SERVICE MANUAL

DATSUN 240Z
MODEL S30 SERIES

NISSAN

NISSAN MOTOR CO., LTD.
TOKYO, JAPAN

SECTION EM

EM

ENGINE MECHANICAL

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The L24 engine is a 2,393 cc (146.0 cu in) in line overhead camshaft six-cylinder engine and has 83 mm (3.27 in) bore and 73.7 mm (2.90 in) stroke. The engine features wedge-shaped combustion chamber, aluminum head and fully balanced 7-bearing crankshaft to turn out smooth, dependable power.

The cylinder block is cast in a single unit, featuring deep skirting.

The SU type carburetor is used to provide proper air-fuel mixture.

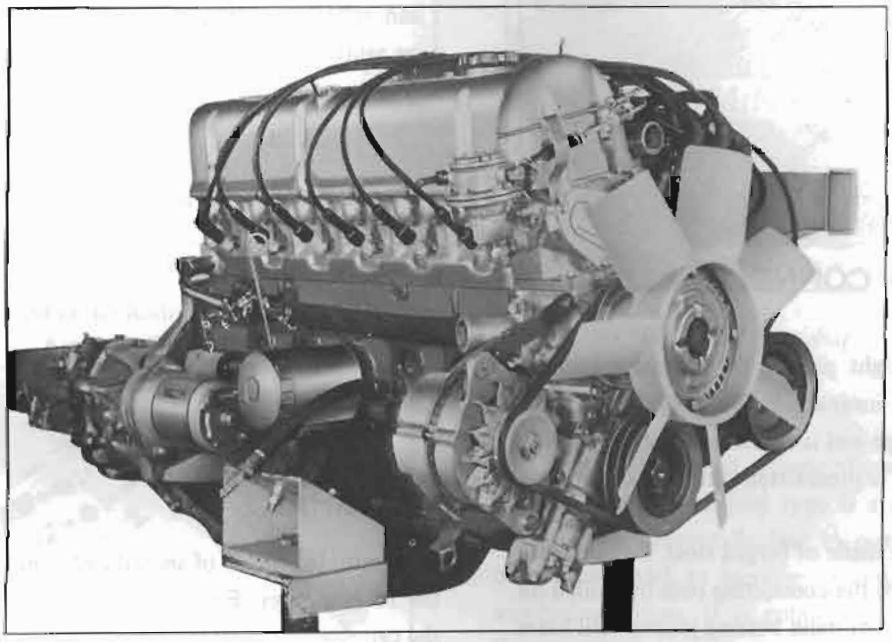

Fig. EM-1 General view

CYLINDER BLOCK

The cylinder block, which is of a monoblock special casting structure, adopts the seven bearing-support system, for quietness and higher durability. Of a highly rigid deep-skirt design, it requires no complicated tappet chamber because of the OHC engine system and thus is light-weight.

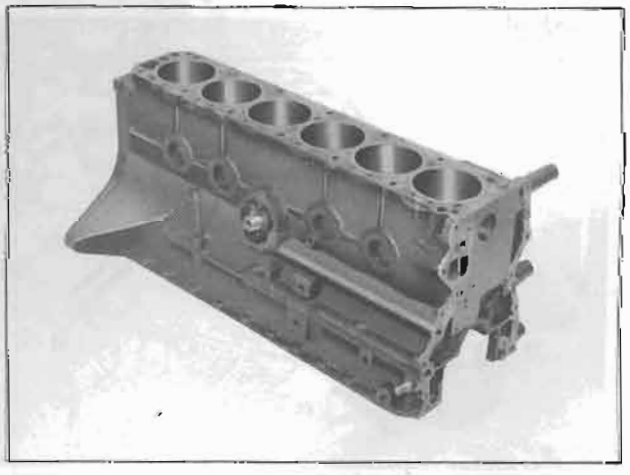

Fig. EM-2 Cylinder block

CRANKSHAFT

The crankshaft is a special forged steel. Provided with a high capacity balance weight, it shows quietness and high durability at high speed operation. Main bearings are lubricated from oil holes which intersect the main oil gallery which runs parallel to the cylinder bores.

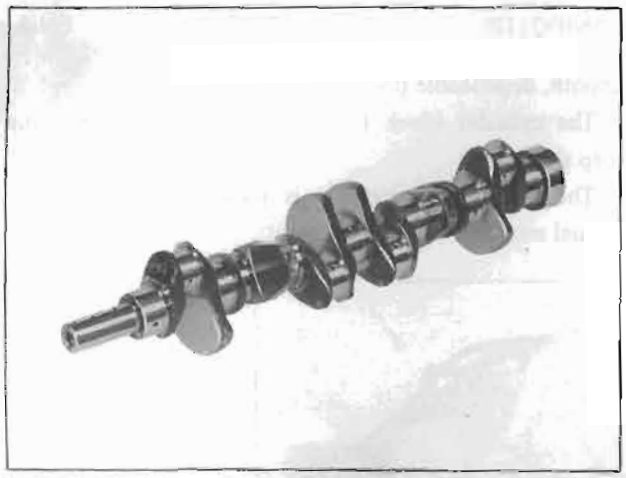

Fig. EM-3 Crankshaft

PISTONS AND CONNECTING RODS

New-design light-weight pistons are of cast aluminum slipper-skirt type with invar-strut. The piston pin is of a special steel hollow type and is connected to the piston in a full floating fit, and is press-fitted onto the connecting rod.

Connecting rods are made of forged steel. Full pressure lubrication is directed to the connecting rods by drilled oil passages from the adjacent main bearing journal. Oil holes at the connecting rod journals are located so that oil is supplied to give maximum lubrication just proper to full bearing load.

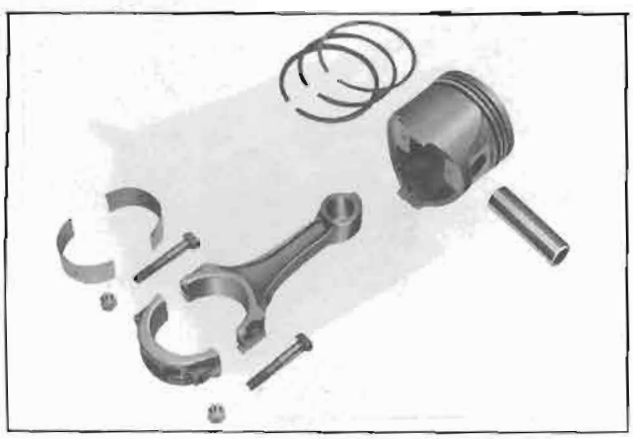

Fig. EM-4 Piston and connecting rod

CYLINDER HEAD

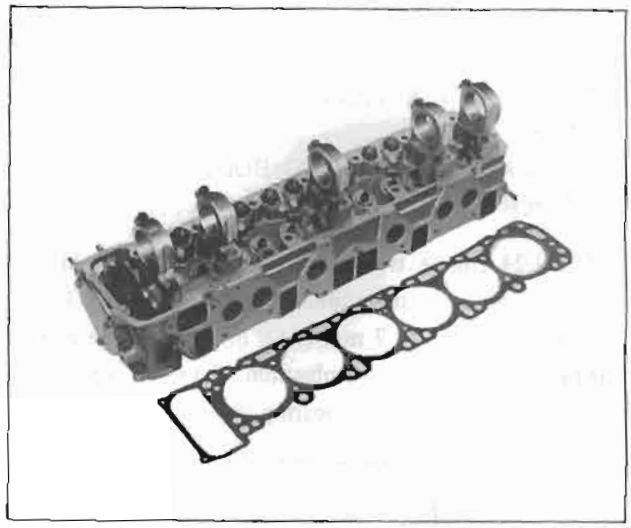

Fig. EM-5 Cylinder head

The cylinder head is made of light and strong aluminum alloy with good cooling efficiency. A special aluminum cast valve seat is used on the intake valve, while a special cast valve seat is installed on the exhaust valve.

These parts are all hot press-fitted.

CAMSHAFT

Camshaft is made of special cast iron and located inside the rocker cover. Five aluminum alloy brackets support the camshaft.

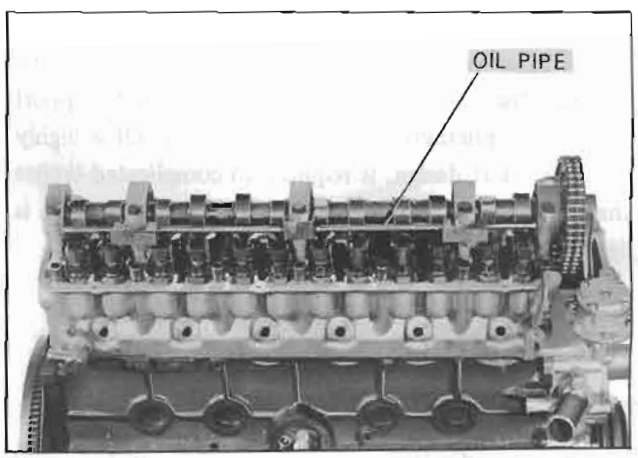

Fig. EM-6 Camshaft

Camshaft bearings are lubricated from oil holes which intersect the main oil gallery of the cylinder head.

To lubricate the cam pad surface of the rocker arm, an oil pipe with many oil holes is provided along the camshaft. This oil pipe provided is supported by No. 1, 3 and 5 camshaft brackets and from No. 3 brackets lubrication is supplied to this oil pipe.

VALVE MECHANISM

The valve system has a pivot type rocker arm that is activated directly by the cam mechanism, and this has made its moving parts considerably lighter and provides an ideal high-speed performance.

The valve springs are of the dual spring type.

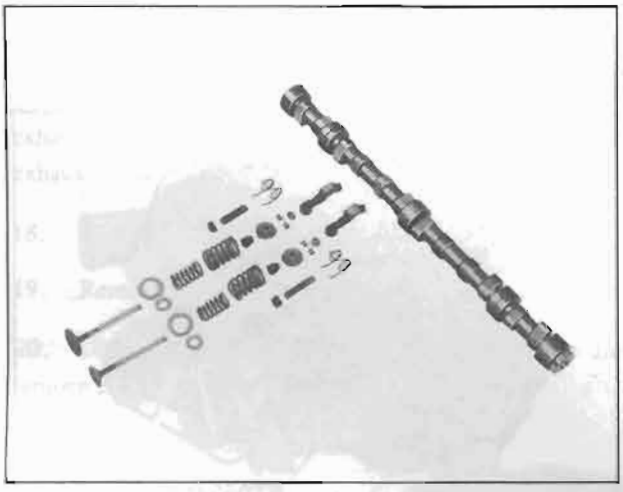

Fig. EM-7 Valve mechanism

CAMSHAFT DRIVE

Camshaft is driven by a double row roller chains driven by crankshaft. The tension of the chain is controlled by a chain tensioner which is operated by spring and oil pressure. The rubber shoe type tensioner insulates vibration of the chain and controls tension of the chain.

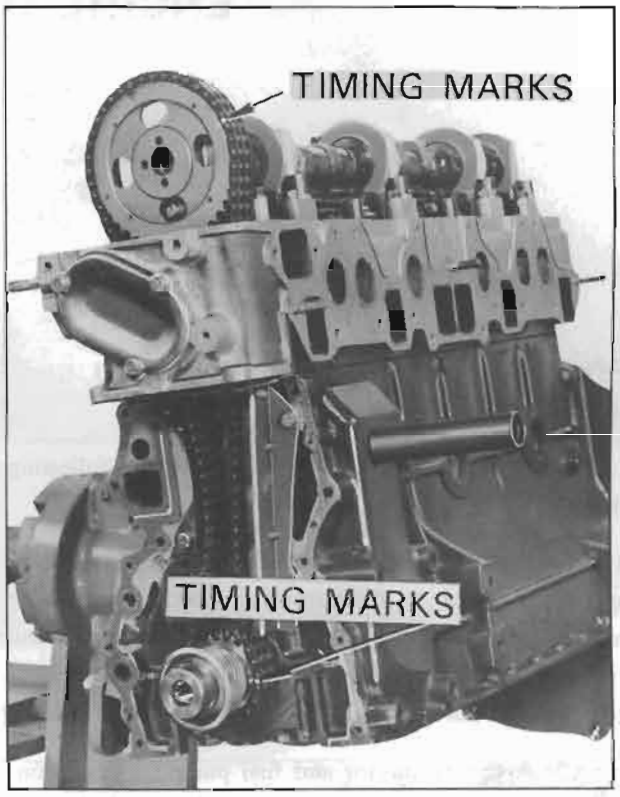

Fig. EM-8 Camshaft driving chain

MANIFOLDS

The intake manifold is made of cast aluminum alloy.

The exhaust manifold type is a dual exhaust system intended to prevent decline in output due to exhaust interference and to increase output through the inertia scavenging action. It is connected to exhaust pipes by flanges, which insure complete absence of exhaust leaks.

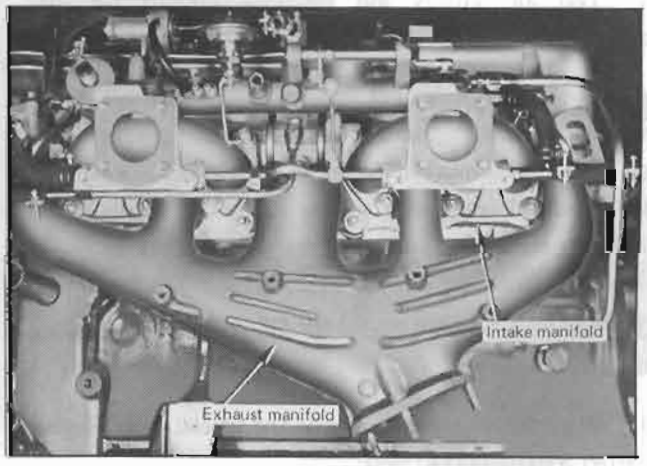

Fig. EM-9 Intake and exhaust manifolds

ENGINE DISASSEMBLY

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PRELIMINARY CLEANING AND INSPECTION

Before disassembling the engine, observe the following items:

1. Fuel, oil or water may leak past the cylinder head and block. Prior to disassembling, check the cylinder head, front chain cover, oil pan and oil filter gaskets and crankshaft and water pump seals for sign of leak past their gasketed surfaces.

2. Check the carburetor and fuel pump for condition; fuel hoses for deterioration, cracks or otherwise leakage of fuel past their jointed or connected surfaces.

3. Remove the air cleaner, alternator, distributor and starter, and plug up carburetor air-horn and distributor hole to prevent entry of foreign matter.

4. Wipe dust and mud off the engine.

5. Inspect the block, rocker cover, front chain cover, oil pan and all other outer parts for visual defects and broken or missing parts such as bolts and nuts.

6. Test all pipings and electrical circuits for discontinuity or broken or damaged insulation.

DISASSEMBLY

To remove the engine from the vehicle, refer to relative topic under Section ER.

1. Remove the transmission from the engine.

2. Thoroughly drain engine oil and coolant by removing the drain plugs.

3. Place the engine assembly on the special tool "Engine Carrier ST07010000."

(1) Remove fan and fan pulley.

(2) Remove the right side engine mounting bracket.

(3) Remove the oil filter using the special tool "Oil Filter Wrench ST19320000."

(4) Remove the oil pressure switch.

(5) Install the engine attachment to the cylinder block using bolt holes securing the alternator bracket and water drain plug.

(6) Set the engine on the engine stand.

"Engine Attachment ST05340000"

"Engine Stand ST0501S000"

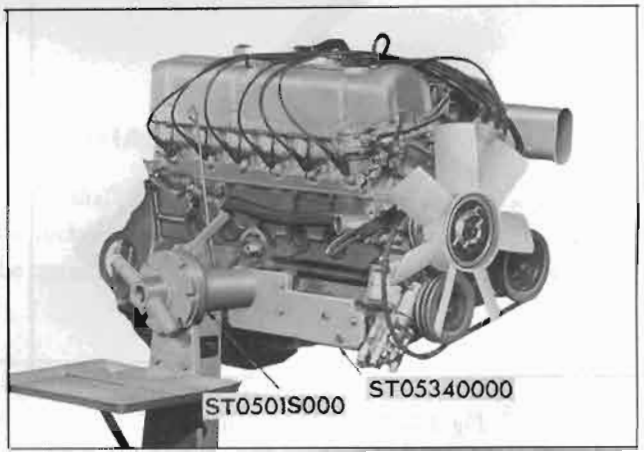

Fig. EM-10 The engine on the engine stand

4. Remove the oil level gauge.

5. Remove the high tension cables.

6. Remove the fuel pump.

7. Remove spark plugs.

8. Disconnect air hoses and vacuum hoses from the air cleaner. A vacuum hose between the balance tube and the

temperature sensor in the air cleaner, should be disconnected at the balance tube connector.

9. Remove the air cleaner cover and element.

10. Remove air cleaner attaching bolts and then remove the air cleaner from both carburetors.

11. Disconnect water hoses, air hoses, vacuum hoses and fuel hoses from both carburetors.

12. Remove carburetor attaching bolts and then remove both carburetors.

13. Disconnect the E.G.R. control tube between the balance tube and the exhaust manifold.

14. Disconnect water hoses from the intake manifold and the balance tube and disconnect air hose from the balance tube.

15. Remove the heat-shield plate and the exhaust manifold cover from the exhaust manifold.

16. Remove intake manifold attaching nuts and remove the intake manifold equipped with the balance tube.

17. Remove air hose from the check valve, remove exhaust manifold attaching nuts and then remove the exhaust manifold.

18. Remove the distributor assembly.

19. Remove the left side engine mounting bracket.

20. Disconnect the air hoses from the air pump and remove the air pump.

21. Remove the fuel line and heater hoses.

22. Remove the thermostat housing.

23. Remove the crank pulley.

Note: As the crank pulley is a vibration damper type, the special tool "Crank Pulley Puller ST16540000" should be used to remove the crank pulley.

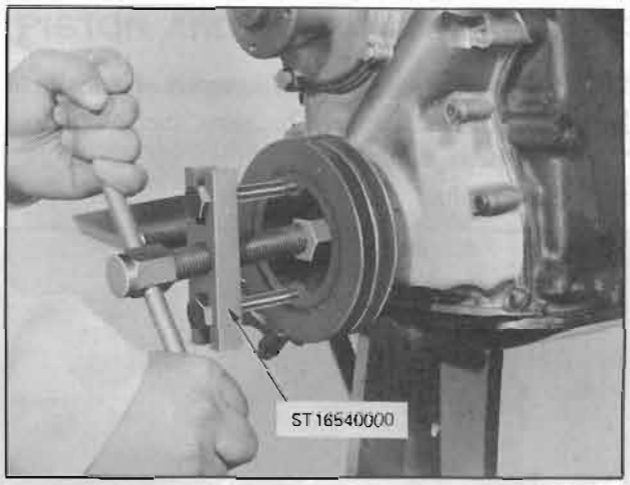

Fig. EM-11 Crank pulley removal

24. Remove the water pump.

25. Remove the rocker cover.

26. Remove the fuel pump drive cam and the camshaft sprocket.

Fig. EM-12 Camshaft drive sprocket removal

Note: For the convenience of the cylinder head replacement, the special tool "Chain Stopper ST17420001" is prepared to support the timing chain during the service operation. By using this tool, the timing marks on the crankshaft sprocket and the timing chain will be unchanged. So the work for aligning the timing marks will be saved so much.

