

CHAPTER FOUR

ENGINE TOP END

This chapter covers the rocker covers, rocker arms, cylinder heads, valves, cylinder blocks, pistons, piston rings and oil tank.

Tables 1-4 are located at the end of this chapter.

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.

When purchasing tools from a dealership or parts supplier, be sure to specify the tools required are for the specific Sportster model being worked on. Many of the tools are specific to the engine. Tools for other engine models may be slightly different.

The manufacturer's part number is provided for many of the tools mentioned in this manual. These part numbers are correct at the time of original publication. The publisher cannot guarantee the part number or the tools in this manual will be available in the future.

ROCKER COVER ASSEMBLY

The rocker cover assembly (**Figure 1**) consists of the outer rocker cover, middle rocker cover and inner rocker cover, which contains the rocker arms and shafts.

The rocker covers can be removed from either cylinder with the engine installed in the frame.

Rocker cover

Removal

Refer to **Figure 1**.

1. Remove the fuel tank as described in Chapter Ten or Chapter Eleven.
2. Remove the air filter and backplate as described in Chapter Ten or Chapter Eleven.
3. If removing the rocker cover on the front cylinder, remove the ignition coil as described in Chapter Twelve.

NOTE

Some rocker cover bolts have a captive washer. Note their position so they can be installed in the correct location

4. Remove the upper rocker arm cover bolts (A, **Figure 2**), steel washers (if used) and fiber washers. See **Figure 3**.
5. Remove the upper rocker arm cover (B, **Figure 2**).
6. Remove the gasket (A, **Figure 4**).
7. Remove the middle rocker arm cover (B, **Figure 4**).
8. Remove and discard the inner and outer gaskets (**Figure 5**).

NOTE

Steps 9A and 9B describe two methods for turning the engine over by hand. When performing Step 9A, the motorcycle must be supported with the rear wheel off the ground.

- 9A. Shift the transmission into fifth gear. While watching the rocker arms, turn the rear wheel until both valves are closed on the cylinder being serviced.
- 9B. Remove the primary cover as described in Chapter Six or Chapter Seven. While watching the rocker arms, turn the engine sprocket nut until both valves are closed on the cylinder being serviced.
10. Loosen, then remove the two rocker arm mounting bolts and washers next to the pushrods (**Figure 6**).
11. Remove the remaining lower rocker arm cover mounting bolts and washers (**Figure 7**).
12. Remove the lower rocker arm cover (**Figure 8**). Discard the gaskets.
13. Remove and discard the fiber washers, which may remain in the cover bolt recesses on the top of the rocker cover.

