minimum thickness of 1/16 in. (1.58 mm). Replace the brake pads as described in Chapter Thirteen.

Disc Brake Fluid Level Check

1A. On 1984-1994 models, to check the front master cylinder, perform the following:

a. Turn the handlebar straight ahead so the master cylinder is level.
b. Observe the brake fluid level by looking at the sight glass (**Figure 64**) on the side of the master cylinder reservoir. If the fluid level is correct, the sight glass will appear dark purple. If the level is low, the sight glass will have a lightened, clear appearance.

1B. On 1995-on models, to check the front master cylinder, perform the following:

a. Turn the handlebar straight ahead so the master cylinder is level.
b. Observe the brake fluid level by looking at the sight glass (**Figure 65**) on the master cylinder reservoir top cover. If the fluid level is correct, the sight glass will appear dark purple. If the level is low, the sight glass will have a lightened, clear appearance.

2A. On 1984-1994 models, to check the rear master cylinder, perform the following:

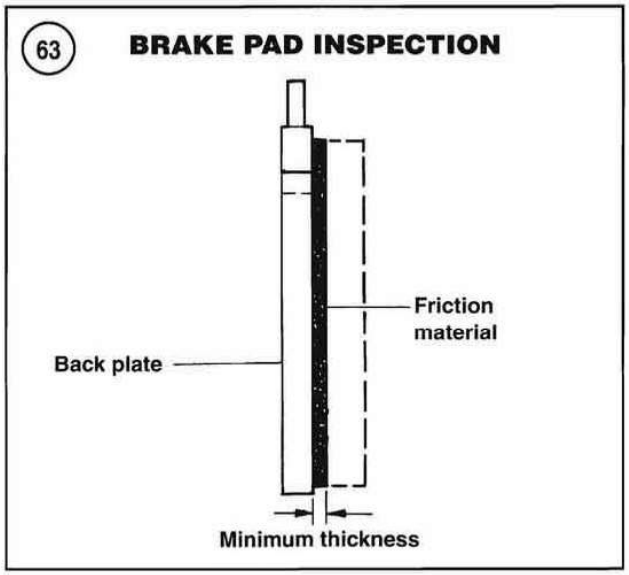
a. Support the motorcycle so that the rear master cylinder is level.
b. Remove the screws securing the top cover and remove the top cover and diaphragm.
c. The brake fluid level should be 1/8 in. (3.17 mm) below the gasket surface.
d. If the fluid level is correct, reinstall the diaphragm and top cover. Tighten the screws securely.

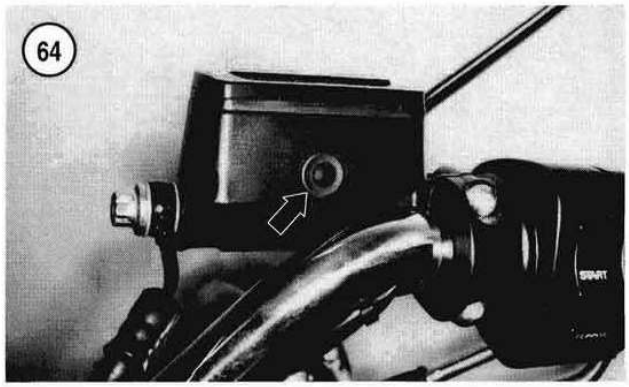
2B. On 1995-on models, to check the rear master cylinder, perform the following:

a. Support the motorcycle so that the rear master cylinder is level.
b. Observe the brake fluid level by looking at the sight glass (**Figure 66**) on the side of the master cylinder reservoir. If the fluid level is correct, the sight glass will appear dark purple. If the level is low, the sight glass will have a lightened, clear appearance.

WARNING

*Do not use brake fluid labeled **DOT 5.1**. This is a glycol-based fluid that is **not compatible** with silicone-based DOT 5. DOT 5 brake fluid is purple while DOT 5.1 is an amber/clear color. Do not mix these two completely different types of brake fluid. Doing so will lead to brake component damage and possible brake failure.*





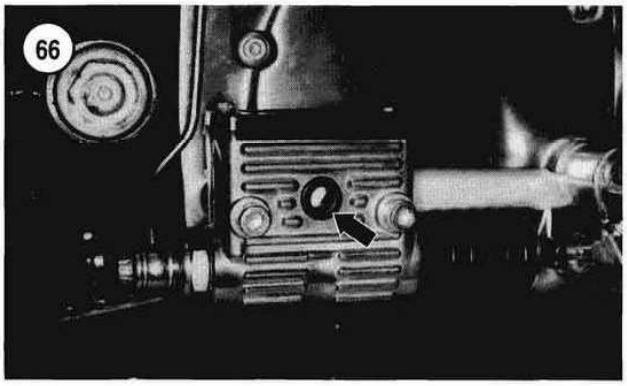
CAUTION

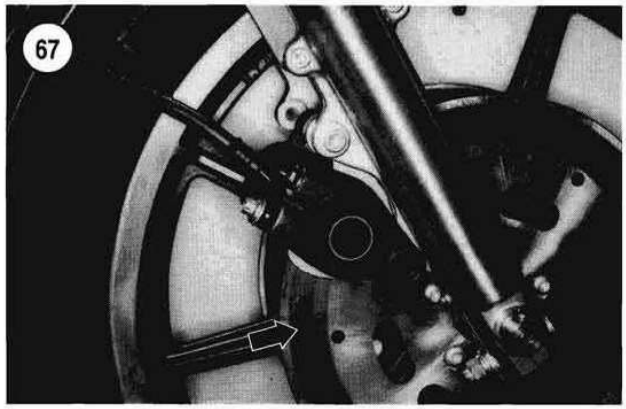
Be careful when handling brake fluid. Do not spill it on painted or plastic surfaces because it damages them. Wash the area immediately with soap and water and thoroughly rinse it.

NOTE

To control the flow of brake fluid, punch a small hole in the seal of a new container of brake fluid next to the edge of the pour spout. This helps eliminate the fluid spillage, especially while adding fluid to the small reservoir.

3. If the brake fluid level is low, perform the following:
   a. If necessary, remove the front cylinder muffler as described in Chapter Eight to access the rear master cylinder.
   b. Clean any dirt from the master cylinder cover prior to removing it.





c. Remove the top cover and lift the diaphragm out of the reservoir.

d. Add fresh DOT 5 brake fluid to correct the level.

e. Reinstall the diaphragm and top cover. Tighten the screws securely.

WARNING

If the brake fluid level is low enough to allow air in the hydraulic system, bleed the brakes as described in Chapter Thirteen.

Front and Rear Brake Disc Inspection

Visually inspect the front and rear brake discs (**Figure 67**, typical) for scoring, cracks or other damage. Measure the brake disc thickness and, if necessary, service the brake discs as described in Chapter Thirteen.

Disc Brake Lines and Seals

Check brake lines between the master cylinders and the brake calipers. If there is any leakage, tighten the connections and bleed the brakes as described in Chapter Thirteen. If this does not stop the leak or if a line is damaged, cracked or chafed, replace the line and seals and bleed the brake.

Disc Brake Fluid Change

Every time the reservoir cover is removed, a small amount of dirt and moisture enters the brake fluid. The same thing happens if a leak occurs or if any part of the hydraulic system is loosened or disconnected. Dirt can clog the system and cause unnecessary wear. Water in the fluid vaporizes at high temperatures, impairing the hydraulic action and reducing brake performance.

To change brake fluid, follow the brake bleeding procedure in Chapter Thirteen. Continue adding new fluid to the master cylinder until the fluid leaving the caliper is clean and free of contaminants and air bubbles.

WARNING

*Do not use brake fluid labeled **DOT 5.1**. This is a glycol-based fluid that is **not compatible** with silicone-based DOT 5. DOT 5 brake fluid is purple while DOT 5.1 is an amber/clear color. Do not mix these two completely different types of brake fluid. Doing so will lead to brake component damage and possible brake failure.*

Front Disc Brake Adjustment (All Models)

The front disc brake does not require periodic adjustment.

Rear Disc Brake Adjustment (All 1984-1996 and 1999 Models)

NOTE

On 1997-1998 models, the rear disc brake does not require periodic adjustment.

1984-early 1987 FXR series models (except FXRD) and 1999 FXR2 and FXR3

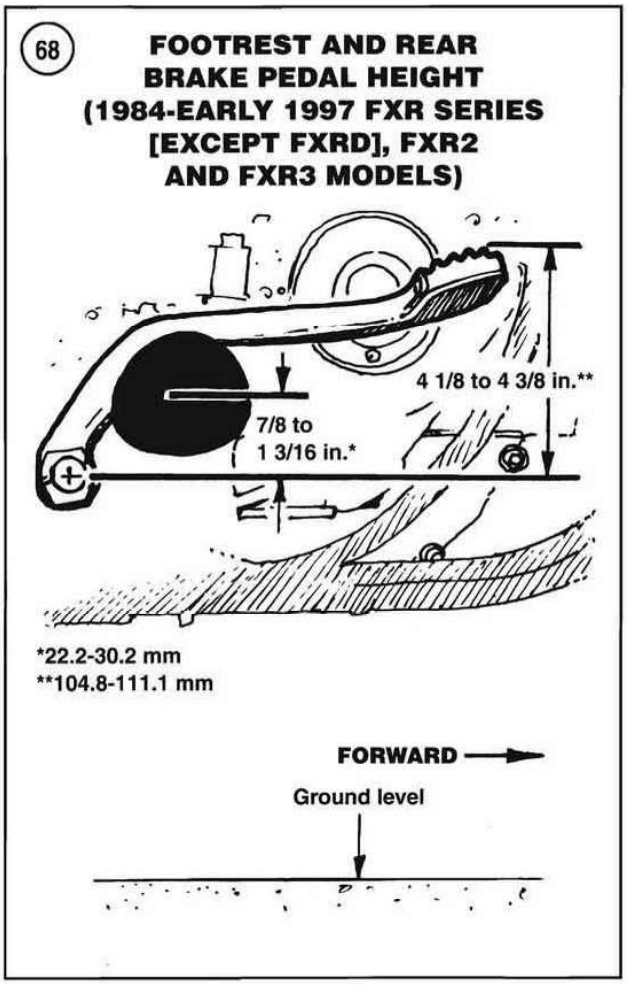
The brake pedal adjustment is a two-part procedure consisting of brake pedal height and pushrod free play.

1. Park the motorcycle on a level surface on the jiffy stand.
2. Place the brake pedal in the at-rest position.
3. Determine brake pedal height as follows:
   a. Place a ruler on the ground next to the brake pedal pivot shaft. Measure the distance from the ground up to the center of the brake pedal pivot shaft; record the measurement.
   b. Measure the distance from the ground up to the top of the brake pedal; record the measurement.
   c. Subtract substep a from substep b. The difference should be 4 1/8-4 3/8 in. (105-111 mm). If the difference is correct, perform Step 7. If the difference is incorrect, perform Step 4.
4. Measure the distance from the center of the footpeg rubber to the brake pedal pivot shaft centerline (**Figure 68**); the correct distance is 7/8-1 3/16 in. (22-30 mm). If necessary, loosen the footpeg mounting bolts and adjust footpeg position to obtain the correct distance measurement. Tighten bolts and recheck. Make sure that the brake pedal arm does not contact the footpeg mounting bracket. Perform Step 5.
5. Measure the distance from the top of the brake pedal to the brake pedal pivot shaft centerline (**Figure 68**); the correct distance is 4 1/8-4 3/8 in. (105-111 mm). If the distance is incorrect, perform the following:
   a. Loosen the rear brake pedal stop bolt locknut and turn the stop bolt in either direction until the correct brake pedal height is achieved.
   b. Hold the stop bolt and tighten the locknut securely.
   c. Recheck the height distance and readjust if necessary.

WARNING

The brake pedal cannot make contact with the exhaust pipe in the normal range of operation. If sufficient clearance is not maintained, complete brake application cannot be achieved.

6. Measure pushrod free play between the brake pedal arm and the brake pedal stop bolt as shown in **Figure 69**. The correct free play is 1/16 in. (1.58 mm). If the free play is incorrect, perform the following.
   a. Loosen the pushrod locknut and turn the pushrod in either direction until the free play is correct.
   b. Hold the pushrod and tighten the locknut securely.
   c. Recheck the free play and readjust if necessary.



WARNING

Insufficient pushrod free play can cause brake drag and incorrect brake operation.

FXRD models

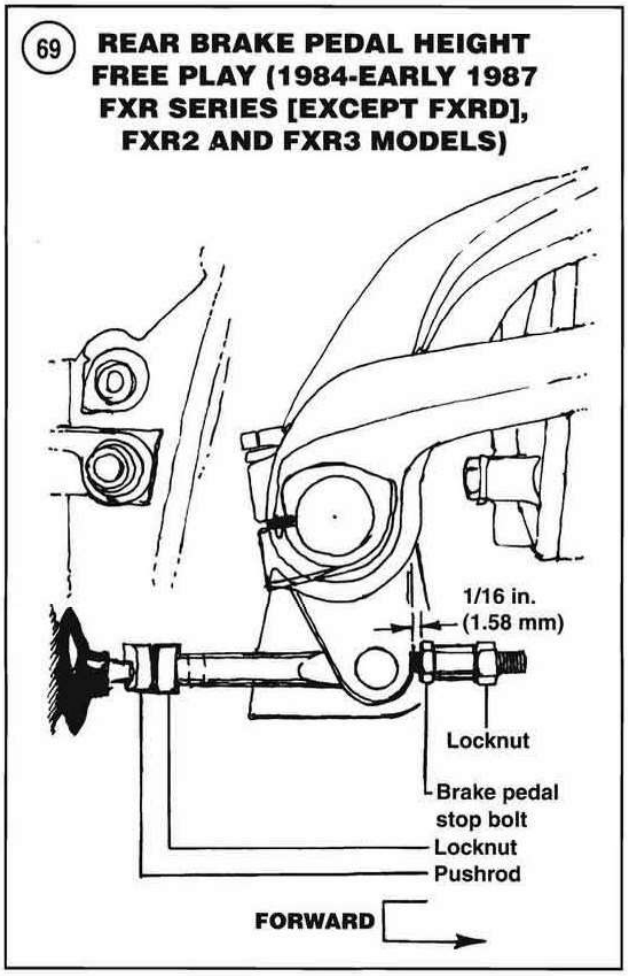
There is no specified brake pedal height specification. It is strictly rider preference, but sufficient clearance must be maintained.

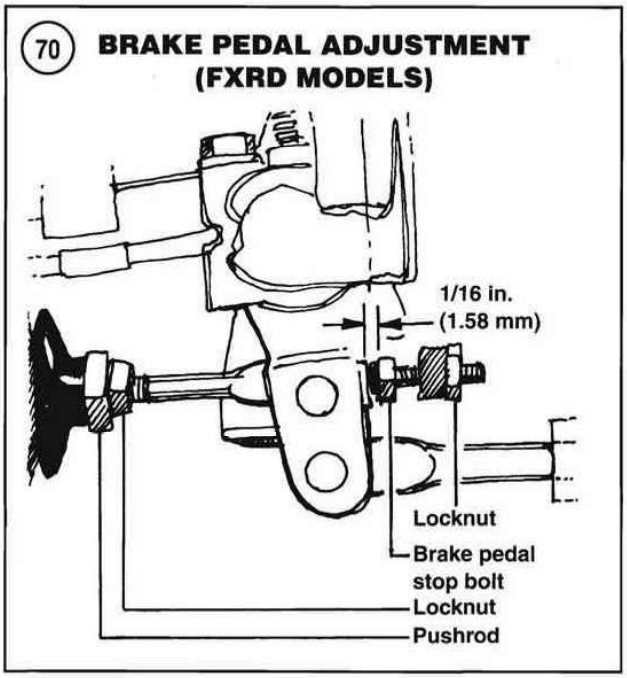
Brake pedal adjustment is a two-part procedure consisting of the brake pedal height and the pushrod free play.

1. Park the motorcycle on level ground on the jiffy stand.
2. Place the brake pedal in the at-rest position.

WARNING

The brake pedal cannot make contact with the floorboard in the normal range of operation. If sufficient clearance is not maintained, complete brake application cannot be achieved.





3. To adjust the brake pedal height, perform the following:
   a. Sit on the motorcycle and operate the rear brake pedal. Determine at what position the brake pedal feels the most comfortable.
   b. If adjustment is necessary, loosen the brake pedal stop bolt locknut (**Figure 70**) and turn the stop bolt in either direction until the desired brake pedal height is achieved.
   c. Hold the stop bolt and tighten the locknut securely.
   d. Recheck the height distance and readjust if necessary.
4. Measure free play between the brake pedal arm and the brake pedal stop bolt as shown in **Figure 70**. The correct free play is 1/16 in. (2 mm). If the free play is incorrect, perform the following:
   a. Loosen the pushrod locknut and turn the pushrod in either direction until the free play is correct.
   b. Hold the pushrod and tighten the locknut securely.
   c. Recheck the free play and readjust if necessary.

WARNING

If 1/16 in. (1.58 mm) pushrod free play cannot be achieved, the brake pedal might be positioned incorrectly. Check the brake pedal position and readjust if necessary. Insufficient pushrod free play can cause brake drag.

Late 1987-1998 FXR series, FXR2 and FXR3

Rear brake adjustment on these models consists of setting the brake pedal height in the proper relationship with the footpeg.

1. Park the motorcycle on level ground on the jiffy stand.
2. Place the brake pedal in the at-rest position.
3. Determine brake pedal height as follows:
   a. Place a ruler on the ground next to the brake pedal pivot shaft. Measure the distance from the ground up to the center of the brake pedal pivot shaft; record the measurement.
   b. Measure the distance from the ground up to the top of the brake pedal; record the measurement.
   c. Subtract substep a from substep b. The difference should be 4 1/8-4 3/8 in. (105-111 mm). If the difference is incorrect, perform Step 5. If the difference is correct, perform Step 7.

WARNING

When adjusting the master cylinder pushrod in Step 4, sufficient thread engagement between the brake rod and pushrod must be maintained. Otherwise, these parts could

disconnect and cause complete loss of the rear brake.

4. Loosen the pushrod locknut and turn the pushrod (**Figure 71**) in either direction until the brake pedal height is correct. Hold the pushrod and tighten the locknut securely. Recheck the brake pedal height and readjust if necessary.
5. Measure the distance from the center of the footpeg rubber to the brake pedal pivot shaft centerline (**Figure 68**); the correct distance is 7/8-1 3/16 in. (22-30 mm). If necessary, loosen the footpeg mounting bolts and adjust footpeg position to obtain the correct distance measurement. Tighten bolts and recheck. Make sure that the brake pedal arm does not contact the footpeg bracket.
6. There is no rear brake free play adjustment on these models. Free play is built into the master cylinder. To check free play, push the brake pedal down by hand. A small amount of free play should be felt. If there is no free play, check the brake pedal assembly for damage. If the pedal assembly is OK, the rear master cylinder might require service; refer to Chapter Fifteen.

FXWG models

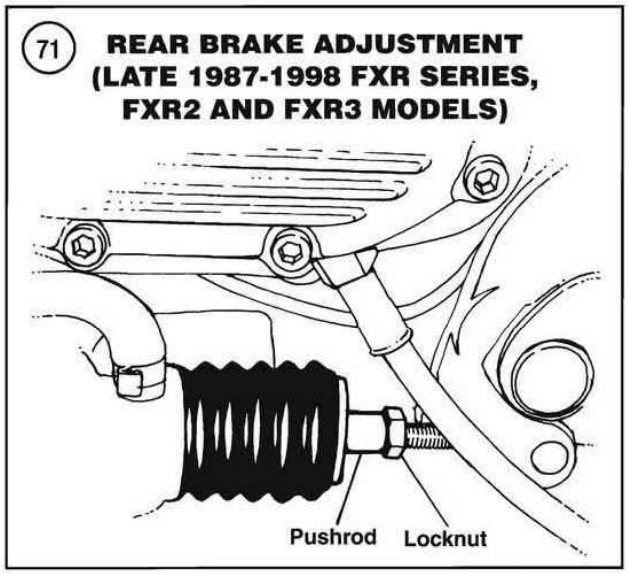
1. Park the motorcycle on level ground on the jiffy stand.
2. Place the brake pedal in the at-rest position.
3. Measure the distance between the brake pedal and the footrest (**Figure 72**). The correct distance is 17/64-1/2 in. (7-13 mm).
4. To adjust, loosen the locknut and turn the stop bolt in either direction until the correct distance is achieved. Tighten the locknut and recheck.
5. Work the brake pedal by hand. When the brake pedal is adjusted correctly, the pushrod will move approximately 1/16 in. (2 mm) before it contacts the master cylinder piston. If necessary, adjust as follows:
   a. Loosen the brake pedal locknut (**Figure 72**).
   b. Loosen the locknut and turn the clevis rod (**Figure 72**) counterclockwise to increase free play or clockwise to decrease it.
   c. Tighten the locknut and recheck the adjustment.

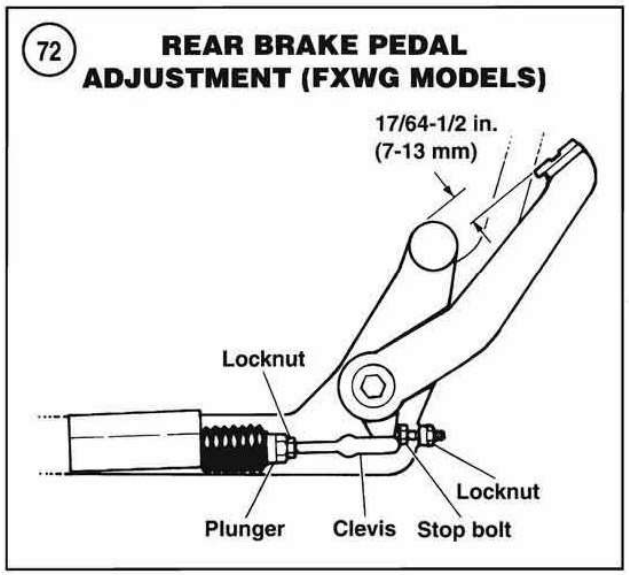
WARNING

Do not test-ride the motorcycle until the rear brake adjustment is correct and the pedal does not interfere with the rear exhaust system or footboard (if so equipped).

FXEF and FXSB models

1. Place the brake pedal in the at-rest position.



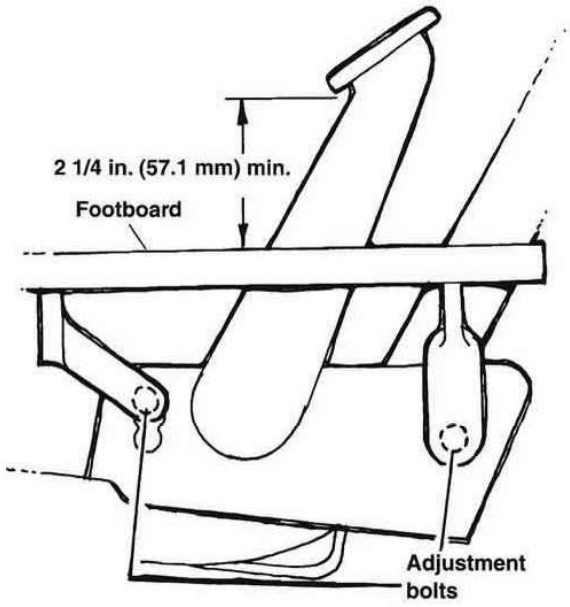


2. Work the brake pedal by hand. When the brake pedal is adjusted correctly, the pushrod will have 1/16 in. (2 mm) free play before it contacts the master cylinder piston.
3. If the free play is incorrect, perform the following:
   a. Loosen the pushrod locknut and turn the pushrod in either direction until the free play is correct.
   b. Hold the pushrod and tighten the locknut securely.
   c. Recheck the free play and readjust if necessary.

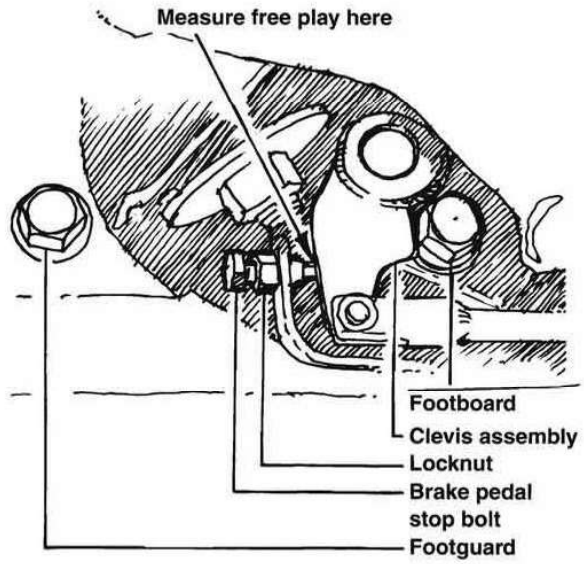
WARNING

If 1/16 in. (1.58 mm) of pushrod free play cannot be achieved, the brake pedal may be positioned incorrectly. Check brake pedal position and readjust if necessary. Insuffi-

73 REAR BRAKE PEDAL CLEARANCE (1984-1996 FLH AND FLT SERIES MODELS)



74 REAR BRAKE FREE PLAY ADJUSTMENT (FLT MODELS)



cient pushrod free play can cause brake drag.

FLH and FLT series models

On 1984-1991 models, the brake pedal adjustment is a two-part procedure consisting of brake pedal height and pushrod free play. On 1992-1996 models, the brake pedal adjustment consists of brake pedal height only because the pushrod free play is built into the master cylinder.

Maintain a minimum clearance of 2 1/4 in. (57 mm) between the brake pedal and footboard at all times. Maintain this clearance whenever the brake pedal height, footboard position or master cylinder pushrod free play is changed.

WARNING

The brake pedal cannot make contact with the floorboard in the normal range of operation. If sufficient clearance is not maintained, complete brake application cannot be achieved.

1. Park the motorcycle on level ground.

2A. To adjust footboard position and clearance, loosen the footboard adjustment bolts (**Figure 73**) and reposition the footboard within the guide slots. Tighten the bolts securely and recheck adjustment. Apply the rear brake pedal to ensure correct brake pedal-to-floorboard clearance; readjust if necessary.

2B. To change brake pedal height, remove the clevis screw and pull the clevis off of the brake pedal shaft. Rotate the clevis on the brake rod in either direction to change the brake pedal position on the brake rod. Reinstall the clevis onto the brake pedal shaft and remeasure pedal clearance (Step 2A). If pedal clearance is correct, install clevis screw and tighten securely.

3A. On 1984-1991 models, after the brake pedal clearance is correct, check and adjust pushrod free play as follows:

a. Place the brake pedal in the at-rest position. Measure the clearance between the end of the stop bolt and the clevis assembly as shown in **Figure 74**. Correct pushrod free play is 3/32-1/8 in. (2.4-3.2 mm).

b. To adjust free play, loosen the stop bolt locknut and turn the stop bolt in either direction. Tighten locknut and recheck clearance.

WARNING

Insufficient pushrod free play can cause brake drag and incorrect brake operation.

3B. On 1992-1996 models, make brake pedal minor height adjustments as follows:

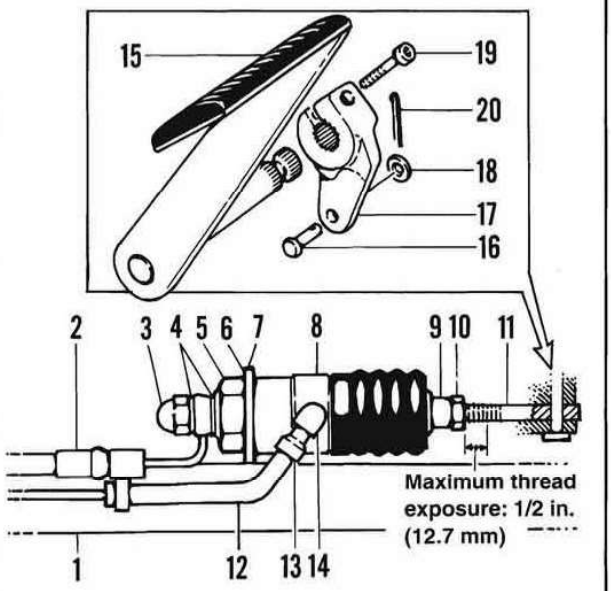
a. Loosen the pushrod locknut (**Figure 75**).
b. Turn the pushrod in either direction to change pedal height. Tighten the locknut securely.
c. Measure the length of the exposed threads on the brake rod as shown in **Figure 75**. The maximum amount of exposed threads is 1/2 in. (12.7 mm). If necessary, loosen the pushrod locknut and readjust the pushrod until less than 1/2 in. (12.7 mm) of threads are exposed. Tighten the locknut and remeasure.

WARNING

If more than 1/2 in. (12.7 mm) of threads are exposed on the brake rod, there is insufficient thread engagement between the brake rod and pushrod. This can allow the brake rod and pushrod to disengage and cause loss of rear brake action.

4. Recheck the brake pedal height.

75 REAR BRAKE PEDAL HEIGHT (1992-1996 FLH AND FLT SERIES MODELS)



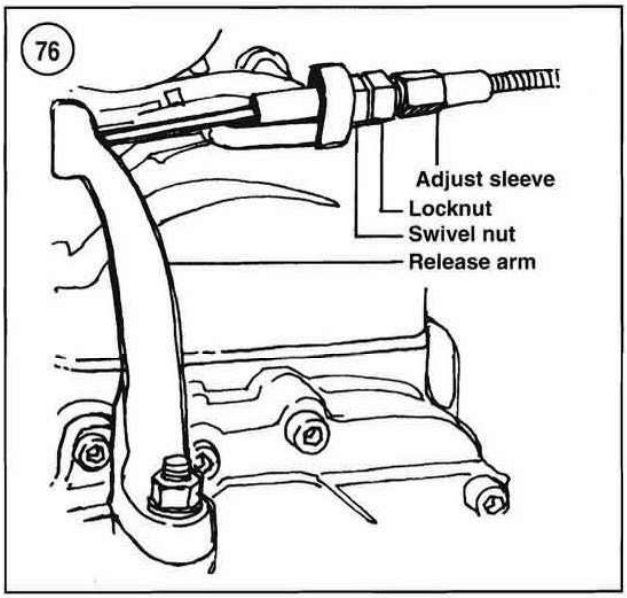
1. Frame tube
2. Brake line
3. Acorn nut
4. Washers
5. Nut
6. Lockplate
7. Frame bracket
8. Master cylinder assembly
9. Pushrod
10. Locknut
11. Brake rod
12. Reservoir hose
13. Clamp
14. Nipple
15. Brake pedal
16. Clevis pin
17. Pedal bracket
18. Washer
19. Pinch bolt
20. Cotter pin

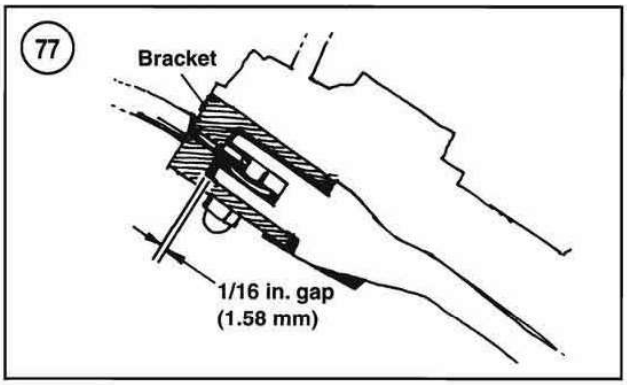
Clutch Adjustment (Dry Clutch Models)

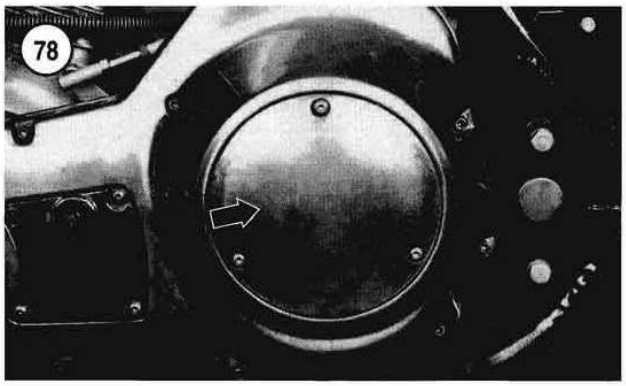
Table 1 lists the recommended clutch inspection and adjustment intervals. If the clutch slips when engaged, or if the motorcycle creeps forward when in gear, the clutch release mechanism must be adjusted.

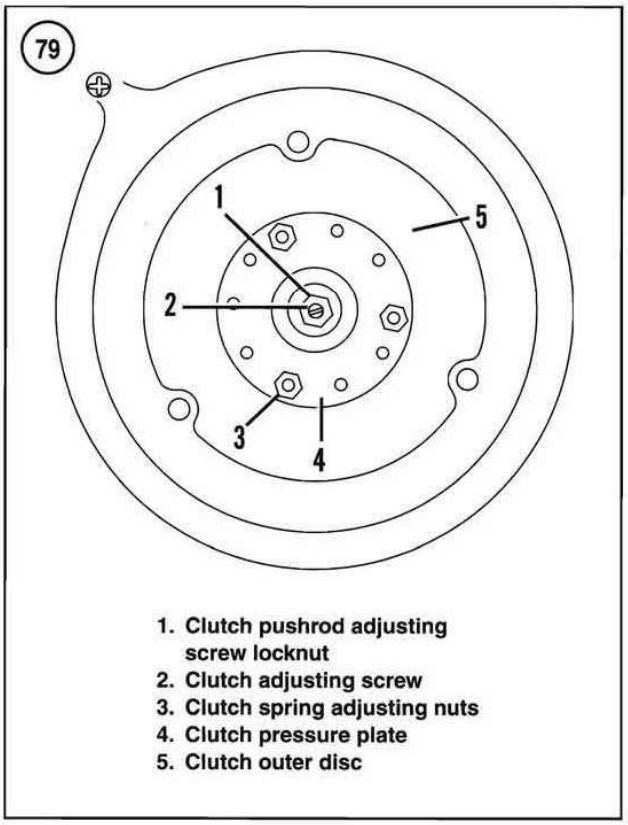
Refer to **Figure 76**.

1. At the clutch release arm end of the clutch cable, perform the following:
   a. Loosen the locknut next to the swivel nut.
   b. Turn the adjust sleeve in either direction to achieve approximately 1/16 in. (1.58 mm) clutch lever free play before the clutch starts to release (**Figure 77**).
   c. Tighten the locknut securely.
   d. If the correct amount of free play cannot be achieved, perform Step 2.
2. Loosen the locknut, next to the swivel nut, and turn the adjust sleeve clockwise to allow slack in the clutch cable. Then disconnect the clutch cable from the release arm.
3. Remove the clutch inspection cover and O-ring (**Figure 78**).
4. Loosen the pushrod locknut (1, **Figure 79**).
5. Turn the clutch adjusting screw (2, **Figure 79**) *clockwise* until all free play is removed from the release arm, then back it out 1/4 turn. Tighten the locknut securely.
6. Install a *new* O-ring and the clutch inspection cover. Tighten the screws securely.
7. Reconnect the clutch cable at the release arm.
8. Perform Step 1 and adjust the clutch cable.









1. Clutch pushrod adjusting screw locknut
2. Clutch adjusting screw
3. Clutch spring adjusting nuts
4. Clutch pressure plate
5. Clutch outer disc

9. If the clutch still slips after making this adjustment, perform the *Clutch Disc Adjustment* in this section.

Clutch Disc Adjustment (Dry Clutch Models)

1. Shift the transmission into neutral.
2. Remove the clutch inspection cover and O-ring (**Figure 78**).
3. Turn the clutch spring adjusting nuts (3, **Figure 79**) *clockwise* 1/2 turn.
4. Temporarily install the clutch inspection cover and O-ring. Tighten the screws.
5. Start the engine and allow it to idle. Then test the clutch by shifting transmission into gear. If clutch slips or drags, repeat Step 3. Turn the engine off.

CAUTION

Do not increase clutch spring tension any more than necessary.

6. Remove the clutch inspection cover and O-ring.
7. Measure the distance between the clutch pressure plate and the outer disc (**Figure 79**) at each of the adjusting nut positions. The distance should be 7/8 in. (22 mm) or more. If the distance is equal to or less than 7/8 in. (22 mm), the clutch might not disengage. Adjust a new clutch to 1 1/32 in. (26 mm).
8. If the clutch disc cannot be adjusted to this specification, refer to Chapter Five and service the clutch and/or clutch cable.
9. Install the clutch inspection cover and *new* O-ring. Tighten the screws securely.

Clutch Adjustment (Wet Clutch with Four-Speed Transmission)

Refer to **Figure 80**.

1. Park the motorcycle on a level surface and support it standing straight up.
2. Disconnect the clutch cable at the release lever at the engine.
3. Remove the clutch inspection cover (**Figure 78**).
4. Loosen the clutch adjuster screw locknut (**Figure 81**).

NOTE

When performing Step 5, lightly push on the release lever to remove any pushrod free play.

5. Turn the adjuster Allen screw (**Figure 80**) and position the release lever 13/16 in. (21 mm) from the transmission cover as shown in **Figure 82**.

6. Secure the adjuster screw with an Allen wrench to keep it from turning. Then tighten the locknut (**Figure 80**) securely.
7. Connect the clutch cable at the release lever.
8. Loosen the clutch cable adjusting screw locknut (**Figure 83**). Turn the adjusting screw in either direction to obtain 1/16 in. (1.58 mm) free play at the clutch hand lever (**Figure 77**). Tighten the locknut securely.
9. Before reinstalling the clutch inspection cover, check the primary chaincase oil level as described in this chapter.
10. Install the clutch inspection cover and *new* O-ring. Tighten the screws securely.

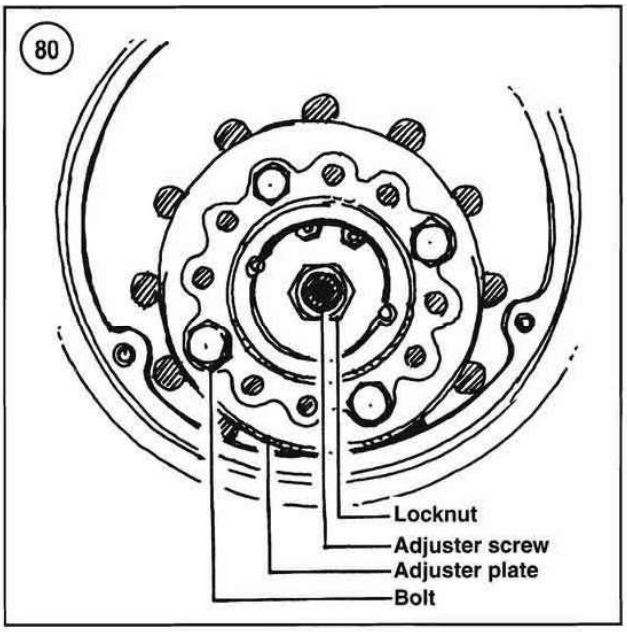
Clutch Adjustment (Late 1984-1989 Wet Clutch with Five-Speed Transmission)

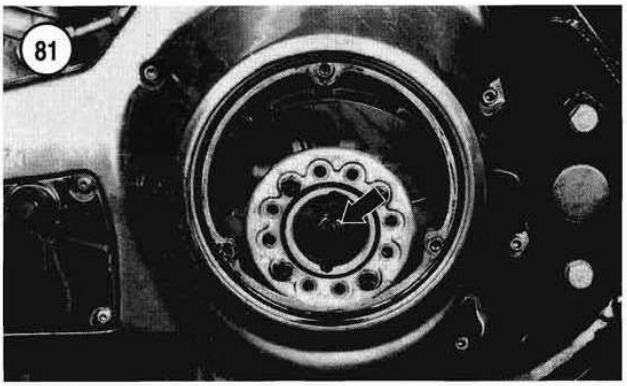
1. Park the motorcycle on a level surface and support it standing straight up.
2A. On late 1984-1986 models, loosen the locknut and turn the adjust sleeve clockwise to loosen the clutch cable (**Figure 76**).
2B. On 1987-1989 models, perform the following:
   a. At the clutch cable in-line adjuster, slide the rubber boot away from the adjuster (**Figure 84**).
   b. Loosen the cable locknut and turn the adjuster to provide as much cable slack as possible.
3. Remove the clutch inspection cover (**Figure 78**).
4. Refer to **Figure 80** and perform the following:
   a. Loosen the clutch pushrod adjusting screw locknut.
   b. Turn the clutch adjusting screw *clockwise* and remove all pushrod free play.
   c. Turn the clutch adjusting screw three-fourths of a turn *counterclockwise.*
   d. Secure the adjuster screw to keep it from turning. Then tighten the locknut securely.
5. Check the primary chaincase oil level as described in this chapter before reinstalling the clutch inspection cover.
6. Reinstall the clutch inspection cover and *new* O-ring. Tighten the screws securely.
7. Pull the handlebar clutch lever three to four times to seat the clutch release mechanism.