27. Remove the oil pipe.

28. Remove the cylinder head assembly. Loosen head bolts diagonally and evenly by using the special tool "Cylinder Head Bolt Wrench ST10120000" and then remove head bolts.

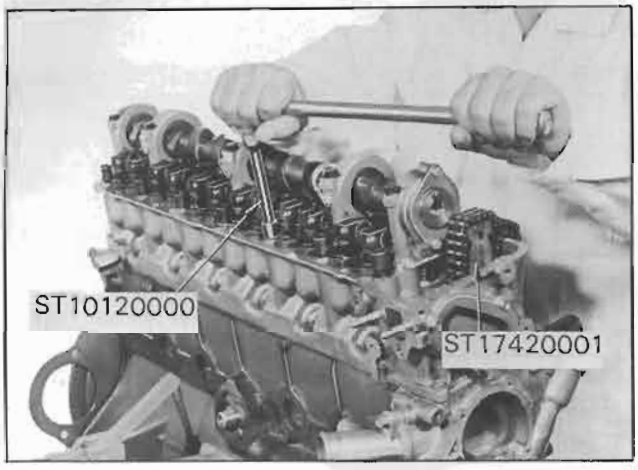

Fig. EM-13 Cylinder head removal

29. Remove the flywheel and end plate.

30. Invert the engine.

31. Remove the oil pan and the oil strainer.

32. Remove the oil pump and its drive gear.

33. Remove the front cover.

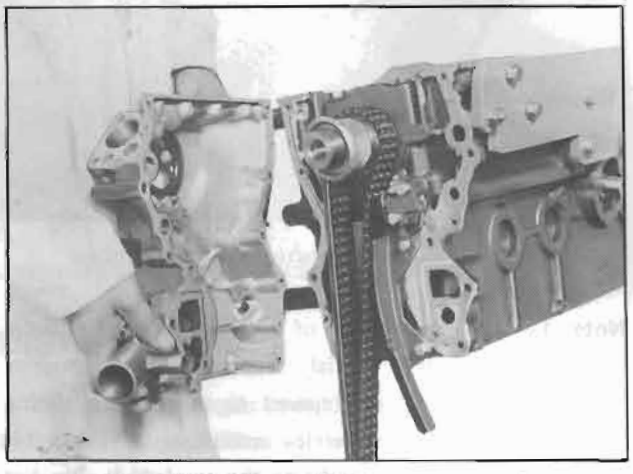

Fig. EM-14 Engine front cover removal

34. Remove the timing chain, chain tensioner and chain guide.

35. Remove the oil thrower, the crankshaft worm gear and the chain drive sprocket.

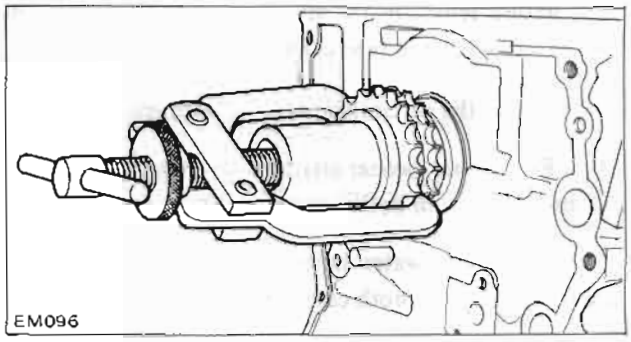

Fig. EM-15 Chain drive sprocket removal

36. Remove the piston and connecting rod assembly. Take off the connecting rod bearings at the same time and keep them in order.

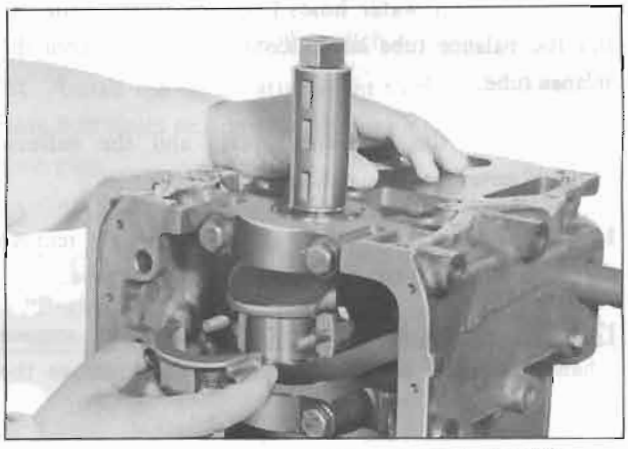

Fig. EM-16 Piston and connecting rod assembly removal

37. Remove the main bearing cap.

Use the special tool "Crankshaft Main Bearing Cap Puller ST1651S000" to remove the rear and center main bearing caps. Keep them in order.

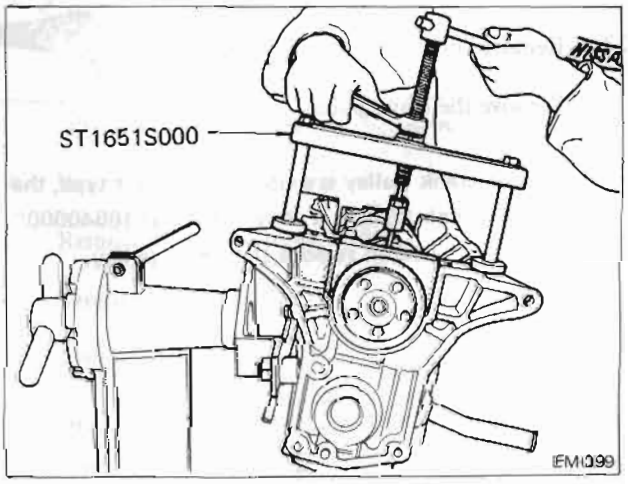

Fig. EM-17 Rear main bearing cap removal

38. Remove the crankshaft rear oil seal.

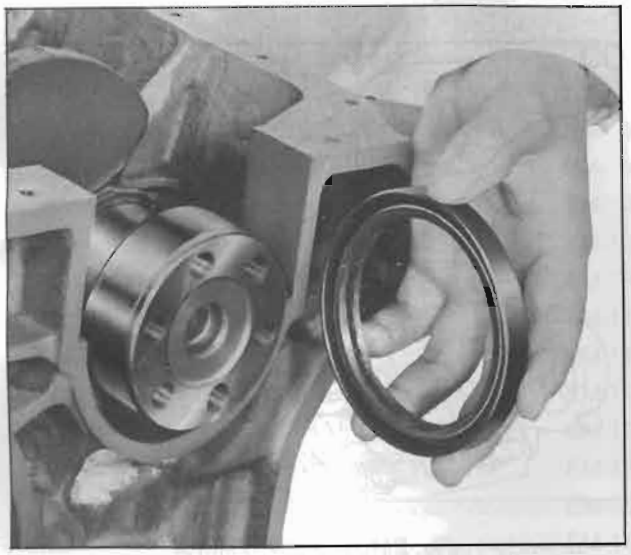

Fig. EM-18 Rear oil seal removal

39. Remove the crankshaft.

40. Remove the buffle plate and the cylinder block net.

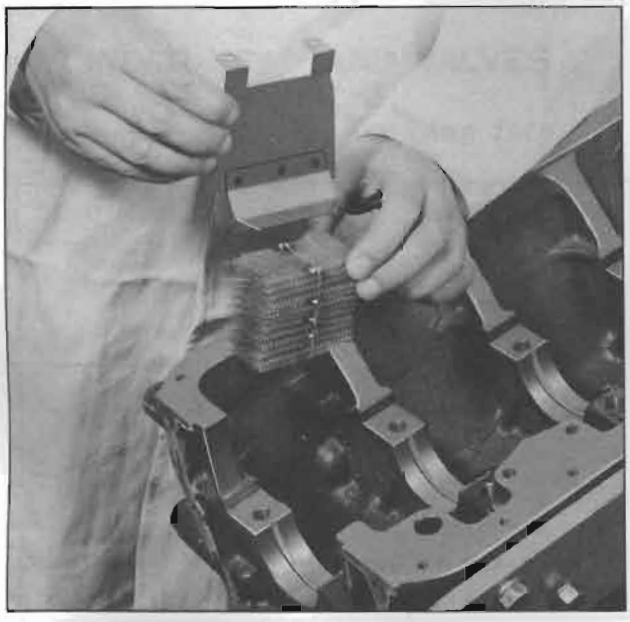

Fig. EM-19 Buffle plate and net removal

PISTON AND CONNECTING ROD

1. Remove the piston rings with a ring remover.

Fig. EM-20 Piston ring removal

2. Press out the piston pin with the special tool "Piston Pin Press Stand ST13030001" and an arbor press.

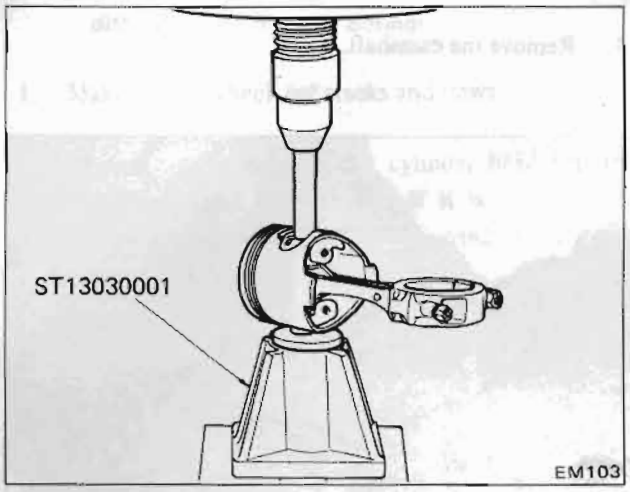

Fig. EM-21 Piston pin removal

3. Keep the disassembled parts in order.

CYLINDER HEAD

1. Remove the valve rocker spring.

2. Loosen the valve rocker pivot lock nut and remove the rocker arm by pressing down the valve spring.

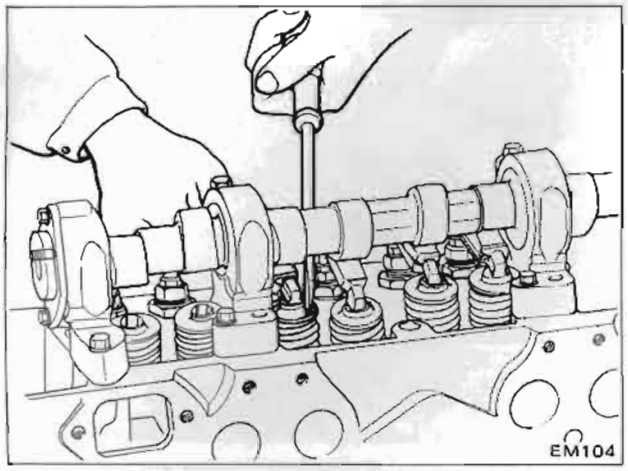

Fig. EM-22 Rocker arm removal

3. Remove the camshaft.

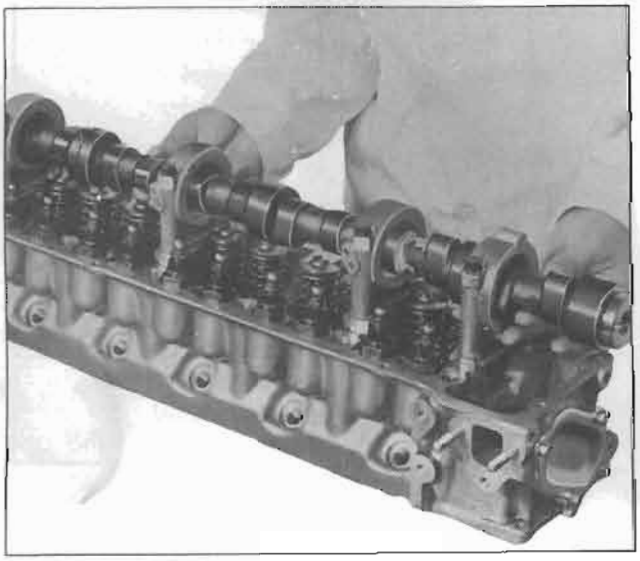

Fig. EM-23 Camshaft removal

Note: At this time, take care not to damage the camshaft bearings and cam lobes.

4. Remove the valves using the special tool "Valve Lifter ST12070000."

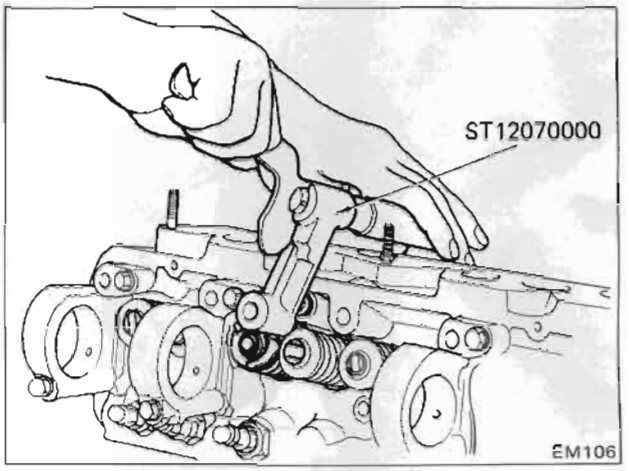

Fig. EM-24 Valve removal

5. Take care not to lose valve spring seat, oil seal, valve collet, and valve rocker guide.

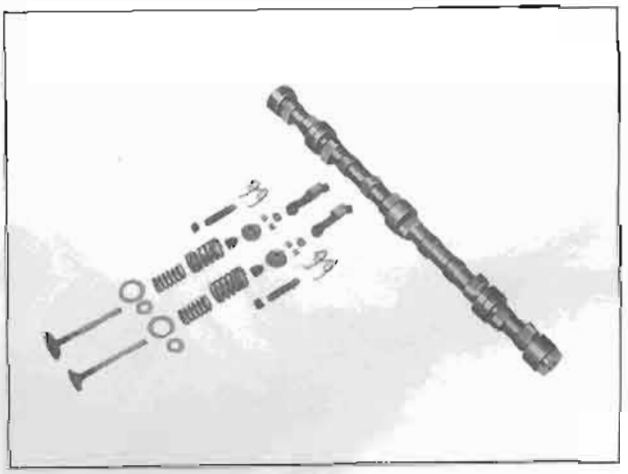

Fig. EM-25 Valve components

Note: Be sure to leave the camshaft bearing intact. Because the bearing centers are liable to be out of alignment.

INSPECTION AND REPAIR

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PREPARATION FOR INSPECTION

1. Before cleaning, check for sign of water and oil leaks in the cylinder block and head.

2. Clean oil and carbon deposits, and sealant from all parts.

3. Clean all oil holes with solvent and dry with compressed air. Make sure that they are not restricted.

CYLINDER HEAD AND VALVES

Checking cylinder head mating face

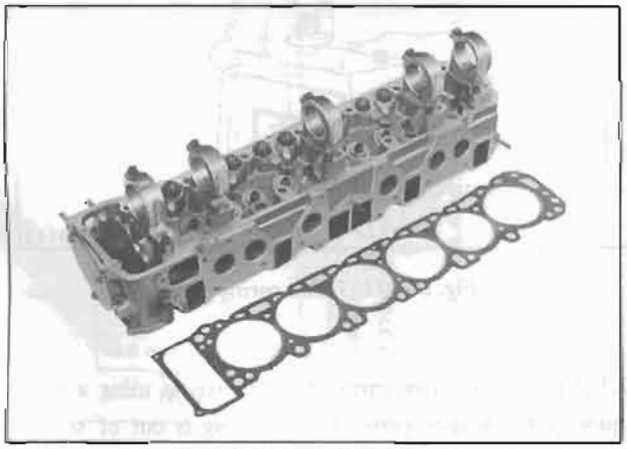


Fig. EM-26 Cylinder head

Note: Never remove camshaft bearings. If you once remove camshaft bearings, the bearing centers will be out of alignment and the recondition is very difficult without center borings.

1. Make a visual check for cracks and flaws.

2. Measure the surface of the cylinder head (on the cylinder block side) for warpage. If it is found to be beyond the limit designated below, regrind the affected surface with a surface grinder.

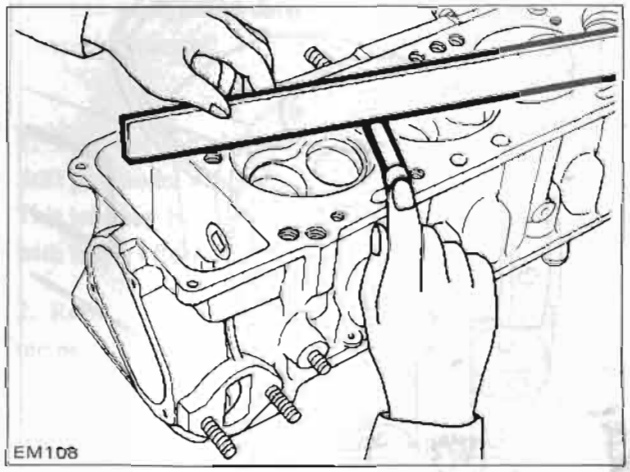


Fig. EM-27 Checking the cylinder head surface

Head surface flatness

Standard	Maximum
Less than 0.05 mm (0.0020 in)	0.1 mm (0.0039 in)

Valve assembly

1. Check each of the intake and exhaust valve assemblies for worn, damaged or deformed valve caps and stems. Correct or replace the valve that is defective.

