

CHAPTER FOUR

ENGINE

The engine is a V-twin liquid-cooled, 4-stroke design. The cylinders are offset and set at a 45° angle; the cylinders fire on alternate crankshaft rotations. Each cylinder is equipped with a single camshaft and 4 valves. The crankshaft is supported by 2 main bearings in a vertically split crankcase.

Both engine and transmission share a common case and the same wet sump oil supply. The clutch is a wet-type located inside the right crankcase cover. Refer to Chapter Five for clutch and Chapter Six for transmission service procedures.

This chapter provides complete procedures and information for removal, inspection, service and reassembly of the engine.

Table 1 provides complete specifications for the engine and **Table 2** lists all of the engine torque specifications. **Tables 1-5** are located at the end of this chapter.

Before beginning work, re-read Chapter One in the front section of this book. You will do a better job with this information fresh in your mind.

ENGINE PRINCIPLES

Figure 1 explains how the engine works. This will be helpful when troubleshooting or repairing the engine.

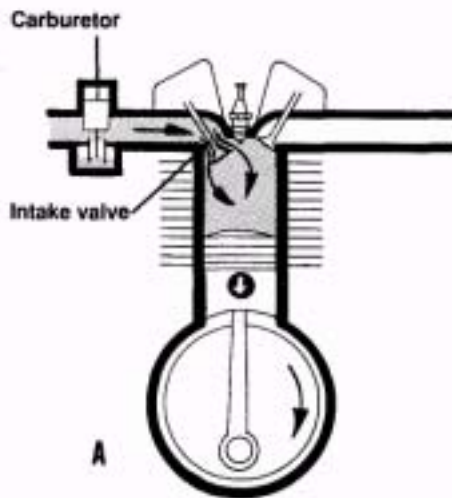
SERVICING ENGINE IN FRAME

The following components can be serviced while the engine is mounted in the frame (the bike's frame is a great holding fixture for breaking loose stubborn bolts and nuts):

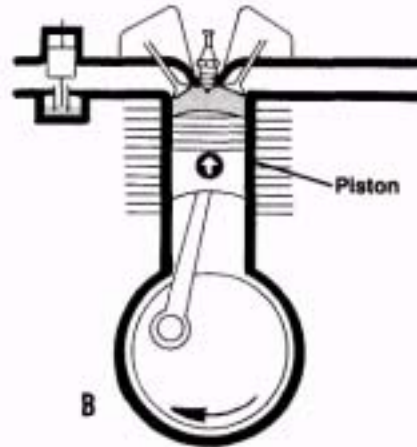
- a. External gearshift mechanism.
- b. Clutch.

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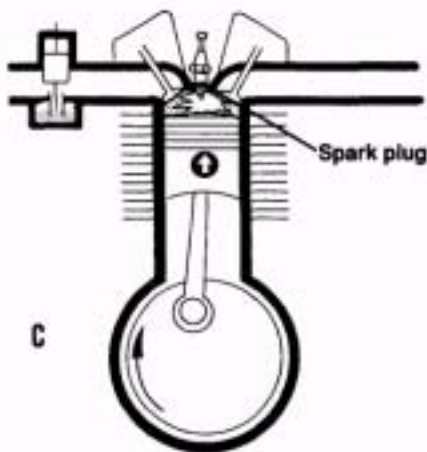
4-STROKE PRINCIPLES



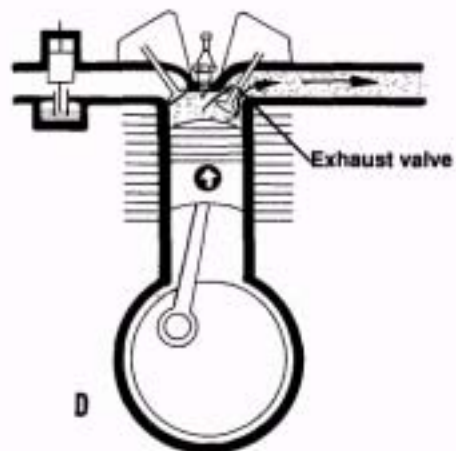
As the piston travels downward, the exhaust valve is closed and the intake valve opens, allowing the new air-fuel mixture from the carburetor to be drawn into the cylinder. When the piston reaches the bottom of its travel (BDC), the intake valve closes and remains closed for the next 1 1/2 revolutions of the crankshaft.



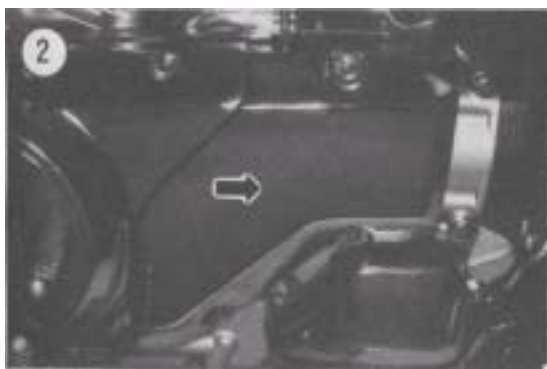
While the crankshaft continues to rotate, the piston moves upward, compressing the air-fuel mixture.



As the piston almost reaches the top of its travel, the spark plug fires, igniting the compressed air-fuel mixture. The piston continues to top dead center (TDC) and is pushed downward by the expanding gases.



When the piston almost reaches BDC, the exhaust valve opens and remains open until the piston is near TDC. The upward travel of the piston forces the exhaust gases out of the cylinder. After the piston has reached TDC, the exhaust valve closes and the cycle starts all over again.

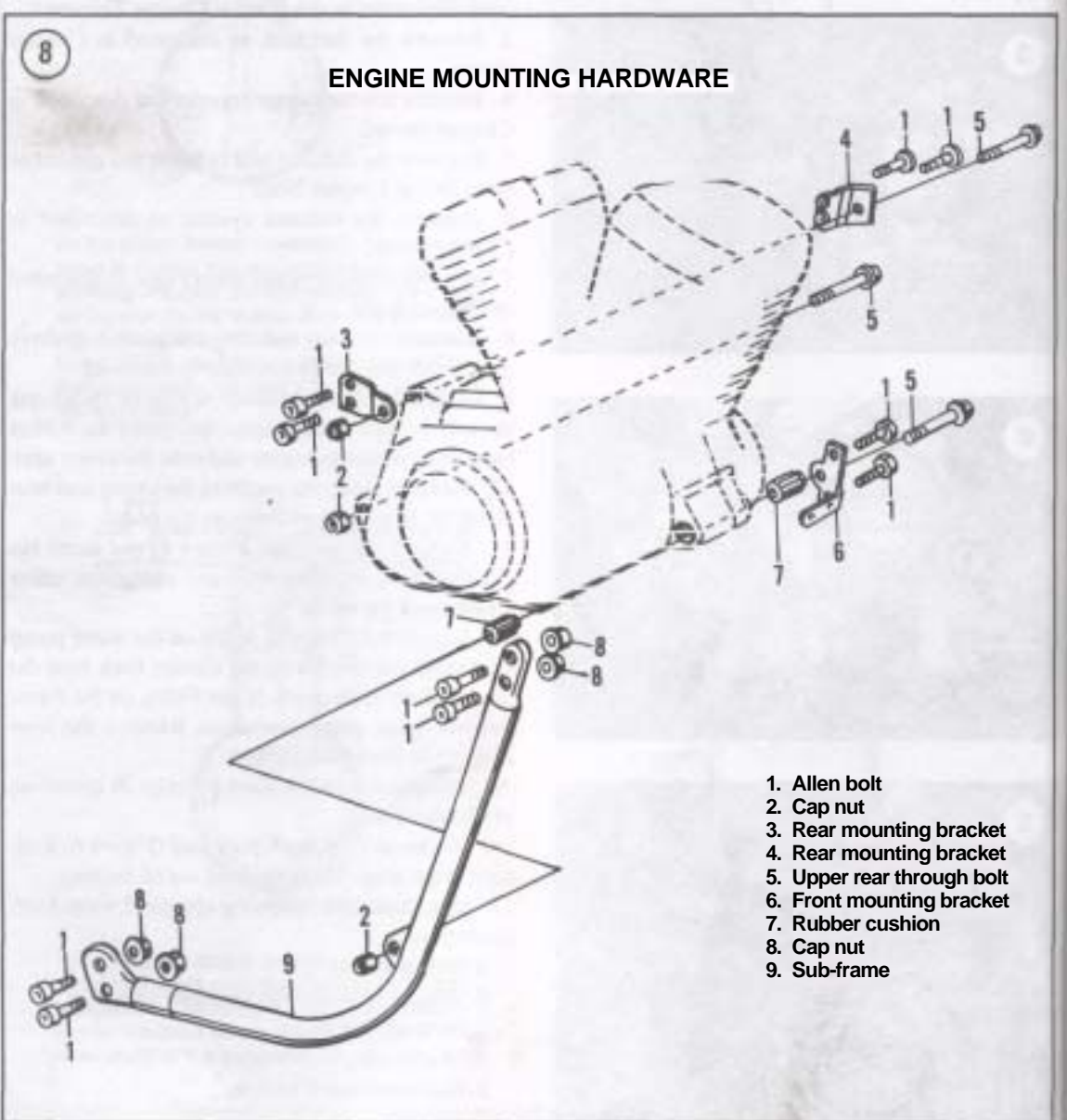


- c. Carburetors.
- d. Starter motor and gears.
- e. Alternator and electrical systems.
- f. Oil pump.

ENGINE

Removal/Installation

1. Drain the engine oil and cooling system as described in Chapter Three.
2. Remove both seats, the frame side covers and frame head side covers as described in Chapter Thirteen.
3. Remove the fuel tank as described in Chapter Seven.
4. Remove the carburetor assembly as described in Chapter Seven.
5. Remove the radiator and radiator fan shroud as described in Chapter Nine.
6. Remove the exhaust system as described in Chapter Seven.
7. Remove the battery and battery case as described in Chapter Eight.
8. Remove the bolts securing the secondary drive gear cover (**Figure 2**) and remove the cover.
9. Loosen the clamping band (A, **Figure 3**) securing the rubber boot to the engine and move the rubber boot away from the engine and onto the swing arm.
10. Remove the screw securing the swing arm trim panel (B, **Figure 3**) and remove the panel.
11. Remove the bolts (A, **Figure 4**) and acorn nut (B, **Figure 4**) securing the water pump trim cover and remove the cover.
12. Loosen the clamping screw on the water pump inlet hose clamps. Move the clamps back onto the hose and off of the neck of the fitting on the frame rail and water pump connector. Remove the hose (**Figure 5**) from both fittings.
13. Remove the clutch slave cylinder as described in Chapter Five.
14. Disconnect the spark plug lead (**Figure 6**) from each spark plug. Move the lead out of the way.
15. Disconnect the following electrical wires from the engine:
 - a. Starter motor.
 - b. Alternator stator and the pulse generator.
 - c. Neutral switch.
 - d. Starter relay.
 - e. Sidestand check switch.
 - f. Ground.





16. Disconnect the crankcase breather hose from the rear cylinder head.

17. Remove the bolt (**Figure 7**) securing the gear shift lever and remove the lever. Reinstall the bolt in the lever to avoid misplacing it.

18. Remove the footpeg assembly as described in Chapter Thirteen.

19. Place wood block(s) and a small hydraulic jack under the engine to support it securely.

20. Take a final look all over the engine to make sure everything has been disconnected.

CAUTION

The following steps require the aid of a helper to safely remove the engine assembly from the frame.

21. Make sure the hydraulic jack is still in place and supporting the engine securely.

22. Loosen, but do not remove, all engine mounting bolts and nuts (**Figure 8**).

23. Remove the rear upper through bolt (**Figure 9**), washer and nut.

24. Remove the rear lower through bolt (A, **Figure 10**), washer and nut.

25. Remove the front upper Allen bolts (**Figure 11**) and nuts and the lower Allen bolts (B, **Figure 10**) and nuts securing the sub-frame to the frame.

26. On the right-hand side, remove the nut (**Figure 12**) from the front through bolt.

27. Remove the sub-frame (**Figure 13**) from the engine and frame.

28. On the left-hand side, remove the front through bolt (**Figure 14**) from the engine and frame mounting bracket.



29. Once again, check that everything has been disconnected from the engine.

30. Slowly move the engine forward to disengage the engine output shaft from the drive shaft universal joint. If necessary, use a screwdriver and disengage the drive shaft's universal joint from the output shaft.

31. Slightly lower the engine on the jack and continue to move the engine forward and toward the right-hand side to clear the remaining frame members.

32. Take the engine to a workbench for further disassembly.

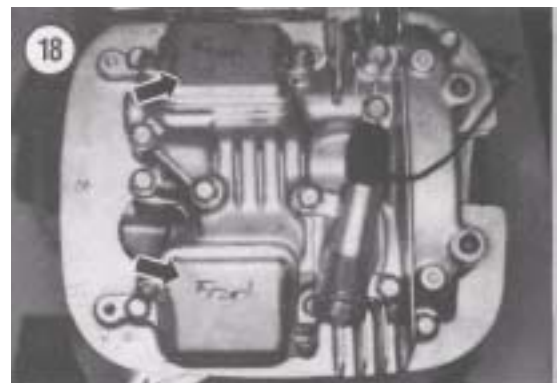
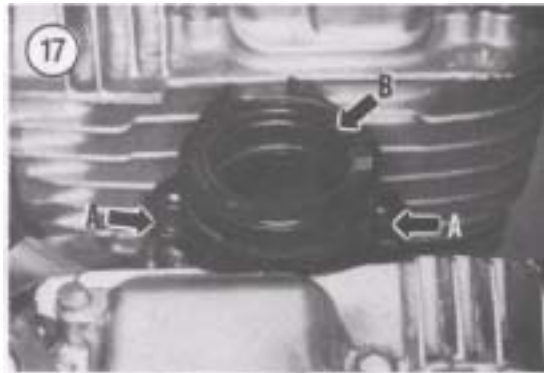
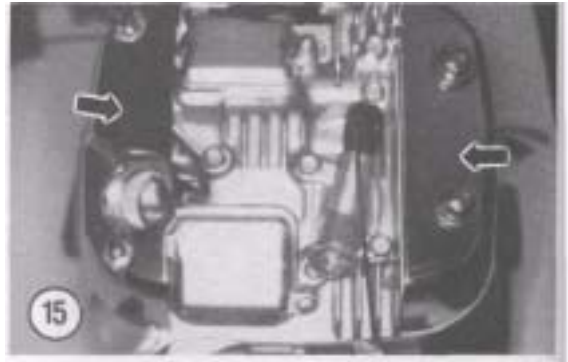
33. Install by reversing these removal steps, noting the following:

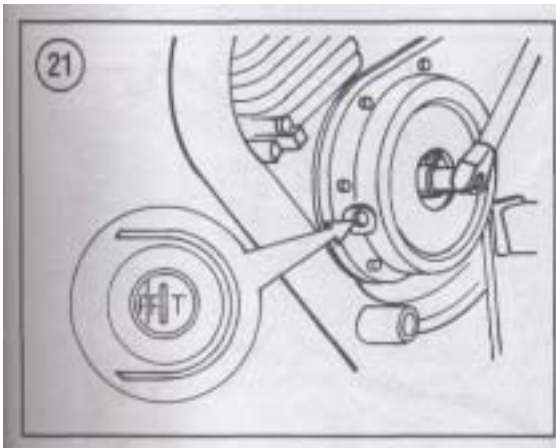
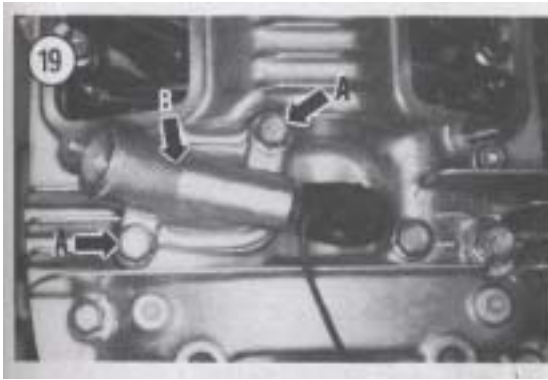
- a. Apply a light coat of molybdenum disulfide grease to the splines of the output shaft and the universal joint prior to engaging these 2 parts.
- b. Tighten the engine mounting bolts to the torque specifications in **Table 2**.
- c. Fill the engine with the recommended type and quantity of oil as described in Chapter Three.
- d. Refill the cooling system as described in Chapter Three.
- e. Start the engine and check for leaks.

FRONT CYLINDER HEAD COVER AND CAMSHAFT

Front Cylinder Removal

1. Remove the engine from the frame as described in this chapter.
2. Remove the bolts securing the cylinder head side covers (**Figure 15**) and remove both side covers.
3. On the spark plug side of the cylinder head, remove the insulator (**Figure 16**).





4. Remove the bolts (A, **Figure 17**) securing the intake pipe (B, **Figure 17**) and remove it from the front cylinder.
5. Mark the valve adjuster covers with an "F" and "R" so they will be reinstalled on the correct location.
6. Remove the valve adjuster covers (**Figure 18**).
7. Remove the bolts (A, **Figure 19**) securing the coolant inlet fitting (B, **Figure 19**) and remove the fitting and O-ring seal.
8. Remove the spark plugs from both cylinder heads. This will make it easier to rotate the engine.

NOTE

*A cylinder at TDC will have free play in **both** sets of intake and exhaust valve rocker arms indicating that both the intake and exhaust valves are closed.*

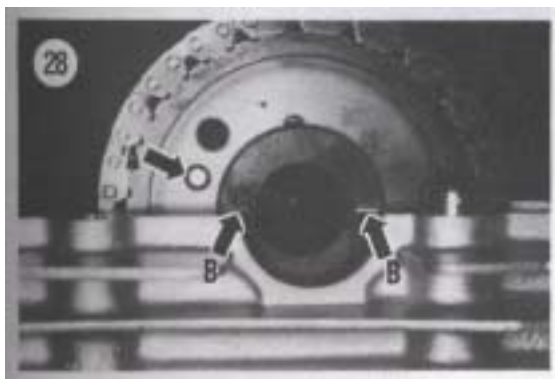
CAUTION

The next steps will position the front cylinder at top dead center (TDC) on the compression stroke. This is necessary to avoid damage to the camshaft, rocker arms and related parts.

9. Remove the alternator bolt hole cover on the alternator cover.
10. Use a 17 mm socket and wrench on the alternator rotor bolt (**Figure 20**). Rotate the engine *clockwise*, as viewed from the left-hand side, until the front cylinder is at top dead center (TDC) on the compression stroke. Align the "F/F T" mark with the center of the inspection hole in the alternator rotor (**Figure 21**).
11. With the "F/F T" mark aligned with the center of the inspection hole in the alternator rotor, jiggle both rocker arms and make sure *both* have free play. If one of the rocker arms (either intake or exhaust) is still under tension, rotate the engine an additional 360° until both rocker arms have free play.
12. Again check that the "F/F T" mark is still aligned with the center of the inspection hole in the alternator rotor (**Figure 21**).
13. Using a crisscross pattern, loosen then remove the bolts (**Figure 22**) securing the cylinder head cover.
14. Loosen the cylinder head cover by tapping around the perimeter with a rubber or soft faced mallet. If necessary, *gently* pry the cover loose with a broad-tipped screwdriver.
15. Remove the front cylinder head cover.
16. Straighten the tab on the camshaft sprocket bolt lockwasher and remove the exposed bolt.

1. Check the timing mark for the *rear cylinder*. Make sure the "R/F T" mark is still aligned with the center of the inspection hole in the alternator rotor (**Figure 24**). If the timing mark is still aligned, proceed to Step 2, if the alignment is *not* correct, proceed as follows:

- a. Pull up on the front camshaft chain and keep it taut, make certain that the camshaft chain is properly meshed onto the crankshaft timing sprocket then rotate the crankshaft in Step b.
- b. Use a 17 mm socket and wrench on the alternator rotor bolt (**Figure 20**). Rotate the engine *clockwise*, as viewed from the left-hand side,



until the rear cylinder is at top dead center (TDC) on the compression stroke. Align the "R/F T" mark with the center of the inspection hole in the alternator rotor (**Figure 24**).

- c. With the "R/F T" mark aligned with the center of the inspection hole in the alternator rotor, jiggle both rocker arms and make sure *both* have free play. If one of rocker arms (either intake or exhaust) is still under tension, rotate the engine an additional 360° until both rocker arms have free play.
- d. Again check that the "R/F T" mark is still aligned with the center of the inspection hole in the alternator rotor (**Figure 24**).

2. Apply a light coat of molybdenum disulfide grease to the camshaft bearing surfaces in the cylinder head.
3. If both camshafts are removed, be sure to install the correct camshaft in the correct cylinder head. The camshafts are marked with a "F" (front cylinder) or "R" (rear cylinder) (**Figure 25**) on the sprocket mounting boss.
4. Apply a *light* coat of cold grease to the locating pin and install it (**Figure 26**) into the end of the camshaft.
5. Install *the front camshaft* into the cylinder head and loop it through the camshaft drive chain. Position the camshaft with the locating pin midway between the 9 and 10 o'clock position (**Figure 27**).

NOTE

When installing the sprocket onto the camshaft be careful not to knock the locating pin out of the camshaft. If the pin works loose it will probably fall down into the crankcase. If this happens the crankcase must be disassembled to retrieve it.

6. Engage the camshaft sprocket with the drive chain and install the sprocket onto the camshaft.
7. Check that the camshaft is still positioned correctly with the locating pin midway between the 9 and 10 o'clock position (A, **Figure 28**) and the timing marks on the end of the camshaft are aligned with the top surface of the cylinder head (B, **Figure 28**).
8. After the sprocket has been installed, make sure the "R/F T" mark is still aligned with the center of the inspection hole in the alternator rotor (**Figure 24**). If necessary, realign the camshaft and sprocket in Steps 5-7.

NOTE

When installing the lockwasher onto the camshaft sprocket, position it so it

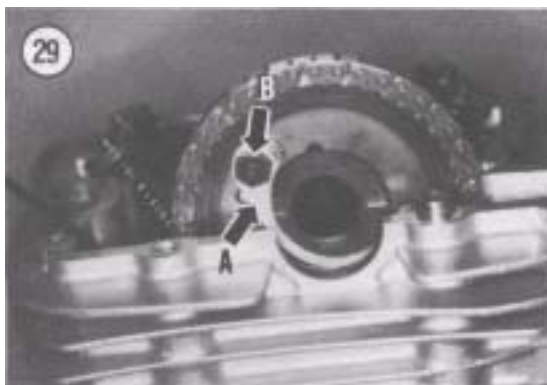
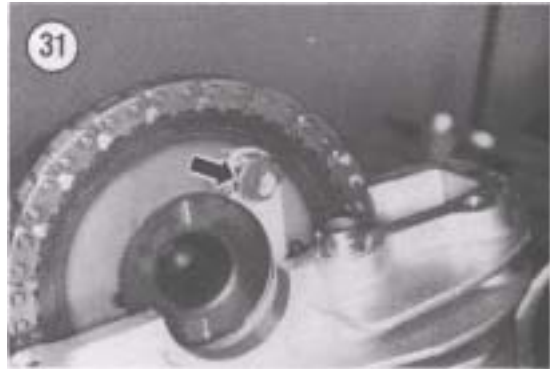
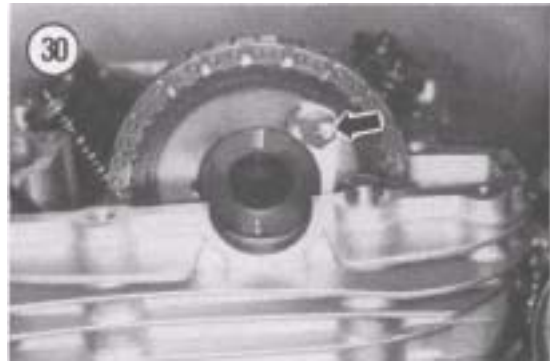
will cover the locating pin in the end of the camshaft after both sprocket bolts are installed.

9. Install a new lockwasher (A, **Figure 29**) and camshaft sprocket bolt (B, **Figure 29**) in the exposed hole. Tighten the bolt only finger tight at this time.
10. Use a 17 mm socket and wrench on the alternator rotor bolt (**Figure 20**). Rotate the engine *clockwise*, as viewed from the left-hand side, until the other sprocket bolt hole is exposed.

CAUTION

Apply redLoctite (No. 271) to the sprocket bolt threads prior to installation.

11. Install the other camshaft sprocket bolt (**Figure 30**) in the exposed hole.
12. Hold down the end of camshaft opposite the camshaft sprocket and tighten the sprocket bolt to the torque specification listed in Table 2. Bend up the tab of the lockwasher against the bolt head (**Figure 31**).
13. Use a 17 mm socket and wrench on the alternator rotor bolt (**Figure 20**). Rotate the engine *clockwise*, as viewed from the left-hand side, until the bolt installed in Step 9 is exposed. Remove this bolt and apply red Loctite (No. 271) to the threads prior to installation.
14. Reinstall the camshaft sprocket bolt. Hold down the end of camshaft opposite the camshaft sprocket and tighten the sprocket bolt to the torque specification listed in Table 2. Bend up the tab of the lockwasher against the bolt head (**Figure 32**).
15. Make sure the camshaft shoulder is properly indexed into the groove in the cylinder head (**Figure 33**).
16. Apply a light coat of molybdenum disulfide grease to the bearing surfaces and lobes of the camshaft (**Figure 34**).



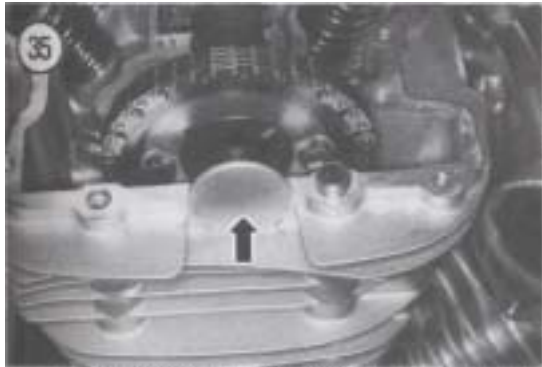


17. Apply a light coat of molybdenum disulfide grease to the camshaft bearing surfaces in the cylinder head cover.

18. Apply a sealant to the edge surfaces of the camshaft end plug and install the plug (**Figure 35**) into the cylinder head. Make sure it is properly seated.

CAUTION

After the modified tie wrap is removed, inspect the end of it to make sure all of it came out and that none of it broke off in the tensioner.



19. If the cylinder head and cylinder were removed, carefully pull the long modified tie wrap (**Figure 36**) out of the camshaft drive chain tensioner.

20. Clean the sealing surface of both the cylinder head and cover as follows:

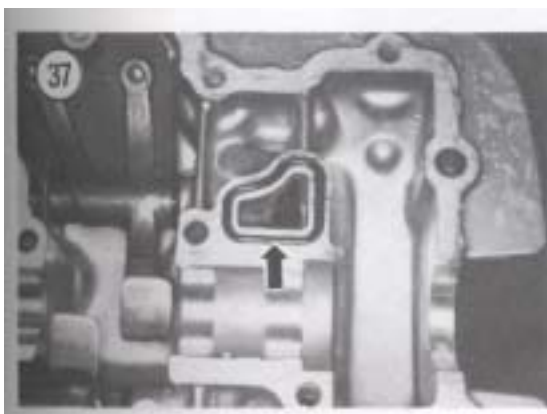
- Remove the old gaskets and clean off all gasket sealer residue from the cylinder head and cover.
- Clean the surface with aerosol electrical contact cleaner and wipe dry with a lint-free cloth.
- Apply a coat of ThreeBond No. 1207, or equivalent, to sealing surface of the cylinder head cover. Do not apply sealant to the rounded surfaces of the camshaft bearing journal surfaces.

21. Install a new O-ring seal (**Figure 37**) in the cylinder head cover.

22. If removed, install both locating dowels (**Figure 38**) into the cylinder head.

23. Install the cylinder head cover onto the camshaft and the cylinder head. Push it down until it bottoms out. Make sure the camshaft end plug is properly seated between the cylinder head and cover (**Figure 39**).

24. Tighten the bolts (**Figure 22**) in a crisscross pattern, starting with the center bolts (surrounding the camshaft) and working outward. Tighten in 2-3 stages to the torque specification listed in **Table 2**.



25. Install a new O-ring seal (**Figure 40**) in the coolant inlet fitting. Install the fitting and the bolts (A, **Figure 19**). Tighten the bolts to the same torque specification as the cylinder head bolts.

26. Check the valve clearance at this time and read just if necessary. Do it at this time since it is much easier to perform valve adjustment with the engine out of the frame. Refer to Chapter Three for the adjustment procedure.

27. Install new O-ring seals (**Figure 41**) in the valve adjuster covers (**Figure 18**) and install the covers and bolts. Tighten the bolts securely.

28. Make sure the O-ring seal (**Figure 42**) is in place in the intake pipe and install it (B, **Figure 17**) onto the cylinder head. Tighten the bolts (A, **Figure 17**) securely.

29. On the spark plug side of the cylinder head, install the insulator (**Figure 16**).

NOTE

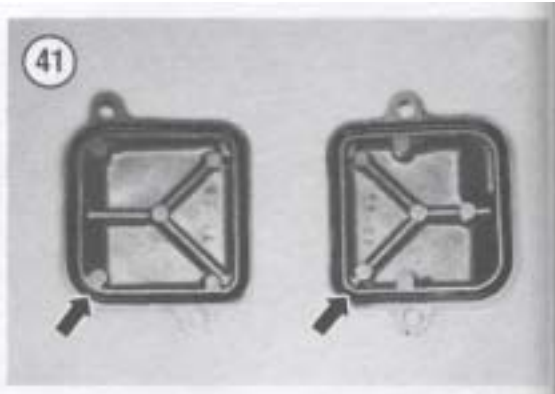
*The cylinder head side cover bolts on the side opposite the spark plug, are also cylinder head cover mounting bolts and must be tightened to the correct torque specification listed in **Table 2**.*

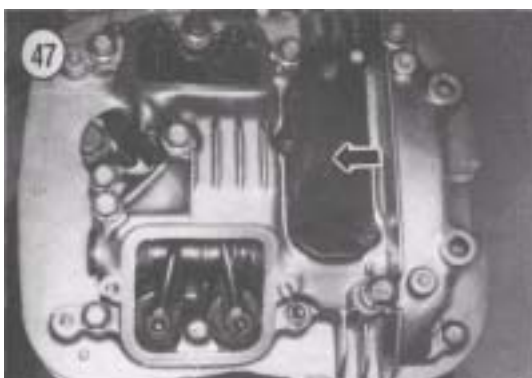
30. Install both cylinder head side covers (**Figure 15**) and bolts. Tighten the bolts, on the side opposite the spark plug, to the torque specification listed in **Table 2**. Tighten the bolts on the other side securely.

REAR CYLINDER HEAD COVER AND CAMSHAFT

Rear Cylinder Removal

1. Remove the engine from the frame as described in this chapter.





2. Remove the bolts securing the cylinder head side covers (**Figure 43**) and remove both side covers.
3. On the spark plug side of the cylinder head, remove the insulator (**Figure 44**).
4. Mark the valve adjuster covers with an "F" and "R" so they will be reinstalled on the correct location.
5. Remove the valve adjuster covers (**Figure 45**).
6. Remove the bolts securing the crankcase breather cover (**Figure 46**) and remove the cover and gasket (A, **Figure 47**).
7. If not already removed, remove the spark plug from both cylinders. This will make it easier to rotate the engine.

NOTE

*A cylinder at TDC will have free play in **both** the both sets of intake and exhaust valve rocker arms indicating that both the intake and exhaust valves are closed.*

CAUTION

The next steps will position the front cylinder at top dead center (TDC) on the compression stroke. This is necessary to avoid damage to the camshaft and related parts.

