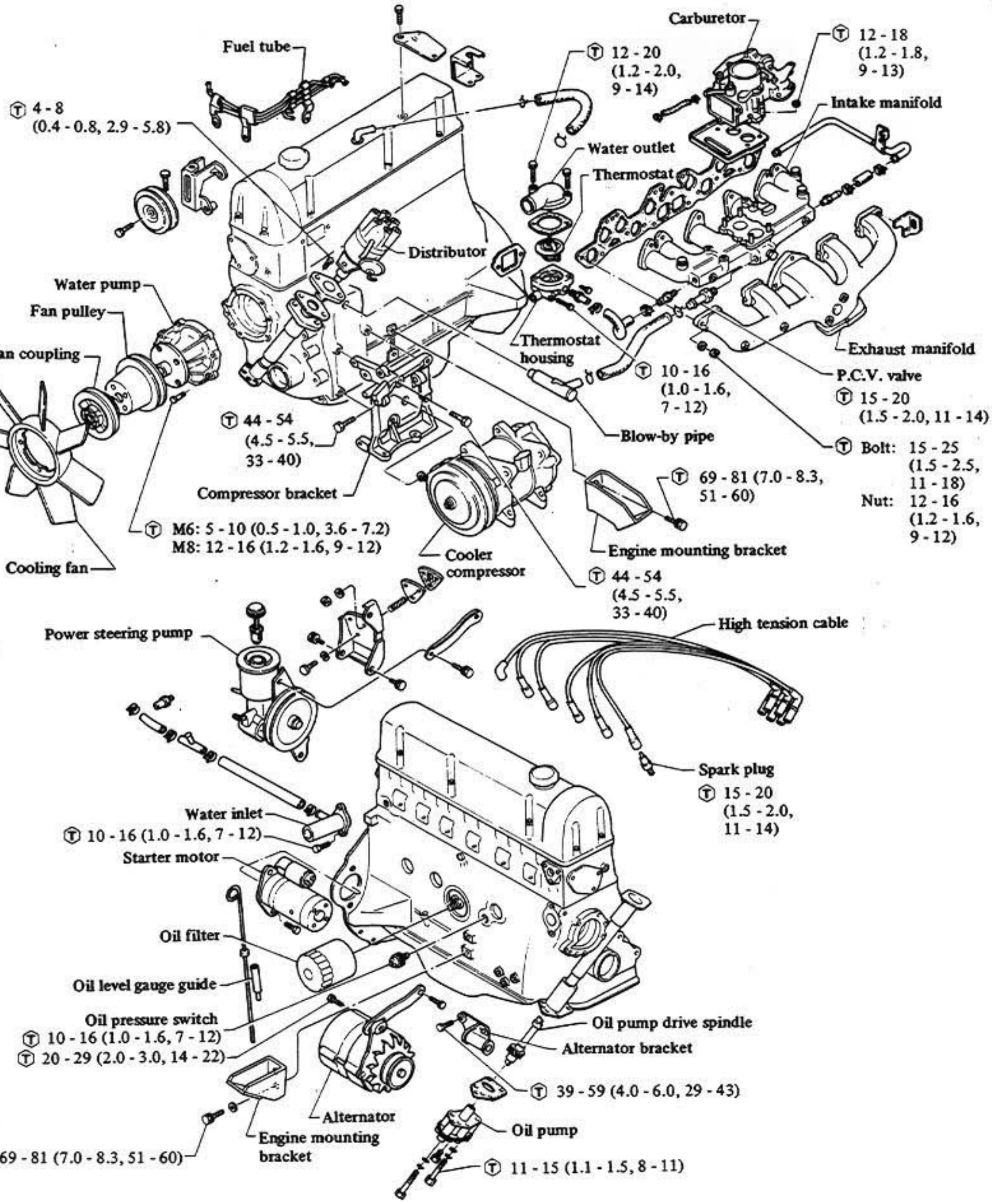
ENGINE MECHANICAL

EM

CONTENTS

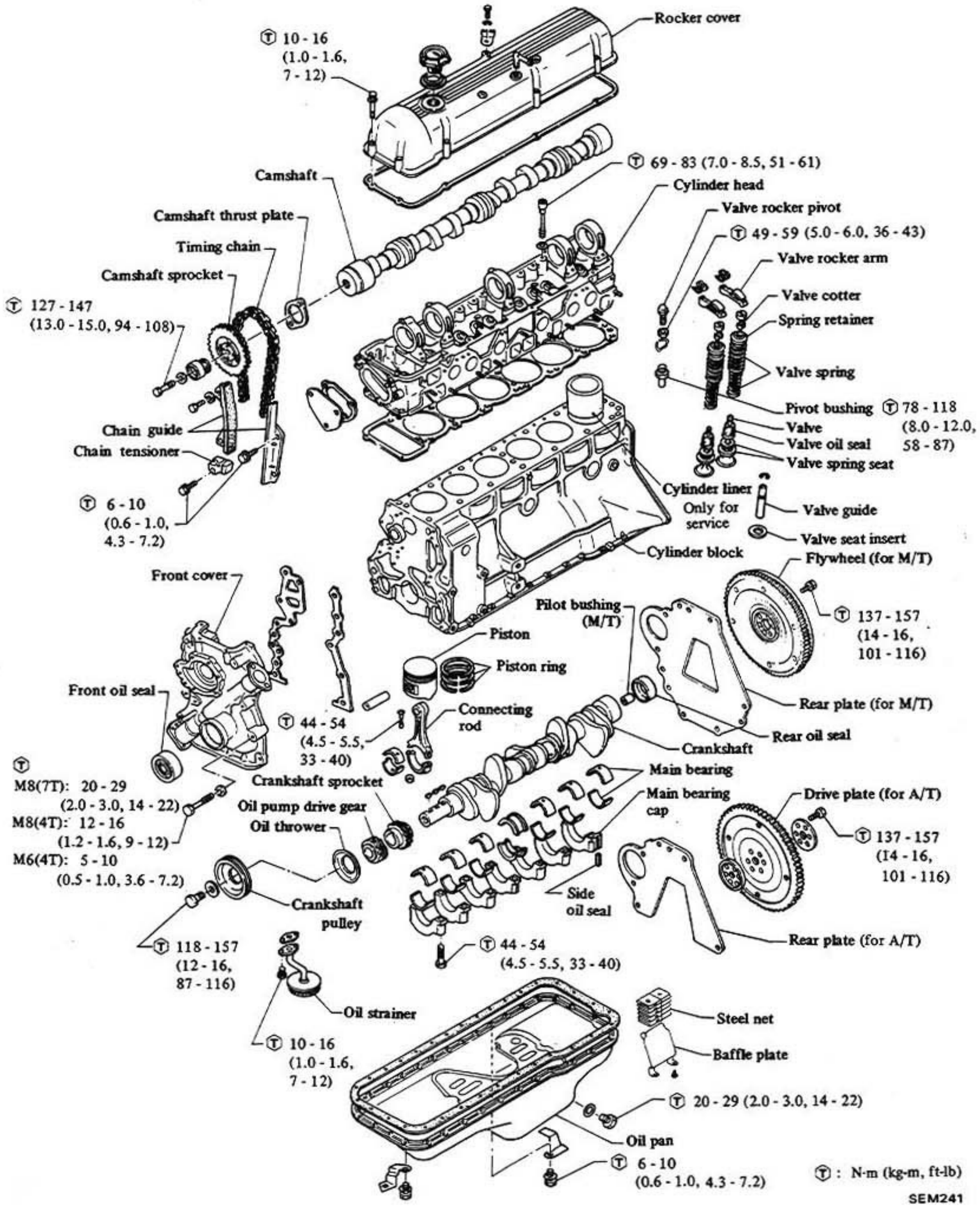
ENGINE COMPONENTS (L28 engine outer parts)



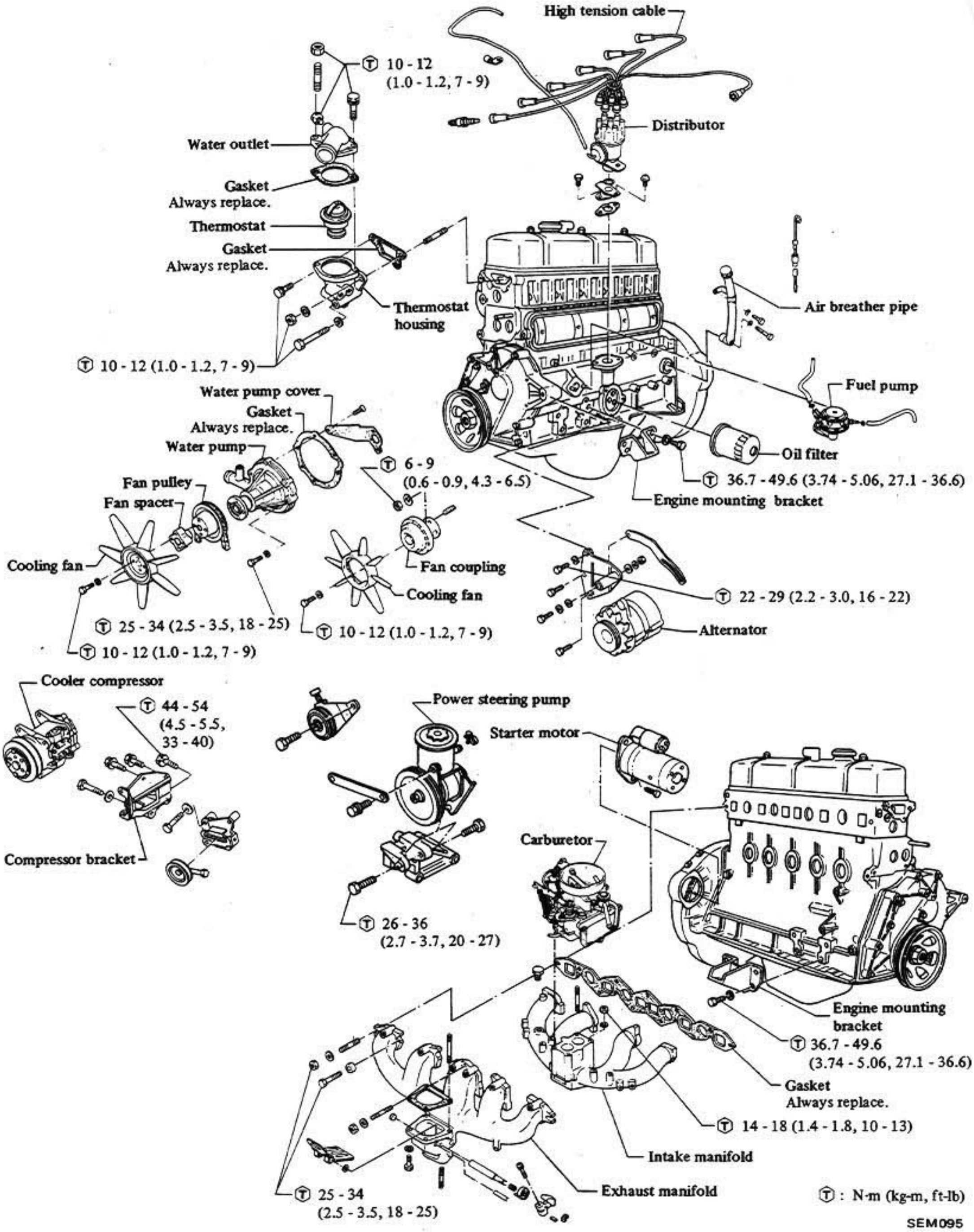
T : N·m (kg-m, ft-lb)