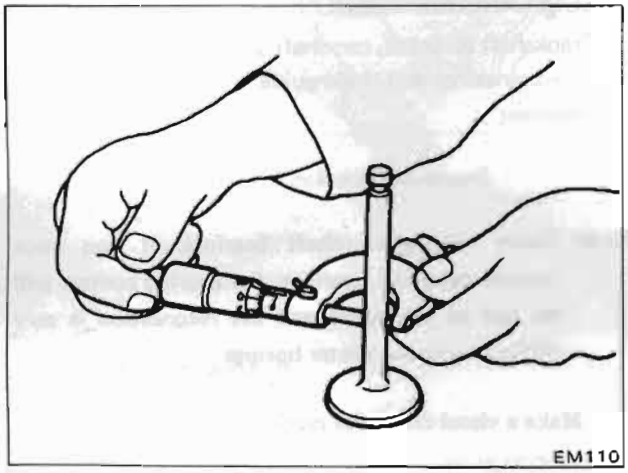


Fig. EM-28 Valve stem diameter check

2. If necessary, the valve face or valve stem end surface should be refaced by using a valve grinder.

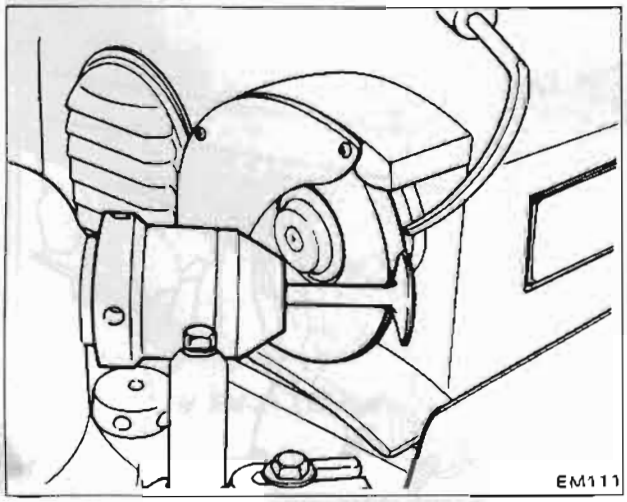


Fig. EM-29 Regrinding valve face

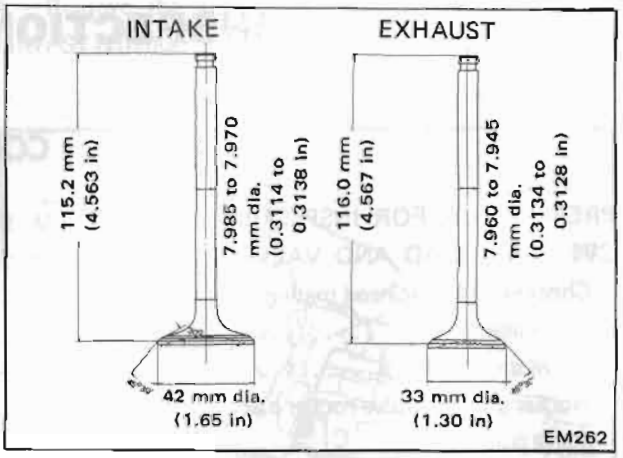


Fig. EM-30 Valve dimensions

Note: When the valve head has been reduced to 0.5 mm (0.0197 in) or less in thickness, replace the valve. Grinding allowance for the valve stem end surface is 0.5 mm (0.0197 in) or less.

Valve spring

1. Measure the free length and the tension of each spring. If the measured value exceeds the specified limit, replace the spring.

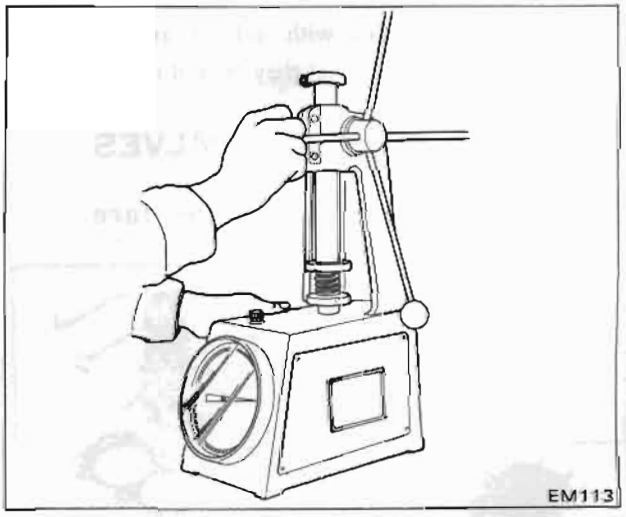


Fig. EM-31 Valve spring test

2. Check the valve spring for squareness using a steel square and surface plate. If the spring is out of square more than 1.6 mm (0.063 in), replace with new ones.

Spring specifications

Free length mm (in)	Outer	49.98 (1.97)
	Inner	44.85 (1.76)
Valve close mm/kg (in/lb)	Outer	40.0/19.7 to 22.9 (1.57/43.43 to 50.49)
	Inner	35.0/11.6 to 13.0 (1.38/25.57 to 28.66)
Valve open mm/kg (in/lb)	Outer	29.5/45.3 to 52.7 (1.16/99.87 to 116.18)
	Inner	24.5/24.2 to 26.8 (0.96/53.35 to 59.08)

Rocker arm and valve rocker pivot

Check the pivot head and the cam contact and pivot contact surfaces of the rocker arm for damage or wear. If defects are found, replace them. A defective pivot necessitates its replacement together with the corresponding rocker arm.

Valve guide

Measure the clearance between the valve guide and the valve stem. If the clearance exceeds the designated limit, replace the worn parts or both valve and valve guide. In this case, it is essential to determine if such a clearance has been caused by a worn or bent valve stem or by a worn valve guide.

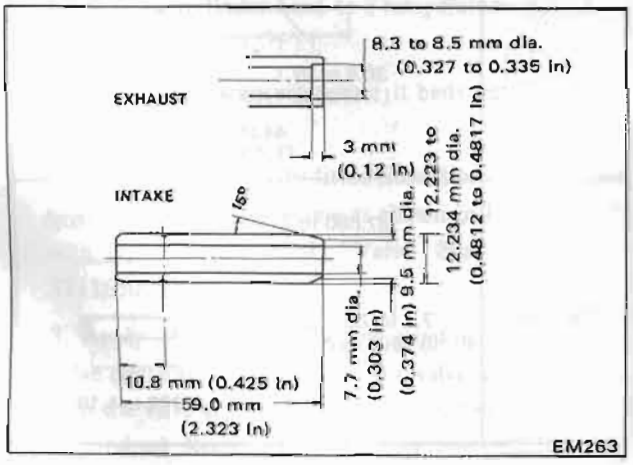


Fig. EM-32 Service valve guide

	Intake valve	Exhaust valve
Stem to guide clearance mm (in)	0.020 to 0.053 (0.0008 to 0.0021)	0.040 to 0.073 (0.0016 to 0.0029)
Max. tolerance of above clearance mm (in)	0.1 (0.0039)	

Determining clearance

Precise measurement of clearance between the valve stem and the valve guide needs the aid of a micrometer and a telescope hole gauge. By using these gauges, check the diameter of the valve stem in three places; top, center and bottom. Insert telescope hole gauge in valve guide bore, measuring at center. Subtract the highest reading of valve stem diameter from valve guide bore measured to obtain its clearance from the two center diameter to obtain valve to valve guide clearance. As an emergency expedient, a valve is pushed in the valve guide and moved to the left and the right at which point if its tip deflects about 0.2 mm (0.0079 in) or more, it will be known that the clearance between the stem and the guide exceeds the maximum limit of 0.1 mm (0.0039 in).

Note: The valve should be moved in parallel with the rocker arm. (Generally, a large amount of wear occurs in this direction.)

Replacement of valve guide

A valve guide found defective must be replaced in the following manner:

1. Take out the old guide by means of a press and a drift pin (under a 2-ton pressure).
This job may be carried out at room temperatures but with better effect at higher temperature.

2. Ream cylinder head side guide hole at room temperature.

Guide hole inner diameter mm (in)	12.185 to 12.196 (0.4797 to 0.4802)

As the valve guides of 0.2 mm (0.0079 in) oversize diameter are available for service, the guide hole should be reamed to the following dimensions.

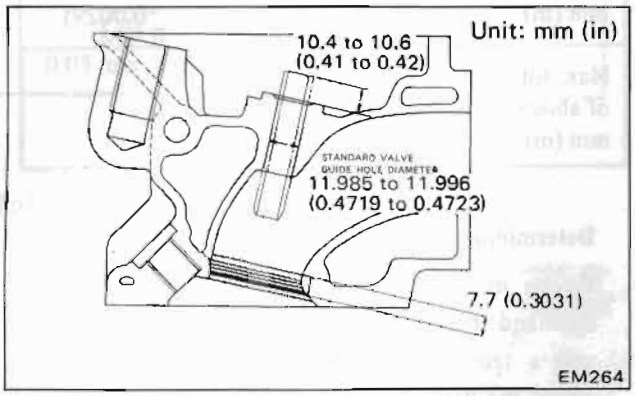


Fig. EM-33 Valve guide installation

3. Press the new valve guide into the valve with care so that it will fit smoothly after heating the cylinder head to a temperature of 150° to 200°C (302° to 392°F).

Interference fit of valve guide to guide hole mm (in)	0.027 to 0.049 (0.0011 to 0.0019)

4. Ream the bore of the valve guide pressed in using the special tool "Valve Guide Reamer Set ST1103S000."

Reaming bore: 8.000 to 8.018 mm
(0.3150 to 0.3157 in)

5. Correct the valve seat surface, with the new valve guide as the axis.

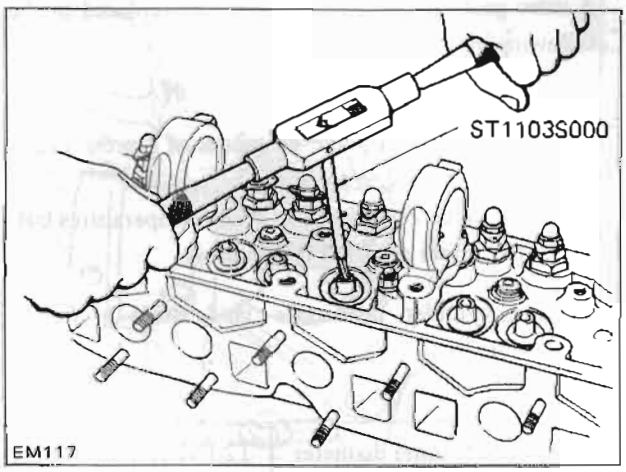


Fig. EM-34 Valve guide reaming

Valve seat inserts

Check the valve seat inserts for any evidence of pitting at valve contact surface, and reseat or replace valve seat inserts if the valve seat insert is worn out excessively.

The valve seat insert of 0.5 mm (0.0197 in) oversize is available for service.

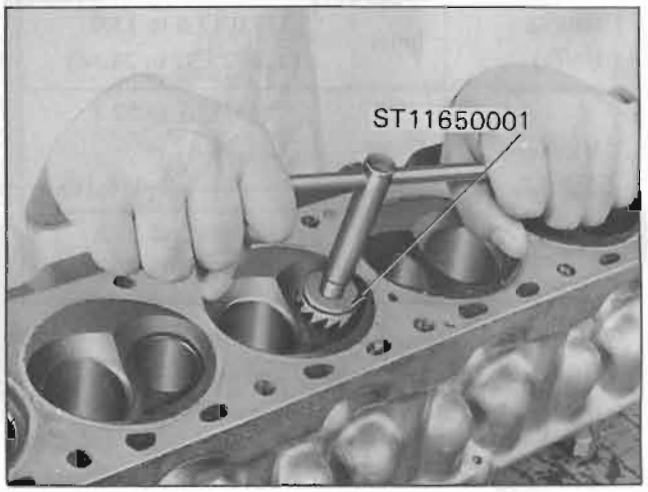


Fig. EM-35 Valve seat correction

Unit: mm (in)

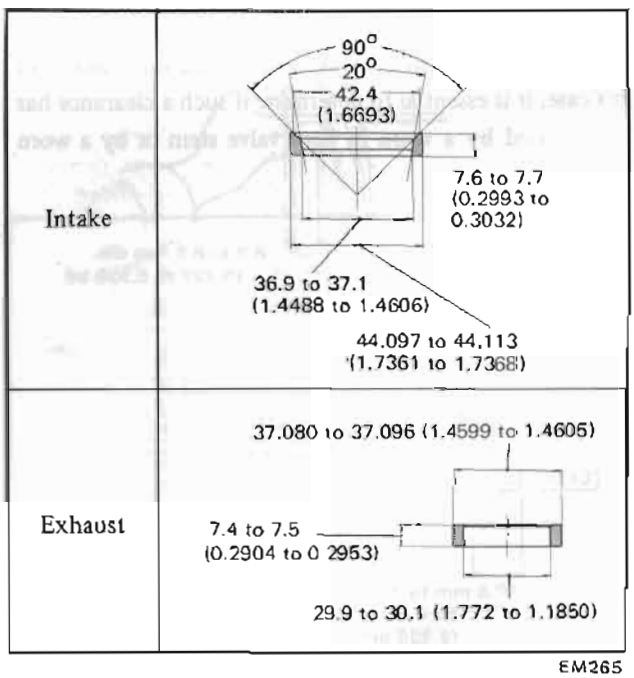


Fig. EM-36 Standard valve seat insert

Cylinder head recess diameter

Unit: mm (in)

Intake	For standard insert	43.987 to 44.033 (1.732 to 1.734)
	For service insert	44.433 to 44.487 (1.749 to 1.751)
Exhaust	For standard insert	36.980 to 37.036 (1.456 to 1.458)
	For service insert	37.480 to 37.536 (1.476 to 1.478)

Unit: mm (in)

Interference fit	Intake	0.08 to 0.11 (0.0031 to 0.0043)
	Exhaust	0.06 to 0.10 (0.0024 to 0.0039)

Replacing the valve seat insert

1. Old inserts can be removed by boring out until the insert collapses. The machine depth stop should be set so that boring cannot continue beyond the bottom face of the insert recess in the cylinder head.

2. Select a suitable valve seat insert and check its outside diameter.

3. Machine the cylinder head recess diameter to the concentric circles to the valve guide center so that the insert will have the correct fit.

4. Ream the cylinder head recess at room temperature.

5. Heat the cylinder head to a temperature of 150° to 200°C (302° to 392°F).

6. Fit the insert ensuring that it beds on the bottom face of its recess.

7. The valve seats newly fitted should be cut or ground to the specified dimensions as shown in Figure EM-35 with the special tool "Valve Seat Cutter Set ST11650001."

8. Apply small amount of fine grinding compound to valve contacting face and put the valve into the guide. Lap the valve against its seat until proper valve seating is obtained. Remove the valve and then clean the valve and valve seat.

CAMSHAFT AND CAMSHAFT BEARINGS

Camshaft bearing clearance check

1. Measure the inner diameter of the camshaft bearing and the outer diameter of the camshaft journal. If wear is found inside the bracket, replace the cylinder head assembly.

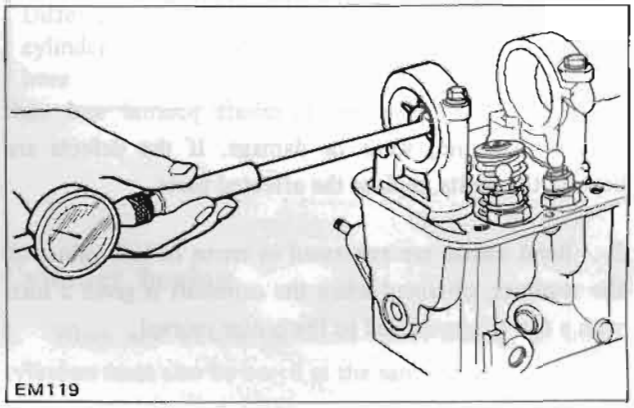
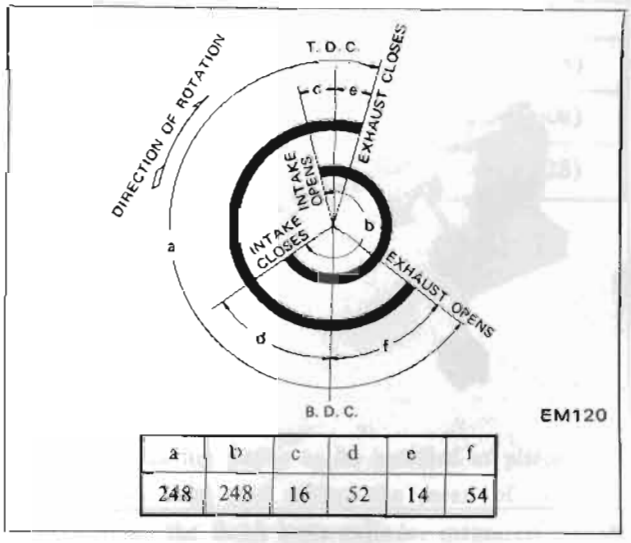


Fig. EM-37 Camshaft bearing check

Unit: mm (in)

	Standard	Wear limit
Camshaft journal to bearing clearance	0.038 to 0.067 (0.0015 to 0.0026)	0.1 (0.0039)
Inner diameter of camshaft bearing	48.00 to 48.016 (1.8898 to 1.8904)	

Valve timing check



a	b	c	d	e	f
248	248	16	52	14	54

Fig. EM-38 Valve timing diagram

This diagram will apply to all cylinders. If any valve is found "out of specifications," one possibility is that cam lobe is worn or damaged, calling for replacement of camshaft.

Camshaft alignment check

1. Check the camshaft, camshaft journal and cam surface for bend, wear or damage. If the defects are beyond the limits, replace the affected parts.

2. Bend values are expressed in terms of half values of the readings, obtained when the camshaft is given a turn with a dial gauge applied to the center journal.

	Standard	Bend limit
Camshaft bend mm (in)	0.015 (0.0006)	0.05 (0.0020)

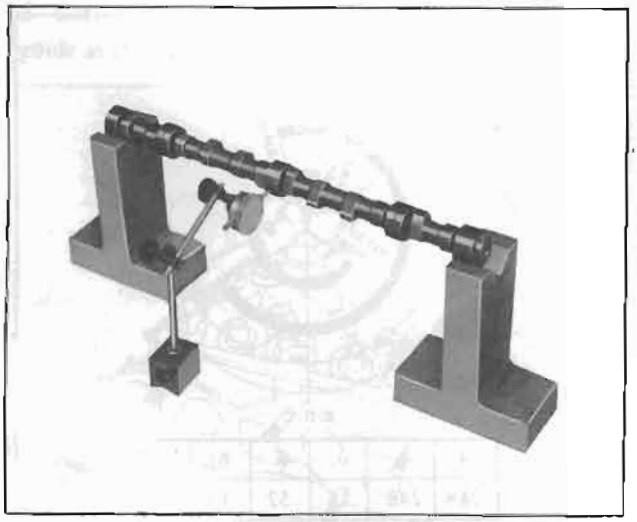


Fig. EM-39 Camshaft bend check

Unit: mm (in)

Standard height of cam	39.95 to 40.00 (1.573 to 1.575)
Wear limit of cam height	0.25 (0.0098)
Allowable difference in diameter between maximum worn and minimum worn parts of camshaft journal	0.05 (0.0020)
Maximum tolerance in journal diameter	0.1 (0.0039)

CYLINDER BLOCK

1. Visually check the cylinder block for cracks and flaws.

2. Measure the top face of the block (cylinder head mating face) for warpage. If the warpage exceeds the limit, correct it.

