SERVICE MANUAL

MODEL
A10 & A12
ENGINE

NISSAN MOTOR CO., LTD.
TOKYO, JAPAN

SECTION EM

ENGINE MECHANICAL

EM

GENERAL DESCRIPTION

CONTENTS

The A10 and A12 engines are of an overhead valve, four cylinder design which has the camshaft located in a high position. The layout of these engine components is basically the same with the exception of the distributor location, oil filter installation direction and the number of the crankshaft main bearings.

Since the A10 and A12 engines differ in minor details only, these two engine models are treated collectively unless otherwise noted.

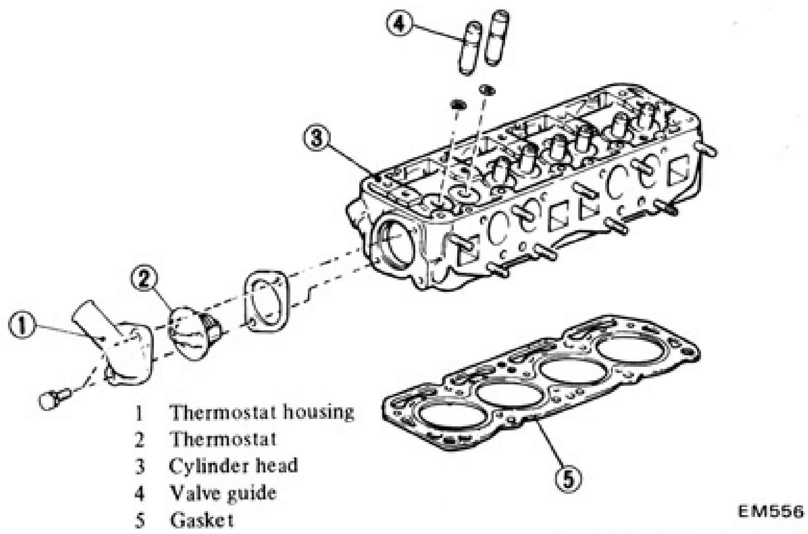


Fig. EM-1 Cylinder head

CYLINDER HEAD

The cylinder heads for the A12 and A10 engines are basically the same.

CYLINDER BLOCK

The design of the cylinder blocks differs for the A12 and A10 engines. The A12-engine cylinder block utilizes a five bearing support system and the A10-engine cylinder block utilizes a three bearing system. Each cylinder block is provided with a baffle plate and a steel net to reduce oil consumption. (The steel net scoops oil.)

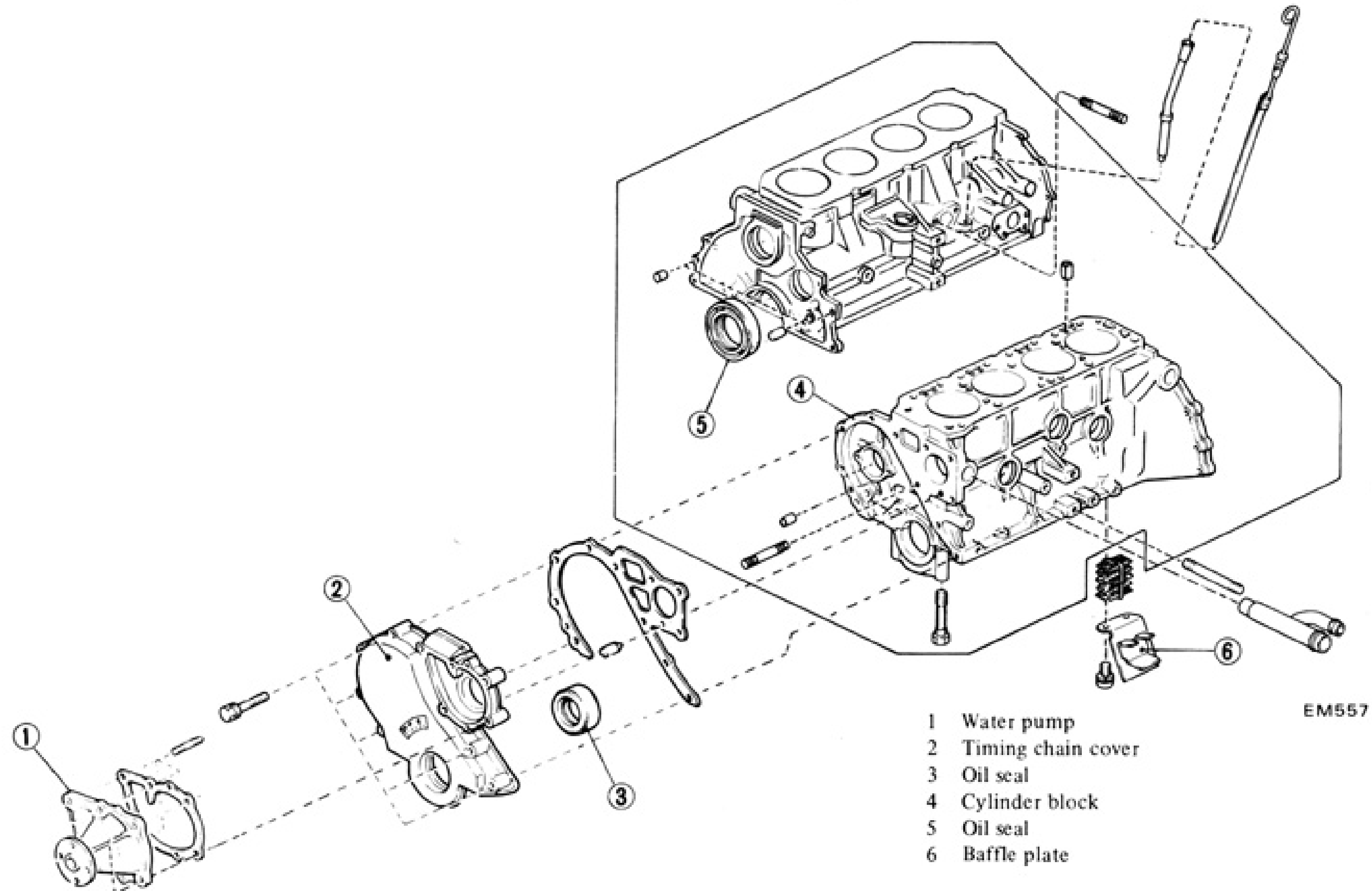


Fig. EM-2 Cylinder block

CRANKSHAFT, PISTON AND CONNECTING RODS

The crankshaft for A10 engine is supported by three main bearings and that for the A12 engine is by five bearings. These main bearings are lubricated through oil holes which intersect the main oil gallery in parallel with the cylinder bores.

The A12 engine uses concave head pistons, and the A10 engine uses flat head pistons. The piston pin is connected to the piston by full floating fit and to the connecting rod by press fit.

Full pressure lubrication is directed to the connecting rod through drilled oil passages from the adjacent main bearing journal so that oil is supplied to give maximum lubrication just before full bearing load is applied.

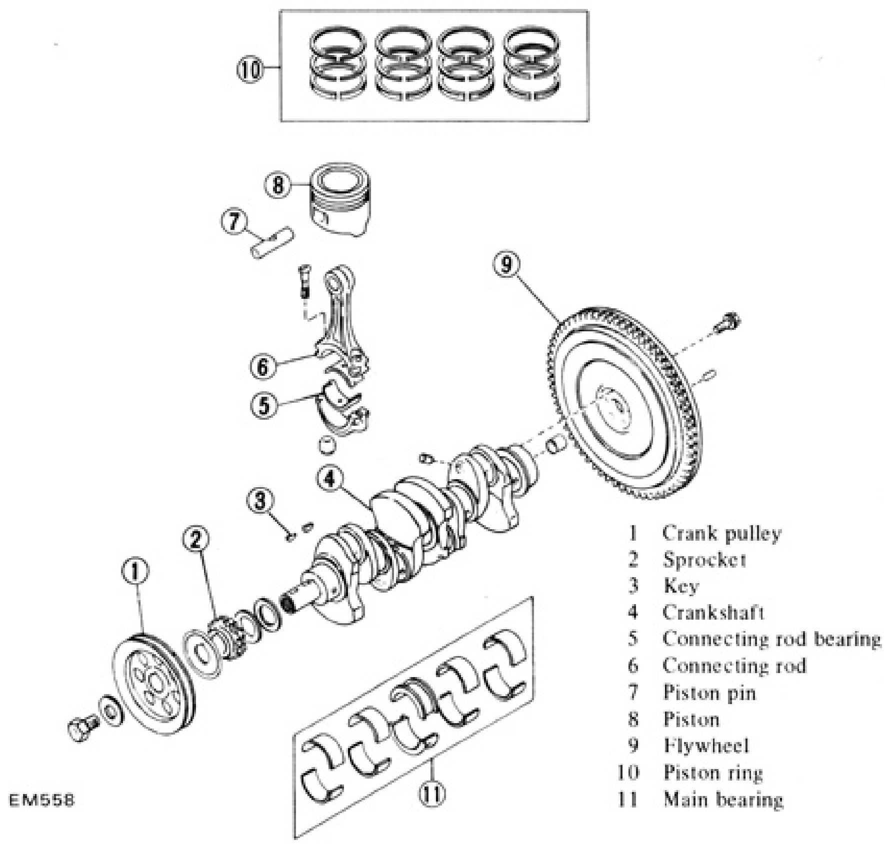


Fig. EM-3 Crankshaft, piston and connecting rod

VALVE MECHANISM, CAMSHAFT, CAMSHAFT DRIVE

The valve system has a push rod type rocker arm which uses the single type valve springs.

The camshaft is supported by five camshaft bearings. Camshaft bearings are lubricated through oil holes which intersect the main oil gallery of the cylinder block.

Concentric passages are drilled in the front and rear parts of the camshaft for supplying oil to each cam lobe through an oil hole drilled in the base circle of each lobe.

Lubricant is supplied to the front oil gallery from 2nd camshaft bearing.

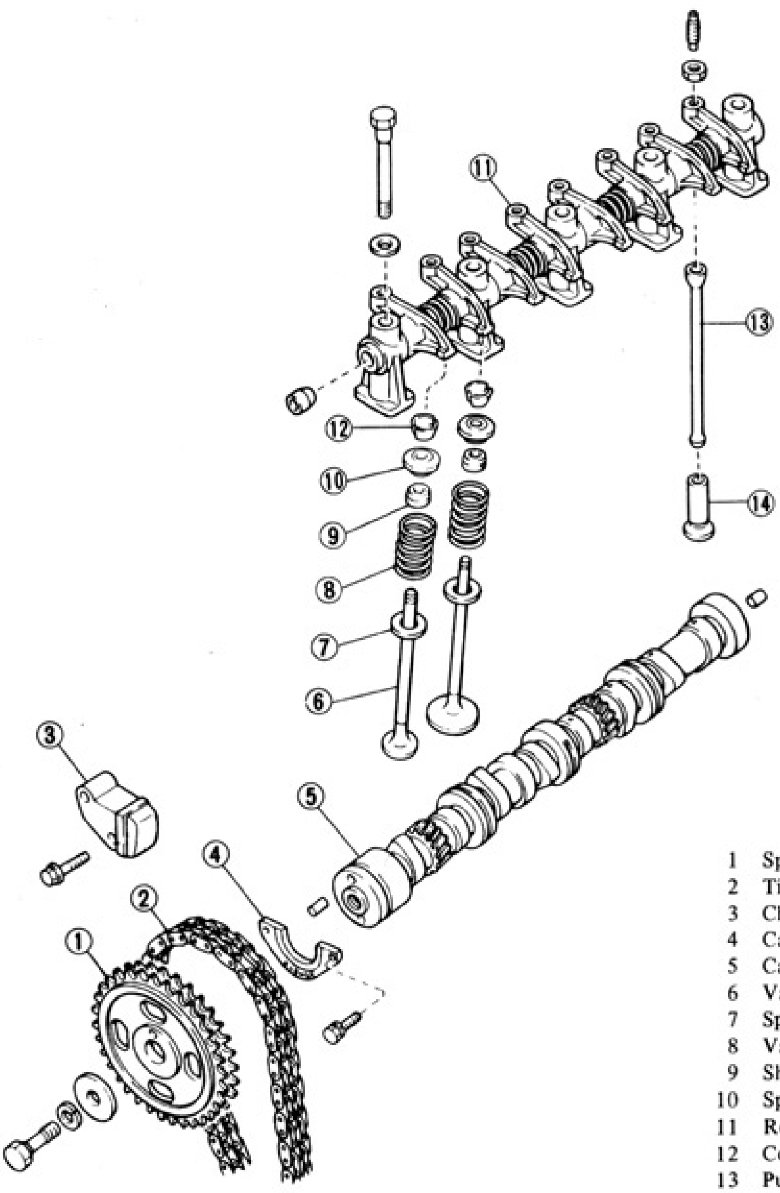
From the center camshaft bearing, lubricant is supplied to the valve rocker shaft through the center rocker shaft bracket.

The location of the distributor drive gear in the camshaft differs between the A10 and the A12 engine.

The camshaft is driven with a double row roller chain from the crankshaft.

The tension of the chain is controlled by the chain tensioner which is operated with springs and oil pressure.

The rubber shoe type tensioner insulates vibration of the chain and controls the tension of the chain.