8. Remove the alternator bolt hole cover on the alternator cover.
9. Use a 17 mm socket and wrench on the alternator rotor bolt (**Figure 48**). Rotate the engine *clockwise*, as viewed from the left-hand side, until the rear cylinder is at top dead center (TDC) on the compression stroke.



Align the "R/F T" mark with the center of the inspection hole in the alternator rotor (**Figure 49**).

10. With the "R/F T" mark aligned with the center of the inspection hole in the alternator rotor, jiggle both rocker arms and make sure *both* have free play. If one of the rocker arms (either intake or exhaust) is still under tension, rotate the engine an additional 360° until both rocker arms have free play.

11. Again check that the "R/F T" mark is still aligned with the center of the inspection hole in the alternator rotor (**Figure 49**).

12. Using a crisscross pattern, loosen then remove the bolts (**Figure 50**) securing the cylinder head cover.

13. Loosen the cylinder head cover by tapping around the perimeter with a rubber or soft faced mallet. If necessary, *gently* pry the cover loose with a broad-tipped screwdriver.

14. Remove the rear cylinder head cover.

15. Straighten the tab on the camshaft sprocket bolt lockwasher and remove the exposed bolt.

CAUTION

If the front camshaft has been removed, pull up on the camshaft chain and keep it taut, make certain that the camshaft chain is properly meshed onto the crankshaft timing sprocket then rotate the crankshaft. If this step is not followed, the chain may become kinked and cause damage to the crankcases, the camshaft chain and the timing sprocket on the crankshaft.

16. Use a 17 mm socket and wrench on the alternator rotor bolt (**Figure 48**). Rotate the engine *clockwise*, as viewed from the left-hand side, until the other sprocket bolt is visible.

17. Straighten the tab on the other camshaft sprocket bolt lockwasher and remove the exposed bolt and the lockwasher.

18. Disengage the camshaft drive chain from the camshaft sprocket and remove the camshaft.

19. Tie a piece of wire to the camshaft chain and tie it to an external portion of the engine or insert a long drift or long socket extension through the camshaft drive chain (**Figure 23**) to prevent the camshaft chain from falling down into the crankcase.

CAUTION

If the crankshaft must be rotated with the camshaft removed, pull up on the

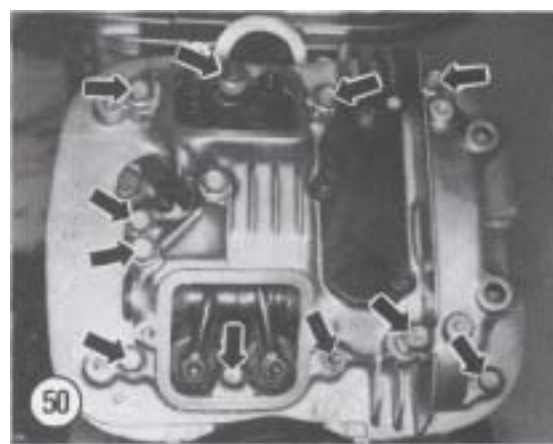
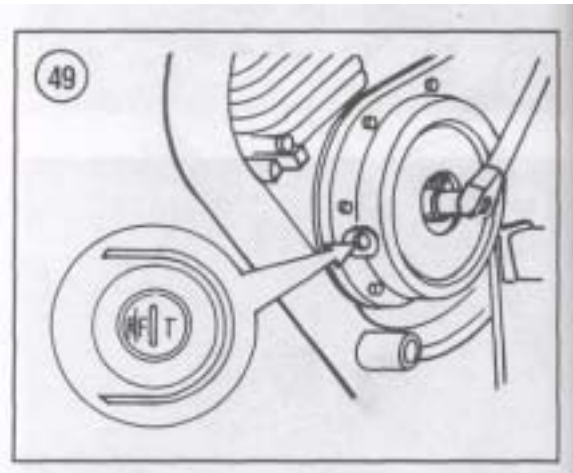
camshaft chain and keep it taut, make certain that the camshaft chain is properly meshed onto the crankshaft timing sprocket then rotate the crankshaft. If this step is not followed, the chain may become kinked and cause damage to the crankcases, the camshaft chain and the timing sprocket on the crankshaft.

20. Inspect the camshaft as described in this chapter.

21. Inspect the cylinder head cover as described in this chapter.

Rear Cylinder Installation

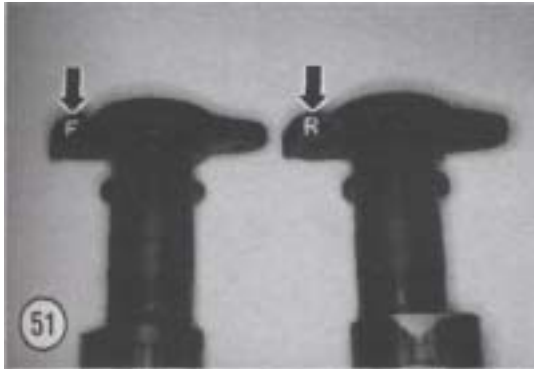
1. Check the timing mark for the *rear cylinder*. Make sure the "R/F T" mark is still aligned with the center of the inspection hole in the alternator rotor (**Figure 49**). If the timing mark is still aligned,



proceed to Step 2, if the alignment is *not* correct, proceed as follows:

CAUTION

If the front camshaft has been removed, have an assistant pull up on the front camshaft chain and keep it taut, make certain that the camshaft chain is properly meshed onto the crankshaft timing sprocket then rotate the crankshaft. If this step is not followed, the chain may become kinked and cause damage to the



crankcases, the camshaft chain and the timing sprocket on the crankshaft.

- a. Pull up on the front camshaft chain and keep it taut, make certain that the camshaft chain is properly meshed onto the crankshaft timing sprocket then rotate the crankshaft in Step b.
 - b. Use a 17 mm socket and wrench on the alternator rotor bolt (**Figure 48**). Rotate the engine *clockwise*, as viewed from the left-hand side, until the rear cylinder is at top dead center (TDC) on the compression stroke. Align the "R/F T" mark with the center of the inspection hole in the alternator rotor (**Figure 49**).
 - c. With the "R/F T" mark aligned with the center of the inspection hole in the alternator rotor, jiggle both rocker arms and make sure *both* have free play. If one of rocker arms (either intake or exhaust) is still under tension, rotate the engine an additional 360° until both rocker arms have free play.
 - d. Again check that the "R/F T" mark is still aligned with the center of the inspection hole in the alternator rotor (**Figure 49**).
2. Apply a light coat of molybdenum disulfide grease to the camshaft bearing surfaces in the cylinder head.
 3. If both camshafts are removed, be sure to install the correct camshaft in the correct cylinder head. The camshafts are marked with a "F" (front cylinder) or "R" (rear cylinder) (**Figure 51**) on the sprocket mounting boss.
 4. Apply a *light* coat of cold grease to the locating pin and install it (**Figure 52**) into the end of the camshaft.
 5. Install the *rear camshaft* into the cylinder head and loop it through the camshaft drive chain (**Figure 53**). Position the camshaft with the locating pin at the 1 o'clock position.

NOTE

When installing the sprocket onto the camshaft be careful not to knock the locating pin out of the camshaft. If the pin works loose it will probably fall down into the crankcase. If this happens the crankcase must be disassembled to retrieve it.

6. Engage the camshaft sprocket with the drive chain and install the sprocket onto the camshaft.

7. Check that the camshaft is still positioned correctly with the locating pin at the 1 o'clock position (A, **Figure 54**) and the timing marks on the end of the camshaft are aligned with the top surface of the cylinder head (B, **Figure 54**).

8. After the sprocket has been installed, make sure the "R/F T" mark is still aligned with the center of the inspection hole in the alternator rotor (**Figure 49**). Realign if necessary, the camshaft and sprocket in Steps 5-7.

NOTE

When installing the lockwasher onto the camshaft sprocket, positioned it so it will cover the locating pin in the end of the camshaft after both sprocket bolts are installed.

9. Install a new lockwasher (A, **Figure 55**) and camshaft sprocket bolt (B, **Figure 55**) in the exposed hole. Tighten the bolt only finger tight at this time.

10. Use a 17 mm socket and wrench on the alternator rotor bolt (**Figure 48**). Rotate the engine *clockwise*, as viewed from the left-hand side, until the other sprocket bolt hole is exposed.

CAUTION

Apply redLoctite (No. 271) to the sprocket bolt threads prior to installation.

11. Install the other camshaft sprocket bolt in the exposed hole,

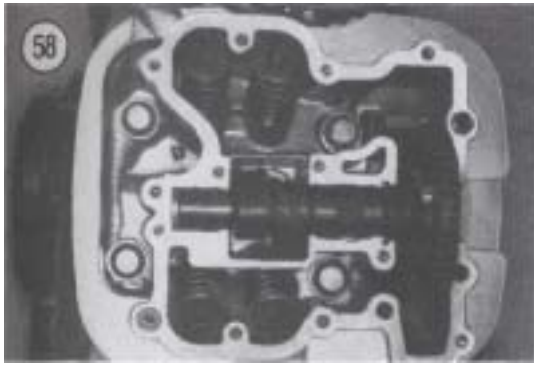
12. Hold down the end of camshaft opposite the camshaft sprocket and tighten the sprocket bolt to the torque specification listed in **Table 2**. Bend up the tab of the lockwasher against the bolt head.

13. Use a 17 mm socket and wrench on the alternator rotor bolt (**Figure 48**). Rotate the engine *clockwise*, as viewed from the left-hand side, until the bolt installed in Step 9 is exposed. Remove this bolt and apply red Loctite (No. 271) to the threads prior to installation.

14. Reinstall the camshaft sprocket bolt. Hold down the end of camshaft opposite the camshaft sprocket and tighten the sprocket bolt to the torque specification listed in **Table 2**. Bend up the tab of the lockwasher against the bolt head (**Figure 56**).

15. Make sure the camshaft shoulder is properly indexed into the groove in the cylinder head (**Figure 57**).





16. Apply a light coat of molybdenum disulfide grease to the bearing surfaces and lobes of the cam shaft (**Figure 58**).

17. Apply a light coat of molybdenum disulfide grease to the camshaft bearing surfaces in the cylinder head cover.

18. Apply a sealant to the edge surfaces of the camshaft end plug and install the plug (A, **Figure 59**) into the cylinder head. Make sure it is properly seated.

CAUTION

After the modified tie wrap is removed, inspect the end of it to make sure all of it came out and that none of it broke off in the tensioner.



19. If the cylinder head and cylinder were removed, carefully pull the long modified tie wrap out of the camshaft drive chain tensioner.

20. Clean the sealing surface of both the cylinder head and cover as follows:

- Remove the old gaskets and clean off all gasket sealer residue from the cylinder head and cover.
- Clean the surface with aerosol electrical contact cleaner and wipe dry with a lint-free cloth.
- Apply a coat of ThreeBond No. 1207, or equivalent, to sealing surface of the cylinder head cover. Do *not* apply sealant to the rounded surfaces of the camshaft bearing journal surfaces.

21. If removed, install both locating dowels into the cylinder head. Refer to B, **Figure 59** and **Figure 60**.

CAUTION

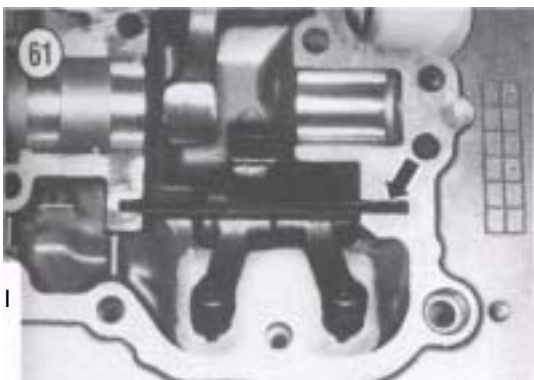
*During cylinder head cover installation, make sure the small bar (**Figure 61**) over the rocker arm does not fall out.*



22. Install the cylinder head cover onto the camshaft and the cylinder head. Push it down until it bottoms out. Make sure the camshaft end plug (A, **Figure 59**) is properly seated between the cylinder head and cover.

23. Tighten the bolts (**Figure 50**) in a crisscross pattern, starting with the center bolts (surrounding the camshaft) and working outward. Tighten in 2-3 stages to the torque specification listed in **Table 2**.

24. Check the valve clearance at this time and readjust if necessary. Do it at this time since it is much easier to perform valve adjustment with the engine out of the frame. Refer to Chapter Three for the adjustment procedure.



25. Install the breather cover gasket (**Figure 47**) and the breather cover (**Figure 46**). Tighten the bolts to the same torque specification as the cylinder head cover bolts.
26. Install new O-ring seals (**Figure 41**) in the valve adjuster covers (**Figure 45**) and install the covers and bolts. Tighten the bolts securely.
27. On the spark plug side of the cylinder head, install the insulator (**Figure 44**).

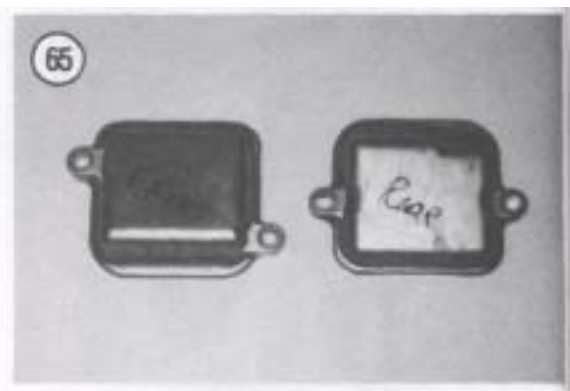
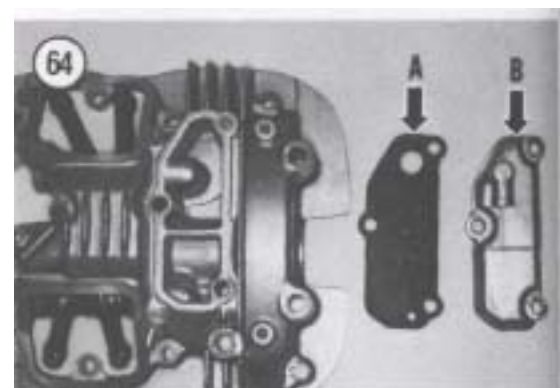
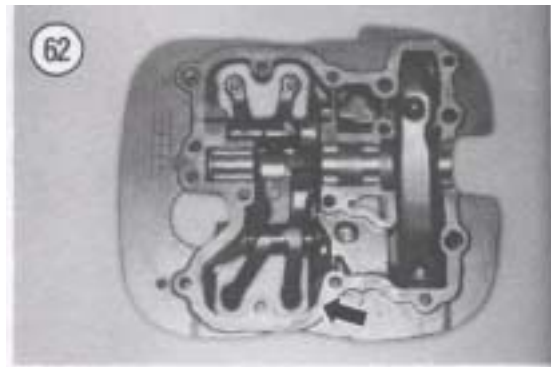
NOTE

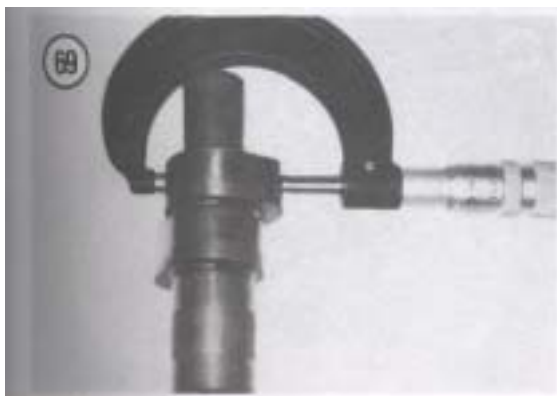
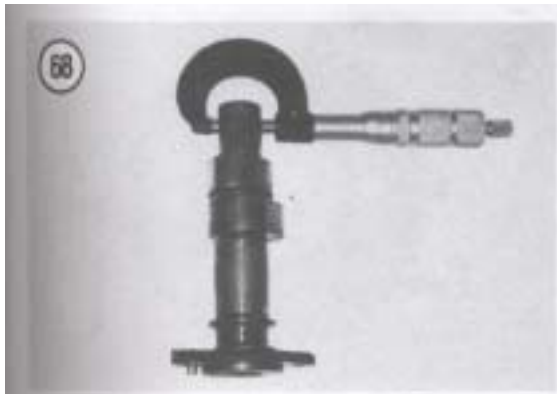
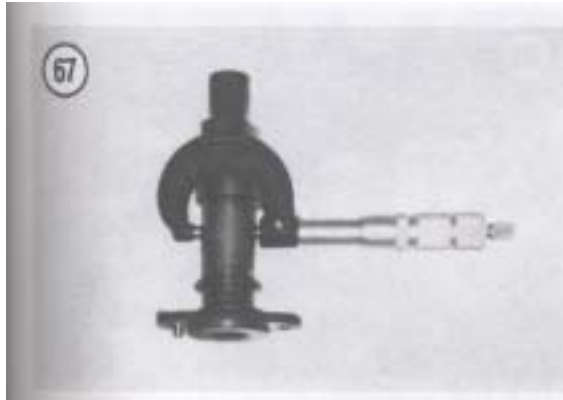
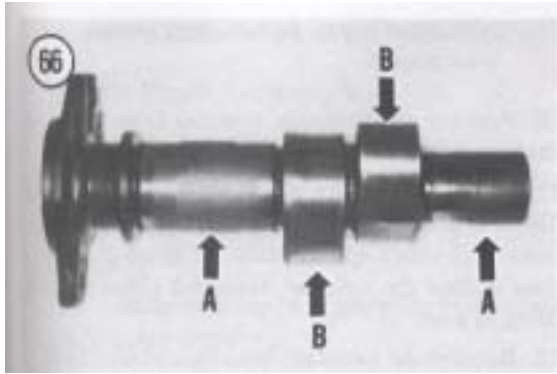
*The cylinder head side cover bolts on the side opposite the spark plug, are also cylinder head cover mounting bolts and must be tightened to the correct torque specification listed in **Table 2**.*

28. Install both cylinder head side covers (**Figure 43**) and bolts. Tighten the bolts, on the side opposite the spark plug, to the torque specification listed in **Table 2**. Tighten the bolts on the other side securely.

**Cylinder Head Cover Inspection
(Front and Rear Cylinders)**

1. Remove all traces of gasket material from the cylinder head cover gasket surfaces (**Figure 62**).
2. After the cylinder head cover has been thoroughly cleaned, place the cover on an inspection surface like a piece of plate glass and check for any warpage at several points with a flat feeler gauge.
3. Measure the warp by inserting a flat feeler gauge between the cylinder head cover gasket surface and the plate glass. There should be no warpage. Replace the cylinder head cover if the gasket surface is warped to or beyond the service limit listed in **Table 1**.
4. On the rear cylinder head cover, perform the following:
 - a. Make sure the small opening (A, **Figure 63**) in the breather area is clear. Clean out if necessary with a piece of wire and blow out with compressed air. Also make sure the large opening (B, **Figure 63**) is clear.
 - b. Inspect the gasket (A, **Figure 64**) for damage or deterioration; replace if necessary.
 - c. Inspect the breather cover (B, **Figure 64**) for cracks or damage; replace if necessary.
5. Inspect the valve adjustment covers (**Figure 65**) for cracks or damage. Make sure the small bolt hole tabs are not cracked or warped. If these tabs are





damaged it may result in an oil leak. Replace the cover(s) if necessary.

6. Disassemble and inspect the rocker arms as described in this chapter.

CAMSHAFT

Camshaft Inspection

1. Inspect the camshaft bearing journals (A, **Figure 66**) for wear.
2. Measure both camshaft bearing journals with a micrometer. Refer to **Figure 67** for the center journal and to **Figure 68** for the end journal. Compare to the dimensions given in **Table 3**. If worn to the service limit or less the camshaft must be replaced.
3. Check the camshaft lobes (B, **Figure 66**) for wear. The lobes should show no signs of scoring and the edges should be square. Slight damage may be removed with a silicone carbide oilstone. Use No. 100-120 grit stone initially, then polish with a No. 280-320 grit stone.
4. Even though the camshaft lobe surface appears to be satisfactory, with no visible signs of wear, the camshaft lobes must be measured with a micrometer (**Figure 69**). Compare to the dimensions given in **Table 1**. If worn to the service limit or less the camshaft must be replaced.
5. Place the camshaft on a set of V-blocks and check its runout with a dial indicator. Compare to the dimension given in **Table 1**. If the runout is to the service limit or more the camshaft must be replaced.
6. Make sure the locating pin (**Figure 52**) is installed in the end of the camshaft is a tight fit. If loose, replace the pin.
7. Inspect the camshaft bearing surfaces in the cylinder head (**Figure 70**) and cylinder head cover



(**Figure 71**). They should not be scored or excessively worn. Replace the cylinder head and cylinder head cover as a set, if the bearing surfaces are worn or scored.

8. Inspect the camshaft sprocket teeth (A, **Figure 72**) for wear; replace if necessary.

9. Make sure the camshaft sprocket bolt holes (B, **Figure 72**) and locating pin hole (C, **Figure 72**) are not elongated or damaged. If damaged, replace the camshaft sprocket.

Camshaft Bearing Clearance Measurement

This procedure requires the use a Plastigage set. The camshaft must be installed into the cylinder head. Before installing the camshaft, wipe all oil residue from the camshaft bearing journals and bearing surfaces in the cylinder head and cylinder head cover.

1. Install the camshaft into the cylinder head with the lobes facing down. Do not attach the drive sprocket to the camshaft.

2. Make sure the locating dowels (**Figure 73**) are in place in the cylinder head.

3. Place a strip of Plastigage material on top of each camshaft center and end bearing journals, parallel to the camshaft.

4. Install the cylinder head cover.

5. Install the bolts securing the cylinder head cover.
6. Tighten the bolts in a crisscross pattern, starting with the center bolts (surrounding the camshaft) and working outward, tighten in 2-3 stages to the torque specification listed in **Table 2**.

CAUTION

Do not rotate the camshafts with the Plastigage material in place.

7. Loosen the cylinder head bolts in 2-3 stages in a crisscross pattern, then remove the bolts.

8. Carefully remove the cylinder head cover.

9. Measure the width of the flattened Plastigage material at the widest point, according to the manufacturer's instructions.

CAUTION

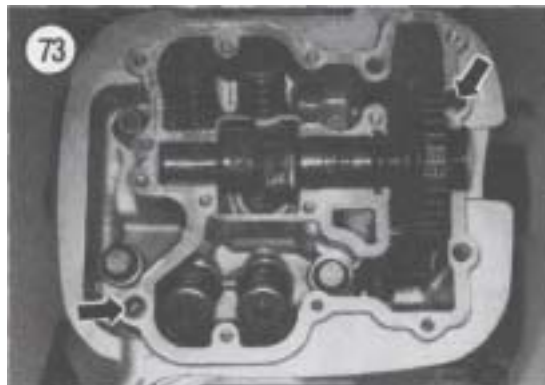
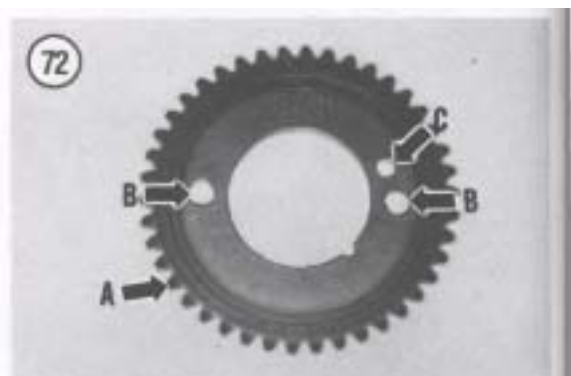
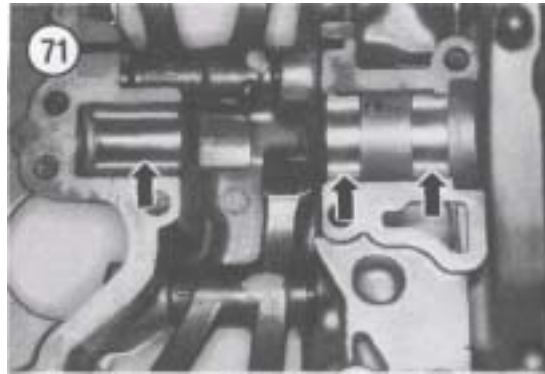
Be sure to remove all traces of Plastigage material from the bearing journals in the cylinder head cover. If any material is left in the engine it can plug up an

oil control orifice and cause severe engine damage.

10. Remove *all* Plastigage material from the camshafts and the bearing caps.

11. If the oil clearance is greater than specified in **Table 1**, and the camshaft bearing journal dimensions were within specification in *Camshaft Inspection*, replace the cylinder head and cylinder head cover as a set.

12. Remove the camshaft from the cylinder head.



ROCKER ARM ASSEMBLIES

3. Loosen both rocker arm shafts (B, **Figure 75**

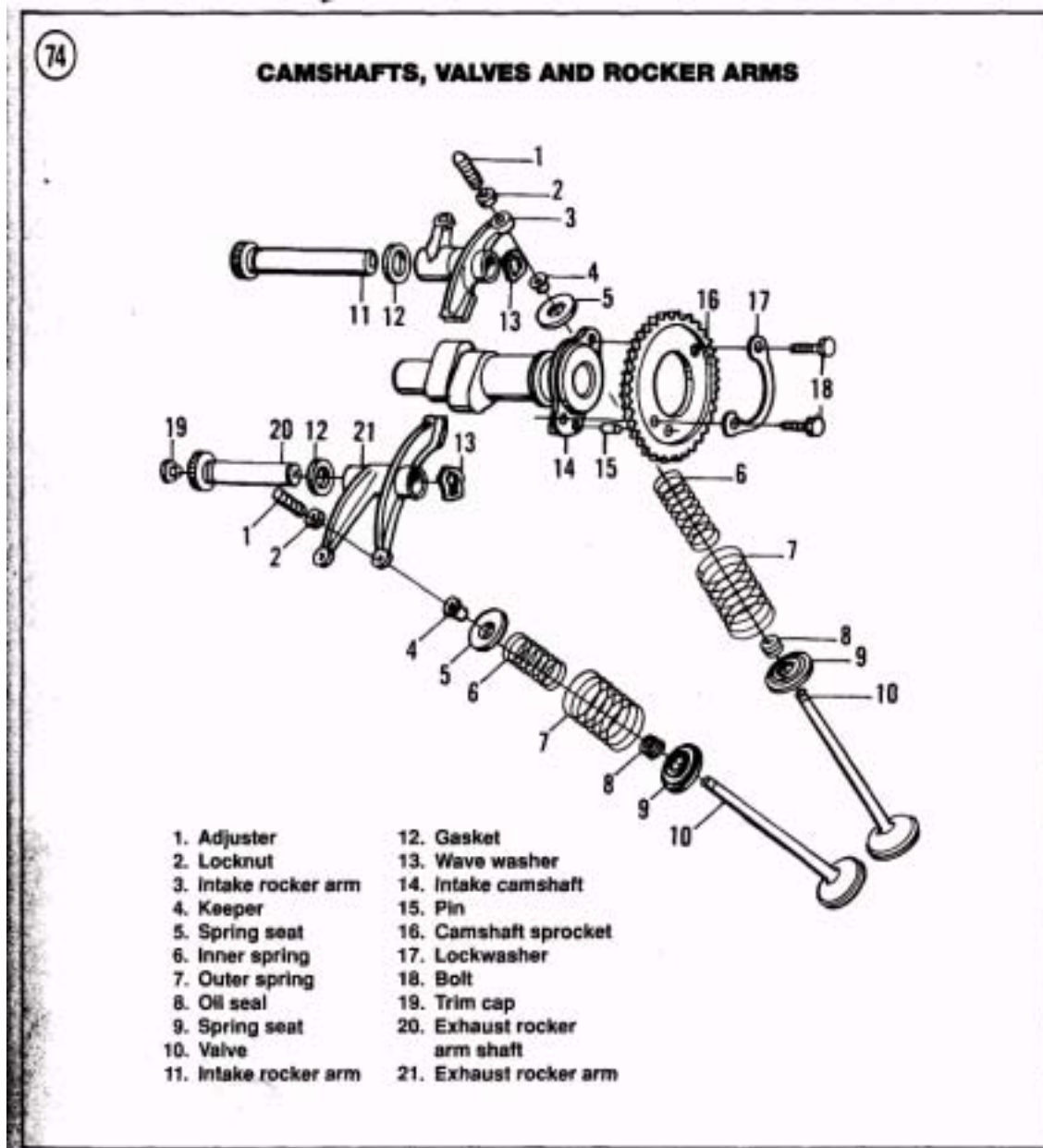
Refer to **Figure 74** for this procedure.

Removal

1. Remove the cylinder head cover as described in this chapter.
2. Remove the trim cap (A, **Figure 75**) from the end of each rocker arm shaft.

NOTE

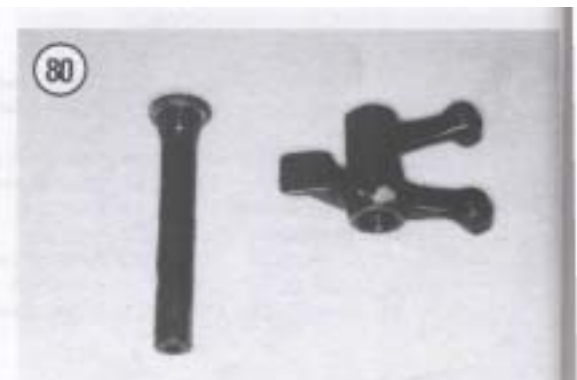
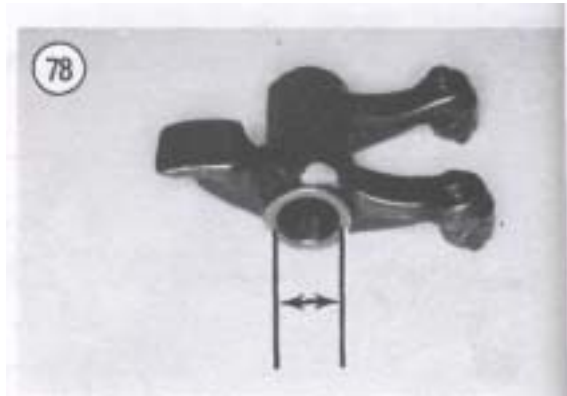
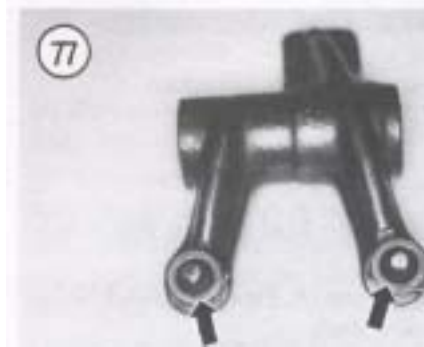
Note that the rocker arms and shafts are different and must be kept separate to avoid the intermixing of parts. Remove one set at a time and place it in a small box and label the rocker arm and shaft either intake or exhaust.



4. Withdraw the intake rocker arm shaft and remove the rocker arm and wave washer. Don't lose the gasket from the shaft.
5. Withdraw the exhaust rocker arm shaft and remove the rocker arm and wave washer. Don't lose the gasket from the shaft.
6. Wash all parts in solvent and thoroughly dry with compressed air.

Inspection

1. Inspect the rocker arm pad where it rides on the cam lobe (**Figure 76**) and where the adjusters ride on the valve stems (**Figure 77**). If the pad is scratched or unevenly worn, inspect the camshaft lobe for scoring, chipping or flat spots. Replace the rocker arm if defective as well as the camshaft if it is damaged.
2. Measure the inside diameter of the rocker arm bore (**Figure 78**) and check against the dimensions in **Table 1**. Replace if worn to the service limit or greater.
3. Inspect the rocker arm shaft for signs of wear or scoring. Measure the outside diameter (**Figure 79**)





with a micrometer and check against the dimensions in **Table 1**. Replace if worn to the service limit or less.

