caliper

Figure 2-84. Clutch Cable and Front Brake Line Routings – Left Side

CLUTCH CONTROL

ADJUSTMENT

Refer to CLUTCH RELEASE MECHANISM, ADJUSTMENT in Section 6.

REMOVAL/DISASSEMBLY

Clutch Cable – Lower (Figure 2-85)

1. Using T-27 TORX driver, remove four TORX screws (1) with washers to remove clutch inspection cover (2). Exercise caution to avoid damaging or dislodging quad ring (14) in primary cover (11).
2. Slide spring (3) with attached hex lockplate (4) from flats of adjusting screw (12).
3. Turn adjusting screw clockwise to release ramp and coupling mechanism. As the adjusting screw is turned, ramp assembly moves forward. Unscrew nut (5) from end of adjusting screw.
4. Remove hook of ramp (6) from button at the rear of cable end coupling (16). Remove cable end (10) from slot in coupling.
5. Turn cable end fitting (9) counterclockwise to remove clutch cable lower section from primary cover (11). Remove O-ring (8) from cable end fitting.

Clutch Lever and Clutch Cable – Upper (Figure 2-86)

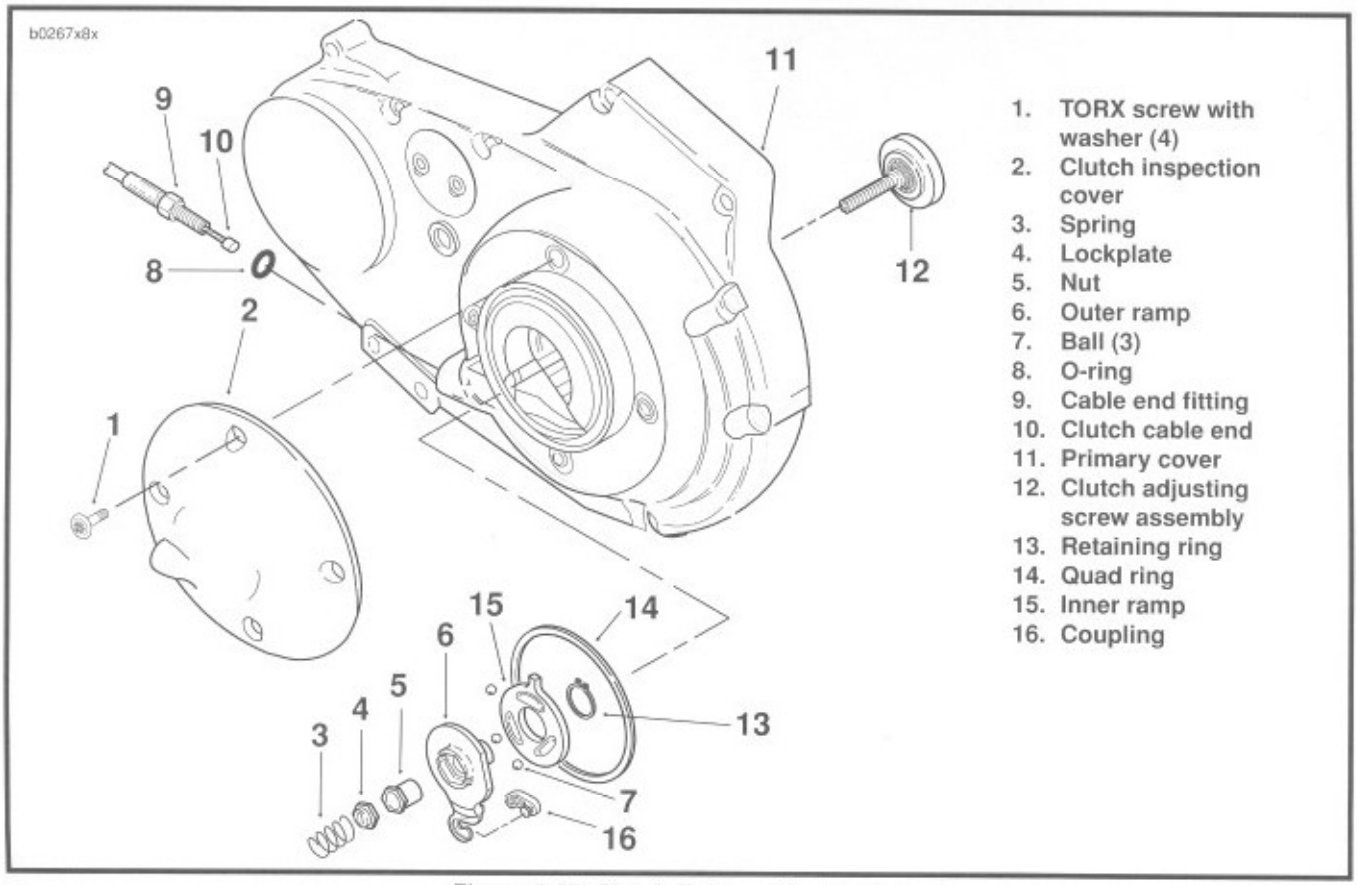
1. Remove retaining ring (4) and pivot pin (5).
2. Remove clutch lever (3) from clutch lever bracket (6).
3. Remove clutch cable pin (2). Disconnect clutch cable (1) upper section from lever (3).

Clutch Hand Control (Figure 2-86)

1. Remove two screws and washers (8) from clutch control clamp (7).
2. Remove clutch control clamp (7) and assembly of clutch cable (1) upper section, clutch lever (3) and clutch lever bracket (6) from left handlebar.

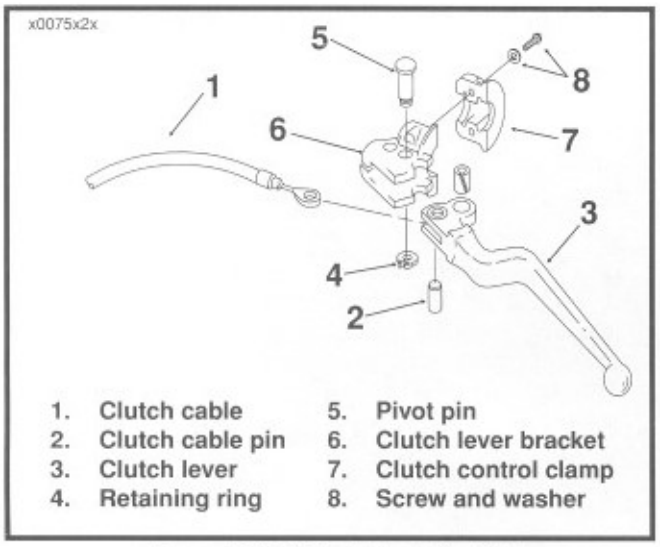
NOTE

You may need to loosen two screws of left handlebar switch housing to remove clutch control clamp (7) and assembly of clutch cable (1) upper section, clutch lever (3) and clutch lever bracket (6) from left handlebar.



1. TORX screw with washer (4)
2. Clutch inspection cover
3. Spring
4. Lockplate
5. Nut
6. Outer ramp
7. Ball (3)
8. O-ring
9. Cable end fitting
10. Clutch cable end
11. Primary cover
12. Clutch adjusting screw assembly
13. Retaining ring
14. Quad ring
15. Inner ramp
16. Coupling

Figure 2-85. Clutch Release Mechanism



1.	Clutch cable	5.	Pivot pin
2.	Clutch cable pin	6.	Clutch lever bracket
3.	Clutch lever	7.	Clutch control clamp
4.	Retaining ring	8.	Screw and washer

Figure 2-86. Clutch Hand Control

ASSEMBLY/INSTALLATION

Clutch Cable – Lower

1. See Figure 2-85. Install O-ring (8) over cable end fitting (9) of clutch cable lower section. Turn fitting clockwise to install into primary cover (11). Tighten fitting to 3-5 ft-lbs (4-7 Nm) torque.

2. Fit coupling (16) over cable end with the rounded side inboard, the ramp connector button outboard. With retaining ring side of ramp assembly facing inward, place hook of ramp around coupling button and rotate assembly counter-clockwise until tang on inner ramp (15) fits in slot of primary cover (11).

3. Thread nut (5) on adjusting screw (12) until slot of screw is accessible with a screwdriver. Fit nut hex into recess of outer ramp (6) and turn adjusting screw counter-clockwise.

4. See Figure 2-84. If not yet performed, route clutch cable (3) forward from primary cover (6), upward through clip (4) on lower left front engine mount to outboard side of left front slider tube, and then rearward to clutch lever (1).

Clutch Lever and Clutch Cable – Upper (Figure 2-86)

1. Connect end of clutch cable (1) upper section to clutch lever (3) using clutch cable pin (2).

2. Position lever within clutch lever bracket (6).

Clutch Hand Control (Figure 2-86)

1. Position clutch control clamp (7) and assembly of clutch cable (1) upper section, clutch lever (3) and clutch lever bracket (6) onto left handlebar. Hold assembly and bracket firmly against left handlebar switch housing.

2. Secure components to left handlebar using two screws and washers (8). Tighten screws to 70-80 **in-lbs** (7.9-9.0 Nm) torque.

NOTE

If two screws of left handlebar switch housing were loosened during removal, tighten to 18-24 ***in-lbs*** *(2.0-2.7 Nm) torque.*

EXHAUST SYSTEM

REMOVAL (Figure 2-87)

1. Remove heat shields (12, 18 and 19) by opening worm drive clamps (6 and 7).
2. Remove nuts (4) from front and rear cylinder head exhaust studs.
3. To access locknut (5), remove master cylinder mounting bolts and lift brake pedal upward. Remove locknut to detach front muffler (16) from sprocket cover stud.
4. Remove locknut (3) and bolt (2) to detach rear muffler (17) from muffler support (15).
5. Remove exhaust system assembly.

DISASSEMBLY (Figure 2-87)

1. Remove Torca clamp assemblies (8) from front and rear mufflers (16 and 17). Discard Torca clamp assemblies-one time usage only.

NOTE

New Torca muffler clamps have eliminated the need for silicone or graphite tape during assembly. To ensure sealing integrity of muffler clamps and prevent the possibility of leakage, Harley-Davidson recommends that muffler clamp assemblies be discarded and replaced each time they are removed.

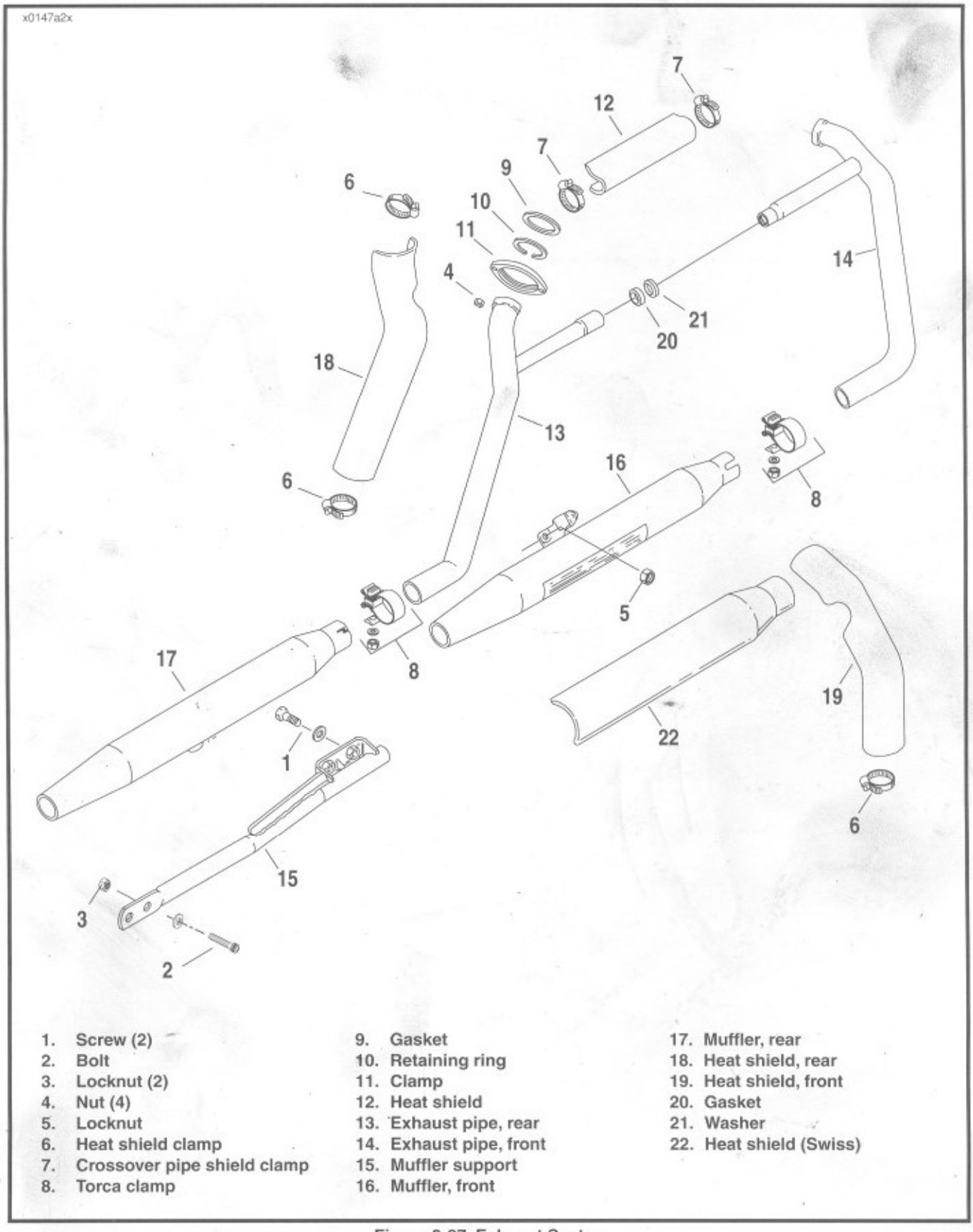
2. Remove front and rear mufflers (16 and 17) from exhaust pipes (13 and 14).
3. Separate front and rear exhaust pipes (13 and 14) at crossover pipe.

ASSEMBLY (Figure 2-87)

1. Insert **new** gasket (20) and washer (21) into crossover pipe on rear exhaust pipe (13). Connect rear exhaust pipe (13) to front exhaust pipe (14) at crossover pipe.
2. Place clamp (11), retaining ring (10) and new gasket (9) over front end of each exhaust pipe (front and rear). Position clamp so that inside counterbore faces cylinder head exhaust port.

INSTALLATION (Figure 2-87)

1. Position front ends of front and rear exhaust pipes (14, 13) into front and rear cylinder heads, respectively. Position holes in clamps (11) over mounting studs and loosely install nuts (4).
2. Place **new** Torca clamps (8) over slotted end of each muffler. Install each muffler (16 and 17) onto the end of its respective exhaust pipe. Front and rear mufflers can be identified by their tabs. Both sides of tab on rear muffler are of equal length (symmetrical) and the hole is smaller; on the front muffler, one side of tab is angular and the hole is larger.
3. Rotate front muffler (16) until tab is at top. Place tab over stud at sprocket cover. Loosely install nut (5) on stud.
4. Rotate rear muffler (17) until tab is at bottom. Align tab with hole in muffler support (15). Insert bolt (2) through holes in muffler support and muffler tab. Loosely install locknut (3) on end of bolt.
5. Tighten nuts (4) at cylinder head exhaust studs to 6-8 ft-lbs (8-11 Nm) torque. Tighten Torca clamps to 35-40 ft-lbs (47-54 Nm) torque. Tighten locknut (5) at sprocket cover stud to 20-40 ft-lbs (27-54 Nm) torque. Tighten locknut (3) at muffler support (15) to 10-15 ft-lbs (14-20 Nm) torque. Install master cylinder mounting bolts, and tighten to 155-190 **in-lbs** (17.5-21.5 Nm) torque.
6. Open worm drive clamps (6) and install heat shields (12, 18 and 19) on exhaust pipes. Position clamp so that screw is on the outboard side in the most accessible position.



1. Screw (2)
2. Bolt
3. Locknut (2)
4. Nut (4)
5. Locknut
6. Heat shield clamp
7. Crossover pipe shield clamp
8. Torca clamp
9. Gasket
10. Retaining ring
11. Clamp
12. Heat shield
13. Exhaust pipe, rear
14. Exhaust pipe, front
15. Muffler support
16. Muffler, front
17. Muffler, rear
18. Heat shield, rear
19. Heat shield, front
20. Gasket
21. Washer
22. Heat shield (Swiss)

Figure 2-87. Exhaust System

FRONT FENDER

REMOVAL (Figure 2-88)

1. Remove four socket head screws (1) and locknuts (2) to detach front fender (3) from front sliders.
2. Remove fender.

INSTALLATION (Figure 2-88)

1. Carefully position front fender between right and left front sliders.
2. Secure fender (3) using four socket head screws (1) and locknuts (2). Tighten locknuts to 8-13 ft-lbs (11-18 Nm) torque.

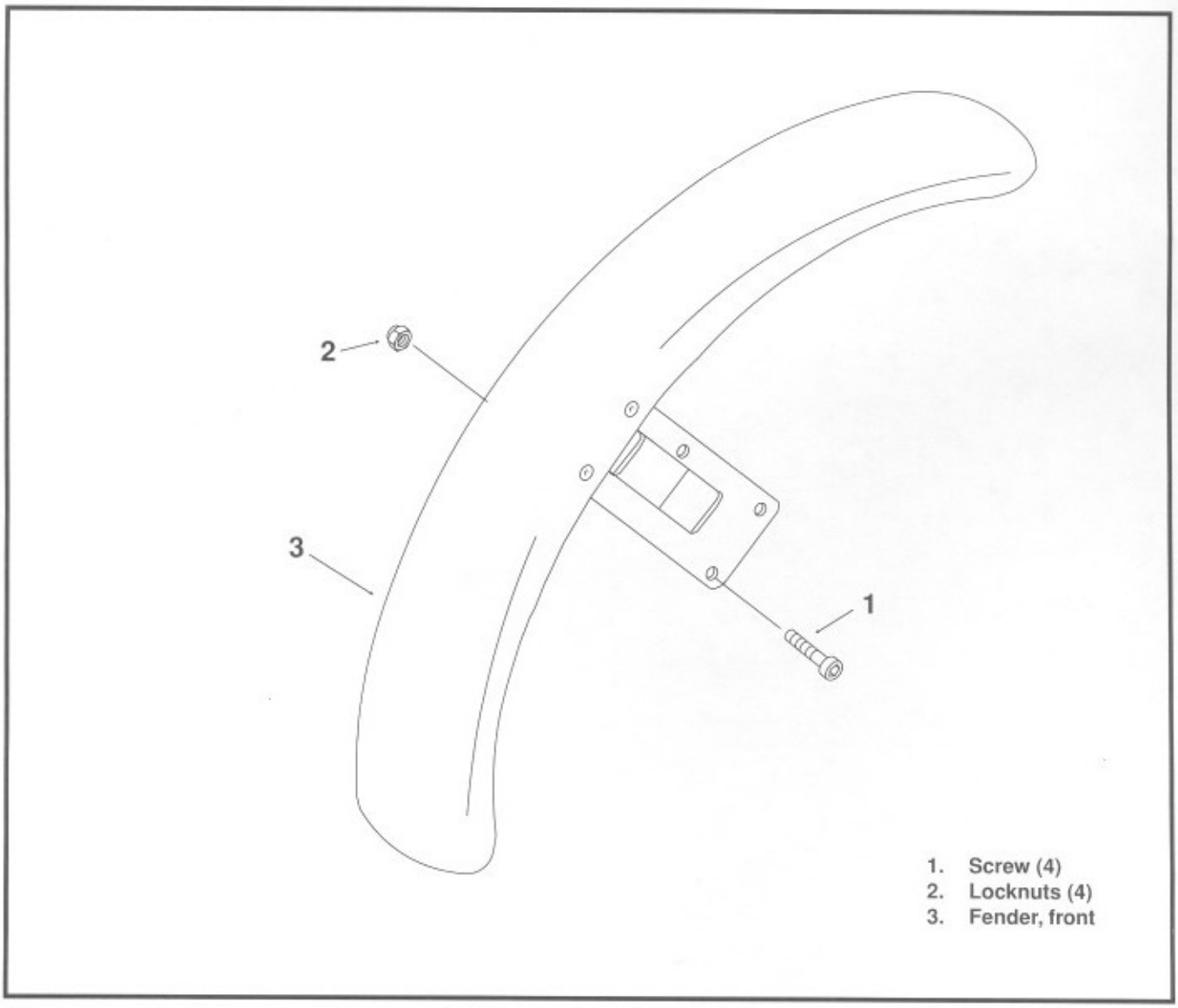
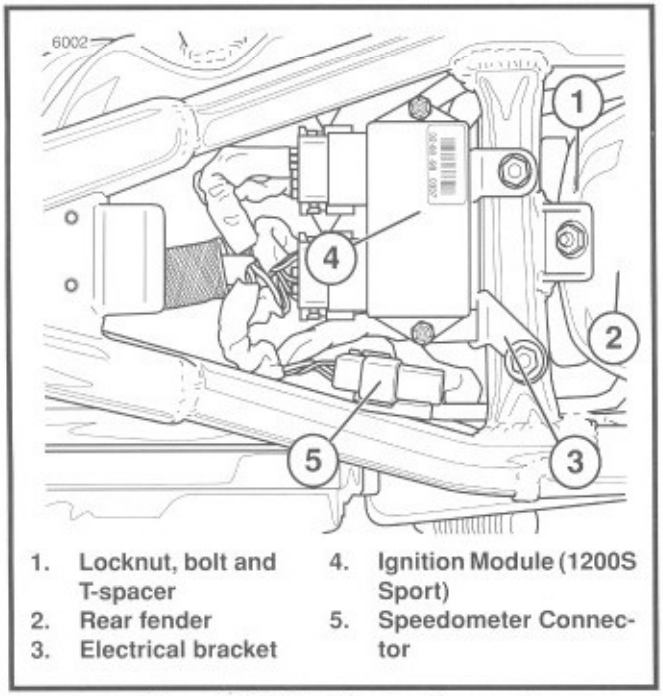


Figure 2-88. Front Fender

REAR FENDER

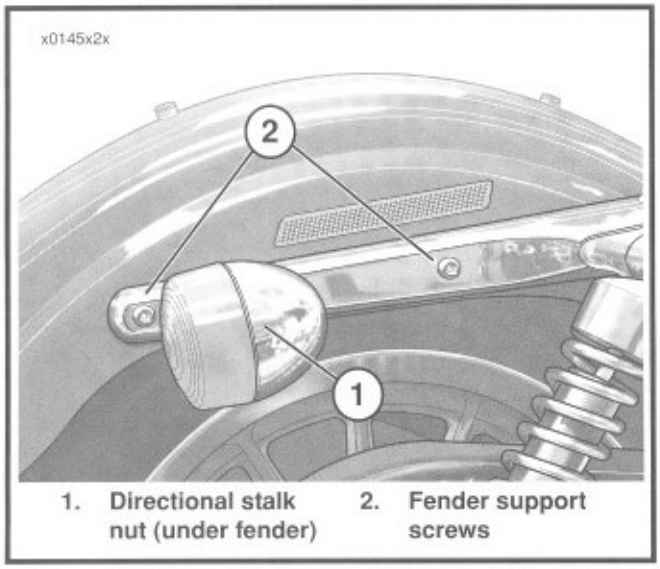
REMOVAL

1. Remove seat. See SEAT, REMOVAL in this Section.
2. See Figure 2-89. Remove locknut, bolt and T-spacer to detach top of rear fender from tab on frame cross member.
3. See Figure 2-90. Remove rear directional stalk nut and T-spacer from inside rear fender (both sides). Remove two fender support nuts, screws and T-spacers (both sides). Move chrome steel strut covers away from rear fender.



1. Locknut, bolt and T-spacer
2. Rear fender
3. Electrical bracket
4. Ignition Module (1200S Sport)
5. Speedometer Connector

Figure 2-89. Rear Fender Removal



1. Directional stalk nut (under fender)
2. Fender support screws

Figure 2-90 Rear Fender, Strut Cover and Directional Lamp Assembly

4. See Figure 2-89. Note the three electrical connectors taped together in the seat area. Connector # 5 houses the terminal connections for the right rear directional, #6 for the left rear directional while the 4-pin connector #4 in the middle houses the tail/brake light connections.
5. Remove tape from connector bundle. Depress latch on connectors to separate pin and socket housings.
6. See Figure 2-89. Remove two bolts to detach electrical bracket from frame cross member. Slightly move electrical bracket to draw socket side of connector out of seat area.
7. See Figure 2-91. Disassemble socket housing following procedure in Chapter 7 page 7-82.
8. Feed tail/brake light leads back through hole in plastic fender extension. Carefully remove rear fender with attached tail/brake light assembly from motorcycle.
9. Unclip tail/brake light lead from clamps spot welded to right inside fender at 8 locations. Remove speed nuts from tapered studs on tail light assembly. Discard speed nuts.
10. Remove tail/brake light fixture from fender.
11. Inspect rubber grommets for cuts, tears or general deterioration; replace as necessary.

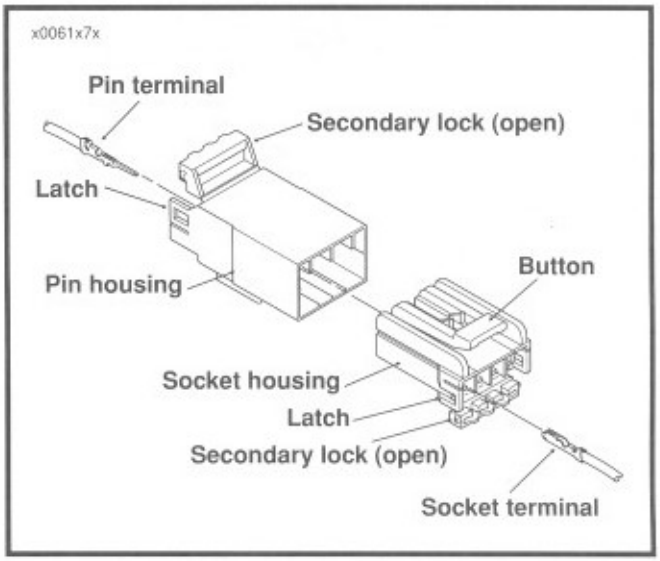
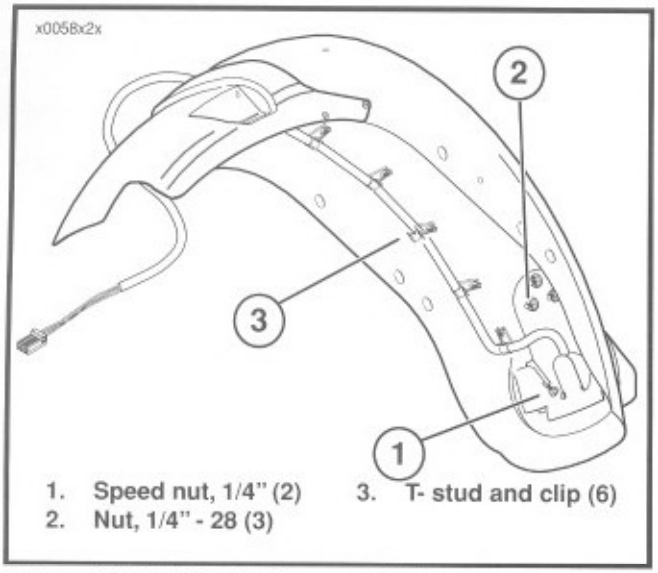


Figure 2-91. 4-Pin Amp Multilock Connector



1. Speed nut, 1/4" (2)
2. Nut, 1/4" - 28 (3)
3. T- stud and clip (6)

Figure 2-92. Tail/Brake Lamp and License Plate Bracket Removal

INSTALLATION

NOTE

Complete steps 1-3 if a new fender is being installed, otherwise proceed to step 4.

1. Remove passenger strap from old fender, if provided. Install passenger strap on new fender. See SEAT, REMOVAL in this Section for more information.
2. See Figure 2-92. Remove three 1/4"-28 nuts securing license plate bracket. Position assembly on new fender. Tighten screws to 6 ft-lbs (8 Nm) torque.
3. Carefully drill out pop rivets securing plastic fender extension with a 1/4-in. (6.35 mm) diameter drill bit. Rivet fender extension to new fender.
4. Insert tapered studs at back of tail/brake light fixture through fender bracket holes. Install **new** speed nuts and tighten.
5. Secure wire lead under clips attached to T-studs welded to underside of fender at 6 locations. Feed tail/brake light lead through hole in plastic fender extension.
6. Verify that grommets are installed at all 7 mounting points- 3 on each side, one at the top. Install grommets so that metal of fender is completely seated in groove on grommet O.D.
7. Install T-spacers in grommets (inboard side).
8. Carefully align holes in fender with those in strut.
9. Where the tail/brake light leads exit the plastic fender extension, run the wires upward and then forward beneath the electrical bracket to the Amp connector in the area of the right side frame rail.
10. Fit rear wire seal into back of socket housing, if removed. Gently push sockets through holes in wire seal into their respective numbered chambers. See Figure 2-93 for wire color locations. Feed socket into chamber until it snaps in place. Slightly tug wire to verify that socket will not back out. (See AMP MULTILOCK ELECTRICAL CONNECTORS, Section 7 for more information.)
11. Install internal seal on lipped side of socket housing. Insert tapered end of secondary locking wedge into socket housing and press down until it snaps in place.
12. Press socket housing into pin housing until it snaps in place. Place large end of slot on attachment clip over T-stud on frame; push assembly forward to engage small end of slot.
13. See Figure 2-89. Align holes in electrical bracket with wellnuts in cross member of motorcycle frame. Install two bolts and tighten to 6-9 **in-lbs** (0.7-1.0 Nm) torque.

⚠CAUTION

Always install and tighten top fender bolt first or undue stresses may lead to fender cracking.

14. Install top fender bolt. Hold bolt head at underside of fender and install nut topside. Tighten top fender nut to 10 ft-lbs (14 Nm) torque.
15. Align holes in chrome strut cover with those in strut. Verify that directional light leads are positioned under strut cover so that they are not pinched when cover is tightened.
16. See Figure 2-90. Slide directional stalk stud through holes in strut cover, strut and fender. Install nut.
17. Install fender support screws through strut cover, strut and fender. Install nuts.
18. Tighten directional stalk and fender support nuts to 8-13 ft-lbs (11-18 Nm) torque.

⚠CAUTION

Check for proper tail lamp operation before riding motorcycle.

19. Install seat. See SEAT INSTALLATION in this Section.

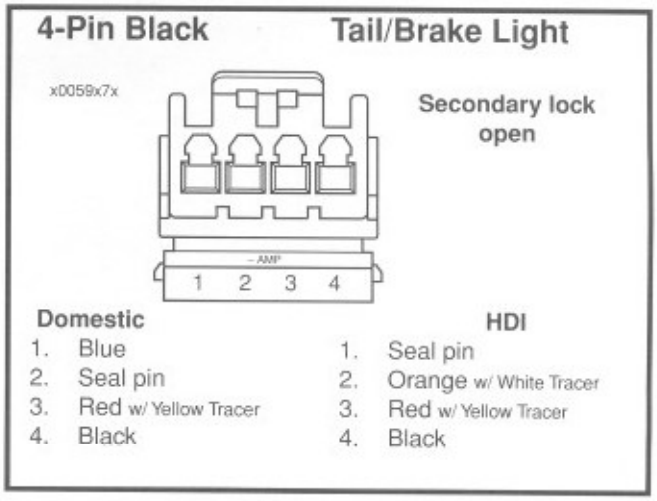


Figure 2-93. Amp Connector

JIFFY STAND

GENERAL

The vehicle is equipped with a jiffy stand (or side stand) that locks when placed in the full forward position (down) with the full weight of the vehicle resting on it.

⚠WARNING

- **Without the weight of the motorcycle resting on the jiffy stand, any vehicle movement could cause the jiffy stand to retract slightly from the full forward position. If the jiffy stand is not in the full forward or lock position when vehicle weight is rested on it, the vehicle could fall over, possibly causing personal injury and/or vehicle damage.**
- **Always park the vehicle on a firm, level surface. The weight of the vehicle can cause it to fall over, possibly causing personal injury and/or vehicle damage.**
- **Be sure jiffy stand is fully retracted before riding. If jiffy stand is not fully retracted during vehicle operation, unexpected contact with the road surface can distract the rider. While the jiffy stand will retract upon contact, the momentary disturbance and/or rider distraction can lead to loss of vehicle control resulting in personal injury and/or vehicle damage.**

REMOVAL

⚠WARNING

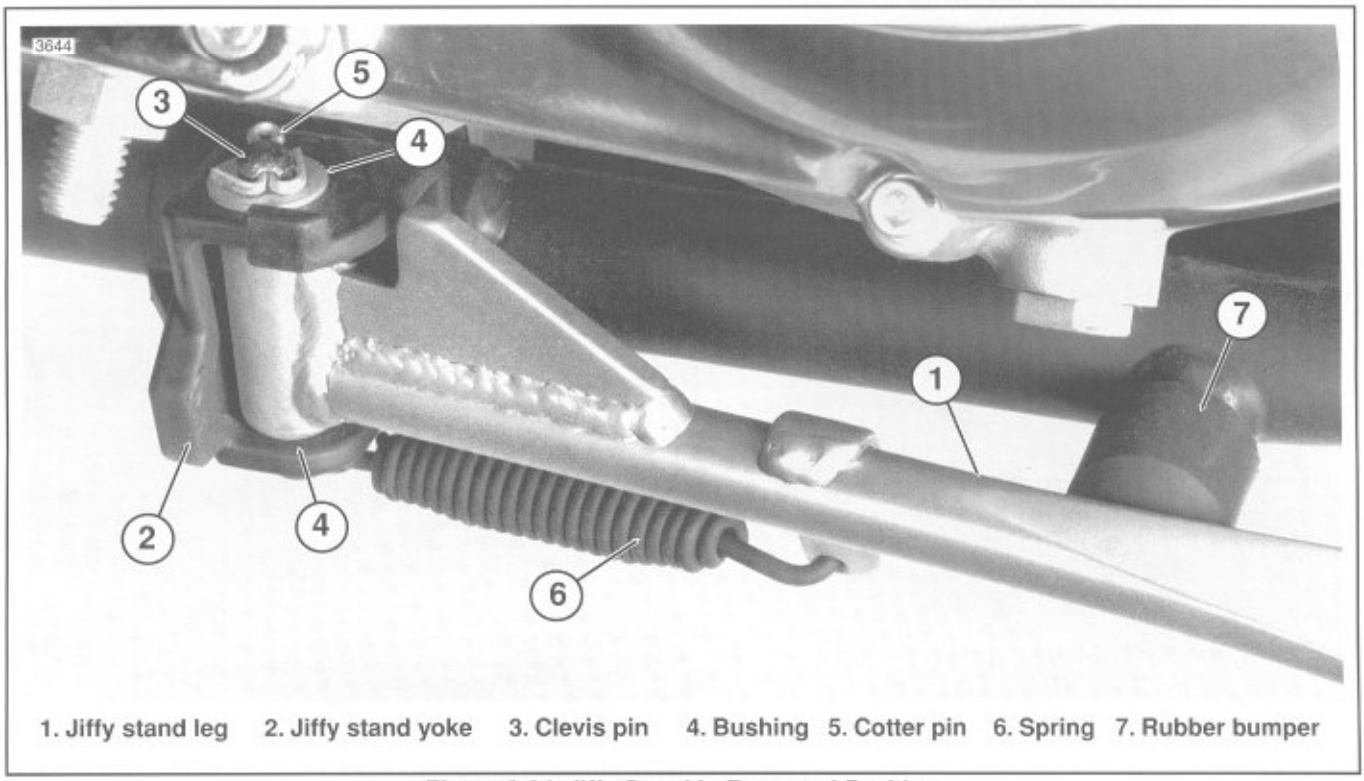
Wear gloves and protective eyeglasses (or face shield) when performing the following procedure. The jiffy stand spring tension could cause the spring, attached components and/or hand tools to fly outward at great speed and could cause personal injury.

1. Block motorcycle under frame so that motorcycle is securely upright and jiffy stand may be moved through its full range of travel.
2. See Figure 2-94. Remove rubber bumper (7) from frame to permit further retraction of jiffy stand leg (1). Additional spring tension relief allows for easier spring removal.
3. Place jiffy stand leg (1) in retracted position. Remove and discard cotter pin (5).
4. See Figure 2-95. While firmly holding jiffy stand leg (1) in fully retracted position, withdraw clevis pin (3) until it disengages with the upper pivot hole of jiffy stand yoke (2).
5. Detach spring (6) from anchor pin using pliers. Unhook other end of spring from jiffy stand leg (1).
6. Remove clevis pin (3) from lower pivot hole of jiffy stand yoke (2). Remove jiffy stand leg (1). Remove upper and lower bushings (4).

CLEANING AND LUBRICATION (Figure 2-95)

Clean and lubricate jiffy stand assembly every 5,000 miles (8,000 km). Proceed as follows:

1. Refer to JIFFY STAND, REMOVAL to remove jiffy stand from motorcycle frame.
2. Thoroughly clean all jiffy stand components, including frame-mounted anchor pin and jiffy stand yoke (2).



1. Jiffy stand leg 2. Jiffy stand yoke 3. Clevis pin 4. Bushing 5. Cotter pin 6. Spring 7. Rubber bumper

Figure 2-94. Jiffy Stand in Retracted Position

3. Apply a small amount of wheel bearing grease to pivot holes of jiffy stand leg (1) and yoke (2), groove of anchor pin (3) and O.D. of clevis pin (6).

4. Refer to JIFFY STAND, INSTALLATION to install jiffy stand to motorcycle frame.

INSTALLATION

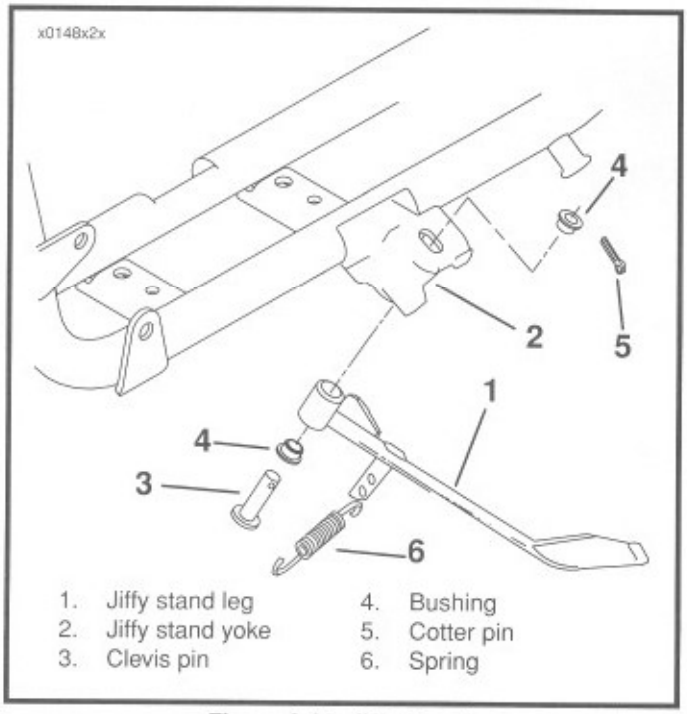
⚠WARNING

Wear gloves and protective eyeglasses (or face shield) when performing the following procedure. The jiffy stand spring tension could cause the spring, attached components and/or hand tools to fly outward at great speed and possibly cause personal injury.

1. Clean and lubricate jiffy stand components according to procedure listed in JIFFY STAND, CLEANING AND LUBRICATION.

2. See Figure 2-95. Hook either end of spring (6) into spring mounting hole on jiffy stand leg (1). Install loose end of spring over anchor pin.

3. While holding end of spring (6) in groove of anchor pin and holding jiffy stand leg (1) in its retracted position, position pivot end of jiffy stand leg within yoke (2) on motorcycle frame. Insert clevis pin (3) through lower pivot hole of yoke and halfway into pivot hole of jiffy stand leg.



1. Jiffy stand leg
2. Jiffy stand yoke
3. Clevis pin
4. Bushing
5. Cotter pin
6. Spring

Figure 2-95. Jiffy Stand

4. See Figure 2-94. Lift jiffy stand leg (1) upward, aligning pivot hole of jiffy stand leg with slotted upper hole of yoke (2). With shoulder down, position bottom bushing (4), over clevis pin (3). Insert clevis pin (3) through holes in jiffy stand leg and yoke.

5. Install upper bushing (4) over end of clevis pin (3) and against upper surface of yoke (2). Insert **new** cotter pin (5) through hole in end of clevis pin. Bend ends of cotter pin apart to secure.

6. Press rubber bumper (7) onto mounting stud on motorcycle frame.

7. Extend and retract jiffy stand leg several times to check for proper operation. In retracted position (up), jiffy stand leg should be securely seated against frame-mounted rubber bumper (7).

8. Place jiffy stand in its full forward position (down). Carefully remove support blocking from beneath motorcycle frame. Rest motorcycle on jiffy stand.

REMOVAL (Figure 2-97)

1. Remove screw (1) to detach seat from rear fender.
2. Slide seat rearward to remove from frame.
3. If dual seat, inspect passenger strap (3) for damage or excessive wear. Remove bolt (4) and flat washer (5) to detach passenger strap from rear fender, if necessary.

INSTALLATION (Figure 2-97)

1. Install passenger strap if mounting dual seat. Align holes on each end of strap with forward hole in rear fender. With concave side up, align hole in flat washer (5) with those in strap (3). Install bolt (4) and tighten to 8-13 ft lbs (11-18 Nm) torque.

⚠WARNING

After installing seat, pull upward on front of seat to be sure it is locked in position. If seat is loose, it could shift during vehicle operation and startle the rider, causing loss of control and personal injury.

2. Verify that rectangular metal plate is tightly secured to seat bottom and that no rivets are loose or missing. Position seat (4) on frame with mounting bracket (3) at rear.
3. See Figure 2-96. Slide seat forward until the tongue welded to center frame support fits snugly in groove at bottom of seat. The groove is formed where the contoured ribs are bridged by the metal plate.
4. Pull up on seat to verify that it is locked in place.
5. See Figure 2-97. Install screw (1) to fasten seat mounting bracket to top of rear fender. Mounting bracket of solo seat uses forward hole in rear fender; dual seat uses rearward hole.
6. Tighten mounting bracket screw (1).
7. Pull up on seat again to verify that it is properly secured, front and rear.

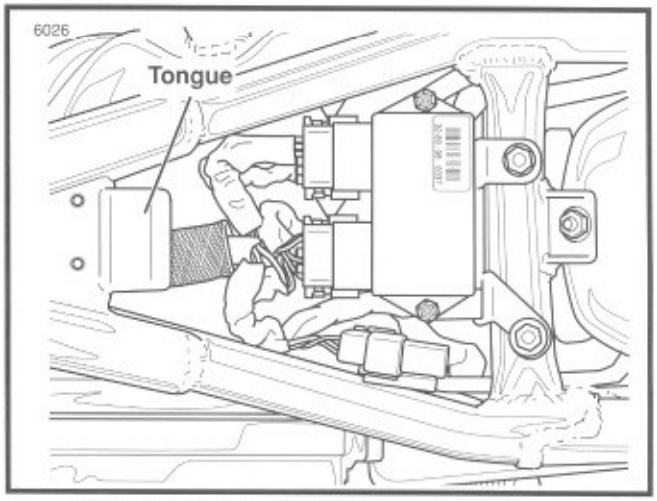
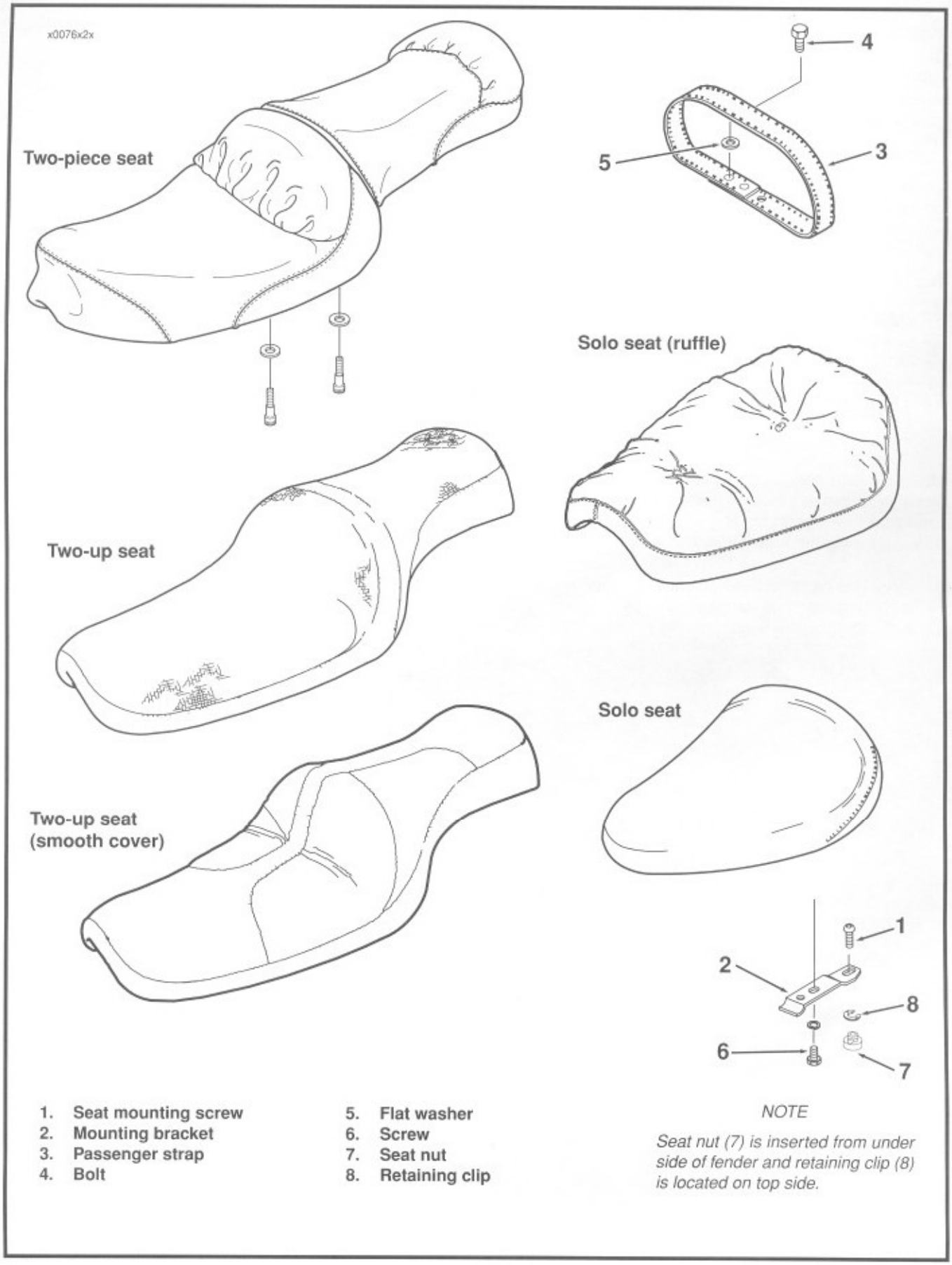


Figure 2-96. Seat Installation (1200S shown)



1. Seat mounting screw
2. Mounting bracket
3. Passenger strap
4. Bolt
5. Flat washer
6. Screw
7. Seat nut
8. Retaining clip

NOTE

Seat nut (7) is inserted from under side of fender and retaining clip (8) is located on top side.

Figure 2-97. Seat

ENGINE 3

SUBJECT PAGE NO.