1 Sprocket
2 Timing chain
3 Chain tensioner
4 Camshaft plate
5 Camshaft
6 Valve
7 Spring seat
8 Valve spring
9 Shroud
10 Spring retainer
11 Rocker arm
12 Collet
13 Push rod
14 Tappet

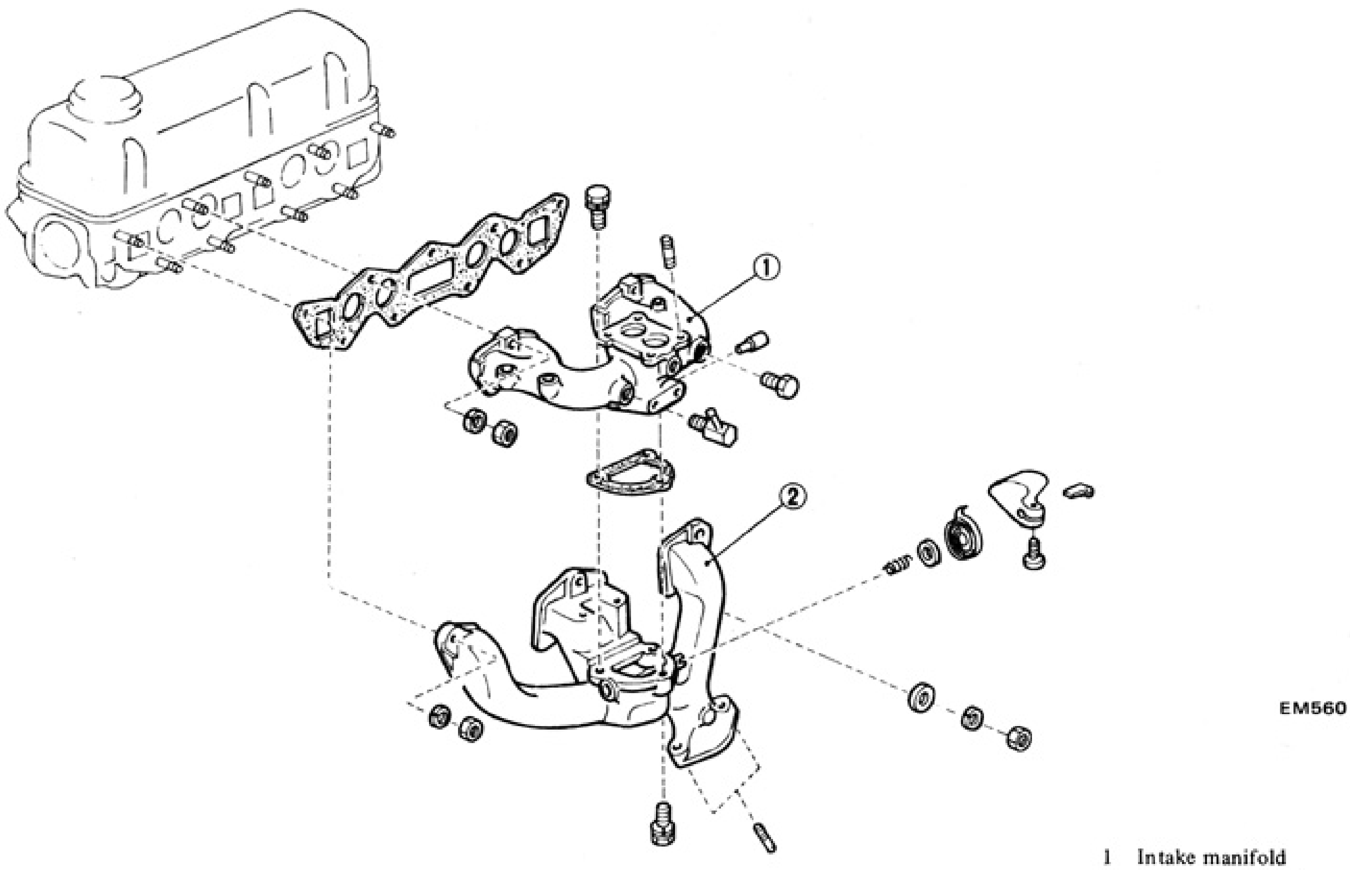
EM559

Fig. EM-4 Valve mechanism

MANIFOLDS

The intake manifold has two openings; one is located on the primary side and the other on the secondary side.

The exhaust manifold has a heat control valve which assures stable and smooth engine running after starting during cold season. The manifold is connected to the exhaust pipe by flanges, which completely eliminate exhaust leaking.



1 Intake manifold
2 Exhaust manifold

Fig. EM-5 Manifold

ENGINE DISASSEMBLY

CONTENTS

ENGINE REMOVAL

To remove engine from car, refer to Section ER for Removal. Remove starting motor.

Remove transmission from engine.

PRELIMINARY CLEANING AND INSPECTION

Before disassembling engine, observe the following items.

1. Fuel, oil or water may leak past cylinder head and block. Prior to disassembling, check rocker cover, cylinder head, timing chain cover, water pump, oil pump, fuel pump, oil

pan gaskets, oil filter, distributor, O-rings, crankshaft, and water pump seals for sign of leak past gasketed surfaces.

2. Check condition of carburetor and fuel pump; fuel hoses for deterioration, cracks or full leakage past jointed or connected surfaces.
3. Wipe dust and mud off engine.
4. Inspect block cylinder head, rocker cover, timing chain cover, oil pan and all other outer parts for visual cracks and damaged or missing parts such as bolts and nuts.
5. Check all piping and electrical circuits for discontinuity and broken or damaged insulation.

DISASSEMBLY

1. Remove engine mounting bracket R.H. (A10 engine). Install Engine Attachment ST05270000 and mount engine on Engine Stand ST0501S000.
2. Remove clutch assembly.
3. Remove alternator and fan belt.
4. Remove alternator bracket and alternator adjusting bar.
5. Remove fan, fan spacer and pulley.
6. Remove oil level gauge.
7. Remove distributor cap and high tension cables as an assembly.
8. Disconnect distributor vacuum line from distributor and remove distributor.
9. Disconnect fuel line from carburetor.
10. Remove fuel pump and fuel line. Remove fuel pump gasket and spacer.
11. Remove thermostat housing and thermostat.
12. Remove engine mounting bracket R.H.
13. Remove oil pump and filter assembly.
14. Remove spark plugs.
15. Install Engine Attachment ST05200000 to cylinder block using engine mounting bracket R.H. attaching studs, fuel pump attaching studs and alternator bracket attaching bolt holes. (A12 engine)
16. Mount engine on Engine Stand ST0501S000. (A12 engine)

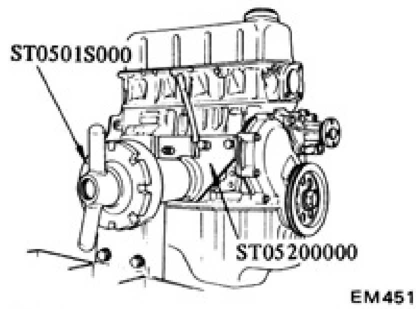


Fig. EM-6 Engine mounted on engine stand

17. Remove engine mounting bracket L.H.
18. Remove P.C.V. hose (pipe connector to control valve).
19. Remove intake and exhaust manifold assembly with carburetor.

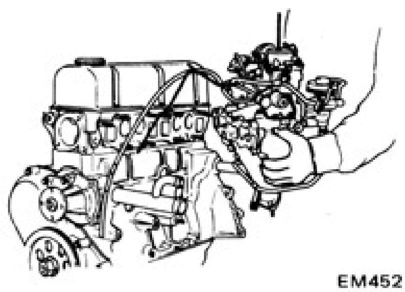


Fig. EM-7 Removing manifolds with carburetor

20. Remove rocker cover.
21. Loosen valve rocker adjusting nuts and turn adjusting screws out to disengage push rods. Then evenly loosen rocker shaft bolts.
22. Remove rocker shaft assembly.

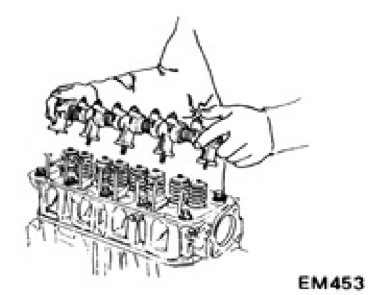


Fig. EM-8 Removing rocker shaft assembly

23. Withdraw push rods, and keep them in correct order.
24. Loosen cylinder head bolts a little at a time in the sequence shown in Figure EM-9, and remove cylinder head.

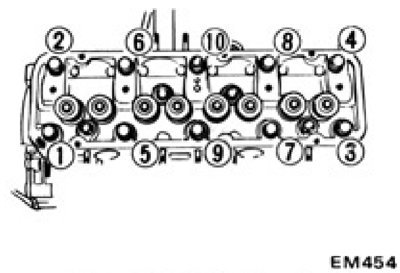


Fig. EM-9 Cylinder head bolt loosening sequence

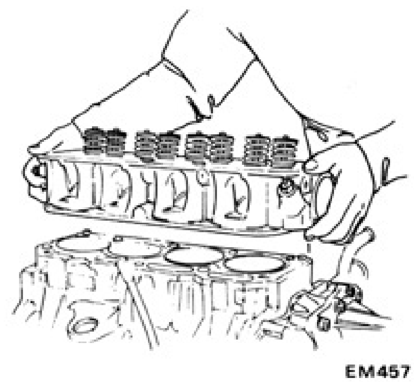


Fig. EM-10 Removing cylinder head

Note: Do not pry between head and block as gasket surfaces may become damaged.

25. Invert engine.
26. Remove oil pan and oil strainer.
27. Invert engine.
28. Remove water pump.
29. Remove crank pulley and timing chain cover.

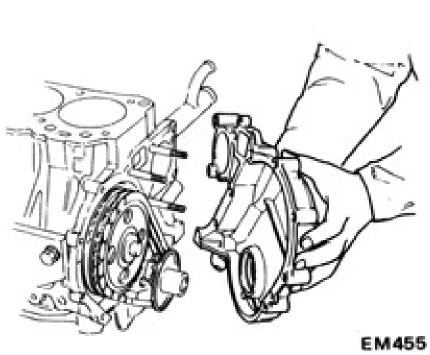


Fig. EM-11 Removing timing chain cover

30. Remove oil thrower and chain tensioner.

31. Loosen camshaft sprocket bolt and remove both sprockets and timing chain as an assembly.

32. Remove connecting rod caps and push piston and connecting rod assemblies out of the bores.

Take off connecting rod bearings and keep them in order.

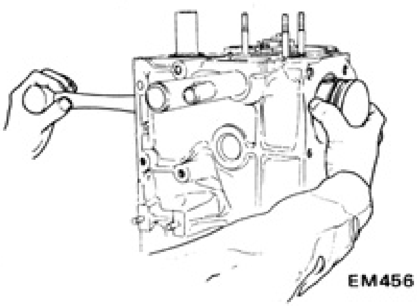


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Fig. EM-12 Removing piston and connecting rod assembly

33. Remove flywheel and rear plate. Be careful not to drop it.

34. Gradually loosen main bearing cap bolts in two or three stages and remove caps. See Figure EM-13.

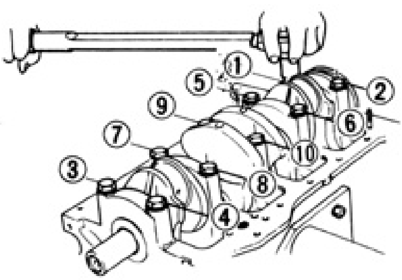

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Fig. EM-13 Main bearing cap bolt loosening sequence

35. Remove rear oil seal.

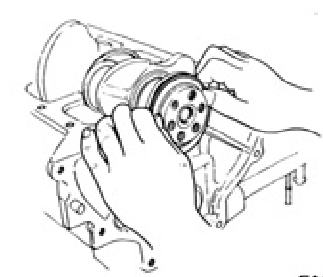

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Fig. EM-14 Removing rear oil seal

36. Carefully lift out crankshaft.

37. Remove main bearings from block and bearing caps.

38. Remove baffle plate and steel net.

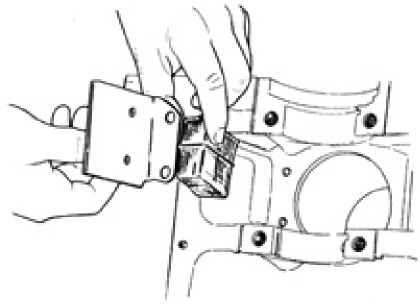

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Fig. EM-15 Removing baffle plate and steel net

39. Remove camshaft plate. Carefully remove camshaft by pulling it toward the front of engine.

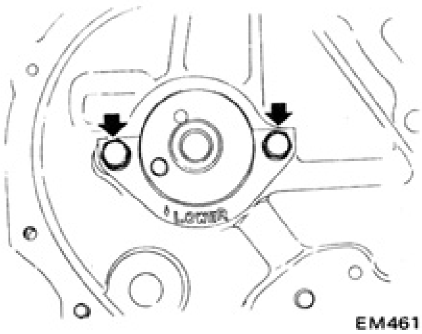

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Fig. EM-16 Camshaft plate

40. Remove valve lifters and keep them in order.

PISTON AND CONNECTING ROD

1. Remove piston rings with a ring remover.

Note: Avoid damaging piston rings by spreading excessively.
This would make them unfit for further service due to breakage or weakened tension.

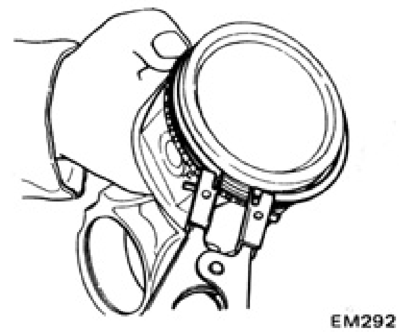

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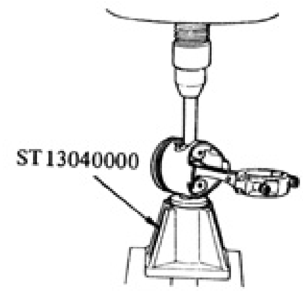
Fig. EM-17 Removing piston ring

2. Press out piston pin with Piston Pin Press Stand ST13040000.



EM103

Fig. EM-18 Removing piston pin

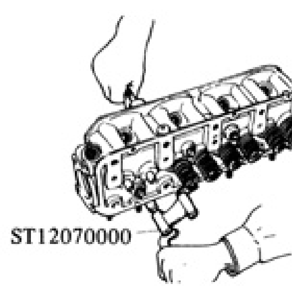
Caution: Make sure press ram, piston pin and press stand are lined up properly.

3. Keep disassembled parts in order.

CYLINDER HEAD

1. Using Valve Lifter ST12070000, compress valve spring and remove valve collet.

2. Release Valve Lifter and remove spring retainer, spring, oil seal, spring seat and valve.



EM462

Fig. EM-19 Removing valve

3. Place valve components in order.

Note: Be careful not to lose valve collet and spring seat.

INSPECTION AND REPAIR

CONTENTS

PREPARATION FOR INSPECTION

1. Before cleaning, check for signs of water and oil leaks in cylinder block and head.
2. Clean oil and carbon deposits from all parts. They should be free of gaskets and sealant.
3. Clean all oil holes with solvent and dry with compressed air. Make sure they are not restricted.