	Standard	Maximum tolerance
Surface flatness mm (in)	less than 0.05 (0.0020)	0.10 (0.0039)

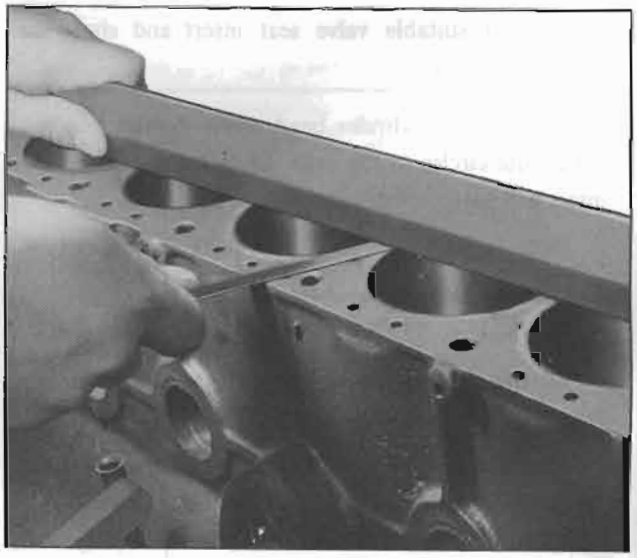


Fig. EM-40 Cylinder block surface check

3. Measure the cylinder bore for out-of-round or excessive taper with a bore gauge. If excessive wear, taper or out-of-round are detected on the cylinder wall, rebore the cylinder wall by a boring machine.

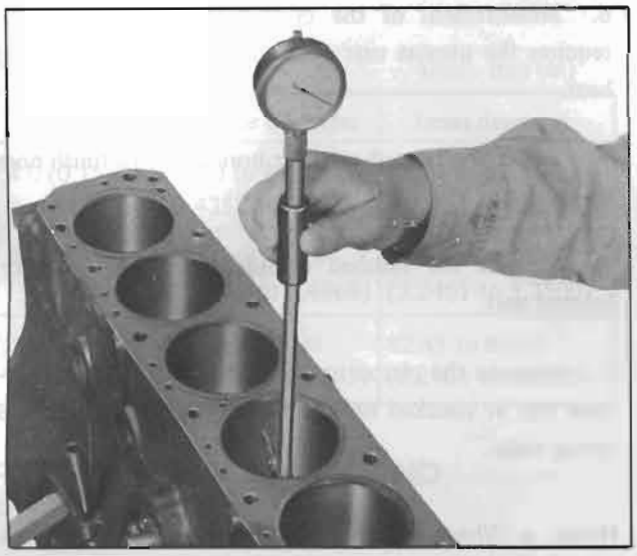


Fig. EM-41 Measuring the cylinder bore

4. When the wear, taper and out-of-round do not exceed the limit, remove the step at the topmost portion of the cylinder by using a ridge reamer or other similar tool.

How to measure cylinder bore

A bore gauge is used. Measure the cylinder bore at top, middle and bottom points in each direction A and B as illustrated and record the measured values.

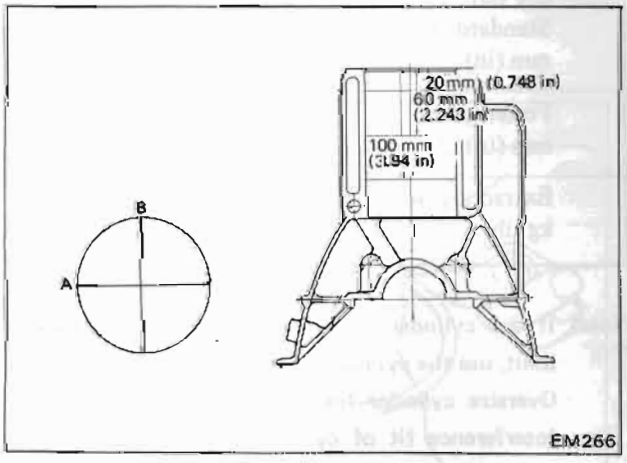


Fig. EM-42 Measuring points of cylinder bore

Unit: mm (in)

	Standard	Wear limit
Cylinder bore	83.000 to 83.050 (3.2677 to 3.2697)	0.2 (0.0097)
Error in cylinder bore elliptic tapered	0.015 (0.0006)	
Difference in cylinder bore	0.05 (0.0020)	0.2 (0.0079)

Cylinder boring

1. When any of the cylinders needs boring, all other cylinders must also be bored at the same time.

2. Determine piston oversize according to the amount of wear of the cylinder.

Oversize piston specifications

Unit: mm (in)

Piston size	Outside diameter
Standard	82.99 to 83.04 (3.267 to 3.269)
Oversize 1	83.22 to 83.27 (3.276 to 3.278)
Oversize 2	83.47 to 83.52 (3.286 to 3.288)
Oversize 3	83.72 to 83.77 (3.296 to 3.298)
Oversize 4	83.97 to 84.02 (3.305 to 3.308)
Oversize 5	84.47 to 84.52 (3.326 to 3.328)

3. By measuring piston to be installed at piston skirt (side thrust face) and adding the mean of clearance specification, the finish hone cylinder measurement can be determined.

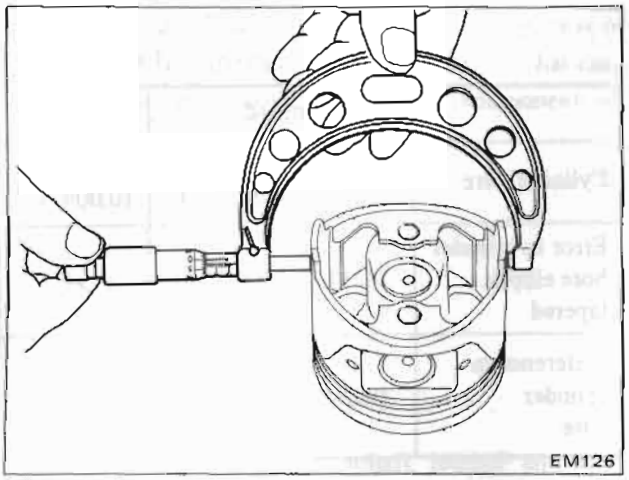


Fig. EM-43 Measuring the piston diameter

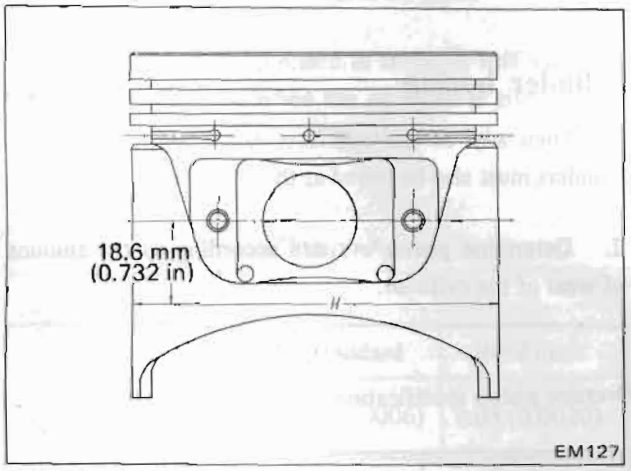


Fig. EM-44 Measuring point of the piston

Rebored size calculation

D = A + B – C = A + [0.005 to 0.025 mm (0.0002 to 0.0010 in)]

Where,

D: Honed diameter
A: Skirt diameter as measured
B: Piston-to-wall clearance
C: Machining allowance 0.02 mm (0.0008 in)

4. Machine the cylinder bore to the determined inner diameter.

Note: To prevent strain due to cutting heat, bore the cylinders in the order of 1-5-3-6-2-4.

5. Do not cut too much out of the cylinder bore at a time, but cut 0.05 mm (0.0020 in) or so at a time.

6. Measurement of the cylinder bore just machined requires the utmost care since it is expanded by cutting heat.

7. Finish the treated cylinder bore to a final finish bore by honing.

8. Measure the finished cylinder bore for elliptic or tapered part.

9. Measure the piston to cylinder clearance. This clearance can be checked easily by using a feeler gauge and a spring scale.

Notes: a. When measuring the clearance, slowly pull the feeler gauge straight upward.
b. It is recommended that the piston and cylinder be heated to 20°C (68°F).

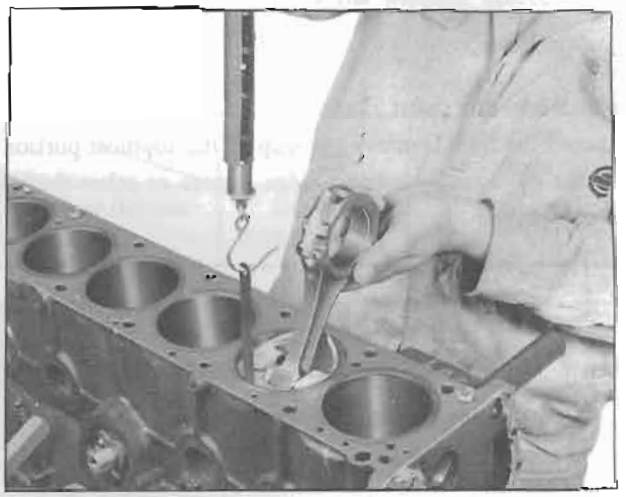


Fig. EM-45 Piston to cylinder clearance check

Standard clearance mm (in)	0.025 to 0.045 (0.0010 to 0.0018)
Feeler gauge mm (in)	0.04 (0.0016)
Extracting force kg (lb)	0.2 to 1.5 (0.4409 to 3.3069)

Note: If the cylinder bore has worn beyond the wear limit, use the cylinder liner.
Oversize cylinder liners are available for service. Interference fit of cylinder liner in the cylinder block should be 0.08 to 0.09 mm (0.0031 to 0.0035 in).

Cylinder liner for service

Unit: mm (in)

	Outside diameter	Inner diameter
4.0 (0.1575) oversize	87.00 to 87.05 (3.4252 to 3.4272)	82.45 to 82.55 (3.2461 to 3.2500)
4.5 (0.1772) oversize	87.50 to 87.55 (3.4449 to 3.4468)	82.45 to 82.55 (3.2461 to 3.2500)
5.0 (0.1969) oversize	88.00 to 88.05 (3.4646 to 3.4665)	82.45 to 82.55 (3.2461 to 3.2500)

PISTON, PISTON PIN AND PISTON RING

1. Check for seizing, scratches and wear. Replace if such a defect is detected.

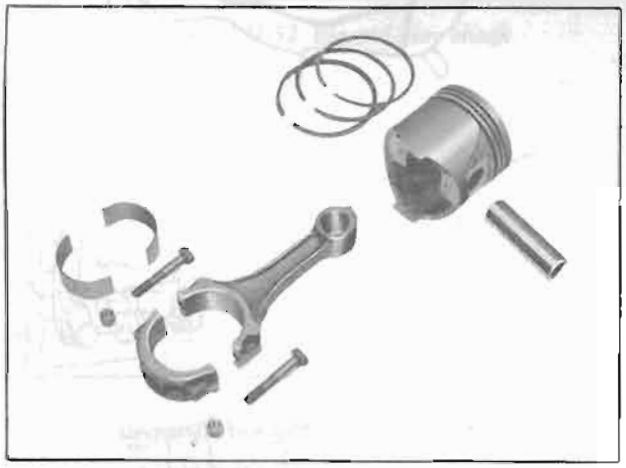


Fig. EM-46 Piston and connecting rod assembly

2. Measure the side clearance of rings in ring grooves as each ring is installed. Clearance with new pistons and rings should be as follows.

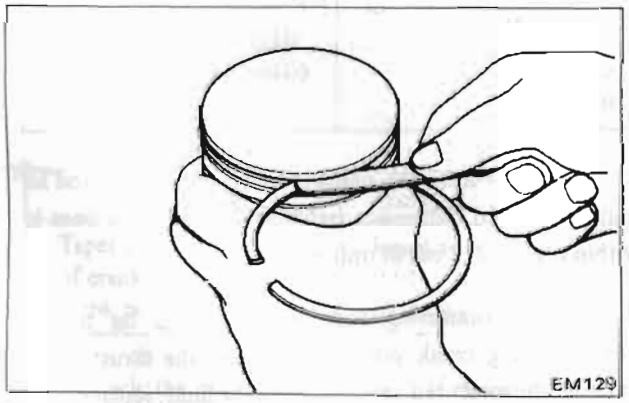


Fig. EM-47 Side clearance measurement

Side clearance

Unit: mm (in)

	Standard	Wear limit
Top ring	0.045 to 0.080 (0.0018 to 0.0031)	0.1 (0.0039)
Second ring	0.030 to 0.070 (0.0012 to 0.0028)	0.1 (0.0039)
Oil ring	0	

Ring gap

Unit: mm (in)

	Standard	Wear limit
Top ring	0.23 to 0.38 (0.0091 to 0.0150)	1.0 (0.0394)
Second ring	0.15 to 0.30 (0.0059 to 0.0118)	1.0 (0.0394)
Oil ring	0.15 to 0.30 (0.0059 to 0.0118)	1.4 (0.0591)

3. Position the piston ring into the cylinder with the piston so as to place it squarely in the cylinder; measure a ring gap with a feeler gauge.

The piston ring should be placed to diameter at upper or lower limit of ring travel.

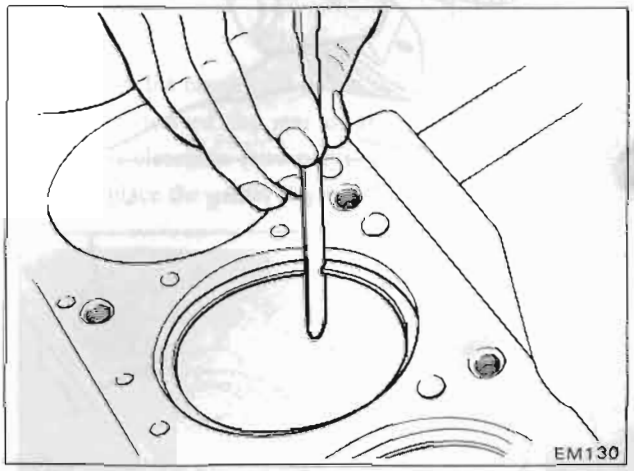


Fig. EM-48 Ring gap measurement

Notes: a. When the piston ring only is to be replaced, without the cylinder bore being corrected, measure the gap at the bottom of the cylinder where the wear is minor.

b. Oversize piston rings are available for service. (0.25, 0.50, 0.75, 1.00, 1.50 oversize).

4. Measure the piston pin hole in relation to the outer diameter of the pin. If wear exceeds the limit, replace such piston pin together with the piston on which it is installed.

Unit: mm (in)

Piston pin outside diameter	20.995 to 21.000 (0.8266 to 0.8268)
Piston pin length	72.00 to 72.25 (2.835 to 2.844)
Piston pin hole diameter	21.001 to 21.008 (0.8268 to 0.8271)

5. Determine the fitting of the piston pin into the piston pin hole to such an extent that it can be finger pressed at room temperature. This piston pin must be a tight press fit into the connecting rod.

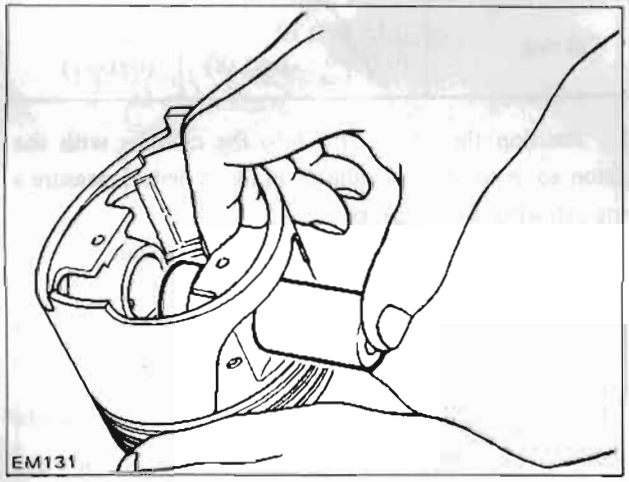


Fig. EM-49 Piston pin fitting

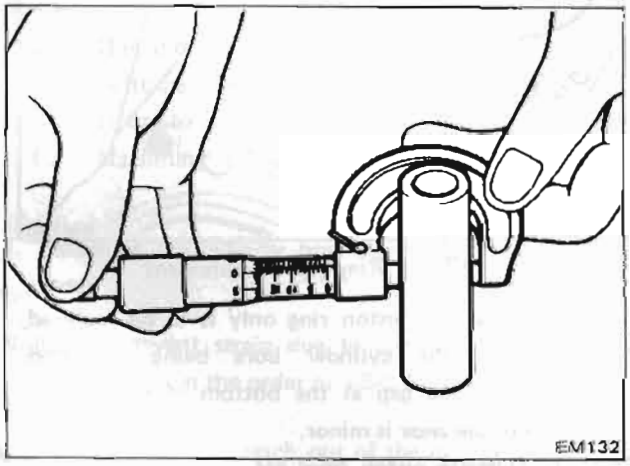


Fig. EM-50 Measuring piston pin diameter

Unit: mm (in)

Piston pin to piston clearance	0.001 to 0.013 (0.00004 to 0.00051)
Interference fit of piston pin to connecting rod	0.015 to 0.033 (0.0006 to 0.0013)

CONNECTING ROD

1. If a connecting rod has any cracks in the both sides of the thrust face and the large end, correct or replace it.

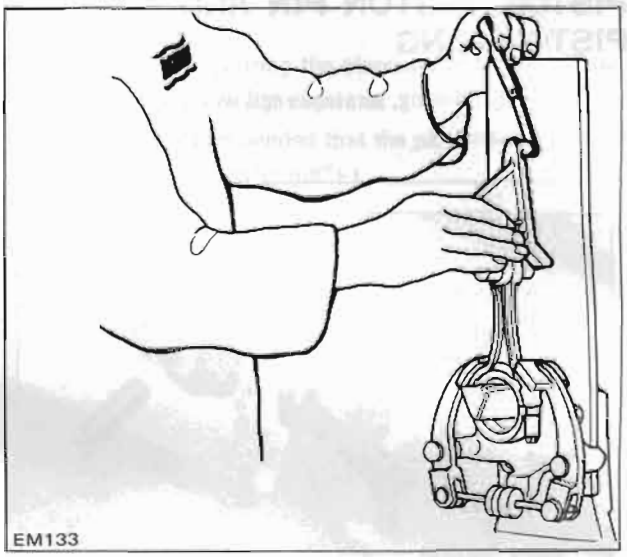


Fig. EM-51 Connecting rod alignment

2. Check the connecting rod for bend or torsion using a connecting rod aligner. If bend or torsion exceeds the limit, correct or replace it.

	Standard	Maximum
Connecting rod bend or torsion (per 100 mm or 3.94 in: length) mm (in)	0.025 (0.0010)	0.05 (0.0020)

3. When replacing the connecting rod, select the rod so that the weight difference between new and old ones is within 6 gr (0.212 oz) in unit weight.

4. Install connecting rods with bearings on to the corresponding crank pins and measure the thrust clearance. If the measured values exceed the limit, replace such connecting rod.