Installation

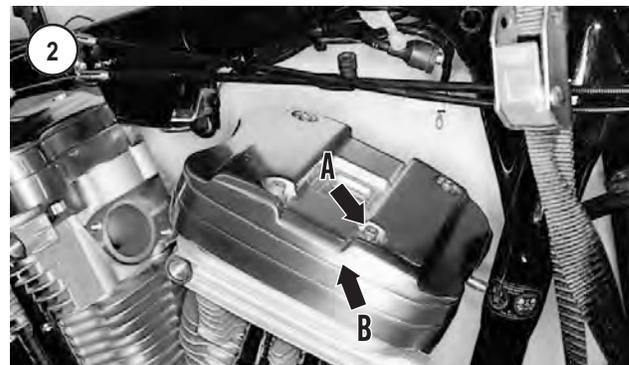
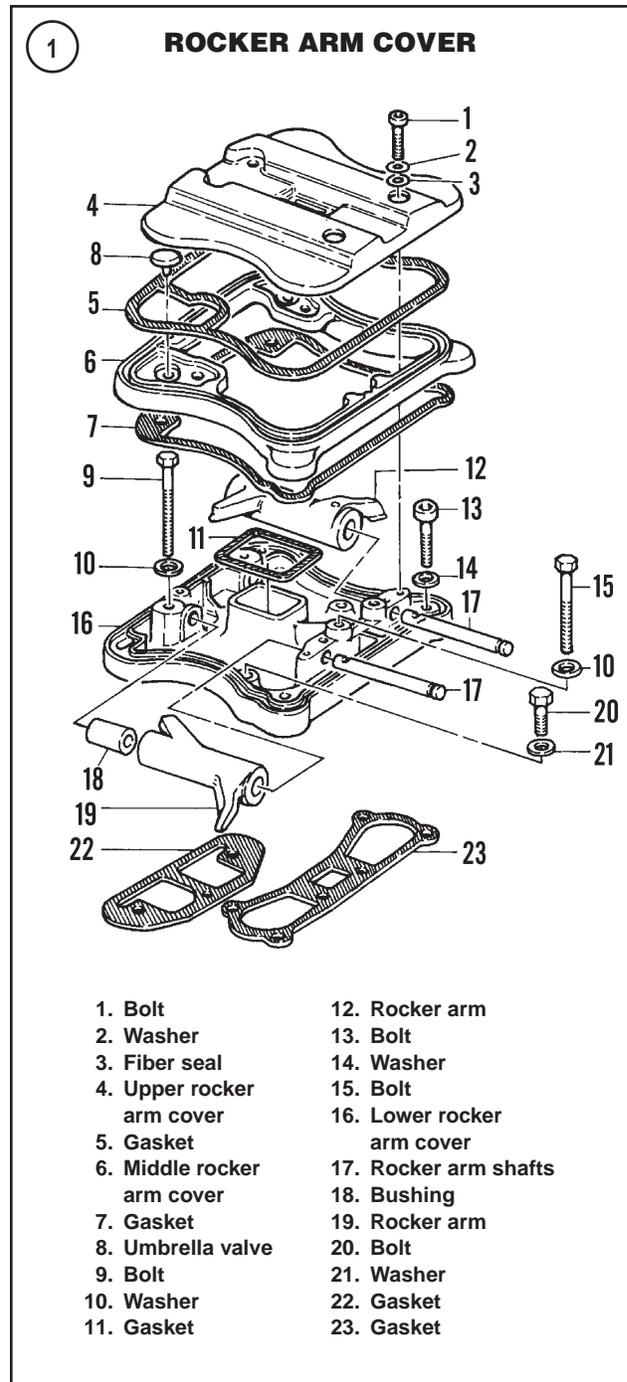
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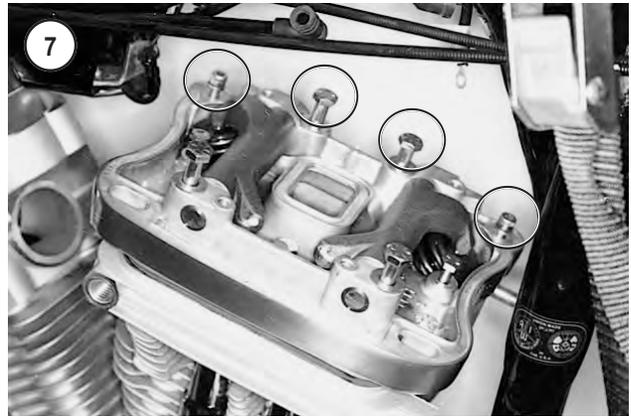
On 2003 models a one-piece gasket is used in place of the two gaskets identified in Step 1A or 1B.

NOTE

On 1986 models, record the crankcase number on the right crankcase half. The number is located above the point where the oil filter hoses connect to the oil pump. Starting with crankcase number 1786 127 043 (883 cc) or number 1886 127 001 (1100 cc), new style hydraulic tappets were installed. If the center number is 126 or less, perform Step 1A. If the center number is 127 or higher, perform Step 1B. On all 1987-2003 models, perform Step 1B.

- 1A. Perform the following in order:
 - a. Install new lower rocker arm cover gaskets with the bead facing up. Refer to **Figure 9**.
 - b. Install the lower rocker arm cover (**Figure 10**).
 - c. Refer to **Figure 1**. Install bolts 9, 13, 15 and 20.
 - d. Tighten bolts 9 and 15 (5/16 in.) in a crisscross pattern to 15-18 ft.-lb. (20-24 N•m).
 - e. Tighten bolts 13 and 20 (1/4 in.) in a crisscross pattern to 120-156 in.-lb. (14-18 N•m).





- f. Rotate the engine so that the tappets for the cylinder being serviced are at the lowest position.

NOTE

If the pushrods were removed, refer to the cylinder head installation section in this chapter and install the pushrods.

NOTE

A piece of wire 13-14 in. (330-356 mm) long with a diameter of 0.050-0.060 in. (1.3-1.5 mm) is required for the next step. Fine wire of this type can be purchased at hobby shops or hardware stores.