SEM093

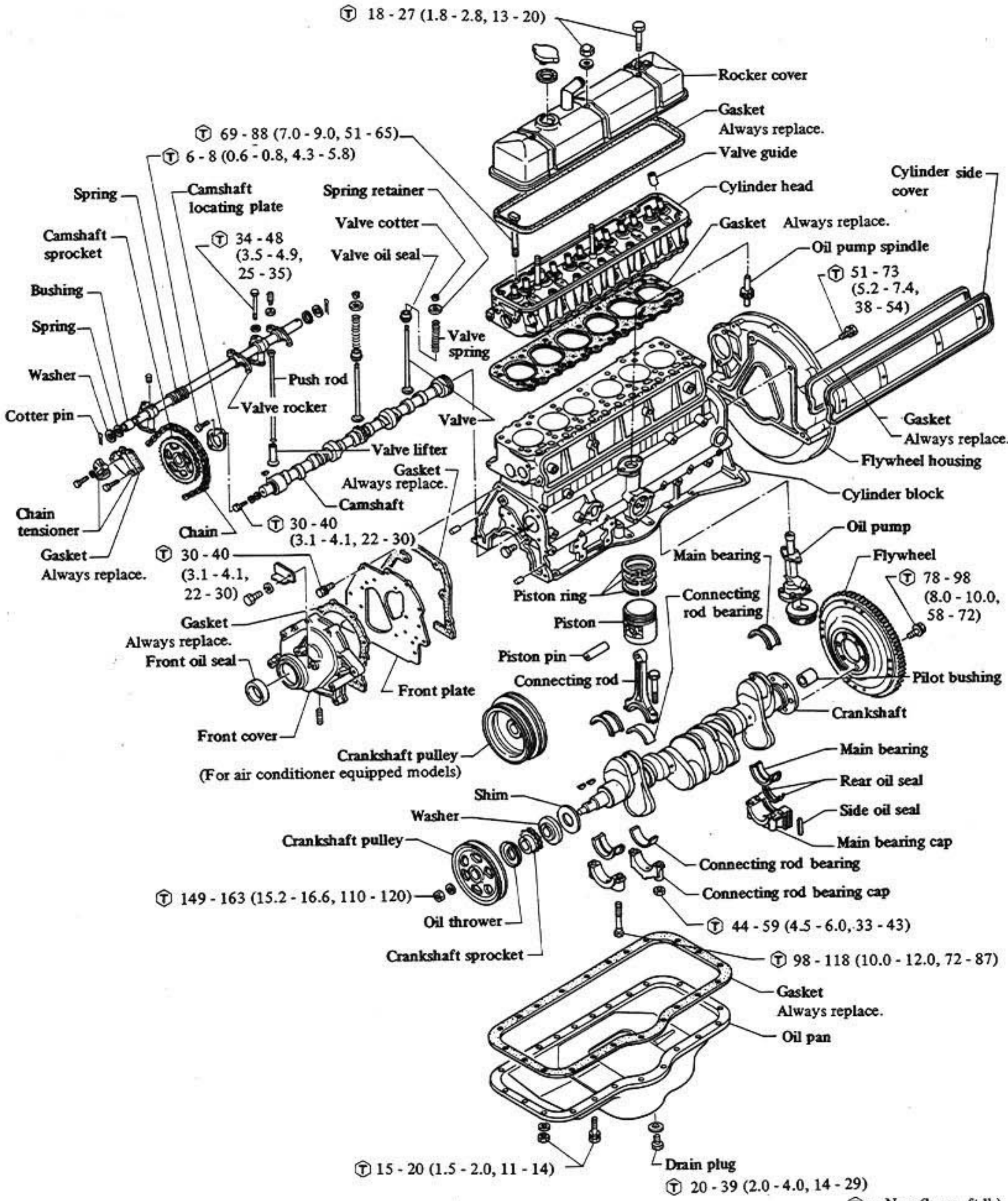
ENGINE COMPONENTS (L28 engine body parts)



ENGINE COMPONENTS (P40 engine outer parts)



ENGINE COMPONENTS (P40 engine body parts)

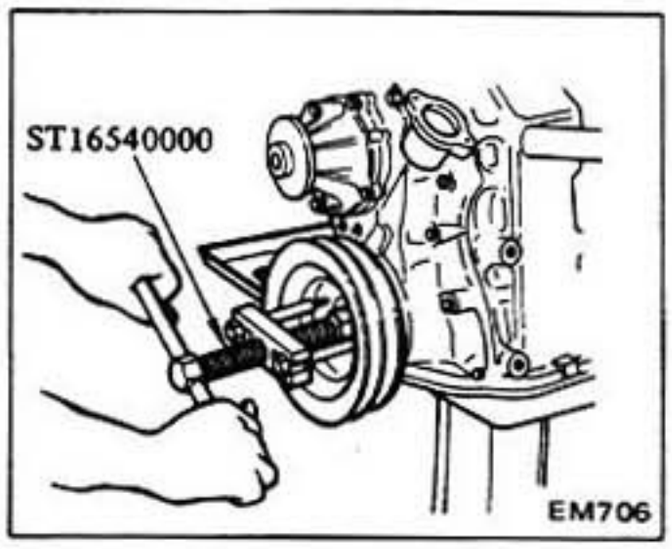


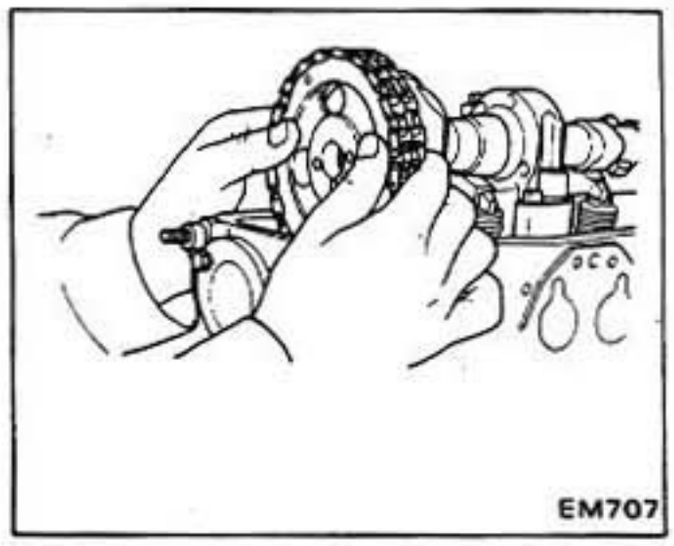
SEM096

ENGINE DISASSEMBLY

PRECAUTIONS

Arrange the disassembled parts on the parts stand in accordance with their assembled locations, sequence, etc., so that the parts will be reassembled to their original locations. Place mating marks on the parts if necessary.