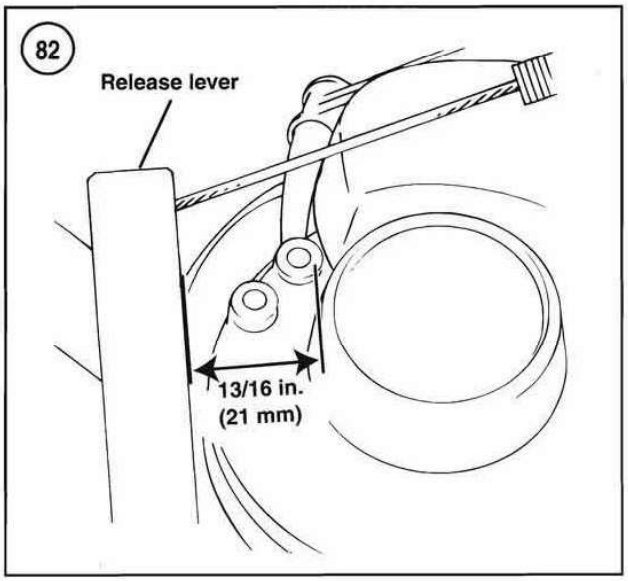
NOTE

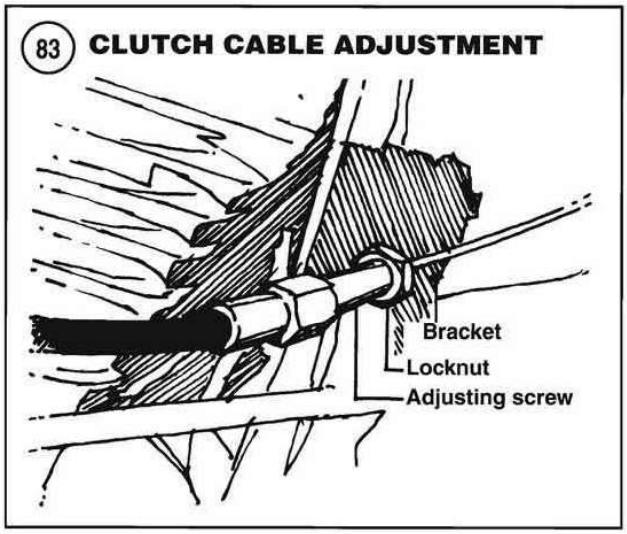
When turning the clutch cable adjuster in Step 8, pull the clutch cable away from the clutch hand lever bracket.

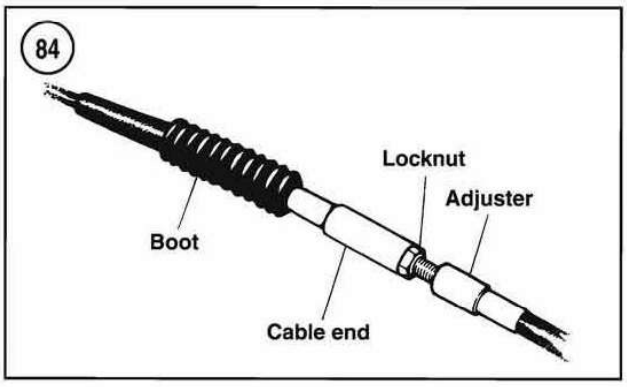
8. Turn the clutch cable adjuster (**Figure 83** or **Figure 84**) until there is 1/8-3/16 in. (3-5 mm) free play between

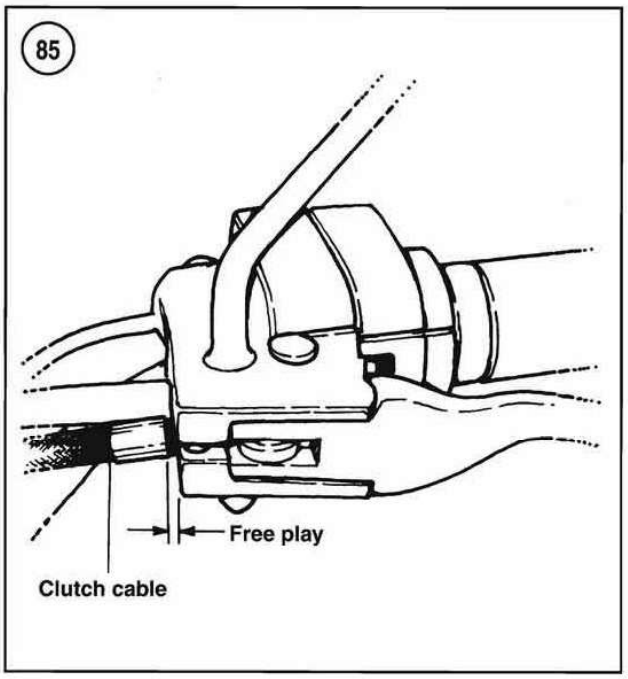












the clutch hand lever bracket and the outer clutch cable end as shown in **Figure 85**.

9. Tighten the clutch cable locknut. On 1987-1989 models, slide the rubber boot over the cable adjuster.
10. If clutch slips or drags, perform *Clutch Diaphragm Spring Adjustment* in this section.

Clutch Diaphragm Spring Adjustment (Late 1984-1989 Wet Clutch with Five-Speed Transmission)

1. Park the motorcycle on a level surface and support it standing straight up.

2A. On late 1984-1986 models, loosen the locknut and turn the adjust sleeve clockwise to loosen the clutch cable (**Figure 76**).

2B. On 1987-1989 models, perform the following:

a. At the clutch cable in-line adjuster, slide the rubber boot away from the adjuster (**Figure 84**).
b. Loosen the cable locknut and turn the adjuster to provide as much cable slack as possible.

3. Remove the clutch inspection cover (**Figure 78**).
4. Refer to **Figure 80** and perform the following:
   a. Loosen the clutch pushrod adjusting screw locknut.
   b. Turn the clutch adjusting screw *clockwise* and remove all pushrod free play.
5. Lay a straightedge across the diaphragm spring (**Figure 86**) and perform the following:
   a. Use a flat feeler gauge and measure the distance between the straightedge and spring.
   b. There should be a gap of more than 0.010 in. (0.25 mm) (**Figure 87**).
   c. If the gap is greater than 0.010 in. (0.25 mm), the spring must be adjusted.

NOTE

*To adjust spring compression in the following steps, remove the adjuster plate (**Figure 88**). Then reinstall it using one of the three different hole positions (**Figure 89**).*

6. Loosen the four adjuster plate bolts (**Figure 88**) in a crisscross pattern one-half to one turn at a time. Continue until all spring tension is removed. Then remove the bolts and spring adjuster.

7. Install the spring adjuster plate at the mounting holes that will accomplish the correct clutch adjustment (**Figure 89**). Note the following:

a. If the spring is bowed outward more than 0.010 in. (0.25 mm), position the adjuster plate at the next hole that offers greater compression.

b. If the spring is dished inward more than 0.010 in. (0.25 mm), position the adjuster plate at the next hole that offers less compression.

c. The factory spring position is flat to 0.010 in. (0.25 mm) concave. No adjustment required at this position (**Figure 87**).

8. Install the four adjuster plate bolts. Tighten in a crisscross pattern to 71-97 ft.-lb. (8-11 N•m). Recheck the adjustment as described in Step 5. If adjustment is correct, remove the four adjuster plate bolts and apply a medium strength threadlocking compound to the bolt threads. Reinstall the bolts and tighten to 71-97 ft.-lb. (8-11 N•m).

9. Adjust clutch as previously described in this section.

Clutch Adjustment (1990-1994 Models)

CAUTION

Because the clutch adjuster clearance increases with engine temperature, adjust the clutch when the clutch is cold. If the clutch is adjusted when the engine is hot, insufficient pushrod clearance can cause the clutch to slip.

1. Park the motorcycle on a level surface and support it standing straight up.

2. At the clutch cable in-line adjuster, slide the rubber boot away from the adjuster (**Figure 84**).

3. Loosen the cable locknut and turn the adjuster to provide as much cable slack as possible.

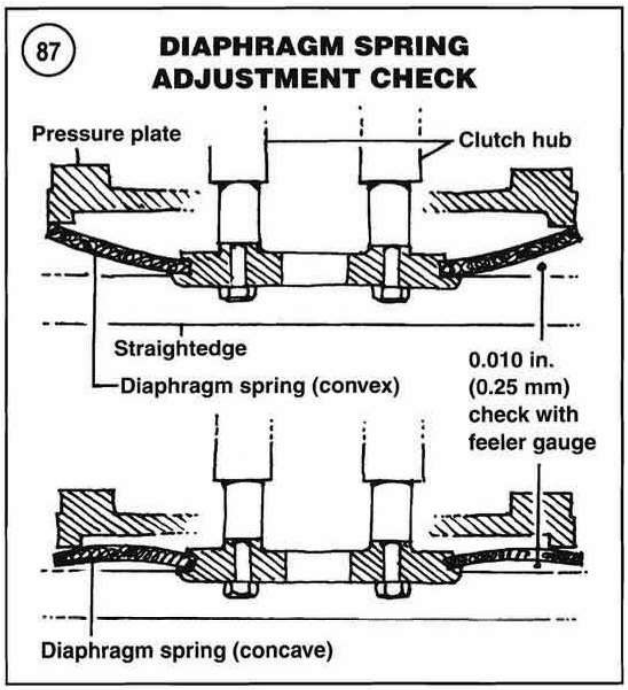
4. Remove the clutch inspection cover (**Figure 78**).

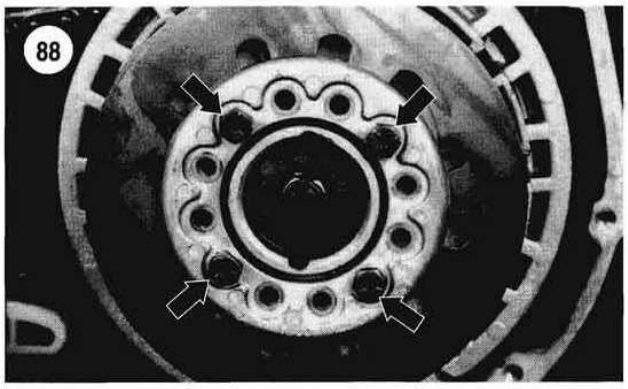
5. Adjust the clutch pushrod free play as follows:

a. Loosen the clutch pushrod adjusting screw locknut (A, **Figure 90**).

b. Turn the clutch adjuster screw (B, **Figure 90**) *clockwise* to remove all pushrod free play.

c. Turn the clutch adjuster screw one-half to three-fourths of a turn *counterclockwise*. Then secure the screw from turning and tighten the locknut securely.





6. Before reinstalling the clutch inspection cover, check the primary chaincase oil level as described in this chapter.

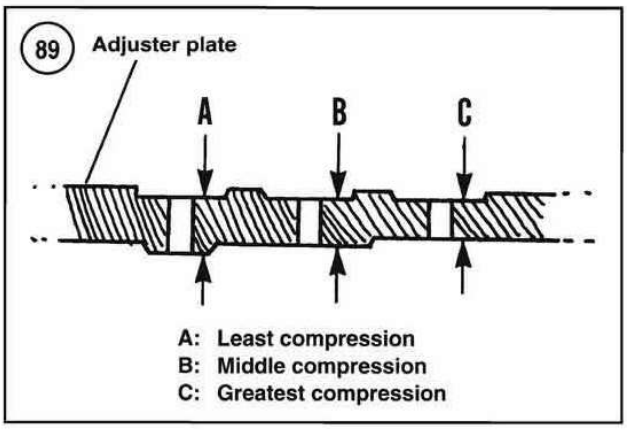
7. Reinstall the clutch inspection cover and *new* O-ring. Tighten the screws securely.

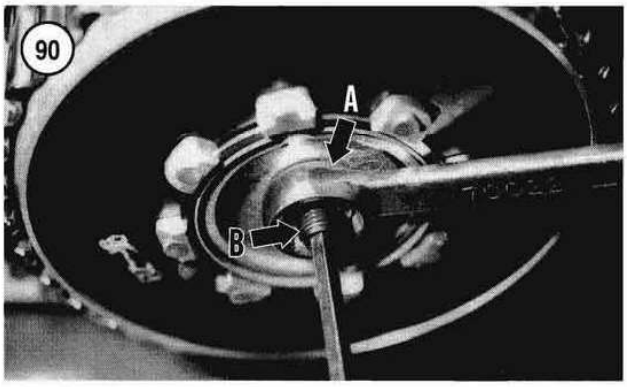
8. Pull the handlebar clutch lever three times to seat the clutch release mechanism.

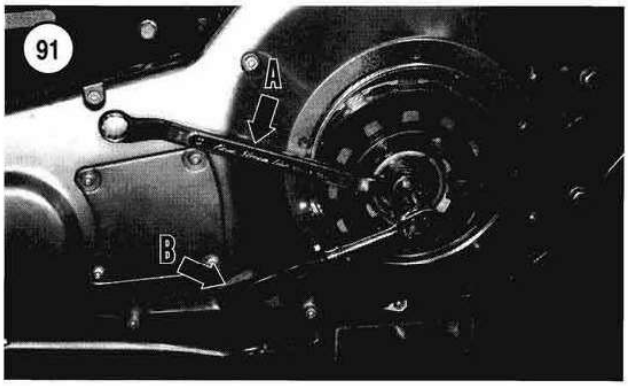
NOTE

When turning the clutch cable adjuster in Step 9, pull the clutch cable away from the clutch hand lever bracket.

9. Turn the clutch cable adjuster (**Figure 84**) until there is the following free play between the clutch hand lever bracket and the outer clutch cable end as shown in **Figure 85**):







a. 1990 models: 1/8-3/16 in. (3-5 mm).
b. 1991-1994 models: 1/16-1/8 in. (2-3 mm).

10. Tighten the clutch cable locknut (**Figure 84**) and slide the rubber boot over the cable adjuster.

Clutch Adjustment (1995-1998 Models)

CAUTION
Because the clutch cable adjuster clearance increases with engine temperature, adjust the clutch when the engine is cold. If the clutch is adjusted when the engine is hot, insufficient pushrod clearance can cause the clutch to slip.

1. Park the motorcycle on a level surface and support it standing straight up.
2. At the clutch cable in-line adjuster, slide the rubber boot away from the adjuster (**Figure 84**).
3. Loosen the cable locknut and turn the adjuster to provide as much cable slack as possible.
4. Remove the clutch inspection cover (**Figure 78**).
5. Check that the clutch cable seats squarely in its perch at the handlebar.
6. At the clutch mechanism, loosen the clutch adjusting screw locknut (A, **Figure 91**) and turn the adjusting screw (B) *clockwise* until it is lightly seated.
7. Squeeze the clutch lever three times to verify the clutch balls are seated in the ramp release mechanism located behind the transmission side cover.
8. Back out the adjusting screw (B, **Figure 91**) *counterclockwise* one-half to one full turn. Then hold the adjusting screw and tighten the locknut (A, **Figure 91**) securely.
9. Once again, squeeze the clutch lever to its maximum limit three times to set the clutch ball and ramp release mechanism.
10. Check the free play as follows:
    a. At the in-line cable adjuster, turn the adjuster away from the locknut until slack is eliminated at the clutch hand lever.
    b. Pull the clutch cable sheath away from the clutch lever. Then turn the clutch cable adjuster to obtain the clearance gap (**Figure 85**) of 1/16-1/8 in. (2-3 mm).
    c. When the adjustment is correct, tighten the clutch in-line cable locknut and slide the rubber boot over the cable adjuster.
11. Install the clutch inspection cover and *new* O-ring. Tighten the screws securely.

Throttle Cables Inspection

Inspect the throttle cables from grip to carburetor or fuel injector module. Make sure they are not kinked or chafed. Replace them if necessary as described in Chapter Seven.

Make sure that the throttle grip rotates smoothly from fully closed to fully open. Check with the handlebar at center, full left and full right positions.

Throttle Cable Adjustment (Cruise Control Models)

Refer to Chapter Fourteen.

Throttle Cables Adjustment (Carbureted Models)

There are two different throttle cables. At the throttle grip, the front cable is the throttle control cable (A, **Figure 92**) and the rear cable is the idle control cable (B). At the carburetor, the outboard cable is the throttle control cable (A, **Figure 93**), and the inboard cable is the idle control cable (B).

1. Remove the air filter and back plate as described in Chapter Eight.
2. At the handlebar, loosen both control cable adjuster locknuts (C, **Figure 92**). Then turn the cable adjusters (A and B, **Figure 92**) *clockwise* as far as possible to increase cable slack.
3. Turn the handlebars so that the front wheel points straight ahead. Then turn the throttle grip to open the throttle completely and hold it in this position.

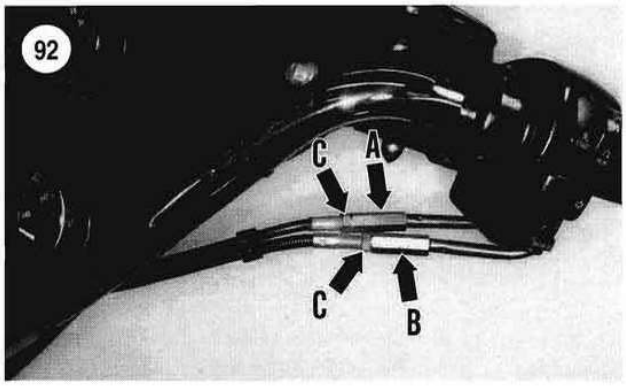
NOTE

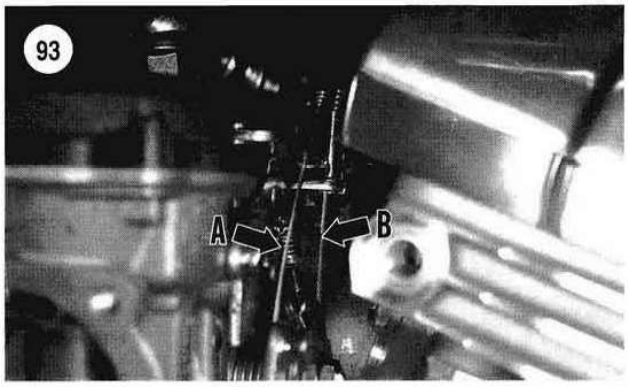
***Figure 94** is shown with the carburetor body removed to better illustrate the steps.*

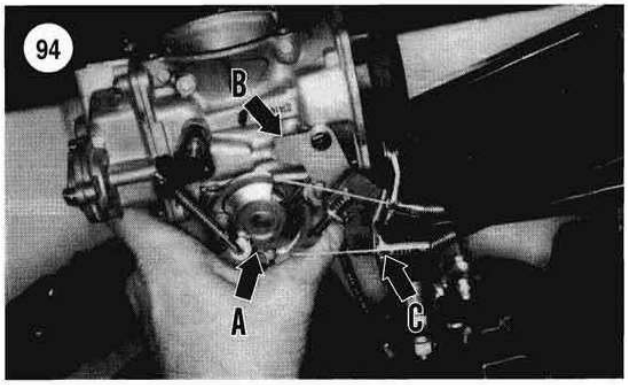
4. At the handlebar, turn the throttle control cable adjuster (A, **Figure 92**) *counterclockwise* until the throttle cam (A, **Figure 94**) stop just touches the stop boss (B) on the carburetor body. Then tighten the throttle cable adjuster locknut and release the throttle grip.
5. Turn the front wheel all the way to the full right lock position and hold it there.
6. At the handlebar, turn the idle cable (B, **Figure 92**) adjuster until the lower end of the idle control cable just contacts the spring in the carburetor cable guide (C, **Figure 94**). Tighten the idle cable locknut.
7. Shift the transmission into neutral and start the engine.
8. Increase engine speed several times. Release the throttle and make sure engine speed returns to idle. If engine speed does not return to idle, at the handlebar, loosen the idle control cable adjuster locknut and turn the cable adjuster *clockwise* as required. Tighten the idle control cable adjuster locknut.
9. Allow the engine to idle in neutral. Then turn the handlebar from side to side. Do not operate the throttle. If the engine speed increases when the handlebar assembly is turned, the throttle cables are routed incorrectly or damaged. Turn off the engine. Recheck cable routing and adjustment.
10. Install the air filter and back plate as described in Chapter Eight.

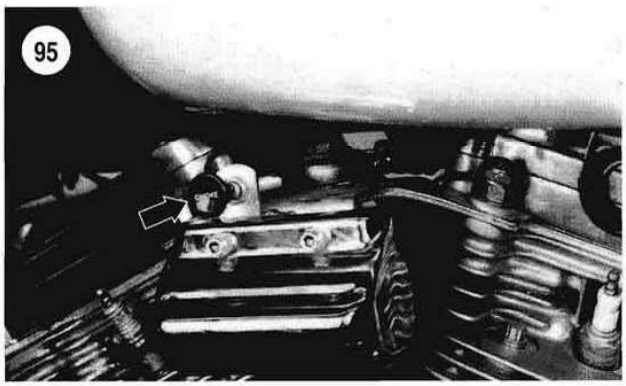
WARNING

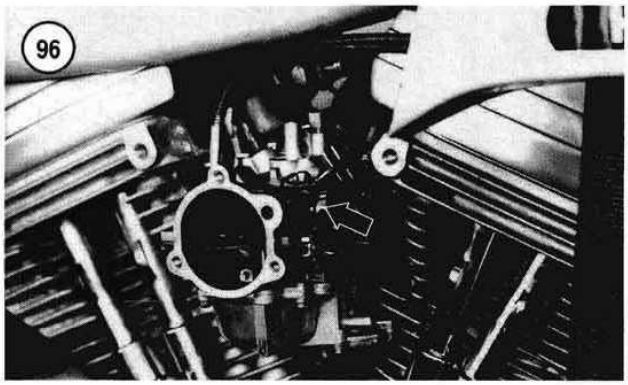
Do not ride the motorcycle until the throttle cables are properly adjusted. Likewise, the cables must not catch or pull when the han-

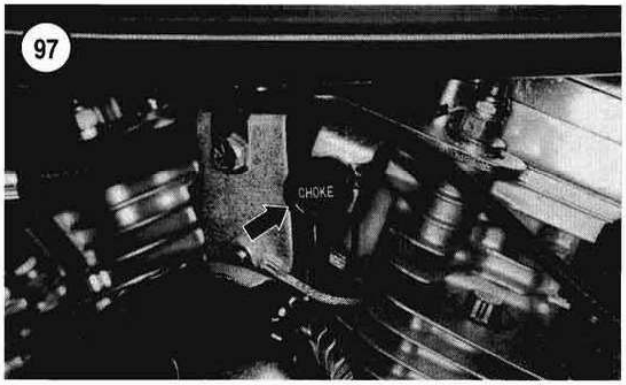


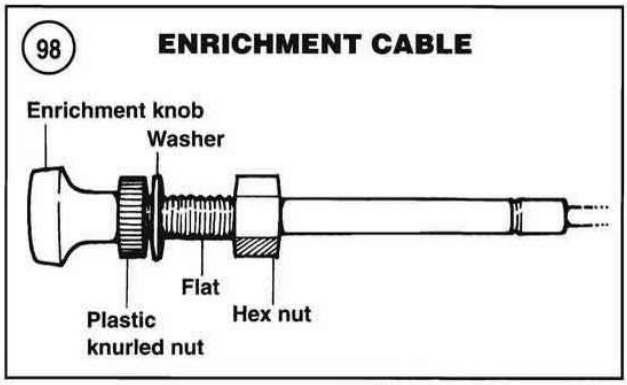












dlebar is turned from side to side. Improper cable routing and adjustment can cause the throttle to stick open. This could cause loss of control and a possible crash. Recheck this adjustment before riding the motorcycle.

Throttle Cables Adjustment (Fuel-Injected Models)

The throttle cable adjustment must be performed by a Harley-Davidson dealership using the Scanalyzer tool.

Choke Cable Adjustment (1984-1989 Carbureted Models)

1. Remove the air filter and back plate as described in Chapter Eight.
2. Operate the choke lever (**Figure 95**) and check for smooth operation of the cable and choke mechanism.
3. Move the lever (**Figure 95**) all the way to the closed position. Then pull the choke arm (**Figure 96**) at the carburetor to make sure it is at the end of its travel. If the choke lever can move an additional amount, it must be adjusted as follows.
4. Loosen the choke cable clamping screw (**Figure 96**) and move the cable sheath up until the choke lever is fully closed. Hold the choke lever in this position and tighten the cable clamping screw.
5. Slide the choke lever all the way to the fully open position.
6. If proper adjustment cannot be achieved using this procedure, the choke cable has stretched and must be replaced.
7. Install the air filter and back plate as described in Chapter Eight.

Starting Enrichment Valve (Choke) Cable Adjustment (1990-on Carbureted Models)

The starting enrichment (choke) knob (**Figure 97**) must move from fully open to fully closed without any sign of binding. The knob must also stay in its fully closed or fully open position without creeping. If the knob does not stay in position, adjust tension on the cable by turning the knurled plastic nut behind the knob (**Figure 98**) as follows:

CAUTION

The starting enrichment (choke) cable must have sufficient cable resistance to work properly. Do not lubricate the enricher cable or its conduit.

1. Loosen the hex nut behind the mounting bracket. Then move the cable to free it from its mounting bracket slot.
2. Hold the cable across its flats with a wrench and turn the knurled plastic nut *counterclockwise* to reduce cable resistance. The knob must slide inward freely.
3. Turn the knurled plastic nut (**Figure 98**) *clockwise* to increase cable resistance. Continue adjustment until the knob remains stationary when pulled all the way out. The knob must move without any roughness or binding.
4. Reinstall the cable into the slot in its mounting bracket with the star washer located between the bracket and hex nut. Tighten the hex nut securely.

5. Recheck the knob movement and readjust if necessary.

Fuel Line Inspection

Inspect the fuel lines from the fuel tank to the carburetor or fuel injection module. Replace leaking or damaged fuel lines. Make sure the hose clamps are in place and holding securely. Check the hose fittings for looseness.

WARNING

A damaged or deteriorated fuel line can cause a fire or explosion if fuel spills onto a hot engine or exhaust pipe.

Fuel Shutoff Valve/Filter

Refer to Chapter Eight for complete details on removal, cleaning and installation of the fuel shutoff valve.

Exhaust System

Check all fittings for exhaust leaks. Do not forget the crossover pipe connections. Tighten all bolts and nuts; replace any gaskets as necessary. Removal and installation procedures are described in Chapter Eight.

Valve Lifter Screen Cleaning

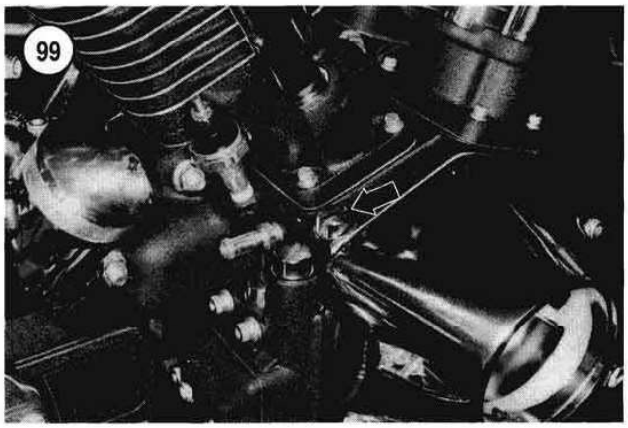
Clean the valve lifter oil screen at each oil change. The valve lifter screen (**Figure 99**) is located in the right crankcase above the oil pump.

1. Remove the lifter screen plug and O-ring (**Figure 99**) from the crankcase.
2. Remove the oil screen and spring (**Figure 100**).
3. Clean the screen and spring in solvent and dry with compressed air.
4. Replace the screen if damaged.
5. If removed, install the spring over the oil screen (**Figure 101**).
6. Install the oil screen (**Figure 100**) into the crankcase with the open end facing down.
7. Install the lifter screen plug and O-ring (**Figure 99**) and tighten to 89-124 in.-lb. (10-14 N•m).

Wheel Bearings

Table 1 lists the recommended wheel bearing cleaning and repacking intervals.

Refer to Chapter Ten for complete service procedures.



Steering Play

Table 1 lists the recommended steering head inspection for looseness and adjustment intervals.

Refer to Chapter Eleven for the adjustment procedures.

Front Suspension Check

Periodically check the front fork mounting bolts for tightness. Refer to Chapter Eleven for torque specifications.

Rear Suspension Check

Periodically check the rear shock absorber and rear suspension swing arm pivot shaft bolts for tightness. Lubricate the rear swing arm bearing at the interval in **Table 1**. Refer to Chapter Twelve for torque specifications and procedures.

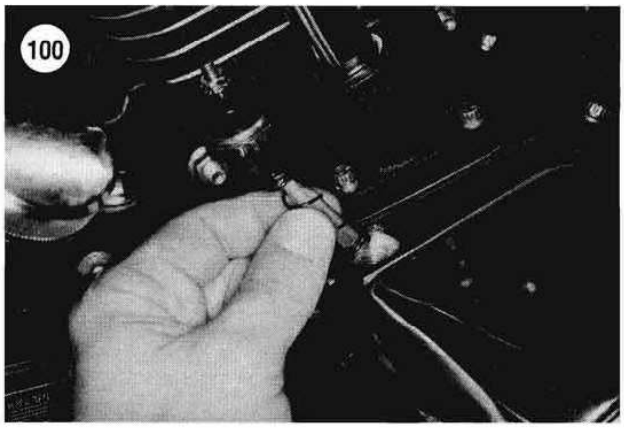
Rear Shock Absorber Check

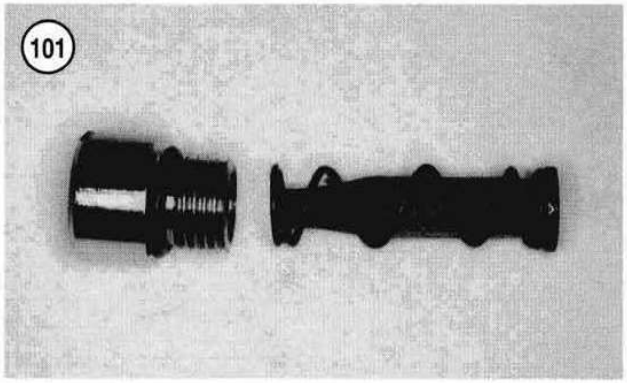
Table 1 lists the recommended rear shock absorber inspection intervals.

1. Check the rear shock absorbers for fluid leaks. If a shock is leaking, it must be replaced.
2. Grasp the shock absorber and twist it from side to side while checking for excessive bushing movement. If the bushings are worn, replace the bushings and/or the shock absorber(s).

Air Shock Adjustment

Refer to Chapter Twelve for air shock adjustment procedures.





Fasteners

Vibration can loosen many fasteners on a motorcycle. Check the tightness of all fasteners, especially those on:

1. Engine mounting hardware.
2. Engine and primary covers.
3. Handlebar and front fork.
4. Gearshift lever.
5. Sprocket bolts and nuts.
6. Brake pedal and lever.
7. Exhaust system.
8. Lighting equipment.

Electrical Equipment and Switches

Check all of the electrical equipment and switches for proper operation. Refer to Chapter Nine.

Rear Brake Caliper Pins and Boots

Table 1 lists the recommended lubrication intervals for the caliper pins.

Check the brake caliper boots for tearing or other damage. The caliper pins should be removed and lubricated. Refer to Chapter Thirteen for service procedures.

TUNE-UP

Perform the following tune-up procedures at the intervals in **Table 1**. Perform a complete tune-up in the following order:

1. Clean or replace the air filter element.
2. Check engine compression.
3. Check or replace the spark plugs.
4. Check the ignition timing.
5. On carbureted models, adjust idle speed.

Air Filter Element Removal/Installation

Remove and clean the air filter at the interval in **Table 1**. Replace the element at the interval in **Table 1** or whenever it is damaged or starts to deteriorate.

The air filter removes dust and abrasive particles before the air enters the carburetor or fuel injection module and the engine. Without the air filter, very fine particles could enter the engine and cause rapid wear of the piston rings, cylinder bores and bearings. They also might clog small passages in the carburetor. Never run the motorcycle without the element installed.

Refer to **Figures 102-107** (carbureted models) or **Figure 108** (fuel-injected models).

1. Remove the air filter cover screw(s) and washer(s) (A, **Figure 109**, typical) and remove the cover (B).

2A. On 1984-1992 models, remove the air filter element (**Figure 110**, typical).

2B. On 1993-1998 domestic carbureted models, gently pull the air filter element away from the back plate and disconnect the two breather hoses (**Figure 111**) from the breather hollow bolts on the back plate. Remove the air filter element.

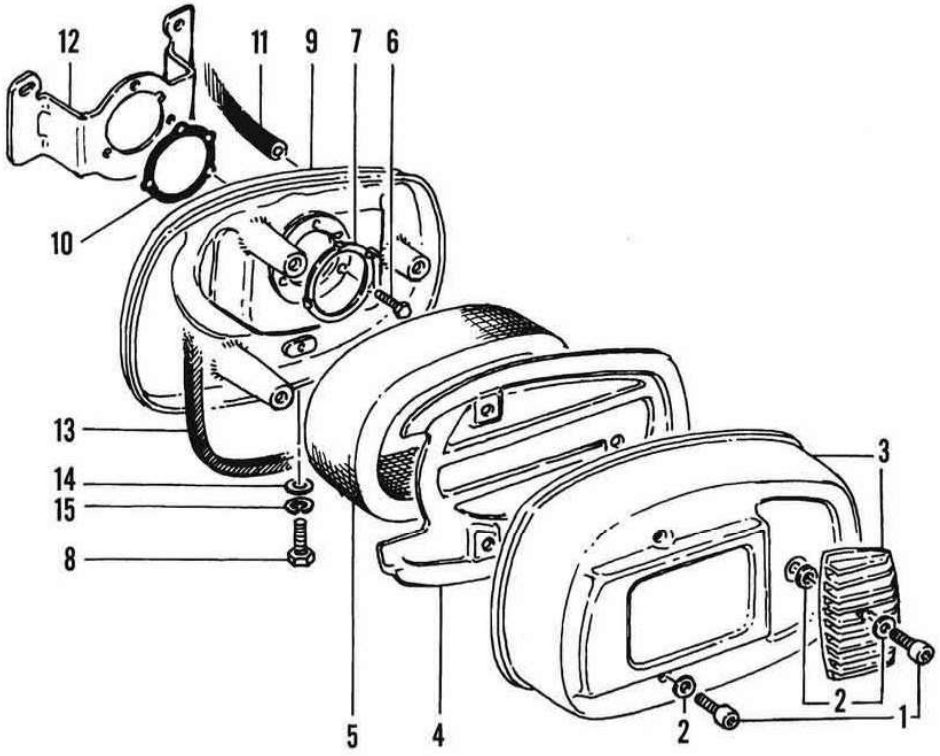
2C. On 1993-1998 international carbureted models, remove the four screws and washers securing the air filter element to the back plate. Remove the air filter element.

2D. On 1995-1998 fuel-injected models, remove the screws securing the air filter element to the back plate. Remove the air filter element.

3. Clean the air filter as described in the following procedure. If the element cannot be cleaned satisfactorily, replace it.
4. Inspect the gasket for damage. Replace if necessary.
5. On models so equipped, inspect the breather hoses (**Figure 112**) for tears or deterioration. Replace if necessary.

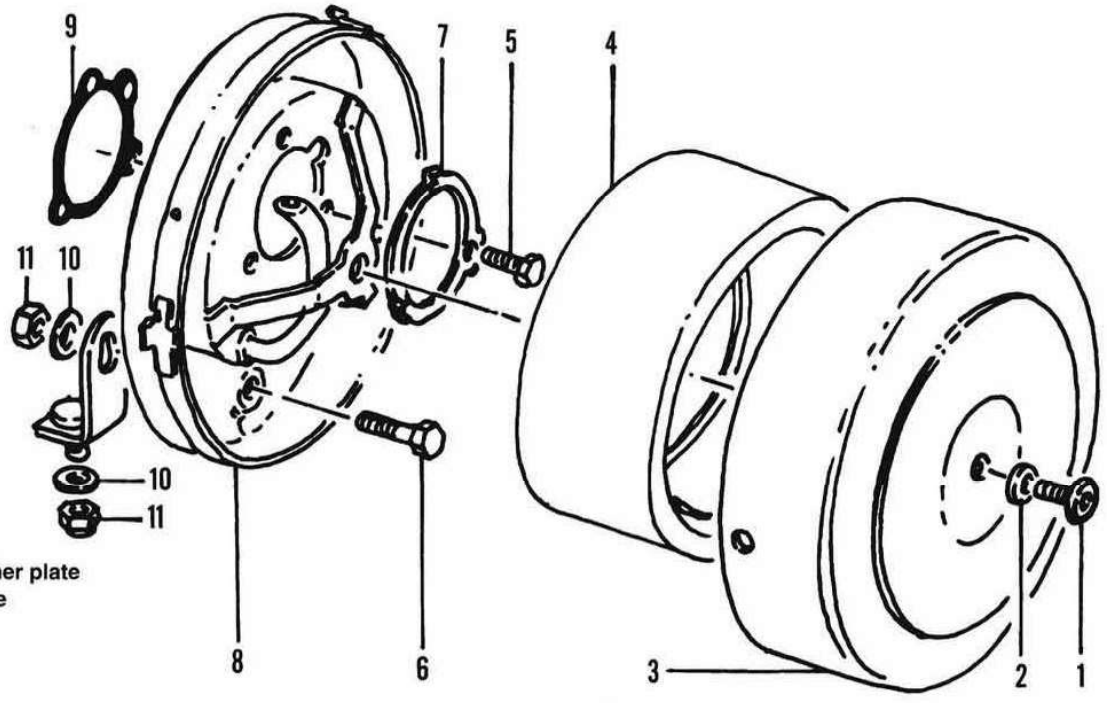
(102) **AIR FILTER (1984-1985 FLH AND FLT SERIES MODELS)**

1. Screw
2. Rubber washer
3. Cover
4. Baffle plate
5. Air filter
6. Bolt
7. Lockwasher plate
8. Bolt
9. Back plate
10. Gasket
11. Hose
12. Bracket
13. Seal strip
14. Washer
15. Lockwasher



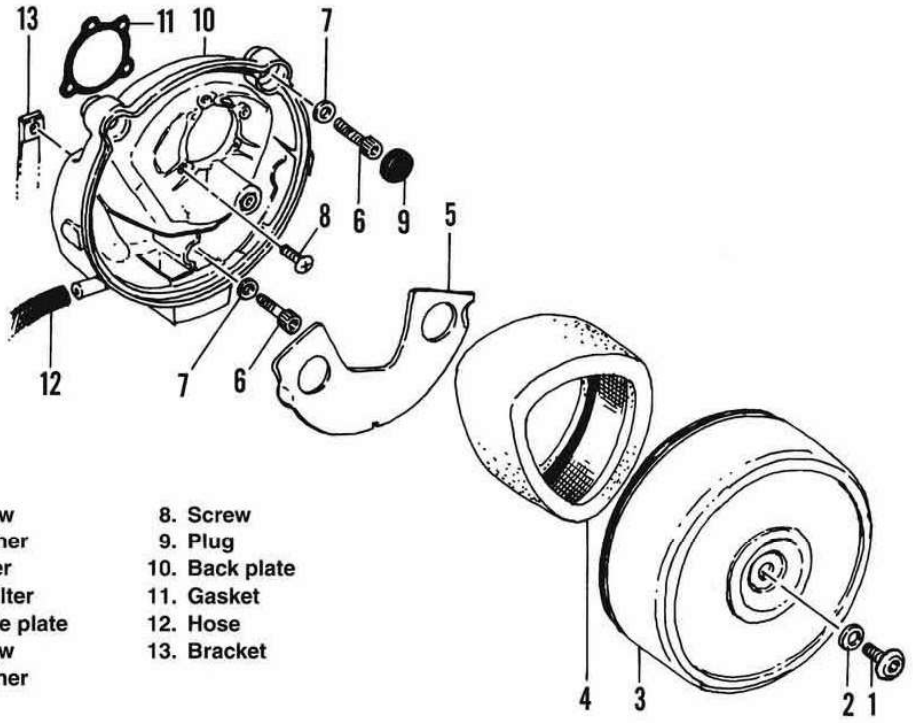
(103) **AIR FILTER (1984-1985 FX SERIES, FXWG, FXSB AND FXEF MODELS)**

1. Screw
2. Washer
3. Cover
4. Air filter
5. Screw
6. Screw
7. Lockwasher plate
8. Back plate
9. Gasket
10. Washer
11. Nut



104

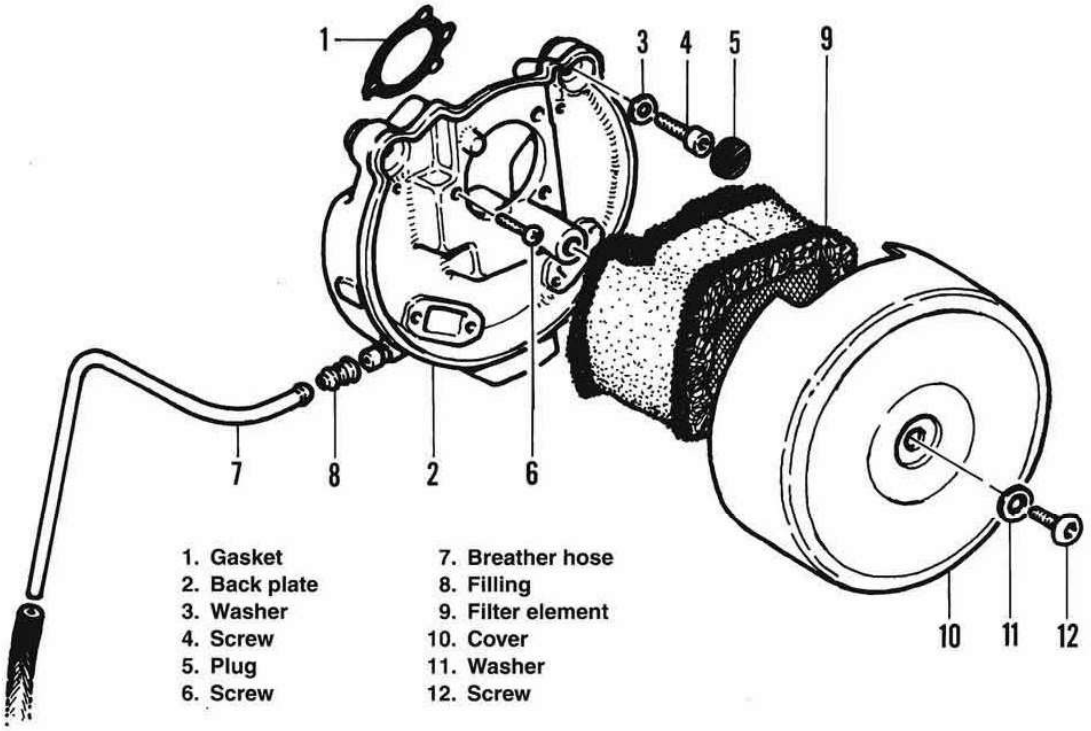
AIR FILTER (1986-1989 MODELS)