- g. Remove the bolts (9, **Figure 1**).
- h. Insert the wire through the pushrod and depress the check valve in the tappet (**Figure 11**) while pushing the pushrod down.

NOTE

The rocker arm shafts have cutouts in them. The cutouts must align with the rocker cover bolt holes.

- i. Remove the wire while keeping the tappet depressed with the pushrod and install the rocker arm (A, **Figure 12**) and shaft (B).
- j. Install the bolts (9, **Figure 1**), and tighten to 15-18 ft.-lb. (20-24 N•m).

1B. Perform the following in order:

- a. Rotate the engine so that the tappets for the cylinder being serviced are at the lowest position.

NOTE

If the pushrods were removed, refer to the cylinder head installation section in this chapter and install the pushrods.

- b. Install new lower rocker arm cover gaskets with the bead facing up. See **Figure 9**.

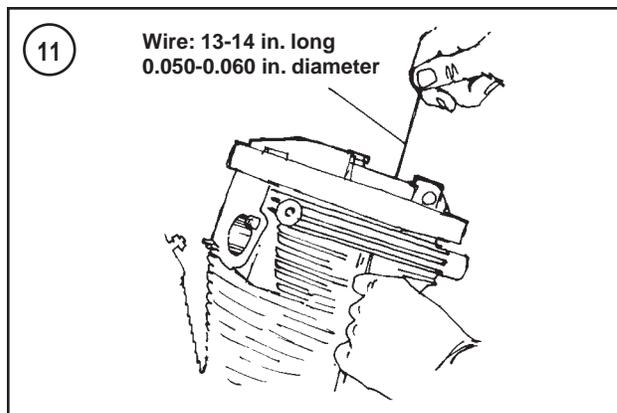
NOTE

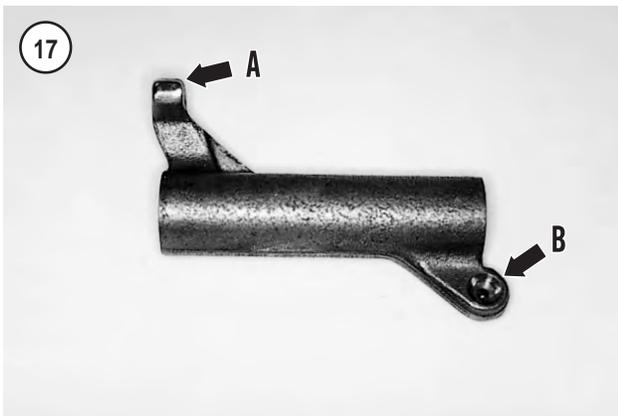
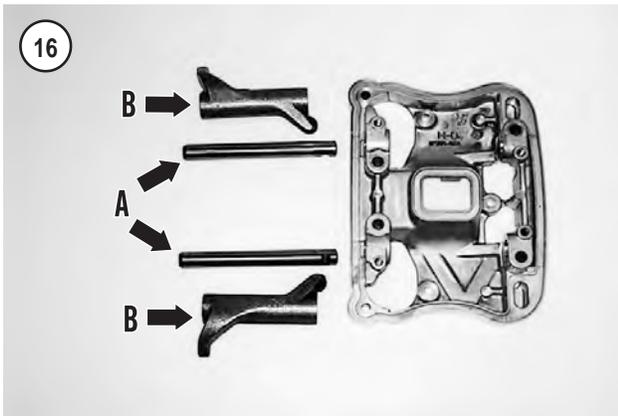
The rocker arm shafts have cutouts in them. The cutouts must align with the rocker cover bolt holes.

- c. Install the rocker arms and rocker arm shafts into the lower rocker arm cover.
- d. Install the rocker arm cover assembly (**Figure 8**).
- e. Align the pushrods with the rocker arm sockets.
- f. Refer to **Figure 1**. Install bolts 9, 13, 15 and 20.
- g. Tighten bolts 9 and 15 (5/16 in.) in a crisscross pattern to 15-18 ft.-lb. (20-24 N•m).
- h. Tighten bolts 13 and 20 (1/4 in.) in a crisscross pattern to 120-156 in.-lb. (14-18 N•m).

CAUTION

On all models, make sure the pushrods can be hand-turned before rotating the engine.