4. Make sure the oil holes in the rocker arm shaft are clean and clear. If necessary, clean out with a piece of wire and thoroughly clean with solvent. Dry with compressed air.

5. Check the gasket and wave washers for breakage or distortion; replace if necessary.

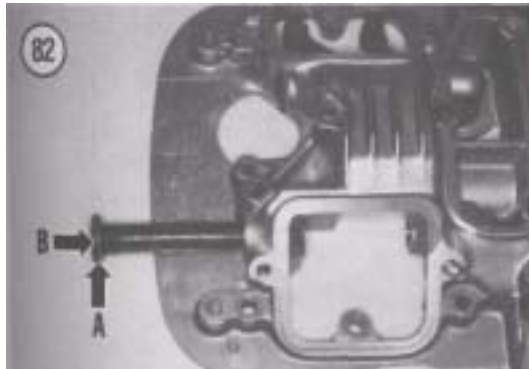
6. Check the overall condition of the rocker arm and shaft for fractures, wear or damage (**Figure 80**); replace if necessary.

Installation

1. Coat the rocker arm shaft, rocker arm bore and the shaft receptacles in the cylinder head with assembly oil or clean engine oil.

NOTE

The rocker arms and shafts are not identical. Refer to the marks made during removal and be sure to install these parts into the correct location within the cylinder head cover.



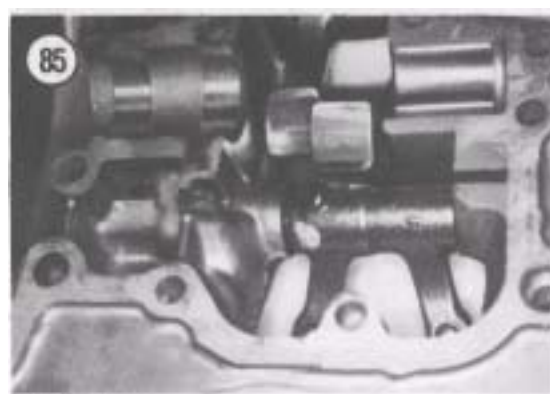
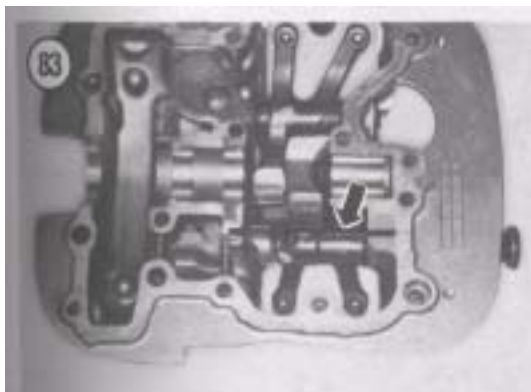
2. **Figure 81** shows the correct order of parts as they are to be installed into the cylinder head.

3. Install the gasket (A, **Figure 82**) onto the rocker arm shaft and install the rocker arm shaft (B, **Figure 82**) part way into the cylinder head cover.

4. Position the rocker arm (**Figure 83**) and push the rocker arm shaft through but not past it, allowing room for installation of the wave washer.

5. Install the wave washer (**Figure 84**) then push the rocker arm shaft through the wave washer and into the cylinder head cover until it stops.

6. Make sure all parts are installed correctly as shown in **Figure 85**, then screw the rocker arm into



the cylinder head cover. Tighten the rocker arm shafts (B, **Figure 75**) to the torque specification listed in **Table 2**.

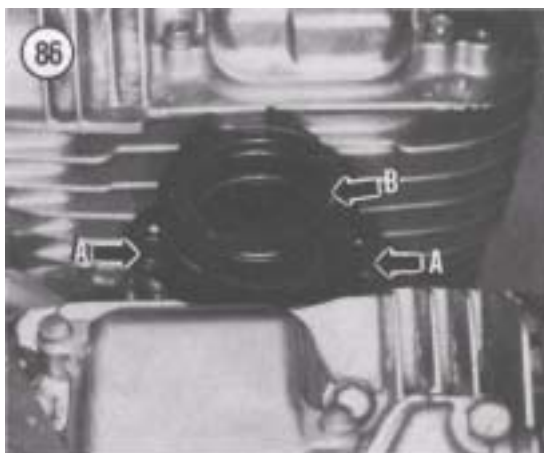
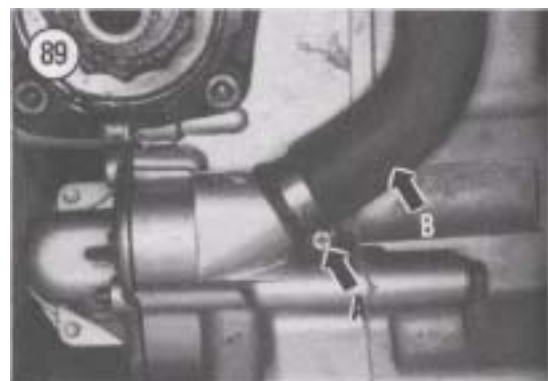
7. Install the trim cap (A, **Figure 75**) into the end of the shaft.
8. Repeat for the other rocker arm assembly.
9. On the intake rocker arm, apply some cold grease to the small bar, then install the small bar (**Figure 61**) into the groove in the cylinder head cover.

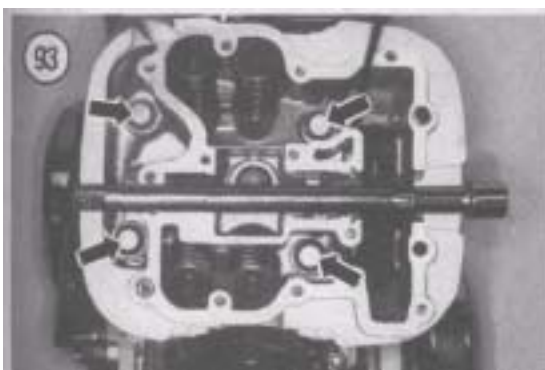
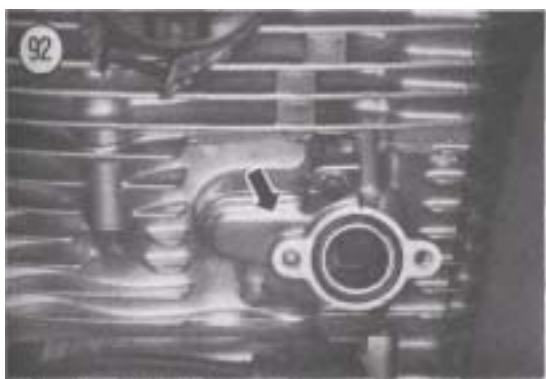
CYLINDER HEAD AND CYLINDER

The cylinder head and cylinder are removed from the crankcase as an assembly then separated after removal.

Removal

1. Remove the bolts (A, **Figure 86**) securing the intake pipe and remove it (B, **Figure 86**).
2. Remove the cylinder head covers as described in this chapter.
3. Loosen the screws of the clamping bands (**Figure 87**) on the short coolant hose connecting both cylinder heads. Move the clamps from the fittings of the cylinder heads and back onto the hose.
4. Loosen the screws of the clamping bands on the short coolant hose connecting both cylinders. Move the clamps from the fittings of the cylinders and back onto the hose (**Figure 88**).
5. For removal of the rear cylinder head and cylinder, perform the following:
 - a. Loosen the clamping screw (A, **Figure 89**) of water pump on that hose fitting at rear of crankcase. Move the clamp back onto the hose and





off of the neck of the fitting, then remove the hose (B, **Figure 89**) from the crankcase fitting.

- b. Remove the bolts (**Figure 90**) securing the metal coolant inlet pipe to the rear cylinder.
 - c. Separate the metal coolant pipe from the cylinder.
 - d. Remove the metal coolant pipe and rubber hose assembly (**Figure 91**) from the engine and frame.
 - e. Remove the bolts securing the coolant fitting (**Figure 92**) to the base of the cylinder and remove it. Don't lose the O-ring seal on each side of the fitting.
6. Using a crisscross pattern, loosen then remove the bolts (**Figure 93**) securing the cylinder head and cylinder to the crankcase.

CAUTION

Remember the small cooling fins are fragile and may be damaged if tapped or pried too hard. Never use a metal hammer.

7. Loosen the cylinder head and cylinder by tapping around the perimeter base of the cylinder with a rubber or soft faced mallet. If necessary, *gently* pry the cylinder from the crankcase with a broad-tipped screwdriver.
8. Untie the wire, or remove the drift or long socket extension securing the camshaft chain.
9. Carefully lift the cylinder head and cylinder assembly (**Figure 94**), then remove from the piston and the crankcase. Carefully disengage the short coolant hoses from the fittings of the other cylinder and cylinder head. Guide the camshaft chain through the opening in the cylinder head and cylinder and secure it to the exterior of the engine. This will prevent the camshaft chain from falling down into the crankcase.
10. Remove the cylinder base gasket and discard it. Don't lose the locating dowels.
11. If only one cylinder head and cylinder assembly is going to be removed, place a clean shop cloth into the opening in the crankcase opening (**Figure 95**) to prevent the entry of foreign matter.
12. Repeat the procedure for the other cylinder head and cylinder assembly if necessary.

Disassembly

1A. For the front cylinder head and cylinder, remove the bolts (**Figure 96**) at the front and the nut (**Figure 97**) at the rear.

1B. For the rear cylinder head and cylinder, remove the nut at the front and the nut (**Figure 98**) at the rear.

2. Loosen the cylinder head from the cylinder by tapping around the perimeter of the cylinder head with a rubber or soft faced mallet. If necessary, *gently* pry the cylinder head from the cylinder with a broad-tipped screwdriver.

3. Carefully remove the cylinder head (A, **Figure 99**) from the cylinder (B, **Figure 99**).

4. Remove the cylinder head gasket. Don't lose the locating dowels.

5. Remove the camshaft chain guide from the cylinder.

6. Remove the bolts (A, **Figure 100**) securing the camshaft chain tensioner (B, **Figure 100**) and remove the tensioner from the cylinder.

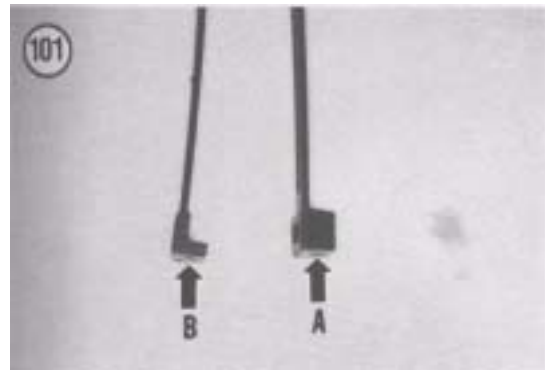
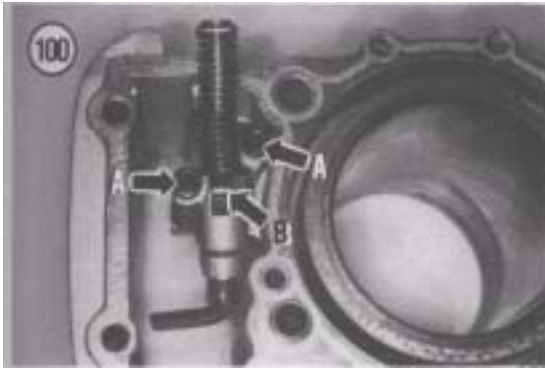
7. Inspect the cylinder head, cylinder and camshaft chain tensioner as described in this chapter.

Assembly

A special tool is required to hold the camshaft chain tensioner spring in the compressed position. The special Suzuki tool, tensioner locking tool (part No. 09918-53810) can be substituted with a home-made tool from a long plastic tie wrap as follows:

- a. Start with a long tie wrap (10-12 in.) (A, **Figure 101**).





b. Trim the locking end of the tie wrap to achieve an "L" shaped end as shown in B, **Figure 101**.

c. Do not trim away too much of the plastic material as the "L" shaped end must not only hold the ratchet in the compressed position, but it must also be strong enough to not break off and stay in the tensioner when the modified tie wrap is withdrawn later in the procedure.

d. Do *not* shorten the overall length of the tie wrap. It must be this long in order to exit through the top of the cylinder head during assembly so it can be removed later in the installation procedure.

NOTE

*The camshaft chain tensioners are unique and must be installed in the correct cylinder. They are marked with a "F" (front) or "R" (rear) **Figure 102**.*

1. Install the correct camshaft chain tensioner (B, **Figure 100**) into the cylinder. Install the bolts (A, **Figure 100**) and tighten securely.

NOTE

The camshaft chain tensioner spring must be compressed, and remain compressed, prior to installing the camshaft chain guide.

2. On the camshaft tensioner assembly, release the ratchet with a small screwdriver, push in on the end of the tensioner to compress the spring, then install the "special tie wrap tool" in the ratchet as shown **Figure 103**. This will hold the tensioner in place and keep the spring compressed.

NOTE

The front and rear cylinder head gaskets have a different hole pattern. Be sure to install the correct gasket on the correct cylinder.

NOTE

*The camshaft chain guides are unique and must be installed in the correct cylinder. They are marked with an "F" (front) or "R" (rear) as shown in **Figure 104**.*

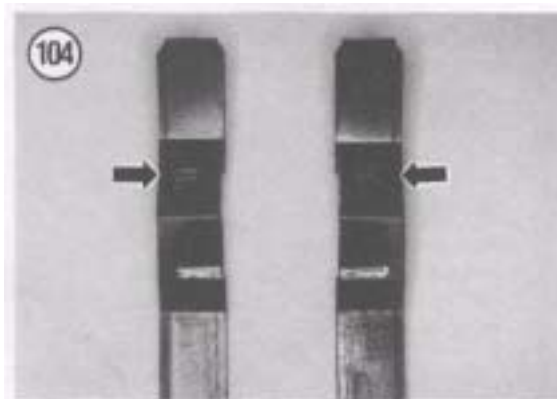
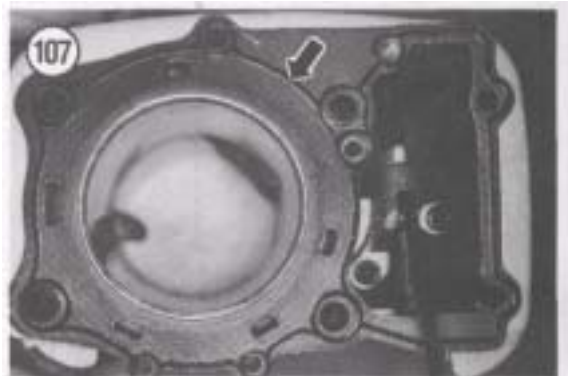
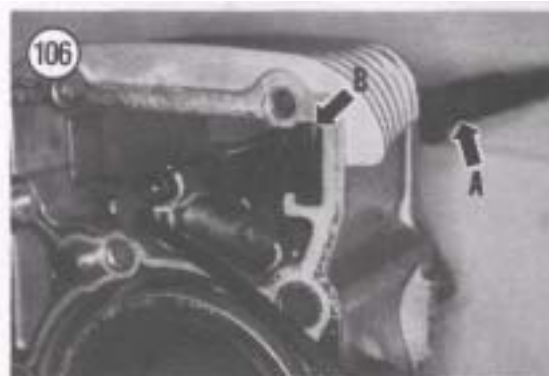
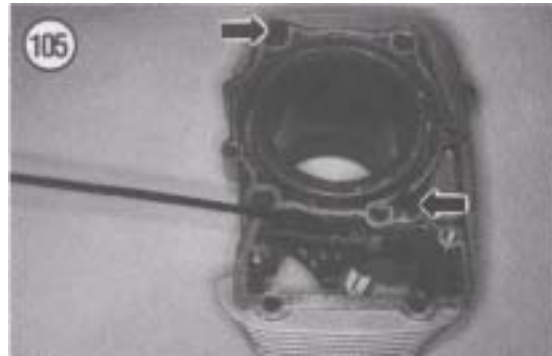
3A. On the front cylinder, perform the following:

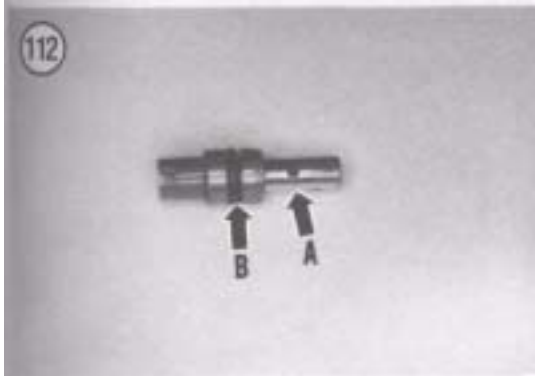
- a. If removed, install the 2 locating dowels (**Figure 105**) in the cylinder.
 - b. Install the camshaft chain guide (A, **Figure 106**) into the cylinder. Make sure it is correctly seated in the locator notch at the top of the cylinder (B, **Figure 106**).
 - c. Install a new cylinder head gasket (**Figure 107**). Make sure all of the gasket holes match the holes in the cylinder (**Figure 108**).
- 3B. On the rear cylinder, perform the following:
- a. Install the camshaft chain guide (A, **Figure 109**) into the cylinder. Make sure it is correctly seated in the locator notch at the top of the cylinder (B, **Figure 109**).
 - b. If removed, install the 2 locating dowels (A, **Figure 110**) in the cylinder.
 - c. Install a new cylinder head gasket (B, **Figure 110**). Make sure all of the gasket holes match the holes in the cylinder (**Figure 108**).

CAUTION

The cylinder head and cylinder should fit together without force. If they do not fit together completely, do not attempt to pull them together with the bolts and nuts in the next step. Separate the 2 parts and investigate the cause of the interference. Do not risk damage by trying to force the part together.

4. Carefully install the cylinder head (A, **Figure 99**) onto the cylinder (B, **Figure 99**). Guide the plastic "tie wrap tool" up through the camshaft chain opening in the cylinder head (**Figure 111**). Push the 2 parts together until they bottom out. 5A. On the front cylinder head and cylinder, install the bolts (**Figure 96**) at the front and the nut (**Figure**





97) at the rear. Tighten the bolts and nut to the torque specification listed in **Table 2. 5B**. On the rear cylinder head and cylinder, install the nut at the front and the nut (**Figure 98**) at the rear. Tighten the nuts to the torque specification listed in **Table 2**.

Installation

1. If used, remove the clean shop cloth from the opening in the crankcase opening.
2. Apply a liberal coat of clean engine oil to the cylinder wall especially at the lower end where the piston will be entering.
3. Also apply clean engine oil to the piston and piston rings. This will make it easier to guide the piston into the cylinder bore.
4. Check that both top surfaces of the crankcase and the bottom surface of the both cylinders are clean prior to installing a new base gasket.

NOTE

The front and rear cylinder base gaskets have a slightly different hole pattern. Be sure to install the correct gasket on the correct location on the crankcase.

5 A. On the front cylinder location on the crankcase, perform the following:

- a. If the oil control orifice was removed, make sure the oil hole (A, **Figure 112**) is open and that the O-ring (B, **Figure 112**) is installed. Install the oil control orifice (**Figure 113**) into the crankcase, pushing it down until it bottoms (**Figure 114**).



- b. If removed, install the locating dowels (A, **Figure 115**).
- c. Install a new cylinder base gasket (B, **Figure 115**).

5B. On the rear cylinder location on the crankcase, perform the following:

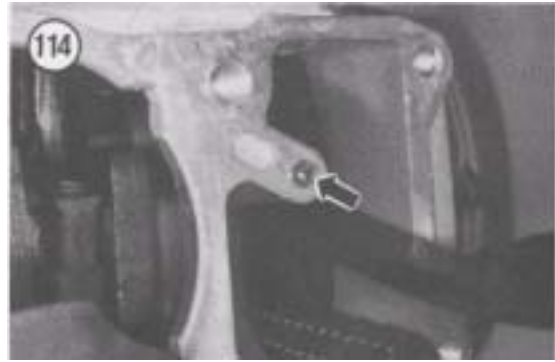
- a. If removed, install the locating dowels (A, **Figure 116**).
- b. Install a new cylinder base gasket (B, **Figure 116**).
- c. If the oil control orifice was removed, make sure the oil hole (A, **Figure 112**) is open and that O-ring (B, **Figure 112**) is installed. Install the oil control orifice into the crankcase (**Figure 117**), pushing it down until it bottoms (**Figure 118**).

6. Make sure the end gaps of the piston rings are *not* lined up with each other—they must be staggered. Lubricate the piston rings and the inside of the cylinder bore with assembly oil or fresh engine oil.

NOTE

The following step requires the aid of an assistant. The cylinder head and cylinder assembly are long and also quite heavy. Trying to hold onto the cylinder head and cylinder assembly by yourself, while guiding it onto the piston could cause damage to the piston and/or piston rings.

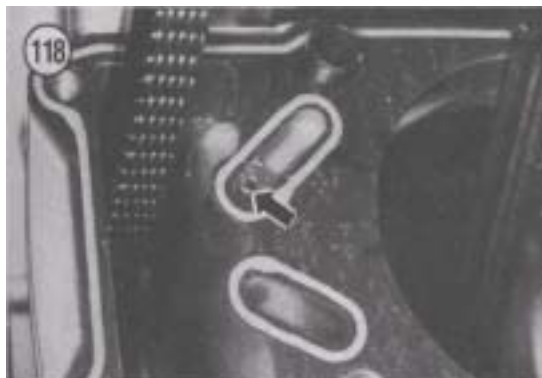
- I. Move the cylinder head and cylinder assembly into position on the crankcase.
8. Install the cylinder head and cylinder assembly. Guide the camshaft chain and camshaft tensioner assembly guide into the camshaft chain slot in the cylinder head and cylinder assembly. Make sure the camshaft tensioner guide indexes correctly into the tensioner assembly in the cylinder.
9. Carefully feed the camshaft chain and wire up through the opening in the cylinder head and cylinder and tie it to the exterior of the assembly.
10. Have the assistant start the cylinder down over the piston while you compress each piston ring with your fingers as it enters the cylinder.
- II. Slide the cylinder head and cylinder assembly down until it bottoms out on the crankcase.
12. Look down into the camshaft chain cavity and make sure the camshaft chain, camshaft tensioner assembly guide and the chain guide are all posi-



tioned correctly and that the camshaft chain is not binding.

13. Install the bolts (**Figure 93**) securing the cylinder head and cylinder to the crankcase. Using a crisscross pattern, tighten the bolts in 2-3 stages to the torque specification listed in **Table 2**.

14. Both short sections of coolant hose should be replaced at this time, because they are difficult to replace after both cylinder heads and cylinders are installed on the crankcase.



NOTE

Make sure hose clamps are installed onto the short sections of the coolant hoses prior to installing the other cylinder head and cylinder assembly. It would be very difficult to install the clamps onto the hoses once both assemblies are in place on the crankcase.

15. Repeat Steps 6-13 for the other cylinder head and cylinder head assembly. The procedure is the same except the short sections of the coolant hoses must be attached to the fittings on both the cylinder head and cylinder during installation.

16. Apply a light coat of rubber lube, or equivalent, to the inner surface of the coolant hoses, to make installation easier.

17. Once the coolant hoses are installed onto both fittings, move the hose clamps into position and tighten securely. Refer to **Figure 87** for the cylinder heads and **Figure 88** for the cylinders. Do not over-tighten as the clamp may cut into the hose.

18. After the rear cylinder head and cylinder have been installed, perform the following:

- Inspect the O-ring seals in the coolant fitting for damage, hardness or deterioration. If necessary, install a new O-ring seal into the back (**Figure 119**) and into the front (**Figure 120**) of the coolant fitting.
- Apply a light coat of oil to the O-rings.
- Install the coolant fitting (**Figure 92**) to the base of the cylinder and install the bolts. Tighten the bolts securely.
- Install the metal coolant pipe and rubber hose assembly (**Figure 91**) onto the engine and frame.
- Install the hose (B, **Figure 89**) onto the neck of the fitting on the crankcase. Don't tighten the hose clamp at this time.
- Install the coolant fitting on the back of the cylinder and install the bolts (**Figure 90**). Tighten the bolts securely.
- Tighten the hose clamp screw (A, **Figure 89**) on the hose.

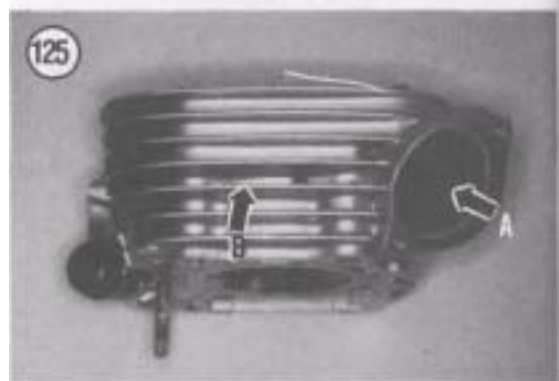
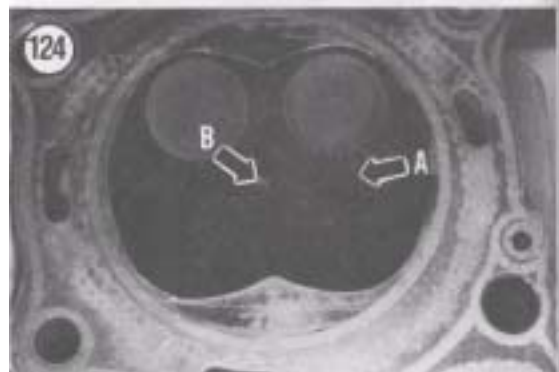
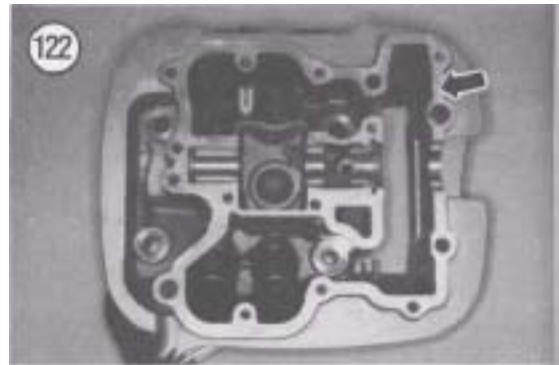
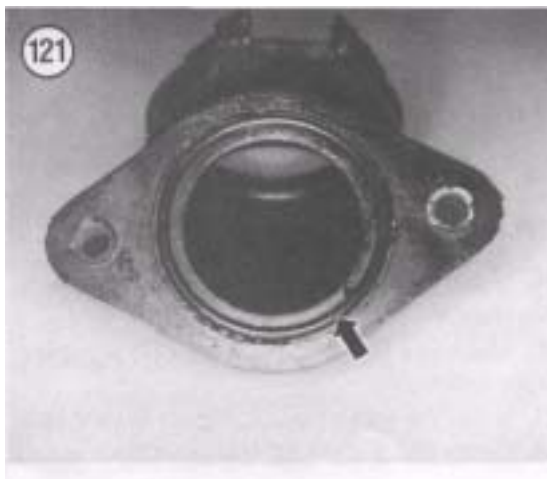
19. Install the cylinder head covers as described in this chapter.

20. Make sure the O-ring (**Figure 121**) is in place in the intake pipe.

21. Install the intake pipe (B, **Figure 86**) and bolts (A, **Figure 86**). Tighten the bolts securely.

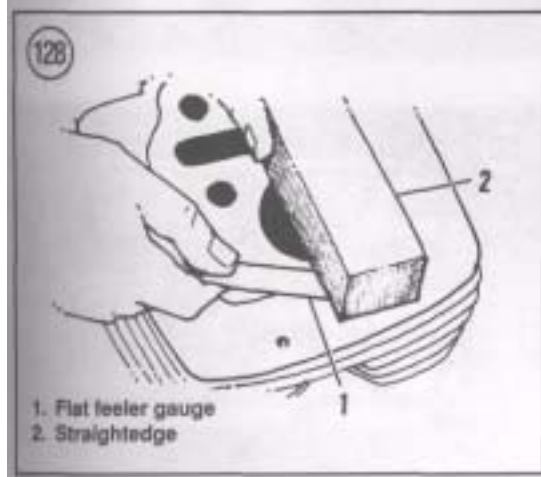
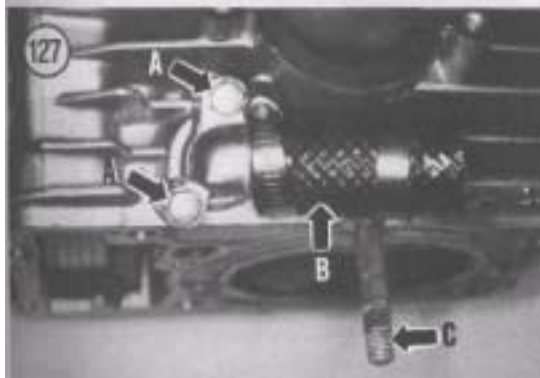
Cylinder Head Inspection

1. Remove all traces of gasket material from the cylinder head upper (**Figure 122**) and lower (**Figure 123**) mating surfaces. Do not scratch the gasket surface.
2. *Without removing the valves*, remove all carbon deposits from the combustion chamber (A, **Figure 124**) and valve ports with a wire brush. A blunt screwdriver or chisel may be used if care is taken not to damage the head, valves and spark plug threads.
3. Examine the spark plug threads (B, **Figure 124**) 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 to clean the threads following the manufacturer's instructions. If thread damage is severe, refer further service to a dealer or competent machine shop.
4. After the carbon is removed from the combustion chamber and the valve ports and the spark plug thread hole is repaired, clean the entire head in cleaning solvent. Blow dry with compressed air.
5. Clean away all carbon from the piston crown. Do not remove the carbon ridge at the top of the cylinder bore.
6. Check for cracks in the combustion chamber and exhaust port (A, **Figure 125**). A cracked head must be replaced.
7. Inspect the camshaft bearing area (**Figure 126**) in the cylinder head for damage, wear or burrs. Clean up if damage is minimal; replace cylinder head if necessary.
8. Inspect the cooling fins (B, **Figure 125**) for cracks or damage.



9. Inspect the short hose coolant fitting for signs of leakage. If present, remove the bolts (A, **Figure 127**) securing the fitting and remove it. Install a new O-ring seal and apply fresh engine oil to the O-ring. Reinstall the fitting and tighten the bolts securely.

10. Inspect the short section of coolant hose (B, **Figure 127**) for cracks, hardness or deterioration. Replace if necessary.



11. Inspect the threads of the stud (C, **Figure 127**) for damage. Clean up with an appropriate size metric die if necessary. Make sure the stud is tightly secured into the cylinder head.

12. After the head has been thoroughly cleaned, place a straightedge across the cylinder head/cylinder gasket surface (**Figure 128**) at several points. Measure the warp by inserting a flat feeler gauge between the straightedge and the cylinder head at each location. Maximum allowable warp is 0.010 in. (0.25 mm). If warpage exceeds this limit, the cylinder head must be replaced.

13. Inspect the valve and valve guides as described in this chapter.

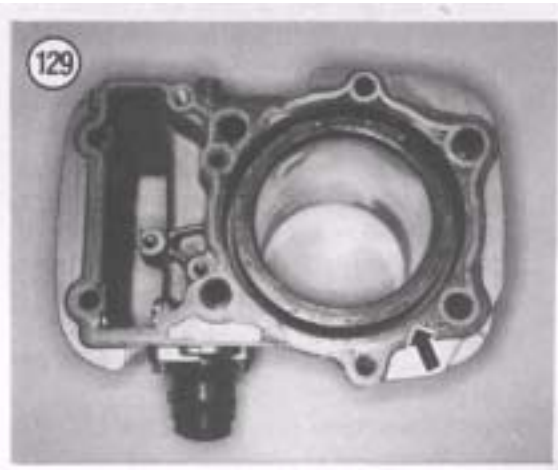
14. Repeat for the other cylinder head.