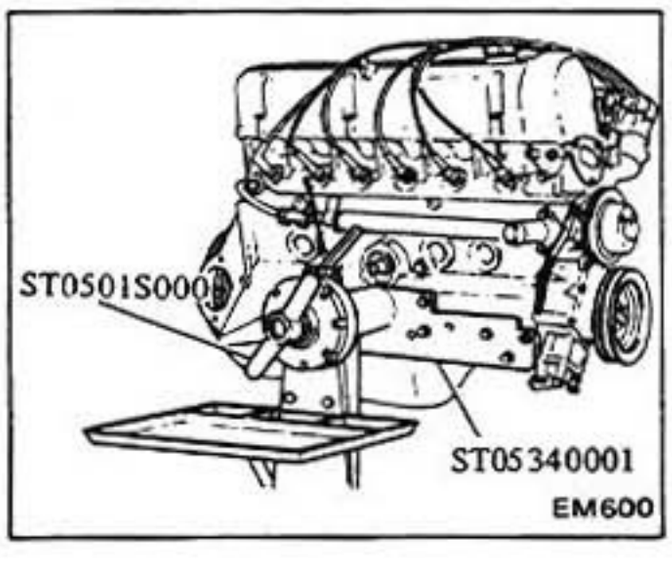


DISASSEMBLING L28 ENGINE OVERALL

MOUNTING ENGINE ON ENGINE STAND

1. Remove following parts located at rear and right side of engine.
- Starter motor
- Clutch cover assembly (M/T)
- Converter housing (A/T)
- Alternator, alternator drive belt and alternator bracket
- Engine mounting bracket R.H.
- Oil filter **using Tool ST19320000**

2. Install engine attachment to cylinder block. Then, mount the engine on the engine stand.



3. Drain engine oil and coolant.

REMOVING OUTER PARTS

Remove following parts:

1. Engine front side parts
- Fan, fan coupling and fan pulley
- Alternator adjusting bar
- Crank pulley **using Tool**

2. Engine left side parts.
- Distributor cap and high tension cable
- Distributor
- Hoses connected to engine
- Fuel line
- Carburetor from intake manifold
- Intake and exhaust manifold as an assembly with gaskets.
- Thermostat housing
- Air conditioner compressor bracket
- Engine mounting bracket L.H.

3. Engine right side parts
- Water inlet
- Water hoses and pipes
- Power steering oil pump bracket
- Oil pressure switch
- Oil level gauge
- Spark plugs

4. Engine bottom side parts
- Oil pump and oil pump drive spindle

REMOVING BODY PARTS

Remove following parts:

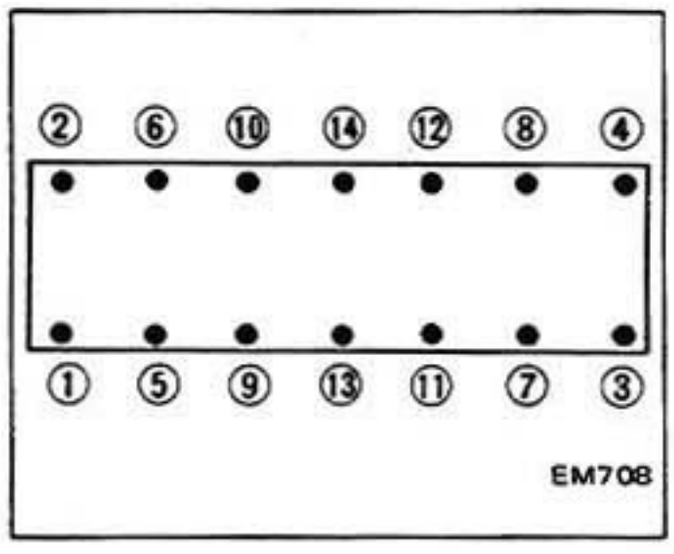
1. Oil pan and oil strainer
2. Valve rocker cover
3. Cylinder head assembly

(1) Remove camshaft bolt by locking camshaft.

(2) Remove fuel pump cam and camshaft sprocket, and slowly lower timing chain.

(3) Remove bolts securing cylinder head to front cover.

(4) Loosen cylinder head bolts in the sequence as shown **using Tool ST10120000.**



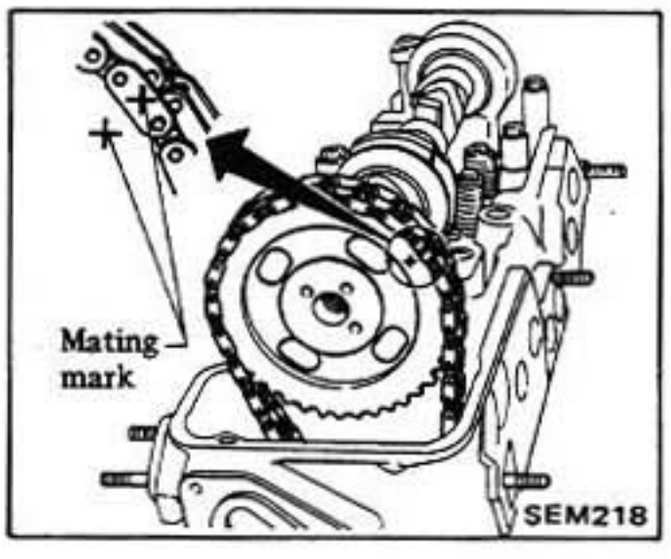
Gradually loosen cylinder head bolts in two or three stages.

(5) Remove cylinder head.

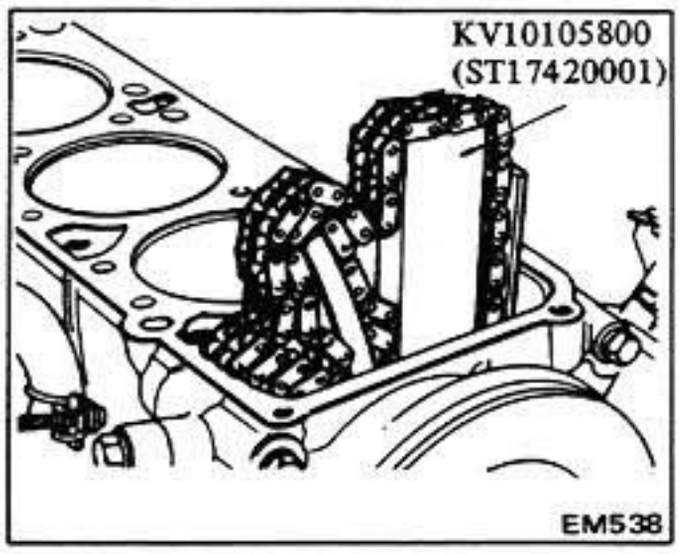
When removing cylinder head from engine installed on car, follow the instructions below.

a. Turn crankshaft until No. 1 piston is at T.D.C. on its compression stroke.

b. To facilitate assembling operation, scribe a mark on timing chain and camshaft sprocket with paint before removal.

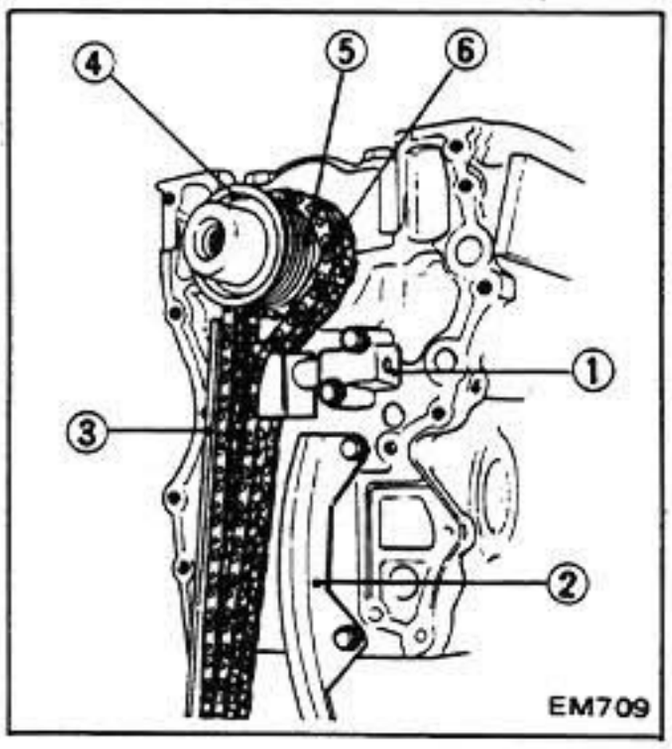


c. Support timing chain by utilizing Tool between timing chains.



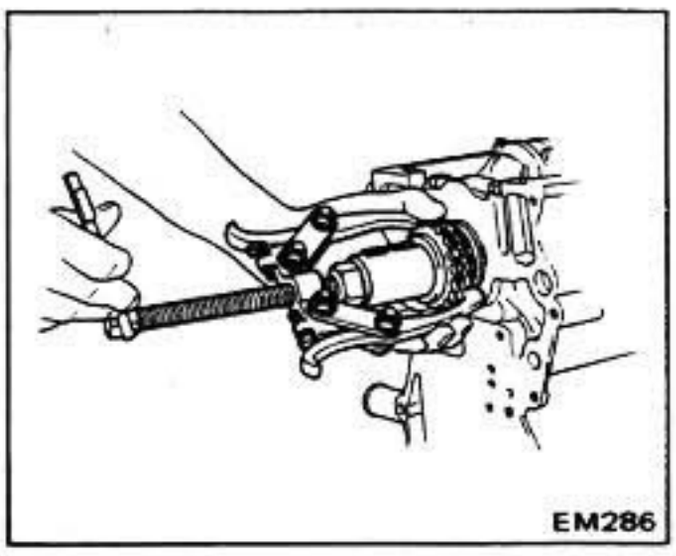
d. Install cylinder head, and then install camshaft sprocket by aligning marks on it and timing chain.

4. Front side parts
- Water pump
- Front cover
- Timing chain
- Chain tensioner and chain guides
- Oil thrower, oil pump drive gear and crankshaft sprocket from crankshaft.