2. Install new center and outer gaskets (**Figure 5**) onto the lower rocker arm cover.
3. Install the middle rocker cover (A, **Figure 13**) onto the lower rocker cover.
4. Install a new gasket (B, **Figure 13**) onto the middle rocker cover.
5. Install the upper rocker cover (**Figure 14**) onto the middle rocker cover.
6. Place a steel washer if used and fiber washer onto each rocker cover mounting bolt (**Figure 3**).
7. Install the rocker cover mounting bolts and tighten to 120-156 in.-lb. (14-18 N•m).
8. Repeat the procedure for the remaining rocker cover assembly.
9. If removed, install the ignition coil as described in Chapter Twelve.
10. Install the air filter and backplate as described in Chapter Ten or Chapter Eleven.
11. Install the fuel tank as described in Chapter Ten or Chapter Eleven.

Removal/inspection/installation

- Label all parts prior to disassembly so they may be installed in their original positions. Refer to **Figure 1**.
1. Before removing the rocker arms, measure rocker arm end clearance as follows:
 - a. Insert a feeler gauge between the rocker arm and the inside rocker arm cover boss as shown in **Figure 15**.
 - b. Record the measurement.
 - c. Repeat for each rocker arm.
 - d. Replace the rocker arm and/or the lower rocker cover if the end clearance exceeds the service limit in **Table 2**.
 2. Using a soft-faced punch, tap each rocker arm shaft (A, **Figure 16**) out of the lower rocker arm cover.
 3. Remove the rocker arms (B, **Figure 16**).
 4. Clean the rocker covers, rocker arms and shafts in solvent. Then clean with hot, soapy water and rinse with clear, cold water. Dry with compressed air.
 5. Blow compressed air through all the oil passages to make sure they are clear.
 6. Examine the rocker arm pads (area that contacts the valve). See A, **Figure 17**. The pad on each rocker arm should be shiny and convex—curving outward. Replace the rocker arm if the pad shows signs of pitting, grooves or excessive wear.
 7. Examine the rocker arm socket (area that retains the pushrod). See B, **Figure 17**. The socket will show wear but it should be smooth without any sign of a step or lip. Replace the rocker arm if the socket is severely worn, cracked or has a step or lip.
 8. Examine the rocker arm shaft (**Figure 18**) for scoring, ridge wear or other damage. If these conditions are present, replace the rocker arm shaft. If the shaft does not show any visual wear or damage, perform Step 9.

9. Measure the rocker arm shaft outside diameter (**Figure 19**) where it rides in the rocker arm and in the lower rocker arm cover. Record both measurements.

10. Measure the rocker arm bushing inside diameter (**Figure 20**) and the lower rocker arm cover bore diameter where the shaft rides (**Figure 21**). Record both measurements.

11. Subtract the measurements taken in Step 9 from those in Step 10 to obtain the following rocker arm shaft clearance measurements:

- a. Shaft fit in rocker cover.
- b. Shaft fit in rocker arm bushing.

12. Replace the rocker arm bushings or the lower rocker arm cover if the clearance exceeds the specifications in **Table 2**. Also, replace any parts which are worn beyond the service limit specification in **Table 2**. Rocker arm bushing replacement is described in this section.

NOTE

*On 1986 models specified in the NOTE under **Installation** in this section, the rocker arms are not installed until the lower rocker cover has been installed on the cylinder head. Disregard the following steps.*

13. Install the rocker arms into their original positions (**Figure 22**).

14. Align the notch (A, **Figure 23**) in the rocker arm shaft with the bolt hole (B) in the lower rocker arm cover and install the rocker arm shaft. Repeat for the opposite rocker arm shaft. See **Figure 24**.