Cylinder Inspection

1. Soak old cylinder head gasket material stuck to the cylinder (**Figure 129**) with solvent. Use a broad-tipped *dull* chisel to gently scrape off all gasket residue. Do not gouge the sealing surface as oil, coolant and air leaks will result.

2. Measure the cylinder bore with a cylinder gauge or inside micrometer at the points shown in **Figure 130**.

3. Measure in 2 axes—in line with the piston-pin and at 90° to the pin. If the taper or out-of-round is 0.004 in. (0.10 mm) or greater, the cylinder must be rebored to the next oversize and a new piston and rings installed. Rebore both cylinders even if only one is worn.



NOTE

The new pistons should be obtained before the cylinders are rebored so that the pistons can be measured. Slight manufacturing tolerances must be taken into account to determine the actual size and working clearance. Piston-to-cylinder wear limit is listed in Table 1.

NOTE

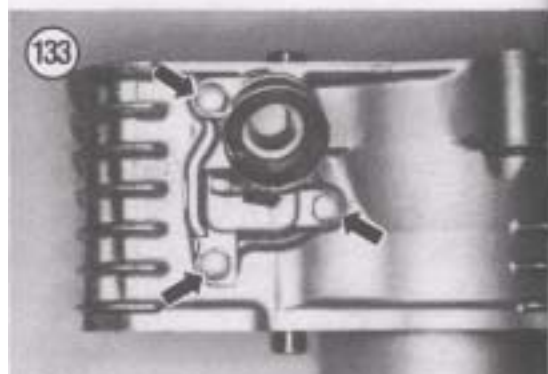
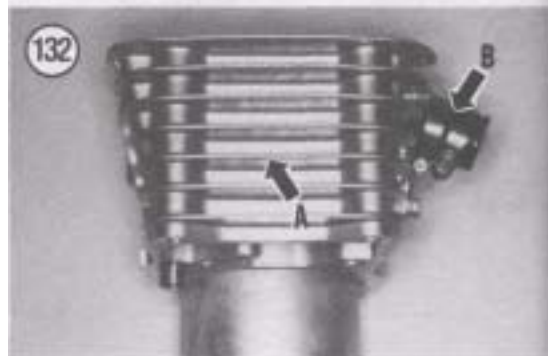
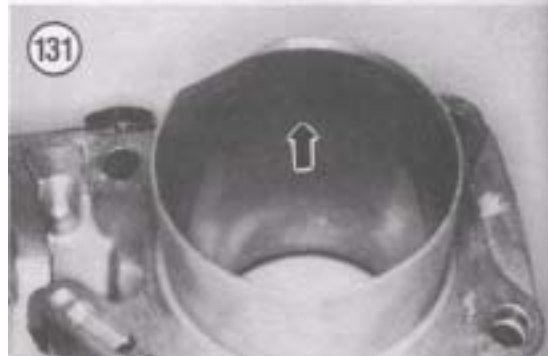
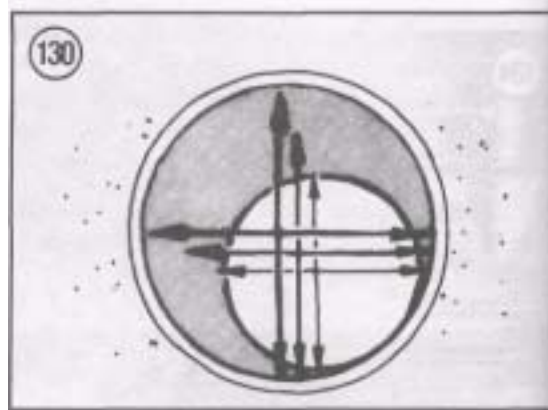
The maximum wear limit on the cylinder is listed in Table 1. If the cylinder is worn to this limit, it must be replaced. Never rebores a cylinder if the finished rebores diameter will be this dimension or greater.

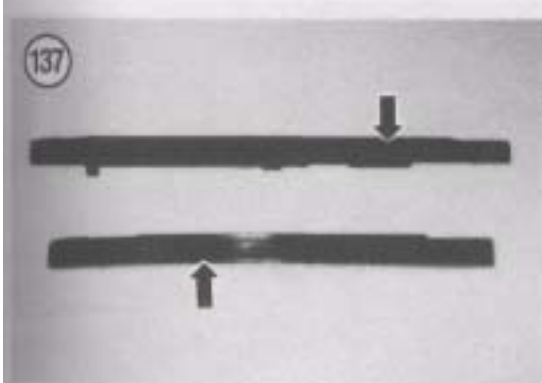
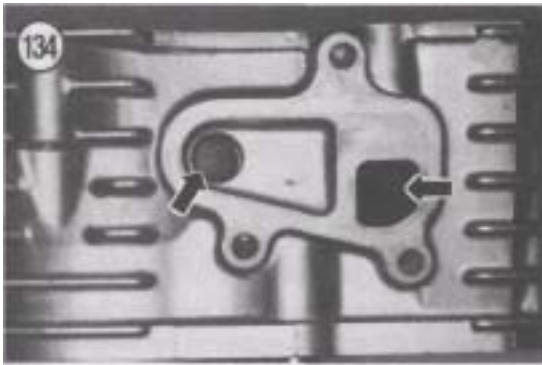
4. If the cylinders are not worn past the service limit, thoroughly check the bore surface (Figure 131) for scratches or gouges. If damaged in any way, the bore will require boring and reconditioning.
5. If the cylinders require reboring, remove all dowel pins from the cylinders, then take them to a dealer or machine shop for service.
6. After the cylinders have been serviced, perform the following:

CAUTION

A combination of soap and hot water is the only solution that will completely clean cylinder walls. Solvent and kerosene cannot wash fine grit out of cylinder crevices. Any grit left in the cylinders will act as a grinding compound and cause premature wear to the new rings.

- a. Wash each cylinder bore in hot soapy water. This is the only way to clean the cylinders of the fine grit material left from the bore and honing procedure.
 - b. Also wash out any fine grit material from the cooling cores surrounding each cylinder.
 - c. After washing the cylinder walls, run a clean white cloth through each cylinder wall. It should *not* show any traces of grit or debris. If the rag is the slightest bit dirty, the wall is not thoroughly cleaned and must be rewashed.
 - d. After the cylinder is cleaned, lubricate the cylinder walls with clean engine oil to prevent the cylinder liners from rusting.
7. Inspect the cooling fins (A, Figure 132) for cracks or damage.





8. Inspect the short hose coolant fitting for signs of leakage. If present, remove the bolts (**Figure 133**) securing the fitting and remove it. Make sure the openings (**Figure 134**) in the cylinder head are open. Install a new O-ring seal and apply fresh engine oil to the O-ring. Reinstall the fitting and tighten the bolts securely.

9. Inspect the short section of coolant hose (B, **Figure 132**) for cracks, hardness or deterioration. Replace if necessary.

10. Repeat for the other cylinder.

Camshaft Chain Tensioner and Guide Adjuster Inspection

1. Inspect all parts of the camshaft chain tensioner adjuster for wear or damage (**Figure 135**). Suzuki does not provide any service specifications for the tensioner adjuster.

2. Make sure the ratchet (**Figure 136**) operates correctly.

3. If any part of the tensioner adjuster body or rack is worn or damaged, replace the entire assembly. Replacement parts are not available.

4. Inspect the camshaft chain guides (**Figure 137**) for wear or deterioration. Replace if necessary.

VALVES AND VALVE COMPONENTS

General practice among those who do their own service is to remove the cylinder heads and take them to a machine shop or dealer for inspection and service. Since the cost is relative to the required effort and equipment, this may be the best approach even for the experienced mechanics.

This procedure is included for those who chose to do their own valve service.

Refer to **Figure 138** for this procedure.

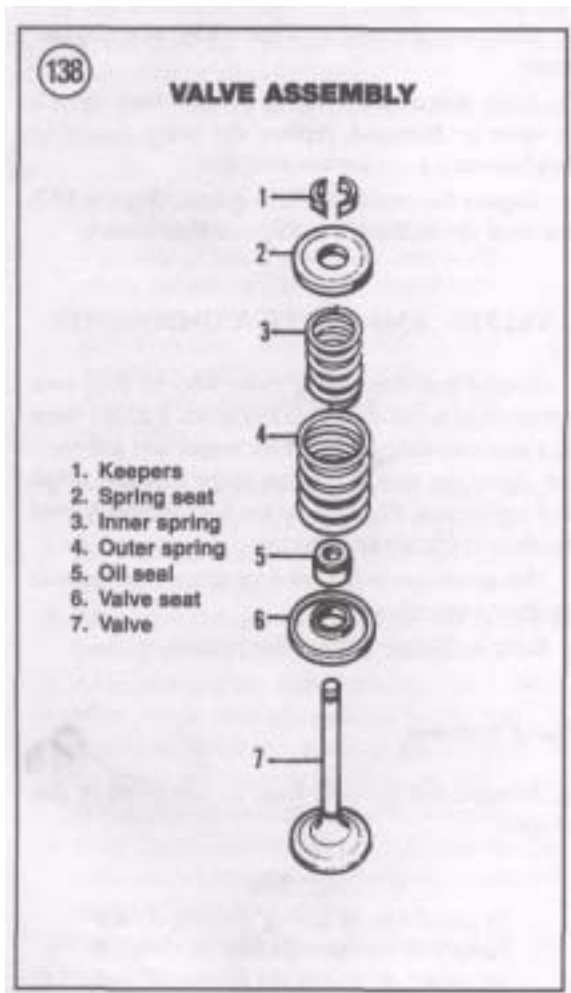
Valve Removal

1. Remove the cylinder head as described in this chapter.

CAUTION

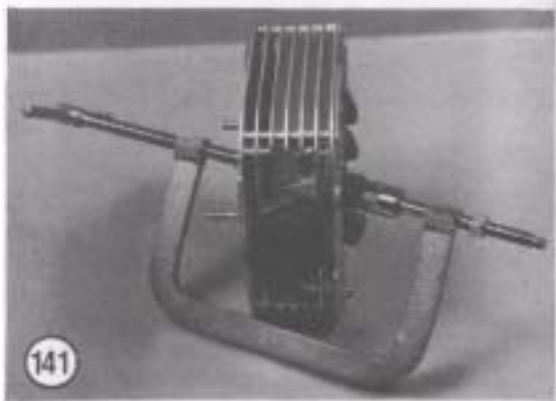
To avoid loss of spring tension, do not compress the springs any more than necessary to remove the keepers.

2. Compress the valve springs with a valve compressor tool (Figure 139). Remove the valve keepers (Figure 140) and release the compression. Remove the valve compressor tool (Figure 141).
3. Remove the valve spring retainer and valve springs.
4. Prior to removing the valve, remove any burrs from the valve stem (Figure 142). Otherwise the valve guide will be damaged.
5. Remove the valve.
6. Remove the oil seal and spring seat from the valve guide.
7. Repeat Steps 2-6 for the remainder of valves requiring service.
8. Mark all parts (Figure 143) as they are disassembled so that they will be installed in their same locations. The exhaust valves are adjacent to the exhaust port and the intake valves are located next to the intake pipe.



Valve Inspection

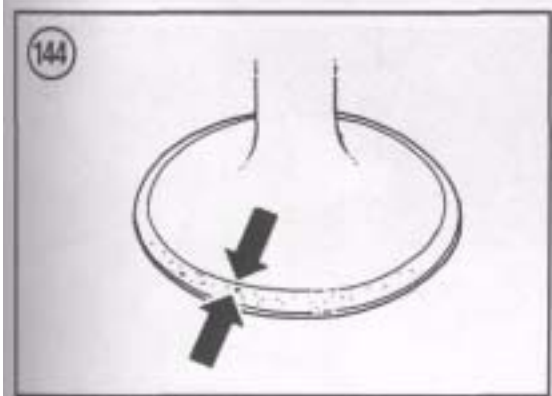
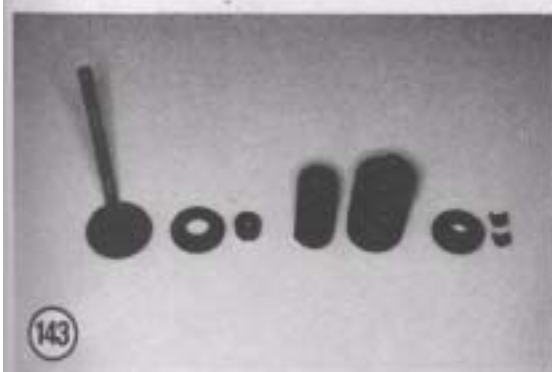
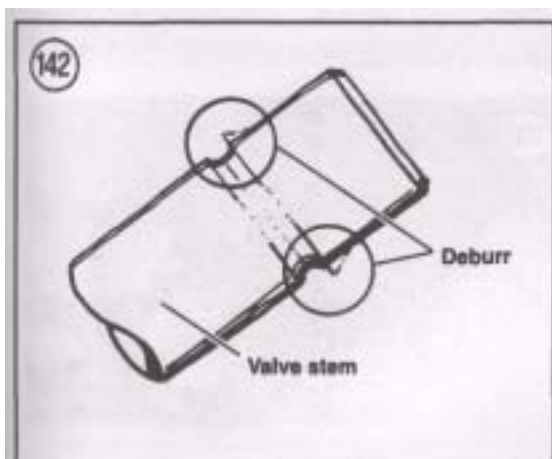
1. Clean the valves with a soft wire brush and solvent.
2. Inspect the contact surface of each valve (Figure 144) for burning or pitting. Unevenness of the contact surface is an indication that the valve is not serviceable. The valve contact surface can *not* be ground and must be replaced if defective.
3. Inspect each valve stem for wear and roughness and measure the vertical runout of the valve stem as



shown in **Figure 145**. The runout should not exceed the service limit listed in **Table 1**.

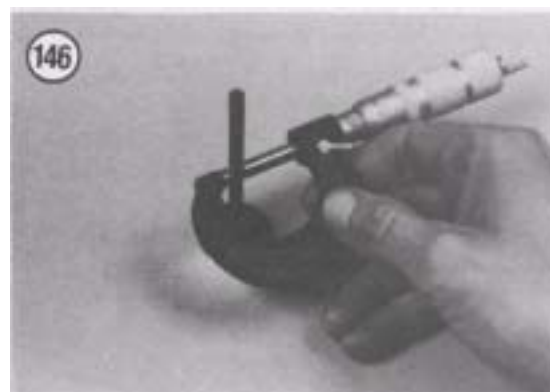
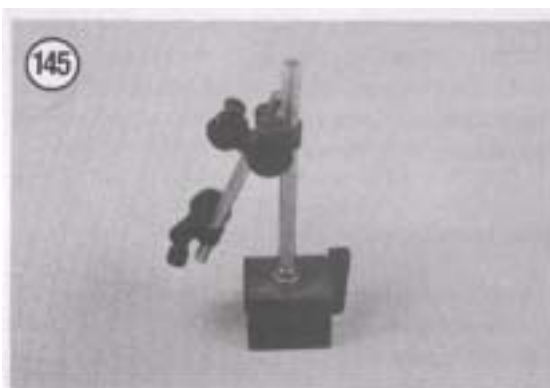
4. Measure each valve stem for wear (**Figure 146**). If worn to the wear limit listed in **Table 1**, or less the valve must be replaced.

5. Measure each valve seating face for wear (**Figure 147**). If worn to the wear limit listed in **Table 1**, or less the valve must be replaced.



6. Remove all carbon and varnish from each valve guide with a stiff spiral wire brush.

7. Insert each valve in its guide. Hold the valve with the head just slightly off the valve seat and rock it sideways in 2 directions, "X" and "Y," perpendicular to each other as shown in **Figure 148**. If the valve-to-valve guide clearance measured exceeds the limit listed in **Table 1**, measure the valve stem. If the valve stem is worn, replace the valve. If the valve stem is within tolerances, replace the valve guide.



8. Measure each valve spring free length with a vernier caliper (**Figure 149**). All should be within the length specified in **Table 1** with no signs of bends or distortion (**Figure 150**). Replace defective springs in pairs (inner and outer).

9. Check the valve spring retainer and valve keepers. If they are in good condition they may be reused; replace as necessary.

10. Inspect the valve seats (**Figure 151**) in the cylinder head. If worn or burned, they must be reconditioned as described in this chapter.

11. Inspect the valve stem end for pitting and wear. If pitted or worn, the end may be resurfaced providing the finished length (**Figure 152**) is not less than length listed in **Table 1**. Replace the valve(s) if the finished length is less than specified.

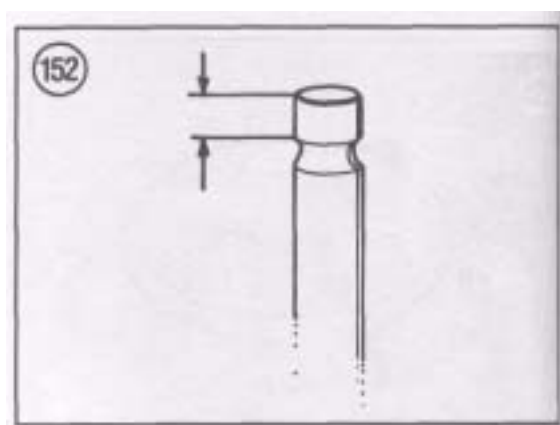
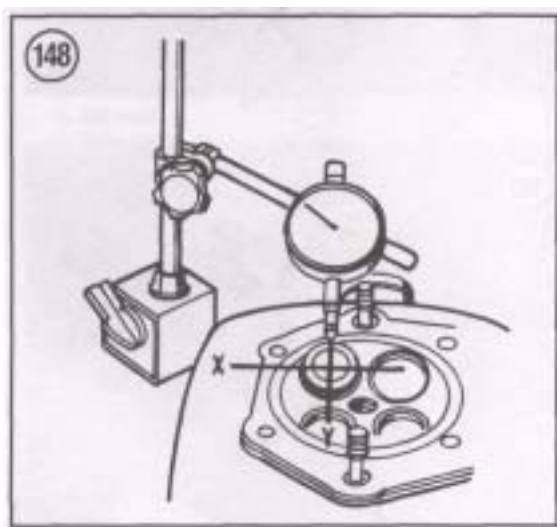
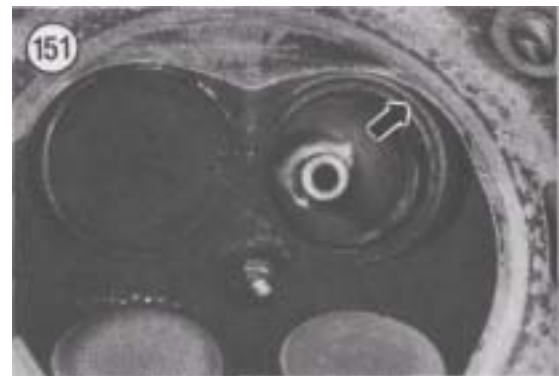
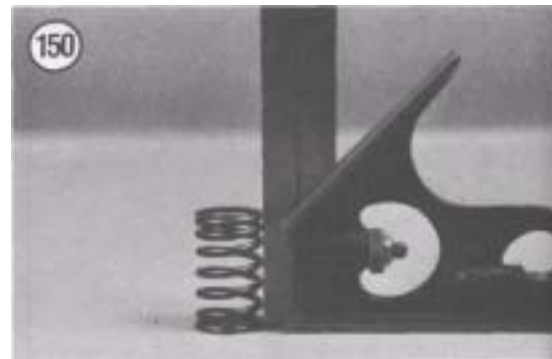
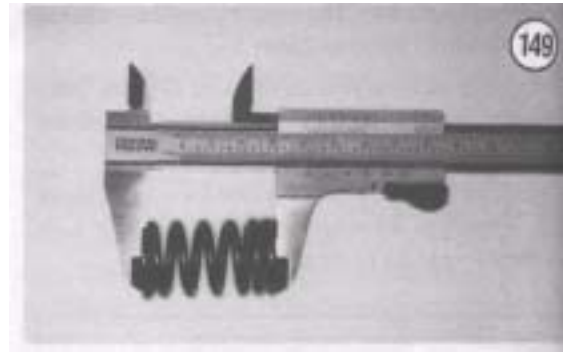
Valve Installation

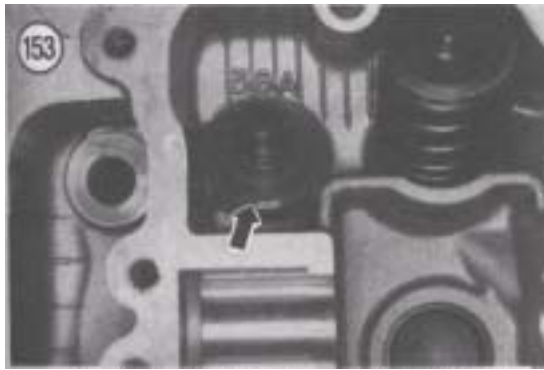
1. Install the valve seat (**Figure 153**). Do not confuse the valve spring retainer (A, **Figure 154**) seat with the spring seat (B, **Figure 154**). The inner diameter is different.

2. Install a new seal on each valve guide (**Figure 155**) and push it down until it bottoms out (**Figure 156**).

3. Coat the valve stems with molybdenum disulfide grease. To avoid damage to the valve stem seal, turn the valve slowly while inserting the valve into the cylinder head (**Figure 157**). Push the valve all the way in (**Figure 158**) until it bottoms.

4. Determine which end of valve springs has closer wound coils (**Figure 159**).



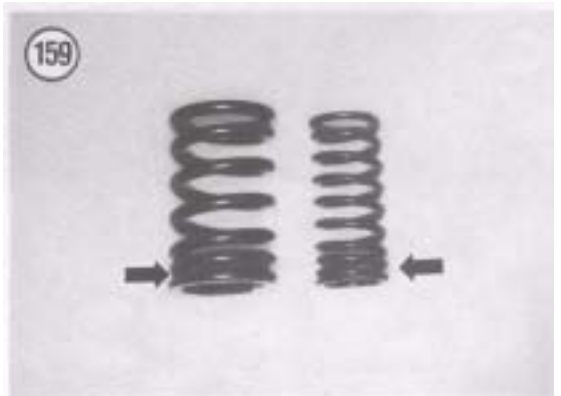
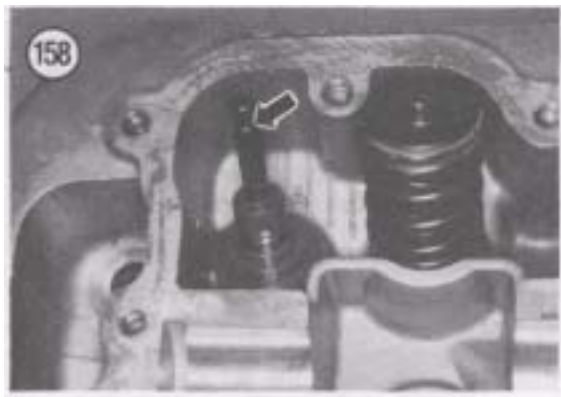
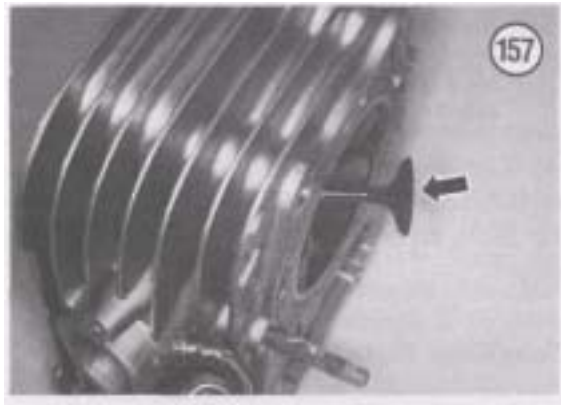
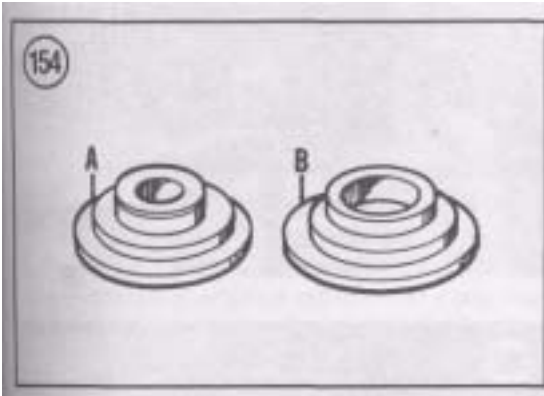


5. Install the inner valve spring (**Figure 160**) and the outer valve spring (**Figure 161**) with the closer wound coils toward the cylinder head.

6. Install the valve spring retainer on top of the valve springs.

CAUTION

To avoid loss of spring tension, do not compress the springs any more than necessary to install the keepers.



7. Compress the valve springs with a compressor tool (**Figure 141**) and install the valve keepers. Make sure the keepers fit snug into the rounded groove in the valve stem.
8. Remove the compression tool.
9. After all springs have been installed, gently tap the end of the valve stem with a soft aluminum or brass drift and hammer. This will ensure that the keepers are properly seated (**Figure 162**).

CAUTION

*If the valve stem end has been resurfaced, make sure that the valve stem face (A, **Figure 163**) is above the valve retainers (B, **Figure 163**).*

10. Repeat for all valve assemblies and for the other cylinder head if necessary.
11. Install the cylinder head(s) as described in this chapter.

Valve Guide Replacement

When valve guides are worn so that there is excessive valve stem-to-guide clearance or valve tipping, the guides must be replaced. This job should only be done by a dealer as special tools are required as well as considerable expertise. If the valve guide is replaced; also replace the respective valve.

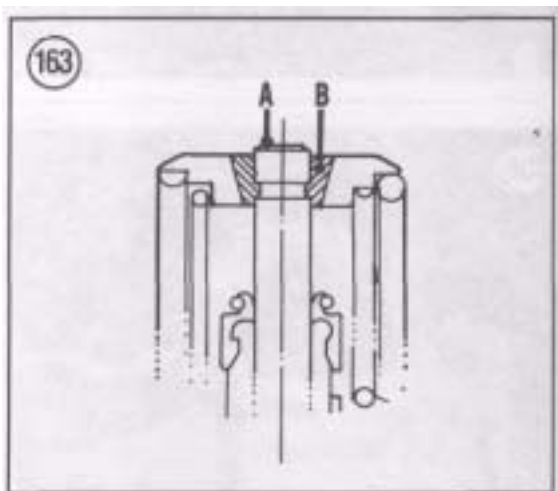
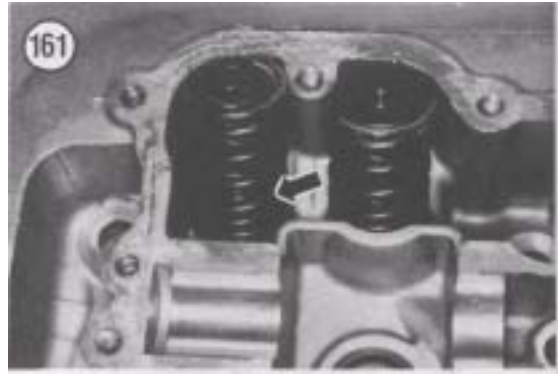
The following procedure is provided in you choose to perform this task yourself.

CAUTION

*There **may** be a residual oil or solvent odor left in the oven after heating the cylinder head. If you use a household oven; first check with the person who*

uses the oven for food preparation to avoid getting into trouble.

1. If still installed, remove the screws securing the intake pipe onto the cylinder head.
2. If still installed, remove the bolts (**Figure 164**) securing the coolant fitting to the cylinder head and remove the fitting and O-ring seal.



3. The valve guides (**Figure 165**) are installed with a slight interference fit. Place the cylinder head in a heated oven (or on a hot plate). Heat the cylinder head to a temperature between 100-150° C (212-300° F). An easy way to check the proper temperature is to drop tiny drops of water on the cylinder head; if they sizzle and evaporate immediately, the temperature is correct.

CAUTION

Do not heat the cylinder head with a torch (propane or acetylene); never bring aflame into contact with the cylinder head or valve guide. The direct heat will destroy the case hardening of the valve guide and will likely cause warpage of the cylinder head.

4. Remove the cylinder head from the oven and hold onto it with kitchen pot holders, heavy gloves or heavy shop cloths—it is very hot.

5. While heating up the cylinder head, place the new valve guides in a freezer (or refrigerator) if possible. Chilling the new guides will slightly reduce their overall diameter while the bores in the hot cylinder

head will be slightly larger due to heat expansion. This size difference will make valve guide installation much easier.

6. Turn the cylinder head upside down on wood blocks. Make sure the cylinder is properly supported on the wood blocks.

7. From the combustion chamber side of the cylinder head, drive out the old valve guide with a hammer and valve guide remover. Use Suzuki special tool, Valve Guide Remover (part No. 09916-44910). Remove the special tool.

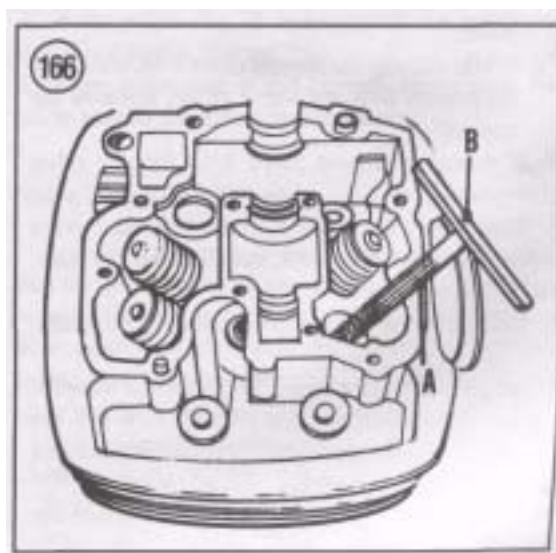
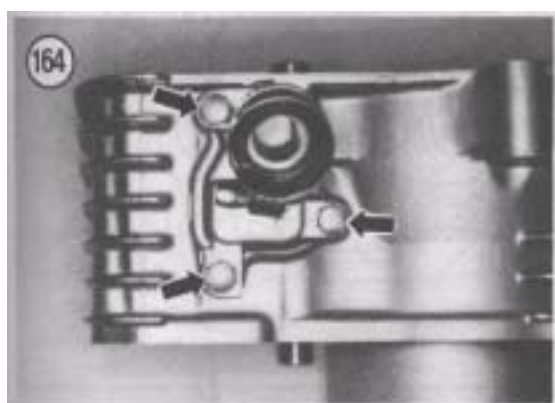
8. Remove and discard the valve guide. *Never* reinstall a valve guide that has been removed as it is no longer true nor within tolerances.

9. Insert the valve guide reamer into the valve guide hole in the cylinder head. Use Suzuki special tools, Valve Guide Hole 10.8 mm reamer (A, **Figure 166**), (part No. 09916-34580) and Reamer Handle (B, **Figure 166**), (part No. 09916-34541). Rotate the reamer *clockwise*. Continue to rotate the reamer and work it down through the entire length of the valve guide hole in the cylinder head.

10. While rotating the reamer *clockwise*, withdraw the reamer from the valve guide hole in the cylinder head. Remove the reamer and handle.

CAUTION

Failure to apply fresh engine oil to both the valve guide and the valve guide hole in the cylinder head will result in damage to the cylinder head and/or the new valve guide.



11. Apply fresh engine oil to the new valve guide and the valve guide hole in the cylinder head.

NOTE

The same tool is used for removal and installation of the valve guide. The same valve guide (same part No.) is used for both intake and exhaust valves.

12. From the top side (spring side) of the cylinder head, drive in the new valve guide. Use Suzuki special tools, Valve Guide Attachment (A, **Figure 167**), (part No. 09916-44920) and Valve Guide Remover (B, **Figure 167**), (part No. 09916-44910).