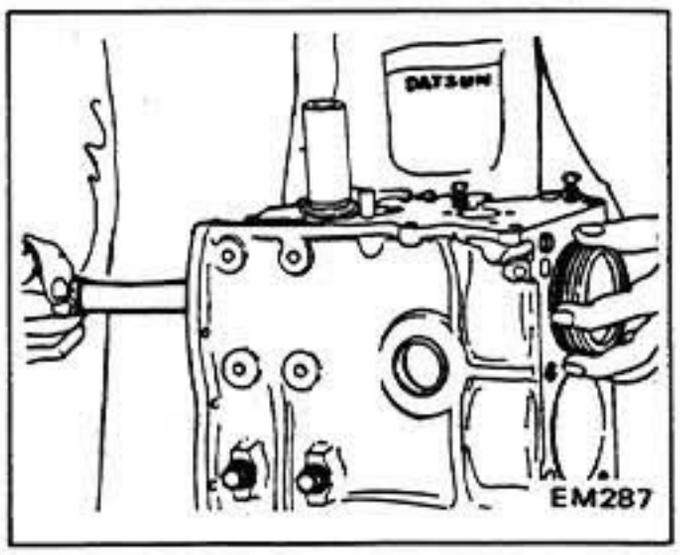


1 Chain tensioner
2 Slack side chain guide
3 Tension side chain guide
4 Oil thrower
5 Oil pump drive gear
6 Crankshaft sprocket

If it is hard to extract crankshaft sproket, use a suitable puller.



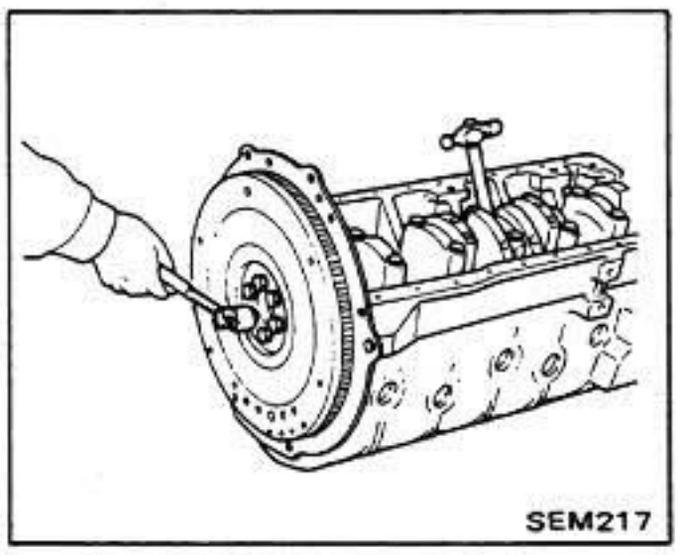
5. Piston and connecting rod assembly
(1) Remove connecting rod bearing cap with bearing.
(2) Push out piston with connecting rod toward cylinder head side.



a. Piston can be easily removed by scraping carbon off top face of cylinder with a scraper.
b. Numbers are stamped on connecting rod and cap corresponding to each cylinder. Care should be taken to avoid wrong combination including bearing.

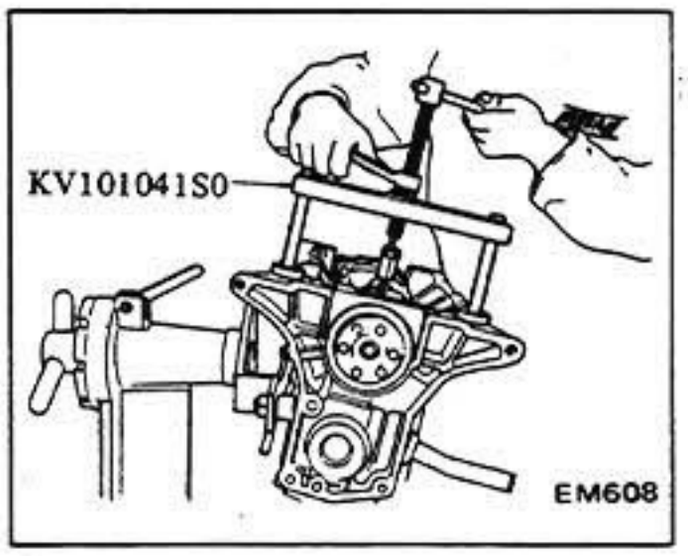
6. Flywheel (M/T) or drive plate (A/T) and rear plate. Remove while crankshaft is locked using hammer handle.

WARNING:
When removing flywheel, be careful not to drop it.

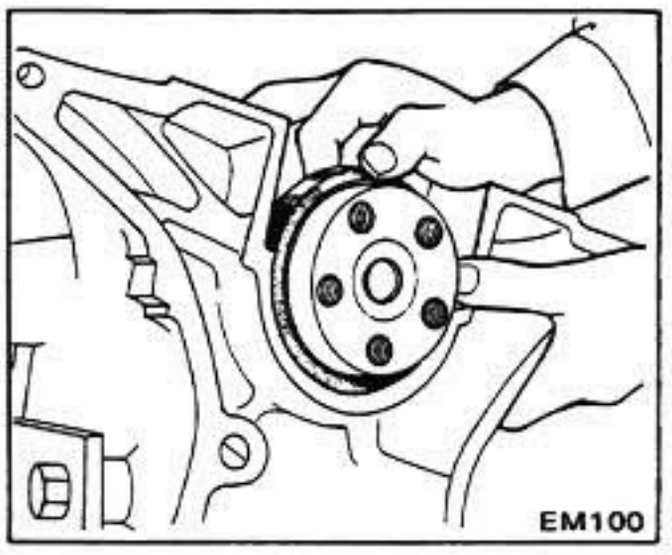


7. Crankshaft.
(1) Remove main bearing cap with bearing.

a. When loosening main bearing cap bolts, loosen from outside in sequence.
Do not completely loosen bolts in one step. Instead use two or three steps for this procedure.
b. Remove center and rear main bearing caps using Tool.
c. Keep them in order.

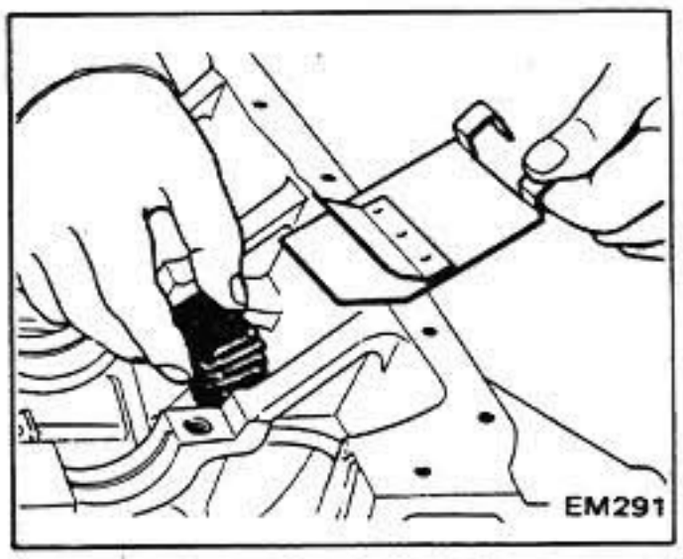


(2) Remove rear oil seal.



When removing rear oil seal without removing main bearing cap, pry it off with a screwdriver so as not to damage crankshaft.

(3) Remove crankshaft.
(4) Remove main bearing at block side.
8. Remove baffle plate and steel net from cylinder block.

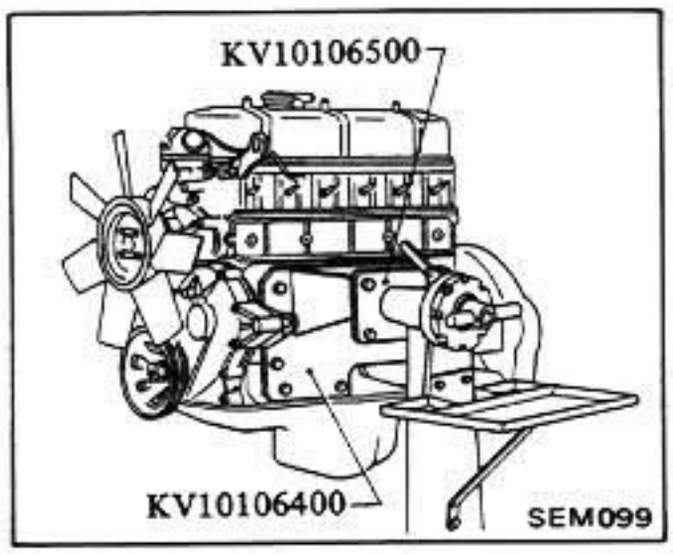


DISASSEMBLING P40 ENGINE OVERALL

MOUNTING ENGINE ON ENGINE STAND

1. Remove following parts located at rear and left side of engine.
- Transmission
- Clutch cover assembly
- Alternator, alternator drive belt and alternator bracket
- Alternator adjusting bar
- Engine mounting bracket L.H.
- Oil filter **using Tool ST19320000**
- Oil level gauge
- Oil pressure switch
- Fuel pump
- Distributor cap and high tension cable
- Distributor
- Oil pump spindle
- Cylinder side cover
- Oil filter stud
- Oil level gauge guide
- Distributor support
- Air breather pipe
- Coolant temperature sensor

2. Drain engine oil and coolant.
3. Oil cooler unit **(Refer to Section LC)**.
4. Install engine attachment to cylinder block. Then, mount the engine on the engine stand.