CYLINDER HEAD VALVES

CHECKING CYLINDER HEAD MATING FACE

1. Measure surface of cylinder head (on cylinder block side) for warpage. If beyond designated limit, regrind surface with a surface grinder until cylinder head is flat within standard value.

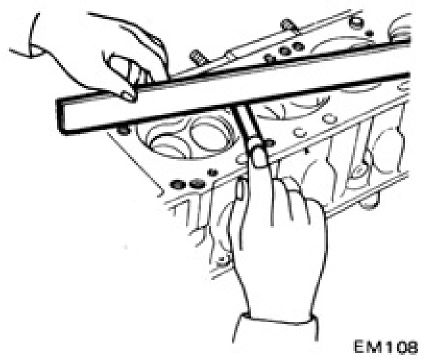

EM108

Fig. EM-20 Checking cylinder head surface

Head surface flatness

Standard	Limit
less than 0.05 mm (0.0020 in)	0.1 mm (0.0039 in)

Surface grinding limit

The grinding limit of cylinder head is dependent upon the engine cylinder block grinding.

Depth of cylinder head grinding is "A"

Depth of cylinder block grinding is "B"

The limit is:
A + B = 0.2 mm (0.0079 in)

VALVE ASSEMBLY

1. Check valve collets and spring retainers for wear or damage.
2. Check each intake and exhaust valve for wear, damage or deformed stems. Repair or replace valve, if required.

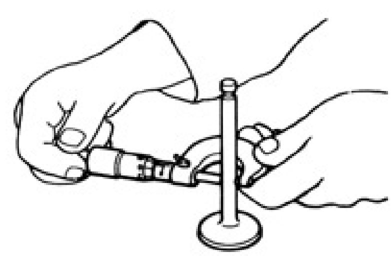

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Fig. EM-21 Checking valve stem diameter

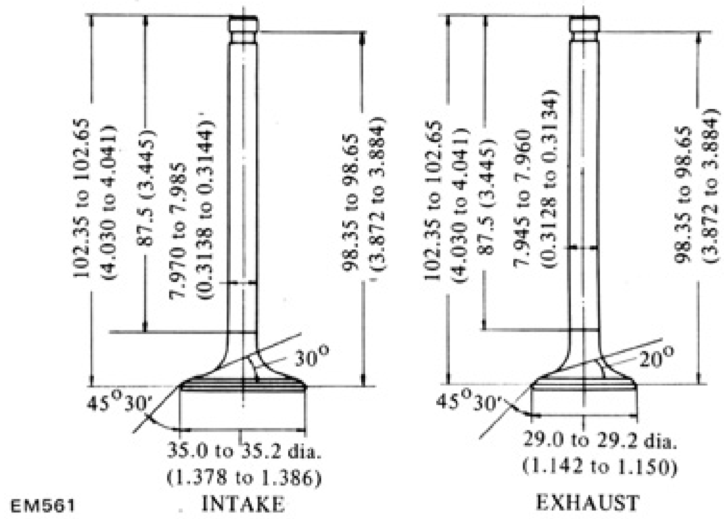

Fig. EM-22 Valve specifications

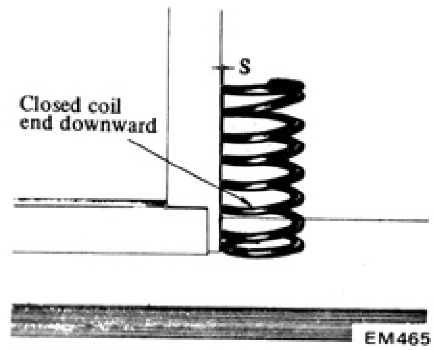

Fig. EM-24 Measuring spring squareness

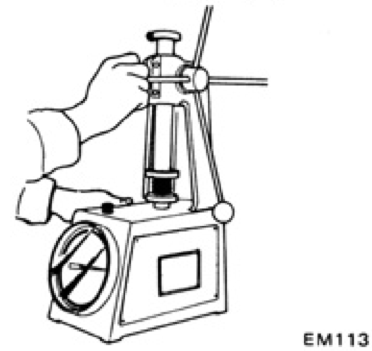

Fig. EM-25 Measuring spring tension

3. The valve face or valve stem end surface should be refaced with a valve grinder.

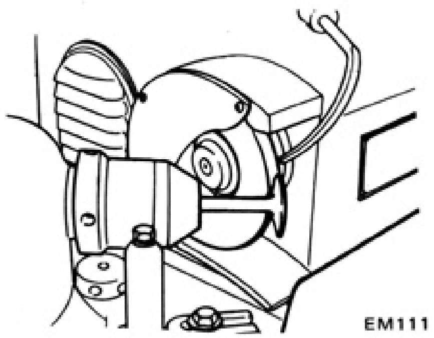

Fig. EM-23 Grinding valve face

Caution: When grinding valves, don't wear gloves and set stand in radial direction of grinder.

Note: When valve head has been reduced to thickness of 0.5 mm (0.020 in) or less, replace. Grinding allowance for valve stem end surface is 0.5 mm (0.020 in) or less.

VALVE SPRING

1. Check valve spring for squareness using a steel square and surface plate. If spring is out of square ("S" in Figure EM-24) beyond specified limit, replace.
2. Measure free length and tension of each spring. If measured value exceeds specified limit, replace spring.

Valve spring specifications

		A10	A12
Valve spring free length	mm (in)	45.7 (1.799)	46.5 (1.831)
Valve spring compressed length (valve open)	mm/kg (in/lb)	31.0/61.2 (1.22/135)	30.2/58.5 (1.19/129)
Valve spring assembled height (valve closed)	mm/kg (in/lb)	38.5/30 (1.52/66.1)	38.7/23.9 (1.52/52.7)
Valve spring out of square ("S")	mm (in)	1.3 (0.051)	

VALVE ROCKER ARM AND SHAFT

1. Check rocker arm bore and shaft for scores or scuffs.
2. Check clearance between each rocker arm and shaft by measuring inner diameter of rocker arm bore and outer diameter of shaft.

If either clearance is not within specification, replace rocker arm and/or shaft.

3. Check valve end contact surface of rocker arm for abnormal wear or scuffs.

When a stepped wear occurs on valve contact surface of valve rocker arm, repair with a valve grinder or replace valve rocker arm.

Grinding allowance is 0.5 mm (0.0197 in) or less.

Valve rocker arm and shaft specifications

Rocker shaft outer diameter mm (in)	19.979 to 20.000 (0.7866 to 0.7874)
Rocker arm to rocker shaft clearance mm (in)	0.020 to 0.054 (0.0008 to 0.0021)
Rocker arm bore diameter mm (in)	20.020 to 20.033 (0.7882 to 0.7887)

2. As an emergency expedient, push valve in valve guide and move to left and right. If its tip deflects about 0.2 mm (0.0079 in) or more, clearance between stem and guide exceeds maximum wear limit of 0.1 mm (0.0039 in).

Note: Valve should be moved parallel to rocker arm. (Generally, a large amount of wear occurs in this direction.)

VALVE LIFTER AND PUSH ROD

1. Check valve lifter for wear or scuffs. Check bottom end of valve lifter to make sure it has a slight convex. Replace valve lifters that are scored, worn or have unsmooth bottom.
2. Check clearance between lifter hole on cylinder block and valve lifter. Replace valve lifter if clearance exceeds wear limit.
3. Check push rod for bending and damage.

Check end of push rod for roughness or excessive wear.

	Standard	Wear limit
Valve lifter/lifter hole clearance mm (in)	0.016 to 0.052 (0.0006 to 0.0020)	0.15 (0.0059)

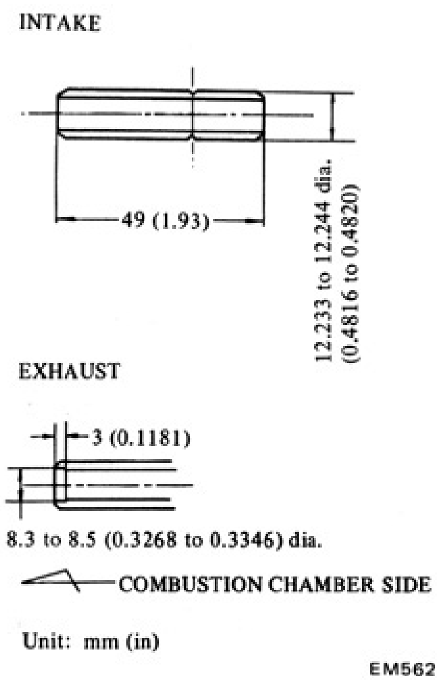

Fig. EM-26 Service valve guide dimensions

VALVE GUIDE

1. Measure clearance between valve guide and valve stem. If clearance exceeds designated limit, replace worn parts or both valve and valve guide.

It is essential to determine whether excessive clearance was caused by a worn or bent valve stem or by a worn valve guide.

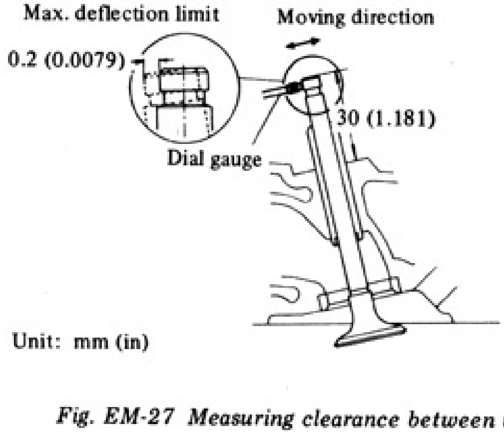

Fig. EM-27 Measuring clearance between valve stem and valve guide

Valve guide specifications

	Intake	Exhaust	Wear limit
Guide to guide hole interference mm (in)	0.022 to 0.044 (0.0009 to 0.0017)		–
Valve guide inner diameter mm (in)	8.000 to 8.015 (0.3150 to 0.3156)		–
Guide to stem clearance mm (in)	0.015 to 0.045 (0.0006 to 0.0018)	0.040 to 0.070 (0.0016 to 0.0028)	0.1

Replacement of valve guide

Oversize valve guide of 0.2 mm (0.0079 in) diameter is available for replacement.

Guide hole inner diameter mm (in)	Service valve guide	12.200 to 12.211 dia. (0.4803 to 0.4807 dia.)
Interference fit of valve guide to guide hole mm (in)		0.022 to 0.044 (0.0009 to 0.0017)

1. To remove old guides, use a drift and a press, and drive them out of rocker cover side toward combustion chamber (under 2-ton pressure). Heating cylinder head will facilitate operation.

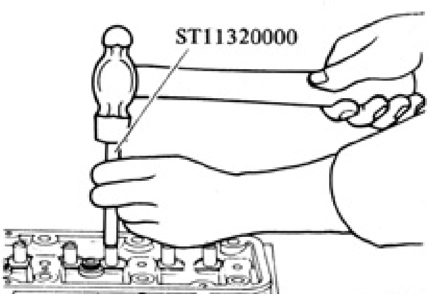

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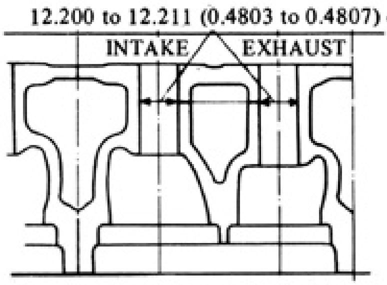
Fig. EM-28 Driving valve guide out of cylinder head

2. Ream cylinder head valve guide hole using Reamer ST11081000 [12.2 mm (0.480 in) dia.] at room temperature.



Unit: mm (in)

EM469

Fig. EM-29 Finish of valve guide hole when oversize valve guide

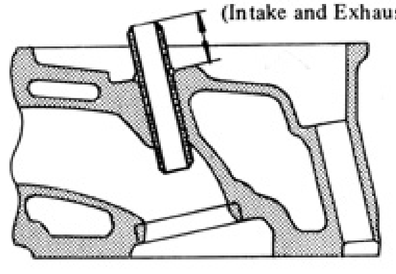


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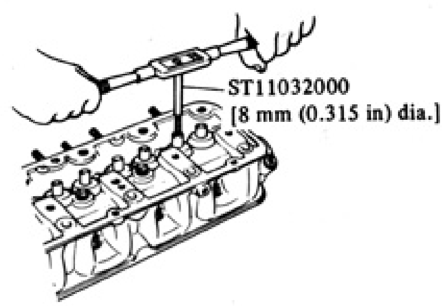
Fig. EM-30 Pressing valve guide

3. Carefully press service valve guide into cylinder head guide hole. It will fit smoothly after heating cylinder head to 150 to 200°C (302 to 392°F).
4. Ream bore with valve guide pressed in using Reamer ST11032000 [8 mm (0.315 in) dia.].

Reaming bore:
8.000 to 8.015 mm
(0.3150 to 0.3156 in)



EM470

Fig. EM-31 Reaming valve guide

5. Reface valve seat with new valve guide as the axis.

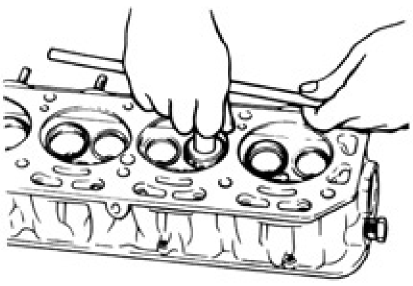
VALVE SEAT

Check valve seat for evidence of pitting at valve contact surface, and reface or replace if worn excessively.

Valve seat insert of 0.5 mm (0.020 in) oversize is available for service.

Refacing valve seat

When width of valve seat is wide or narrow beyond specifications, it should be refaced with valve seat with cutter or grinding stone.