Bushing replacement

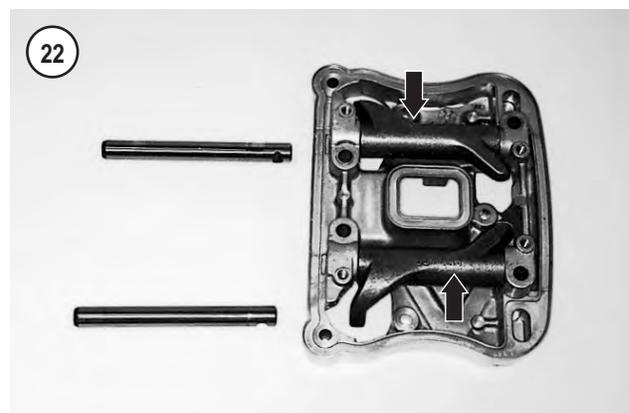
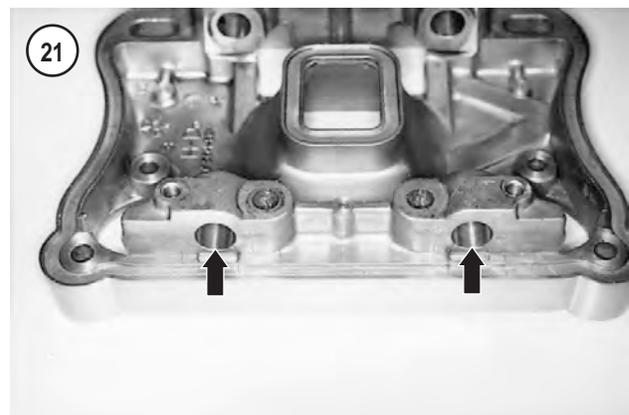
Each rocker arm is equipped with two bushings (**Figure 20**). Replacement bushings must be reamed using the rocker arm bushing reamer (part No. HD-94804-57).

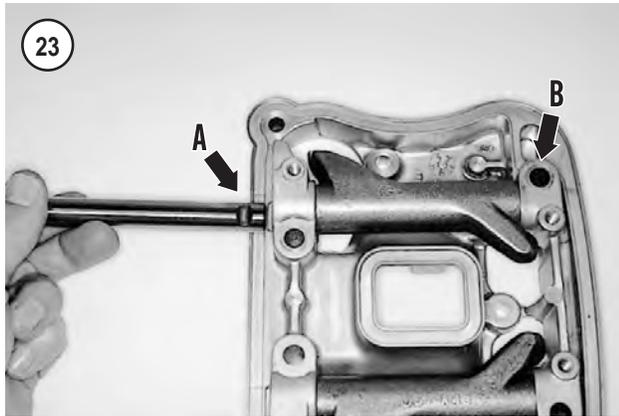
NOTE

Because new bushings must be reamed, remove only one bushing at a time. The opposite bushing will be used as a guide when reaming the first bushing.

1. Press or drive one of the bushings from the rocker arm (**Figure 20**). Do not remove the second bushing. If the bushing is difficult to remove, perform the following:

- a. Thread a 9/16-18 in. tap into the bushing to be removed.
- b. Support the rocker arm in a press so that the tap is at the bottom.
- c. Insert a mandrel through the top of the rocker arm and seat it on top of the tap.
- d. Press on the mandrel to force the bushing/tap out of the rocker arm. Don't let the tap fall.
- e. Remove the tap from the bushing and discard the bushing.





2. Position a new bushing so the split portion faces the top of the rocker arm. Press in the new bushing until its outer surface is flush with the rocker arm bore inside surface (**Figure 20**).

3. Ream the new rocker arm bushing using the rocker arm bushing reamer as follows:

- a. Mount the rocker arm in a vise with soft jaws so that the new bushing is at the bottom.

CAUTION

The reamer must be turned clockwise only. Do not turn the reamer counterclockwise or the reamer may be damaged.

- b. Mount a tap handle on top of the reamer and insert the reamer into the bushing. Turn the reamer clockwise until it passes through the new bushing and remove it from the bottom side. The old bushing left in the rocker arm is used as a guide for the reamer.

4. Remove the rocker arm from the vise and repeat Steps 1-3 to replace the second bushing. The first bushing will now act as a guide for the reamer.

5. When both bushings have been replaced and reamed, clean the rocker arm and bushings in solvent. Clean with hot, soapy water and rinse with clear and cold water. Dry with compressed air.