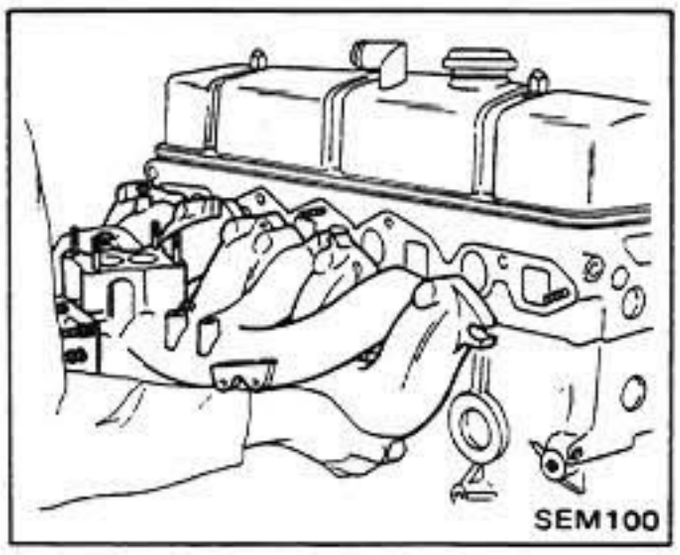


REMOVING OUTER PARTS

Remove following parts:
1. Engine front side parts
- Cooling fan, fan coupling and fan pulley
- Thermostat housing
- Water pump
- Fuel line and front engine slinger
- Crank pulley

2. Engine left side parts
- Spark plugs

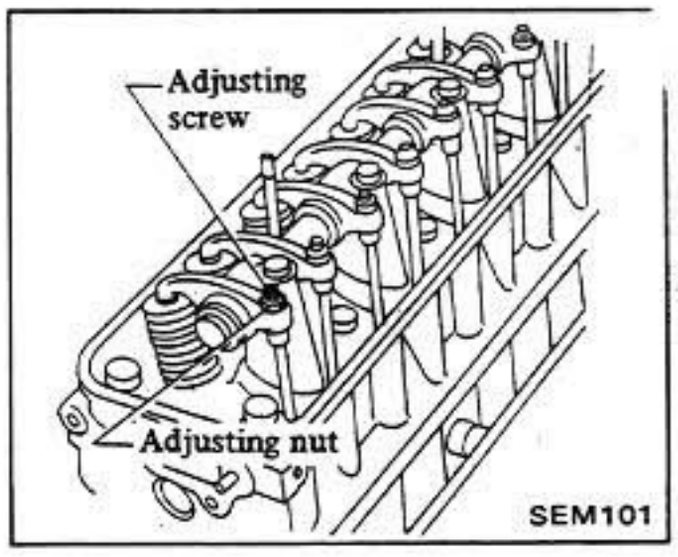
3. Engine right side parts
- Carburetor from intake manifold
- Intake and exhaust manifold as an assembly with gaskets



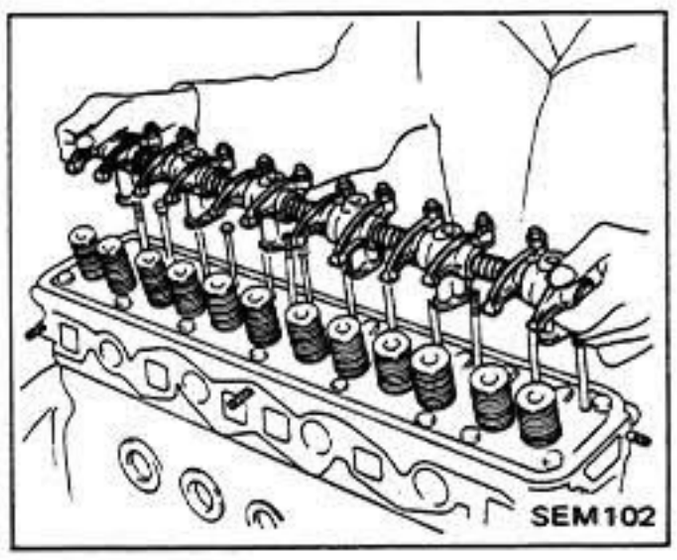
- Rear engine slinger
- Starter motor
- Engine mounting bracket R.H.

REMOVING BODY PARTS

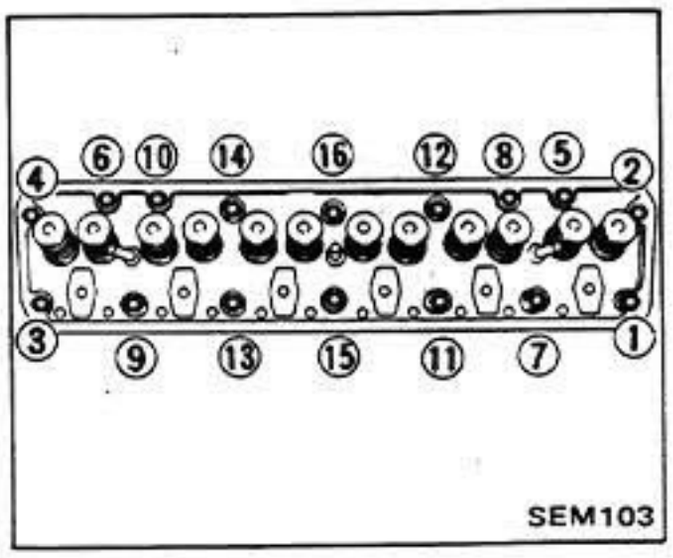
Remove following parts:
1. Valve rocker cover.
2. Valve rocker shaft assembly.
(1) Loosen valve rocker adjusting nuts and turn adjusting screws out to disengage push rods.



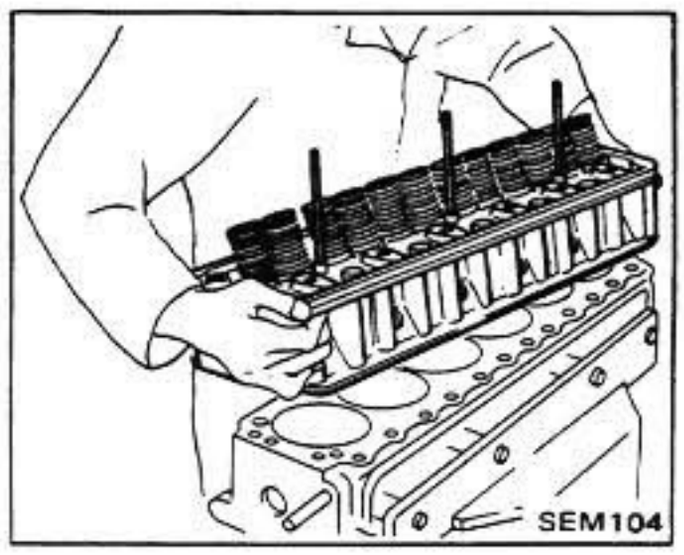
(2) Remove rocker shaft assembly.



(3) Withdraw push rods, and keep them in correct order.
3. Cylinder head assembly
(1) Loosen cylinder head bolts in the sequence as shown.

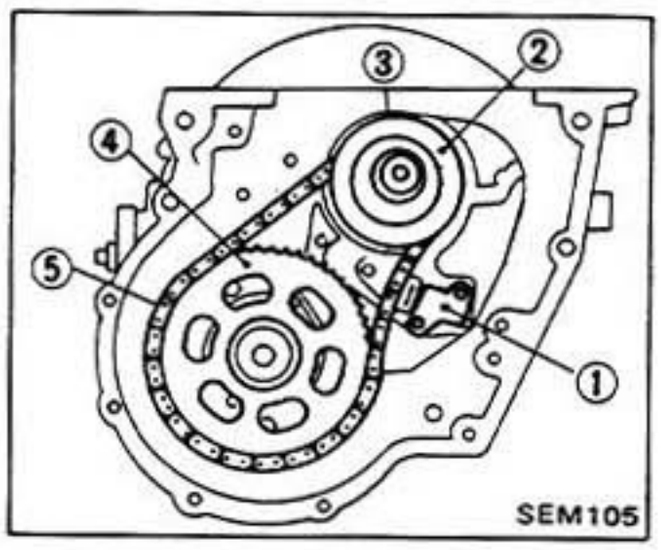


(2) Remove cylinder head.



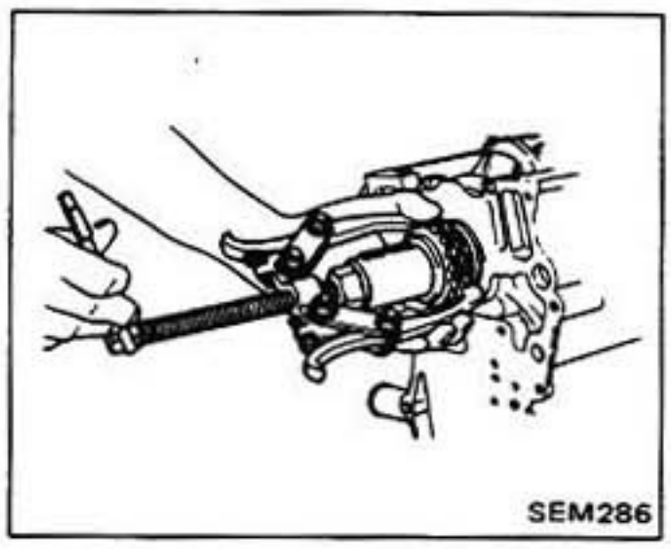
4. Oil pan and oil pump
5. Front side parts
- Front cover
- Chain tensioner, chain guide and oil thrower
- Camshaft sprocket, crankshaft sprocket and timing chain

To facilitate assembling operation, scribe a mark on timing chain and camshaft sprocket with paint before removal.



1 Chain tensioner
2 Oil thrower
3 Crankshaft sprocket
4 Camshaft sprocket
5 Timing chain

If it is hard to extract crankshaft sprocket, use a suitable puller.