EM471

Fig. EM-32 Refacing valve seat with valve seat cutter

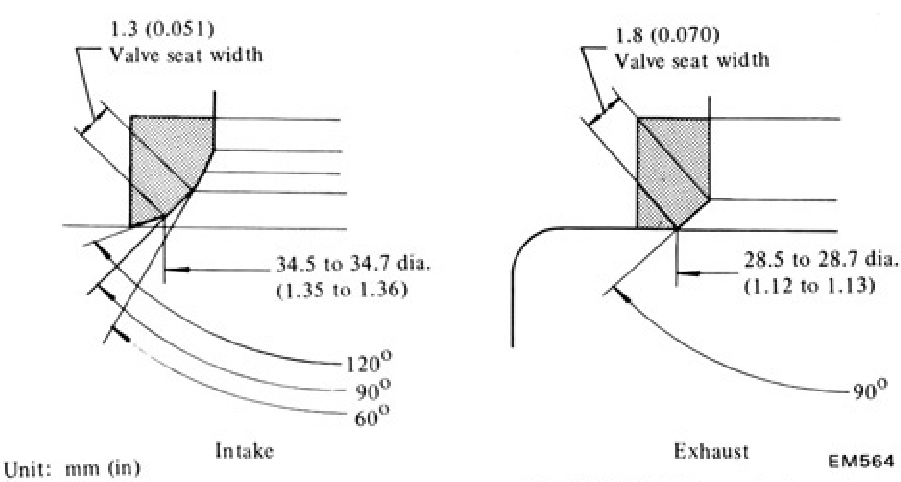
Replacing valve seat insert

1. Old insert can be removed by boring out until it collapses. Machine depth stopper should be set so that boring cannot continue beyond the bottom face of the insert recess in cylinder head.
2. Machine cylinder head recess in concentric circles to valve guide center so that insert will have correct fit.
3. Ream cylinder head recess at room temperature.

Unit: mm (in)

	Cylinder head recess diameter	Interference fit
Intake	37.500 to 37.516 (1.4764 to 1.4770)	0.064 to 0.096 (0.0025 to 0.0038)
Exhaust	33.500 to 33.516 (1.3189 to 1.3195)	

4. Heat cylinder head to temperature of 150 to 200°C (302 to 392°F).
5. Fit insert ensuring that it seats on bottom face of its recess.
6. Newly fitted valve seat should be cut or ground with suitable seat cutter or grinding stone.



EM564

Fig. EM-33 Valve seat dimensions

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

Remove valve and clean valve and valve seat.

CAMSHAFT AND CAMSHAFT BEARING

CAMSHAFT BEARING CLEARANCE

Journal diameters should be checked with a micrometer, and bearings with an inside dial gauge. Measurements should then be compared to determine whether bearings are worn. If worn beyond 0.15 mm (0.0059 in), replace using Camshaft Bearing Drift ST16110000.

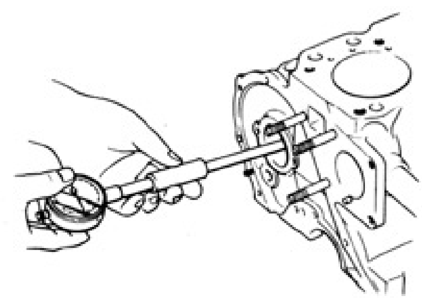


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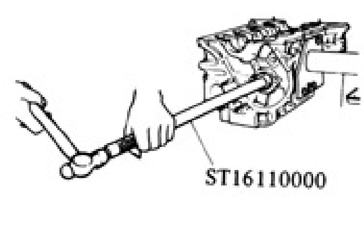
Fig. EM-34 Measuring camshaft bearing inner diameter

Notes:

a. In press-fitting a new bearing, make certain that oil holes in block and bearing are properly aligned.

b. After replacing all bearings, finish bearing inner diameters by line boring.

c. Install welch plug into cylinder block, applying sealant.



EM475

Fig. EM-35 Replacing camshaft bearings

Camshaft journal and bearing specifications

Unit: mm (in)

Bearing position	Size		Finish of camshaft journal diameter	Camshaft journal to bearing clearance	Finish of camshaft bearing inner diameter	Camshaft journal to bearing clearance wear limit
No. 1	Standard		43.783 to 43.796 (1.7237 to 1.7242)	0.037 to 0.060 (0.0015 to 0.0024)	43.833 to 43.843 (1.7257 to 1.7261)	0.15 (0.0059)
	Under-size	0.25 (0.0098)	43.233 to 43.246 (1.7021 to 1.7026)		43.583 to 43.593 (1.7041 to 1.7044)	
		0.50 (0.0197)	43.283 to 43.296 (1.7041 to 1.7046)		43.333 to 43.343 (1.7060 to 1.7064)	
		0.75 (0.0295)	43.033 to 43.046 (1.6942 to 1.6947)		43.083 to 43.093 (1.6962 to 1.6966)	
No. 2	Standard		43.283 to 43.296 (1.7041 to 1.7046)	0.027 to 0.050 (0.0011 to 0.0020)	43.323 to 43.333 (1.7056 to 1.7060)	
	Under-size	0.25 (0.0098)	43.033 to 43.046 (1.6942 to 1.6947)		43.073 to 43.083 (1.6958 to 1.6962)	
		0.50 (0.0197)	42.783 to 42.796 (1.6844 to 1.6849)		42.823 to 42.833 (1.6859 to 1.6863)	
		0.75 (0.0295)	42.533 to 42.546 (1.6745 to 1.6750)		42.573 to 42.583 (1.6761 to 1.6765)	
No. 3	Standard		42.783 to 42.796 (1.6844 to 1.6849)	0.040 to 0.063 (0.0016 to 0.0025)	42.836 to 42.846 (1.6865 to 1.6868)	
	Under-size	0.25 (0.0098)	42.533 to 42.546 (1.6745 to 1.6750)		42.586 to 42.596 (1.6766 to 1.677)	
		0.50 (0.0197)	42.283 to 42.296 (1.6647 to 1.6652)		42.336 to 42.346 (1.6668 to 1.6672)	
		0.75 (0.0295)	42.033 to 42.046 (1.6548 to 1.6554)		42.086 to 42.096 (1.6569 to 1.6573)	
No. 4	Standard		42.283 to 42.296 (1.6647 to 1.6652)	0.027 to 0.050 (0.0011 to 0.0020)	42.323 to 42.333 (1.6663 to 1.6667)	
	Under-size	0.25 (0.0098)	42.033 to 42.046 (1.6548 to 1.6554)		42.073 to 42.083 (1.6564 to 1.6568)	
		0.50 (0.0197)	41.783 to 41.796 (1.6450 to 1.6455)		41.823 to 41.833 (1.6466 to 1.6470)	
		0.75 (0.0295)	41.533 to 41.546 (1.6352 to 1.6357)		41.573 to 41.583 (1.6367 to 1.6371)	
No. 5	Standard		41.208 to 41.221 (1.6224 to 1.6229)	0.037 to 0.060 (0.0015 to 0.0024)	41.258 to 41.268 (1.6243 to 1.6247)	
	Under-size	0.25 (0.0098)	40.958 to 40.971 (1.6125 to 1.6130)		41.008 to 41.018 (1.6145 to 1.6140)	
		0.50 (0.0197)	40.708 to 40.721 (1.6027 to 1.6032)		40.758 to 40.768 (1.6046 to 1.6050)	
		0.75 (0.0295)	40.458 to 40.471 (1.5928 to 1.5933)		40.508 to 40.518 (1.5948 to 1.5952)	

CAMSHAFT ALIGNMENT

1. Check camshaft, camshaft journal and cam surface for bending, wear or damage. If fault is beyond limits, replace affected parts.
2. A bend value is one-half of the reading obtained when camshaft is turned one full revolution with a dial gauge applied to the center journal.
3. Camshaft end play can be checked by installing camshaft, camshaft locating plate and camshaft sprocket in their respective positions. End play can then be checked with a dial gauge or feeler gauge. If end play exceeds 0.10 mm (0.0039 in), replace locating plate.

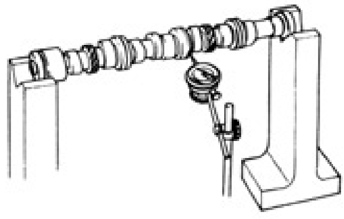

EM476

Fig. EM-36 Checking camshaft bend

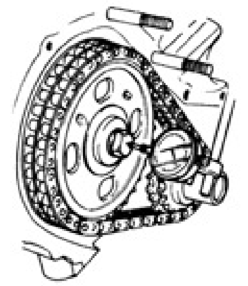

EM477

Fig. EM-37 Checking camshaft end play

Camshaft specifications

Unit: mm (in)

		Standard	Wear/repair limit
Camshaft bend		Less than 0.015 (0.0006)	0.05 (0.0020)
Cam height	Intake	36.200 to 36.250 (1.4252 to 1.4272)	35.700 (1.4055)
	Exhaust	36.930 to 36.980 (1.4539 to 1.4559)	36.430 (1.4342)
Difference in diameter max. worn and min. worn parts of camshaft journal		0.03 to 0.07 (0.0012 to 0.0028)	0.10 (0.0039)
Camshaft end play		0.01 to 0.05 (0.0004 to 0.0020)	0.10 (0.0039)

CYLINDER BLOCK

1. Check flatness of block gasket surface with a straight edge and feeler gauge at two diagonal and five longitudinal positions.
2. Place straight edge along diagonal lines of block plane and longitude, and inspect for level with a feeler gauge.

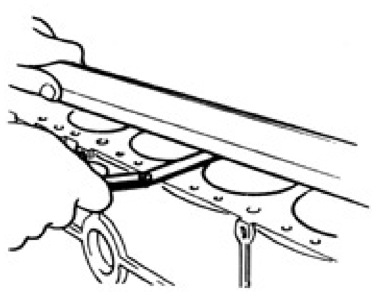

EM303

Fig. EM-38 Checking cylinder block surface

Surface flatness

Unit: mm (in)

Standard	Limit
Less than 0.05 (0.0020)	0.1 (0.0039)

Surface grinding limit

Grinding limit of cylinder block is dependent upon cylinder head grinding of engine.

Depth of cylinder head grinding is "A"

Depth of cylinder block grinding is "B"

The limit is:

A + B = 0.2 mm (0.008 in)

3. With bore gauge, measure cylinder bore for out-of-round or taper. If out-of-round or taper is excessive, rebore cylinder walls with a boring machine. Measurement should be taken along bores for taper and around bores for out-of-round. See Figure EM-40.

Out-of-round	X–Y
Taper	C–D

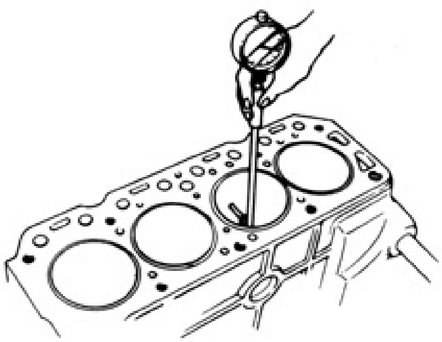
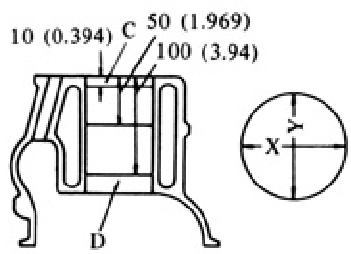

EM478

Fig. EM-39 Measuring cylinder bore diameter

4. When wear, taper, or out-of-round is minor and within limits remove ridge at topmost portion of cylinder using a ridge reamer or similar tool.

HOW TO MEASURE CYLINDER BORE

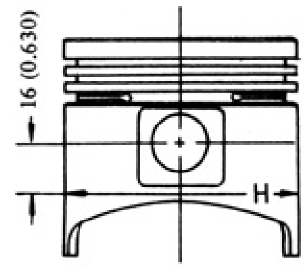
With a bore gauge, measure cylinder bore at top, middle and bottom positions in X and Y directions as shown in Figure EM-40 and record measured values.



Unit: mm (in)

EM565

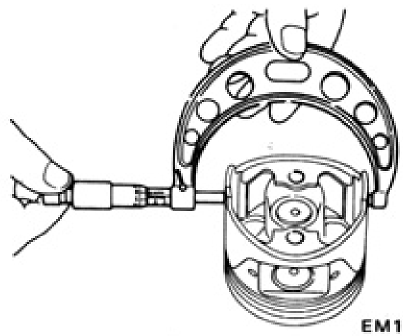
Fig. EM-40 Cylinder bore measuring positions



Unit: mm (in)

EM480

Fig. EM-41 Piston diameter measuring position



EM126

Fig. EM-42 Measuring piston diameter

Cylinder bore specifications

Unit: mm (in)

		Standard	Wear limit
Cylinder bore	Inner diameter	73.000 to 73.050 (2.8740 to 2.8760)	0.20 (0.0079)
	Out-of-round	Less than 0.015 (0.0006)	
	Taper		
Difference in cylinder bore between cylinders		0.05 (0.0020)	0.20 (0.0079)

CYLINDER BORING

1. When any cylinder needs boring, all other cylinders must also be bored at same time.
2. Determine piston oversize according to amount of cylinder wear.

Piston for service

Unit: mm (in)

		Piston diameter
Standard		72.987 to 73.037 (2.8735 to 2.8755)
Oversize	0.50 (0.0197)	73.467 to 73.517 (2.8924 to 2.8944)
	1.00 (0.0394)	73.967 to 74.017 (2.9121 to 2.9140)
	1.50 (0.0591)	74.467 to 74.517 (2.9318 to 2.9337)

3. The size to which cylinders must be honed is determined by adding piston-to-cylinder clearance to the largest piston diameter (at piston skirt in thrust direction).

Calculation of cylinder bore diameter to be machined

$D = A + B - C = A +$ [0.003 to 0.023 mm (0.0001 to 0.0009 in)]

Where

D: Cylinder bore diameter to be machined
A: Piston diameter as measured
B: Piston to cylinder bore clearance = 0.023 to 0.043 mm (0.0009 to 0.0017 in)
C: For honing allowance = 0.02 mm (0.0008 in)

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

4. Do not cut too much out of cylinder bore at a time. Cut 0.05 mm (0.0020 in) or so at a time.
5. Measurement of cylinder bore just machined requires the utmost care since it is expanded by cutting heat.
6. As a final step, cylinders should be honed to final size.
7. Measure finished cylinder bore for out-of-round or tapered part.
8. Measure piston to cylinder clearance.

This clearance can be checked easily with a feeler gauge and a spring balance hooked on feeler gauge, measuring amount of force required to pull out gauge from between piston and cylinder.

