ENGINE SERVICE

ENGINE CUTAWAY VIEW

Fig. 3-1

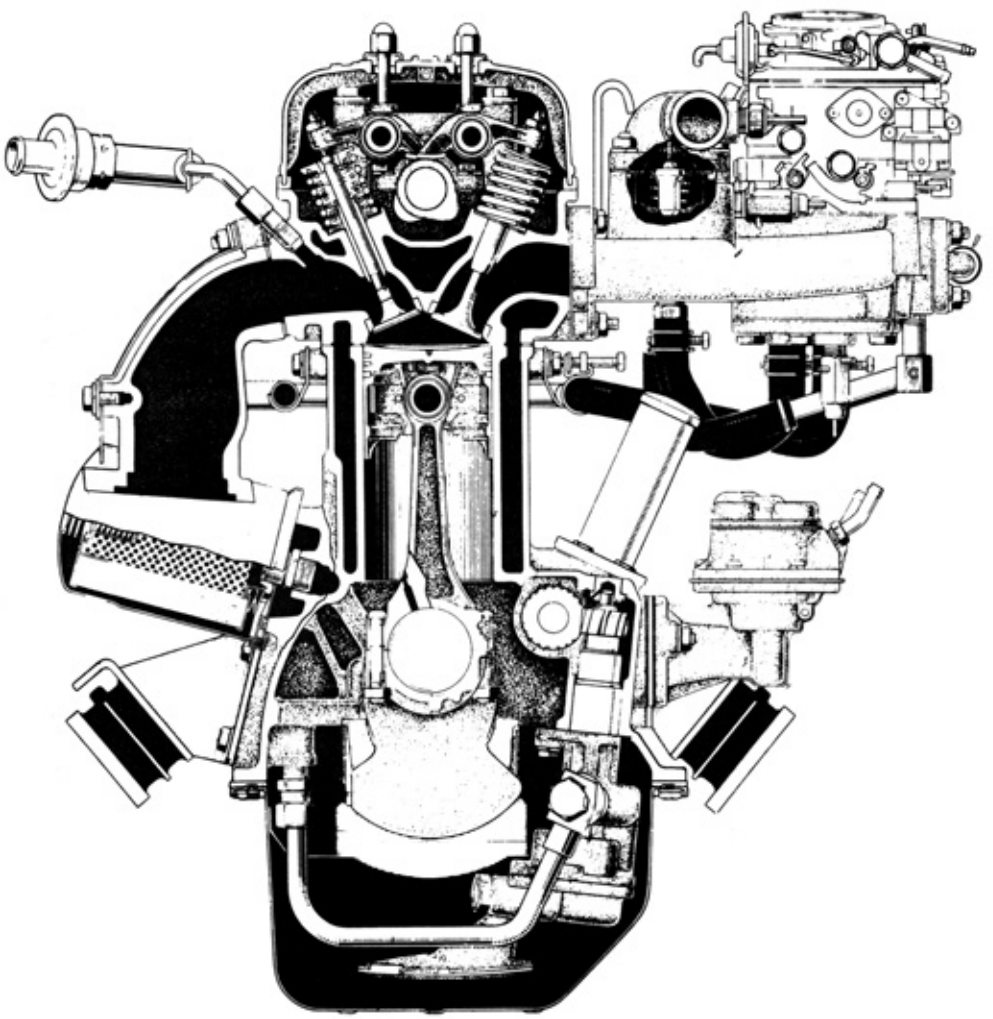
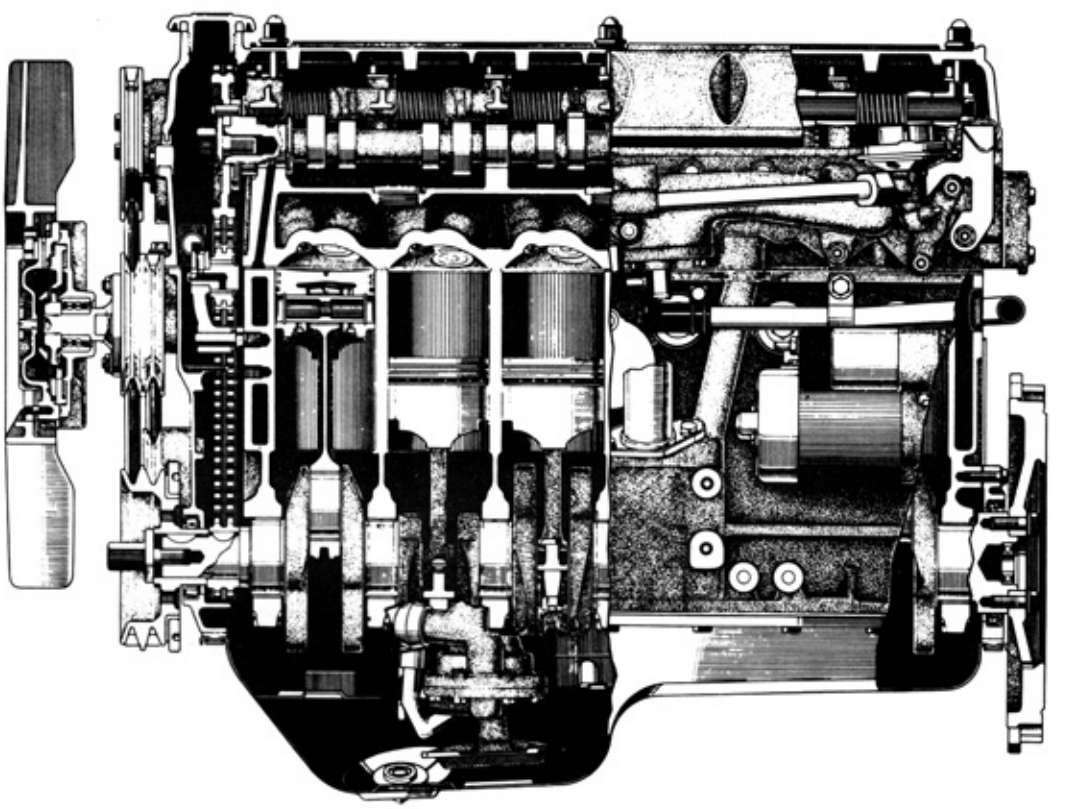


Fig. 3-2

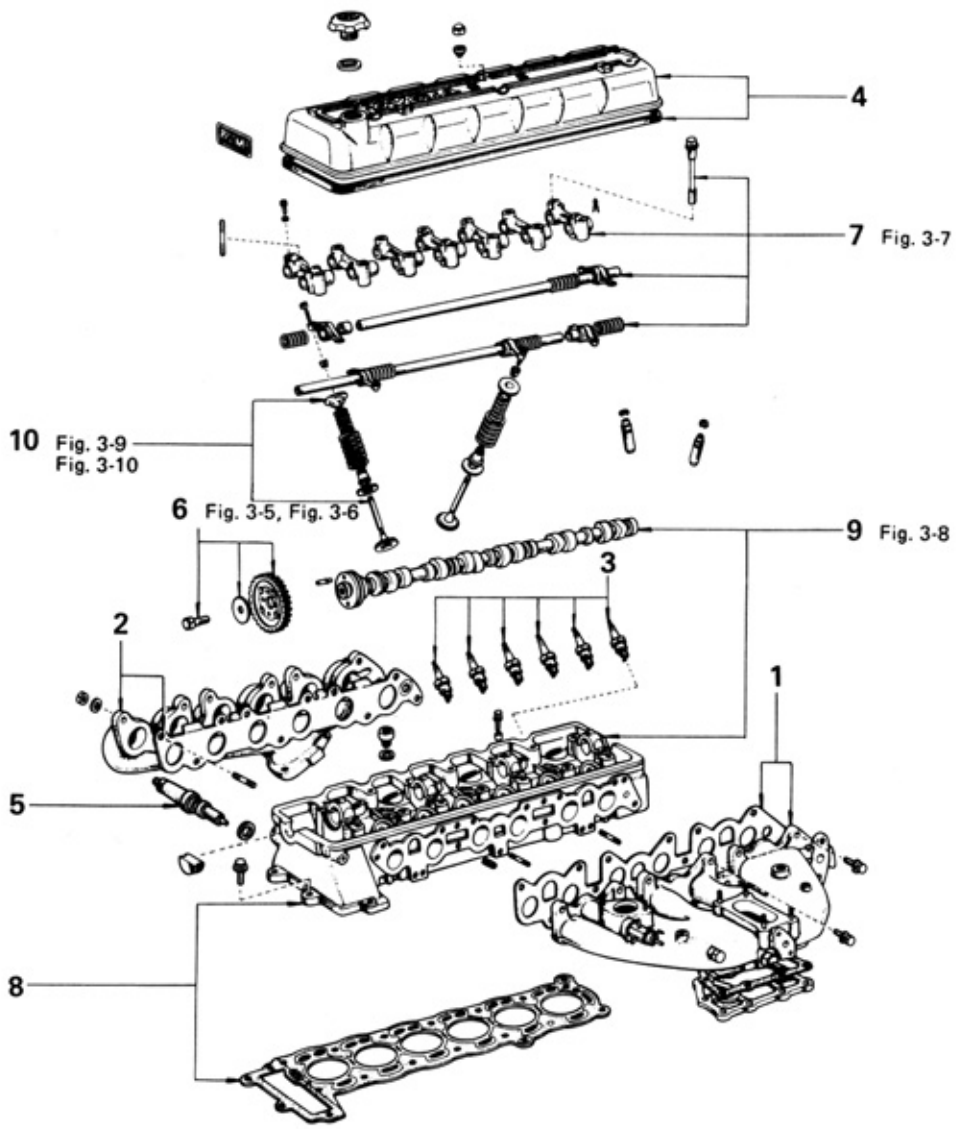


CYLINDER HEAD SERVICE

DISASSEMBLY

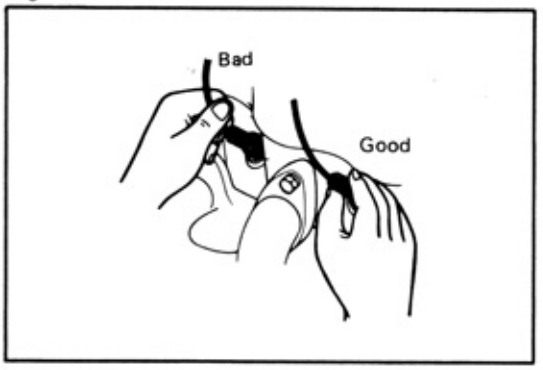
Disassemble in numerical order.

Fig. 3-3



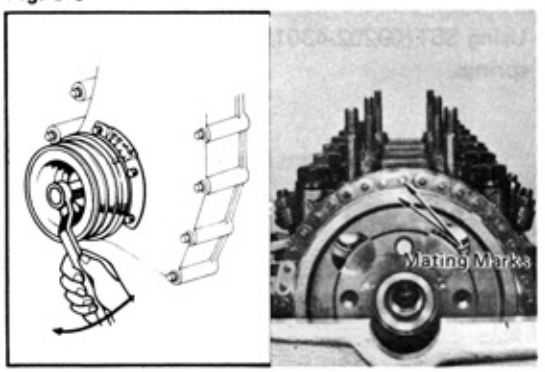
1. Intake Manifold & Gasket
2. Exhaust Manifold & Gasket
3. Spark Plug
4. Cylinder Head Cover & Gasket
5. Chain Tensioner
6. Camshaft Timing Gear
7. Rocker Arm Assembly
8. Cylinder Head & Gasket
9. Camshaft & Bearing
10. Valve & Spring

Fig. 3-4



In detaching the plug cord, always hold the cover part of the plug cord when pulling off.
Never pull the cord itself.

Fig. 3-5

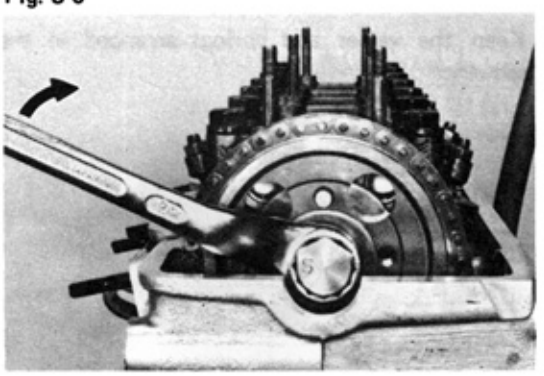


Turn the crankshaft in normal direction until the No.1 piston is set at TDC/compression.

– Note –

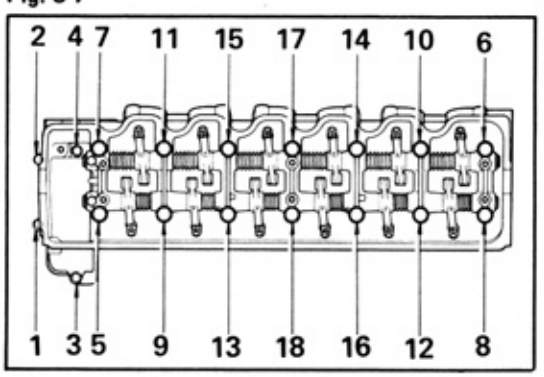
Place mating marks on the camshaft timing gear and timing chain.

Fig. 3-6



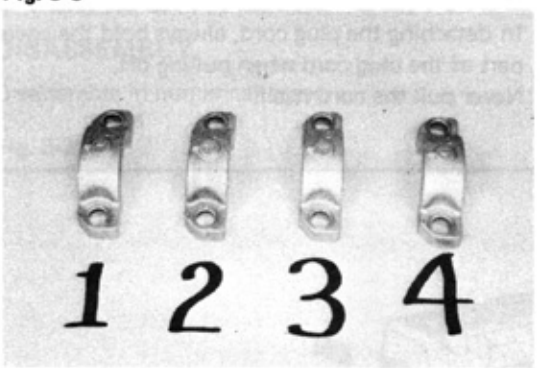
Camshaft timing gear set bolt has left hand threads.

Fig. 3-7



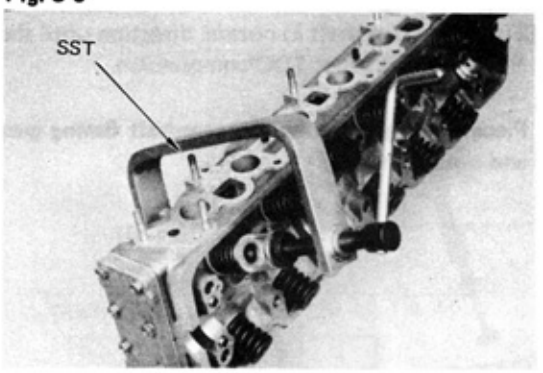
In removing the rocker shaft set bolts and nuts, loosen them uniformly, in two or three passes, in the order numbered in the diagram.

Fig. 3-8



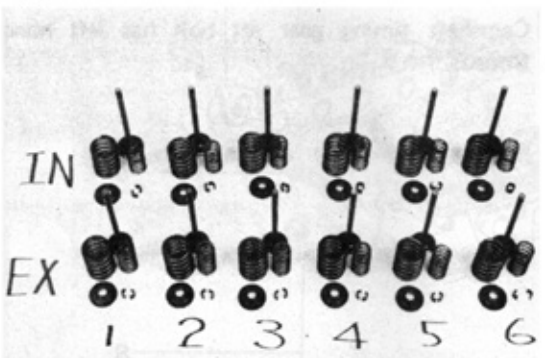
Keep the camshaft bearing caps arranged in proper order so that they can be reassembled back to their original combinations.

Fig. 3-9



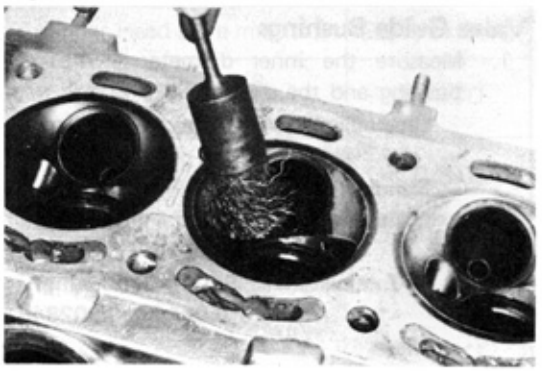
Using SST [09202-43012], remove the valves and springs.

Fig. 3-10



Keep the valves and springs arranged in the sequence of cylinders.

Fig. 3-11



INSPECTION AND REPAIR

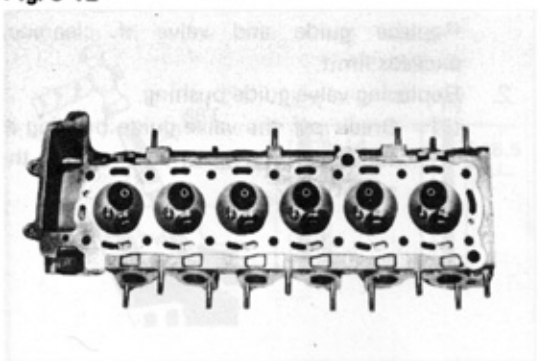
Cylinder Head

1. Remove carbon adhering on the cylinder head.

– Caution –

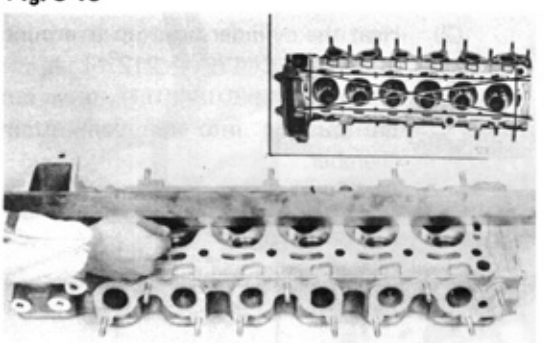
Use care not to damage the valve seats and cylinder head under surface.

Fig. 3-12



2. Inspect for cracks and damage.
   In addition to visual inspection, check for cracks with a flow detector.
   Repair or replace if found defective.

Fig. 3-13



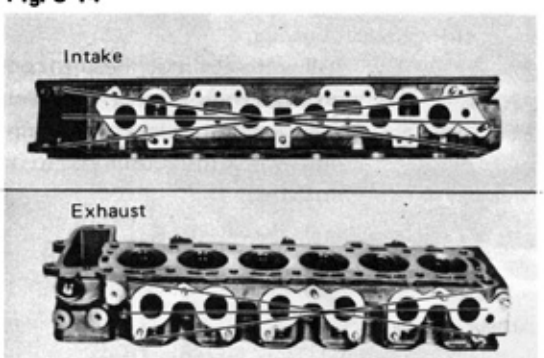
3. Cylinder head under surface warpage.
   Check for warp in the cylinder head under surface with a straight edge as illustrated. If the warpage exceeds specified limit, replace or correct by machining, with a surface grinder.

   Warpage limit 0.05 mm (0.002 in.)
   Maximum reface limit 0.2 mm (0.008 in.)

– Note –

Measure the warpage at the four sides and the diagonals as illustrated.

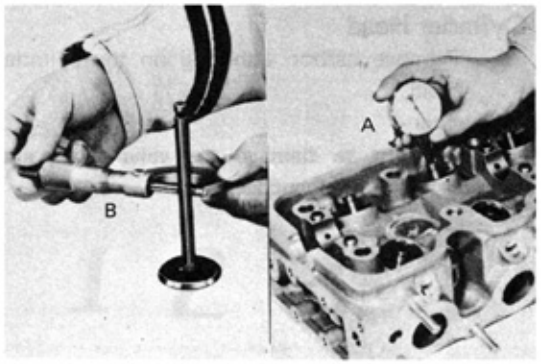
Fig. 3-14



4. Manifold mounting surface warpage.
   Follow the same procedure as above.

   Warpage limit
   Intake 0.08 mm (0.0031 in.)
   Exhaust 0.10 mm (0.0039 in.)

Fig. 3-15



Valve Guide Bushings

1. Measure the inner diameter (A) of the bushing and the diameter (B) of the stem.

Clearance between stem and bushing
A–B

Standard clearance

Intake	**0.025 – 0.060 mm (0.0010 – 0.0024 in.)**
Exhaust	**0.035 – 0.070 mm (0.0014 – 0.0028 in.)**

Limit

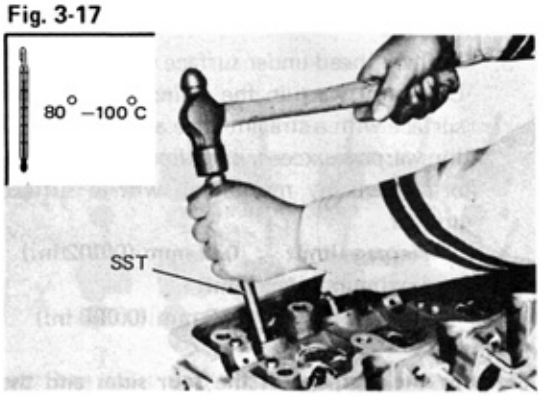
Intake	**0.10 mm (0.0039 in.)**
Exhaust	**0.13 mm (0.0051 in.)**

Replace guide and valve if clearance exceeds limit.

2. Replacing valve guide bushing.
   (1) Break off the valve guide bushing at the snap ring part, and remove the snap ring.

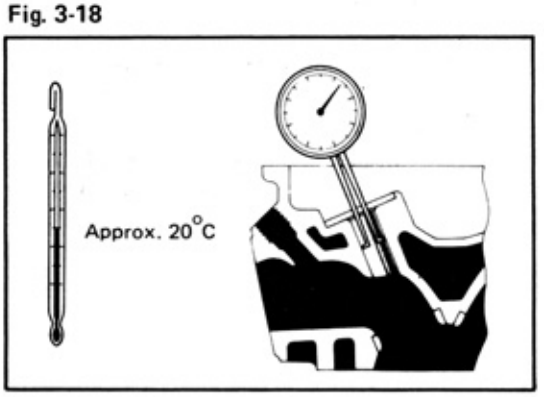
Fig. 3-16

Fig. 3-17



   (2) Heat the cylinder head up to around 80° – 100°C (176° – 212°F)
   (3) Using SST [09201-60011], drive out the bushing into the combustion chamber.