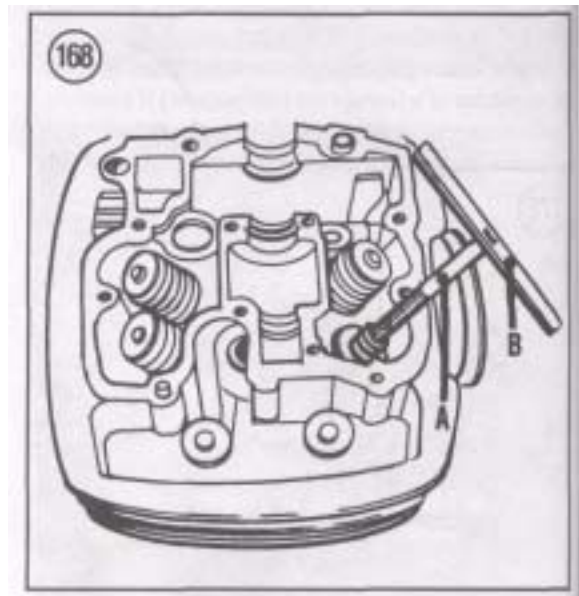
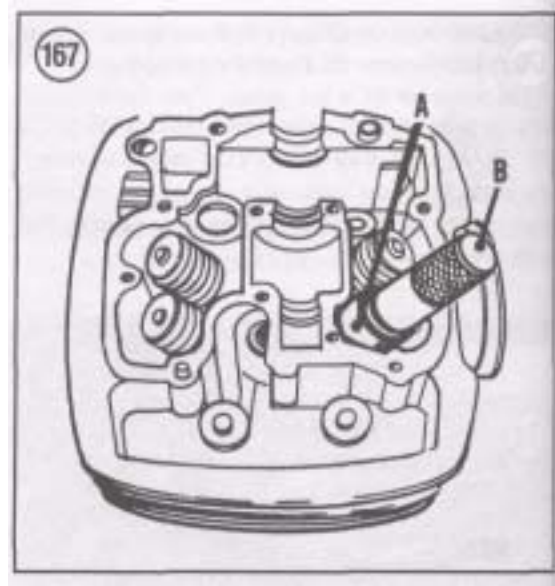
13. After installation, ream the new valve guide as follows:

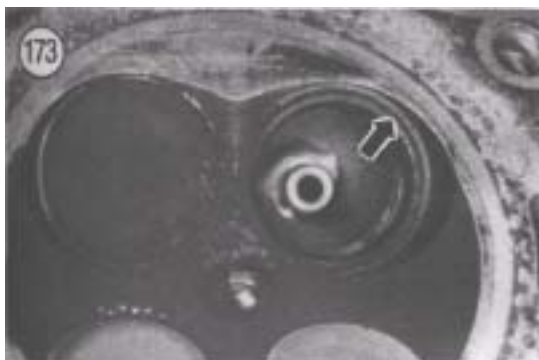
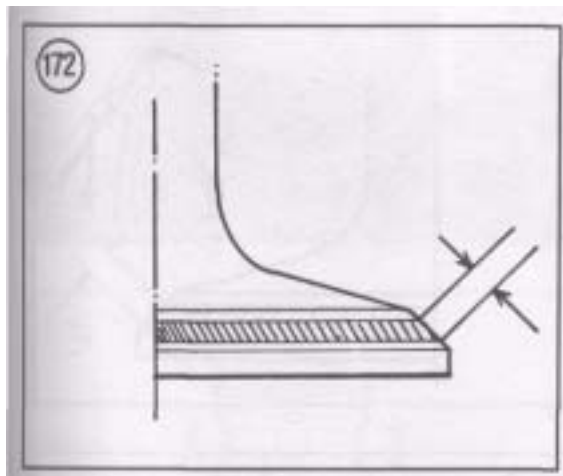
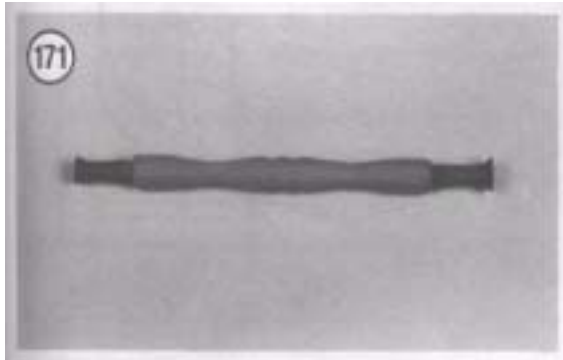
- Use Suzuki special tools, Valve Guide 7mm Reamer (A, **Figure 168**), part No. 09916-34520 and Reamer Handle (B, **Figure 168**), part No. 09916-34541.
- Apply cutting oil to both the new valve guide and the valve guide reamer.

CAUTION

*Always rotate the valve guide reamer **clockwise**. If the reamer is rotated **counterclockwise**, damage to a good valve guide will occur.*

- Rotate the reamer *clockwise*. Continue to rotate the reamer and work it down through the entire length of the new valve guide. Apply additional cutting oil during this procedure.
 - Rotate the reamer *clockwise* until the reamer has traveled all the way through the new valve guide.
 - While rotating the reamer *clockwise*, withdraw the reamer from the valve guide. Remove the reamer.
14. If necessary, repeat Steps 1-13 for any other valve guides.
15. Thoroughly clean the cylinder head and valve guides with solvent to wash out all metal particles. Dry with compressed air.
16. Reface the valve seats as described in this chapter.
17. Install the intake pipe. To prevent a vacuum leak, install a new O-ring seal (**Figure 169**) into the groove in the intake pipe. Install the intake pipes and tighten the screws securely.
18. Install a new O-ring seal (**Figure 170**) into the backside of the coolant fitting and install the fitting





onto the cylinder head. Tighten the bolts (**Figure 164**) securely.

Valve Seat Inspection

1. Remove the valves as described in this chapter.
2. The most accurate method for checking the valve seal is to use Prussian Blue or machinist's dye, available from auto parts stores or machine shops. To check the valve seal with Prussian Blue or machinist's dye, perform the following:
 - a. Thoroughly clean off all carbon deposits from the valve face with solvent or detergent, then thoroughly dry.
 - b. Spread a thin layer of Prussian Blue or machinist's dye evenly on the valve face.
 - c. Moisten the end of a suction cup valve tool (**Figure 171**) and attach it to the valve. Insert the valve into the guide.
 - d. Using the suction cup tool, tap the valve up and down in the cylinder head. Do *not* rotate the valve or a false indication will result.
 - e. Remove the valve and examine the impression left by the Prussian Blue or machinist's dye. If the impression left in the dye (on the valve or in the cylinder head) is not even and continuous and the valve seat width (**Figure 172**) is not within specified tolerance listed in **Table 1**, the cylinder head valve seat must be reconditioned.
3. Closely examine the valve seat (**Figure 173**) in the cylinder head. It should be smooth and even with a polished seating surface.
4. If the valve seat is okay, install the valves as described in this chapter.
5. If the valve seat is not correct, recondition the valve seat as described in this chapter.

Valve Seat Reconditioning

Special valve cutter tools and considerable expertise are required to properly recondition the valve seats in the cylinder heads. You can save considerable money by removing the cylinder heads and taking just the cylinder heads to a dealer or machine shop and have the valve seats ground.

The following procedure is provided in you choose to perform this task yourself.

The Suzuki valve seat cutter and T-handle are available from a Suzuki dealer or from machine shop

supply outlets. Follow the manufacturer's instruction in regard to the operating the cutter. You will need the Suzuki Valve Seat Cutter (N-116), a T-handle (N-503), adapter (N-503-1) and the Solid Pilot (N-140-5.5) or equivalent.

The valve seat for both the intake valves and exhaust valves are machined to the same angles. The valve contact surface is cut to 45° angle and the area above the contact surface (closest to the combustion chamber) is cut to a 15° angle (Figure 174).

1. Carefully rotate and insert the solid pilot into the valve guide. Make sure the pilot is correctly seated.
2. Use the 45° angle side of the cutter, install the cutter and the T-handle onto the solid pilot.
3. Using the 45° cutter, descale and clean the valve seat with one or two turns.

CAUTION

Measure the valve seat contact area in the cylinder head after each cut to make sure the contact area is correct and to prevent removing too much material. If too much material is removed, the cylinder head must be replaced.

4. If the seat is still pitted or burned, turn the 45° cutter additional turns until the surface is clean. Refer to the previous CAUTION to avoid removing too much material from the cylinder head.

5. Remove the valve cutter, T-handle and solid pilot from the cylinder head.

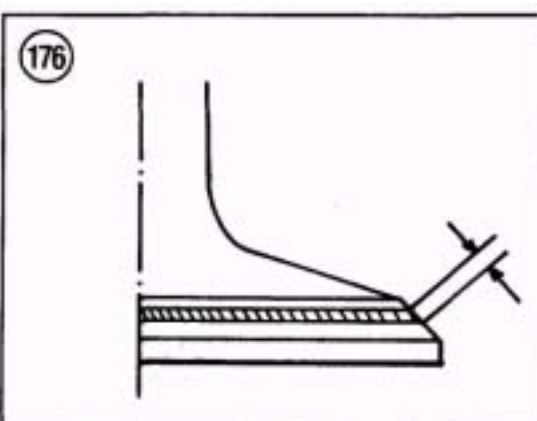
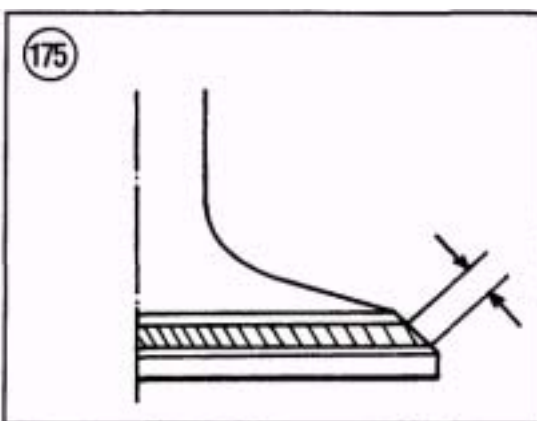
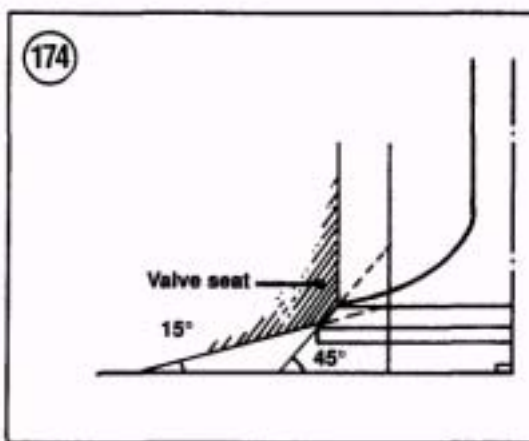
6. Inspect the valve seat-to-valve face impression as follows:

- a. Spread a thin layer of Prussian Blue or machinist's dye evenly on the valve face.
- b. Moisten the end of a suction cup valve tool (Figure 171) and attach it to the valve. Insert the valve into the guide.
- c. Using the suction cup tool, tap the valve up and down in the cylinder head. Do *not* rotate the valve or a false indication will result.
- d. Remove the valve and examine the impression left by the Prussian Blue or machinist's dye.
- e. Measure the valve seat width as shown in Figure 172. Refer to Table 1 for the seat width.

7. If the contact area is too *high* on the valve, or if it is too wide, use the 15° side of the cutter and remove a portion of the top area of the valve seat material to lower and narrow the contact area (Figure 175).

8. If the contact area is too *low* on the valve, or too narrow, use the 45° cutter and remove a portion of the lower area of the valve seat material to raise and widen the contact area (Figure 176).

9. After the desired valve seat position and width is



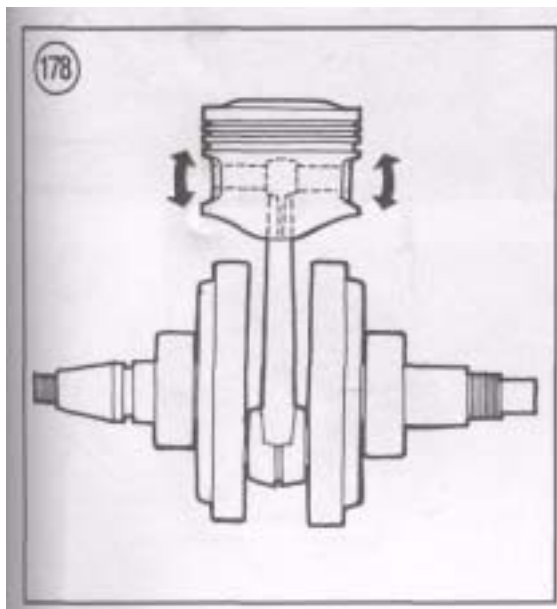
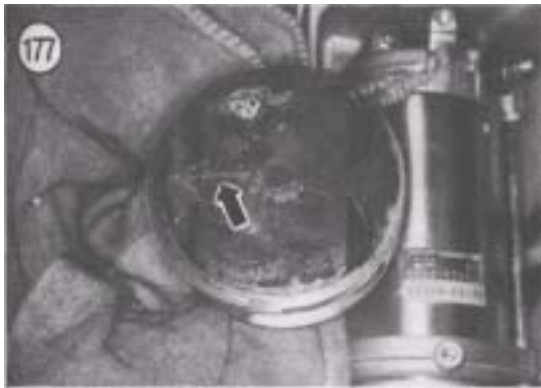
obtained, use the 45° side of the cutter and T-handle

and very lightly clean of any burrs that may have been caused by the previous cuts.

CAUTION

*Do **not** use any valve lapping compound after the final cut has been made.*

10. Check that the finish has a smooth and velvety surface, it should *not* be shiny or highly polished. The final seating will take place when the engine is first run.
11. Repeat Steps 1-10 for all remaining valve seats.
12. Thoroughly clean the cylinder head and all valve components in solvent or detergent and hot water.
13. Install the valve assemblies as described in this chapter and fill the ports with solvent to check for leaks. If any leaks are present, the valve seats must



be inspected for foreign matter or burrs that may be preventing a proper seal.

14. If the cylinder head and valve components were cleaned in detergent and hot water, apply a light coat of engine oil to all bare metal steel surfaces to prevent any rust formations.

PISTONS AND PISTON RINGS

Piston

Removal/Installation

1. Remove the cylinder head and cylinder assemblies as described in this chapter.
2. Stuff clean shop cloths into the cylinder bore crankcase opening to prevent objects from falling into the crankcase.
3. Lightly mark the top of the pistons with an "F" (front) or "R" (rear) so they will be installed into the correct cylinder. Also mark an arrow (**Figure 177**) indicating the direction of the piston which is toward the front of the engine.
4. If necessary, remove the piston rings as described in this chapter.
5. Before removing the piston, hold the rod tightly and rock the piston as shown in **Figure 178**. Any rocking motion (do not confuse with the normal sliding motion) indicates wear on the piston pin, piston pin bore or connecting rod small-end bore (more likely a combination of these). Mark the piston and pin so that they will be reassembled into the same set.
6. Remove the clips from each side of the piston pin bore with a small screwdriver, scribe or needlenose pliers (**Figure 179**). Hold your thumb over one edge of the clip when removing it to prevent the clip from springing out.



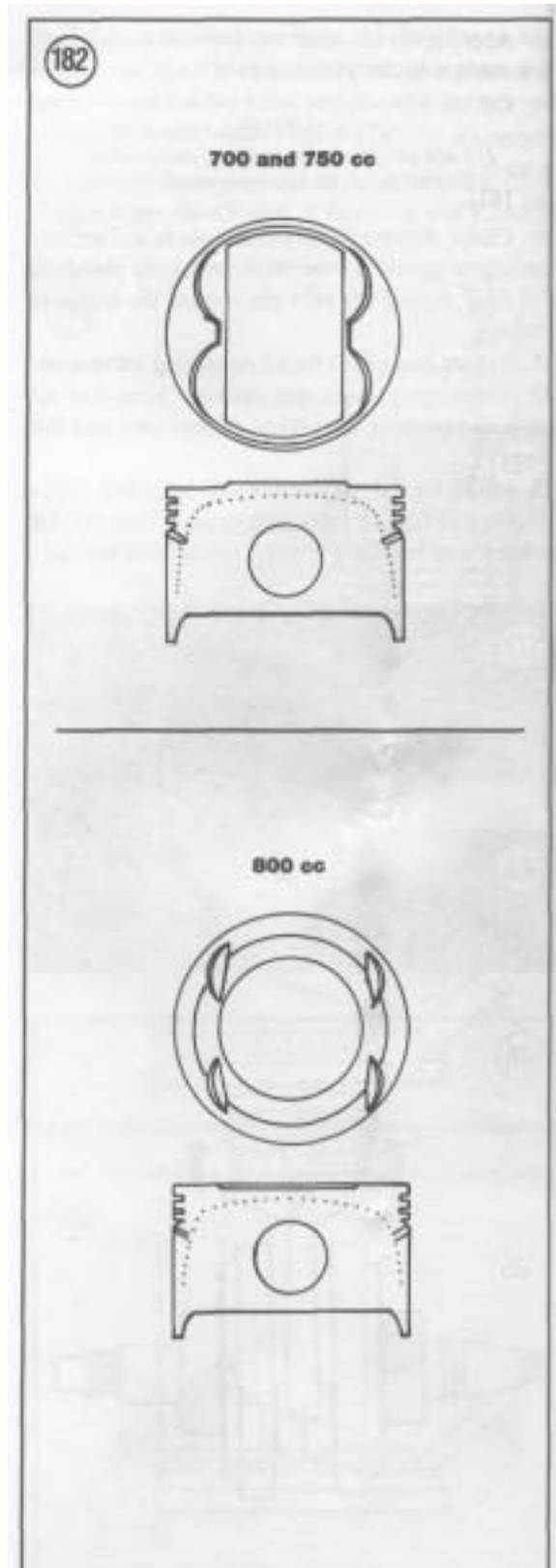
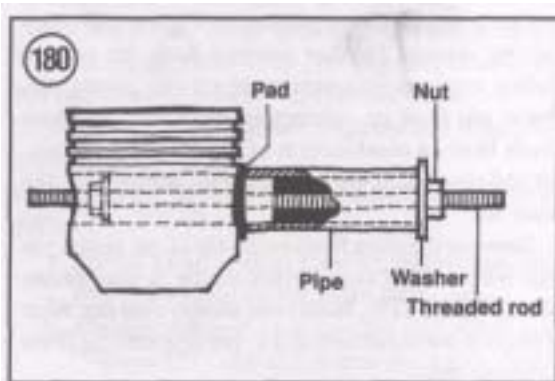
7. Use a proper size wooden dowel or socket extension and push out the piston pin.

CAUTION

Be careful when removing the pin to avoid damaging the connecting rod. If it is necessary to gently tap the pin to remove it, be sure that the piston is properly supported so that lateral shock is not transmitted to the connecting rod lower bearing.

8. If the piston pin is difficult to remove, heat the piston and pin with a butane torch. The pin will probably push right out. Heat the piston to only about 140° F (60° C), i.e., until it is too warm to touch, but not excessively hot. If the pin is still difficult to push out, use a homemade tool as shown in **Figure 180**.

9. Lift the piston from the connecting rod and inspect it as described in this chapter.
10. If the piston is going to be left off for some time, place a piece of foam insulation tube over the end of the rod to protect it.



11. Apply molybdenum disulfide grease to the inside surface of the connecting rod piston pin bore.
12. Oil the piston pin with assembly oil or fresh engine oil and install it in the piston until its end extends slightly beyond the inside of the boss (**Figure 181**).

NOTE

*The piston crown design was changed when the engine was increased from 700 and 750 cc to the larger 800 cc as shown in **Figure 182**. If new pistons are going*



to be installed, be sure to install the correct type to avoid any interference.

13. Correctly position the piston-to-connecting rod as follows:
 - a. Refer to arrow mark (**Figure 177**) made during disassembly and install the piston with the arrow toward the front of the engine.
 - b. If the pistons were not marked, or new pistons are being installed, position the piston with the "triangle" mark on the crown pointing toward the exhaust valve side of the cylinder.
14. Place the piston over the connecting rod.
15. Line up the piston pin with the hole in the connecting rod. Push the piston pin through the connecting rod and into the other side of the piston until it is even with the piston pin clip grooves.

CAUTION

If it is necessary to tap the piston pin into the connecting rod, do so gently with a block of wood or a soft-faced hammer. Make sure you support the piston to prevent the lateral shock from being transmitted to the connecting rod lower bearing.

NOTE

*In the next step, install the clips with the gap away from the cutout in the piston (**Figure 183**).*

16. Install new piston pin clips (**Figure 184**) in both ends of the pin boss. Make sure they are seated in the grooves in the piston.
17. Check the installation by rocking the piston back and forth around the pin axis and from side to side along the axis. It should rotate freely back and forth but not from side to side.
18. Install the piston rings as described in this chapter.
19. Repeat Steps 1-18 for the other piston.

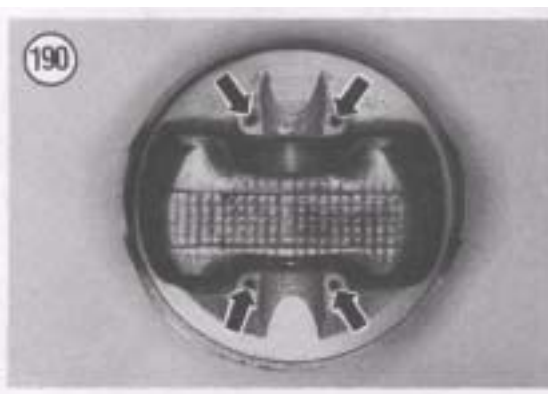
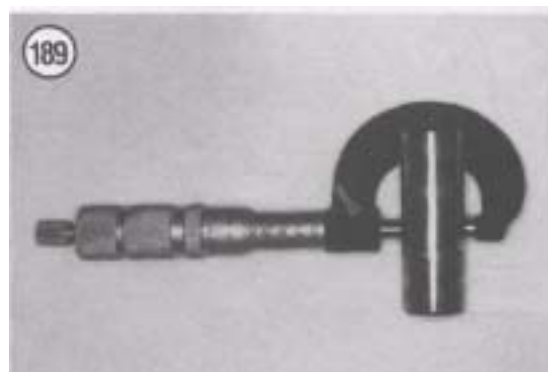
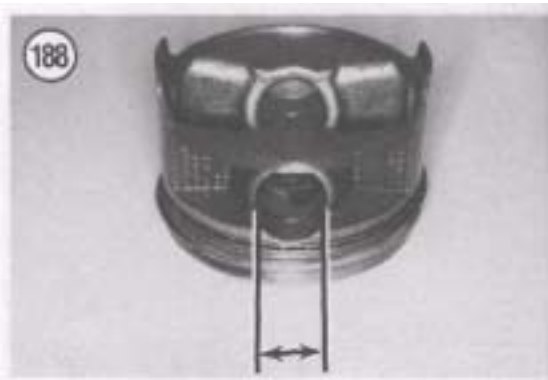
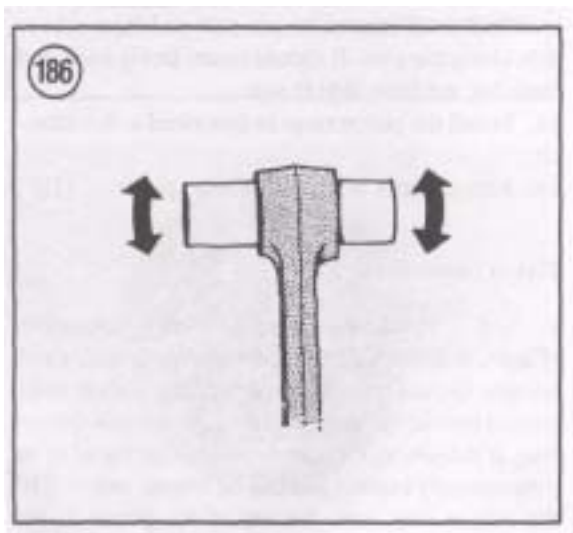
Piston Inspection

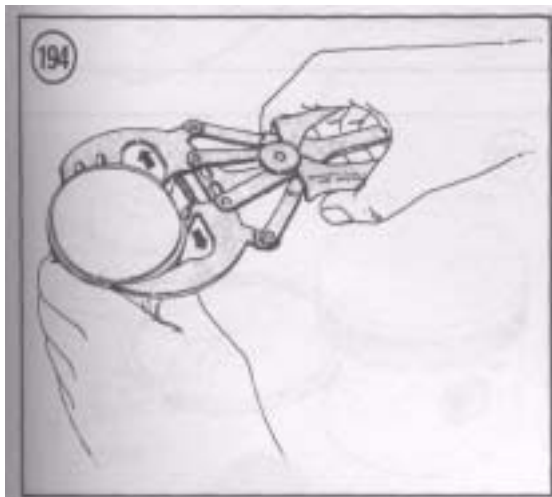
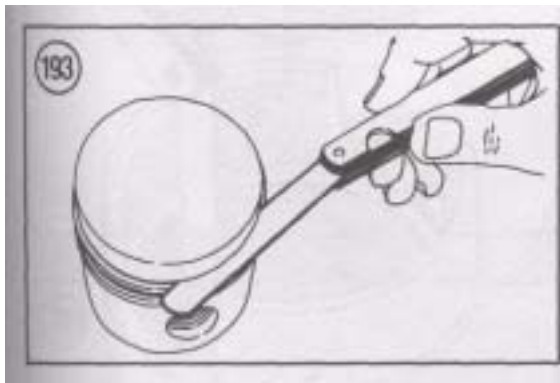
1. Carefully clean the carbon from the piston crown (**Figure 185**) with a chemical remover or with a soft scraper. Do not remove or damage the carbon ridge around the circumference of the piston above the top ring. If the piston, rings and cylinder are found to be dimensionally correct and can be reused, removal of the carbon ring from the top of the piston or the

carbon ridge from the top of the cylinder will promote excessive oil consumption.

CAUTION Do not wire brush the piston skirts.

2. Examine each ring groove for burrs, dented edges and wide wear. Pay particular attention to the top compression ring groove as it usually wears more than the other grooves.
3. If damage or wear indicates piston replacement, select a new piston as described under *Piston Clearance Measurement* in this chapter.
4. Oil the piston pin and install it in the connecting rod. Slowly rotate the piston pin and check for radial and axial play (**Figure 186**). If any play exists, the piston pin should be replaced, providing the rod bore is in good condition.
5. Measure the inside diameter of the piston pin bore (**Figure 187**) with a snap gauge (**Figure 188**) and measure the outside diameter of the piston pin with a micrometer (**Figure 189**). Compare with dimensions given in **Table 1**. Replace the piston and piston pin as a set if either or both are worn.
6. Check the oil control holes (**Figure 190**) in the piston for carbon or oil sludge buildup. Clean the holes with a small diameter drill bit and blow out with compressed air.
7. Check the piston skirt for galling and abrasion which may have been caused by piston seizure. If light galling is present, smooth the affected area with No. 400 emery paper and oil or a fine oilstone. However, if galling is severe or if the piston is deeply scored, replace it.





8. If damage or wear indicate piston replacement, select a new piston as described under *Piston Clearance Measurement* in this chapter.

Piston Clearance Measurement

1. Make sure the piston and cylinder walls are clean and dry.
2. Measure the inside diameter of the cylinder bore at a point 1/2 in. (13 mm) from the upper edge with a bore gauge.
3. Measure the outside diameter of the piston across the skirt (**Figure 191**) at right angles to the piston pin. Measure at a distance 0.60 in. (15 mm) up from the bottom of the piston skirt.
4. Subtract the dimension of the piston from the cylinder dimension and compare to the dimension listed in **Table 1**. If clearance is excessive, the piston should be replaced and the cylinder should be re-bored to the next oversize. Purchase the new piston first; measure its diameter and add the specified clearance to determine the proper cylinder bore diameter.

Piston Ring Removal/Installation

WARNING

*The edges of all piston rings (**Figure 192**) are very sharp. Be careful when handling them to avoid cutting your fingers.*

1. Measure the side clearance of each ring in its groove with a flat feeler gauge (**Figure 193**) and compare to dimensions given in **Table 1**. If the clearance is greater than specified, the rings must be replaced. If the clearance is still excessive with the new rings, the piston must also be replaced.
2. Remove the old rings with a ring expander tool (**Figure 194**) or by spreading the ends with your thumbs just enough to slide the ring up over the piston (**Figure 195**). Repeat for the remaining rings.
3. Carefully remove all carbon buildup from the ring grooves with a broken piston ring (**Figure 196**).
4. Inspect the grooves carefully for burrs, nicks or broken and cracked lands. Recondition or replace the piston if necessary.
5. Check the end gap of each ring. To check the ring, insert the ring, one at a time, into the bottom of the cylinder bore and push it in about 3/4 in. (20 mm)

with the crown of the piston to ensure that the ring is square in the cylinder bore. Measure the gap with a flat feeler gauge (**Figure 197**) and compare to dimensions in **Table 1**. If the gap is greater than specified, the rings should be replaced. When installing new rings, measure their end gap in the same manner as for old ones. If the gap is less than specified, carefully file the ends with a fine-cut file until the gap is correct.

NOTE

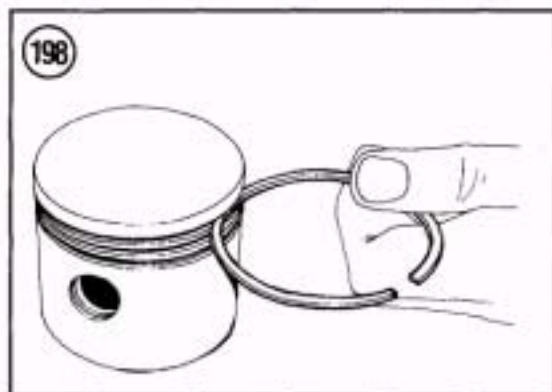
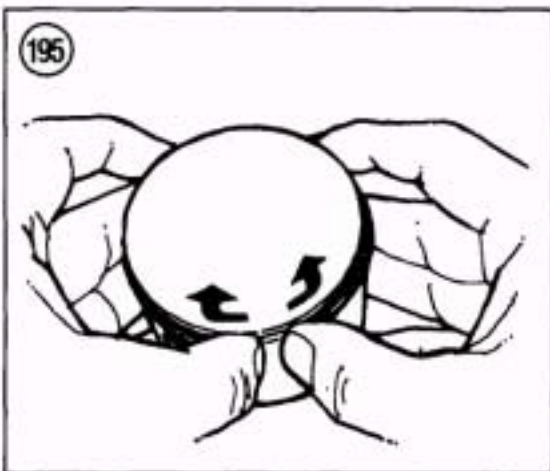
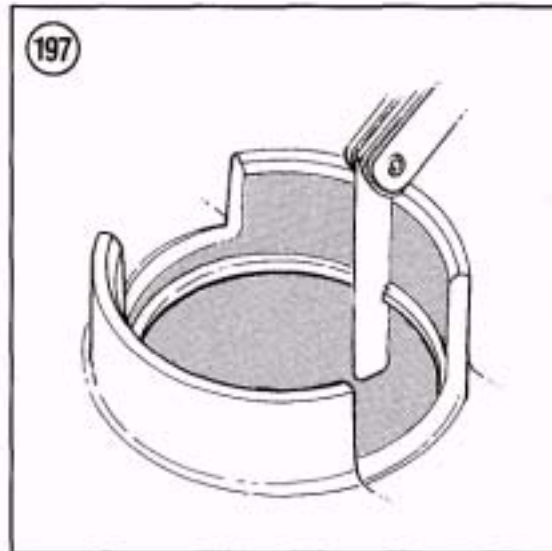
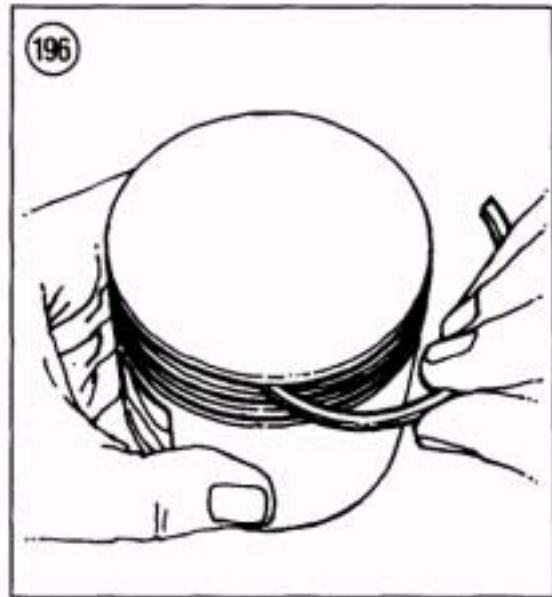
It is not necessary to measure the oil control ring expander spacer. If the oil control ring rails show wear, all 3 parts of the oil control ring should be replaced as a set.