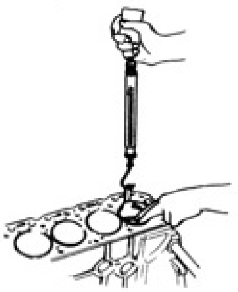

EM379

Fig. EM-43 Measuring piston fit in cylinder

Notes:

a. **When measuring clearance, slowly pull feeler gauge straight upward.**

b. **It is recommended that piston and cylinder be warmed to 20°C (68°F).**

Unit: mm (in)

Standard clearance	0.023 to 0.043 (0.0009 to 0.0017)
Feeler gauge	0.03 (0.0012)
Extracting force	0.5 to 1.5 (0.020 to 0.059)

Note: **If cylinder bore has worn beyond the wear limit, use cylinder liner.**
Undersize cylinder liners are available for service.
Interference fit of cylinder liner in 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	Inside diameter
4.0 (0.157)	Undersize	77.00 to 77.05 (3.0315 to 3.0335)	72.50 to 72.60 (2.8543 to 2.8583)
4.5 (0.177)	Undersize	77.50 to 77.55 (3.0512 to 3.0531)	72.50 to 72.60 (2.8543 to 2.8583)
5.0 (0.197)	Undersize	78.00 to 78.05 (3.0709 to 3.0728)	72.50 to 72.60 (2.8543 to 2.8583)

PISTON, PISTON PINS AND PISTON RINGS

1. Remove carbon from piston and ring grooves with a carbon scraper and a curved steel wire. The wire will be useful in cleaning bottom land of ring groove. Clean out oil slots in bottom land of oil ring groove.

2. Check for damage, scratches and wear. Replace if fault is detected.

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

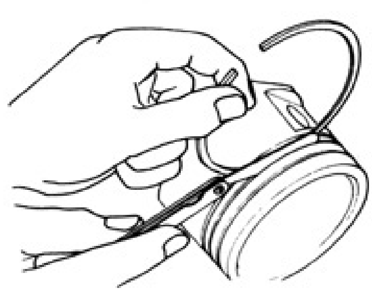

EM481

Fig. EM-44 Measuring piston ring side clearance

4. Push ring into cylinder with a piston so as to place it squarely in cylinder; measure ring gap with a feeler gauge. Ring should be placed to diameter at upper or lower limit of ring travel.

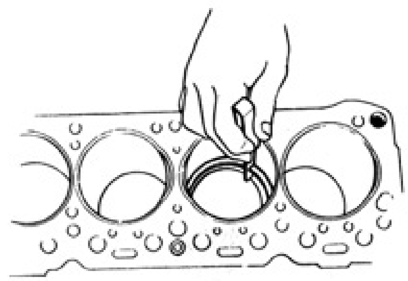

EM482

Fig. EM-45 Measuring ring gap

Notes:

a. **When only piston ring is to be replaced, without cylinder bore being corrected, measure gap at bottom of cylinder where wear is minor.**
Proper ring fit in ring groove is very important for proper performance and long life. A sticky ring causes blow-by or oil-up, resulting in premature wear on ring and cylinder wall. If it is too loose, this accelerates wear on sides of ring groove to aggravate ring play.

b. **Oversize piston rings are available. [0.5 mm (0.020 in), 1.0 mm (0.039 in) oversize]**

Side clearance

	Standard mm (in)	Wear limit mm (in)
Top ring	0.04 to 0.07 (0.0016 to 0.0028)	0.20 (0.0079)
2nd ring	0.04 to 0.07 (0.0016 to 0.0028)	0.20 (0.0079)
Oil ring	0.04 to 0.08 (0.0016 to 0.0031)	0.20 (0.0079)

Ring gap

	Standard mm (in)	Wear limit mm (in)
Top ring	0.20 to 0.35 (0.0079 to 0.0138)	1.00 (0.0394)
2nd ring	0.20 to 0.35 (0.0079 to 0.0138)	1.00 (0.0394)
Oil ring	0.30 to 0.90 (0.0118 to 0.0354)	1.00 (0.0394)

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

Piston pin diameter	mm (in)	17.447 to 17.452 (0.6869 to 0.6871)
Piston pin hole diameter	mm (in)	17.453 to 17.460 (0.6871 to 0.6874)
Interference fit of piston pin to connecting rod	mm (in)	0.020 (0.0008)

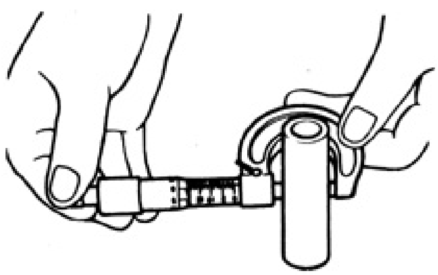


Fig. EM-46 Measuring piston pin diameter

6. Determine fitting of piston pin into 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 connecting rod.

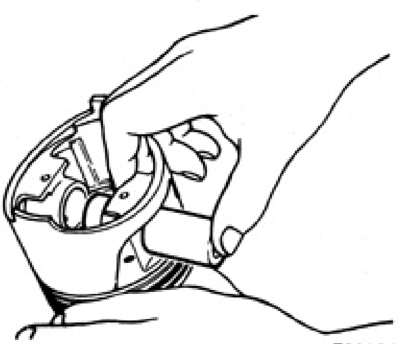


Fig. EM-47 Piston pin fitting

CONNECTING ROD

1. If a connecting rod has any flaw on either side of thrust face and large end, correct or replace it.

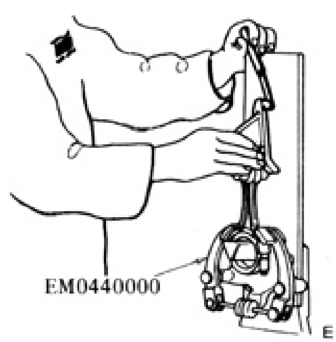


Fig. EM-48 Checking rod alignment

2. Check connecting rod for bend or torsion using a Connecting Rod Aligner EM0440000. If bend or torsion exceeds limit, correct or replace.
If bend or torsion exceeds limit, correct or replace.

3. When replacing connecting rod, select rod so weight difference between new and old ones is within 5 gr (0.176 oz).
4. Install connecting rods with bearings on to corresponding crank pins and measure thrust clearance. If measured value exceeds limit, replace connecting rod.

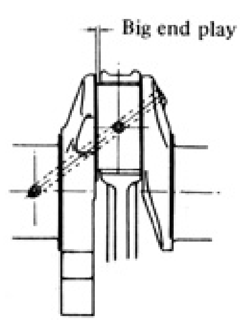


Fig. EM-49 Checking big end play

		Standard	Repair/replace limit
Connecting rod	Bend (per 100 mm or 3.94 in :length)	Less than 0.05 (0.0020)	0.10 (0.0039)
	Torsion (per 100 mm or 3.94 in :length)	Less than 0.07 (0.0028)	
	Big end play	0.2 to 0.3 (0.008 to 0.012)	0.4 (0.016)

CRANKSHAFT

1. Whenever crankshaft is removed from engine, it should be cleaned thoroughly in a suitable solvent. After cleaning, check crankshaft journal and crank pin in a suitable solvent. After cleaning, check crankshaft journal and crank pin for score, bias wear or cracks. Repair or replace as required. If fault is minor, dress with fine crocus cloth.
2. Check journals and crank pins for taper and out-of-round with micrometer. Measurement should be taken along journals for taper and around journals for out-of-round. See Figure EM-50 for detailed information.

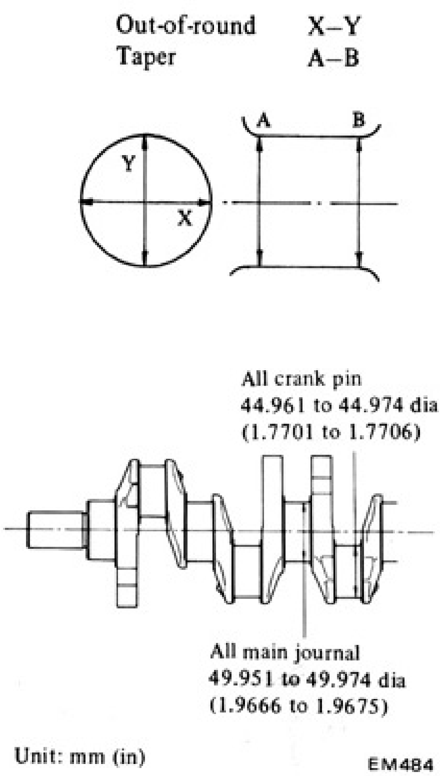


Fig. EM-50 Crankshaft dimensions

If journal or crank pins are tapered or out-of-round beyond limits, replace with a new shaft.

3. Crankshaft can be checked for bend by placing it on V-blocks and using a dial gauge with its indicating finger resting on center journal.

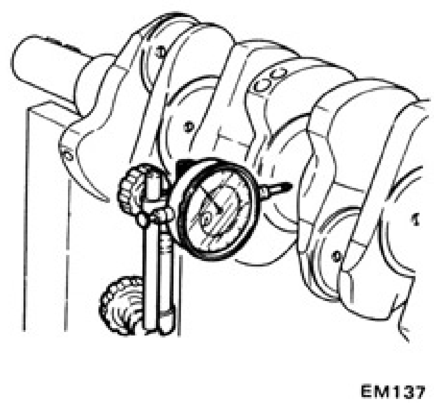


Fig. EM-51 Checking crankshaft bend

	Standard	Repair/replace limit
Taper and out-of-round of journal and crank pin mm (in)	Less than 0.01 (0.0004)	0.03 (0.0012)
Crankshaft bend mm (in)	Less than 0.015 (0.0006)	0.05 (0.0020)

Note: When measuring bend, use a dial gauge. Bend value is half of reading obtained when crankshaft is turned one full revolution with a dial gauge attached to its center journal.

4. After regrinding crankshaft, finish it to the necessary size indicated on page EM-20 by using an adequate undersize bearing according to extent of required repair.
5. After grinding journals or crank pins, crankshaft should be checked for end play. This can be done by installing shaft in engine block with main bearings and bearing caps torqued to 5.0 to 6.0 kg-m (36 to 43 ft-lb). Without disturbing above setting, bar crankshaft as far endwise as possible and insert a feeler gauge in clearance between crankshaft thrust face and main bearing thrust flange.

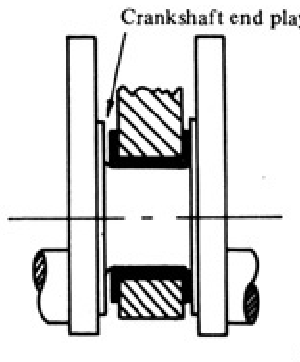


Fig. EM-52 Checking crankshaft end play

	Standard	Wear limit
Crankshaft free end play mm (in)	0.05 to 0.15 (0.0020 to 0.0059)	0.30 (0.0118)

6. In case of B210 and B120, check crankshaft pilot bushing at the rear end of crankshaft for wear or damage. Replace if fault is detected.

To replace crankshaft rear pilot bushing proceed as follows:

(1) Pull out bushing using Pilot Bushing Puller ST16680001.

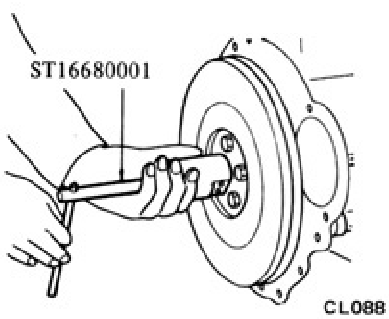


Fig. EM-53 Pulling out pilot bushing

(2) Before installing a new bushing, thoroughly clean bushing hole. Press fit bushing so its height above flange end is 2.8 mm (0.110 in). Do not oil bushing.

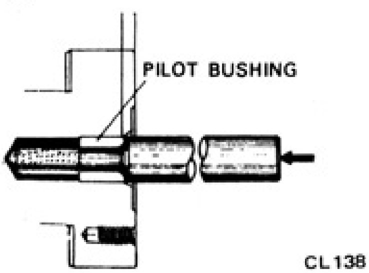


Fig. EM-54 Press-fitting new pilot bushing

BUSHING AND BEARING

MEASURING MAIN BEARING CLEARANCE

1. Thoroughly clean all bearings. Check for scratches, melt, score or wear.

Replace bearings, if fault is detected.

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

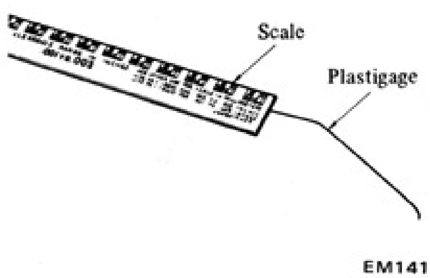


Fig. EM-55 Plastigage

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

Tightening torque:
5.0 to 6.0 kg-m (36 to 43 ft-lb)

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

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

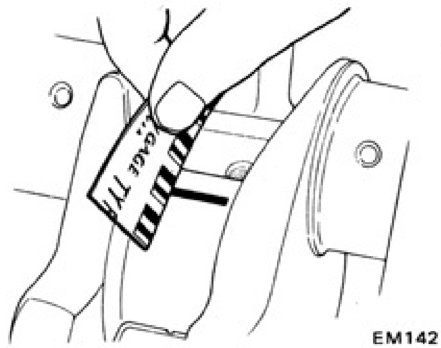


Fig. EM-56 Measuring bearing clearance

MEASURING CONNECTING ROD BEARING CLEARANCE

1. Measure connecting rod bearing clearance in same manner as above.

Connecting rod big end nut tightening torque:
A12
3.2 to 3.8 kg-m
(23 to 27 ft-lb)
A10
3.0 to 3.6 kg-m
(22 to 26 ft-lb)

When new bearings are used bearing fit, or more specifically, oil clearance should always be inspected. If it exceeds 0.10 mm (0.0039 in) (maximum), correct undersize bearings. should be selected or journals should be ground to fit next undersize bearings.

Note: Since bearings are precision insert type, it is not necessary to file bearing caps or to grind bearing surfaces with an emery cloth to correct bearing clearance.