	Standard	Wear limit
Big end play mm (in)	0.2 to 0.3 (0.0079 to 0.0118)	0.30 (0.0118)

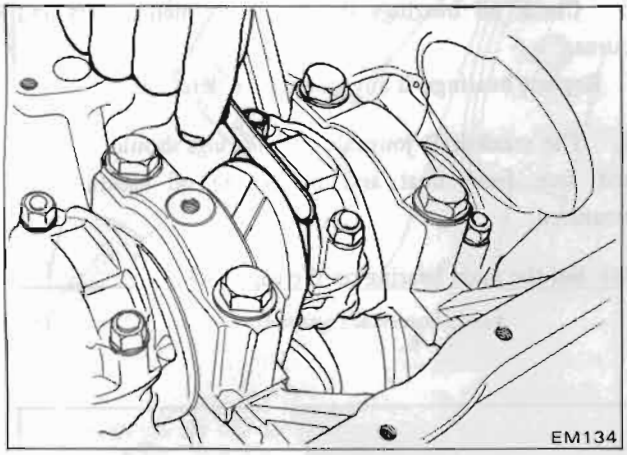


Fig. EM-52 Big end play check

CRANKSHAFT

1. Check the shaft journal and crank pin for scars, bias wear or cracks.

Repair or replace as required.

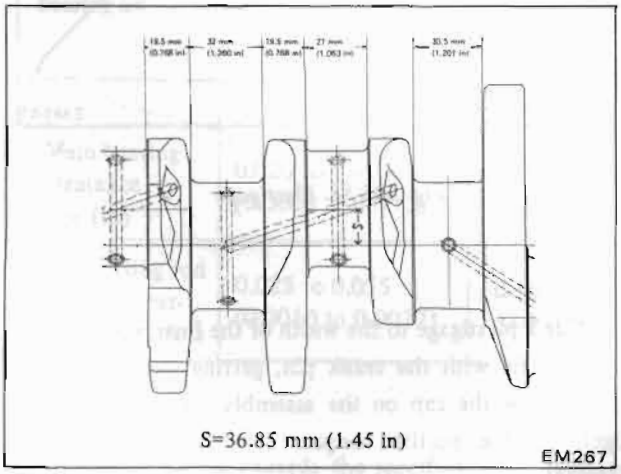


Fig. EM-53 Crankshaft dimensions

	Standard	Maximum
Taper and out-of-round of crank journal and crank pin mm(in)	less than 0.01 (0.0004)	0.03 (0.0012)

2. Check the crankshaft for bend. If the bend exceeds the specified value, repair or replace the crankshaft.

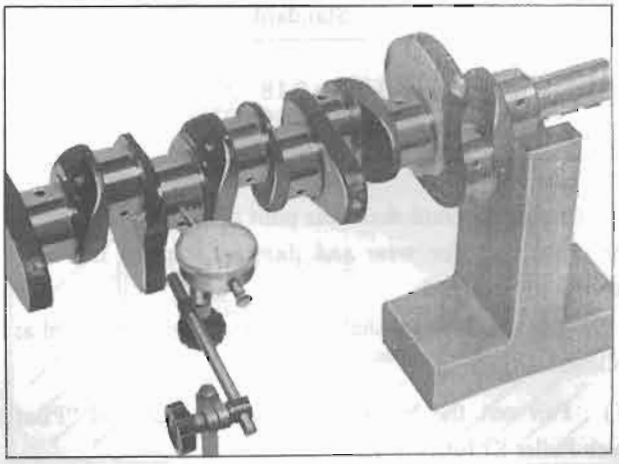


Fig. EM-54 Crankshaft bend check

	Standard	Maximum
Crankshaft bend mm (in)	less than 0.025 (0.0010)	0.05 (0.0020)

Note: When measuring the bend, use a dial gauge. Bend value is half of the reading obtained when the crankshaft is given a turn with the dial gauge applied to its center journal.

3. After regrinding the crankshaft, finish it to the necessary size indicated in the list on page EM-22 by using an adequate undersize bearing according to the extent of required repair.

4. Install the crankshaft in the cylinder block. Force the crankshaft toward the rear of the engine. Then measure the thrust clearance (end play). If it exceeds the specified value, replace the center bearing.

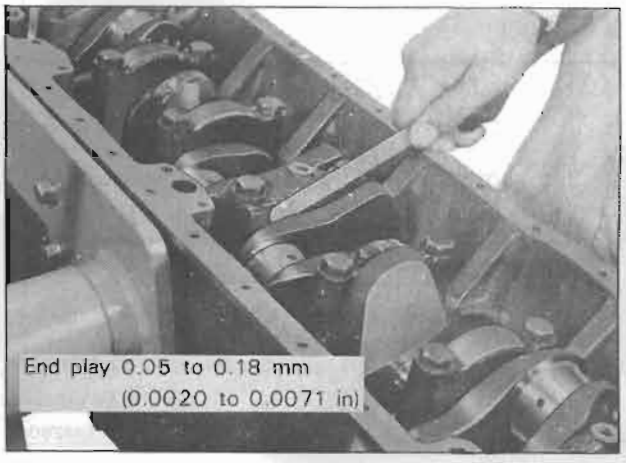


Fig. EM-55 Crankshaft end play check

	Standard	Wear limit
Crankshaft end play mm (in)	0.05 to 0.18 (0.0020 to 0.0071)	0.3 (0.0118)

5. Check the crankshaft rear pilot bushing at the rear of the crankshaft for wear and damage. Replace it if any defects are detected.

To replace the crankshaft rear pilot bushing, proceed as follows:

(1) Pull out the bushing using the special tool "Pilot Bush Puller ST16610001."

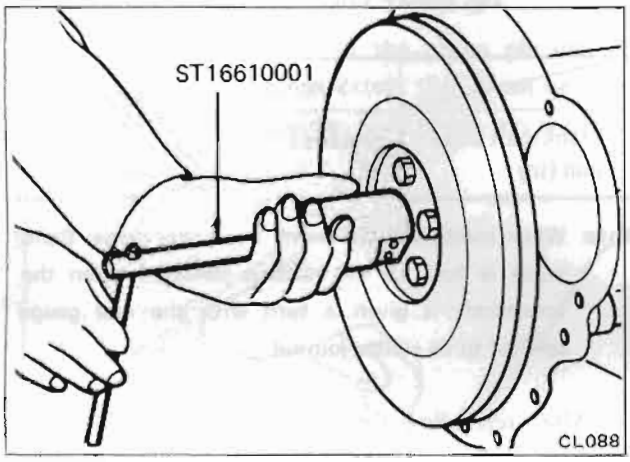


Fig. EM-56 Pulling out pilot bushing

(2) Before installing a new bushing, thoroughly clean the bushing hole. Press-fit the bushing so that its height above flange end is 4.5 to 5.0 mm (0.18 to 0.20 in). Do not oil the bushing.

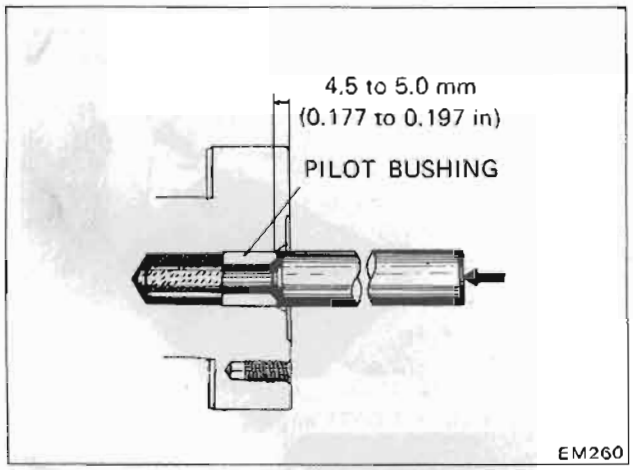


Fig. EM-57 Press-fitting new pilot bushing

BEARINGS

Measurement of main bearing clearance

1. Check all bearings for scratches, melts, scars and burns.

Replace bearings, if any defects are detected.

2. The crankshaft journals and bearings should be clean and free from dust and oil before oil clearance is measured.

3. Set the main bearing on the cap block.

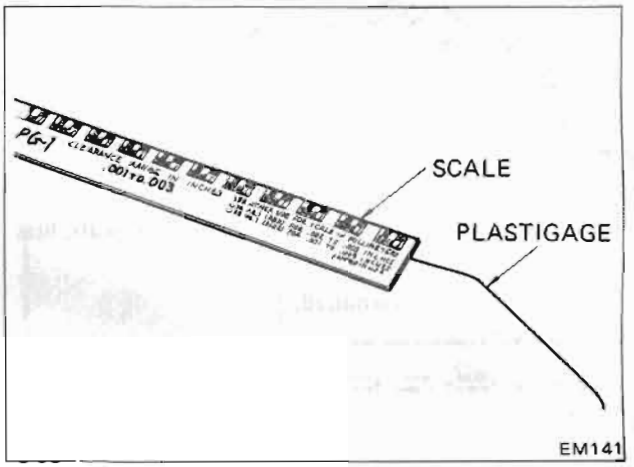


Fig. EM-58 Plastigage

4. Cut a plastigage to the width of the bearing and place it in parallel with the crank pin, getting clear of the oil hole. Install the cap on the assembly and tighten them together to the specified torque.

Tightening torque: 4.5 to 5.5 kg-m (33 to 40 ft-lb)

Note: Do not turn the crankshaft while the plastigage is being inserted.

5. Remove the cap, and measure the width of the plastigage at its widest part with the scale printed in the plastigage envelope.

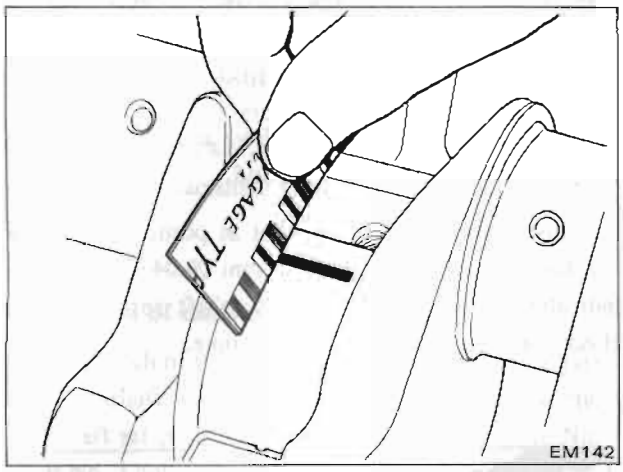


Fig. EM-59 Bearing clearance check

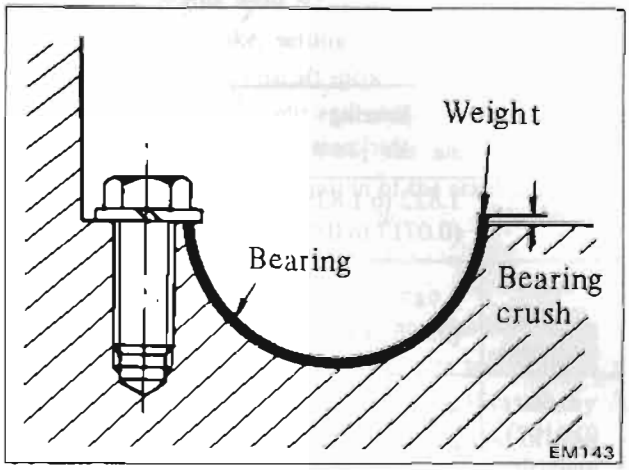


Fig. EM-60 Bearing crush check

Measurement of connecting rod bearing clearance

1. Measure the connecting rod bearing clearance in the same manner as the crankshaft.

Tightening torque: 4.5 to 5.5 kg-m (32.6 to 39.8 ft-lb)

Bearing oil clearance

	Standard	Wear limit
Main bearing clearance mm (in)	0.020 to 0.072 (0.0008 to 0.0028)	0.12 (0.0047)
Connecting rod bearing clearance mm (in)	0.025 to 0.055 (0.0010 to 0.0022)	0.10 (0.0039)

2. If the clearance exceeds the specified value, replace the bearing with undersized one and, consequently, grind out the crankshaft journal.

Fitting bearings

The bearings are manufactured with crush to make bearing snug down into its bore. To measure this, proceed as follows:

1. Set the main bearing in the main bearing cap recess or the cylinder block bearing recess correctly.

2. Lock the one side of bearing and press the other side antil the bearing back surface touches the recess.

3. Then, measure bearing crush with a feeler gauge. See Figure EM-60. The standard bearing crush value is listed below.

Bearing crush

All main bearing mm (in)	0 to 0.03 (0 to 0.0012)
All connecting rod bearing mm (in)	0.015 to 0.045 (0.0006 to 0.0018)

4. Handle the connecting rod bearing in the same manner as above.

Connecting rod cap tightening torque: 4.5 to 5.5 kg-m (32.6 to 39.8 ft-lb).

Main bearing undersize

Unit: mm (in)

Bearing size	Bearing thickness	Crank journal diameter
Standard	1.822 to 1.835 (0.0717 to 0.0722)	54.942 to 54.955 (2.1631 to 2.1636)
0.25 (0.0098) undersize	1.947 to 1.960 (0.0767 to 0.0772)	54.692 to 54.705 (2.1532 to 2.1537)
0.50 (0.0197) undersize	2.072 to 2.085 (0.0816 to 0.0821)	54.442 to 54.455 (2.1434 to 2.1439)
0.75 (0.0295) undersize	2.197 to 2.210 (0.0865 to 0.0870)	54.192 to 54.205 (2.1335 to 2.1341)
1.00 (0.0394) undersize	2.322 to 2.335 (0.0914 to 0.0919)	53.942 to 53.955 (2.1237 to 2.1242)

Connecting rod bearing undersize

Unit: mm (in)

Bearing size	Bearing thickness	Crank pin diameter
Standard	1.493 to 1.506 (0.0588 to 0.0593)	49.961 to 49.974 (1.9670 to 1.9675)
0.06 (0.0024) undersize	1.523 to 1.536 (0.0600 to 0.0605)	49.901 to 49.914 (1.9646 to 1.9651)
0.12 (0.0047) undersize	1.553 to 1.566 (0.0611 to 0.0617)	49.841 to 49.854 (1.9622 to 1.9628)
0.25 (0.0098) undersize	1.618 to 1.631 (0.0637 to 0.0642)	49.711 to 49.724 (1.9571 to 1.9576)
0.50 (0.0197) undersize	1.743 to 1.756 (0.0686 to 0.0691)	49.461 to 49.474 (1.9473 to 1.9478)
0.75 (0.0295) undersize	1.868 to 1.881 (0.0735 to 0.0741)	49.211 to 49.224 (1.9374 to 1.9379)
1.00 (0.0394) undersize	1.993 to 2.006 (0.0785 to 0.0790)	48.961 to 48.974 (1.9726 to 1.9281)

MISCELLANEOUS COMPONENTS

Crankshaft sprocket, camshaft sprocket

1. Check tooth surfaces for flaws and wears. Replace the sprocket if any defects are found.

2. Install the camshaft sprocket in position and check for run-out. If it exceeds 0.1 mm (0.04331 in) total indicator reading, replace the camshaft sprocket. Also check for end play at the same time.

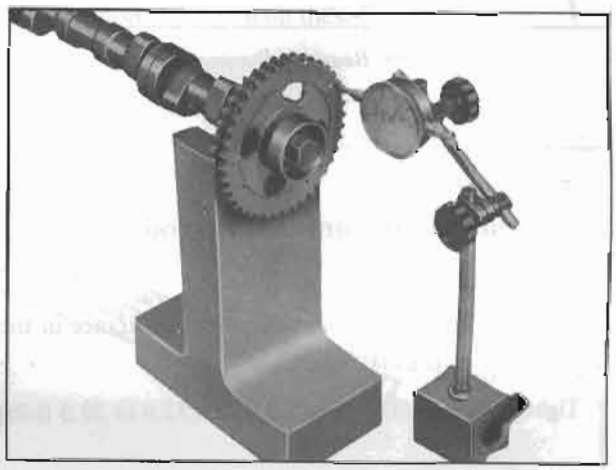


Fig. EM-61 Camshaft sprocket run-out check

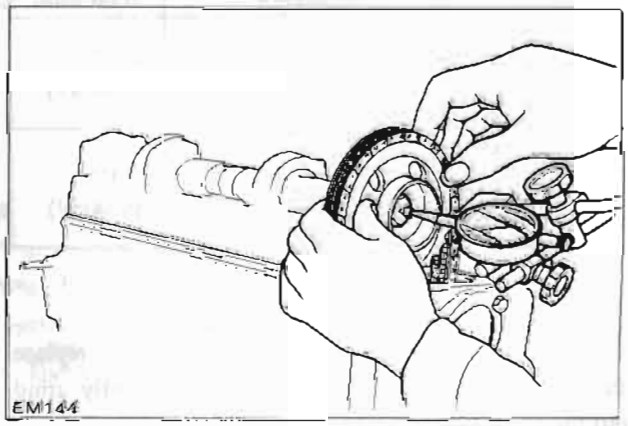


Fig. EM-62 Camshaft end play check

Camshaft end play

0.08 to 0.38 mm (0.0031 to 0.0058 in)

3. Check the chain for damage, severe wear and stretch at its roller links. Replace a defective chain.

4. When the chain stretches extremely, the valve timing goes out of order. Two location (Camshaft set) holes are provided in the camshaft sprocket to correct the valve timing.

Adjustment of camshaft sprocket location

If the stretch of the chain roller links is extreme, adjust the camshaft sprocket location by transferring the camshaft set position of the camshaft sprocket to No. 2 or No. 3 hole.

1. Turn the engine until No. 1 piston is at T.D.C. on its compression stroke. Examine whether the camshaft location notch on the camshaft sprocket comes off the left end of the oblong groove on the camshaft locating plate.
(If the camshaft location notch is off the left end of the oblong groove, the stretch of the chain is beyond the limit.)

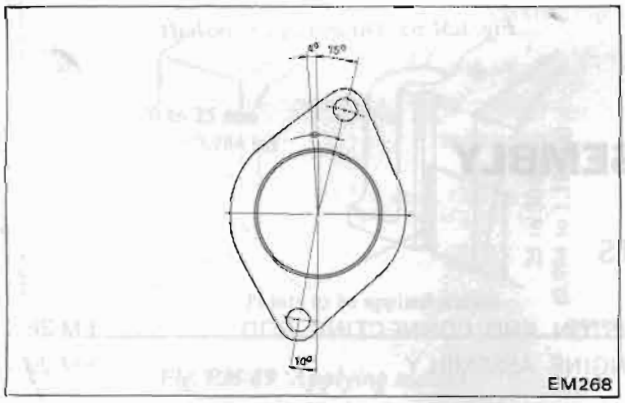


Fig. EM-63 Camshaft locating plate

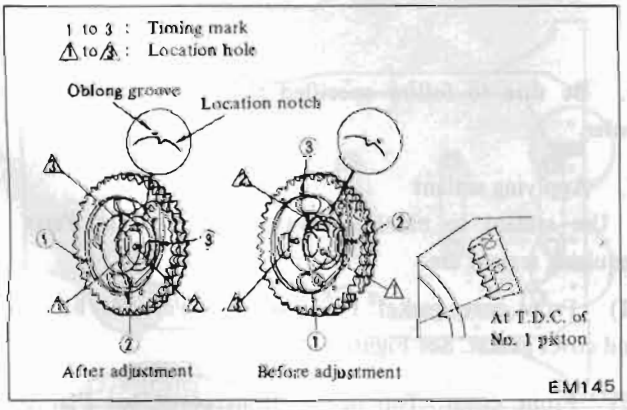


Fig. EM-64 Camshaft sprocket

2. Turn the engine until No. 1 piston is at T.D.C. on its compression stroke, setting the camshaft on No. 2 location hole of the camshaft sprocket. Then this No. 2 hole should be on the right end of the oblong groove. When the No. 2 hole is used, the amount of the modification is 4° by the rotation of the crankshaft.