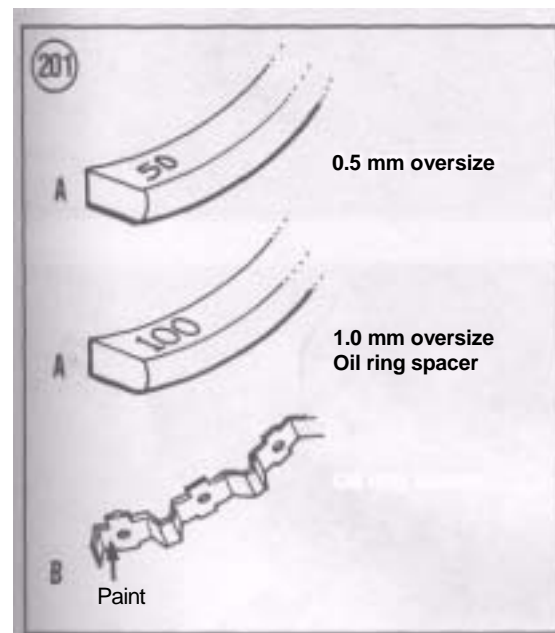
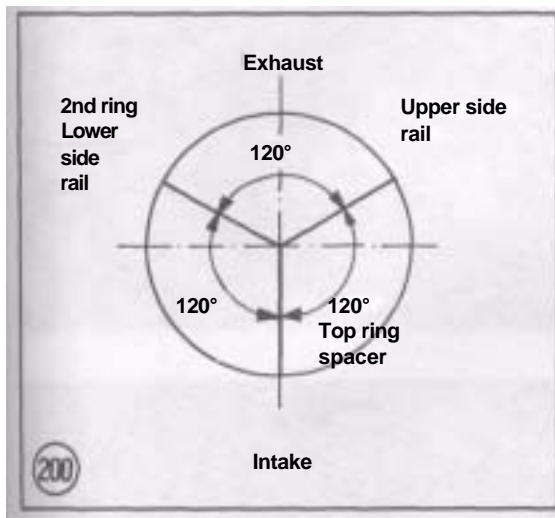
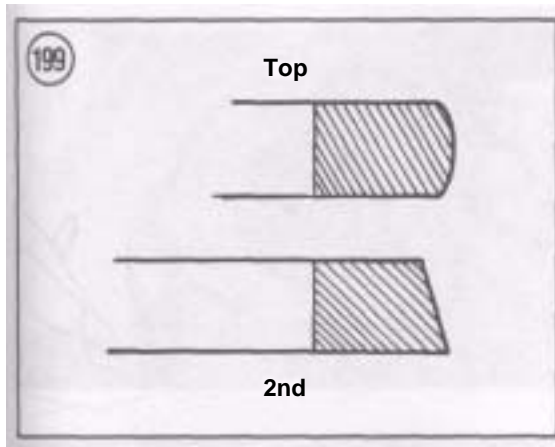
6. Roll each ring around its piston groove as shown in **Figure 198** to check for binding. Minor binding is probably caused by groove still dirty or nicked. Small nicks may be cleaned up with a fine-cut file.

NOTE

Install the compression rings with their markings facing up.

1. Install the piston rings—first, the bottom, then the middle, then the top ring—by carefully spreading the ends with your thumbs and slipping the rings over the top of the piston. Remember that the piston rings must be installed with the manufacturer's marks on them toward the top of the piston or there is the possibility of oil pumping past the rings. Install the rings in the order shown in **Figure 199**. 8. Make sure the rings are seated completely in their grooves all the way around the piston and that the





ends are distributed around the piston as shown in **Figure 200**. The important thing is that the ring gaps are not aligned with each other when installed to prevent compression pressure from escaping.

9. If installing oversize compression rings, check the number (A, **Figure 201**) to make sure the correct rings are being installed. The ring numbers should be the same as the piston oversize number.

10. If installing oversize oil rings, check the paint color spot (B, **Figure 201**) to make sure the correct rings are being installed. The paint color spots indicate the following size:

- No color, standard size.
- Red: 0.5 mm oversize.
- Yellow: 1.0 mm oversize.

11. If new rings were installed, measure the side clearance of each ring in its groove with a flat feeler gauge (**Figure 193**) and compare to dimensions given in **Table 1**.

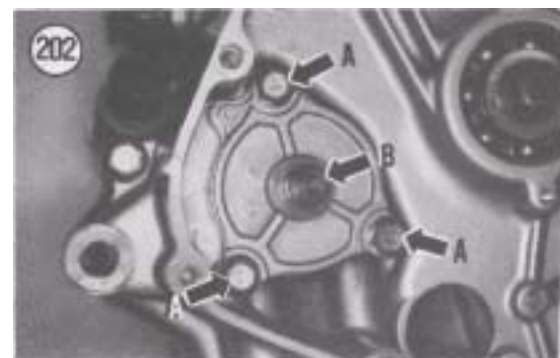
12. After the rings are installed, apply clean engine oil to the rings. Rotate the rings several complete revolutions in their respective grooves. This will assure proper oiling when the engine is first started after and piston service.

OIL PUMP

Removal/Installation

The oil pump can be removed with the engine mounted in the frame; this procedure is shown with the engine removed for clarity.

- Remove the clutch assembly as described in Chapter Five. During clutch removal, the oil pump driven gear was removed.
- Remove the bolts (A, **Figure 202**) securing the oil pump to the crankcase and remove the oil pump assembly.



3. Using needlenose pliers, reach into the crankcase and turn the water pump shaft so the raised tab is vertical (Figure 203).
4. Rotate the oil pump drive shaft so the groove (Figure 204) will also be vertical when the oil pump is installed into the crankcase.
5. Install the oil pump into the crankcase and align the oil pump drive shaft with the water pump shaft. If necessary, slightly rotate the oil pump shaft (B, Figure 202) back and forth to assure correct alignment.
6. Push the oil pump in until it bottoms out.
7. Temporarily install the driven gear. Hold the oil pump in place on the crankcase and rotate the oil pump shaft to make sure it rotates freely with no binding. Remove the driven gear.
8. Install the bolts (A, Figure 202) and tighten to the torque specification listed in Table 2.

Inspection

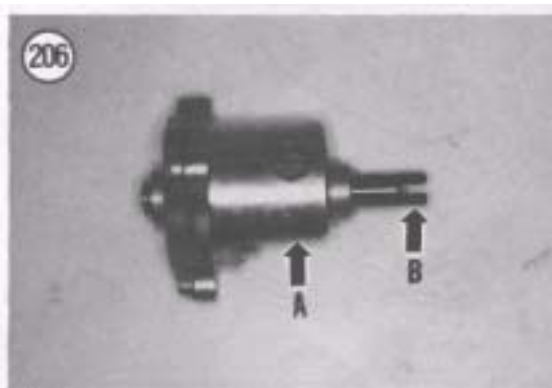
There are no replacement parts for the oil pump except for the driven gear and drive chain. Do not try to disassemble the oil pump.

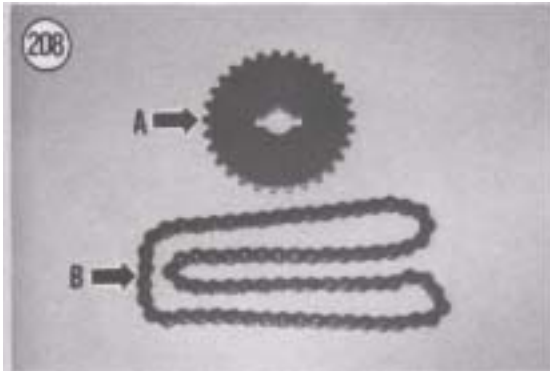
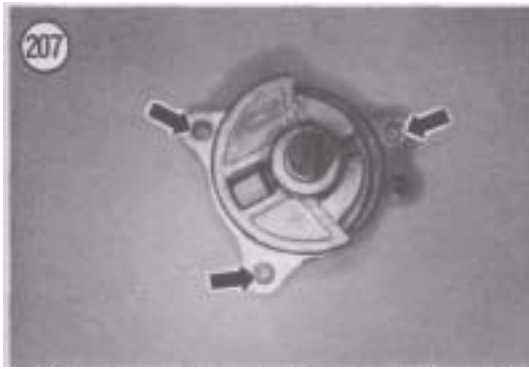
1. Make sure the screw (Figure 205) securing the oil pump together is tight.
2. Inspect the oil pump body and cover for cracks (A, Figure 206). If worn or damaged, replace the oil pump assembly.
3. Inspect the drive shaft (B, Figure 206) for wear or damage. If worn or damaged, replace the oil pump assembly.
4. Inspect the oil pump mounting bosses (Figure 207) for fractures or damage. If damaged, replace the oil pump assembly.
5. Inspect the teeth on the driven gear (A, Figure 208). Replace the driven gear if the teeth are damaged or any are missing. If the gear is damaged, inspect the drive chain (B, Figure 208) as it may also be damaged. Replace the chain if necessary.

PRIMARY DRIVE GEAR

Removal

1. Remove the engine from the frame as described in this chapter.





CAUTION
The primary drive gear bolt has **left-hand** threads. Turn the wrench **clockwise to loosen** it and **counterclockwise to tighten** it.

2A. If the clutch assembly is still in place, perform the following:

- Stuff shop cloth between the clutch outer housing gear and the primary drive gear (A, **Figure 209**). This will prevent the gear from rotating while loosening the bolt.
- Turn the wrench *clockwise* and loosen the primary drive gear bolt (B, **Figure 209**).

2B. If the clutch assembly is removed, perform the following:

- If still in place, remove the piston from one of the connecting rods.
- Insert a 1/2 in. drive socket extension or round drift through the small end of the connecting rod.

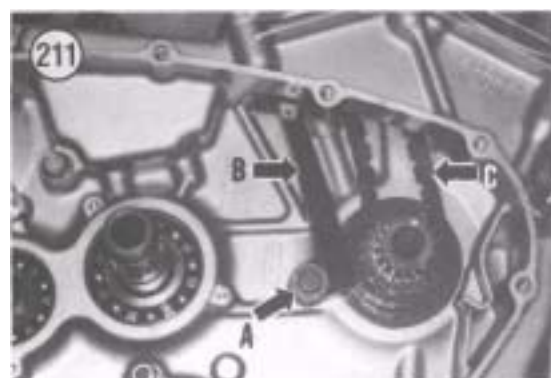
CAUTION
Use only a **round** extension or drift. Any other shape could cause damage to the connecting rod piston pin hole surface.

- Rotate the crankshaft until the extension or round drift, in the connecting rod, is resting on the top surface of the crankcase.
- Turn the wrench *clockwise* and loosen the primary drive gear bolt (A, **Figure 210**).
- Remove the socket extension or drift from the connecting rod.

3. If not already removed, remove the clutch assembly as described in Chapter Five.

4. Remove the bolt and the primary drive gear (B, **Figure 210**).

5. Remove the bolt and washer (A, **Figure 211**) securing the rear cylinder camshaft chain tensioner



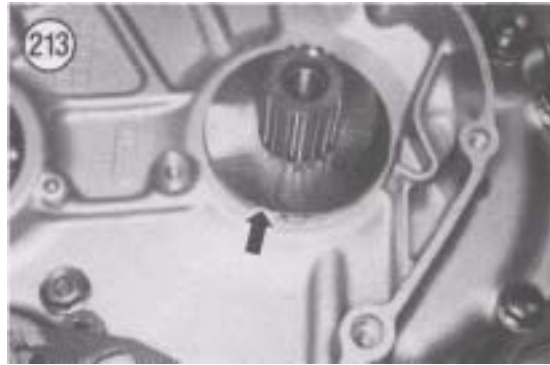
guide (B, **Figure 211**). Remove the guide and the washer behind it. There is a washer on each side of the tensioner guide. Don't lose the collar in the mounting hole in the tensioner guide.

6. Disengage the rear cylinder camshaft chain (C, **Figure 211**) from the camshaft chain sprocket and remove the chain.

7. Remove the rear cylinder camshaft chain sprocket (**Figure 212**) from the crankshaft.

8. Remove the outer thrust washer (**Figure 213**).

9. Inspect all components as described in this chapter.



Installation

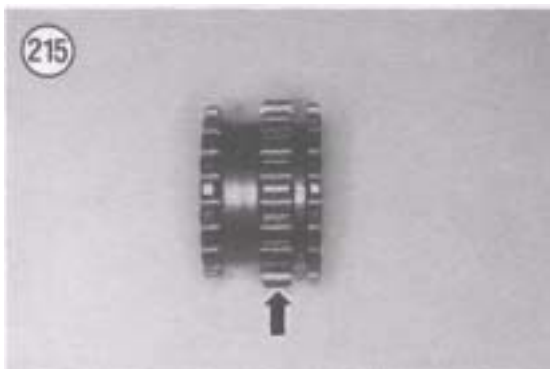
1. Position the outer thrust washer with the beveled side (**Figure 214**) going on first toward the crankshaft surface and install the outer thrust washer.

2. Position the front cylinder camshaft chain sprocket with the alignment mark facing out. This will locate the chain sprocket teeth (**Figure 215**) in toward the crankcase surface.

3. Align the mark (A, **Figure 216**) on the rear cylinder camshaft chain sprocket with the mark (B, **Figure 216**) on the end of the crankshaft and install the sprocket onto the crankshaft (**Figure 212**).

4. Install the rear cylinder camshaft chain (C, **Figure 211**) onto the camshaft chain sprocket and make sure it is properly meshed.

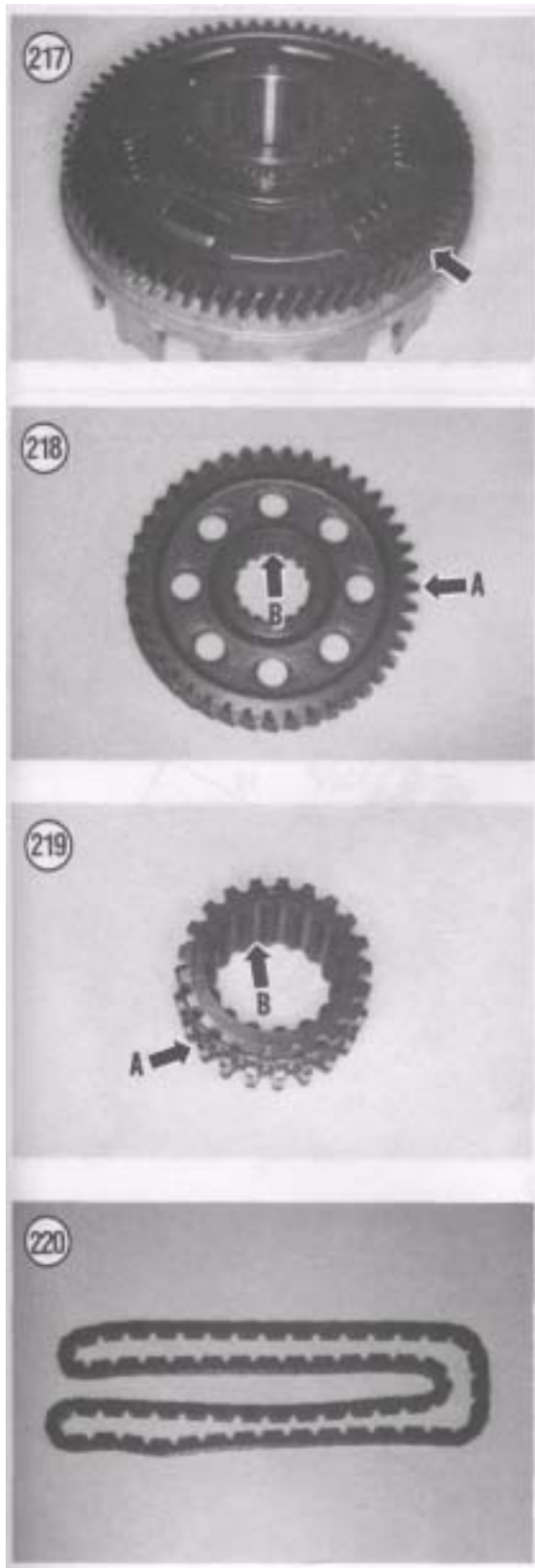
5. Make sure the collar is in place in the tensioner guide mounting hole.



CAUTION

The collar must be in place and a washer must be installed on each side of the camshaft chain tensioner guide to allow it to pivot freely on the mounting bolt. If these parts are not installed cor-





rectly, the guide will be stiff and will not be able to take the slack out of the camshaft chain.

6. Install the rear cylinder camshaft chain tensioner guide (B, **Figure 211**). Place a washer between the tensioner guide and the crankcase surface, then install the bolt and washer (A, **Figure 211**). Tighten the bolt securely.
7. Install the primary drive gear (B, **Figure 210**) and bolt (A, **Figure 210**).

CAUTION

*The primary drive gear bolt has **left-hand** threads. Turn the wrench **counterclockwise** to tighten it in the following step.*

8. Use the same tool set-up used in Step 2A or 2B of the *Removal* procedure to prevent the crankshaft from rotating while tightening the bolt.
9. Turn the wrench *counterclockwise* and tighten the primary drive gear bolt (A, **Figure 210**) to the torque specification listed in **Table 2**.
10. Install the clutch assembly as described in Chapter Five.

Inspection

NOTE

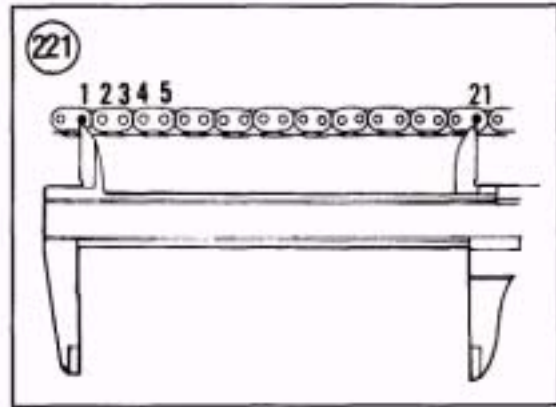
*If the primary drive gear teeth are damaged, inspect the gear teeth on the clutch outer housing (**Figure 217**) as it may also be damaged and require replacement.*

1. Inspect the primary drive gear (A, **Figure 218**) for chipped or missing teeth, wear or damage. Replace the gear if necessary.
2. Check the inner splines (B, **Figure 218**) for wear or damage, replace the gear if necessary.
3. Inspect the front cylinder camshaft chain sprocket (A, **Figure 219**) for chipped or missing teeth, wear or damage. Replace the sprocket if necessary.
4. Check the inner splines (B, **Figure 219**) for wear or damage, replace the sprocket if necessary.
5. Inspect the front cylinder camshaft chain tensioner guide for deterioration, cracks or damage, replace if necessary.
6. Inspect the camshaft chain (**Figure 220**) for wear or damage to the links and pins. Replace if necessary.

If the chain is damaged, also inspect the sprocket at each end as they may also be damaged.

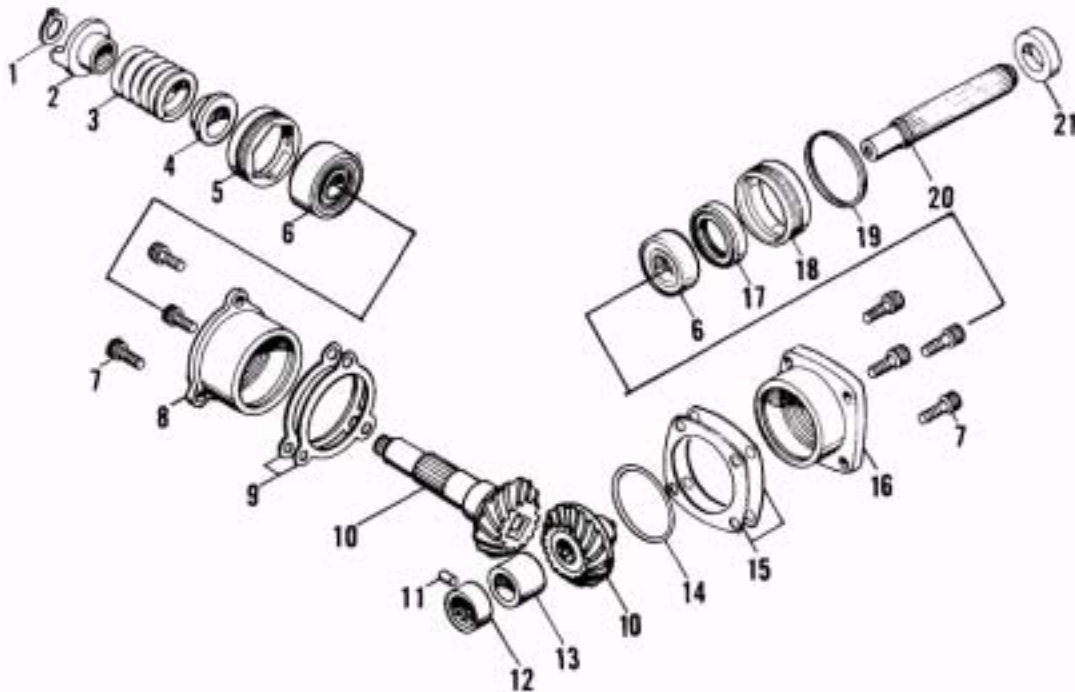
7. Measure the camshaft chain for stretching as follows:

- Place the chain on a flat surface and pull the chain taut to remove all slack.
- Use a vernier caliper and measure the distance between 21 pins (or 20 pitches) as shown in **Figure 221**.
- Repeat Steps 7a and 7b several times at various locations around the chain. The chain usually wears and stretches unevenly. It is important to



222

SECONDARY GEAR ASSEMBLY



- | | |
|--------------------|-------------------------|
| 1. Circlip | 12. Needle bearing |
| 2. Cam | 13. Spacer |
| 3. Spring | 14. O-ring |
| 4. Spring seat | 15. Shim |
| 5. Bearing stopper | 16. Driven gear housing |
| 6. Bearing | 17. Oil seal |
| 7. Bolt | 18. Bearing stopper |
| 8. Housing | 19. O-ring |
| 9. Shim | 20. Shaft |
| 10. Gear set | 21. Oil seal |



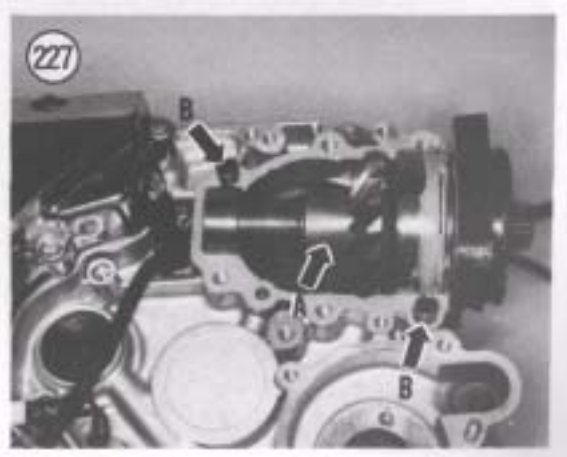
identify and measure the part of the chain that is stretched and worn the most, d. If the chain has stretched to the service limit of 128.9 mm (5.07 in.) or greater, replace the chain.

SECONDARY GEAR ASSEMBLY

Removal

Refer to **Figure 222** for this procedure.

1. Remove the engine from the frame as described in this chapter.
2. Install the universal joint (**Figure 223**) onto the output shaft of the secondary gear housing. This will keep the internal gears from rotating during nut removal in the following step.
3. Hold onto the universal joint with a large Crescent wrench and loosen the nut (**Figure 224**) securing the secondary gear nut.
4. Remove the nut and washer and the universal joint.
5. Loosen in a crisscross pattern, then remove the secondary gear housing bolts (**Figure 225**).
6. Remove the bolts (**Figure 226**) securing the secondary gear case and remove the case.
7. Remove the secondary bevel gear assembly and bearing (A, **Figure 227**).
8. Separate the crankcase as described in this chapter.
9. Remove the secondary reduction gear (**Figure 228**) from the transmission shaft.
10. Remove the Allen bolts (A, **Figure 229**) securing the secondary bevel drive gear and remove the assembly (B, **Figure 229**) from the crankcase. Also remove the shims located between the assembly and the crankcase mounting surface. Note the number of

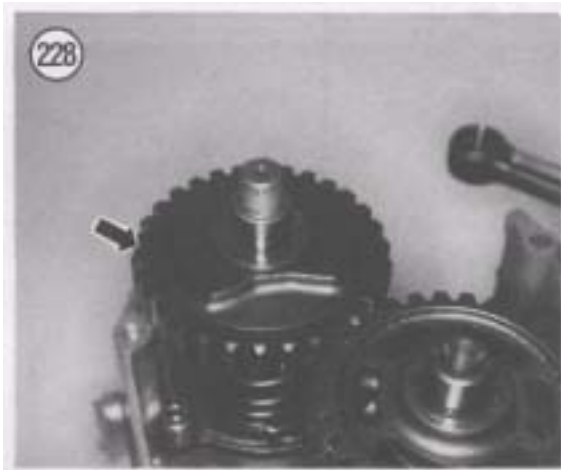


shims as the same number must be reinstalled to maintain the correct gear lash between the two bevel gears in the assembly.

11. Inspect the components as described in this chapter.

Installation

1. Apply a light coat of engine oil to the secondary bevel drive gear receptacle in the crankcase.
2. Be sure to install the same number of shims (Figure 230) between the assembly and the crankcase mounting surface as noted during removal.
3. Install the secondary bevel drive gear assembly (A, Figure 231), then install the secondary reduction gear (B, Figure 231) onto the gear assembly to assist in installation.
4. Slowly push the secondary bevel drive gear assembly into the receptacle in the crankcase. Align the mounting bolt holes in the shims and assembly with the holes in the crankcase. After bolt hole alignment is achieved, remove the secondary reduction gear (B, Figure 231).
5. Install the Allen bolts (A, Figure 229) and tighten to the torque specification listed in Table 2.
6. Assemble the crankcase as described in this chapter.
7. Make sure the shaft bearing locating pin (Figure 232) is in place in the crankcase.
8. Position the secondary bevel gear assembly bearing (A, Figure 233) so it will index properly with the locating pin (B, Figure 233) and install the secondary bevel gear assembly and bearing (A, Fig-





ure 227). Make sure the bearing has seated properly onto the locating pin.

9. If removed, make sure the small O-ring seal is in place, then install the oil control orifice (**Figure 234**). Push it down until it seats completely (**Figure 235**).

10. If removed, install the case locating dowels (B, **Figure 227**) in the crankcase.

NOTE

Use ThreeBondNo. 1207, or equivalent gasket sealer. When selecting an equivalent, avoid thick and hard-setting materials.

11. Apply a light coat of gasket sealer to the secondary case sealing surfaces on the crankcase.

12. Correctly position the driven gear housing so the drain hole (**Figure 236**) is facing down.

13. Install the case and bolts (**Figure 226**). Tighten the bolts in 2 stages, initial and final, to the final torque specification listed in **Table 2**.

14. Apply red Loctite (No. 271) to the secondary gear housing bolts prior to installation.

15. Install the secondary gear housing bolts (**Figure 225**) and tighten to the torque specification listed in **Table 2**.

16. Install the universal joint onto the output shaft of the secondary gear housing. This will keep the internal gears from rotating while tightening the nut in the following step.

17. Install the washer and nut (**Figure 224**).

18. Hold onto the universal joint with a large Crescent wrench and tighten the nut securing the secondary gear. Tighten the nut to the torque specification listed in **Table 2**.

NOTE

Make sure the transmission is in neutral.

19. Rotate the universal joint and make sure there is no binding within the secondary gear assembly. If the assembly will not rotate properly, correct the problem at this time. Remove the universal joint.

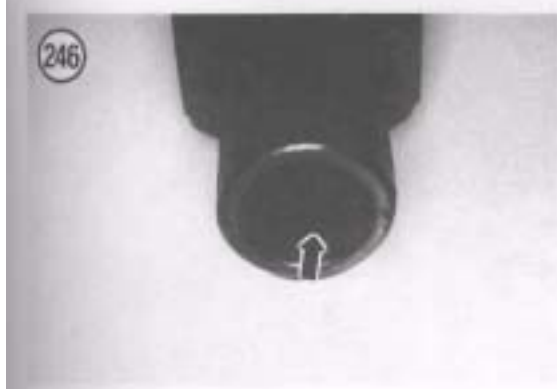
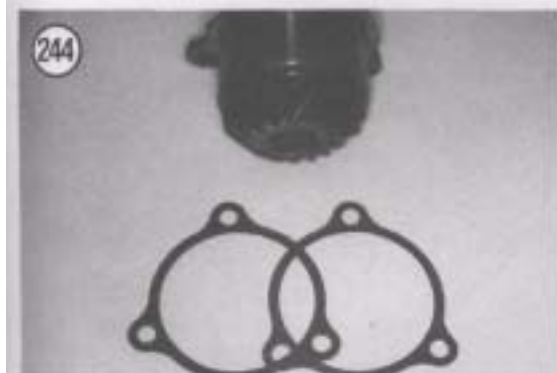
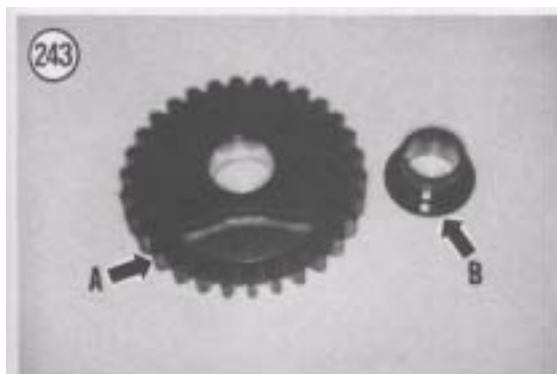
20. Install the engine into the frame as described in this chapter.

Inspection

Special tools are required to disassemble the driven shaft assembly. Refer this type of work to a Suzuki dealer or competent machine shop.

1. Inspect for chipped or missing teeth on the drive gear (**Figure 237**) and the driven gear (**Figure 238**). If either gear is damaged both the drive and driven gears must be replaced as a set.
2. Inspect the driven gear assembly splines (**Figure 239**) for wear or damage. If damaged, both the drive and driven gears must be replaced as a set. Also check the inner splines of the universal joint as they may also be damaged.
3. Inspect driven gear shaft small roller bearing (**Figure 240**). Make sure it rotates freely with no binding. Replace the bearing if necessary.
4. Inspect the spring (A, **Figure 241**) for wear, cracks or damage and replace if necessary.
5. Install the secondary reduction gear (B, **Figure 241**) onto the drive gear shaft and check for proper engagement. Check the cams (A, **Figure 242**) and ramps (B, **Figure 242**) for wear, cracks or burrs. Replace if necessary.
6. Inspect the secondary reduction gear for chipped or missing teeth (A, **Figure 243**). Inspect the inner and outer bearing surfaces of the bushing (B, **Figure 243**) for wear. Insert the bushing into the gear and





check for looseness or excessive wear. Replace if necessary.