SPECIFICATIONS

NOTE

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

General	883	1200	1200S Sport
Number of cylinders	2	2	2
Type	4-cycle, 45°V	4-cycle, 45°V	4-cycle, 45°V
Horsepower	57 @ 6,000 rpm	66 @ 5,200 rpm	69 @ 5,500 rpm
Bore (inches)	3.000 in.	3.498	3.498
(mm)	76.20 mm	88.85 mm	88.85 mm
Stroke (inches)	3.812	3.812	3.812
(mm)	96.82 mm	96.82 mm	96.82 mm
Piston displacement (cubic inches)	53.9	73.3	73.3
(cc)	883 cc.	1201 cc.	1201 cc.
Torque (foot-pounds)	53 @ 4,500 rpm	72 @ 4,000 rpm	76 @ 4,000 rpm
(Nm)			
Compression ratio	9.0 to 1	9.0 to 1	10.0 to 1
Oil tank capacity with filter (U.S. quarts)	3	3	3
(liters)	2.8 liters	2.8 liters	2.8 liters

ITEM	NEW COMPONENTS		SERVICE WEAR LIMITS
	883cc	1200cc	
Valve			
Fit in guide			
Exhaust	0.0015-0.0033 in.	*	0.0040 in.
	0.038-0.084 mm	*	0.102 mm
Intake	0.008-0.0026 in.	*	0.0035 in.
	0.020-0.066 mm	*	0.089 mm
Seat width	0.040-0.062 in.	*	0.090 in.
	1.02-1.57 mm	*	2.29 mm
Stem protrusion from cylinder valve pocket	1.975-2.011 in.	*	2.031 in.
	50.17-51.08	*	51.59 mm
Outer spring – free length	2.105-2.177 in.	*	2.105 in. (min.)
	53.47-55.30 mm		53.47 mm
Intake			
1.751-1.848 in. (closed)	72-92 lbs	*	
	32.6 kg.-41.7 kg.	*	
1.286 - 1.383 in. (open)	183-207 lbs	*	
	82.9-93.8 kg	*	
Exhaust			
1.751-1.848 in. (closed)	72-92 lbs	*	1.926 in. (min.)
	32.6-41.7 kg	*	48.92 mm
1.332 - 1.429 in. (open)	171-195 lbs	*	
	77.5-88.3 kg	*	
Inner spring – free length	1.926-1.996 in.	*	
	48.92-50.70 mm		
Intake			
1.577-1.683 in. (closed)	38-49 lbs	*	
	17.2-22.2 kg	*	
1.112-1.218 in. (open)	98-112 lbs	*	
	44.4-50.7 kg	*	
Exhaust			
1.577-1.683 in. (closed)	38-49 lbs	*	
	17.2-22.2 kg	*	
1.158-1.264 in. (open)	91-106 lbs	*	
	41.2-48.0 kg	*	

* Same as 883 cc

SPECIFICATIONS (CONTINUED)

ITEM	NEW COMPONENTS		SERVICE WEAR LIMITS
	883cc	1200cc	
Rocker Arm			
Shaft fit in bushing (loose)	0.0005-0.0020 in. 0.013-0.051 mm	* *	0.0035 in. 0.089 mm
End clearance	0.003-0.013 in. 0.08-0.33 mm	* *	0.025 in. 0.64 mm
Bushing fit in rocker arm (tight)	0.004-0.002 in. 0.10-0.05 mm	* *	
Rocker Arm Shaft			
Shaft fit in rocker cover (loose)	0.0007-0.0022 in. 0.018-0.056 mm	* *	0.0035 in. 0.089 mm
Piston			
Compression ring gap (top & 2nd)	0.010-0.023 in. 0.25-0.58 mm	0.007-0.020 in. 0.18-0.51 mm	0.032 in. 0.81 mm
Oil control ring rail gap	0.0010-0.053 in. 0.25-1.35 mm	0.009-0.052 in. 0.23-1.32 mm	0.065 in. 1.65 mm
Compression ring side clearance			
Top	0.0020-0.0045 in. 0.051-0.114 mm	0.0020-0.0045 in. 0.051-0.114 mm	0.0065 in. 1.65 mm
2nd	0.0020-0.0045 in. 0.051-0.114 mm	0.0016-0.0041 in. 0.041-0.104 mm	0.0065 in. 1.65 mm
Oil control ring side clearance	0.0014-0.0074 in. 0.036-0.188 mm	0.0016-0.0076 in. 0.041-0.193 mm	0.0094 in. 0.239 mm
Piston pin fit (loose) (room temperature)	0.00005-0.00045 in. 0.0013-0.0114 mm	*	0.00100 in. 0.0254 mm
Cylinder Head			
Valve guide in head (tight)	0.0033-0.0020 in. 0.084-0.051 mm	* *	
Valve seat in head (tight)	0.0035-0.0010 in. 0.089-0.025 mm	* *	
Head gasket surface (flatness)	0.006 in. total 0.15 mm	* *	0.006 in. total 0.15 mm
Cylinder			
Taper			0.002 in. 0.05 mm
Out of round			0.003 in. 0.08 mm
Warpage (gasket surfaces)			
Top			0.006 in. .15 mm
Base			0.008 in. 0.20 mm
Bore diameter ± 0.0002 in.			**883cc** **1200cc**
Standard	3.0005 in. 76.213 mm	3.4978 in. 88.844 mm	3.0035 in. 3.5008 in. 76.289 mm 88.920 mm
0.005 Oversize (O.S.)	3.0048 in. 76.323 mm	3.502 in. 88.95 mm	3.0078 in. 3.505 in. 76.398 mm 89.03 mm
0.010 O.S. Bore	3.0098 in. 76.449 mm	3.507 in. 89.08 mm	3.0128 in. 3.510 in. 76.525 mm 89.15 mm
0.020 O.S. Bore	3.0198 in. 76.703 mm	3.517 in. 89.33 mm	3.0228 in. 3.520 in. 76.779 mm 89.41 mm
0.030 O.S. Bore	3.0298 in. 76.957 mm	3.527 in. 89.59 mm	3.0328 in. 3.530 in. 77.033 mm 89.66 mm
0.040 O.S. Bore	3.0398 in. 77.211 mm	—	3.0428 in. — 77.287 mm

* Same as 883 cc

SPECIFICATIONS (CONTINUED)

ITEM	NEW COMPONENTS		SERVICE WEAR LIMITS
	883cc	1200cc	
Connecting Rod			
Piston pin fit (loose)	0.00125-0.00175 in.	*	0.00200 in.
	0.0318-0.0445 mm	*	0.0508 mm
Side play between flywheels	0.005-0.025 in.	*	0.030 in.
	0.13-0.64 mm	*	
Fit on crankpin (loose)	0.0004-0.0017 in.	*	0.0027 in.
	0.010-0.043 mm	*	0.069 mm
Tappet			
Fit in guide	0.0008-0.0023 in.	*	0.003 in.
	0.020-0.058 mm	*	0.08 mm
Roller fit	0.0006--0.0013 in.	*	
	0.015-0.033 mm	*	
Roller end clearance	0.008-0.022 in.	*	0.026 in.
	0.203-0.559 mm	*	0.660 mm
Oil Pump			
Oil pressure at normal operating temperature (pressure reading taken at oil pressure switch fitting)			
with engine speed of 1000 rpm	7-12 psi.	*	
	0.5-0.8 kN/cm^2	*	
with engine speed of 2500 rpm	10-17 psi.	*	
	0.7-1.2 kN/cm^2	*	
Feed/scavenge inner/outer gerotor clearance	0.003 in.	*	0.004 in.
	0.08 mm	*	0.10 mm
Shaft to pump clearance	0.0025 in.	*	
	0.064 mm	*	
Gearcase			
Cam gear shaft in bushing (loose)	0.0007-0.0022 in.	*	0.003 in.
	0.018-0.056 mm	*	0.08 mm
Cam gear shaft end play (min) (except rear intake)	0.005-0.024 in.	*	0.025 in.
	0.13-0.61 mm	*	0.64 mm
		*	
Rear intake cam gear shaft end play (min)	0.006-0.024 in.	*	0.040 in.
	0.15-0.61 mm	*	1.02 mm
Flywheel			
Runout (flywheels at rim)	0.000-0.010 in.	*	0.010 in.
	0.00-0.25 mm	*	0.25 mm
Runout (shaft at flywheel end)	0.000-0.002 in.	*	0.002 in.
	0.00-0.05 mm	*	0.05 mm
End play	0.001-0.005 in.	*	0.005 in.
	0.025-0.13 mm	*	0.13 mm
Sprocket Shaft Bearing			
Outer race fit in crankcase (tight)	0.0004-0.0024 in.	*	
	0.010-0.061 mm	*	
Bearing inner race fit on shaft (tight)	0.0002-0.0015 in.	*	
	0.005-0.038 mm	*	
Pinion Shaft Bearings			
Pinion shaft journal diameter	1.2500-1.2496 in.	*	1.2494 in. (min)
	31 750-31.740 mm	*	31.735 mm
Outer race diameter in right crankcase	1.5646-1.5652 in.	*	1.5672 in. (max)
	39.741-39.756 mm	*	39.807 mm
Bearing running clearance	0.00012-0.00088 in.	*	
	0.0030-0.0224 mm	*	
Fit in cover bushing fit (loose)	0.0023-0.0043 in.	*	0.0050 in.
	0.058-0.109 mm	*	0.127 mm

* Same as 883 cc

SPECIFICATIONS (CONTINUED)

ITEM	NEW COMPONENTS		SERVICE WEAR LIMITS
	883cc (HDI)	1200cc	
Ignition System			
Timing during engine cranking	5° BTDC (0° BTDC)	*	
Timing with engine speed at 950-1050	20° BTDC	*	
Spark plug gap (6R12)	0.038-0.043 in. 0.97-1.09 mm	* *	
Engine Speed			
Slow idle	950-1050 rpm	*	
Setting ignition timing	1650-1950 rpm	*	
Torque Values			
Crank pin nut	150-185 ft-lbs 203-251 Nm	* *	
Pinion gear nut	35-45 ft-lbs 47-61 Nm	* *	
Oil tank mounting locknuts	3-5 ft-lbs 4-7 Nm	* *	
Oil pump mounting screws	125-150 **in-lbs** 14.1-17.0 Nm	* *	
Push rod tube seal plate bolts	15-18 **ft-lbs** 20-24 Nm	* *	
Gearcase cover fasteners	80-110 **in-lbs** 9.0-12.4 Nm	* *	
Rocker cover			
5/16 in. bolts	15-18 ft-lbs 20-24 Nm	* *	
1/4 in. bolts	10-13 ft-lbs 14-18 Nm	* *	
1 Rear engine mount fasteners			
Frame to crankcase	25-30 ft-lbs 34-41 Nm	* *	
Negative cable nut	65-80 **in-lbs** 7-10 Nm	* *	
2 Lower front engine bracket fasteners			*NOTE* *Torque engine mount fasteners in the numerical sequence shown in bold.*
Crankcase	25-30 ft-lbs 34-41 Nm	* *	
Frame	25-30 ft-lbs 34-41 Nm	* *	
3 Upper front engine bracket fasteners			
Cylinder head	25-30 ft-lbs 34-41 Nm	* *	
Frame	30-35 ft-lbs 41-47 Nm	* *	
4 Top center engine bracket fasteners			
Cylinder head	25-30 ft-lbs 34-41 Nm	* *	
Frame	30-35 ft-lbs 41-47 Nm	* *	
Timer screws (inner cover & sensor plate)	15-20 **in-lbs** 1.7-2.3 Nm	* *	
Spark plug	11-18 ft-lbs 15-24 Nm	* *	
Rotor bolt	43-48 **in-lbs** 4.9-5.4 Nm	* *	
Tappet plate screws	80-11 **in-lbs** 9.0-12.4 Nm	* *	

* Same as 883 cc

ENGINE

GENERAL

The V2 Evolution™ engine is a two-cylinder, four-cycle, air-cooled, overhead-valve V-twin. It has three major component assemblies: **cylinder, crankcase,** and **gearcase.**

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

The up-and-down motion of the piston in the cylinder is converted to circular motion in the **crankcase.** The multi-piece crankshaft consists of a crank pin mounted between two counterweighted flywheels, which rotate on two end shaft bearings. The lower end of the rear cylinder connecting rod is forked to fit around the single-end front cylinder connecting rod, allowing a single connecting rod crank pin connection to the flywheel.

The **gearcase** is located on the right side of the crankcase. The gearcase houses the gear train, which operates and times the valves and ignition. The cam gear train, consisting of four cam shafts with one cam lobe on each shaft, is gear driven. The engine valves are opened and closed through the mechanical linkage of tappets, push rods, and rocker arms. Hydraulic lifters, located in the tappets, automatically compensate for heat expansion to maintain the no-lash fit of valve train components. Tappets serve to transmit the cam action to the valve linkage. Valve timing is obtained by aligning timing marks when installing cam gears.

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

The trigger rotor has two openings which time the cylinders.

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

XL Sport

The 1200S model has a single fire twin plug ignition. Each head has two spark plugs which fire at the end of that cylinder's compression stroke. The other cylinder's spark plugs do not fire.

The trigger rotor has six openings which time the cylinders.

Fuel

Gasoline/alcohol Blends

Harley-Davidson motorcycles were designed to obtain the best performance and efficiency using unleaded gasoline (87 pump octane or higher). Some fuel suppliers sell gasoline/alcohol blends as a fuel. The type and amount of alcohol added to the fuel is important.

- DO NOT USE GASOLINE CONTAINING METHANOL. Using gasoline/Methanol blends will result in starting and driveability deterioration and damage to critical fuel system components.
- Gasolines containing METHYL TERTIARY BUTYL ETHER (MTBE): Gasoline/MTBE blends are a mixture of gasoline and as much as 15% MTBE. Gasoline/MTBE blends can be used in your motorcycle.
- ETHANOL (Ethanol or grain alcohol) is a mixture of 10% ethanol and 90% unleaded gasoline. It is identified as "gasohol," "ethanol enhanced," or "contains ethanol." Gasoline/Ethanol blends can be used in your motorcycle.

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, Harley-Davidson recommends you operate your motorcycle on straight, unleaded gasoline.

Lubrication

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

ADJUSTMENT/TESTING

General

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

Most commonly, only cylinder head and cylinder repair is

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

Follow the procedure under STRIPPING MOTORCYCLE FOR ENGINE REPAIR, to strip motorcycle for removal of cylinder heads, cylinders, and pistons.

After disassembling "upper end" only, it may be found that crankcase repair is necessary; this requires removal of engine crankcase from chassis outlined under STRIPPING MOTORCYCLE FOR ENGINE REPAIR.

⚠CAUTION

If engine is removed from chassis, do not lay engine on primary side. Laying engine on primary side will damage the clutch cable end fitting.

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

Piston slap is a condition where piston and/or cylinder are worn out-of-round and are loose fitting, allowing the piston to slap from front to rear of the cylinder as it moves up and down.

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 the engine. Starting engine with throttle open may result in serious engine damage.

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

Diagnosis	Text 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 Harley-Davidson V-twin engines:

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

NOTE

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

Air Leak Location	Possible Causes
Carburetor intake.	Intake valve leaking.
Exhaust pipe.	Exhaust valve leaking.
Timing inspection hole.	Piston rings leaking. Worn or broken piston. Worn cylinder.
Head gasket.	Leaking gasket.

9. Repeat procedure on rear cylinder.

⚠CAUTION

After completing the cylinder leakage test(s), make sure that the throttle plate is in the closed position before starting the engine. Starting engine with throttle open may result in serious engine damage.

Diagnosing Smoking Engine or High Oil Consumption

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

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

STRIPPING MOTORCYCLE FOR ENGINE REPAIR

Remove seat.

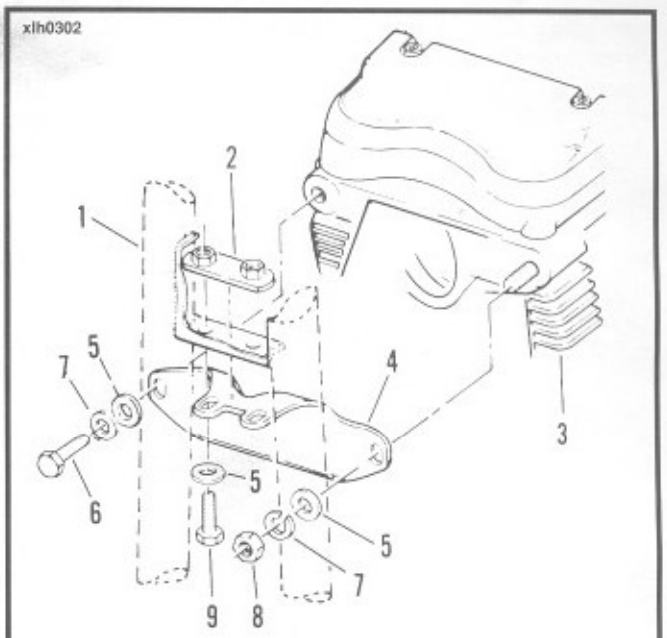
⚠WARNING

To prevent accidental starter operation and possible personal injury, disconnect battery cables (negative first) before doing any work on the engine, drive or electrical system.

Remove air cleaner assembly and backplate.

Disconnect spark plug wires. Remove: horn, ignition coil, bracket, and throttle cable clip.

Drain gasoline. Remove fuel tank.



1. Frame
2. Nut plate
3. Front cylinder
4. Top front engine mounting bracket
5. Washer (4)
6. Bolt
7. Lockwasher
8. Nut
9. Bolt (2)

Figure 3-2. Upper Front Engine Mount Bracket

1. Top center engine mounting bracket
2. Washer (2)
3. Screw (2)
4. Locknut, hex flange
5. V.O.E.S.
6. Nut plate
7. Bolt (2)
8. Shim*
9. Washer
10. Bolt

*Shim thickness
0.030 in. (0.76 mm)
0.060 in. (1.52 mm)
0.090 in. (2.29 mm)

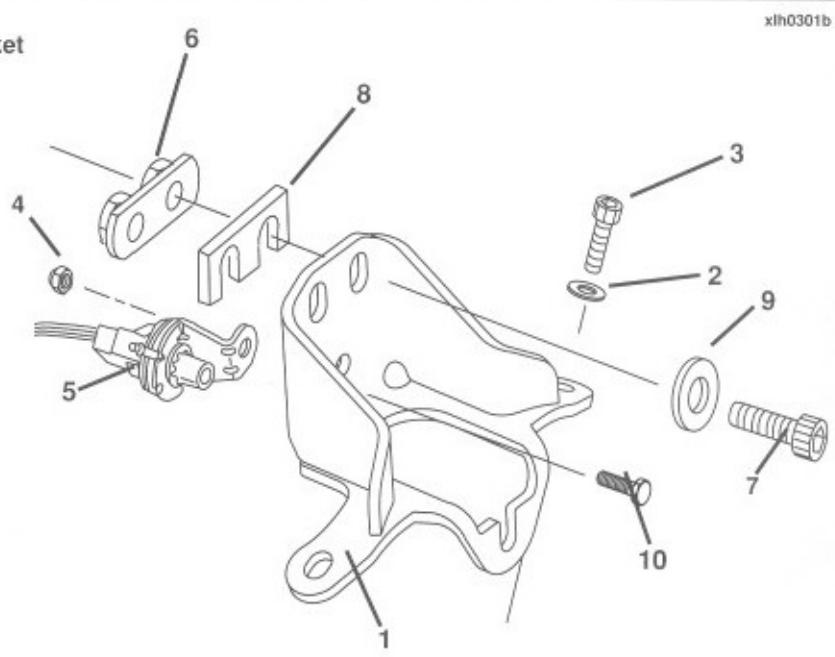


Figure 3-1. Top Center Engine Mount Bracket

⚠WARNING

Gasoline is flammable and fumes are explosive. To avoid possible personal injury, drain gasoline in well-ventilated area away from fire, flame or spark hazard. Drain gasoline into approved gasoline container only.

Free enrichener control-Disconnect V.O.E.S./ MAP hose at carburetor and V.O.E.S. wire from ignition module.

Remove carburetor with intake manifold.

Remove exhaust system.

Drain primary chaincase/transmission lubricant.

See Figure 3-1. Remove top center engine mounting bracket and shim(s).

See Figure 3-2. Remove top front engine mounting bracket.

NOTE

At this point, upper end can be worked on. See CYLINDER HEAD.

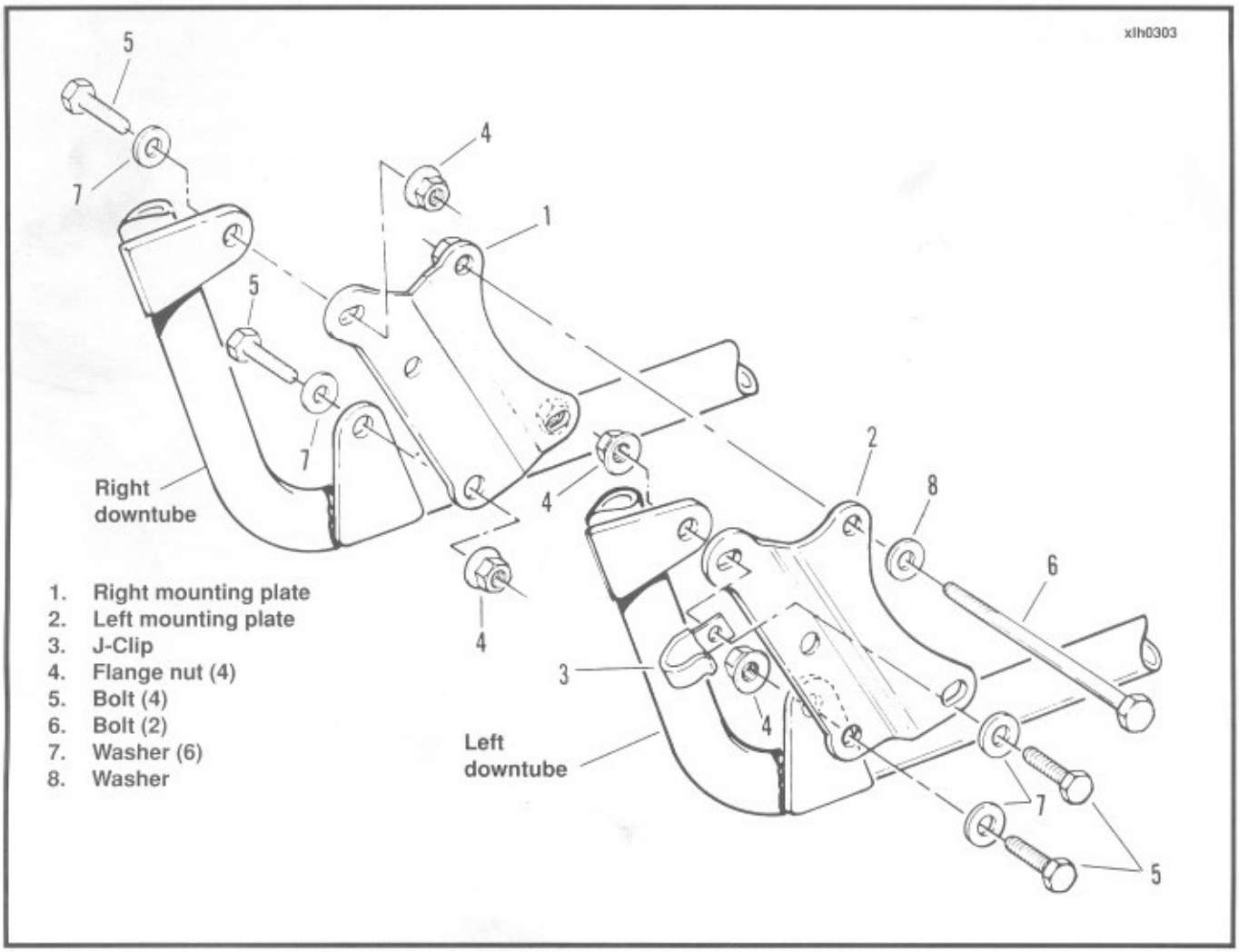


Figure 3-3. Lower Front Engine Mount Brackets

Remove rear brake master cylinder mounting bolts. Disconnect brake linkage from master cylinder.

↓

Remove rear belt sprocket cover with brake pedal and linkage.

↓

Remove rear belt.

↓

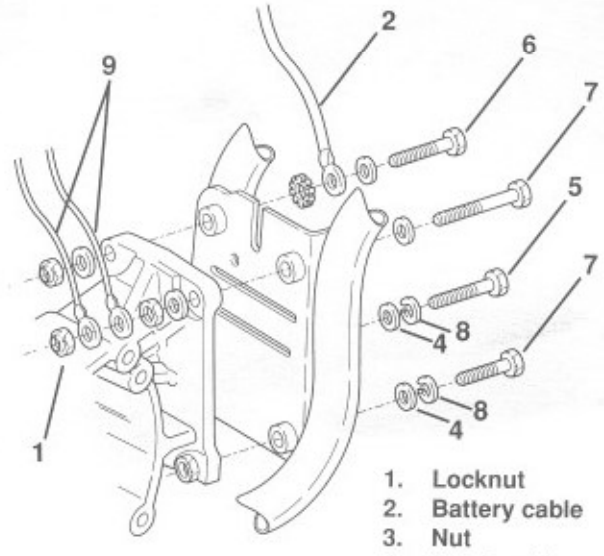
Disconnect wire to oil pressure switch.

↓

Disconnect neutral switch wire.

↓

Unplug ignition timer plate wires from wiring harness.



1. Locknut
2. Battery cable
3. Nut
4. Washer (6)
5. Bolt
6. Bolt
7. Bolt (2)
8. Lockwasher (4)
9. Main harness grounds

Figure 3-4. Rear Engine Mount Fasteners

Disconnect positive battery cable from battery. Disconnect 18-gauge green wire from starter motor.

↓

Remove battery. Remove battery tray.

↓

Disconnect the regulator/rectifier from the alternator stator at the plug beneath the regulator.

↓

Disconnect battery grounding cable attached to rear crankcase bolt.

↓

Detach clutch cable. Remove clutch handlever from handlebar.

↓

Drain engine oil. Remove oil feed, return, and vent lines at oil tank.

↓

See Figure 3-3. Remove hardware attaching lower front engine mounting plates.

↓

See Figure 3-4. Remove bolts (5, 6, and 7) attaching rear of engine to frame.

↓

Lift engine up off the mounting pad. Slip engine from right side while tipping top of engine slightly off center of chassis.

↓

⚠CAUTION

Do not lay engine on primary side as damage to clutch cable connection could result.

INSTALLING THE ENGINE

Place engine in frame from right side of motorcycle.

↓

See Figure 3-4. Install four rear engine mounting bolts (5, 6, and 7), washers (4) and nuts (3 and 1). Tighten fasteners to 25-30 ft-lbs (34-41 Nm) torque.

↓

See Figure 3-3. Install lower front engine mounting brackets with bolts (6) and washers (8). Secure plates to lower front engine frame mounts with bolts (5), washers (7) and nuts (4). Tighten engine bolts to 25-30 ft-lbs (34-41 Nm) torque. Tighten frame bolts to 25-30 ft-lbs (34-41 Nm) torque.

↓

See Figure 3-2. Install upper front engine mounting bracket; loosely attach hardware. Tighten engine bolts to 25-30 ft-lbs (34-41 Nm) torque. Tighten frame bolts to 30-35 ft lbs (41-47 Nm) torque.

↓

See Figure 3-1. Install top center engine mounting bracket; loosely attach hardware. Connect V.O.E.S./ MAP and ignition switch. Tighten engine bolts to 25-30 ft-lbs (34-41 Nm) torque. Tighten frame bolts to 30-35 ft-lbs (41-47 Nm) torque.

↓

See ENGINE LUBRICATION SYSTEM in this section, and connect feed, return, and vent lines to oil tank. Use new hose clamps.

↓

Connect battery ground wire to crankcase bolt.

↓

Connect battery positive cable and 18-gauge green wire to starter motor.

↓

Plug regulator/rectifier into stator connection. Attach sensor to wire harness. Connect neutral switch.

↓

Connect oil pressure switch wire.

↓

Attach clutch cable lever & bracket to handlebar.

↓

Install carburetor with intake manifold.

↓

NOTE
Use air cleaner backplate as guide to align carburetor manifold assembly.

↓

Attach throttle and enrichener cables to carburetor.

↓

Slide enrichener control into slot of mounting bracket. Tighten nut at backside of bracket.

↓

Install rear belt.

↓

Install rear belt sprocket cover with brake pedal and linkage.

↓

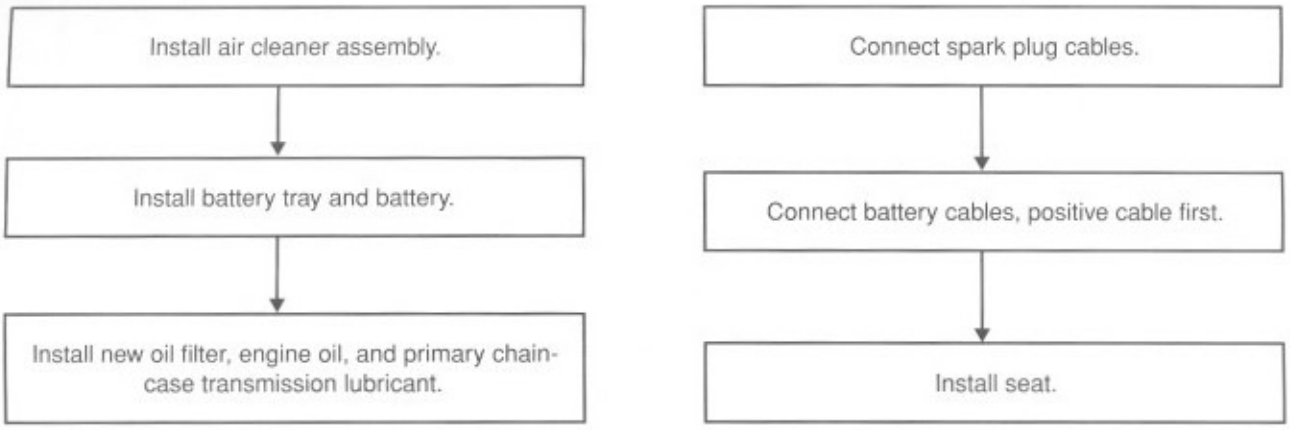
Install right footrest and master cylinder assembly. Connect brake linkage to master cylinder.

↓

Install exhaust system.

↓

Install fuel tank, fuel lines, horn (if applicable), throttle cable clip,ignition coil, and bracket.


Install air cleaner assembly.
Install battery tray and battery.
Install new oil filter, engine oil, and primary chain-case transmission lubricant.
Connect spark plug cables.
Connect battery cables, positive cable first.
Install seat.

CYLINDER HEAD

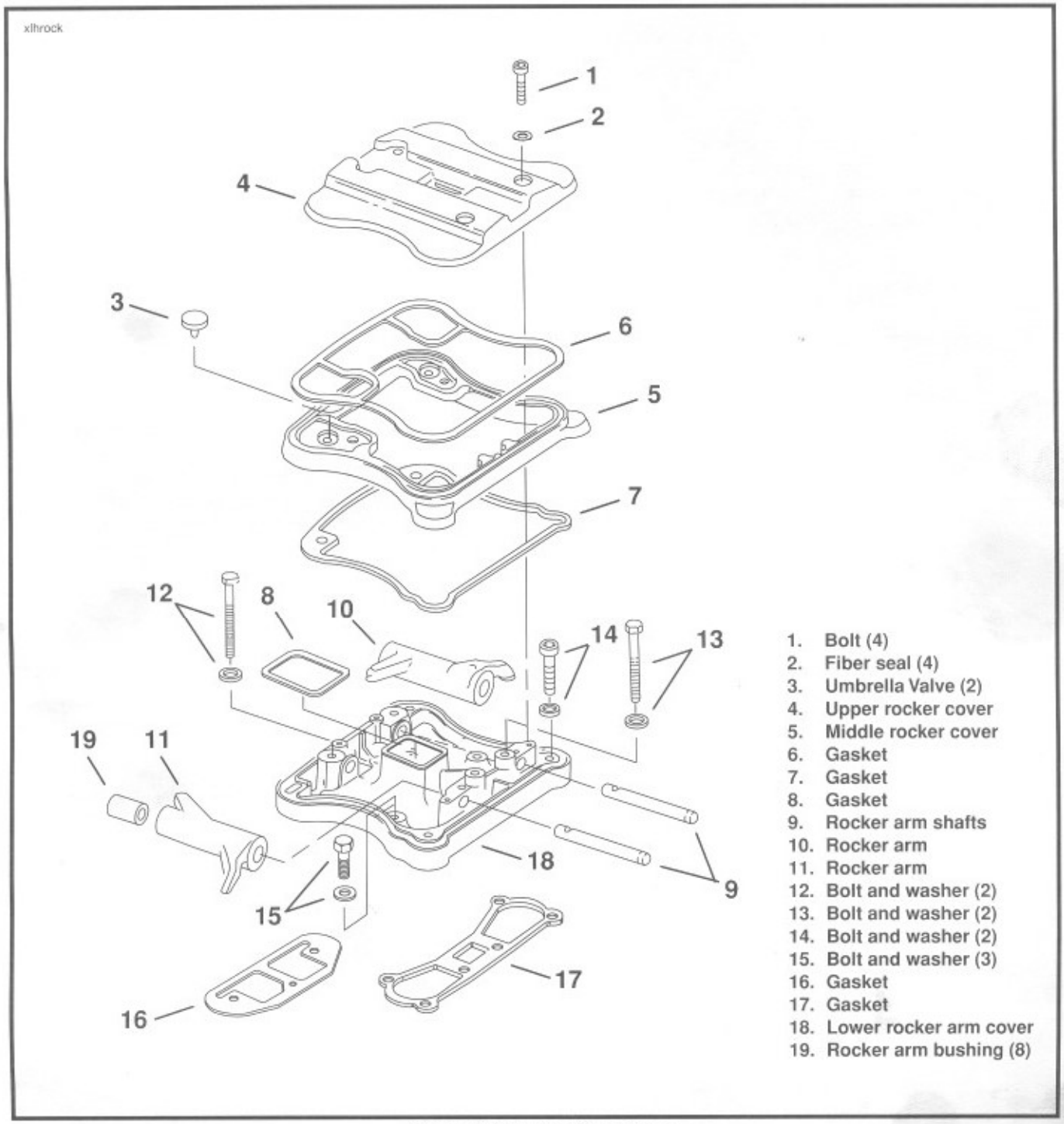
REMOVAL

Before removing the cylinder head assembly, strip motorcycle as described in STRIPPING MOTORCYCLE FOR ENGINE REPAIR. The rocker arm covers and internal components must be removed before removing cylinder heads.

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

⚠CAUTION

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



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

Figure 3-5. Rocker Arm Cover

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

3. Rotate crankshaft until both valves are closed on head being repaired.

4. Remove two 5/16 in. rocker arm retaining bolts (12) at push rod end.

5. Remove remaining fasteners and washers (13, 14, 15) holding lower rocker arm cover to cylinder head.

6. Remove lower rocker cover (18).

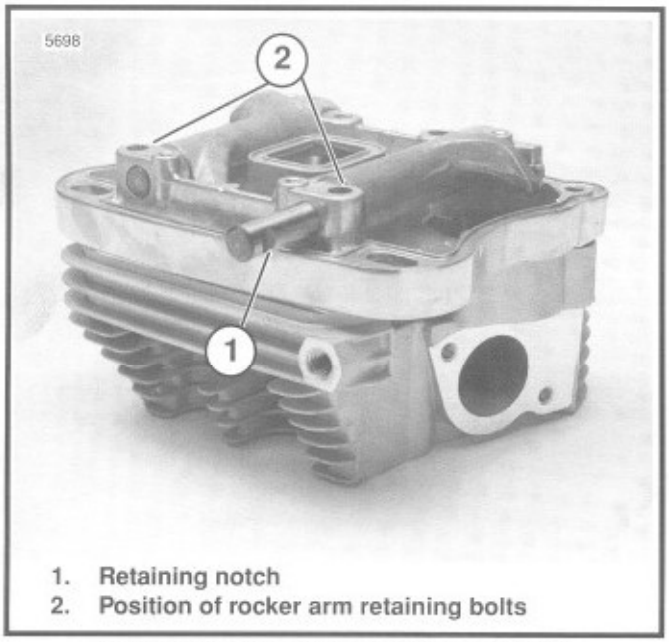
NOTE

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

⚠CAUTION

Mark rocker arm shafts for reassembly in their original positions. Valve train components must be reinstalled in their original positions during reassembly or increased engine wear may result.

7. See Figure 3-6. Remove rocker arm shafts by tapping them out using a hammer and a soft metal punch.



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

Figure 3-6. Removing Rocker Arm Shafts

8. See Figure 3-5. Remove rocker arms (10, 11); mark them for reassembly in their original locations.

⚠CAUTION

Distortion to the head, cylinder, and crankcase studs may result if head screws are not loosened (or tightened) gradually in the sequence shown in Figure 3-7.

9. See Figure 3-7. Loosen each head screw 1/8-turn following the sequence shown.

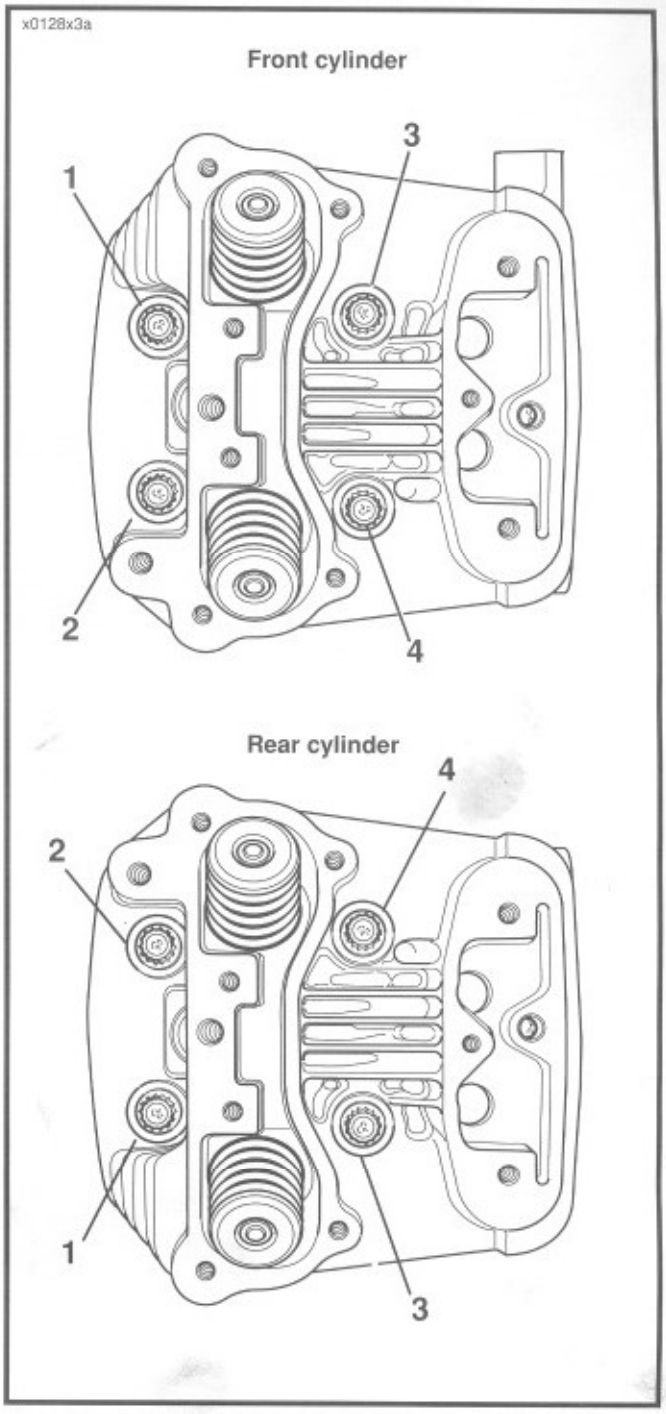


Figure 3-7. Head Screw Loosening / Tightening Sequence

10. Continue loosening in 1/8-turn increments until screws are loose. Remove screws and thick washers.

11. See Figure 3-8. Remove cylinder head (18), head gasket (4), and O-rings (14).

12. See Figure 3-9. Remove socket screws (11), washers (13), and retainers (9). Remove push rod covers (7), seals (8), O-rings (10), and push rods (12). Mark the location and orientation (top and bottom) of each push rod.

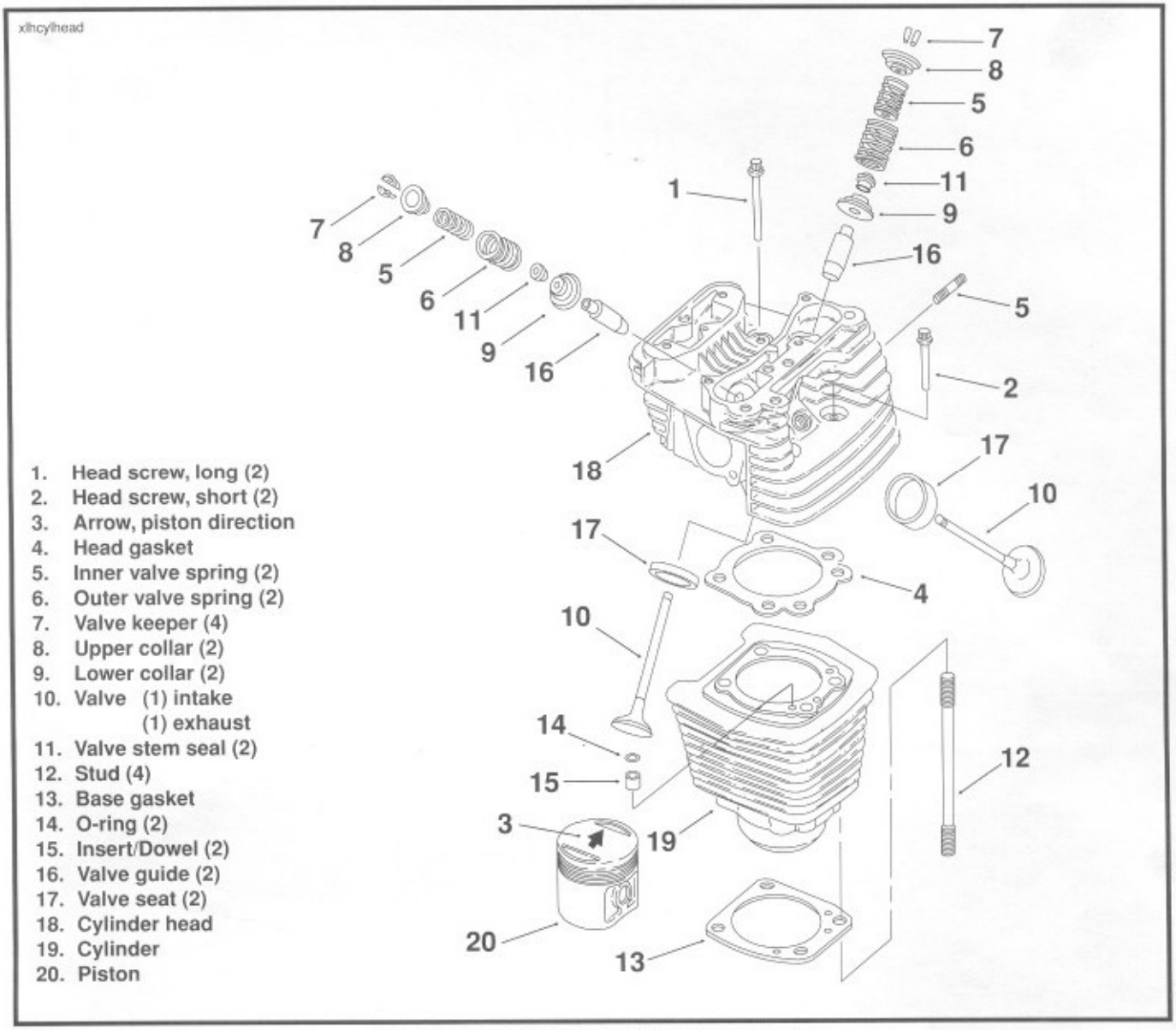


Figure 3-8. Cylinder Head, Cylinder and Piston

13. Remove socket screw (5), washer (14) and plate (4). Remove O-rings (3) from ends of pins (2). Grasp pins (2) and pull from crankcase. Use a pliers if necessary. Lift lifter out of crankcase bore.

14. Repeat Steps 1-13 for the other head.

DISASSEMBLY

1. See Figure 3-8. Compress valve springs (5 and 6) with VALVE SPRING COMPRESSOR (Part No. HD-34736B) (as shown in Figure 3-10).

2. See Figure 3-8. Remove keepers (7), upper collar (8) and springs (5 and 6). Mark keepers for reassembly in original position.

3. Use a fine tooth file to remove any burrs on the valve stem at the keeper groove.

4. Mark valve to ensure that it will be reassembled in the same head.

5. Remove valve (10), valve stem seal (11) and lower collar (9).

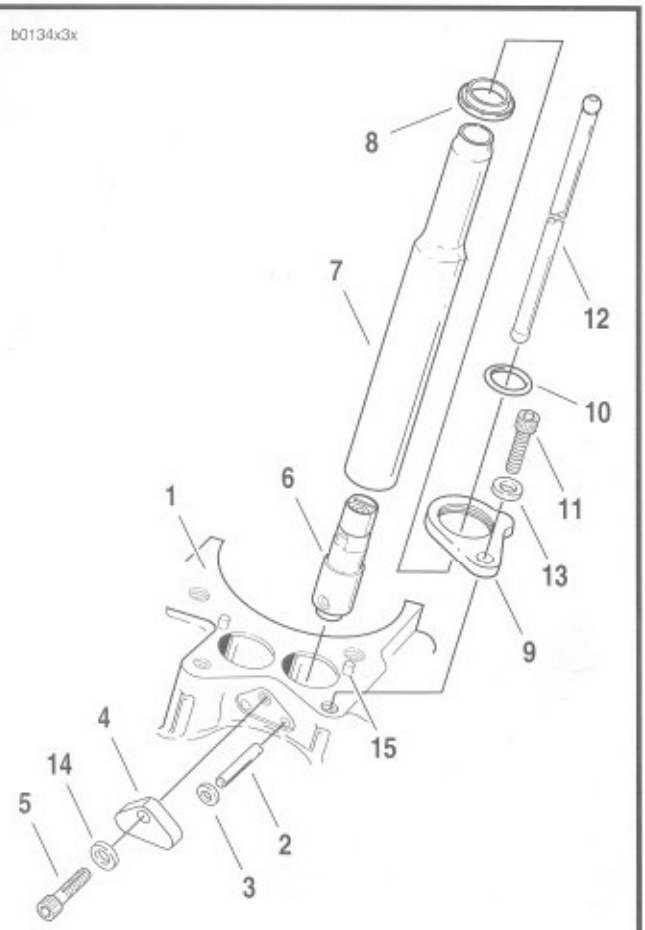
6. Repeat Steps 1-5 for the other valve.

7. Disassemble the other head following Steps 1-6.

CLEANING, INSPECTION, AND REPAIR

1. Bead blast or scrape carbon from head, top of cylinder and valve ports. Be careful to avoid scratching or nicking cylinder head and cylinder joint faces. Blow off loosened carbon or dirt with compressed air.

2. Soak cylinder head in an aluminum-compatible cleaner/ solvent to loosen carbon deposits.



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

Figure 3-9. Middle Valve Train Components (Quantities per Engine Cylinder)

3. Wash all parts in non-flammable solvent, followed by a thorough washing with hot, soapy water. Blow out oil passages in head. Be sure they are free of sludge and carbon particles. Remove loosened carbon from valve head and stem using a wire wheel. Never use a file or other hardened tool which could scratch or nick valve. Polish valve stem with very fine emery cloth or steel wool.

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

5. See Figures 3-11 and 3-12. Measure rocker arm shaft diameter at the positions where shaft fits in lower rocker arm cover and where rocker arm bushings ride. Record the measurements.

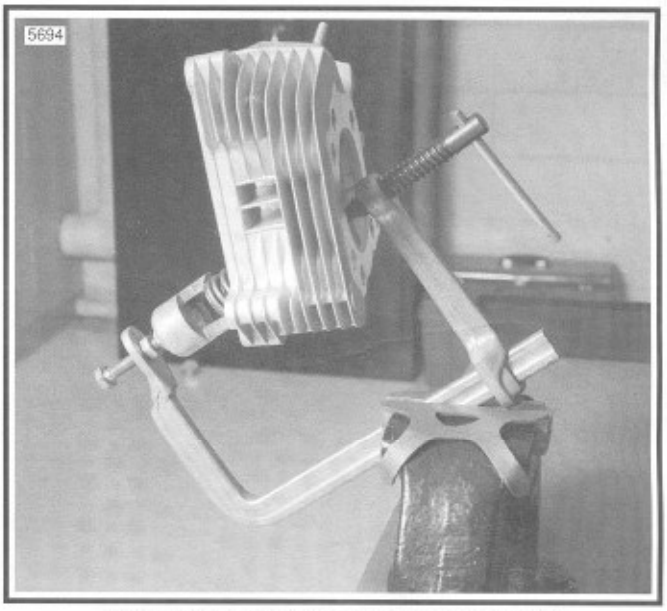


Figure 3-10. Compressing Valve Springs

Figure 3-11. Measuring Rocker Arm Shaft Diameter (Rocker Cover Position)

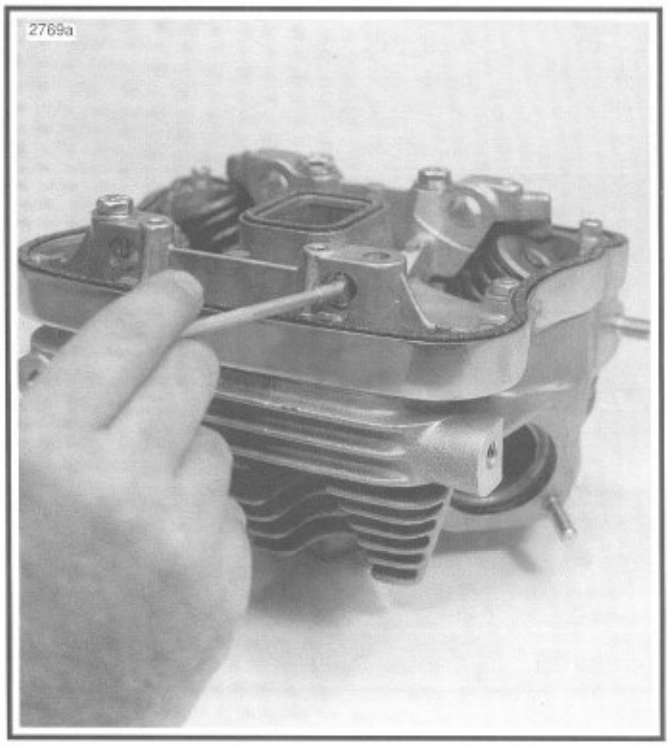


Figure 3-13. Measuring Rocker Arm Shaft Bore Diameter in Lower Rocker Cover

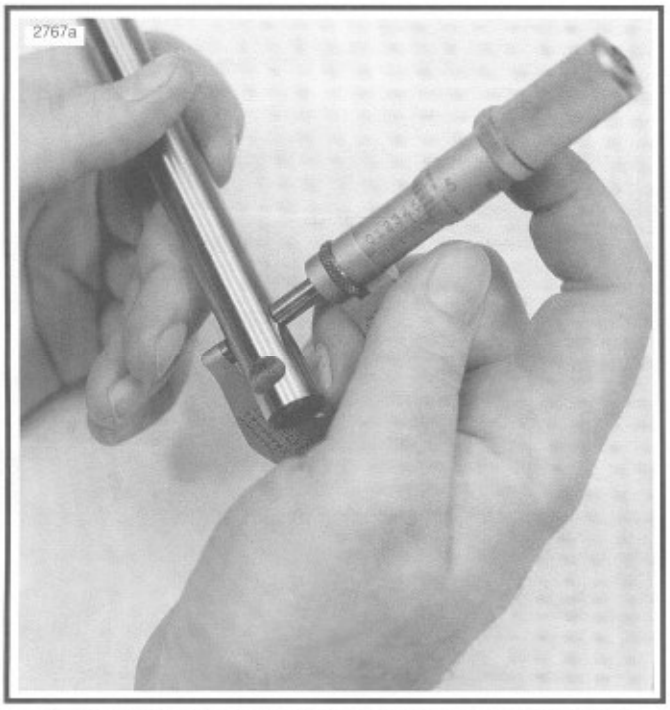


Figure 3-12. Measuring Rocker Arm Shaft Diameter (Rocker Arm Bushing Position)

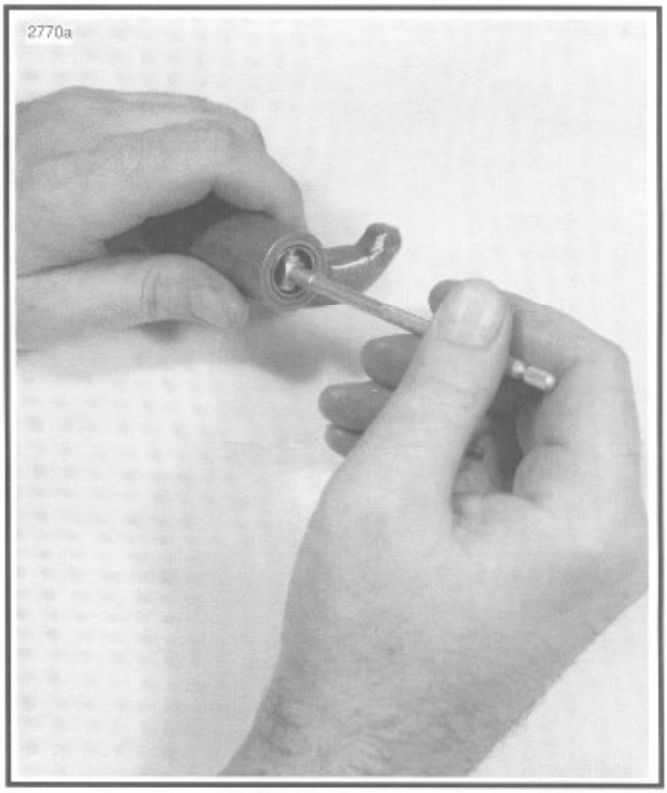


Figure 3-14. Measuring Rocker Arm Bushing Inner Diameter

6. See Figures 3-13 and 3-14. Measure rocker arm shaft bore diameter in lower rocker cover and rocker arm bushing inner diameter. Record the measurements.