1. Screw
2. Washer
3. Cover
4. Air filter
5. Baffle plate
6. Screw
7. Washer
8. Screw
9. Plug
10. Back plate
11. Gasket
12. Hose
13. Bracket

105

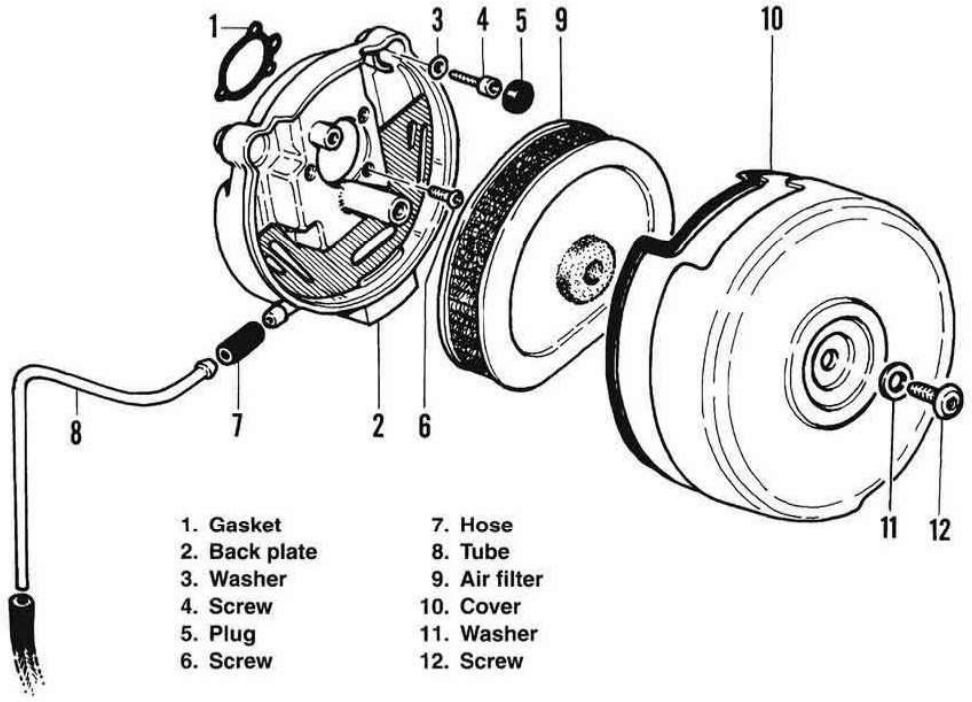
AIR FILTER (1990 MODELS)



1. Gasket
2. Back plate
3. Washer
4. Screw
5. Plug
6. Screw
7. Breather hose
8. Filling
9. Filter element
10. Cover
11. Washer
12. Screw

(106)

AIR FILTER (1991-1992 MODELS)

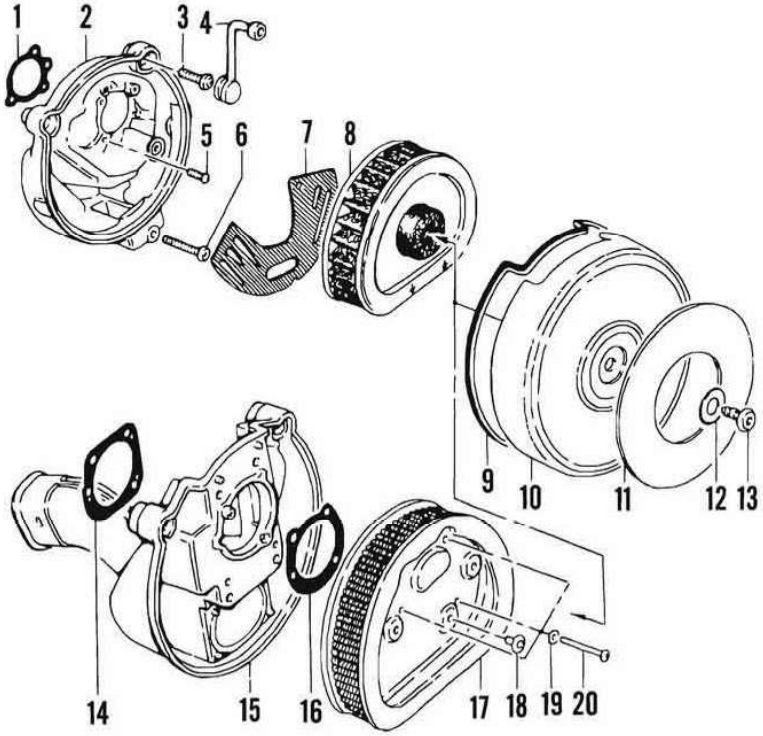


1. Gasket
2. Back plate
3. Washer
4. Screw
5. Plug
6. Screw
7. Hose
8. Tube
9. Air filter
10. Cover
11. Washer
12. Screw

(107)

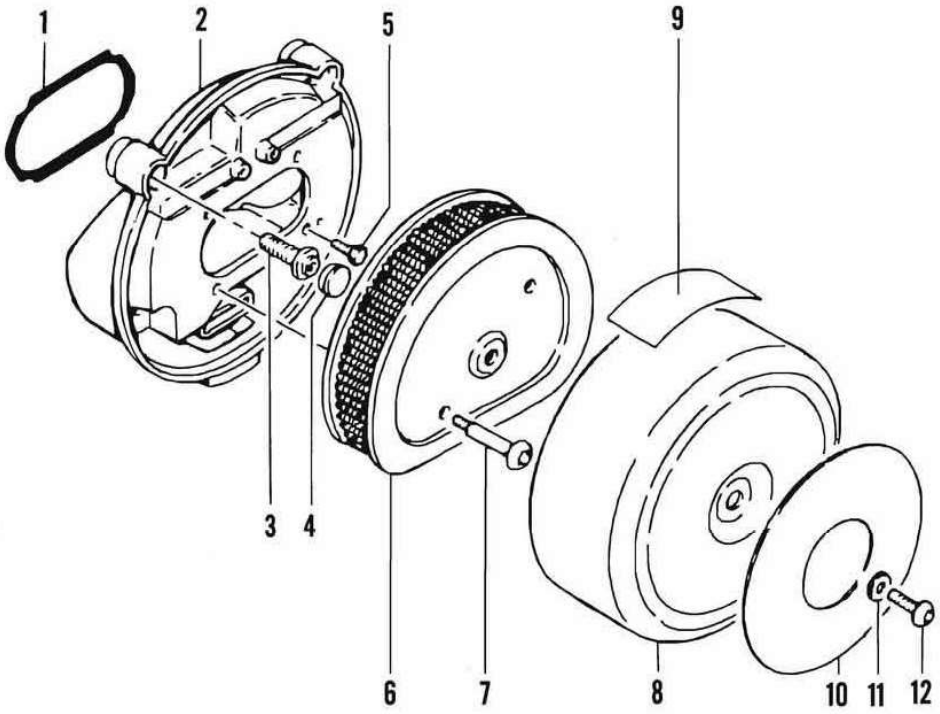
AIR FILTER (1993-1998 CARBURETED MODELS)

1. Gasket
2. Back plate
3. Breather screw
4. Breather connector
5. Screw
6. Screw
7. Baffle plate (California)
8. Air filter
9. Gasket
10. Cover
11. Trim
12. Washer
13. Screw
14. Gasket
15. Back plate (International)
16. Gasket
17. Air filter (International)
18. Plug (International)
19. Washer (International)
20. Screw (International)

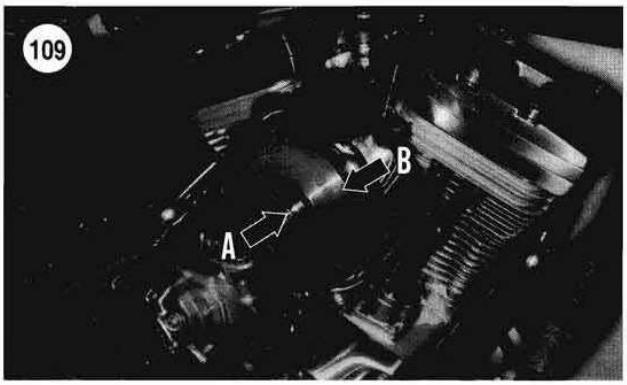


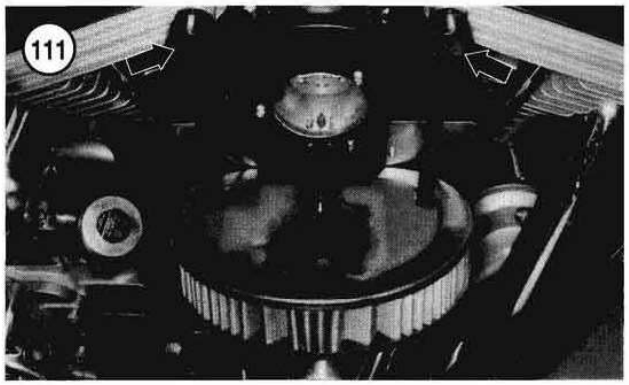
108

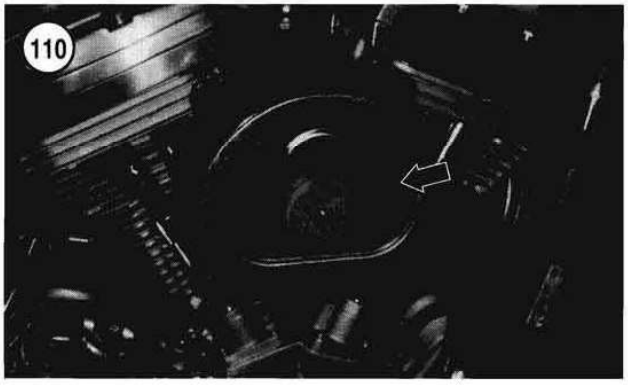
AIR FILTER (1995-1998 FUEL-INJECTED MODELS)



1. Gasket
2. Back plate
3. Breather screw
4. Plug
5. Screw
6. Air filter
7. Shoulder screw
8. Cover
9. Label
10. Trim
11. Washer
12. Screw







6. If removed, install a new gasket and breather hoses (**Figure 112**) (models so equipped) to backside of the element.

7. Position the element with the flat side and arrows (**Figure 113**) facing down.

NOTE

If an aftermarket air filter element is being installed, position it onto the back plate following the manufacturer's instructions.

8A. On 1984-1992 models, install the air filter element (**Figure 110**, typical).

8B. On 1993-1998 domestic carbureted models, move the air filter element into position on the back plate and connect the two breather hoses (**Figure 111**) to the breather hollow bolts on the back plate.

8C. On 1993-1998 international carbureted models, install the air filter element into position and install the four screws and washers. Tighten the screws securely.

8D. On 1995-1998 fuel-injected models, install the air filter element into position and install the screws. Tighten the screws securely.

9. Inspect the seal ring on the air filter cover for hardness or deterioration. Replace if necessary.

10. Install the air filter cover (B, **Figure 109**, typical), washer(s) and the screw(s). Tighten the screw securely.

Air Filter Element Cleaning and Re-Oiling (1984-1990 Models)

Service the air filter element in a well-ventilated area, away from all sparks and flames

1. Remove the air filter element as described in this section.
2. Remove the wire mesh from inside the filter element.

WARNING

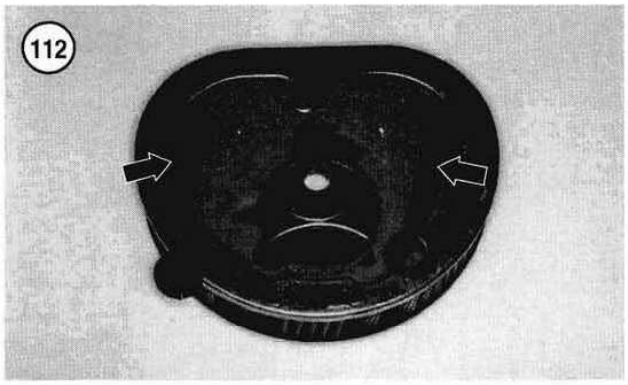
Do not clean the filter element in gasoline.

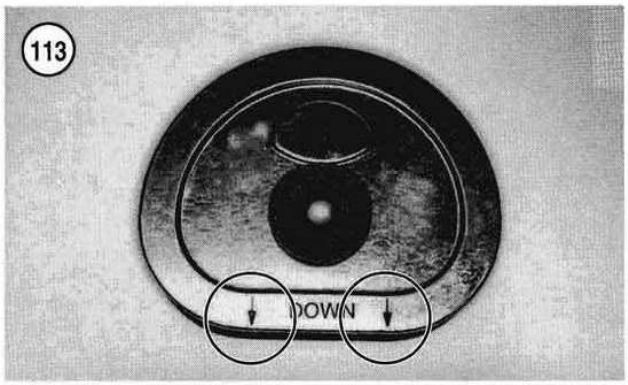
3. Clean the filter element with a filter solvent to remove oil and dirt.
4. Inspect the filter element. Replace if it is torn or broken in any area.
5. Fill a clean pan with liquid detergent and warm water.
6. Submerge the filter element in the cleaning solution and gently work the solution into the filter pores. Soak and gently squeeze the filter element to clean it.

CAUTION

Do not wring or twist the filter element when cleaning it. This could damage a filter pore or tear the filter loose at a seam. This would allow unfiltered air to enter the engine and cause severe and rapid wear.

7. Rinse the filter element under warm water while soaking and gently squeezing it.
8. Repeat Step 6 and Step 7 two or three times or until there are no signs of dirt being rinsed from the filter.
9. After cleaning the element, inspect it again carefully. If it is torn or broken in any area, replace it. Do not run the engine with a damaged filter element.
10. Set the filter aside and allow it to dry thoroughly.

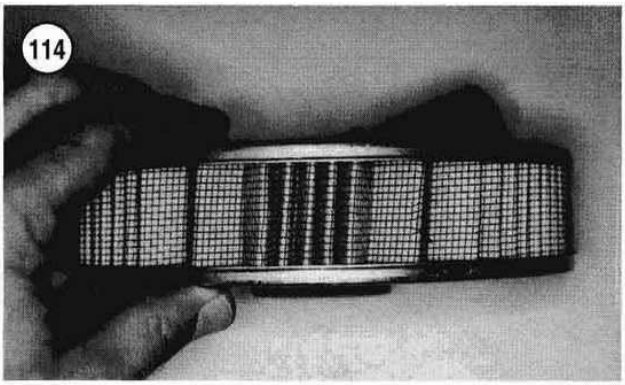


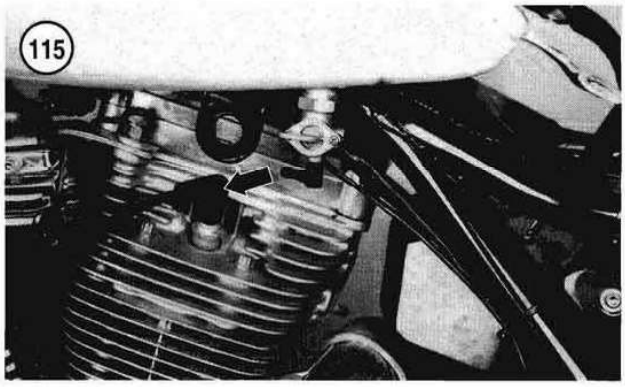


CAUTION

Make sure the filter element is completely dry before oiling it.

11. Properly oiling the filter element is a messy but important job. Wear a pair of disposable rubber gloves when performing this procedure. Oil the filter as follows:
    a. Purchase a box of gallon size storage bags. The bags can be used when cleaning the filter as well as for storing engine and carburetor parts during disassembly.
    b. Place the filter element into a storage bag.
    c. Pour foam filter oil or clean engine oil onto the filter to soak it.
    d. Gently squeeze and release the filter element to soak oil into the filter pores. Repeat until all of the filter pores are saturated with oil.
    e. Remove the filter element from the bag and check the pores for uneven oiling. Uneven oiling is shown by light or dark areas on the filter element. If necessary, soak the filter element and squeeze it again.
    f. When the filter oiling is even, squeeze the filter element a final time to remove excess oil.
    g. Pour the leftover filter oil from the bag back into the bottle for reuse.





h. Dispose of the plastic storage bag.

12. Install the air filter element as described in this section.

Air Filter Element Cleaning (1991-1998 Models)

1. Remove the air filter element as described in this section.
2. Replace the filter element if damaged.

WARNING

Do not clean the filter element in gasoline.

CAUTION

Do not tap or strike the air filter element on a hard surface to dislodge dirt. Doing so will damage the element.

3. Place the air filter in a pan filled with lukewarm water and mild detergent. Move the filter element back and forth to help dislodge trapped dirt. Thoroughly rinse it in clean water to remove all detergent residue.
4. Hold the air filter up to a strong light. Check the filter pores for dirt and oil. Repeat Step 3 until there is no dirt or oil in the filter pores. If the air filter cannot be cleaned, or if the filter is saturated with oil or other chemicals, replace it.

CAUTION

Do not use high air pressure to dry the filter because this will damage it. Maximum air pressure is 32 psi (221 kPa).

CAUTION

In the next step, do not blow compressed air through the outer surface of the filter element. Doing so can force dirt trapped on the outer filter surface deeper into the filter element and restrict airflow and damage the filter element.

5. Gently apply compressed air through the inside surface of the filter element to remove loosened dirt and dust trapped in the filter.
6. Inspect the air filter element (**Figure 114**). Replace it if it is torn or damaged. Do not ride the motorcycle with a damaged air filter element because it will allow dirt to enter the engine.
7. Clean the breather hoses in the same lukewarm water and mild detergent. Make sure both hoses are clean and clear. Clean them out with a pipe cleaner if necessary.
8. Wipe the inside of the cover and back plate with a clean damp shop rag.

CAUTION

Air will not pass through a wet or damp filter element. Make sure the filter element is dry before installing it.

9. Allow the filter element to dry completely. Then reinstall it as described in this section.

Compression Test

A compression test is one of the most effective ways to check the condition of the engine. If possible, check the compression at each tune-up and record and compare it with the readings at subsequent tune-ups. This will help spot any developing problems.

1. Prior to starting the compression test, check for the following:
   a. The cylinder head bolts are tightened as specified in Chapter Four.
   b. The battery is fully charged to ensure proper engine cranking speed.
2. Warm the engine to normal operating temperature. Shut off the engine.
3. Remove both spark plugs (**Figure 115**) and reinstall them in their caps. Place the spark plugs against the cylinder heads to ground them.
4. Connect the compression tester to one cylinder following the manufacturer's instructions (**Figure 116**).

5. Place the throttle in the wide-open position.
6. On carbureted models, make sure the starting enrichment (choke) knob is off.
7. Crank the engine over until there is no further rise in pressure.
8. Record the reading and remove the tester.
9. Repeat Steps 4-8 for the other cylinder.
10. Reinstall the spark plugs and reconnect their caps.

Results

When interpreting the results, note the difference between the readings and compare the readings to the specification. **Table 8** lists the standard engine compression specification. Pressure must not vary between the cylinders by more than 10 percent. Greater differences indicate worn or broken rings, leaky or sticky valves, a blown head gasket or a combination of all.

If compression readings do not differ between cylinders by more than 10 percent, the rings and valves are in good condition. A low reading (10 percent or more) on one cylinder indicates valve or ring trouble. To decide which, pour about a teaspoon of engine oil into the spark plug hole. Turn the engine over once to distribute the oil. Then take another compression test and record the reading. If the compression increases significantly, the valves are good, but the rings are defective on that cylinder. If compression does not increase, the valves require servicing.

NOTE

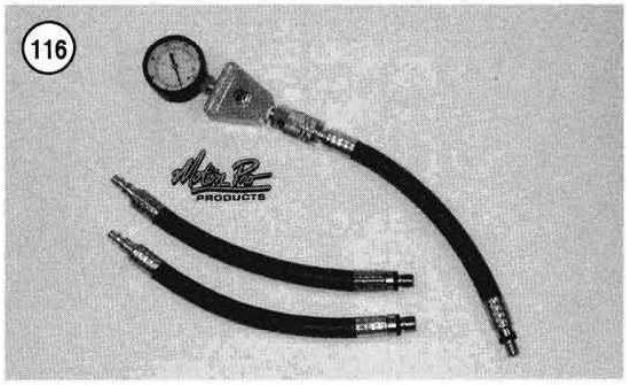
An engine cannot be tuned to maximum performance with low compression.

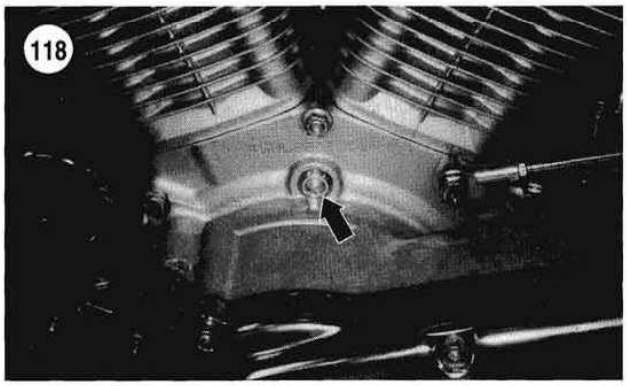
Cylinder Leakdown Test

A cylinder leakdown test can determine engine problems from leaking valves; blown head gaskets; or broken, worn or stuck piston rings. A cylinder leakage test is performed by applying compressed air to the cylinder and then measuring the percent of leakage. A cylinder leakdown tester (**Figure 117**) and an air compressor are required to perform this test.

Follow the manufacturer's directions and the following information when performing a cylinder leakdown test.

1. Start and run the engine until it reaches normal operating temperature.
2. Remove the air filter assembly. Then set the throttle and choke valves in their wide-open position.
3. Remove the ignition timing inspection plug from the crankcase (**Figure 118**).



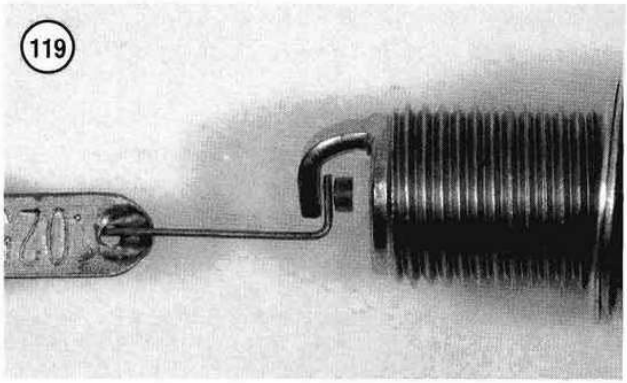


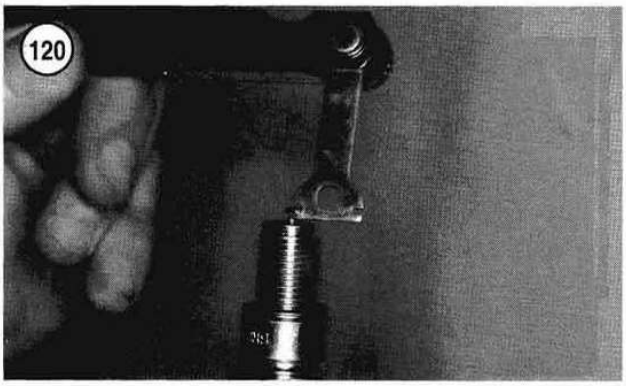
4. Set the piston for the cylinder being tested to TDC on its compression stroke. Reinstall the timing plug.
5. Remove both spark plugs (**Figure 115**).

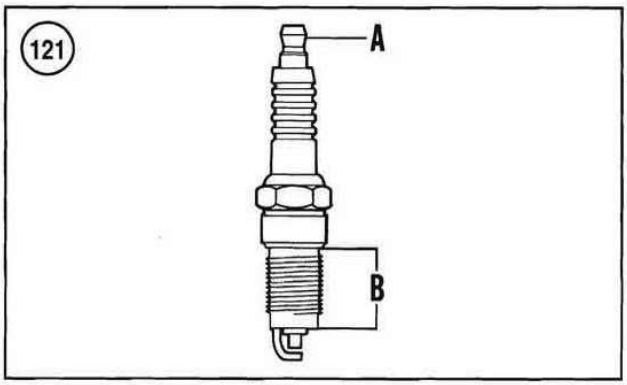
NOTE

The engine might turn over when air pressure is applied to the cylinder. To prevent this from happening, shift the transmission into fifth gear and lock the rear brake pedal so that the rear brake is applied.

6. Listen for leaking air while noting the following:







a. Air leaking through the exhaust pipe indicates a leaking exhaust valve.

b. Air leaking through the carburetor or fuel induction module indicates a leaking intake valve.

NOTE

Air leaking through the valves can also be caused by pushrods that are too long.

c. Air leaking through the ignition timing inspection hole indicates worn or broken piston rings, a leaking cylinder head gasket or a worn piston.

7. Repeat for the other cylinder.

Spark Plug Removal

CAUTION

Whenever the spark plug is removed, dirt around it can fall into the plug hole. This can cause serious engine damage.

1. Blow away loose dirt or debris that might have accumulated around the base of the spark plug and could fall into the cylinder head.
2. Grasp the spark plug lead (**Figure 115**) and twist it from side to side to break the seal. Then pull the cap off the spark plug. If the cap is stuck to the plug, twist it slightly to break it loose.

NOTE

Use a special spark plug socket equipped with a rubber insert that holds the spark plug. This type of socket is necessary for both removal and installation because the spark plugs are recessed in the cylinder head.

3. Install the spark plug socket onto the spark plug. Make sure it is correctly seated. Install an open-end wrench or socket handle and remove the spark plug. Mark the spark plug with the cylinder number from which it was removed.
4. Repeat Steps 1-3 for the remaining spark plug.
5. Thoroughly inspect each plug. Look for broken center porcelain, excessively eroded electrodes and excessive carbon or oil fouling.
6. Inspect the spark plug caps and secondary wires for damage or hardness. If any portion is damaged, replace the cap and secondary wire as an assembly. The front and rear cylinder assemblies have different part numbers.

Spark Plug Gapping and Installation

Carefully gap the spark plugs to ensure a reliable, consistent spark. Use a special spark plug gapping tool and a wire feeler gauge.

1. Insert a wire feeler gauge between the center and side electrode of the plug (**Figure 119**). The correct gap is in **Table 8**. If the gap is correct, a slight drag will be felt as the wire gauge is pulled through. If there is no drag, or if the gauge will not pass through, bend the side electrode with a gapping tool (**Figure 120**) to adjust to the proper gap in **Table 8**.
2. Install the terminal nut (A, **Figure 121**).

3. Apply a *light* coat of antiseize lubricant to the threads of the spark plug before installing it. Do *not* use engine oil on the plug threads.

CAUTION

The cylinder head is aluminum, and the spark plug hole is easily damaged if the spark plug is cross-threaded.

4. Slowly screw the spark plug into the cylinder head by hand until it seats. Very little effort is required. If force is necessary, the plug is cross-threaded; unscrew it and try again.

CAUTION

Do not overtighten. This will only distort the gasket and destroy its sealing ability.

5. Hand-tighten the plug until it seats against the cylinder head. Then tighten it to 14 ft.-lb. (19 N•m).
6. Install the spark plug cap and lead to the correct spark plug. Rotate the cap slightly in both directions and make sure it is attached to the spark plug.
7. Repeat for the other spark plug.

Spark Plug Heat Range

Spark plugs are available in various heat ranges that are hotter or colder than the plugs originally installed by the manufacturer.

Select a plug with a heat range designed for the loads and conditions under which the motorcycle will be operated. A plug with an incorrect heat range can foul, overheat and cause piston damage.

In general, use a hot plug for low speeds and low temperatures. Use a cold plug for high speeds, high engine loads and high temperatures. The plug should operate hot enough to burn off unwanted deposits but not so hot that it is damaged or causes preignition. To determine if plug heat range is correct, remove each spark plug and examine the insulator.

Do not change the spark plug heat range to compensate for adverse engine or air/fuel conditions.

When replacing plugs, make sure the reach or thread length (B, **Figure 121**) is correct. A longer than standard plug could interfere with the piston and cause engine damage.

Refer to **Table 8** for recommended spark plugs.

Spark Plug Reading

Reading the spark plugs can provide information regarding engine performance. Reading plugs that have been in use indicates spark plug operation, air/fuel mixture composition and engine conditions (such as oil consumption or piston ring wear). Before checking the spark plugs, operate the motorcycle under a medium load for approximately 6 miles (10 km). Avoid prolonged idling before shutting off the engine. Remove the spark plugs as described in this section. Examine each plug and compare it to those in **Figure 122**. Refer to the following sections to determine the operating conditions.

If the plugs are being inspected to determine if carburetor jetting is correct, start with new plugs and operate the motorcycle at the load that corresponds to the jetting information desired. For example, on carbureted models, if the main jet is in question, operate the motorcycle at full throttle, shut the engine off and coast to a stop.

Normal condition

If the plug has a light tan or gray deposit and no abnormal gap wear or erosion, the engine, air/fuel mixture and ignition conditions are good. The plug in use is of the proper heat range and may be serviced and returned to use.

Carbon-fouled

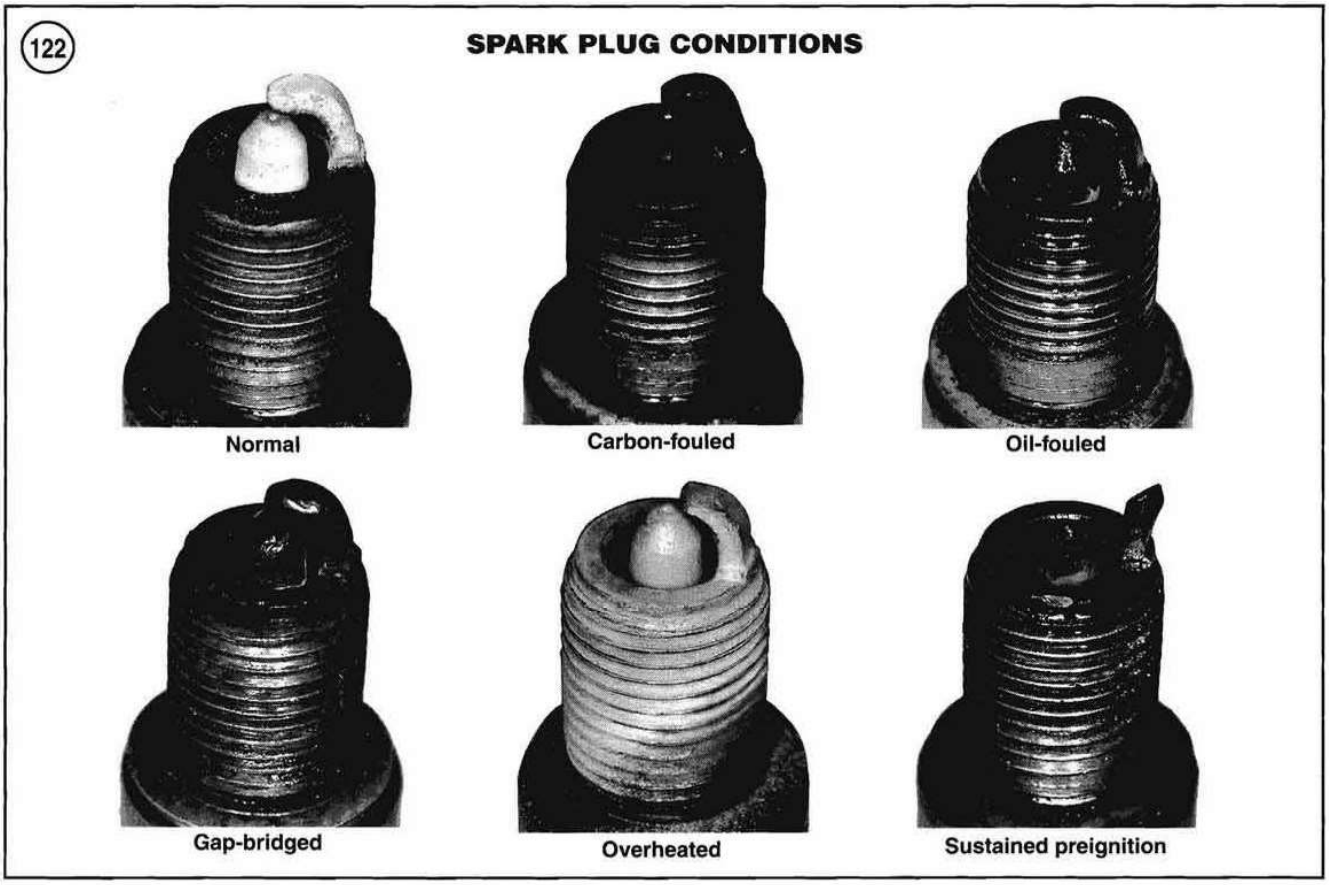
Soft, dry, sooty deposits covering the entire firing end of the plug are evidence of incomplete combustion. Even though the firing end of the plug is dry, the plug insulation decreases when in this condition. An electrical path is formed that bypasses the electrodes and causes a misfire condition. Carbon fouling can be caused by one or more of the following:

1. Rich fuel mixture.
2. Cold spark plug heat range.
3. Clogged air filter.
4. Improperly operating ignition component.
5. Ignition component failure.
6. Low engine compression.
7. Prolonged idling.

Oil-fouled

The tip of an oil-fouled plug has a black insulator tip, a damp oily film over the firing end and a carbon layer over the entire nose. The electrodes are not worn. Oil-fouled spark plugs may be cleaned in an emergency, but it is better to replace them. Correct the cause of fouling before returning the engine to service. Common causes for this condition are as follows:

1. Incorrect air/fuel mixture.
2. Low idle speed or prolonged idling.



3. Ignition component failure.
4. Cold spark plug heat range.
5. Engine still being broken in.
6. Valve guides worn.
7. Piston rings worn or broken.

Gap bridging

Plugs with gap bridging have gaps shorted out by combustion deposits between the electrodes. If this condition is encountered, check for excessive carbon or oil in the combustion chamber. Be sure to locate and correct the cause of this condition.

Overheating

Badly worn electrodes, premature gap wear and a gray or white blistered porcelain insulator surface are signs of overheating. The most common cause is a spark plug of the wrong heat range (too hot). If the spark plug is the correct heat range and is overheated, consider the following causes:

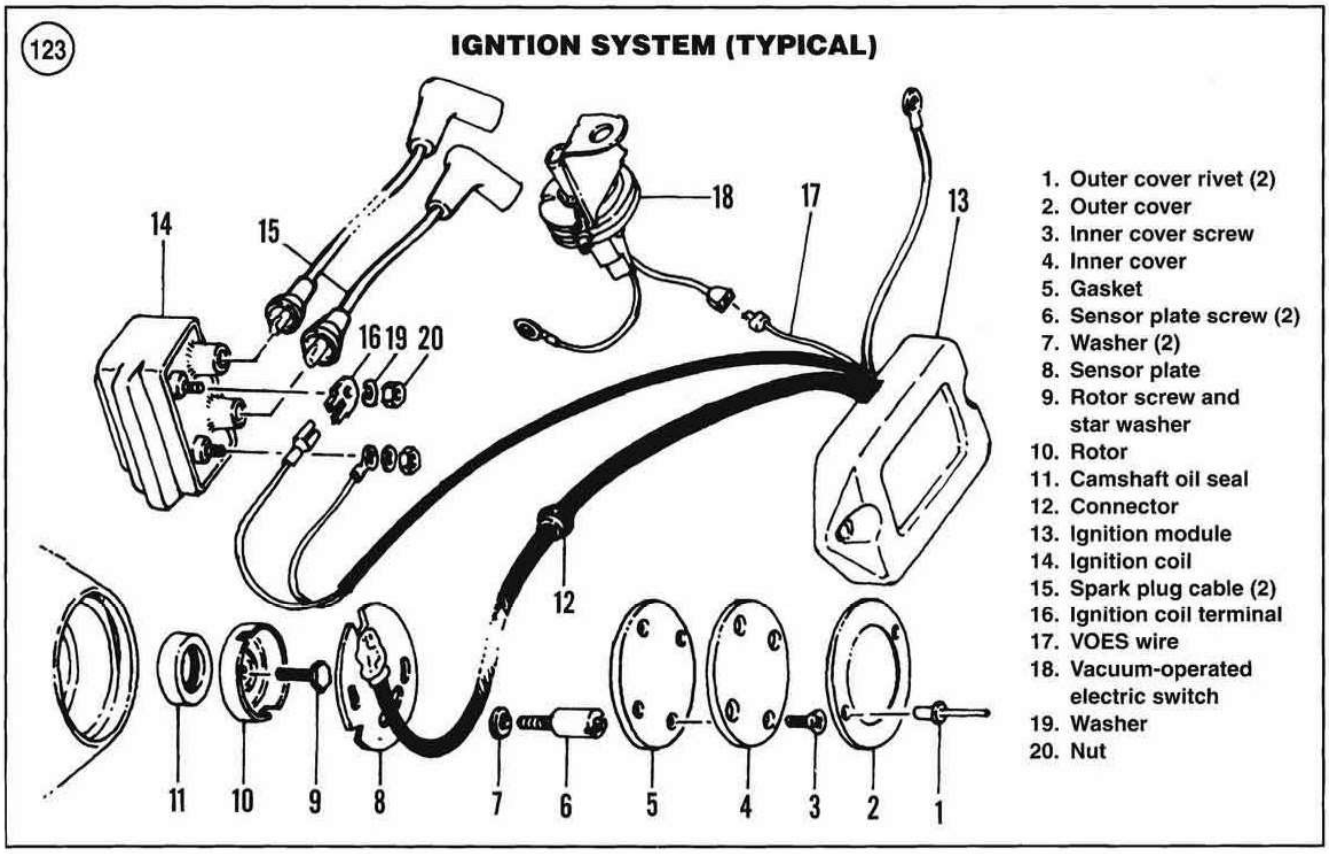
1. Lean air/fuel mixture.
2. Improperly operating ignition component.
3. Engine lubrication system malfunction.
4. Cooling system malfunction.
5. Engine air leak.
6. Improper spark plug installation (overtightened).
7. No spark plug gasket.

Worn out

Corrosive gases formed by combustion and high-voltage sparks have eroded the electrodes. A spark plug in this condition requires more voltage to fire under hard acceleration. Replace it with a new spark plug.

Preignition

If the electrodes are melted, preignition is almost certainly the cause. Check for intake air leaks at the manifold and carburetor, or throttle body, and advanced ignition timing. It is also possible that the plug is the wrong heat range (too hot). Find the cause of the preignition before returning the engine to service. For additional information on preignition, refer to *Preignition* in Chapter Two.



IGNITION SERVICE

Ignition Timing Inspection and Adjustment (Carbureted Models)

Refer to **Figure 123**.

1. Park the motorcycle on a level surface on the jiffy stand.

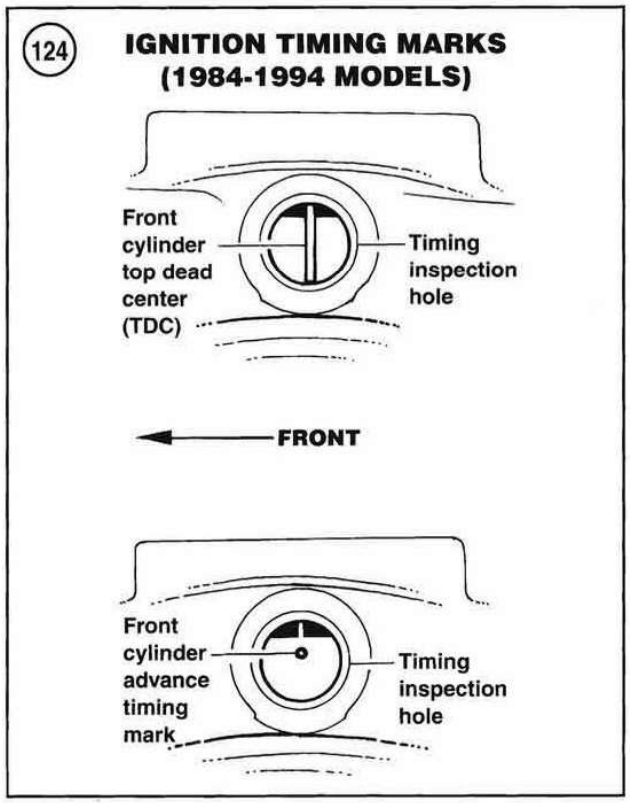
2. Remove the plug from the timing hole on the left side of the engine (**Figure 118**). A clear plastic viewing plug is available from Harley-Davidson dealers to minimize oil spray. Make sure the plug does not contact the crankshaft flywheel.