7. Inspect the drive gear assembly shims (**Figure 244**) for wear or damage. Replace if necessary and replace with shims of the exact same thickness. Take the old shims along to ensure an exact matchup as there are 5 different shim thicknesses available from Suzuki.

8. Move the universal joint (**Figure 245**) back and forth and pull in and out on it. Check for looseness or stiffness, replace if necessary.

9. Inspect the universal joint inner splines for wear or damage. Refer to **Figure 246** and **Figure 247**. If the splines are damaged, also check the outer splines on the drive shaft for damage. Replace the universal joint if necessary.

CRANKCASE

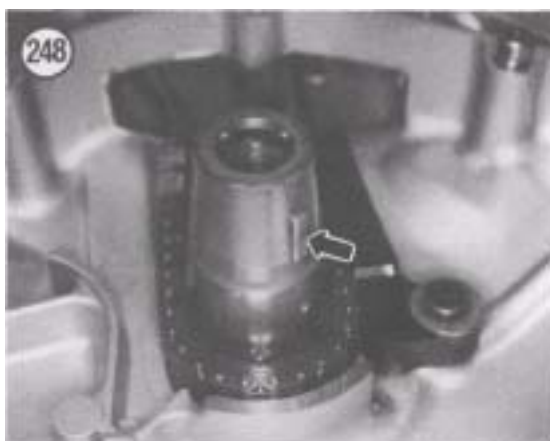
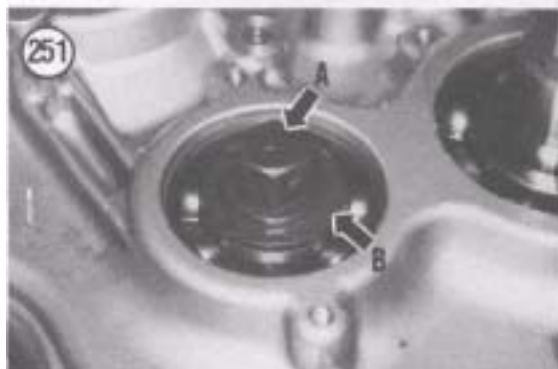
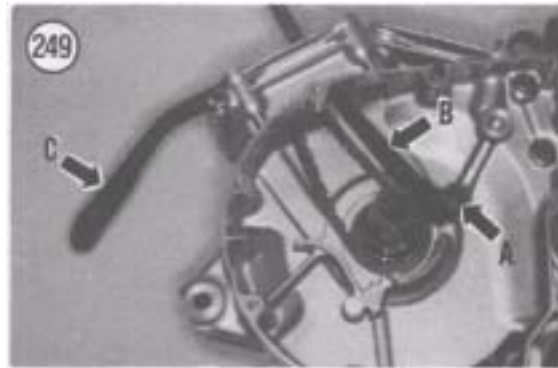
Service to the lower end requires that the crankcase assembly be removed from the motorcycle frame and disassembled (split).

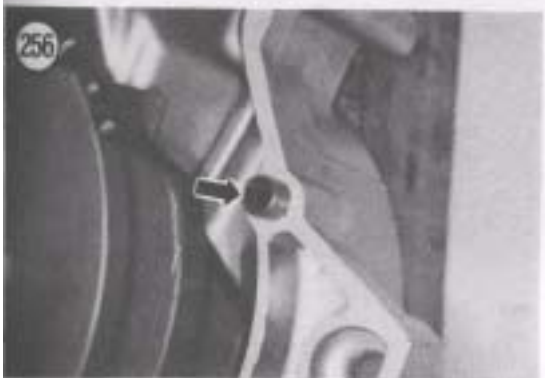
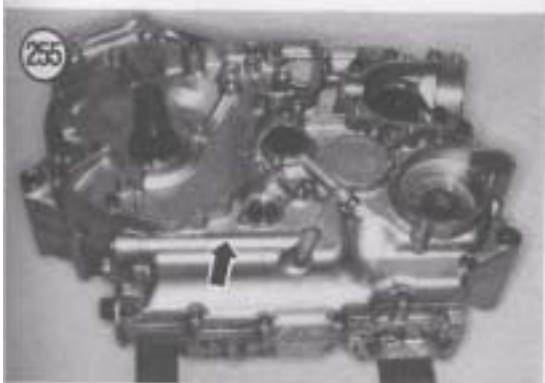
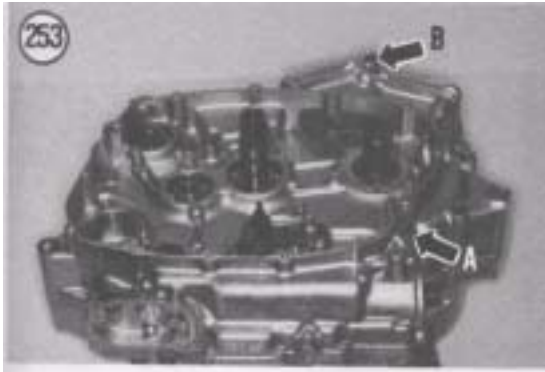
Disassembly

1. Remove the engine as described in this chapter.
2. Remove the following exterior assemblies from the crankcase assembly:
 - a. Cylinder head and cylinder assemblies: this chapter.
 - b. Alternator: Chapter Eight.
 - c. Starter clutch assembly: Chapter Eight.
 - d. Oil sump and filter: this chapter.
 - e. External shift mechanism: Chapter Six.



- f. Clutch: Chapter Five
 - g. Water pump: Chapter Nine.
 - h. Starter motor: Chapter Eight,
 - i. Neutral switch: Chapter Eight.
 - j. Oil pressure switch: Chapter Eight.
3. If still in place, remove the Woodruff key (**Figure 248**) from the crankshaft taper.
 4. Remove the bolt and washer (A, **Figure 249**) securing the front cylinder camshaft chain tensioner guide (B, **Figure 249**). Remove the guide and the washer behind it. There is a washer on each side of the tensioner guide. Don't lose the collar in the mounting hole in the tensioner guide.
 5. Disengage the front cylinder camshaft chain (C, **Figure 249**) from the camshaft chain sprocket and remove the chain.
 6. Shift the transmission into gear.
 7. Install the universal joint (**Figure 250**) onto the output shaft of the secondary gear housing. This will keep the transmission shaft and gears from rotating during bolt removal in the following step.
 8. Hold onto the universal joint with a large Crescent wrench and loosen the bolt (A, **Figure 251**) securing the transmission main shaft to the crankcase.
 9. Remove the bolt and washer (B, **Figure 251**) from the end of the shaft.
 10. Remove the secondary gear assembly from the exterior of the crankcase as described in this chapter.
 11. Starting with the right-hand side, loosen all bolts 1/2 turn in a crisscross pattern, then remove the bolts. Make sure all bolts are removed. Don't lose the washer (**Figure 252**) under the lower front bolt adjacent to the oil pump mounting area (A, **Figure 253**). This washer must be reinstalled under the





correct bolt during assembly to prevent an oil leak. There is also a washer (**Figure 254**) under the bolt at the top of the crankcase where the 2 cylinders meet (**B, Figure 253**).

12. Turn the crankcase over with the left-hand side facing up.

13. On the left-hand side, loosen all bolts 1/2 turn in a crisscross pattern (**Figure 255**). Remove all bolts. Make sure all bolts are removed.

14. Turn the crankcase back over so the right-hand side is facing up.

CAUTION

If it is necessary to pry the crankcase apart, do it very carefully so that you do not mar the gasket surfaces. If you do, the cases will leak and must be replaced as a set. They cannot be repaired.

15. Carefully tap around the perimeter of the crankcase with a plastic mallet (do not use a metal hammer) to help separate the case halves. Separate the case halves by pulling the right-hand crankcase up and off the left-hand case half.

16. After removing the right-hand crankcase half, the transmission and crankshaft assemblies should stay with the left-hand crankcase. Check the right-hand crankcase to make sure no transmission shims are stuck to the bearings. If found, reinstall them immediately in their original positions.

17. Remove the 2 small dowel pins from the left-hand crankcase half. Refer to **Figure 256** and **Figure 257**.

18. Remove the small O-ring (**Figure 258**) from the left-hand crankcase half.



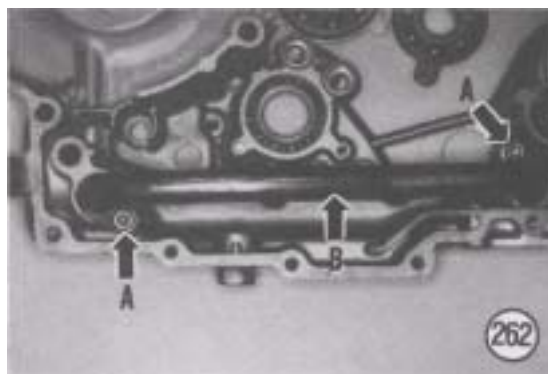
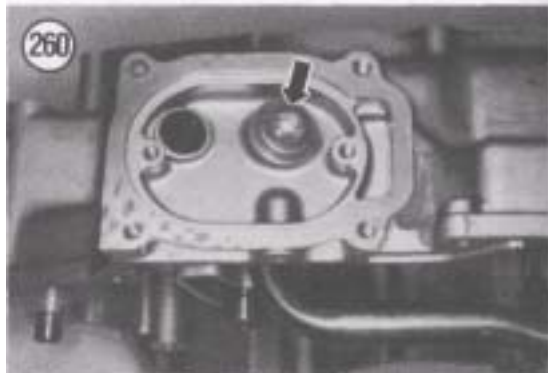
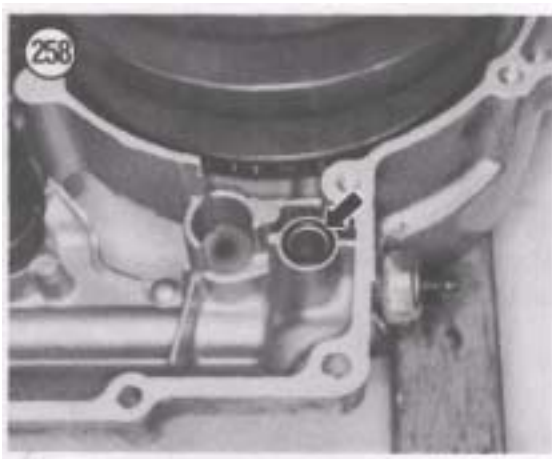
19. Remove the transmission, shift forks and shift drum assemblies from the left-hand crankcase half as described in Chapter Five in this section of the manual.

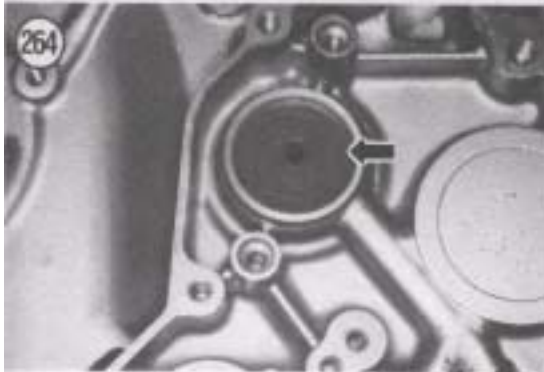
20. Remove the crankshaft assembly as described in this chapter.

Inspection

The following procedure may include the use of highly specialized and expensive measuring instruments. If such instruments are not readily available, have the measurements performed by a dealer or qualified machine shop.

1. Remove all old gasket residue material from both crankcase mating surfaces.
2. Soak any old gasket material stuck to the surface with solvent. Use a broad-tipped *dull* chisel and gently scrape off all gasket residue. Do not gouge the sealing surfaces as oil and air leaks will result.
3. Remove all oil gallery plugs and sealing washers. Refer to **Figure 259**, **Figure 260** and **Figure 261**.
4. Remove the bolts (A, **Figure 262**) and remove the oil pipe (B, **Figure 262**) and O-rings from the right-hand case half.
5. Remove the oil pressure relief valve (**Figure 263**) from the right-hand crankcase half.
6. Remove the clutch pushrod oil seal (**Figure 264**) from the left-hand crankcase half.
7. Thoroughly clean the inside and outside of both crankcase halves with cleaning solvent. Dry with compressed air. Make sure there is no solvent residue left in either part as it will contaminate the new engine oil.





8. Check all bolts and threaded holes for stripping, cross-threading or deposit buildup. Threaded holes should be blown out with compressed air as dirt buildup in the bottom of a hole may prevent the bolt from being torqued properly. Replace damaged bolts and washers.

9. Inspect machined surfaces for burrs, cracks or other damage. Refer to **Figure 265** and **Figure 266**. Repair minor damage with a fine-cut file or oilstone.

10. Make sure that all oil passages throughout both crankcase halves are clean.

11. Apply a light coat of engine oil to the bearing surfaces to prevent any rust formation.

12. Inspect the threads for the oil filter. Clean off with a wire brush if necessary. If the threads are damaged, clean them up with an appropriate size metric thread die.

13. Inspect the crankcase bearings as described in this chapter.

14. Make sure the oil control orifice oil hole (A, **Figure 267**) is clear. Clean out with a piece of wire and compressed air.

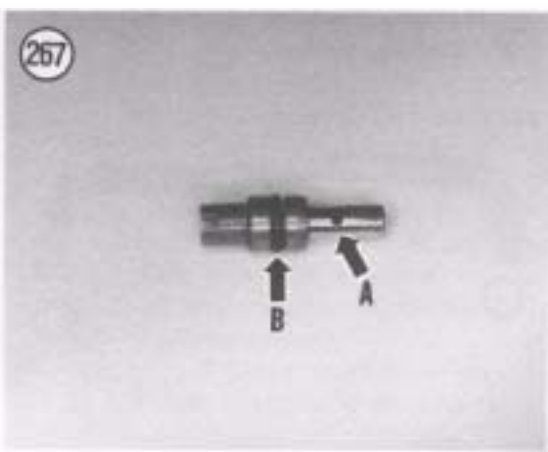
15. Inspect the O-ring (B, **Figure 267**) for deterioration or hardness and replace if necessary.

16. Install all items removed during this inspection process.

17. Install new O-ring seals (**Figure 268**) on the oil pipe prior to installation. Tighten the bolts securely.

Crankcase Bearings Inspection

1. After cleaning the crankcase halves in cleaning solvent and drying with compressed air, lubricate the bearings with engine oil.



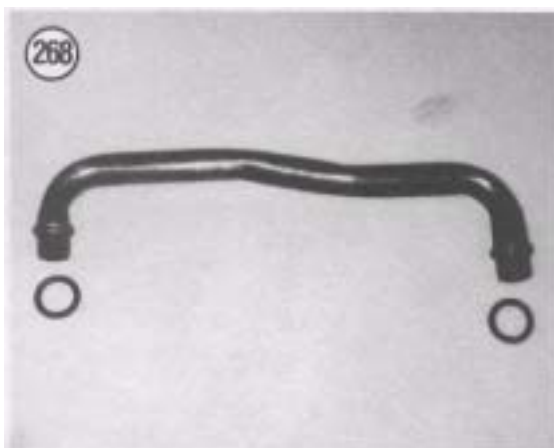
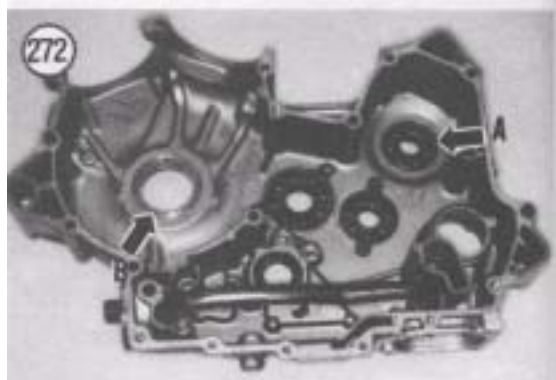
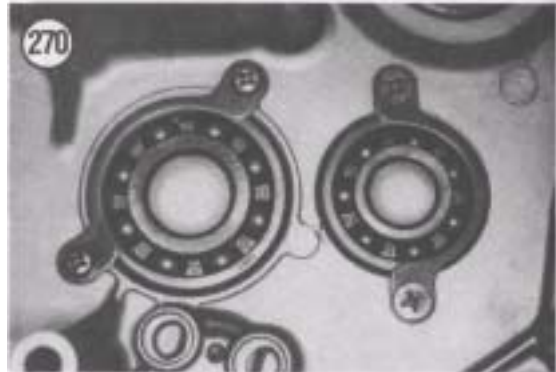
2. With your fingers, rotate the transmission bearing inner races and check for play or roughness. Refer to **Figure 269** and **Figure 270**. Replace the bearing(s) if it is noisy or if it does not spin smoothly.
3. Rotate the shift drum bearing inner race (**Figure 271**) with your finger and check for play or roughness. Replace the bearing if it is noisy or if it does not spin smoothly.
4. Rotate the secondary gear shaft bearing inner race (**Figure 272**) slowly and check for play or roughness. Replace the bearing if it is noisy or does not spin smoothly.
5. Inspect the crankshaft main bearings (**Figure 273**) for wear (bluish tint) or damage. Make sure they are locked in place (**Figure 274**). The bearing inside dimension is measured as described under *Crankshaft Bearing and Oil Clearance Measurement* in this chapter. If the bearings are damaged or worn, have them replaced.

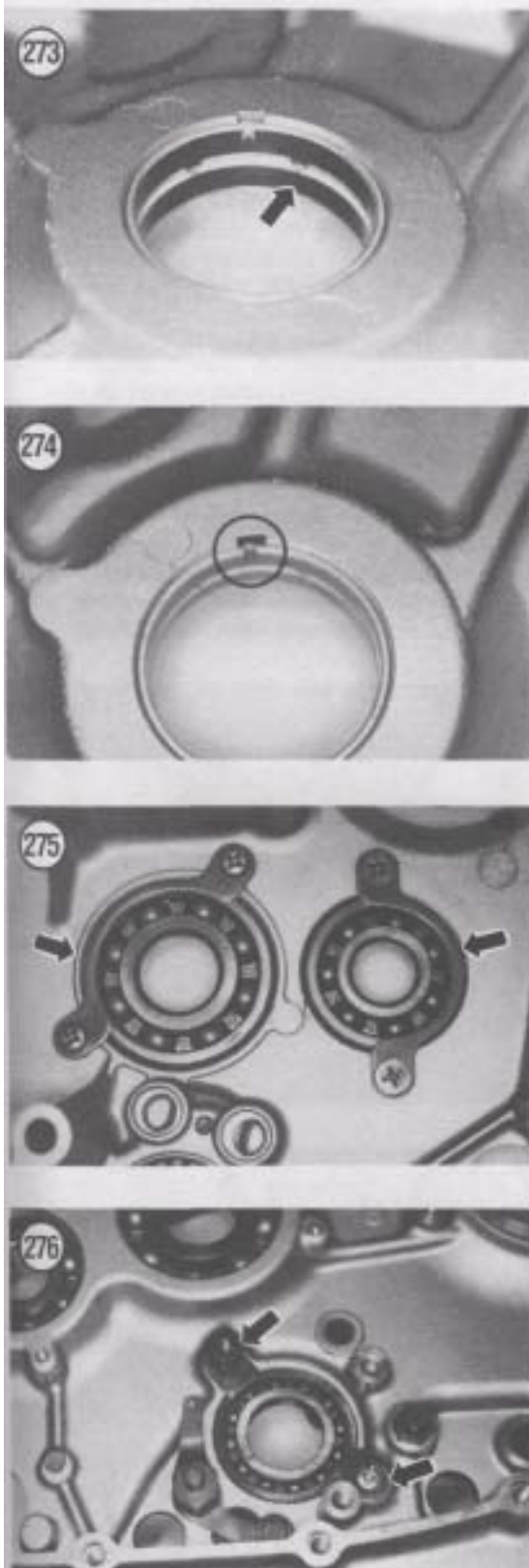
Crankcase Bearings Replacement

Crankshaft main bearings

The crankshaft main bearings are removed and installed from the crankcase halves with a hydraulic press and special tools. After the new bearings are installed, they must be honed.

To avoid damage to a costly set of crankcase halves, this procedure should be entrusted to a Suzuki dealer or machine shop. Improper removal and installation of the bearings could result in costly crankcase damage.





Other than crankshaft main bearings

1. On bearings equipped with retainers, perform the following:

NOTE

The bearing retainer screws had a locking agent applied to the threads during installation and may be difficult to remove. To avoid damage or "rounding" off of the screw head, use the recommended tool in this procedure.

- a. Use an impact driver with the appropriate size bit and loosen the screws securing the bearing retainers. Refer to **Figure 275** and **Figure 276**.
- b. Remove the screws and retainers.

WARNING

*There **may** be a residual oil or solvent odor left in the oven after heating the crankcase. If you use a household oven, first check with the person who uses the oven for food preparation to avoid getting into trouble.*

- c. Heat the crankcase to approximately 205-257° F (95-125° C) in an oven or on a hot plate.

CAUTION

Do not attempt bearing removal by heating the crankcases with a torch as this type of localized heating may warp the cases.

- d. Wearing a pair of work gloves for protection, remove the case from the oven and place it on wood blocks for support.
 - e. Drive out the bearing with a suitable size drift placed on the outside bearing race. A large socket also works well for bearing removal.
2. Perform Steps 1c-1e for the secondary gear shaft bearing and remove the bearing.
 3. Special Suzuki tools are required to remove bearings from blind holes (**Figure 269**). Remove these bearings as follows:
 - a. Install the bearing removers (part No. 09914-79610 and 099923-73210) into the bearing so they grab the backside of the bearing inner race.
 - b. Attach the slide shaft (part No. 09930-30102) onto the bearing removers.
 - c. Using a quick in-and-out strokes of the slide shaft, withdraw the bearing from the crankcase.

4. Before installing new bearings, clean the bearing housing and oil passages with solvent. Dry thoroughly with compressed air.
5. Install new crankcase bearings by reversing the removal steps, noting the following:
 - a. Installation of the bearings is made easier by first placing the bearings in a freezer for approximately 30 minutes. Then reheat the crankcase half and install the bearing by driving it squarely into position. If the bearing cocks in its bore, remove it and reinstall. It may be necessary to refreeze the bearing and reheat the case half.
 - b. Lubricate the bearing races with clean engine oil after installation.
 - c. On bearings with retainers, apply red Loctite (No. 271) to the screw threads prior to installation, then install the retainer.

Assembly

1. Prior to installation of all parts, coat all rotating parts with assembly oil or engine oil.
2. Place the left-hand crankcase on wood blocks.
3. Install the crankshaft as described in this chapter. Make sure the connecting rods are positioned correctly within the cylinder openings (**Figure 277**).
4. Install the shift drum, shift forks and transmission assemblies as described in Chapter Five.
5. Install the small O-ring (**Figure 258**) into the left-hand crankcase half. Apply clean engine oil to the O-ring.
6. If removed, install the 2 small dowel pins into the left-hand crankcase half. Refer to **Figure 256** and **Figure 257**.
7. Apply oil to the transmission shafts and crankshaft bearing surfaces.
8. Clean the crankcase mating surfaces of both halves with aerosol electrical contact cleaner.
9. Make sure both crankcase half sealing surfaces are perfectly clean and dry.

NOTE

Use ThreeBondNo. 1207, or equivalent gasket sealer. When selecting an equivalent, avoid thick and hard-setting materials.

10. Apply a light coat of gasket sealer to the sealing surfaces of the left-hand half. Make the coating as thin as possible.

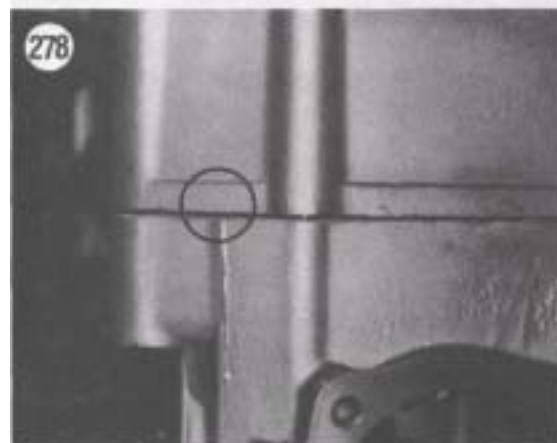
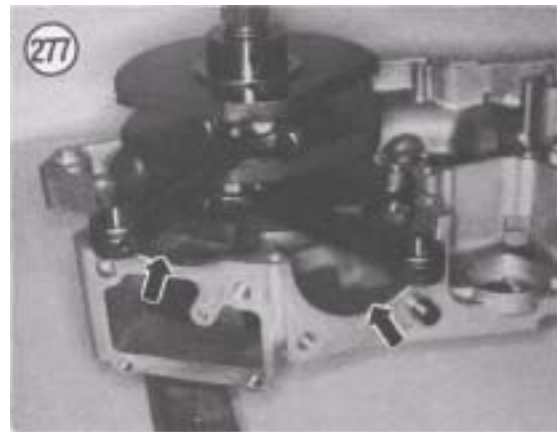
11. Align the right-hand crankcase bearings with the left-hand assembly. Join both halves and tap together lightly with a plastic mallet—do not use a metal hammer as it will damage the cases.

NOTE

*Due to the spring in the secondary drive gear assembly, the crankcase halves will **not** come completely together as shown in **Figure 278**. The gap shown is a normal gap distance, but if the gap is larger than shown, refer to the following CAUTION.*

CAUTION

The crankcase halves should fit together without force. If the crankcase halves do not fit together, with the exception of the previously mentioned normal gap, do not attempt to pull them together with the crankcase bolts. Separate the crankcase halves and investi-



gate the cause of the interference. If the transmission shafts were disassembled, recheck to make sure that a gear is not installed backwards. Do not risk damage by trying to force the cases together.

NOTE

Install all bolts in the crankcase half so that all bolt heads protrude up from the surface of the crankcase the same amount as shown in Figure 279. If they do not, the bolt is installed in the wrong location. Remove the bolt and insert it in the correct hole.

12. Install the bolts in the right-hand crankcase. Tighten in a crisscross pattern in two stages to a final torque listed in Table 2.

NOTE

On the right-hand side, don't forget to install the washer (Figure 252) under

the lower front bolt adjacent to the oil pump mounting area (A, Figure 253). This washer must be reinstalled under the correct bolt during assembly to prevent an oil leak. Also install the washer (Figure 254) under the bolt at the top of the crankcase where the 2 cylinders meet (B, Figure 253).

13. Turn the crankcase assembly over and install the bolts in the left-hand crankcase. Tighten in a crisscross pattern in two stages to a final torque listed in Table 2.

14. Install the secondary gear assembly onto the exterior of the crankcase as described in this chapter.

15. Shift the transmission into gear.

16. Install the universal joint onto the output shaft of the secondary gear housing. This will keep the transmission shaft and gears from rotating during bolt installation in the following step.

17. Install the washer (A, Figure 280) and bolt (B, Figure 280) into the end of the transmission mainshaft.

18. Hold onto the universal joint with a large Crescent wrench and tighten the transmission bolt (B, Figure 280) to the torque specification listed in Table 2.

19. Remove the universal joint.

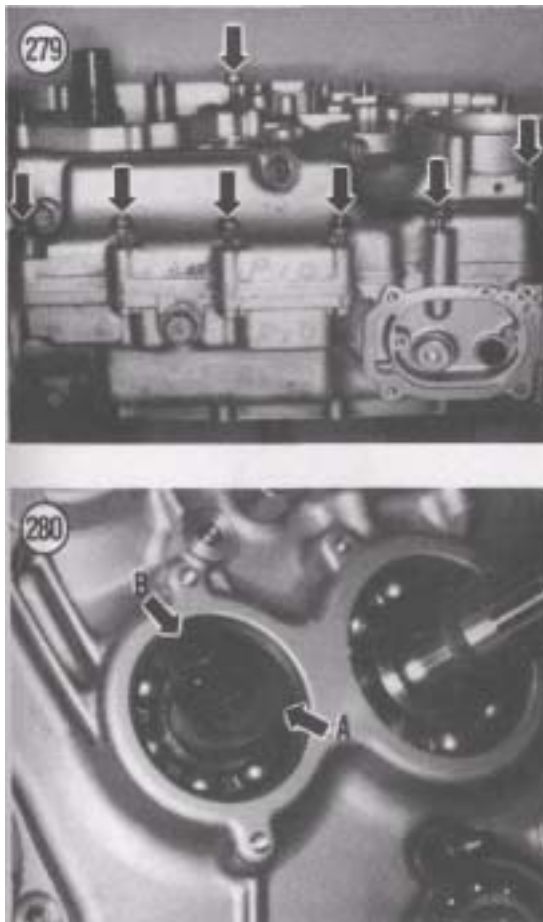
20. Install, then engage the front cylinder camshaft chain (C, Figure 249) onto the camshaft chain sprocket on the crankshaft. Make sure it is properly meshed with the sprocket teeth.

21. Install the front cylinder camshaft chain tensioner guide (B, Figure 249). Make sure the collar is in place in the tensioner guide mounting hole. Install a washer on each side of the guide, then install the bolt (A, Figure 251) and tighten to the torque specification listed in Table 2.

22. If removed, install Woodruff key (Figure 248) into the crankshaft taper. Make sure it is centered in the groove.

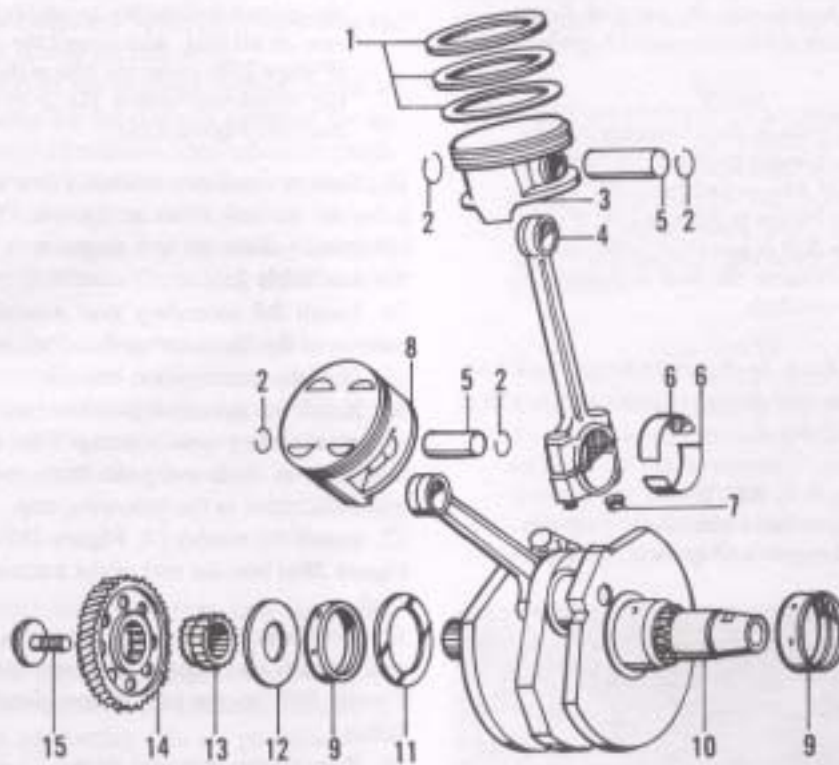
23. Install the following exterior assemblies onto the crankcase assembly:

- a. Oil pressure switch: Chapter Eight.
- b. Neutral switch: Chapter Eight.
- c. Starter motor: Chapter Eight.
- d. Water pump: Chapter Nine.
- e. Clutch: Chapter Five
- f. External shift mechanism: Chapter Six.
- g. Oil sump and filter: this chapter.
- h. Starter clutch assembly: Chapter Eight.