Fig. 3-18



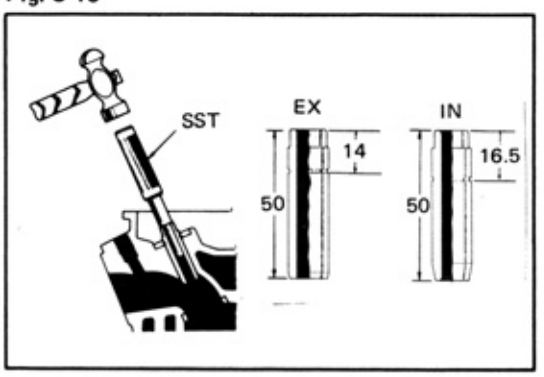
   (4) Select bushing
      1) Allow the cylinder head to cool down to room temperature and measure the cylinder head bore into which the bushing is to be installed.

Intake and Exhaust

Cylinder Head Bore mm (in.)	Guide Bushing
13.000 – 13.018 (0.5118 – 0.5125)	Use STD
Over 13.018 (Over 0.5125)	Use O/S 0.05

2) Select the bushing.
3) If the bushing cylinder head bore is more than 13.018 mm (0.5125 in.), machine the bore to the following dimension.
13.050 to 13.068 mm (0.5138 to 0.5145 in.)

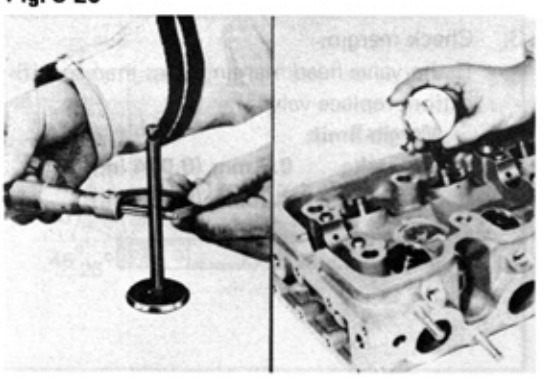
Fig. 3-19



(5) Reheat the cylinder head to around 80° to 100°C (176° to 212°F).
(6) Drive in new bushing untill the snap ring contacts head. Use SST [09201-60011].

– Note –
Different bushings are used for the intake and exhaust.

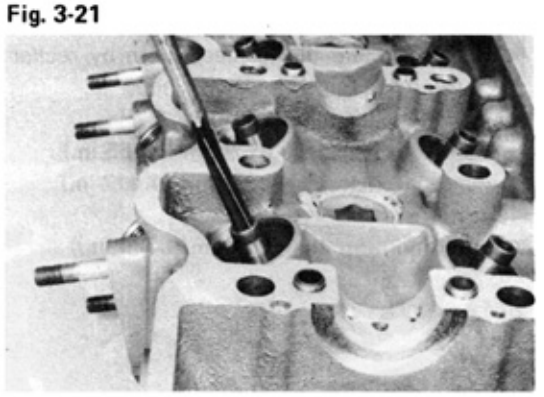
Fig. 3-20



(7) Measure the clearance between the valve guide bushing and valve stem to verify that it is within the specified clearance.

Intake	**0.025 – 0.060 mm (0.0010 – 0.0024 in.)**
Exhaust	**0.035 – 0.070 mm (0.0014 – 0.0028 in.)**

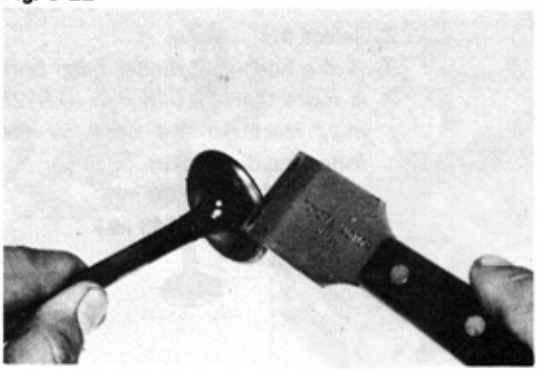
Fig. 3-21



(8) After replacing the bushing, ream the bushing bore if necessary.

– Caution –
1. **Perform the reaming operation by turning the reamer carefully and while removing chips and applying coolant.**
   Do not use engine oil as this could cause sezing and spoil the work.
2. **Measure the bore from time to time to prevent overcutting.**
3. **After reaming, make sure that all chips have been removed.**

Fig. 3-22



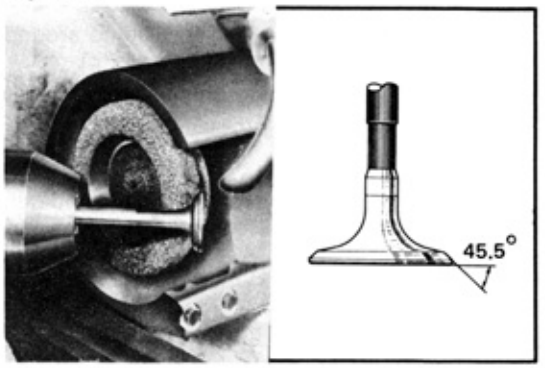
Valve

– Caution –

When replacing the valve, be sure to replace the valve bushing at the same time.

1. Clean valves.

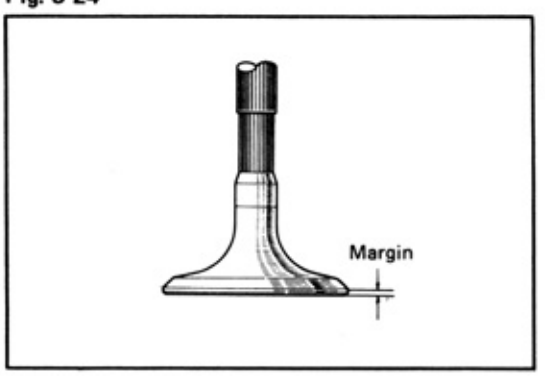
Fig. 3-23



2. If there are any damages or excessive wear at the valve seating face, correct with a valve refacer.

   Seating face angle 45.5°

Fig. 3-24



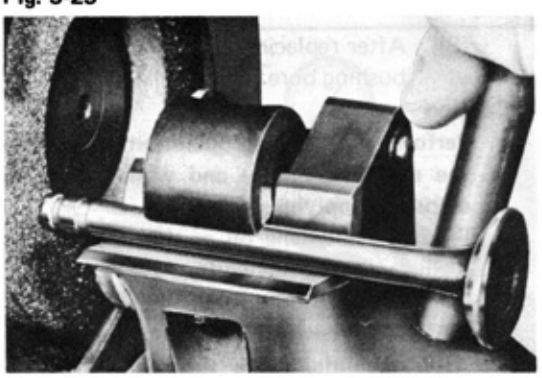
3. Check margin.
   If the valve head margin is less than specification, replace valve.

   Margin limit

   Intake 0.6 mm (0.024 in.)

   Exhaust 1.0 mm (0.039 in.)

Fig. 3-25



4. If valve stem tip has been worn by rocker arm, resurface with valve grinder.

   Overall length limit

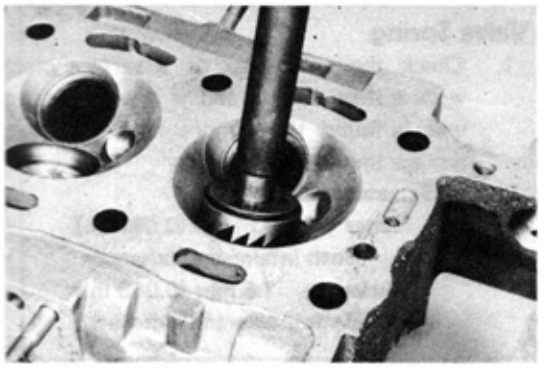
   Intake 115.7 mm (4.555 in.)

   Exhaust 112.7 mm (4.417 in.)

– Caution –

Do not grind more than 0.5 mm (0.020 in.)

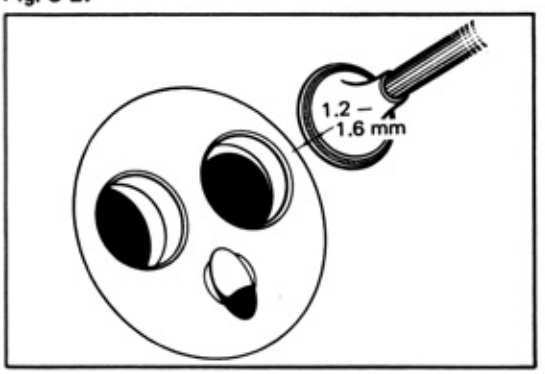
Fig. 3-26



Valve Seat

1. Clean valve seats with 45° cutter.
   Remove only enough metal to clean seat.

Fig. 3-27



2. Check the valve seating position.
   Apply a thin coat of prussian blue or white lead on the valve seat and press the valve down on the seat. At this time, do not turn the valve.

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

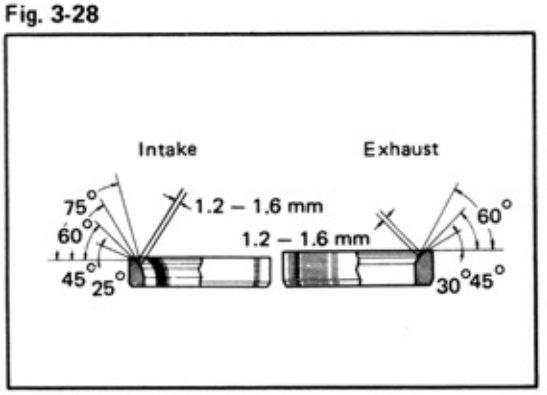
   Both intake and exhaust

   1.2 – 1.6 mm (0.047 – 0.063 in.)

– Note –

Use refaced valve or a new valve.

Fig. 3-28



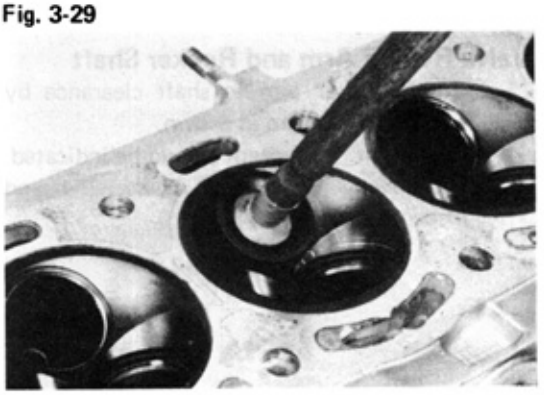
3. Correct valve seat.

– Caution –

For cutting the exhaust side seats, use cemented carbide tip cutters.

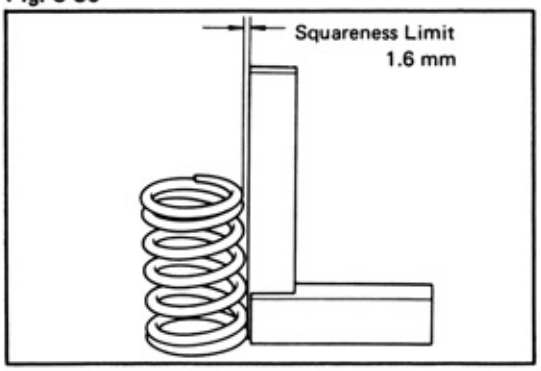
(1) If the valve is contacting at its valve stem side, correct with 60° and 45° cutters, If contacting at the valve head side, correct with 30° (25°) and 45° cutter.

Fig. 3-29



(2) Finish by lapping the valve and valve seat together with abrasive compound.

Fig. 3-30



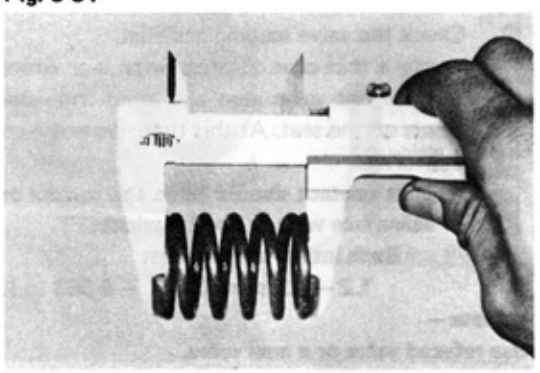
Valve Spring

1. Check the squareness on a surface plate with a steel square, and if the spring top end is found tilted more than the limit, replace the spring.

Squareness limit

Inner	**1.6 mm (0.063 in.)**
(Both intake and exhaust)	
Outer	**1.6 mm (0.063 in.)**
(Both intake and exhaust)	

Fig. 3-31

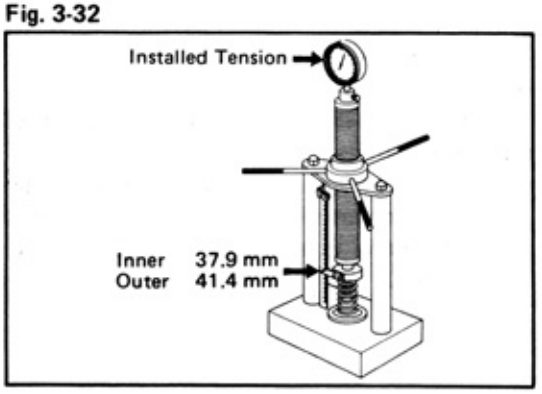


2. Measure the free heights of the springs and replace any of them not up to the specified value.

Free height

Inner	**44.9 mm (1.768 in.)**
Outer	**46.9 mm (1.846 in.)**

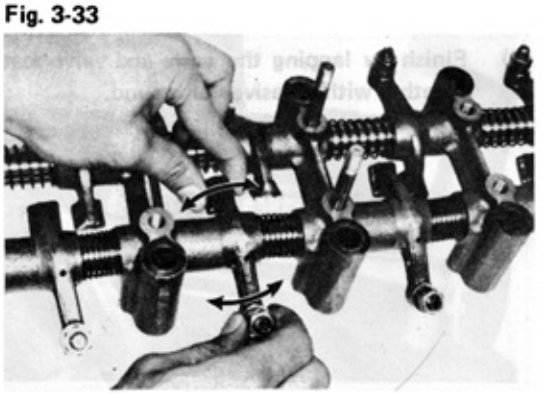
Fig. 3-32



3. Using a spring tester, measure the load when the spring is compressed to installed height, and replace the spring if below the load limit.

		Inner	Outer
Installed length mm (in.)	IN EX	37.9 (1.492)	41.4 (1.630)
Installed tension STD kg (lb)	IN EX	6.4–7.8 (14.1–17.2)	17.1–21.1 (37.7–46.5)
Installed tension limit kg (lb)	IN EX	6.0 (13.2)	15 (33.1)

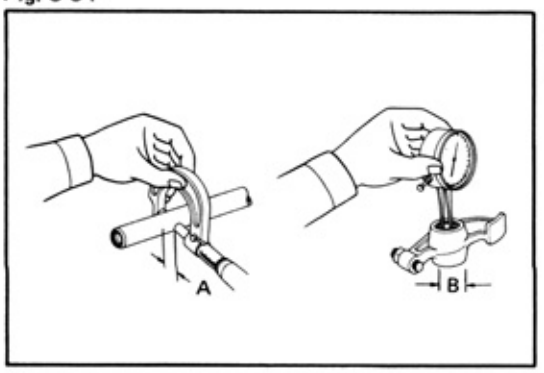
Fig. 3-33



Valve Rocker Arm and Rocker Shaft

1. 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.

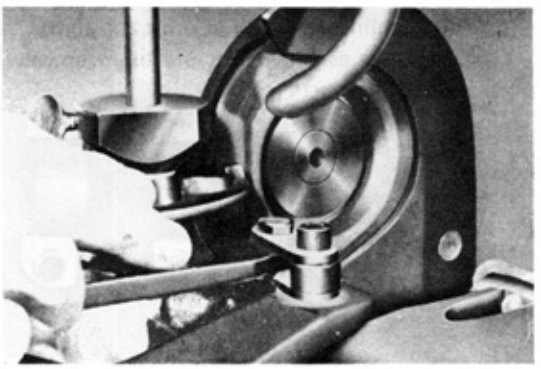
Fig. 3-34



2. Inspect the valve rocker arm and shaft, if worn excessively, replace the rocker arm or shaft.

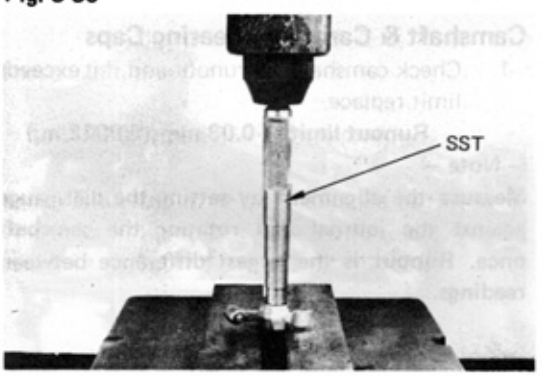
Oil clearance limit 0.06 mm (0.0024 in.)
Standard 0.012 – 0.033 mm (0.0005 – 0.0013 in.)

Fig. 3-35



3. If the valve rocker arm surface that contacts the camshaft is worn excessively, replace the rocker arm.
If only a light ridged wear, correct with valve refacer and oil stone.

Fig. 3-36

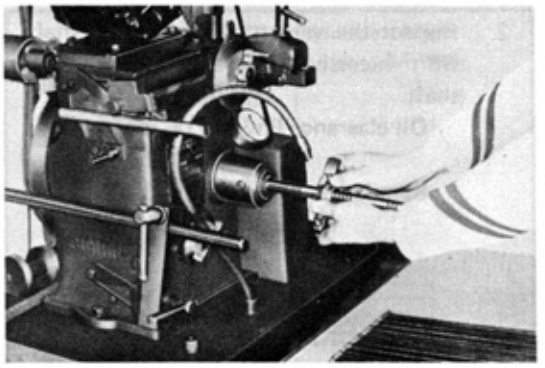


4. Replace any rocker shaft spring found damaged.
   (1) Press out the bushing, using SST [09222-30010].
   (2) Apply oil in the rocker arm bore for the bushing, and press in the new bushing by means of a press or vise until it is square with the arm hole.

Fig. 3-37

– Caution –
Be sure to have the oil holes in the bushing and arm aligned properly.

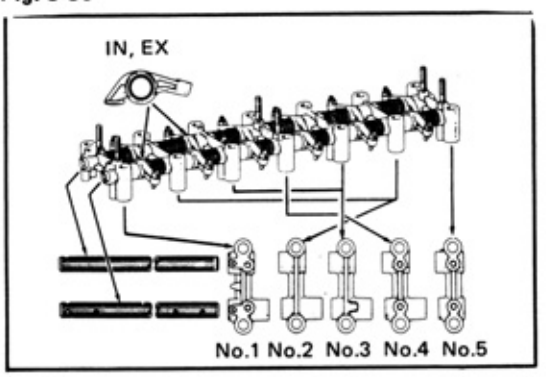
Fig. 3-38



(3) Finish the bushing bore with a pin hole grinder.
Standard oil clearance between shaft and bushing.

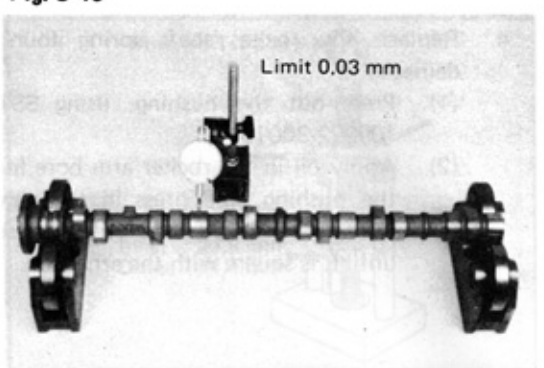
Standard 0.012 – 0.033 mm (0.0005 – 0.0013 in.)

Fig. 3-39



5. Assembling valve rocker arms and shafts.
Assemble as shown left, starting from valve rocker support No.1.

Fig. 3-40



Camshaft & Camshaft Bearing Caps

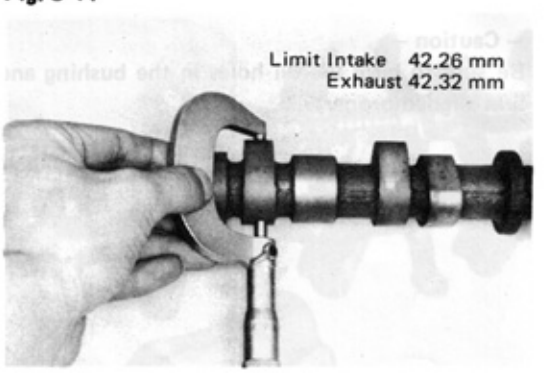
1. Check camshaft for runout and if it exceeds limit replace.

Runout limit 0.03 mm (0.0012 in.)

– Note –

Measure the alignment by setting the dial gauge against the journal and rotating the camshaft once. Runout is the largest difference between readings.

Fig. 3-41

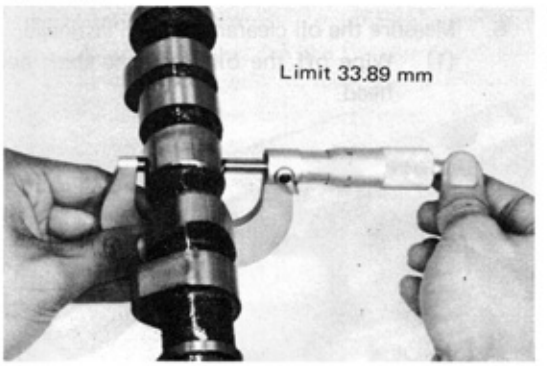


2. Measure cam heights. If measured valves are less than specified valves, replace camshaft.

Cam height limit

Intake 42.26 mm (1.6638 in.)
Exhaust 42.32 mm (1.6661 in.)

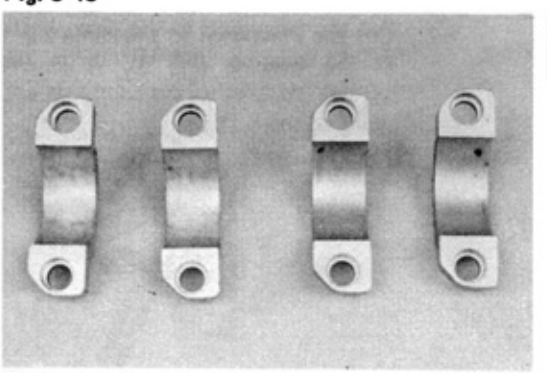
Fig. 3-42



3. Measure journal diameter. If it is less than specified limit, replace camshaft.

Journal diameter limit
33.89 mm (1,334 in.)