7. Check the clearances and measurements obtained in Steps 5 and 6 against the SERVICE WEAR LIMITS.

8. Repair or replace parts exceeding the SERVICE WEAR LIMITS.

9. Assemble rocker arms and rocker arm shafts into lower rocker cover.

10. Check end play of rocker arm with feeler gauge.

11. Replace rocker arm or lower cover or both if end play exceeds 0.025 in. (0.63 mm).
12. Valve heads should have a seating surface width of 0.040-0.062 in. (1.02-1.57 mm), and should be free of pit marks and burn spots. The color of carbon on exhaust valves should be black or dark brown. White or light buff carbon indicates excessive heat and burning.
13. Valve seats are also subject to wear, pitting, and burning. They should be resurfaced whenever valves are refinished.
14. Clean valve guides by lightly honing with VALVE GUIDE HONE (Part No. HD-34723).
15. Scrub guides with VALVE GUIDE BRUSH (Part No. HD-34751) and hot soapy water. Measure valve stem outer diameter and valve guide inner diameter. Check measurements against SERVICE WEAR LIMITS.
16. Inspect spark plug threads for damage. If threads in head are damaged, a special plug type insert can be installed using a 12mm spark plug repair kit.
17. Inspect valve springs for broken or discolored coils.
18. See Figure 3-15. Check free length and compression force of each spring. Compare with ENGINE SPECIFICATIONS. If spring length is shorter than specification, or if spring compression force is below specification, replace spring.

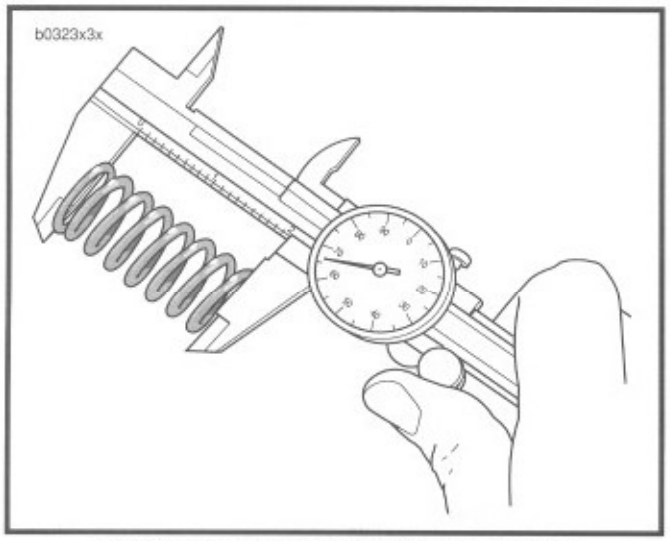


Figure 3-15. Checking Spring Free Length

19. Examine push rods, particularly the ball ends. Replace any rods that are bent, worn, discolored, or broken.
20. See Figure 3-16. Check head gasket surface on head for flatness. Machine or replace any head which exceeds SERVICE WEAR LIMIT of 0.006 in. (0.15 mm).

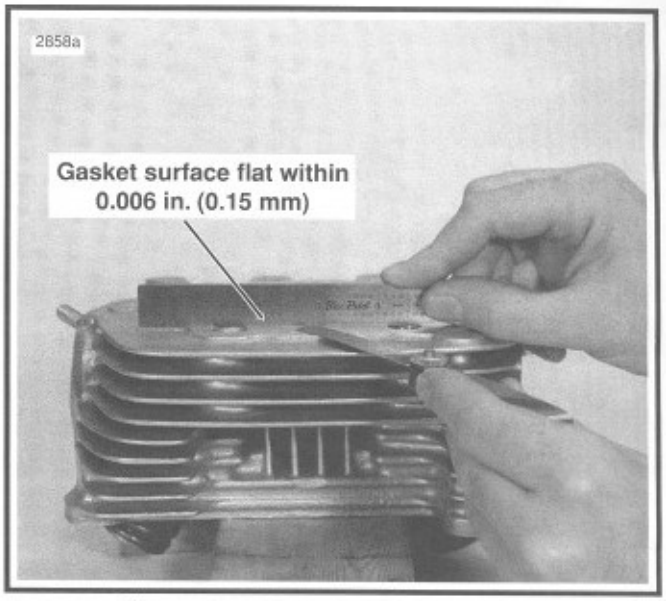


Figure 3-16. Checking Gasket Surface

Rocker Arms and Bushings

1. See Figure 3-17. To replace worn bushings, press or drive them from the rocker arm. If bushing is difficult to remove, turn a 9/16-18 tap into bushing. From opposite side of rocker arm, press out bushing and tap.
2. Press replacement bushing into rocker arm, flush with arm end, and split portion of bushing towards top of arm.
3. Using remaining old bushing as a pilot, line ream new bushing with Harley-Davidson ROCKER ARM BUSHING REAMER (Part No. HD-94804-57).
4. Repeat for other end of rocker arm.

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 the following chart. If valve stems and/or guides are worn beyond service wear limits, install new parts.

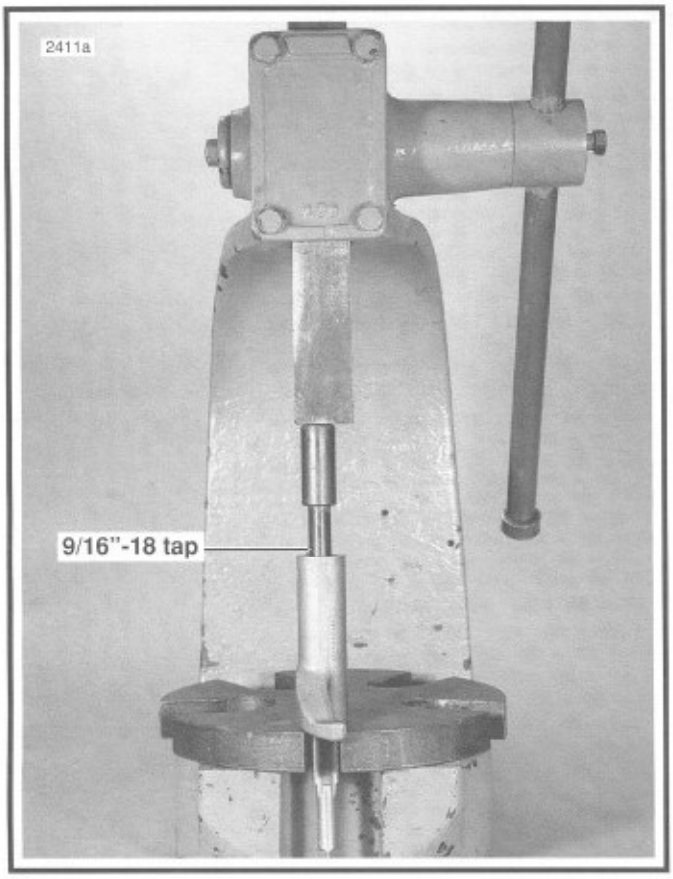


Figure 3-17. Removing Rocker Arm Bushing

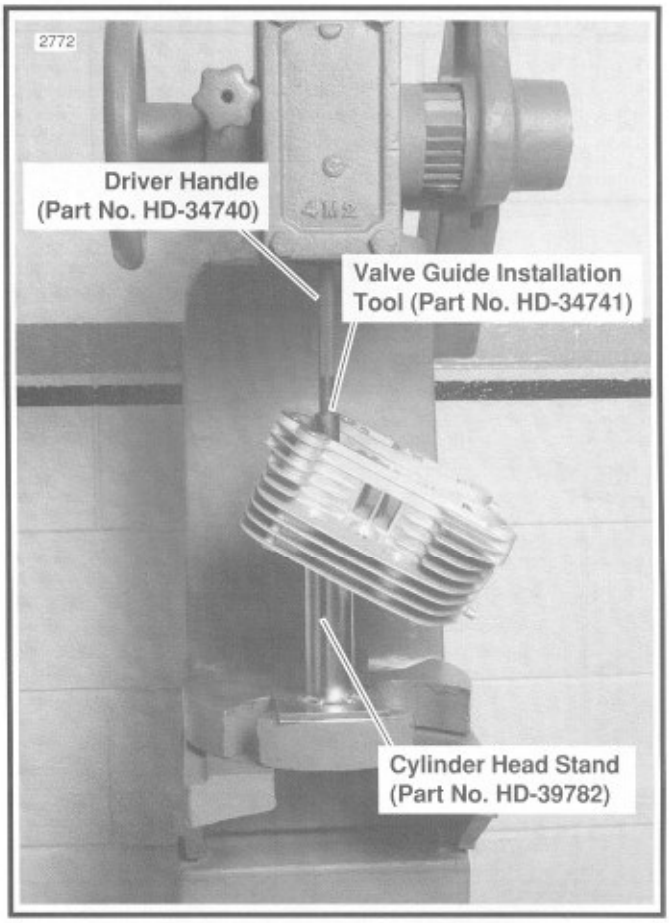


Figure 3-18. Installing Shoulderless Valve Guide

VALVE STEM CLEARANCES AND SERVICE WEAR LIMITS

Valve	Clearance	Service Wear Limit
Exhaust	0.0015-0.0033 in.	0.0040 in.
Intake	0.008-0.0026 in.	0.0035 in.

1. To remove shoulderless guides, press or tap guides toward combustion chamber using DRIVER HANDLE AND REMOVER (Part No. HD-34740).
2. Clean and measure valve guide bore in head.
3. Measure outer diameter of a new standard valve guide. The guide diameter should be 0.0020-0.0033 in. (0.051-0.084 mm). larger than bore in head. If it is not, select one of the following oversizes: +0.001 in., +0.002 in., or +0.003 in. (+0.025, +0.05 +0.08 mm) (intake and exhaust).
4. See Figure 3-18. Install shoulderless guides using VALVE GUIDE INSTALLATION TOOL (Part No. HD-34731) and DRIVER HANDLE (Part No. HD-34740). Press or drive guide until the tool touches the machined surface surrounding the guide. At this point, the correct guide height has been reached.
5. Ream guides to final size or within 0.0010 in. (0.025 mm) of final size using VALVE GUIDE REAMER- Part No. HD-39932 (Steel) or Part No. HD-39932-CAR (Carbide). Use REAMER LUBRICANT (Part No. HD-39964) or liberal amounts of suitable cutting oil to prevent reamer chatter.
6. See Figure 3-19. Apply the proper surface finish to the valve guide bores using the VALVE GUIDE HONE (Part No. HD-34723). Lubricate hone with honing oil. Driving hone with an electric drill, work for a crosshatch pattern with an angle of approximately 60°.

NOTE

The hone is not intended for the removal of material.

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

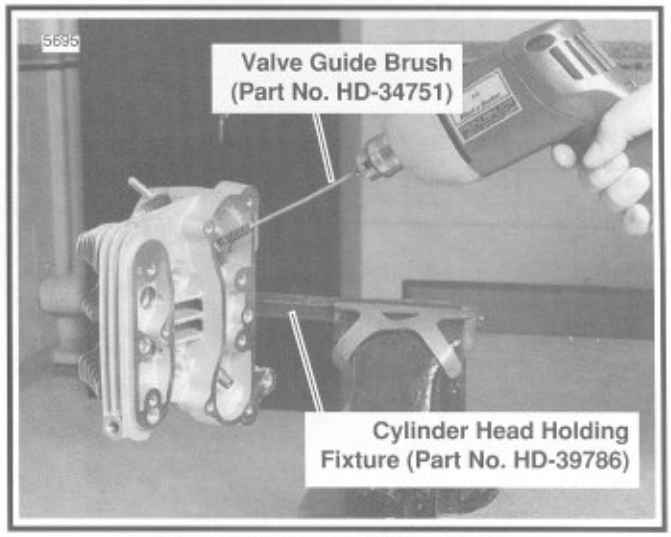


Figure 3-19. Honing Valve Guides

Grinding Valve Faces and Seats

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

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

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

See Figure 3-20. Correct 3-angle valve seat angles are shown. Use NEWAY VALVE SEAT CUTTERS; which are part of NEWAY VALVE SEAT CUTTER SET, (Part No. HD-35758) to cut the seats. Always grind valves before cutting seats.

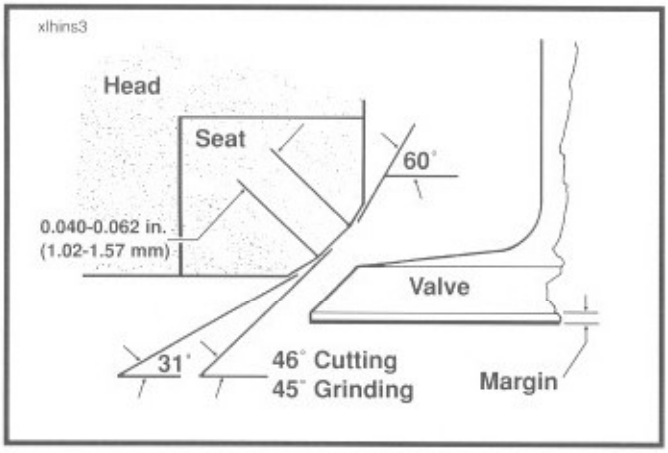


Figure 3-20. Valve Seat Angles

1. Using the #622 cutter, cut 46° (or grind 45°) valve seat angle first. Use cutting oil to avoid chatter marks. Cut or grind only enough to clean up the seat.

2. Apply a small amount of lapping compound to the valve face. Rotate valve against seat using VALVE LAPPING TOOL (Part No. HD-96550-36A).

3. See Figure 3-20. Check the contact pattern on valve face. It should be 0.040-0.062 in. (1.02-1.57 mm) wide, and its center should be positioned 2/3 of the way toward the outside edge of face.

4. If valve seat pattern is too close to the stem side of valve face, use the #205 cutter to cut the 60° angle to raise the seat. If pattern is too close to the edge of valve face, use cutter #622 to cut a 31° angle to lower the seat.

5. After cutting either or both 31° or 60° angles to position seat, final cut 46° (or grind 45°) seat angle to obtain proper 0.040-0.062 in. (1.02-1.57 mm) width.

6. Recheck valve seat width and location with lapping compound as described in Step 2.

7. To achieve a smooth even finish, place a piece of 280 grit emery paper under the cutter head and rotate cutter.

8. See Figure 3-21. Wipe valve seats and valve faces clean. Measure valve stem protrusion. If valve stem protrudes more than 2.034 in. (51.66 mm), valve seat or cylinder head must be replaced. If valve stem protrusion is within the acceptable range, valves and seats are ready for lapping.

⚠CAUTION

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

Figure 3-21. Measuring Valve Stem Protrusion

Replacing Valve Seats

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

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

Lapping Valve Faces and Seats (Figure 3-22)

NOTE

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

1. Apply a light coat of fine lapping compound to valve face. Insert valve in guide. Position one rubber cup end of VALVE LAPPING TOOL (Part No. HD-96550-36A) onto head of valve. Holding lapping tool as shown, apply only very light pressure against valve head, and rotate lapping tool and valve alternately clockwise and counterclockwise a few times.

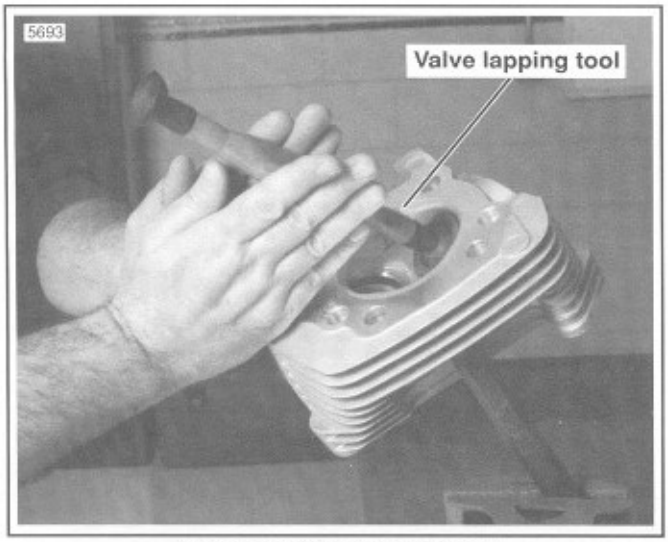


Figure 3-22. Lapping Valves

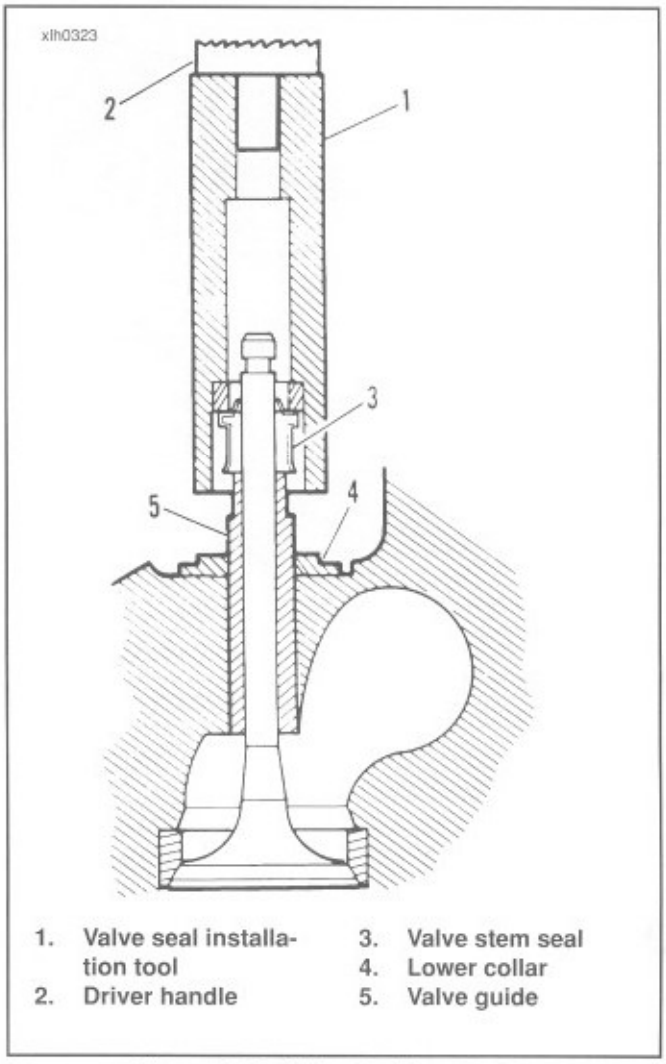
2. Lift valve and rotate it about 1/3 of a turn clockwise. Repeat lapping procedure in Step 1.
3. Repeat Step 2. Then, remove valve.
4. Wash valve face and seat; dry with a new, clean cloth or towel.
5. If inspection shows an unbroken lapped finish of uniform width around both valve and seat, valve is well seated. If lapped finish is not complete, further lapping (or grinding and lapping) is necessary.

ASSEMBLY

⚠CAUTION

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

1. Wash cylinder head and valves in warm, soapy water to remove all lapping compound.
2. Scrub valve guide bores with VALVE GUIDE BRUSH (Part No. HD-34751) and hot, soapy water.
3. Blow dry with compressed air.
4. Apply a liberal amount of engine oil to the valve stem.
5. See Figure 3-23. Insert valve into guide and install lower collar (4).



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

Figure 3-23. Valve Seal Installation

6. See Figure 3-24. Place a protective sleeve over the valve stem keeper groove. Coat the sleeve with oil and place a new seal over the valve stem.

⚠CAUTION

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

7. See Figure 3-23. Tap the seal onto the guide using the VALVE SEAL INSTALLATION TOOL (Part No. HD-34643A) and DRIVER HANDLE (Part No. HD-34740). The seal is completely installed when the tool touches the lower collar (4).
8. See Figure 3-8. Install valve springs (5 and 6) and upper collar (8).
9. Compress springs with VALVE SPRING COMPRESSOR (Part No. HD-34736B).

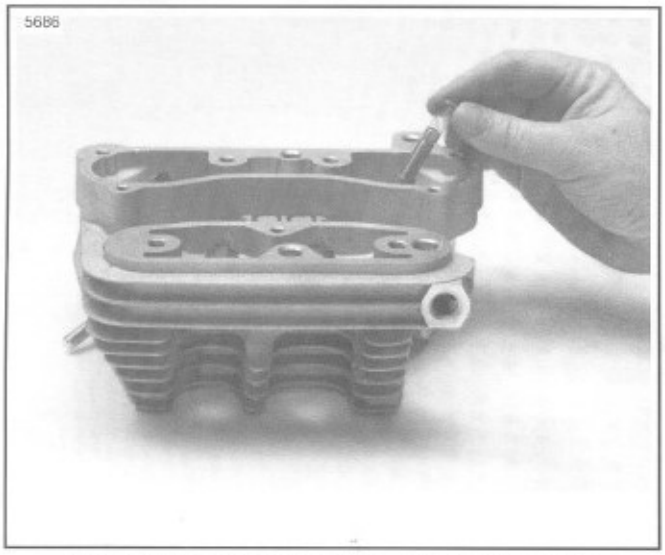


Figure 3-24. Valve Guide Seal Protector Sleeve

10. Insert keepers (7) into upper collar (8), making sure they engage groove in valve stem. The keeper gaps should be equal.

11. Release and remove VALVE SPRING COMPRESSOR.

12. Repeat Steps 4 - 11 for the remaining valve(s).

INSTALLATION

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

1. See Figure 3-8. Coat mating surfaces of cylinder studs (12) and head screws (1 and 2) with parts cleaning solution.

2. Scrape old oil and any carbon deposits from threads by using a back-and-forth motion, threading each head screw onto its mating cylinder stud.

3. Remove head screws from studs. Wipe or blow dry thread surfaces.

4. Apply oil to stud threads and to the underside of the head screw shoulder.

⚠CAUTION

Only oil film must remain on the head screw surfaces. Too much oil will pool in the head screw sleeve preventing full thread engagement.

5. Blow or wipe off excess oil from head screws.

6. Thoroughly clean and dry the gasket surfaces of cylinder (19) and cylinder head (18).

7. Install a new O-ring (14) on each dowel (15).

⚠CAUTION

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

8. Install a new head gasket (4) to cylinder.

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

10. Install head screws (1 and 2) finger tight.

⚠CAUTION

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

11. See Figure 3-7. For each cylinder head, start with screw numbered one, as shown. In increasing numerical sequence (i.e. – 1, 2, 3, 4), tighten head screws in the following stepes:

FIRST STEP:	Tighten each screw to 7-9 ft-lbs (9-12 Nm) torque.
SECOND STEP:	Tighten each screw to 12-14 ft-lbs (16-19 Nm) torque.
THIRD STEP:	**Loosen all screws**
FORTH STEP:	Tighten each screw to 7-9 ft-lbs (9-12 Nm) torque.
FIFTH STEP:	Tighten each screw to 12-14 ft-lbs (16-19 Nm) torque.
SIXTH STEP:	SeeFigure 3-25. Mark cylinder head and head screw shoulder with a line as shown (View A). Tighten each screw a quarter turn (90˚) (View B).

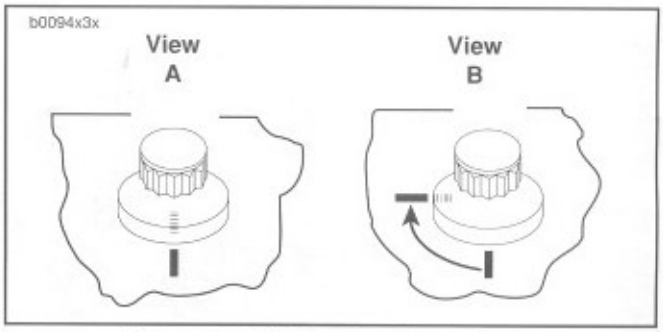


Figure 3-25. Tightening Head Screws

12. See Figure 3-9. Rotate engine so that both tappets (6), from the cylinder being serviced, will be installed on the base circle (lowest position) of the cam.

13. Apply a liberal amount of engine oil to tappet assembly (especially roller needles), to ensure smooth initial operation.

14. Insert tappet (6) into bore in crankcase (1). Rotate tappet so that flats at upper end of tappet face the front and rear of the engine. If the tappet is installed incorrectly, pins (2) cannot be inserted.

15. Insert pins (2) in the holes in crankcase. Place new O-rings (3) over ends of pins. Install plate (4) using screw (5) with washer (14). Tighten screw (5) to 80-110 in-lbs. (9.0-12.4 Nm).

16. Slide new seal (8), and place retainer (9), over top of push rod cover (7). Position new O-ring (10) at top of push rod cover. Hold cover at an angle and insert top through hole in cylinder head. Push up on cover while aligning bottom of cover with tappet bore in crankcase. Lower retainer (9) with seal (8) onto crankcase, aligning locating pin (15) with hole in retainer.

17. Insert screw (11) with washer (13) through hole in retainer (9), and thread into tapped hole in crankcase. Tighten screw (11) to 15-18 ft-lbs (20-24 Nm) torque.

18. Identify push rod color coding and length, and respective push rod positions in engine (see Push Rod Selection Table below). Place intake and exhaust push rods (12) onto seat at top of tappet (6).

Push Rod Selection Table

Position	Color Code, Part Number, Length
Exhaust (Front & Rear)	3 Band - Pink, 17904-89, 10.800 in.
Intake (Front & Rear)	1 Band - Brown, 17897-89, 10.746 in.

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

⚠CAUTION

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

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

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

22. Repeat above procedures for other cylinder.

CYLINDER AND PISTON

REMOVAL/DISASSEMBLY (Figure 3-26)

1. Strip motorcycle as described under STRIPPING MOTORCYCLE FOR ENGINE REPAIR in this section.

2. Remove cylinder head as described under CYLINDER HEAD, REMOVAL in this section.

3. Clean crankcase around base of cylinder to prevent dirt and debris from entering crankcase while removing cylinder.

4. Turn engine over until one piston (3) is at bottom of its stroke.

5. Carefully raise cylinder (1) just enough to permit placing clean towel under piston to prevent any foreign matter from falling into crankcase.

NOTE

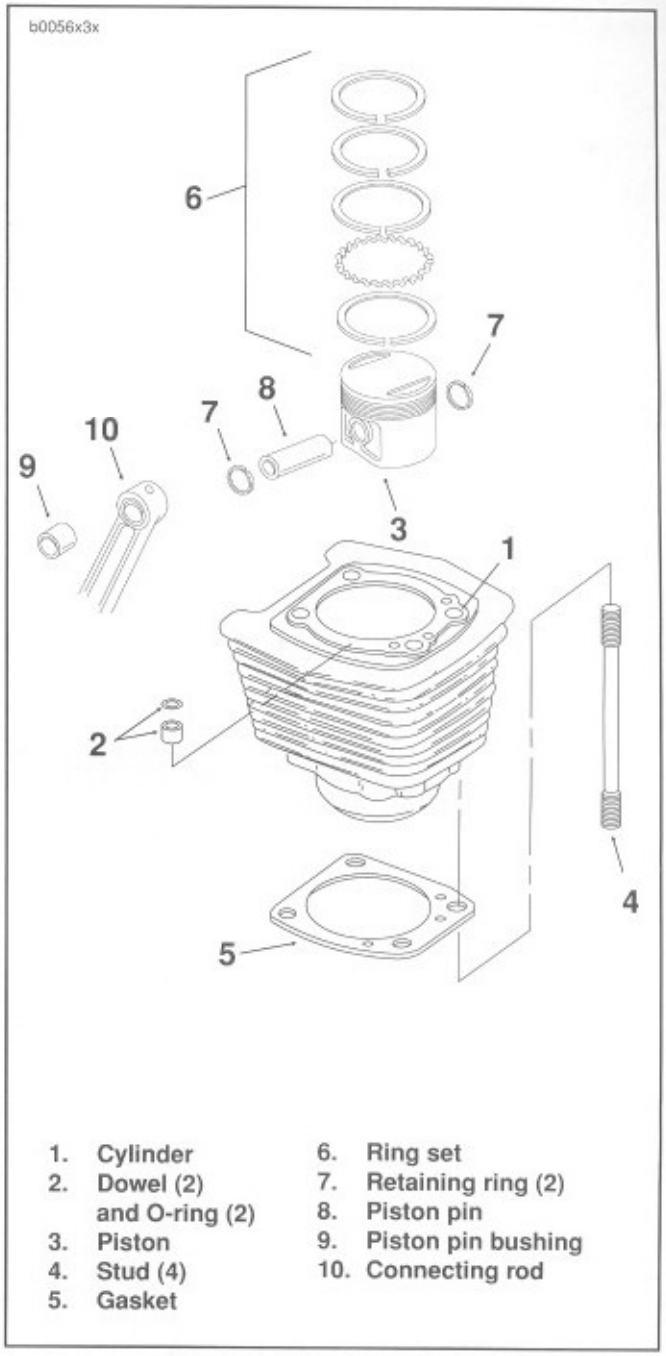
If cylinder does not come loose, tap lightly with rawhide hammer. Never try to pry cylinder up.

6. Carefully lift cylinder (1) over piston (3) and studs (4). Do not allow piston (3) to fall against cylinder studs. Discard cylinder base gasket (5).

⚠CAUTION

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

7. Install a 6-in. (150 mm) length of 1/2-in. (12.7 mm) I.D. plastic or rubber hose over each stud. This will protect the studs and the pistons.



1. Cylinder
2. Dowel (2) and O-ring (2)
3. Piston
4. Stud (4)
5. Gasket
6. Ring set
7. Retaining ring (2)
8. Piston pin
9. Piston pin bushing
10. Connecting rod

Figure 3-26. Cylinder and Piston

⚠WARNING

The next step covers removing the piston pin retaining rings. These rings are highly compressed in the ring groove and may "fly out" with considerable force when pried out of the groove, possibly resulting in personal injury. Safety glasses or goggles must be worn while removing or installing retaining rings.

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

⚠CAUTION

The piston pin retaining rings must not be reused. Removal may weaken retaining rings and they may break or dislodge. Either occurrence will damage engine.

NOTE

Since the piston pin is a loose fit in the piston, the pin will easily slide out. The pins have tapered ends to help seat the round retaining rings. See Figure 3-27. 1200cc piston pins are stamped with a V-groove at one end.

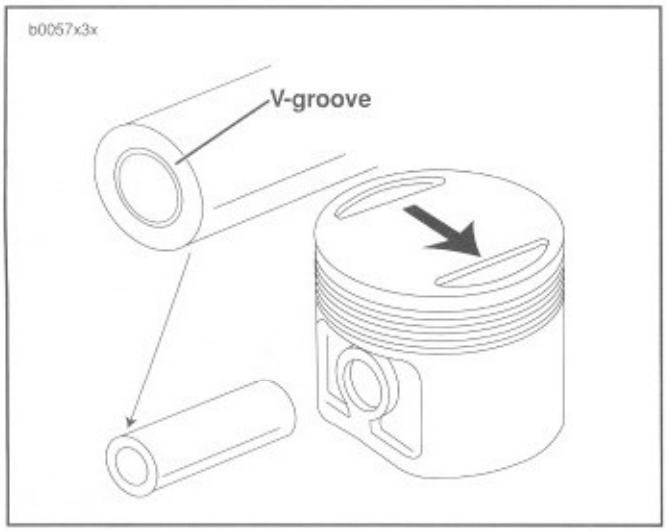


Figure 3-27. Piston Pin and Piston Identification

9. Mark each pin boss with either an "F"or an "R" to indicate front or rear cylinder, respectively. See Figure 3-27. The arrow at the top of 883cc and 1200cc pistons must always point toward the front of the engine.

⚠CAUTION

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

10. Spread piston rings (6) outward until they clear grooves in piston (3) and lift off.

CLEANING, INSPECTION, AND REPAIR

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 piston pin properly fitted to upper connecting rod bushing has a 0.00125 to 0.00175 in. (0.0317-0.0444 mm) clearance in bushing. If piston pin-to-bushing clearance exceeds 0.00200 in. (0.0508 mm), replace worn parts. See CONNECTING ROD BUSHINGS.
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 (Figure 3-28)

⚠CAUTION

If either cylinder gasket surface does not meet flatness specifications, replace cylinder and piston.

1. Check that cylinder top (head) gasket surface is flat within 0.006 in. (0.15 mm). Lay a straight edge across the surface, then try to insert a feeler gauge between the straightedge and the gasket surface.
2. Check that the cylinder base gasket surface is flat within 0.008 in. (0.20 mm). Lay a straightedge across the surface, then try to insert a feeler gauge between the straightedge and the gasket surface.

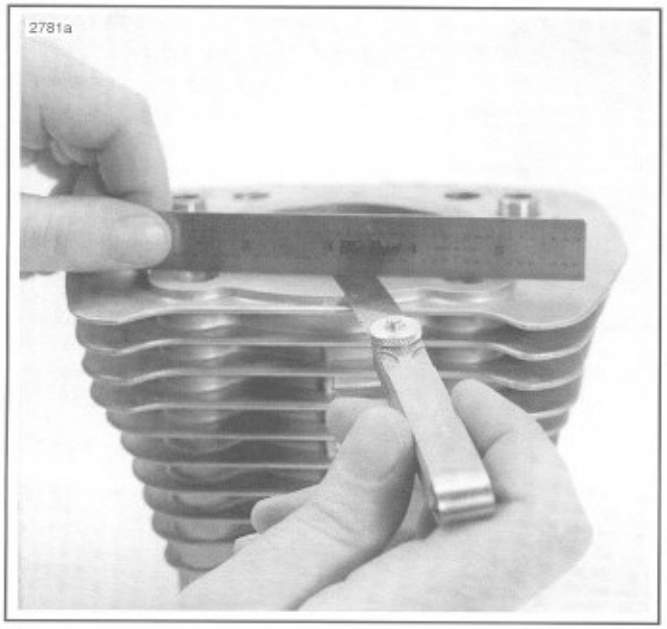


Figure 3-28. Checking Gasket Surfaces

Measuring Cylinder Bore (Figure 3-29)

1. Remove any burrs from the cylinder gasket surfaces.
2. Install a head and base gasket, and CYLINDER TORQUE PLATES (Part No. HD-33446) and TORQUE PLATE BOLTS (Part No. HD-33446-86). Tighten the bolts using the same method used when installing the cylinder head screws. See INSTALLATION, CYLINDER HEAD earlier in this Section.

NOTE

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

3. Take cylinder bore measurement in ring path, starting about 1/2 in. (13 mm) from top of cylinder, measuring from front to rear, and then side to side. Record readings.
4. Repeat measurement at center, and then at bottom of ring path. Record readings. This process will determine if cylinder is out-of-round (or "egged") and will also show any cylinder taper or bulge. See cylinder bore service wear limits chart. If cylinder is not scuffed or scored and is within service limit, see Fitting Cylinder to Piston.

Figure 3-29. Measuring Cylinder Bore

Cylinder Bore Service Wear Limits

Bore Sizes	883cc	1200cc
Standard Bore	3.0035 in. 76.289 mm	3.5008 in. 88.920 mm
0.005 O.S. bore 0.13 mm	3.0078 in. 76.398 mm	3.5050 in. 89.027 mm
0.010 O.S. bore 0.25 mm	3.0128 in. 76.525 mm	3.5100 in. 89.154 mm
0.020 O.S. bore 0.51 mm	3.0228 in. 76.779 mm	3.5200 in. 89.408 mm
0.030 O.S. bore 0.76 mm	3.0328 in. 77.033 mm	3.5300 in. 89.662 mm
0.040 O.S. bore 1.02 mm	3.0428 in. 77.287 mm	--

NOTE

If piston clearance exceeds service limit, cylinders should be rebored and/or honed to next standard oversize, and refitted with the corresponding piston and rings. Do not fit piston tighter than 0.0007 in. (0.018 mm) See SPECIFICATIONS.

Measuring Piston

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

The pistons have the typical elliptical shape when viewed from the top. However, they also are barrel-shaped when viewed from the side. This barrel shape is not symmetrical.

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

Fitting Cylinder to Piston

Since pistons cannot be accurately measured with standard measuring instruments, the bore sizes, given in Step 2 under Boring and Honing Cylinder, must be observed. Example: A 0.005 in. (0.13 mm) oversize piston will have the proper clearance with a bore size of 3.0048 in. ± 0.0002 in. (76.322 mm ± 0.005 mm) for the 883cc engine.

Boring and Honing Cylinder

1. The cylinder must be bored with gaskets and torque plates attached. Bore the cylinder to 0.003 in. (0.08 mm) under the desired finished size.
2. Hone the cylinder to its finished size using a 280 grit rigid hone followed by a 240 grit flexible ball hone. Honing must be done with the torque plates attached. All honing must be done from the bottom (crankcase) end of the cylinder. Work for a 60° crosshatch pattern.

Final cylinder bore sizes, after honing are as follows:

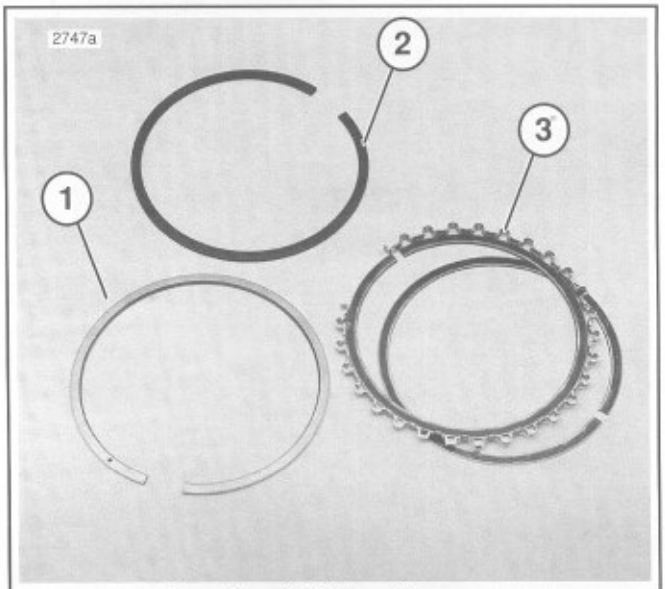
Bore Sizes	883cc	1200cc
Standard bore*	3.0005 in. 76.213 mm	3.4978 in. 88.844 mm
0.005 O.S. bore	3.0048 in. 76.323 mm	3.502 in. 88.95 mm
0.010 O.S. bore	3.0098 in. 76.449 mm	3.507 in. 89.08 mm
0.020 O.S. bore	3.0198 in. 76.703 mm	3.517 in. 89.33 mm
0.030 O.S. bore	3.0298 in. 76.957 mm	3.527 in 89.59 mm
0.040 O.S. bore	3.0398 in. 77.211 mm	--

*All bore sizes + 0.0002 in.

When cylinder requires oversize reboring to beyond 0.040 in. (1.02 mm) on 883cc engines, or 0.30 in. (7.6 mm) on 1200cc engines, the oversize limit has been exceeded and cylinder must be replaced.

NOTE

The same piston may be used if cylinder bore was not changed, unless it is scuffed or grooved. However, replace rings and hone the cylinder walls with a No. 2 40 grit flexible hone to facilitate ring seating.



1. **Top ring – Install either side up**
2. **Second ring – Install dot toward top**
3. **Oil control rings**

Figure 3-30. Piston Rings

Fitting Piston Rings

NOTE

Ring sets and pistons, 0.040 in. (1.02 mm) oversize, are not available on 1200cc engines.

See Figure 3-30. Piston rings are of two types: compression and oil control. The two compression rings are positioned in the two upper piston ring grooves. The dot on the second compression ring must face upward. Ring sets are available to fit standard and oversize pistons.

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

1. See Figure 3-31. Place piston in cylinder about 1/2 in. (13 mm) from top. Set ring to be checked squarely against piston as shown. Check end gap with thickness gauge. See SPECIFICATIONS for tolerance.

NOTE

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

2. See Figure 3-32. Apply engine oil to piston grooves. Use a piston ring expander tool 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 ring with dot towards top.

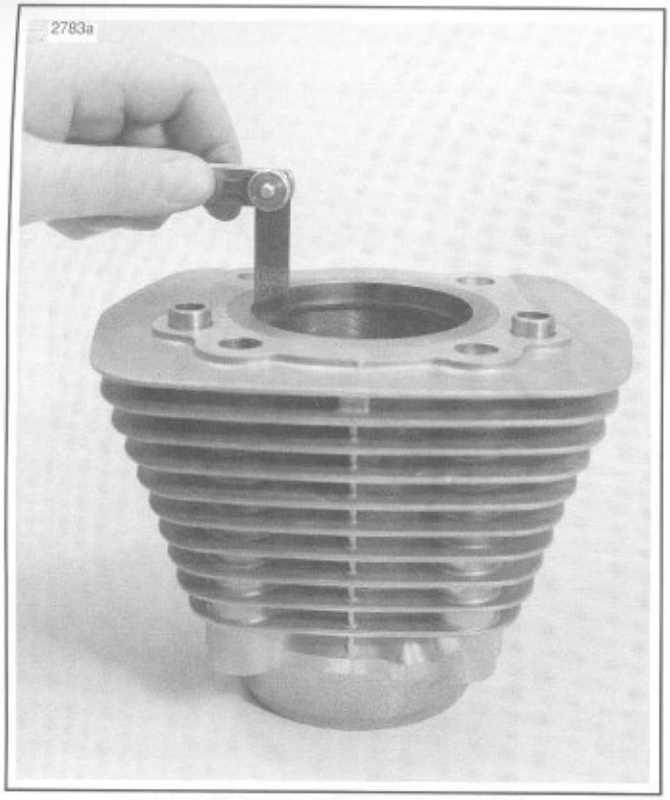


Figure 3-31. Measuring Ring End Gap

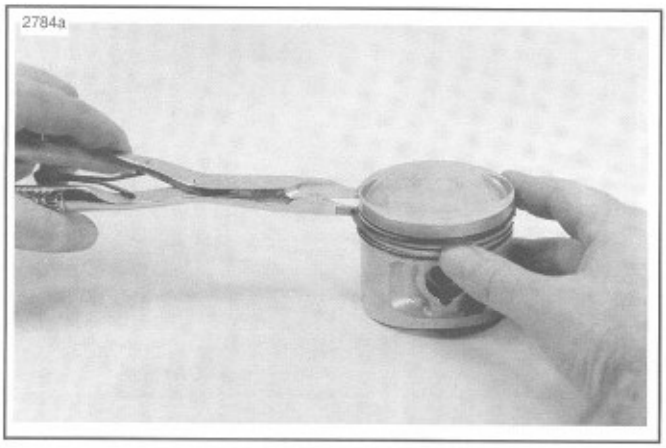


Figure 3-32. Installing Piston Rings

See Figure 3-33. 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.

3. See Figure 3-34. Check for proper side clearance with thickness gauge, as shown. See SPECIFICATIONS for tolerance.

NOTE

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

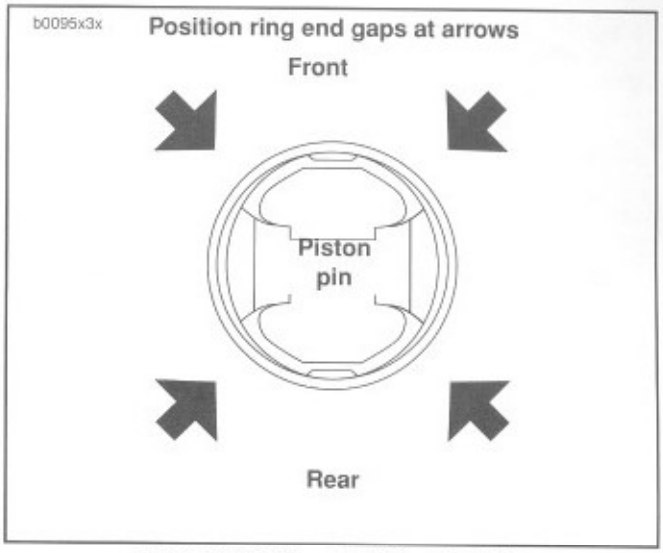


Figure 3-33. Ring End Gap Position

Figure 3-34. Measuring Ring Clearance in Groove

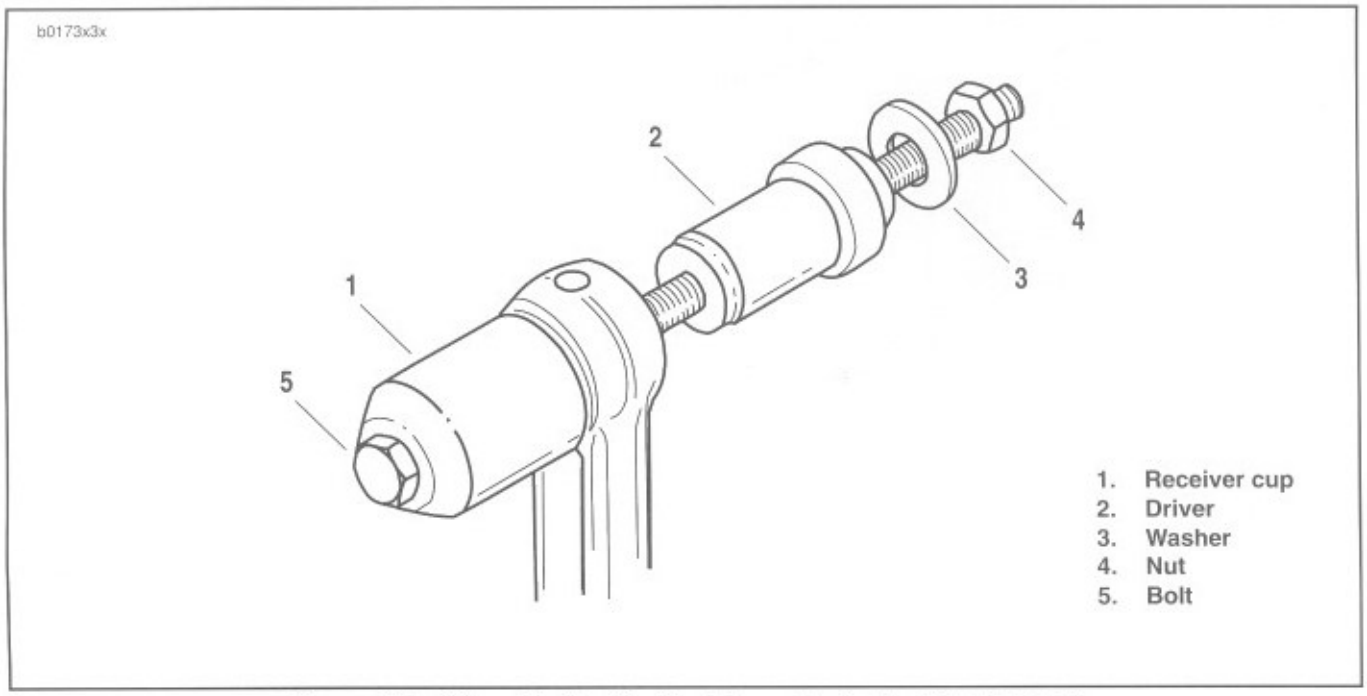


Figure 3-35. Piston Pin Bushing Tool Assembly for Bushing Removal

Connecting Rod Bushing

REMOVAL/INSTALLATION

When connecting rod bushing is worn to excessive pin clearance (0.002 in. or more) (0.05 mm) it must be replaced.