Bearing oil clearance

	Standard	Wear limit
Main bearing clearance	0.020 to 0.062 (0.0008 to 0.0024)	0.10 (0.0039)
Connecting rod bearing clearance	0.020 to 0.050 (0.0008 to 0.0020)	

Finish of crank journal when undersize main bearings

Unit: mm (in)

Main bearing undersize		Crank journal diameter
Standard size		49.951 to 49.964 (1.9666 to 1.9671)
Undersize	0.02 (0.0008)	49.949 to 49.962 (1.9665 to 1.9670)
	0.25 (0.0098)	49.701 to 49.714 (1.9567 to 1.9572)
	0.50 (0.0197)	49.451 to 49.464 (1.9469 to 1.9474)
	0.75 (0.0295)	49.201 to 49.214 (1.9370 to 1.9376)
	1.00 (0.0394)	48.951 to 48.964 (1.9272 to 1.9277)

Finish of crank journal when undersize connecting rod bearings

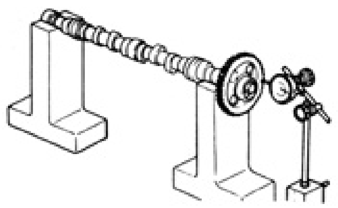
Unit: mm (in)

Connecting rod bearing undersize		Crank pin diameter
Standard size		44.961 to 44.974 (1.7701 to 1.7706)
Undersize	0.25 (0.0098)	44.711 to 44.724 (1.7603 to 1.7608)
	0.50 (0.0197)	44.461 to 44.474 (1.7504 to 1.7509)
	0.75 (0.0295)	44.211 to 44.224 (1.7406 to 1.7411)

MISCELLANEOUS COMPONENTS

CRANKSHAFT SPROCKET AND CAMSHAFT SPROCKET

1. Check tooth surface for flaws or wear. Replace sprocket if fault is found.
2. Install camshaft sprocket in position and check for runout. If exceeds 0.1 mm (0.004 in) total indicator reading, replace camshaft sprocket.



EM309

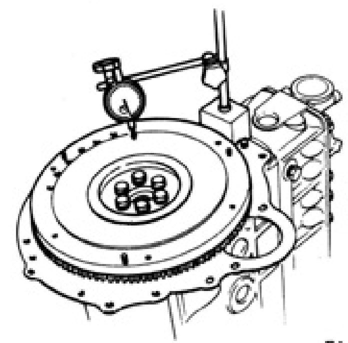
Fig. EM-57 Checking camshaft sprocket runout

CHAIN AND CHAIN TENSIONER

1. Check chain for stepped wear, scratches or other problems on roller links. Replace if necessary.
2. Check chain tensioner for wear, breakage or any other fault which would interfere with proper chain function. Replace if necessary.

FLYWHEEL

1. Check ring gear. If worn or damaged excessively, replace.
2. Clutch contacting face of flywheel should be smooth. If worn, damaged or roughened beyond limits repair or replace.
3. Measure flywheel for runout. This can be checked with a dial gauge, by rotating it in either direction with indicating finger resting on flywheel face farthest from center. If runout exceeds 0.2 mm (0.008 in), replace flywheel.



EM312

Fig. EM-58 Checking flywheel runout

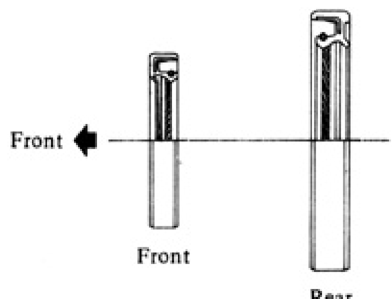
Note: Removal and installation of ring gear requires use of hydraulic press. It is also necessary to heat ring gear to 180 to 200°C (356 to 392°F) thus facilitating removal and installation. Do not heat ring gear to more than 300°C (572°F). To do so could result in impaired hardness of ring gear.

CRANKSHAFT FRONT AND REAR OIL SEAL

First check rear oil seal for worn or folded over sealing lip or oil leakage. If necessary, replace with a new seal.

Notes:

a. When installing a new seal, pay attention to mounting direction.
b. It is good practice to renew oil seal whenever engine is overhauled.
c. Don't apply grease to oil seal groove.



EM487

Fig. EM-59 Crankshaft oil seal

ENGINE ASSEMBLY

CONTENTS

PRECAUTION

Before assembling engine, observe following precautions:

1. Clean all disassembled parts with clean solvent. All oil holes in crankshaft, camshaft, valve rocker shaft, etc. should be thoroughly cleaned to remove all traces of grinding chips or lint. Always use clean solvent.
2. In general, used gaskets, packings and oil seals should be replaced.
3. Under no circumstances should lockwashers be reused.
4. Place bolts, nuts and washers back in their original parts or from which they were removed.

5. Most packings serve best when liquid packing is applied to sealing surfaces. When designated, use suitable liquid packing to eliminate possibility of water, oil and gas leak.
6. Prior to assembling, all sliding surfaces should be liberally oiled.
7. Proper tightening is essential to successful performance of all car repairs. It is also important to follow correct tightenig sequence in pulling up cylinder head. Be on alert at all times to amount of clearance permitted.
8. Cleanliness of tools or parts such as work bench used in making a repair is essential. When setting up a job every precaution should be taken that tools or parts are free of dirt, mud and oil. Do not work in dust and grit, for they are primary cause of wear in any engine.

CYLINDER HEAD

1. When installing service lip seal, insert valve spring seat into valve guide. Install valve lip seal by lightly tapping its head with a plastic hammer through Valve Lip Seal Drift ST11100000.

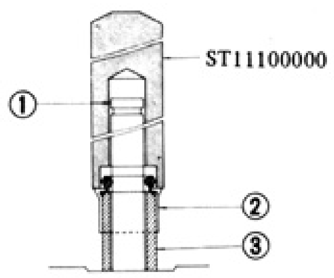


Fig. EM-60 Installing valve lip seal

2. Insert valve into valve guide.
3. Insert valve spring seat and install shroud.
4. Install valve spring and valve spring retainer. Compress valve spring with Valve Lifter ST12070000 and fit valve collets in place. Release Valve Lifter slowly. Refer to page EM-7 for Cylinder Head Disassembly.

Notes:

a. **Do not interchange valves between cylinders, for their sliding or seating surfaces have undergone wearing-in or have been lapped at assembly, forming specific contact with mating parts.**
b. **Check to be sure that valves are properly seated on valve seats without foreign particles stuck in between.**
c. **Valve spring is an uneven pitch type. Install spring facing white painted side to cylinder head surface.**

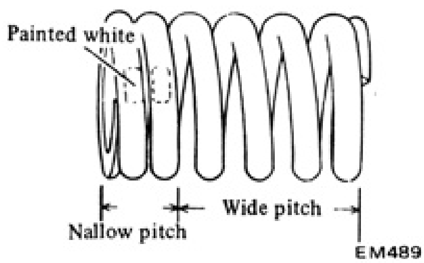


Fig. EM-61 Valve spring

PISTON AND CONNECTING ROD

1. Assemble pistons, piston pins and connecting rods to designated cylinder. Refer to page EM-7 for Piston Pin Removal.

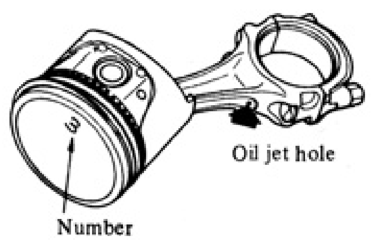


Fig. EM-62 Arranging piston and connecting rod

Notes:

a. **Piston is pressed into connecting rod. Fitting force is from 1 to 3 tons and aid of Piston Pin Press Stand ST13040000 is necessary. When pressing piston pin in connecting rod, apply engine oil to pin and small end of connecting rod.**
b. **Arrange so oil jet hole of connecting rod big end is directed toward right side of cylinder block.**
c. **Be sure to install piston in cylinders with stamped number of piston head toward front of engine.**

2. Install piston rings

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

Notes:

a. **Top ring is chromium-plated on cylinder wall contacting face.**
b. **Second ring has larger taper surface than top ring.**
c. **In combined oil ring, upper rail is same as lower one.**

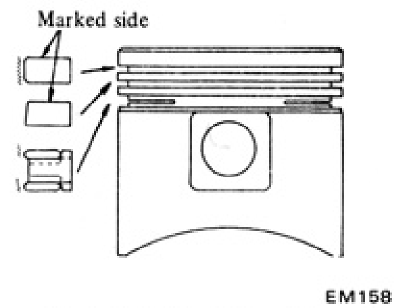


Fig. EM-63 Installing piston ring

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

Note: Clean their mating surface.

VALVE ROCKER SHAFT ASSEMBLY

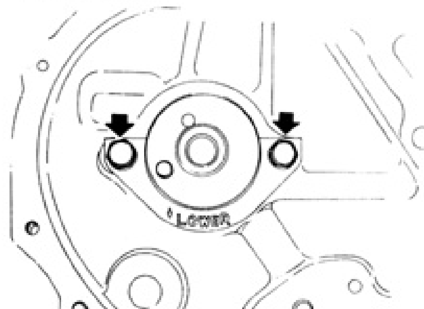
Install parts in reverse order of disassembly.

ENGINE ASSEMBLY

1. The first step in engine assembly is to bolt Engine Attachment ST05200000 to right hand side of cylinder block. In succession, install block in Engine Stand ST0501S000 with engine bottom up.
2. Apply a light coat of engine oil to sliding surfaces of valve lifters; insert lifters in holes in cylinder block.

3. To install camshaft, be sure to coat sliding surfaces of camshaft bushings with a light coat of engine oil. Insert camshaft in cylinder block from front side of engine, exercising care not to damage camshaft bushings.
4. Install camshaft locating plate and torque attaching bolts to 0.4 to 0.5 kg-m (2.9 to 3.6 ft-lb), using a suitable torque wrench.

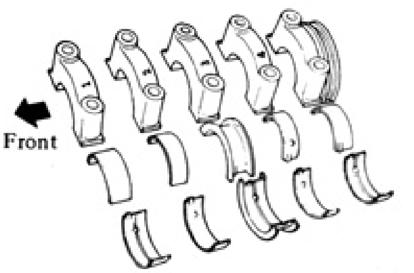
Note: Set locating plate so as the "Lower" mark comes to engine bottom side.



EM461

Fig. EM-64 Installing camshaft locating plate

5. Install baffle plate and steel net.
6. Set main bearings at proper portion of cylinder block and caps.



EM492

Fig. EM-65 Main bearings and caps

Notes:

a. **Center bearing (No. 3 bearing for A12 engine and No. 2 bearing for A10 engine) is a flanged type to cope with thrust force.**
b. **Two inner bearings (No. 2 and No. 4 for A12 engine) are the same.**
c. **Front bearing (No. 1) is the same in type as rear bearing (No. 5 for A12 engine and No. 3 for A10 engine).**
d. **All bearings except No. 1, No. 3 and No. 5 bearings for A12 engine are interchangeable between upper and lower bearings. Make certain that bearings with oil holes are installed on cylinder block.**
e. **Bearings for A10 and A12 engines are not interchangeable.**

7. Apply engine oil to main bearing surfaces on both sides of cylinder block and cap.

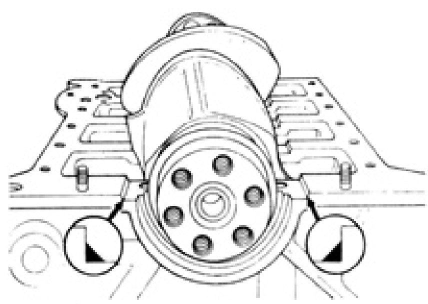
Install crankshaft.

8. Install main bearing cap and tighten bolts to specified torque.

Tightening torque:
5.0 to 6.0 kg-m (36 to 43 ft-lb)

Notes:

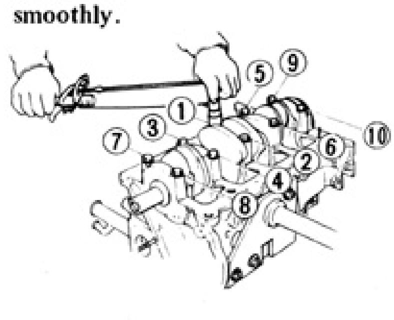
a. **Apply seal to each rear main bearing contact corner of cylinder block as shown in Figure EM-66.**



EM493

Fig. EM-66 Applying sealant

b. **Arrange parts so arrow mark on bearing cap faces toward front of engine.**
c. **Prior to tightening bearing cap bolts, place bearing cap in proper position by shifting crankshaft in axial direction.**
d. **Tighten bearing cap bolts gradually in two to three stages outwardly from center bearing in the sequence shown in Figure EM-67.**
e. **After securing bearing cap bolts, ascertain that crankshaft turns smoothly.**



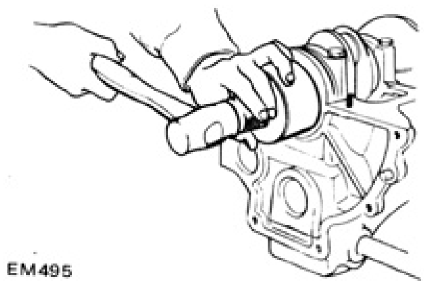
EM494

Fig. EM-67 Torque sequence of cap bolts

9. Make sure there is proper end play at crankshaft.

For inspection procedure, refer to instructions under heading "Crankshaft".

10. Install rear oil seal using suitable drift. Apply engine oil to sealing lip of oil seal.



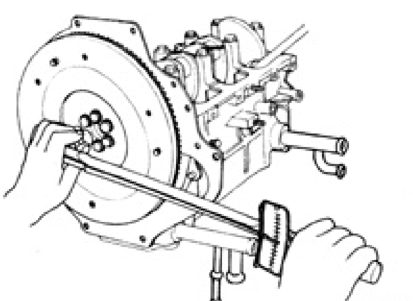
EM495

Fig. EM-68 Installing rear oil seal

Note: Make sure that oil seals are properly installed in their locations.

11. Install rear plate.
12. Install flywheel securely, and tighten bolts to specified torque.

Tightening torque:
A12
6.5 to 7.5 kg-m
(47 to 54 ft-lb)
A10
5.0 to 6.0 kg-m
(36 to 43 ft-lb)



EM496

Fig. EM-69 Installing flywheel

Note: Tighten bolts in a criss-cross fashion.

13. Rotate engine quarter turn and install piston-rod assembly using Piston Ring Compressor EM03470000.

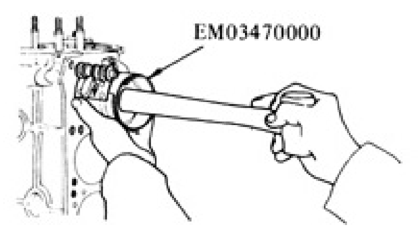


Fig. EM-70 Installing piston rod assembly

Notes:

a. **Insert pistons in corresponding cylinders.**
b. **Apply engine oil to sliding parts.**
c. **Arrange pistons so number stamped on piston head faces to front of engine.**
d. **Before installing piston, piston rings should be positioned as shown in Figure EM-71.**

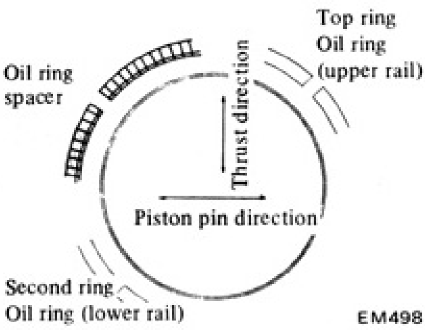


Fig. EM-71 Positioning piston ring gap

14. Apply engine oil to bearing surfaces.

Install connecting rod caps.

