

# ENGINE SERVICE

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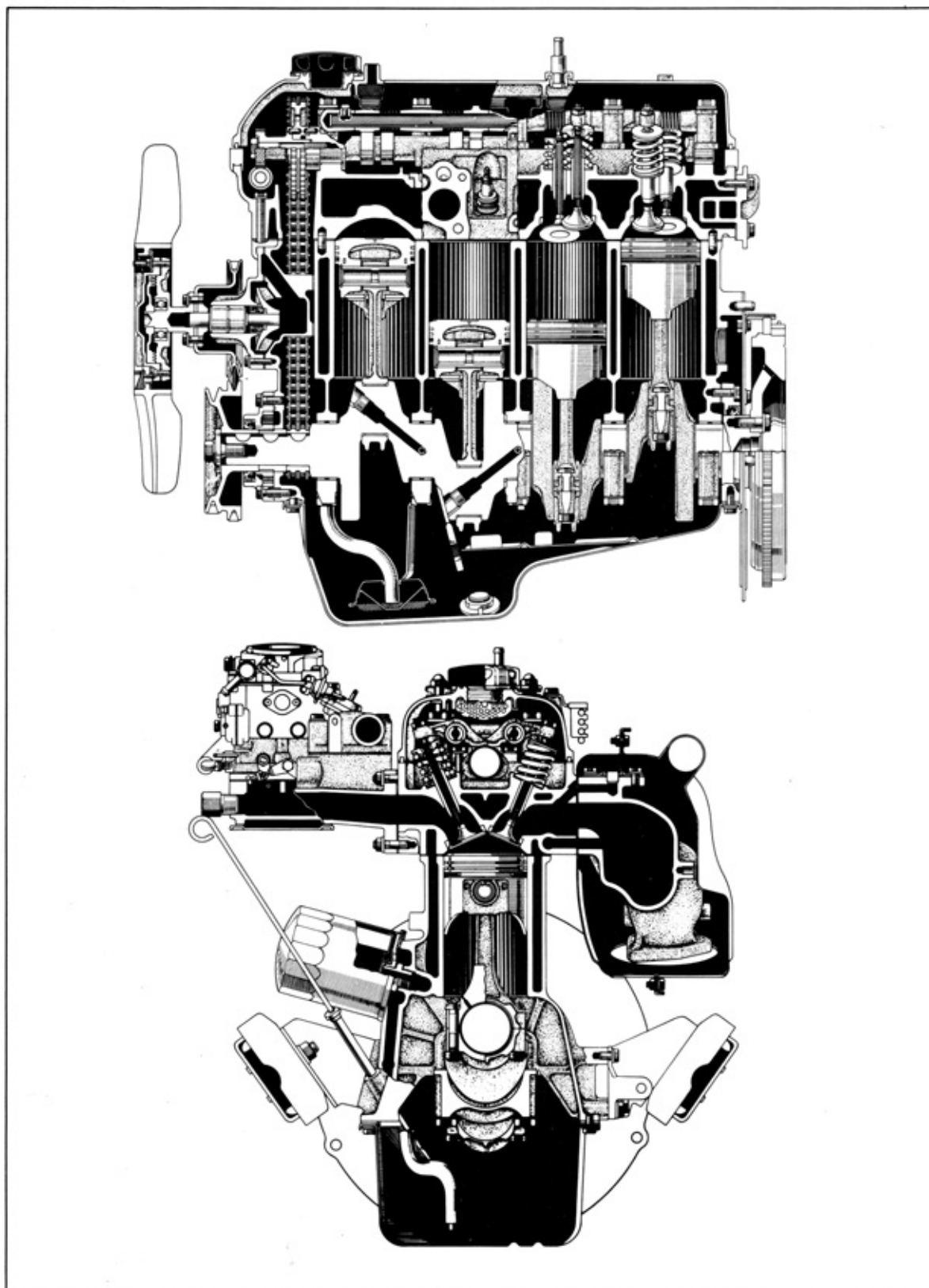
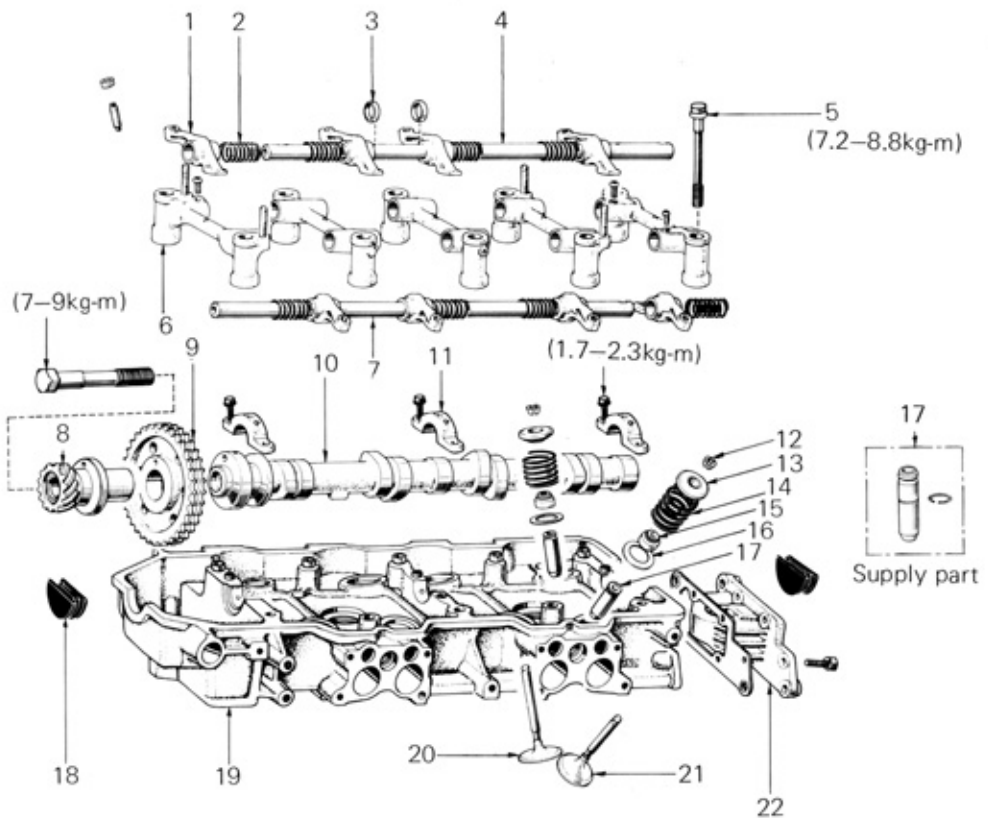


Fig. 3-1 Cross-Sectional View

## VALVE SERVICE



- |                           |                             |
|---------------------------|-----------------------------|
| 1. Rocker arm             | 12. Valve keeper            |
| 2. Spring                 | 13. Spring retainer         |
| 3. Spacer                 | 14. Valve spring            |
| 4. Rocker shaft (Intake)  | 15. Valve seal              |
| 5. Head bolt              | 16. Spring seat             |
| 6. Rocker stand           | 17. Valve guide             |
| 7. Rocker shaft (Exhaust) | 18. Half circle seal        |
| 8. Distributor drive gear | 19. Cylinder head           |
| 9. Cam sprocket           | 20. Intake valve            |
| 10. Camshaft              | 21. Exhaust valve           |
| 11. Camshaft bearing cap  | 22. Rear cover (EGR cooler) |

Fig. 3-2 Component Parts



Fig. 3-3 Disconnect Battery

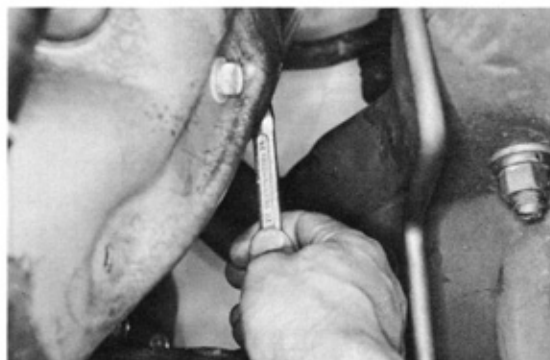


Fig. 3-4 Disconnect Exhaust Pipe

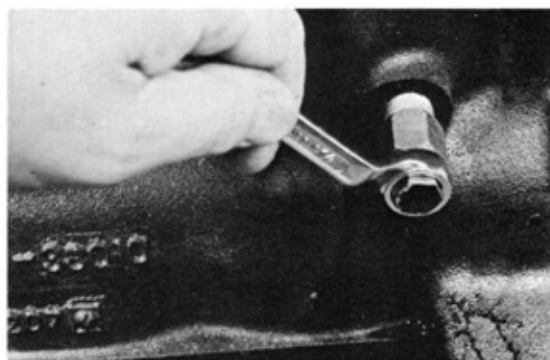


Fig. 3-5 Drain Coolant

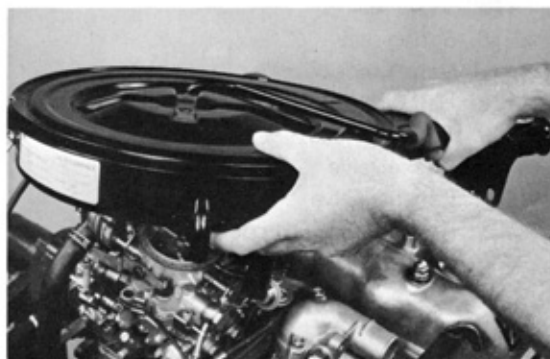


Fig. 3-6 Remove Air Cleaner

1. DISCONNECT BATTERY.  
Disconnect ground first.
2. DISCONNECT EXHAUST PIPE.  
Remove three exhaust pipe flange nuts.
3. DRAIN COOLANT.  
Drain coolant from radiator and engine block into a clean container. If specific gravity of coolant is correct, it may be reused.
4. REMOVE AIR CLEANER.  
Remove all necessary hoses and hold-down bolts and lift air cleaner assembly from carburetor.



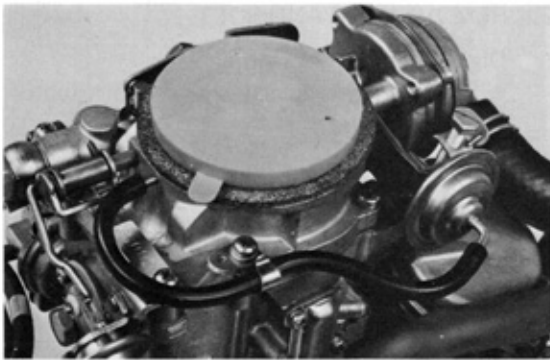


Fig. 3-7 Cover Carburetor

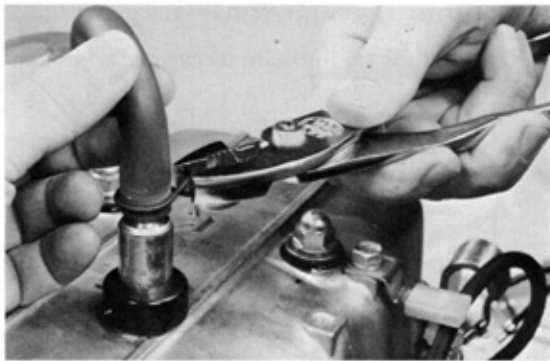


Fig. 3-8 Remove Hose

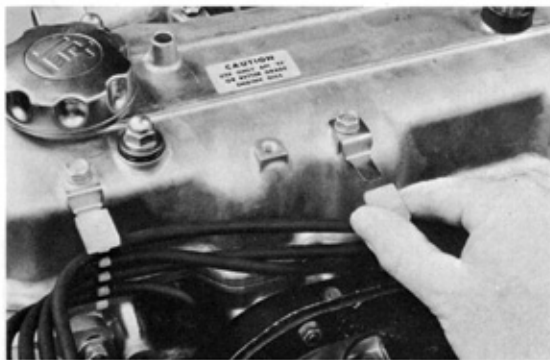


Fig. 3-9 Remove Wire Holders

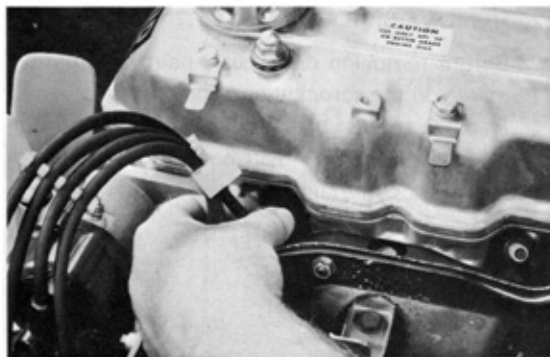


Fig. 3-10 Remove Plug Wires

#### 5. COVER CARBURETOR.

Using a plastic carburetor cover or a clean shop towel, cover carburetor. This could avoid serious engine damage after reassembly.

#### 6. REMOVE HOSES AND LINKAGE.

Remove all hoses and linkages to intake manifold, carburetor and head.

— Note —

**Check vacuum hose identification before removing. If identification is not clear, use masking tape to tag each hose for reassembly.**

#### 7. REMOVE WIRE HOLDERS.

Reassembly will be speeded if spark plug wires are left in plastic support clips.

#### 8. REMOVE PLUG WIRES.

To avoid damage to plug wires, grasp wire at plug boot when pulling.

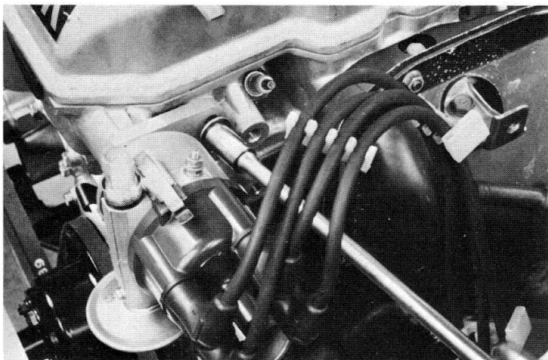


Fig. 3-11 Remove Wire and Bolt

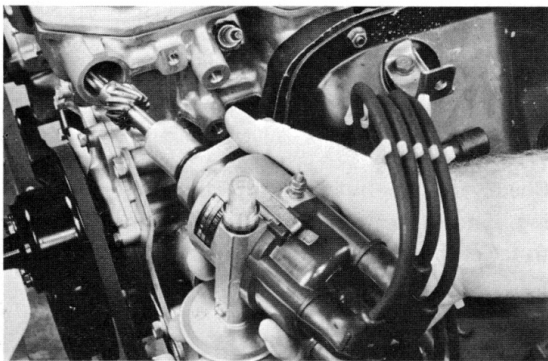


Fig. 3-12 Remove Distributor

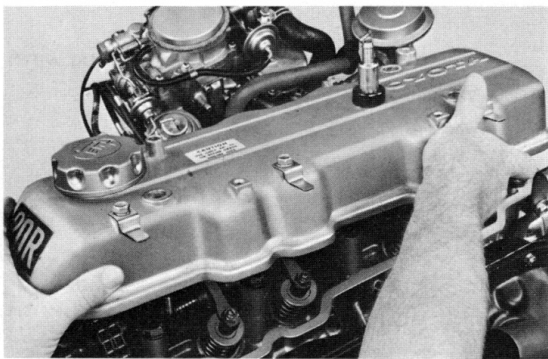


Fig. 3-13 Remove Valve Cover

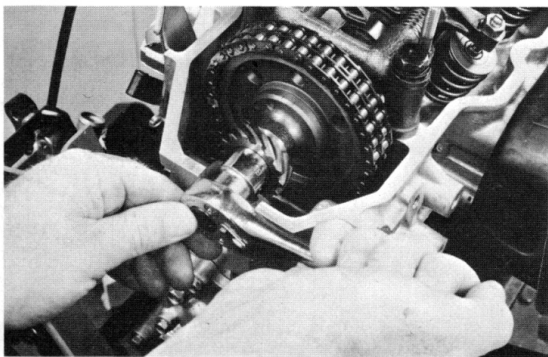


Fig. 3-14 Remove Sprocket Bolt

## 9. REMOVE WIRE AND BOLT.

Disconnect primary ignition wire.

With a 12mm wrench, remove distributor hold-down bolt.

## 10. REMOVE DISTRIBUTOR.

Remove distributor with its cap and wires as a unit.

This will speed reassembly.

## 11. REMOVE VALVE COVER.

Using a 3/8" drive impact wrench and a 14mm socket, remove the 4 nuts holding the valve cover. Remove valve cover.

## — Note —

**Set No. 1 piston to T.D.C compression position.**

## 12. REMOVE SPROCKET BOLT.

Before removing drive gear, paint the mating marks on the sprocket and chain.

Remove rubber half circle seal. Use a 19mm socket and remove distributor drive gear and cam sprocket retaining bolt.

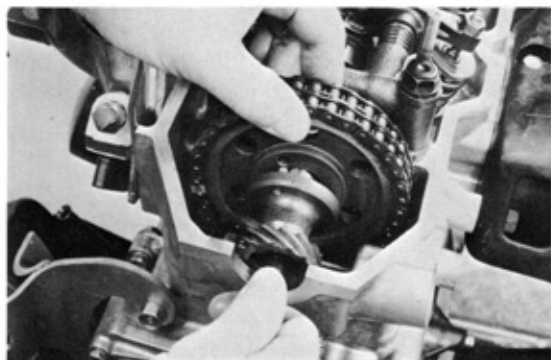


Fig. 3-15 Remove Distributor Drive

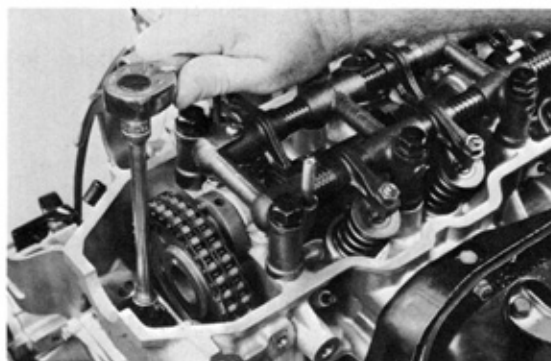


Fig. 3-16 Remove Chain Cover Bolt

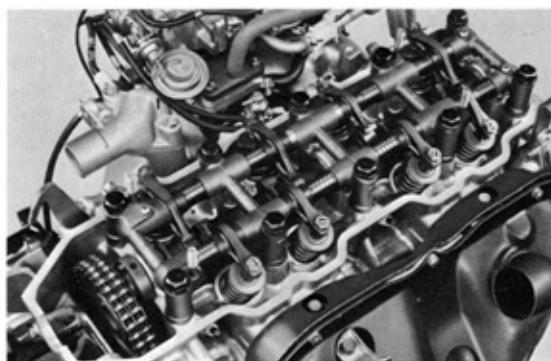


Fig. 3-17 Remove Head Bolts

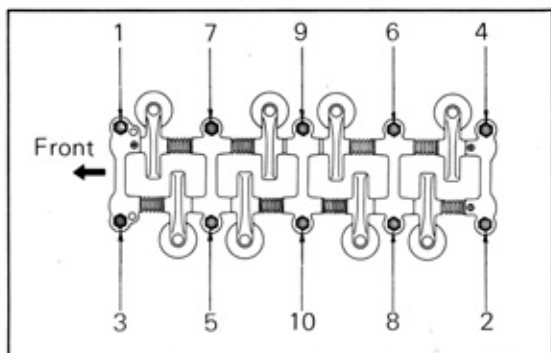


Fig. 3-18 Loosening Order

## 13. REMOVE DISTRIBUTOR DRIVE.

Remove distributor drive gear from sprocket. Allow cam sprocket and chain to remain in position as shown.