Fig. 3-43

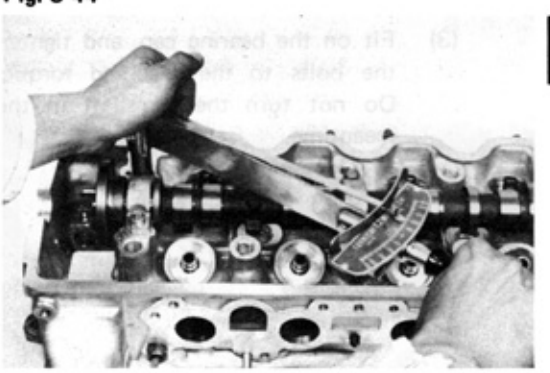


4. Inspect the bearing cap surface for flaking, melting, burning, and other defects, and replace if defective.

– Caution –

1. **Never attempt to adjust bearing clearance by using shims or a scraper.**
2. **Never sand down the bearing cap surface.**

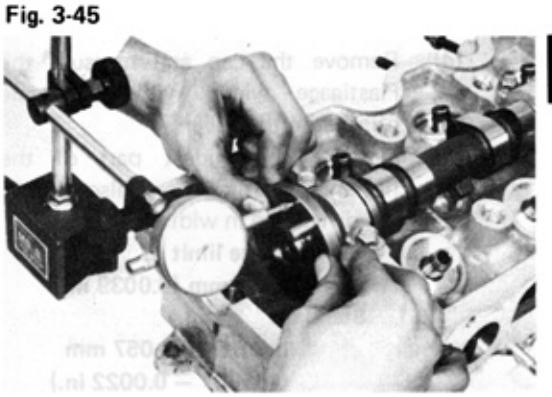
Fig. 3-44



5. Measure the camshaft thrust clearance
   (1) Install the camshaft in the cylinder head and tighten the cap to the specified torque.

Specified torque 1.7 – 2.3 kg-m
(12.3 – 16.6 ft-lbs.)

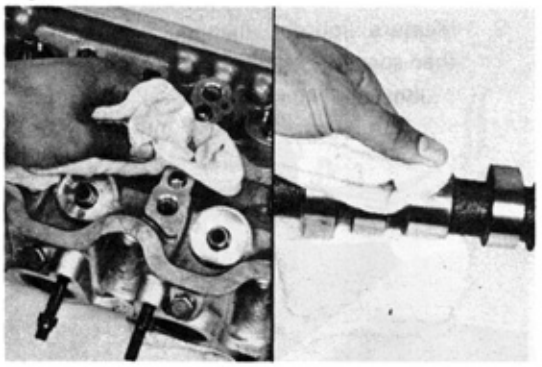
Fig. 3-45



(2) Measure the thrust clearance with dial gauge.

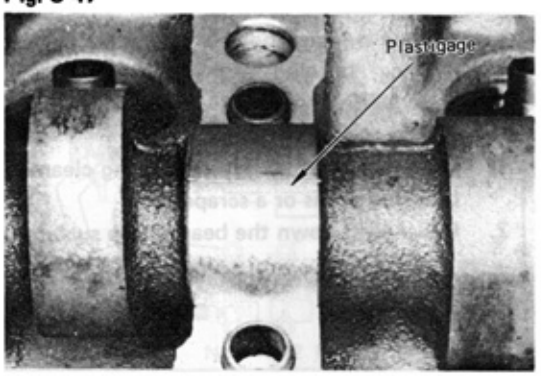
Thrust clearacne
Standard 0.08 – 0.18 mm
(0.0031 – 0.0071 in.)
Limit 0.3 mm (0.012 in.)

Fig. 3-46



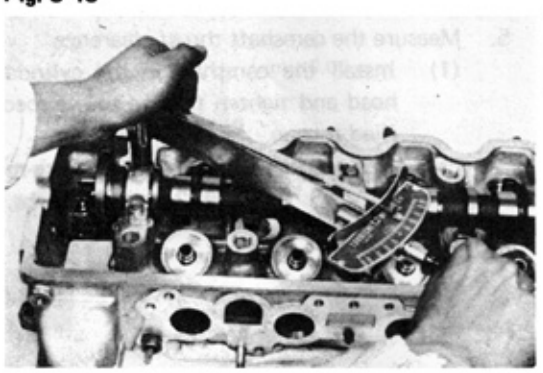
6. Measure the oil clearance with Plastigage.
   (1) Wipe off the oil from the shaft and head.

Fig. 3-47



(2) Cut the Plastigage to the same width as the bearing and lay it on the journal, parallel to the camshaft and avoiding the oil hole.

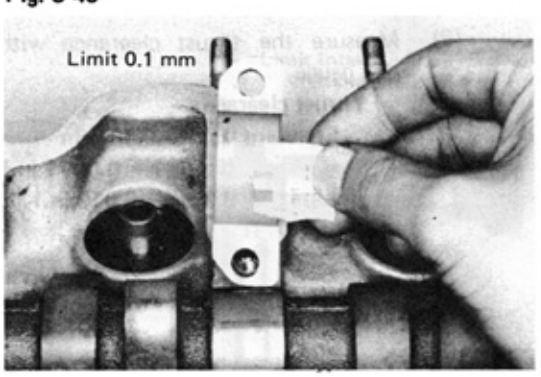
Fig. 3-48



(3) Fit on the bearing cap, and tighten the bolts to the specified torque. Do not turn the camshaft in the meantime.

Tightening torque
1.7 – 2.3 kg-m
(12.3 – 16.6 ft-lbs.)

Fig. 3-49

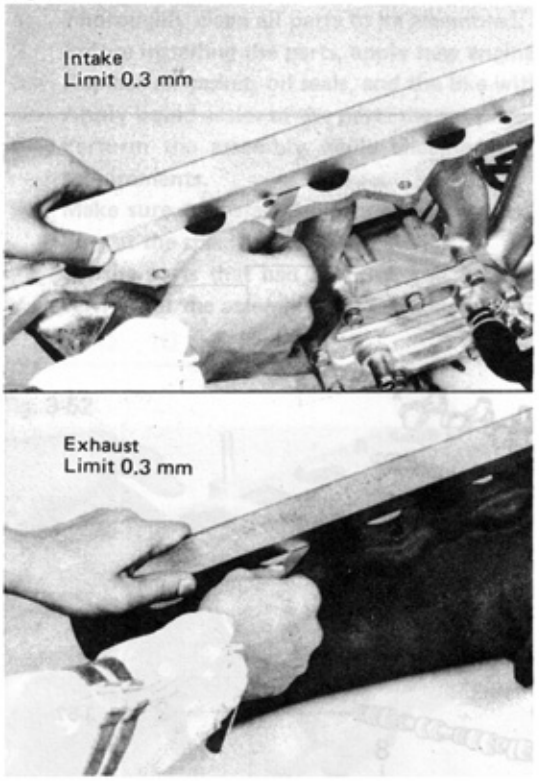


(4) Remove the cap and measure the Plastigage width with the scale printed on the cover.

(5) Measure the widest part of the flattened Plastigage, and also observe the difference in widths at the ends.

Oil clearance limit
0.1 mm (0.0039 in.)
Standard
0.017 – 0.057 mm
(0.007 – 0.0022 in.)

Fig. 3-50



Manifolds (Intake & Exhaust)

1. Inspect the parts for corrosion, damage, cracks, and other defects, and repair or replace if faulty.
2. Inspect the surfaces contacting the cylinder head for warpage, and repair or replace if warped over the limit.

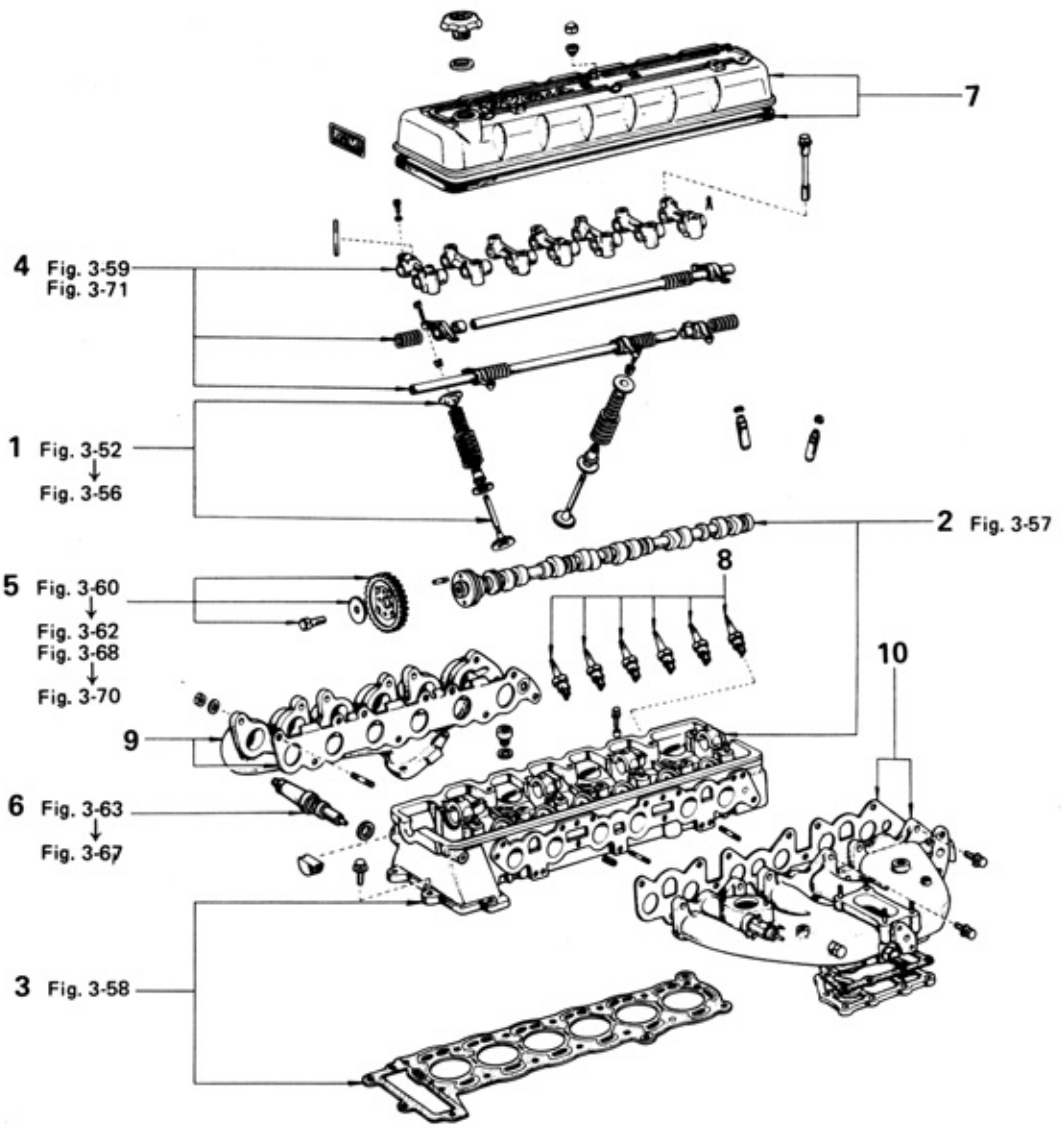
Warpage limit

Intake	**0.3 mm (0.012 in.)**
Exhaust	**0.3 mm (0.012 in.)**

ASSEMBLY

Assemble in numerical order.

Fig. 3-51

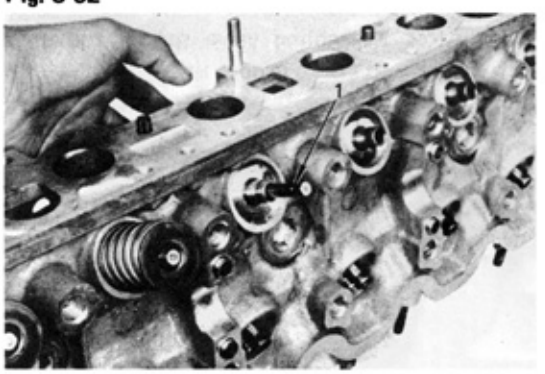


1. Valve & Spring
2. Camshaft & Cap
3. Cylinder Head & Gasket
4. Rocker Arm Assembly
5. Camshaft Timing Gear
6. Chain Tensioner
7. Cylinder Head Cover & Gasket
8. Spark Plug
9. Exhaust Manifold & Gasket
10. Intake Manifold & Gasket

– Note –

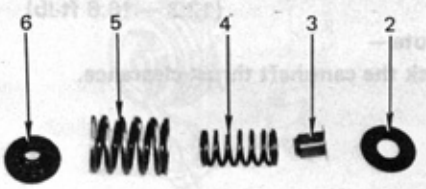
1. **Thoroughly clean all parts to be assembled.**
2. **Before installing the parts, apply new engine oil on all sliding and rotating surfaces.**
3. **Replace all gasket, oil seals, and the like with new parts.**
4. **Apply liquid sealer at the parts that require prevention of water or oil leakage.**
5. **Perform the assembly while checking on the parts for oil clearance, thrust clearance, and similar requirements.**
6. **Make sure to install the proper bolts, nuts, washers, and other fasteners, and to tighten the bolts and nuts at the specified torque.**
7. **On the parts that had been marked at disassembly, ressemble them in accordance with the marks, and verify that the assembly had been made correctly before advancing to the next step.**

Fig. 3-52



1. Insert the valve (1) into the cylinder head guide bushing.

Fig. 3-53

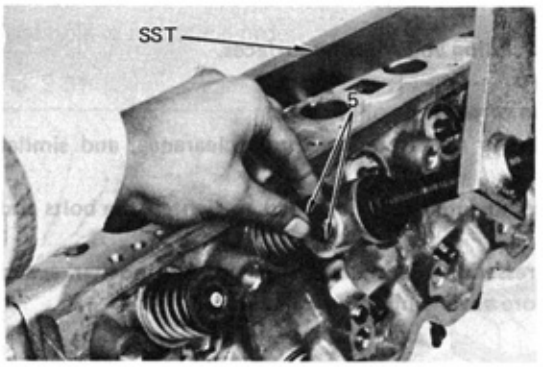


2. Assemble on the plate washer (2), oil seal (3), inner and outer springs (4), and valve spring retainer (5).

Fig. 3-54

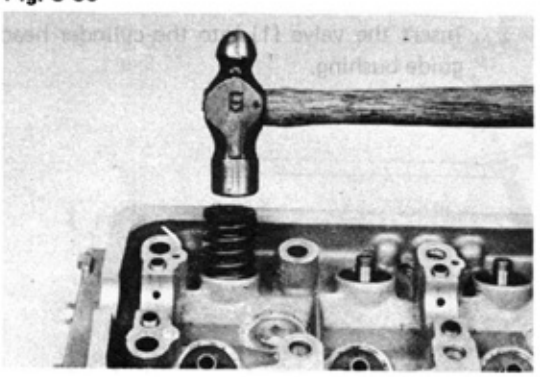
– Caution –
Different oil seals are used for the intake and exhaust so that care should be taken not to assemble the wrong type.

Fig. 3-55



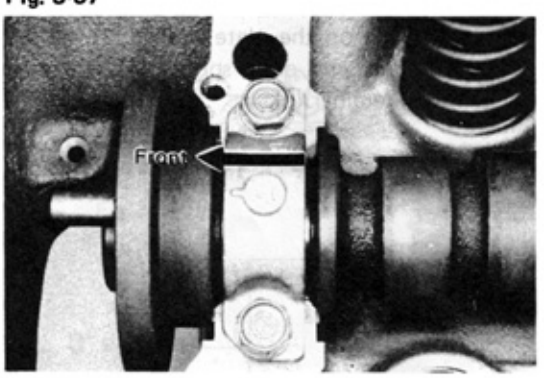
3. Compress the valve springs with SST [09202-43012] and install the retainer lock (5).

Fig. 3-56



4. After assembling valve spring, top stem lightly to assure proper fit.

Fig. 3-57



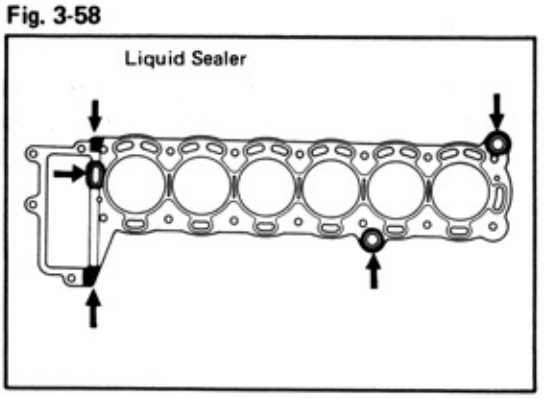
Assemble the camshaft bearing caps with their arrow marks pointed toward the front.

Tightening torque 1.7 – 2.3 kg-m (12.3 – 16.6 ft-lb)

– Note –

Check the camshaft thrust clearance.

Fig. 3-58

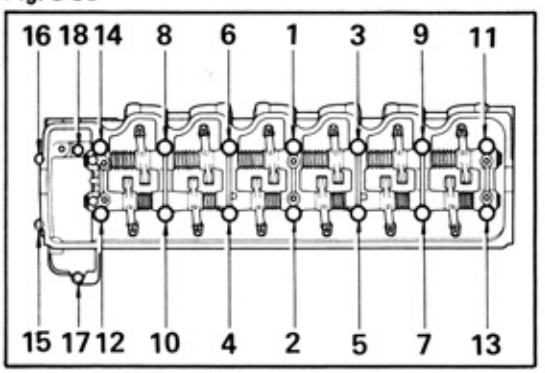


Apply liquid sealer on the cylinder head, around the oil holes in the block, and in the vicinity of the timing chain cover and cylinder block.

– Caution –

Clean out all water, oil, and other foreign matter from the bolt holes in the cylinder head and block upper surface.

Fig. 3-59



Tighten the head bolts gradually in three to four passes in the sequence shown in figure, tightening at specified torque in the final pass.

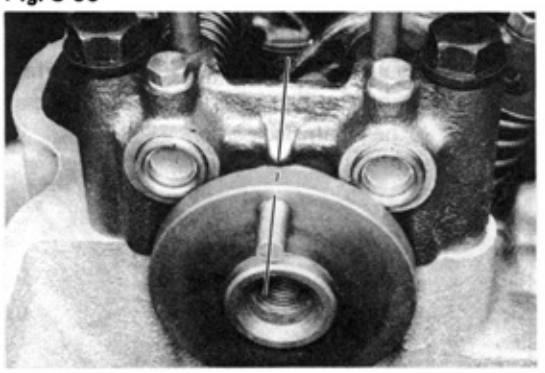
Tightening torque

12 mm bolts	**7.5 – 8.5 kg-m (54.3 – 61.5 ft-lb)**
8 mm bolts	**1.5 – 2.2 kg-m (10.9 – 15.9 ft-lb)**

– Caution –

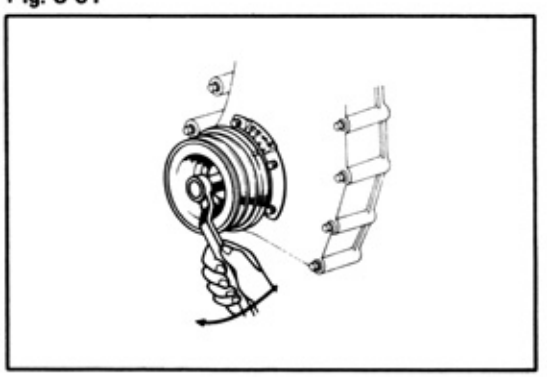
Before tightening, loosen valve adjusting screws and lock nuts.

Fig. 3-60



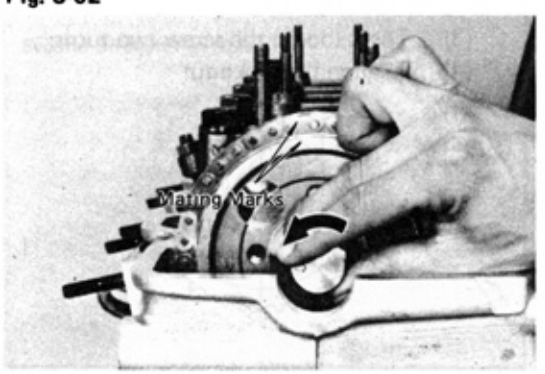
1. Align the camshaft flange timing mark (Pin) against the embossed mark on the valve rocker support No.1.

Fig. 3-61



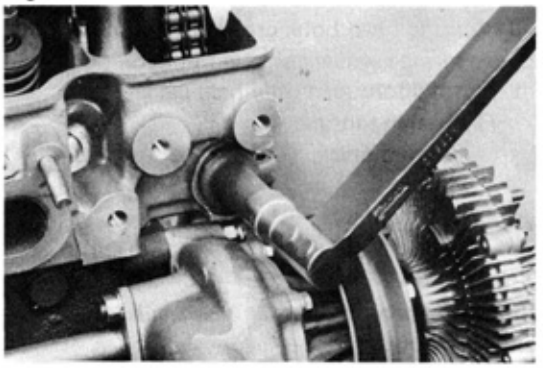
2. Set the timing mark to 0° mark on the timing gear cover.

Fig. 3-62



3. Assemble the camshaft timing gear matching the mating marks.
4. Screw in the set bolt (left hand thread) only finger tight.