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CRANKSHAFT ASSEMBLY

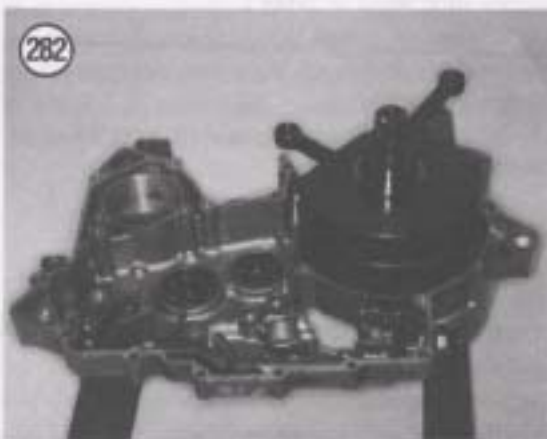


- 1. Piston ring set
- 2. Circlip
- 3. Piston
- 4. Connecting rod
- 5. Piston pin
- 6. Connecting rod bearing inserts

- 7. Connecting rod cap nut
- 8. Piston
- 9. Crankshaft bearing insert
- 10. Crankshaft

- 11. Inner thrust washer
- 12. Outer thrust washer
- 13. Front cylinder camshaft chain drive sprocket
- 14. Primary drive gear
- 15. Bolt

282



283

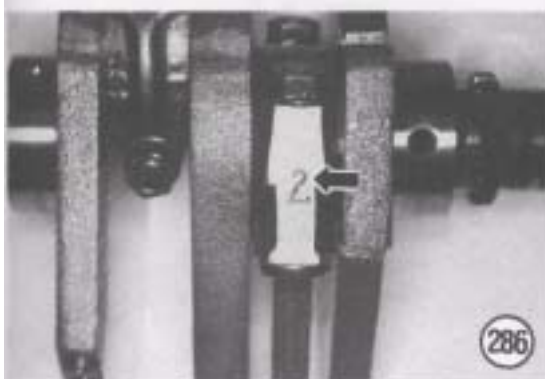
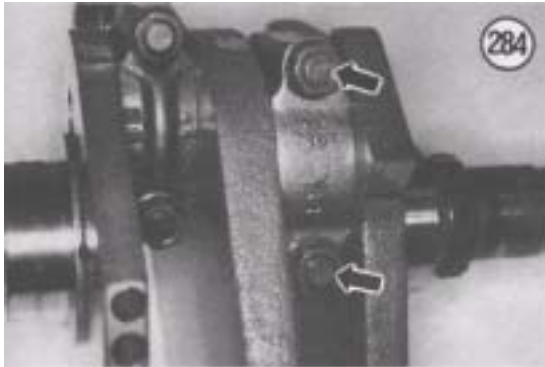


- i. Alternator: Chapter Eight.
- j. Cylinder head and cylinder assemblies: this chapter. 24. Install the engine as described in this chapter.

CRANKSHAFT AND CONNECTING RODS

Removal/Installation Refer to **Figure**

281 for this procedure.



1. Split the crankcase as described in this chapter.
2. Remove the crankshaft assembly (**Figure** 282) from the left-hand crankcase half.
3. Remove the inner thrust washer (**Figure** 283) from the right-hand end of the crankshaft.
4. Remove the connecting rod cap bolt nuts (**Figure** 284) and separate the rods from the crankshaft.

NOTE

The rear cylinder connecting rod is located nearest the tapered end (alternator rotor location) of the crankshaft.

5. Mark each rod and cap as a set. Also mark them with a "F" (front) and "R" (rear) to indicate from what cylinder they were removed.
6. Mark each bearing insert so that it can be reinstalled in its original position, if it is reused.
7. Install the bearing inserts into each connecting rod and cap. Make sure they are locked in place correctly (**Figure** 285).

CAUTION

If the old bearings are reused, be sure they are installed in their exact original positions.

8. Lubricate the bearings and crankpins with molybdenum disulfide grease.
9. Position the connecting rod and cap with the I.D. code number (**Figure** 286) facing toward the rear of the engine.
10. Install the caps and tighten the caps nuts evenly, in 2 stages, to the torque specification listed in **Table 2**.
11. Position the inner thrust washer with the oil control grooves facing in toward the crankshaft.
12. Install the inner thrust washer (**Figure** 283) onto the right-hand end of the crankshaft.

NOTE

*When installing the crankshaft, align the front and rear connecting rods with their respective cylinder position (**Figure** 277). Continue to check this alignment until the crankshaft is completely installed.*

13. Position the crankshaft with the tapered end going into the left-hand crankcase and install the crankshaft in the left-hand crankcase (**Figure** 282).
14. Inspect the crankshaft side thrust clearance as described in the following procedure.

15. Assemble the crankcase as described in this chapter.

Crankshaft Side Thrust Clearance

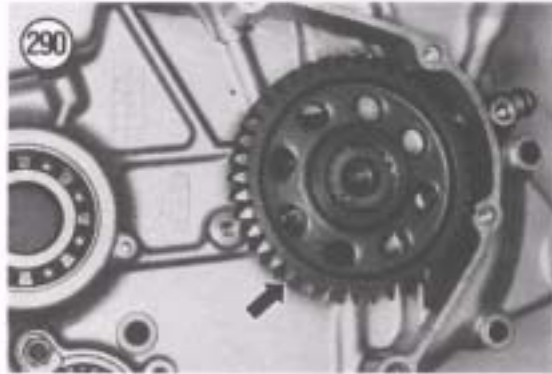
Whenever the crankshaft is removed from the crankcase, the side thrust clearance must be checked. Side thrust clearance is adjusted by replacing the *inner* thrust washer with one of a different thickness.

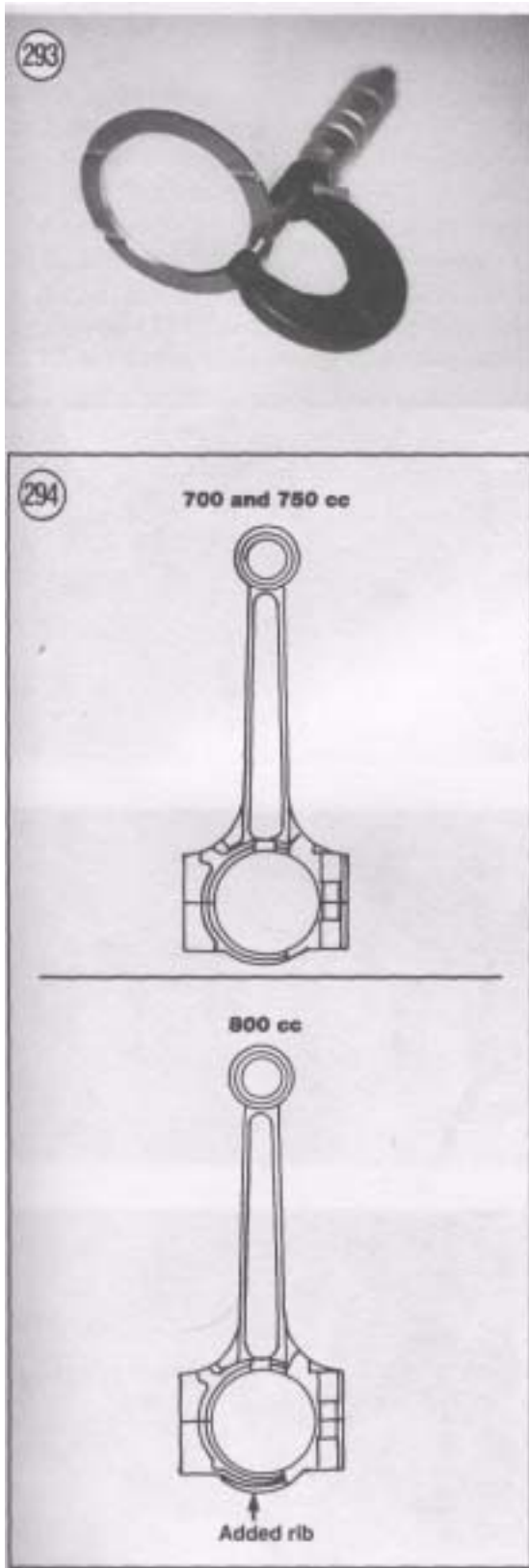
1. Position the inner thrust washer with the oil control grooves facing in toward the crankshaft.
2. Install the inner thrust washer (**Figure 283**) onto the right-hand end of the crankshaft.

NOTE

*When installing the crankshaft, align the front and rear connecting rods with their respective cylinder position in the crankcase (**Figure 277**). Continue to check this alignment until the crankshaft is completely installed.*

3. Position the right-hand crankcase half over the splined (right) end of the crankshaft.





4. Position the outer thrust washer on the outer side of the right-hand crankcase, with the beveled side (**Figure 287**) toward the center of the crankshaft, then install the outer thrust washer (**Figure 288**).

5. Align the mark on the rear cylinder camshaft chain sprocket with the alignment mark on the end of the crankshaft and install the sprocket onto the crankshaft (**Figure 289**). Push it down until it stops against the outer thrust washer.

6. Install the primary drive gear (**Figure 290**) and bolt (**Figure 291**).

7. Have an assistant hold onto the crankshaft and tighten the bolt to the torque specification listed in **Table 2**.

8. Insert a flat feeler gauge (**Figure 292**) between the outer thrust washer and the right-hand crankcase surface. The specified thrust clearance is listed in **Table 1**. If the thrust clearance is incorrect, perform the following:

- Reverse Steps 1-7 and remove the crankshaft from the right-hand crankcase half.
- Remove and measure the *inner* thrust washer with a Vernier caliper or micrometer (**Figure 293**).
- The inner thrust washers are available from a Suzuki dealer in increments of 0.025 mm (0.0010 in.). The thrust washer thickness and part numbers are listed in **Table 3**. Select a new inner thrust washer that will accomplish the specified thrust clearance listed in **Table 1**.
- Install the new inner thrust washer and repeat this procedure to make sure the thrust clearance is now within specification.
- Remove all components from the right-hand crankcase half, then assemble as described in this chapter.

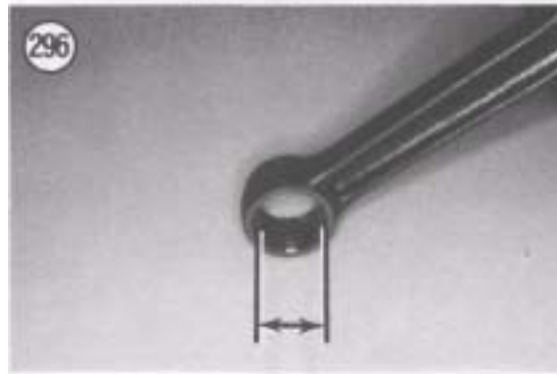
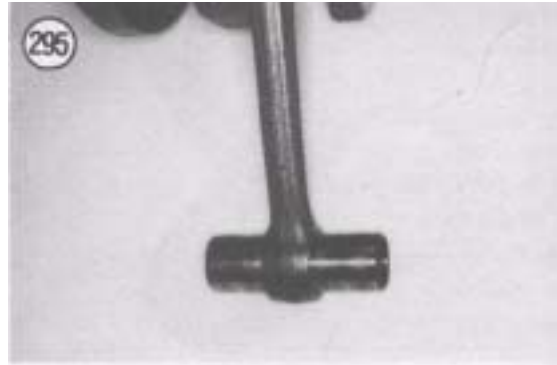
Connecting Rod Inspection

NOTE

*The connecting rod design was changed when the engine was increased from 700 and 750 cc to the larger 800 cc as shown in **Figure 294**. If new connecting rods are going to be installed, be sure to install the correct type to avoid any interference.*

1. Check each rod and cap for obvious damage such as cracks and burrs.

2. Check the connecting rod small end for wear or scoring.
3. Insert the piston pin into the connecting rod (**Figure 295**) and rotate it. Check for looseness or roughness. Replace the defective part.
4. Measure the inside diameter of the connecting rod small end (**Figure 296**) with an inside micrometer. Compare to the dimension listed in **Table 1**. If the dimension is greater than specified, replace the connecting rod assembly.
5. Take the rods to a machine shop and have them checked for twisting and bending.
6. Examine the bearing inserts (A, **Figure 297**) for wear, scoring or burning. They may be reused if they are in good condition. Before discarding any bearing insert, check the back and note if it is stamped with a number indicating that it is undersize. A previous owner may have fitted the engine with undersize bearings.
7. Inspect the connecting rod threaded studs (B, **Figure 297**) for wear or damaged threads. If damaged, replace the connecting rod and stud.
8. Check bearing clearance as described in this chapter.



Connecting Rod Bearing and Oil Clearance Measurement

CAUTION

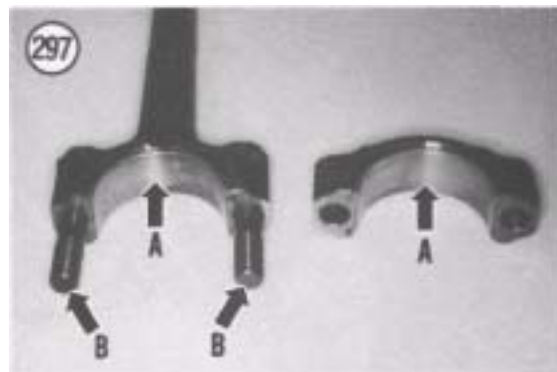
If the old bearings are to be reused, be sure that they are installed in their exact original locations.

1. Wipe bearing inserts and crankpins clean. Install bearing inserts in rod and cap (A, **Figure 297**).
2. Place a piece of Plastigage on one crankpin parallel to the crankshaft.
3. Install rod, cap and nuts, then tighten the nuts to the torque specification listed in **Table 2**.

CAUTION

Do not rotate crankshaft while Plastigage is in place.

4. Remove nuts and the rod cap.
5. Measure width of flattened Plastigage according to the manufacturer's instructions. Measure at both ends of the strip. A difference of 0.001 in. (0.025 mm) or more indicates a tapered crankpin; the crankshaft must be reground or replaced. Use a microme-

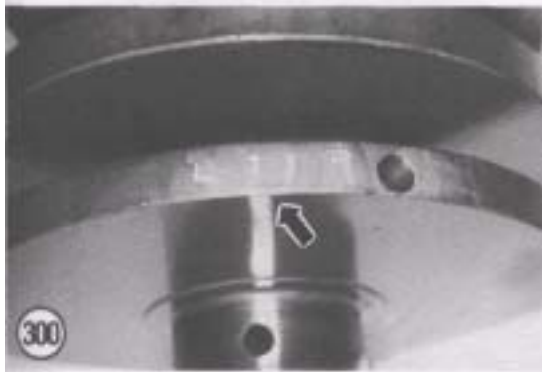


ter and measure the crankpin OD (Figure 298) to get an exact journal dimension.

6. If the crankpin taper is within tolerance, measure the bearing clearance with the same strip of Plastigage. Correct bearing clearance is specified in **Table 1**. Remove Plastigage strips.

7. If the bearing clearance is greater than specified, use the following steps for new bearing selection.

8. The connecting rods and caps are marked with a code number "1," "2" or "3" (**Figure 299**) indicating the inside diameter of the bore in connecting rod.



NOTE

On some models, the crankshaft has a mark on each counterbalance while others, both numbers are stamped on 1 counterbalance and look like "LI 1R."

9. The crankshaft is marked on the counterbalancer with a "1," "2" or "3" (**Figure 300**) indicating the outside diameter for the crankpin journal.

10. Select new bearings by cross-referencing the connecting rod journal I.D. code in the vertical column with the crankpin O.D. code number in the horizontal column. Where the columns intersect, the new bearing color is indicated. **Table 4** gives the bearing color and **Table 5** gives bearing color and thickness.

11. After new bearings have been installed, recheck clearance with Plastigage. If the clearance is out of specifications, either the connecting rod or the crankshaft is worn beyond the service limit. Refer the engine to a dealer or qualified specialist.

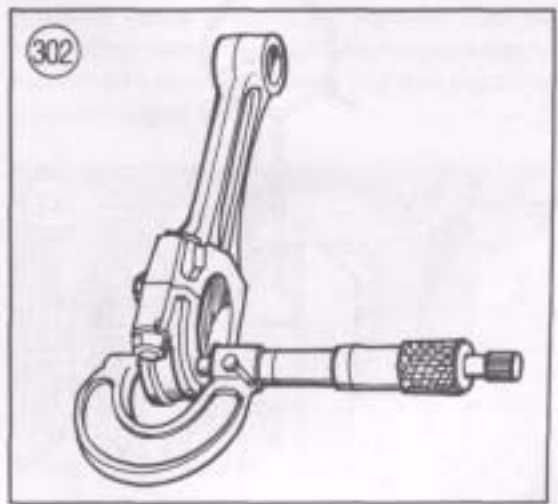
Connecting Rod Side Clearance Measurement

1. With both connecting rods attached to the crankshaft, insert a flat feeler gauge between the counterweight and the connecting rod big end at the locations shown in **Figure 301**.

2. The specified side clearance is listed in **Table 1**.

3. If the clearance is out of specification, perform the following:

- Measure the connecting big end width with a micrometer (**Figure 302**) and compare to the



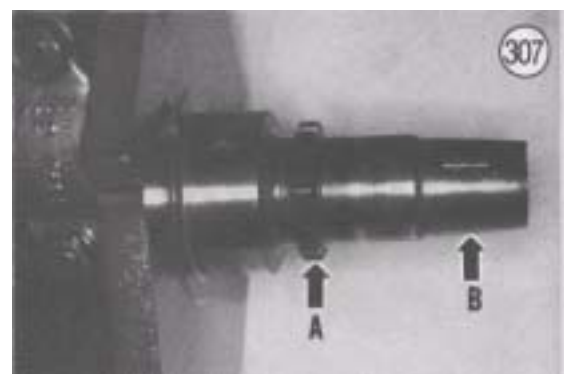
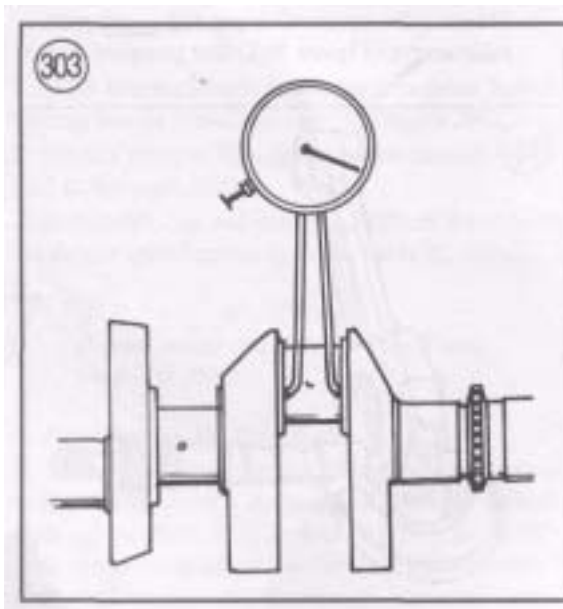
dimension listed in **Table 1**. If the width is less than specified, replace the connecting rod assembly.

- b. Measure the crankpin width with a dial caliper (**Figure 303**) and compare to the dimension listed in **Table 1**.

If the width is greater than specified, replace the crankshaft.

Crankshaft Inspection

1. Clean crankshaft thoroughly with solvent. Clean oil holes with rifle cleaning brushes; flush thoroughly and dry with compressed air. Lightly oil all surfaces immediately to prevent rust.
2. Inspect the connecting rod journals (**Figure 304**) and the main bearing journals (**Figure 305**) for scratches, ridges, scoring, nicks, etc.
3. If the surfaces of all bearing journals are satisfactory, measure the main bearing journals with a micrometer (**Figure 306**) and check for out-of-roundness and taper.
4. Inspect the camshaft chain sprocket (A, **Figure 307**) on the left-hand end. If it is worn or damaged, the crankshaft will have to be replaced.
5. Inspect the taper (B, **Figure 307**) where the alternator rotor is installed on the left-hand end. If it is worn or damaged, the crankshaft will have to be replaced.



6. Inspect the splines (**Figure 308**) on the right-hand end for wear or damage. Minor damage can be cleaned up with a fine-cut file, but if damage is severe the crankshaft will have to be replaced.

Crankshaft Bearing and Oil Clearance Measurement

1. Wipe bearing inserts in the crankcase and the main bearing journals clean.
2. Use a micrometer and measure the main journal OD (**Figure 306**) at two places. Write these dimensions down.
3. Use a bore gauge and measure the main journal insert ID (**Figure 309**) at two places. Write these dimensions down.
4. To determine oil clearance, subtract the crankshaft OD (Step 2) from the main journal insert ID (Step 3).
5. The oil clearance specification is listed in **Table 1**. If the clearance is out of specifications, either the crankshaft or the bearing insert is worn beyond the service limit.

NOTE

The main bearings are removed and installed with a hydraulic press and special tools. After the bearings have been installed, they must be honed to a specific dimension. To avoid damage to a costly set of crankcase halves, this procedure should be entrusted to a Suzuki dealer or machine shop. Improper removal and installation of the bearings could result in severe crankcase damage.

BREAK-IN

Following cylinder servicing (boring, honing, new rings, etc.) and major lower end work, the

engine should be broken-in just as if it were new. The performance and service life of the engine depends greatly on a careful and sensible break-in. For the first 500 miles, no more than one-third throttle should be used and speed should be varied as much as possible within the one-third throttle limit. Prolonged, steady running at one speed, no matter how moderate, is to be avoided, as is hard acceleration.

Following the 500-mile service, increasingly more throttle can be used but full throttle should not be used until the motorcycle has covered at least 1,000 miles and then it should be limited to short bursts until 1,500 miles have been logged.

The mono-grade oils recommended for break-in and normal use provide a superior bedding pattern for rings and cylinders than do multi-grade oils. As a result, piston ring and cylinder bore life are greatly increased. During this period, oil consumption will be higher than normal. It is therefore important to frequently check and correct the oil level. At no time, during break-in or later, should the oil level be allowed to drop below the bottom line on the inspection window; if the oil level is low, the oil will become overheated resulting in insufficient lubrication and increased wear.

500-Mile Service

It is essential that the oil and filter be changed after the first 500 miles. In addition, it is a good idea to change the oil and filter at the completion of break-in (about 1,500 miles) to ensure that all of the particles produced during break-in are removed from the lubrication system. The small added expense may be considered a smart investment that will pay off in increased engine life.

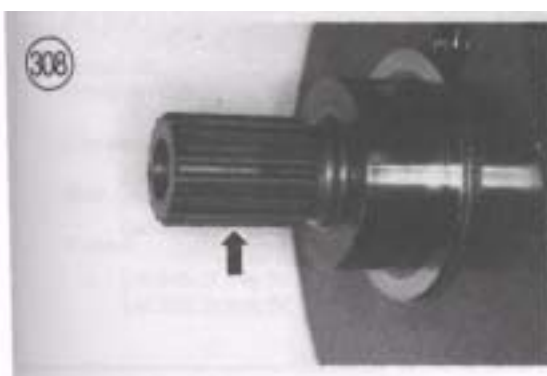


Table 1 ENGINE SPECIFICATIONS

Specification	Wear limit	
General Type and number of cylinders	V-2 cylinder, SOHC, liquid cooled	Bore x stroke
700 cc	80.0 x 69.6 mm (3.1 5 x 2.74 in.)	750 cc
80.0 x 74.4 mm (3.1 5 x 2.93 in.)	800 cc	83.0 x 74.4 mm (3.27 x 2.93 in.)
Displacement	700 cc	699 cc (43 cu. in.)
747 cc (45.6 cu. in.)	800 cc	805 cc (49.1 cu. in.)
Compression pressure	1,300-1,600 kPa (1 85-228 psi)	Camshaft (1985-1 987) Cam lobe height
1986-1987 (U.S.), 1985 (U.K.) Intake		35.925-35.965 mm
35.62 mm (1.41 44-1.41 59 in.)	(1.402 in.) Exhaust	36.91
9-36.959 mm	36.61mm (1.4535-1.4551 in.)	(1.441 in.) 1988-on (U.S.),
1986-on (U.K.) Intake		35.954-35.994 mm
(1.4155-1.4171 in.)	(1.401 in.) Exhaust	35.60 mm
mm	36.61 mm (1.4535-1.4551 in.)	(1.441 in.) Journal O.D. Center journal
24.959-24.980 mm	— (0.9826-0.9835 in.)	— End journal
19.959-1 9.980 mm	— (0.7858-0.7866 in.)	— Journal oil clearance Intake
and exhaust Center and end		0.032-0.066 mm
(0.001 3-0.0026 in.)	(0.0059 in.) Runout	0.150mm
0.10mm (0.004 in.)	Rocker arm I.D. Intake and exhaust	12.000-1 2.01 8 mm
— (0.4724-0.4731 in.)	Rocker arm shaft O.D. Intake and exhaust	1 1 .966-1 1
.984 mm	— (0.4711-0.4718 in.)	Cylinder head distortion
0.05 mm (0.002 in.)	Cylinder head cover distortion	—
0.05 mm (0.002 in.)	Camshaft chain 20-pitch length	—
128.9 mm (5.07 in.)	Valves and valve springs	Valve stem O.D. Intake
5.465-5.480 mm	— (0.21 26-0.21 57 in.)	Exhaust
5.450-5.465 mm	— (0.2146-0.21 52 in.)	Valve guide I.D. Intake and exhaust
5.500-5.512 mm	— (0.2165-0.2170 in.)	Valve stem-to-guide clearance Intake
0.020-0.047 mm	0.35 mm (0.014 in.)	(0.0008-0.0019 in.) Exhaust
0.035-0.062 mm	0.35 mm (0.014 in.)	(0.001 4-0.0024 in.) Valve head tip
—	0.35 mm (0.01 4 in.)	Valve head thickness
0.05 mm (0.002 in.)		—
(continued)		

Table 1 ENGINE SPECIFICATIONS (continued)

	Specification	Wear limit
Valves and valve springs (continued)		
Valve stem end length	—	4.0 mm (0.16 in.)
Valve seat width	0.9-1.1 mm (0.035-0.043 in.)	—
Valve spring free length		
Inner	—	38.3 mm (1.51 in.)
Outer	—	40.1 mm (1.58 in.)
Cylinders		
Bore		
700 & 750 cc	80.000-80.015 mm (3.1496-3.1502 in.)	80.080 mm (3.1527 in.)
800 cc	83.000-83.015 mm (3.2677-3.2683 in.)	83.085 mm (3.2711 in.)
Cylinder/piston clearance		
700 cc	0.050-0.060 mm (0.0020-0.0024 in.)	0.120 mm (0.0047 in.)
750 & 800 cc	0.045-0.055 mm (0.0018-0.0022 in.)	0.120 mm (0.0047 in.)
Out-of-round	—	0.05 mm (0.002 in.)
Pistons		
700 & 750 CC	79.945-79.960 mm (3.1474-3.1480 in.)	79.880 mm (3.1449 in.)
800 cc	82.950-82.965 mm (3.2657-3.2663 in.)	82.880 mm (3.2630 in.)
Piston pin bore	20.003-20.008 mm (0.7875-0.7877 in.)	20.03 mm (0.7886 in.)
Piston pin outer diameter	19.996-20.000 mm (0.7872-0.7874 in.)	19.988 mm (0.7869 in.)
Piston-to-piston pin clearance	0.002-0.014 mm (0.0001-0.0005 in.)	0.04 mm (0.002 in.)
Piston rings		
Number per piston		
Compression	2	—
Oil control	1	—
Ring end gap		
Top and second	0.20-0.35 mm (0.008-0.016 in.)	0.70 mm (0.028 in.)
Connecting rods		
Piston pin hole I.D.	20.010-20.018 mm (0.7878-0.7881 in.)	20.040 mm (0.7890 in.)
Big end side clearance	0.10-0.20 mm (0.004-0.008 in.)	0.30 mm (0.012 in.)
Big end width	21.95-22.00 mm (0.864-0.866 in.)	—
Big end oil clearance	0.024-0.042 mm (0.0009-0.0017 in.)	0.080 mm (0.003 in.)
Crankshaft		
Crankpin O.D.	40.982-41.000 mm (1.6135-1.6142 in.)	—
Crankpin width	22.10-22.15 mm (0.870-0.872 in.)	—
Main bearing oil clearance	0.020-0.050 mm (0.0008-0.0020 in.)	0.080 mm (0.031 in.)
Runout	—	0.05 mm (0.002 in.)
(continued)		

Table 1 ENGINE SPECIFICATIONS (continued)

Specification	Wear limit
Crankshaft thrust clearance at primary drive gear .	700&750CC
0.040-0.120 mm	— (0.0016-0.0047 in.) 800 cc
0.050-0.1 Omm	— (0.002-0.004 in.)

Table 2 ENGINE TIGHTENING TORQUES

Item	N.m	ft.lb.
Engine mounting bolts and nuts Engine mounting bracket		18-28
13-20 Sub-frame Allen bolts and nuts	40-60	29-
43.5 Through bolts and nuts	70-80	50.5-
63.5 Camshaft sprocket bolts	14-16	10-
11.5 Cylinder head cover bolts Bolt length 140 mm & 243 mm		21-25
15-18 All other lengths	9-11	6.5-8
Rocker arm shafts	25-30	18-21.5
Cylinder head-to-cylinder nuts	8-12	6-8.5
Cylinder head-to-cylinder bolts	9-11	6.5-8
Cylinder head and cylinder bolts	35-40	25.5-29.0 Oil
pump mounting bolts	7-9	5.6.5 Primary
drive gear bolt	80-110	58-79.5 Secondary
gear bevel gear assembly Allen bolts		18-28
13-20 Case bolts Initial		12-18
8.5-13 Final	20-24	14.5-
17.5 Secondary gear housing bolts	18-28	13-20
Secondary drive gear nut	80-110	58-79.5
Transmission main shaft bolt	60-70	43.5-50.5
Crankcase bolts Initial 6 mm		—
— 8mm	12-18	8.8-13.0
Final 6mm	9-13	6.5-9.5
8mm	20-24	14.5-17.5
Camshaft chain tensioner guide bolt	8-12	6-8.5
Connecting rod cap nuts Initial		22-28
16-20 Final	51-55	37-40

Table 3 CRANKSHAFT SIDE CLEARANCE THRUST WASHER

Part No.	Thrust washer thickness
09060-48001	1 .925-1 .950 mm (0.0758-0.0768 in.)
09060-48002	1 .950-1 .975 mm (0.0768-0.0778 in.)
09060-48003	1 .975-2.000 mm (0.0778-0.0787 in.)
09060-48004	2.000-2.025 mm (0.0787-0.0797 in.)
09060-48005	2.025-2.050 mm (0.0797-0.0807 in.)
09060-48006	2.050-2.075 mm (0.0807-0.0817 in.)
09060-48007	2.075-2.100 mm (0.0817-0.0827 in.)
09060-48008	2.100-2.125 mm (0.0827-0.0837 in.)
09060-48009	2.125-2.150 mm (0.0837-0.0847 in.)
09060-48010	2.150-2.175 mm (0.0847-0.0857 in.)

Table 4 CONNECTING ROD BEARING SELECTION

	Crankpin Journal OD size code		
	1	2	3
Connecting rod ID code number	Green	Black	Brown
Number 1 Number 2	Black	Brown	Yellow
Number 3	Brown	Yellow	Blue

Table 5 CONNECTING ROD BEARING INSERT COLOR AND THICKNESS

Color	Thickness	
Green	1.485-1.488 mm (0.0585-0.0586 in.)	
Black	1.488-1.491 mm (0.0586-0.0587 in.)	<i>f-</i>
Brown	1.491-1.494 mm (0.0587-0.0588 in.)	
Yellow	1.494-1.497 mm (0.0588-0.0589 in.)	
Blue	1.497-1.500 mm (0.0589-0.0590 in.)	