## 14. REMOVE CHAIN COVER BOLT.

Using a 14mm socket, remove one bolt in front of head. This must be done before head bolts are removed.

## 15. REMOVE HEAD BOLTS.

It is extremely important that cylinder head bolts be removed in the numerical sequence shown in Fig. 3-18. Head warpage or cracking could result from using incorrect sequence.

## 16. REMOVE ROCKER ARM ASSEMBLY.

Remove head bolts in order illustrated. Rocker arm assembly uses dowels, therefore it will be necessary to use a pry bar evenly on front and rear of assembly in order to lift it from head.

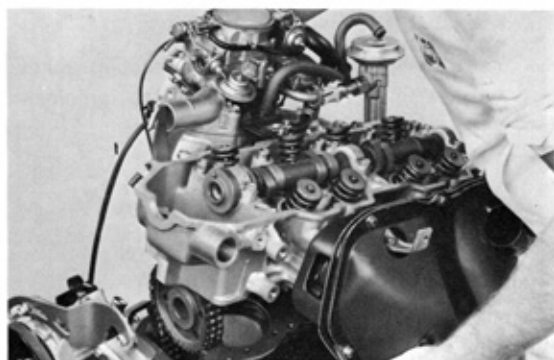


Fig. 3-19 Remove Head

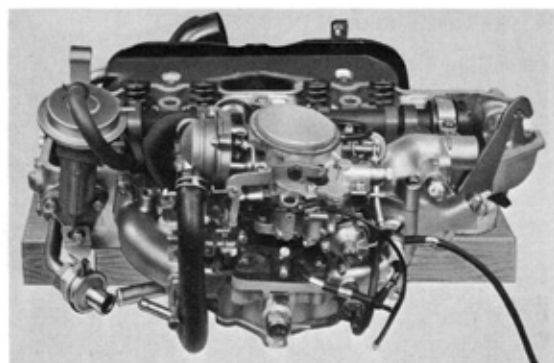


Fig. 3-20 Support Head on Bench



Fig. 3-21 Drain Engine Oil

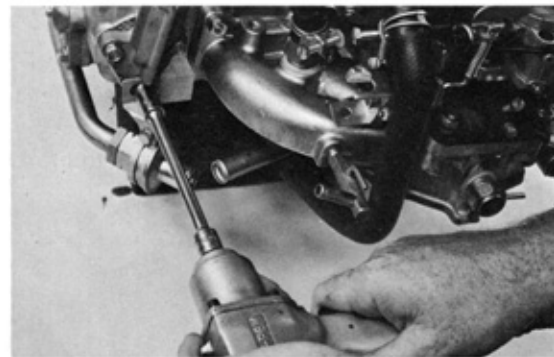


Fig. 3-22 Remove EGR Valve

17. REMOVE HEAD.

Cylinder head also has dowels. Do not pry between cylinder head gasket and block deck. You may damage the head.

18. SUPPORT HEAD ON BENCH.

Support head assembly with manifolds attached, with wood blocks.

19. DRAIN ENGINE OIL.

It is important to drain engine oil after head has been removed. Antifreeze coolant will run into oil pan and must be drained out or it will damage lower end bearings.

20. REMOVE EGR VALVE.

Using a 3/8" drive impact wrench and a 12mm socket, remove EGR valve.

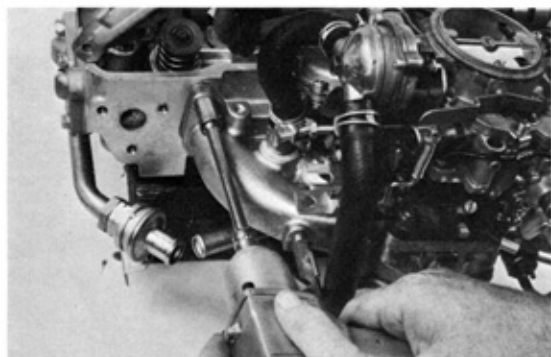


Fig. 3-23 Remove Intake Manifold

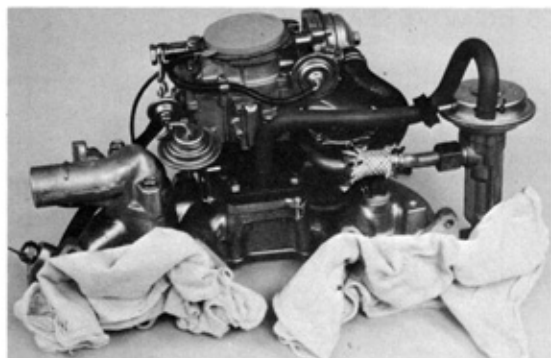


Fig. 3-24 Cover Ports

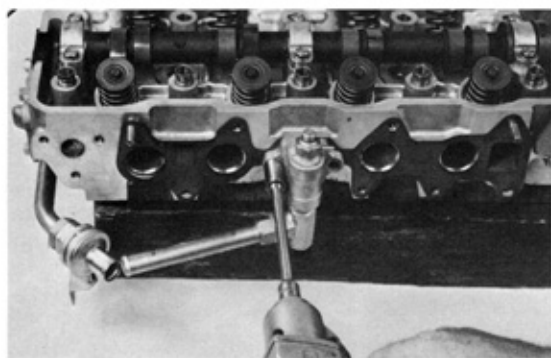


Fig. 3-25 Remove Thermostatic Valve

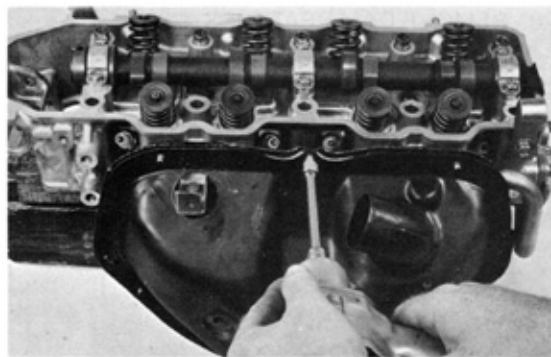


Fig. 3-26 Remove Outer Insulator

21. REMOVE INTAKE MANIFOLD.

Remove bolts holding manifold and remove intake manifold.

22. COVER PORTS.

Use clean shop towels to cover all intake manifold ports. This will help keep foreign material from entering engine after reassembly.

23. REMOVE THERMOSTATIC VALVE.

Remove two bolts and remove valve fitting and manifold gasket.

24. REMOVE OUTER INSULATOR.

Using a 10mm socket and impact wrench, remove 6 nuts holding exhaust manifold heat insulator.

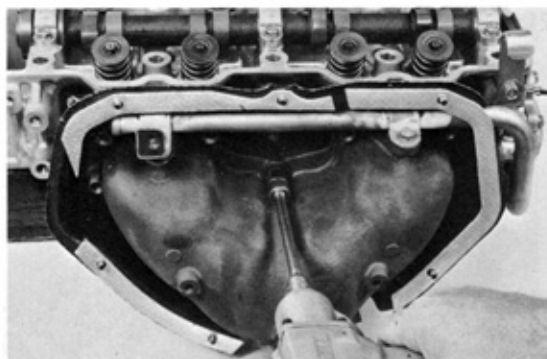


Fig. 3-27 Remove Exhaust Manifold

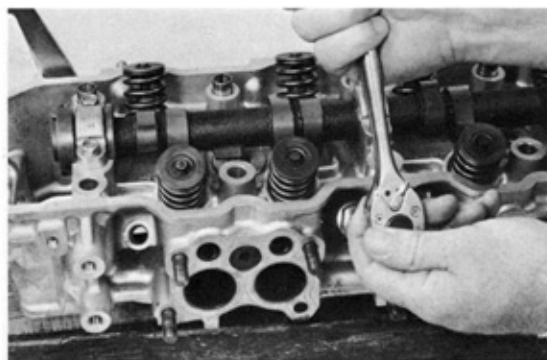


Fig. 3-28 Remove Spark Plugs

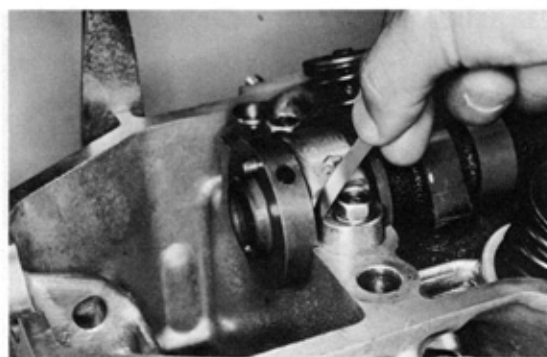


Fig. 3-29 Measure Cam Thrust

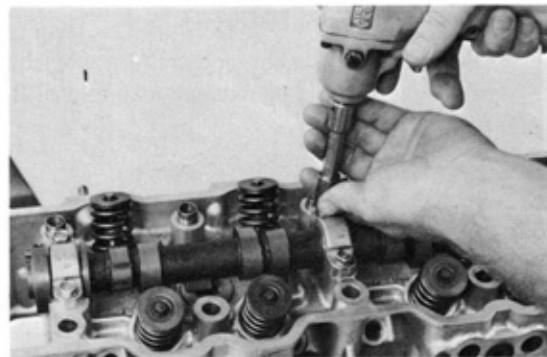


Fig. 3-30 Remove Cam Bearings

## 25. REMOVE EXHAUST MANIFOLD.

Using a 14mm impact socket, remove exhaust manifold nuts. Remove manifold with air injection tube and inner heat insulator as a unit.

## 26. REMOVE SPARK PLUGS.

## 27. MEASURE CAM THRUST.

Using a feeler gauge, measure camshaft thrust clearance. If clearance is beyond limit, replace head.

<b>Limit</b>	<b>0.25mm (0.0098 in)</b>
<b>Standard</b>	<b>0.08 to 0.18mm (0.0031 to 0.0071 in)</b>

## 28. REMOVE CAM BEARINGS.

Using a 12mm impact socket, remove cam bearing caps.

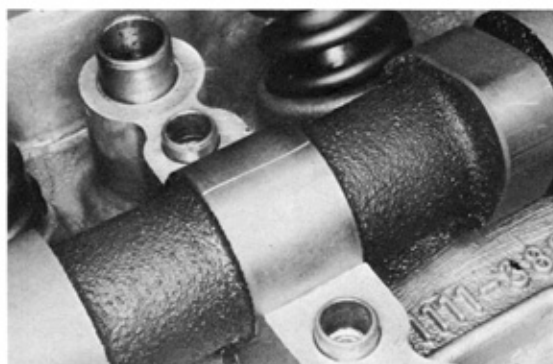


Fig. 3-31 Lay Plastigage

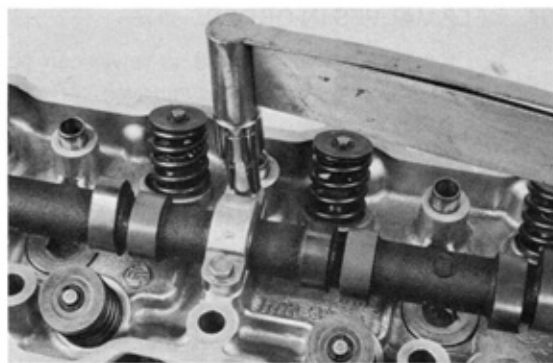


Fig. 3-32 Install Bearing Cap

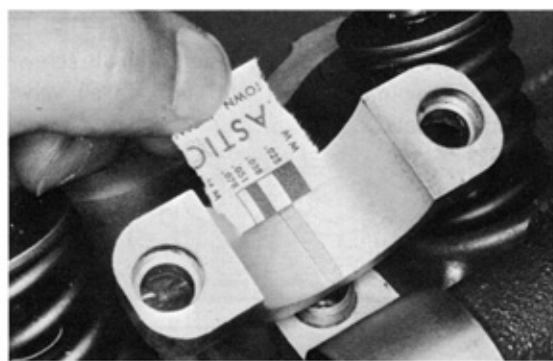


Fig. 3-33 Measure Oil Clearance

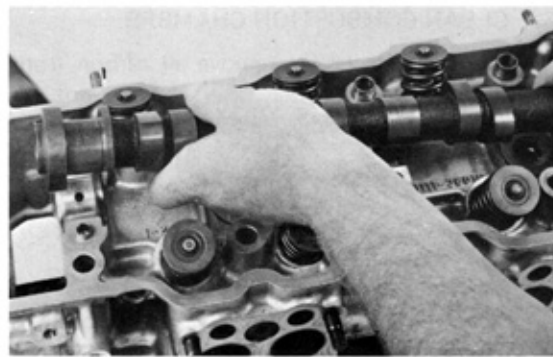


Fig. 3-34 Remove Cam

## 29. MEASURE JOURNAL OIL CLEARANCE.

Lay strip of plastigage across each journal.

## 30. INSTALL BEARING CAP.

Reinstall correct numbered bearing cap on each journal, with arrows pointing to front. Tighten to specified torque.

<b>Torque</b>	<b>1.7 to 2.3 kg-m (12.3 to 16.6 ft-lb)</b>
---------------	-------------------------------------------------

## 31. MEASURE OIL CLEARANCE.

Remove cap and measure plastigage at its widest point. If clearance is over the limit, replace head and/or camshaft.

<b>Clearance limit</b>	<b>0.1mm (0.004 in)</b>
<b>Standard</b>	<b>0.01 to 0.05mm (0.0004 to 0.0020 in)</b>

## 32. REMOVE CAM.

Lift out camshaft.





Fig. 3-35 Remove Valves

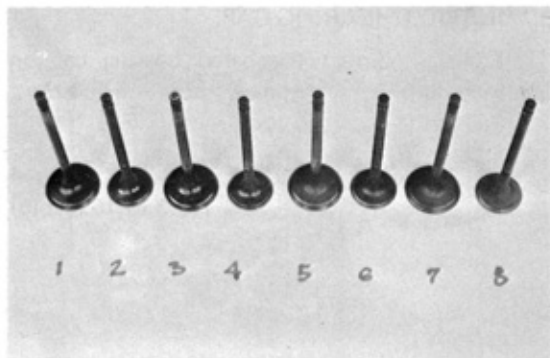


Fig. 3-36 Keep Valves in Order



Fig. 3-37 Remove Seals and Seats



Fig. 3-38 Clean Combustion Chamber

33. REMOVE VALVES.

Using a valve spring compressor, remove intake and exhaust keepers, retainers, springs and valves.

34. KEEP VALVES IN ORDER.

Use a numbered valve board so valves can be reassembled in same order as removed.

35. REMOVE SEALS AND SEATS.

Remove all valve seals. Using a small screwdriver or magnet lift and remove all valve spring seats.

36. CLEAN COMBUSTION CHAMBER.

Using a wire brush, remove all carbon from combustion chamber. Be careful not to scratch head gasket surface.



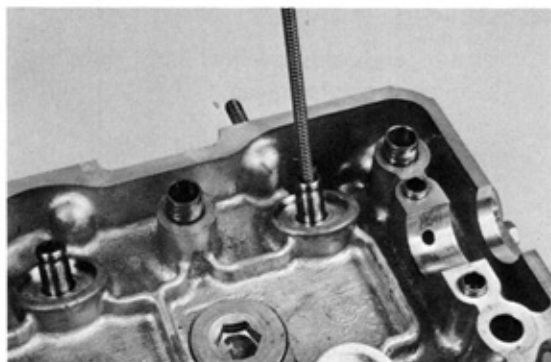


Fig. 3-39 Clean Valve Guides

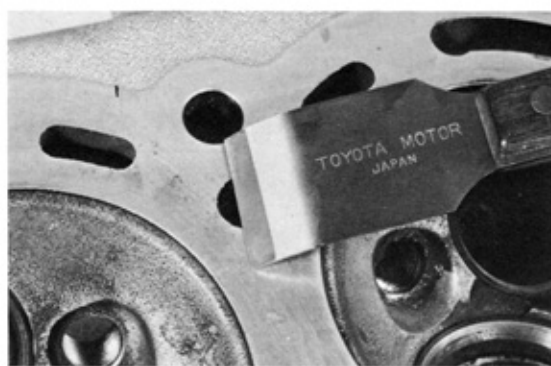


Fig. 3-40 Remove Gaskets

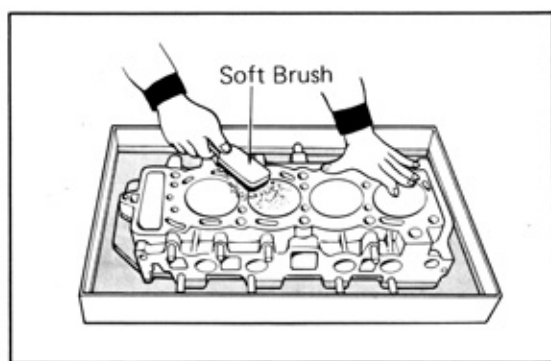


Fig. 3-41 Clean Head

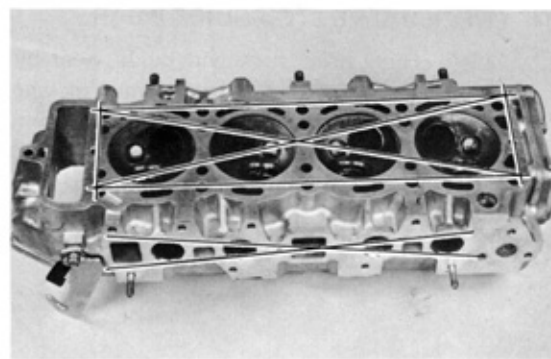


Fig. 3-42 Check Head Flatness

### 37. CLEAN VALVE GUIDES.

Clean all valve guides with guide brush and solvent.