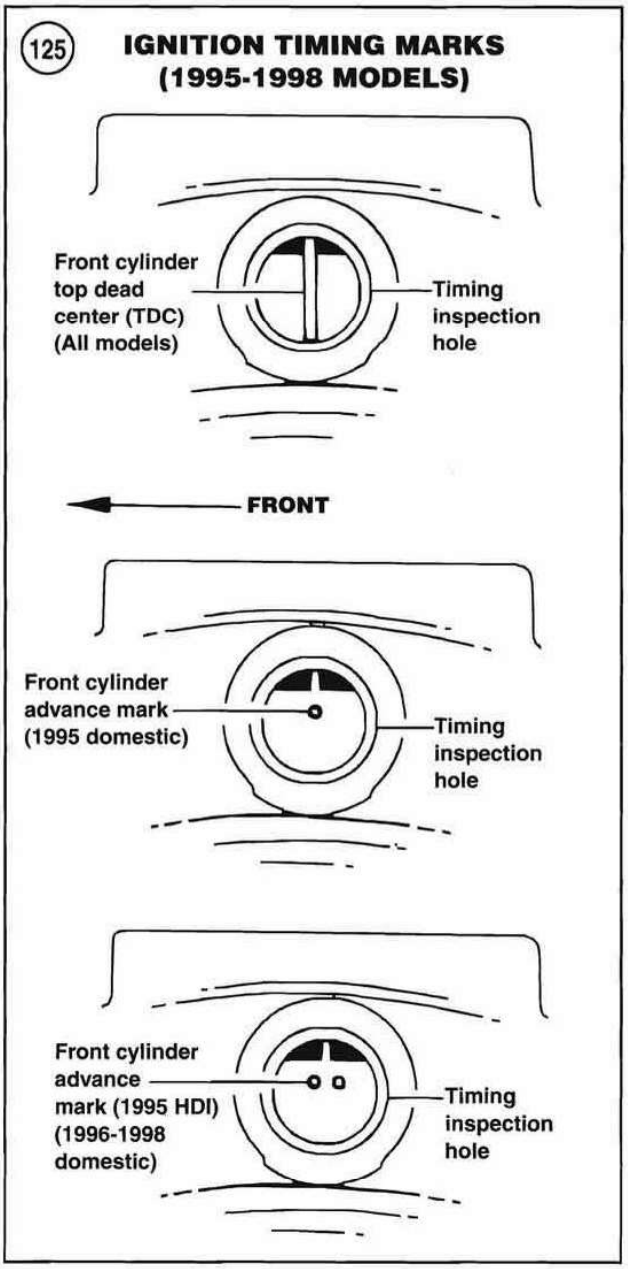
3. Connect a portable tachometer following the manufacturer's instructions. The motorcycle tachometer (models so equipped) is not accurate enough in the low rpm range for this adjustment.

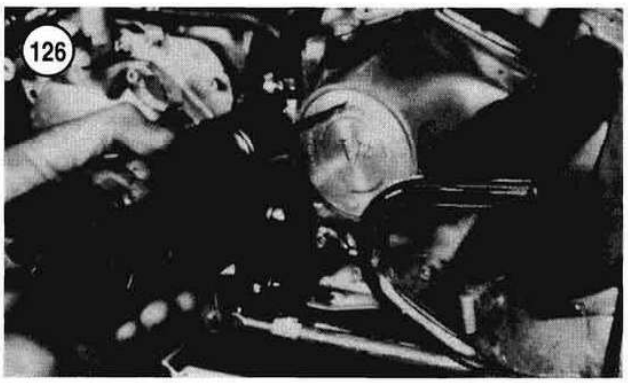
4. Connect an inductive clamp-on timing light to the front cylinder spark plug wire following the manufacturer's instructions.

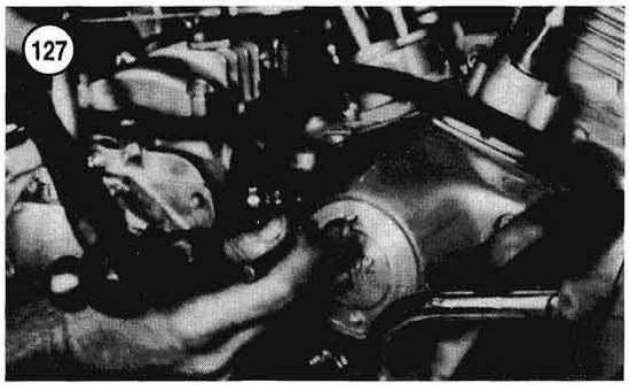
NOTE

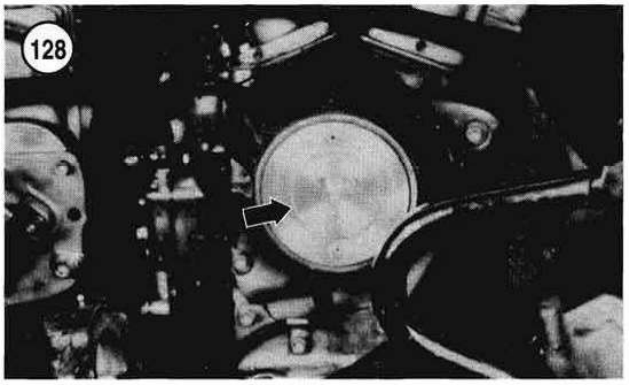
Make sure the vacuum hose is connected to the carburetor and the vacuum-operated











electric switch (VOES) when checking ignition timing.

5. Start the engine and allow to idle at the engine speed listed in **Table 9**. If necessary, adjust idle as described in this chapter.
6. Aim the timing light at the timing inspection hole. At the specified idle rpm, the front cylinder advance mark should appear in the center of the inspection window. Refer to **Figure 124** for 1983-1994 models or **Figure 125** for 1995-1998 models for ignition timing mark(s). If the mark(s) does not align, stop the engine and adjust the ignition timing, starting with Step 8.
7. If the ignition timing is incorrect, reinstall the timing hole plug (**Figure 118**) and proceed to Step 8.
8. Drill out the outer cover pop rivets (**Figure 126**) with a 3/8-in. (9.5 mm) drill bit.
9. Using a punch, lightly tap the rivets out of the outer cover (**Figure 127**).
10. Remove the outer cover (**Figure 128**).
11. If necessary, lightly tap the rivets out of the inner cover (**Figure 129**).
12. Remove the inner cover screws and remove the inner cover (**Figure 130**).
13. Remove the gasket (**Figure 131**).

14. Remove any remaining rivet bits from the ignition housing.
15. Loosen the timing plate sensor plate screws (**Figure 132**) just enough to allow the plate to rotate. Start the engine and turn the plate as required so that the advanced mark is aligned as described in Step 6. Make sure idle speed specified in Step 6 is maintained when checking timing. Tighten the screws and recheck ignition timing.
16. Install the gasket and inner cover.

NOTE

*When installing pop rivets to secure the outer cover, make sure to use the headless type shown in **Figure 133**. The end of a normal pop rivet will break off on installation and damage the timing mechanism.*

17. Install the outer cover and secure with the new rivets (**Figure 134**).
18. As part of the tune-up, check the vacuum-operated electric switch (VOES) as follows:
    a. Start the engine and allow to idle.
    b. Disconnect the vacuum line at the carburetor.

NOTE

*The carburetor VOES port is identified in **Figure 135** (1984-1989 models) and **Figure 136** (1990-on models).*

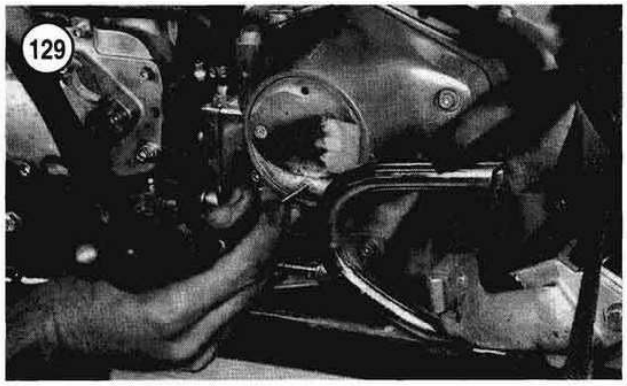
NOTE

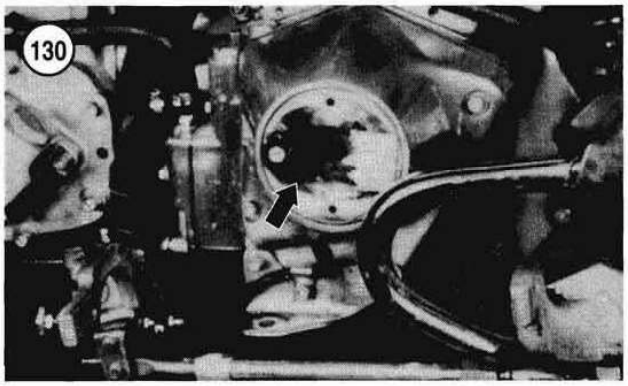
***Figure 135** and **Figure 136** are shown with the carburetor removed to better illustrate the step.*

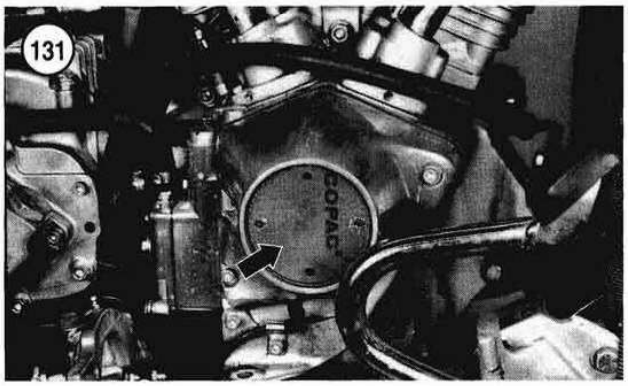
    c. Plug the carburetor VOES port with a finger. With the port blocked, the engine speed should decrease, and the ignition timing should retard. When the vacuum hose is reconnected to the VOES port, the engine speed should increase and the ignition timing should advance.
    d. If the engine failed to operate as described in substep c, check the VOES wire connection (**Figure 123**) at the ignition module. Also check the VOES ground wire for looseness or damage. If the wire connections are good, have the VOES tested by a Harley-Davidson dealership.

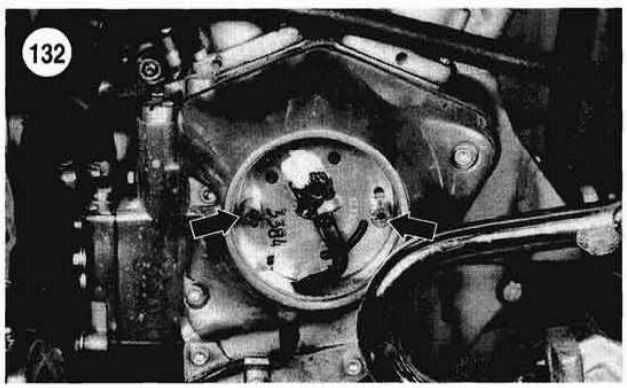
CAUTION

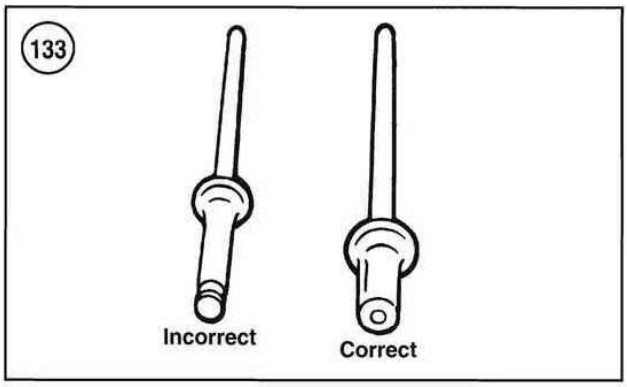
The vacuum-operated electric switch (VOES) must be tested at each tune-up and replaced if malfunctioning. A damaged VOES switch will allow too high a spark advance and will cause severe engine knock and damage.

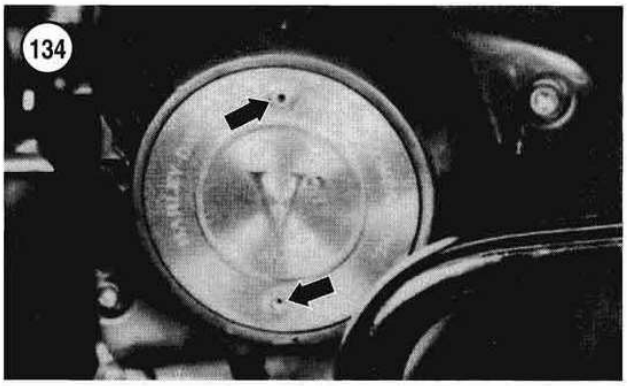


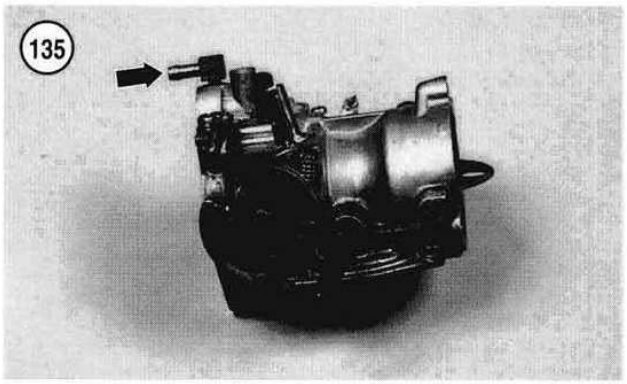


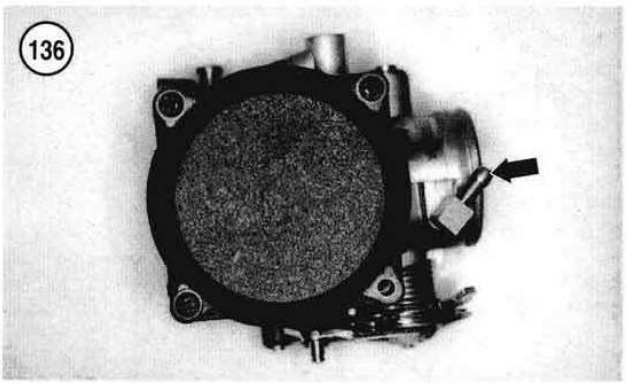


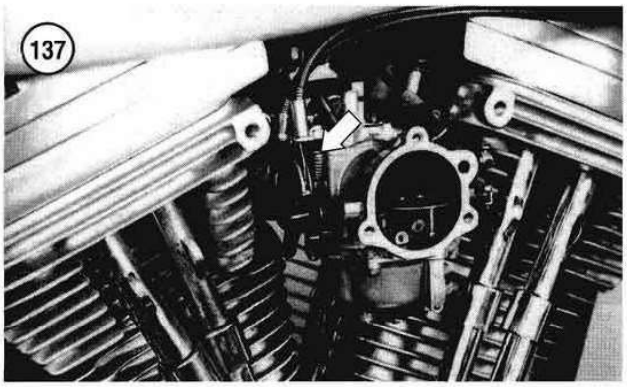












Ignition Timing Inspection (Fuel-Injected Models)

The fuel-injected models are equipped with a fully transistorized ignition system and are controlled by the electronic control module. Harley-Davidson does not provide any ignition timing procedures for these models If an ignition related problem is suspected, inspect the ignition components as described in Chapter Nine.

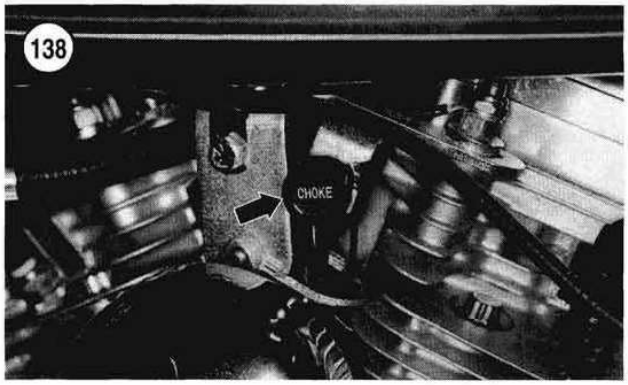
CARBURETOR ADJUSTMENTS

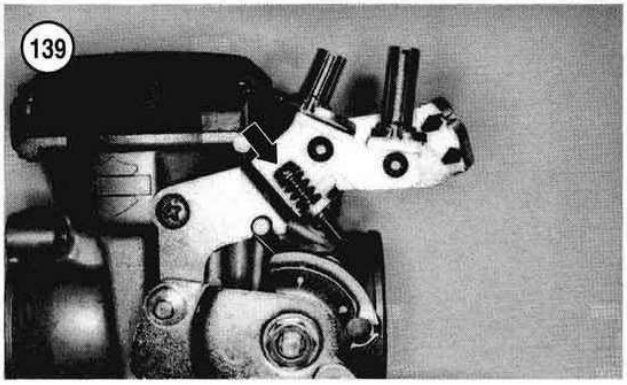
Slow and Fast Idle Adjustment (1984-1989 Models)

1. Park the motorcycle on a level surface and support it standing straight up.
2. Attach a tachometer to the engine following the manufacturer's instructions.
3. Start the engine and warm it to normal operating temperature. When the engine can run without the enrichment (choke) being applied, proceed to Step 3.

NOTE
***Figure 137** is shown with the air filter assembly removed to better illustrate the step.*

4. With the engine at idle speed, compare the engine rpm reading to the idle speed specification listed in **Table 9**. If the slow idle speed is incorrect, turn the throttle stop screw (**Figure 137**) to achieve the correct slow idle speed.
5. The idle mixture is set and sealed and cannot be adjusted.
6. Rev the engine a couple of times and release the throttle. Engine rpm should return to the idle speed set in Step 3. Readjust if necessary.
7. Pull the choke knob (**Figure 138**) out to its first detent and compare the tachometer reading to the fast idle speed specification listed in **Table 9**. If the fast idle speed is incorrect, turn the fast idle screw to achieve the correct fast idle speed.





Then push the choke knob all the way in and check that the idle drops to the slow idle speed (**Table 9**). If the choke does not operate correctly, adjust it as described in this chapter.

8. Disconnect the tachometer.

Idle Speed Adjustment (1990-1998 Models)

1. Park the motorcycle on a level surface and support it standing straight up.
2. Attach a tachometer to the engine following the manufacturer's instructions.
3. Start the engine and warm it to normal operating temperature. When the engine can run without the enrichment (choke) being applied, proceed to Step 3. Make sure the enrichment valve is pushed all the way in to the closed position.

NOTE

***Figure 139** is shown with the carburetor removed to better illustrate the step.*

4. With the engine at idle speed, compare the engine rpm reading to the idle speed specification listed in **Table 9**. If the slow idle speed is incorrect, turn the throttle stop screw (**Figure 139**) to achieve the correct slow idle speed.
5. The idle mixture is set and sealed and cannot be adjusted.
6. Rev the engine a couple of times and release the throttle. Engine rpm should return to the idle speed set in Step 3. Readjust if necessary.
7. Disconnect and remove the tachometer.

Table 1 MAINTENANCE SCHEDULE[1]

Pre-ride check	
	Check tire condition and inflation pressure
	Check wheel rim condition
	Check light and horn operation
	Check engine oil level; add oil if necessary
	Check brake fluid level and condition; add fluid if necessary
	Check the operation of the front and rear brake lever and pedal
	Check throttle operation
	Check enricher (choke) cable operation (carbureted models)
	Check clutch lever operation
	Check drive chain condition (models so equipped)
	Check drive belt condition (models so equipped)
	Check fuel level in fuel tank; top off if necessary
	Check fuel system for leaks
Initial 500 miles (800 km)	
	Change engine oil and filter
	Check tappet oil screen
	Check battery condition; clean cable connections if necessary
	Check brake fluid level and condition; add fluid if necessary
	Check front and rear brake pads and discs for wear

(continued)

Table 1 MAINTENANCE SCHEDULE[1] (continued)

Initial 500 miles (800 km) (continued)	
	Check tire condition and inflation pressure
	Check primary chain deflection; adjust if necessary
	Change primary chaincase lubricant
	Change transmission lubricant
	Check clutch lever operation; adjust if necessary
	Check drive chain tension; adjust if necessary (models so equipped)
	Check drive belt tension and alignment; adjust if necessary (models so equipped)
	Check drive belt and sprockets condition (models so equipped)
	Inspect spark plugs
	Check vacuum-operated electric switch (VOES)
	Inspect air filter element
	Lubricate front brake and clutch lever pivot pin
	Lubricate brake cable if necessary
	Lubricate clutch cable if necessary
	Check throttle cable operation
	Check enricher (choke) cable operation (carbureted models)
	Check engine idle speed; adjust if necessary
	Check fuel system for leaks
	Check electrical switches and equipment for proper operation
	Check cruise control throttle disengagement switch operation (models so equipped)
	Check oil and brake lines for leakage
	Check engine mounting hardware for tightness
	Check all fasteners for tightness[2]
	Lubricate swing arm pivot shaft and bearings (FX series models)
	Road test the motorcycle
Every 2500 miles (4000 km)	
	Check transmission lubricant level; add lubricant if necessary
	Check drive belt tension and alignment; adjust if necessary
	Inspect air filter element
	Check throttle operation
	Check enricher (choke) cable operation (carbureted models)
	Check fuel system for leaks
	Check oil and brake lines for leakage
	Check electrical switches and equipment for proper operation
	Road test the motorcycle
Every 5000 miles (8000 km)	
	Change engine oil and filter
	Check tappet oil screen
	Change primary chaincase lubricant
	Change transmission lubricant
	Check battery condition; clean cable connections if necessary
	Check brake fluid level and condition; add fluid if necessary
	Check front and rear brake pads and discs for wear
	Check tire condition and inflation pressure
	Check wire wheel spoke nipple tightness; adjust if necessary (models so equipped)
	Check primary chain deflection; adjust if necessary
	Check drive belt tension and alignment; adjust if necessary (models so equipped)
	Check drive chain tension; adjust if necessary (models so equipped)
	Check clutch lever operation; adjust if necessary
	Check drive belt and sprockets condition (models so equipped)
	Check drive and driven sprockets condition (models so equipped)
	Check steering head bearing adjustment; adjust if necessary
	Inspect spark plugs
	Inspect ignition timing
	Check vacuum-operated electric switch (VOES)

(continued)

Table 1 MAINTENANCE SCHEDULE[1] (continued)

Every 5000 miles (8000 km) (continued)	Inspect and oil the air filter element (1984-1991)
	Inspect air filter element (1992-1998)
	Lubricate front brake and clutch lever pivot pin
	Lubricate clutch cable if necessary
	Lubricate speedometer cable
	Lubricate fitting on rear brake linkage (models so equipped)
	Check throttle cable operation
	Check enricher (choke) cable operation (carbureted models)
	Check engine idle speed; adjust if necessary
	Check fuel system for leaks
	Check electrical switches and equipment for proper operation
	Check oil and brake lines for leakage
	Check air suspension components and hoses (models so equipped)
	Check rubber engine mounts (models so equipped)
	Check all fasteners for tightness[2]
	Lubricate swing arm pivot shaft and bearings (FX series models)
	Lubricate non-nylon lined control cables
	Perform a tune-up
	Lubricate throttle grip
	Check solenoid-operated butterfly valve for proper operation
	Road test the motorcycle
Every 10,000 miles (16,000 km)	
	Replace spark plugs
	Perform a compression test
	Change front fork oil
	Lubricate rear swing arm bearings
	Inspect engine mounts for wear or damage; replace if necessary
	Check stabilizer links
	Lubricate brake caliper pins
	Clean and repack wheel bearings
	Road test the motorcycle
Every 20,000 miles (32,000 km)	
	Lubricate steering head bearings
	Inspect fuel tank filter; replace if necessary
	Inspect fuel supply valve filter screen

1. Consider this maintenance schedule a guide to general maintenance and lubrication intervals. Harder than normal use and exposure to mud, water, high humidity indicate more frequent servicing to most of the maintenance items.
2. Except cylinder head bolts. Cylinder head bolts must be tightened following the procedure listed in Chapter Four. Improper tightening of the cylinder head bolts can cause cylinder gasket damage and/or cylinder head leakage.

Table 2 TIRE INFLATION PRESSURE (FXR, FLH AND FLT [COLD])[1]

Item	psi	kPa
Front (rider only)		
1984-1985		
FXRS (K291T[2])	30	207
FXRT (K291T[2])	30	207
FLT/FLTC	–	–
FLHT/FLHTC (K101A[2])	28	193
1986-1998		
FXR series models	30	207
FLH and FLT series models	36	248
Front (rider with one passenger)		
1984-1985		
FXRS	30	207
FXRT	30	207
FLT/FLTC and FLHT/FLHTC	28	193

(continued)

Table 2 TIRE INFLATION PRESSURE (FXR, FLH AND FLT [COLD])[1] (continued)

Item	psi	kPa
Front (rider with one passenger)		
1984-1985 (continued)		
FLT with sidecar	28	193
1986-1998		
FXR series models	30	207
FLH and FLT series models	36	248
Rear (rider only)		
1984-1985		
FXRS (K291T[2])	36	248
FXRT (K291T[2])	36	248
FLT/FLTC	–	–
FLHT/FLHTC (K101A[2])	36	248
1986-1998		
FXR series	36	248
FLH and FLT series models	36	248
Rear (rider with one passenger)		
1984-1985		
FXRS	40	275
FXRT	40	275
FLT/FLTC and FLHT/FLHTC	36	248
FLT with sidecar	40	275
1986-1998		
FXR series models	40	275
FLH and FLT series models	40	275

1. Tire inflation pressure is for OE tires. Aftermarket tires might require different inflation pressure. The use of tires other than those specified by Harley-Davidson can cause instability.
2. Indicates the OE Dunlop tire designation.

Table 3 TIRE INFLATION PRESSURE (FXWG, FXSB AND FXEF [COLD])[1]

Item	psi	kPa
Front (rider only)		
FXWG	30	207
FXEF and FXSB		
K181[2]	30	207
K291T[2]	36	248
Front (rider with one passenger)		
FXWG		
F rib	30	207
K101A	–	–
FXEF and FXSB		
K181[2]	30	207
K291T[2]	36	248
Rear (rider only)		
FXWG	32	221
FXEF and FXSB		
K181[2]	32	221
K291T[2]	36	248
Rear (rider with one passenger)		
FXWG		
F rib	32	221
K101A	28	193
FXEF and FXSB		
K181[2]	32	221

1. Tire inflation pressure is for OE tires. Aftermarket tires might require different inflation pressure. The use of tires other than those specified by Harley-Davidson can cause instability.
2. Indicates the OE Dunlop tire designation.

Table 4 ENGINE OIL

Type	HD rating	Viscosity	Ambient operating temperature
HD Multigrade	HD360	SAE 10W/40	Below 40°F (4° C)
HD Multigrade	HD360	SAE 20W/50	Above 40°F (4° C)
HD Regular heavy	HD360	SAE 50	Above 60°F (16° C)
HD Extra heavy	HD360	SAE 60	Above 80°F (27° C)

Table 5 RECOMMENDED LUBRICANTS AND FLUIDS

Brake fluid	DOT 5 silicone
Fork oil	HD Type E or an equivalent
Battery	Purified or distilled water
Transmission	HD Transmission Lubricant or an equivalent
Clutch	HD Transmission Lubricant or an equivalent
Drive chain	
Enclosed drive chain	SAE 50 or SAE 60
Open drive chain (without O-rings)	Commercial drive chain lubricant
Open drive chain (with O-rings)	Commercial drive chain lubricant recommended for O-ring chains

Table 6 ENGINE AND PRIMARY DRIVE/TRANSMISSION OIL CAPACITIES

Engine oil tank	
FXR series models	3.0 qts. (2.8 L)
FLT/FLH series models	4.0 qts. (3.8 L)
FXWG, FXSB and FXEF	4.0 qts. (3.8 L)
Transmission	
1984-1990	16 oz. (473 mL)
1991-1998	20-24 oz. (591-710 mL)
Primary chaincase	
Early 1984	N.A.
Late 1984-1990	1.5 qt. (1.4 L)
1991-1996	38-44 oz. (1.1-1.3 L)
1997-1998	32 oz. (946 mL)
Rear chaincase (1984-1985)	6 oz. (177 mL)

Table 7 FRONT FORK OIL CAPACITY

Model and year	Oil Change oz.	Oil Change cc	Rebuild oz.	Rebuild cc
FXR				
1984-1987 FXR and FXRS	6.25	184.8	7.0	206.9
1984-1987 FXRD and FXRT	7.0	206.9	7.75	229.2
1987-1994 FXLR	9.2	272	10.2	300.9
1988-1994 FXR and FXRS	9.2	272	10.2	300.9
1988-1994 FXRT and FXRS-SP and FXRS-Con	10.5	310.5	11.5	339.2
1999 FXR2 and FXR3	9.2	272	10.2	300.9
FXWG	10.2	300.9	11.2	330.4
FXSB	7.5	221.8	6.75	199.6
FXEF	5.0	147.8	6.5	192.2
FLT and FLH series models	7.75	229.2	8.5	251.3

Table 8 TUNE-UP SPECIFICATIONS

Engine compression	90 psi (620 kPa)
Spark plugs	
Type	HD 5R6A
Gap	0.038-0.043 in. (0.97-1.09 mm)
Ignition timing	
Type	Electronic
Timing specifications	
Early 1984	
Range	5-50° BTDC
Start	5° BTDC
Fast idle at 1800-2800 rpm	35° BTDC
Late 1984-1994	
Range	0-35° BTDC
Start	0° BTDC
Fast idle at 1800-2800 rpm	35° BTDC
1995 domestic	
Range	0-35° BTDC
Start	TDC
Fast idle at 1050-1500 rpm	35° BTDC
1995 HDI	
Range	0-42.5° BTDC
Start	TDC
Fast idle at 1050-1500 rpm	20° BTDC
1996-1998	
Range	0-42.5° BTDC
Start	TDC
Fast idle at 1050-1500 rpm	20° BTDC

Table 9 IDLE SPEED SPECIFICATIONS

Model and year	Speed
FXR, FLH and FLT series models	
1984-1987	
Slow idle	900-950 rpm
Fast idle	1500 rpm
1988-1989	
Slow idle	1000 rpm
Fast idle	1500 rpm
1990	1000 rpm
1991-1996	1000-1050 rpm
1997-1998	1050-1500 rpm
FXR2 and FXR3	1000-1050 rpm
FXWG, FXSB and FXEF	
Slow idle	1000-1050 rpm
Fast idle	1500-1550 rpm

Table 10 FRONT FORK AIR CONTROL (FXR SERIES MODELS 1984-1994)

	Recommended air pressure psi (kPa)	
Vehicle load	Front fork	Accumulator 1984-1987 FXRD and FXRT
Rider weight up to 150 lbs. (68 kg)	4-8 (28-55)	5-30 (34-207)
Each additional 25 lbs. (11 kg), add	2.0 (14)	
Passenger weight: For each 50 lbs. (23 kg), add	1.0 (7)	
Maximum pressure	20 (138)	30 (207)

Table 11 FRONT FORK AIR CONTROL (1984-1994 FLH AND FLT SERIES MODELS)

Ride	Amount of antidive	Recommended pressure psi (kPa)
Firm	Stiff	20 (138)
Normal	Normal	15 (103)
Soft	Soft	10 (69)

Table 12 AIR SUSPENSION ADJUSTMENTS (1995-1998 FLH AND FLT SERIES MODELS)

	Recommended pressure psi (kPa)	
Load	Front fork	Rear shock absorber
Rider weight		
Up to 150 lbs. (68 kg)	–	–
For each additional 25 lbs. (11 kg), add	1.0 (7)	1.0 (7)
Passenger weight: For each additional 50 lbs. (23 kg), add	–	1.5 (10)
Luggage weight: For each additional 10 lbs. (6 kg), add	1.0 (7)	3.0 (21)
Maximum pressure	25 (172)	35 (241)

Table 13 MAINTENANCE AND TUNE-UP TORQUE SPECIFICATIONS

Item	ft.-lb.	in.-lb.	N•m
Clutch diaphragm spring bolts			
late 1984-1989 wet clutch	–	71-97	8-11
Engine front mounting bracket			
Side bolts	33-38	–	45-52
Center bolt	35-45	–	47-61
Front fork air pipe hex bolts			
(1997-1998 models)	–	97-106	11-12
Primary drive chain shoe			
nut or bolt	22-29	–	30-39
Rear axle nut			
1984-1988	60-65	–	81-88
1989-1998	60	–	81
Spark plugs	14	–	19
Swing arm anchor bolt			
(enclosed chain models)	20	–	27
Valve lifter screen plug	–	89-124	10-14

CHAPTER FOUR

ENGINE

This chapter provides complete service and overhaul procedures, including information for disassembly, removal, inspection, service and engine reassembly.

Refer to **Tables 1-5** at the end of the chapter for specifications.

All models covered in this manual are equipped with the V-2 Evolution, an air-cooled four-stroke overhead-valve V-twin engine. The engine consists of three major assemblies: engine, crankcase and gearcase. Viewed from the right side of the engine, engine rotation is clockwise.

Both cylinders fire once in 720° of crankshaft rotation. The rear cylinder fires 315° after the front cylinder. The front cylinder fires again in another 405°. Note that one cylinder is always on its exhaust stroke when the other fires on its compression stroke.

SERVICE PRECAUTIONS

Before servicing the engine, note the following:

1. Review the information in Chapter One, especially the *Service Methods and Precision Measuring Tools* sections. Accurate measurements are critical to a successful engine rebuild.

2. Throughout the text, there are references to the left and right sides of the engine. These refer to the engine as it is mounted in the frame, not how it may sit on the workbench.

3. Always replace worn or damaged fasteners with those of the same size, type and torque requirements. Make sure to identify each bolt before replacing it. Lubricate bolt threads with engine oil, unless otherwise specified, before tightening. If a specific torque value is not listed in **Table 5**, refer to the general torque specifications in Chapter One.

CAUTION

The engine is assembled with hardened fasteners. Do not install fasteners with a lower strength grade classification.

4. Use special tools where noted.

5. Store parts in boxes, plastic bags and containers (**Figure 1**). Use masking tape and a permanent, waterproof marking pen to label parts.

6. Use a box of assorted size and color vacuum hose identifiers (Lisle part No. 74600) (**Figure 2**) for identifying hoses and fittings during engine removal and disassembly.
7. Use a vise with protective jaws to hold parts.
8. Use a press or special tools when force is required to remove and install parts. Do not try to pry, hammer or otherwise force them on or off.
9. Replace all O-rings and oil seals during reassembly. Apply a small amount of grease to the inner lips of each new seal to prevent damage when the engine is first started.
10. Record the location, position and thickness of all shims as they are removed.

SPECIAL TOOLS

Engine service requires a number of special tools. These tools and their part numbers are listed with the individual procedures. For a complete list of the special tools mentioned in this manual, refer to **Table 12** in Chapter One. The engine tools used in this chapter are either H-D or JIMS special tools. JIMS special tools are available through many aftermarket motorcycle suppliers.

When purchasing special tools, make sure to specify that the tools required are for the specific year and model number motorcycle being worked on. Many of the tools are specific to this engine. Tools for other engine models might be slightly different.

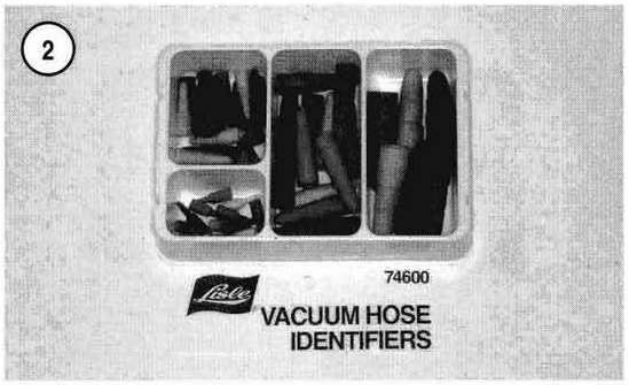
SERVICING ENGINE IN FRAME

Many components can be serviced while the engine is mounted in the frame:
1. Rocker arm cover.
2. Cylinder head.
3. Cylinders and pistons.
4. Camshafts.
5. Gearshift mechanism.
6. Clutch.
7. Transmission.
8. Carburetor or fuel injection induction module.
9. Starter and gears.
10. Alternator and electrical systems.

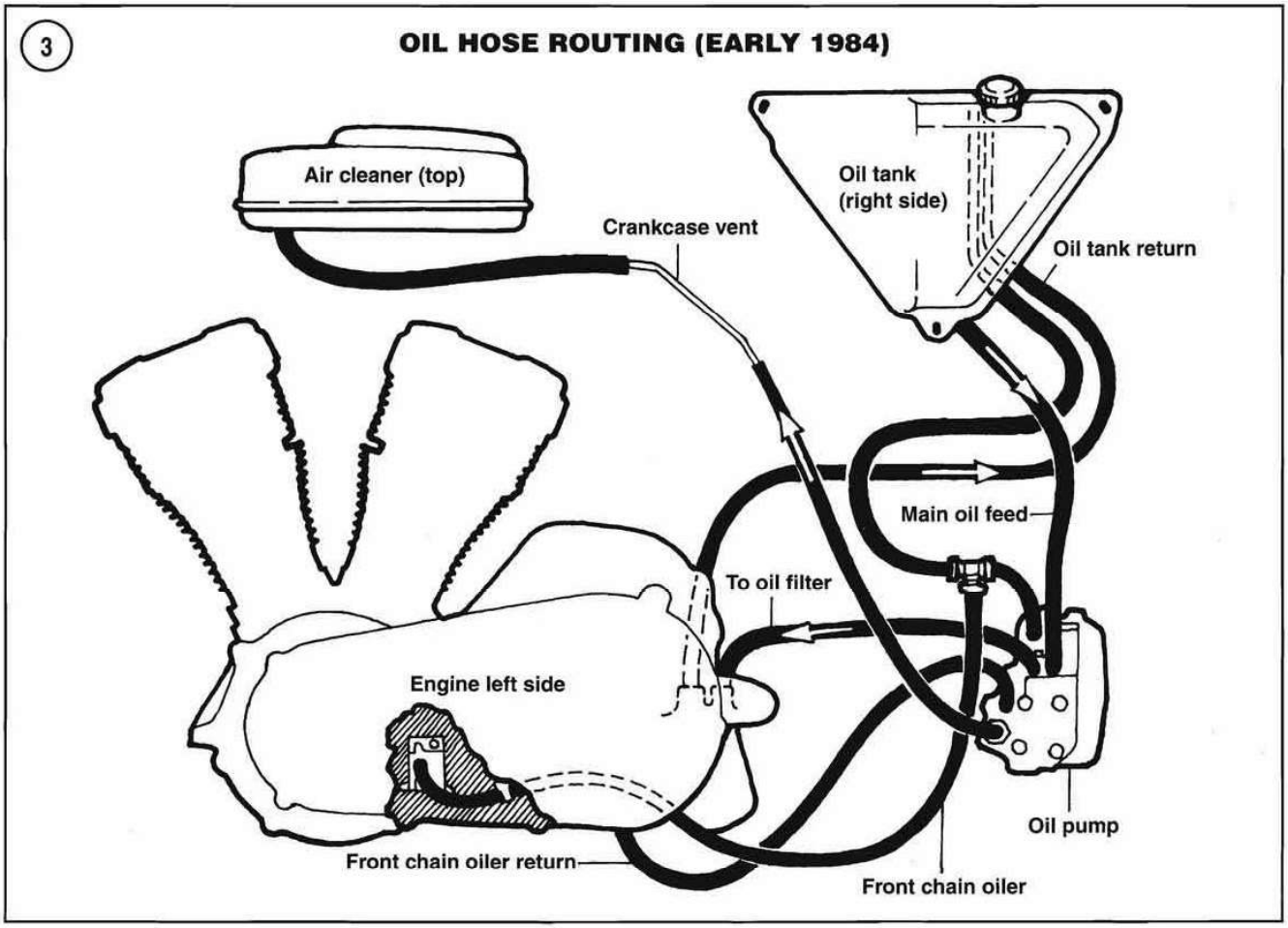
ENGINE

Removal

1. Thoroughly clean the engine of all dirt and debris.
2. Remove the seat as described in Chapter Fifteen.



3. Disconnect the negative battery cable as described in Chapter Nine.
4. Support the motorcycle on a stand or floor jack. See *Motorcycle Stands* in Chapter Ten.
5. Remove the fuel tank as described in Chapter Nine.
6. On models so equipped, remove both saddlebags as described in Chapter Fifteen.
7. Remove both frame side covers as described in Chapter Fifteen.
8. On models so equipped, remove the inner front fairing as described in Chapter Fifteen.
9. Remove the air filter and backing plate as described in Chapter Eight.
10A. On carbureted models, remove the carburetor as described in Chapter Eight.
10B. On fuel-injected models, remove the fuel injection induction module as described in Chapter Eight.
11. Remove the exhaust system as described in Chapter Eight.
12. Remove the rear brake pedal as described in Chapter Thirteen.
13. Remove all four footboards as described in Chapter Fifteen.



14. Drain the engine oil and oil tank as described in Chapter Three.

15. Label and disconnect the engine-to-oil tank oil lines. Refer to **Figures 3-9**. Plug the ends to prevent the entry of debris.

16. Disconnect the wire from the oil pressure switch (**Figure 10**).

17. Disconnect the alternator connector from the crankcase (**Figure 11**).

18. On FXR series models, perform the following:
   a. Disconnect the choke knob and cable from the upper cylinder stabilizer bar and bracket.
   b. Disconnect spark plug wires and cap assemblies and move them out of the way.
   c. Remove the ignition switch and the ignition coil as described in Chapter Nine.