1. See Figure 3-36. Install plastic hoses over studs.
2. Secure connecting rod with ROD CLAMPING FIXTURE (Part No. HD-95952-33A).

NOTE

If CONNECTING ROD CLAMPING TOOL holes are too small, enlarge the holes in the tool.

3. See Figure 3-35. Attach PISTON PIN BUSHING TOOL (Part No. HD-95984-32C) to the connecting rod (receiver cup on one side of the rod and the driver on the opposite side) as shown.
4. Use two box wrenches and push the worn bushing from the connecting rod.
5. Remove the piston pin bushing tool from the connecting rod.
6. Remove the bushing from the receiver cup.
7. See Figure 3-36. Attach the PISTON PIN BUSHING TOOL (Part No. HD-95984-32C) to the connecting rod; place the new bushing between the connecting rod and the driver.

NOTE

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

8. Clean up and size bushing to 0.0010-0.0005 in. (0.025-0.013 mm) undersize using REAMER (Part No. HD-94800-26A).

   Sizing bushing with less than 0.00125 in. (0.0317 mm) clearance can result in a bushing loosening and/or seized pin in rod.

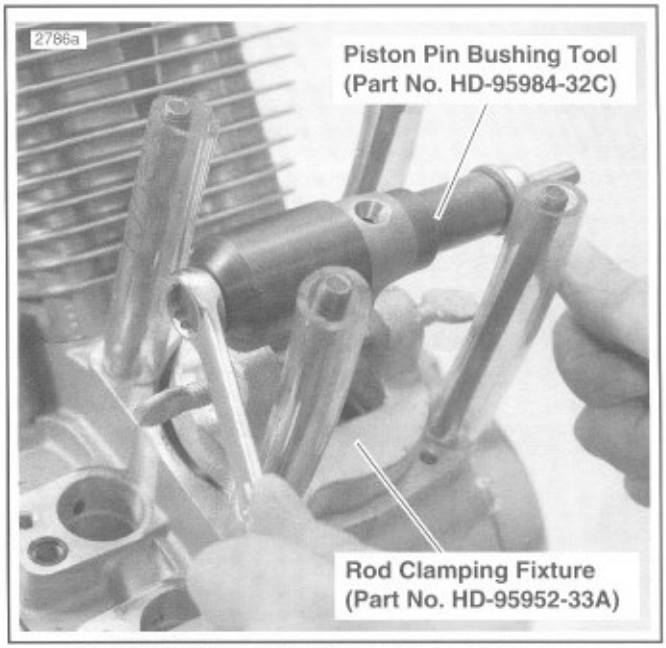


Figure 3-36. Installing New Piston Pin Bushing

9. Hone bushing to final size using CONNECTING ROD 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.

REPAIR

⚠CAUTION

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

ASSEMBLY/INSTALLATION

1. Install the piston assembly over connecting rod.

NOTE

New 1200cc and 883cc pistons must be installed with the arrow, at the top of the piston, pointing towards the front of the engine.

2. Install piston pin.
3. See Figure 3-37. Install new piston pin retaining rings with the PISTON PIN RETAINING RING INSTALLER (Part No. HD-34623A). Make sure the ring groove is clean and that the ring is fully seated in the groove with the gap away from the slot at the bottom.

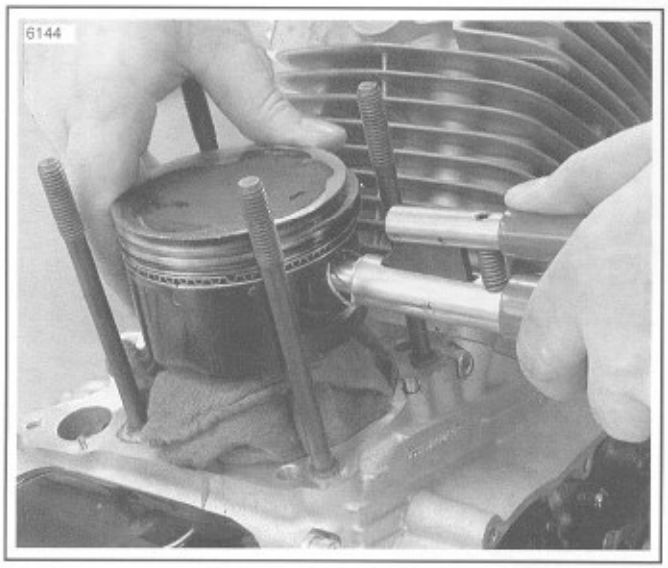


Figure 3-37. Installing Piston Retaining Rings

⚠CAUTION

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

4. See Figure 3-33. Make sure the piston ring end gaps are properly positioned as shown.
5. Lubricate cylinder wall, piston, pin and rod bushing with engine oil.

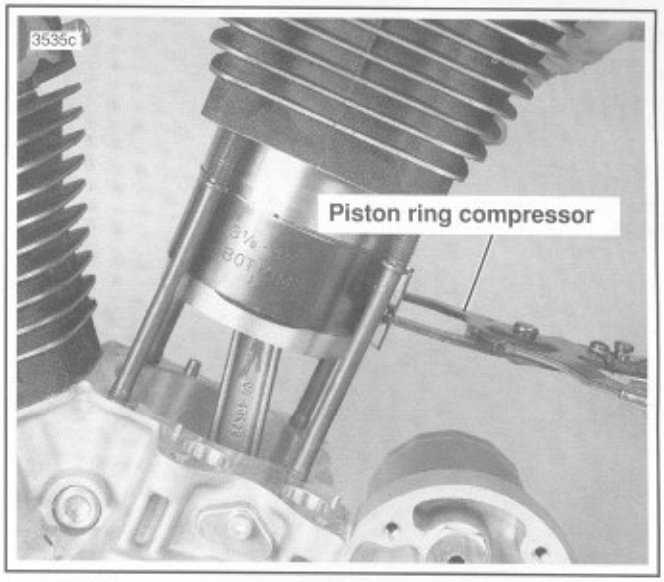


Figure 3-38. Installing Cylinder Over Piston

6. Turn engine until piston is at top dead center.
7. See Figure 3-38. Compress the piston rings using PISTON RING COMPRESSOR (Part No. HD-96333-51B).
8. Remove cylinder stud sleeves. Install a new cylinder base gasket. Make sure the piston does not bump the studs or crankcase.
9. Install the cylinder over the piston as shown.
10. Remove the piston ring compressor.
11. Assemble and install cylinder head. See CYLINDER HEAD, ASSEMBLY/INSTALLATION in this section.
12. Install assembled engine to motorcycle. See INSTALLING THE ENGINE in this section.

CHECKING AND ADDING OIL

Check engine oil level in oil tank at least once every 500 miles (800 km). Check level more frequently if engine uses more oil than normal or if vehicle is operated under harsh conditions. Oil tank capacity is three quarts (U.S.) (2.8 liters). Check table in ENGINE LUBRICATION SYSTEM, CHANGING OIL AND FILTER for recommended engine oil viscosity.

1. Run engine until engine oil is at normal operating temperature. Turn engine off.
2. Hold motorcycle upright so that it is not leaning on jiffy stand. Remove filler cap from oil tank on right side of vehicle. Wipe attached dipstick clean.
3. Install filler cap onto oil tank. Make sure cap is fully seated on tank.
4. See Figure 3-39. Remove filler cap and check warm oil level on dipstick. Dipstick has two marks. If oil level in tank is at or below lower mark, add one quart (0.946 liter) of Harley-Davidson oil to tank.
5. Repeat Steps 2-4 to verify correct engine oil level in oil tank. Do not fill oil tank to the level above upper mark on dipstick.

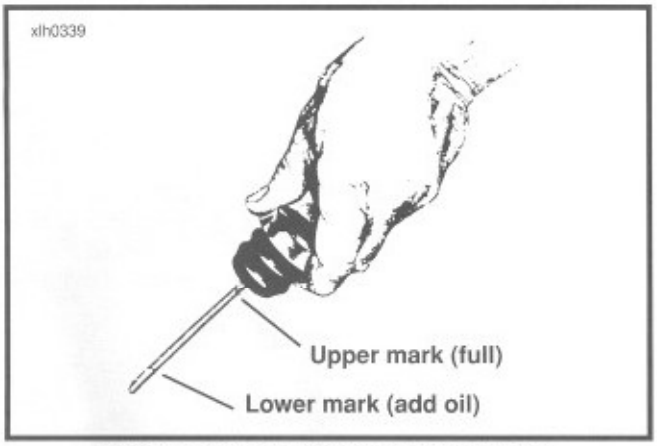


Figure 3-39. Oil Tank Filler Cap/Dipstick

CHANGING OIL AND FILTER

General

After a new engine has run its first 500 miles (800 km), and at 5000 mile (8000 km) intervals or annually thereafter, completely drain oil tank of used oil. Refill with fresh oil. If vehicle is driven extremely hard, used in competition, or driven on dusty roads, change engine oil at shorter intervals. Always change oil filter when changing engine oil. Proceed as follows:

Removal

1. Run engine until engine oil has reached normal operating temperature.
2. Place a suitable container under the engine crankcase. The container must be able to hold approximately three U.S. quarts (2.8 liters).
3. Locate the oil tank drain hose (see Figure 3-40). The drain hose is secured to a lug on the rear muffler mount.
4. Remove the Corbin clamp, pull the drain hose from the lug and insert the free end into the container. Completely drain engine oil from oil tank. It is not necessary to drain engine crankcase.

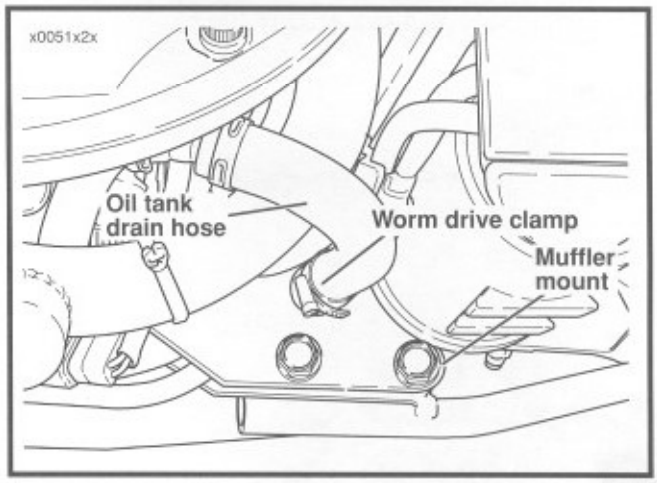


Figure 3-40. Oil Tank Drain Hose

NOTE

Oil will flow more quickly if the filler cap/dipstick is removed from the oil tank.

5. Move drain pan beneath front of engine crankcase.
6. Turn oil filter counterclockwise to remove from filter mount (see Figure 3-41). Discard oil filter.

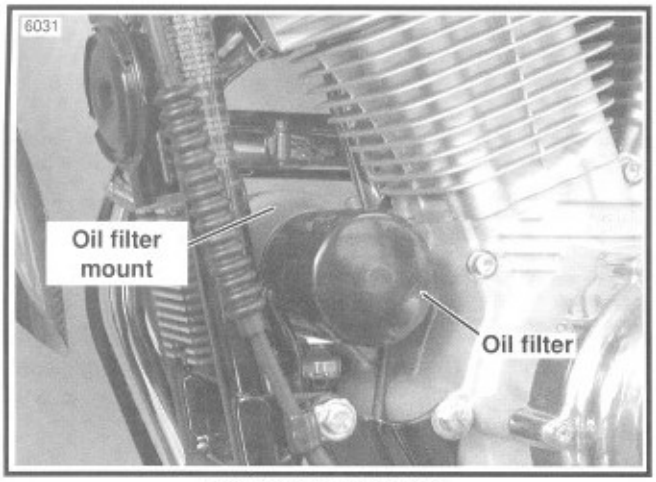


Figure 3-41. Oil Filter

Recommended Engine Oil Viscosity

Harley-Davidson Type	Viscosity	Harley-Davidson Rating	Lowest Ambient Temperature	Cold Weather Starts Below 50°F (10°C)
HD Multigrade	SAE 10W40	HD 240	Below 40° (4°C)	Excellent
HD Multigrade	SAE 20W50	HD 240	Above 40° (4°C)	Good
HD Regular Heavy	SAE 50	HD 240	Above 60° (16°C)	Poor
HD Extra Heavy	SAE 60	HD 240	Above 80° (27°C)	Poor

Installation

1. Pour about 4 fluid ounces (U.S.) (120 ml) of fresh, clean engine oil into **new** oil filter. Allow time for oil to soak into filter element.

NOTE

Partially fill oil filter before installation to minimize the time required for buildup of oil pressure when engine is first started.

2. Wipe filter gasket contact surface of oil filter mount with a clean cloth. Coat filter gasket with clean engine oil.

3. Install oil filter. Hand tighten filter 1/2 to 3/4-turn after gasket contacts filter mount surface.

4. See Figure 3-40. Use Corbin clamp to secure oil tank drain hose to lug on muffler mount.

5. Install 3 quarts (U.S.) (2.8 liters) to engine oil tank minus the 4 fl. oz. (120 ml) added in step 1. Always use the proper grade of oil for the lowest expected air temperature before the next regularly scheduled oil change.

⚠CAUTION

Remove Corbin clamp and drain hose from rear muffler mount lug. Allow a small amount of oil to flow from hose before reconnection. This action removes air from the drain hose and prevents the possibility of oil pump cavitation.

6. Install filler cap onto oil tank. Make sure cap is fully seated.

7. Start engine. Verify that oil pressure signal light turns off when engine speed is 1000 rpm or above.

8. Check for oil leaks at oil filter and oil tank drain hose. Turn engine off.

WINTER LUBRICATION

Normal fuel combustion in a gasoline engine produces water vapor and carbon dioxide along with other gases and particulates. When first starting and warming an engine, some of the water vapor that gets into the engine crankcase condenses to form liquid water. If the engine is driven long enough to thoroughly warm the crankcase, most of this liquid water is again vaporized and exhausted through the crankcase breather system.

A moderately driven vehicle making short runs may not be able to vacate water vapors allowing liquid water to accumulates in the oil tank. This is especially true if the vehicle is operated in cold weather. In freezing weather, an accumulation of water in the engine oil may become slush or ice, which can block oil lines and lead to severe engine damage. Water remaining in the engine oil for long periods of time can form an acidic sludge that is corrosive to metal engine parts and causes accelerated wear of moving components.

In winter the oil change interval should be shorter than normal. The colder the weather, the shorter the recommended oil change interval. A vehicle used only for short runs in cold weather must have the engine oil drained frequently.

OIL HOSE ROUTING

The feed, vent and return ports are located on the bottom of the oil tank to reduce under seat congestion (see Figures 3-42). A short hose routes the oil from the feed port at the lower front corner (inboard side) to a pipe elbow. The elbow ensures that the hose does not become crimped or kinked, thereby depriving the engine of oil during operation (oil starvation). The elbow routes the oil flow straight down to a pipe tee. The short hose (oil drain) from the pipe tee goes to the rear muffler mount lug where it is held in place by a worm drive clamp. From the other port of the pipe tee the oil flow crosses to the right side of the vehicle where the hose runs forward to the oil pump inlet. From the feed section of the oil pump, another feed hose directs the flow up to the oil filter mount (see page 3-35 for further description). Eventually, oil drains to the sump where it collects in the scavenge section of the oil pump. The return hose, which is tie-wrapped to the feed hose, routes the oil back to the tank where the cycle is repeated.

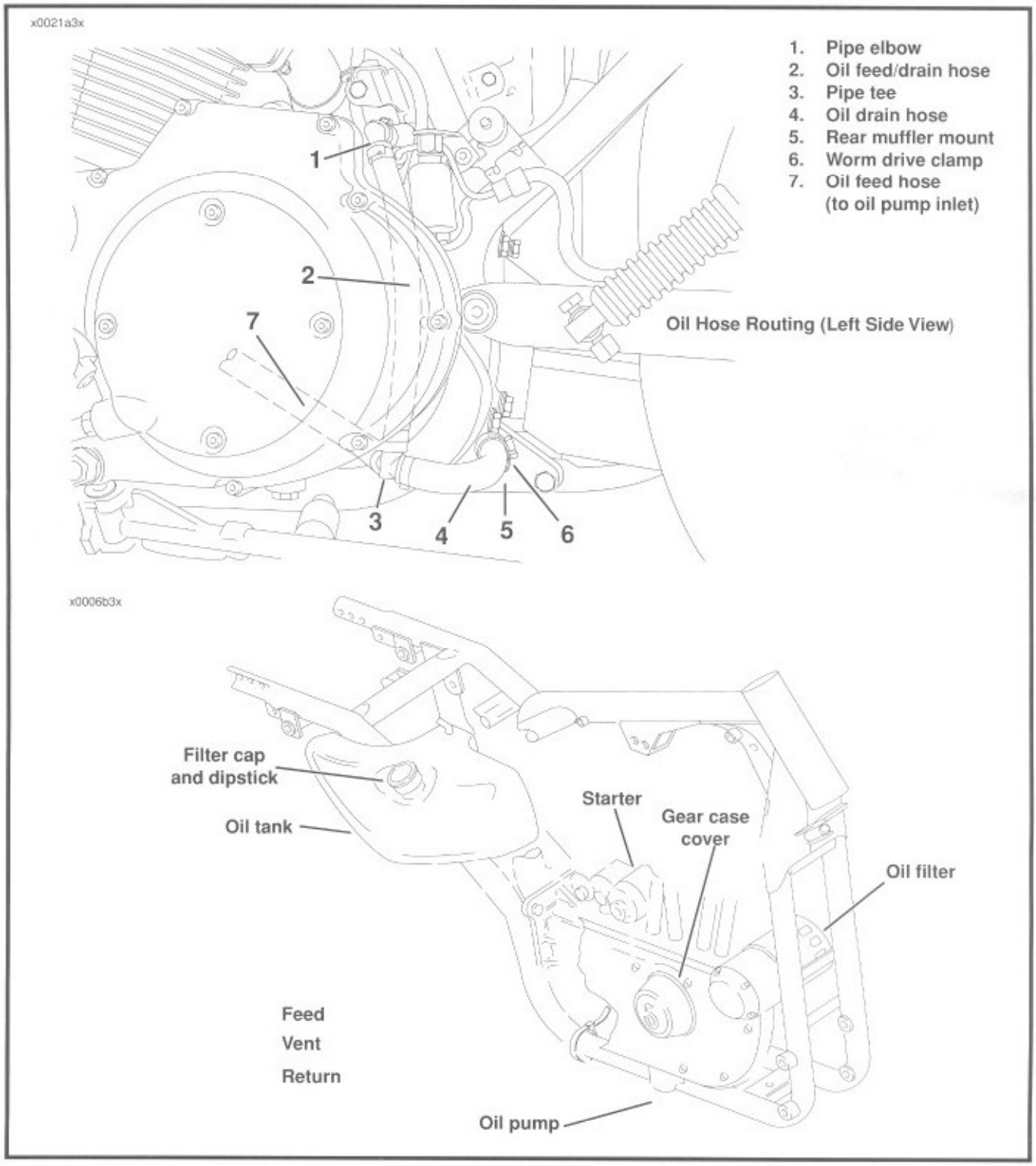


Figure 3-42. Engine Oil Tank, Oil Filter and Hose Routing Locations

OIL TANK

Removal and Disassembly

1. Remove seat. See SEAT, REMOVAL in Section 2.

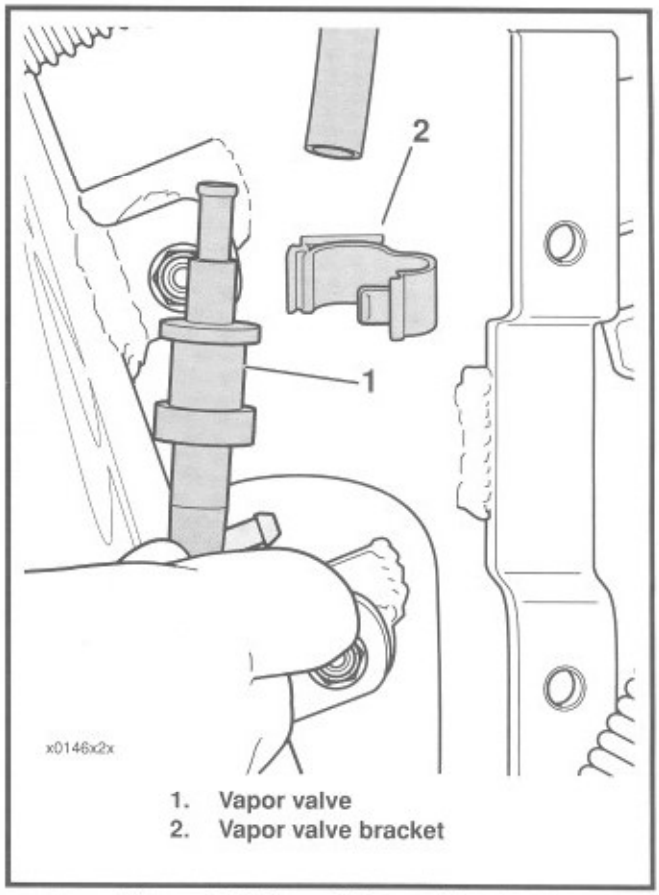
⚠WARNING

If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion resulting in personal injury and/or property damage.

2. Disconnect battery cables, negative cable first. See BATTERY, DISCONNECTION AND REMOVAL in Section 7.
3. Remove battery from battery tray. Push ignition module connector on rear side plate of battery tray upward to unsnap attachment clip from T-stud. Lift connector off T-stud.
4. Drain oil tank. See ENGINE LUBRICATION SYSTEM, CHANGING OIL AND FILTER, REMOVAL. The oil filter need not be removed unless it is due to be replaced. Leave oil tank drain hose disconnected from lug on muffler mount.
5. Remove locknut securing tab at bottom of battery tray to frame-mounted rubber mount stud. Remove bolts and washers securing three corners of tray to oil tank brackets. Note that wire form retainer for positive battery cable is secured under front bolt. Remove battery tray.
6. Remove two bolts to detach electrical bracket from motorcycle frame. Remove rubber wellnuts from frame. Inspect for cuts, tears or general deterioration. Replace as necessary.
7. See Figure 3-43. Remove vapor valve assembly from inboard side of oil tank. Insert thin blade of screwdriver into slot of vapor valve bracket. Turn screwdriver gently to unsnap clip. Remove vapor valve body from bracket. Remove hose connection from neck of vapor valve. (On California models, remove carbon canister-to-carburetor purge hose from groove of vapor valve bracket.)
8. Cut cable strap securing wire harness to bracket welded next to top inboard seam of oil tank.
9. Slightly move electrical bracket to access upper rear rubber mount on oil tank. Remove locknuts from three oil tank rubber mount studs. Lift oil tank slightly away from motorcycle frame to access oil hoses. All hose connections are on the bottom of the tank.
10. For ease of assembly, mark oil tank hoses for identification- oil feed, vent and return. The straight tube on inboard side of tank next to lower front rubber mount is the feed port. Vent and return tubes can be identified by their 90 degree bends; the smaller O.D. tube is the vent fitting, the larger O.D. tube is the return oil fitting. Disconnect hoses from oil tank.
11. Remove oil tank from motorcycle. Remove vapor valve bracket from T-stud on inboard side of oil tank.
12. See Figure 3-44. Remove three rubber mounts from oil tank. Inspect rubber mounts for cuts, tears or general deterioration. Replace as necessary.
13. Mark position of trim strips on upper and lower inboard seams of oil tank. Remove trim strips.

Assembly and Installation

1. See Figure 3-45. Install three rubber mounts (12) onto oil tank (9). Note that washers are **not** used.
2. Install trim strips (7) in marked positions on upper and lower inboard seams of oil tank (9). Apply upper trim strips to seams on each side of battery tray bracket (8). Use a rubber mallet to seat strips on seams, if necessary. Verify that strips butt up against bracket.



1. **Vapor valve**
2. **Vapor valve bracket**

Figure 3-43. Vapor Valve and Bracket

3. Install vapor valve bracket on T-stud on inboard side of oil tank. Position oil tank near its installed location on motorcycle.
4. Install marked oil feed, drain, vent and return hoses in their proper locations on oil tank fittings. See Figures 3-41 and 3-45. Be sure that installed hoses (and battery cables) do not touch brake line.
5. Position oil tank (9) in its installed location on motorcycle. Align studs on inboard side of rubber mounts with flanges welded to frame members. See Figure 3-46. Install locknuts to secure oil tank to frame. Tighten locknuts to 3-5 ft-lbs (4-7 Nm) torque.
6. See Figure 3-43. Hold fuel tank vapor valve in an upright position with the long necked end at the top. Insert neck of vapor valve into hose until hose end contacts shoulder. Position body of vapor valve in bracket. Snap bracket closed. (On California models, install carbon

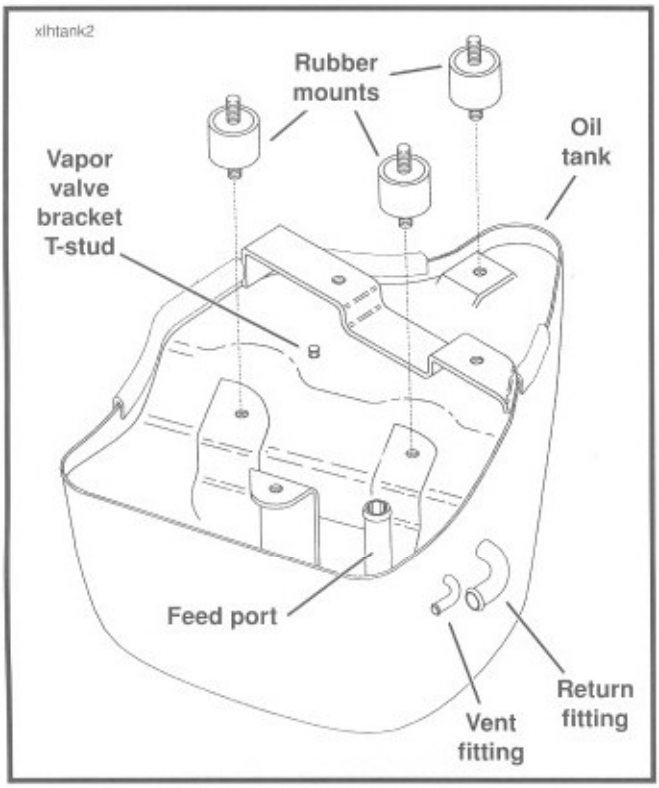


Figure 3-44. Remove/Inspect Rubber Mounts

canister-to-carburetor purge hose in groove of vapor valve bracket.)

7. Align holes in electrical bracket with wellnuts in cross member of motorcycle frame. Install two bolts. Tighten bolts to 6-9 **in-lbs** (0.7-1.0 Nm) torque. See Figure 3-47.

8. Secure wire harness to bracket welded next to top inboard seam of oil tank. Cable strap should pull harness onto trim strip and off unprotected metal seam of oil tank.

9. See Figure 3-48. Position battery tray onto motorcycle fitting tab at bottom of tray over frame-mounted rubber mount stud. Secure three corners of battery tray to brackets on oil tank using bolts and washers. Position wire form retainer for positive battery cable under front bolt. Install locknut on frame-mounted rubber mount stud. Tighten three bolts to 12-15 ft-lbs (16-20 Nm) torque. Tighten locknut on rubber mount stud to 36-60 **in lbs** (4.1-6.8 Nm) torque.

10. Use worm drive clamp to secure free end of oil tank drain hose to rear muffler mount lug. See Figure 3-49.

11. Fill oil tank. See ENGINE LUBRICATION SYSTEM, CHANGING OIL AND FILTER, INSTALLATION.

1. Pipe tee
2. Hose clamp
3. Pipe elbow
4. Feed/drain hose, 3 inch
5. Feed/drain hose, 8 inch
6. Drain hose, 4-1/4 inch
7. Trim strip (3)
8. Battery tray bracket
9. Oil tank
10. Rear muffler mount
11. Worm drive clamp
12. Rubber mount (3)
13. Feed hose

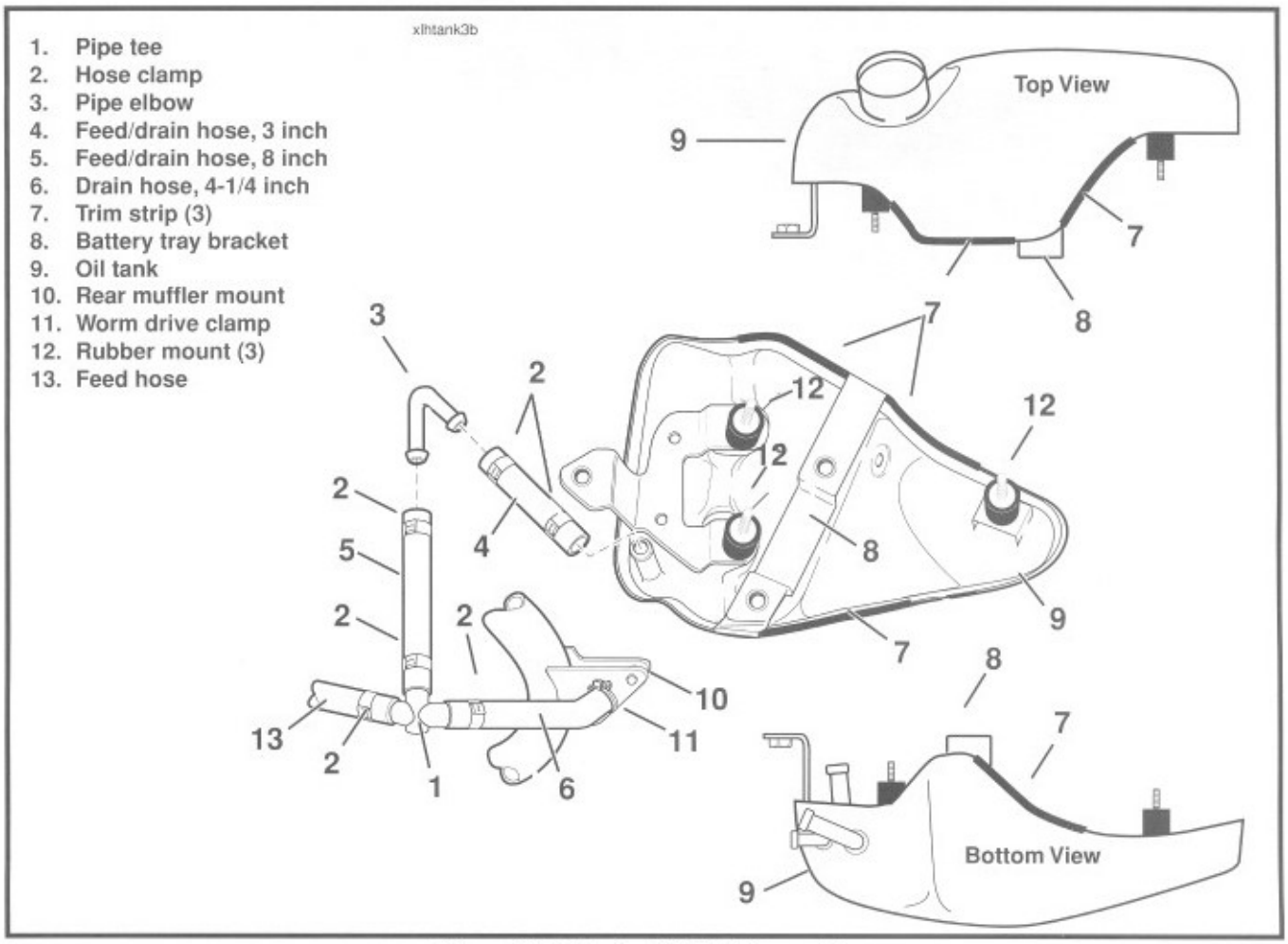


Figure 3-45. Engine Oil Tank Assembly

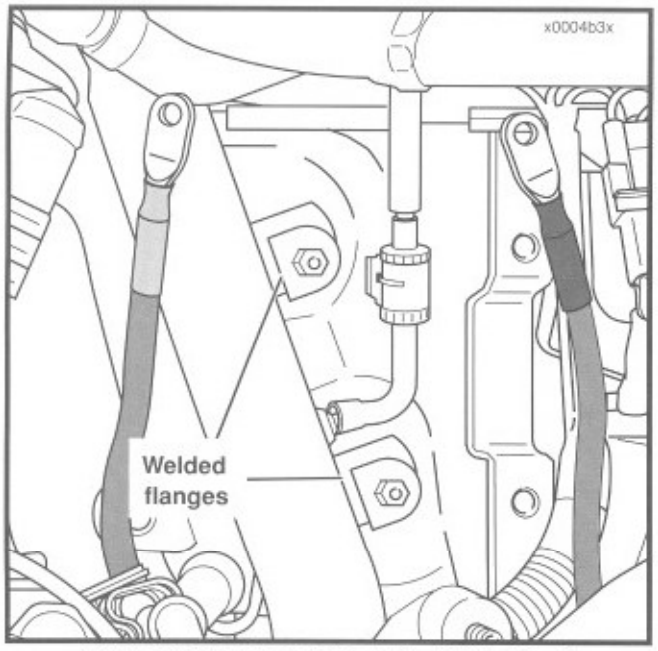


Figure 3-46. Install Oil Tank (Left Side View)

⚠CAUTION

Remove worm drive clamp and drain hose from rear muffler mount lug. Allow a small amount of oil to flow from hose before reconnection. This action removes air from the hose and prevents the possibility of oil pump cavitation.

12. Place large end of slot on attachment clip (of ignition module connector) over T-stud on rear side plate of battery tray; push connector assembly to engage small end of slot. Install battery pad and battery onto battery tray.

13. Install battery cables, positive cable first. See BATTERY, INSTALLATION AND CONNECTION in Section 7.

14. Install seat. See SEAT, INSTALLATION in Section 2.

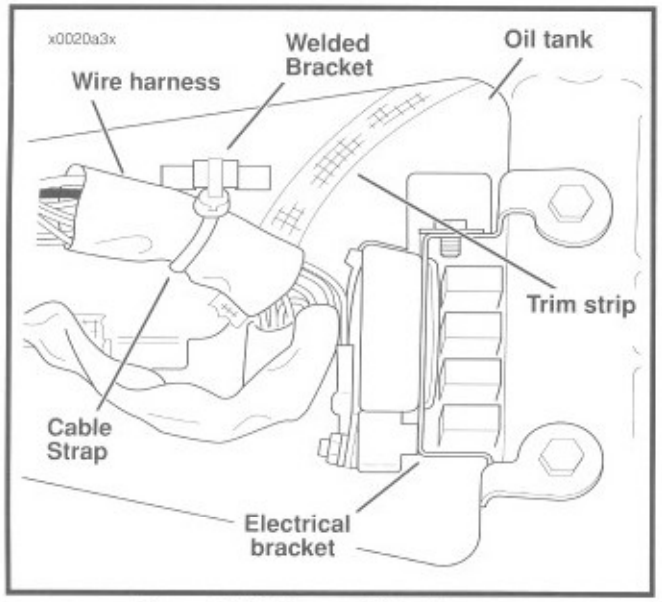


Figure 3-47. Secure Wire Harness

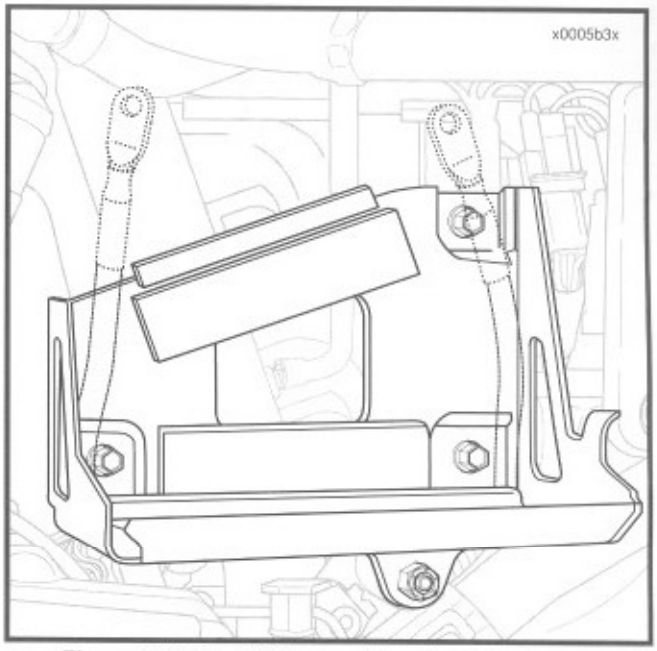


Figure 3-48. Install Battery Tray (Left Side View)

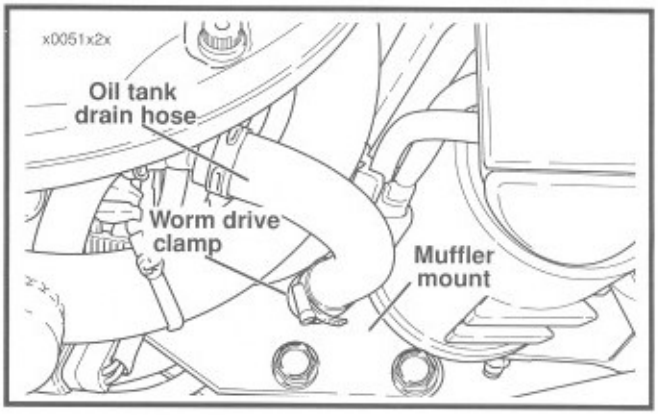


Figure 3-49. Secure Oil Tank Drain Hose

OIL PRESSURE SIGNAL LIGHT SWITCH (FIGURE 3-50)

The oil pressure signal light switch is a pressure-actuated diaphragm-type switch. When oil is not circulating through the system or when oil pressure is abnormally low, spring tension holds the switch contacts closed, thereby completing the signal light circuit and causing the indicator lamp to illuminate.

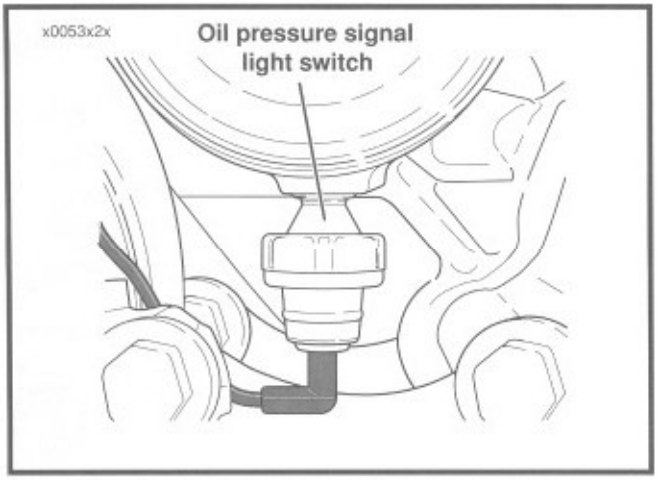


Figure 3-50. Oil Pressure Signal Light Switch

OIL PRESSURE SIGNAL LIGHT

The oil pressure signal light turns ON when:

- Ignition switch is turned on prior to starting engine.
- Oil is not circulating through the running engine.
- Oil pressure is abnormally low on the running engine.
- Engine is idling far below 1000 rpm.

The oil pressure signal light turns OFF when:

- Oil is circulating with adequate pressure through the engine running at 1000 rpm or greater.

NOTE

If the ignition is turned back on immediately after the engine is stopped, the oil light may not turn on right away because of oil pressure retained in the filter housing.

Oil Pressure Signal Light	Probable Causes
Stays on at speeds above idle.	● Empty oil tank. ● Clogged feed line (ice and sludge, freezing temperatures). ● Air-bound oil line ● Grounded oil switch wire. ● Malfunctioning signal switch. ● Diluted oil. ● Malfunctioning check valve (see OIL FILTER MOUNT).
Flickers at idle.	● Incorrect idle speed. Malfunctioning or improperly installed check valve (see OIL FILTER MOUNT).
Does not glow when ignition is turned on (prior to operating engine).	● Malfunctioning signal switch. ● Malfunction in wiring. ● Burned-out signal bulb. ● Dead battery (see NOTE above).

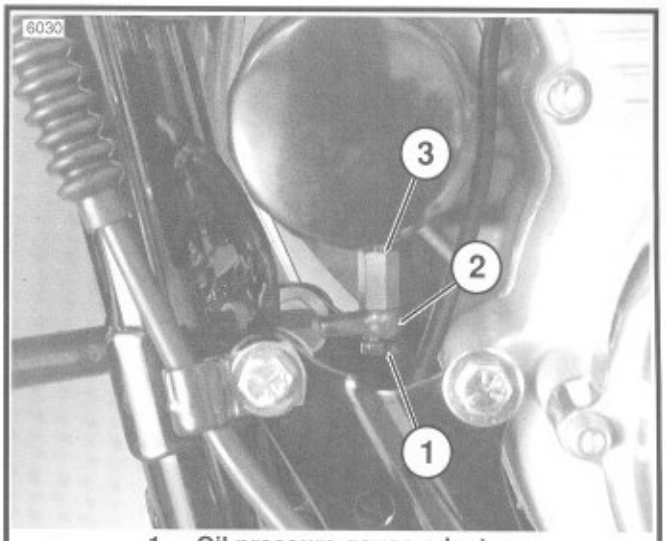
OIL PRESSURE (FIGURE 3-51)

The oil pump is nonregulatory and delivers its entire volume of oil under pressure to the oil filter mount. When an engine is cold, the engine oil will be more viscous (i.e., thicker). During start-up of a cold engine, oil pressure will be higher than normal and oil circulation will be somewhat restricted within the oiling system. As the engine warms to normal operating temperature, the engine oil will warm up and become less viscous — oil pressure decreases.

When an engine is operated at high speeds, the volume of oil circulated through the oiling system increases, resulting in higher oil pressure. As engine speed is reduced, the volume of oil pumped is also reduced, resulting in lower oil pressure.

To check oil pressure, use OIL PRESSURE GAUGE (Part No. HD-96921-52A) and OIL PRESSURE GAUGE ADAPTER (Part No. HD-96940-52A). Remove oil pressure switch and insert pressure gauge fitting.

Run the engine until oil reaches normal operating temperature (motorcycle should be driven at least 20 miles (32 km) at or above 50 mph (80 km/h)). At 2500 rpm, oil pressure will vary from 10-17 psi (69-117 kN/m^2). At idle speed (950-1050 rpm), oil pressure will vary from 7-12 psi (48-83 kN/m^2).



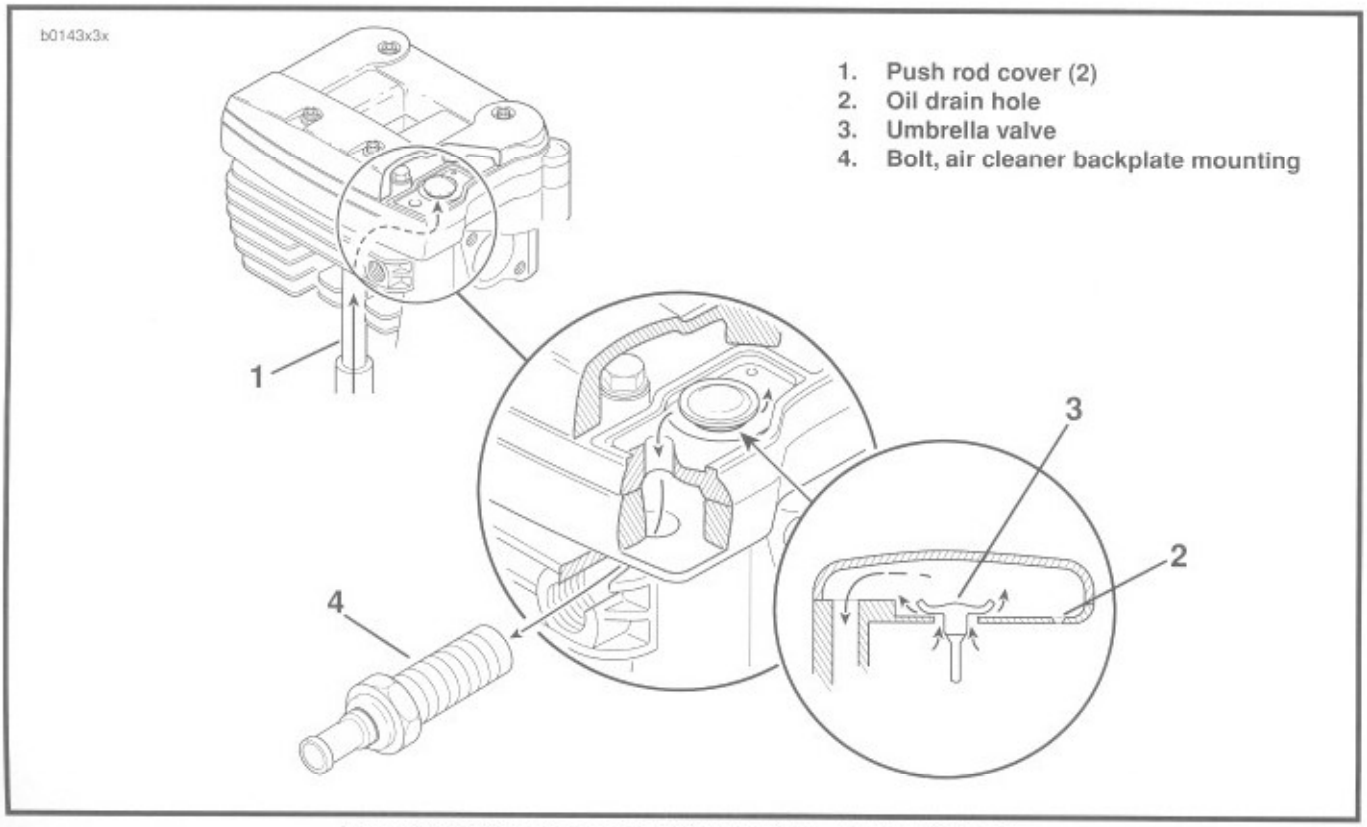
1. **Oil pressure gauge adapter**
2. **Oil pressure gauge**
3. **Nipple adapter**

Figure 3-51. Checking Oil Pressure

CRANKCASE BREATHING SYSTEM (Figure 3-52)

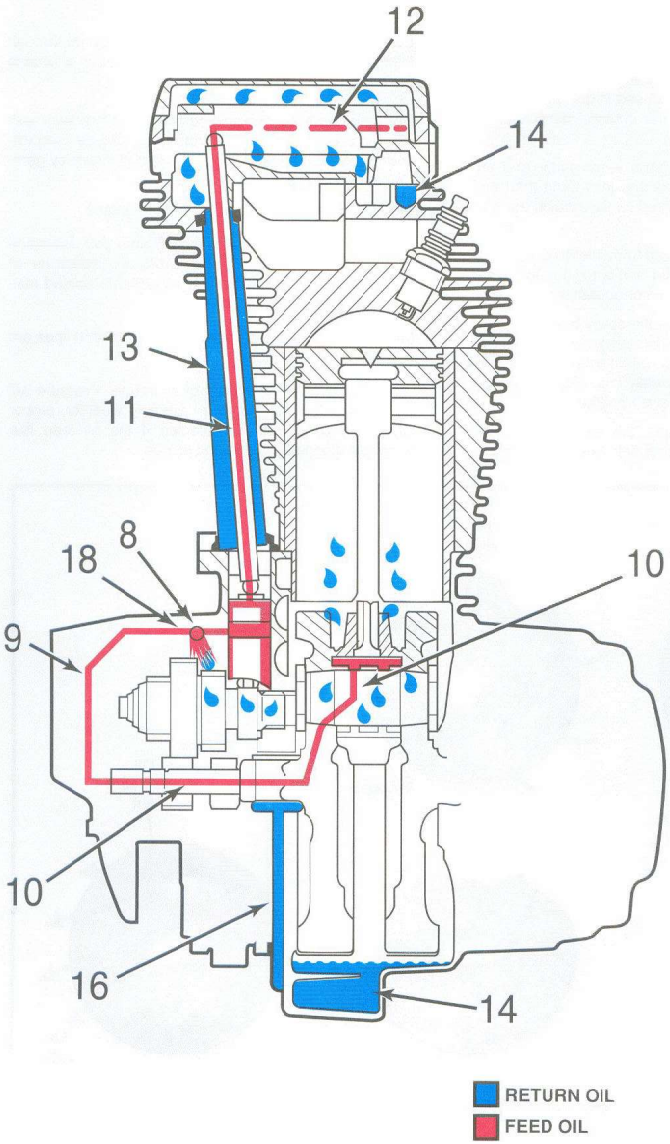
On piston downstroke, a mixture of crankcase air and oil mist is vented up the push rod covers (1) through an umbrella valve (3) in each middle rocker box section.