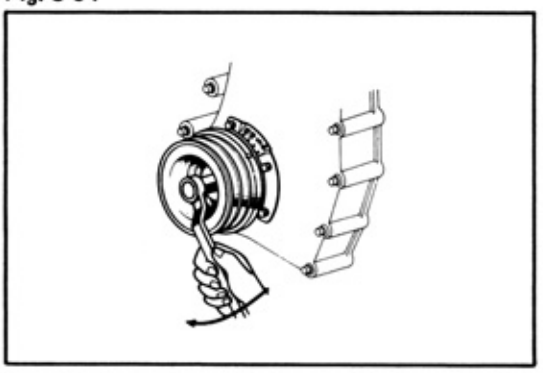
Fig. 3-63



5. Tighten the chain tensioner to the specified torque.

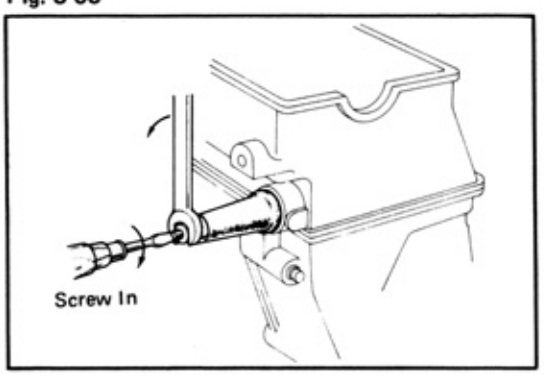
Tightening torque	**3.0 – 4.0 kg-m (21.7 – 28.9 ft-lb)**

Fig. 3-64



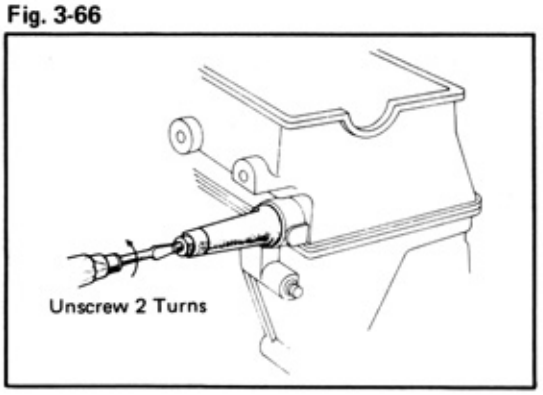
6. Chain tensioner adjustment.
   (1) Turn the crankshaft in regular direction until there is maximum slack at the chain slack side.

Fig. 3-65



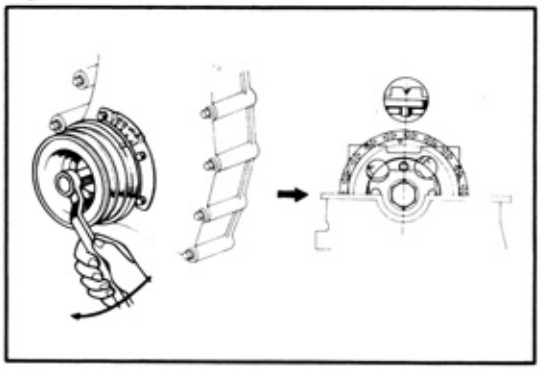
   (2) Loosen the locknut and turn the screw clockwise until resistance is felt.

Fig. 3-66



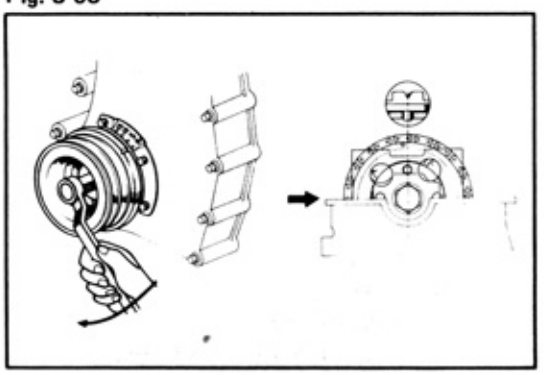
   (3) Then, loosen the screw two turns.
   (4) Tighten the locknut.

Fig. 3-67



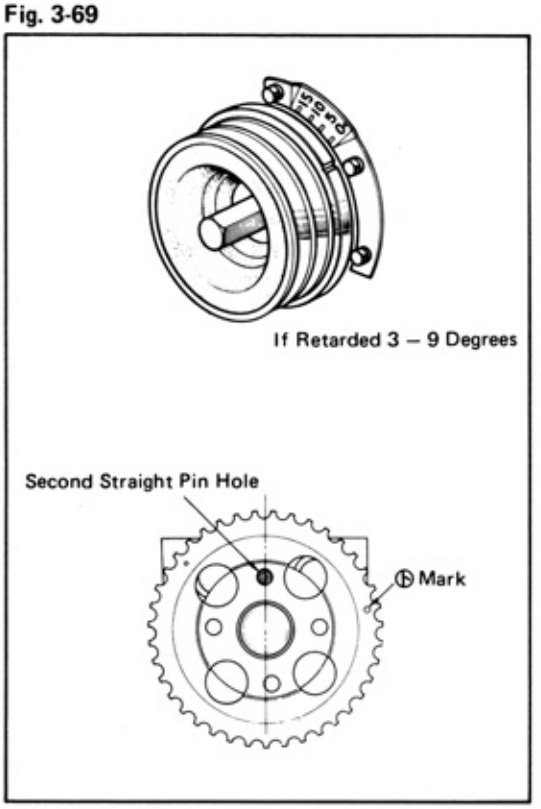
7. Check and adjust the valve timing in the following sequence.
   (1) Turn the crankshaft in regular direction until the No.1 piston is at TDC/-compression.
   (2) At this position, the timing pin in camshaft flange should be aligned at the center of the embossed mark on valve rocker support No.1.

Fig. 3-68



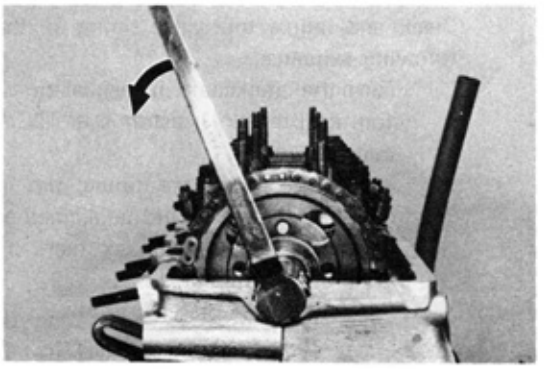
8. If the valve timing is faulty, adjust as follows:
   (1) Turn the crankshaft in regular direction until the timing pin in camshaft flange is aligned with the embossed mark on the valve rocker support No.1.

Fig. 3-69



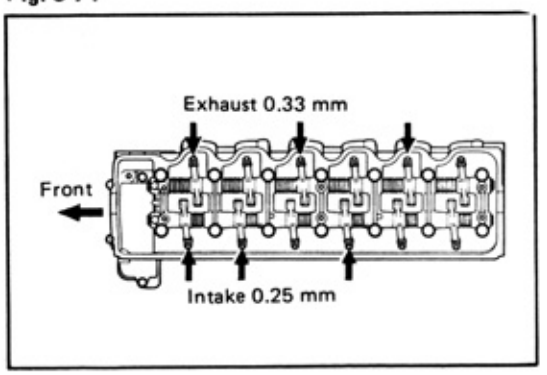
   (2) Read the scale on the timing chain cover (at crankshaft pulley side).
   (3) If retarded 3 to 9 degrees, loosen the camshaft set bolt (LH threads) and reposition the camshaft gear to the second straight pin hole.
   (4) Recheck the valve timing.

Fig. 3-70



9. Tighten the camshaft timing gear set bolt at the specified torque.
   Tightening torque 6.5 – 7.5 kg-m (47.0 – 54.3 ft-lb)

Fig. 3-71



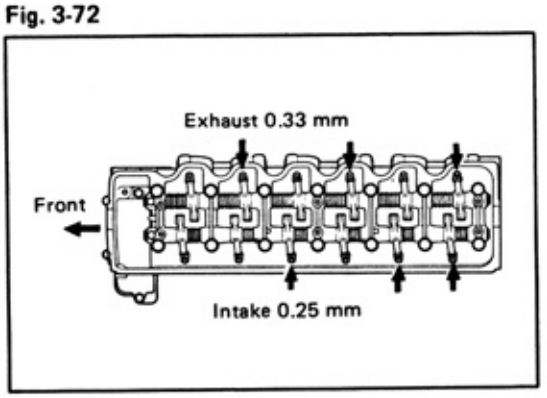
Using thickness gauge, adjust the valve clearance.

Valve clearance (cold)

Intake 0.25 mm (0.0098 in.)
Exhaust 0.33 mm (0.0130 in.)

1. Set the No.1 cylinder at compression top dead center and adjust the clearances in the following valves.
   Intake side
   No.1, No.2 & No.4 cylinders
   Exhaust side
   No.1, No.3 & No.5 cylinders

Fig. 3-72



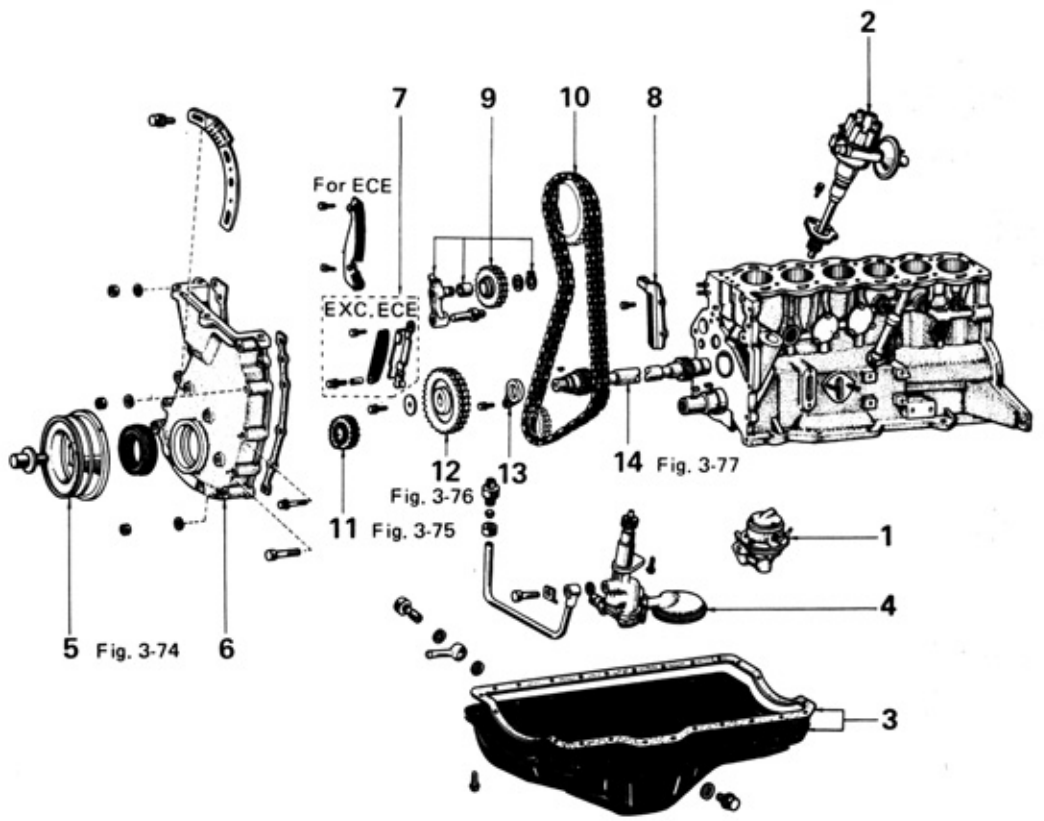
2. Rotate the crankshaft one turn clockwise and adjust the clearance in the following valves.
   Intake side
   No.3, No.5 & No.6 cylinders
   Exhaust side
   No.2, No.4 & No.6 cylinders

TIMING CHAIN SERVICE

DISASSEMBLY

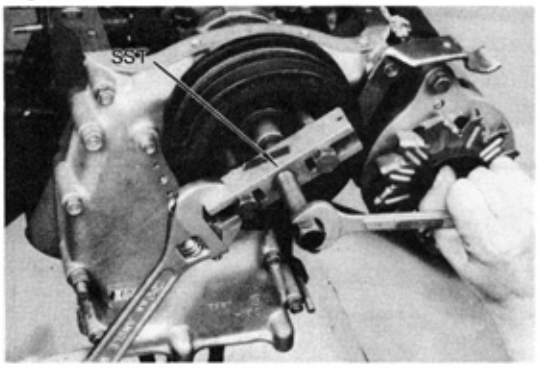
Disassemble in numerical order.

Fig. 3-73



1. Fuel Pump
2. Distributor
3. Oil Pan
4. Oil Pump
5. Crankshaft Pulley
6. Timing Gear Cover
7. Chain Vibration Damper No.1 & Guide
8. Chain Vibration Damper No.2
9. Tension Gear & Arm
10. Chain
11. Crankshaft Timing Gear
12. Pump Driveshaft Gear
13. Pump Drive Shaft Plate
14. Pump Drive Shaft

Fig. 3-74

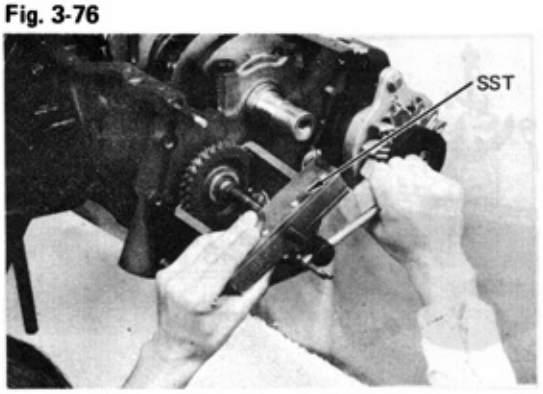


Using SST[09213-31021], remove the crankshaft pulley.

Fig. 3-75

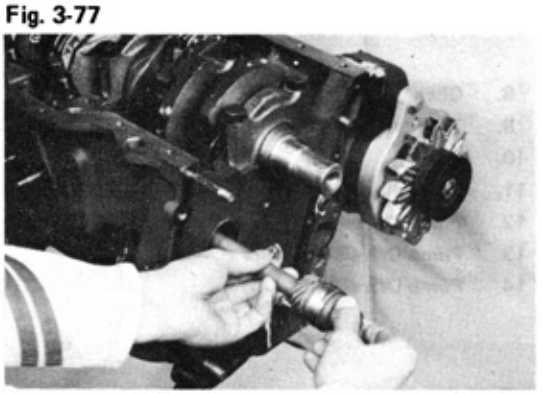
Using SST[09213-36010], remove the crank shaft timing gear.

Fig. 3-76



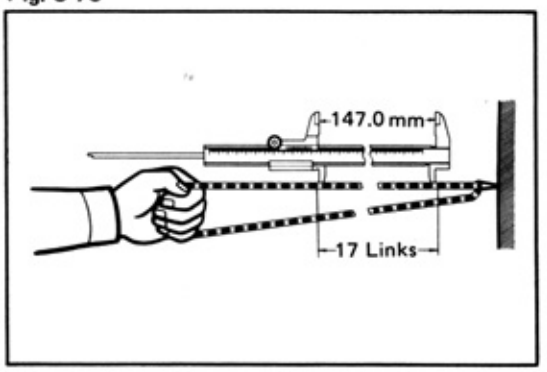
Using SST[09213-36010], remove the pump drive shaft gear.

Fig. 3-77



Draw out the pump drive shaft, using care not to damage the pump drive shaft bearing.

Fig. 3-78



INSPECTION & REPAIR

Timing Chain

Elongation check

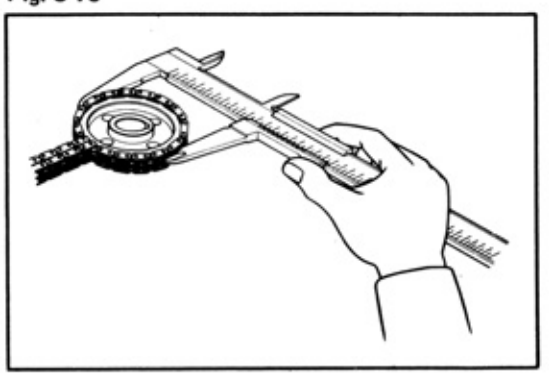
Measure the length of 17 links with the chain stretched tight with the force of one hand.

Make the same measurements at more than three other places selected at random.

If over the limit at any one place, replace the chain.

Timing chain elongation limit (at 17 links)
147.0 mm (5.787 in.)

Fig. 3-79



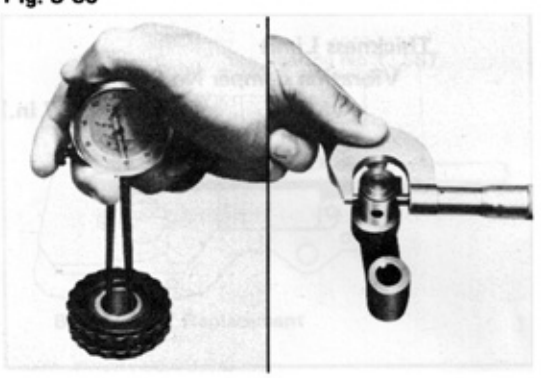
Timing Gears

Wear check

Wrap the chain around the gear, and with vernier calipers, measure the gear outside diameter (outer sides of chain rollers).

Wear limit
For crankshaft gear 64.9 mm (2.555 in.)
For pump drive shaft gear
95.9 mm (3.776 in.)
For camshaft timing gear
126.0 mm (4.961 in.)

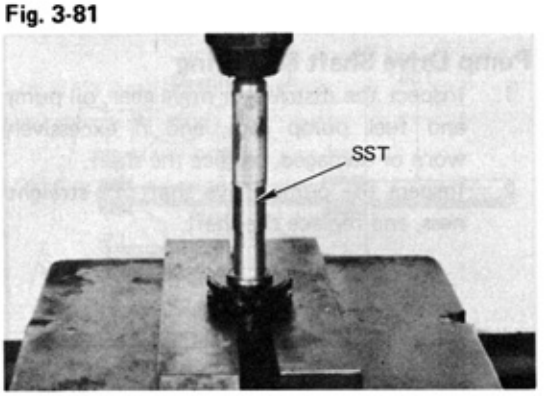
Fig. 3-80



Tension Gear

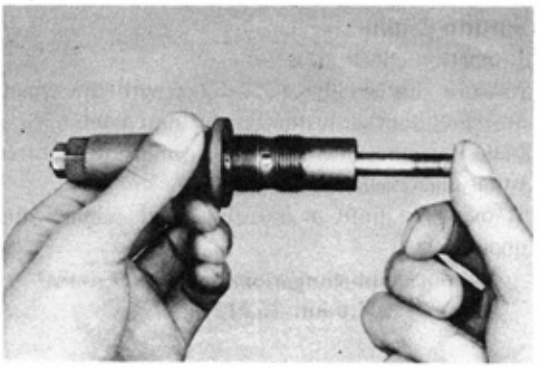
1. Inspect the tension gear teeth, tension gear shaft and solid bushing, and replace if worn or damage.
2. Measure the clearance between the tension gear and shaft.
   Oil clearance limit 0.1 mm (0.039 in.)
   Standard 0.020 – 0.054 mm
   (0.0008 – 0.0021 in.)

Fig. 3-81



3. Replace the bushing, using SST[09222-30010] and a press.

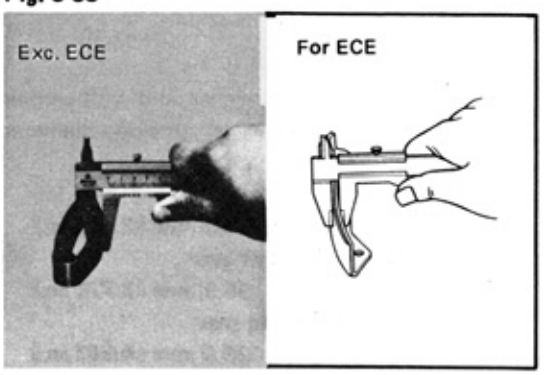
Fig. 3-82



Chain Tensioner & Damper

1. Check the tensioner plunger to see that it slides smoothly in the body cylinder.

Fig. 3-83



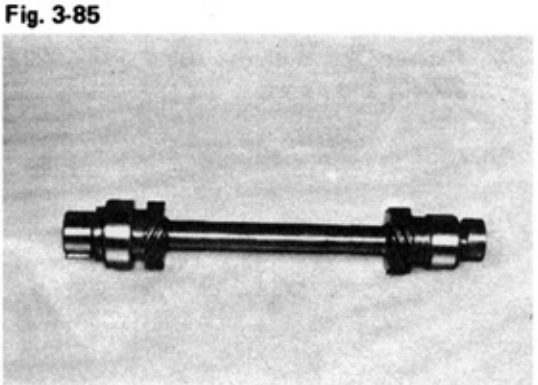
2. Measure the wall thicknesses of vibration dampers.

Thikness Limit
Vibration damper No.1
4.0 mm (0.157 in.)

Fig. 3-84

Thickness Limit
Vibration damper No.2
5.0 mm (0.197 in.)

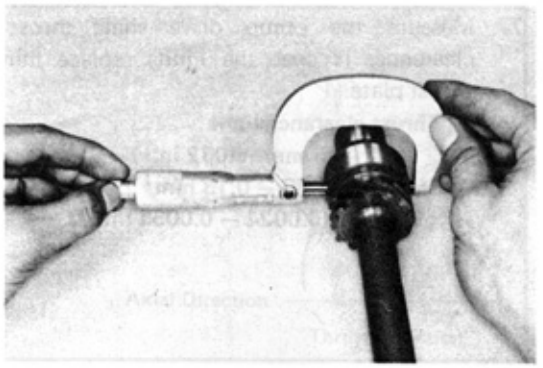
Fig. 3-85



Pump Drive Shaft & Bearing

1. Inspect the distributor drive gear, oil pump and fuel pump cam, and if excessively worn or damaged, replace the shaft.
2. Inspect the pump drive shaft for straightness, and replace the shaft.

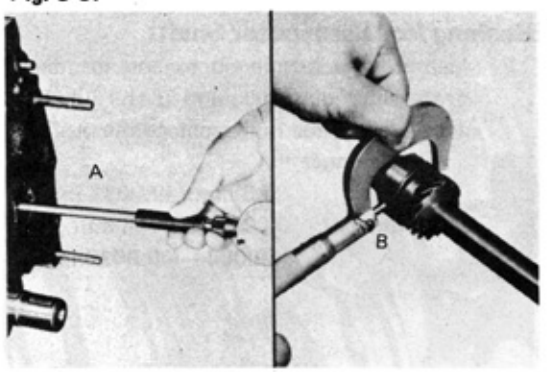
Fig. 3-86



3. Inspect the pump drive shaft jurnals, and if damaged or worn, replace the shaft.

Taper and out-of-round limit
0.01 mm
(0.0004 in.)