- Front plate and gasket

6. Camshaft locating plate, camshaft and valve lifters, and keep then in correct order.
7. Piston and connecting rod assembly

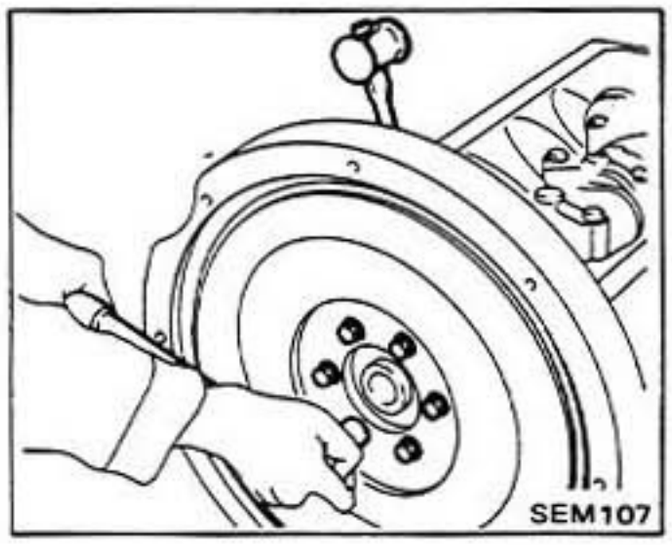
(1) Remove connecting rod bearing cap with bearing.

(2) Push out piston with connecting rod toward cylinder head side.

a. Piston can be easily removed by scraping carbon off top face of cylinder with a scraper.
b. Numbers are stamped on connecting rod and cap corresponding to each cylinder. Care should be taken to avoid wrong combination including bearing.

8. Flywheel and flywheel housing.
- Remove flywheel while crankshaft is locked, using hammer handle.

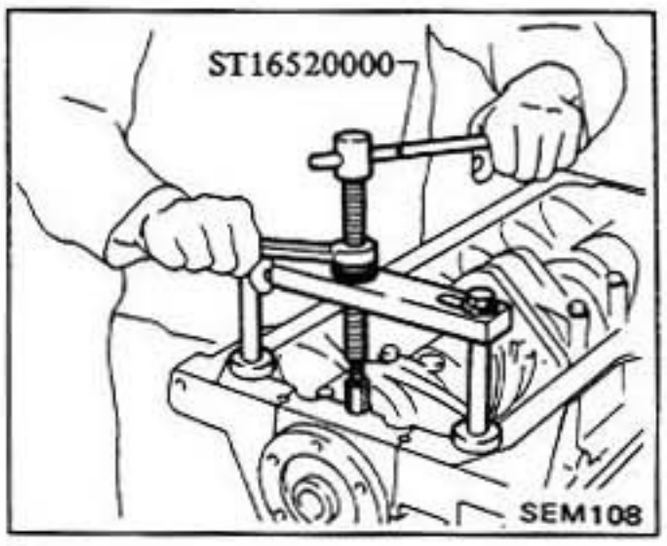
WARNING:
When removing flywheel, be careful not to drop it.



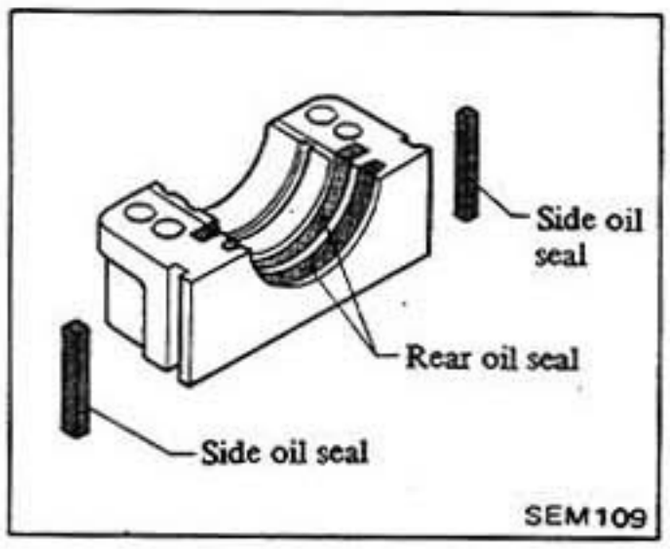
9. Crankshaft

(1) Remove main bearing cap with bearing.

a. When loosening main bearing cap bolt, loosen from outside in sequence.
Do not completely loosen bolts in one step. Instead use two or three steps for this procedure.
b. Remove rear main bearing cap using Tool.
c. Keep them in order.



(2) Remove rear and side oil seal.

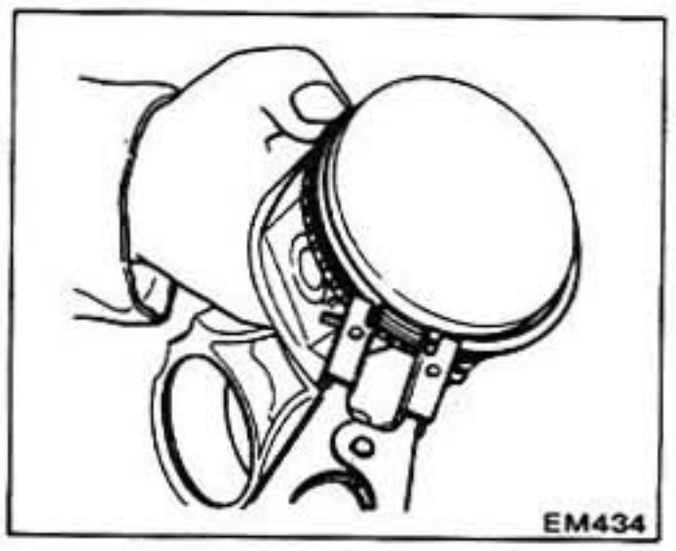


(3) Remove crankshaft.
(4) Remove main bearing and rear oil seal at block side.

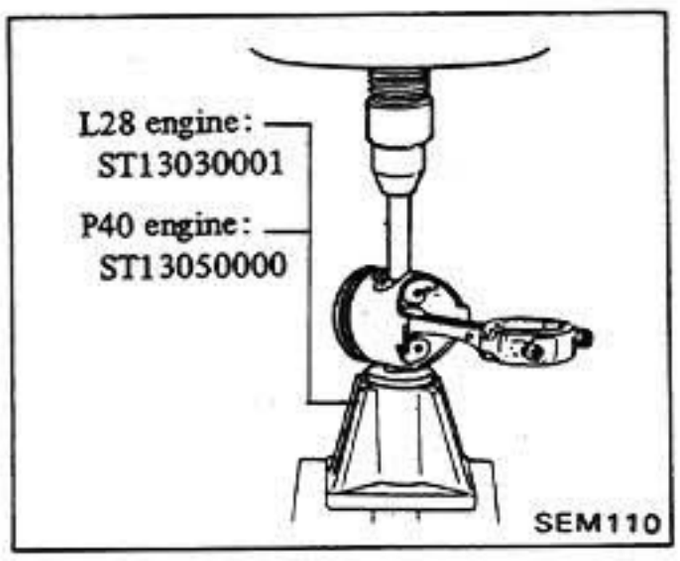
DISASSEMBLING PISTON AND CONNECTING ROD

1. Remove top & second piston rings with a ring remover and remove oil ring expander & rails by hand.

When removing piston rings, be careful not to scratch piston.



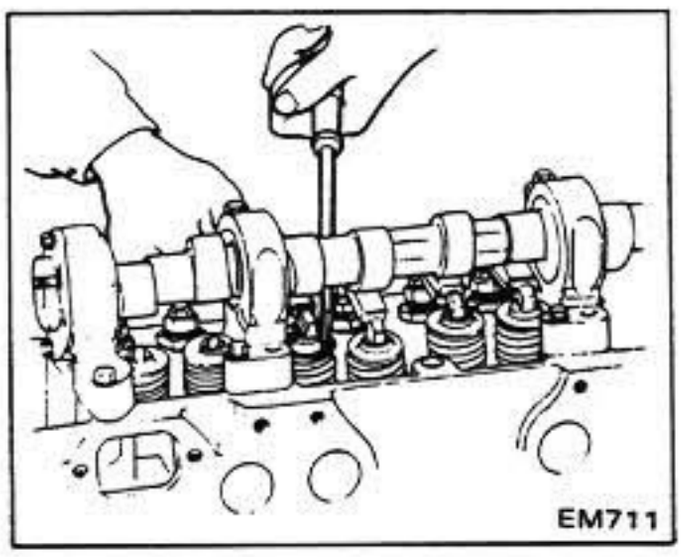
2. Press piston pin out, **using press and Tool.**



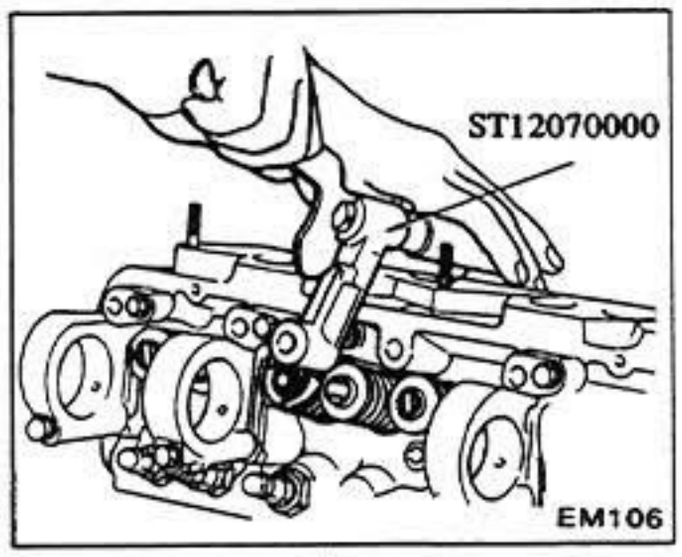
DISASSEMBLING CYLINDER HEAD

L28 ENGINE

1. Remove valve rocker spring.
2. Loosen valve rocker pivot lock nut and set cam nose to upper position, then remove rocker arm by pressing down on valve spring.