### 38. REMOVE GASKETS.

Using a gasket scraper, remove all gasket material from manifold and head surfaces. Aluminum is soft; do not scratch surfaces.

### 39. CLEAN HEAD.

Use approved low flash point solvent for cleaning. Do not clean head in hot tank as this will dissolve aluminum.

### 40. CHECK HEAD FLATNESS.

Using a precision straight edge check head and manifold surfaces for flatness.

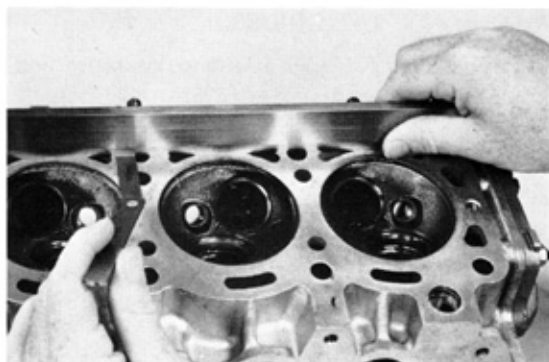


Fig. 3-43 Use Feeler Gauge

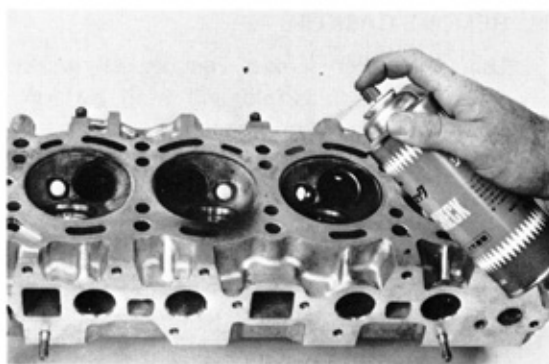


Fig. 3-44 Check for Cracks

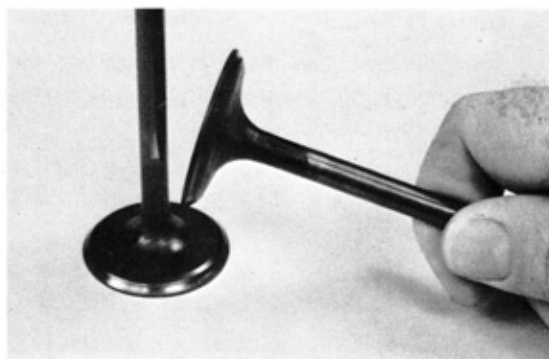


Fig. 3-45 Clean Valves

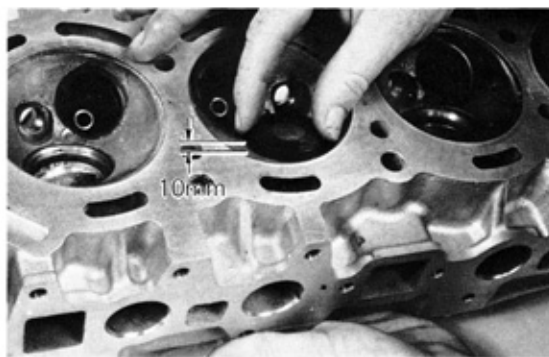


Fig. 3-46 Check Valve Stem Guide Wear

## 41. USE FEELER GAUGE.

If warpage exceeds specified limit, correct by machining or replace head.

**Head surface warpage limit**

**0.15mm (0.0059 in)**

**Manifold surface warpage limit**

**0.2mm (0.008 in)**

## 42. CHECK FOR CRACKS.

Using dye penetrant check for cracks in combustion chamber, intake and exhaust ports. Also check head surface and top of head.

## 43. CLEAN VALVES.

Use an old valve to chip any carbon from valve head. Complete cleaning job with wire brush.

## — Note —

**A carboned valve head indicates worn valve guide and/or seal.**

## 44. CHECK VALVE STEM GUIDE WEAR.

Quick check valve stem and guide wear by inserting correct valve in guide and moving valve as shown. If movement exceeds 0.16mm (0.006 in) for intake or 0.02mm (0.008 in) for exhaust, additional measurements are necessary.



Fig. 3-47 Measure Valve Guide

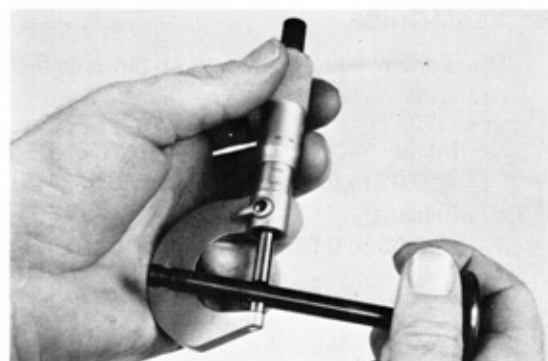


Fig. 3-48 Measure Valve Stem

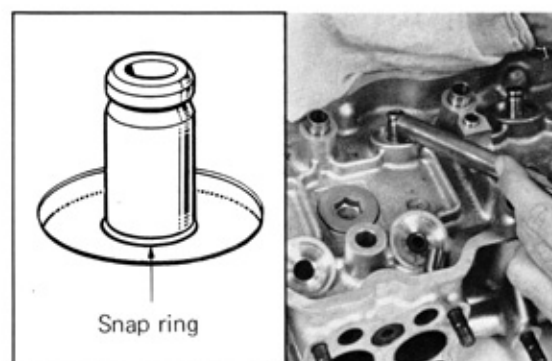


Fig. 3-49 Break Guide

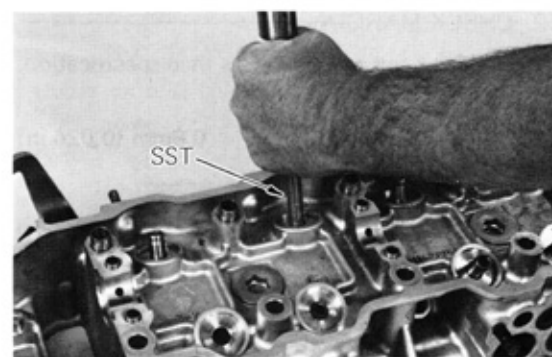


Fig. 3-50 Remove Guide

## 45. MEASURE VALVE GUIDE.

Using a dial indicator or telescoping gauge, measure inside diameter of valve guide.

## 46. MEASURE VALVE STEM

Subtract stem measurement. Replace guide and valve if clearance exceeds the following.

<b>Intake</b>	<b>0.08mm (0.0031 in)</b>
<b>Exhaust</b>	<b>0.10mm (0.0039 in)</b>

## 47. REPLACE WORN GUIDE.

If snap ring is installed as shown, break valve guide using a brass punch and hammer.

## 48. REMOVE GUIDE.

Using SST [09201-60011], drive out guide with hammer.

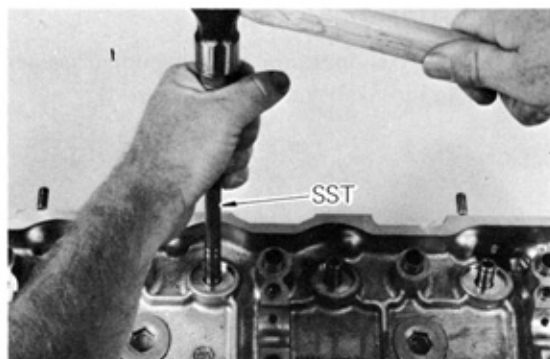


Fig. 3-51 Install New Guide

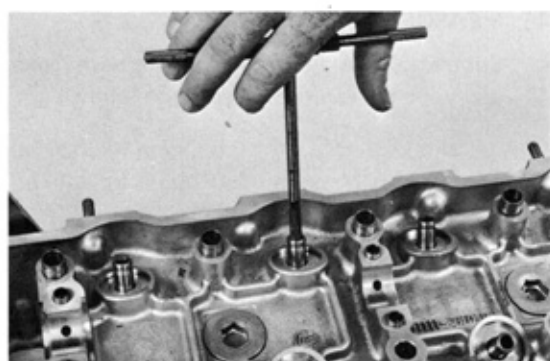


Fig. 3-52 Ream Guide

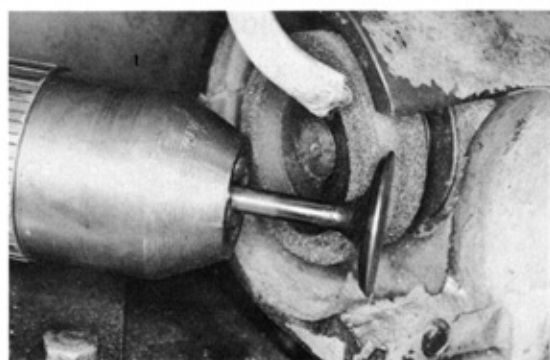


Fig. 3-53 Grind Valves

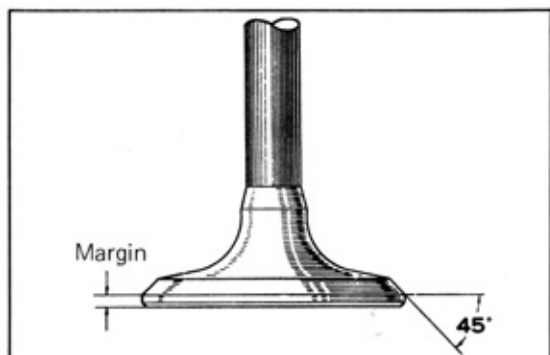


Fig. 3-54 Check Margin

## 49. INSTALL NEW GUIDE.

Using SST [09201-60011], drive in new guide until the snap ring contacts head.

## 50. REAM GUIDE.

Use a sharp 8mm reamer to obtain specified clearance.

**Intake**

**0.02 to 0.06mm (0.0006 to 0.0024 in)**

**Exhaust**

**0.03 to 0.07mm (0.0012 to 0.0026 in)**

## 51. GRIND VALVES.

Grind all valves. Remove only enough metal to remove pits and carbon.

**Valve face angle: 45°**

## 52. CHECK MARGIN.

If valve head margin is less than specification, replace valve.

**Margin limit**

**0.6mm (0.024 in)**

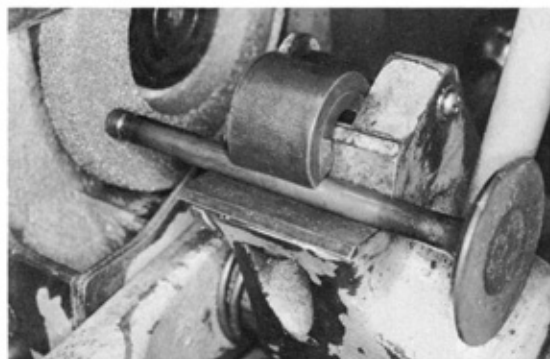


Fig. 3-55 Resurface Valve Tip

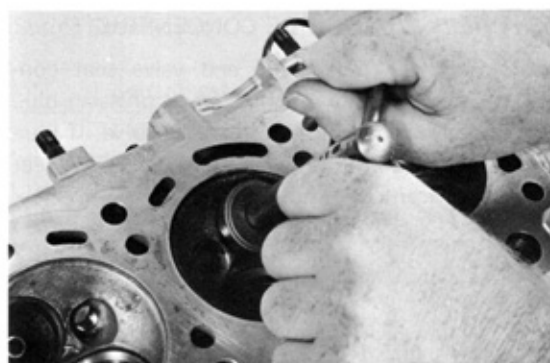


Fig. 3-56 Resurface Valve Seats



Fig. 3-57 Locate Valve Contact

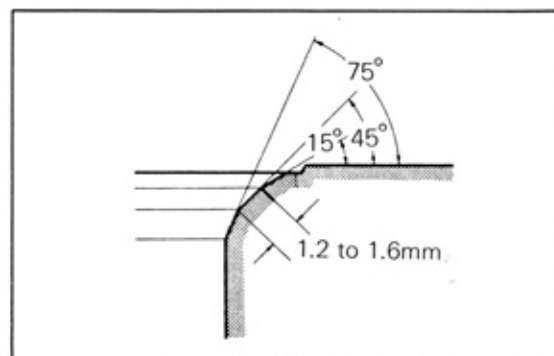


Fig. 3-58 Correct Seat Position

## 53. RESURFACE VALVE TIP.

If valve stem tip has been worn by rocker arm, resurface with valve grinder. **DO NOT GRIND MORE THAN 0.5mm (0.020 in).**

## 54. RESURFACE VALVE SEATS.

Resurface valve seats with 45° carbide cutter. Remove only enough metal to clean seat.

## 55. LOCATE VALVE CONTACT.

Coat valve face with prussian blue or white lead. Locate contact point on valve by rotating valve against seat.

## — Note —

**Seat contact should be in middle of valve face with the following width:**

**1.2 to 1.6mm (0.047 to 0.063 in)**

## 56. CORRECT SEAT POSITION.

To correct seating that is too high, use 15° and 45° cutters. If seating is too low, use 75° and 45° cutters.



Fig. 3-59 Check Valve Concentricity



Fig. 3-60 Check Seat/Guide Concentricity

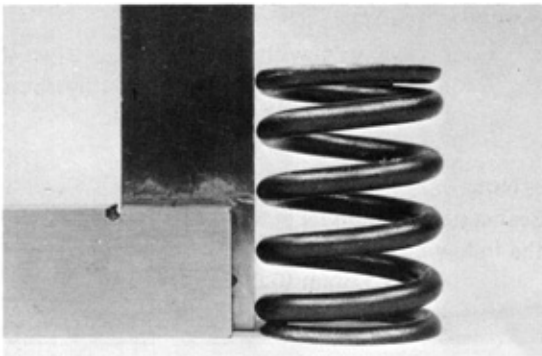


Fig. 3-61 Check Spring Squareness

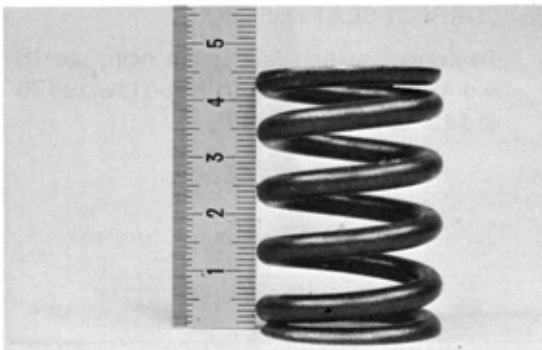


Fig. 3-62 Measure Spring Height

## 57. CHECK VALVE CONCENTRICITY.

To check valve stem and face concentricity lightly coat seat with prussian blue. Install valve and rotate. If blue appears 360° around face, valve stem and face are concentric. If not replace valve.

## 58. CHECK SEAT/GUIDE CONCENTRICITY.

To check valve guide and valve seat concentricity, apply a light coat of prussian blue on valve face. Install and rotate valve. If blue appears 360° around valve seat, guide and seat are concentric. If not, recut seat.

## 59. CHECK SPRING SQUARENESS.

Check squareness of valve springs with steel square. If spring is out of square more than limit, replace.

**Limit (intake and exhaust)**

**1.9mm (0.075 in)**

## 60. MEASURE SPRING HEIGHT.

Measure free height of all springs. Replace any spring that is out of specification.

**Free height**

**45.6mm (1.795 in)**

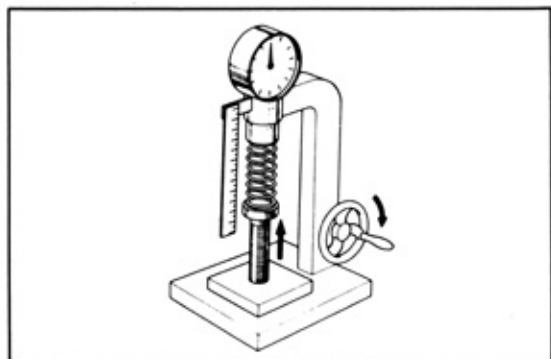


Fig. 3-63 Measure Spring Tension

## 61. MEASURE SPRING TENSION.

Using a spring tester, measure tension of each spring at the specified installed height. Replace any spring that does not meet specification.

## Spring Specification

Squareness	1.9mm	(0.075 in)
Free height	45.6mm	(1.795 in)
Installed height	40.5mm	(1.594 in)
Installed tension limit	24.5kg	(54.0 lb)
Installed tension	27.2kg	(60.0 lb)



Fig. 3-64 Insert Valve

## 62. INSERT VALVES.

Lubricate and insert valves in order. Install spring seats and valve seals.

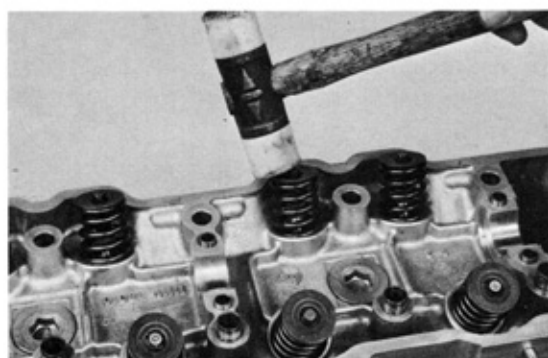


Fig. 3-65 Tap Stem Lightly

## 63. INSTALL SPRINGS.

Install springs and spring retainers. Compress spring and fit two keepers around valve stem. Tap stem lightly to assure proper fit.