Tightening torque:
A12
3.2 to 3.8 kg-m
(23 to 27 ft-lb)
A10
3.0 to 3.6 kg-m
(22 to 26 ft-lb)

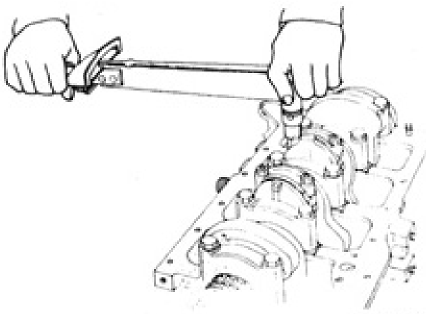


Fig. EM-72 Tightening connecting rod cap

Note: Arrange connecting rods and connecting rod caps so cylinder numbers face in same direction.

15. Make sure there is proper end play at connecting rod big end.

For inspection procedure, refer to instructions under heading "Connecting rod".

Big end play:
0.2 to 0.3 mm
(0.008 to 0.012 in)

16. Insert crank sprocket keys in keyways of crankshaft. Install camshaft and crankshaft sprockets temporarily for adjustment of tooth height by using adjusting washers.

Height difference mm (in)	less than 0.5 (0.020)
Adjusting washer thickness mm (in)	0.15 (0.0059)

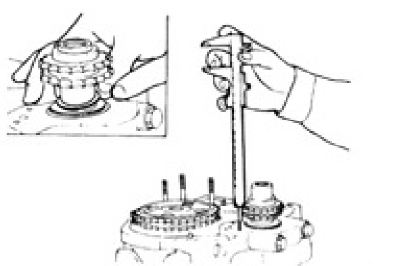


Fig. EM-73 Adjusting sprocket tooth height

17. Install timing chain and camshaft sprocket with their markings properly aligned. Oil sprocket teeth and chain with engine oil.

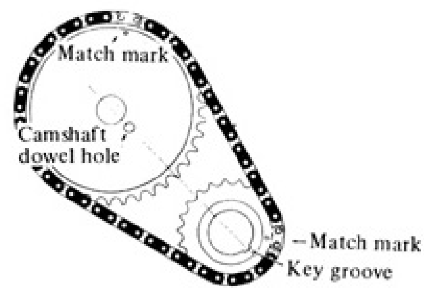


Fig. EM-74 Aligning markings

Note: Make sure camshaft sprocket dowel hole and crankshaft sprocket key are in line and both dowel hole and key are located downward.

18. Tighten camshaft sprocket bolt to 4.0 to 4.8 kg-m (29 to 35 ft-lb) by means of suitable torque wrench.

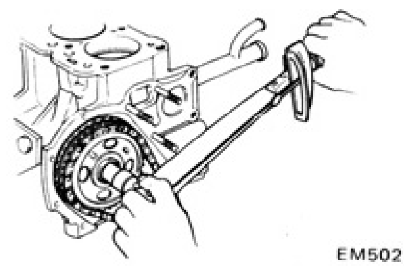


Fig. EM-75 Tightening camshaft sprocket bolt

19. Install chain tensioner and tighten tensioner attaching bolts to 0.6 to 0.8 kg-m (4.3 to 5.8 ft-lb)

20. Check projection "L" of tensioner spindle.

Correct projection "L" is below 15 mm (0.591 in). Replace spindle when over this limit.

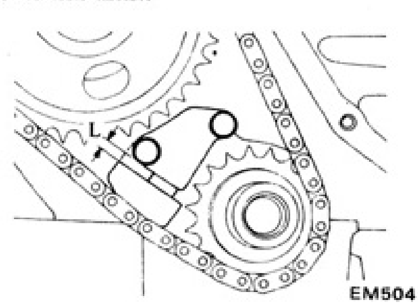


Fig. EM-76 Checking projection of tensioner spindle

21. Correctly install oil thrower in front of camshaft sprocket.
22. Press new oil seal in timing chain cover. (Front cover oil seal should be replaced when front cover is disassembled.)
23. Install timing chain cover with gasket in place.

Note: Apply lithium grease to sealing lip of oil seal.

Timing chain cover bolts tightening torque:
0.5 to 0.7 kg-m
(3.6 to 5.1 ft-lb)

Refer to page EM-6 for Chain Cover Removal.

24. Install water pump with gasket in place.

Water pump attaching bolts tightening torque:
0.9 to 1.4 kg-m
(6.5 to 10.1 ft-lb)

25. Install crank pulley, then set No. 1 piston at T.D.C. on compression stroke.

Crank pulley nut tightening torque:
15 to 20 kg-m
(108 to 145 ft-lb)

26. Invert engine. Install oil strainer and oil pan using new gasket and oil seal.

Note: Give coating of sealant to seam between gasket and oil seal.

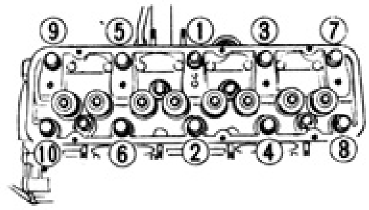
Oil pan bolt tightening torque:
B210 & B120
0.4 to 0.6 kg-m
(2.9 to 4.3 ft-lb)
F10
1.5 to 1.9 kg-m
(11 to 14 ft-lb)

28. Tighten cylinder head bolts.

Tightening torque:
A12
7.0 to 7.5 kg-m
(51 to 54 ft-lb)
A10
6.0 to 6.5 kg-m
(43 to 47 ft-lb)

Notes:

a. **One of cylinder head bolts is smaller in diameter than others and has a hollow head. It should be installed on right side center of cylinder head.**
b. **Tightening should be made in two or three steps, finally torquing to specification.**
c. **Retighten cylinder head bolt to the above specified torque after engine has been warmed up.**



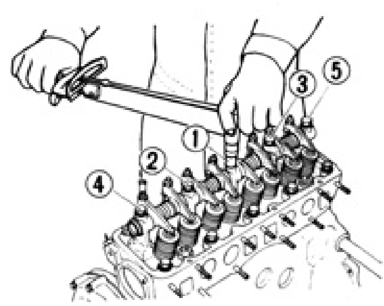
EM505

Fig. EM-77 Cylinder head bolt tightening sequence

29. Apply engine oil to both ends of push rods and insert in proper sequence.
30. Apply engine oil to valve stem end and rocker arm contact surfaces. Position rocker shaft assembly on cylinder head.
31. Tighten rocker shaft bracket bolts to specified torque.

Tightening torque:
2.0 to 2.5 kg-m (14 to 18 ft-lb)

Note: Tightening should be done in two or three stages outwardly from center bracket.



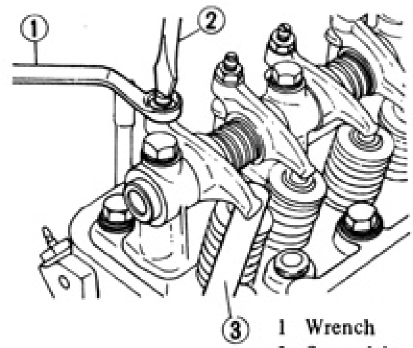
EM506

Fig. EM-78 Rocker shaft bolt tightening sequence

32. Adjust valve clearance to specified value.

Notes:

a. **First set clearance to 0.25 mm (0.0098 in) when engine is cold.**
b. **After engine has been assembled, warm it up for at least several minutes, finally adjust clearance to specification. For details, refer to Adjusting Intake and Exhaust Valve Clearance in ET Section (Page ET-3).**



1 Wrench
2 Screwdriver
3 Feeler gauge

EM507

Fig. EM-79 Adjusting valve clearance

	Intake and Exhaust valves
Valve clearance (hot) mm (in)	0.35 (0.0138)

33. Install rocker cover.
34. Install intake, exhaust manifolds and carburetor assembly.

Tightening torque:
0.9 to 1.4 kg-m
(6.5 to 10.1 ft-lb)

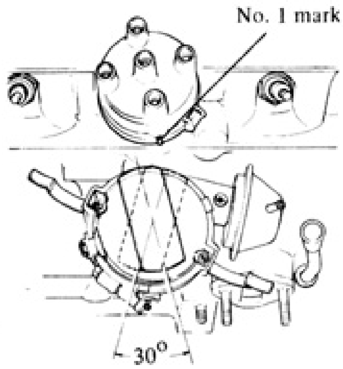
35. Install pipe connector to control valve hose and engine mounting bracket L.H.
36. Install distributor.

Notes;:

a. **Be sure to set No. 1 piston to T.D.C. of compression stroke.**

b. Before installation, return distributor rotor approximately 30 degrees from its correct position. Insert distributor, meshing distributor drive gear and driven gear.

c. After installation distributor rotor should align with mark on rotor cap.



EM566

Fig. EM-80 Correct position of rotor

37. Dismount engine from Engine Stand ST0501S000 and place it on suitable engine stand. (A12 engine)

Remove Engine Attachment ST05200000.

38. Install spark plugs, and engine mounting bracket R.H.

39. Install oil pump and filter assembly.

40. Install thermostat and thermostat housing.

41. Install fuel pump and fuel lines.

Do not forget to install spacer and gasket.

42. Install distributor vacuum line.

43. Install distributor cap and high tension cables as an assembly. Connect high tension cables.

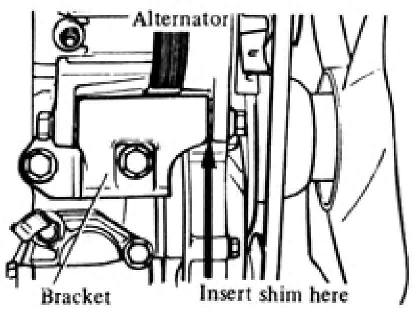
44. Insert oil level gauge.

45. Install fan, fan pulley and fan spacer.

Lock bolts by bending lock washers.

46. Install alternator bracket, adjusting bar fan belt and alternator.

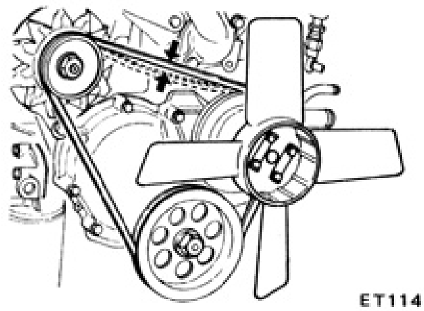
Note: When installing alternator on bracket, add shim of proper thickness to take up clearance between alternator and bracket.



EM509

Fig. EM-81 Installing alternator

47. Check to be sure deflection of fan belt is held within 12 to 16 mm (0.473 to 0.630 in) when thumb pressure [10 kg (22 lb)] is applied midway between pulleys.

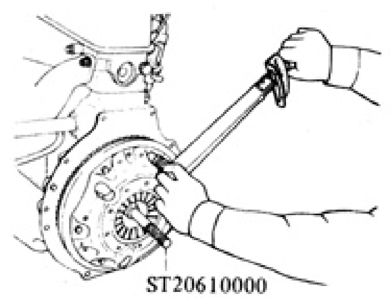


ET114

Fig. EM-82 Fan belt tension

48. Install clutch and cover assembly using Clutch Aligning Bar ST20610000.

For details, refer to Installation in CL Section.



EM510

Fig. EM-83 Installing clutch assembly

49. Dismount engine from Engine Stand ST0501S000 and place it on suitable engine stand. (A10 engine)

Remove Engine Attachment ST05270000.

SERVICE DATA AND SPECIFICATIONS

Valve mechanism			
Valve clearance			
(Cold)	Intake	mm (in)	0.25 (0.0098)
	Exhaust	mm (in)	0.25 (0.0098)
(Hot)	Intake	mm (in)	0.35 (0.0138)
	Exhaust	mm (in)	0.35 (0.0138)
Valve			
Head diameter			
	Intake	mm (in)	37.0 to 37.2 (1.457 to 1.465)
	Exhaust	mm (in)	30.0 to 30.2 (1.181 to 1.189)
Stem diameter			
	Intake	mm (in)	7.970 to 7.985 (0.3138 to 0.3144)
	Exhaust	mm (in)	7.945 to 7.960 (0.3128 to 0.3134)
Length		mm (in)	102.35 to 102.65 (4.030 to 4.041)
Valve spring			
Out of square		mm (in)	1.3 (0.051)
Free length			
	A12	mm (in)	46.5 (1.831)
	A10	mm (in)	45.7 (1.799)
Pressured length			
	A12	mm/kg (in/lb)	30.2/58.5 (1.19/129)
	A10	mm/kg (in/lb)	31.0/61.2 (1.22/135)
Valve guide			
Length		mm (in)	49 (1.929)
Height from head surface		mm (in)	18 (0.709)
Inner diameter		mm (in)	8.000 to 8.015 (0.3150 to 0.3156)
Outer diameter		mm (in)	12.233 to 12.244 (0.4816 to 0.4820)
Interference fit		mm (in)	0.022 to 0.044 (0.0009 to 0.0017)
To stem clearance			
	Intake	mm (in)	0.015 to 0.045 (0.0006 to 0.0018)
	Exhaust	mm (in)	0.040 to 0.070 (0.0016 to 0.0028)
Valve seat			
Width			
	Intake	mm (in)	1.3 (0.051)
	Exhaust	mm (in)	1.8 (0.071)