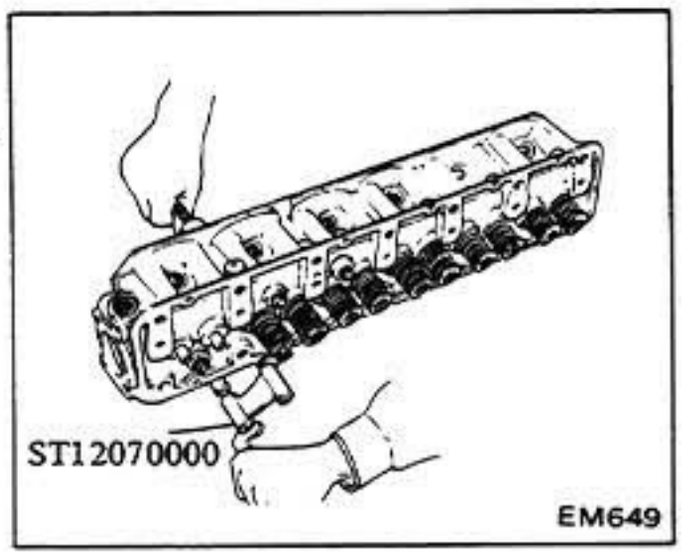
3. Remove camshaft.
4. Remove valves, valve springs and relating parts **using Tool.**



- **Keep the disassembled parts in order.**
- **Do not remove rocker pivot bushing from cylinder head.**

P40 ENGINE

Remove valves, valve springs and relating parts **using Tool.**



Keep the disassembled parts in order.

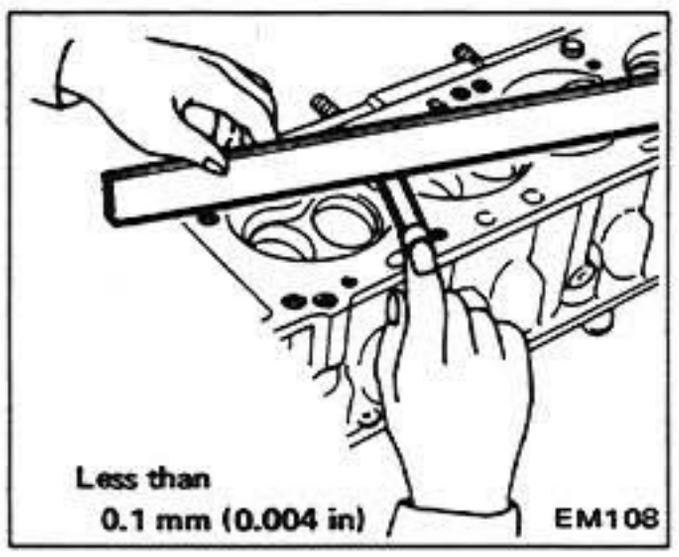
INSPECTION AND REPAIR

CYLINDER HEAD

CHECKING CYLINDER HEAD MATING FACE

1. Make a visual check for cracks and flaws.
2. Measure the surface of cylinder head (on cylinder block side) for warpage.

If beyond the specified limit, correct with a surface grinder.



Surface grinding limit:

The grinding limit of cylinder head is determined by the cylinder block grinding in an engine.

Depth of cylinder head grinding is "A"

Depth of cylinder block grinding is "B"

The limit is as follows:

A + B = 0.2 mm (0.008 in)

VALVE GUIDE

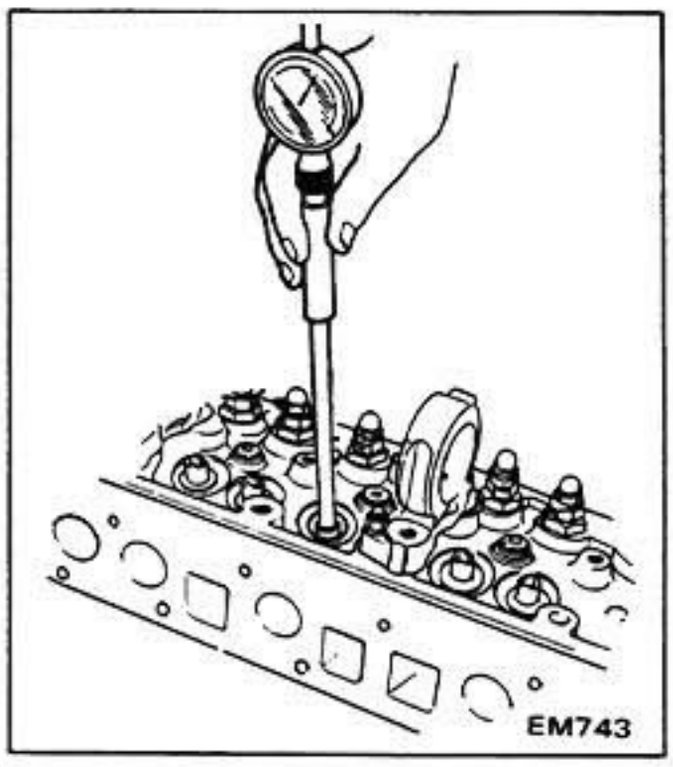
Measure the clearance between valve guide and valve stem. If the clearance exceeds the specified limit, replace the worn parts or both valve and valve guide. In this case, it is essential to determine if such a clearance has been caused by a worn or bent valve stem or by a worn valve guide.

Determining clearance

1. Precise method:

(1) Measure the diameter of valve stem with a micrometer in three places; top, center and bottom.

(2) Measure valve guide bore at center using telescope hole gauge.



(3) Subtract the highest reading of valve stem diameter from valve guide bore to obtain the stem to guide clearance.

Stem to guide clearance:

Maximum limit

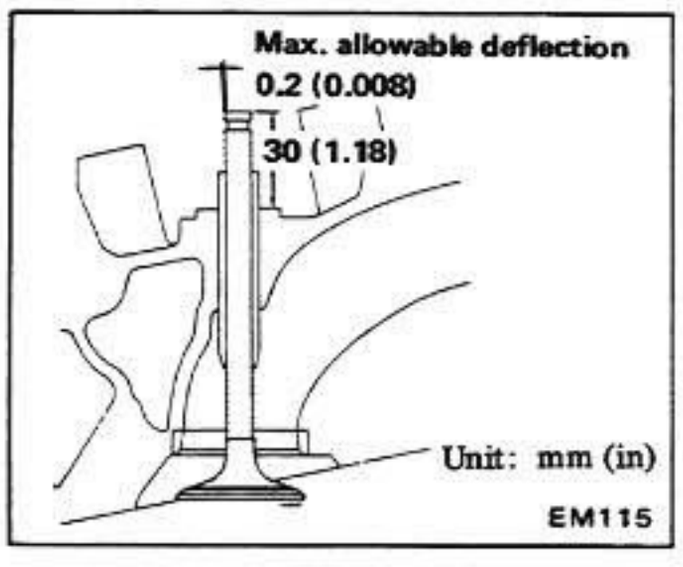
0.1 mm (0.004 in)

2. Expedient method

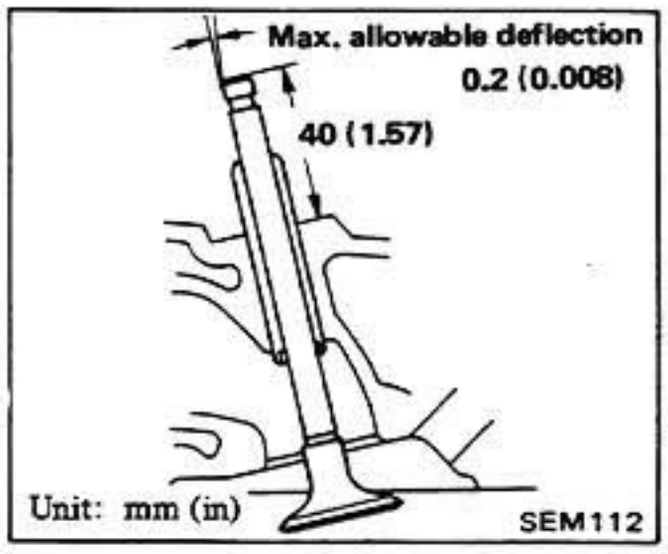
Pry the valve in lateral direction, and measure the deflection at stem tip with dial gauge.

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

L28 engine



P40 engine

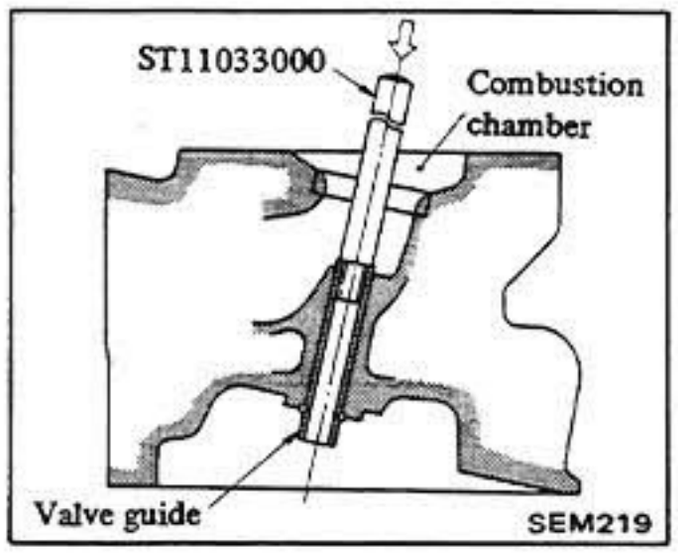


Replacement of valve guide

To remove old guides, **use a press [under a 20 kN (2t, 2.2 US ton, 2.0 Imp ton) pressure]or a hammer, and Tool.**