19. On FLH and FLT series models, remove the ignition coil and spark plug assembly as described in Chapter Nine.

20. On models so equipped, remove the screws securing the crankshaft position sensor (**Figure 12**) and remove it from the crankcase.

21. On models so equipped, disconnect the wires from the engine temperature sensor (**Figure 13**).

22. Remove the primary chaincase assembly, including the inner housing, as described in Chapter Five.

23. Remove the alternator rotor and stator as described in Chapter Nine.

24A. On FXWG, FXSB and FXEF models, remove the upper cylinder head stabilizer bar and bracket assembly (**Figure 14**).

24B. On all other models, remove the upper cylinder head stabilizer bar and bracket assembly (**Figure 15**).

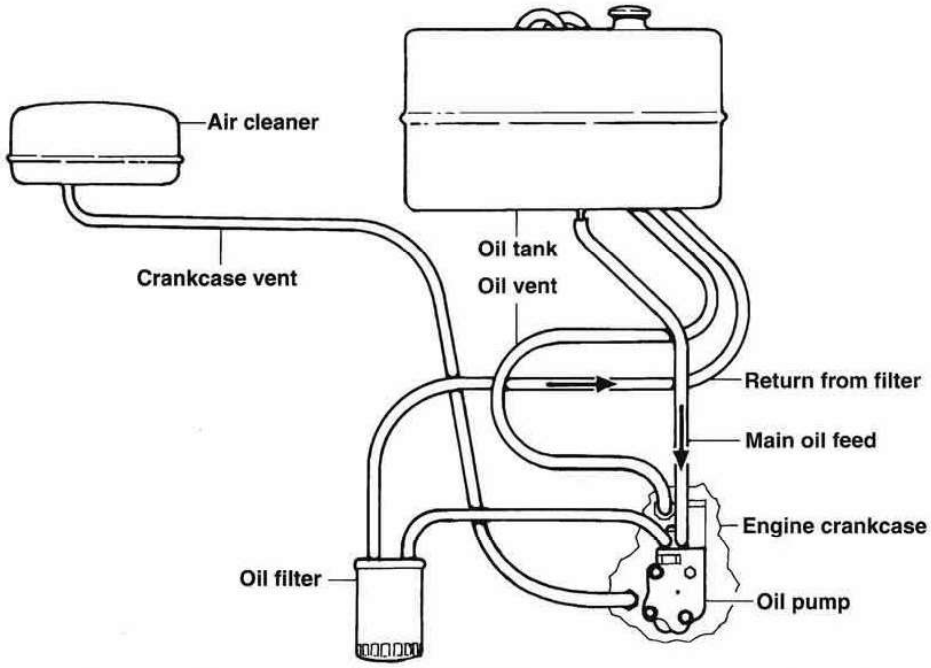
25. On the left side, remove the front stabilizer and outer end bolt.

26. Disconnect the hose from the breather cover and move the hose out of the way.

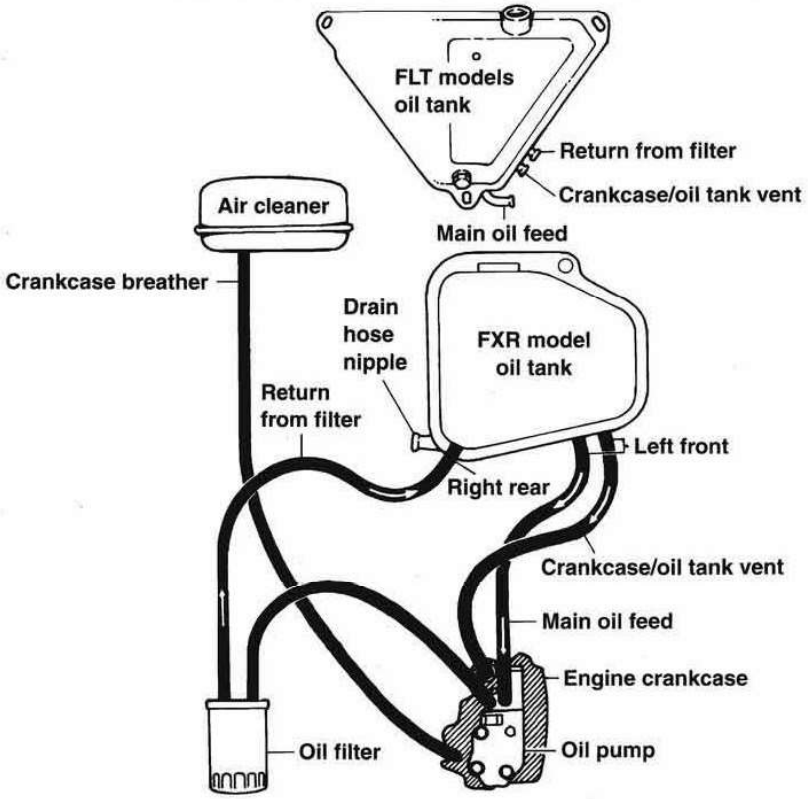
27. Remove the voltage regulator as described in Chapter Nine.

28. Remove the clutch cable from the lower portion of the crankcase as described under *Clutch Cable Replacement* in Chapter Six.

4 OIL HOSE ROUTING (LATE 1984-1990 FXR, FLH AND FLT SERIES MODELS)



5 OIL HOSE ROUTING (1991 FXR, FLH AND FLT SERIES MODELS)



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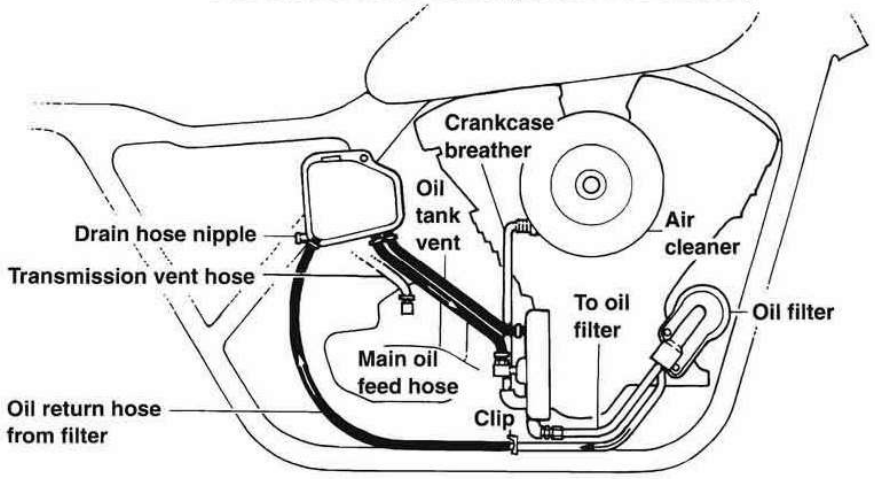
OIL HOSE ROUTING (1992-1998 FXR)



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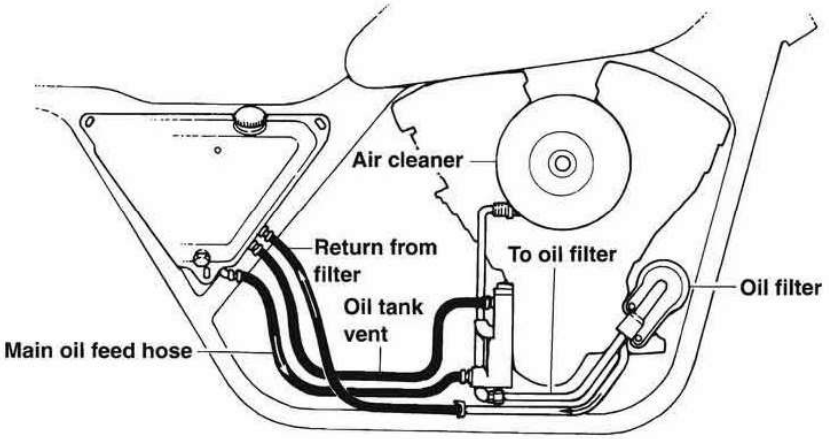
OIL HOSE ROUTING (1992 FLH AND FLT SERIES MODELS)



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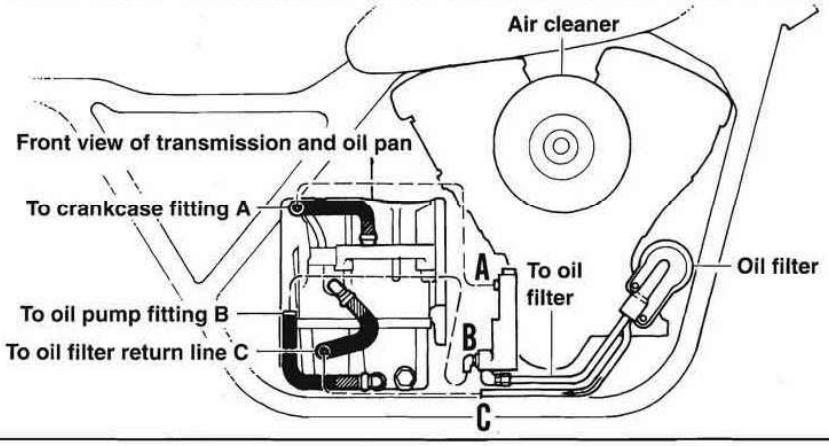
OIL HOSE ROUTING (1993-1998 FLH AND FLT SERIES MODELS)



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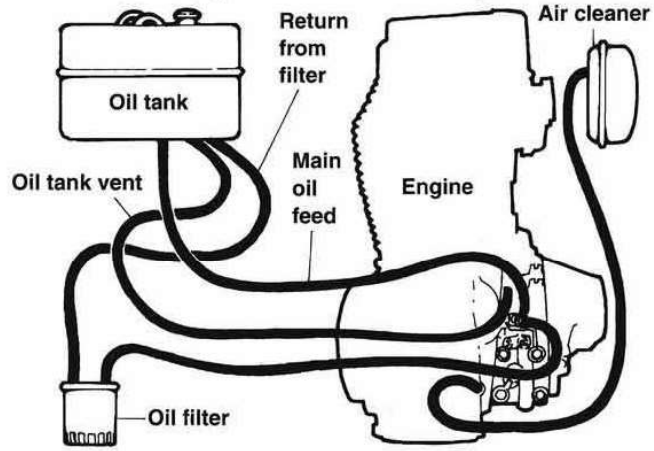
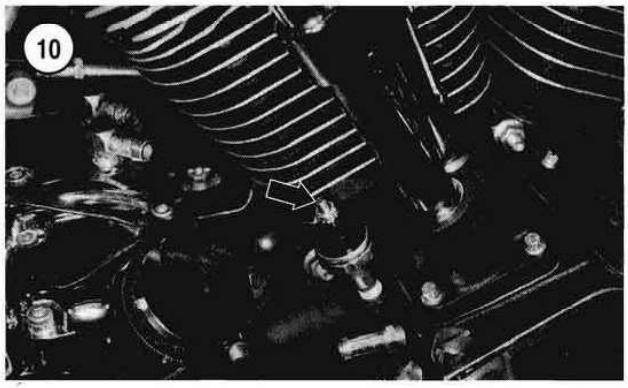
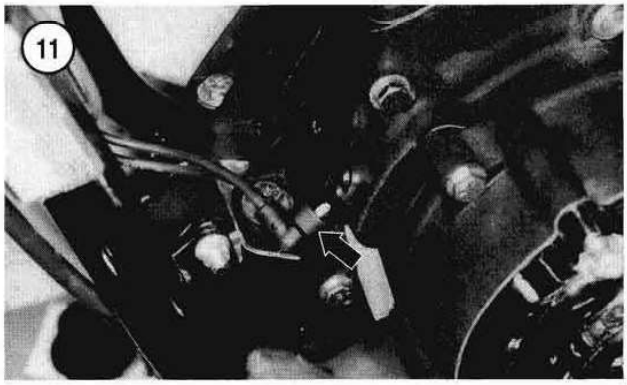
OIL HOSE ROUTING (1985-1986 FXWG, FXEF AND FXSB)







29. Wrap the frame front down tubes with protective tape to prevent surface damage in the following steps.

30. Cover both rocker covers with foam padding to protect the finish.

31. Support the transmission case with a jack or wooden blocks. Apply sufficient jack pressure on the transmission prior to removing the engine-to-transmission mounting bolts.

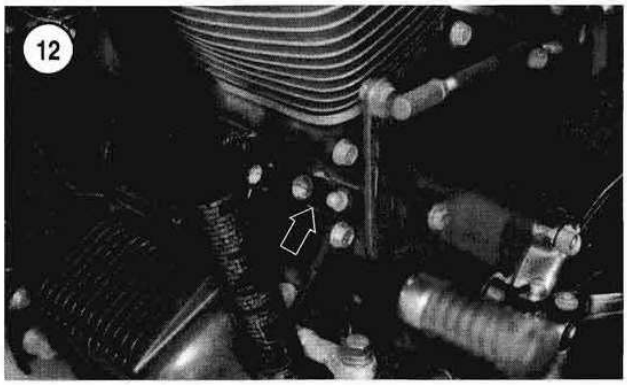
32. Using a ratchet strap, secure the transmission to the frame so it will not shift after the engine is removed.

33. Remove the front engine mount bolts, washers and nuts (**Figure 16**).

34. Remove the bolts and washers (**Figure 17**) securing the engine to the transmission.

35. Support the engine with a floor jack. Apply enough jack pressure on the crankcase to support it prior to removing the engine mounting bolts.

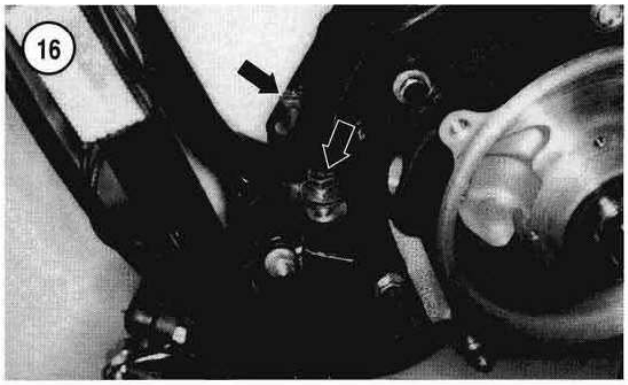
36. Check the engine to make sure all wiring, hoses and other related components have been disconnected from the engine. Check that nothing will interfere with the removal of the engine from the right side of the frame.

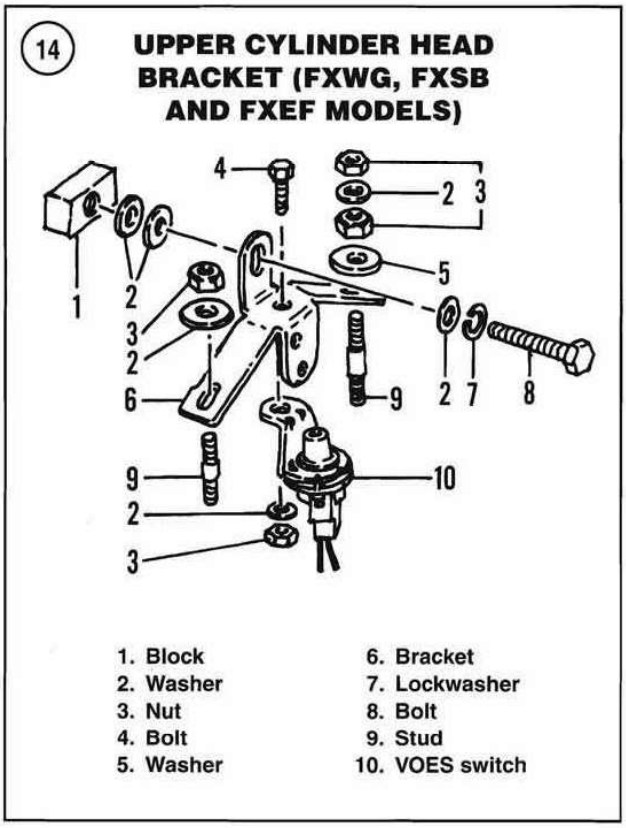


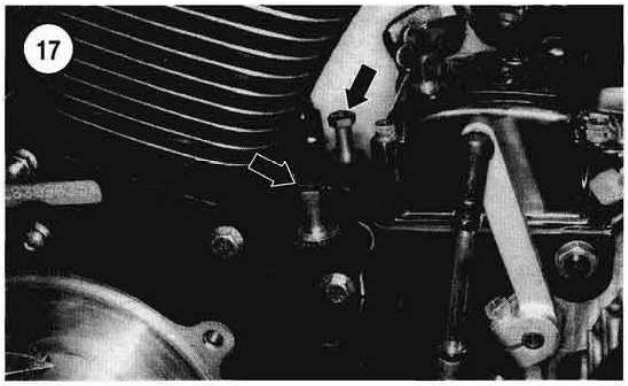
37. Remove the engine from the right side of the frame.

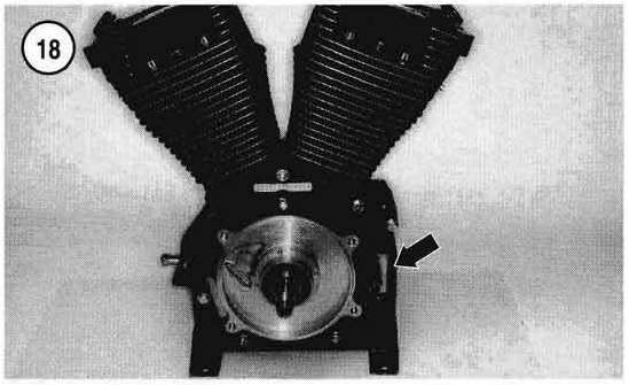
38. Mount the engine in the big twin engine stand (JIMS part No. 1006T) (**Figure 18**) or an equivalent.

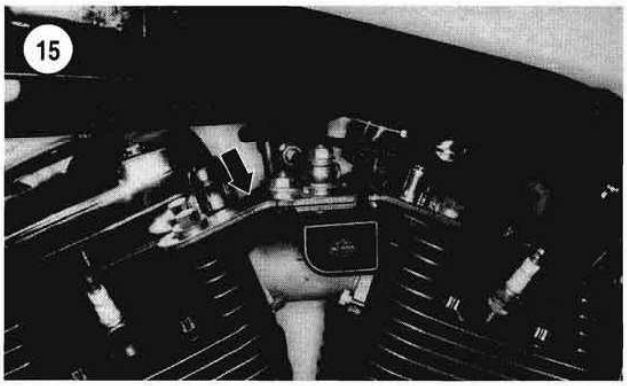
39. Service the front engine mount, if necessary.











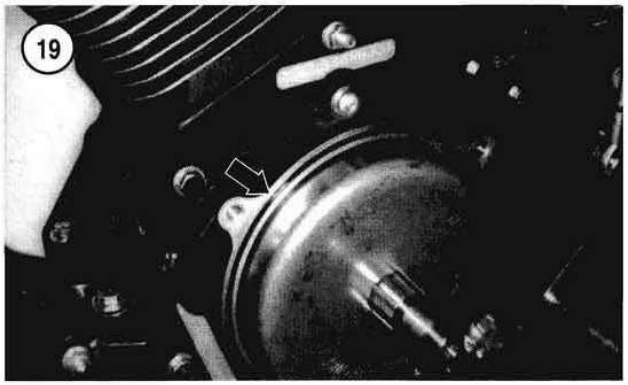
40. Clean the front and rear engine mount bolts and washers in solvent and dry thoroughly.

41. Replace leaking or damaged oil hoses.

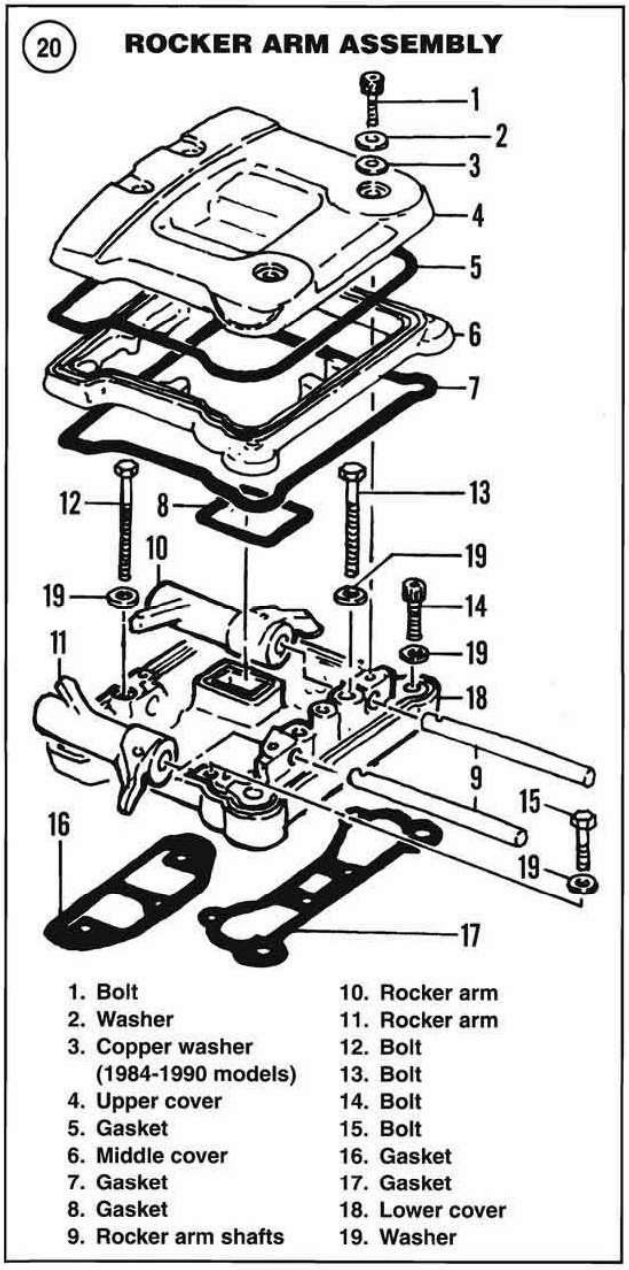
Installation

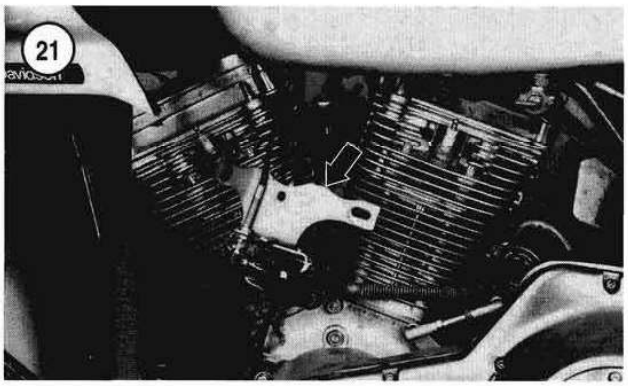
1. Recheck that all wiring, hoses and other related components are out of the way and will not interfere with engine installation.

2. Correctly position a floor jack and piece of wood under the frame to support the engine when it is installed into the frame.
3. Install the engine from the right side of the frame and place it on the floor jack. Apply enough jack pressure on the crankcase to support it prior to installing the engine mounting bolts.
4. Slide the engine assembly toward the rear next to the transmission.
5. Install the rear engine-to-transmission bolts and washers (**Figure 17**) hand-tight at this time.
6. Install the front two bolts, washers and nuts (**Figure 16**) securing the engine to the lower mounting bracket front isolator. Tighten finger-tight at this time.
7. Tighten the engine-to-transmission bolts 33-38 ft.-lb. (45-52 N•m).
8. Tighten the engine front lower mounting bolts and nuts to 33-38 ft.-lb. (45-52 N•m).
9. Remove the ratchet strap from the transmission and frame.
10. Remove the floor jack.
11. Remove the protective tape from the frame front down tubes.
12. Remove the foam padding from the rocker covers.
13. Install the clutch cable onto the lower portion of the crankcase as described under *Clutch Cable Replacement* in Chapter Five.
14. Connect the hose to the breather cover.
15A. On FXWG, FXSB and FXEF models, from the left side of the engine, install the upper cylinder head stabilizer bar and bracket assembly (**Figure 14**). Tighten the bolts and nuts securely.
15B. On all other models, from the left side of the engine stabilizer, perform the following:
   a. Install the stabilizer link and upper mounting bracket assembly onto the frame and engine.
   b. Install the two bolts and washers securing the upper mounting bracket to the cylinder heads. Tighten to 28-35 ft.-lb. (38-47 N•m).
   c. Install the bolt and nut securing the inboard end of the stabilizing link to the frame and tighten securely.
16. Install the voltage regulator as described in Chapter Nine.
17. Install the alternator stator and rotor assembly as described in Chapter Nine.
18. Install a *new* O-ring (**Figure 19**) onto the crankcase shoulder.
19. Install the primary chaincase inner housing and assembly as described in Chapter Five.
20. Adjust the clutch and primary chain as described in Chapter Three.



21. Install the primary chain outer housing as described in Chapter Five.
22. On models so equipped, connect the wires onto the engine temperature sensor (**Figure 13**).
23. On models so equipped, install the crankshaft position sensor (**Figure 12**) onto the crankcase and tighten the screws securely.
24. On FLH and FLT series models, install the ignition coil and spark plug assembly as described in Chapter Nine.
25. On FXR series models, perform the following:
   a. Install the ignition switch and the ignition coil as described in Chapter Nine.
   b. Connect spark plug wires and cap assemblies to the spark plugs.
   c. Connect the choke knob and cable to the upper cylinder stabilizer bar and bracket.
26. Connect the alternator connector to the crankcase (**Figure 11**).
27. Connect the wire to the oil pressure switch (**Figure 10**).
28. Connect the engine-to-oil tank oil lines. Refer to **Figures 3-9**). Install *new* clamps.
29. Refill the engine oil and oil tank as described in Chapter Three.
30. On wet-clutch models, refill the primary chaincase as described in Chapter Three.
31. Install all four footboards as described in Chapter Fifteen.
32. Install the rear brake pedal as described in Chapter Thirteen.
33. Install the exhaust system as described in Chapter Eight.
34A. On carbureted models, install the carburetor as described in Chapter Eight.
34B. On fuel-injected models, install the fuel injection induction module as described in Chapter Eight.
35. Install the air filter and backing plate as described in Chapter Eight.





36. On models so equipped, install the inner front fairing as described in Chapter Fifteen.
37. Install both frame side covers as described in Chapter Fifteen.
38. On models so equipped, install both saddlebags as described in Chapter Fifteen.
39. Install the fuel tank as described in Chapter Nine.
40. Remove the motorcycle stand or floor jack.
41. Connect the negative battery cable as described in Chapter Nine.
42. Remove the seat as described in Chapter Fifteen.
43. Check vehicle alignment as described in Chapter Nine.
44. Start the engine and check for leaks.

ROCKER ARMS AND ROCKER ARM COVERS

Refer to **Figure 20**.

Removal

1. If the engine is mounted in the frame, perform the following:
   a. Perform Steps 1-11 under *Engine Removal* in this chapter.
   b. Remove the upper cylinder head mounting bracket (**Figure 15**).
2. On FXR series models, remove the ignition coil bracket assembly (**Figure 21**) and move it out of the way.
3. Remove the bolts and washers securing the upper rocker cover and remove the cover and gasket.
4. Remove the middle rocker cover and gasket.
5. Remove both spark plugs as described in Chapter Three to make it easier to rotate the engine by hand.

CAUTION

The piston must be at top dead center (TDC) to avoid damage to the pushrods and rocker arms in the following steps.

6A. With the primary chain cover in place, position the piston for the cylinder being worked on at top dead center (TDC) on the compression stroke as follows:
   a. Support the motorcycle on a stand with the rear wheel off the ground. Refer to *Motorcycle Stands* in Chapter Ten.
   b. Shift the transmission into fourth or fifth gear.
   c. Rotate the rear wheel in the direction of normal rotation.
   d. Stop rotating the rear wheel when both the intake and exhaust valves are closed.

e. Wiggle both rocker arms. There should be free play indicating that both valves are closed. This indicates that the piston is at top dead center (TDC) on the compression stroke and both valves are closed. Also, the pushrods are in the unloaded position.

f. Look into the spark plug hole with a flashlight and verify that the piston is at TDC.

6B. With the primary chain cover removed, position the piston for the cylinder being worked on at top dead center (TDC) on the compression stroke as follows:

a. Shift the transmission into neutral.

b. Install the sprocket shaft nut onto the end of the left side of the crankshaft.

c. Place a socket or wrench on the compensating sprocket shaft nut.

d. Rotate the compensating sprocket shaft *counterclockwise* until both the intake and exhaust valves are closed.

e. Wiggle both rocker arms. There should be free play indicating that both valves are closed. This indicates that the piston is at top dead center (TDC) on the compression stroke and both valves are closed. Also, the pushrods are in the unloaded position.

f. Look into the spark plug hole with a flashlight and verify that the piston is at TDC.

7. Remove the pushrod covers as follows:

a. Using a screwdriver, pry the spring cap retainer (**Figure 22**) out from between the cylinder head and spring cap. Remove the spring cap retainer.

b. Slide the upper cover down (A, **Figure 23**).

c. Repeat for the opposite pushrod cover.

8. Mark each pushrod as to its top and bottom position and its position in the cylinder head. The pushrods must be installed in their original positions during assembly.

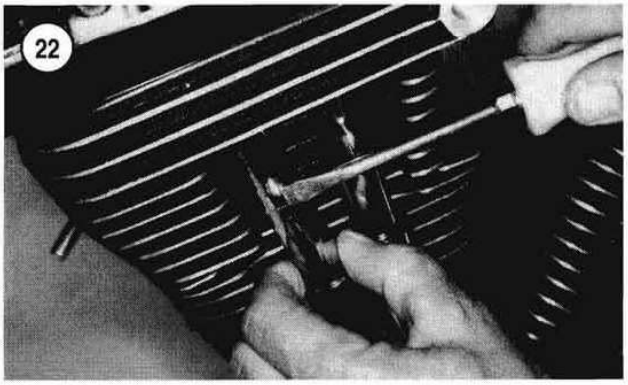
CAUTION

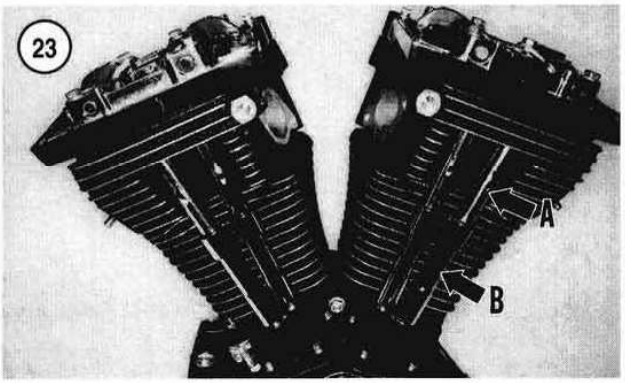
When removing the pushrods in the following steps, do not mix the parts from each set. When reinstalling the original pushrods, install them so that each end faces in its original operating position. The pushrods develop a set wear pattern and installing them upside down may cause rapid wear to the pushrod, lifter and rocker arm.

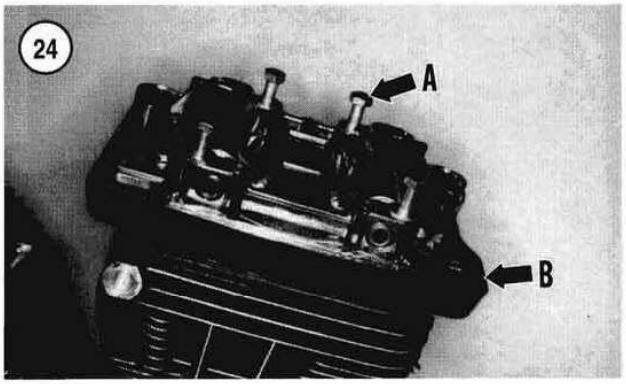
9. Remove the bolts (A, **Figure 24**) securing the lower rocker cover and rocker arms.

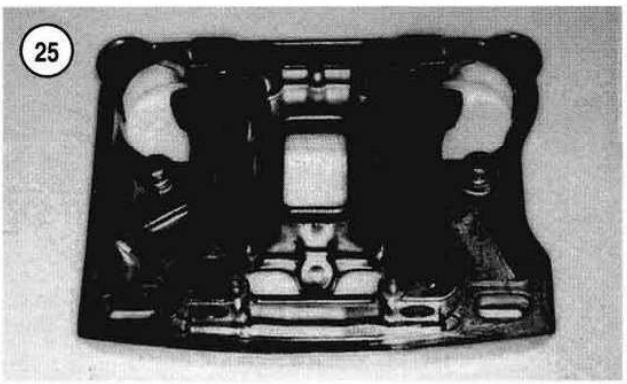
10. Remove the rocker arms and the lower rocker cover (B, **Figure 24**) as an assembly (**Figure 25**).

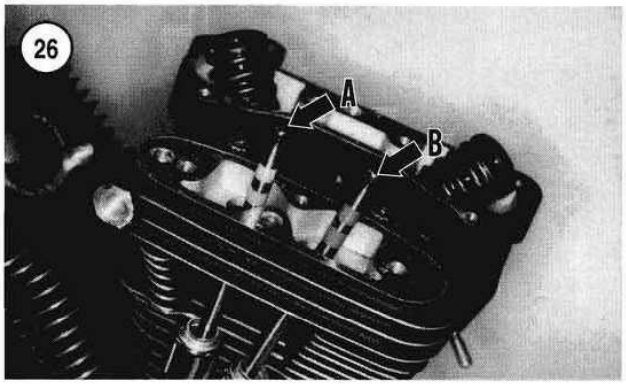
11. Remove the intake (A, **Figure 26**) and exhaust (B) pushrods up through the cylinder head.

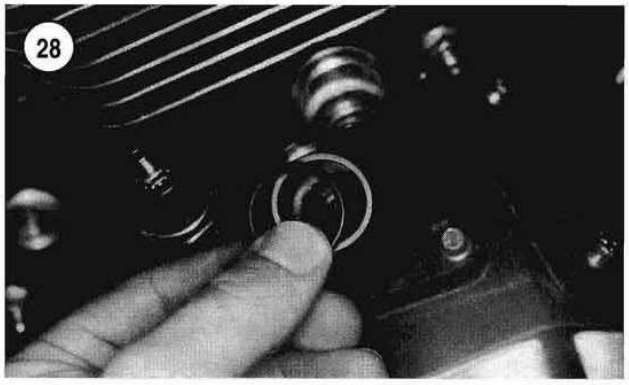


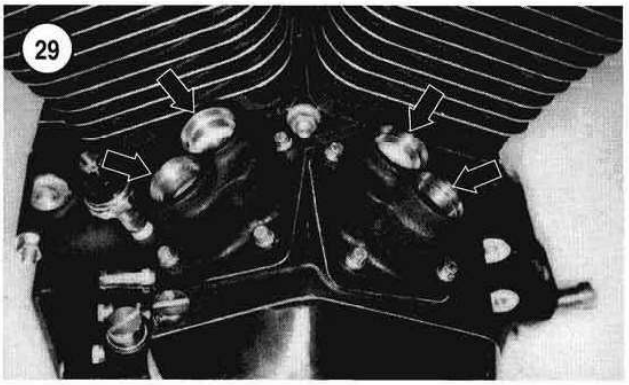


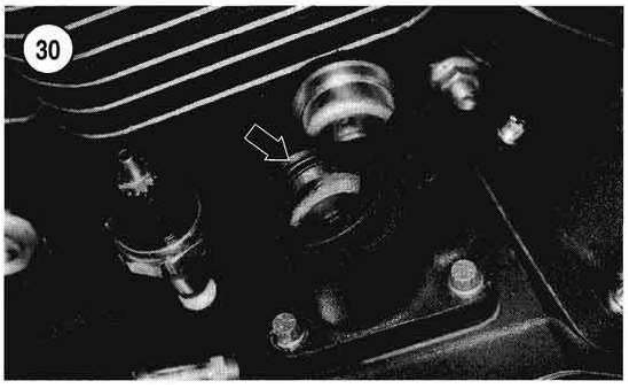








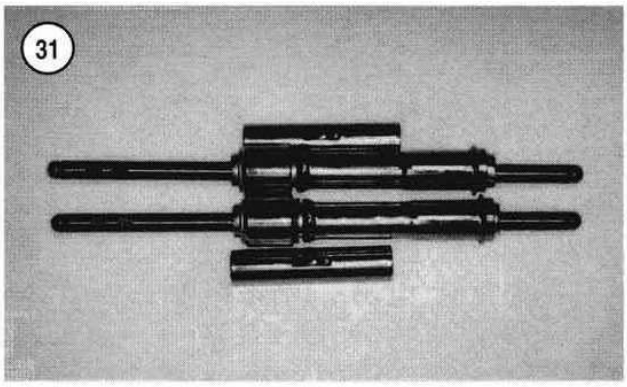


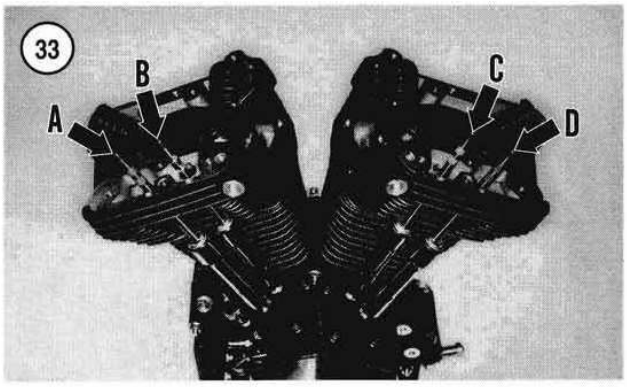


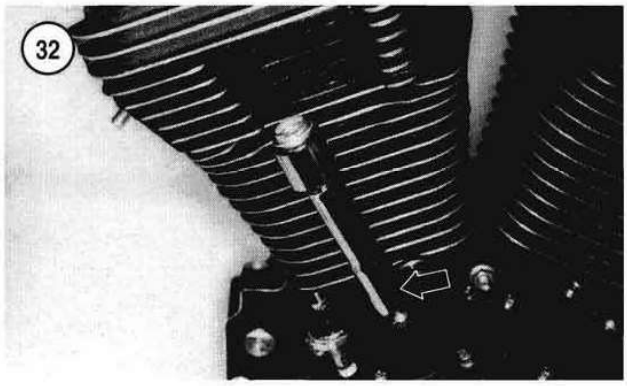
12. Remove the pushrod cover assemblies (B, **Figure 23**).
13. Remove the upper (**Figure 27**) and lower (**Figure 28**) pushrod cover O-ring and washer.
14. Disassemble and inspect the rocker arm/cylinder head assembly as described in this chapter.

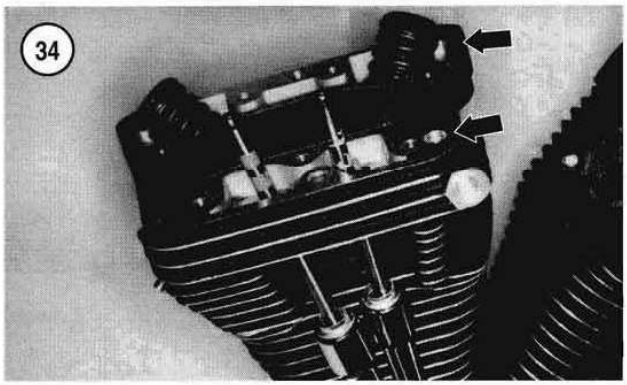
Installation

1. Install the valve lifters as described in this chapter if they were removed.
2. If the engine has been rotated since it was originally set on TDC, rotate the engine until both lifters (**Figure 29**) for the cylinder head being worked on seat onto the lowest camshaft position (base circle).
3. Install the pushrod covers (B, **Figure 23**) as follows:
   a. Install a *new* lower O-ring and washer (**Figure 28**) into the lifter block (**Figure 30**).
   b. Install a *new* upper O-ring (**Figure 27**) into the cut-out in the bottom of the cylinder head.
   c. If the pushrod covers were disassembled, assemble them as described under *Pushrods and Pushrod Covers* in this chapter.
   d. Refer to the marks made during removal and install the pushrod sets (**Figure 31**) in the correct locations in the crankcase.
   e. Install the pushrod cover into the valve lifter block (**Figure 32**) and O-ring.
4. If installing *new* pushrods, refer to the following identification marks:
   a. Purple: rear exhaust (A, **Figure 33**).
   b. Blue: rear intake (B, **Figure 33**).
   c. Yellow: front intake (C, **Figure 33**).
   d. Green: front exhaust (D, **Figure 33**).
5. Install the pushrods as follows:
   a. Center the pushrod cover in between the cylinder head and valve lifter block.









b. If the pushrods were labeled during removal, install each pushrod in the original location in the cylinder head.

c. If the pushrods were not labeled during removal, refer to Step 12 and install each pushrod in the original location in the cylinder head.

6. Install *new* lower rocker cover gaskets (**Figure 34**) onto the cylinder head.

7. Install the lower rocker cover and rocker arm assembly (B, **Figure 24**) onto the cylinder head while guiding the pushrod ends into the rocker arm sockets (A, **Figure 35**).