Fig. 3-87

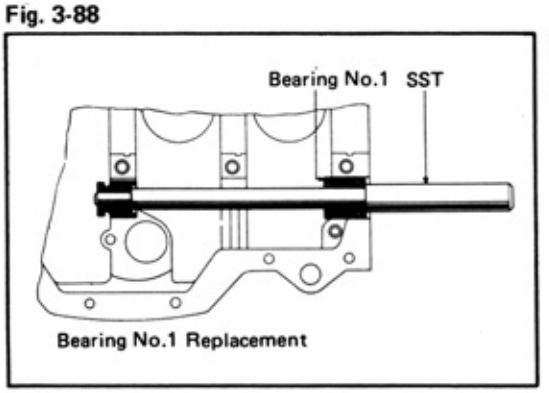


4. Inspect the bearings, and if worn, damaged, melted, contacting improperly, or otherwise defective, replace the bearings.
5. Measure the oil clearance.

Oil clearance = A – B

Limit	**0.08 mm (0.0031 in.)**
Standard	**0.025 – 0.066 mm (0.0010 – 0.0026 in.)**

Fig. 3-88



6. If the oil clearance exceeds the specified limit, replace the bearing with SST [09233-41010].
When replacing bearings, use No.2 as the guide for bearing No.1, and No.1 as the guide for bearing No.2.

Pump Drive Shaft Bearing Finished Sizes mm (in.)

	No.1 (Front)	No.2 (Rear)
Journal diameter (B)	40.959–40.975 (1.6126–1.6132)	32.959–32.975 (1.2976–1.2982)
Bearing bore diameter (A)	41.000–41.025 (1.6141–1.6151)	33.000–33.025 (1.2992–1.3001)

Fig. 3-89

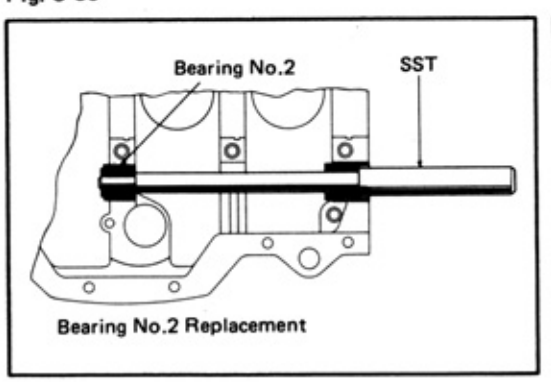
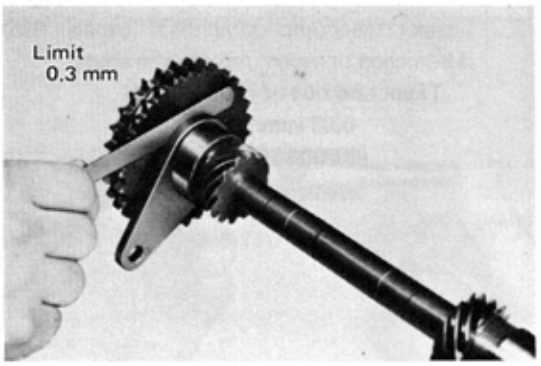


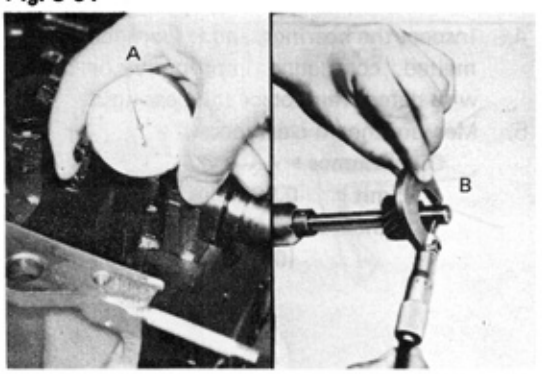
Fig. 3-90



7. Measure the pump drive shaft thrust clearance. If over the limit, replace the thrust plate.

Thrust clearance limit
0.3 mm (0.012 in.)
Standard 0.06 – 0.13 mm
(0.0024 – 0.0051 in.)

Fig. 3-91

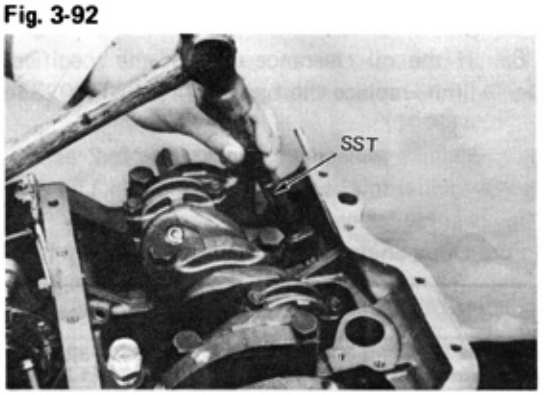


Bushing (for Distributor Shaft)

1. Measure the bushing bore and the distributor shaft diameter, and if the oil clearance exceeds the limit, replace the bushing.

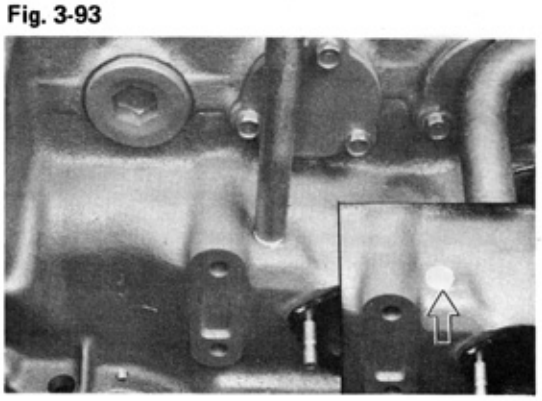
Oil clearance = A – B
Limit 0.08 mm (0.0031 in.)
Standard 0.010 – 0.048 mm
(0.0004 – 0.0019 in.)

Fig. 3-92



2. Use SST[09212-41010] to replace the bushing.

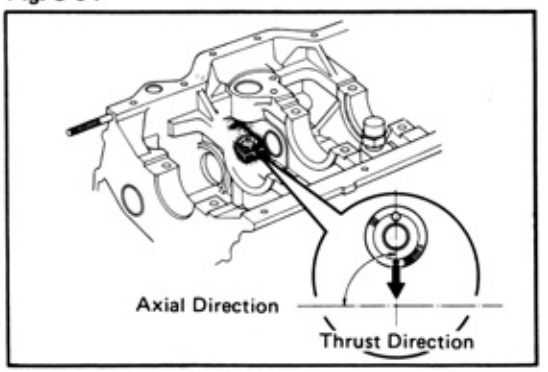
Fig. 3-93



Bushing (for Pump Drive Shaft Guide)

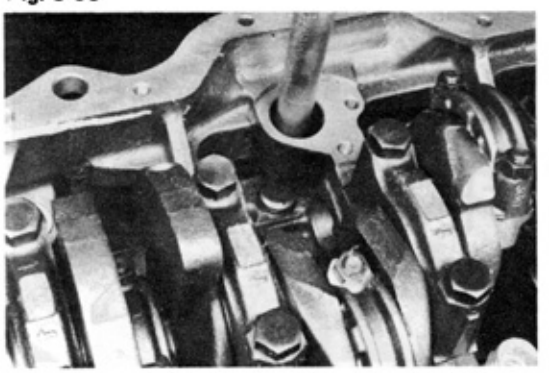
1. Inspect the bushing and replace if worn excessively or damaged.
2. Drive out the bushing from the outer side of block.

Fig. 3-94



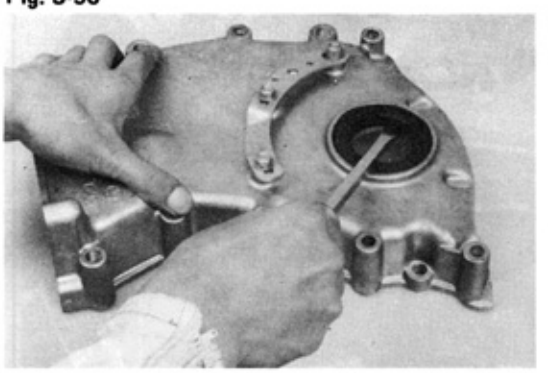
3. Bushing installed direction.
   Install the bushing with its oil hole positioned toward the pump drive gear.

Fig. 3-95



4. Drive in the bushing, using care not to damage it. After driving it in, check to see that the oil pump shaft can be installed.

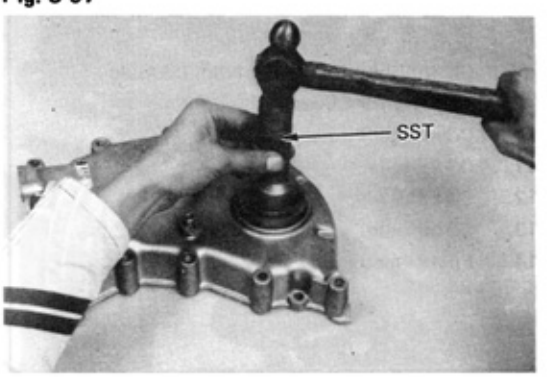
Fig. 3-96



Front Oil Seal

1. Inspect the crankshaft front oil seals and replace if the lips are worn, damaged, or cracked.
2. Front oil seal replacement
   (1) Remove with a screwdriver or similar tool.

Fig. 3-97



(2) Install the new crankshaft front oil seal by driving it in with SST [09223-50010].

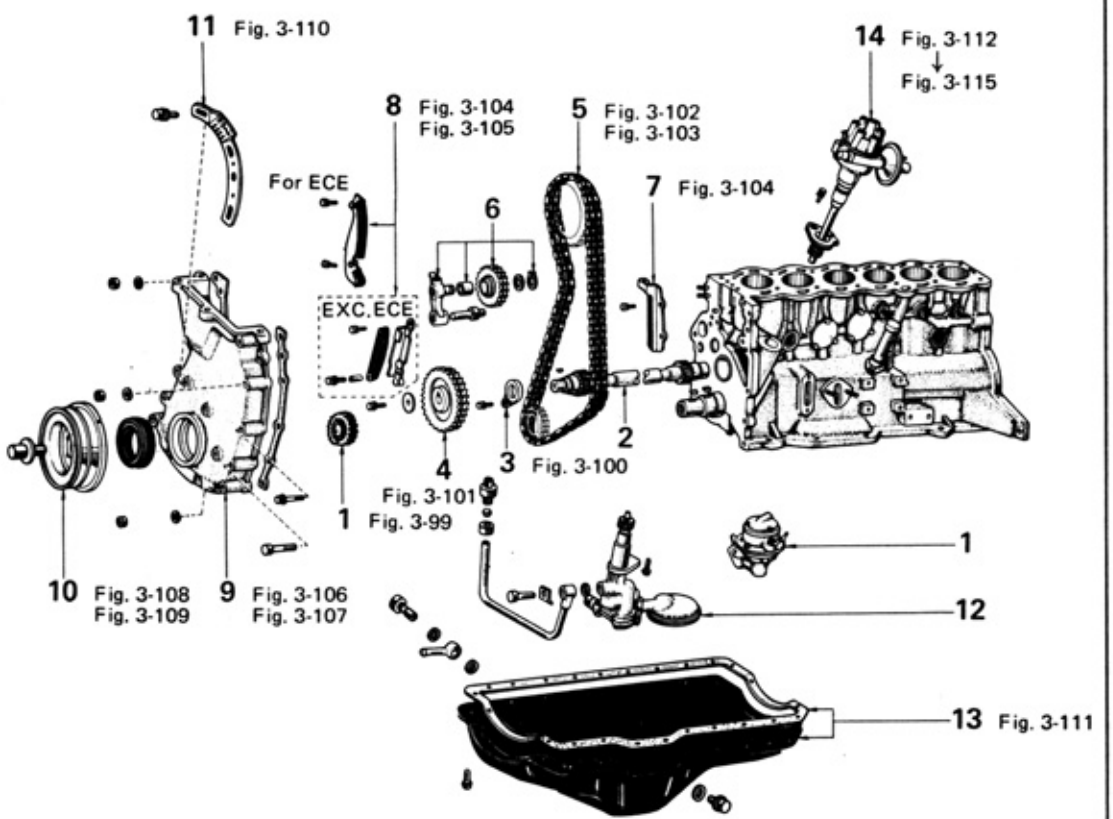
– Note –

After driving in the seal, be sure to coat the seal lip lightly with MP grease.

ASSEMBLY

Assemble in numerical order.

Fig. 3-98

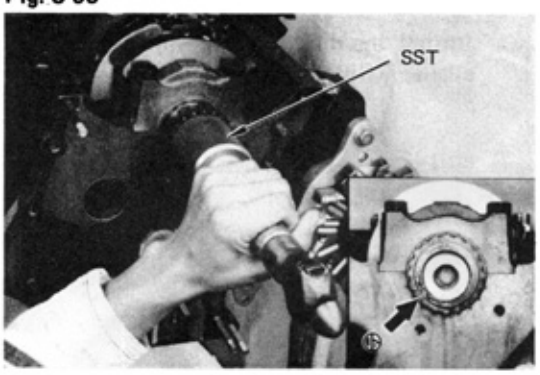


1. Crankshaft Timing Gear
2. Pump Drive Shaft
3. Pump Drive Shaft Plate
4. Pump Drive Shaft Gear
5. Chain
6. Tension Gear & Arm
7. Chain Vibration Damper No.2
8. Chain Vibration Pamper No.1 & Guide
9. Timing Gear Cover
10. Crankshaft Pulley
11. Oil Pump
12. Oil Pan
13. Distributor
14. Fuel Pump

– Note –

1. **Thoroughly clean all parts to be assembled.**
2. **Before installing the parts, apply new engine oil on all sliding and rotating surfaces.**
3. **Replace all gaskets, oil seals, and the like with new parts.**
4. **Apply liquid sealer at the parts that require prevention of water or oil leakage.**
5. **Perform the assembly while checking on the parts for oil clearance, thrust clearance, and similar requirements.**
6. **Make sure to install the proper bolts, nuts, washers, and other fasteners, and to tighten the bolts and nuts at the specified torque.**
7. **On the parts that had been marked at disassembly, reassemble them in accordance with the marks, and verify that the assembly had been made correctly before advancing to the next step.**

Fig. 3-99

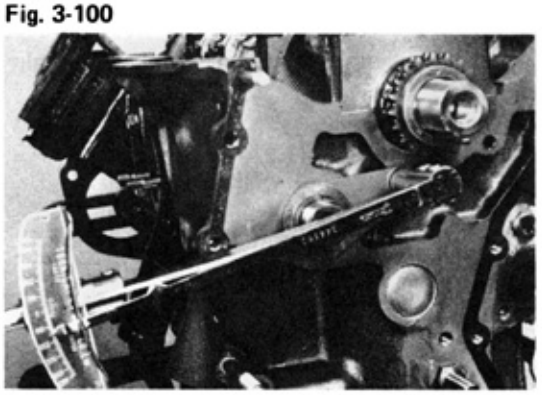


Using SST [09214-41010], install the crankshaft timing gear.

– Note –

Have the gear ⊕ mark facing the front side.

Fig. 3-100

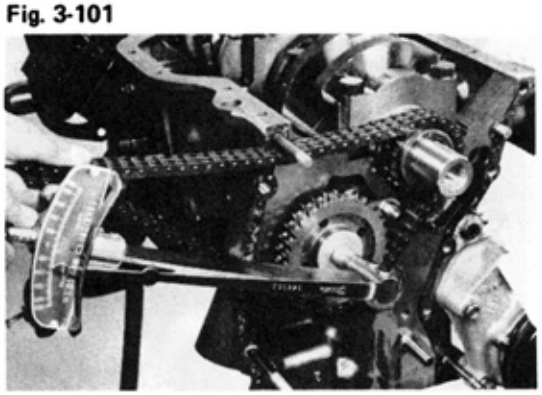


Position the flat side of the thrust plate toward the block, and install the thrust plate to the shaft in floated state.

Tightening torque

1.0 to 1.6 kg-m (7.2 to 11.6 ft-lb)

Fig. 3-101

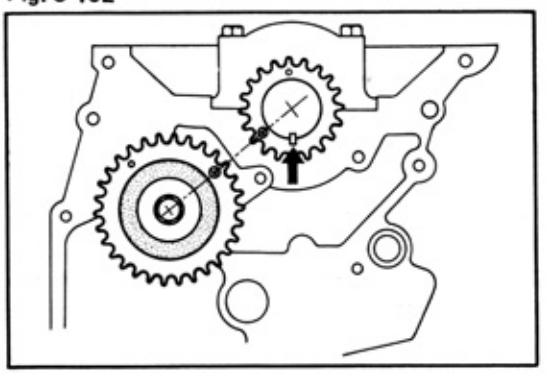


Utilize the chain and tighten the pump drive shaft gear at the specified torque.

Tightening torque

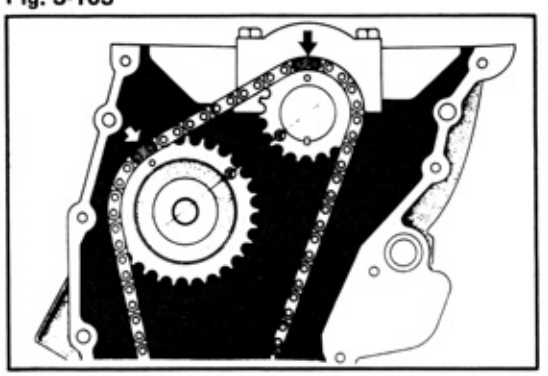
1.0 to 1.6 kg-m (7.2 to 11.6 ft-lb)

Fig. 3-102



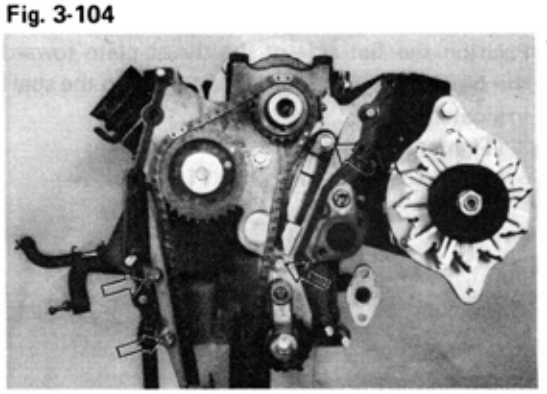
1. Position the crankshaft key straight downward (toward cylinder head).
2. Set the pump drive shaft gear such that its Ⓕ will be directly opposed to the Ⓕ mark on the crankshaft timing gear.

Fig. 3-103



3. Install the timing chain with white mark aligned with the gear punch mark.

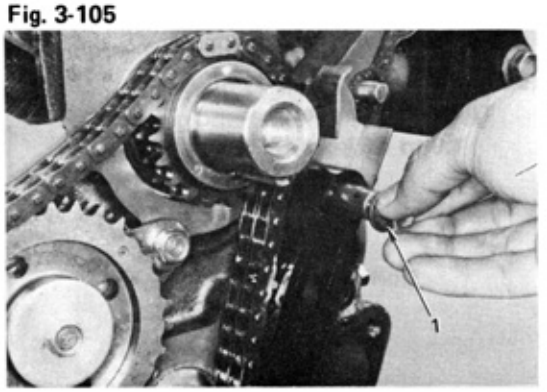
Fig. 3-104



Install the vibration damper and the chain damper.

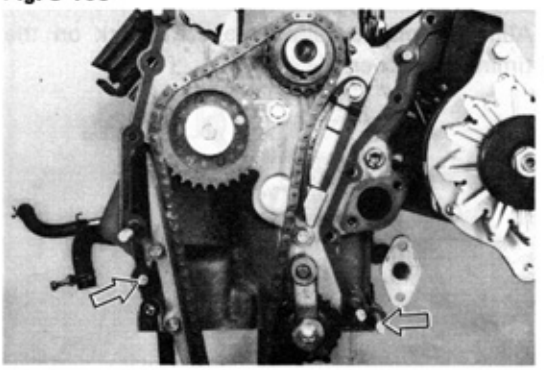
Tightening torque
1.0 – 1.6 kg-m (7.2 – 11.6 ft-lb)

Fig. 3-105



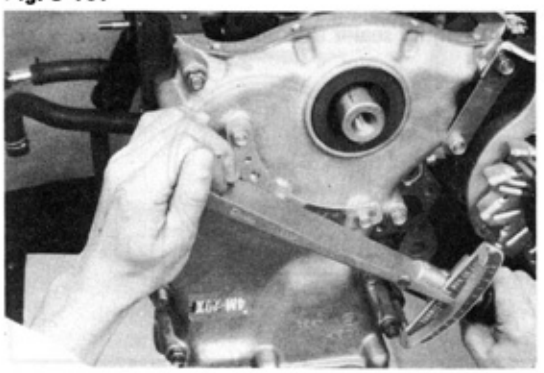
Insert the collar (1) on bolt (A) before installing. (Exc. ECE)

Fig. 3-106



Apply liquid sealer at two places as shown.

Fig. 3-107

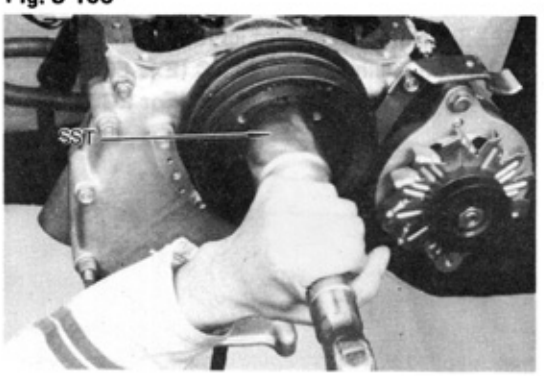


Install the timing chain cover over a gasket.

Tightening torque

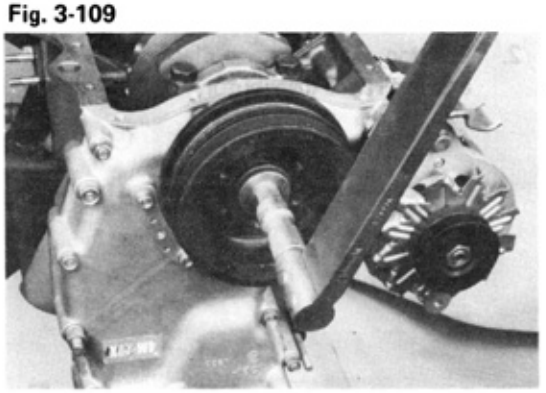
8 mm bolt	**1.0 – 1.6 kg-m (7.2 – 11.6 ft-lb)**
10 mm bolt	**1.9 – 3.1 kg-m (13.7 – 22.4 ft-lb)**
8 mm nut	**1.5 – 2.2 kg-m (10.9 – 15.9 ft-lb)**
10 mm nut	**1.9 – 3.1 kg-m (13.7 – 22.4 ft-lb)**

Fig. 3-108



Using SST[09214-41010], drive in the crankshaft pulley.