The oil mist separates from the crankcase air, collects and passes through a small drain hole (2) where it eventually returns to the crankcase. The crankcase air is routed through a passage in each cylinder head. The crankcase air then travels through each air cleaner backing plate mounting bolt (4) into the filtered side of the air cleaner.



1. **Push rod cover (2)**
2. **Oil drain hole**
3. **Umbrella valve**
4. **Bolt, air cleaner backplate mounting**

Figure 3-52. Crankcase Breathing System – Typical Cylinder



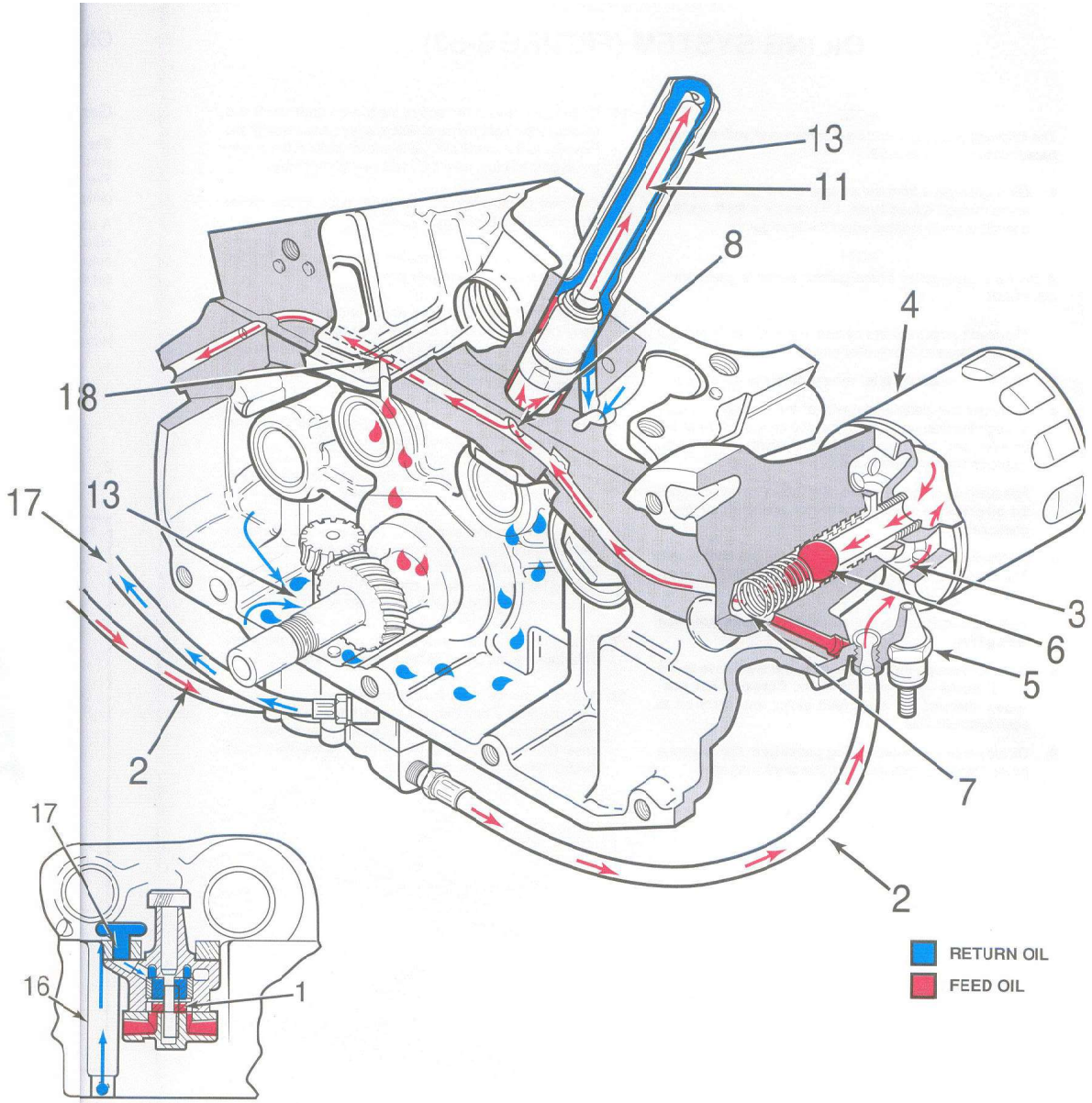


Figure 3-53. Lubrication Diagram

OILING SYSTEM (FIGURE 3-53)

NOTE

The following paragraph numbers correspond with the numbered callouts in Figure 3-53.

1. Oil is gravity-fed from the oil tank to the gerotor-style oil pump through a **feed hose.** Oil enters the **feed section** and fills a cavity located under the feed pump.

NOTE

A complete explanation of the gerotor pump is given under OIL PUMP.

2. The feed pump transfers oil from the inlet cavity through the **feed hose** to the oil filter mount.
3. Oil flows through the **filter mount cavity** to the oil filter.
4. Oil enters the peripheral cavity of the **oil filter,** passes through the filtering medium into the central cavity of the oil filter, and flows into the filter adapter (fitting which connects filter to filter mount).
5. Adequate oil pressure in the filter mount cavity activates the **oil pressure signal light switch** and shuts off the oil pressure signal light.
6. Oil flowing from the filter adapter opens the **check ball.** The check ball opens at 4-6 psi (28-41 kN/m^2) oil pressure.
7. With the check ball open, oil flows into the **crankcase feed galley.**
8. Oil flows through the feed galley in the crankcase to the tappet blocks and hydraulic lifters. **Cross-drilled passages** intersect the main feed galley and carry oil to each hydraulic lifter.
9. Oil also enters an **intersecting passage** in the gearcase cover. Oil flow is then routed to the crankshaft area.
10. Oil enters a hole in the end of the **pinion gear shaft** and travels to the right flywheel where it is routed through the flywheel to the **crankpin.** Oil is forced through the crankpin to properly lubricate the rod bearing assembly.
11. Oil flows up passages in the **push rods** to the rocker arm shafts and bushings.
12. The valve stems are lubricated by oil supplied through drilled oil holes in the **rocker arms.**
13. Oil collected in the push rod areas of the cylinder heads flows down the **push rod covers,** through drain holes in the **tappet blocks** and into the gearcase. After providing lubrication to the gearcase components the oil flows to the return side of the oil pump.
14. Feed oil to the rocker area is returned to the crankcase through a **passage** in the head and cylinder.
15. Oil collected in the **sump** is splash-fed to the pistons, cylinder walls and flywheel components.
16. Oil collected in the sump area returns to the scavenge section of the oil pump through a **passage** located in the rear section of the sump. Oil flow to the pump is accomplished by the scavenging effect of the pump and by the pressure created by the downward stroke of the pistons.
17. Return oil fills a **cavity** above the pump's return gears. The return gears pump oil back to the oil tank.
18. A small amount of oil flows from the feed galley in the right crankcase half through a **restricted orifice,** which sprays the oil onto the rear intake cam gear in the gearcase. Oil is transferred to the teeth of all the cam gears through the gear meshing action.

OIL PUMP

General

See Figure 3-54. The oil pump consists of two gerotor gear sets, feed and scavenge (return), housed in one pump body. The feed pump distributes oil to the engine, the scavenge pump returns oil to the tank.

A gerotor-type gear set has two parts — an inner and an outer gerotor. The inner gerotor has one less tooth than the outer gerotor. Both gerotors have fixed centers which are offset to each other.

In a gerotor gear set, oil is transferred from inlet to outlet as it is trapped between the rotating inner and outer gerotors. The illustration shows the principle of gerotor operation:

1. During the first 180° of rotation, the cavity between inner and outer gerotors gradually increases in size until it reaches its maximum size, equivalent to the full volume of the "missing tooth." The gradually enlarging cavity creates a vacuum into which oil flows from the inlet.
2. During the next 180° of rotation, the size of the cavity decreases forcing oil into the outlet. See Figure 3-55.

Gravity-fed oil from the oil tank enters the pump through fitting (5). It is forced by gerotor set (7) through a hose to the oil filter.

Return oil from the flywheel compartment is drawn back into the pump. Returning oil from the gearcase compartment drains directly into the pump and is forced by gerotor set (9) back to the oil tank.

See Figure 3-53 for oil passages within the engine.

The oil pump seldom needs servicing. Before you disassemble an oil pump suspected of not producing adequate oil pressure, be absolutely certain that all possible related malfunctions have been eliminated:

1. Make sure all oil line clamps are tight and that lines are not pinched or damaged.
2. Check oil level and condition of oil in tank. Pressure will be affected if oil is diluted. In freezing weather, proper circulation of oil can be affected if the oil feed line becomes clogged with ice and sludge.

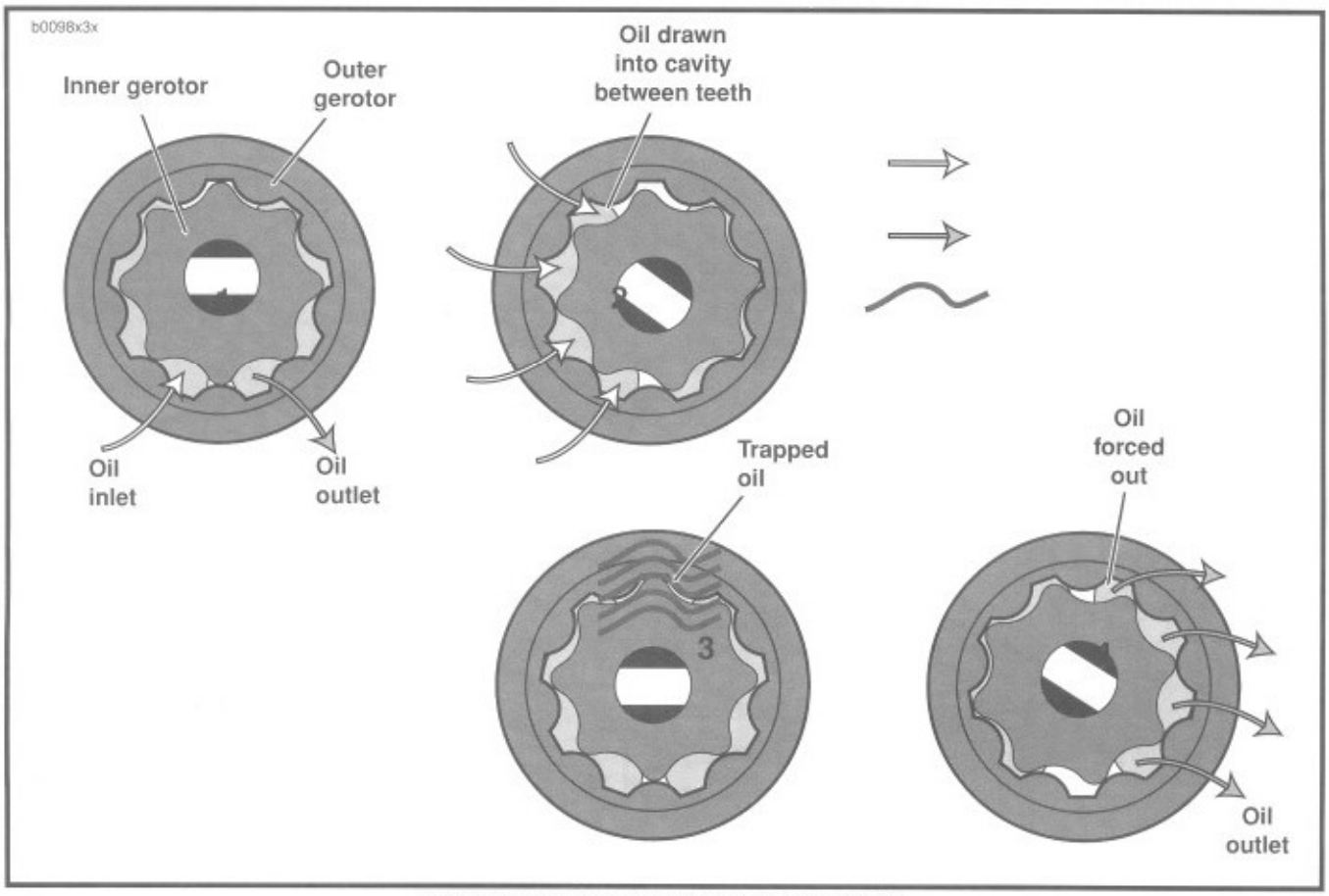
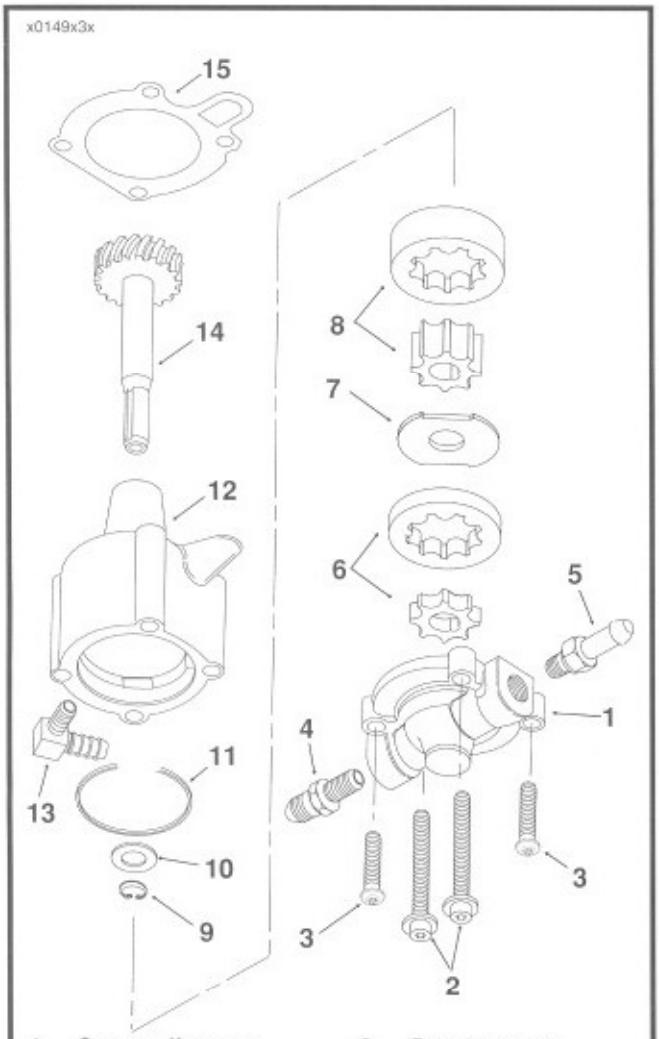


Figure 3-54. Principle of Gerotor Operation

3. Check for a grounded oil pressure switch wire or a faulty switch if oil indicator light fails to go out with engine running.

4. See ENGINE, LUBRICATION for additional information.



1. Cover, oil pump
2. Screw, w/washer (2)
3. Screw, Torx (2)
4. Connector
5. Hose fitting
6. Gerotor assy, feed
7. Gerotor separator plate
8. Gerotor assy, scavenge
9. Retaining ring
10. Washer, thrust
11. O-ring
12. Body, oil pump
13. Elbow fitting
14. Gear shaft
15. Gasket

Figure 3-55. Oil Pump

Removal/Disassembly

NOTE

Oil pump can be removed with engine in frame and without removing gearcase cover.

1. Drain oil from oil tank.
2. See Figure 3-45. Disconnect and tag the three oil hoses from the pump as shown.

NOTE

Do not remove feed hose fitting from the pump. Loosen large nut connected to fitting and then remove pressurized feed hose.

3. See Figure 3-55. Carefully remove two screws (2) that secure pump to crankcase. Pump will drop with screws removed. Discard mounting gasket (16).
4. Remove two Torx screws (3). Lift cover (1) off body (12). Remove and discard O-ring (11).
5. Slide both pieces of feed gerotor set (6), separator plate (7) and both pieces of scavenge gerotor set (8) off gear shaft (14).
6. Remove and discard retaining ring (9). Remove thrust washer (10) and gear shaft (14).

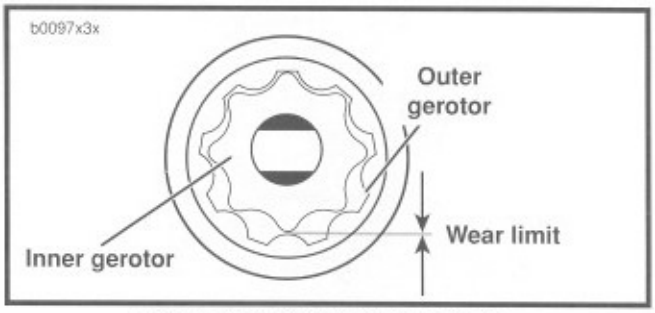


Figure 3-56. Gerotor Wear Limits

Cleaning, Inspection, and Repair

1. Clean all parts in cleaning solvent. Blow out holes and oil passages with compressed air.
2. See Figure 3-56. Inspect both gerotor sets for wear. Mesh pieces of each set together as shown. Use a feeler gauge to determine clearance.

The maximum allowable clearance between gerotors is 0.004 in. (0.10 mm). Replace gerotors as a set if clearance exceeds this dimension.

3. Measure thickness of feed gerotors with a micrometer. If they are not the same thickness, replace as a set.
4. Check gear shaft (14) teeth for damage or wear. Replace if necessary.

Assembly

1. See Figure 3-55. Install gear shaft (14) through body (12). Position thrust washer (10) over end of shaft. Install **new** retaining ring (9) into groove in shaft.

NOTE

Liberally coat all moving parts with clean engine oil to ensure easy assembly and smooth operation at start-up.

2. Insert inner gerotor of the scavenge gerotor set (8) over gear shaft.
3. Place outer gerotor over inner to complete scavenge set (8).
4. Position separator plate (7) into case and line up slots on perimeter with tabs inside oil pump body (12).
5. Place feed gerotor set (6) over gear shaft (14).
6. Install a **new** O-ring (11) into groove in cover (1). Place cover onto pump body. Install two Torx cover screws (3). Tighten screws (3) to 125-150 **in-lbs** (14.1-16.9 Nm) torque.
7. Place new mounting gasket (16) in position.
8. Secure pump to crankcase with two screws (2). Tighten screws to 125-150 in-lbs (14.1-16.9 Nm) torque.
9. See Figure 3-41. Install oil pump hoses at pump.

NOTE

Use new hose clamps. If fittings were removed, use TEFLON® PIPE SEALANT or HYLOMAR® on fitting threads.

OIL FILTER MOUNT

General (Figure 3-57)

Oil is pressure-fed from the oil pump to the oil filter mount (2) via a hose connection (6). Oil travels through the filter mount into the filter via outer filter holes.

Adequate oil pressure activates the oil pressure signal light switch (5) in the filter mount, which turns off the oil pressure indicator lamp.

The check ball (3) in the filter adapter (1) "opens" at 4-6 psi (28-41 kN/m^2) oil pressure. Filtered oil leaves the filter, flowing past the check ball.

Disassembly (Figure 3-57)

1. Remove oil filter adapter (1) from oil filter mount (2). Remove check ball (3) and spring (4).
2. Remove oil pressure signal light switch (5).

Cleaning and Inspection (Figure 3-57)

Thoroughly clean all parts in cleaning solvent. Blow out holes and passages using compressed air.

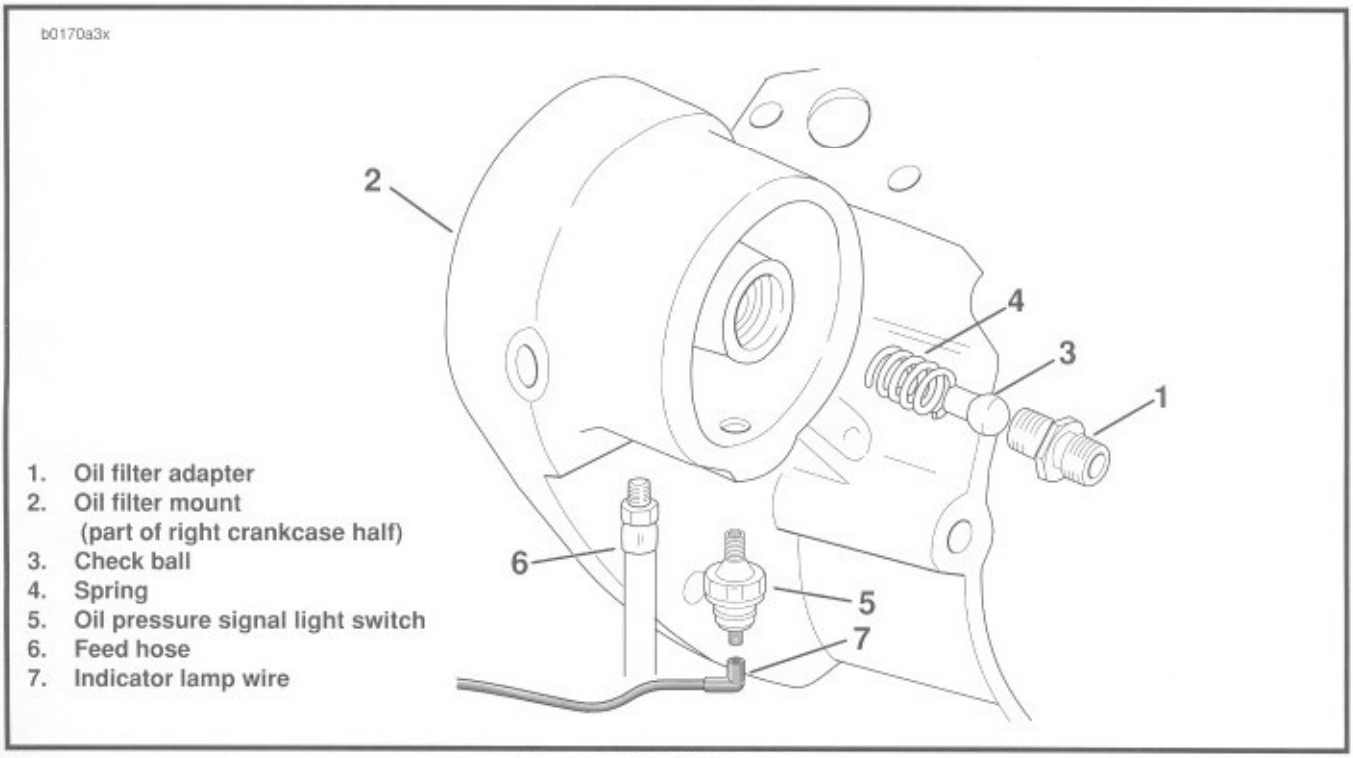


Figure 3-57. Oil Filter Mount

Assembly (Figure 3-57)

NOTE

Use TEFLON® PIPE SEALANT or HYLOMAR® on all fittings installed to oil filter mount.

1. Install oil pressure signal light switch (5). Tighten to 5-7 ft-lbs (7-9 Nm) torque.
2. Apply LOCTITE® THREADLOCKER 242 (blue) to the threads on that end of the adapter (1) which is installed into oil filter mount (2). Do not apply LOCTITE to adapter threads on oil filter element side.

NOTE

The oil filter adapter has identical ends; either end may be installed into the oil filter mount.

3. Place spring (4) and check ball (3) into threaded hole at center of mount (2). Push adapter (1) against ball to compress spring. Install threaded end (with LOCTITE) into threaded hole at center of mount (2). Tighten adapter to 8-12 ft-lbs (11-16 Nm) torque.
4. Connect pressure switch wire.
5. Pour about 4 fl oz. (120 ml) of clean engine oil into filter. Apply a light coat of oil to oil filter gasket. Install oil filter onto oil filter mount/adapter assembly; tighten filter an additional 1/2 to 3/4 turn after gasket contacts filter mount surface.
6. Fill oil tank with proper oil. See LUBRICATION.

VALVE TAPPETS

GENERAL

See Figures 3-9 and 3-58. The tappet assembly consists of tappet and roller. The tappet and roller, under compression force from valve spring, follow the surface of the revolving cam. The up-and-down motion produced is transmitted to the valve by the push rod and rocker arm. The tappet contains a piston (or plunger) and cylinder; it also contains a check valve, which allows the unit to fill with engine oil, thereby reducing clearance in the valve train.

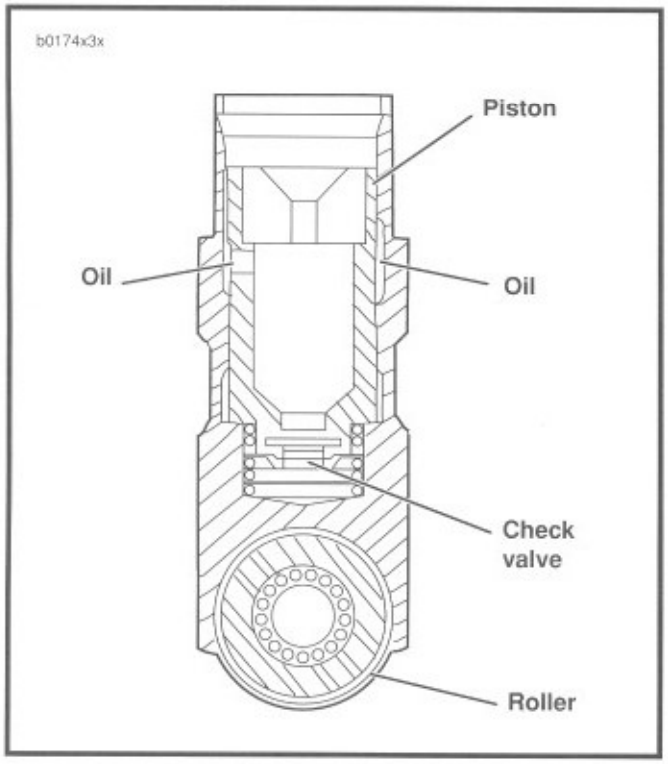


Figure 3-58. Tappet Assembly

When a tappet is functioning properly, the assembly operates with minimal tappet clearance. The unit automatically compensates for heat expansion to maintain a no-clearance condition.

It is normal for tappets to click when engine is started after standing for some time. Tappets have a definite leakdown rate which permits the oil in the tappets to escape. This is necessary to allow units to compensate for various expansion conditions of parts and still maintain correct clearance operation. Tappets are functioning properly if they become quiet after a few minutes of engine operation.

REMOVAL (FIGURE 3-9)

1. Clean all dirt from around crankcase, and blow loose particles from area with compressed air.
2. Remove the upper, middle, and lower rocker covers. See CYLINDER HEAD earlier in this section. Pull the push rod upward through top of cylinder head.
3. Remove socket screw (11) and washer (13). Lift retainer plate (9) and seal (8) upward a few inches on push rod cover (7). Push upward on push rod cover while pulling bottom of cover (7) clear of crankcase. Remove cover (7).
4. Remove socket screw (5), washer (14), and plate (4). Pull O-rings (3) off ends of pins (2) and discard. Grasp ends of pins (2) and pull outward free of crankcase. A pliers is a handy tool to free pins (2). With a thin-bladed screwdriver in the retainer groove at the top of the tappet, pry upward on the tappet until it extends above the gearcase and can be pulled out by hand.

CLEANING AND INSPECTION

1. Clean all parts, except roller/tappet assembly, thoroughly in solvent. Blow dry with compressed air.
2. Inspect valve tappets for excessive clearance in guide. Clearance should be 0.0008-0.0020 in. (0.020-0.051 mm).
   Accurately measure tappet bore inner diameter with a gauge. Service wear limit is 0.0030 in. (0.076 mm). Excessive tappet guide clearance is corrected by fitting a new tappet and/or replacing crankcases.

NOTE

Inside and outside micrometers used for measuring tappets and tappet guides must be calibrated to ensure accurate readings.

3. Check tappet roller free play. Roller clearance on pin should be within 0.0006-0.0010 in. (0.015-0.025 mm). Recommended service practice is tappet replacement. Service wear limit is 0.0015 in. (0.038 mm).
4. Check tappet roller end clearance. Clearance should be 0.008-0.022 in. (0.203-0.559 mm). Service wear limit is 0.026 in. (0.660 mm).
5. Tappets should be soaked in clean engine oil and kept covered until assembly.

INSTALLATION (Figure 3-9)

1. Rotate engine so that both tappets (6), from the cylinder being serviced, will be installed on the base circle (lowest position) of the cam.
2. Apply a liberal amount of engine oil to tappet assembly (especially roller needles), to ensure smooth initial operation.
3. Insert tappet (6) into bore in crankcase (1). Rotate tappet so that flats at upper end of tappet face the front and rear of the engine. If the tappet is installed incorrectly, pins (2) cannot be inserted.
4. Insert pins (2) in the holes in crankcase. Place new O-rings (3) over ends of pins. Install plate (4) using screw (5) with washer (14). Tighten screw (5) to 80-110 **in-lbs** (9.0-12.4 Nm).
5. Slide new seal (8), and place retainer (9), over top of push rod cover (7). Position new O-ring (10) at top of push rod cover. Hold cover at an angle and insert top through hole in cylinder head. Push up on cover while aligning bottom of cover with tappet bore in crankcase. Lower retainer (9) with seal (8) onto crankcase, aligning locating pin (15) with hole in retainer.
6. Insert screw (11) with washer (13) through hole in retainer (9), and thread into tapped hole in crankcase. Tighten screw (11) to 15-18 ft-lbs (20-24 Nm) torque.
7. Install rocker covers. See CYLINDER HEAD earlier in this section.

GEARCASE COVER AND CAM GEARS

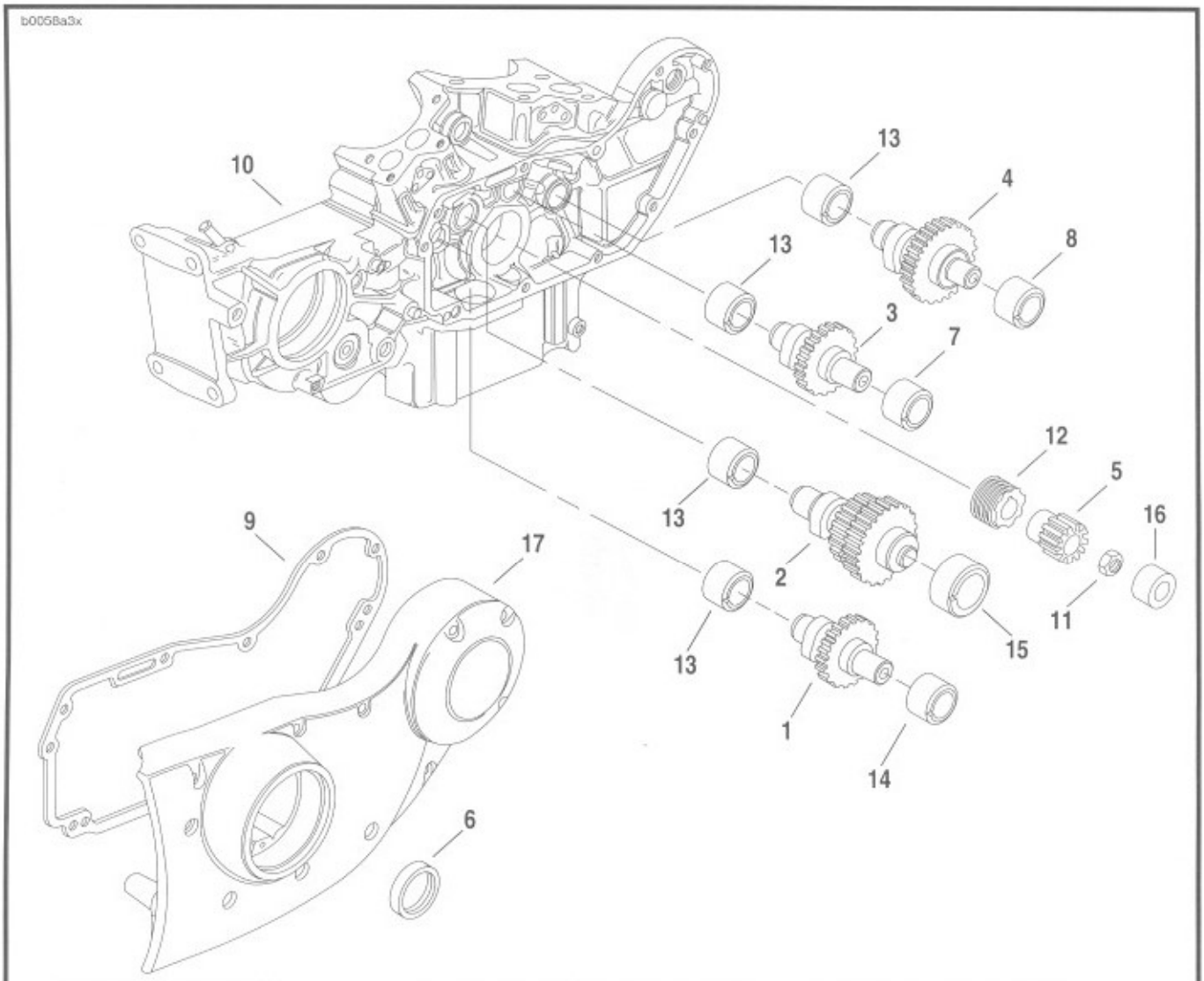
GENERAL

Read the complete gearcase section carefully before you begin any service work.

For the gearcase components to operate at their optimum, all components must be properly fitted and matched. Changing one component can affect many others. It is important to know and understand all inspection procedures and how components interact.

REMOVAL/DISASSEMBLY (Figure 3-59)

1. Thoroughly clean area around gearcase cover (17) and tappets. Blow loose dirt from crankcase with compressed air.
2. Remove any parts that will interfere with gearcase disassembly (i.e., exhaust pipe, footrest, air cleaner, brake pedal, etc.).
3. Remove push rods; see CYLINDER HEAD.
4. Remove tappets; see VALVE TAPPETS.



1. Rear exhaust cam gear
2. Rear intake cam gear
3. Front intake cam gear
4. Front exhaust cam gear
5. Pinion gear
6. Seal
7. Front intake cam gear bushing
8. Front exhaust cam gear bushing
9. Gearcase cover gasket
10. Right crankcase half
11. Nut
12. Oil pump drive gear
13. Cam gear bushing (4)
14. Rear exhaust cam gear bushing
15. Rear intake cam gear bushing
16. Pinion shaft bushing
17. Gearcase cover

Figure 3-59. Gearcase and Valve Train Components

5. Check for minimum cam gear end play; see ASSEMBLY procedure. Record readings.
6. Remove cam position sensor and rotor; see Section 7.
7. Place a pan under gearcase to collect oil. Remove cover screws. Carefully remove gearcase cover. Discard old gasket (9).

NOTE

If cover does not come loose on removal of screws, tap lightly with a rawhide hammer. Never pry cover off.

8. Remove cam gears (1, 2, 3, and 4). Carefully mark each component to ensure correct installation.

NOTE

Nut (11) is secured by Loctite-262 on the nut threads.

9. Remove nut (11). Slide pinion gear (5) and oil pump drive gear (12) off pinion shaft.

CLEANING, INSPECTION, AND REPAIR

1. Thoroughly clean gearcase compartment, gearcase cover, and gears in solvent to remove oil and carbon deposits.
2. Blow out all cover oil passages and bushings with compressed air.
3. Clean old gasket material from gearcase and cover faces with cleaning solvent.

Cam and Pinion Gear Identification, Inspection, and Selection

See Figure 3-60. Cam lobes are stamped with a number (1, 2, 3, or 4) followed by letter "D" or "W." The number identifies the cam location/function; the letter "D" or "W" indicates model year application:

1D (or W) = rear exhaust
2D (or W) = rear intake
3D (or W) = front intake
4D (or W) = front exhaust

Use only "W" cams on 1998 XL Sport models. "D" cams are used on all other models.

See Figure 3-61. Measure the gear diameter with a micrometer over 0.108 in. (2.74 mm) diameter gauge pins on opposite sides of the gear. The pins are of the proper size to fit between the contacting surfaces of the gear teeth. Gear diameter should be measured in at least two places 90° apart. Use GAUGE PIN SET (Part No. HD-38361) when measuring pinion and cam gear sizes.

Cam and pinion gears are individually selected for each specific gear cover through sophisticated computer-aided measuring techniques in a controlled environment. Each gear is assigned an individual color code based on its diameter (measured with gauge pins). When cam and/or pinion gears

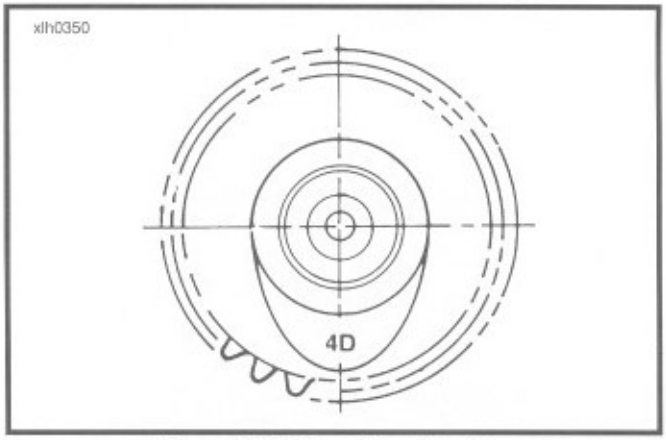


Figure 3-60. Cam Identification

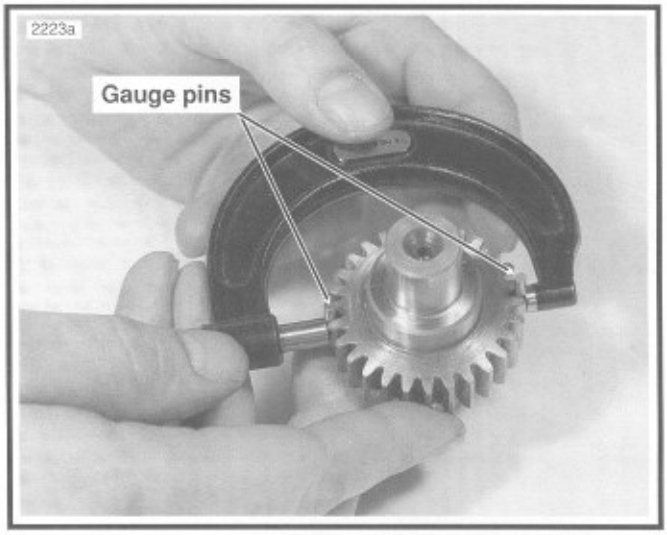


Figure 3-61. Measuring Gear Size

are replaced, always use the same color code as found on gears being replaced to ensure that the gear operation remains as quiet as possible. See Figure 3-62 for location of cam and pinion gear color codes.

NOTE

On flywheel pinion shaft, a paint dot is located on the shaft perimeter near the centerline of the keyway. This dot identifies the pinion shaft inner race size. Do not use this dot to select pinion gear size.

See the CAM AND PINION GEAR COLOR CODE AND DIAMETER table which follows. Compare the previously measured diameter of each gear with the specifications (listed in inches) shown in the table to determine amount of wear on gear teeth.

NOTE

Prior to changing any cam gears, check gear shaft fit within corresponding bushings. Worn bushings can cause excessive backlash.

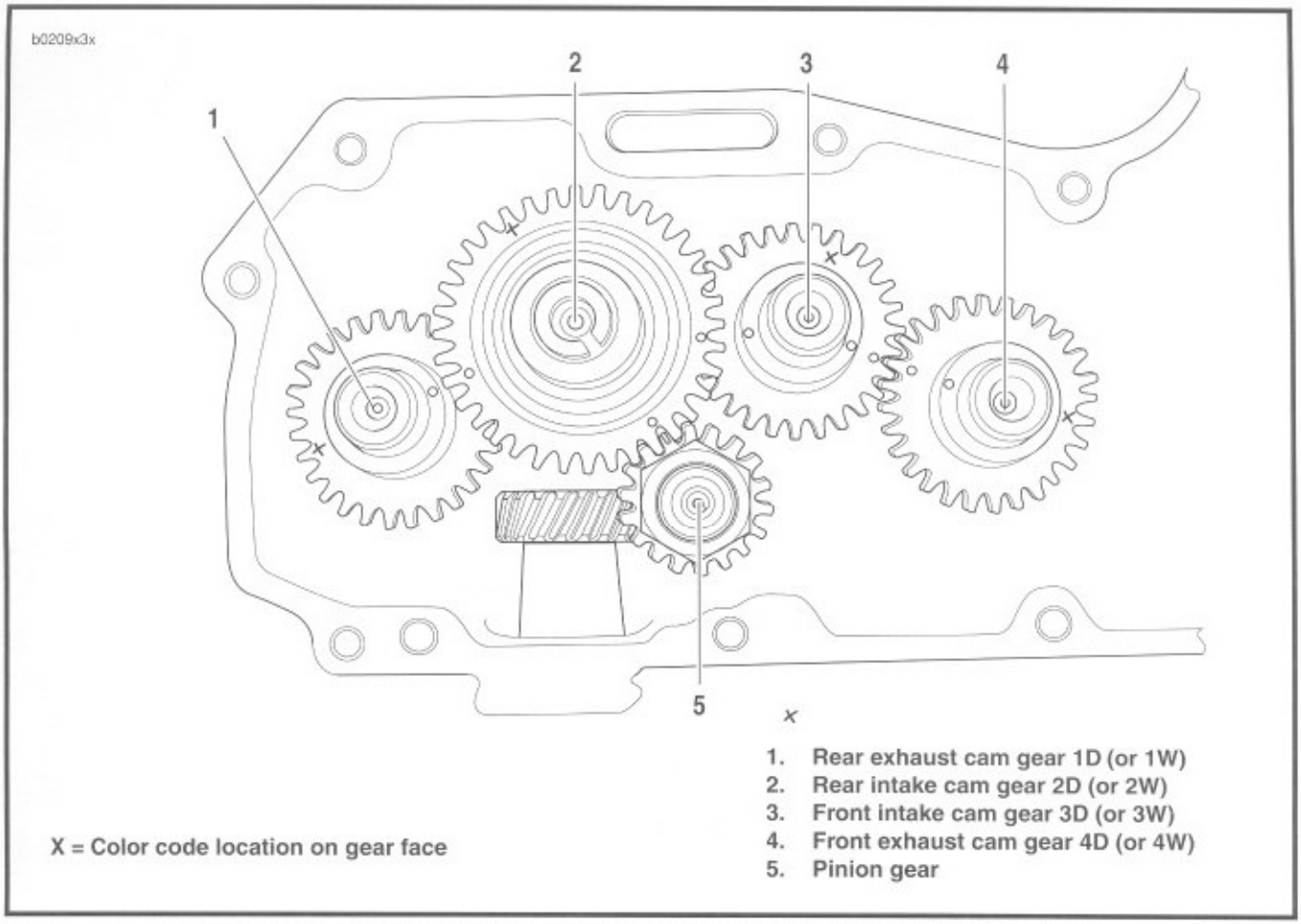


Figure 3-62. Cam and Pinion Gear Color Code Location and Timing Mark Indexing

CAM AND PINION GEAR COLOR CODE AND DIAMETER

GEAR NO. & POSITION	1	2 INBOARD	2 OUTBOARD	3	4	5
COLOR CODE (1 paint dot)	Rear Exhaust	Rear Intake	Rear Intake	Front Intake	Front Exhaust	Pinion
BROWN	1.9010-1.9014 (48.285-48.296)	1.9040-1.9044 (48.362-48.372)	2.4026-2.4030 (61.026-61.036)	1.9010-1.9014 (48.285-48.296)	1.9040-1.9044 (48.362-48.372)	1.2758-1.2761 (32.405-32.413)
BLUE	1.9015-1.9019 (48.298-48.308)	1.9035-1.9039 (48.349-48.359)	2.4031-2.4035 (61.039-61.049)	1.9015-1.9019 (48.298-48.308)	1.9035-1.9039 (48.349-48.359)	1.2754-1.2757 (32.395-32.403)
RED	1.9020-1.9024 (48.311-48.321)	1.9030-1.9034 (48.336-48.346)	2.4036-2.4040 (61.051-61.062)	1.9020-1.9024 (48.311-48.321)	1.9030-1.9034 (48.336-48.346)	1.2750-1.2753 (32.385-32.393)
WHITE	1.9025-1.9029 (48.323-48.334)	1.9025-1.9029 (48.323-48.334)	2.4041-2.4045 (61.064-61.074)	1.9025-1.9029 (48.323-48.334)	1.9025-1.9029 (48.323-48.334)	1.2746-1.2749 (32.375-32.382)
GREEN	1.9030-1.9034 (48.336-48.346)	1.9020-1.9024 (48.311-48.321)	2.4046-2.4050 (61.077-61.087)	1.9030-1.9034 (48.336-48.346)	1.9020-1.9024 (48.311-48.321)	1.2742-1.2745 (32.365-32.372)
YELLOW	1.9035-1.9039 (48.349-48.359)	1.9015-1.9019 (48.298-48.308)	2.4051-2.4055 (61.089-61.100)	1.9035-1.9039 (48.349-48.359)	1.9015-1.9019 (48.298-48.308)	1.2738-1.2741 (32.354-32.362)
BLACK	1.9040-1.9044 (48.362-48.372)	1.9010-1.9014 (48.285-48.296)	2.4056-2.4060 (61.102-61.112)	1.9040-1.9044 (48.362-48.372)	1.9010-1.9014 (48.285-48.296)	1.2734-1.2737 (32.344-32.352)

Bushing Inspection and Removal

1. See Figure 3-59. Bushings (7, 8, 13, 14, 15, and 16) are press fit in gearcase cover (17) and crankcase. Inspect each bushing against its corresponding cam gear shaft or pinion gear shaft.

Gear Shaft	Correct Clearance	Service Wear Limit
Cam	0.0007-0.0022 in. 0.018-0.056 mm	0.003 in. 0.08 mm
Pinion	0.0023-0.0043 in. 0.058-0.109 mm	0.005 0.13 mm

2. See Figure 3-63. Use a BUSHING AND BEARING PULLER (Part No. HD-95760-69A) to remove bushings from gearcase cover and crankcase.

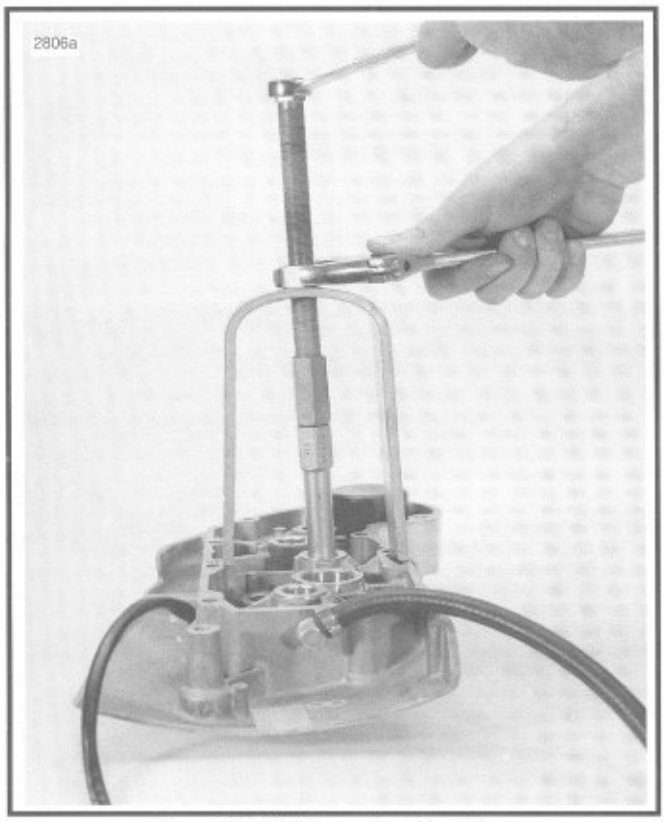


Figure 3-63. Removing Bushing

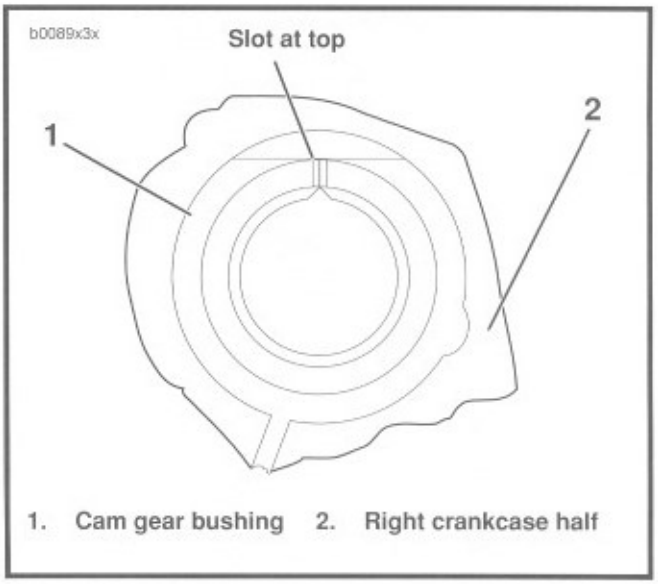
Bushing Installation

NOTE

Installing and reaming crankcase and gearcase cover bushings may alter the center distances between mating gears and may result in an increase in gear noise. For quiet-running gears, the gears should be matched to the center distances.

CAM GEAR BUSHINGS IN RIGHT CRANKCASE HALF

1. See Figure 3-64. Each cam gear bushing (1), to be installed in right crankcase half (2), must be positioned in crankcase bore with its oiling slot at exact top of bore (12 o'clock position).