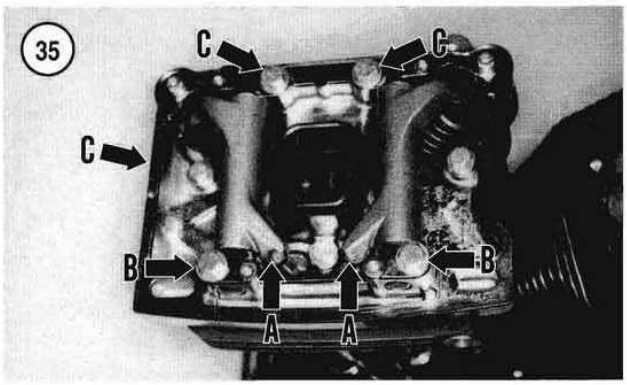
NOTE

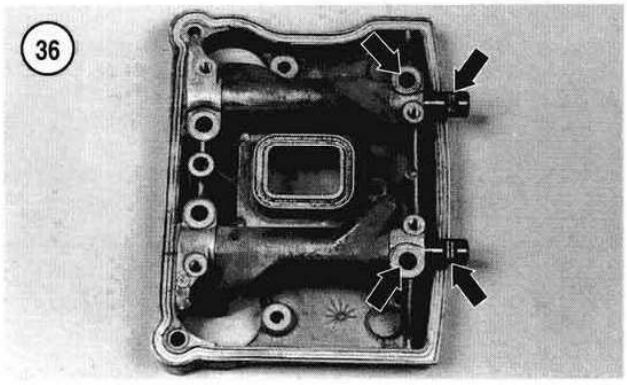
*If the right side bolts will not pass through the rocker arm, the notch in the rocker arm shaft is not properly aligned with the mating bolt hole (**Figure 36**). Realign if necessary.*

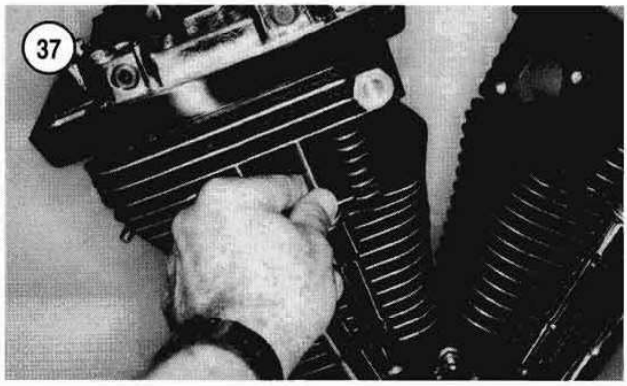
8. Install the lower rocker arm cover bolts as follows. The longer bolts (B, **Figure 35**) on the right side (pushrod side) and the shorter bolts (C) on the left side of the engine.

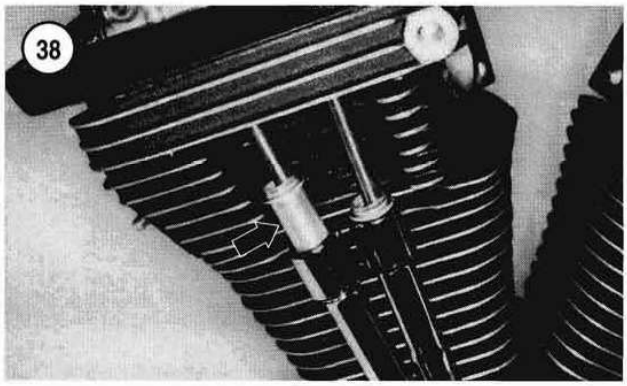
CAUTION

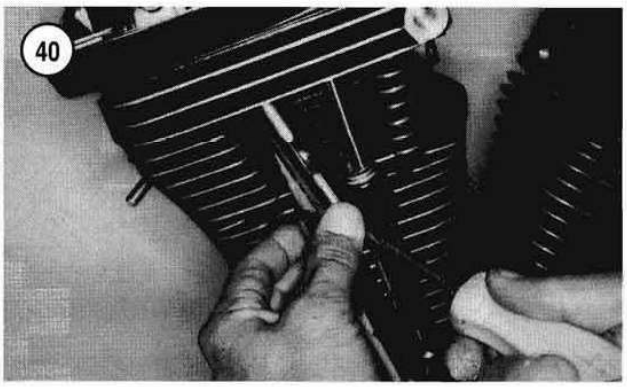
To avoid damaging a pushrod, rocker arms or valves, tighten the lower rocker arm cover bolts evenly and in a crisscross pat-

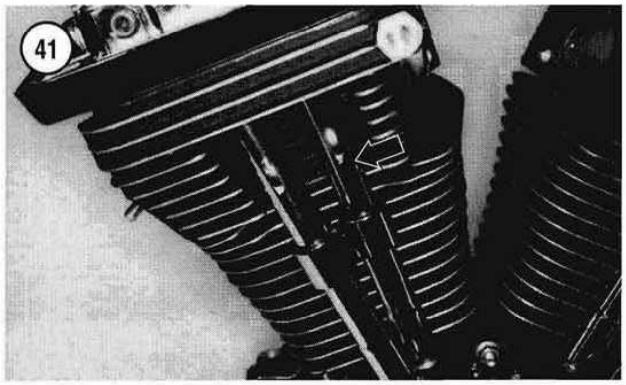


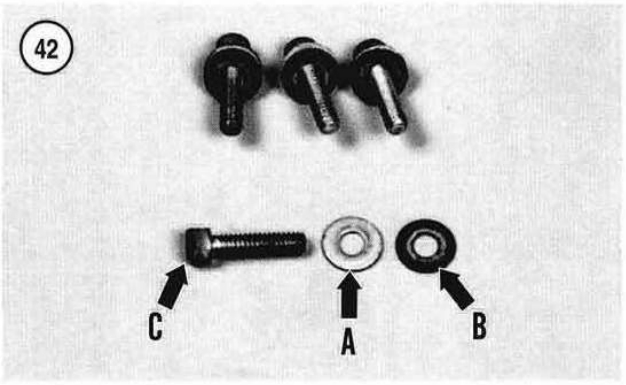












*tern. When tightening, spin each pushrod by hand (**Figure 37**) to make sure that the lower rocker cover is being tightened evenly. If one or both pushrods cannot be rotated, loosen the mounting bolts and determine the cause.*

9. Tighten the lower rocker cover bolts in a crisscross pattern to 15-18 ft.-lb. (20-25 N•m). Tighten the bolts in small increments to help bleed the lifters.

10. Push the upper pushrod cover up (**Figure 38**) and seat it in the cylinder head with a screwdriver (**Figure 39**).

11. Position the spring cap retainer between the cap and the cylinder head and pry it into place with a screwdriver (**Figure 40**).

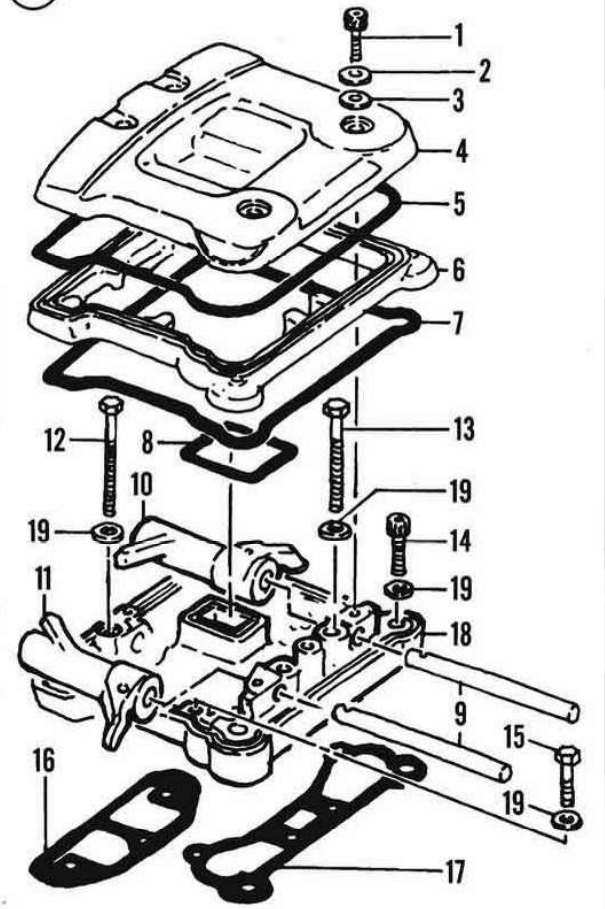
12. Repeat Step 10 and 11 for the other pushrod cover (**Figure 41**).

13. Install a *new* gasket (C, **Figure 35**) onto the lower pushrod cover and install the middle pushrod cover.

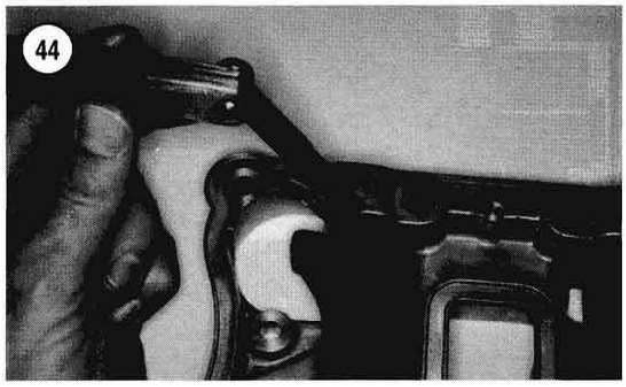
14. Install a *new* gasket onto the middle pushrod cover.

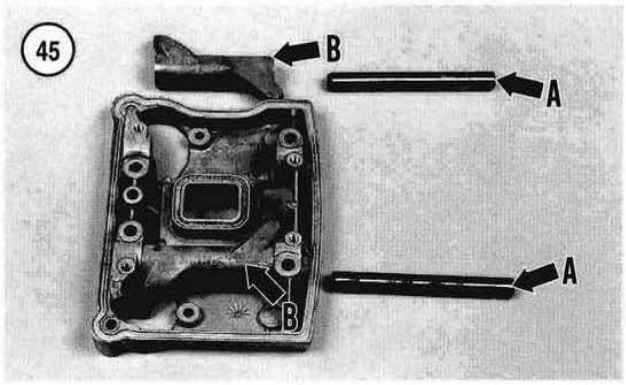
15. Install the upper pushrod cover onto the middle pushrod cover.

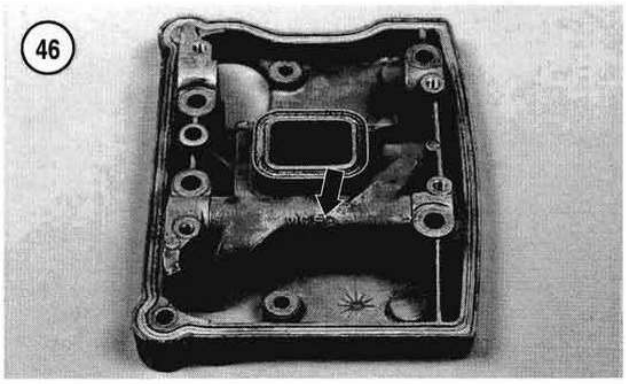
16A. On 1984-1990 models, install the steel washer (A, **Figure 42**) followed by the copper washer (B) onto the bolt (C) on the upper pushrod cover.

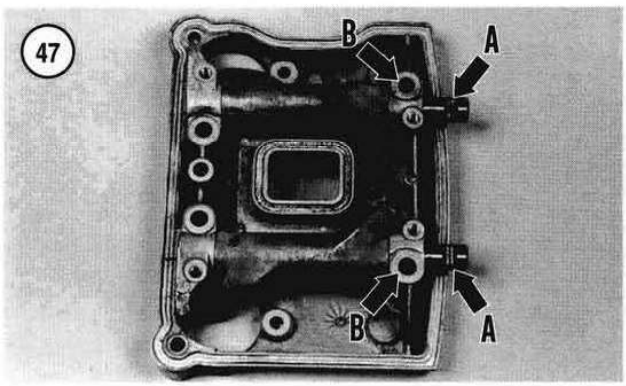


1. Bolt
2. Washer
3. Copper washers (1984-1990 models)
4. Upper cover
5. Gasket
6. Middle cover
7. Gasket
8. Gasket
9. Rocker arm shafts
10. Rocker arm
11. Rocker arm
12. Bolt
13. Bolt
14. Bolt
15. Bolt
16. Gasket
17. Gasket
18. Lower cover
19. Washer









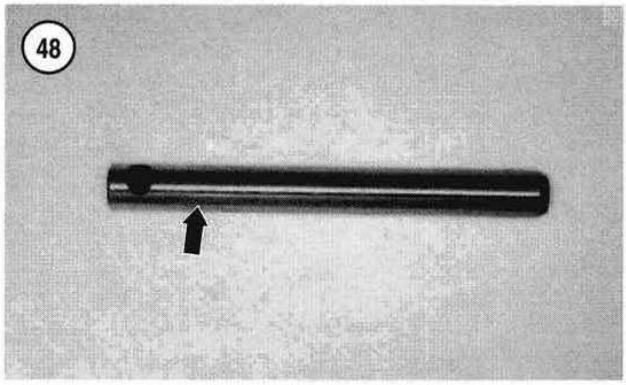
16B. On 1991-1998 models, install the washer onto the bolt on the upper pushrod cover.

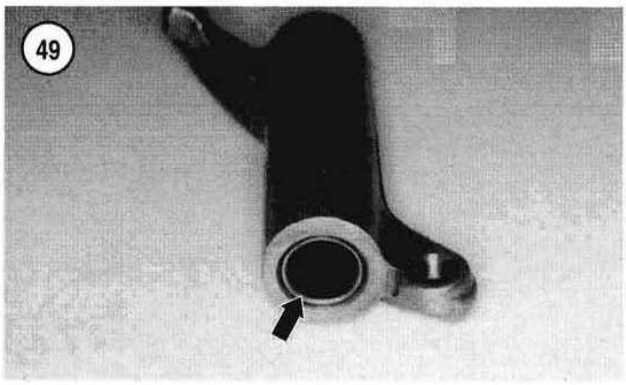
17. Check that the middle rocker cover is spaced evenly on all sides. Then tighten the upper cover 1/4-in. bolts to 124-159 in.-lb. (13-18 N•m) in a crisscross pattern.

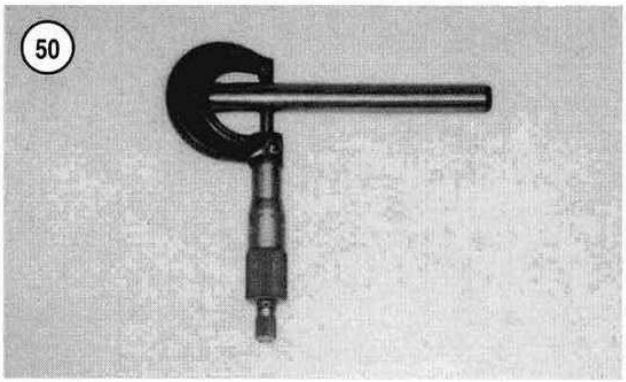
Rocker Arm Disassembly/Assembly

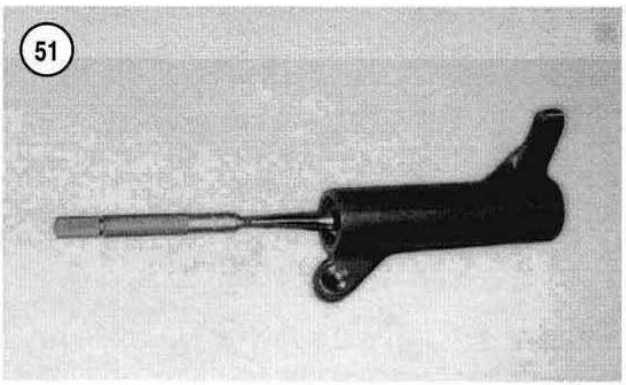
Refer to **Figure 43**.

1. Remove the lower rocker cover as described in this section.









2. Before disassembling the rocker arms, measure the rocker arm side clearance as follows:
   a. Insert a flat feeler gauge between the rocker arm end and the side of the lower rocker cover (**Figure 44**).
   b. Record the dimension.
   c. Repeat for each rocker arm.
   d. Replace the rocker arm and/or the lower rocker cover if the end clearance is not within the specification in **Table 2**.
3. Prior to disassembling the rocker arms, mark each one with an IN (intake) or EX (exhaust) to ensure they will be installed in their original positions.
4. Remove the rocker arm shafts (A, **Figure 45**) and remove the rocker arms (B).
5. Thoroughly clean all parts in solvent and dry with compressed air. Blow through all oil passages.
6. Inspect all parts as described in this section.
7. Install the rocker arm in its original position (**Figure 46**).
8. Install the rocker arm shaft partway into the lower rocker cover and rocker arm.
9. Align the notch in the rocker arm shaft (A, **Figure 47**) with the mating bolt hole (B) in the lower rocker cover and install the shaft all the way. Check for correct alignment. Realign if necessary.
10. Repeat Steps 7-9 for the remaining rocker arm and shaft.

Rocker Arm Component Inspection

1. Examine the rocker arm pads and ball sockets for pitting and excessive wear; replace the rocker arms if necessary.
2. Examine the rocker arm shaft (**Figure 48**) for scoring, ridge wear or other damage. If these conditions are present, replace the rocker arm shaft. If the shaft does not show any wear or damage, continue with Step 8.
3. Check the rocker arm bushing (**Figure 49**) for wear or scoring.
4. Measure the rocker arm shaft diameter (**Figure 50**) where it contacts the rocker arm bushings and lower rocker cover. Measure both ends of the shaft. Record each measurement.
5. Measure the rocker arm bushing inside diameter (**Figure 51**) and the lower rocker cover bore diameter. Record each measurement.
6. Subtract the measurements taken in Step 4 from those taken in Step 5 to obtain the following rocker arm shaft measurements:
   a. Shaft-to-lower rocker cover.
   b. Shaft-to-rocker arm bushing.
7. Replace the rocker arm, the bushing or the lower rocker cover if the clearance exceeds the specifications in **Table 2**.

8. Inspect the rocker arm shaft contact surfaces (**Figure 52**) on the lower rocker cover for wear or elongation.
9. Inspect the gasket surfaces of the upper rocker cover (A, **Figure 53**) and the middle rocker cover (B) for damage or warp.
10. Inspect the gasket surfaces of the lower rocker cover (**Figure 54**) for damage or warp.

CYLINDER HEAD

Removal

Refer to **Figure 55**.

1. Remove the rocker arm assembly as described in this chapter.
2. Remove the bolts (**Figure 56**) securing the cylinder head one-eighth turn at a time in the pattern shown in **Figure 57**.
3. Tap the cylinder head with a plastic mallet to loosen it. Then lift it off the cylinder.
4. Remove and discard the cylinder head gasket.
5. Remove the O-rings and dowel pins (**Figure 58**) from the cylinder.
6. Repeat these steps for the opposite cylinder head.
7. Repeat Steps 1-6 and remove the opposite cylinder head assembly.
8. Inspect the cylinder head assembly as described in this section.

Installation

1. If removed, install the piston and cylinder as described in this chapter.
2. Assemble and inspect the rocker arm/cylinder head assembly as described in this chapter.
3. Install the two dowel pins (**Figure 58**) into the top of the cylinder.
4. Install a *new* O-ring over each dowel pin. Apply a light coat of clean engine oil to the O-rings.

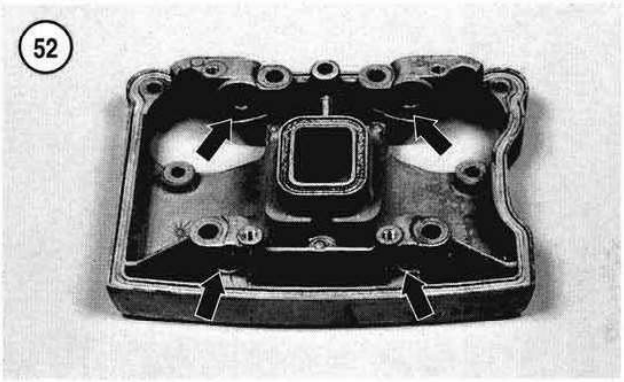
CAUTION

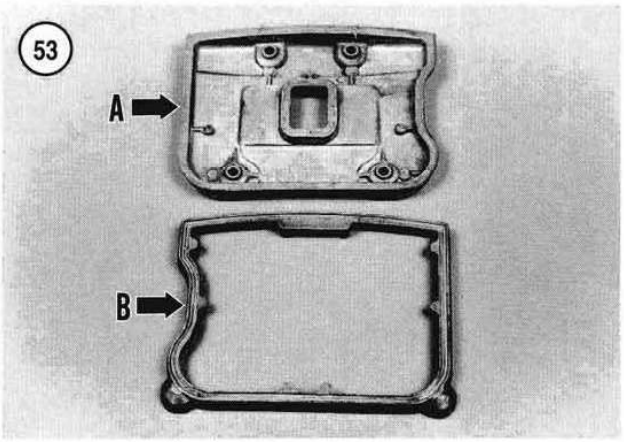
Because the O-rings center the head gasket on the cylinder, install them before installing the head gasket.

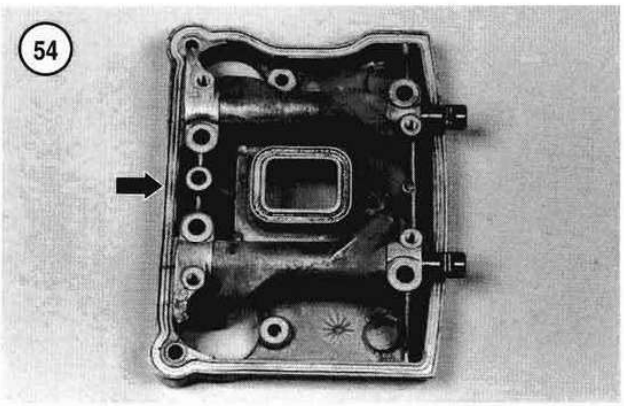
5. Install a *new* cylinder head gasket onto the cylinder.

CAUTION

Do not use sealer on the cylinder head gasket. If using an aftermarket head gasket, follow the manufacturer's instructions for gasket installation.







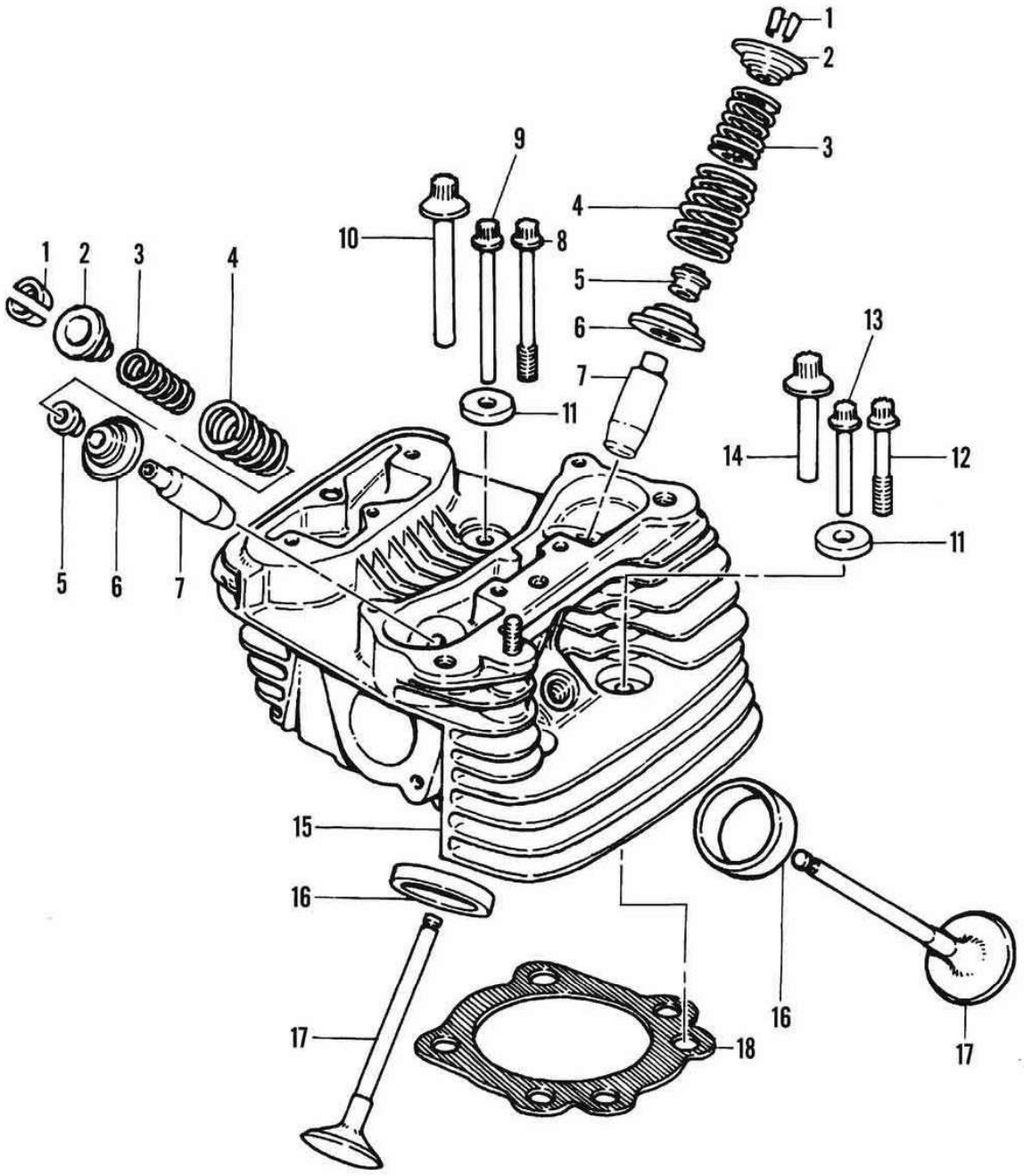
NOTE

*The cylinder heads are **not identical**. Refer to the FRONT or REAR mark (**Figure 59**) cast into the top surface of the cylinder head.*

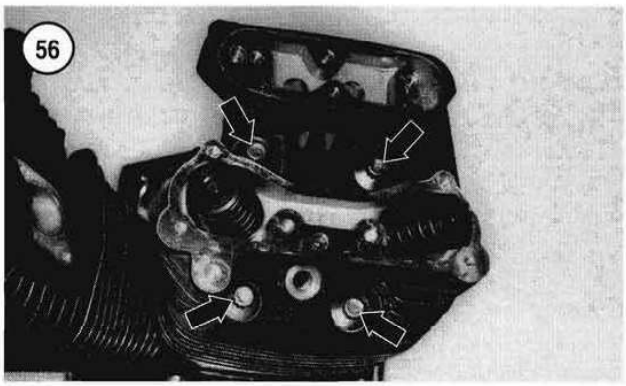
6. Install the cylinder head onto the cylinder and the dowel pins. Position the head carefully to avoid moving the head gasket out of alignment.

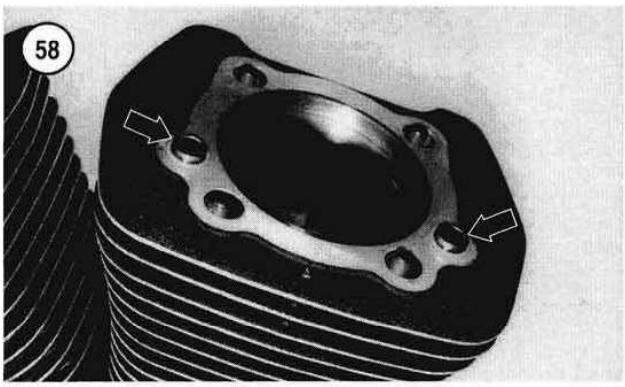
(55)

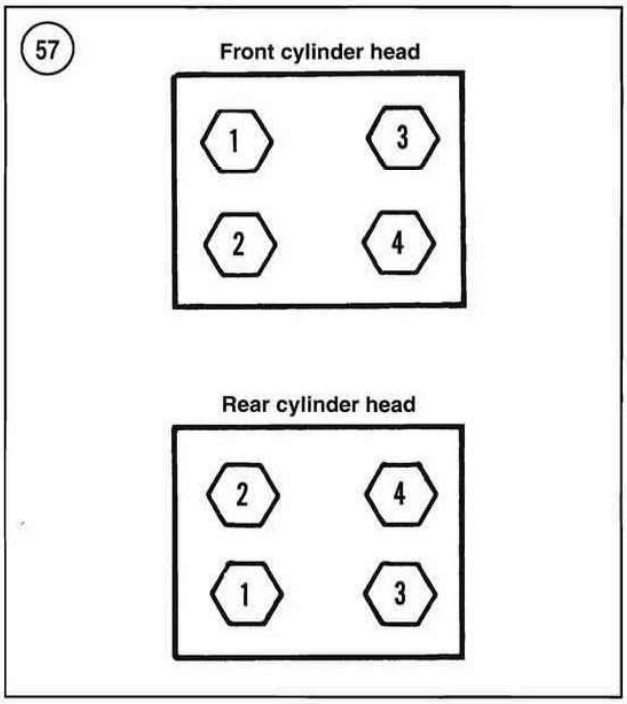
CYLINDER HEAD

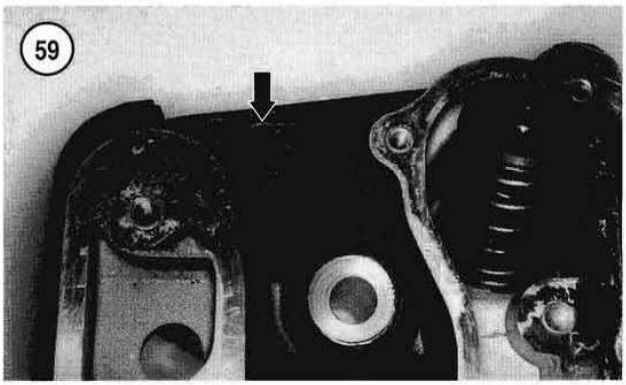


1. Valve keepers
2. Upper retainer
3. Inner valve spring
4. Outer valve spring
5. Seal
6. Lower retainer
7. Valve guide
8. Bolt (1984-early 1985)
9. Bolt (late 1985-1987)
10. Bolt (1988-1998)
11. Washer (1984-1987)
12. Bolt (1984-early 1985)
13. Bolt (late 1985-1987)
14. Bolt (1988-1998)
15. Cylinder head
16. Valve seat
17. Valves
18. Cylinder head gasket









7. Lubricate the cylinder studs and cylinder head bolts as follows:
   a. Clean the cylinder head bolts in solvent and dry with compressed air.
   b. Apply clean engine oil to the cylinder head bolt threads and to the flat shoulder surface on each bolt. Wipe off any excess oil from the bolts. Leave only an oil film on these surfaces.
   c. Make sure to install washers onto the bolts on 1984-1987 models.

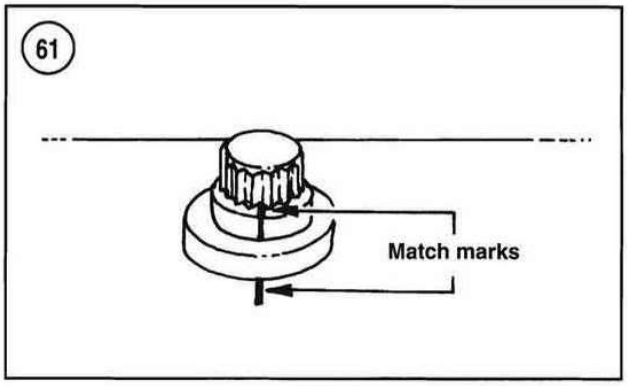
NOTE

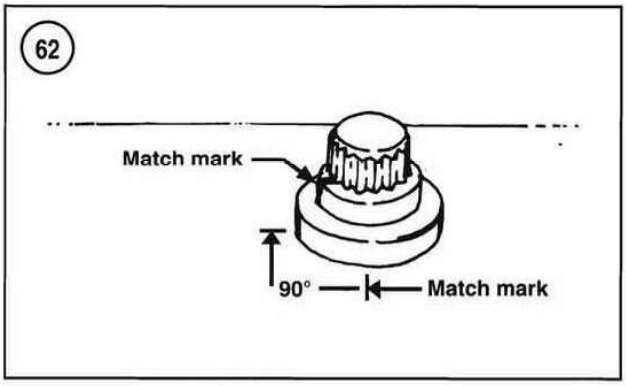
*The original equipment cylinder head bolts and washers (**Figure 60**, typical) are made of Grade 8 material. Do not substitute these items with a part of lesser strength. Late style cylinder head washers **cannot** be used on early style cylinder head bolts.*

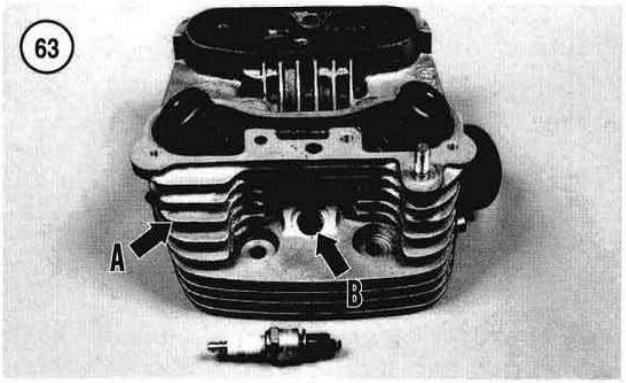
8. Install the cylinder head long bolts in the center bolt holes; install the short bolts in the outer bolt holes next to the spark plug hole. Tighten the cylinder head bolts (**Figure 56**) only finger-tight at this time.

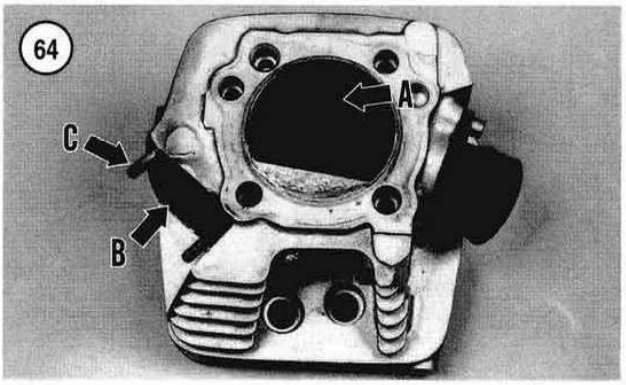
CAUTION

Failure to follow the tightening pattern and sequence in Step 8 may cause cylinder head distortion and gasket leakage.









9. Refer to **Figure 57** for the front and rear cylinder head bolt tightening sequence. Tighten the cylinder head bolts as follows:
   a. Starting with bolt No. 1, tighten each bolt in order to 80-106 in.-lb. (9-12 N•m).
   b. Then once again, starting with bolt No. 1, tighten each bolt in order to 142-168 in.-lb. (16-19 N•m).
   c. Make a vertical mark with a permanent marker on each bolt head (**Figure 61**). Make another mark on the cylinder head.
   d. Following the tightening sequence in **Figure 57**, turn each bolt head a quarter turn *clockwise* using the match marks as a guide (**Figure 62**).
   e. When the marks appear as shown in **Figure 62**, the tightening sequence is complete.
   f. Repeat for the opposite cylinder head.

Inspection

Refer to **Figure 55**.

1. Thoroughly clean the outside of the cylinder head. Use a stiff brush, soap and water and remove all debris from the cooling fins (A, **Figure 63**). If necessary, use a piece of wood and scrape away any lodged dirt. Clogged cooling fins can cause overheating, leading to possible engine damage.
2. Without removing the valves, use a wire brush to remove all carbon deposits from the combustion chamber (A, **Figure 64**). Use a fine wire brush dipped in solvent or make a scraper from hard wood. Take care not to damage the head, valves or spark plug threads.

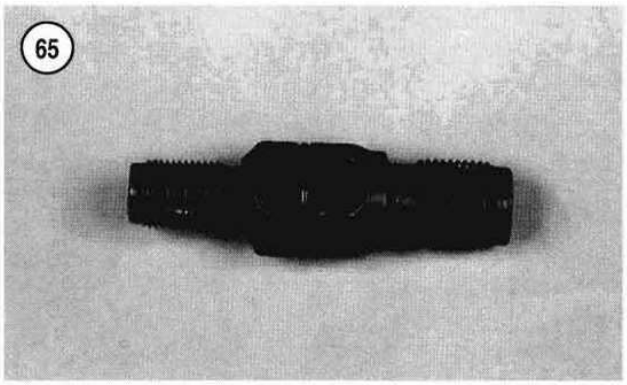
CAUTION

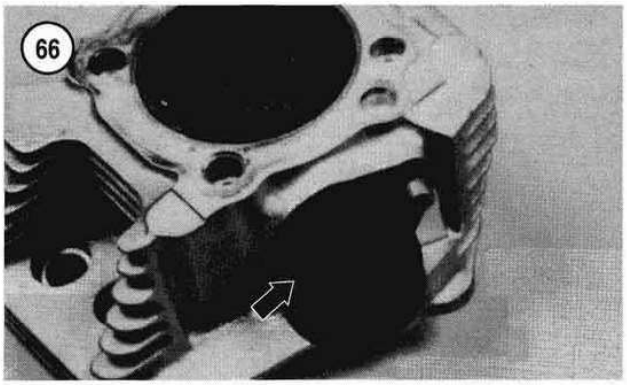
Cleaning the combustion chamber with the valves removed can damage the surfaces of the valve seat. A damaged or even slightly scratched valve seat will cause poor valve seating.

3. Examine the spark plug threads (B, **Figure 63**) in the cylinder head for damage. If damage is minor, or if the threads are dirty or clogged with carbon, use a spark plug thread tap (**Figure 65**) to clean the threads following the manufacturer's instructions. If thread damage is severe, restore the threads by installing a steel thread insert. Purchase thread insert kits at automotive supply stores or have them installed by a Harley-Davidson dealership or machine shop.

CAUTION

Aluminum spark plug threads commonly are damaged due to galling, cross-threading and overtightening. To prevent galling, apply an antiseize compound to the plug





threads before installation and do not overtighten.

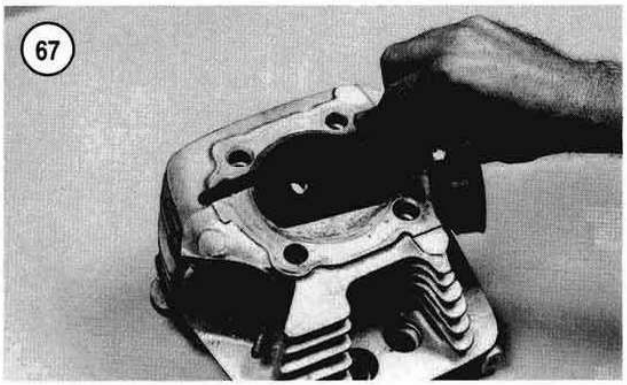
NOTE

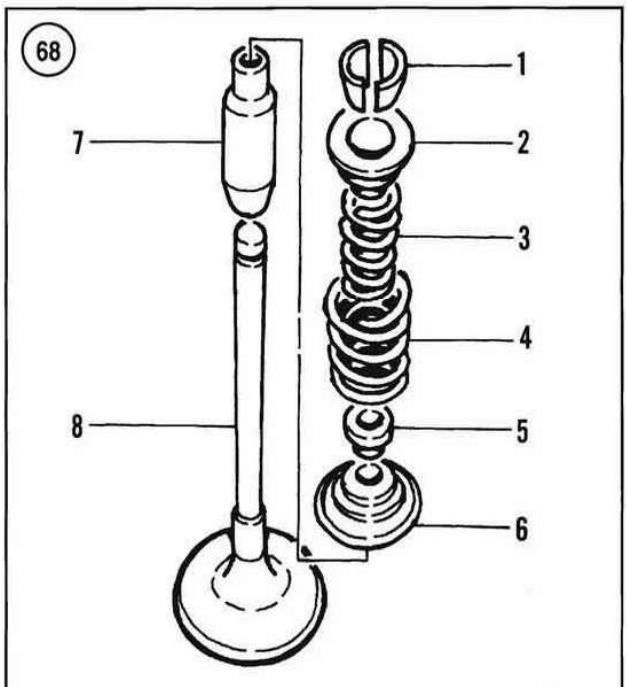
When using a tap to clean spark plug threads, coat the tap with an aluminum tap-cutting fluid or kerosene.

4. After all carbon is removed from combustion chambers and valve ports and, if necessary, the spark plug thread hole is repaired, clean the entire head in solvent. Blow dry with compressed air.
5. Examine the crown on the piston. The crown should show no signs of wear or damage. If the crown appears pecked or spongy, also check the spark plug, valves and combustion chamber for aluminum deposits. If these deposits are found, the cylinder has overheated. Check for a lean fuel mixture or other conditions that could result in preignition.
6. On 1984-1989 models, check the intake manifolds (**Figure 66**) for cracks or tear damage that could allow unfiltered air to enter the engine. Also check the manifold bolts for tightness. If you removed the manifold, install it with a new gasket.
7. Check for cracks in the combustion chamber, the intake port and the exhaust port (B, **Figure 64**). Replace a cracked head if welding cannot repair it.
8. Inspect the exhaust pipe mounting bolt threads (C, **Figure 64**) for damage. Repair with a thread die if damaged.