3. If the valve timing can not be corrected by using No. 2 hole, use No. 3 hole as in the same procedure as mentioned above. The amount the modification by using No. 3 hole is 8° by the rotation of the crankshaft.

4. When the modification becomes impossible even by transferring the camshaft location hole, replace the chain assembly.

Chain tensioner and chain guide

Check for wear and breakage. Replace if necessary.

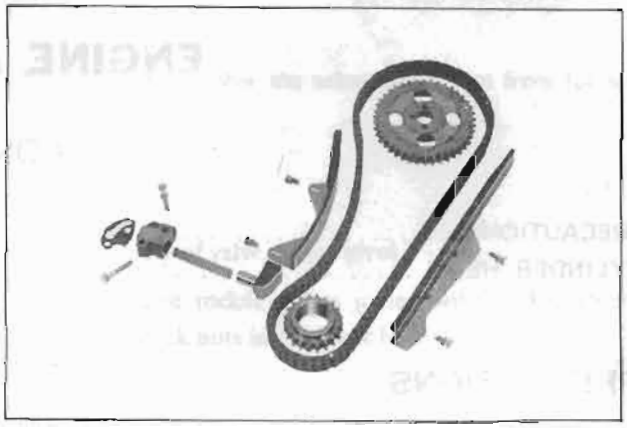


Fig. EM-65 Camshaft drive mechanism

Flywheel

1. Check the clutch disc contact surface of the flywheel for damage and wear. Repair or replace if necessary.

2. Measure runout of the clutch disc contact surface with a dial gauge. If it exceeds 0.1 mm (0.04331 in) total indicator reading, replace it.

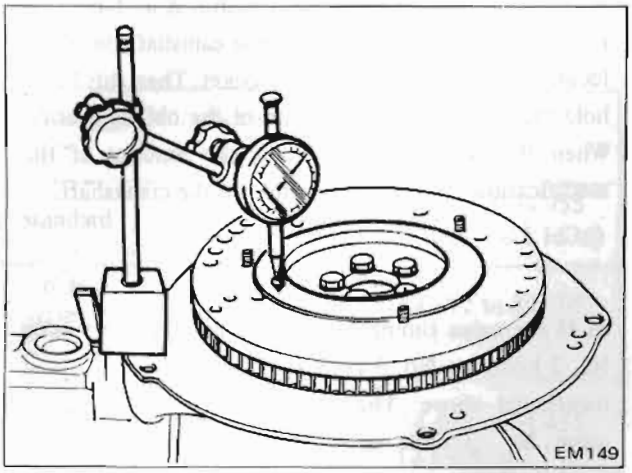


Fig. EM-66 Checking flywheel runout

3. Check tooth surfaces of the ring gear for flaws and wear. Replace if necessary.

Note: Replace the ring gear at about 180° to 200°C (356° to 392°F).

Front cover and rear oil seal

First check the front cover and rear oil seal for worn or folded over sealing lip or oil leakage. If necessary, replace with a new seal using the special tool "Front Oil Seal Drift Set ST1524S000" for the front oil seal. When installing a new seal, pay attention to its mounting direction.

Note: Renew the oil seal whenever the engine is overhauled.

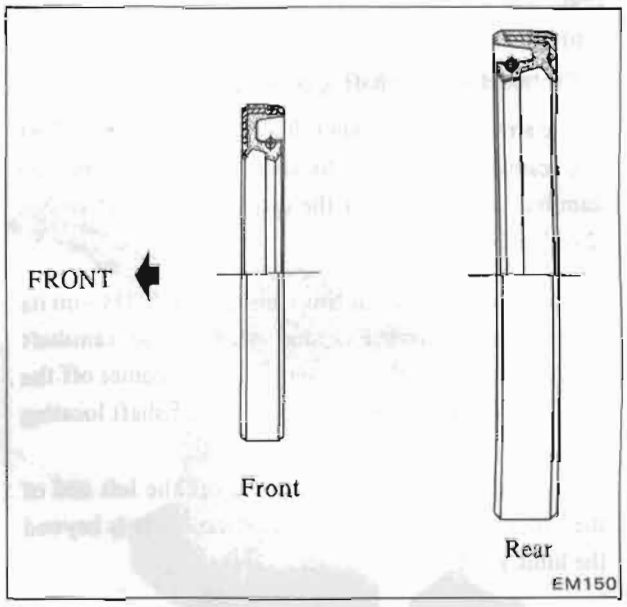


Fig. EM-67 Oil seal of crankshaft

ENGINE ASSEMBLY

CONTENTS

PRECAUTIONS EM-24
CYLINDER HEAD EM-25
PISTON AND CONNECTING ROD EM-26
ENGINE ASSEMBLY EM-26

PRECAUTIONS

1. Use thoroughly cleaned parts. Particularly, make sure that oil holes are clear of foreign matter.

2. When installing sliding parts such as bearings, be sure to apply engine oil to them.

3. Use new packings and oil seals.

4. Keep tools and work benches clean.

5. Keep the necessary parts and tools ready near at hand.

6. Be sure to follow specified tightening torque and order.

7. Applying sealant

Use sealant to eliminate water and oil leaks. Parts requiring sealant are:

(1) Front cover gasket: Front side of the cylinder block and cover gasket. See Figure EM-68.

(2) Front cover: Top of the front cover, see Figure EM-68.

(3) The main bearing cap and cylinder block: Each side of the rear main bearing cap and each corner of the cylinder block. See Figure EM-69.

(4) Cylinder block: Step portions at four mating surfaces (the cylinder block to the front chain cover and the cylinder block to the rear main bearing cap). See Figure EM-70.

Note: Do not apply sealant too much.

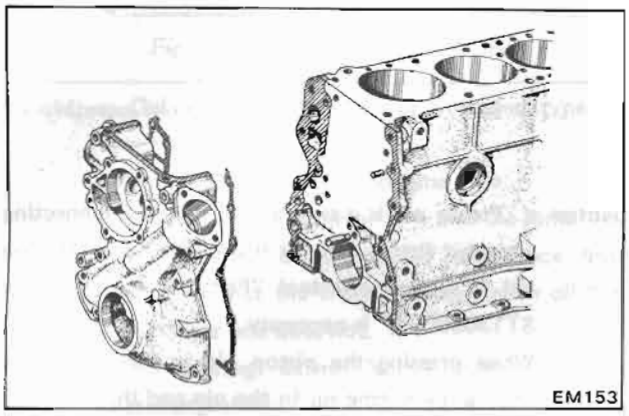


Fig. EM-68 Applying sealant (Front cover and gasket)

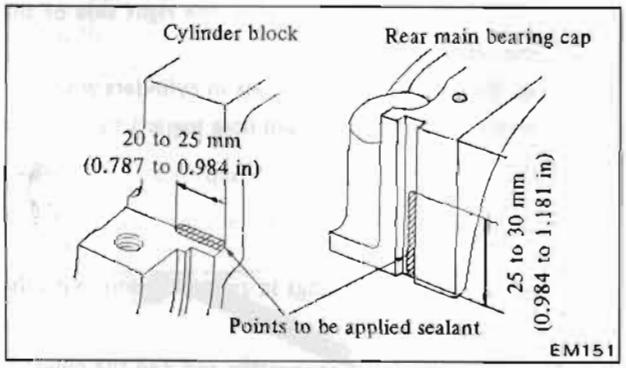


Fig. EM-69 Applying sealant (Main bearing cap and cylinder block)

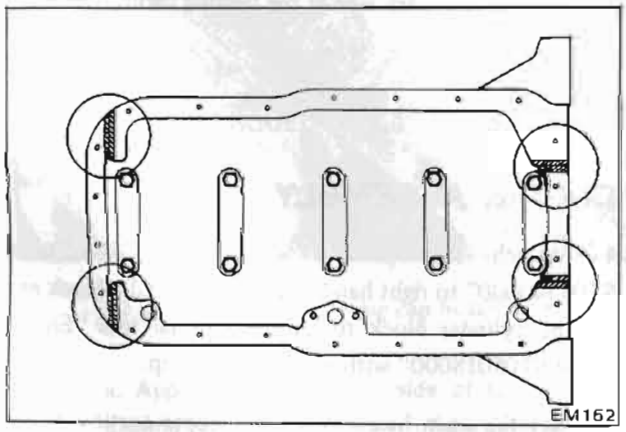


Fig. EM-70 Applying sealant (Cylinder block)

CYLINDER HEAD

1. Assembly of valve and valve spring

Set the valve spring seat in position, and fit the valve guide with the oil seal.

Using the special tool "Valve Lifter ST12070000," assemble the valve in the order shown below, valve, inner and outer valve springs, spring retainer, valve collet and valve rocker guide.

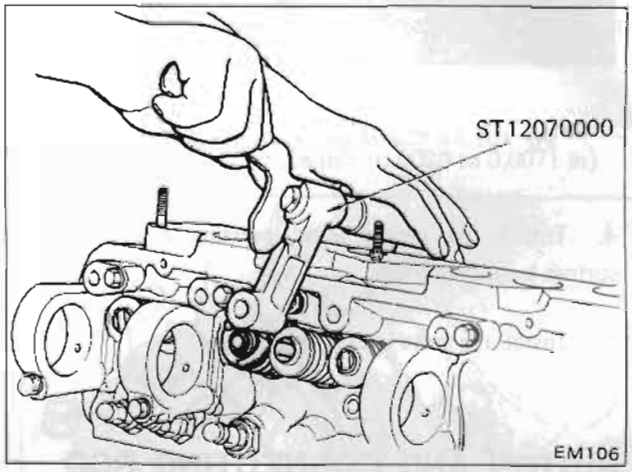


Fig. EM-71 Valve installation

Note: Check whether the valve face is free from foreign matters.

2. Assembly of valve rocker pivot.

Screw valve rocker pivots joined with rocker spring washer and lock nuts in the pivot bush.

3. Assembly of camshaft

Install the camshaft in cylinder head carefully and set the locating plate. Do not damage the bearing inside.

Note: The oblong groove of locating plate must be directed toward the front side of the engine.

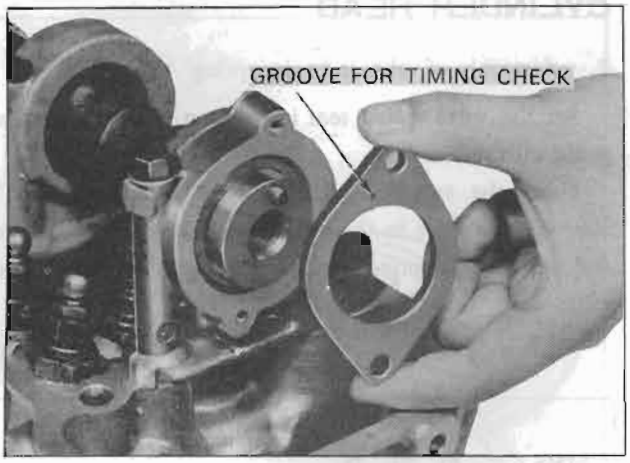


Fig. EM-72 Camshaft locating plate installation

4. Install the rocker arms, pressing down the valve springs by screwdriver.

5. Install the valve rocker springs.

PISTON AND CONNECTING ROD

1. Assemble piston, piston pin and connecting rod assorted according to cylinder number for every cylinder.

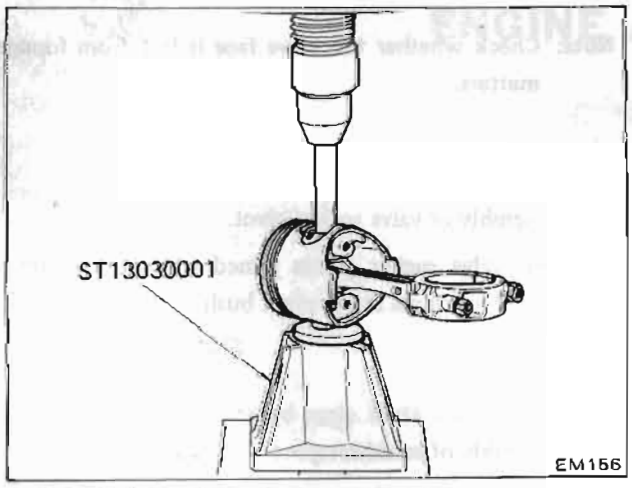


Fig. EM-73 Piston pin installation

Fig. EM-74 Piston and connecting rod assembly

Notes: a. Piston pin is a tight press fit to the connecting rod, and fitting force is from 1 to 3 tons and the aid of the special tool "Piston Pin Press Stand ST13030001," is necessary.
When pressing the piston pin in the connecting rod, apply engine oil to the pin and the small end of the connecting rod.
b. Arrange so as the oil jet of the connecting rod large end is directed toward the right side of the cylinder block.
c. Be sure to install pistons in cylinders with "F" mark near the piston pin hole toward the front of the engine.

2. Install the piston rings.

Install top and second rings in right position, with the marked side up.

3. Fix bearings on the connecting rod and the connecting rod cap.

Note: Clean the back side of the bearing carefully.

ENGINE ASSEMBLY

1. Attach the special tool "Engine Attachment ST05340000" to right hand side of the cylinder block and set the cylinder block to another special tool "Engine Stand ST0501S000" with engine bottom up.

2. Set the main bearings on the proper portion of the cylinder block.

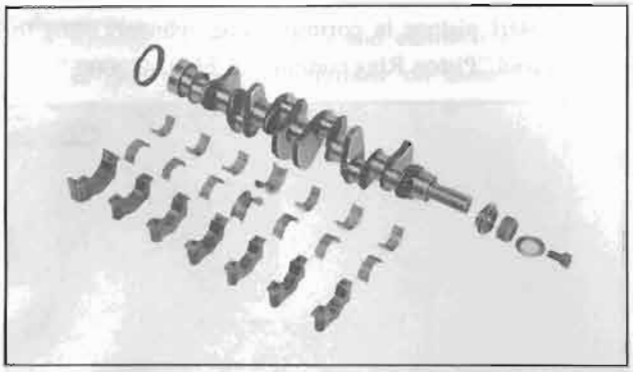


Fig. EM-75 Main bearing and caps

Notes: a. Only the center bearing is a flanged type for thrust force.
b. All inter bearings are the same type.
c. The front bearing (No. 1) is also the same type with the rear bearing. Only difference both bearings is that the front bearing has an oil hole and the rear one does not.
d. All bearings except No. 1 bearing have an interchangeability between upper and lower bearings.

3. Apply the engine oil to the main bearing surfaces on both the sides of the cylinder block and cap. Then, install the crankshaft.

4. Install the main bearing cap and tighten the bolts with specified torque.

Tightening torque: 4.5 to 5.5 kg-m (3.3 to 4.0 ft-lb)

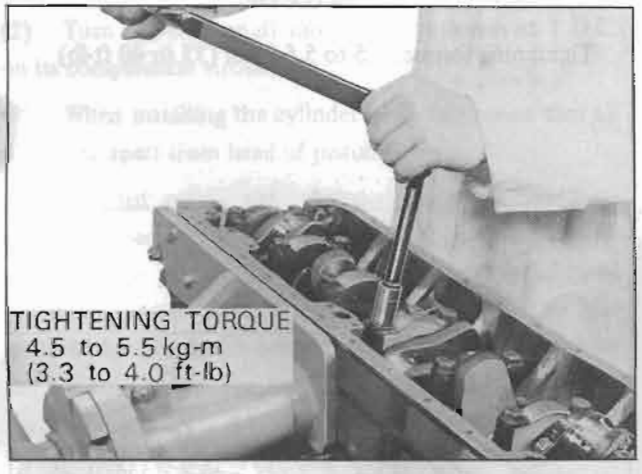


Fig. EM-76 Main bearing cap installation

Notes: a. Apply sealant to each side of the rear main bearing cap and each corner of the cylinder block as shown in Figure EM-69.
b. Arrange so as the arrow mark on the bearing cap is faced toward the front of the engine.
c. Prior to the tightening of the bearing cap bolts, place the bearing cap at a proper position by shifting the crankshaft in the axial direction.
d. The tightening operation should be made gradually in separating three of four stages and outwardly from center bearing.
e. After securing the bearing cap bolts, ascertain that the crankshaft turns smoothly.

5. Force the crankshaft toward the rear of the engine and check the crankshaft end play.

Crankshaft end play:

0.05 to 0.18 mm (0.0020 to 0.0071 in)

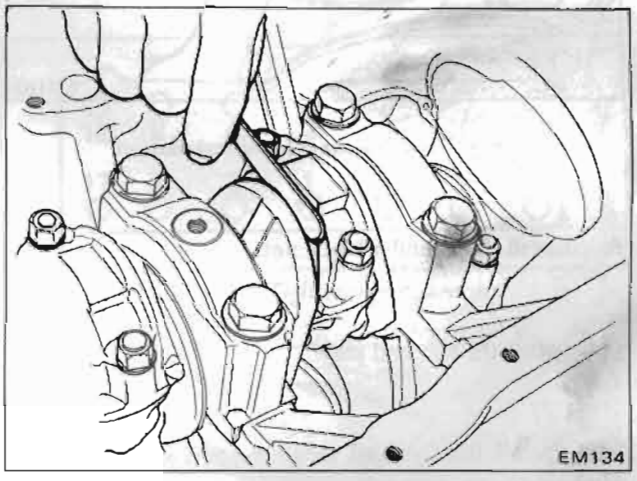


Fig. EM-77 Camshaft end play check

6. Install the side oil seals into the rear main bearing cap. Prior to installing, apply sealant to these seals.

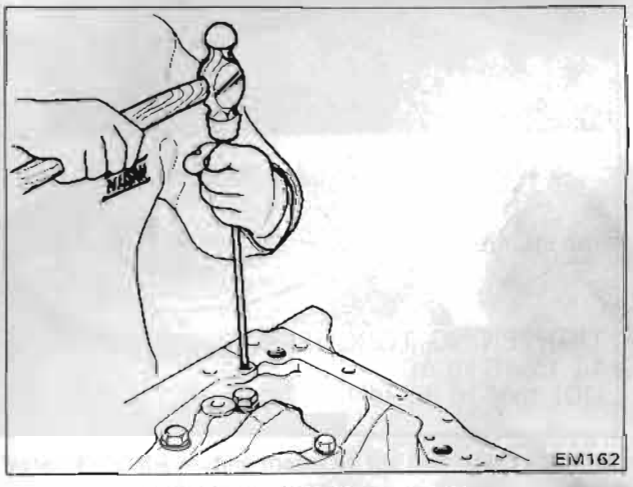


Fig. EM-78 Side oil seal installation

7. Install the crankshaft rear oil seal using the special tool "Crankshaft Rear Oil Seal Drift ST15310000."

Apply a lithium grease to sealing lip of the oil seal.