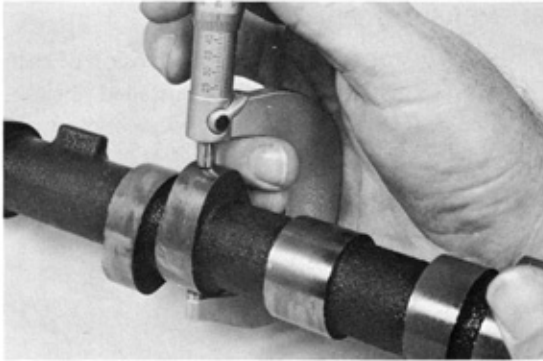


Fig. 3-66 Measure Camshaft

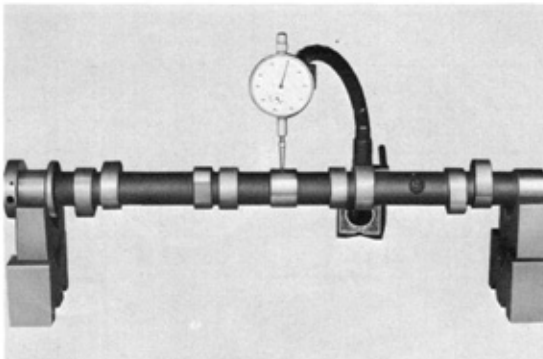


Fig. 3-67 Check Runout

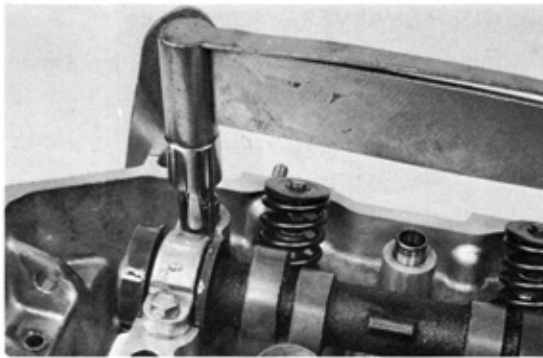


Fig. 3-68 Install Camshaft

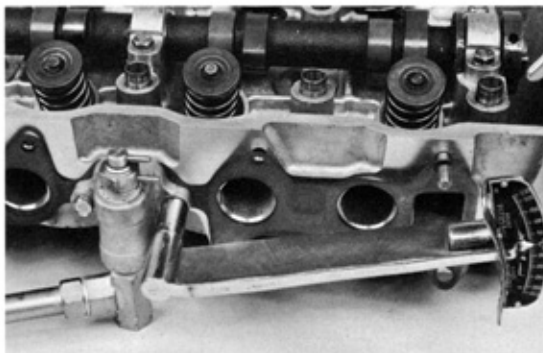


Fig. 3-69 Install Thermostatic Valve

## 64. MEASURE CAMSHAFT.

Measure cam lobes. If wear exceeds specification, replace camshaft.

**Lobe height intake**

**42.63 to 42.72mm (1.6783 to 1.6819 in)**

**Lobe height exhaust**

**42.69 to 42.78mm (1.6806 to 1.6841 in)**

## 65. CHECK RUNOUT.

Place camshaft in V blocks and measure runout at center journal. If runout exceeds specification, replace camshaft.

**Runout limit**

**0.2mm (0.008 in)**

## 66. INSTALL CAMSHAFT.

Coat all bearing journals with engine oil. Install bearing caps in numbered order with arrows pointing toward front. Install cap bolts and tighten to specified torque.

**Cap bolt torque**

**1.7 to 2.3kg-m (12.3 to 16.6 ft-lb)**

## 67. INSTALL THERMOSTATIC VALVE.

Position intake manifold gasket and install thermostatic vacuum switching valve assembly.

**Torque 1.5 to 2.1kg-m (10.8 to 15.2ft-lb)**



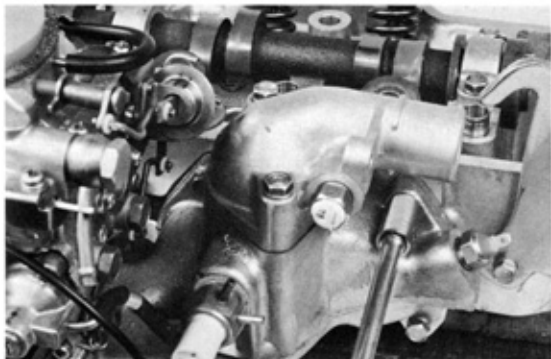


Fig. 3-70 Install Intake Manifold

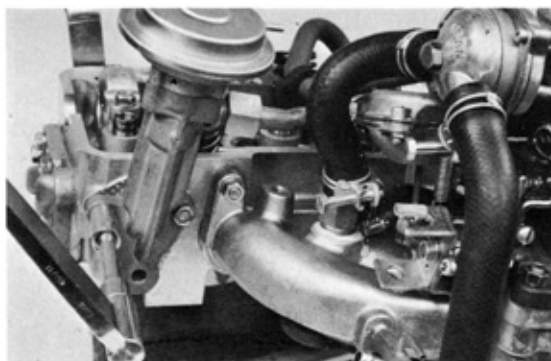


Fig. 3-71 Install EGR Valve

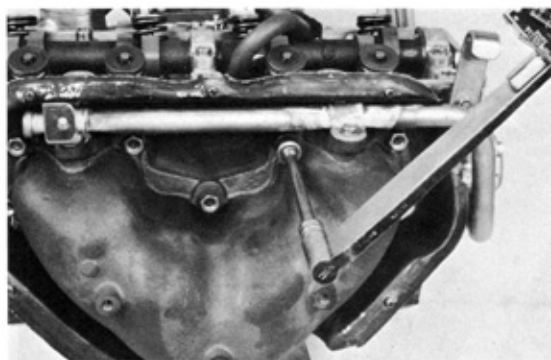


Fig. 3-72 Install Exhaust Manifold

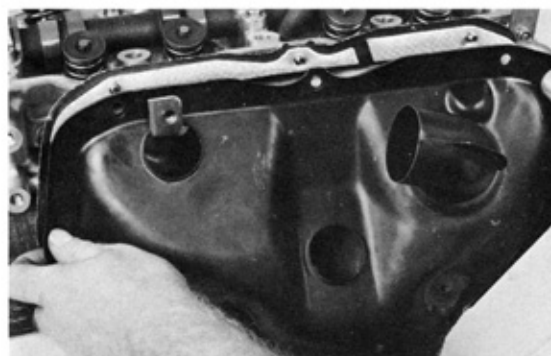


Fig. 3-73 Install Outer Heat Insulator

68. INSTALL INTAKE MANIFOLD.

Install intake manifold over gasket and tighten bolts to specified torque.

**Torque 1.5 to 2.1kg-m (10.8 to 15.2ft-lb)**

69. INSTALL EGR VALVE.

Position new gasket. Apply sealer to upper right bolt and install two bolts on EGR valve.

**Torque 1 to 1.6kg-m (7.2 to 11.6ft-lb)**

70. INSTALL EXHAUST MANIFOLD.

Install inner heat insulator and exhaust manifold.

**Torque 4 to 5kg-m (28.9 to 36.2ft-lb)**

Install third EGR valve bolt with air injection pipe support.

71. INSTALL OUTER HEAT INSULATOR.

Position gaskets and install heat insulator.

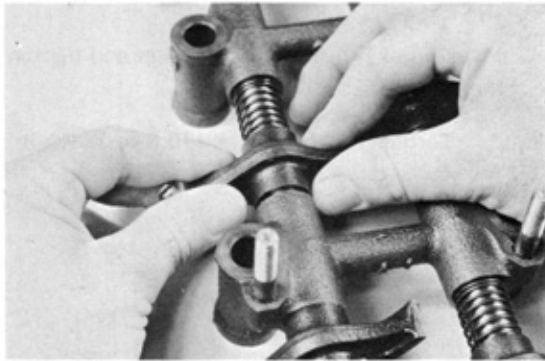


Fig. 3-74 Inspect Rocker Arms

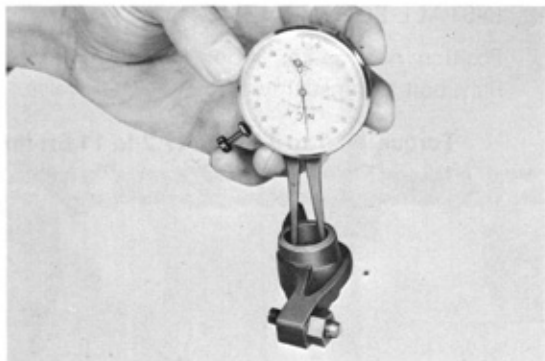


Fig. 3-75 Measure Oil Clearance

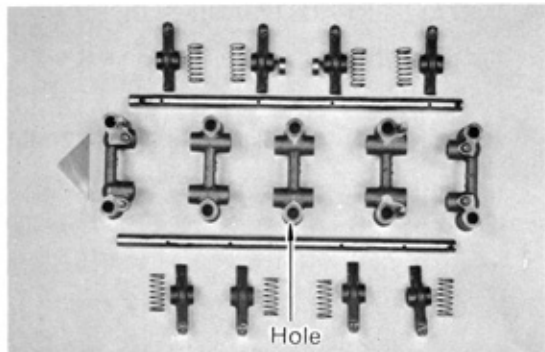


Fig. 3-76 Assemble Rockers and Shafts



Fig. 3-77 Clean Cylinders and Block Deck

## 72. INSPECT ROCKER ARMS.

Check rocker arm to shaft clearance by moving rocker arm as shown. Little or no movement should be indicated. If movement is felt, disassemble and inspect.

## 73. MEASURE OIL CLEARANCE.

If movement was felt above, measure rocker oil clearance with dial indicator and outside micrometer. If clearance is excessive replace rocker arms and/or shaft.

<b>Clearance</b>	<b>0.01 to 0.05mm</b> <b>(0.0004 to 0.0020 in)</b>
------------------	-------------------------------------------------------

## 74. ASSEMBLE ROCKERS AND SHAFTS.

All rocker arms are the same. All rocker stands are different. Assemble as shown. Arrow indicates front.

## 75. CLEAN CYLINDERS AND BLOCK DECK.

Bring each piston to TDC and scrape carbon from piston top. Remove all gasket material from block deck. Blow carbon and oil from bolt holes.

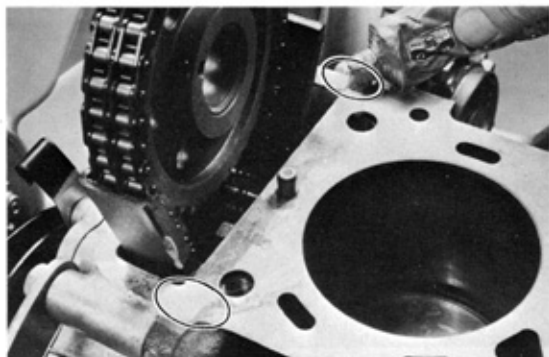


Fig. 3-78 Apply Sealer

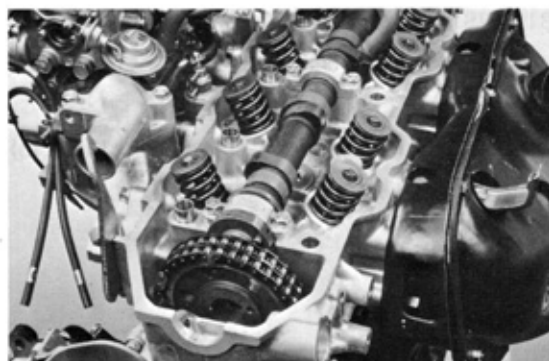


Fig. 3-79 Install Head

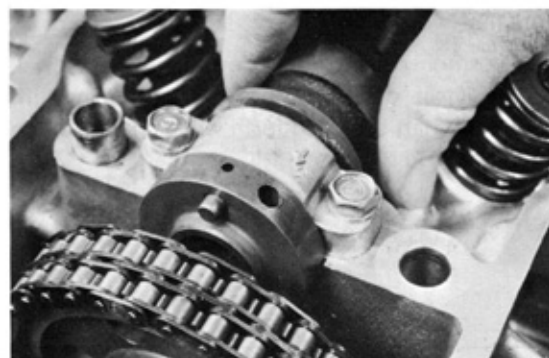


Fig. 3-80 Position Camshaft

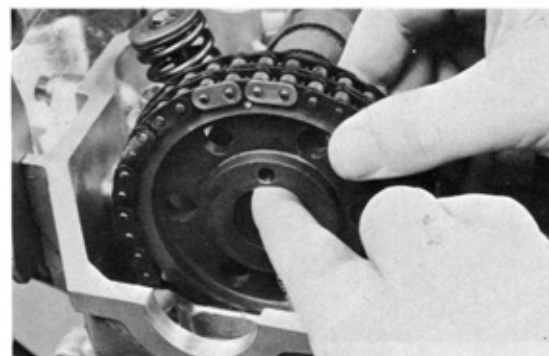


Fig. 3-81 Set Cam Timing

**76. APPLY SEALER.**

Apply liquid sealer to two locations shown and position head gasket over dowels.

**— Note —**

Align the mating marks which were painted on the sprocket and chain at disassembly, if sprocket was removed.

**77. INSTALL HEAD.**

Position head over locating dowels.

**78. POSITION CAMSHAFT.**

Turn camshaft to position dowel at top.

**79. SET CAM TIMING.**

While holding up on sprocket, turn engine crankshaft to position cam sprocket hole at top as shown.

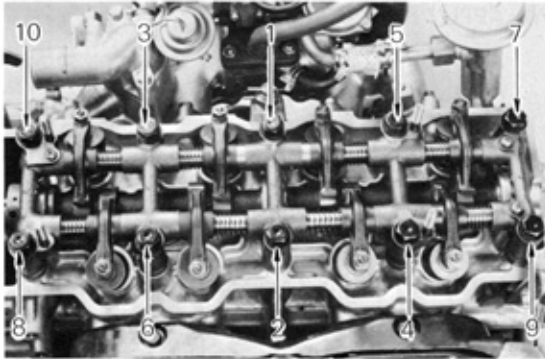


Fig. 3-82 Install Rocker Arm Assembly

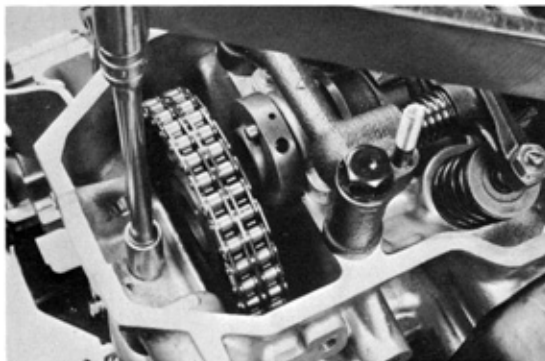


Fig. 3-83 Install Chain Cover Bolt



Fig. 3-84 Install Sprocket

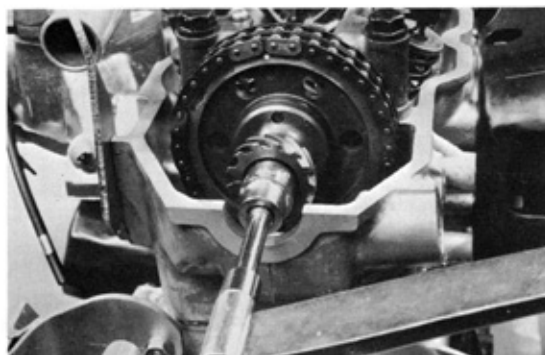


Fig. 3-85 Install Distributor Drive Gear

## 80. INSTALL ROCKER ARM ASSEMBLY.

Position assembly over locating dowels and tighten bolts in three steps in order to specified torque.

**Torque** **7.2 to 8.8kg-m**  
**(52.1 to 63.7ft-lb)**

## 81. INSTALL CHAIN COVER BOLT.

Tighten front chain cover bolt to specified torque.

**Torque** **1 to 1.6kg-m (7.2 to 11.6ft-lb)**

## 82. INSTALL SPROCKET.

Position chain sprocket over camshaft dowel. If chain does not seem long enough, turn crankshaft back and forth while holding up on chain and sprocket.

## 83. INSTALL DISTRIBUTOR DRIVE GEAR.

Position distributor drive gear\* over chain sprocket and tighten bolt to specified torque.

**Torque** **7 to 9kg-m (50.6 to 65.1ft-lb)**

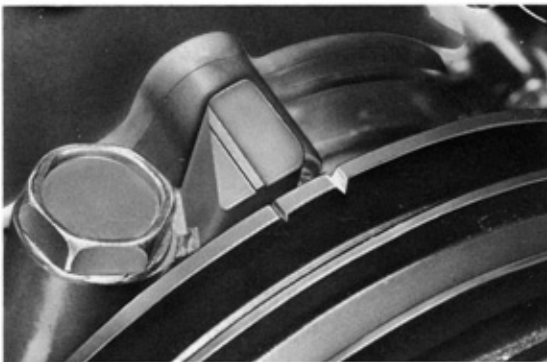


Fig. 3-86 Set No. One To TDC

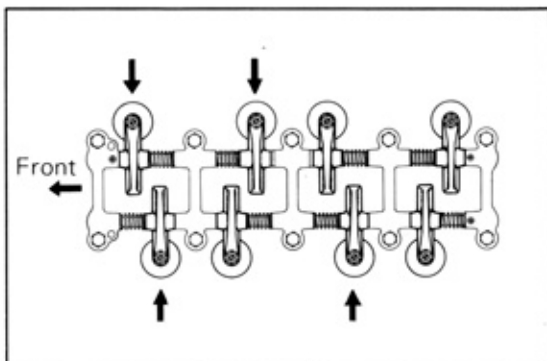


Fig. 3-87 Adjust Valve Clearance

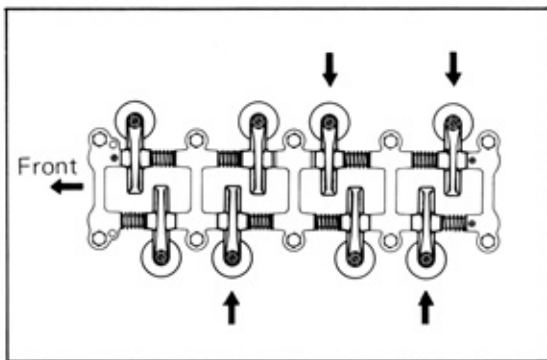


Fig. 3-88 Adjust Valve Clearance



Fig. 3-89 Align 8° BTDC Mark

## 84. SET NO. ONE TO T.D.C./COMPRESSION.

At T.D.C. compression position, sprocket timing mark should be at slightly left of top.

## 85. ADJUST VALVE CLEARANCE.

Valve clearance is measured between valve stem and rocker arm. Adjust valves indicated by arrows only.

**Valve clearance****Intake****0.2mm (0.008 in)****Exhaust****0.3mm (0.012 in)**

## 86. ROTATE CRANKSHAFT 360°

Turn crankshaft one complete revolution and align timing marks at pulley. Adjust remaining valves as indicated by arrows.

## 87. ALIGN 8° BTDC MARK.

Turn crankshaft 352° to mark on pulley. This will set camshaft for distributor installation.