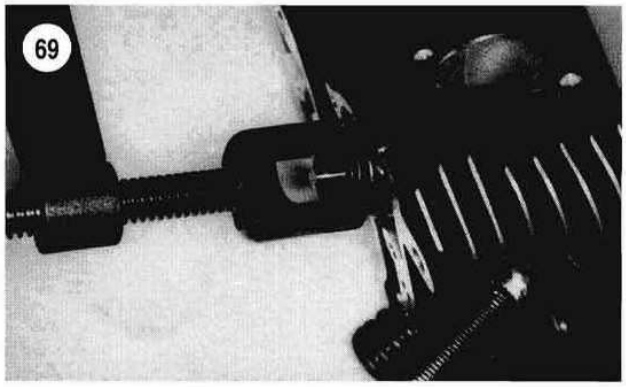
CAUTION

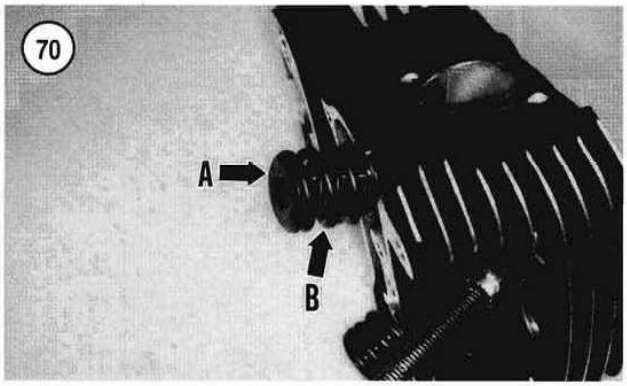
If the cylinder head is bead-blasted, clean the head thoroughly with solvent and then with hot soapy water. Residual grit seats in small crevices and other areas and can be hard to remove. Also run a tap through each exposed thread to remove grit from the threads. Residue grit left in the engine will cause premature wear.

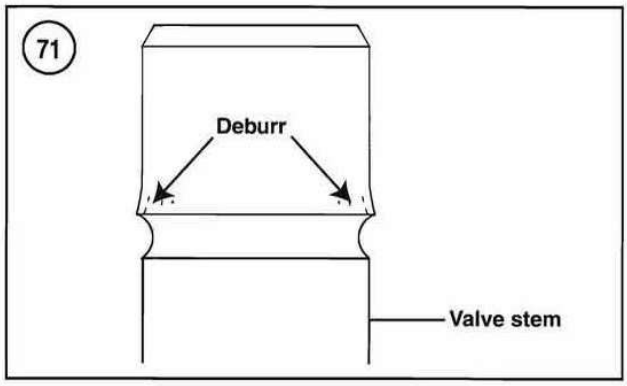


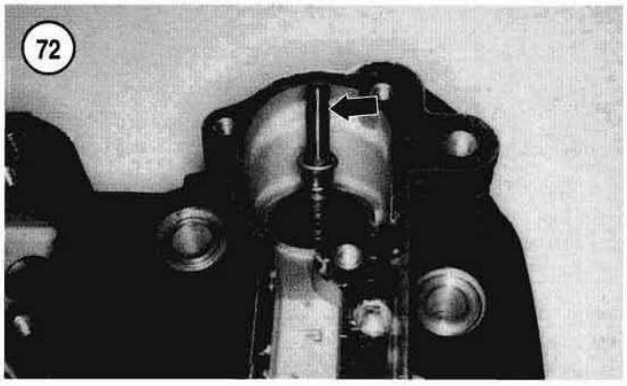


1. Valve keepers
2. Upper spring seat
3. Inner valve spring
4. Outer valve spring
5. Valve guide seal
6. Lower spring seat
7. Valve guide
8. Valve









9. Thoroughly clean the cylinder head.
10. Place a straightedge across the gasket surface at several points and measure for warp by attempting to insert a feeler gauge between the straightedge and cylinder head at each location (**Figure 67**). Maximum allowable warp is listed in **Table 2**. Distortion or nicks in the cylinder head surface could cause an air leak and result in overheating. If warp exceeds the limit, the cylinder head must be resurfaced or replaced. Consult with a Harley-Davidson dealership or machine shop experienced in this type of work.
11. Check the lower rocker housing mating surfaces for warp using the procedure in Step 10.
12. Check the valves and valve guides as described under *Valves and Valve Components* in this chapter.

VALVES AND VALVE COMPONENTS

Complete valve service requires a number of special tools, including a valve spring compressor to remove and install the valves. The following procedures describe how to check for valve component wear and to determine what type of service is required.

Refer to **Figure 68**.

Valve Removal

1. Remove the cylinder head as described in this chapter.
2. Install the valve spring compressor squarely over the valve spring upper retainer (**Figure 69**) and against the valve head.

CAUTION

To avoid loss of spring tension, compress the spring only enough to remove the valve keepers.

3. Tighten the valve spring compressor until the valve keepers separate from the valve stem. Lift the valve keepers out through the valve spring compressor with a magnet or needlenose pliers.
4. Gradually loosen the valve spring compressor and remove it from the cylinder head.
5. Remove the spring retainer (A, **Figure 70**) and the valve springs (B).

CAUTION

*Remove any burrs from the valve stem groove (**Figure 71**) before removing the valve (**Figure 72**); otherwise, the valve guide will be damaged as the valve stem passes through it.*

6. Remove the valve from the cylinder while rotating it slightly.
7. Remove the valve guide oil seal (**Figure 73**).
8. Remove the valve spring lower retainer (**Figure 74**).

CAUTION

Keep the components of each valve assembly together by placing each set in a divided carton, or into separate small boxes or small reclosable plastic bags. Identify the components as either intake or exhaust. If both cylinders are disassembled, also label the components as front and rear. Do not mix components from the valves, or excessive wear may result.

9. Repeat Steps 3-8 and remove the remaining valve.

Valve Installation

1. Clean the end of the valve guide.
2. Install the spring lower retainer (**Figure 74**). Push it down until it is seated on the cylinder head surface.
3. Coat a valve stem with Torco MPZ, molybdenum disulfide paste or equivalent. Install the valve partway into the guide. Then, slowly turn the valve as it enters the oil seal and continue turning it until the valve is installed all the way.
4. Work the valve back and forth in the valve guide to make sure the lubricant is distributed evenly within the valve guide.
5. Withdraw the valve and apply an additional coat of the lubricant.
6. Reinstall the valve into the valve guide but do not push the valve past the top of the valve guide.
7. Use isopropyl alcohol and thoroughly clean all traces of lubricant from the outer surface of the valve guide.

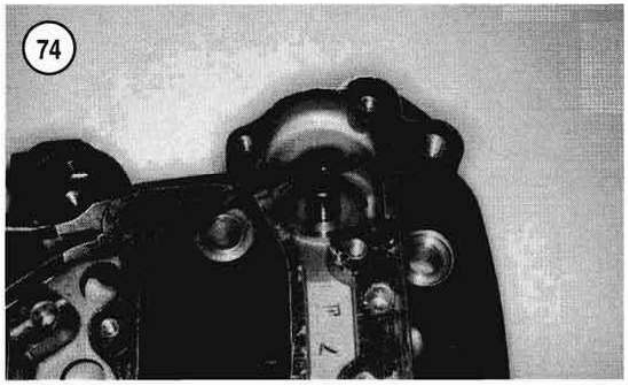
CAUTION

Do not allow any of the retaining compound to enter the valve guide bore.

8. Apply Loctite Retaining Compound RC 620 or an equivalent to the oil seal seating surface and to the outer surface of the valve guide.
9. Push the valve all the way into the cylinder head until it bottoms.

CAUTION

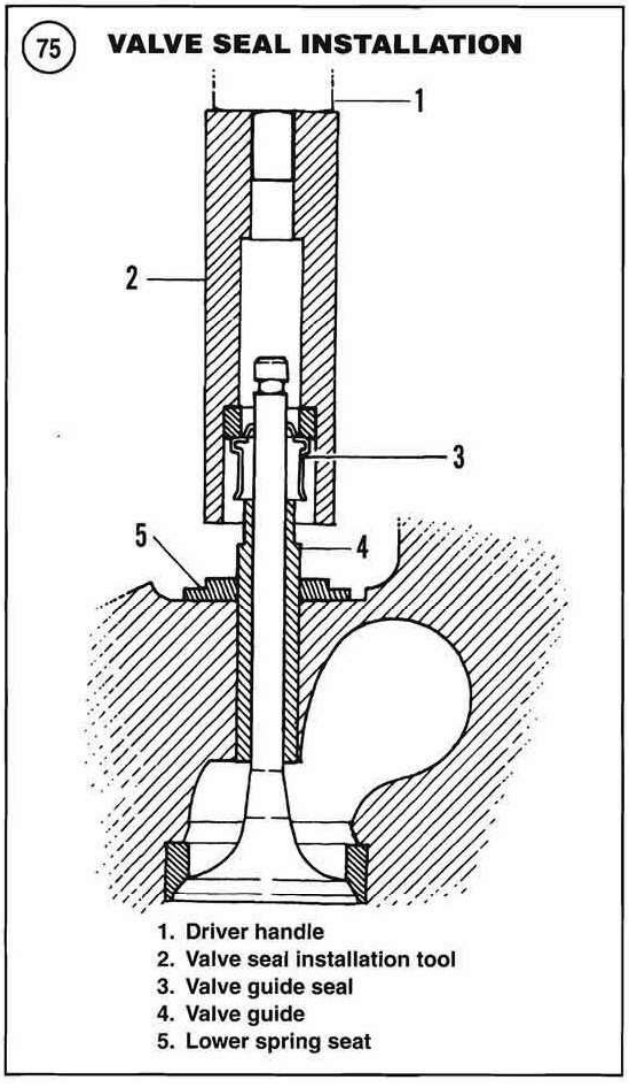
The oil seal will be torn as it passes the valve stem keeper groove if the plastic capsule is not installed in Step 10. The capsule is included in the top end gasket set.

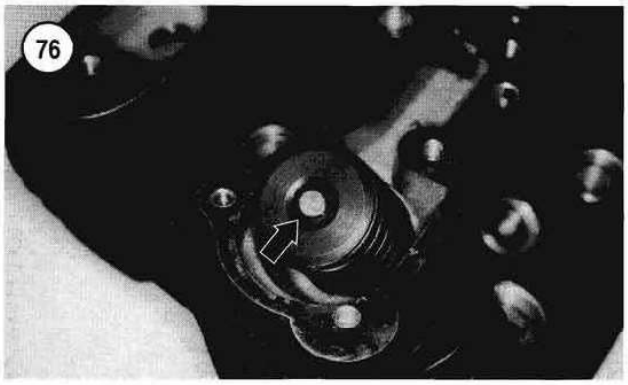


10. Hold the valve in place and install the plastic capsule onto the end of the valve stem. Apply a light coat of clean engine oil to the outer surface of the capsule.
11. With the valve held in place, install the oil seal onto the valve stem.
12A. If special tools are used, use JIMS Valve Guide Seal tool (part No. 34643-84) and driver handle (**Figure 75**) and push the oil seal down until it bottoms on the cylinder head surface.
12B. If special tools are not used, use an appropriately sized deep socket and push the oil seal down until it bottoms on the cylinder head surface.
13. Remove the plastic capsule from the valve stem. Keep the capsule as it will be used on the remaining valves.
14. Install the inner valve spring and make sure it is properly seated on the lower spring retainer.
15. Install the outer valve spring and make sure it is properly seated on the lower spring retainer.
16. Install the upper spring retainer on top of the valve springs.

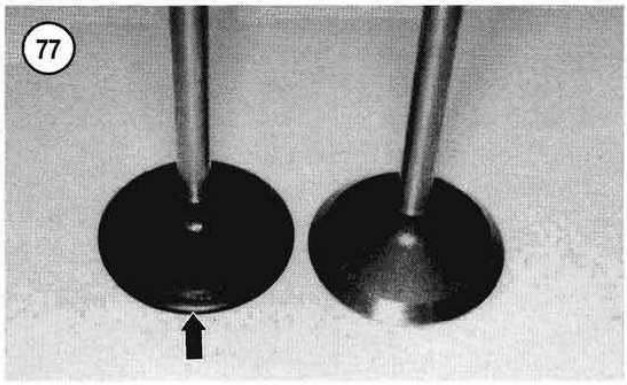
CAUTION

To avoid loss of spring tension, compress the springs only enough to install the valve keepers.





17. Compress the valve springs with a valve spring compressor (**Figure 69**) and install the valve keepers.
18. Make sure both keepers are seated around the valve stem prior to releasing the compressor.



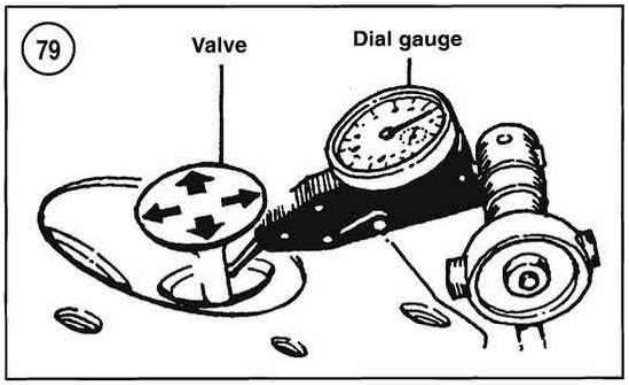
19. Slowly release tension from the compressor and remove it. After removing the compressor, inspect the valve keepers to make sure they are properly seated (**Figure 76**). Tap the end of the valve stem with a *soft-faced* hammer to ensure that the keepers are properly seated.
20. Repeat Steps 1-19 for the remaining valves.
21. Install the cylinder head as described in this chapter.

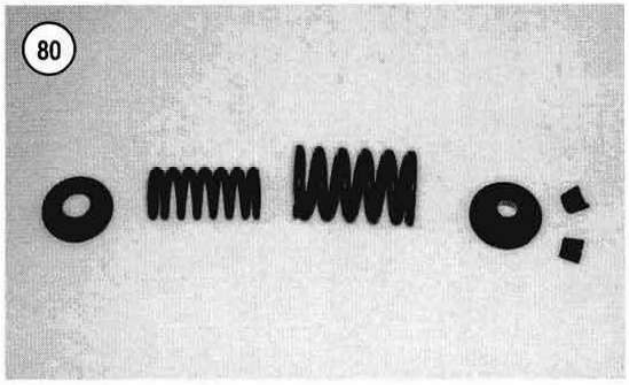
Valve Inspection

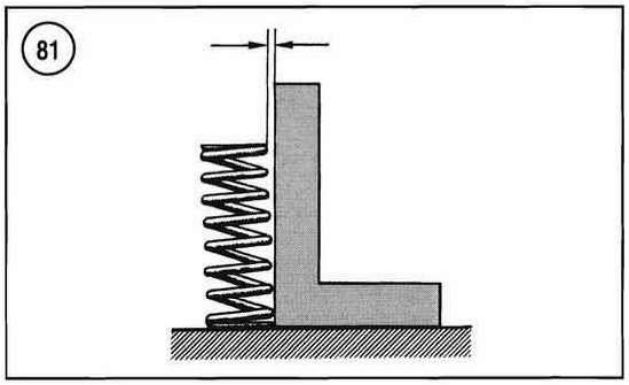
When measuring the valves and valve components in this section, compare the actual measurements to the new and wear limit specifications in **Table 2**. Replace parts that are out of specification or show damage as described in this section.

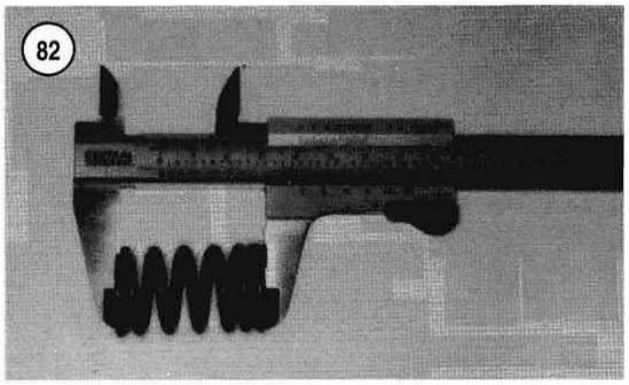
1. Clean valves in solvent. Do not gouge or damage the valve seating surface.
2. Inspect the valve face. Minor roughness and pitting (**Figure 77**) can be removed by lapping the valve as described in this chapter. Excessive unevenness to the contact surface is an indication that the valve is not serviceable.
3. Inspect the valve stem for wear and roughness. Then measure the valve stem outside diameter with a micrometer (**Figure 78**).

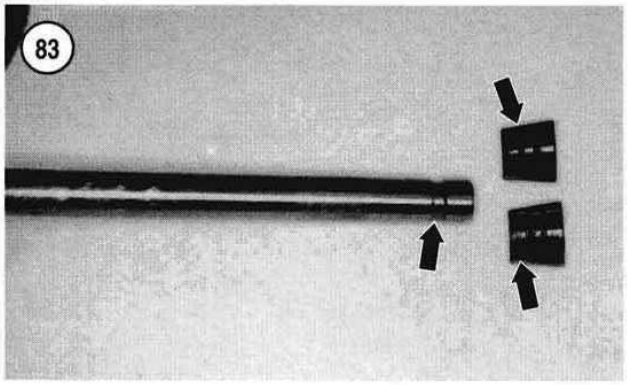
4. Remove all carbon and varnish from the valve guides with a stiff spiral wire brush before measuring wear.
5. Measure the valve guide inside diameter with a small hole gauge. Measure at the top, center and bottom positions. Then measure the small hole gauge.
6. Determine the valve stem-to-valve guide clearance by subtracting the valve stem outside diameter from the valve guide inner diameter. Compare this measurement to the specification listed in **Table 2**.
7. If a small hole gauge is not available, insert each valve into its guide. Attach a dial indicator to the valve stem next to the head (**Figure 79**). Hold the valve slightly off its seat and rock it sideways in both directions 90° to each other. If the valve rocks more than slightly, the guide is probably worn. However, as a final check, take the cylinder head to a Harley-Davidson dealership or machine shop and have the valve guides measured. Valve stem-to-guide clearance specifications are in **Table 2**.
8. Check the inner and outer valve springs as follows:
   a. Check each of the valve springs (**Figure 80**) for visual damage.
   b. Use a square and visually check the spring for distortion or tilt (**Figure 81**).
   c. Measure the valve spring free length with a vernier caliper (**Figure 82**) and check against the dimension in **Table 2**.
   d. Repeat for each valve spring.
   e. Replace defective springs as a set (inner and outer).
9. Check the valve spring upper and lower retainers seats for cracks or other damage.
10. Check the fit of the valve keepers on the valve stem end (**Figure 83**). The valve keepers must index tightly into the valve stem groove.
11. Inspect the valve seats (**Figure 84**) in the cylinder head. If worn or burned, they can be reconditioned as described in this chapter. Seats and valves in near-perfect condition can be reconditioned by lapping with fine Carborundum paste. Check as follows:
   a. Clean the valve seat and corresponding valve mating areas with contact cleaner.
   b. Coat the valve seat with layout fluid.
   c. Install the valve into its guide and rotate it against its seat with a valve lapping tool. Refer to *Valve Lapping* in this chapter.
   d. Lift the valve out of the guide and measure the seat width at various points around the seat with a vernier caliper.
   e. Compare the seat width with the specification in **Table 2**. If the seat width is less than specified or uneven, resurface the seats as described in this chapter.

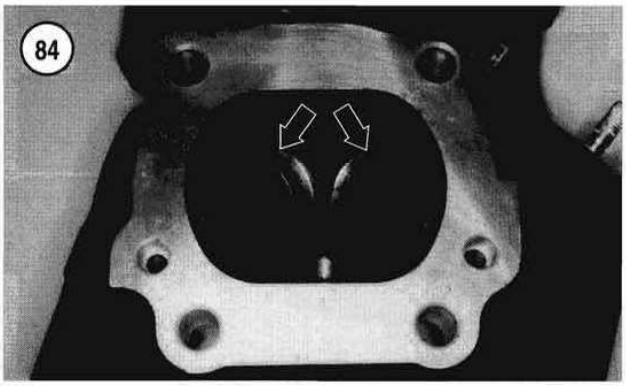


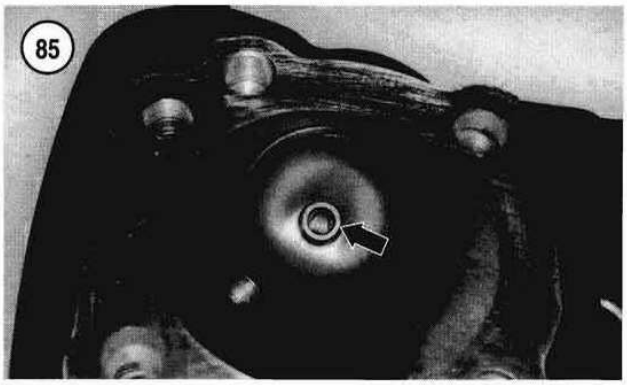


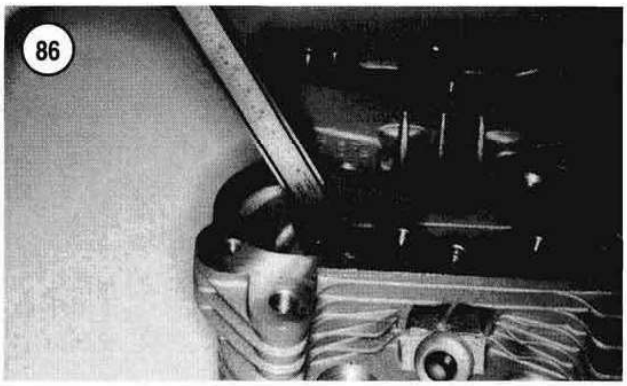












f. Remove all layout fluid residue from the seats and valves.

Valve Guide Replacement

Tools

The following tools or the equivalents are required to replace the valve guides.

1. Driver handle and remover (part No. HD-34740).
2. Valve guide installation sleeve (part No. HD-34741).
3. Valve guide reamer (part No. HD-39932) and T-handle (part No. HD-39847).
4. Valve guide reamer honing lubricant (part No. HD-39964).
5. Valve guide hone (part No. HD-34723).
6. Valve guide brush (part No. HD-34751).

Procedure

1. Place the cylinder head on a wooden surface with the combustion chamber side facing down.
2. Shoulderless valve guides (**Figure 85**) are used. Before the valve guides are removed, note and record the shape of the guide that projects into the combustion chamber. If the valve guide installation tool is *not* going to be used, measure the distance from the face of the guide to the cylinder head surface with a vernier caliper (**Figure 86**). Record the distance for each valve guide. The new valve guides must be installed to this *exact* same height dimension.
3. Remove the valve guides as follows:

CAUTION

Use the valve guide removal tool of the correct size when removing the valve guides; otherwise, the tool might expand the end of the guide. An expanded guide will widen and damage the guide bore in the cylinder head as it passes through it.

NOTE

The valve guides can either be pressed out or driven out. Pressing out is recommended because it lessens the chance of cylinder head damage.

a. Support the cylinder head so that the combustion chamber faces down.
b. If driving the guides out, place the cylinder head on a piece of wood.
c. If pressing the guides out, support the cylinder head in the press so that the valve guide is perpendicular

to the press table with a cylinder head stand (JIMS part No. 39782).

d. Insert the driver handle and remover into the top of the valve guide.
e. Press or drive the valve guide out through the combustion chamber.
f. Repeat substeps a-e for the remaining valve guides.

4. Clean the valve guide bores in the cylinder head.
5. Because the valve guide bores in the cylinder head might have enlarged during removal of the old guides, measure each valve guide bore prior to purchasing the new guides. Then purchase the new valve guides to match its respective bore diameter. Determine the bore diameter as follows:
   a. Measure the valve guide bore diameter in the cylinder head with a bore gauge or snap gauge. Record the bore diameter.
   b. The new valve guide outside diameter must be 0.0020-0.0033 in. (0.050-0.084 mm) larger than the guide bore in the cylinder head. When purchasing new valve guides, measure the outside of the new guide diameter with a micrometer. If the outside diameter is not within this specification, oversize valve guide(s) must be installed. See a Harley-Davidson dealership for available sizes.
6. Apply a thin coating of molylube or white grease to the entire outer surface of the valve guide before installing it in the cylinder head.

CAUTION

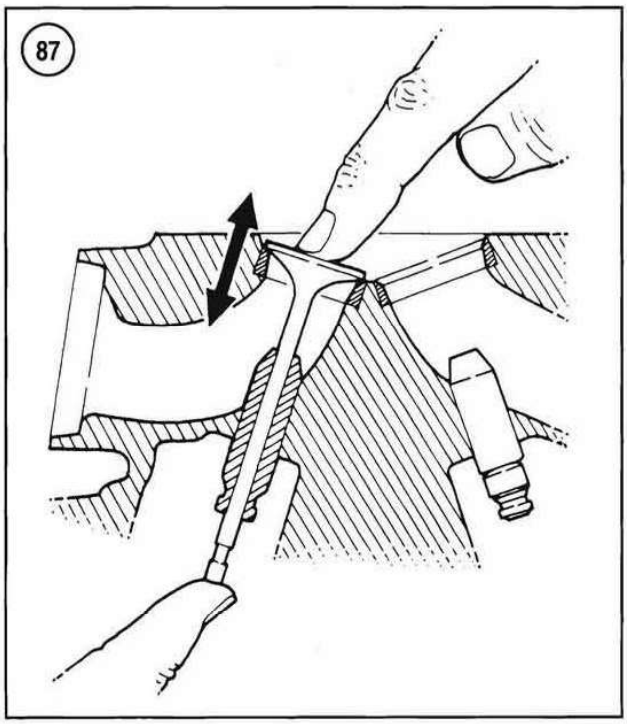
When installing oversize valve guides, make sure to match each guide to its respective bore in the cylinder head.

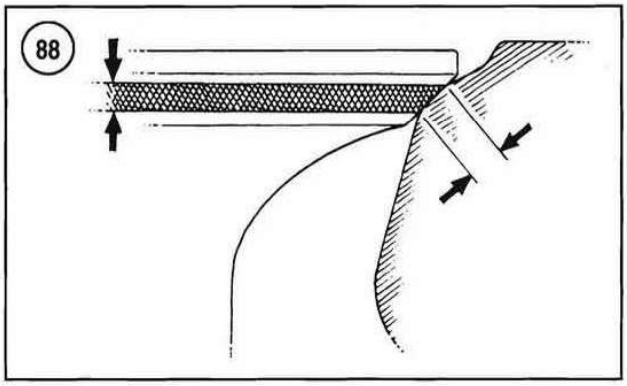
7. Install the new guide using the driver handle and valve guide installation tools. Press or drive the guide into the cylinder head until the valve guide installation tool bottoms out on the cylinder head surface. When the tool bottoms on the cylinder head surface, the valve guide is installed to the correct height. If the driver handle tool is not used, install the valve guide to the same height recorded prior to removing the valve guide; measure the valve guide installed height using a vernier caliper (**Figure 86**) when installing it.

NOTE

Replacement valve guides are sold with a smaller inside diameter than the valve stem, so the guide must be reamed to fit the valve stem.

8. Ream the new valve guide as follows:
   a. Apply a liberal amount of reamer lubricant to the ream bit and to the valve guide bore.



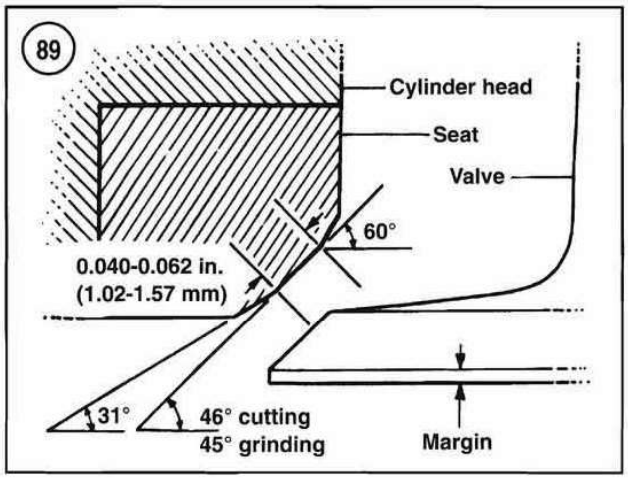


   b. Start the reamer straight into the valve guide bore.

CAUTION

Apply pressure only to the end of the drive socket. If pressure is applied to the T-handle, it will result in an uneven, rough cut and a tapered bore.

   c. Apply thumb pressure to the end of the drive socket portion of the T-handle while rotating the T-handle *clockwise*. Only *light* pressure is required. Apply additional lubricant to the reamer and into the valve guide while rotating the reamer.
   d. Continue to rotate the reamer until the entire bit has traveled through the valve guide and the shank of the reamer rotates freely.



CAUTION

Never back the reamer out through the valve guide because the guide will be damaged.

e. Remove the T-handle from the reamer. Remove the reamer from the combustion side of the cylinder head.

f. Apply low-pressure compressed air and clean the small shavings from the valve guide bore. Then clean the valve guide bore with the small spiral brush.

9. Hone the valve guide as follows:

a. Install the valve guide hone into a high-speed electric drill.

b. Lubricate the valve guide bore and hone stones with the reamer lubricant. *Do not* use motor oil.

c. Carefully insert the hone stones into the valve guide bore.

d. Start the drill and move the hone back and forth in the valve guide bore for ten to 12 complete strokes. Work for a 60° crosshatch pattern.

10. Repeat Steps 8 and 9 for each valve guide.

11. Soak the cylinder head in a container filled with hot soapy water. Then clean the valve guides with a valve guide brush or an equivalent bristle brush. *Do not* use a steel brush. Do not use cleaning solvent, kerosene or gasoline because these chemicals will not remove all of the abrasive particles produced during the honing operation. Repeat this step until all of the valve guides are thoroughly cleaned. Then rinse the cylinder head and valve guides in clear, cold water and dry with compressed air.

12. After cleaning and drying the valve guides, apply clean engine oil to the guides to prevent rust.

13. Resurface the valve seats as described in *Valve Seat Reconditioning* in this section.

Valve Seat Inspection

1. Remove all carbon residue from each valve seat. Then clean the cylinder head as described under *Valve Inspection* in this section.

NOTE

The most accurate method of checking the valve seat width and position is with machinist's dye.

2. Check the valve seats in their original locations with machinist's dye as follows:

a. Thoroughly clean the valve face and valve seat with contact cleaner.

b. Spread a thin layer of Prussian Blue or machinist's dye evenly on the valve face.

c. Insert the valve into its guide.

d. Support the valve by hand (**Figure 87**) and tap the valve up and down in the cylinder head. Do not rotate the valve, or a false reading will result.

e. Remove the valve and examine the impression left by the machinist's dye. The impressions on the valve and the seat must be even around their circumferences, and the width (**Figure 88**) must be within the specifications in **Table 2**. If the width is beyond the specification, or if the impression is uneven, recondition the valve seats.

3. Closely examine the valve seat in the cylinder head (**Figure 84**). It must be smooth and even with a polished seating surface.

4. If the valve seat is in good condition, install the valve as described in this chapter.

5. If the valve seat is not correct, recondition the valve seat as described in this section.

Valve Seat Reconditioning

Valve seat reconditioning requires considerable expertise and special tools. In most cases, it is more economical and practical to have these procedures performed by an experienced machinist.

The following procedure is provided for those equipped to perform the task. A Neway Valve seat cutter set (part No. HD-082454) or equivalent is required. Follow the manufacturer's instructions.

Refer to **Figure 89** for valve seat angles. Although the valve seat angles for both the intake and exhaust valves are the same, different cutter sizes are required. Also note that a 45° seat angle is specified when grinding the seats, but a 46° seat angle is specified when cutting seats.

1. Clean the valve guides as described under *Valve Inspection* in this section.

2. Carefully rotate and insert the solid pilot into the valve guide. Make sure the pilot is correctly seated.

CAUTION

Valve seat accuracy depends on a correctly sized and installed pilot.

3. Using the 45° grinding stone or 46° cutter, descale and clean the valve seat with one or two turns.

CAUTION

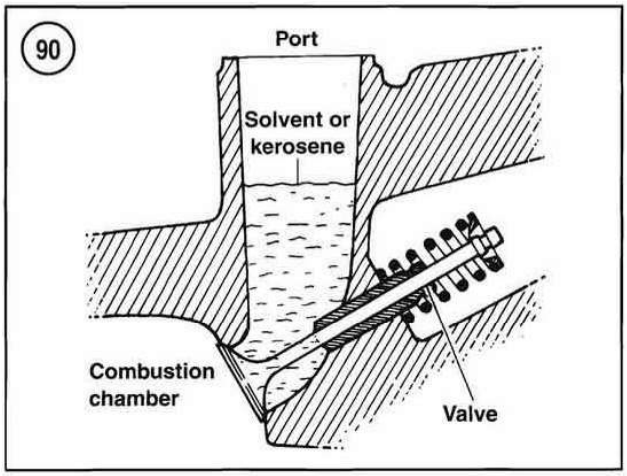
*Measure the valve seat contact area in the cylinder head (**Figure 88**) after each cut to make sure its size and area are correct. Overgrinding will sink the valves too far into the cylinder head and require replacement of the valve seat.*

4. If the seat is still pitted or burned, turn the cutter until the surface is clean. Work slowly and carefully to avoid removing too much material from the valve seat.
5. Remove the pilot from the valve guide.
6. Apply a small amount of valve lapping compound to the valve face and install the valve. Using a valve lapping tool, rotate the valve against the valve seat. Remove the valve.
7. Measure the valve seat with a vernier caliper (**Figure 88**). Record the measurement to use as a reference point when performing the following.

CAUTION

The 31° cutter removes material quickly. Work carefully and check the progress often.

8. Reinsert the solid pilot into the valve guide. Be certain the pilot is properly seated. Install the 31° cutter onto the solid pilot and lightly cut the seat to remove one fourth of the existing valve seat.
9. Install the 60° cutter onto the solid pilot and lightly cut the seat to remove the lower fourth of the existing valve seat.
10. Measure the valve seat with a vernier caliper. Then fit the 45° grinding stone or 46° cutter onto the solid pilot and cut the valve seat to the specified seat width in **Table 2**.
11. When the valve seat width is correct, check valve seating as follows.
12. Remove the solid pilot from the cylinder head.
13. Inspect the valve seat-to-valve face impression as follows:
    a. Clean the valve seat with contact cleaner.
    b. Spread a thin layer of Prussian Blue or machinist's dye evenly on the valve face.
    c. Insert the valve into its guide.

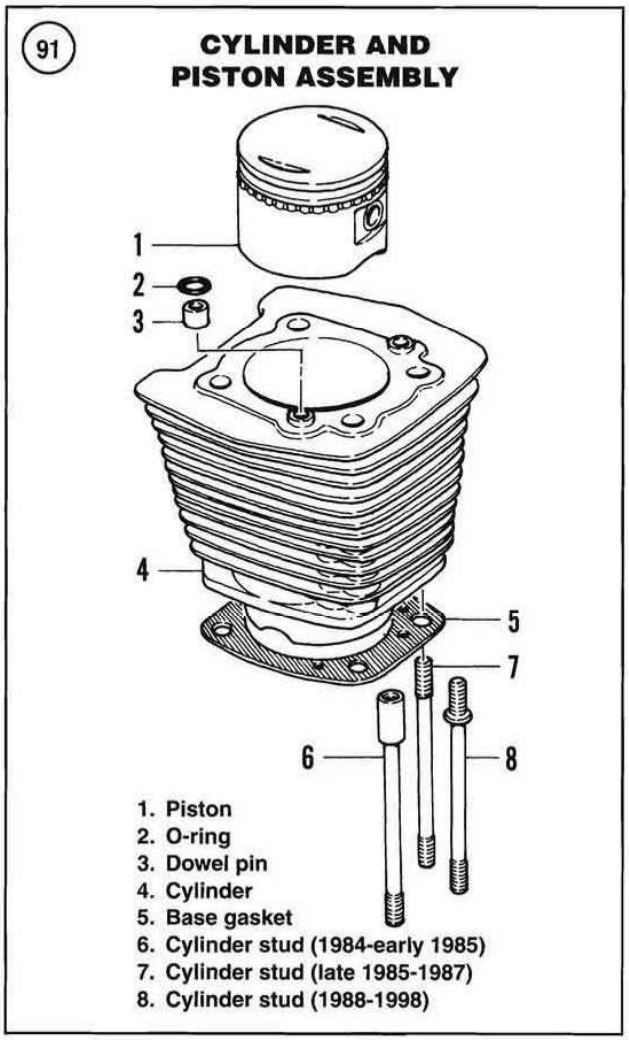


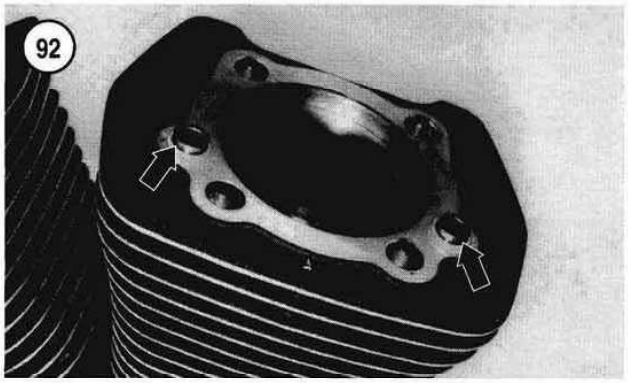
    d. Support the valve with two fingers and turn it with the valve lapping tool.
    e. Remove the valve and examine the impression left by the Prussian Blue or machinist's dye.
    f. Measure the valve seat width (**Figure 88**). Refer to **Table 2** for the correct seat width.
    g. The valve seat contact area must be in the center of the valve face area.
14. If the contact area is too high on the valve, or if it is too wide, cut the seat with the 31° cutter. This will remove part of the top valve seat area to lower or narrow the contact area.
15. If the contact area is too low on the valve, or if it is too wide, use the 60° cutter and remove part of the lower area to raise and widen the contact area.
16. After obtaining the desired valve seat position and angle, use the 45° grinding stone or the 46° cutter and very lightly clean off any burrs caused by the previous cuts.
17. When the contact area is correct, lap the valve as described in this chapter.
18. Repeat Steps 1-17 for the remaining valve seats.
19. Thoroughly clean the cylinder head and all valve components in solvent. Then clean with detergent and hot water and rinse in cold water. Dry with compressed air. Then apply a light coat of engine oil to all nonaluminum metal surfaces to prevent rust formation.

Valve Lapping

If valve wear or distortion is not excessive, attempt to restore the valve seal by lapping the valve to the seat.

After lapping the valves, install the valve assemblies and test each valve seat for a good seal by pouring solvent into the ports (**Figure 90**). If the seal is good, no solvent will leak past the seat surface. If solvent leaks past any





seat, the combustion chamber will appear wet. Disassemble the leaking valve and repeat the lapping procedure or recondition the valve as described in this chapter.

1. Smear a light coating of fine-grade valve lapping compound on the seating surface of the valve.
2. Insert the valve into the head.
3. Wet the suction cup of the lapping tool and stick it to the head of the valve. Lap the valve to the seat by spinning the tool between both hands while lifting and moving the valve around the seat one-fourth turn at a time.
4. Wipe off the valve and seat frequently to check the progress. Lap only enough to achieve a precise seating ring around valve head.
5. Closely examine the valve seat in the cylinder head. The seat must be smooth and even with a polished seating ring.
6. Thoroughly clean the valves and cylinder head in solvent to remove all grinding compound residue. Compound left on the valves or the cylinder head will cause rapid engine wear.
7. After installing the valves into the cylinder head, test each valve for proper seating. Check by pouring solvent into the intake and exhaust ports. Solvent must not leak past the valve seats. If leakage occurs, the combustion chamber will appear wet. If solvent leaks past any of the seats, disassemble that valve assembly and repeat the lapping procedure until there are no leaks.

Valve Seat Replacement

Valve seat replacement requires considerable experience and equipment. Refer this work to a Harley-Davidson dealership or machine shop.

CYLINDER

Removal

Refer to **Figure 91**.

1. Remove the cylinder head as described in this chapter.
2. Remove all dirt and foreign material from the cylinder base.
3. Remove the two dowel pins and O-rings (**Figure 92**) from the top of the cylinder.
4. Turn the engine until the piston is at bottom dead center (BDC).

NOTE

The front and rear cylinders are identical (same part number). Mark each cylinder so they will be installed in their original positions.

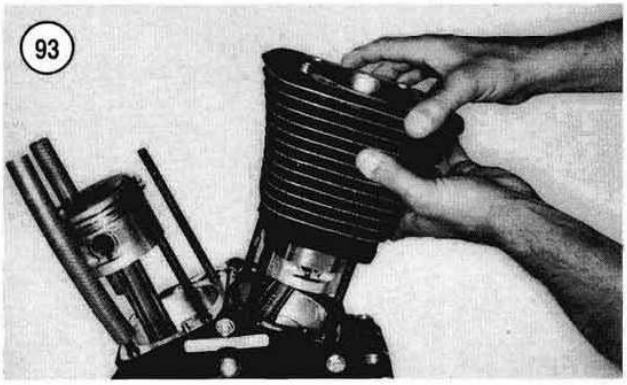
5. Loosen the cylinder by tapping around the perimeter with a plastic mallet.
6. Pull the cylinder straight up (**Figure 93**) and off the piston and cylinder studs.

7. Stuff clean shop rags into the crankcase opening to prevent objects from falling into the crankcase.
8. Install a vinyl or rubber hose over the studs (A, **Figure 94**). This will protect both the piston and studs from damage.

CAUTION

After removing the cylinder, be careful when working around the cylinder studs to avoid bending or damaging them. The slightest bend could cause a stud to fail.