Fig. 3-109



Tighten the crankshaft pulley set bolt at specified torque.

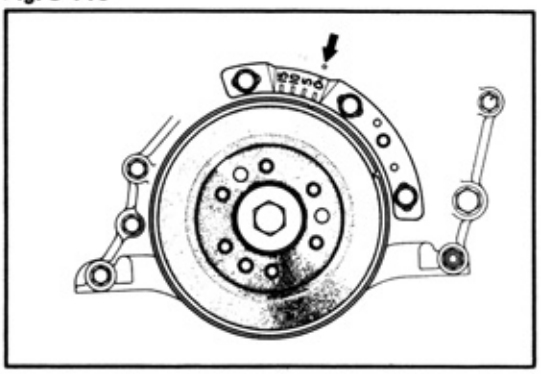
Tightening torque

13.5 – 16.5 kg-m (97.7 – 119.3 ft-lb)

– Note –

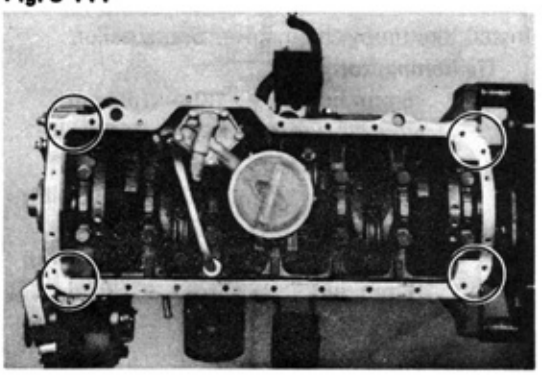
Do not turn the crankshaft when tightening.

Fig. 3-110



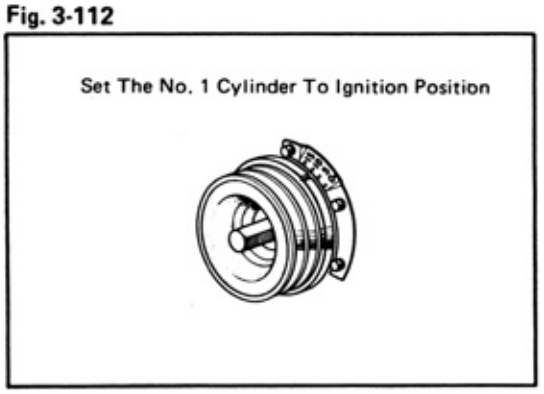
Align 0° mark against the dent mark on the timing gear cover.

Fig. 3-111



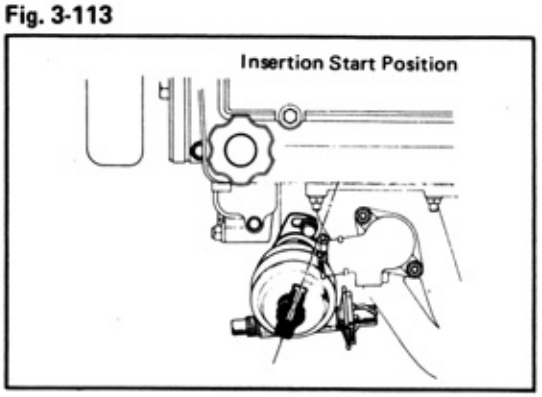
Apply liquid sealer at four places as shown.

Fig. 3-112



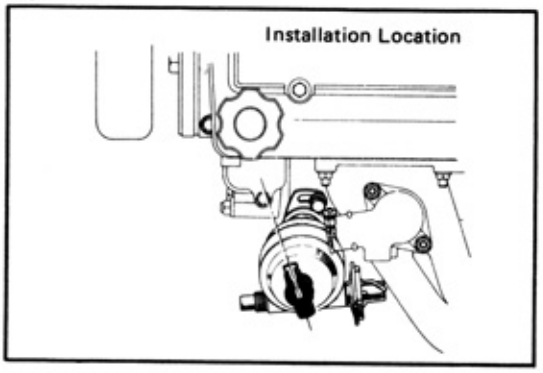
1. Set No.1 cylinder to ignition timing.
   Ignition timing **8° BTDC (Exc ECE)**
   12° BTDC (For ECE)

Fig. 3-113



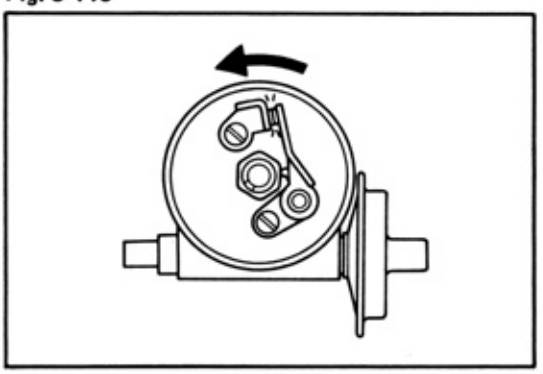
2. Position the rotor and diaphram as shown and insert the distributor.

Fig. 3-114



3. When fully installed, rotor should point toward as shown.

Fig. 3-115



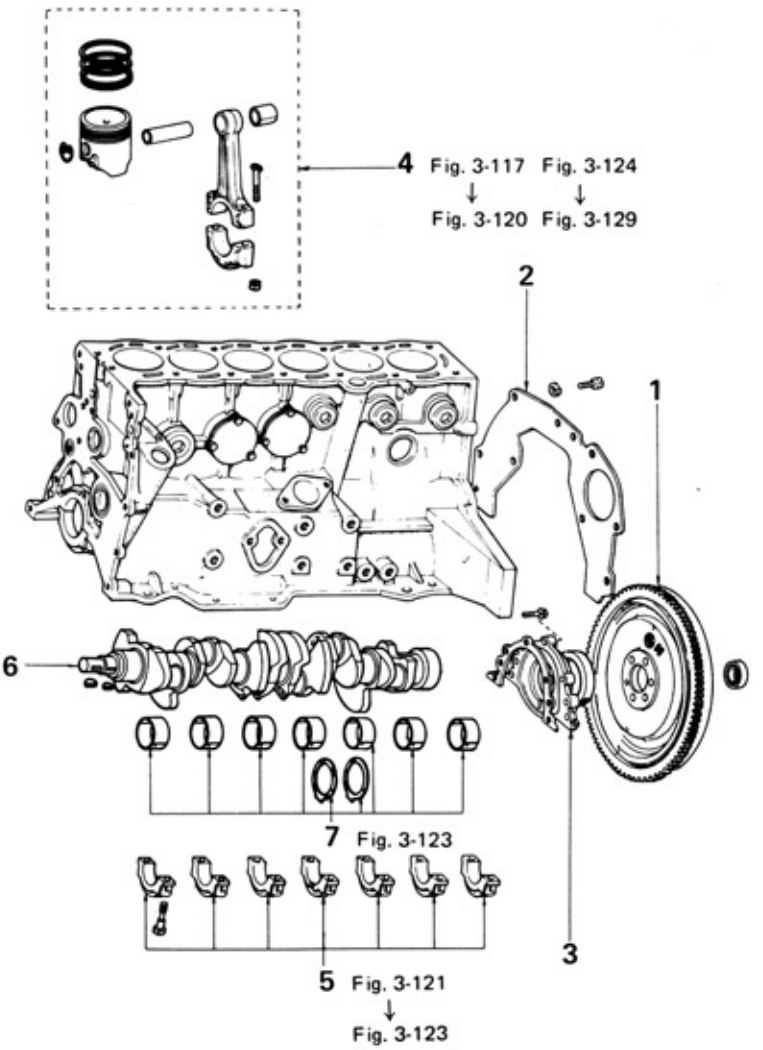
4. Turn the distributor housing and set it at the place where the points just begin to open.

CYLINDER BLOCK SERVICE

DISASSEMBLY

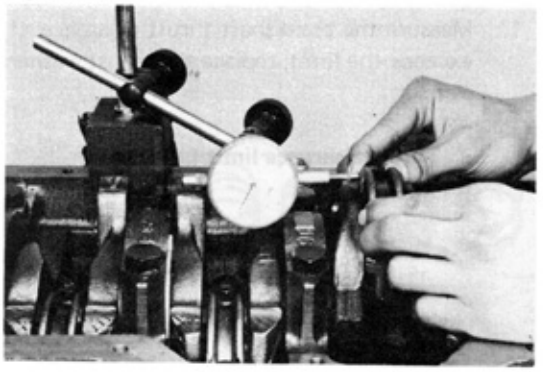
Disassemble in numerical order.

Fig. 3-116



1. Flywheel
2. Rear End Plate
3. Rear Oil Seal Retainer
4. Piston With Connecting Rod
5. Crankshaft Bearing Cap
6. Crankshaft
7. Crankshaft Bearing Set

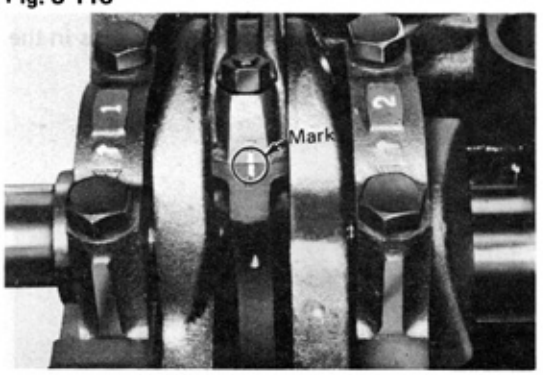
Fig. 3-117



1. Measure connecting rod thrust clearance. If exceeds the limit, replace the connecting rod.

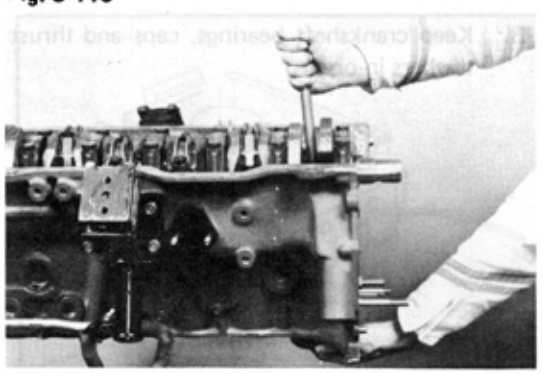
Thrust clearance limit
0.3 mm (0.012 in.)

Fig. 3-118



2. Mark connecting rod and cap for correct reassembly.

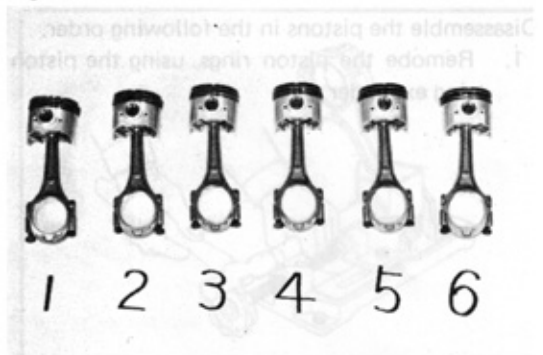
Fig. 3-119



3. Remove the pistons from the cylinders, using care not to drop them.

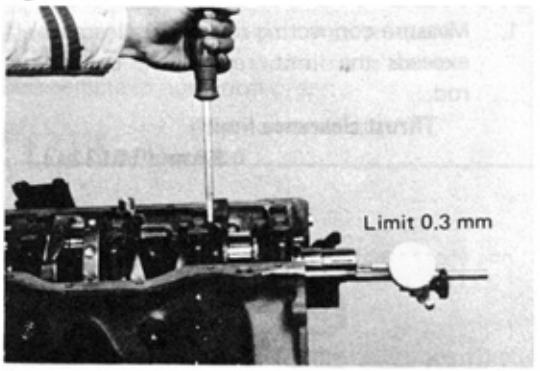
– Note –
Use care not to damage crankshaft.

Fig. 3-120



4. Attach the bearing caps temporarily to the connecting rods.
Keep the connecting rod and bearing in order.

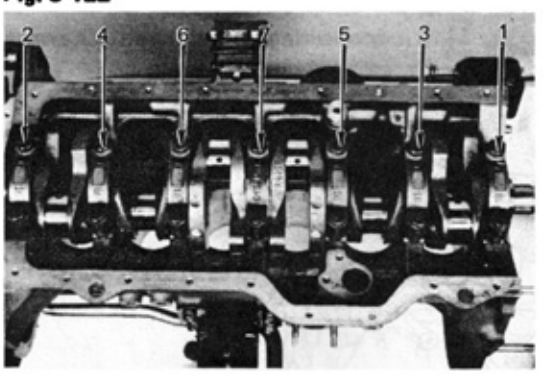
Fig. 3-121



1. Measure the crankshaft thrust clearance. If exceeds the limit, replace the thrust washer as a set.

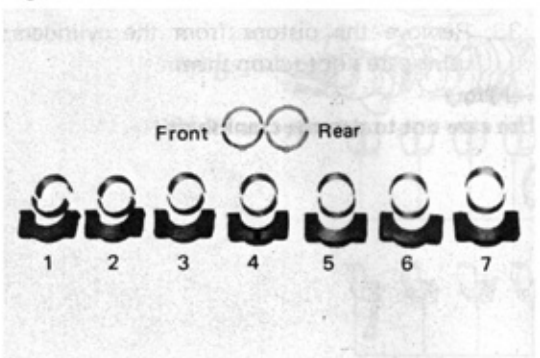
Thrust clearance limit	**0.3 mm (0.012 in.)**

Fig. 3-122



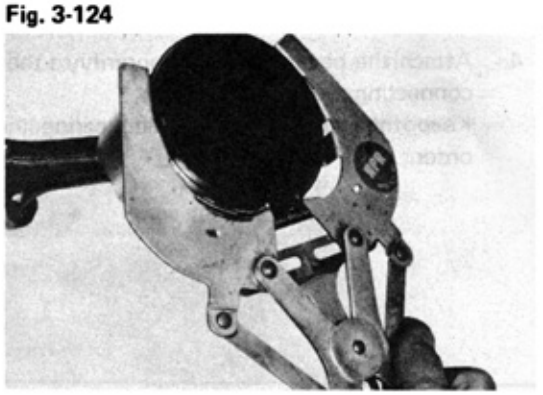
2. Remove the crankshaft bearing caps in the sequence shown in the illustration.

Fig. 3-123



3. Keep crankshaft bearings, caps and thrust washers in order.

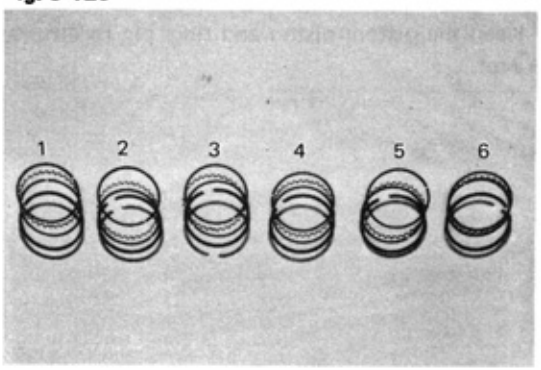
Fig. 3-124



Disassemble the pistons in the following order.

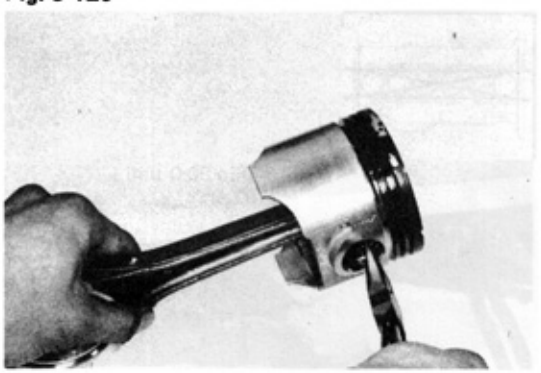
1. Remobe the piston rings, using the piston ring expander.

Fig. 3-125



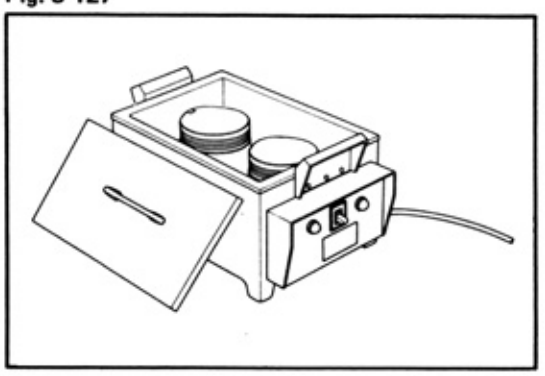
2. Keep the removed piston rings separated in accordance with cylinder.

Fig. 3-126



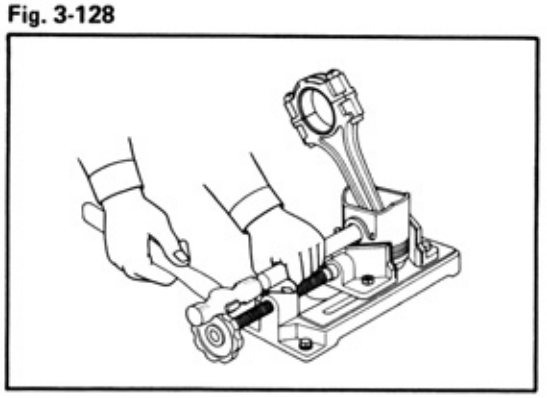
1. Remove the hole snap rings, using the needle-nose pliers.

Fig. 3-127



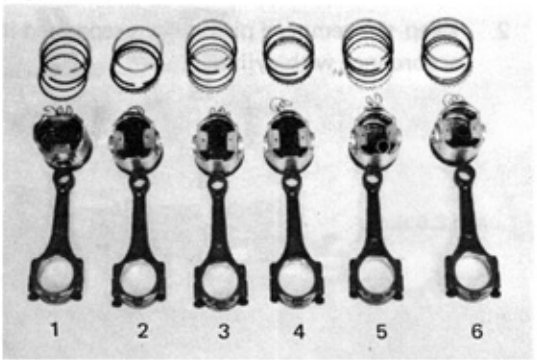
2. Heat the piston in a piston heater to about 60°C (140°F).

Fig. 3-128



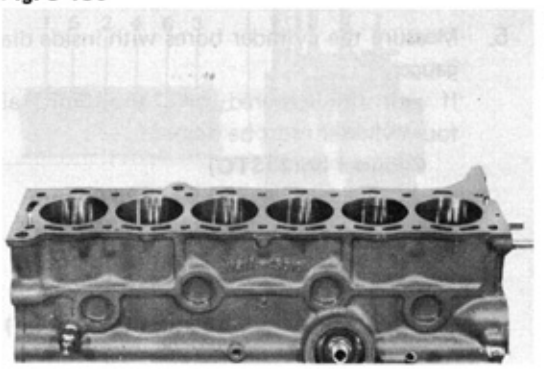
3. Remove the piston pin by tapping lightly with a plastic hammer.

Fig. 3-129



⚠ Keep the piston, piston and rings pin together as a set.

Fig. 3-130

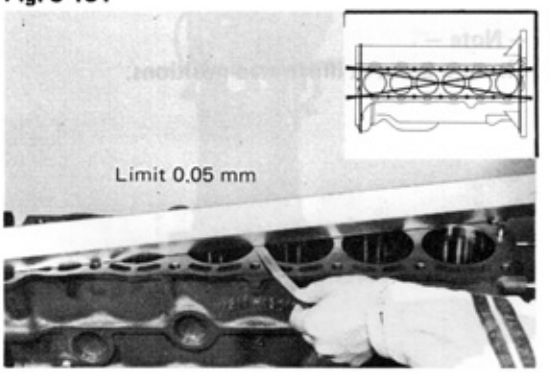


INSPECTION & REPAIR

Cylinder Block

1. Inspect for cracks and damage. If found defective, repair or replace.

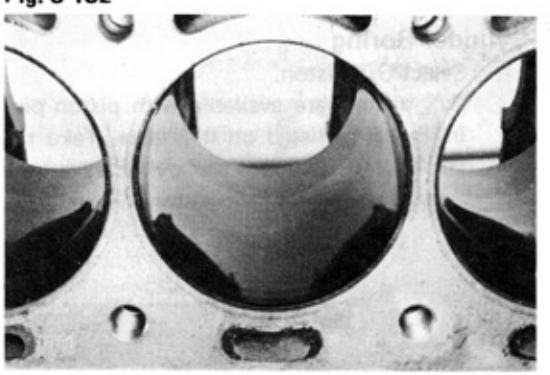
Fig. 3-131



2. Measure the warpage at the four sides and diagonals.

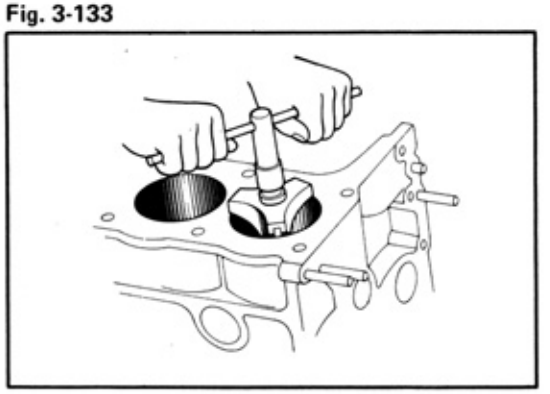
Warpagelimit **0.05 mm (0.0020 in.)**

Fig. 3-132



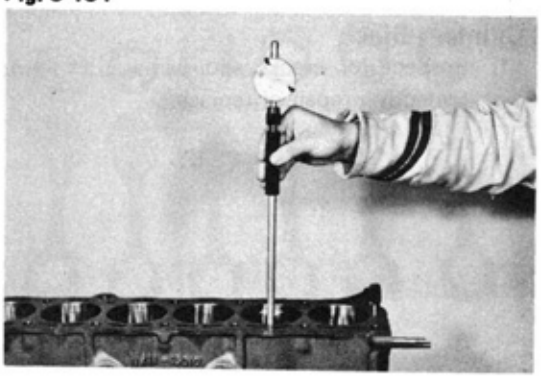
3. Visually inspect cylinders for scratches and the ridge. If deep scrathes are present, cylinder must be rebored.