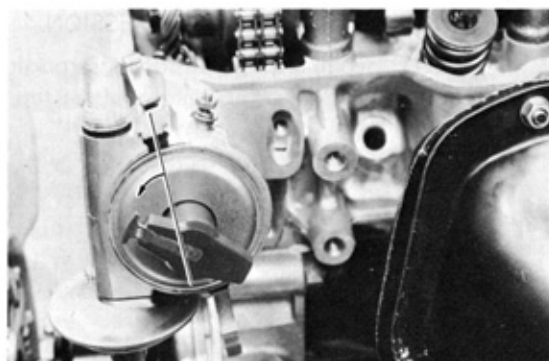


Fig. 3-90 Install Distributor

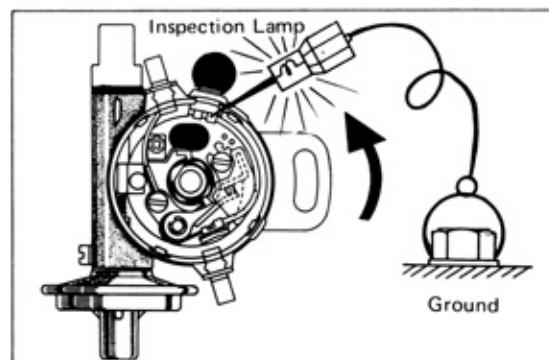


Fig. 3-91 Set Timing

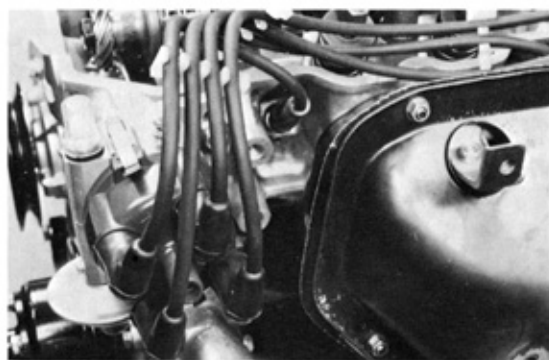


Fig. 3-92 Install Spark Plugs and Wires

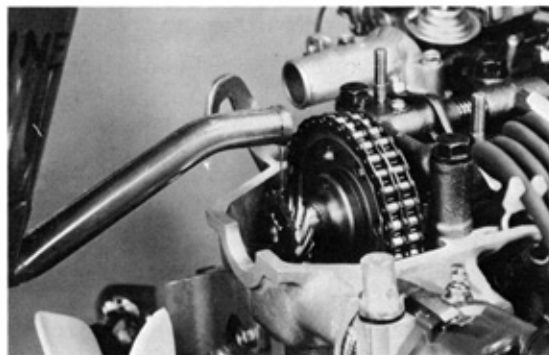


Fig. 3-93 Add Engine Oil

## 88. INSTALL DISTRIBUTOR.

Coat shaft tip with engine oil.

Begin insertion of distributor with octane selector pointing up and rotor pointing toward upper hold-down spring. When fully installed, rotor will have rotated to position shown.

## 89. SET TIMING

Connect the inspection lamp to the terminal of the distributor point and the ground.

Turn on the ignition switch without cranking. Rotate distributor housing clockwise until the inspection lamp goes out.

Rotate the housing counterclockwise carefully until the inspection lamp begins to light, then tighten hold down bolt coated with sealer to specified torque.

**Torque**

**1.5 to 2.1 kg-m  
(10.8 to 15.2 ft-lb)**

## 90. INSTALL SPARK PLUGS AND WIRES.

Adjust all plug gaps to 0.8mm (0.03 in) and install.

Install distributor point cover, dust cover, rotor, cap and wires.

**Plug torque**

**1.5 to 2.1kg-m  
(10.8 to 15.2ft-lb)**

## 91. ADD ENGINE OIL.

Install front and rear half round rubber cover seals and pour 4qts of grade SE or better oil over distributor gear and rocker assembly. Be sure pan drain plug is tight.

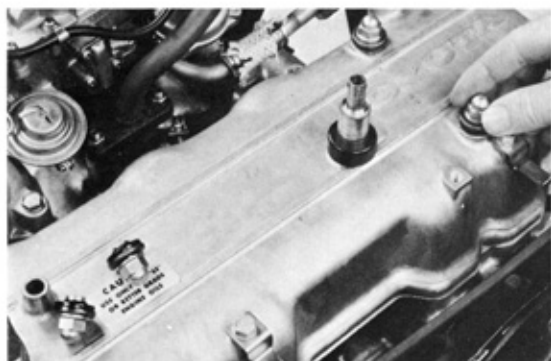


Fig. 3-94 Install Valve Cover

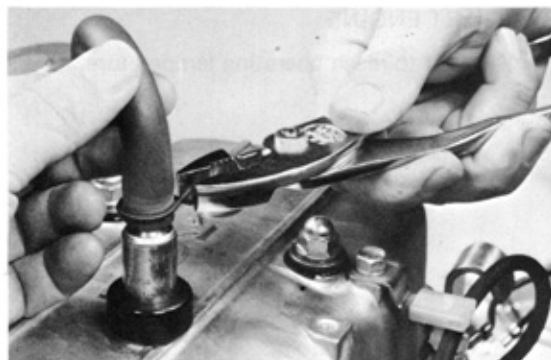


Fig. 3-95 Connect Hoses and Wires



Fig. 3-96 Fill Radiator



Fig. 3-97 Install Exhaust Pipe

**92. INSTALL VALVE COVER.**

Inspect rubber nut seals and replace if necessary. Install valve cover and tighten nuts to specified torque.

**Torque 1 to 1.6kg-m (7.2 to 11.6ft-lb)**

**93. CONNECT HOSES AND WIRES.**

Connect fuel, coolant, vacuum and emission control hoses.

Connect carburetor linkage and solenoid wire. Connect ignition wires, ground cable. Reposition spark plug wire support clips.

**94. FILL RADIATOR.**

Use only approved coolant mixed to specifications.

**95. INSTALL EXHAUST PIPE.**

Tighten three exhaust pipe flange nuts to specified torque.

**Torque 3.5 to 4.5kg-m  
(25.3 to 32.6ft-lb)**





Fig. 3-98 Reconnect Battery

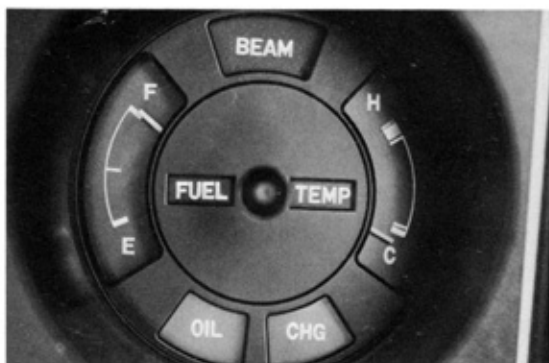


Fig. 3-99 Start Engine

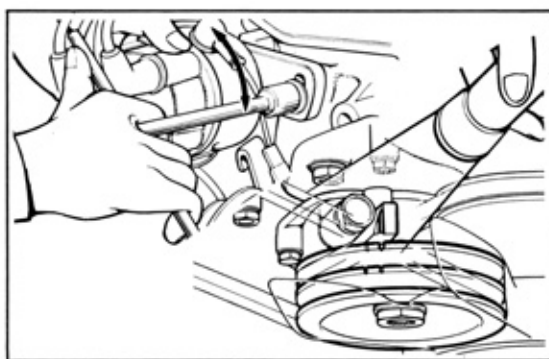


Fig. 3-100 Reset Timing

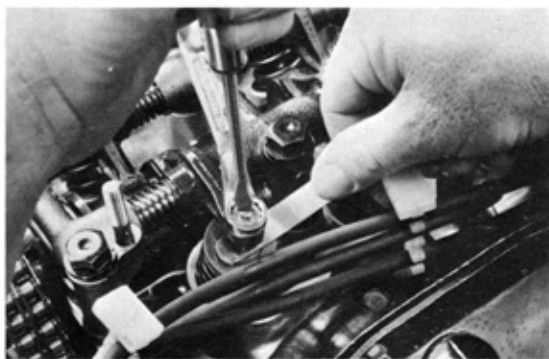


Fig. 3-101 Reset Valves

96. RECONNECT BATTERY.

97. START ENGINE.

Allow it to reach operating temperature.

98. RESET TIMING.

Use a timing light to set initial timing to  $8^{\circ}$  BTDC.

— Note —

For vehicle equipped with the HAC system, set the timing after disconnecting the hose from the distributor sub-diaphragm.

99. RESET VALVES.

Stop engine. Check valve clearance between valve stem and rocker arm.

**Hot clearance**

Intake	0.2mm (0.008 in)
Exhaust	0.3mm (0.012 in)

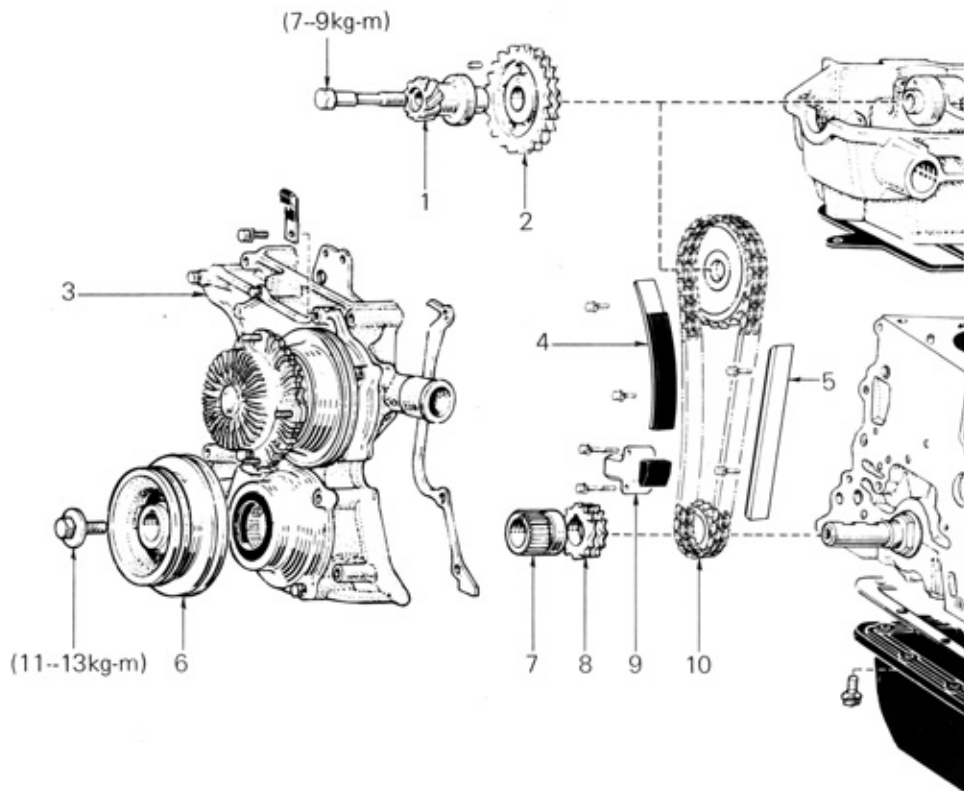


**100. ROAD TEST.**

Install valve cover and road test vehicle. Check for smooth idle, smooth acceleration and no exhaust smoke.

101. Refer to Tune-up Section for carburetor mixture and idle speed adjustments.

## TIMING CHAIN SERVICE



- |                           |                        |
|---------------------------|------------------------|
| 1. Distributor drive gear | 6. Crankshaft pulley   |
| 2. Cam sprocket           | 7. Pump drive spline   |
| 3. Chain cover assembly   | 8. Crankshaft sprocket |
| 4. Chain damper No. 2     | 9. Chain tensioner     |
| 5. Chain damper No. 1     | 10. Chain              |

Fig. 3-102 Component Parts

**SEE**

**VALVE SERVICE SECTION**

**FIRST 17 STEPS**

**1. REMOVE CYLINDER HEAD.**

Perform first 17 steps in Valve Service Section pages 3-4 through 3-8.

**2. REMOVE OIL PAN.**

Using a 12mm socket and impact wrench, remove pan bolts and pan. Remove gasket.



Fig. 3-103 Remove Oil Pan

**3. REMOVE RADIATOR.**

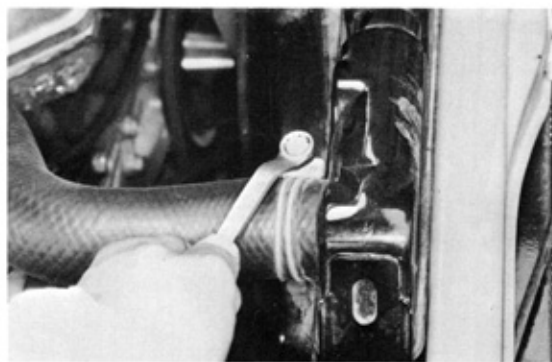


Fig. 3-104 Remove Radiator

**4. REMOVE V BELTS.**

Loosen air pump and alternator belt adjusting bolts. Remove two V belts.

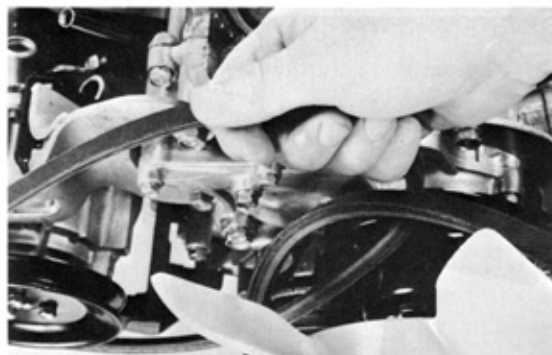


Fig. 3-105 Remove V Belts

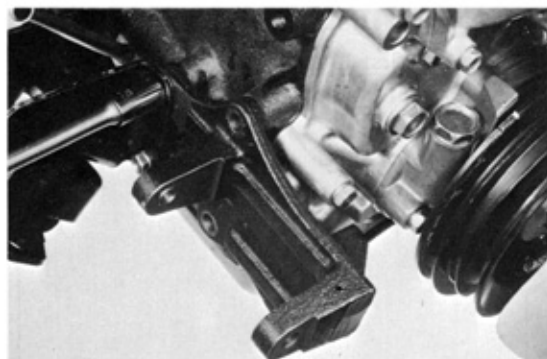


Fig. 3-106 Remove Air Pump

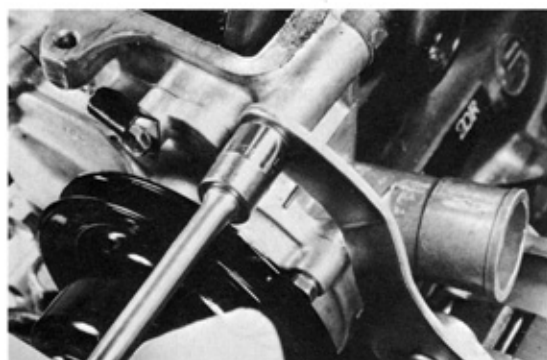


Fig. 3-107 Remove Alternator Adjuster

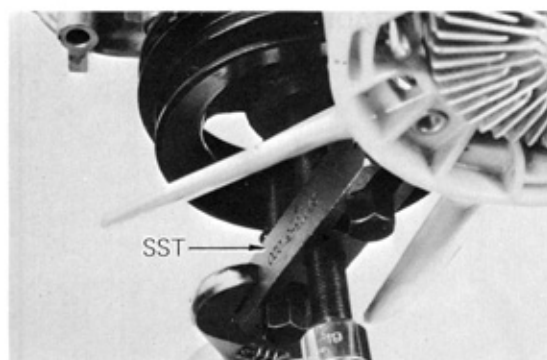


Fig. 3-108 Remove Crankshaft Pulley

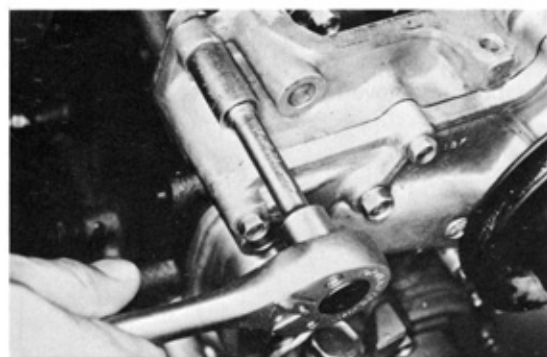


Fig. 3-109 Remove By-pass Tube Bolts

## 5. REMOVE AIR PUMP.

Remove adjuster bracket, pump through bolt, and four bracket bolts. Remove air pump and bracket.

## 6. REMOVE ALTERNATOR ADJUSTER.

Remove alternator adjuster bracket at chain cover and move toward alternator.

## 7. REMOVE CRANKSHAFT PULLEY.

Remove pulley center bolt. Install SST[09213-31020] puller and remove pulley. If front seal is to be replaced, see page 3-54.

## 8. REMOVE WATER BY-PASS TUBE BOLTS.

Remove two bolts holding water by-pass tube.

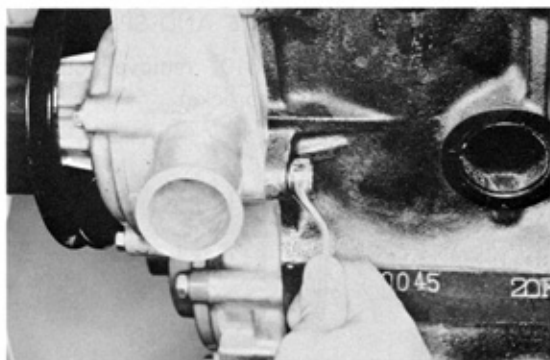


Fig. 3-110 Remove Rear Bolt

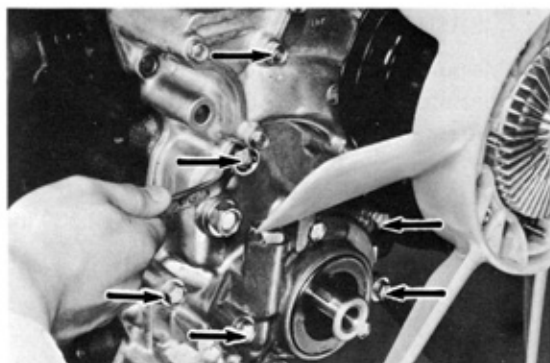


Fig. 3-111 Remove Cover Bolts

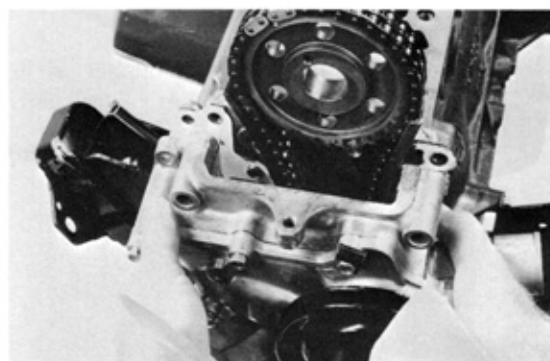


Fig. 3-112 Remove Chain Cover Assembly

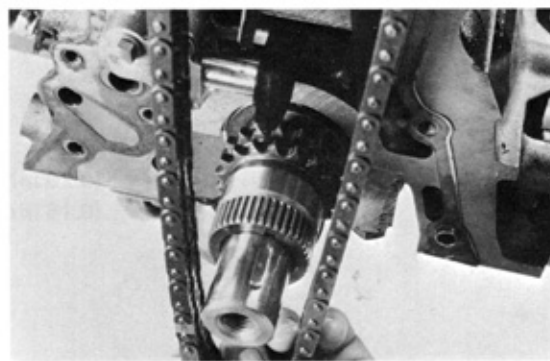


Fig. 3-113 Remove Chain and Sprocket

9. REMOVE REAR BOLT.

Remove one bolt located on left side of front engine block.