1. Cam gear bushing 2. Right crankcase half

Figure 3-64. Cam Gear Bushing Installed in Crankcase

2. Using an arbor press, install each bushing in its crankcase bore so that bushing shoulder contacts crankcase boss.

3. After you install a new bushing in right crankcase half, ream the bushing to correct size. See BUSHING REAMING.

CAM GEAR BUSHINGS (EXCEPT REAR INTAKE BUSHING) IN GEARCASE COVER

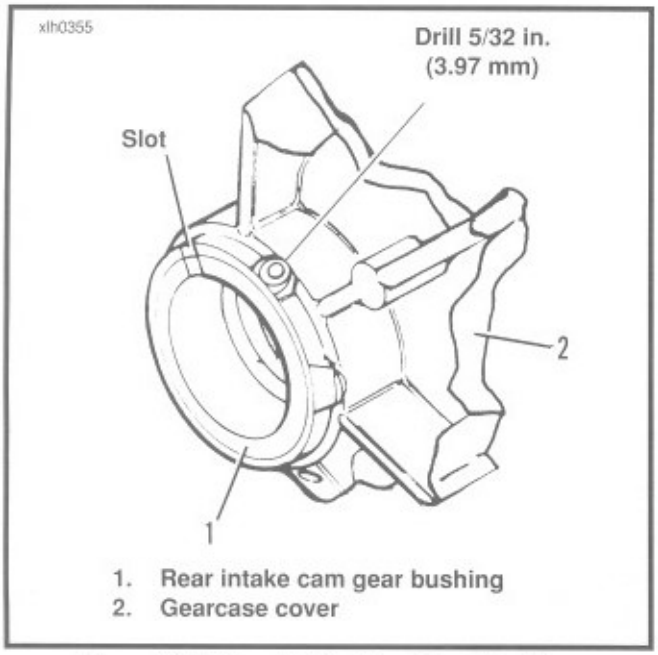
1. See Figure 3-59. Using an arbor press, install each bushing (7, 8, and 14) in its gearcase cover (17) bore so that bushing shoulder contacts cover boss. There is no need to orient these particular bushings in any specific position of rotation within gearcase cover bores.

2. After you install a new bushing in gearcase cover, line-ream the bushing to correct size. See BUSHING REAMING.

REAR INTAKE CAM GEAR BUSHING IN GEARCASE COVER

1. See Figure 3-59. Rear intake cam gear bushing (15) must be installed in its gearcase cover (17) bore using an arbor press. You will need to orient the bushing in a specific position of rotation within the cover bore, and will need to drill a lubrication hole in the bushing, according to the following procedures.

2. See Figure 3-65. Position bushing (1) over bore of gearcase cover (2) with chamfered edge downward and slot upward. Align slot in bushing with slot in gearcase cover boss. Press bushing into cover bore until bushing is flush with cover boss.



1. Rear intake cam gear bushing
2. Gearcase cover

Figure 3-65. Rear Intake Cam Gear Bushing Installed in Gearcase Cover

3. Drill a 5/32-in. (3.97 mm) diameter hole through bushing using existing hole in gearcase cover as a guide.
4. After you install a new bushing in gearcase cover, line-ream the bushing to the correct size. See BUSHING REAMING.

PINION SHAFT BUSHING IN GEARCASE COVER

1. See Figure 3-59. Using an arbor press, install pinion shaft bushing (16) in its gearcase cover (17) so that bushing is flush with cover boss. There is no need to orient this particular bushing in any specific position of rotation within the gearcase cover bore.
2. Although the original pinion shaft bushing is not "pinned," the replacement bushing must be secured, from possible rotation within the cover bore, by installation of a dowel pin. See Figure 3-66. Drill a No. 31 hole, 0.281 in. (7.14 mm) deep, at top side of boss (side toward top of gearcase cover), centering the drill bit on the cover bore circle (hole is drilled half in bushing O.D. and half in cover bore I.D.).
3. Drive a new dowel pin no more than 0.20 in. (5.1 mm) below the bushing face. Carefully peen edges of hole to lock the pin in place.
4. After you install a new bushing in gearcase cover, line-ream the bushing to the correct size. See BUSHING REAMING.

Bushing Reaming

NOTE

- *Installing and reaming crankcase and gearcase cover bushings may alter the center distances between mating gears and may result in an increase in gear noise. For quiet-running gears, the gears should be matched to the center distances.*

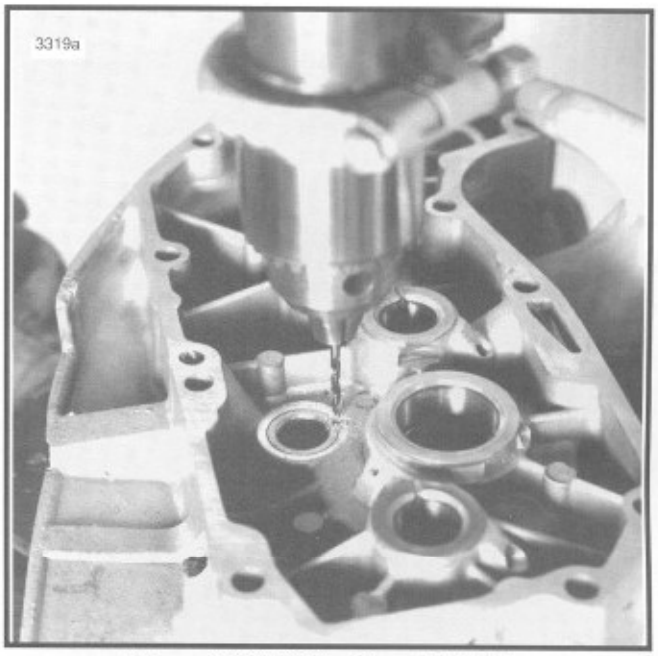


Figure 3-66. Drilling Dowel Pin Hole

- *Bushings in right crankcase half serve as pilots for reaming gearcase cover bushings and must, therefore, be reamed to size first.*
- *After reaming any bushing, check shaft fit in the bushing. It may be necessary to make a second pass with reamer to attain proper fit.*

CAM GEAR BUSHINGS IN RIGHT CRANKCASE HALF

1. Separate two halves of crankcase, if not already accomplished. Place right crankcase half on flat surface with gearcase side upward. Bushing to be reamed must be oriented as shown in Figure 3-64.
2. See Figure 3-67. Position CAMSHAFT BUSHING REAMER PILOT (Part No. HD-38871) onto gearcase side of crankcase half; upper right and lower left indexing holes in pilot must be placed over dowels in crankcase half. Insert two bolts (supplied with pilot) through two remaining holes in pilot, and into threaded holes of crankcase half. Tighten bolts securely.
3. Insert the 11/16-in. diameter reamer through pilot hole and into bushing while turning reamer clockwise. Continue turning reamer clockwise through bushing until smooth shank of reamer passes through hole in pilot.
4. Detach reamer from handle. Pull reamer out opposite side of crankcase half.
5. Thoroughly clean right crankcase half, removing all metal chips/shavings. Blow out all oil passages using compressed air.

CAM GEAR BUSHINGS (EXCEPT REAR INTAKE BUSHING) IN GEARCASE COVER

NOTE

Newly installed cam gear bushings in the gearcase cover must be line reamed, using the right crankcase half as a pilot for the reamer, to establish correct clearance and to ensure perfect alignment. If crankcase halves are not separated on your motorcycle, use a spare right crankcase half to perform the following line reaming procedures.

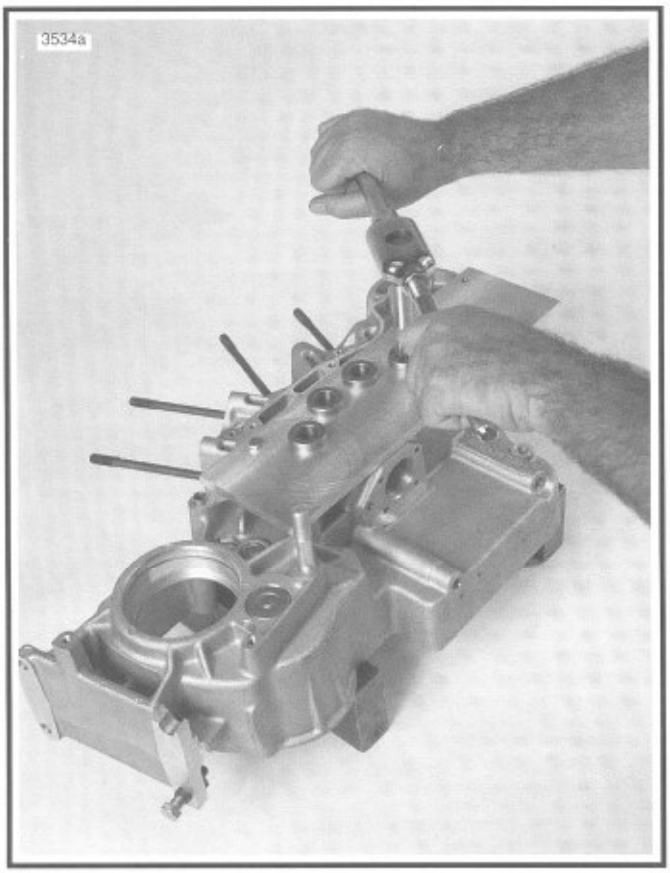


Figure 3-67. Reaming Cam Gear Bushing in Right Crankcase Half

1. See Figure 3-59. Bushings (7, 8, and 14) to be reamed must be installed in gearcase cover (17) as described in BUSHING INSTALLATION. Attach gearcase cover to right crankcase half (10), which has been disassembled from left crankcase half, securing with a minimum of three mounting screws.
2. Insert a standard 11/16-in. diameter reamer through the previously reamed cam gear bushing (13) in right crankcase half, which is in line with one of the bushings to be reamed in gearcase cover.
3. Turn reamer clockwise through bushing in cover until reamer bottoms. Then give reamer one complete clockwise turn to size the bushing. Continue turning reamer clockwise while extracting reamer from bushing.
4. Repeat Steps 2 and 3 for remaining two cam gear bushings (except rear intake bushing) in gearcase cover, if required.
5. Separate gearcase cover from right crankcase half. Inspect bushings for proper cam gear shaft fit. Repeat line reaming operation if necessary.
6. Thoroughly clean gearcase cover, removing all metal chips/shavings. Blow out all oil passages using compressed air.

REAR INTAKE CAM GEAR BUSHING IN GEARCASE COVER

NOTE

A newly installed rear intake cam gear bushing in the gearcase cover must be line reamed, using the right crankcase half as a pilot for the reamer, to establish correct clearance and to ensure perfect alignment. If crankcase halves are not separated on your motorcycle, use a spare right crankcase half to perform the following line reaming procedures.

1. See Figure 3-59. Rear intake cam gear bushing (15) must be installed in gearcase cover (17) as described in BUSHING INSTALLATION.
2. Identify the previously reamed rear intake cam gear bushing (13) in right crankcase half (10), which has been disassembled from left crankcase half. Insert the shank end of REAR INTAKE CAM GEAR BUSHING REAMER (Part No. HD-94803-67) through gearcase side of this bushing.
3. With reamer inserted into bushing in right crankcase half, attach gearcase cover to right crankcase half, securing with a minimum of three mounting screws.
4. Turn reamer clockwise through bushing in gearcase cover until reamer bottoms. Then give reamer one complete clockwise turn to size the bushing. Continue turning reamer clockwise while extracting reamer from bushing.
5. Separate gearcase cover from right crankcase half. Inspect bushing for proper cam gear shaft fit. Repeat line reaming operation if necessary.
6. Thoroughly clean gearcase cover, removing all metal chips/shavings. Blow out all oil passages using compressed air.

PINION SHAFT BUSHING IN GEARCASE COVER

NOTE

A newly installed pinion shaft bushing in the gearcase cover must be line reamed, using both the right crankcase half and Part No. HD-94812-87 as pilots for the reamer, to establish correct clearance and to ensure proper alignment. If crankcase halves are not separated on your motorcycle, use a spare right crankcase half to perform the following line reaming procedures.

1. See Figure 3-59. Pinion shaft bushing (16) must be installed in gearcase cover (17) as described in BUSHING INSTALLATION. Attach gearcase cover to right crankcase half (10), which has been disassembled from left crankcase half, securing with a minimum of three mounting screws.

2. See Figure 3-68. Install PINION SHAFT BUSHING REAMER PILOT (Part No. HD-94812-87) into right crankcase roller race. Insert PINION SHAFT BUSHING REAMER (Part No. HD-94812-1) through the pilot.

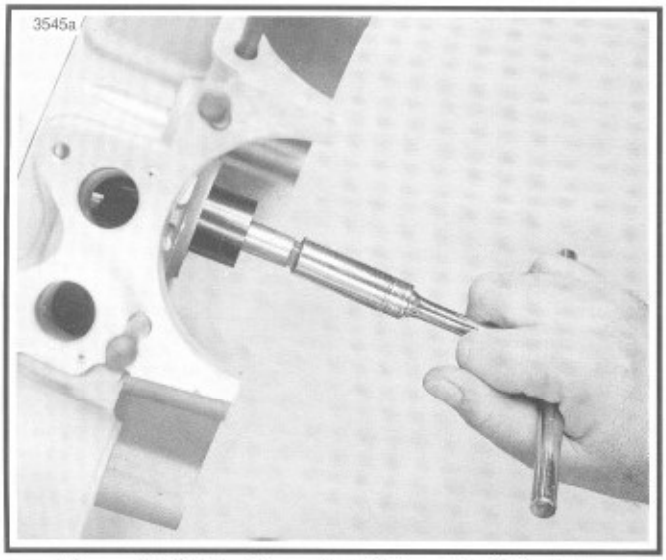


Figure 3-68. Line Reaming Pinion Shaft Bushing

3. Turn reamer clockwise through bushing in gearcase cover until reamer bottoms. Then give reamer one complete clockwise turn to size the bushing. Continue turning reamer clockwise while extracting reamer from bushing.

4. Separate gearcase cover from right crankcase half. Inspect bushing for proper pinion shaft fit. Repeat line reaming operation if necessary.

5. Remove pilot from right crankcase roller race. Thoroughly clean gearcase cover, removing all metal chips/shavings. Blow out all oil passages using compressed air.

ASSEMBLY/INSTALLATION

1. See Figure 3-59. Install oil pump drive gear (12) and pinion gear (5) to pinion shaft. Note that timing mark on pinion gear tooth is aligned with keyway in I.D. of pinion gear, as shown in Figure 3-69. See Figure 3-70. The timing mark will allow you to easily position pinion gear (1) over shaft key (2) and against oil pump drive gear (3) on pinion shaft (4).

2. See Figure 3-59. Clean pinion shaft threads and nut (11) threads. Apply several drops of LOCTITE® Threadlocker 262 (red) to threads of nut.

3. See Figure 3-71. Install CRANKSHAFT LOCKING TOOL (Part No. HD-41506) over pinion shaft. Install nut to pinion shaft, tightening to 35-45 ft-lbs (47-61 Nm) torque.

4. See CAM AND PINION GEAR IDENTIFICATION, INSPECTION, AND SELECTION, and Figures 3-60 and 3-62. Liberally apply engine oil to bushings, shafts, and gears. Install all cam gears into bushings of right crankcase half, properly aligning timing marks of cam gears and pinion gear as shown in Figure 3-62.

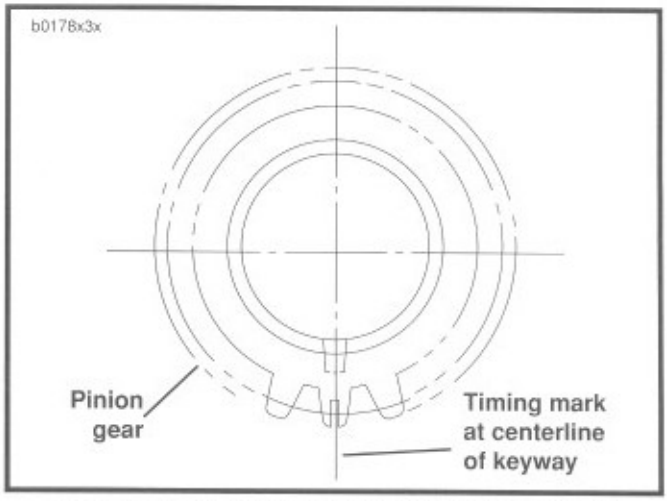


Figure 3-69. Pinion Gear Timing Mark and Keyway

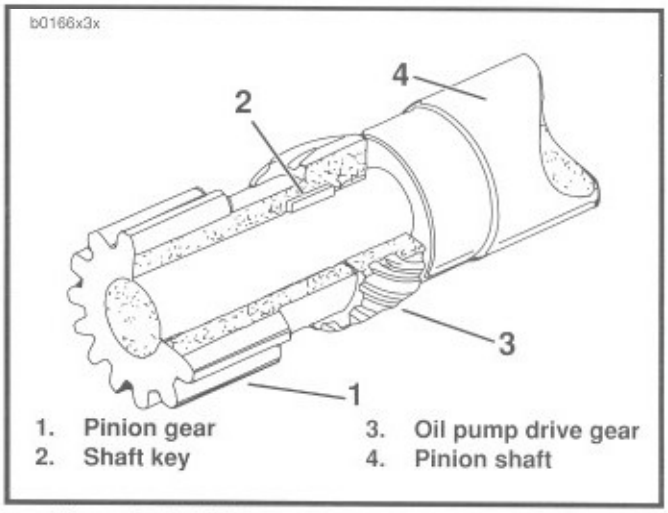


Figure 3-70. Oil Pump Drive Gear and Pinion Gear Installed on Pinion Shaft

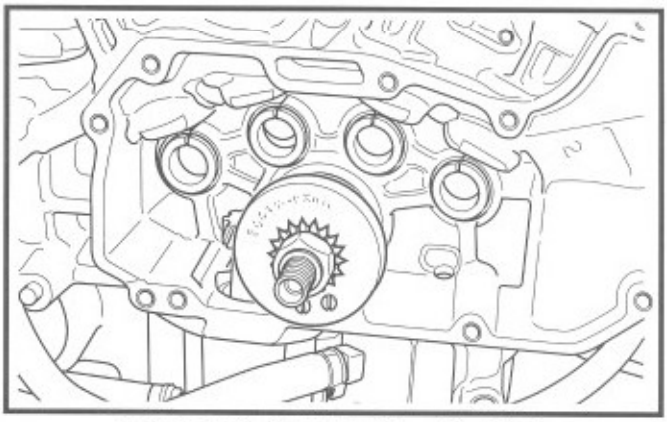


Figure 3-71. Crankshaft Locking Tool

NOTE

Because of the larger diameter additional gear (which meshes with the pinion gear) on the outboard end of the rear intake (2D) cam gear, the rear exhaust (1D) and front intake (3D) cam gears must both be installed before the rear intake (2D) cam gear is installed.

4. See Figure 3-59. Install a new seal (6) and new dry gasket (9) on gearcase cover (17).

5. Install gearcase cover over all gears and onto right crankcase half (10). Secure cover to crankcase half with 11 socket head screws. Tighten screws evenly to 80-110 **in-lbs** (9.0-12.4 Nm) torque according to the torque sequence shown in Figure 3-72.

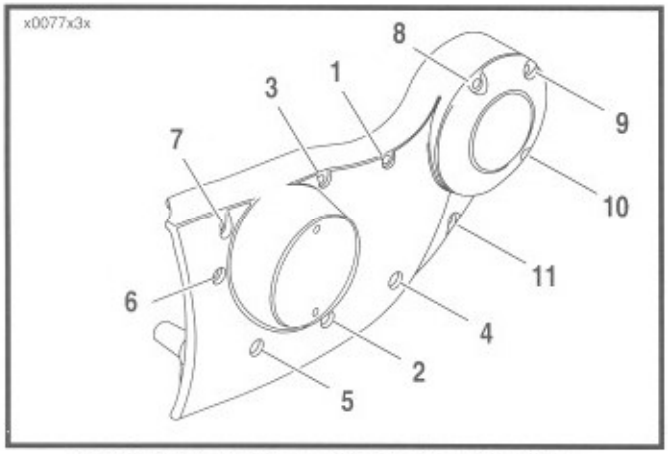


Figure 3-72. Gearcase Cover Mounting Screw Torque Sequence

6. Check cam gear end play for each cam gear as follows:

   - Turn engine over until lobe of cam gear being checked is pointing toward its respective tappet guide hole.
   - Using a flat blade screwdriver, gently pry the cam gear toward gearcase cover.
   - Using a feeler gauge, measure gap between bushing (in crankcase half) and cam gear shaft thrust face (shoulder). This is cam gear end play.
   - Compare your cam gear end play measurements with the SPECIFICATIONS at the beginning of this section. Make repairs as required if end gap is less than the minimum specified, or greater than the maximum specified (Service Wear Limits).

7. Install valve tappets and push rods (see VALVE TAPPETS).

8. Install cam position sensor and rotor. Static time or align scribed marks with sensor screws (see Section 7).

9. Install any components removed to gain access to gearcase (i.e. exhaust system components, footrest, air cleaner).

CRANKCASE

GENERAL

When rod bearings, pinion shaft bearing, or sprocket shaft bearing are in need of repair, the engine must be removed from the chassis; see STRIPPING MOTORCYCLE FOR ENGINE REPAIR in this section. It is recommended procedure to check and make repairs to cylinder heads, cylinders, gearcase and transmission at the same time (perform entire engine overhaul).

⚠CAUTION

Laying engine on primary side will damage clutch cable end fitting.

ADJUSTMENT/TESTING

Flywheel End Play

See Figure 3-73. Before completely disassembling crankcases, check flywheel end play.

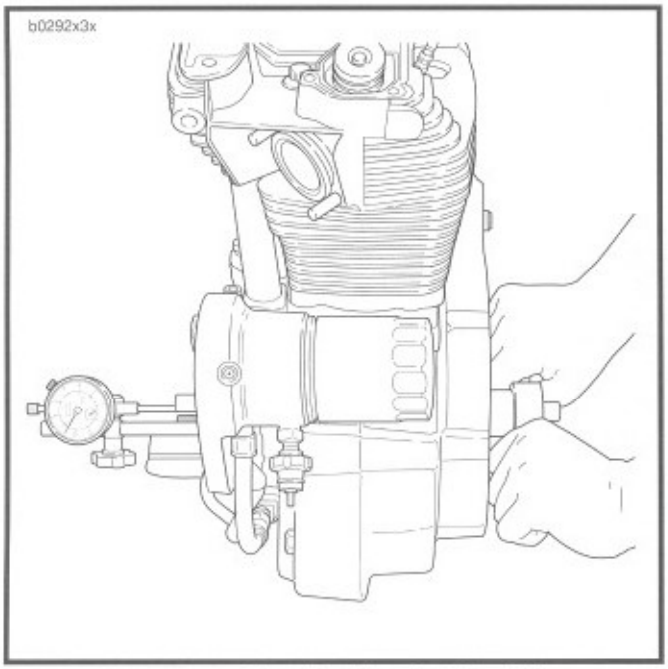


Figure 3-73. Checking Flywheel End Play

1. After engine has been removed from chassis, securely fasten it to a stand or workbench.
2. Remove gearcase cover. Attach a dial indicator to gear side crankcase with indicator stem on end of gearshaft.
3. Sprocket shaft bearings must be preloaded to obtain an accurate flywheel end play reading. A suitable tool can be made by welding two handles to an old sprocket shaft nut. Install the nut and sprocket. Tighten nut to 150-165 ft-lbs (203-224 Nm) torque.
4. Rotate and push on sprocket shaft while reading dial indicator. Then rotate and pull on sprocket shaft while reading dial indicator. If difference (end play) in indicator readings is not 0.001-0.005 in. (0.025-0.13 mm), bearing inner spacer (shim) (item 6, Figure 3-75) must be replaced. Choose spacer from following table. Use a thinner spacer for less end play; use a thicker spacer for more end play.

Flywheel End Play Spacers (Shims)

Part Number	Thickness	
	inches	mm
9155	0.0975-0.0985	2.476-2.502
9142	0.0995 - 0.1005	2.527-2.553
9143	0.1015-0.1025	2.578-2.603
9144	0.1035 - 0.1045	2.629-2.654
9145	0.1055 - 0.1065	2.680-2.705
9146	0.1075 - 0.1085	2.730-2.756
9147	0.1095 - 0.1105	2.781-2.807
9148	0.1115 - 0.1125	2.832-2.857
9149	0.1135 - 0.1145	2.883-2.908

DISASSEMBLY

Crankcase Halves

1. Remove cylinder heads; see CYLINDER HEAD, REMOVAL in this section.
2. Remove cylinders and pistons; see CYLINDER AND PISTON, REMOVAL in this section.

⚠CAUTION

After removing cylinders, install plastic or rubber hose over cylinder studs. Never lift or move crankcase by grasping cylinder studs.

3. Remove oil pump and gearcase components; see ENGINE LUBRICATION SYSTEM, OIL PUMP, REMOVAL and GEARCASE COVER AND CAM GEARS, REMOVAL in this section.

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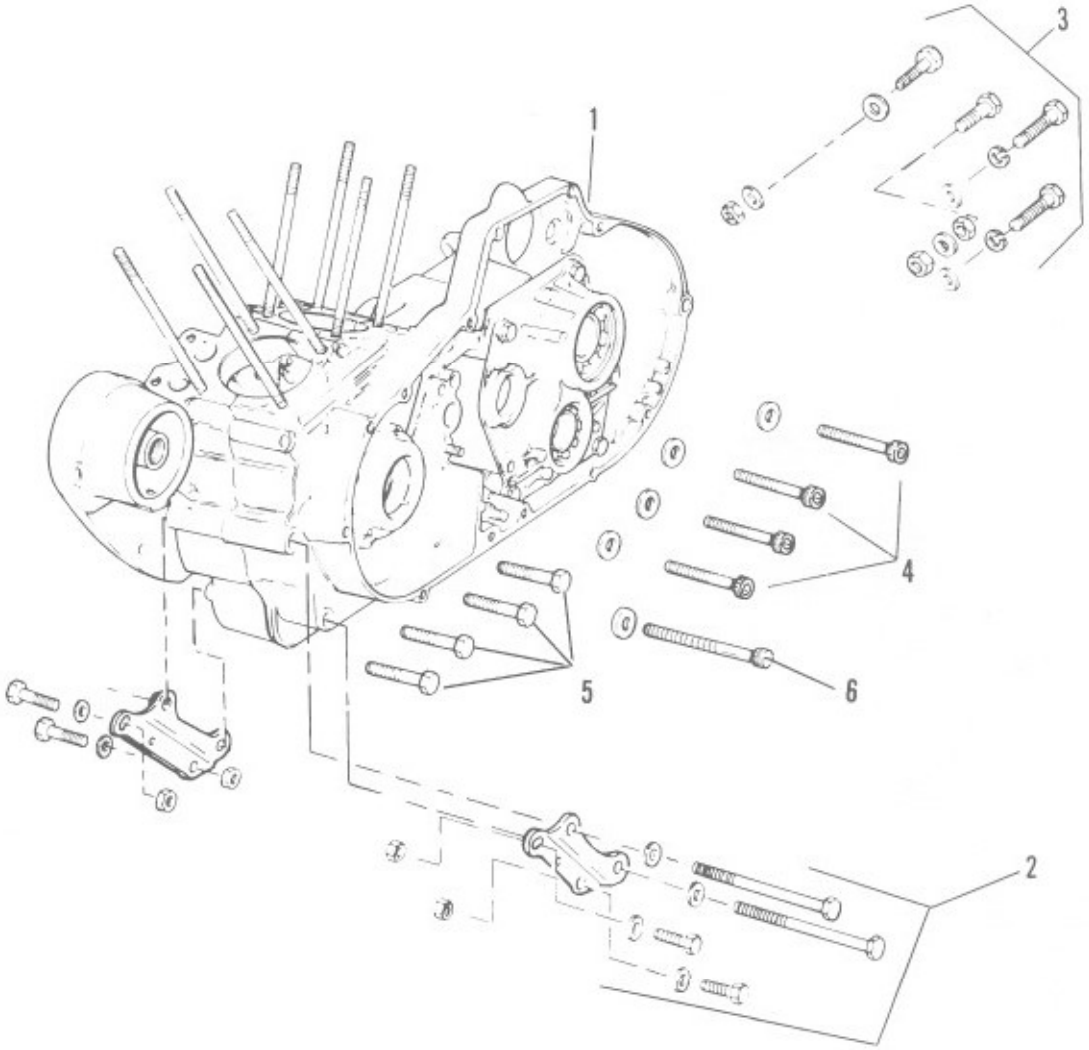


1. Crankcase
2. Engine front mounting hardware
3. Engine rear mounting hardware
4. Upper case hex socket head screw – 2-1/2 in. long (4)
5. Bottom case hex head bolt – 3/4 in. long (4)
6. Access door hex socket head screw – 3-3/4 in. long

Figure 3-74. Crankcase Hardware

4. Remove clutch and primary drive components; see PRIMARY DRIVE / CLUTCH, REMOVAL in Section 6.

5. Remove starter motor; see ELECTRIC STARTER, STARTER, REMOVAL in Section 5.

6. Remove transmission; see TRANSMISSION CASE, REMOVAL in Section 6.

7. See Figure 3-74. Remove screws (4) and rear engine mount bolt securing crankcase halves together.

8. Position crankcase on work bench, gearcase side up. Tap crankcase with rawhide mallet to loosen top half and separate the halves.

⚠WARNING

The following step requires using a press. Wear eye protection and make certain set-up is stable. The force involved could cause parts to "fly out" and cause bodily injury.

9. See Figure 3-75. Mount the left case half and flywheel assembly on a press table, supporting crankcase on parallel bars. Press on end of sprocket shaft with arbor press until flywheel assembly is free from case half. Do not drive flywheel assembly from case half as flywheels may be knocked out of alignment.

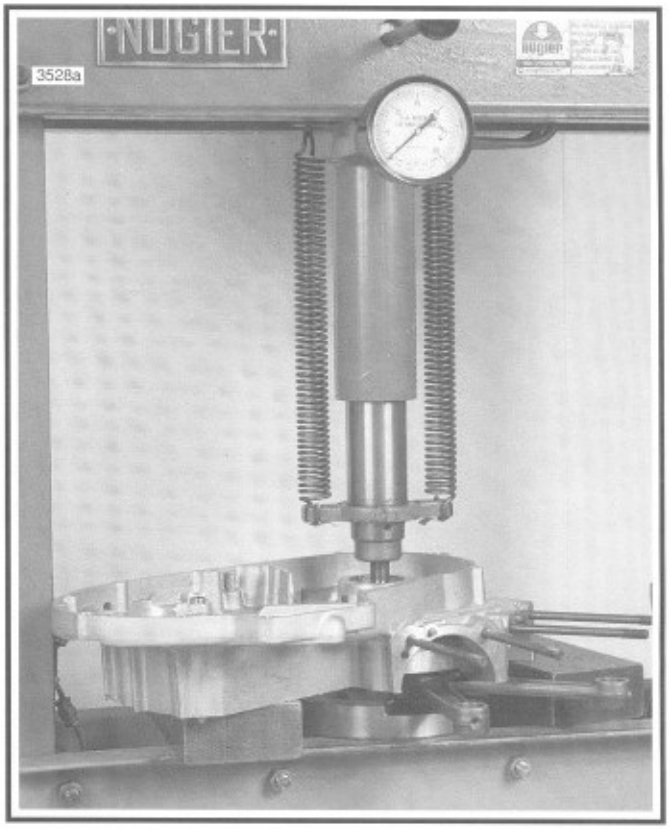


Figure 3-75. Pressing Flywheel from Crankcase

NOTE

See Figure 3-76. If it is necessary to remove either the pinion shaft bearing (11) or sprocket shaft bearing (4 and 9), proceed as follows:

10. Pinion bearing (11) will remain on pinion shaft. Remove retaining ring (10), and bearing (11) may be slipped off pinion shaft.

11. See Figure 3-78. Pull sprocket shaft bearing with WEDGE ATTACHMENT FOR CLAW PULLER (Part No. HD-95637-46) and TWO JAW PULLER (Part No. HD-97292-61) using bolts in place of jaws.

12. See Figure 3-77. Use CRANKSHAFT BEARING TOOL (Part No. HD-94547-80) to remove sprocket shaft outer races.

NOTE

See Figure 3-76. Do not remove retaining ring (7); the crankcase can easily be damaged during the removal process. Removal of the retaining ring is not necessary for the removal or installation of the outer bearing races.

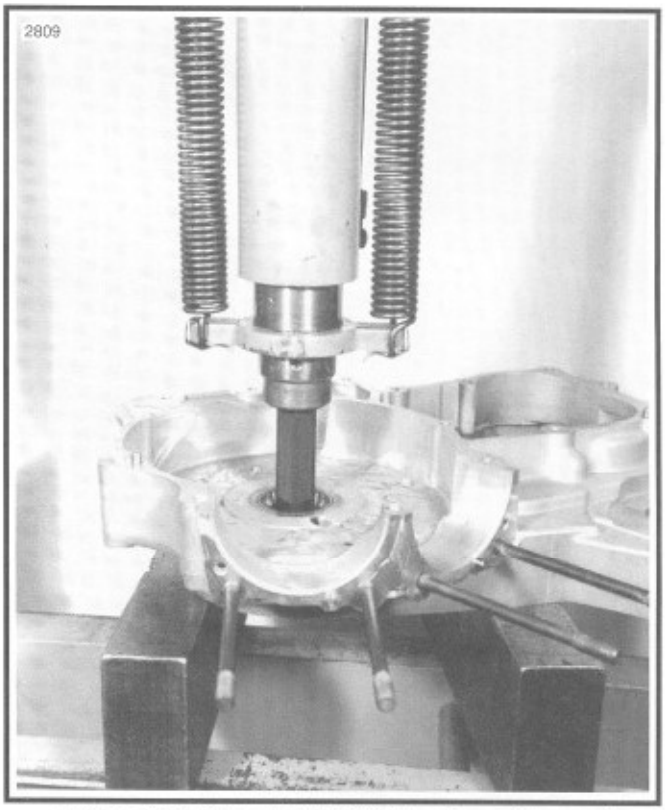
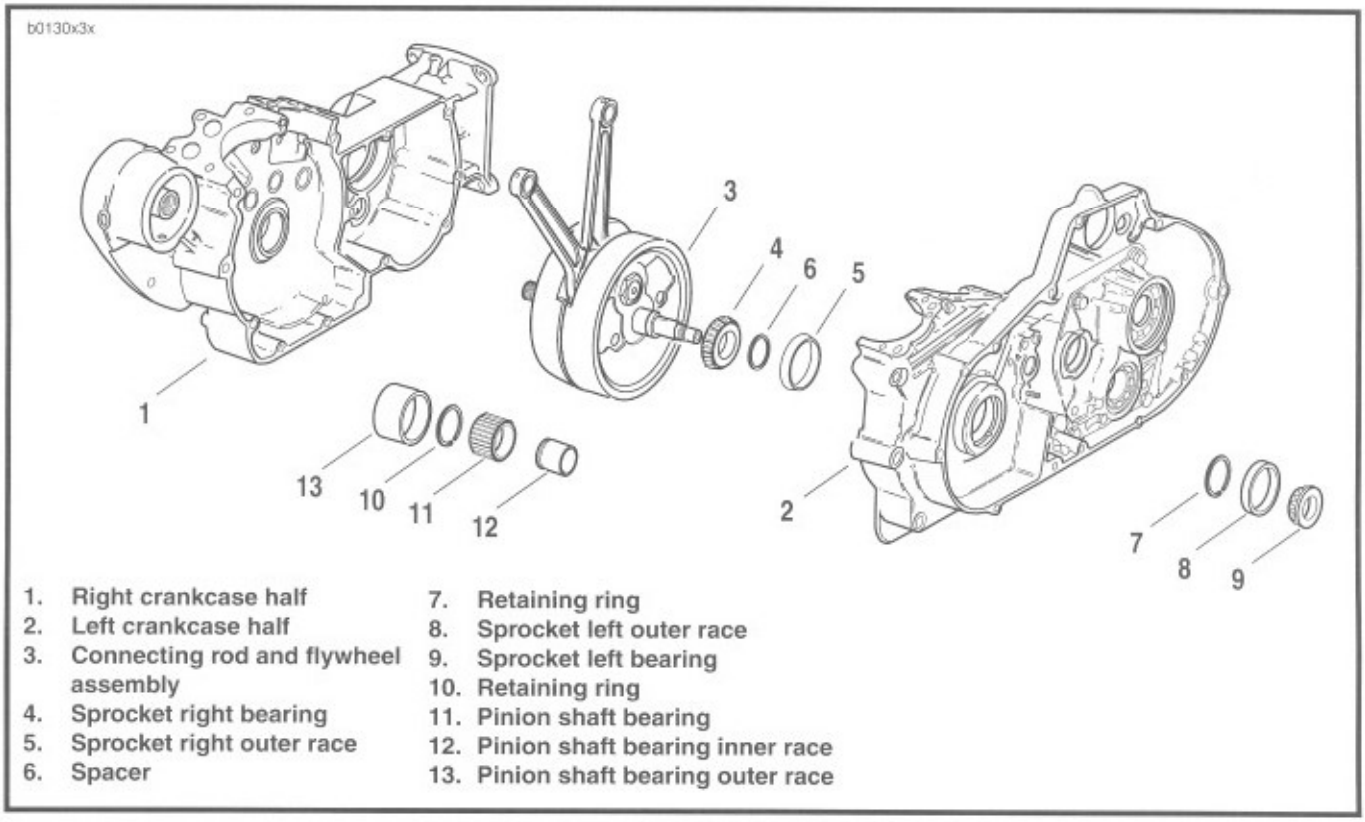


Figure 3-77. Sprocket Shaft Outer Race Removal



1. **Right crankcase half**
2. **Left crankcase half**
3. **Connecting rod and flywheel assembly**
4. **Sprocket right bearing**
5. **Sprocket right outer race**
6. **Spacer**
7. **Retaining ring**
8. **Sprocket left outer race**
9. **Sprocket left bearing**
10. **Retaining ring**
11. **Pinion shaft bearing**
12. **Pinion shaft bearing inner race**
13. **Pinion shaft bearing outer race**

Figure 3-76. Crankcase and Flywheel Assembly

Flywheels (Figure 3-79)

1. Place flywheel assembly in holding fixture. Remove crank pin nut (1). Strike left flywheel with soft metal mallet at about 90 degrees from crank pin hole on wheel periphery to loosen. Lift left flywheel (2) off crank pin.

2. Hold down crank pin bearing assembly (4) with a short length of pipe or tubing so connecting rods (3) may be slipped off bearings, then remove bearing assembly. Secure bearings (4) together in set until they are washed and refitted to crank pin.

3. Remove crank pin nut (9), then tap crank pin (6) out of flywheel and remove key (7).

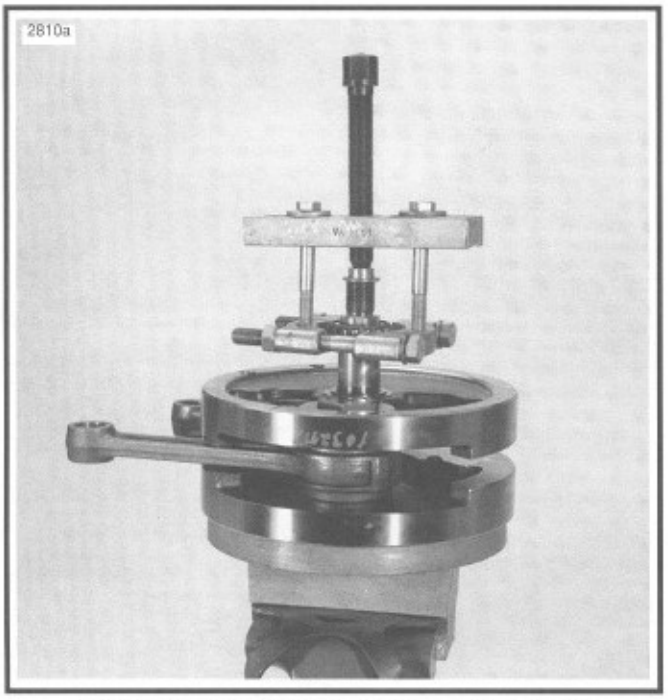


Figure 3-78. Removing Sprocket Shaft Roller Bearing

CLEANING AND INSPECTION

1. Wash all parts in solvent and blow dry with compressed air. Examine crank pin for wear, grooving and pitting. If the surface is at all worn, replace with new pin. Examine flywheel washers. If either washer is worn or grooved, it should be replaced. See REPLACING FLYWHEEL WASHERS.

2. Examine connecting rod lower races. If they appear slightly grooved or shouldered where edge of bearing rollers ride, they may be lapped out, and an oversize crank pin and new bearing installed. If they appear badly worn, grooved or pitted, new rods should be installed, preferably as an assembly with new bearings and crank pin.

3. Inspect bearing for wear, pitting and heat discoloration, replace as required.

4. Inspect crank pin, crank pin roller and connecting rods for correct free play.

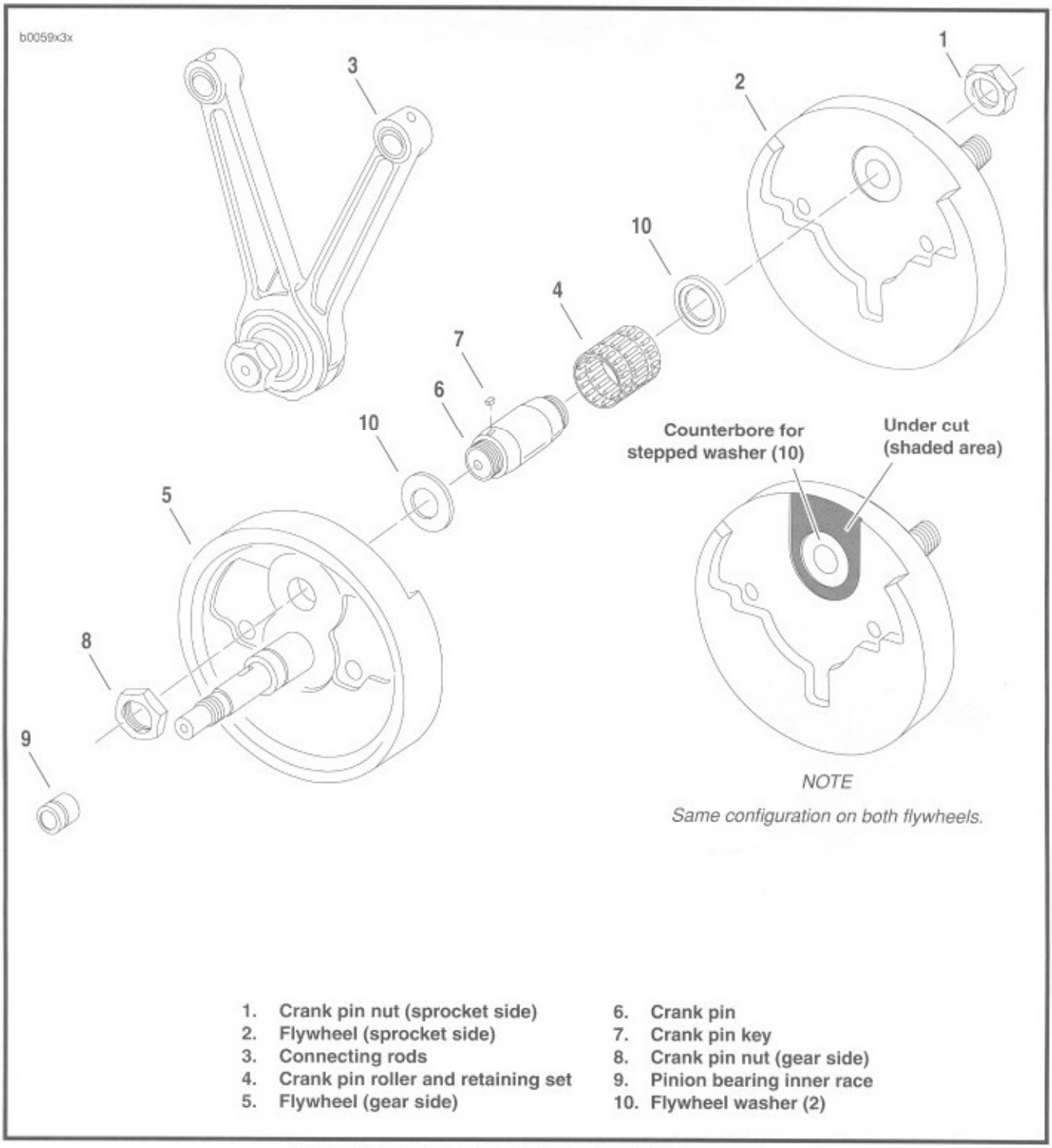
REPLACING FLYWHEEL WASHERS (FIGURE 3-79)

Replace worn flywheel washers (10) as follows:

1. The washer is a close fit in flywheel recess and is secured originally by punching flywheel metal tight against the washer at several points. It is usually necessary to drill a small hole (1/8 in. (3.2 mm) or smaller) at the outer edge of the washer to permit prying with a pointed tool.

NOTE

Drill hole only slightly deeper than thickness of washer. Avoid removing more material than necessary.



1. Crank pin nut (sprocket side)
2. Flywheel (sprocket side)
3. Connecting rods
4. Crank pin roller and retaining set
5. Flywheel (gear side)
6. Crank pin
7. Crank pin key
8. Crank pin nut (gear side)
9. Pinion bearing inner race
10. Flywheel washer (2)

Figure 3-79. Flywheel and Connecting Rod Assembly

2. Before installing a new washer, scrape outer edge of recess, where metal was punched against original washer, so new washer will seat fully against recess bottom. If washer does not seat fully, forked rod will not have necessary clearance (side play).

⚠CAUTION

Be sure stepped thrust washers are installed with step facing crank pin bearing. Incorrect assembly may damage components.

3. Carefully tap new washers into place and using a punch, peen metal over edge to retain washer.

LAPPING CONNECTING ROD RACES (Figure 3-80)

Connecting rod lower races that are likely to clean up within range of oversize bearing rollers and are otherwise in serviceable condition, should be trued and sized with CONNECTING ROD LAPPING ARBOR (Part No. HD-96740-36).

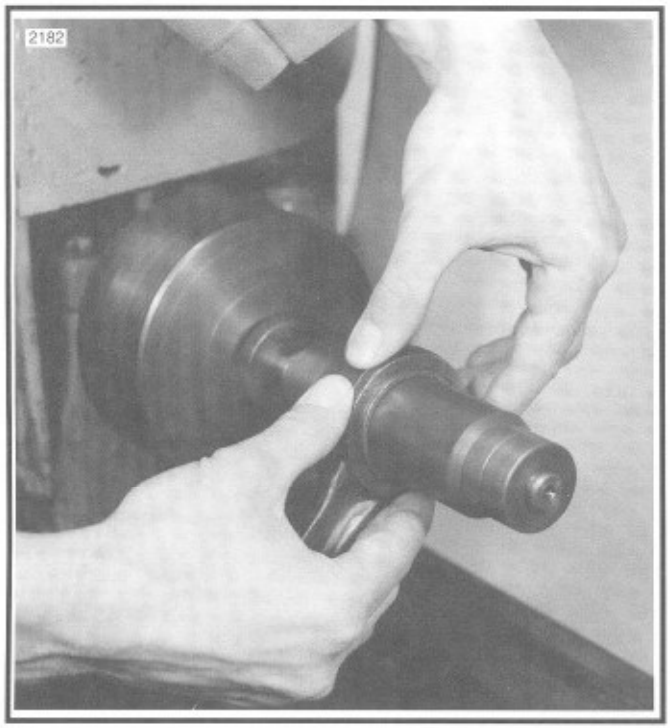


Figure 3-80. Lapping Connecting Rod Races

1. Clean lap before using.
2. Clamp lap into lathe chuck, carefully load lap with #220 grit grinding compound, mixed with oil. Adjust lathe to turn at approximately 150-200 rpm.
3. Carefully slide connecting rod over lap. Adjust lap to a dragging, but free, fit in rod race.

NOTE

A loose lap will BELL MOUTH bearing races, so lap must be kept adjusted at all times

4. Start lathe and work rod back and forth, over full length of lap. Hold rod as near race end as possible.
5. Check rod frequently. When rod is lapped true and all traces of pit marks or grooves are cleaned up, wash and blow rod dry.
6. Repeat lapping procedure for other rod race.
7. Bearing races should have a soft velvety appearance and be free of shiny spots.

FITTING ROD BEARINGS

See Figure 3-81. The new crank pin bearing set packages are color coded with either a red or blue identification. This color coding is used by the bearing manufacturer only. The color coding DOES NOT indicate size selection for crank pin bearing replacement.

⚠CAUTION

Either a red or a blue coded bearing set may be used. DO NOT intermix bearings from a red and a blue bearing set because this may cause excessive loading on one bearing, resulting in premature bearing failure.

The bearings consist of rollers retained in steel cages. The wide bearing (male/front rod) retains rollers both internally and externally. The two narrow bearings (female/rear rod) only retain the rollers externally, so care must be taken to slide the bearing set directly from the inner sleeve onto the crank pin; this will prevent the rollers from dropping out of the cage.

Only one size replacement bearing set (standard, either red or blue coding) is sold. Oversize bearings are not available. Bearing clearance or fit is controlled by the connecting rod race inside diameters and the crank pin diameter. Two oversize crank pins are available.