Fig. 3-133



4. Machine off the ridge from the cylinder upper part. Use a tool such as a ridge remover.

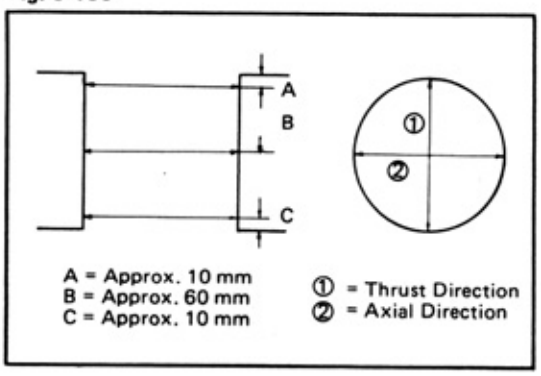
Fig. 3-134



5. Measure the cylinder bores with inside dial gauge.
   If worn or tapered over the limit, all four cylinder must be rebored.

   Cylinder bore (STD)
   79.99 80.04 mm
   (3.1492 3.1512 in.)
   Wear limit 0.2 mm (0.008 in.)
   Taper and out-of round limit
   0.02 mm (0.0008 in.)

Fig. 3-135



– Note –
Measure bores at illustrated positions.

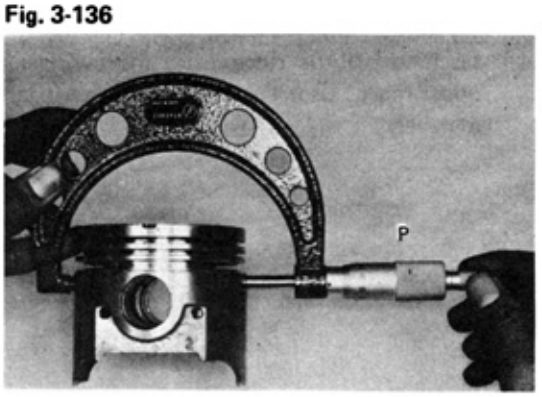
Piston Sizes (at 20°C) mm (in.)

Size	Piston Outside Diameter
STD	79.93 – 79.98 (3.1469 – 3.1488)
O/S 0.50	80.43 – 80.48 (3.1665 – 3.1685)
O/S 0.75	80.68 – 80.73 (3.1764 – 3.1784)
O/S 1.00	80.93 – 80.98 (3.1862 – 3.1882)

Cylinder Boring

1. Select O/S piston.
   O/S pistons are available with piston pins in the sizes listed on the table. Take the largest bore among the cylinders as the standard and select the pistons accordingly.

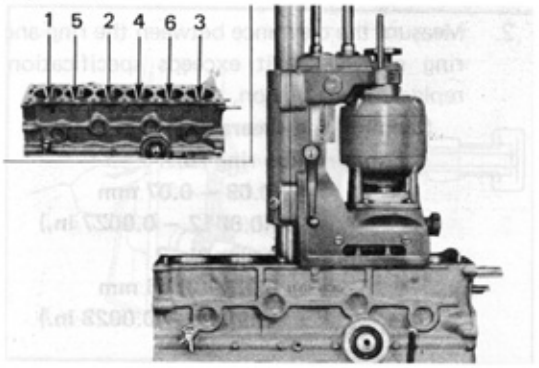
Fig. 3-136



2. Dimension of boring cylinder.
   (1) Measure the pistons to be used.
   (2) Calculate the size to which each cylinder is to be rebored by means of the following equation.

   Size to be rebored = P + C – H
   P : Piston diameter
   C : Piston clearance
   0.05 – 0.07 mm (0.0020 – 0.0028 in.)
   H : Allowance for honing
   less than 0.02 mm (0.0008 in.)

Fig. 3-137

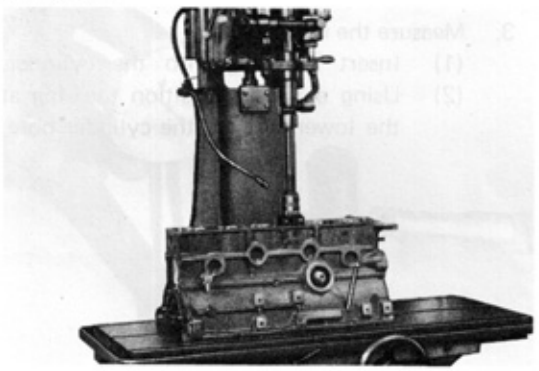


3. Boring the cylinder to the calculated sizes.

– Caution –

1. **When boring to the final size, set the cutter so that not more than 0.05 mm (0.0020 in.) of metal will be removed at one setting.**
2. **Bore the cylinders in the sequence illustrated to prevent warpaging caused by heating.**
3. **Use care in measuring. The bore will measure larger immediately after boring due to expansion by heat.**

Fig. 3-138



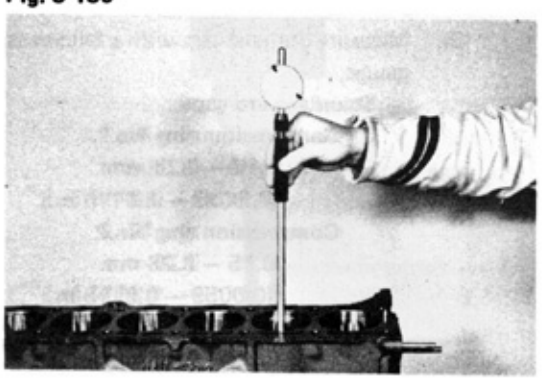
4. Hone the cylinder bores for accurate finishing of their walls.

Honing amount
0.02 mm (0.0008 in.) maximum

– Caution –

Excessive honing will destroy the finished accurancy (roundness).

Fig. 3-139



5. Measure the cylinder bores.

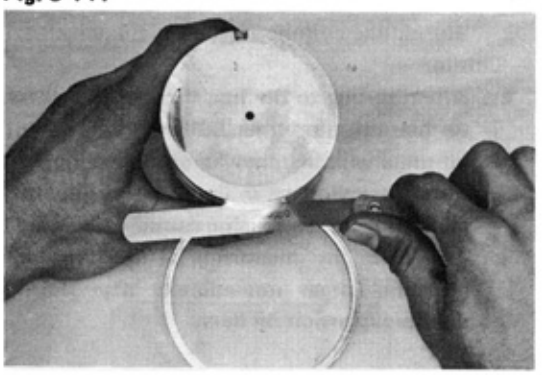
Taper and out-of-round
0.02 mm (0.0008 in.) maximum
Bore difference among cylinders
0.05 mm (0.0020 in.) maximum
Standard piston clearance
0.05 – 0.07 mm (0.0020 – 0.0028 in.)
(At 20°C or 68°F)

Fig. 3-140

Piston, Piston Pin, and Piston Rings

1. Check fit between piston and piston pin by trying to rock piston.
   If any movement is felt, piston and pin, must be replaced.

Fig. 3-141



2. Measure the clearance between the ring and ring groove. If it exceeds specification, replace ring or piston.

Standard ring clearance

Compression ring No.1

0.03 – 0.07 mm

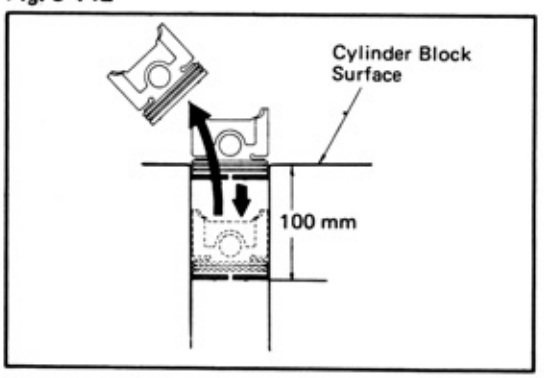
(0.0012 – 0.0027 in.)

Compression ring No.2

0.02 – 0.06 mm

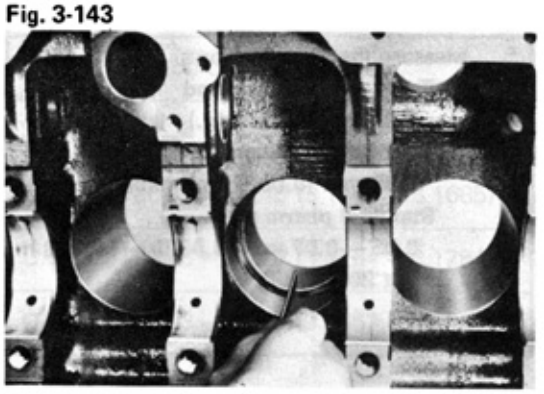
(0.0008 – 0.0023 in.)

Fig. 3-142



3. Measure the ring end gap.
   (1) Insert the ring into the cylinder.
   (2) Using a piston, position the ring at the lower part of the cylinder bore.

Fig. 3-143



(3) Measure the end gap with a thickness gauge.

Standard end gaps

Compression ring No.1

0.10 – 0.28 mm

(0.0039 – 0.0110 in.)

Compression ring No.2

0.15 – 0.28 mm

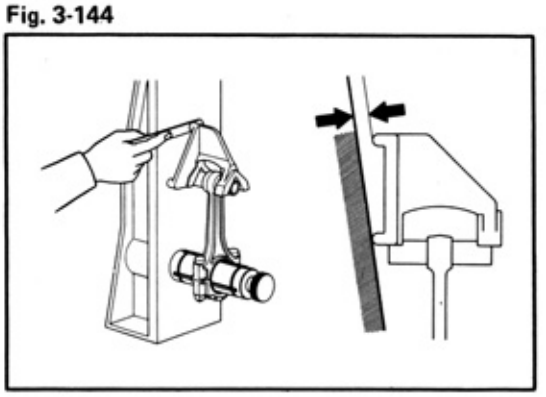
(0.0059 – 0.0110 in.)

Oil ring

0.20 – 0.90 mm

(0.0079 – 0.0354 in.)

Fig. 3-144



Connecting Rod & Bearing

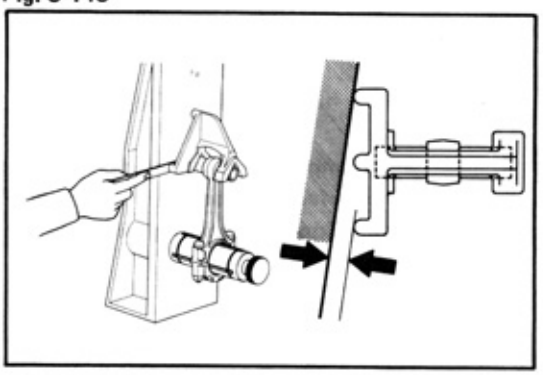
1. Check rod for alignment with a connecting rod aligner. If misaligment exceeds the limit, correct or replace rod.
   (1) Check rod for bent.

Bent limit

0.05 mm per 100 mm

(0.002 in. per 3.94 in.)

Fig. 3-145

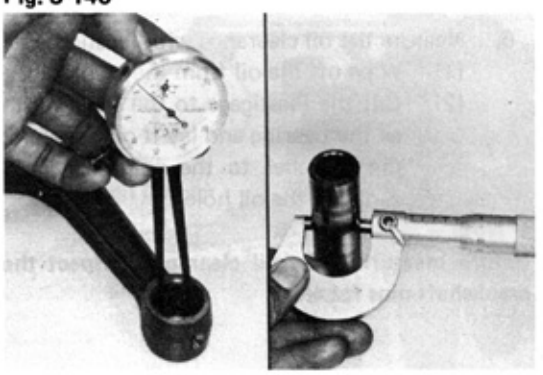


(2) Check rod for twist.

Twist limit

0.15 mm per 100 mm
(0.006 in. per 3.94 in.)

Fig. 3-146

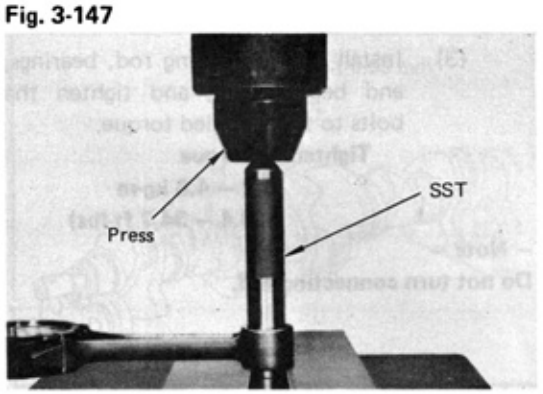


2. Measure oil clearance between bush and pin.

Oil clearance limit

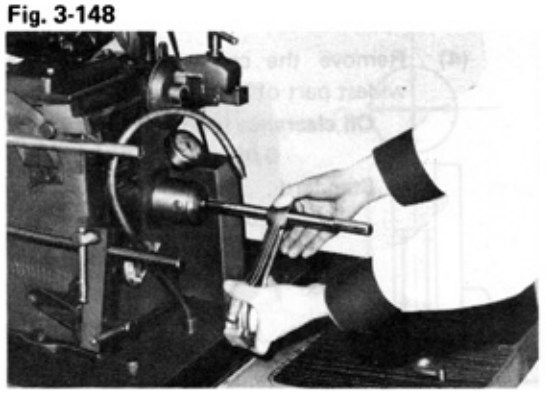
0.015 mm (0.0006 in.)

Fig. 3-147



3. If the connecting rod bushing is worn or damaged, replace it by using SST [09222-30010].

Fig. 3-148

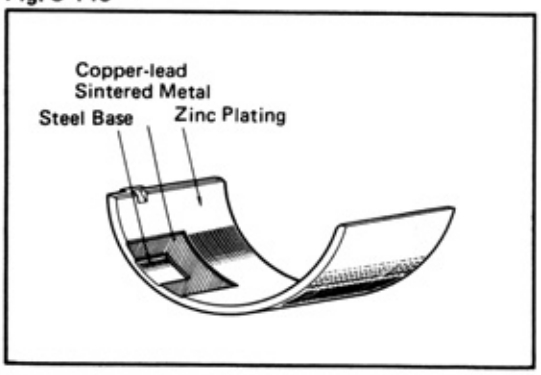


4. After pressing in the bushing, finish the bushing bore with a pin hole grinder.

Standard oil clearance

0.005 – 0.011 mm
(0.0002 – 0.0004 in.)

Fig. 3-149

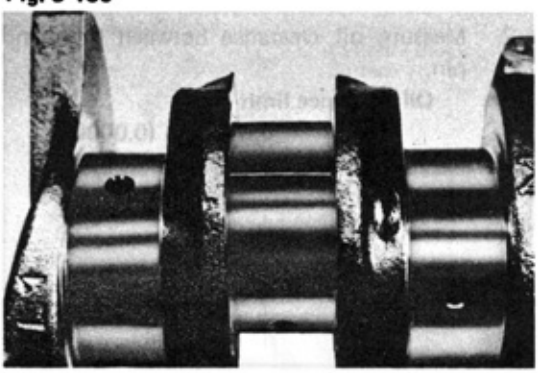


5. Inspect the bearing surface for flaking, melting, burning, and other defects, and replace the bearing if defective.

– Caution –

1. **Never attempt to adjust with shims or work the surface with scraper.**
2. **Never sand down the bearing surface.**

Fig. 3-150

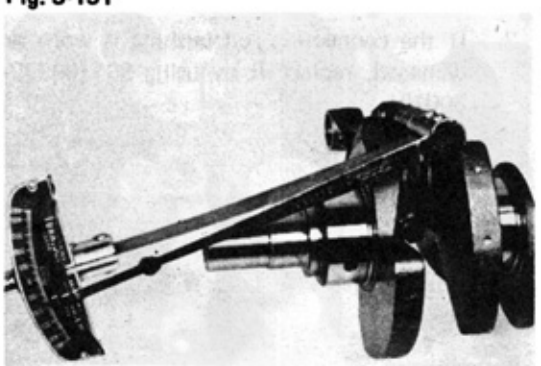


6. Neasure the oil clearance with Plastigage.
   (1) Wipe off the oil from the crank pin.
   (2) Cut the Plastigage to the same width as the bearing and lay it on the crank pin, parallel to the crankshaft and avoiding the oil hole,

– Note –

Before measuring the oil clearance, inspect the crankshaft pins for wear.

Fig. 3-151



(3) Install the connecting rod, bearings, and bearing cap, and tighten the bolts to the specified torque.

Tightening torque

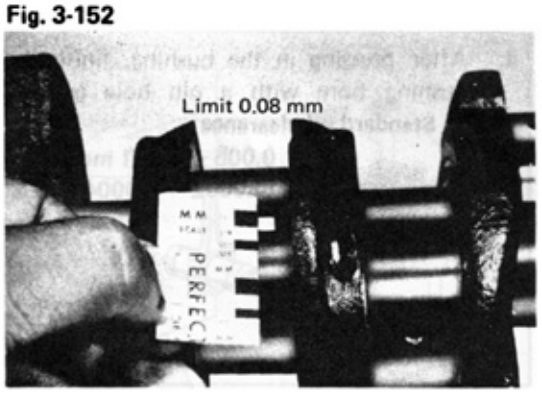
4.2 – 4.8 kg-m

(30.4 – 34.7 ft-lbs)

– Note –

Do not turn connecting rod.

Fig. 3-152



(4) Remove the cap and measure the widest part of the plastigage.

Oil clearance limit

0.08 mm (0.0031 in.)

Standard

0.021 – 0.053 mm

(0.0008 – 0.0021 in.)

Crank Pin Finished Dimensions

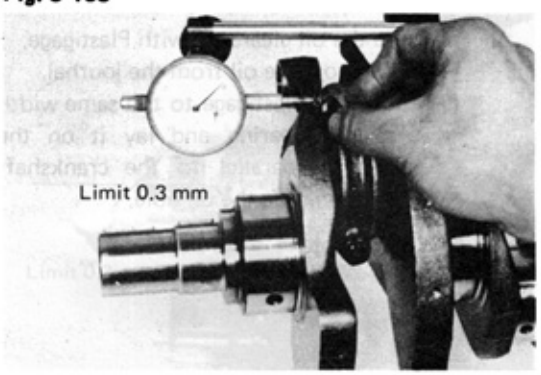
Bearing Size	Crank Pin Diameter
STD	51.976 – 52.000 (2.0463 – 2.0472)
U/S 0.05	51.925 – 51.939 (2.0443 – 2.0448)
U/S 0.25	51.725 – 51.735 (2.0364 – 2.0368)
U/S 0.50	51.475 – 51.485 (2.0266 – 2.0269)

7. If the oil clearance exceed the limit, replace the bearing in accordance with table.

– Note –

If the specified oil clearance cannot be obtained with the use of U/S 0.05 bearings, grind down the crank pin to allow use of U/S 0.25 bearings.

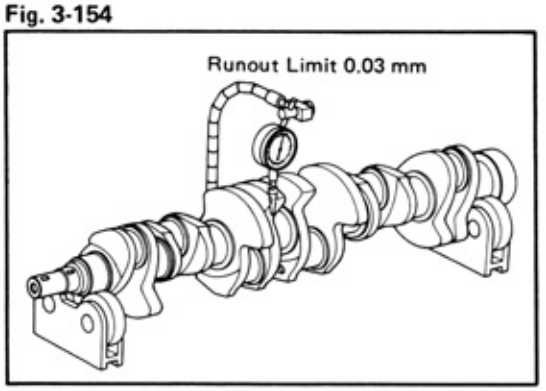
Fig. 3-153



8. Assemble the connecting rod and measure the thrust clearance.
   Replace the connecting rod if clearance exceeds the limit.

   Thrust clearance limit
   0.30 mm (0.018 in.)
   Standard 0.160 – 0.296 mm (0.0063 – 0.0117 in.)

Fig. 3-154

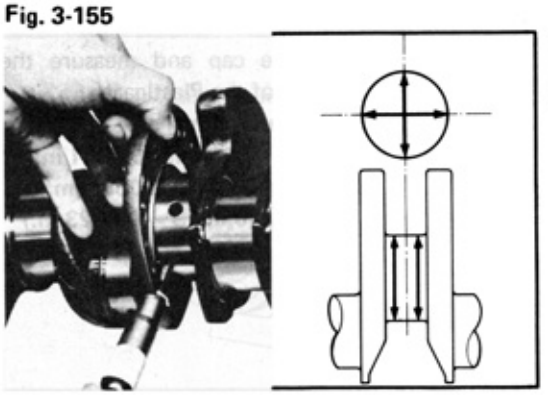


Crankshaft & Bearings

1. Place crankshaft in V blocks and measure runout at center journal. If runout exceeds specified limit, correct or replace.

   Runout limit 0.03 mm (0.0012 in.)

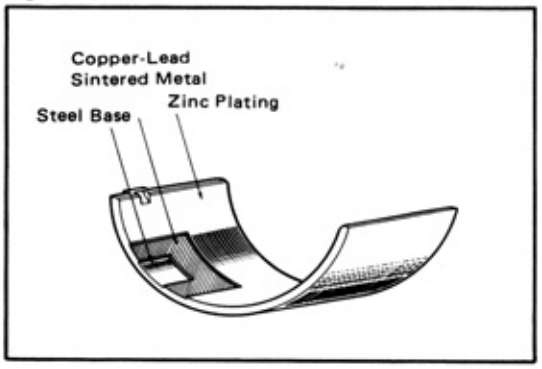
Fig. 3-155



2. Inspect the crankshaft journals and pins for damage and eccentric wear (out-of-round and taper). If defective, correct the journals and pins.

   Out-of round and taper limits
   0.02 mm (0.0008 in.)

Fig. 3-156

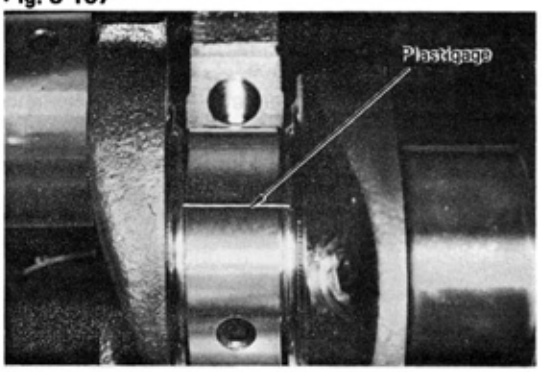


3. Inspect the bearing surface for flaking, melting, burning, and other defects, and replace the bearing if damaged.

– Caution –

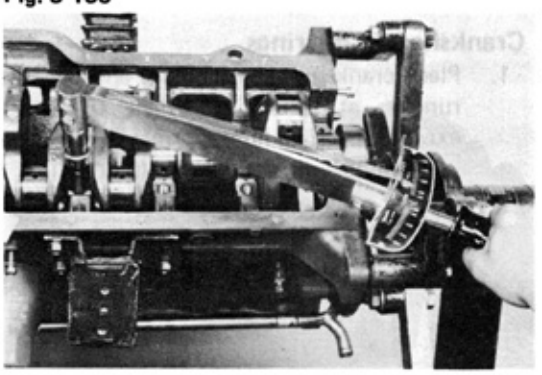
1. **Never attempt to adjust with shims or work the surface with scraper.**
2. **Never sand down the bearing surface.**

Fig. 3-157



4. Measure the oil clearance with Plastigage.
   (1) Wipe off the oil from the journal.
   (2) Cut the plastigage to the same width as the bearing and lay it on the journal, parallel to the crankshaft and avoiding the oil hole.