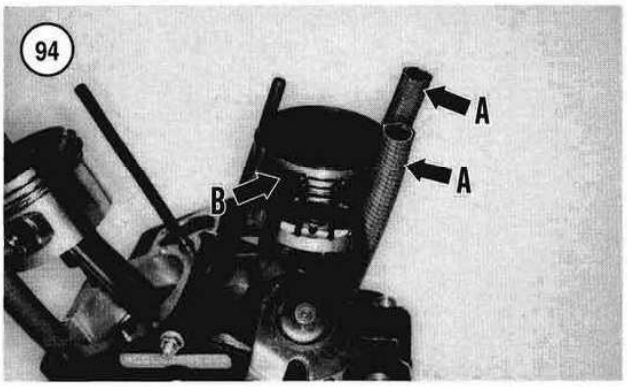
9. Repeat Steps 1-8 for the other cylinder.



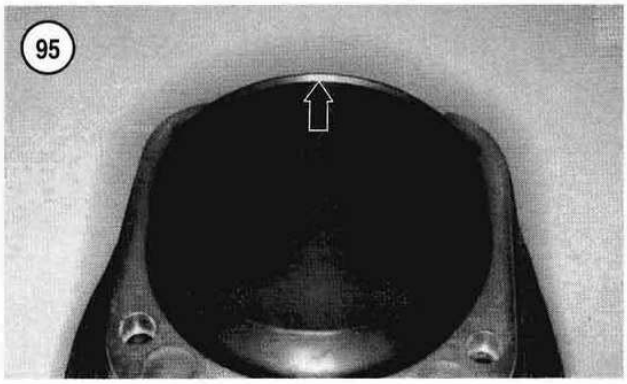
Installation

NOTE

*When a cylinder has been bored oversize, the inner lead-in angle at the base of the bore skirt (**Figure 95**) has been eliminated. This lead-in angle is necessary so the piston rings can safely enter the cylinder bore. If necessary, use a chamfering cone (JIMS part No. 2078) or a hand grinder with a fine stone and grind in a new lead-in angle. The finished surface must be smooth so it will not catch and damage the piston rings during installation.*



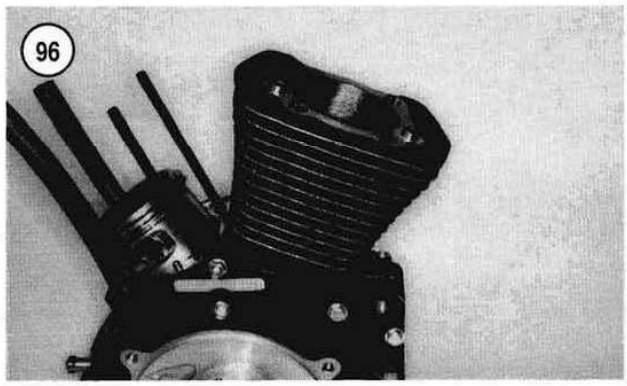
1. If removed, install the pistons and rings as described in this chapter.
2. Remove all gasket residue and clean the cylinder as described under *Inspection* in this chapter.
3. Remove the vinyl or rubber hose from each stud.
4. If removed, install the locating dowels into the crankcase.
5. Turn the crankshaft until the piston is at top dead center (TDC).
6. Lubricate the cylinder bore, piston and piston rings liberally with clean engine oil.
7. Correctly position the piston ring end gaps as described under *Piston Ring Replacement* in this chapter.
8. Compress the piston rings with a ring compressor (B, **Figure 94**).

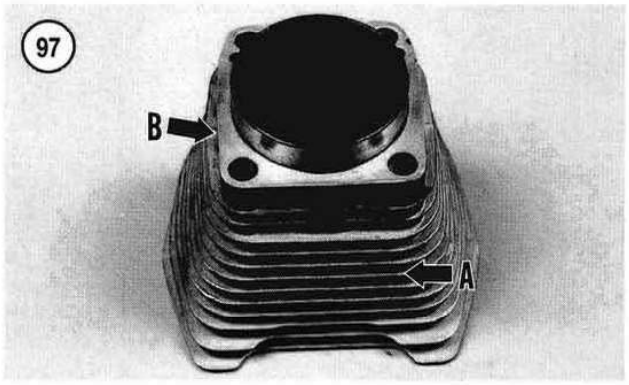


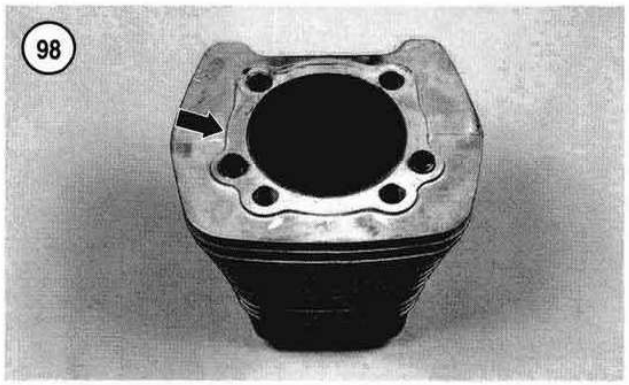
NOTE

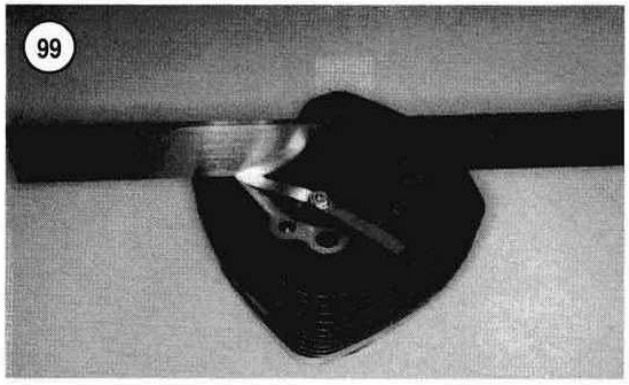
Install the cylinder in its original position as noted during removal.

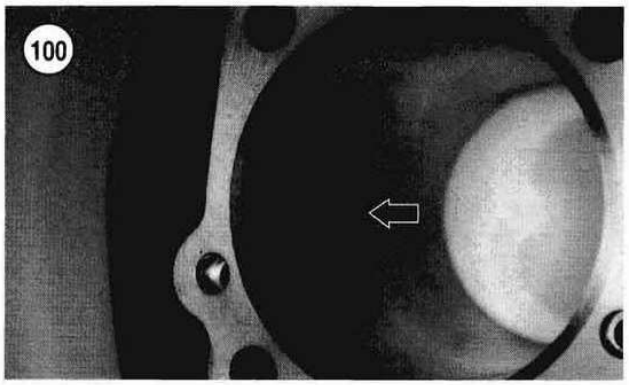
9. Carefully align the cylinder (front facing forward) with the cylinder studs and slide it down until it is over the top of the piston. Then continue sliding the cylinder down and past the rings. Remove the ring compressor once the piston rings enter the cylinder bore. Remove the shop rag from the crankcase opening.











10. Continue to slide the cylinder down (**Figure 93**) until it bottoms out on the crankcase (**Figure 96**).
11. Repeat to install the other cylinder.
12. Install the cylinder heads as described in this chapter.

Inspection

The pistons on all models cannot be accurately measured with standard measuring instruments and techniques. This is because the piston has a complex shape due to its design and manufacturing.

Piston-to-cylinder clearance is checked by measuring the cylinder bore only. If a cylinder is worn, the cylinder must be bored to specific factory specifications and not to match a particular piston size as with conventional methods. Refer piston-to-cylinder matching to a Harley-Davidson dealership.

The following procedure requires the use of highly specialized and expensive measuring instruments. If such instruments are not readily available, have the measurements performed by a Harley-Davidson dealership or qualified machine shop.

To obtain an accurate cylinder bore measurement, the cylinder must be tightened between torque plates (JIMS part No. 1287). Measurements made without the torque plates will be inaccurate and may vary by as much as 0.001 in. (0.025 mm). Refer this procedure to a shop equipped and experienced with this procedure if the tools are not available. The cylinder bore must be thoroughly clean and at room temperature to obtain accurate measurements. Do not measure the cylinder immediately after it has been honed because it will still be warm. Measurements can vary by as much as 0.002 in. (0.051 mm) if the cylinder block is not at room temperature.

1. Thoroughly clean the outside of the cylinder. Use a stiff brush, soap and water and clean all debris from the cooling fins (A, **Figure 97**). If necessary, use a piece of wood and scrape away any lodged dirt. Clogged cooling fins can cause overheating leading to possible engine damage.
2. Carefully remove all gasket residue from the top (**Figure 98**) and bottom (B, **Figure 97**) cylinder block gasket surfaces.
3. Thoroughly clean the cylinder with solvent and dry with compressed air. Lightly oil the cylinder block bore to prevent rust.
4. Check the top and bottom cylinder gasket surfaces with a straightedge and feeler gauge (**Figure 99**). Replace the cylinder if warp exceeds the limit in **Table 2**.
5. Check the cylinder bore (**Figure 100**) for scuff marks, scratches or other damage.

6. Install the torque plate onto the cylinder (**Figure 101**) following the manufacturer's instructions.

7. Measure the cylinder bore with a bore gauge or inside micrometer at the positions indicated in **Figure 102**. Perform the first measurement 0.500 in. (12.7 mm) below the top of the cylinder (**Figure 103**). Do not measure areas where the rings do not travel.

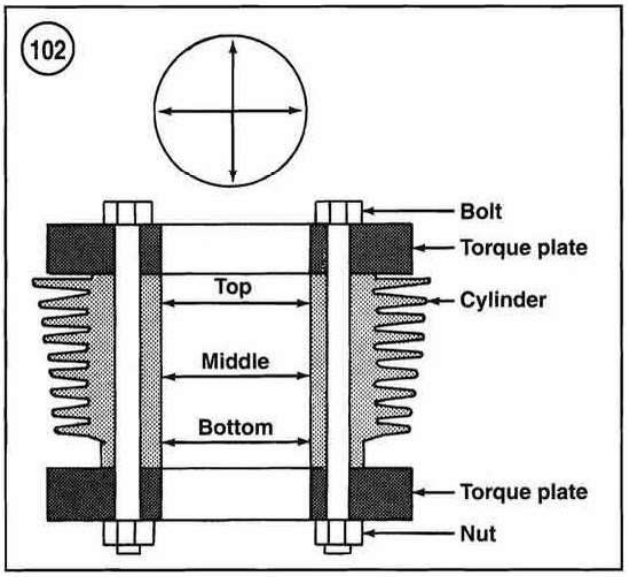
8. Measure in two axes: aligned with the piston pin and at 90° to the pin. If the taper or out-of-round measurements exceed the service limits in **Table 2**, bore both cylinders to the next oversize and install oversize pistons and rings. Confirm the accuracy of all measurements and consult with a parts supplier on the availability of replacement parts before having the cylinder serviced.

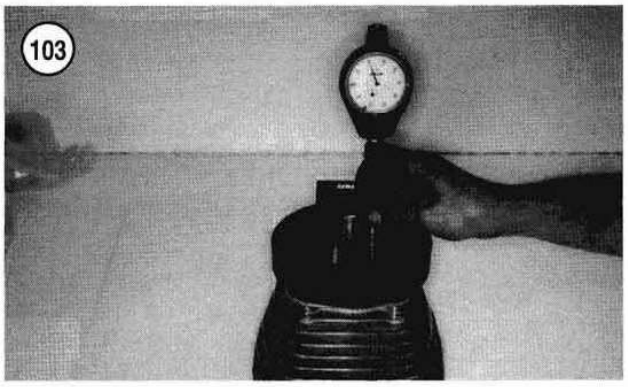
9. Remove the torque plates.

10. If the cylinders were serviced, wash each cylinder in hot soapy water to remove the fine gritty material left from the boring or honing process. After washing, run a clean white cloth through the cylinder bore. If the cloth shows traces of grit or oil, the bore is not clean. Repeat until the cloth passes through cleanly. When the bore is clean, dry with compressed air. Then lubricate with clean engine oil to prevent the bore from rusting.

CAUTION

The use of hot soapy water is the only procedure that will completely clean the cylinder bore. Solvent and kerosene cannot wash fine grit out of the cylinder crevices. Abrasive grit left in the cylinder will cause premature engine wear.





Cylinder Studs and Cylinder Head Bolts Inspection and Cleaning

The cylinder studs and cylinder head bolts must be in good condition and properly cleaned prior to installing the cylinder and cylinder heads. Damaged or dirty studs may cause cylinder head distortion and gasket leakage.

CAUTION

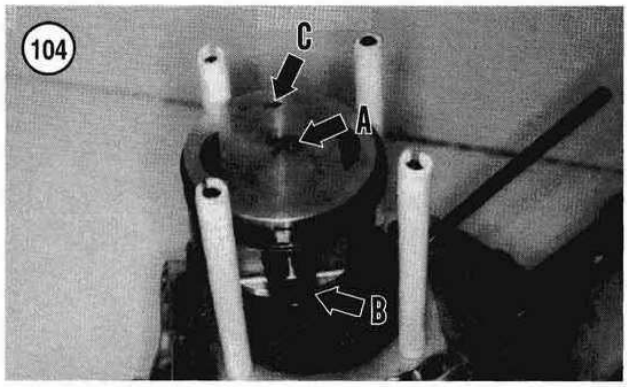
The cylinder studs, cylinder head bolts and washers consist of hardened material. Do not substitute these items with a part made of a lower grade material. If replacement is required, purchase the parts from the manufacturer.

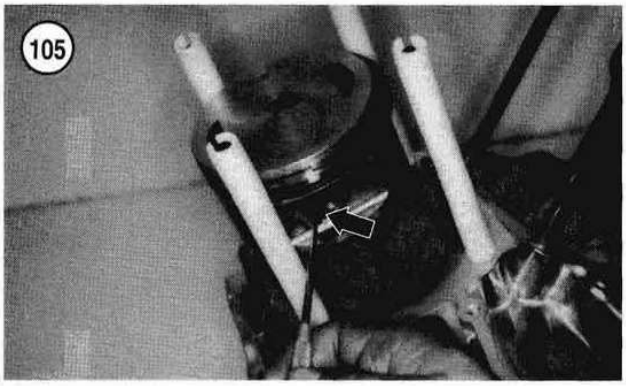
1. Inspect the cylinder head bolts. Replace any that are damaged.

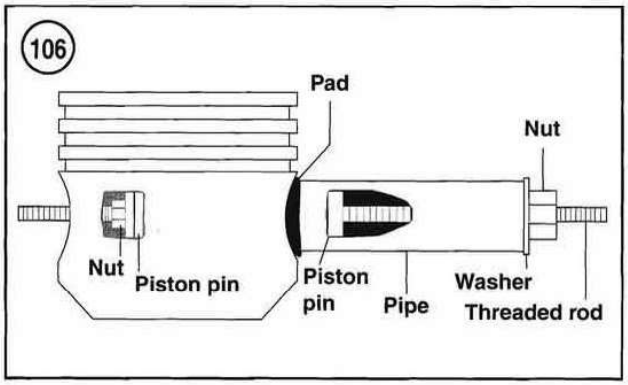
2. Examine the cylinder studs for bending, looseness or damage. Replace studs as described under *Cylinder Stud Replacement* in this chapter. If the studs are in good condition, perform Step 3.

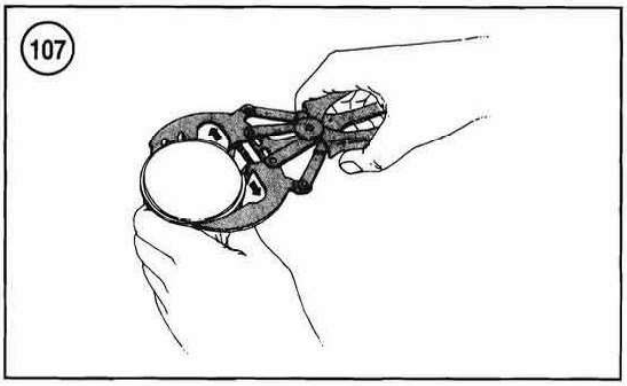
3. Cover both crankcase openings with shop rags to prevent debris from falling into the engine.

4. Remove all carbon residue from the cylinder studs and cylinder head bolts as follows:









a. Apply solvent to the cylinder stud and mating cylinder head bolt threads and thread the bolt onto the stud.
b. Turn the cylinder head bolt back and forth to loosen and remove the carbon residue from the threads. Remove the bolt from the stud. Wipe off the residue with a shop rag moistened in cleaning solvent.
c. Repeat until both thread sets are free of all carbon residues.
d. Spray the cylinder stud and cylinder head bolt with an aerosol parts cleaner and allow them to dry.
e. Set the cleaned bolt aside and install it on the same stud when installing the cylinder head.

5. Repeat Step 4 for each cylinder stud and cylinder head bolt set.

PISTONS AND PISTON RINGS

Refer to **Figure 91**.

Piston and Piston Rings Removal

1. Remove the cylinder as described in this chapter.
2. Cover the crankcase with clean shop rags.
3. Lightly mark the pistons with an *F* (front) or *R* (rear) (A, **Figure 104**).

WARNING

The piston pin retaining rings may spring out of the piston during removal. Wear safety glasses when removing them in Step 4.

4. Using an awl, pry the piston pin retaining rings (**Figure 105**) out of the piston. Place a thumb over the hole to help prevent the rings from flying out during removal.

NOTE

Mark the piston pins so they can be reinstalled into their original pistons.

5. Support the piston and push out the piston pin (B, **Figure 104**). If the piston is difficult to remove, use a piston pin removal tool (**Figure 106**).
6. Remove the piston from the connecting rod.
7. Remove the piston rings using a ring expander tool (**Figure 107**) or spread them by hand (**Figure 108**) and remove them.
8. Inspect the pistons, piston pins and piston rings as described in this chapter.

Piston Inspection

1. If necessary, remove the piston rings as described in this chapter.

2. Carefully clean the carbon from the piston crown (**Figure 109**) with a soft scraper. Large carbon accumulations reduce piston cooling and result in detonation and piston damage. Re-letter the piston as soon as it is cleaned to keep it properly identified.

CAUTION

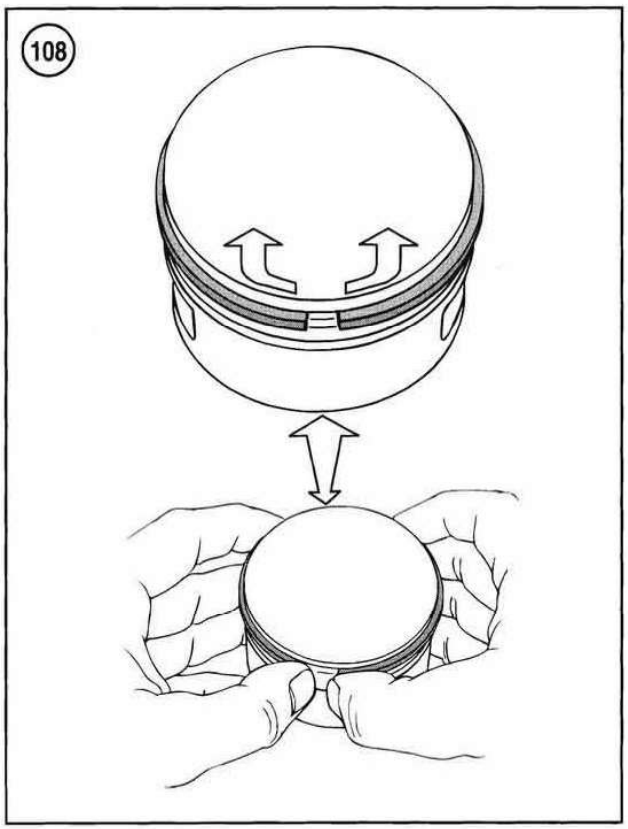
Be very careful not to gouge or otherwise damage the piston when removing carbon. Never use a wire brush to clean the piston ring grooves. Do not attempt to remove carbon from the sides of the piston above the top ring or from the cylinder bore near the top. Removal of carbon from these two areas may cause increased oil consumption.

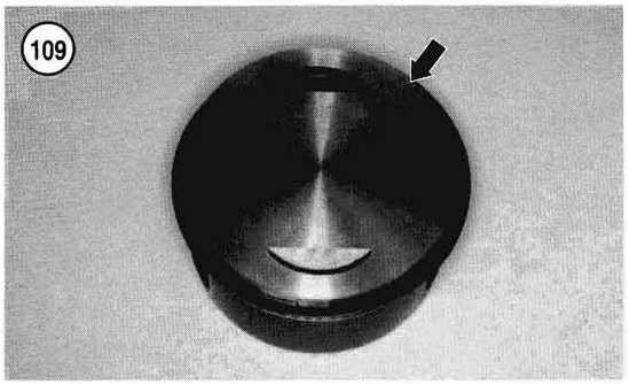
3. After cleaning the piston, examine the crown. The crown should show no signs of wear or damage. If the crown appears pecked or spongy-looking, also check the spark plug, valves and combustion chamber for aluminum deposits. If these deposits are found, the engine is overheating.
4. Examine each ring groove for burrs, dented edges or other damage. Pay particular attention to the top compression ring groove as it usually wears more than the others. The oil rings and grooves generally wear less than compression rings and their grooves. If there is evidence of oil ring groove wear, or if the oil ring assembly is tight and difficult to remove, the piston skirt might have collapsed due to excessive heat and become permanently deformed. Replace the piston.
5. Check the piston skirt for cracks or other damage. If a piston shows signs of partial seizure (bits of aluminum buildup on the piston skirt), the piston should be replaced to reduce the possibility of engine noise and further piston seizure.

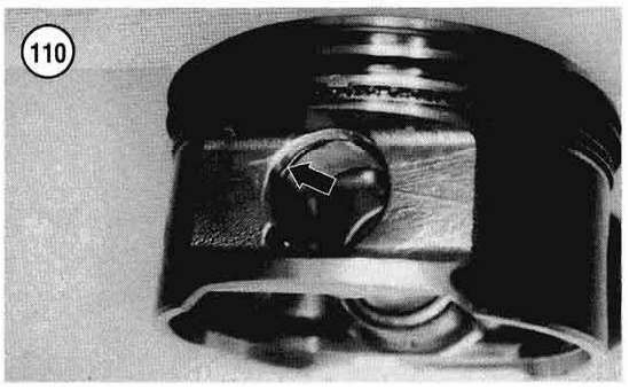
NOTE

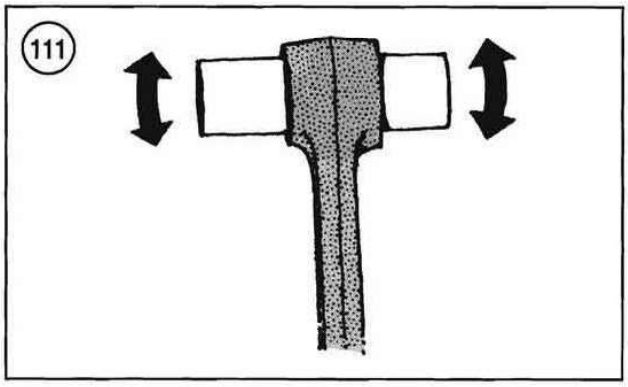
If the piston skirt is worn or scuffed unevenly from side-to-side, the connecting rod might be bent or twisted.

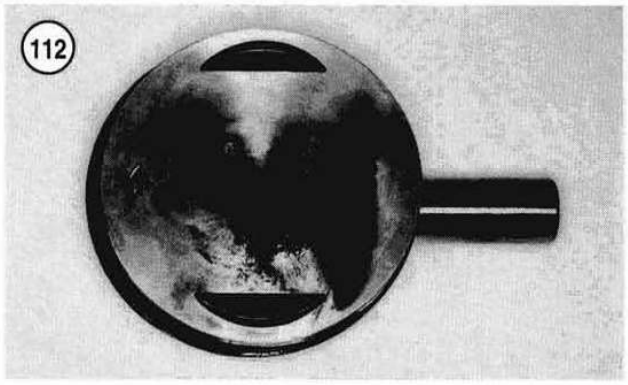
6. Check the circlip groove (**Figure 110**) on each side for wear, cracks or other damage. If the grooves are questionable, check the circlip fit by installing a new circlip into each groove and then attempt to move the circlip from side to side. If the circlip has any side play, the groove is worn, and the piston must be replaced.
7. Measure piston-to-cylinder clearance as described under *Cylinder Inspection* in this chapter.
8. If damage or wear indicates piston replacement, select a new piston as described under *Piston Clearance* in this chapter. If the piston, rings and cylinder are not damaged and are dimensionally correct, they can be reused.

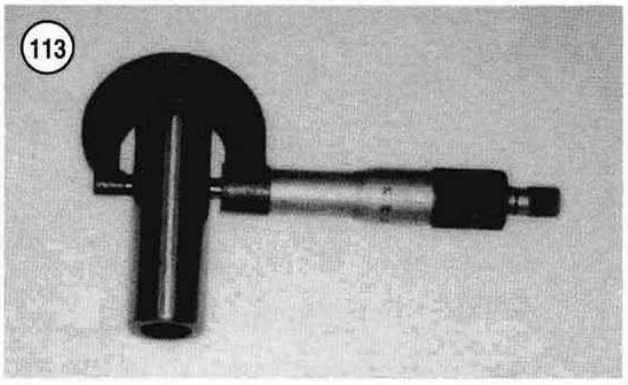


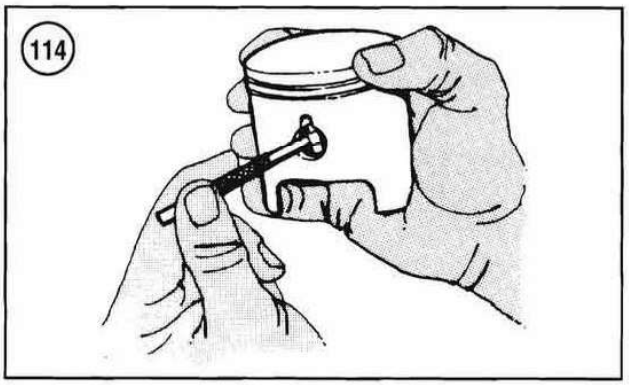


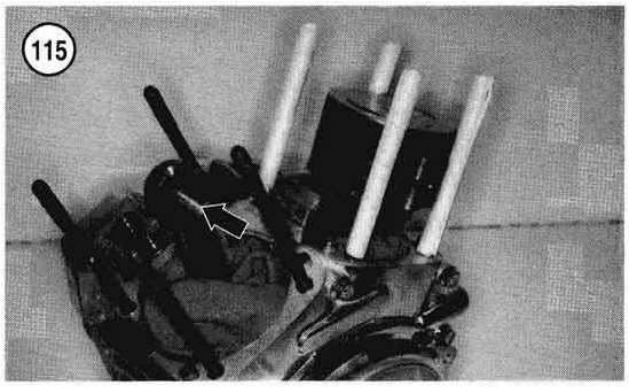












Piston Pin Inspection and Clearance

1. Clean the piston pin in solvent and dry thoroughly.
2. Inspect the piston pin for chrome flaking or cracks. Replace if necessary.
3. Oil the piston pin and install it in the connecting rod (**Figure 111**). Slowly rotate the piston pin and check for radial play.
4. Oil the piston pin and install it in the piston (**Figure 112**). Check the piston pin for excessive play.
5. To measure piston pin-to-piston clearance, perform the following:
   a. Measure the piston pin outer diameter with a micrometer (**Figure 113**).
   b. Measure the inside diameter of the piston pin bore (**Figure 114**) with a snap gauge. Measure the snap gauge with a micrometer.
   c. Subtract the piston pin outer diameter from the piston pin bore to obtain the clearance dimension. Check against the specification in **Table 2**.
   d. If out of specification, replace the piston and/or the piston pin.
6. Replace the piston pin and/or piston or connecting rod if necessary.

Piston Pin Bushing in Connecting Rod Inspection and Replacement

The piston pin bushings are reamed to provide correct piston pin-to-bushing clearance. This clearance is critical in preventing pin knock and top-end damage.

1. Inspect the piston pin bushings (**Figure 115**) for excessive wear or damage (pit marks, scoring or wear grooves). Then check to make sure the bushing is not loose. The bushing must be a tight fit in the connecting rods.
2. Measure the piston pin diameter (**Figure 113**) where it contacts the bushing.

3. Measure the piston pin bushing inside diameter using a snap gauge (**Figure 116**).
4. Subtract the piston pin outer diameter from bushing inner diameter to determine piston pin clearance. Replace the pin and bushing if they are worn to the service limit in **Table 2**.

Piston Pin Bushing Replacement

Tools

The following special tools are required to replace and ream the piston pin bushings. The clamp tool is required only if the bushing is being replaced with the crankcase assembled. If these tools are not available, have a shop with the proper equipment perform the procedure.

1. Connecting rod clamp tool (JIMS part No. 1248).
2. Connecting rod bushing tool (JIMS part No. 95970-32C).
3. Connecting rod bushing reamer tool (JIMS part No. 1726-1).
4. Connecting rod bushing hone (HD-422569).

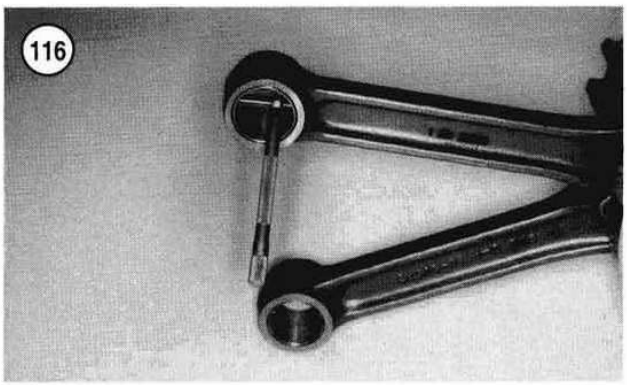
Procedure

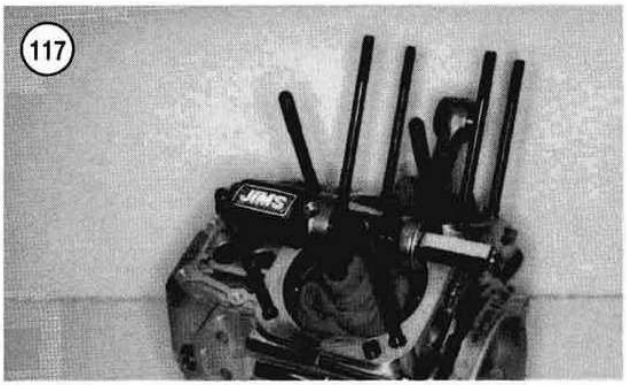
1. Remove two of the plastic hoses protecting the cylinder studs.
2. Install the connecting rod clamping tool as follows:
   a. Install the clamp portion of the connecting rod clamping tool over the connecting rod so the slots engage the cylinder head studs. Do not scratch or bend the studs.
   b. Position the threaded cylinders with the knurled end facing up and install the cylinders onto the studs. Tighten securely to hold the clamp in place.
   c. Alternately tighten the thumbscrews onto the side of the connecting rod. Do not turn only one thumbscrew, as this will move the connecting rod off center and when tightening the other thumbscrew will cause the connecting rod to flex or bend.
3. Cover the crankcase opening to keep bushing particles from falling into the engine.

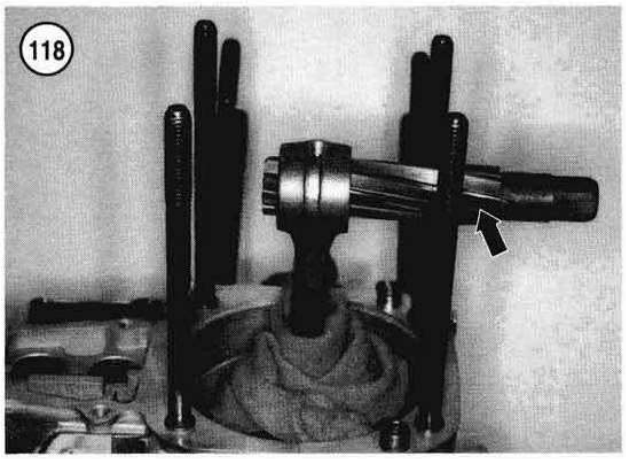
NOTE

When installing the new bushing, align the oil slot in the bushing with the oil hole in the connecting rod.

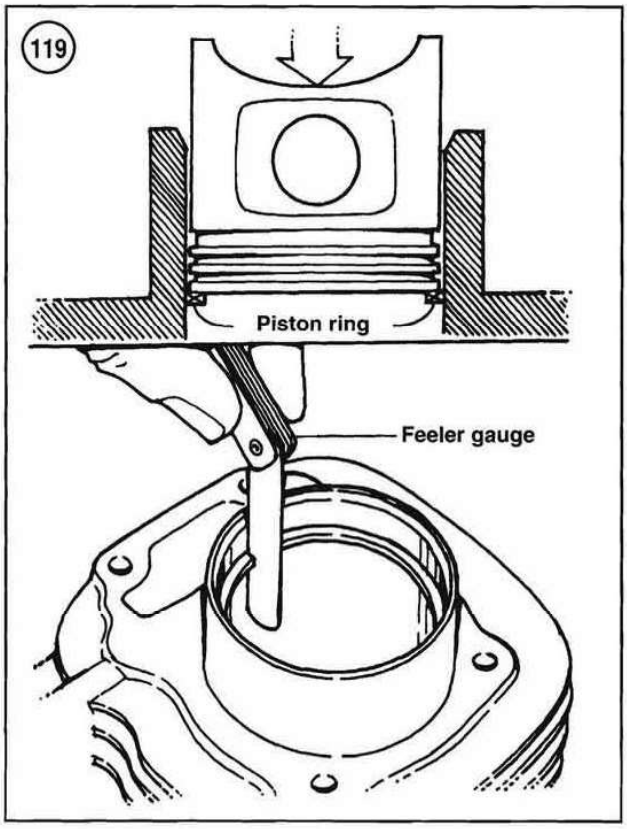
4. Following the tool manufacturer's instructions, replace the bushing using the connecting rod bushing tool (**Figure 117**). The new bushing must be flush with both sides of the connecting rod.

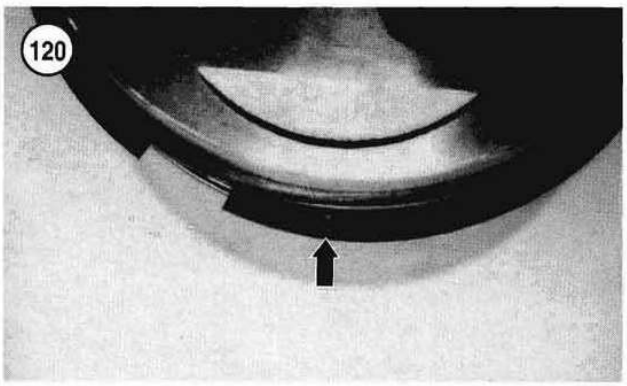


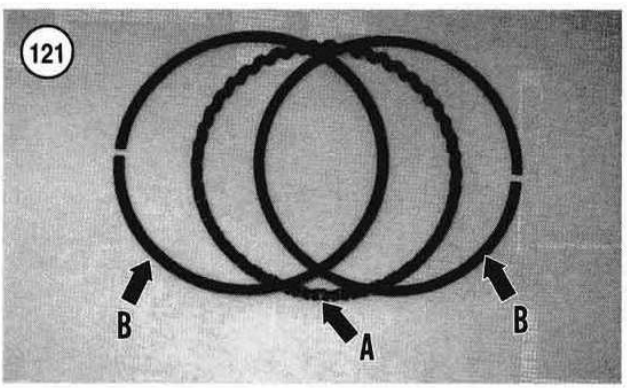




5. Following the manufacturer's instructions, ream the piston pin with the bushing reamer tool (**Figure 118**).
6. Hone the new bushing to obtain the piston pin clearance specified in **Table 2**. Use honing oil, not engine oil, when honing the bushing to size.
7. Install the piston pin through the bushing. The pin must move through the bushing smoothly. Confirm pin clearance using a micrometer and bore gauge.
8. Carefully remove all metal debris from the crankcase.







Piston Ring Inspection

1. Clean the piston ring grooves as described under *Piston Inspection*.
2. Inspect the ring grooves for burrs, nicks, or broken or cracked lands. Replace the piston if necessary.
3. Insert one piston ring into the top of its cylinder and tap it down approximately 1/2 in. (12.7 mm) while using the piston to square it in the bore. Measure the ring end gap (**Figure 119**) with a feeler gauge and compare with the specification in **Table 2**. Replace the piston rings as a set if any one ring end gap measurement is excessive. Repeat for each ring.
4. Roll each compression ring around its piston groove. The ring must move smoothly with no binding. If a ring binds in its groove, check the groove for damage. Replace the piston if necessary.

Piston Ring Installation

Each piston is equipped with three piston rings: two compression rings and one oil ring assembly. The top compression ring is not marked. The lower compression is marked with a dot (**Figure 120**).

Harley-Davidson recommends that *new* piston rings be installed every time the piston is removed. Always lightly hone the cylinder before installing new piston rings.

1. Wash the piston in hot soapy water. Then rinse with cold water and dry with compressed air. Make sure the oil control holes in the lower ring groove are clear.
2. Install the oil ring assembly as follows:
   a. The oil ring consists of three rings: a ribbed spacer ring (A, **Figure 121**) and two steel rings (B).
   b. Install the spacer ring into the lower ring groove. Butt the spacer ring ends together. Do not overlap the ring ends.
   c. Insert one end of the first steel ring into the lower groove so that it is below the spacer ring. Then spiral the other end over the piston crown and into the lower groove. To protect the ring end from scratching the side of the piston, place a piece of shim stock or a thin flat feeler gauge between the ring and piston.
   d. Repeat substep c to install the other steel ring above the spacer ring.

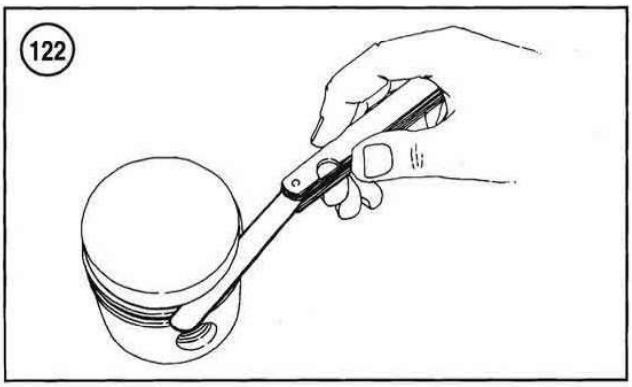
NOTE

When installing the compression rings, use a ring expander as shown in ***Figure 107****. Do not expand the rings any more than necessary to install them.*

3. Install the lower compression ring as follows:

a. A dot mark is located on one side of the lower compression ring.
b. Install the *new* lower compression ring with the dot mark facing up (**Figure 120**).

4. Install the top compression ring as follows:
   a. The top compression ring is not marked.
   b. Install the *new* top compression ring with either side facing up.
5. Check the ring side clearance with a feeler gauge as shown in **Figure 122**. Check the side clearance in several spots around the piston. If the clearance is larger than the service limit in **Table 2**, replace the piston.
6. Stagger the ring gaps around the piston.

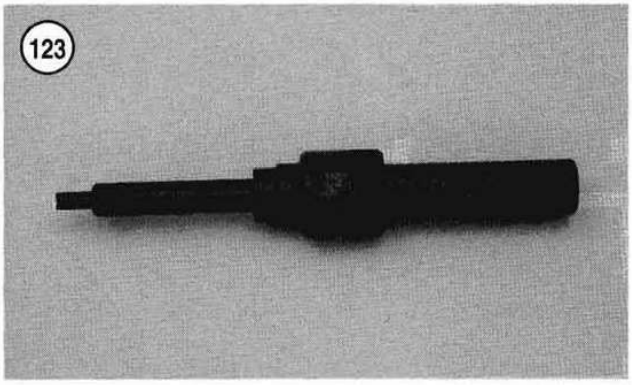


Piston Installation

1. Cover the crankcase openings to avoid dropping a retaining ring into the engine.

CAUTION

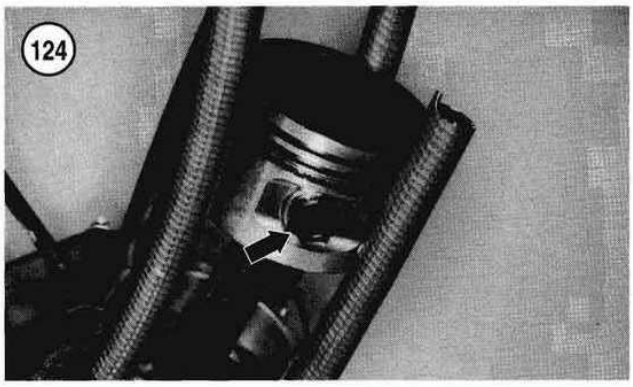
*Use the JIMS Piston Pin Keeper Tool (part No. 34623-83) (**Figure 123**) to avoid distorting the very rigid retaining rings during installation.*



2. Install a *new* piston pin retaining ring into one groove in the piston. Make sure the pin seats in the groove completely.
3. Coat the connecting rod bushing and piston pin with assembly oil.
4. Slide the piston pin into the piston until its end is flush with the piston pin boss.

NOTE

The piston markings described in Step 5 are for original equipment pistons. If using aftermarket pistons, follow the manufacturer's directions for piston alignment and installation.



5. Place the piston over the connecting rod with its arrow mark (C, **Figure 104**) facing toward the front of the engine. Install used pistons on their original connecting rods; refer to the marks made on the piston during removal.
6. Push the piston pin (**Figure 124**) through the connecting rod bushing and into the other side of the piston. Push the piston pin in until it bottoms on the retaining ring.
7. Install the other *new* piston pin retaining ring into the piston groove using the special tool. Make sure it seats properly in the piston groove (**Figure 125**).
8. Repeat for the other piston.
9. Install the cylinders as described in this chapter.