Angle		degree	90
Interference fit		mm (in)	0.064 to 0.096 (0.0025 to 0.0038)
Camshaft			
End play		**mm (in)**	**0.01 to 0.05 (0.0004 to 0.0020)**
Lobe lift	**A10**	**mm (in)**	**5.35 (0.211)**
	A12	**mm (in)**	**5.65 (0.222)**
Cam height			
	Intake	mm (in)	36.200 to 36.250 (1.4252 to 1.4272)
	Exhaust	mm (in)	36.930 to 36.980 (1.4539 to 1.4559)
Journal diameter			
	No. 1	mm (in)	43.783 to 43.976 (1.7237 to 1.7242)
	No. 2	mm (in)	42.283 to 43.296 (1.6647 to 1.7046)
	No. 3	mm (in)	42.783 to 42.796 (1.6844 to 1.6849)
	No. 4	mm (in)	42.283 to 42.296 (1.6647 to 1.6652)
	No. 5	mm (in)	41.208 to 41.221 (1.6224 to 1.6229)
Bend		mm (in)	Less than 0.015 (0.0006)
Journal to bearing clearance			
	No. 1	mm (in)	0.037 to 0.060 (0.0015 to 0.0024)
	No. 2	mm (in)	0.027 to 0.050 (0.0011 to 0.0020)
	No. 3	mm (in)	0.040 to 0.063 (0.0016 to 0.0025)
	No. 4	mm (in)	0.027 to 0.050 (0.0011 to 0.0020)
	No. 5	mm (in)	0.037 to 0.060 (0.0015 to 0.0024)
Bearing inner diameter			
	No. 1	mm (in)	43.833 to 43.843 (1.7257 to 1.7261)
	No. 2	mm (in)	43.323 to 43.333 (1.7056 to 1.7060)
	No. 3	mm (in)	42.836 to 42.846 (1.6865 to 1.6868)
	No. 4	mm (in)	42.323 to 42.333 (1.6663 to 1.6667)
	No. 5	mm (in)	41.258 to 41.268 (1.6243 to 1.6247)
Connecting rod			
Big end play		mm (in)	0.2 to 0.3 (0.008 to 0.012)
Bearing clearance		mm (in)	0.020 to 0.050 (0.0008 to 0.0020)
Wear limit		mm (in)	0.10 (0.0039)
Bend (per 100 mm or 3.94 in: length)		mm (in)	Less than 0.05 (0.0020)
Torsion (per 100 mm or 3.94 in: length)		mm (in)	Less than 0.07 (0.0028)
Crankshaft and main bearing			
Journal			
Diameter		mm (in)	49.951 to 49.974 (1.9666 to 1.9675)
Taper & out of round		mm (in)	Less than 0.01 (0.0004)

Free end play	mm (in)	0.05 to 0.15 (0.0020 to 0.0059)
Wear limit	mm (in)	0.30 (0.0118)
Crank pin		
Diameter	mm (in)	44.961 to 44.974 (1.7701 to 1.7706)
Taper & out of round	mm (in)	Less than 0.01 (0.0004)
Clearance	mm (in)	0.020 to 0.062 (0.0008 to 0.0024)
Wear limit	mm (in)	0.10 (0.0039)
Crankshaft bend	mm (in)	0.015 (0.0006)
Flywheel		
Clutch face runout	mm (in)	Less than 0.2 (0.008)
Piston		
Diameter		
Standard	mm (in)	72.987 to 73.037 (2.8735 to 2.8755)
Oversize (0.50)	mm (in)	73.467 to 73.517 (2.8924 to 2.8944)
Oversize (1.00)	mm (in)	73.967 to 74.017 (2.9121 to 2.9140)
Oversize (1.50)	mm (in)	74.467 to 74.517 (2.9318 to 2.9337)
Piston pin hole		
Diameter	mm (in)	17.453 to 17.460 (0.6871 to 0.6874)
Piston pin		
Diameter	mm (in)	17.447 to 17.452 (0.6869 to 0.6871)
To piston clearance	mm (in)	0.001 to 0.013 (0.00004 to 0.00051)
Interference fit of piston pin to connecting rod	mm (in)	0.020 (0.0008)
Piston ring		
Side clearance		
Top ring	mm (in)	0.04 to 0.07 (0.0016 to 0.0028)
2nd ring	mm (in)	0.04 to 0.07 (0.0016 to 0.0028)
Oil ring	mm (in)	0.04 to 0.08 (0.0016 to 0.0032)
Gap		
Top ring	mm (in)	0.20 to 0.35 (0.0079 to 0.0138)
2nd ring	mm (in)	0.20 to 0.35 (0.0079 to 0.0138)
Oil ring	mm (in)	0.30 to 0.90 (0.0118 to 0.0354)
Cylinder block		
Bore		
Inner diameter	mm (in)	73.000 to 73.050 (2.874 to 2.876)
Wear limit	mm (in)	0.20 (0.0079)
Out of round	mm (in)	Less than 0.015 (0.0006)
Taper	mm (in)	Less than 0.015 (0.0006)
Difference between cylinders	mm (in)	Less than 0.015 (0.0006)

Surface flatness		mm (in)	Less than 0.05 (0.0020)
Cylinder head			
Surface flatness		mm (in)	Less than 0.05 (0.0020)
Tightening torque			
Cylinder head bolt			
	A12	kg-m (ft-lb)	7.0 to 7.5 (51 to 54)
	A10	kg-m (ft-lb)	6.0 to 6.5 (43 to 47)
Rocker shaft bracket bolt		kg-m (ft-lb)	2.0 to 2.5 (14 to 18)
Connecting rod big end nut			
	A12	kg-m (ft-lb)	3.2 to 3.8 (23 to 27)
	A10	kg-m (ft-lb)	3.0 to 3.6 (22 to 26)
Flywheel bolt			
	A12	kg-m (ft-lb)	6.5 to 7.5 (47 to 54)
	A10	kg-m (ft-lb)	5.6 to 6.0 (41 to 43)
Main bearing cap bolt		kg-m (ft-lb)	5.0 to 6.0 (36 to 43)
Camshaft sprocket bolt		kg-m (ft-lb)	4.0 to 4.8 (29 to 35)
Oil pan bolt			
	B210, B120	kg-m (ft-lb)	0.4 to 0.6 (2.9 to 4.3)
	F10	kg-m (ft-lb)	1.5 to 1.9 (11 to 14)
Oil pump bolt		kg-m (ft-lb)	0.9 to 1.4 (6.5 to 10)
Oil pan drain plug		kg-m (ft-lb)	2.0 to 3.0 (14 to 22)
Locating plate bolt		kg-m (ft-lb)	0.5 to 0.8 (3.6 to 5.8)
Manifold nut		kg-m (ft-lb)	0.9 to 1.4 (6.5 to 10)
Fuel pump nut		kg-m (ft-lb)	0.9 to 1.4 (6.5 to 10)
Crank pulley bolt		kg-m (ft-lb)	15 to 20 (108 to 145)
Engine mounting bolt		kg-m (ft-lb)	1.9 to 2.5 (14 to 18)
Water pump bolt		kg-m (ft-lb)	0.9 to 1.4 (6.5 to 10)
Front cover bolt		kg-m (ft-lb)	0.5 to 0.7 (3.6 to 5.1)

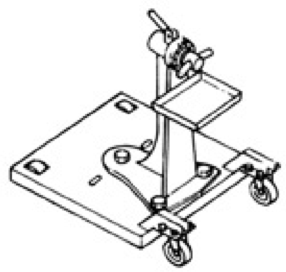
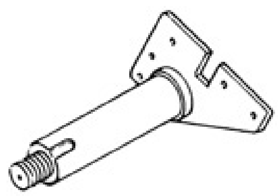
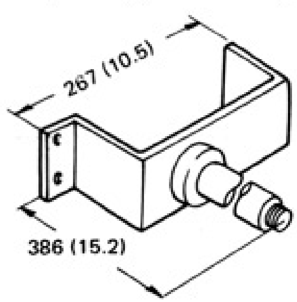
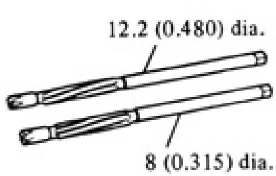
TROUBLE DIAGNOSES AND CORRECTIONS

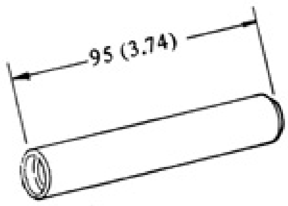
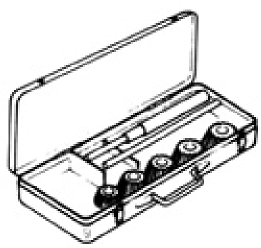
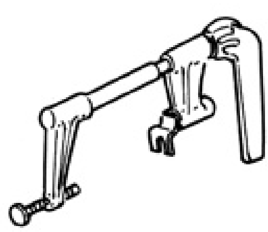
Condition	Probable cause	Corrective action
I. Noisy engine Knocking of crank-shaft and bearing	Loose main bearing	Replace
	Seized bearing	Replace
	Bent crankshaft	Repair or replace
	Excessive crankshaft end play	Replace center thrust bearing
Piston and connecting rod knocking	Loose bearing.	Replace
	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 vaive spring	Replace
	Seized valve	Repair or replace

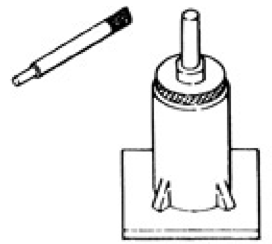
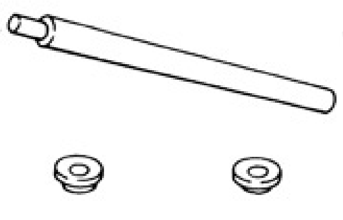
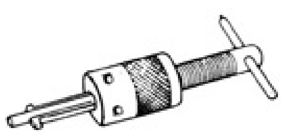
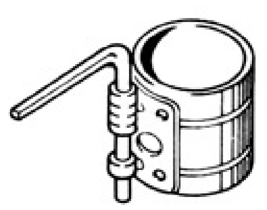
Condition	Probable cause	Corrective action
Water pump knocking	Improper shaft end play	Replace
	Broken impeller	Replace
II. Other mechanical trouble Stuck valve	Improper valve clearance	Adjust
	Insufficient clearance between valve stem and guide	Clean stem or ream the guide
	Weakened or broken valve spring	Replace
	Biting or damage of valve stem	Replace or clean
	Poor fuel quality	Use good fuel
Seized valve seat	Improper valve clearance	Adjust
	Weakened valve spring	Replace
	Thin valve head edge	Replace valve
	Narrow valve seat	Reface
	Overheating	Repair or replace
	Over speeding	Drive at proper speed
	Sticked valve guide	Repair
Excessively worn cylinder and piston	Shortage of engine oil	Add or replace oil Check oil level on daily basis
	Dirty engine oil	Clean crankcase, replace oil and replace oil filter element
	Poor oil quality	Use proper oil
	Overheat	Repair or replace
	Wrong assembly of piston with connecting rod	Repair or replace
	Improper piston ring clearance	Adjust
	Dirty air cleaner	Clean periodically
	Too rich mixture	Adjust
	Engine over run	Drive correctly
	Stuck choke valve	Clean and adjust
	Over choking	Start in correct way

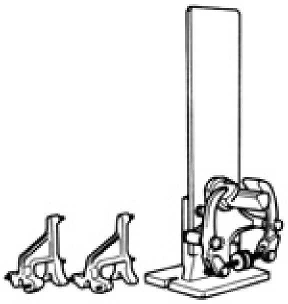
Condition	Probable cause	Corrective action
Faulty connecting rod	Shortage of engine oil	Add or replace oil Check oil level on daily basis
	Low oil pressure	Correct
	Poor engine oil quality	Use proper oil
	Rough crankshaft surface	Grind and replace bearing
	Clogged oil passage	Clean
	Bearing worn or eccentric	Replace
	Bearing improperly assembled	Repair
	Loose bearing	Replace
	Incorrect connecting rod alignment	Repair or replace
Faulty crankshaft bearing	Shortage of engine oil	Add or replace Check oil level on daily basis
	Low oil pressure	Adjust
	Poor quality engine oil	Use proper oil
	Worn or out-of-round crankshaft journal	Repair
	Clogged oil passage in crankshaft	Clean
	Bearing worn or eccentric	Replace
	Bearing improperly assembled	Repair
	Non concentric crankshaft or bearing	Replace

SPECIAL SERVICE TOOLS

No.	Tool number & tool name	Description Unit: mm (in)	For use on	Reference page or Figure No.
1.	ST0501S000 Engine stand assembly ST05011000 Engine stand ST05012000 Base	This engine stand assembly is used for disassembling or assembling engine or differential carrier throughout 360° in all directions.  SE184	A10 A12	Fig. EM-6 Page EM-22 Page EM-26
2.	ST05200000 Engine attachment	This engine attachment is installed to cylinder block and mounted on engine stand ST0501S000 in disassembling or assembling engine.  SE338	A12	Fig. EM-6 Page EM-22 Page EM-26
3.	ST05270000 Engine attachment	Attachment for setting the engine on the engine stand.  SE266	A10	Fig. EM-15
4.	ST1108S000 Valve guide reamer set ST11081000 Reamer (12.2 mm dia.) ST11032000 (8.0 mm dia.)	This reamer set used for: • Finishing the cylinder head valve guide hole. • Finishing the valve guide bore.  SE147	A10 A12	Fig. EM-31 Page EM-11

No.	Tool number & tool name	Description Unit: mm (in)	For use on	Reference page or Figure No.
5.	ST11100000 Valve lip seal drift	This tool is used to install new valve lip seal.  SE337	A10	Fig. EM-60
6.	ST11320000 Valve guide drift	This tool is used to remove valve guide and install new valve guide.  SE033	A10	Fig. EM-28
7.	ST11670000 Valve seat cutter set	This cutter set is used to reface a valve seat.  SE193	A10	Fig. EM-32
8.	ST12070000 Valve lifter	This tool is used to compress valve spring by the combined action of its cam and lever, thereby facilitating the removal or installation of valve collet (for general use).  SE194	A10 A12	Fig. EM-19 Page EM-22

No.	Tool number & tool name	Description	For use on	Reference page or Figure No.
9.	ST13040000 Piston pin press stand	This tool is used with a press to drive pin into, or out of, connecting rod.  SE302	A10	Fig. EM-18 Page EM-22
10.	ST16110000 Camshaft bearing drift	This tool is used to remove camshaft bearings and install new bearings.  SE267	A10 A12	Fig. EM-35
11.	ST16680001 Pilot bushing puller	This tool is used to pull pilot bushing out of place.  SE142	B210 B120	Fig. EM-53
12.	EM03470000 Piston ring compressor	This tool is used to compress piston rings while piston is being inserted into cylinder.  SE199	All	Fig. EM-70

No.	Tool number & tool name	Description	For use on	Reference page or Figure No.
13.	EM0440000 Connecting rod aligner	 SE385	All	Figure EM-48