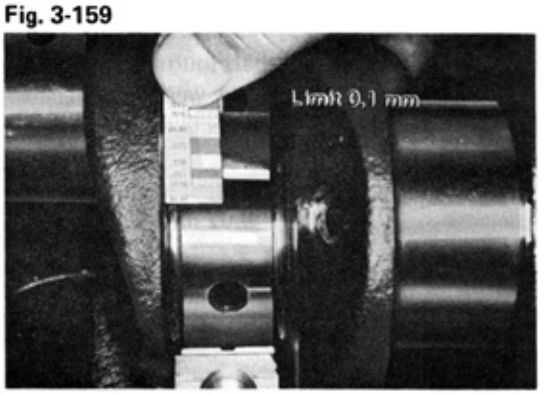
Fig. 3-158



   (3) Fit on the crankshaft, bearing and cap, and tighten the bolts to the specified torque.

Tightening torque
9.9 – 10.9 kg-m
(71.6 – 78.8 ft-ibs.)

Fig. 3-159



   (4) Remove the cap and measure the widest part of the Plastigage.

Oil clearance limit
0.10 mm (0.0031 in.)
Standard 0.034 – 0.058 mm
(0.0013 – 0.0023 in.)

Journal Finished Dimension mm (in)

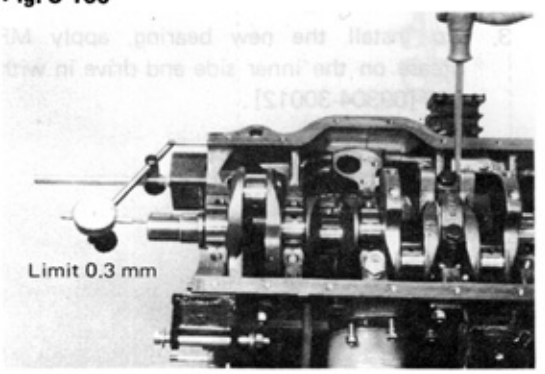
Bearing Size	Journal Diameter
STD	59.988 – 60.012 (2.3617 – 2.3627)
U/S 0.05	59.936 – 59.946 (2.3597 – 2.3601)
U/S 0.25	59.730 – 59.740 (2.3516 – 2.3519)
U/S 0.50	59.490 – 59.510 (2.3421 – 2.3429)

5. If the oil clearance exceeds the limit, replace the bearing in accordance with table.

– Note –

If the specified oil clearance cannot be obtained with the use of U/S 0.05 bearing, grind down the journal to allow use of U/S 0.25 bearing.

Fig. 3-160



6. Measure the crankshaft thrust clearance at the crankshaft center bearing.

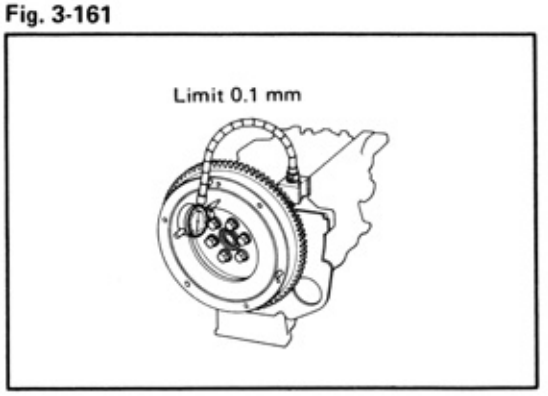
Thrust clearance limit
0.3 mm (0.012 in.)
Standard 0.05 – 0.25 mm (0.0020 – 0.0098 in.)

Thrust Washer Thickness

Washer Size	Thickness mm (in)
STD	2.925 – 2.975 (0.1152 – 0.1171)
O/S 0.125	2.988 – 3.038 (0.1177 – 0.1196)
O/S 0.250	3.050 – 3.100 (0.1201 – 0.1220)

7. If the thrust clearnce has exceeded the limit, replace the thrust washer as a set.

Fig. 3-161



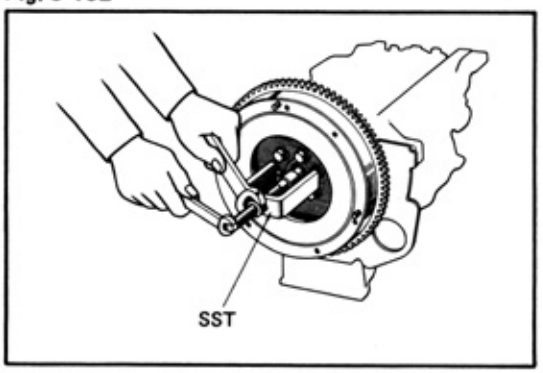
Flywheel

1. Inspect the surface contacting the clutch disc and if damaged or excessively worn, replace the flywheel.
2. Measure the runout of the surface contacting the clutch disc, and if it exceeds the specified limit, replace the flywheel.

Runout limit 0.1 mm (0.004 in.)

3. Inspect the ring gear and replace if damaged, cracked, worn.

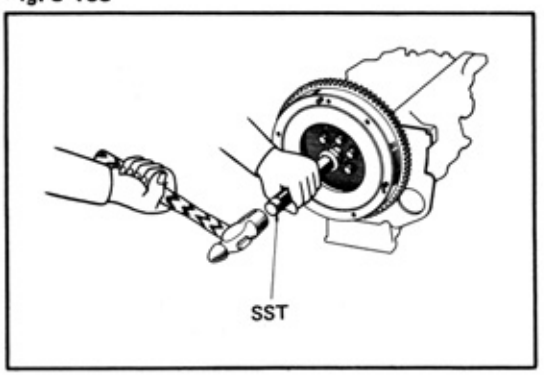
Fig. 3-162



Bearing (for input shaft front)

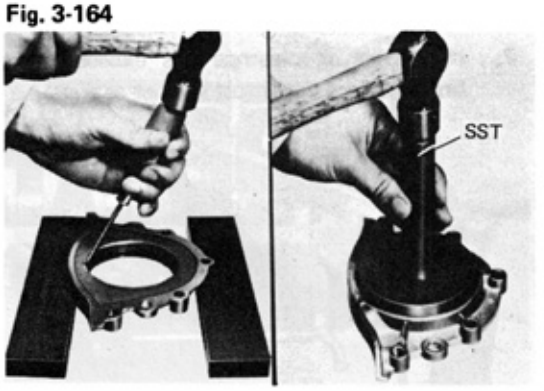
1. Turn the bearing by hand while applying force in the rotating direction. Replace the bearing if it offers abnormal resistance to the hand, or if it sticks.
2. Remove the bearing by pulling it out with SST [09303-35010].

Fig. 3-163



3. To install the new bearing, apply MP grease on the inner side and drive in with SST [09304-30012].

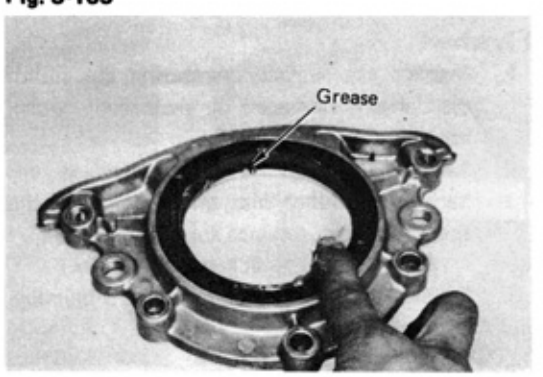
Fig. 3-164



Rear Oil Seal

1. Inspect the crankshaft rear oil seals and replace if the lips are worn, damaged, or cracked.
2. Rear oil seal replacement
   (1) Remove the old oil seal with a screwdriver.
   (2) Heat the oil seal retainer to about 80°C (176°F).
   (3) Install the new crankshaft rear oil seal by driving it in with SST [09223-41010].

Fig. 3-165

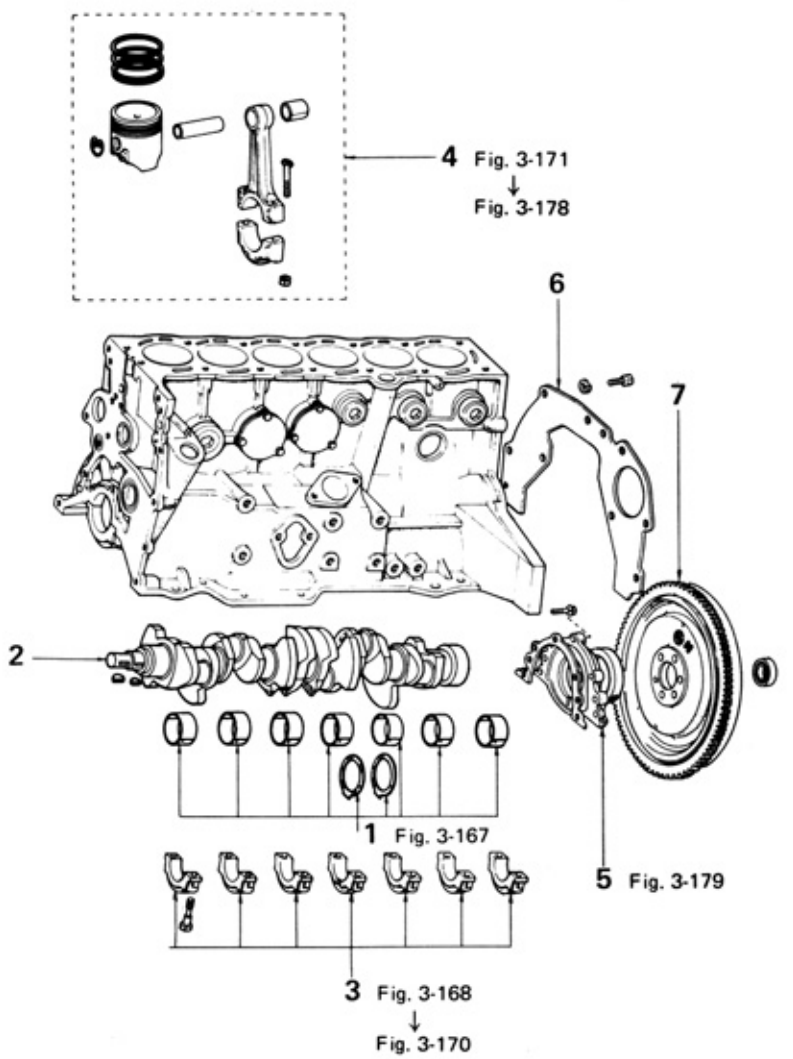


3. After driving in the seal, be sure to coat the seal lip lightly with MP grease.

ASSEMBLY

Assemble in numerical order.

Fig. 3-166

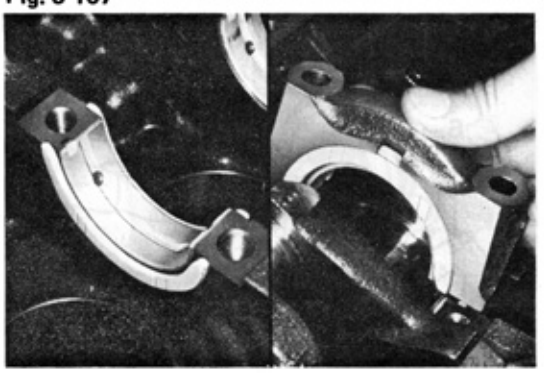


1. Crankshaft Bearing Set
2. Crankshaft
3. Crankshaft Bearing Cap
4. Piston With Connecting Rod
5. Rear Oil Seal Retainer
6. Rear End Plate
7. Flywheel

– Note –

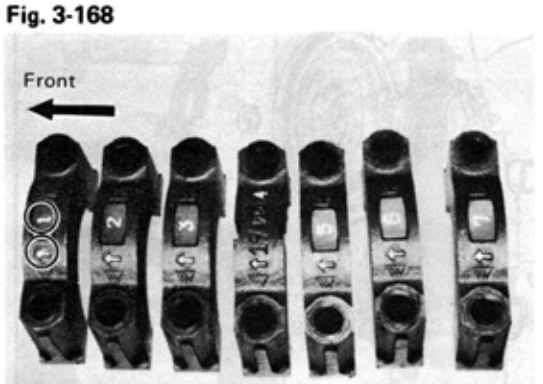
1. **Thoroughly clean all parts to be assembled.**
2. **Before installing the parts, apply new engine oil on all sliding and rotating surfaces.**
3. **Replace all gaskets, oil seals, and the like with new parts.**
4. **Apply liquid sealer at the parts that require prevention of water or oil leakage.**
5. **Perform the assembly while checking on the parts for oil clearance, thrust clearance, and similar requirements.**
6. **Make sure to install the proper bolts, nuts, washers, and other fasteners, and to tighten the bolts and nuts at the specified torque.**
7. **On the parts that had been marked at disassembly, reassemble them in accordance with the marks, and verify that the assembly had been made correctly before advancing to the next step.**

Fig. 3-167



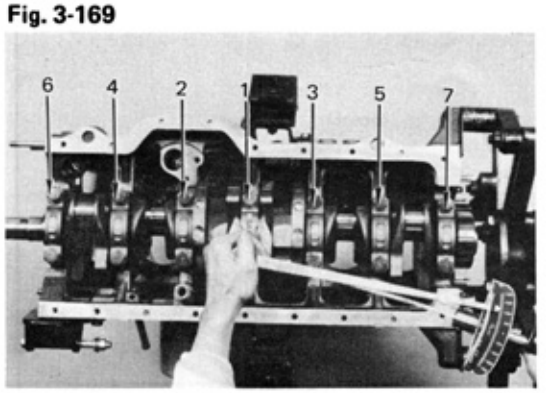
Install the thrust washers with their oil grooves faced toward the outside.

Fig. 3-168



1. Each bearing cap is provided with an arrow mark to indicate the front side and a number.
   Make sure that each bearing cap is assembled in the correct direction and location.

Fig. 3-169

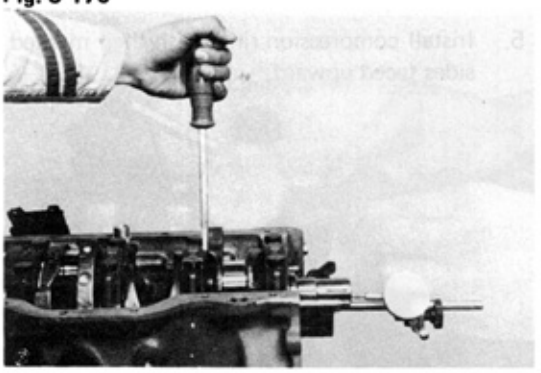


2. Install the bearing caps in the sequence of numbers shown in the figure, and tighten the bolts to the specified torque in two or three passes.
   Tightening torque
   9.9 – 10.9 kg-m (17.6 – 78.8 ft-lb)

– Note –

After tightening down the bearing caps, check the crankshaft to see that it turns lightly.

Fig. 3-170

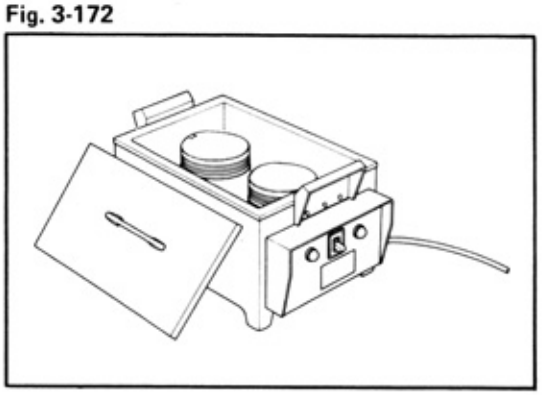


3. Measure the crankshaft thrust clearance.
   Thrust clearance standard
   0.05 – 0.25 mm
   (0.0020 – 0.0098 in.)

Fig. 3-171

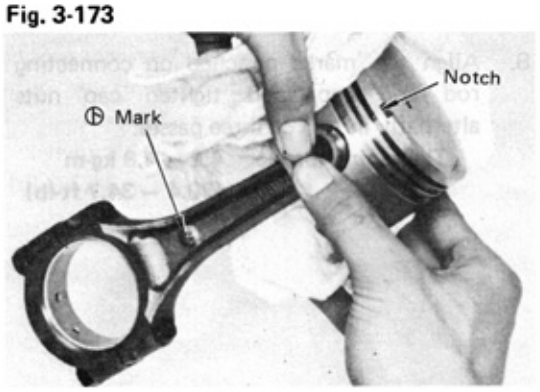
1. Install snap ring on one side.

Fig. 3-172



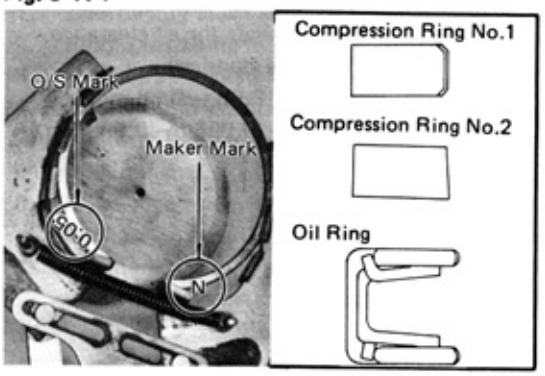
2. Heat the piston to about 60°C (140°F).

Fig. 3-173



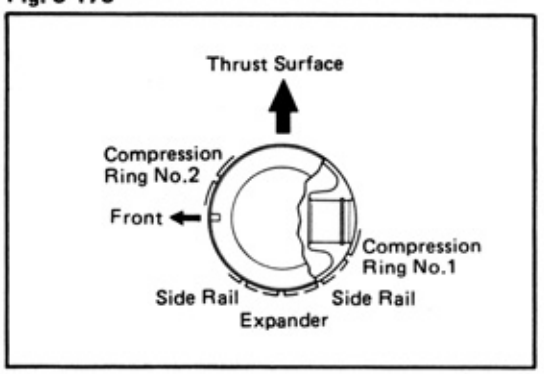
3. Push in piston pin with thumb, aligning piston notch with rod mark.
4. Install snap ring on the other side.

Fig. 3-174



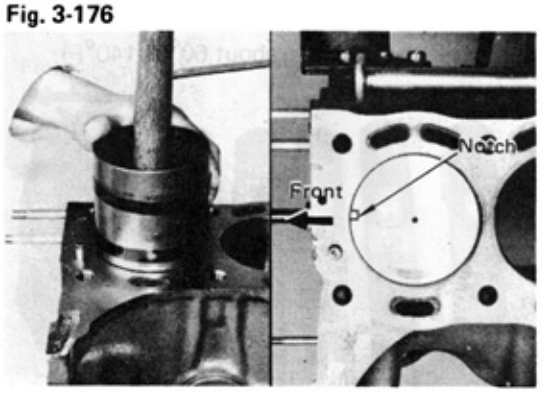
5. Install compression rings with their marked sides faced upward.

Fig. 3-175



6. Position the piston ring end gaps as shown in the diagram.

Fig. 3-176

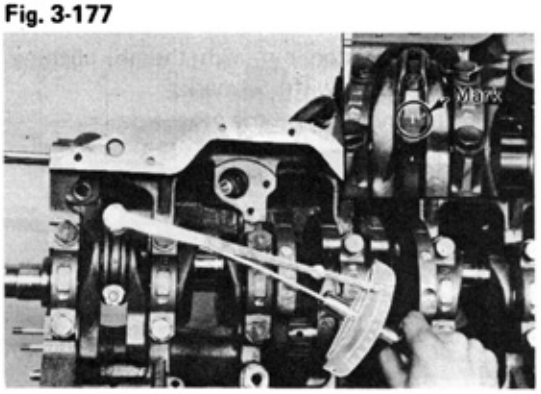


7. Push correctly numbered piston assembly into cylinder with notch and mark on rod forward. Use piston ring compressor.

– Note –

Use care not to damage crank pin.

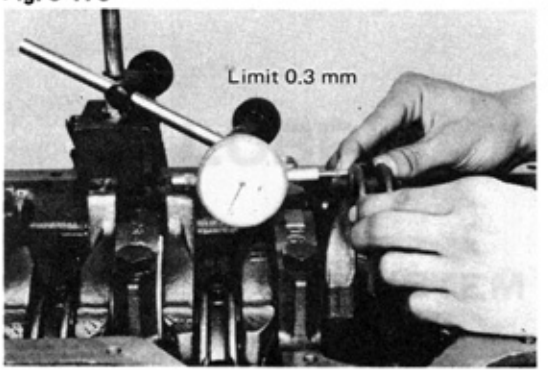
Fig. 3-177



8. Align the marks punched on connecting rod and cap, and tighten cap nuts alternatly in two or three passes.

Tightening torque 4.2 – 4.8 kg-m (30.4 – 34.7 ft-lb)

Fig. 3-178



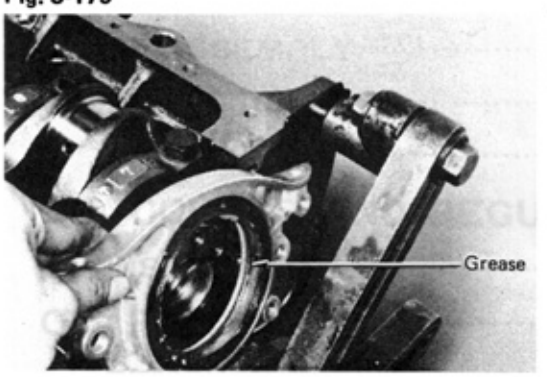
9. Measure the connecting rod thrust clearance.

Thrust clearance standard

0.160 – 0.296 mm

(0.0063 – 0.0117 in.)

Fig. 3-179



Install the oil seal retainer with multipurpose grease lightly applied on the oil seal lip.

MEMO