10. REMOVE COVER BOLTS.

Remove all timing chain cover bolts indicated by arrows.

11. REMOVE CHAIN COVER ASSEMBLY.

Use a plastic faced hammer to tap off timing chain cover. If removal is difficult, check to be sure all bolts have been removed.

12. REMOVE CHAIN AND SPROCKET.

Remove chain from damper and remove cam sprocket and chain.

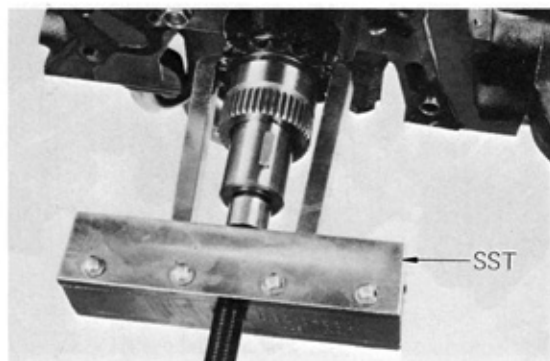


Fig. 3-114 Remove Pump Drive and Sprocket



Fig. 3-115 Measure Chain and Sprocket Wear

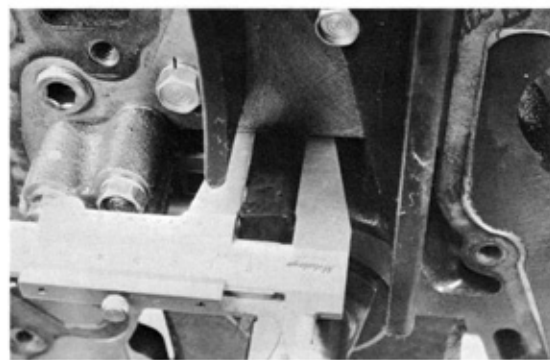


Fig. 3-116 Measure Chain Tensioner

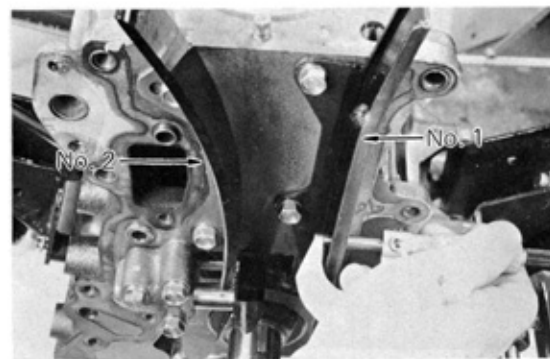


Fig. 3-117 Measure Chain Damper

## 13. REMOVE PUMP DRIVE AND SPROCKET.

Using SST [09213-36010] remove both oil pump drive and chain sprocket.

## 14. MEASURE CHAIN AND SPROCKET WEAR.

Measure chain and sprocket as illustrated. If measurement is below limit, replace chain and two sprockets.

**Crankshaft sprocket Limit**

**59.4mm (2.339 in)**

**Camshaft sprocket Limit**

**113.8mm (4.480 in)**

## 15. MEASURE CHAIN TENSIONER.

Inspect for wear. Measure tensioner as illustrated. If worn or below limit, replace unit.

**Limit**

**11mm (0.43 in)**

## 16. MEASURE CHAIN DAMPER.

Inspect chain dampers for wear. Measure each damper. If either is visibly worn or measures less than limit, replace units.

**Limit No. 1**

**5mm (0.20 in)**

**No. 2**

**4.5mm (0.18 in)**

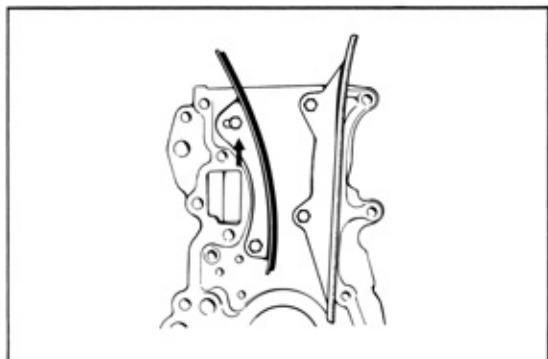


Fig. 3-118 Install New Damper

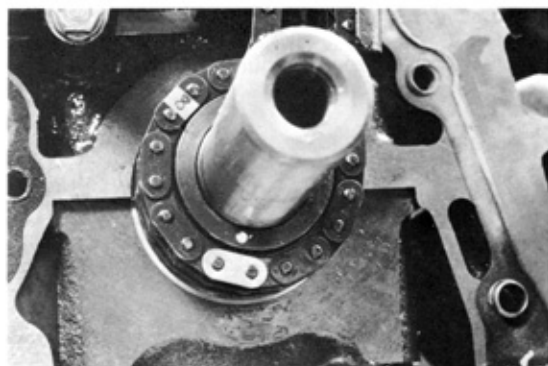


Fig. 3-119 Install Sprocket and Chain

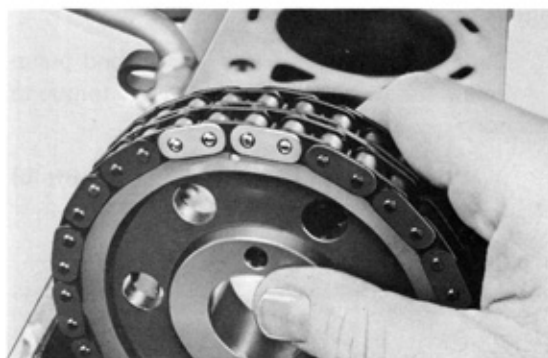


Fig. 3-120 Position Cam Sprocket in Chain

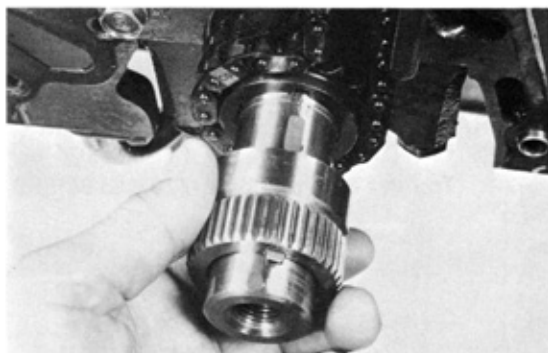


Fig. 3-121 Install Oil Pump Drive

**17. INSTALL NEW DAMPER.**

Bolt down dampers as illustrated.

**18. INSTALL SPROCKET AND CHAIN.**

Turn crankshaft until shaft key is at TDC. Slide sprocket over key. Position chain with single bright link over sprocket.

**19. POSITION CAM SPROCKET IN CHAIN.**

Install cam sprocket in chain so that timing mark is located between two bright chain links.

**20. INSTALL OIL PUMP DRIVE.**

Slide oil pump drive spline over crankshaft key.



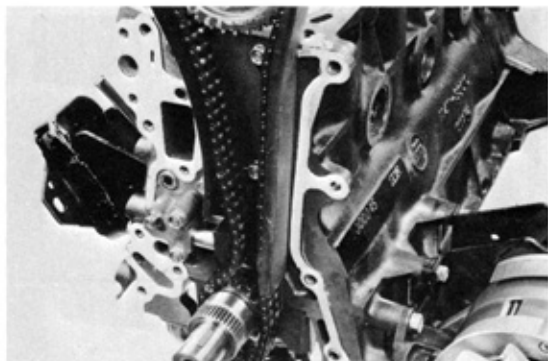


Fig. 3-122 Install Cover Gasket

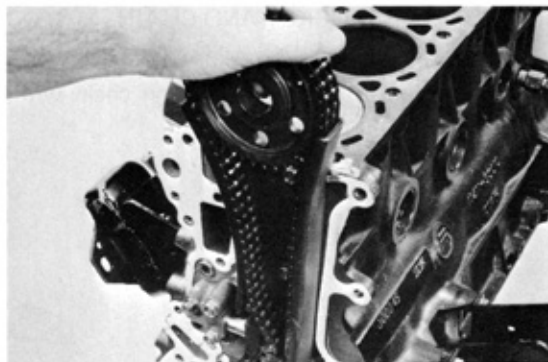


Fig. 3-123 Rotate Cam Sprocket

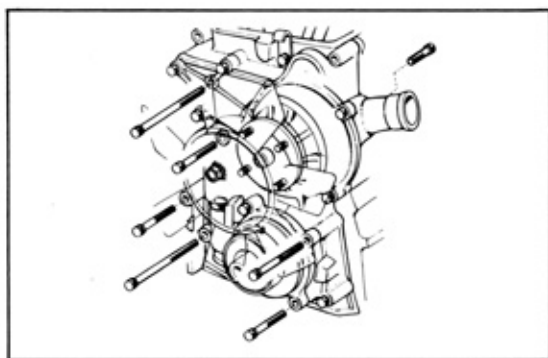


Fig. 3-124 Install Chain Cover Assembly

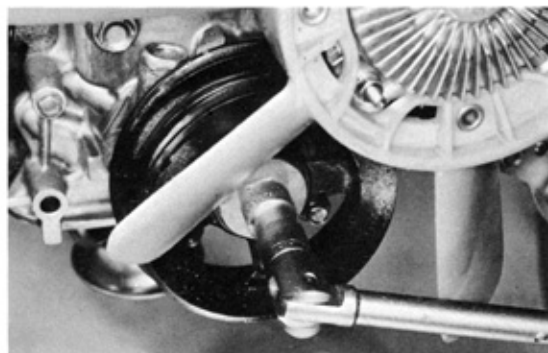


Fig. 3-125 Install Pulley

## 21. INSTALL COVER GASKET.

Remove old cover gaskets. Clean gasket surface and install new gaskets over dowels.

## 22. ROTATE CAM SPROCKET.

Turn cam sprocket counterclockwise to take slack out of chain.

## 23. INSTALL CHAIN COVER ASSEMBLY.

Slide cover assembly over dowels and pump spline. Insert bolts as illustrated and torque to specification.

**Torque 1 to 1.6kg-m (7.2 to 11.6ft-lb)**

## 24. INSTALL PULLEY.

Install crankshaft pulley over key. Torque bolt to specification. **DO NOT TURN CRANKSHAFT.**

**Torque 11 to 13kg-m (79.6 to 94ft-lb)**

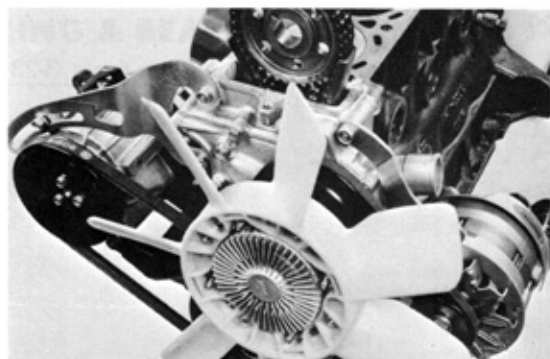


Fig. 3-126 Install Air Pump and Belts

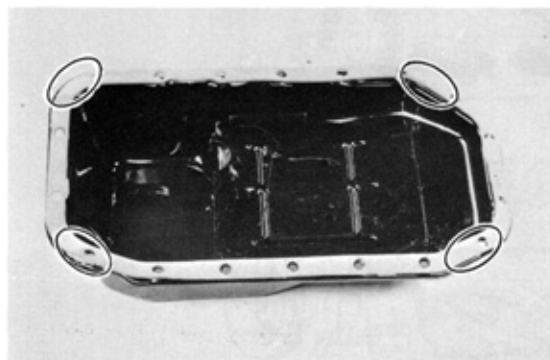


Fig. 3-127 Apply Sealer



Fig. 3-128 Install Pan

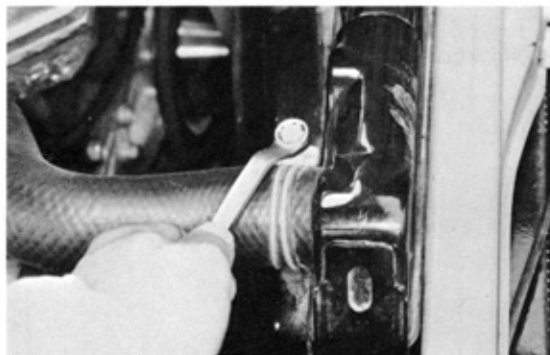


Fig. 3-129 Install Radiator

**25. INSTALL AIR PUMP AND BELTS.**

Install air pump bracket and air pump. Install alternator adjusting bracket and two belts. Adjust belts.

**26. APPLY SEALER.**

Apply sealer to pan gasket as illustrated.

**27. INSTALL PAN.**

Install pan over studs.  
Tighten bolts to specification.

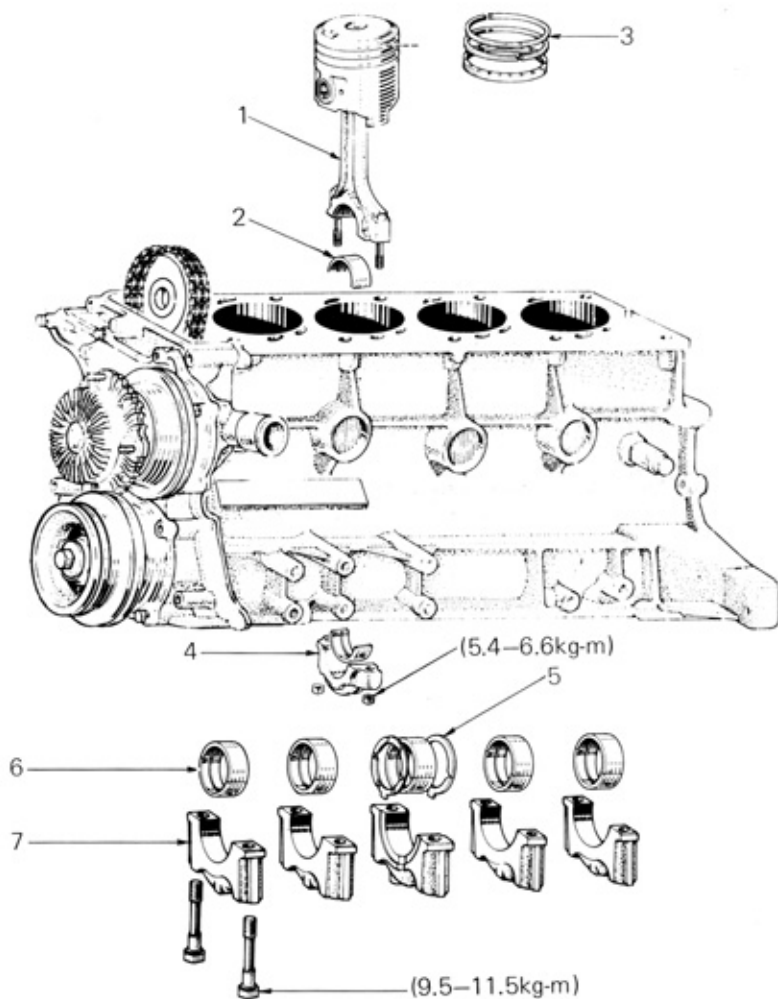
**Torque****40 to 80kg-cm  
(34.7 to 69.4 in-lb)****28. INSTALL RADIATOR.**

Install radiator and water hoses.

**SEE  
VALVE SERVICE SECTION  
STEPS 76 TO 101**

29. **INSTALL HEAD.**

Refer to Valve Service Section pages 3-23 through 3-29 for top end reassembly.

**RING & BEARING SERVICE**

1. Connecting rod with piston
2. Rod bearing
3. Piston ring
4. Rod cap

5. Thrust bearing
6. Main bearing
7. Main bearing cap

Fig. 3-130 Component Parts

SEE  
VALVE SERVICE SECTION  
FIRST 17 STEPS

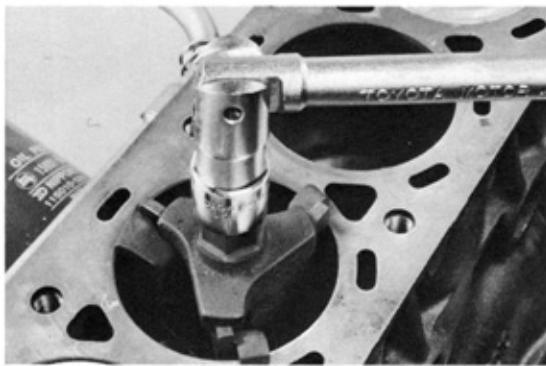


Fig. 3-131 Remove Cylinder Ridge

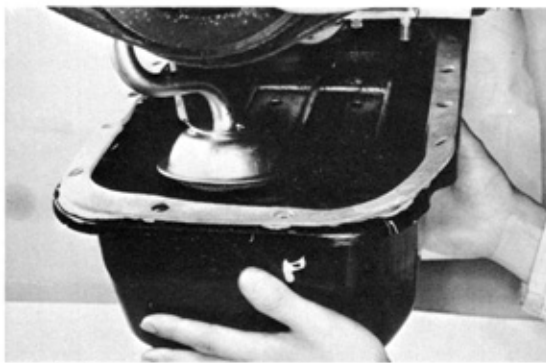


Fig. 3-132 Remove Engine Pan

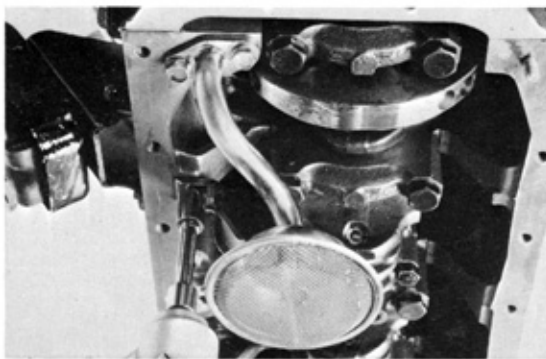


Fig. 3-133 Remove Oil Screen

1. REMOVE CYLINDER HEAD.

Perform first 17 steps in Valve Service Section pages 3-4 through 3-8.