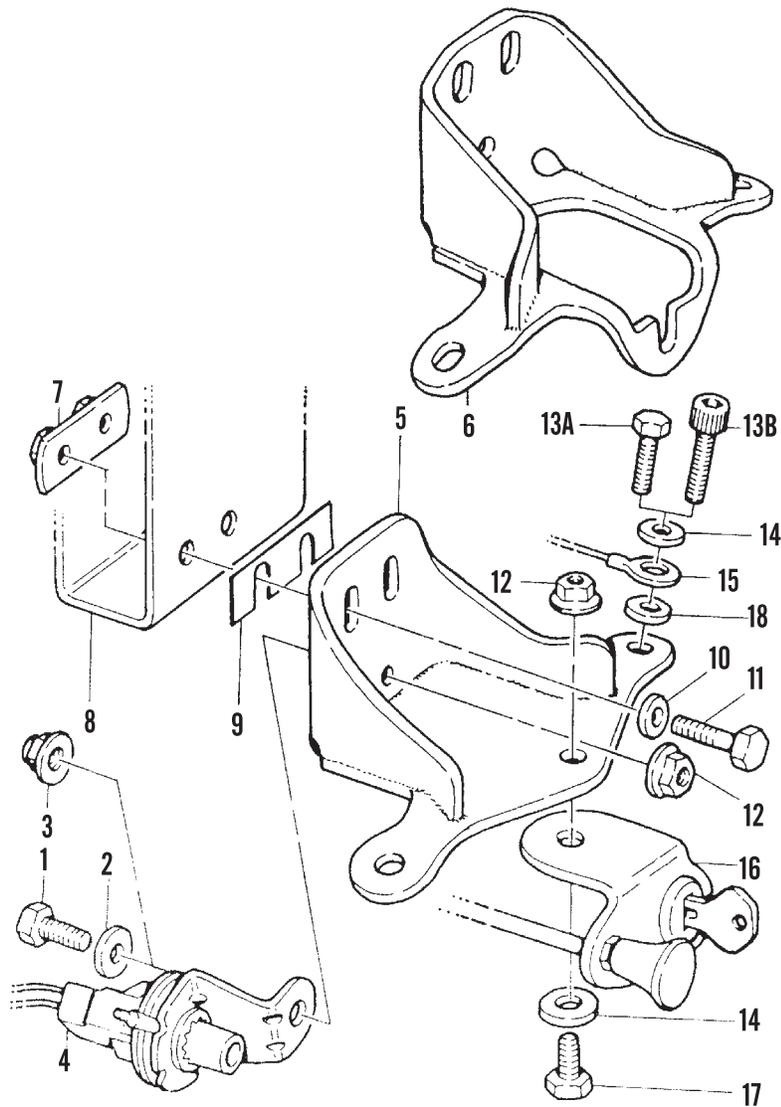
6. Measure the inside diameter of each bushing with a snap gauge. When properly reamed, the bushings should provide 0.0005-0.0020 in. (0.012-0.050 mm) shaft clearance.

CYLINDER HEAD

Removal

1. Remove the exhaust system as described in Chapter Ten or Chapter Eleven.
2. Remove the air filter assembly and backplate as described in Chapter Ten or Chapter Eleven.
3. On 1986-1994 models, disconnect the ignition switch wires and remove the ignition switch as described in Chapter Twelve. Remove the choke knob bracket (**Figure 25**) as described in Chapter Ten.
4. Disconnect the spark plug wires and set them out of the way.
5. Remove the ignition coil as described in Chapter Twelve.
6. On 1995-2003 models, remove the choke knob bracket mounting screw. Secure the knob so it is out of the way.
7. On all models except 1998-2003 1200S models, remove the vacuum hose (**Figure 26**) from the VOES fitting on the carburetor, and disconnect the VOES electrical connector at the ignition module as described in Chapter Twelve.
8. Remove the carburetor as described in Chapter Ten or Chapter Eleven.
9. Remove the top center engine mount (**Figure 27**) as follows:

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TOP CENTER ENGINE MOUNT

1. Bolt
2. Washer (1986-1991 models)
3. Locknut (1992-2003 models)
4. Vacuum-operated electric switch (all models except 1998-2003 1200S models)
5. Top center engine bracket (1986-1994 models)
6. Top center engine bracket (1995-2003 models)
7. Nut plate
8. Frame
9. Shim

10. Washer
11. Bolt
12. Locknut
- 13A. Bolt (1986-1991 models)
- 13B. Bolt (1992-2003 models)
14. Lockwasher (1986-1994 models)/
Washer (1995-2003 models)
15. VOES ground wire (1986-1993 models)
16. Ignition bracket (1986-1994 models)
17. Bolt
18. Washer (1986-1994 models)