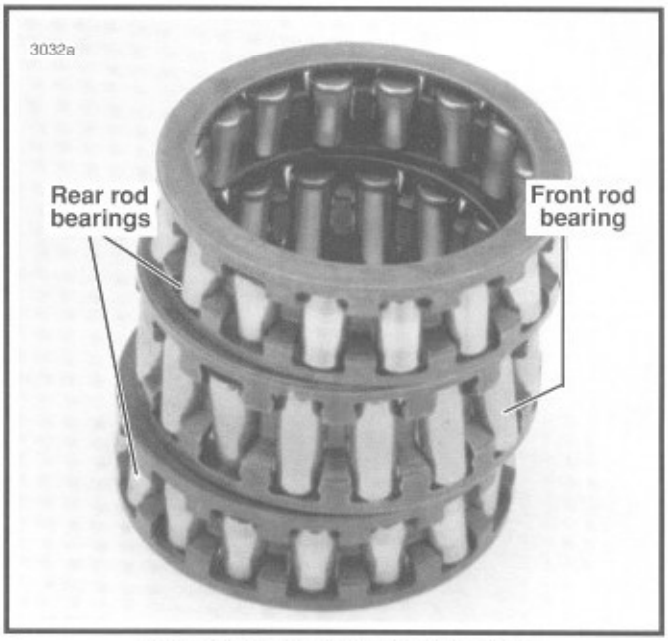


Figure 3-81. Crankpin Bearing Set

1. See Figure 3-82. Measure inside diameter (ID) of lapped connecting rod races with a dial bore gauge that has 0.0001 in. (0.0025 mm) graduations. Measure the ID at four places as shown. Record the four measurements. If any race ID exceeds Service Wear Limit of 1.6270 in. (41.326 mm), replace races or connecting rod set. If race ID measurements are less than 1.6270 in. (41.326 mm), continue procedure as follows:

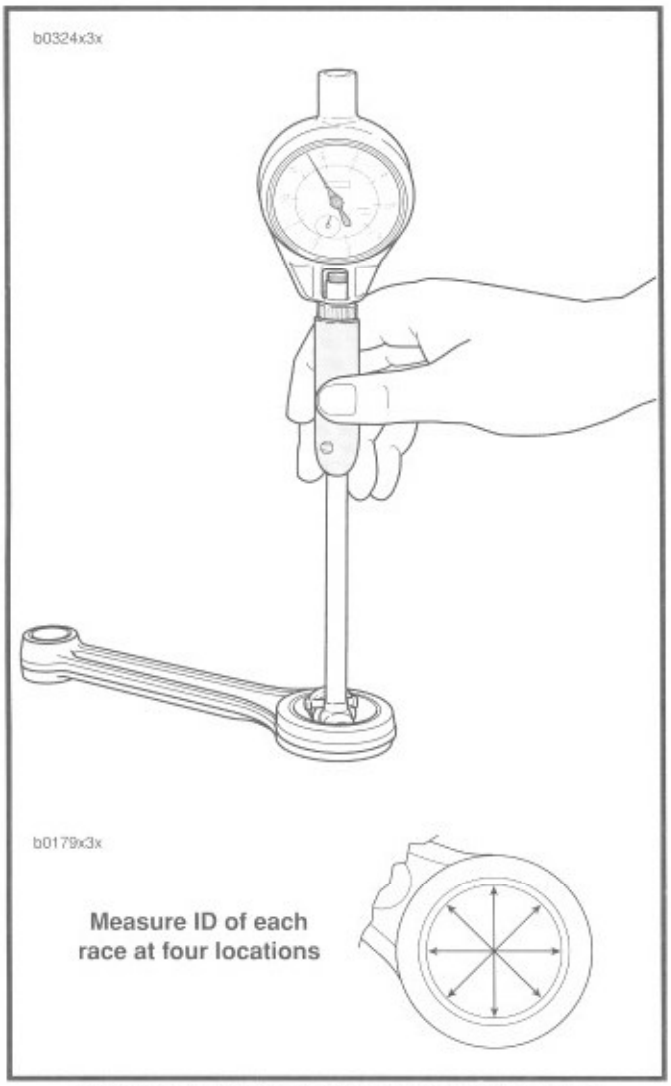


Figure 3-82. Measuring Connecting Rod Race Inside Diameter

2. Compare the measurements recorded in Step 1 with the ranges given in the following table. If the four measurements taken in each race differ, use the smallest measurements.

NOTE

Front and rear rod race ID must be within the same tolerance range given in the above table. The following example will illustrate the procedure necessary if the lapped connecting rod races on both rods do not fall in the same range.

RACE DIAMETER AND CRANK PIN SIZE

CONNECTING ROD RACE ID REQUIRED	CRANK PIN REQUIRED
1.6245-1.6250 in. 41.262-41.275 mm	Standard 0.0010 in. oversize 0.025 mm
1.6255-1.6260 in. 41.288-41.300 mm	0.0020 in. oversize 0.051 mm
1.6265-1.6270 in. 41.313-41.326 mm	Service wear limit exceeded. Replace races or rods.
Greater than 1.6270 in. 41.326 mm	

3. As an example, assign the following values to the measurements taken in Step 1.

   Front connecting rod race diameter: 1.6255 in.
   41.288 mm

   Rear connecting rod race diameter: 1.6250 in.
   41.275 mm

For the above example measurements, the RACE DIAMETER AND CRANK PIN SIZE table specifies that the front connecting rod would require a 0.0010 in. (0.025 mm) oversize crank pin, while the rear connecting rod could use the standard sized crank pin. The rear connecting rod races must be lapped so they have the same ID (within 0.0002 in. (0.005 mm)) as the front rod.

4. See Figure 3-83. Oversize (OS) crank pins are available in two oversizes: 0.0010 and 0.0020 in. (0.025 and 0.051 mm) OS crank pins will have a blue or red paint dot applied to the ends of the pins. A blue dot indicates 0.0010 in. (0.025 mm) OS, a red dot indicates 0.0020 in. (0.051 mm) OS. Standard size crank pins will not be marked.

5. Before assembling the flywheel assembly, recheck connecting rods as follows:

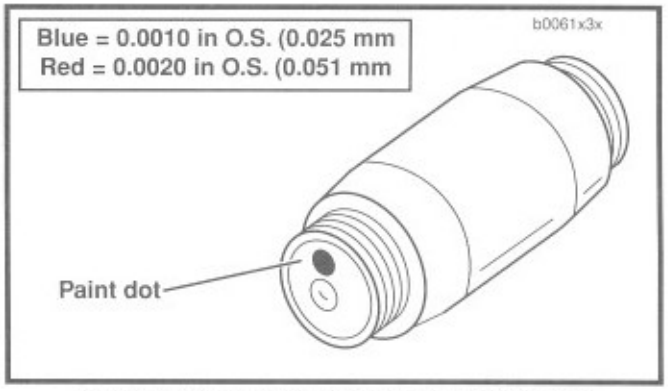


Figure 3-83. Oversize Crank Pin Identification

⚠CAUTION

After the appropriate connecting rod race ID range specified in RACE DIAMETER AND CRANK PIN SIZE table has been achieved, verify that the following specifications are also met:

CONNECTING ROD	SPECIFICATION
Rear	Difference in ID of two races must not exceed 0.0001 in. (0.0025 mm).
Front and rear	Difference in ID of races in front and rear connecting rods must not exceed 0.0002 in. (0.005 mm).
Front and rear	Races must be round within 0.00025 in. (0.0064 mm). (Difference between largest and smallest ID measurement in any race must not exceed 0.00025 in. (0.0064 mm)).

NOTE

Always use new bearings and crank pin after resizing (lapping) connecting rods to insure proper running clearance.

⚠CAUTION

Fitting components tighter than recommended may result in seizing and bearing damage when heat expands parts.

FITTING SPROCKET BEARINGS

If flywheel end play is within tolerance, and if tapered roller bearings and races pass visual check and have no apparent wear, the same set may be reinstalled. Make certain all parts of bearing are installed in exactly the same order in which they were removed. If any part of bearing assembly is worn, entire assembly should be replaced.

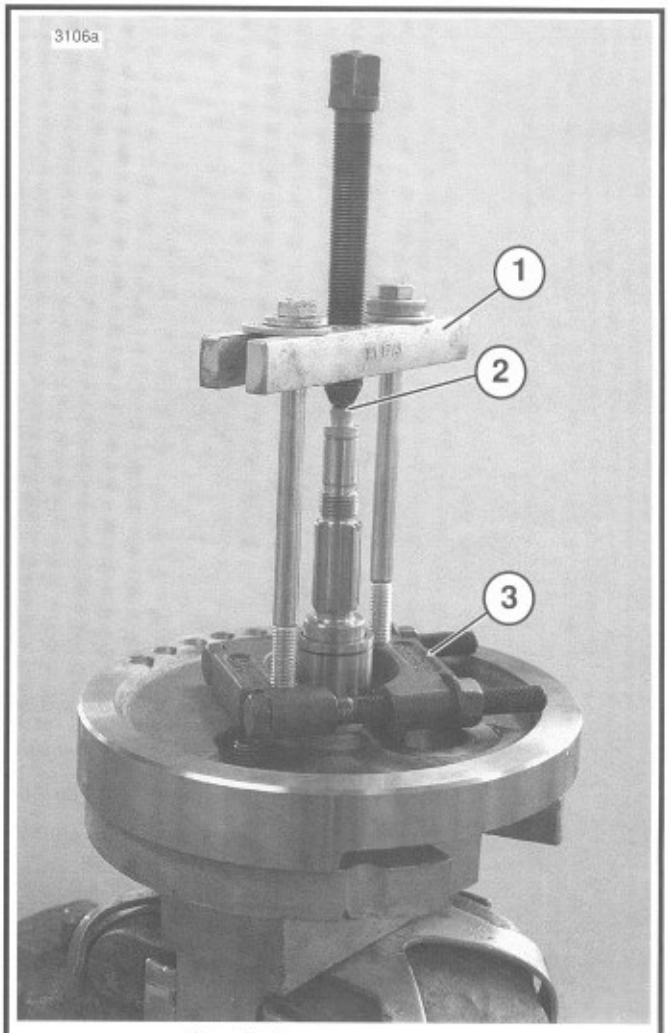
FITTING PINION BEARINGS

See Figure 3-76. A pressed-in bushing in the right crankcase half is the outer race (13). The inner race (12) is pressed on the pinion shaft.

See Figure 3-84. To remove pinion shaft inner race, use PULLER (Part No. HD-97292-61), CENTER CAP (Part HD-95652-43A), and BEARING SEPARATOR (Snap-on Tools Stock No. CJ950). Apply heat to race to aid removal. Four sizes of pinion bearings are available.

Pinion bearing selection at the factory, during engine rebuild, or replacement of crankcase set or flywheel assembly is based on the largest measured outside diameter (OD) of the inner race and the smallest measured inside diameter (ID) of the outer race (crankcase bushing).

A running clearance of 0.0002-0.0008 in. (0.005-0.020 mm) is established during crankcase set or flywheel assembly replacement and engine rebuild.



1. Puller
2. Center cap
3. Bearing separator

Figure 3-84. Pulling Pinion Shaft Inner Race

See Figure 3-85. Installed inner races are identified at the factory as shown.

See Figure 3-86. Outer races are identified at the factory as shown.

NOTE

The different sizes of crankcase sets and flywheel assemblies will not have separate part numbers. That is, a replacement crankcase set may have a class 1, 2 or 3 pinion outer race. Replacement flywheel assemblies will have either a class A or B inner race.

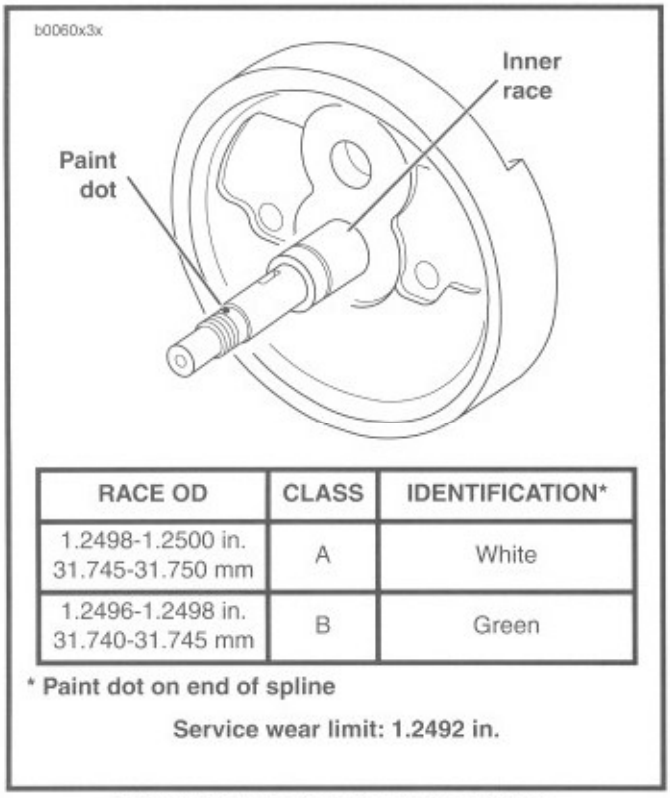
See Figure 3-87. Pinion bearings are identified as shown.

Bearing Selection

Select bearings using the identification information given for inner and outer races and bearings. See Pinion Shaft Bearing Selection table.

NOTE

If either inner or outer race show wear, measure both races to confirm correct bearing fit.

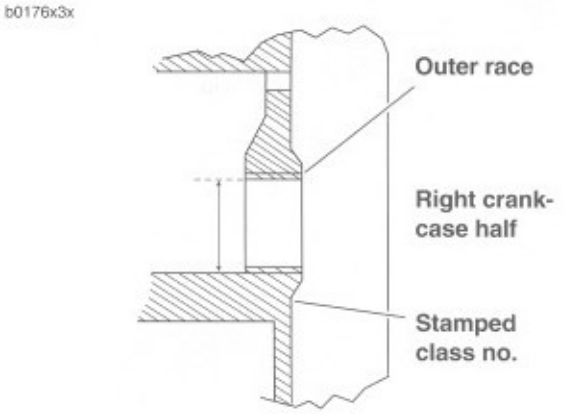


RACE OD	CLASS	IDENTIFICATION*
1.2498-1.2500 in. 31.745-31.750 mm	A	White
1.2496-1.2498 in. 31.740-31.745 mm	B	Green

*** Paint dot on end of spline**

Service wear limit: 1.2492 in.

Figure 3-85. Factory Inner Race Sizes

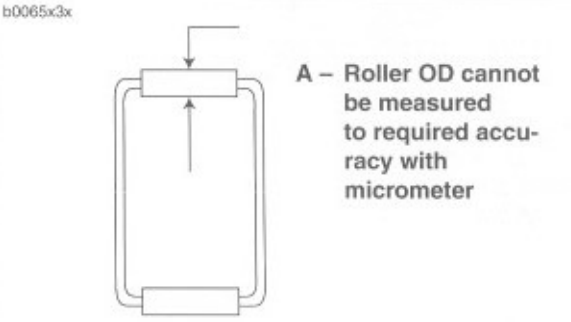


RACE ID	CLASS NO.	STAMPED IDENTIFICATION*
1.5646-1.5648 in. 39.741-39.746 mm	1	1
1.5648-1.5650 in. 39.746-39751 mm	2	2
1.5650-1.5652 in. 39.751-39756 mm	3	3

*** Stamped number inside crankcase near race**

Service wear limit: 1.5672 in.

Figure 3-86. Factory Outer Race Sizes



ROLLER OD (A)	IDENTIFICATION (Package color)
Largest	Red
	Blue
	White (Grey)
Smallest	Green

Figure 3-87. Bearing Identification

Pinion Shaft Bearing Selection

FACTORY STAMPED NUMBER	OUTER RACE ID	BEARING SIZE AS IDENTIFIED BY COLOR CODING										
	over 1.5672 in. 39.807 mm	Service Wear Limit Exceeded – Replace Outer Race and Resize										
	1.5670-1.5672 in. 39.802-39.807 mm											Red
	1.5668-1.5670 in. 39.797-39.802 mm										Red	Blue
	1.5666-1.5668 in. 39.792-39.797 mm									Red	Blue	White-Gray
	1.5664-1.5666 in. 39.787-39.792 mm								Red	Blue	White-Gray	Green
	1.5662-1.5664 in. 39.781-39-787 mm							Red	Blue	White-Gray	Green	
	1.5660-1.5662 in. 39.776-39.781 mm						Red	Blue	White-Gray	Green		
	1.5658-1.5660 in. 39.771-39.776 mm					Red	Blue	White-Gray	Green			
	1.5656-1.5658 in. 39.766-39.771 mm				Red	Blue	White-Gray	Green				
	1.5654-1.5656 in. 39.761-39.766 mm			Red	Blue	White-Gray	Green					
	1.5652-1.5654 in. 39.756-39.761 mm		Red	Blue	White-Gray	Green						
3	**1.5650-1.5652 in. 39.751-39.756 mm**	**Red**	**Blue**	White-Gray	Green							
2	**1.5648-1.5650 in. 39.746-39.751 mm**	**Blue**	**White-Gray**	Green								
1	**1.5646-1.5648 in. 39.741-39.746 mm**	**White-Gray**	**Green**									
INNER RACE OD (In)		**1.2496-1.2498 in.**	**1.2498-1.2500 in.**	1.2500-1.2502 in.	1.2502-1.2504 in.	1.2504-1.2506 in.	1.2506-1.2508 in.	1.2508-1.2510 in.	1.2510-1.2512 in.	1.2512-1.2514 in.	1.2514-1.2516 in.	1.2516-1.2518 in.
		31.740 31.745 mm	**31.745 31.750 mm**	31.750-31.755 mm	31.755-31.760 mm	31.760-31.765 mm	31.765-31.770 mm	31.770-31.755 mm	31.775-31.780 mm	31.780-31.786 mm	31.786-31.791 mm	3.791-31.796 mm
FACTORY COLOR CODE		**Green**	**White**									

1. Measure ID of outer race at four places with a dial bore gauge. Take measurement on ID where bearing rollers ride. Record the four measurements.
2. If the largest measurement is larger than 1.5672 in. (39.807 mm) or the required lapping to remove wear marks would enlarge bore beyond 1.5672 in., continue at Step 8.
3. If the largest measurement is 1.5672 in. (39.807 mm) or less, cover the cam bearings with masking tape to prevent debris from entering bearings. Assemble crankcase halves.

NOTE

The next step requires lapping the outer race. To keep sprocket shaft and pinion shaft bearings aligned the lap must be supported by an adaptor or pilot in the left crankcase half.

4. See CRANKCASE, LAPPING ENGINE MAIN BEARING RACES in this section. Race must be lapped until all wear marks are removed.
5. Measure ID of race at four places and record the measurements.
6. Check measurements against these specifications:

   Largest I.D. measured: 1.5672 in. (39.807 mm) or less

   Roundness of I.D.: within 0.0002 in. (0.005 mm)

   Taper: within 0.0002 in. (0.005)
7. If lapping increased bore ID to larger than 1.5672 in. (39.807 mm), go to Step 8. If roundness or taper do not meet specifications, continue lapping until specifications are met. If all specifications are met, continue at Step 10 to remove and size inner race.
8. Press the outer race from the right crankcase. Press new outer race into crankcase flush with inside edge of cast-in insert.

   See Figure 3-88; dimensions are shown for fabrication of tools used in pressing the outer race into or out of crankcase.

9. The new outer race must be lapped slightly to true and align with left case bearing and to meet the following specifications; see CRANKCASE, LAPPING ENGINE MAIN BEARING RACES in this section.

   I.D.: 1.5646 - 1.5652 in. (39.741 - 39.756 mm)
   Roundness: within 0.0002 in. (0.005 mm)
   Taper: within 0.0002 in. (0.005 mm)
   Surface finish: 16 RMS

10. See Figure 3-84. Pull inner race from pinion shaft using PULLER (Part No. HD-97292-61), CENTER CAP (Part No. HD-95652-43A), and BEARING SEPARATOR (Snap-on Tools Stock No. CJ950). Apply heat to race to aid removal.

11. See Figure 3-88. Press new inner race on pinion shaft as shown. The new inner race must be ground by a machinist to OD dimension range given in Pinion Shaft Bearing Selection table for the finished lapped ID of the outer race. The finished inner race must meet these specifications.

    See Figure 3-89 for necessary dimensions for constructing a press-on tool. When the tool bottoms against the flywheel, correct inner race location is automatically established.

    Roundness: within 0.0002 in.
    Taper: within 0.0002 in. (0.005 mm)
    Surface finish: 16 RMS

12. The following example illustrates how to determine the required inner race OD.

    EXAMPLE:

    A. If smallest measured ID of outer race is 1.5651 in. (39.754 mm) the Pinion Shaft Bearing Selection table indicates an inner race OD range of 1.2496-1.2504 in. (31.740 - 31.760 mm) is required.

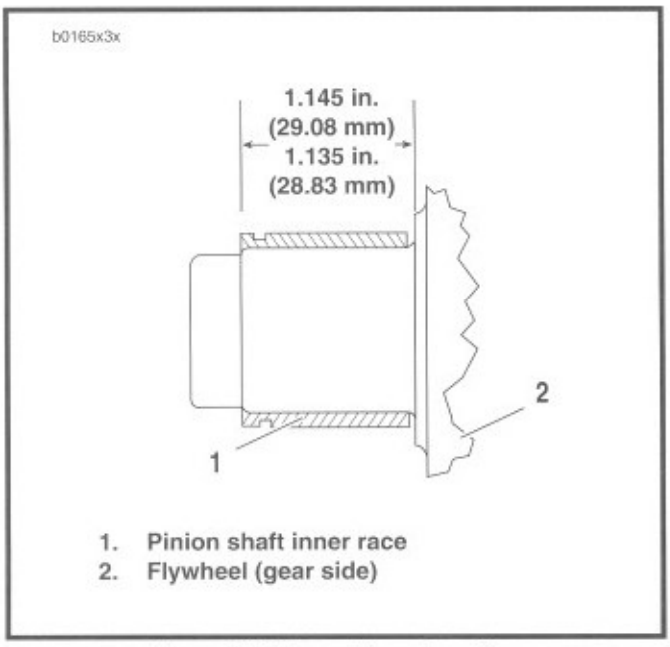


Figure 3-88. Inner Race Location

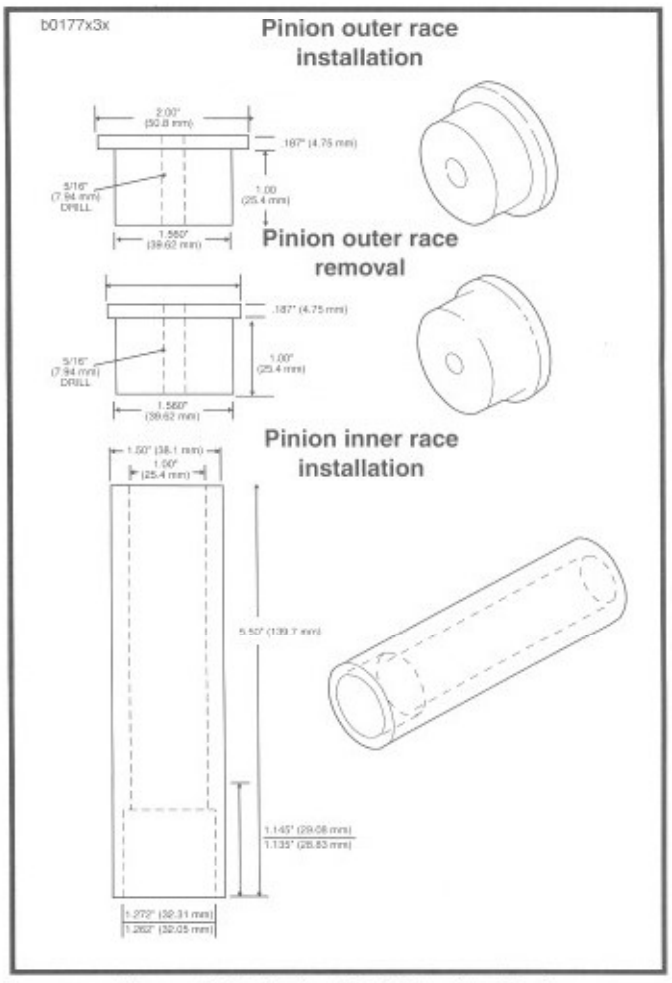


Figure 3-89. Pinion Shaft Bearing Tools

NOTE

Have machinist grind outer race to center or middle of required OD range. This will prevent grinding outer race undersize and gives a more easily achieved tolerance range.

A. Grind inner race. Measure OD at four places and check that specifications in Step 11 are met.

B. For example purposes, the largest measured OD of inner race after grinding is 1.2499 in. (31.747 mm) OD.

C. See Pinion Shaft Bearing Selection table. With a 1.5651 in. ID outer race and a 1.2499 in. (31.747 mm) OD inner race, a blue bearing is required.

NOTE

Always use the smallest outer race ID measurement and the largest OD inner race measurement when selecting bearings.

LAPPING ENGINE MAIN BEARING RACES (FIGURE 3-90)

1. Secure right and left crankcase halves with three crankcase stud bolts (top center and bottom left and right). The sprocket shaft bearing outer races and large spacer must be installed in left crankcase.
2. Obtain CRANKCASE MAIN BEARING LAPPING TOOL (Part No. HD-96710-40B). Assemble CRANKCASE MAIN BEARING LAP (Part No. HD-96718-87) to lapping handle. Assemble guide sleeve to sprocket shaft bearing bushing. Sleeves, for use with tapered bearing, are assembled to case with bearings and small spacer collar. Finger-tighten the sleeve parts.
3. Insert lap shaft with arbor assembled through pinion bearing bushing and into guide sleeve. Tighten arbor expansion collars using a length of 0.156 in. (3.96 mm) rod as spanner until arbor begins to drag. Do not adjust arbor snug in bushing or bushing will "bell," a condition where hole is larger at ends than it is in the center.

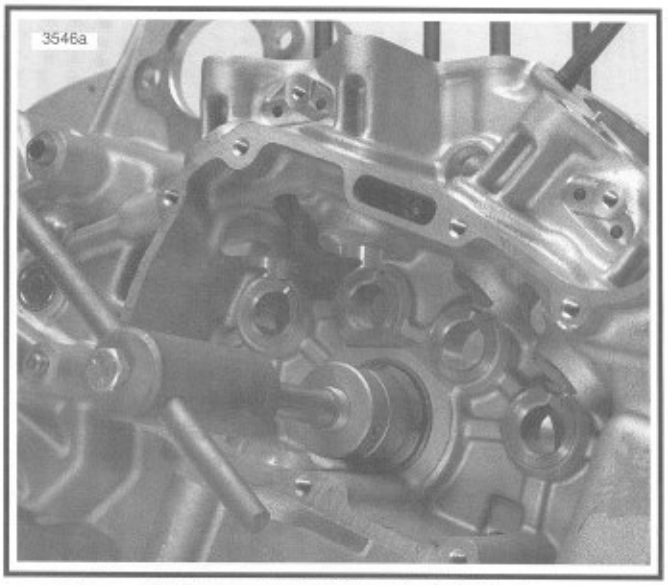


Figure 3-90. Lapping Pinion Shaft Main Bearing

4. Withdraw arbor far enough to coat lightly with 220 grit lapping compound. Do not apply a heavy coat. Reposition lap in bushing and turn handle at moderate hand speed. Work lap back and forth in bushing, as it is revolved, to avoid grooving and tapering.
5. At frequent intervals, remove lap from crankcase wash and inspect bushing. Lapping is completed when entire bushing surface has a dull, satin finish rather than a glossy, smooth appearance. If necessary, flush off lap in cleaning solvent, air dry and apply fresh, light coat of fine lapping compound.

ASSEMBLY

Flywheels

After correct connecting rod bearing fit has been attained, clean and assemble parts as follows:

1. Carefully clean all flywheel components using a non-petroleum-based solvent, such as LOCTITE CLEANING SOLVENT or electrical contact cleaner. Thoroughly dry all components.
2. See Figure 3-79. Apply two drops of PERMABOND® HM-161 to the crank pin threads, and apply no more than two drops to the nut bearing faces.

⚠CAUTION

Do not apply any PERMABOND HM-161 Compound or Retaining Compound to shaft tapers.

3. Assemble crank pin (6) to gear-side flywheel (5) making sure that key (7) is in proper position. Tighten crank pin nut. See ENGINE, SPECIFICATIONS for proper torque.
4. Position gear-side flywheel assembly in a flywheel fixture with crank pin pointing up. Wipe crank pin taper clean.
5. See Figure 3-91. Slip bearings, and connecting rods over crank pin. Assemble angular boss of the female rod adjacent to large radius side of the male rod as shown. The side of the male rod with the larger radius is narrower in the area where it fits between the forks of the female rod.
6. Verify that oil passages through pinion shaft, gear-side flywheel, and crank pin are clear by blowing compressed air into oil galley at end of pinion shaft.
7. Install sprocket-side flywheel. Lightly tighten nut.
8. See Figure 3-92. Hold steel straightedge along outer face of wheel rims at 90° from crank pin as shown. Tap outer rim of top wheel until wheels are concentric. Tighten nut, recheck with straightedge at frequent intervals.

NOTE

Use soft metal hammer to realign wheels.

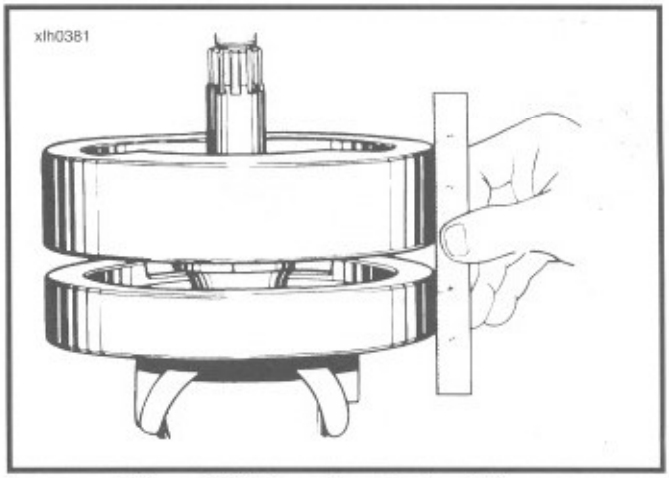


Figure 3-92. Squaring Flywheel Faces

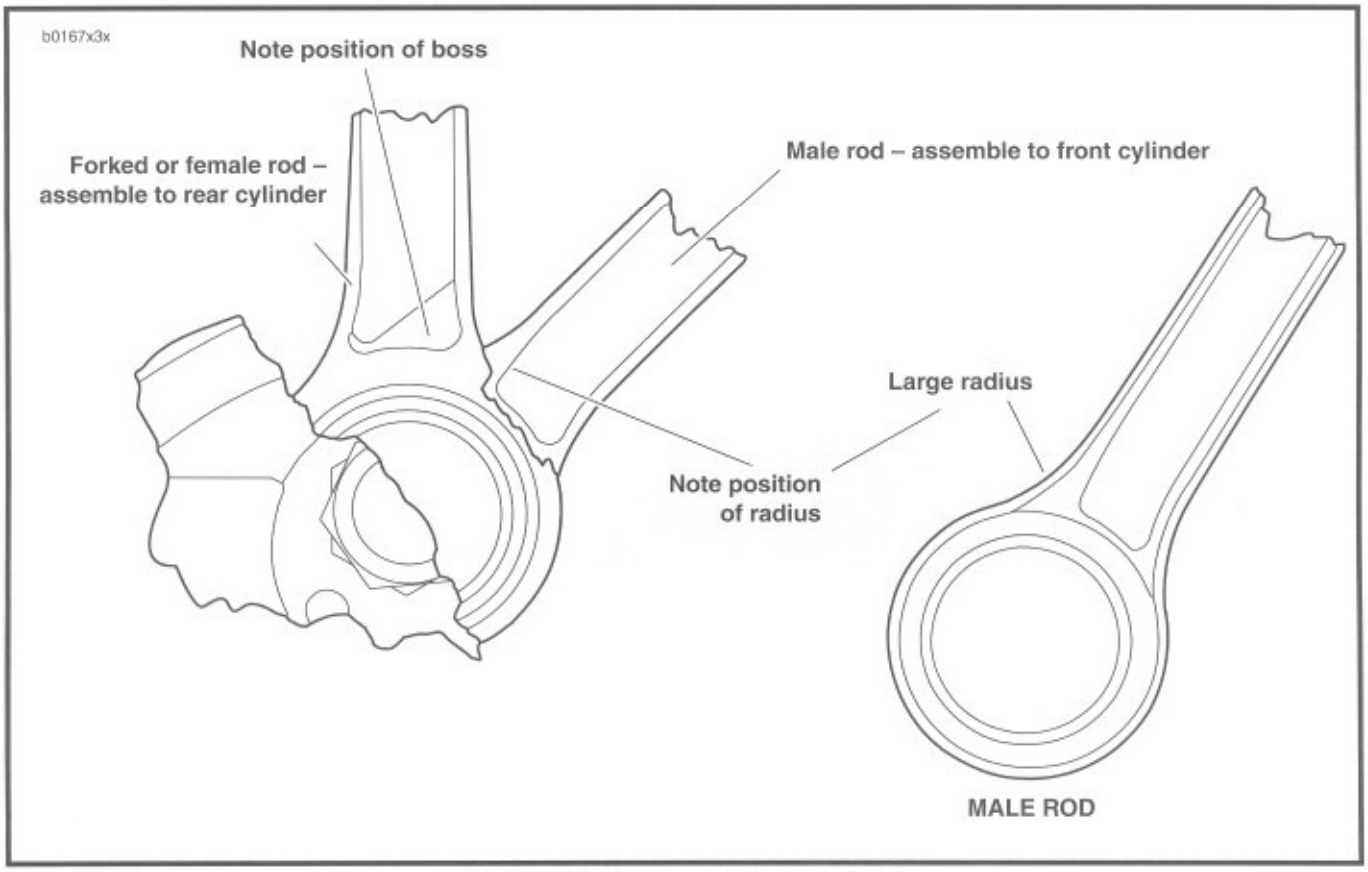


Figure 3-91. Installing Connecting Rods

9. Tighten crank pin nut to 150-185 ft-lbs (203-251 Nm) torque. See Figure 3-93. Install flywheel assembly in Harley-Davidson FLYWHEEL TRUING DEVICE (Part No. HD-96650-80) as shown. Adjust so centers are snug. Wheels must turn freely; however, shafts must not be loose in centers. If flywheel assembly is either loose or squeezed, indicators will not indicate accurately. Adjust indicators to take reading as near to flywheels as possible, so pointers read at about the middle of the scales.

10. Turn flywheels slowly and observe the movement of indicator pointers. Movement toward flywheels indicate high points of shafts. Find highest point of each shaft and chalk-mark flywheel rims at those points. Remove flywheel from stand and make corrections as follows:

11. See Figure 3-93. Flywheel may be out of true three ways, A, B and C or a combination of two of the three ways.

12. When wheels are both out of true as indicated in A, tighten C-clamp on rims or wheels opposite crank pin and lightly tap the rim at the crank pin with lead or copper mallet.

13. When wheels are both out of true as indicated in B, drive a hardwood wedge between the wheels opposite the crank pin and lightly tap the rims near the crank pin with a lead or copper mallet.

14. When wheels are out of true as indicated in C, strike the rim of the wheel a firm blow at about 90° from crank pin on high side.

15. When wheels are out of true in a combination of any of the conditions shown, correct C first, tapping rim of offending wheel only, and then correct condition A or B.

NOTE

The number of blows required and how hard they should be struck depends on how far shafts are out of true and how tight nuts are drawn. Always remove the flywheels from the stand, and strike the flywheel rim only at 90° to the crank pin. Use only a soft metal mallet. Never strike wheels a hard blow near crank pin. This could result in a broken crank pin.

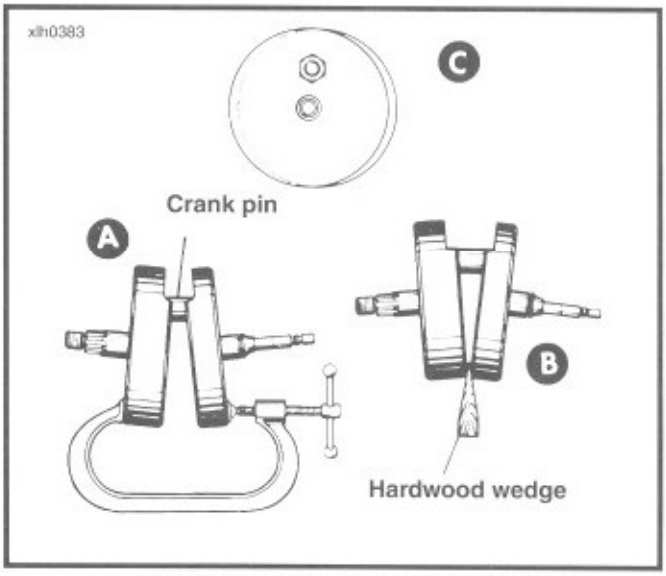


Figure 3-94. Correcting Flywheel Alignment

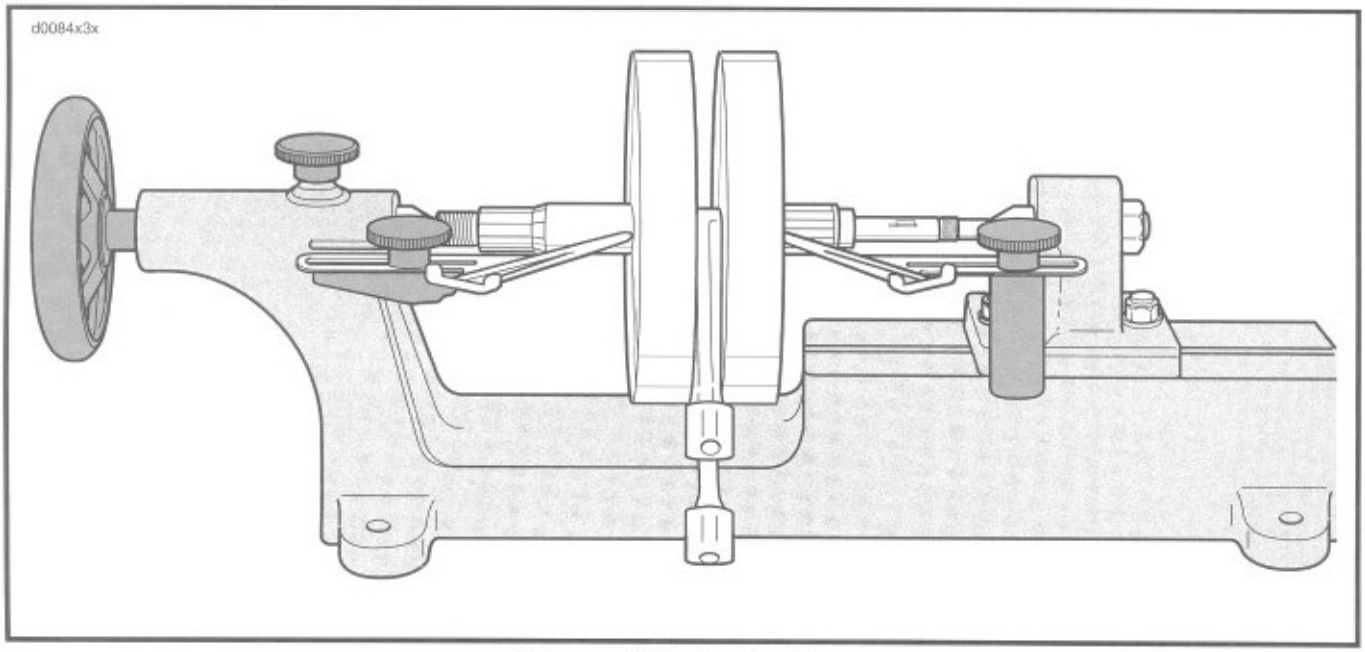


Figure 3-93. Truing Flywheel

16. See Figure 3-93. Readjust centers, revolve wheels and take reading from indicator. Repeat truing operation until indicated shaft runout does not exceed 0.001 in. (0.025 mm) (each graduation on indicator is 0.002 in. (0.05 mm)).
17. If it is impossible to true wheels, check for a cracked flywheel, damaged or enlarged tapered hole, or a sprocket or pinion shaft worn out-of-round at surface where indicator reading is being taken.
18. See Figure 3-95. When wheels are true, check connecting rod side play with thickness gauge as shown. If it is greater than tolerance shown in engine SPECIFICATIONS, draw up crank pin nuts until within tolerance. Insufficient play between rods and flywheel face is caused by one of the following conditions:
    A. Flywheels and crank pin assembled with oil on tapers and nut over-tightened. Disassemble, clean and reassemble.
    B. New flywheel washers installed and not fully seated. Disassemble, inspect, replace deepest seating flywheel or crank pin. As last resort, grind down width of forked rod.
    C. Taper holes enlarged as a result of having been taken apart several times. Replace deepest seating wheel.
    D. Cracked flywheel at tapered hole. Replace flywheel.
19. After rod side play is checked and adjusted, check that crank pin nut is tightened to specified torque, again check wheel trueness on truing device. Correct any runout as above.

Crankcase Halves

Lubricate all parts with Harley-Davidson 20W50 engine oil, and proceed as follows:

1. See Figure 3-96. The original retaining ring (1) is left in place to avoid damaging the bearing bore of the left crankcase half. Verify that gap in retaining ring (1) is aligned with oil supply hole (2) in left crankcase half bearing bore.

NOTE

See Figure 3-97. Use SPROCKET SHAFT BEARING OUTER RACE INSTALLATION TOOL (1, 2) (Part No. HD-39458) to install left and right outer races (4, 5) of sprocket shaft tapered roller bearings into left crankcase half (6). Always install left outer race (4) prior to installing right outer race (5) because the installer base (1) is usable only when you follow this sequence of race installation

2. Insert "SPORTSTER" end of installer base (1) into inboard side of left crankcase half (6) bearing bore until base contacts installed retaining ring (3).
3. Position left outer race (4) over bearing bore on outboard side of left crankcase half (6).
4. Insert shaft of installer plug (2) through left outer race (4) and into installer base (1). Press race into bore until firmly seated against retaining ring (3).

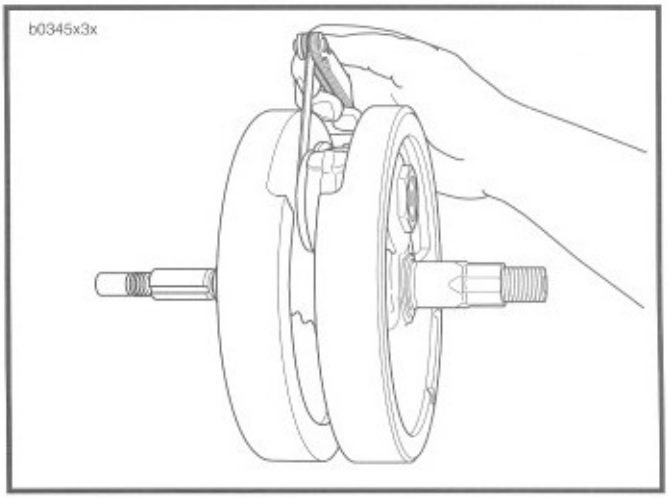
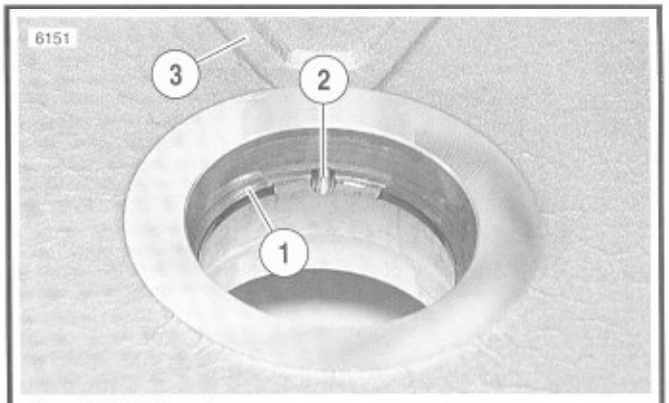
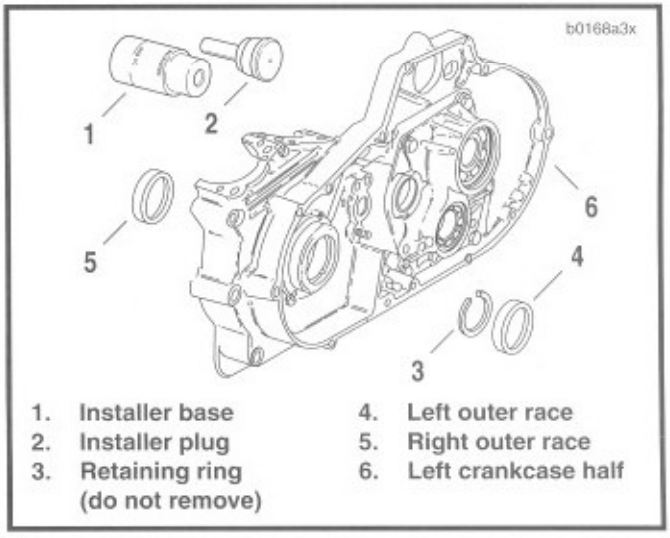


Figure 3-95. Checking Connecting Rod Side Play



1. **Retaining ring**
2. **Oil supply hole**
3. **Oil supply channel**

Figure 3-96. Retaining Ring



1. **Installer base**
2. **Installer plug**
3. **Retaining ring (do not remove)**
4. **Left outer race**
5. **Right outer race**
6. **Left crankcase half**

Figure 3-97. Installing Sprocket Shaft Bear Outer Races

5. Insert "SPORTSTER" end of installer base (1) into outboard side of left crankcase half (6) bearing bore until base contacts outboard surface of installed left outer race (4).

6. Position right outer race (5) over bearing bore on inboard side of left crankcase half (6).

7. Insert shaft of installer plug (2) through right outer race (5) and into installer base (1). Press race into bore until firmly seated against retaining ring (3).

NOTE

See Figure 3-98. Use SPROCKET SHAFT BEARING/SEAL INSTALLATION TOOL (Part No. HD-42579) to install sprocket shaft tapered roller bearings and seal.

8. Install inner bearing (6).

   a. Place **new** bearing, small end upward, over end of sprocket shaft.

   b. Thread pilot (1) onto sprocket shaft until pilot bottoms on sprocket shaft shoulder.

   c. Sparingly apply graphite lubricant to threads of pilot shaft to ensure smooth operation.

   d. Slide sleeve (5) over pilot (1) until sleeve contacts inner bearing race. Install Nice bearing (4), washer (3) and handle (2) on top of sleeve.

   e. Rotate handle clockwise until bearing (6) contacts flywheel shoulder. Remove tool from sprocket shaft.

9. See Figure 3-76. Install spacer (6) and outer bearing (9).

   a. See Figure 3-99. Carefully place crankcase half over sprocket shaft so that it rests flat on inner bearing.

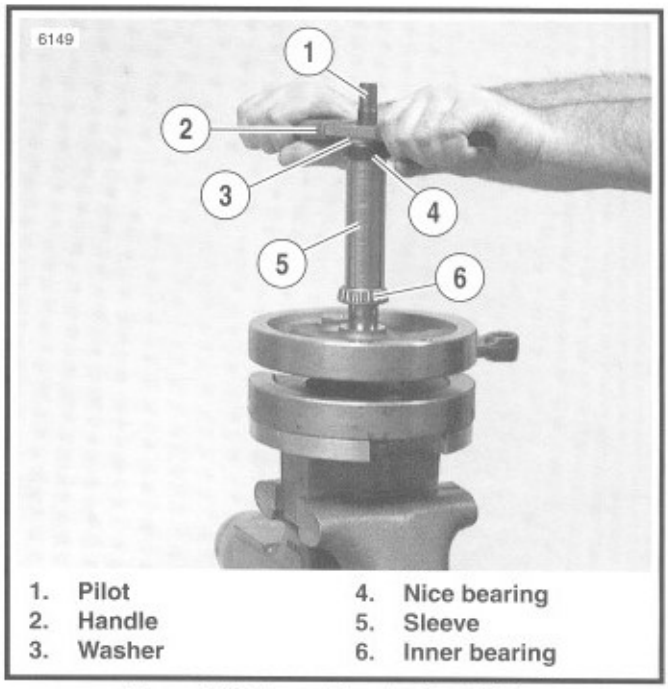
   b. Slide **new** inner spacer over sprocket shaft until it contacts inner bearing race.

   c. Place **new** outer bearing, small end downward, over sprocket shaft.

   d. Assemble SPROCKET SHAFT BEARING/SEAL INSTALLATION TOOL (Part No. HD-42579) onto sprocket shaft. Follow procedure in Step 8.

   e. Rotate handle clockwise until bearing firmly contacts inner spacer. Inner and outer bearings must be tight against inner spacer for correct bearing clearance. Remove tool from sprocket shaft.

   f. Spin crankcase half to verify that flywheel assembly is free.



1. **Pilot**
2. **Handle**
3. **Washer**
4. **Nice bearing**
5. **Sleeve**
6. **Inner bearing**

Figure 3-98. Inner Bearing Installation

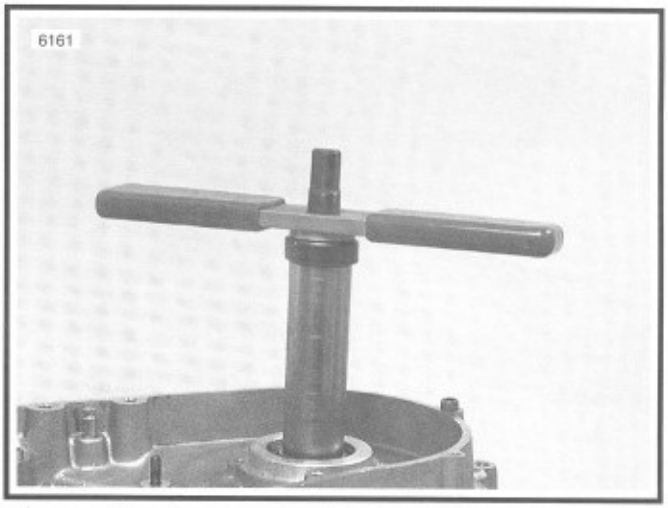


Figure 3-99. Installing Flywheel Spacer and Outer Bearing

10. See Figure 3-100. Install **new** spacer in seal ID. With the open (lipped) side facing outward, center seal/spacer assembly over bearing bore.