2. REMOVE CYLINDER RIDGE.

Machine piston ring ridge from top of cylinder.

— Note —

If this step is not performed prior to removing pistons, piston ring lands will be damaged.

3. REMOVE ENGINE PAN.

Using a 3/8" drive impact wrench and 12mm socket, remove engine pan.

4. REMOVE OIL SCREEN.

Remove three bolts holding oil pick-up screen.

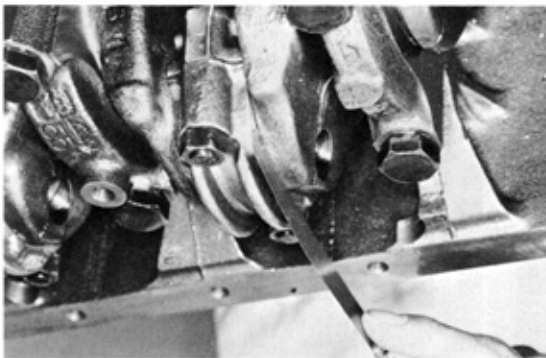


Fig. 3-134 Measure Rod Thrust Clearance

## 5. MEASURE ROD THRUST CLEARANCE.

Using a feeler gauge, measure rod thrust clearance. If clearance is over limit, rod must be replaced.

**Thrust limit                    0.3mm (0.012 in)**

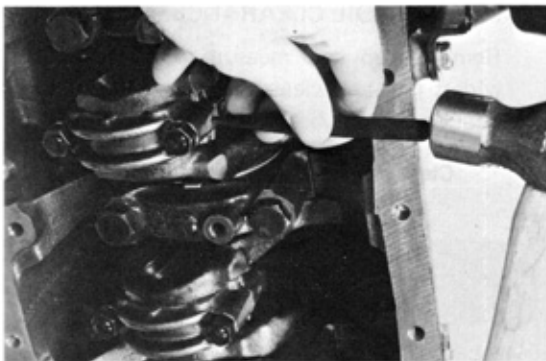


Fig. 3-135 Mark Rods and Caps

## 6. MARK RODS AND CAPS.

Using a center punch or numbering stamp, mark connecting rods and caps. This will assure correct reassembly.

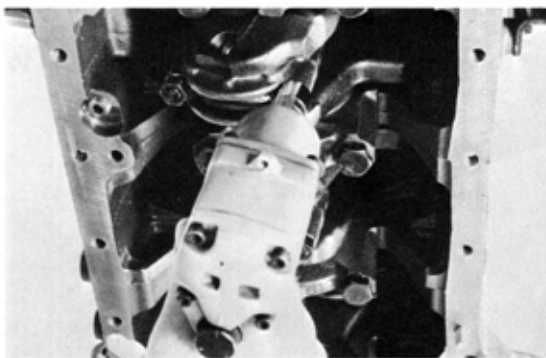


Fig. 3-136 Remove Rod Caps

## 7. REMOVE ROD CAPS.

Tap rod caps lightly with a plastic hammer. Keep bearing insert with cap.



Fig. 3-137 Measure Rod Pin Oil Clearance

## 8. MEASURE ROD JOURNAL OIL CLEARANCE.

Lay strip of plastigage across pin.

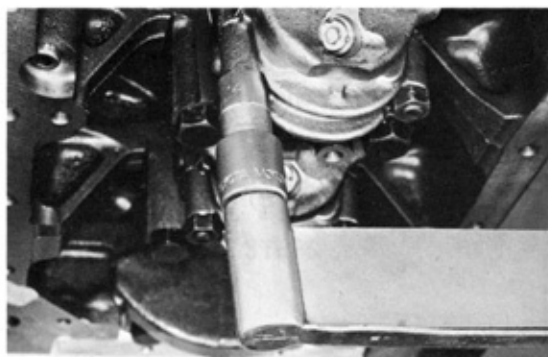


Fig. 3-138 Install Rod Cap

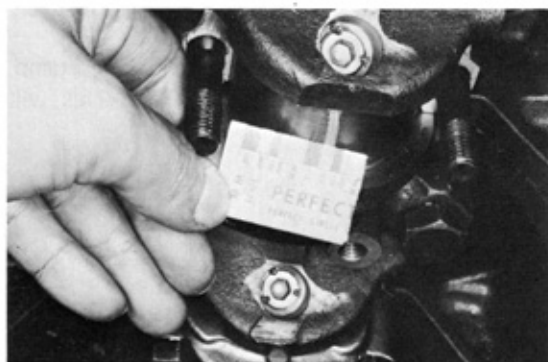


Fig. 3-139 Measure Oil Clearance



Fig. 3-140 Cover Rod Bolts

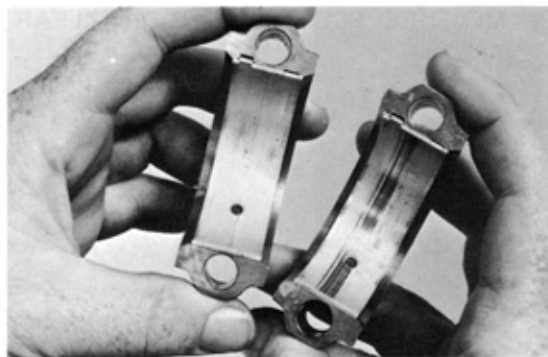


Fig. 3-141 Inspect Bearing Wear

## 9. INSTALL ROD CAP.

Reinstall rod cap. Tighten to specified torque.

<b>Torque</b>	<b>5.4 to 6.6kg-m (39.1 to 47.7ft-lb)</b>
---------------	-----------------------------------------------

## 10. MEASURE OIL CLEARANCE.

Remove cap and measure plastigage at its widest point. If clearance is not within specification, replace bearings.

<b>Clearance</b>	<b>0.025 to 0.055mm (0.0010 to 0.0022 in)</b>
------------------	---------------------------------------------------

## 11. PUSH OUT ASSEMBLY.

Cover rod bolts with a short length of hose to protect crankshaft from damage.

## 12. INSPECT BEARING WEAR.

Inspect rod bearings for flaking or scoring. The bearing illustrated was damaged by dirt in engine. If bearings are damaged, they must be replaced.

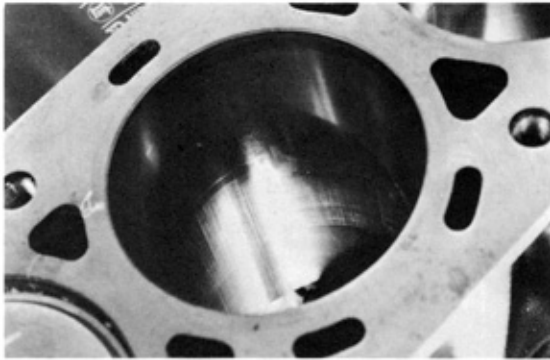


Fig. 3-142 Inspect Cylinders

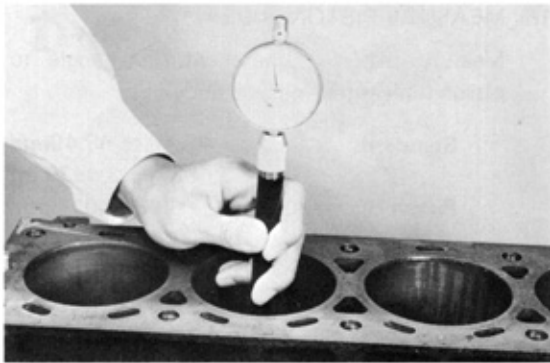


Fig. 3-143 Measure Cylinder Bore



Fig. 3-144 Degraze and Clean Cylinders



Fig. 3-145 Check Pin Fit

## 13. INSPECT CYLINDERS.

Visually inspect cylinders for vertical scratches. If deep scratches are present, the cylinder must be honed or rebored.

## 14. MEASURE CYLINDER BORE.

Measure cylinders at top and bottom as shown. If cylinder exceeds specification, cylinder must be bored.

<b>Wear limit</b>	<b>0.2mm (0.008 in)</b>
<b>Standard</b>	<b>88.50 to 88.53mm (3.4842 to 3.4854 in)</b>

## 15. DEGRAZE AND CLEAN CYLINDERS.

Cover crankshaft journals. Using a graze breaker, remove graze from cylinder bore. Clean bore with soap and water. Dry bore and crankshaft.

## 16. CHECK PIN FIT.

Check pin fit by trying to rock piston at right angle to pin. If any movement is felt, piston and/or rod bushing must be replaced.





Fig. 3-146 Heat Piston

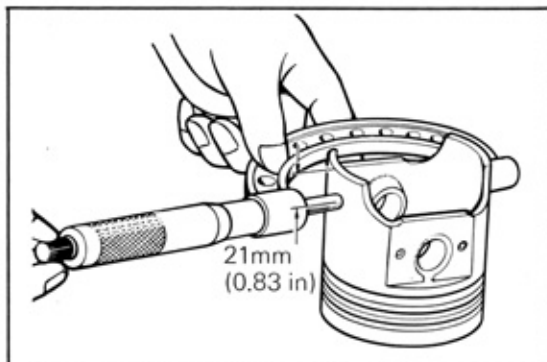


Fig. 3-147 Measure Piston



Fig. 3-148 Clean Pistons



Fig. 3-149 Inspect Ring Lands

## 17. REMOVE PISTON PIN.

Heat piston in piston heater to about  $80^{\circ}\text{C}$  ( $180^{\circ}\text{F}$ ) and remove piston pin.

— Note —

**Piston and pin are matched set.**

## 18. MEASURE PISTON.

Measure piston diameter at right angle to piston pin center line.

<b>Standard</b>	<b>88.46 to 88.49mm</b> <b>(3.4827 to 3.4839 in)</b>
<b>Piston clearance</b>	<b>0.03 to 0.05mm</b> <b>(0.0012 to 0.0020 in)</b>

## 19. CLEAN PISTONS.

Scrape carbon from piston top. Clean ring grooves with groove cleaning tool or broken ring. Finish cleaning process with solvent and brush.

**DO NOT USE WIRE WHEEL.**

## 20. INSPECT RING LANDS.

Measure clearance between new piston ring and ring land. If clearance is over limit, piston must be replaced.

<b>Compression ring 1 and 2</b>	
<b>Limit</b>	<b>0.2mm (0.008 in)</b>

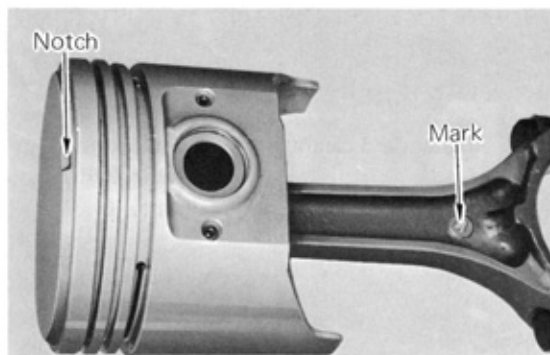


Fig. 3-150 Assemble Piston and Rod

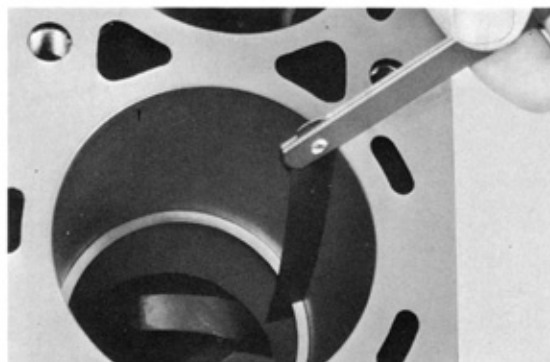


Fig. 3-151 Measure Ring End Gap

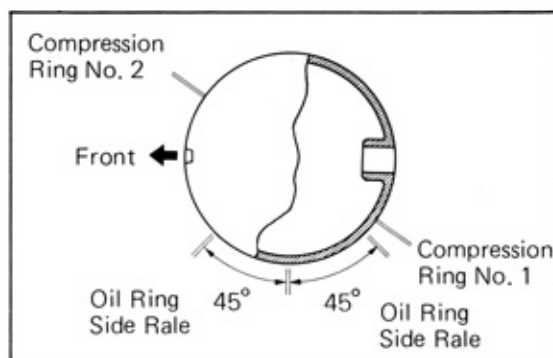


Fig. 3-152 Position Rings on Piston



Fig. 3-153 Measure Rod Journals

## 21. ASSEMBLE PISTON AND ROD.

Heat piston and assemble piston, pin and rod, aligning piston notch with rod mark.

## 22. MEASURE RING END GAP.

Insert new compression ring into cylinder bore. Using a piston, push ring to bottom of normal ring travel. Measure end gap with feeler gauge. If not within specification, ring must be replaced. DO NOT FILE RING ENDS.

**Eng gap 0.1 to 0.3mm (0.004 to 0.012 in)**

## 23. POSITION RINGS ON PISTON.

Position top two compression rings with code marks facing up, using a ring expander.

## 24. MEASURE ROD JOURNALS.

Measure rod journals for out-of-round, taper and diameter. If wear is excessive, crank must be reground or replaced (See page 3-52).

**Standard**                      **52.99 to 53.00mm**  
**(2.0862 to 2.0866 in)**



Fig. 3-154 Measure Crankshaft Thrust

## 25. MEASURE CRANKSHAFT THRUST.

Measure clearance at center bearing. If excessive, replace thrust bearing.

<b>Standard clearance</b>	<b>0.02 to 0.20mm</b> <b>(0.0008 to 0.0079 in)</b>
<b>Clearance limit</b>	<b>0.3mm (0.012 in)</b>

## Thrust Washer Sizes

Sizes	Thickness	
STD	2.00mm	(0.0787 in)
O/S 0.125	2.06mm	(0.0811 in)
O/S 0.250	2.13mm	(0.0839 in)

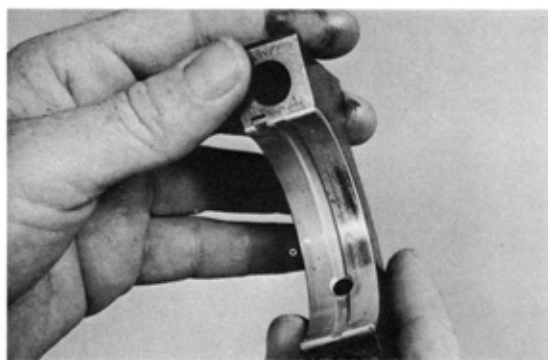


Fig. 3-155 Inspect Main Bearings

## 26. INSPECT MAIN BEARINGS.

Remove main bearing caps and inspect bearings for pitting and radial scratches. If either is observed, replace bearings.



Fig. 3-156 Measure Main Bearings

## 27. MEASURE MAIN BEARINGS.

Check oil clearance of main bearings with plastigage. If clearance is not within specification, replace bearings.

<b>Clearance</b>	<b>0.025 to 0.055mm</b> <b>(0.0010 to 0.0022 in)</b>
<b>Torque</b>	<b>9.5 to 11.5kg-m</b> <b>(68.7 to 83.2ft-lb)</b>

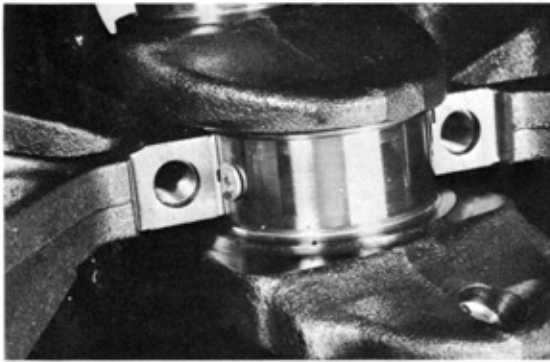


Fig. 3-157 Roll Out Main Bearings

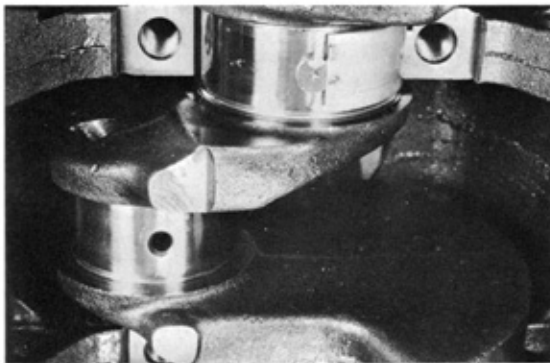


Fig. 3-158 Roll in New Bearing



Fig. 3-159 Check Oil Clearance

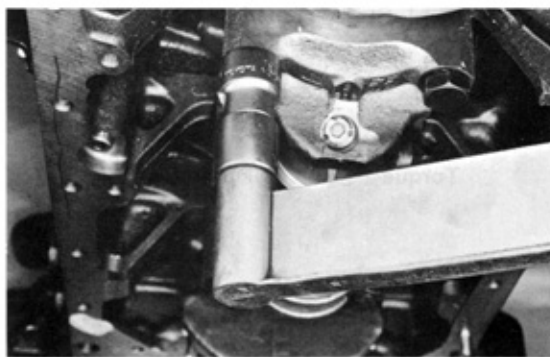


Fig. 3-160 Tighten Main Bearings

**28. ROLL OUT MAIN BEARINGS.**

To remove upper bearing half, insert roll out tool into crankshaft journal oil hole. Turn crankshaft slowly to roll out bearing shell.

**29. ROLL IN NEW BEARING.**

Lubricate bearing face only. Push upper shell into position. Use roll out tool to roll upper bearing into position if necessary.

**30. CHECK OIL CLEARANCE.**

As a final check, plastigage bearings. If clearance is still excessive, crank must be removed and machined and undersized bearings installed.

**31. TIGHTEN MAIN BEARINGS.**

Tighten all main bearing cap bolts to specified torque.