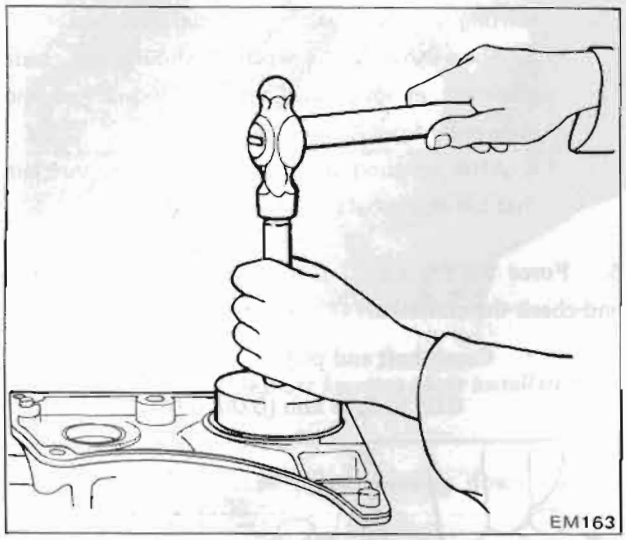


Fig. EM-79 Rear oil seal installation

8. Install the cylinder block net.

9. Install the rear end plate.

10. Install the flywheel securely and tighten the bolts with specified torque.

Tightening torque: 14 to 16 kg-m (101 to 116 ft-lb)

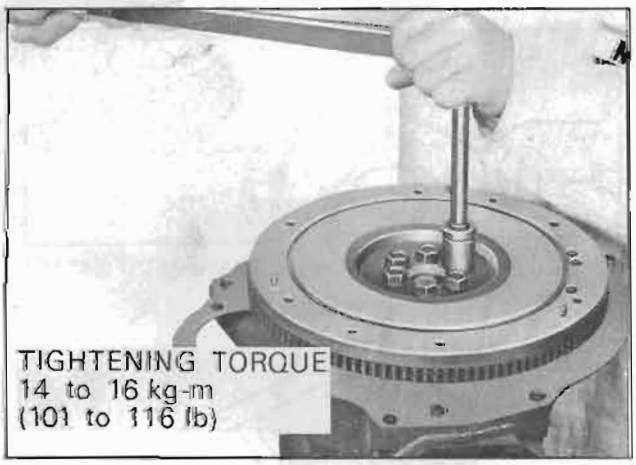


Fig. EM-80 Flywheel installation

11. Insert pistons in corresponding cylinders using the special tool "Piston Ring compressor EM03470000."

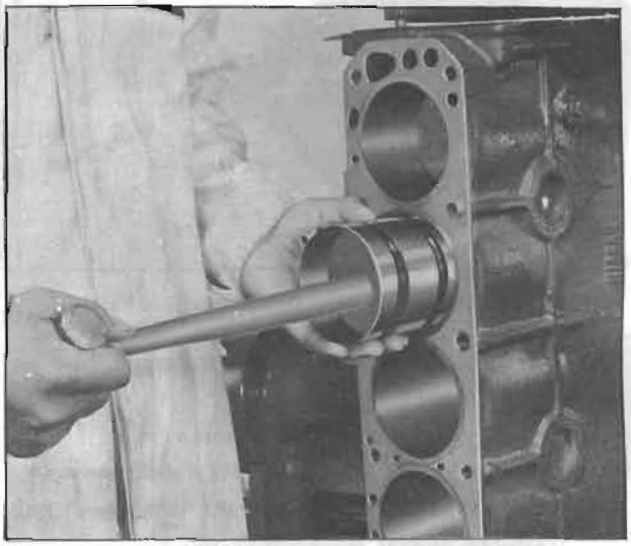


Fig. EM-81 Piston-rod assembly intallation

Notes: a. Apply the engine oil to sliding parts.
b. Arrange so as the "F" marked on the piston faces the front of the engine.
c. Install piston rings at 180° to each other, avoiding their fit in the thrust and piston pin directions.

12. Install the connecting rod cap.

Tightening torque: 4.5 to 5.5 kg-m (33 to 40 ft-lb)

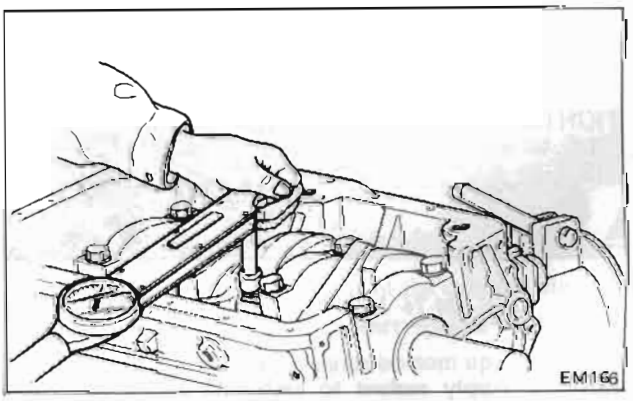


Fig. EM-82 connecting rod cap installation

Note: Arrange connecting rods and connecting rod caps so that the cylinder number on them faces the same direction.

13. Measure the end play of the connecting rod big end.

Big end play:
0.20 to 0.30 mm (0.0079 to 0.0118 in)

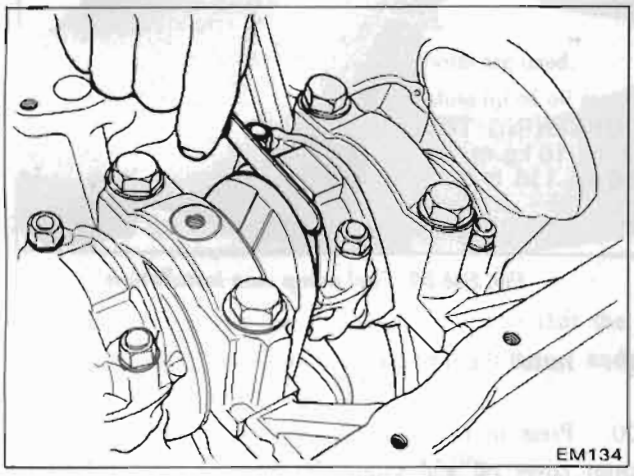


Fig. EM-83 Big end play check

14. Install the cylinder head assembly to the cylinder block.

(1) Thoroughly clean the cylinder block and head surface. Do not apply sealant to any other part of the cylinder block and head surface.

(2) Turn the crankshaft until No. 1 piston is at T.D.C. on its compression stroke.

(3) When installing the cylinder head, make sure that all valves are apart from head of pistons.

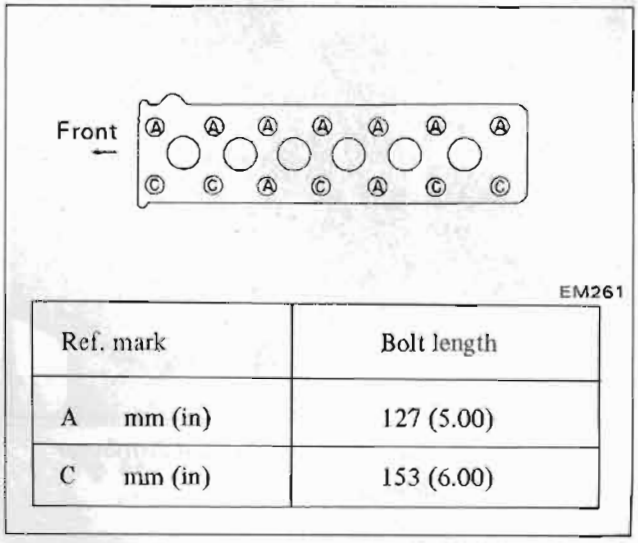
(4) Do not rotate the crankshaft and the camshaft separately, because valves will hit head of pistons.

(5) Tighten the head bolts using the special tool "Cylinder Head Bolt Wrench ST10120000" to the specified torque. Head bolts should be tightened in three steps according to the tightening sequence as shown in Figure EM-85.

Note that two types of bolts are used.

Tightening torque:

1st turn	4.0 kg-m (29 ft-lb)
2nd turn	6.0 kg-m (43 ft-lb)
3rd turn	6.5 to 8.5 kg-m (47 to 61 ft-lb)



Ref. mark	Bolt length
A mm (in)	127 (5.00)
C mm (in)	153 (6.00)

Fig. EM-84 Cylinder head bolts

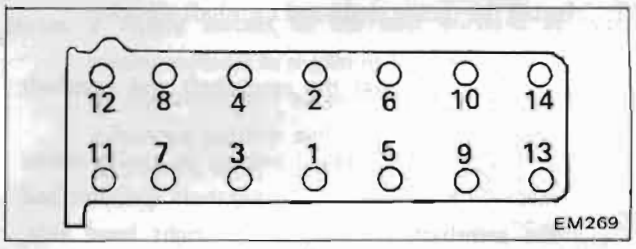


Fig. EM-85 Tightening sequence

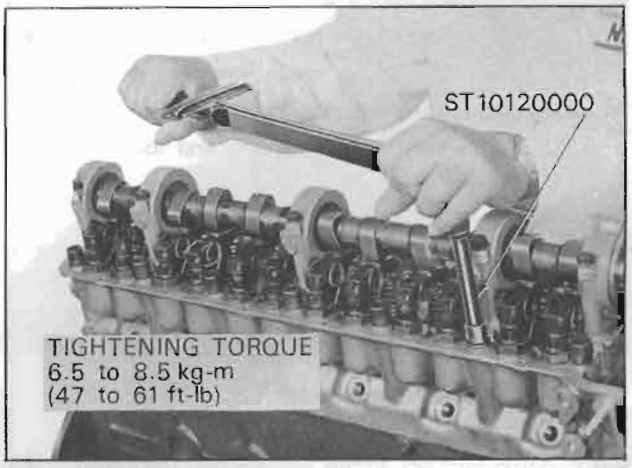


Fig. EM-86 Tightening cylinder head bolts

15. Install the crankshaft sprocket and distributor drive gear and fit the oil throwers.

Crankshaft pulley bolt tightening torque:
12 to 16 kg-m (87 to 116 ft-lb)

Note: Face the mating marks of the crankshaft sprocket forwards.

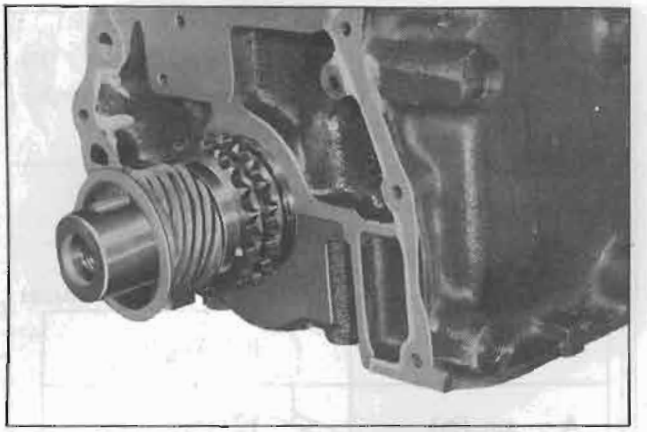
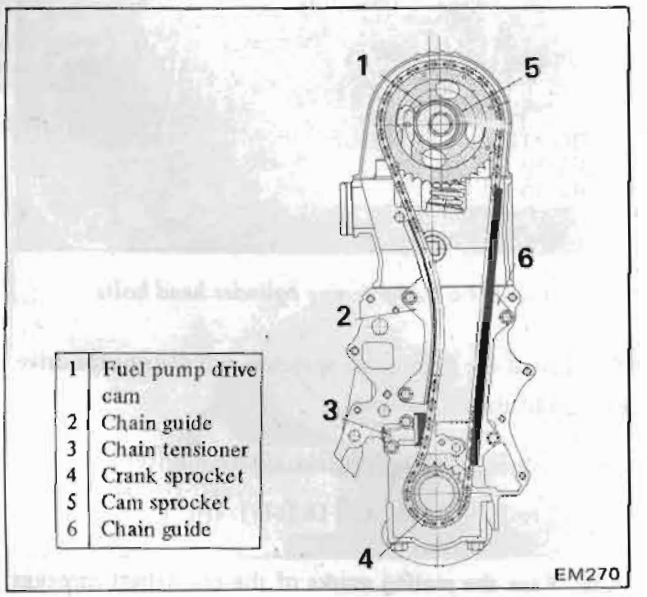


Fig. EM-87 Crankshaft sprocket and distributor drive gear

16. Install the chain guide to the cylinder block.

17. Install the timing chain and camshaft sprocket.

Notes: a. Make sure that the crankshaft and camshaft keys point upwards.
b. Set the timing chain making its mating marks meet with those of the crankshaft sprocket and the camshaft sprocket at the right hand side. There are 42 chain links between two mating marks of the timing chain.
c. No. 1 hole on the camshaft sprocket is factory adjusted. When the chain stretches excessively, adjust the camshaft sprocket at No. 2 or 3 hole.
d. Use a set of timing marks and location hole numbers.



1	Fuel pump drive cam
2	Chain guide
3	Chain tensioner
4	Crank sprocket
5	Cam sprocket
6	Chain guide

Fig. EM-88 Timing chain installation

18. Tighten the camshaft sprocket together with fuel pump cam to the specified torque.

Tightening torque: 12 to 16 kg-m (86 to 116 ft-lb)

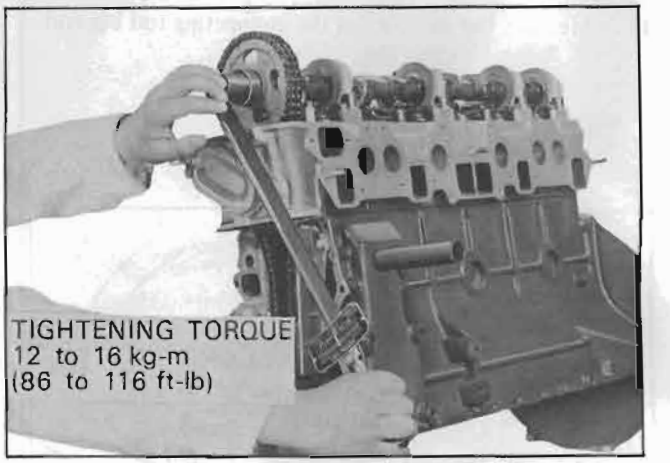


Fig. EM-89 Fuel pump cam installation

19. Install the timing chain tensioner.

20. Press in the new oil seal to the front cover. (the front cover oil seal should be replaced when the front cover is disassembled.)

21. Install the front cover with the gasket in place and tighten front cover attaching bolts to the specified torque.

Tightening torque:

Bigger diameter bolts

1.0 to 1.6 kg-m (7.2 to 11.5 ft-lb)

Smaller diameter bolts

0.4 to 0.8 kg-m (2.9 to 5.8 ft-lb)

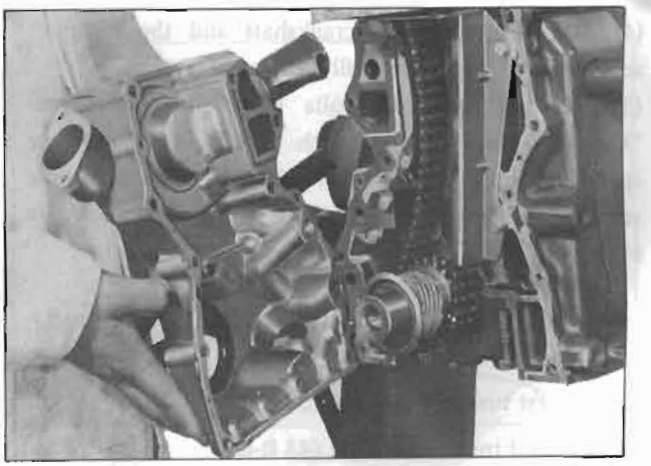


Fig. EM-90 Front cover installation

Notes: a. Apply sealant to the front side of the cylinder block and the front cover gasket as shown in Figure EM-68.
b. Apply sealant only to the top of the front cover as shown in Figure EM-68.
c. Install the front cover with the head gasket in place.
d. Check the height difference between the cylinder block upper face and the front cover upper face. Its difference must be less than 0.15 mm (0.0059 in).
e. Note that different types of bolts are used.
f. Apply a lithium grease to sealing lip of oil seal.

22. Install the crankshaft pulley and water pump.

23. Turn the engine on the engine stand so that the engine bottom is up, and install the oil pump and distributor driving spindle into the front cover.

Oil pump attaching bolt tightening torque:

1.1 to 1.5 kg-m (8.0 to 10.8 ft-lb)

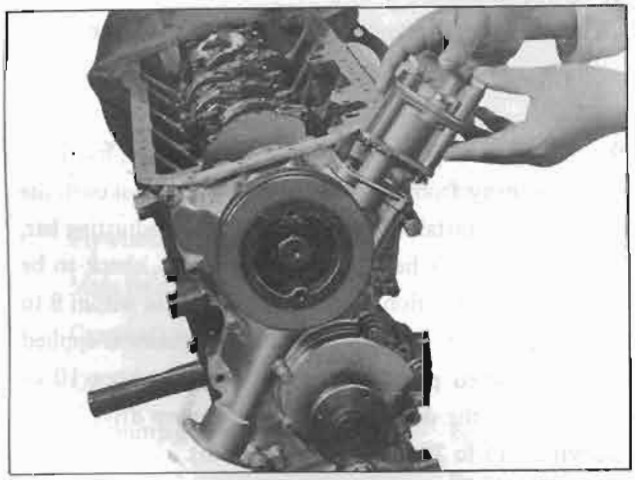


Fig. EM-91 Oil pump installation

Notes: a. Install the distributor drive spindle so that the projection on its top is located in 11:25 a.m. position, at this time, the smaller bowshape will be placed toward the front.
b. Do not forget to install the gasket.

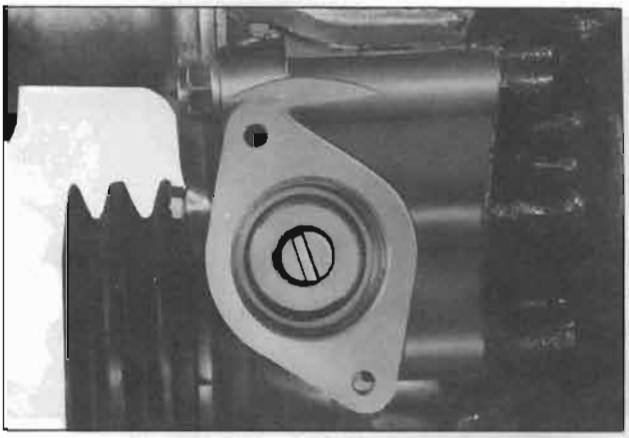


Fig. EM-92 Setting the distributor driving spindle

24. Install the oil strainer and the oil pan using the gasket.

Notes: a. Apply sealant to the step portions at four mating surfaces as shown in Figure EM-70.
b. Tightening the oil pan should be performed in criss-cross pattern and finally to 0.6 to 0.9 kg-m (4.3 to 6.5 ft-lb) torque.