⚠CAUTION

Do not remove the spacer after installation or the new seal will have to be discarded and the procedure repeated.

11. See Figure 3-101. Install bearing seal and spacer.
    a. Center seal/spacer driver (2) over seal, so that the sleeve (smaller OD) seats between seal wall and garter spring.
    b. Assemble SPROCKET SHAFT BEARING/SEAL INSTALLATION TOOL (1) (Part No. HD-42579) and SPROCKET SHAFT SEAL/SPACER INSTALLER (Part No. HD-42774) onto sprocket shaft. Follow procedure in Step 8.
    c. Rotate handle clockwise until the spacer makes contact with the bearing. Remove tool from sprocket shaft.
12. See Figure 3-102. Install pinion shaft bearing.
    a. Lubricate pinion shaft bearing with engine oil.
    b. Slip bearing on pinion shaft.
    c. Install **new** retaining ring in groove of pinion shaft bearing inner race.
13. Assemble crankcase halves together.
    a. Apply a thin coat of DOW CORNING SILASTIC or 3-M 800 sealant to crankcase joint faces.
    b. Slide pinion shaft through outer race in right crankcase.
    c. Attach crankcase halves using hardware shown in Figure 3-71.
    d. Tighten 1/4-in. fasteners to 70-110 **in-lbs** (7.9-12.4 Nm)
    e. Tighten 5/16-in. fasteners to 15-18 ft-lbs (20.3-24.4 Nm).
14. See Figure 3-103. Install cylinder studs.
    a. Pack clean towels into crankcase opening.
    b. Place a steel ball into a head screw (1).
    c. The cylinder studs (2) have a shoulder (3) at the lower end. Place the end of the stud without the shoulder into the head screw.
    d. Install the stud in the crankcase with the shoulder end down. Use an air gun (4) to drive the stud until the shoulder reaches the crankcase.
    e. Remove air gun. Use a torque wrench to tighten stud to 10 ft-lbs (13.6 Nm).
15. Install pistons and cylinders. See CYLINDER AND PISTON, INSTALLATION in this Section.
16. Install oil pump. See ENGINE LUBRICATION SYSTEM, OIL PUMP, INSTALLATION in this section.
17. Install cam gears, gearcase cover, tappet guides and tappets. See GEARCASE COVER AND CAM GEARS, INSTALLATION.
18. Install cylinder heads. See CYLINDER HEAD, INSTALLATION in this Section.

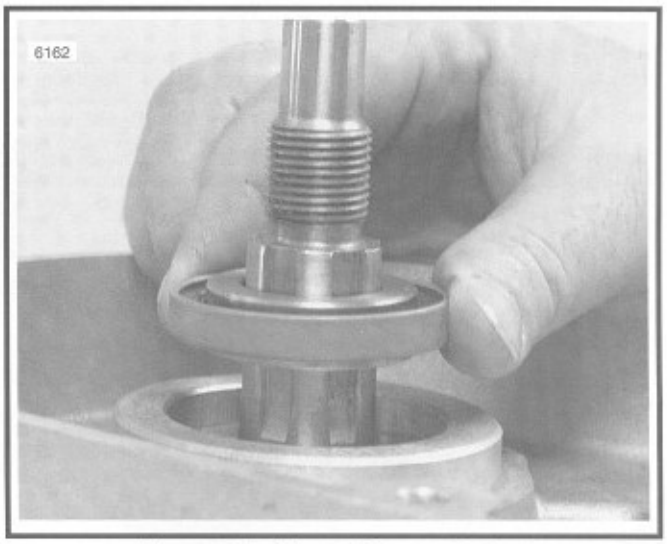
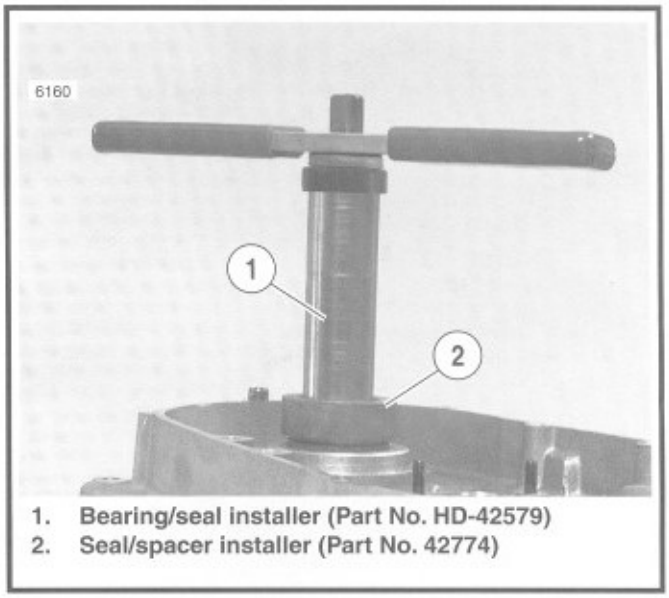


Figure 3-100. Install Spacer in Seal



1. **Bearing/seal installer (Part No. HD-42579)**
2. **Seal/spacer installer (Part No. 42774)**

Figure 3-101. Install Bearing Seal/Spacer

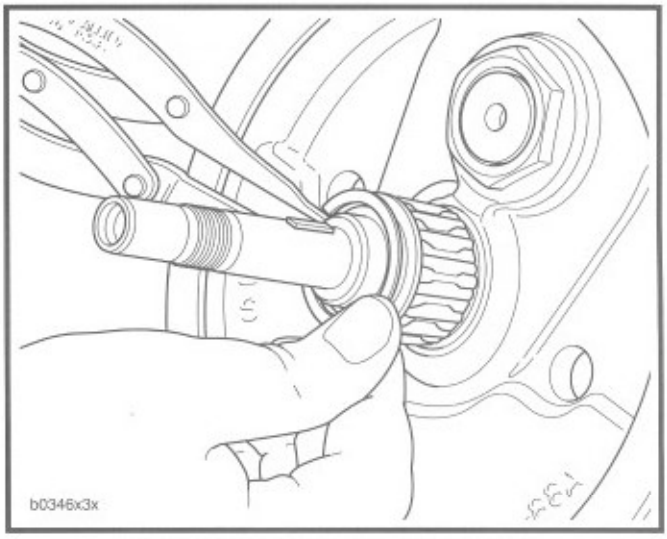


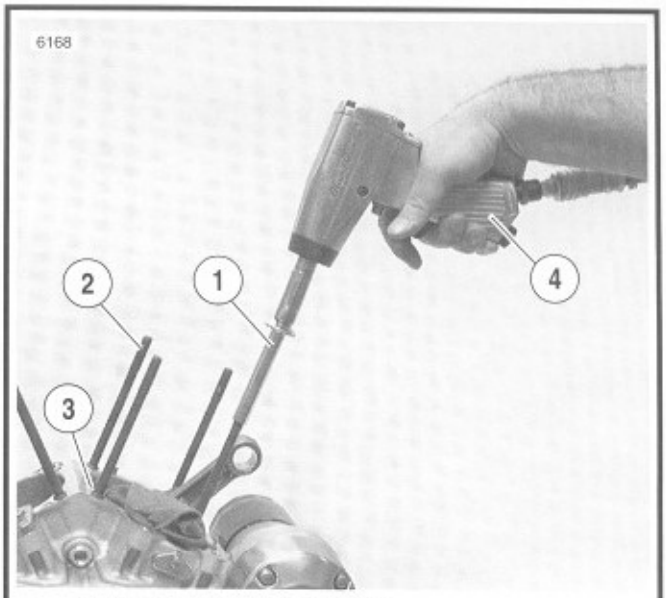
Figure 3-102. Pinion Shaft Bearing

19. Install starter. See ELECTRIC STARTER, STARTER, INSTALLATION in Section 5.
20. Install transmission. See TRANSMISSION INSTALLATION AND SHIFTER PAWL ADJUSTMENT in Section 6.
21. Install all primary drive components. This includes engine sprocket, primary chain, complete clutch assembly, engine sprocket nut and mainshaft nut. See PRIMARY DRIVE/CLUTCH, INSTALLATION in Section 6.
22. Install primary cover. See PRIMARY COVER under PRIMARY DRIVE/CLUTCH, INSTALLATION in Section 6.

NOTE

Be sure to refill transmission to proper level with fresh lubricant. See TRANSMISSION, LUBRICATION in Section 6.

23. See INSTALLING THE ENGINE and perform the applicable steps.



1. **Head screw with ball inside**
2. **Cylinder stud**
3. **Shoulder on cylinder stud**
4. **Air gun**

Figure 3-103. Cylinder Studs

FUEL SYSTEM 4

SUBJECT PAGE NO.

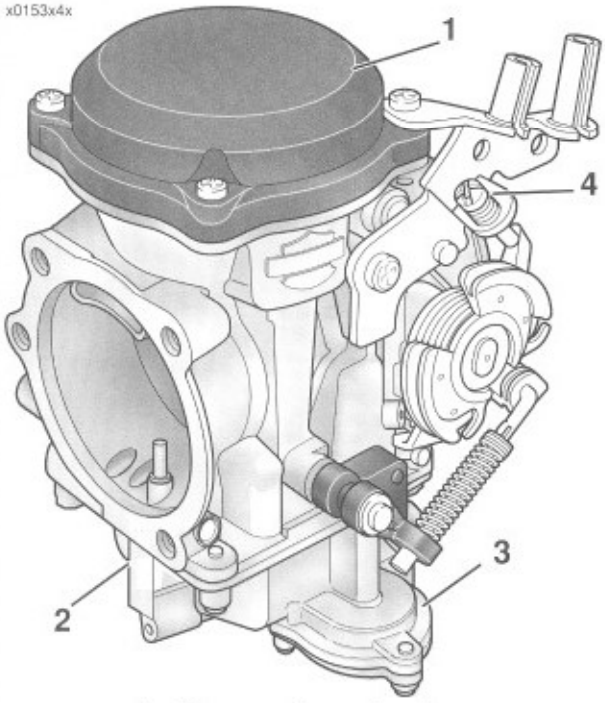
SPECIFICATIONS

	XLH 883			XLH 1200 / 1200S Sport		
	49 State	Calif.	HDI, Swiss	49 State	Calif.	HDI, Swiss
Carburetor Jet Sizes						
Main jet	160	170	190	170/195	185/195	190/195
Slow jet	42	42	42	42	42	42
Carburetor Adjustments						
Engine slow idle speed	1050 rpm					
Engine speed for setting ignition timing	1050-1500 rpm					
Fuel Tank Capacity						
Total	3.30 gallons (U.S.) 12.5 liters					
Reserve	0.50 gallon (U.S.) 1.9 liters					
Torque Values						
Intake manifold flange bolts	6-10 ft-lbs 8-14 Nm					
Air cleaner backplate to cylinder bolts	10-20 ft-lbs 14-27 Nm					
Air cleaner backplate to carburetor bolts	3-5 ft-lbs 4-7 Nm					
Fuel tank mounting bolts	8-16 ft-lbs 11-22 Nm					
Air cleaner cover screws	3-5 ft-lbs 4-7 Nm					

CARBURETOR

GENERAL (Figure 4-1)

The carburetor is a constant-velocity, gravity-fed type with a float-operated inlet valve, a variable venturi, a throttle stop screw (for idle speed adjustment) and a fuel enrichment system (for starting).



1. **Vacuum piston chamber**
2. **Float chamber**
3. **Accelerator pump**
4. **Idle speed adjusting screw**

Figure 4-1. Carburetor

Idle and transfer ports provide a balanced fuel mixture during the transition period from stop to mid-range. A vacuum piston controls venturi opening.

The carburetor is specifically designed to control exhaust emissions. All jets are fixed. The idle mixture has been pre-set at the factory. The idle mixture screw is recessed in the carburetor casting. The opening is sealed with a plug because it is intended that the idle mixture be non-adjustable.

NOTE

Adjusting mixture setting by procedures other than specified in this section may be in violation of Federal or State regulations.

This system partially compensates for changes in the mixture that are normally caused by changes in altitude. Because atmospheric pressures drop as altitude increases, the pressure difference in the upper and lower chambers is reduced; this results in less fuel being delivered to the engine, thereby maintaining the correct air/fuel ratio for better engine performance and reduced exhaust emissions.

All models except the 1200S have a drain for emptying the float chamber during seasonal or extended periods of storage.

NOTE

The XL1200S Sport model does NOT have a drain for emptying the float chamber.

The carburetor is equipped with an accelerator pump. The accelerator pump system uses sudden throttle openings (rapid accelerations) to quickly inject raw fuel into the carburetor venturi; this provides extra fuel for smooth acceleration.

TROUBLESHOOTING

OVERFLOW

Check for:	Remedy:
1. Restricted fuel tank vent system.	1. Correct restricted hose. Replace vapor valve.
2. Loose float bowl screws.	2. Tighten screws.
3. Damaged float bowl O-ring.	3. Replace O-ring.
4. Damaged or leaking float assembly.	4. Replace float assembly.
5. Particle contamination in fuel inlet fitting cavity.	5. Clean and clear cavity and fuel supply tract.
6. Worn or dirty inlet valve or seat.	6. Clean or replace valve and clean seat.
7. Improper fuel level in float bowl.	7. Adjust float tab for correct fuel level.

POOR IDLING

Check for:	Remedy:
1. Idle speed improperly adjusted.	1. Adjust operating idle speed.
2. Inlet system air leak (faster idling).	2. Correct as required.
3. Loose low speed jet.	3. Tighten jet.
4. Contaminated or plugged low speed system.	4. Clean contaminants and clear passages.
5. Enrichener valve not seated or leaking.	5. Adjust, clean or replace.
6. Leaking accelerator pump.	6. Repair.

POOR FUEL ECONOMY

Check for:	Remedy:
1. Excessive use of enrichener system.	1. Limit system use.
2. Enrichener valve not seated or leaking.	2. Adjust, clean or replace.
3. Dirty air cleaner element.	3. Clean or replace as required.
4. Restricted fuel tank vent system.	4. Correct restricted hose. Replace vapor valve.
5. High speed riding style.	5. Modify riding habits.
6. Idle speed improperly adjusted.	6. Adjust operating idle speed.
7. Loose jets.	7. Tighten jets.
8. Fuel level too high.	8. Adjust float level.
9. Plugged or restricted bowl vent.	9. Clean and clear passages.
10. Worn or damaged needle or needle jet.	10. Replace needle or needle jet.
11. Vacuum piston assembly malfunction.	11. See Vacuum Piston Troubleshooting.
12. Plugged air jets or passages.	12. Clean and clear passages.
13. Excessive accelerator pump output.	13. Check and clean accelerator pump bypass orifice.

POOR ACCELERATION

Check for:	Remedy:
1. Throttle cables misaligned.	1. Adjust throttle cables.
2. Inlet system air leak.	2. Correct as required.
3. Restricted fuel tank vent system.	3. Correct restricted hose. Replace vapor valve.
4. Restricted fuel supply passages.	4. Correct and clear restriction.
5. Plugged bowl vent or overflow.	5. Clean and clear passages.
6. Enrichener valve not seated or leaking.	6. Adjust, clean or replace.
7. Worn or damaged needle or needle jet.	7. Replace assembly.
8. Vacuum piston malfunction.	8. See Vacuum Piston Troubleshooting.
9. Plugged jets or passages.	9. Clean and clear as required.
10. Fuel level (float chamber) too low.	10. Adjust float level.
11. Accelerator pump leaking or no output.	11. Repair as necessary.

HARD STARTING

Check for:	Remedy:
1. Enrichener system plugged, not properly functioning or improperly operated.	1. Clean, adjust, or replace; or read Owner's Manual.
2. Inlet system air leak.	2. Correct as required.
3. Restricted fuel supply.	3. Correct fuel supply or passages.
4. Fuel overflow.	4. See Overflow Troubleshooting.
5. Plugged slow jet or passages.	5. Clean and clear jet or passages.

POOR PERFORMANCE ON ROAD

Check for:	Remedy:
1. Idle speed improperly adjusted.	1. Adjust operating idle speed.
2. Inlet system air leak.	2. Correct as required.
3. Restricted fuel tank vent system.	3. Correct restricted hose. Replace vapor valve.
4. Dirty or damaged air cleaner element.	4. Clean or replace.
5. Enrichener valve not seated or leaking.	5. Adjust, clean or replace.
6. Restricted fuel supply tract.	6. Correct and clear restriction.
7. Plugged bowl vent or overflow.	7. Clean and clear passages.
8. Loose or plugged fuel and air jets or passages.	8. Clean, clear and correct as required.
9. Worn or damaged needle or needle jet.	9. Replace assembly.
10. Vacuum piston assembly malfunction.	10. See Vacuum Piston Troubleshooting.
11. Accelerator pump inoperative.	11. Repair as required.

POOR HIGH-SPEED PERFORMANCE

Check for:	Remedy:
1. Inlet system air leak.	1. Clean or replace
2. Enrichener valve not seated or leaking.	2. Adjust, clean or replace.
3. Restricted fuel tank vent system.	3. Correct restricted hose. Replace vapor valve.
4. Restricted fuel supply tract.	4. Correct and clean restriction.
5. Dirty or damaged air cleaner element.	5. Clean or replace.
6. Plugged bowl, vent or overflow.	6. Clean and clear passages.
7. Worn or damaged needle or needle jet.	7. Replace assembly.
8. Vacuum piston assembly malfunction.	8. See Vacuum Piston Troubleshooting.
9. Loose or plugged main jets or passages.	9. Tighten, clean, clear as required.
10. Improper fuel level.	10. Adjust float level.
11. Accelerator pump inoperative.	11. Repair as required.

VACUUM PISTON ASSEMBLY TROUBLESHOOTING

PISTON DOES NOT RISE PROPERLY	
Check for:	**Remedy:**
1. Piston atmosphere vent blocked.	1. Clear vent.
2. Diaphragm cap loose, damaged or leaking.	2. Tighten or replace cap.
3. Spring binding.	3. Correct or replace spring.
4. Diaphragm pinched at lip groove.	4. Reposition diaphragm lip.
5. Torn diaphragm.	5. Replace piston diaphragm assembly.
6. Piston binding.	6. Clean piston slides and body or replace piston.
7. Piston vacuum passage plugged.	7. Clean and clear passage.
PISTON DOES NOT CLOSE PROPERLY	
Check for:	**Remedy:**
1. Spring damaged.	1. Replace spring.
2. Piston binding.	2. Clean piston slides and body or replace piston.
3. Piston diaphragm ring dirty or damaged.	3. Clean or replace piston.

OPERATION

Enrichener

The enrichener knob, next to the ignition switch, controls the opening and closing of the enrichener valve at the carburetor.

COOL ENGINE

BE SURE THROTTLE IS CLOSED. Pull enrichener knob fully out. Turn the ignition switch on and press starter switch to operate the electric starter.

⚠CAUTION

You must pay close attention to a C. V. carburetor equipped vehicle's warm-up time. Both excessive use and insufficient use of the enrichener may cause poor performance, erratic idle, poor fuel economy and spark plug fouling.

OUTSIDE TEMPERATURE LESS THAN 50˚F (10˚C)

The vehicle should be allowed to warm up for only 15-30 seconds before being driven. Initial warm-up periods longer than 30 seconds are not recommended. For temperatures well below 50˚F (10˚C), you may need to twist the throttle once or twice immediately before attempting engine start-up. This will add extra fuel from the carburetor accelerator pump to assist the start-up.

1. If the outside temperature is less than 50˚ F (10˚C), ride for five minutes or three miles (5 km) with enrichener knob fully out.
2. Push the enrichener knob in to approximately 1/2 way. Ride another two minutes or two miles (3 km).
3. See Figure 4-2. Then push enrichener knob fully in. If engine will not idle at specified rpm, pull out enrichener knob enough to allow correct idle speed. Ride another two minutes or two miles (3 km); then push enrichener knob fully in.

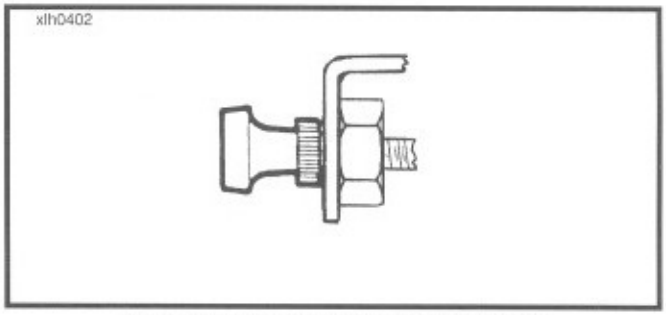


Figure 4-2. Enrichener Knob Fully In

OUTSIDE TEMPERATURE GREATER THAN 50˚ F (10˚C)

The vehicle should be allowed to warm up for only 15-30 seconds before being driven. Initial warm-up periods longer than 30 seconds are not recommended.

1. If the outside temperature is greater than 50˚F (10˚C), ride for three minutes or two miles (3 km) with enrichener knob fully out.
2. Push the enrichener knob in to approximately 1/2 way. Ride another two minutes or two miles (3 km).
3. Then push enrichener knob fully in. If engine will not idle at specified rpm, pull out enrichener knob enough to allow correct idle speed. Ride another two minutes or two miles (3 km); then push enrichener knob fully in.

WARM OR HOT ENGINE

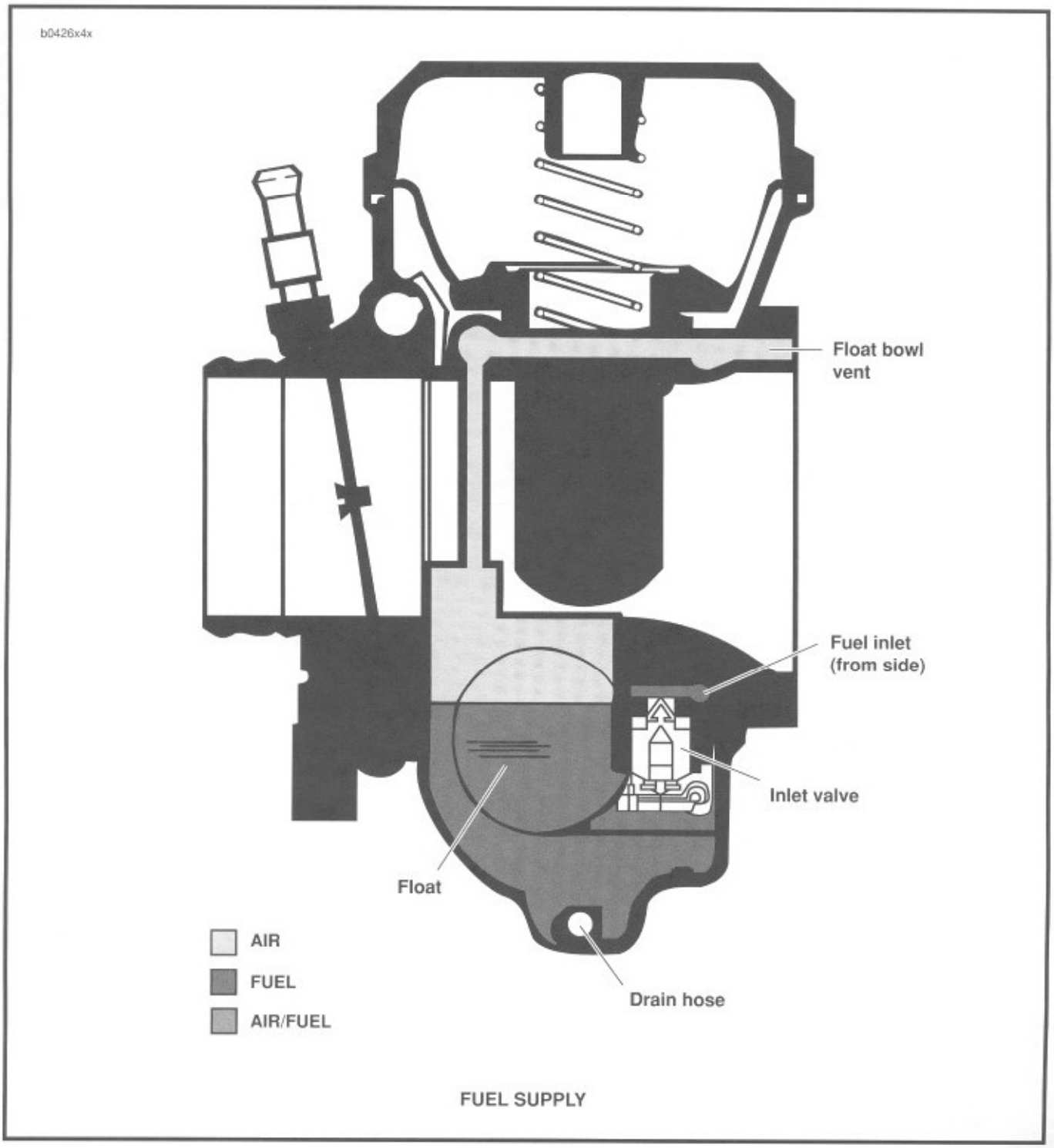
Open throttle 1/8-1/4 of full travel. Turn on ignition switch and operate electric starter. See Figure 4-2. DO NOT USE ENRICHENER, unless engine will not idle at specified rpm. If engine will not idle at specified rpm, pull out enrichener knob enough to allow correct idle speed. Ride two minutes or two miles (3 km); then push enrichener knob fully in.

Fuel Supply System

Fuel from the fuel tank passes through the carburetor inlet valve into the carburetor float chamber. The rising fuel level in the float chamber lifts the float, which in turn lifts the attached inlet valve closer to the valve seat. When the fuel reaches the level predetermined by the float level setting, the float will lift the inlet valve into its seated position, thereby closing the valve and stopping fuel flow to the float chamber.

When fuel is used by the running engine, the fuel level in the float chamber drops; this lowers the float and inlet valve, thereby causing the valve to open and the fuel flow to resume.

The float chamber is vented to atmosphere through an air passage in the carburetor body. The opening for the float chamber vent passage is next to the carburetor main venturi inlet, on the carburetor body surface to which the air cleaner backplate is mounted.



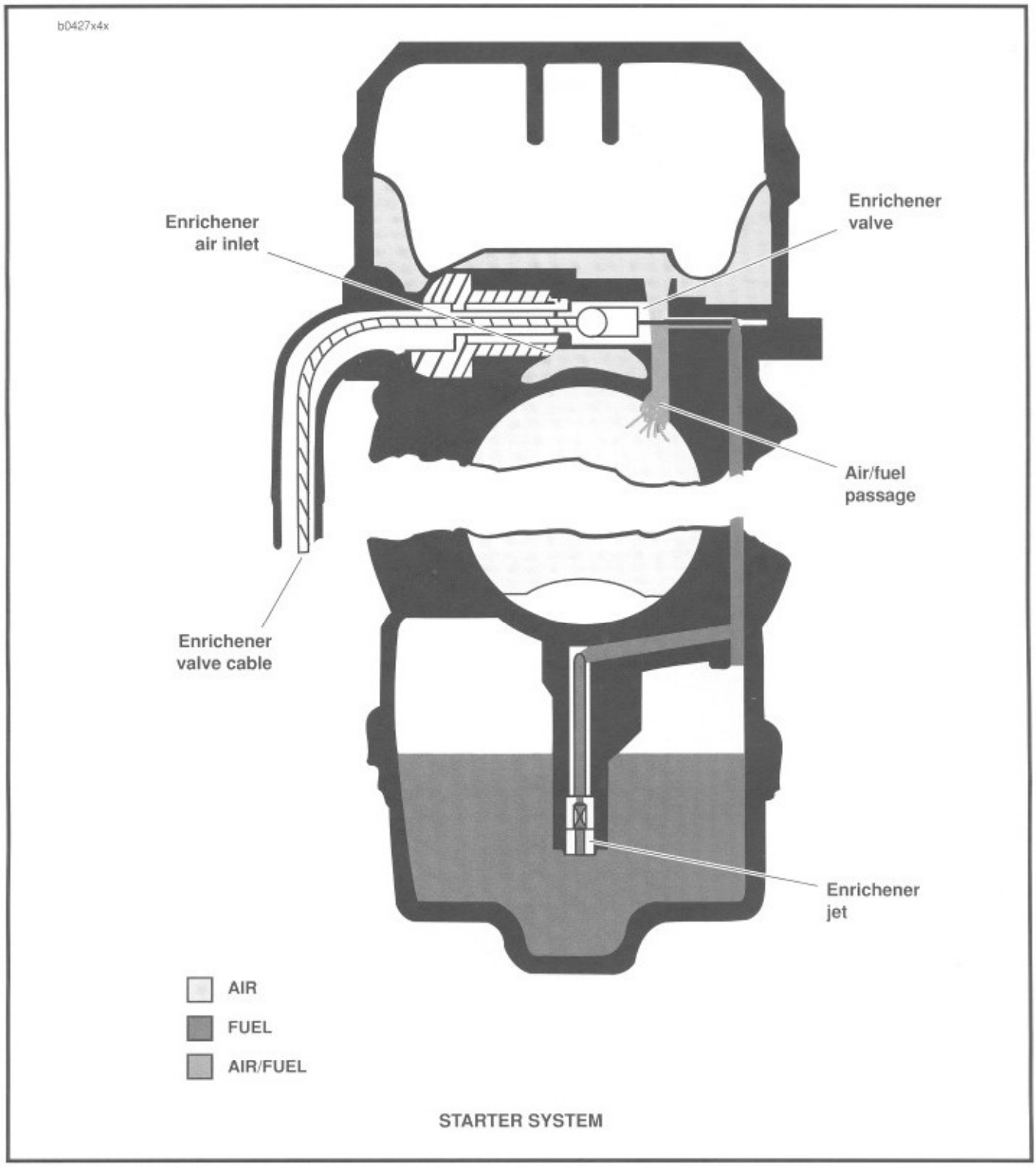
FUEL SUPPLY

Starter System

The starting circuit consists of a cable-actuated enrichener valve and converging fuel and air passages in the carburetor body.

The enrichener air/fuel passage opens to the carburetor venturi, where low pressure exists when the engine is running. Fuel in the carburetor float bowl and air in the enrichener air inlet are vented to atmosphere and are at atmospheric pressure (greater pressure than in the carburetor venturi).

When the enrichener knob is pulled outward, the enrichener valve opens the air/fuel passage to the low pressure carburetor venturi. Fuel in the float bowl, at atmospheric pressure, flows upward through a metering enrichener jet and then through a passage to the lower pressure enrichener valve chamber. Air in the enrichener air inlet, at atmospheric pressure, also flows into the lower pressure enrichener valve chamber and mixes with the incoming fuel. The resulting air/fuel mixture flows through the air/fuel passage into the carburetor venturi, effectively increasing the amount of fuel delivered to the combustion chambers.



STARTER SYSTEM

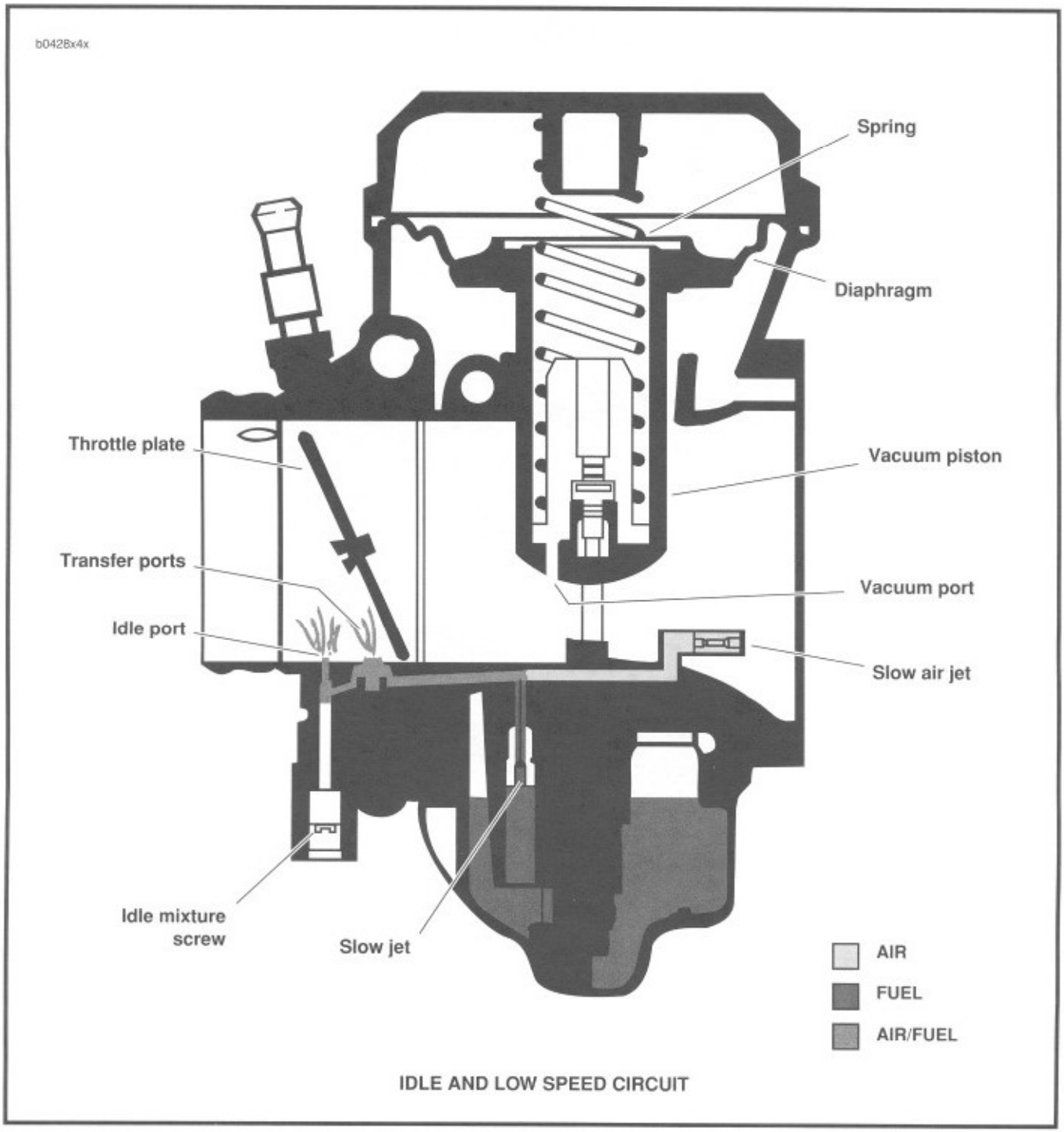
Idle- and Low-Speed Circuit

At idle (with the throttle plate closed and the main air stream obstructed), engine idle speed is maintained by fuel metered through the slow jet. Air from the slow air jet mixes with the fuel and is delivered to the idle port at the low pressure side of the throttle plate.

At low speed (with the throttle plate slightly open), the transfer ports are exposed to the low pressure side of the throttle plate, and additional fuel is directed to the barrel of the carburetor.

During the transition period from idle speed to mid-range, the idle and transfer ports also supply some fuel to the carburetor barrel; this allows for a smoother transition.

The venturi opening is reduced by the low position of the vacuum piston. This enables initial air stream velocities to be higher than normally attainable with fixed-venturi carburetors. The higher air stream velocities provide improved atomization of fuel necessary for good acceleration and driveability.



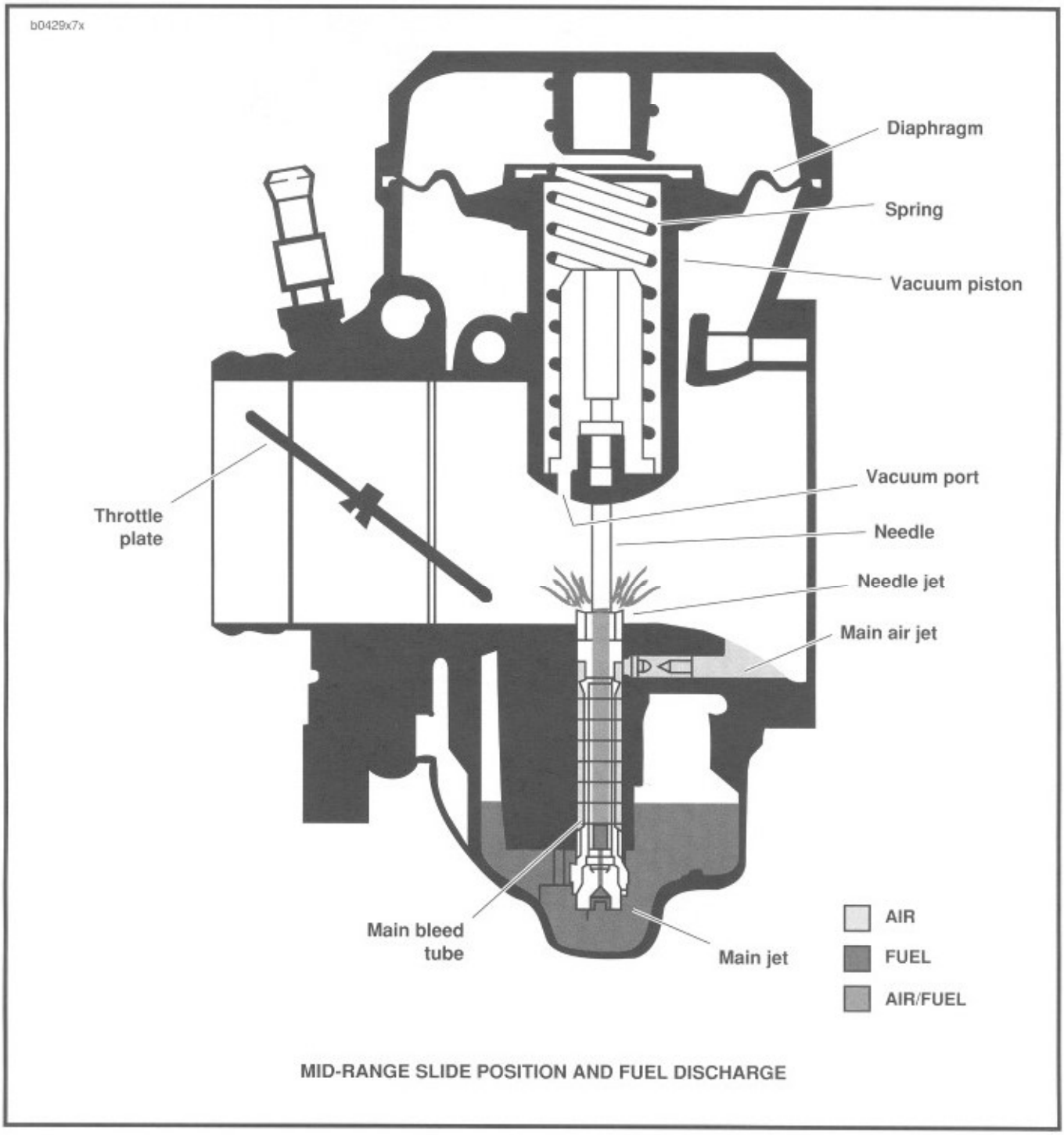
IDLE AND LOW SPEED CIRCUIT

Mid Range Slide Position and Fuel Discharge

As the throttle plate is opened, air flow increases through the carburetor; this causes air pressure to decrease in the carburetor venturi (near the needle jet) and in the chamber above the diaphragm (which is vented to the venturi through a vacuum port and passage in the vacuum piston).

The chamber beneath the diaphragm is vented to higher atmospheric pressure by a passage to the carburetor inlet. The higher air pressure at the underside of the diaphragm overcomes spring pressure and moves the vacuum piston upward in proportion to the pressure difference between the chambers.

The tapered needle moves upward with the vacuum piston, thereby opening the needle jet. With the needle jet open, the main bleed tube is exposed to the lower pressure of the carburetor venturi. This causes fuel in the float bowl (at atmospheric pressure) to flow through the main jet and into the main bleed tube. Air from the main air jet (at atmospheric pressure) flows through the main bleed tube openings and mixes with the incoming fuel. The air/fuel mixture is then delivered through the needle jet into the main air stream of the venturi.

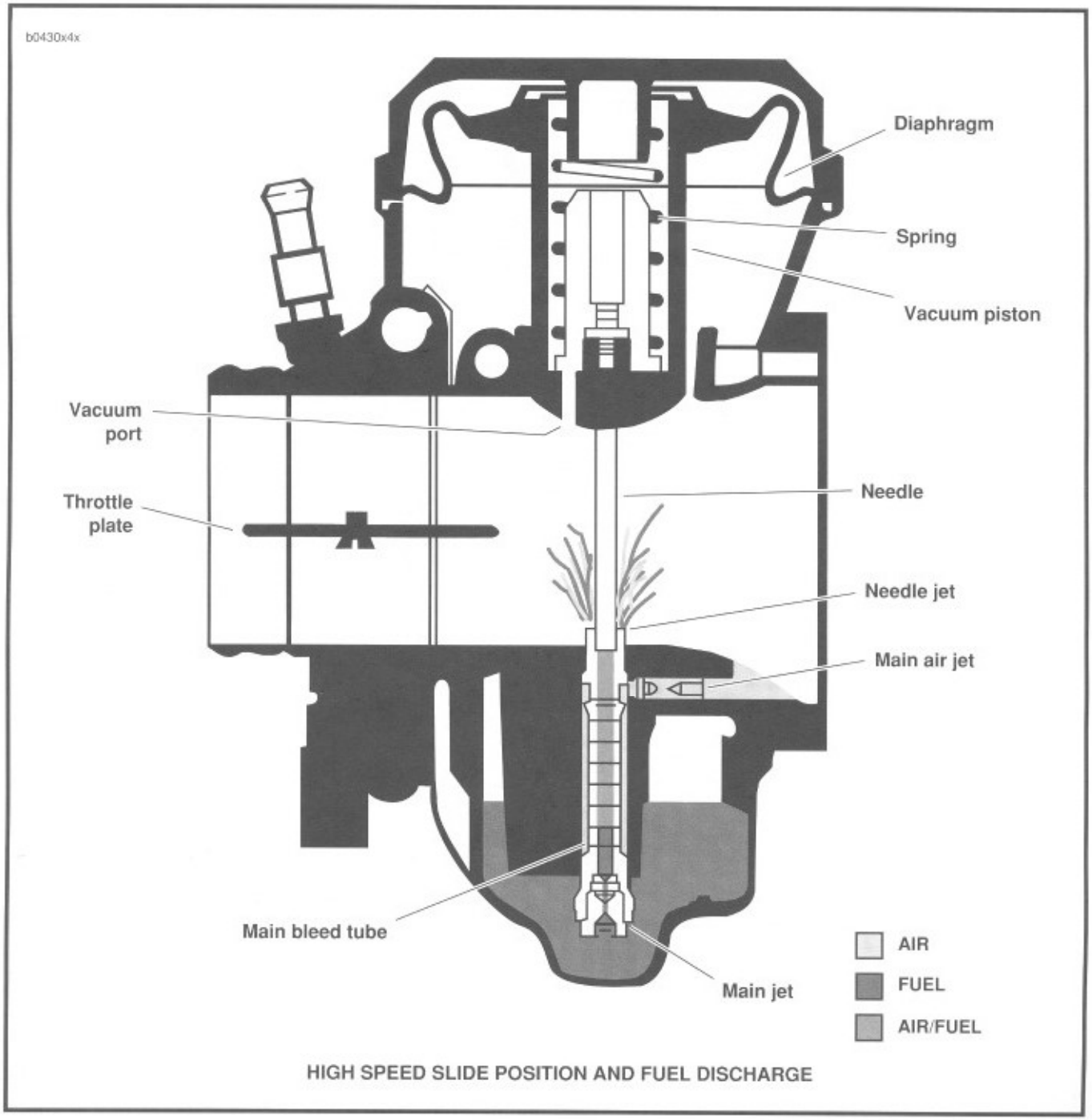


MID-RANGE SLIDE POSITION AND FUEL DISCHARGE

High-Speed Circuit Slide Position and Fuel Discharge

As the throttle plate is opened, the pressure difference between the chambers above and below the diaphragm increases and the vacuum piston moves further upward.

The venturi opening increases and the needle is lifted further out of the needle jet. The quantity of fuel and the volume of air are simultaneously increased and metered to the proportions of engine demand by the variable venturi and needle lift. With the vacuum piston fully upward, the venturi opening is fully enlarged and the needle jet opening exposure to the air stream is at its maximum. Air and fuel supplies are now available in quantities sufficient to meet maximum engine demand.

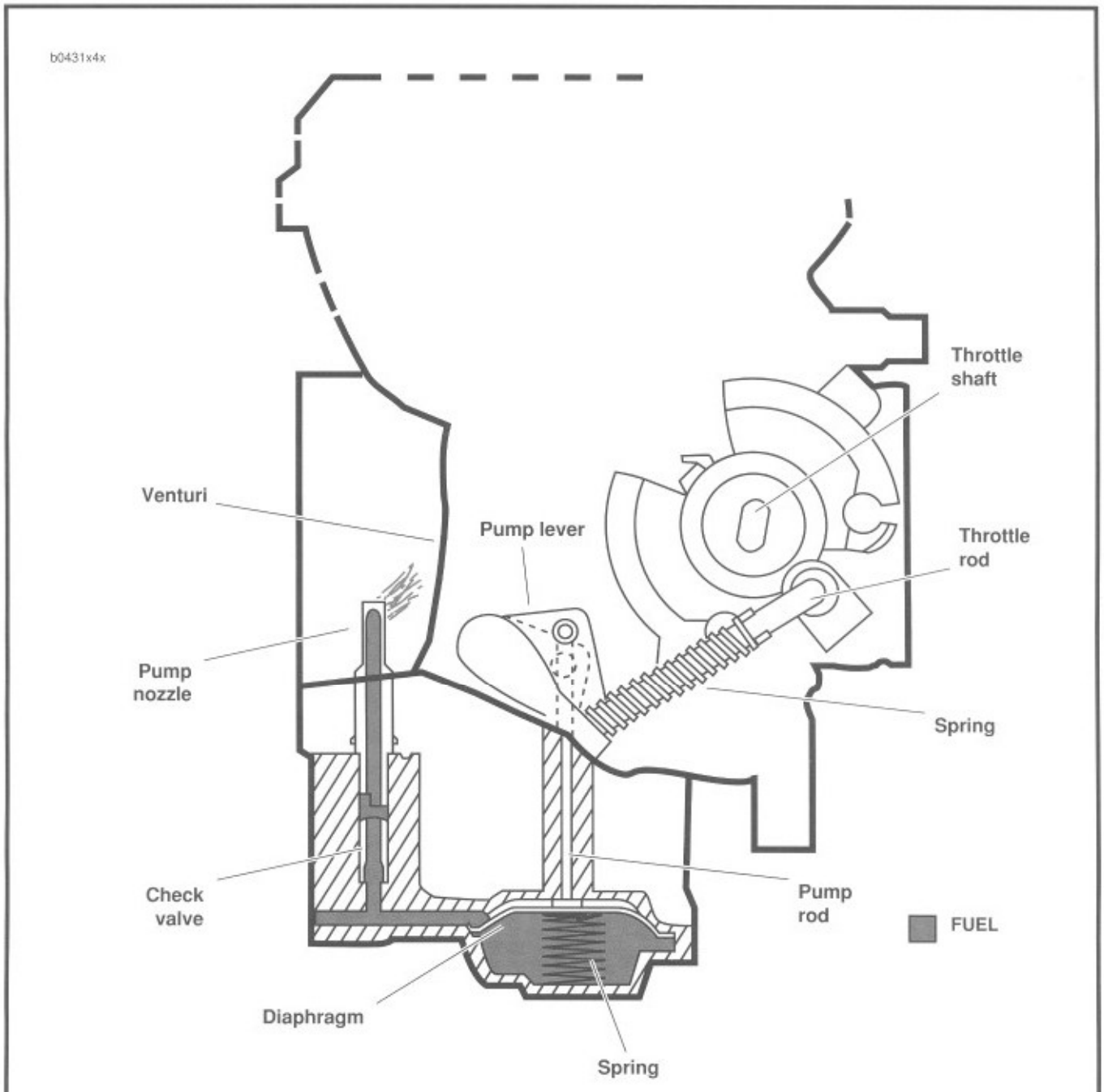


HIGH SPEED SLIDE POSITION AND FUEL DISCHARGE

Accelerator Pump System

The accelerator pump system uses sudden throttle openings (rapid acceleration) to quickly inject fuel into the carburetor venturi; the extra fuel provides for smooth acceleration. This fuel also assists engine operation during cold engine warm-up when the enrichener is turned off prematurely.

Rapid throttle action, during the first third of throttle travel, causes the accelerator pump rod to depress the accelerator pump diaphragm. This forces fuel in the pump to flow through a fuel passage (which has a "one-way" check valve), through the pump nozzle, and then into the venturi. When the throttle closes, the pump rod lifts up and away from the pump diaphragm; a spring below the diaphragm pushes the diaphragm upward, thereby causing the lower pump cavity to refill with fuel from the float bowl. The check valve prevents backflow of fuel from the pump nozzle/fuel passage during this refilling phase.



ACCELERATOR PUMP SYSTEM