**Torque**

**9.5 to 11.5kg-m  
(68.7 to 83.2ft-lb)**



Fig. 3-161 Install Bearing Inserts

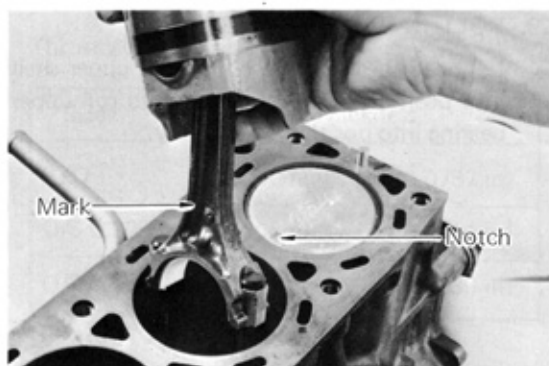


Fig. 3-162 Install Piston/Rod Assembly

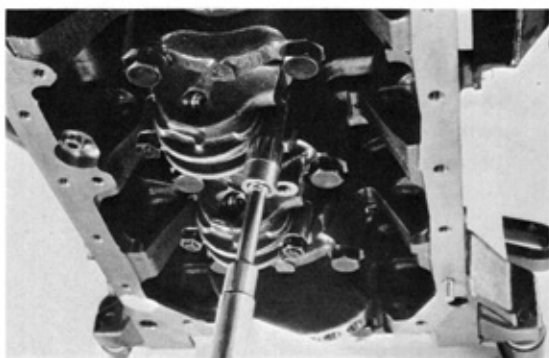


Fig. 3-163 Install Rod Bearing Caps

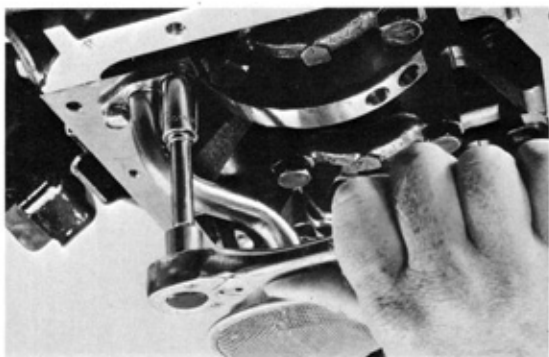


Fig. 3-164 Install Clean Oil Screen

## 32. INSTALL BEARING INSERTS.

Install bearing inserts in rods and caps lubricating face only.

## 33. INSTALL PISTON/ROD ASSEMBLY.

Lubricate cylinder and rod journal with clean engine oil. Push correctly numbered piston/rod assembly into cylinder with notch and mark on rod forward.

## 34. INSTALL ROD BEARING CAPS.

Match numbered cap with numbered rod. Tighten nuts to specified torque.

**Torque** **5.4 to 6.6kg-m**  
**(39.1 to 47.7ft-lb)**

## 35. INSTALL CLEAN OIL SCREEN.

Position oil screen gasket and install oil screen assembly with three bolts. Tighten to specified torque.

**Torque** **1 to 1.6kg-m (7.2 to 11.6ft-lb)**

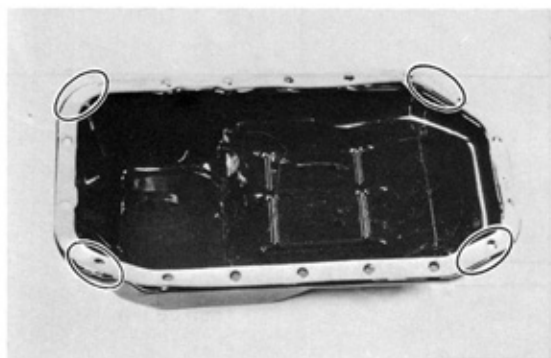


Fig. 3-165 Apply Gasket Sealer

36. APPLY GASKET SEALER.

Apply liquid sealer to four points on pan gasket and install gasket.



Fig. 3-166 Install Pan

37. INSTALL PAN.

Install pan over gasket. Insert bolts and tighten to specification.

<b>Torque</b>	<b>40 to 80kg-cm</b> <b>(34.7 to 69.4 in-lb)</b>
---------------	-----------------------------------------------------

Fig. 3-166 Install Pan

**SEE**

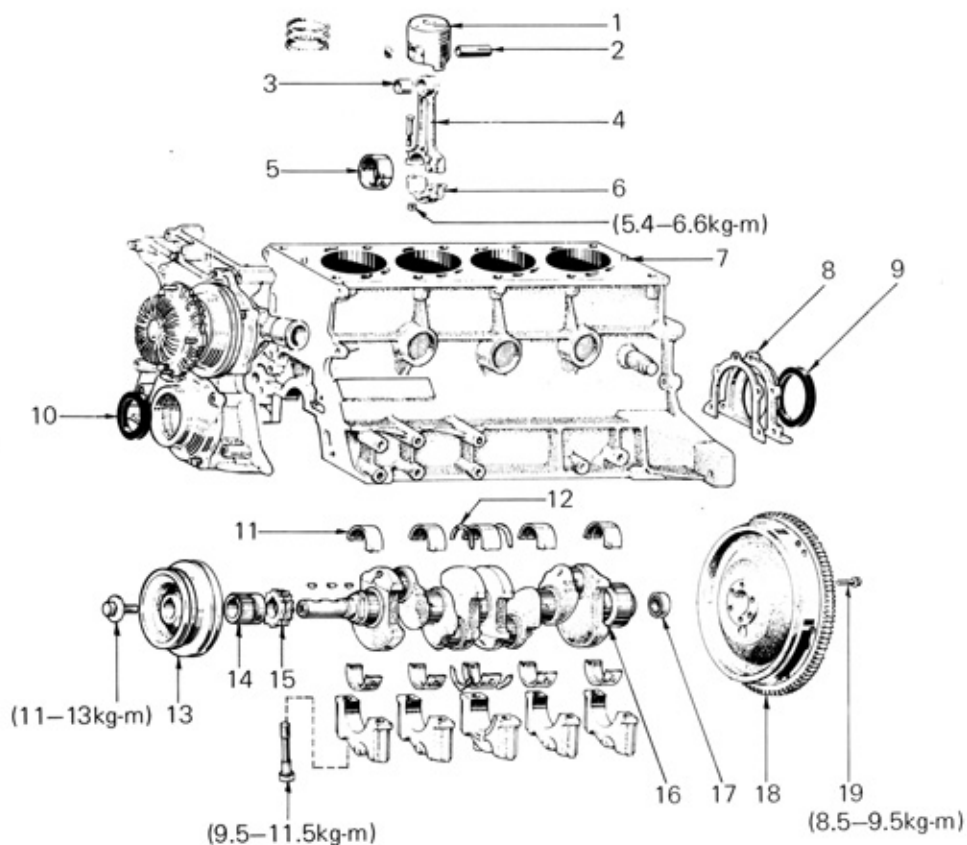
**VALVE SERVICE SECTION**

**STEPS 76 TO 101**

38. INSTALL HEAD.

Refer to Valve Service Section pages 3-23 through 3-29 for top end reassembly.

## MAJOR ENGINE SERVICE



- |                           |                         |
|---------------------------|-------------------------|
| 1. Piston                 | 11. Main bearing        |
| 2. Piston pin             | 12. Thrust bearing      |
| 3. Rod bushing            | 13. Crankshaft pulley   |
| 4. Connecting rod         | 14. Pump drive spline   |
| 5. Rod bearing            | 15. Crankshaft sprocket |
| 6. Rod cap                | 16. Crankshaft          |
| 7. Cylinder block         | 17. Pilot bearing       |
| 8. Rear oil seal retainer | 18. Flywheel            |
| 9. Rear oil seal          | 19. Flywheel bolt       |
| 10. Front oil seal        |                         |

Fig. 3-167 Component Parts

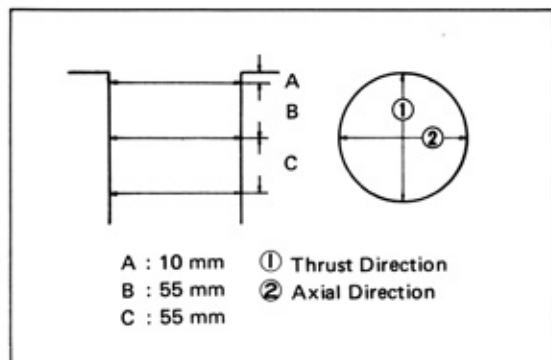


Fig. 3-168 Measuring Positions

Piston sizes:

O/S 0.50	88.96 to 88.99mm (3.5024 to 3.5035 in)
O/S 1.00	89.46 to 89.49mm (3.5220 to 3.5232 in)

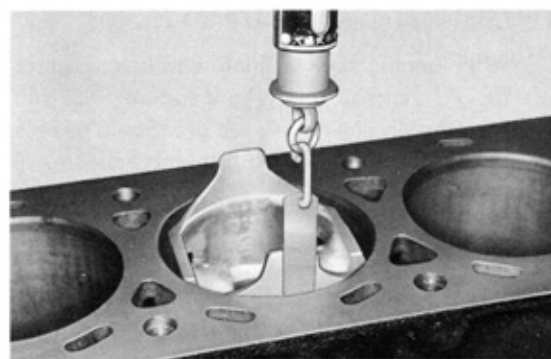


Fig. 3-169 Fit Piston to Cylinder

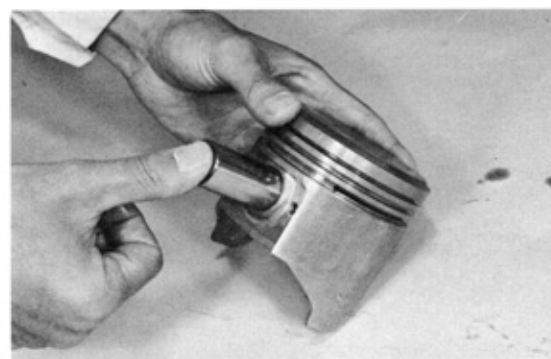


Fig. 3-170 Check Piston Pin Fit

## CYLINDER BORING

### 1. MEASURE CYLINDER.

If cylinder bore is worn or tapered over limit or if cylinder wall is scored, rebore cylinder and install oversized pistons.

### 2. SELECT OVERSIZE (O/S) PISTONS.

O/S pistons with pins are available in the sizes listed. Replace pistons in matched sets based on cylinder to be rebored.

### 3. FIT PISTON TO CYLINDER.

Insert into cylinder, piston and feeler gauge as illustrated. If the correct scale reading is indicated, the piston to cylinder clearance is correct.

<b>Feeler gauge</b>	<b>0.03 to 0.05mm</b> <b>(0.0012 to 0.0020 in)</b>
<b>Scale pull</b>	<b>1.0 to 2.5kg</b> <b>(2.2 to 5.5 lb)</b>

## PISTON, PIN AND ROD SERVICE

### 1. CHECK PISTON PIN FIT.

At normal room temperature, pin has an interference fit with piston. At 80°C (180°F) pin should be able to be pushed into piston with thumb. If pin can be installed at lower temperature, replace piston and pin.



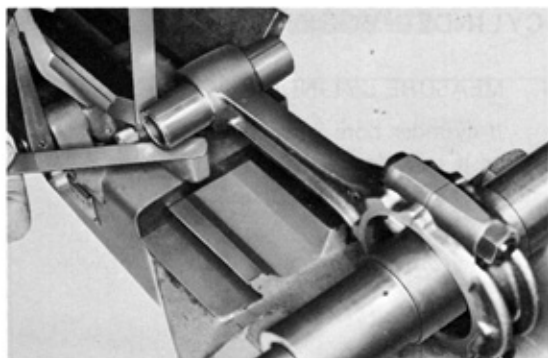


Fig. 3-171 Check Rod Alignment

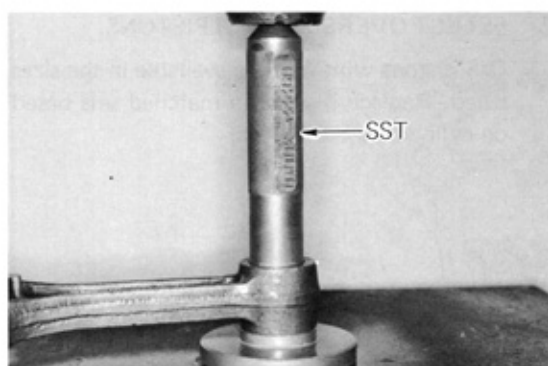


Fig. 3-172 Replace Rod Bushing



Fig. 3-173 Hone Bushing

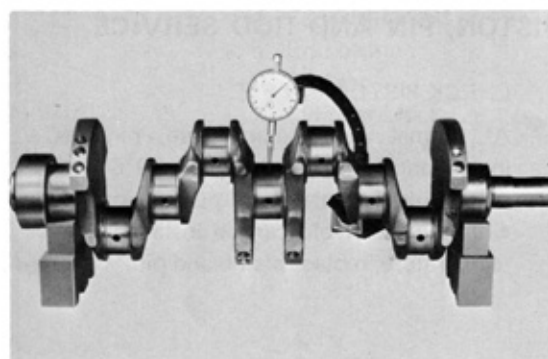


Fig. 3-174 Measure Crankshaft Alignment

## 2. CONNECTING ROD ALIGNMENT.

Using a rod aligner, check rod for correct alignment. If misalignment exceeds the limit, correct or replace rod.

### Bend and twist limit

**0.05mm (0.0020 in)**

## 3. REPLACE ROD BUSHING.

Measure piston pin to rod bushing clearance. If clearance exceeds the limit, replace bushing using SST [09222-30010].

### Clearance limit

**0.015mm (0.0006")**

### Standard

**0.005 to 0.011mm  
(0.0002 to 0.0004 in)**

## 4. CHECK BUSHING AND PIN FIT.

After honing new bushing, check for correct fit. At normal room temperature with pin coated with engine oil, the pin should be able to be pushed into rod with thumb pressure.

## CRANKSHAFT SERVICE

### 1. CHECK RUNOUT.

Place crankshaft in V blocks and measure runout at center journal. If runout exceeds specification, replace crankshaft.

### Runout limit

**0.1mm (0.004 in)**

Bearing Size	Rod Pin Finished Diameter mm (in)
STD	52.99 to 53.00 (2.0862 to 2.0866)
U/S 0.25	52.70 to 52.71 (2.0748 to 2.0752)

Bearing Size	Journal Finished Diameter mm (in)
STD	59.98 to 60.00 (2.3614 to 2.3622)
U/S 0.25	59.70 to 59.71 (2.3504 to 2.3508)

## 2. ROD PIN GRINDING.

If rod pins are to be reground because of excessive wear, grind crank and install new bearings using illustrated chart.

## 3. CRANK JOURNAL GRINDING.

If main journals are to be reground, select correct undersize journal dimension and new bearing using illustrated chart.

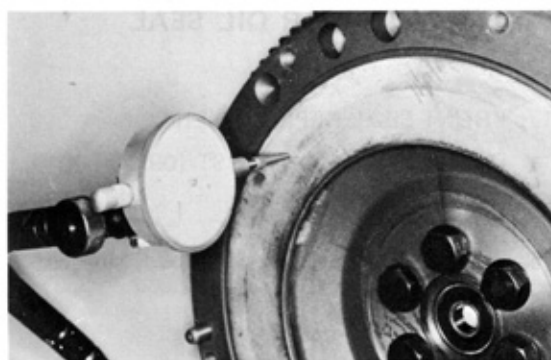


Fig. 3-175 Check Flywheel Runout

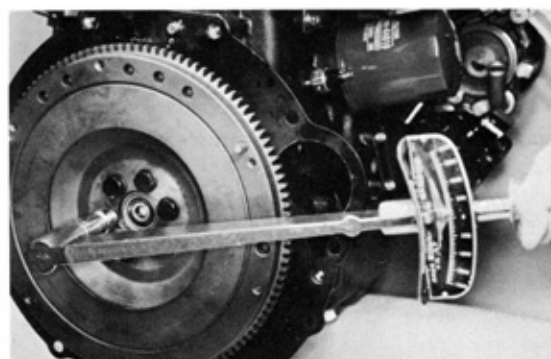


Fig. 3-176 Install Flywheel

## FLYWHEEL AND PILOT BEARING SERVICE

### 1. INSPECT FLYWHEEL.

Inspect clutch surface and ring gear. If necessary, replace flywheel.

**Runout limit**                      **0.2mm (0.008 in)**

### 2. INSTALL FLYWHEEL.

Tighten to specified torque.

**Torque**                                      **8.5 to 9.5kg-m**  
**(61.5 to 68.7ft-lb)**

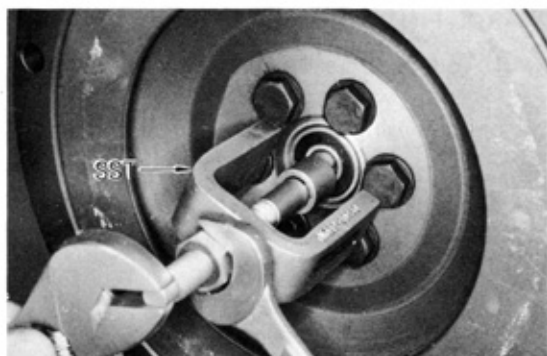


Fig. 3-177 Remove Bearing

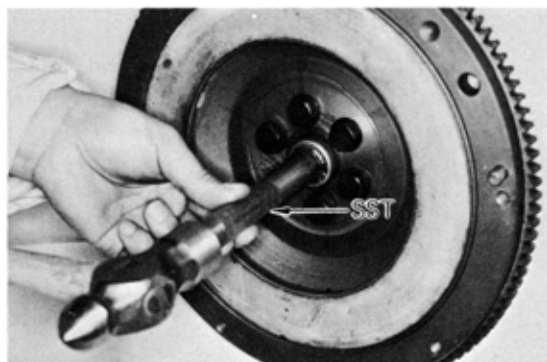


Fig. 3-178 Install Bearing



Fig. 3-179 Replace Front Seal



Fig. 3-180 Replace Rear Seal

3. REMOVE PILOT BEARING.

If necessary, remove bearing, using SST [09303-35010].

4. INSTALL BEARING.

Drive in new bearing, using SST [09304-30012].

### FRONT AND REAR OIL SEAL SERVICE

1. FRONT SEAL REPLACEMENT.

Drive in new seal using SST [09223-50010].

— Note —

Take care not to damage oil pump body surface.

2. REAR SEAL REPLACEMENT.

— Note —

To replace rear seal it is necessary to remove engine or transmission from car.

Drive in new seal, using SST [09223-41010].