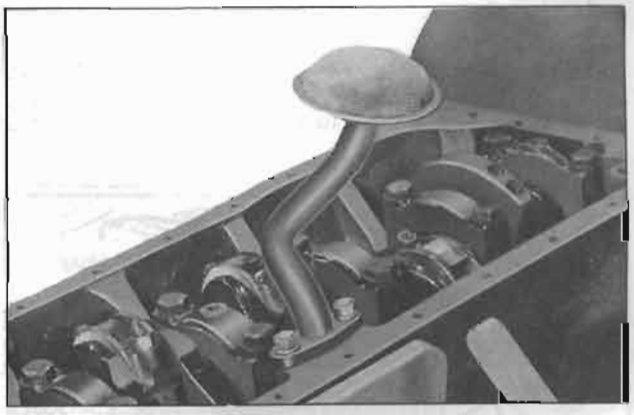


Fig. EM-93 Oil strainer installation

25. Invert the engine and install the fuel pump, water inlet elbow, thermostat housing, thermostat, and the water outlet elbow in their positions.

Fuel pump tightening torque:

1.2 to 1.8 kg-m (8.7 to 13.0 ft-lb)

Note: Do not forget to install the fuel pump spacer and packings. Packing is inserted between the spacer and block and between the spacer and fuel pump.

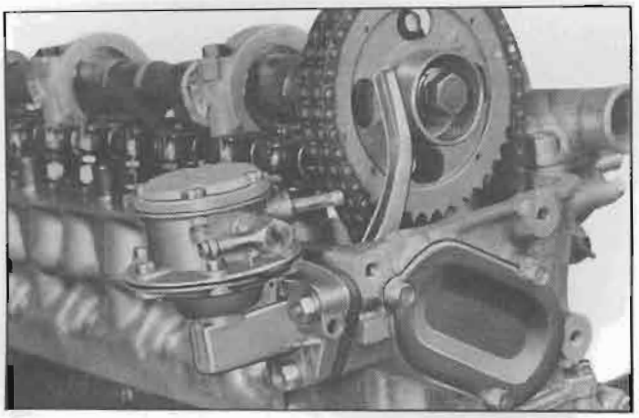


Fig. EM-94 Fuel pump installation

26. Install the engine slingers, exhaust manifold.

27. Install the intake manifold with carburetor and heat shield plate.

28. Adjust the valve clearance to the specified dimensions. See the "Specifications." The pivot lock nut should be tightened with the special tool "Pivot Adjuster ST10640001" to the specified torque.

Pivot lock nut tightening torque:

5.0 to 6.0 kg-m (36.2 to 43.4 ft-lb)

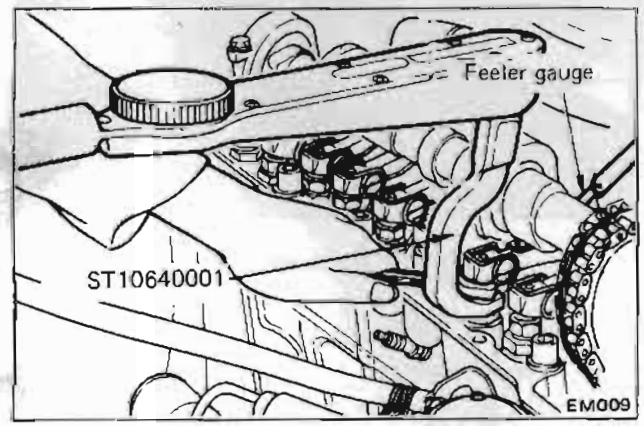


Fig. EM-95 Adjusting valve clearance

Notes: a. First set the clearance to the cold specifications.

b. After the engine has been assembled, run it for several minutes, and finally adjust the clearance to the warm specifications.

29. Install the oil pipe.

30. Install the rocker cover.

Note: Bond the gasket to the rocker cover using sealant and then install the rocker cover to the cylinder head.

31. Install the air pump.

32. Install all spark plugs.

33. Install the distributor assembly.

34. Connect high tension cables to all spark plugs.

35. Install the engine mounting on the left hand side.

36. Connect the fuel, vacuum, heater and air hoses.

All pipes and hoses should be clamped securely, being careful not to allow them to interfere with adjacent or surrounding parts.

37. Install the cooling fan and air cleaner.

38. Install the clutch assembly.

Use the special tool "Clutch Aligning Bar ST20630000" to install the clutch disc in position.

Clutch assembly attaching bolt tightening torque:

1.5 to 2.2 kg-m (11 to 16 ft-lb)

39. Using an overhead hoist and lifting cable, hoist the engine up away from the engine stand and down onto the engine carrier. Install the alternator bracket, adjusting bar, alternator, and fan belt in this order. Then, check to be sure that the deflection of the fan belt is held within 8 to 12 mm (0.32 to 0.47 in) when thumb pressure is applied midway between pullys (A pressed force is about 10 kg (22 lb)). Also the deflection of the air pump drive belt is held within 15 to 20 mm (0.59 to 0.79 in).

40. Install the engine mounting bracket (right hand), oil filter, oil pressure switch oil level gauge and water drain plug. When installing the oil filter, fasten it on the cylinder block by hand.

Note: Do not overtighten the filter, or oil leakage may occur.

41. Pour engine oil into the engine to the specified level.

SERVICE DATA AND SPECIFICATIONS

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GENERAL SPECIFICATIONS EM-34
TIGHTENING TORQUE EM-35
SPECIFICATIONS EM-35

GENERAL SPECIFICATIONS

Engine model		L24
Cylinder arrangement		6, in line
Displacement	cc (cu in)	2,393 (146.0)
Bore x stroke	mm (in)	83 x 73.7 (3.27 x 2.90)
Valve arrangement		O.H.C.
Firing order		1-5-3-6-2-4
Engine idle rpm		
Manual transmission		750
Automatic transmission (in "D" range)		600
Compression ratio		8.8 : 1
Oil pressure (Warm at 2,000) rpm	kg/cm (psi)	3.5 to 4.0 (50 to 57)

TIGHTENING TORQUE

Cylinder head bolts	kg-m (ft-lb)	6.5 to 8.5 (47 to 61)
Connecting rod big end nuts	kg-m (ft-lb)	4.5 to 5.5 (33 to 40)
Flywheel bolts	kg-m (ft-lb)	14 to 16 (101 to 116)
Main bearing cap bolts	kg-m (ft-lb)	4.5 to 5.5 (3.3 to 4.0)
Camshaft sprocket bolt	kg-m (ft-lb)	12 to 16 (86 to 116)
Oil pan bolts	kg-m (ft-lb)	0.6 to 0.9 (4.3 to 6.5)
Oil pump bolts	kg-m (ft-lb)	1.1 to 1.5 (8.0 to 10.8)
Fuel pump bolts	kg-m (ft-lb)	1.2 to 1.8 (8.7 to 13.0)
Crankshaft pulley bolts	kg-m (ft-lb)	12 to 16 (87 to 116)
Front cover bolts		
Bigger diameter bolts	kg-m (ft-lb)	1.0 to 1.6 (7.2 to 11.5)
Smaller diameter bolts	kg-m (ft-lb)	0.4 to 0.8 (2.9 to 5.8)
Rocker pivot lock nuts	kg-m (ft-lb)	5.0 to 6.0 (36.2 to 43.4)
Rocker shaft bracket bolts	kg-m (ft-lb)	1.8 to 2.0 (13.0 to 14.5)
Manifold nuts	kg-m (ft-lb)	0.8 to 1.2 (5.8 to 8.7)

SPECIFICATIONS

a) Valve mechanism

Valve clearance (Hot)	- Intake	mm (in)	0.25 (0.0098)
	- Exhaust	mm (in)	0.30 (0.0118)
Valve clearance (Cold) (reference value)	- Intake	mm (in)	0.20 (0.0079)
	- Exhaust	mm (in)	0.25 (0.0098)
Valve head diameter	- Intake	mm (in)	42 (1.65)
	- Exhaust	mm (in)	33 (1.30)
Valve stem diameter	- Intake	mm (in)	7.970 to 7.985 (0.3114 to 0.3138)
	- Exhaust	mm (in)	7.945 to 7.960 (0.3128 to 0.3134)
Valve length	- Intake	mm (in)	116.5 (4.59)
	- Exhaust	mm (in)	117.5 (4.63)
Valve lift		mm (in)	11.0 (0.433)
Valve spring free length	- Outer	mm (in)	49.98 (1.97)
	- Inner	mm (in)	44.85 (1.76)
Valve spring loaded length	- Outer	mm/kg (in/lb)	29.5/49.0 (1.16/108.03)
	- Inner	mm/kg (in/lb)	24.5/25.5 (0.96/56.22)
Valve spring assembled height	- Outer	mm/kg (in/lb)	40.0/21.3 (1.57/46.96)
	- Inner	mm/kg (in/lb)	35.0/12.3 (1.38/27.12)
Valve spring effective turns	- Outer		5.0
	- Inner		5.5
Valve spring wire diameter	- Outer	mm (in)	4.0 (0.16)
	- Inner	mm (in)	2.9 (0.11)
Valve spring coil diameter	- Outer	mm (in)	33.2 (1.31)
	- Inner	mm (in)	24.9 (0.98)
Valve guide length	- Intake	mm (in)	59.0 (2.32)
	- Exhaust	mm (in)	59.0 (2.32)
Valve guide height from head surface		mm (in)	10.4 to 10.6 (0.41 to 0.42)
Valve guide inner diameter	- Intake	mm (in)	8.000 to 8.018 (0.3150 to 0.3154)
	- Exhaust	mm (in)	8.000 to 8.018 (0.3150 to 0.3154)
Valve guide outer diameter (Standard)	- Intake	mm (in)	11.985 to 11.996 (0.4718 to 0.4723)
	- Exhaust	mm (in)	11.985 to 11.996 (0.4718 to 0.4723)
Valve guide to stem clearance	- Intake	mm (in)	0.020 to 0.053 (0.0008 to 0.0021)
	- Exhaust	mm (in)	0.040 to 0.073 (0.0016 to 0.0029)
Valve guide interference fit		mm (in)	0.027 to 0.049 (0.0011 to 0.0019)
Valve seat width	- Intake	mm (in)	1.4 to 1.6 (0.055 to 0.0063)
	- Exhaust	mm (in)	1.8 to 2.2 (0.071 to 0.087)

Valve seat angle	- Intake		45°
	- Exhaust		45°
Valve seat interference fit	- Intake	mm (in)	0.08 to 0.11 (0.0031 to 0.0043)
	- Exhaust	mm (in)	0.06 to 0.10 (0.0024 to 0.0039)

b) **Camshaft**

Camshaft end play		mm (in)	0.08 to 0.38 (0.0031 to 0.0150)
Camshaft robe lift		mm (in)	7.00 (0.275)
Camshaft journal diameter	- 1st	mm (in)	47.949 to 47.962 (1.8877 to 1.8883)
	- 2nd	mm (in)	47.949 to 47.962 (1.8877 to 1.8883)
	- 3rd	mm (in)	47.949 to 47.962 (1.8877 to 1.8883)
	- 4th	mm (in)	47.949 to 47.962 (1.8877 to 1.8883)
	- 5th	mm (in)	47.949 to 47.962 (1.8877 to 1.8883)
Camshaft bend		mm (in)	0.015 (0.0006)
Camshaft journal to bearing clearance		mm (in)	0.038 to 0.067 (0.0015 to 0.0026)
Camshaft bearing inner diameter	- 1st	mm (in)	48.000 to 48.016 (1.8898 to 1.8904)
	- 2nd	mm (in)	48.000 to 48.016 (1.8898 to 1.8904)
	- 3rd	mm (in)	48.000 to 48.016 (1.8898 to 1.8904)
	- 4th	mm (in)	48.000 to 48.016 (1.8898 to 1.8904)
	- 5th	mm (in)	48.000 to 48.016 (1.8898 to 1.8904)

c) **Rocker arm lever ratio** 1.50

d) **Connecting rod**

Center distance	mm (in)	139.9 (5.508)
Bearing thickness (Standard)	mm (in)	1.493 to 1.506 (0.0588 to 0.0593)
Big end play	mm (in)	0.20 to 0.30 (0.0079 to 0.0118)
Connecting rod bearing clearance	mm (in)	0.025 to 0.055 (0.0010 to 0.0022)
Connecting rod bend (per 100 mm or 3.937 in)	mm (in)	0.025 (0.0010)

e) **Crankshaft and main bearing**

Journal diameter	mm (in)	54.942 to 54.955 (2.1631 to 2.1636)
Journal taper & out-of-round	mm (in)	less than 0.01 (0.0004)
Crankshaft end play	mm (in)	0.05 to 0.18 (0.0020 to 0.0071)
Wear limit of dittoed play	mm (in)	0.3 (0.0118)
Crank pin diameter	mm (in)	49.961 to 49.974 (1.9670 to 1.9675)
Crank pin taper & out-of-round	mm (in)	less than 0.01 (0.0004)
Main bearing thickness	mm (in)	1.822 to 1.835 (0.0717 to 0.0722)
Main bearing clearance	mm (in)	0.020 to 0.072 (0.0008 to 0.0028)
Wear limit of dittoed clearance	mm (in)	0.12 (0.0047)
Crankshaft bend	mm (in)	0.025 (0.0010)

f) Piston

Piston diameter	Standard	mm (in)	82.99 to 83.04 (3.267 to 3.269)
	Oversize 1	mm (in)	83.22 to 83.27 (3.276 to 3.278)
	Oversize 2	mm (in)	83.47 to 83.52 (3.286 to 3.288)
	Oversize 3	mm (in)	83.72 to 83.77 (3.296 to 3.298)
	Oversize 4	mm (in)	83.97 to 84.02 (3.305 to 3.308)
	Oversize 5	mm (in)	84.47 to 84.52 (3.326 to 3.328)
Ellipse difference		mm (in)	0.32 to 0.35 (0.0126 to 0.0138)
Ring groove width	- Top	mm (in)	2.0 (0.08)
	- Second	mm (in)	2.0 (0.08)
	- Oil	mm (in)	4.0 (0.16)
Piston to bore clearance		mm (in)	0.025 to 0.045 (0.0010 to 0.0018)
Piston pin hole off-set		mm (in)	0.95 to 1.05 (0.0374 to 0.0413)

g) Piston pin

Pin diameter	mm (in)	20.995 to 21.000 (0.8266 to 0.8268)
Pin length	mm (in)	72.00 to 72.25 (2.8346 to 2.8445)
Piston pin to piston clearance	mm (in)	0.001 to 0.013 (0.00004 to 0.00051)
Interference fit of piston pin to connecting rod bushing	mm (in)	0.015 to 0.033 (0.0006 to 0.0013)

h) Piston ring

Ring height	- Top	mm (in)	1.977 (0.0778)
	- Second	mm (in)	1.977 (0.0778)
	- Oil	mm (in)	–
Side clearance	- Top	mm (in)	0.045 to 0.080 (0.0018 to 0.0031)
	- Second	mm (in)	0.030 to 0.070 (0.0012 to 0.0028)
	- Oil	mm (in)	0
Ring gap	- Top	mm (in)	0.23 to 0.38 (0.0091 to 0.0150)
	- Second	mm (in)	0.15 to 0.30 (0.0059 to 0.0118)
	- Oil	mm (in)	0.15 to 0.30 (0.0059 to 0.0118)

TROUBLE DIAGNOSES AND CORRECTIONS

Condition	Probable causes	Corrective action
1. Noisy engine		
Knocking of crankshaft and bearing	Loose main bearing	Replace.
	Seized bearing	Replace.
	Bent crankshaft	Repair or replace.
	Uneven wear of journal	Correct.
	Excessive crankshaft end play	Replace center bearing.
Piston and connecting rod knocking	Loose bearing	Replace.
	Seized bearing	Replace.
	Loose piston pin	Replace pin or bushing.
	Loose piston in cylinder	Recondition cylinder.
	Broken piston ring	Replace.
	Improper connecting rod alignment	Realign.
Camshaft knocking	Loose bearing	Replace.
	Excessive axial play	Replace bearing thrust plate.
	Rough gear teeth	Repair.
	Broken cam gear	Replace.
Timing chain noise	Improper chain tension	Adjust.
	Worn and/or damaged chain	Replace
	Worn sprocket	Replace.
	Worn and/or broken tension adjusting mechanism	Replace.
	Excessive camshaft and bearing clearance	Replace.
Camshaft and valve mechanism knocking	Improper valve clearance	Adjust.
	Worn adjusting screw	Replace.
	Worn rocker face.	Replace.
	Loose valve stem in guide	Replace guide.
	Weakened valve spring	Replace.
	Seized valve	Repair or replace.
Water pump knocking	Improper shaft end play	Replace.
	Broken impeller	Replace.

II. Other mechanical trouble		
Sticked valve	Improper valve clearance	Adjust.
	Insufficient clearance between valve stem and guide	Clean stem or ream the guide.
	Weakened or broken valve spring	Replace.
	Biting or damage of valve stem	Replace or clean.
	Poor quality of fuel	Use good fuel.
Seized valve seat	Improper valve clearance	Adjust.
	Weakened valve spring	Replace.
	Thin valve head edge	Replace valve.
	Narrow valve seat	Reface.
	Overheat	Repair or replace.
	Over speeding	Drive under proper speed.
	Sticked valve guide	Repair.
Excessively worn cylinder and piston	Shortage of engine oil	Add or replace oil.
	Dirty engine oil	Clean crankcase, replace oil and oil filter.
	Poor quality of oil	Use right oil.
	Overheat	Repair or replace.
	Wrong assembly of piston with connecting rod	Repair or replace.
	Improper piston ring clearance	Adjust.
	Broken piston ring	Replace.
	Dirty air cleaner	Replace.
	Too rich mixture	Adjust.
	Engine over run	Drive under proper speed.
	Sticked choke valve	Clean and adjust.
	Overchoking	Start correct way.
Defective connecting rod	Shortage of engine oil	Add oil or replace.
	Low oil pressure	Correct.
	Poor quality of engine oil	Use right oil.
	Rough surface of crankshaft	Grind and replace bearing.
	Clogged oil passage	Clean.
	Wear or eccentricity of bearing	Replace.
	Wrong assembly of bearing	Repair.

	Loose bearing	Replace.
	Incorrect connecting rod alignment	Repair or replace.
Defective crankshaft bearing	Shortage of engine oil	Add or replace.
	Low oil pressure	Adjust.
	Poor quality of engine oil	Use right oil.
	Wear or out of round of crankshaft journal	Repair.
	Clogged oil passage in crankshaft	Clean.
	Wear or eccentricity of bearing	Replace.
	Wrong assembly of bearing	Repair.
	Eccentric crankshaft or bearing	Replace.

SERVICE JOURNAL OR BULLETIN REFERENCE

DATE	JOURNAL or BULLETIN No.	PAGE No.	SUBJECT