L28 engine

1. Drive them out toward rocker cover side **using Tool.** Heating the cylinder head will facilitate the operation.

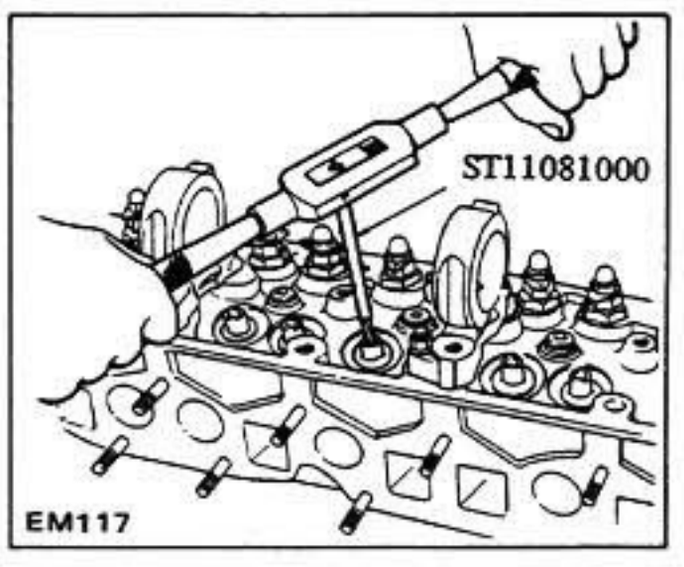


2. Ream cylinder head valve guide hole **using Tool at room temperature.**

Reaming bore:

12.185 - 12.196 mm

(0.4797 - 0.4802 in)



3. Fit snap ring on new valve guide. **Heat cylinder head to 150 to 200°C (302 to 392°F),** and press the guide onto cylinder haed until the snap ring comes in contact with cylinder head surface.

Valve guide with 0.2 mm (0.008 in) oversize diameter is available for service.

Refer to S.D.S.

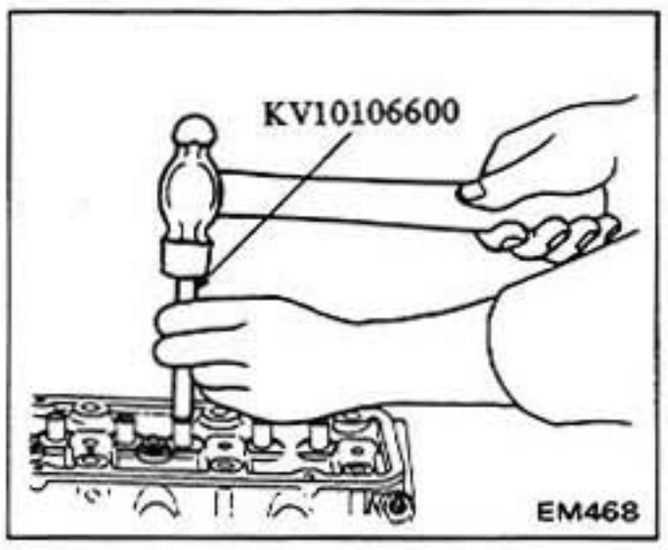
4. Ream the bore **using Tool ST11032000.**

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

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

P40 engine

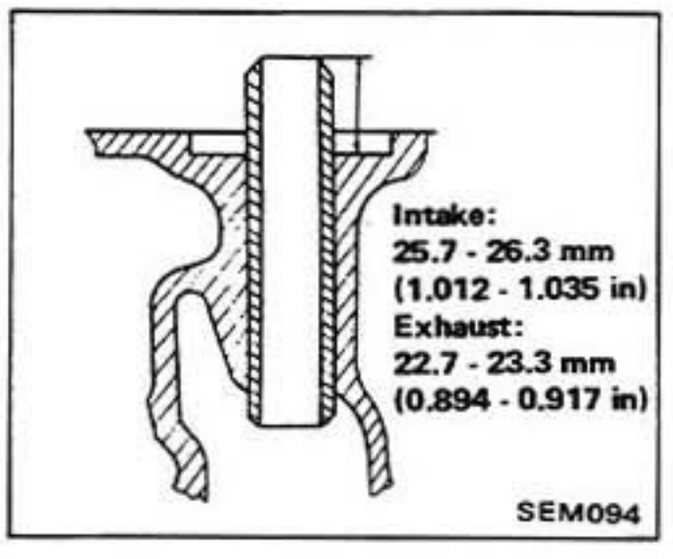
1. **Using Tool**, drive them out opposite to rocker cover. Heated cylinder head will facilitate the operation.



2. Make sure that interference between valve guide and guide hole is within the specified value.

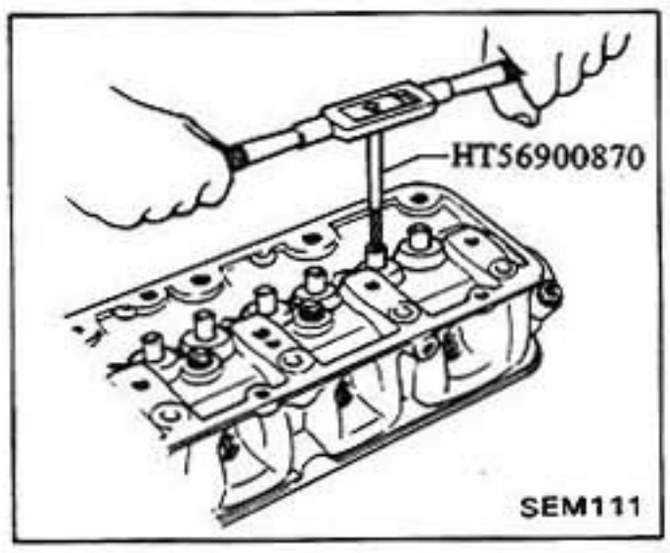
Interference between valve guide and guide hole:
0.013 - 0.045 mm
(0.0005 - 0.0018 in)

3. Insert and press new valve guide into cylinder head, **using Tool KV10106600, after heating cylinder head to 150 to 200°C (302 to 392°F).**



4. Ream bore using a suitable reamer.

Reaming bore:
8.685 - 8.700 mm
(0.3419 - 0.3425 in)



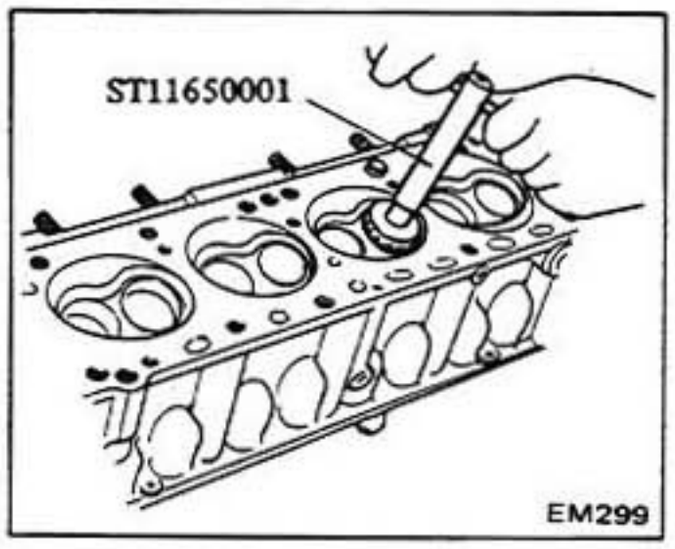
VALVE SEAT

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

Correct valve seat surface **using Tool** and grind with a grinding compound.

Valve seat insert of 0.5 mm (0.020 in) oversize is available for service (L28 engine).

Refer to S.D.S.



a. When repairing valve seat, check valve and valve guide for wear beforehand. If worn, replace them. Then correct valve seat.
b. The cutting should be done with both hands for uniform cutting.

Replacement of valve seat insert (L28 engine)

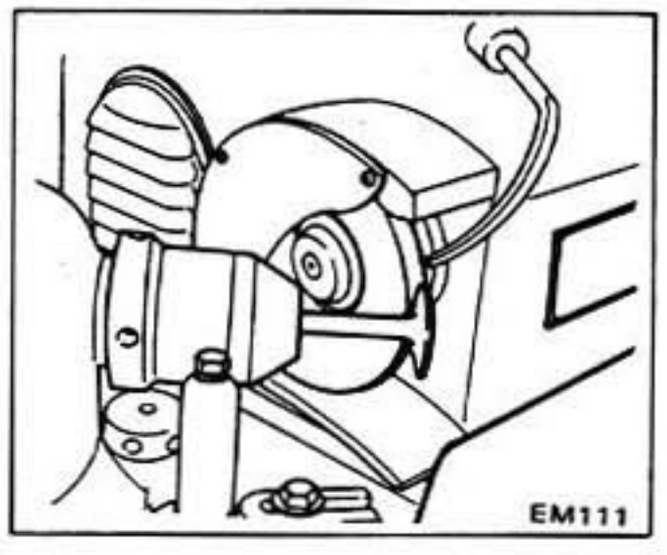
1. Old insert can be removed by boring out until it collapses. The machine stop depth should be set so that boring cannot continue beyond the bottom face of the insert recess in cylinder head.
2. Select a suitable valve seat insert and check its outside diameter.
3. Machine the cylinder head recess in the concentric circles which center on the valve guide.
4. Ream the cylinder head recess at room temperature. **Refer to S.D.S.**
5. Heat cylinder head to a temperature of 150 to 200°C (302 to 392°F).
6. Fit insert ensuring that it bends on the bottom face of its recess, and caulk more than 4 points.
7. Newly-fitted valve seats should be cut or ground **using Tool ST11650001 at the specified dimensions as shown in S.D.S.**
8. 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 then clean valve and valve seat.

VALVE

1. Check each of the intake and exhaust valves for worn, damaged or deformed valve head or stem. Correct or replace the valve that is faulty.
2. Valve face or valve stem end surface should be refaced by using a valve grinder.

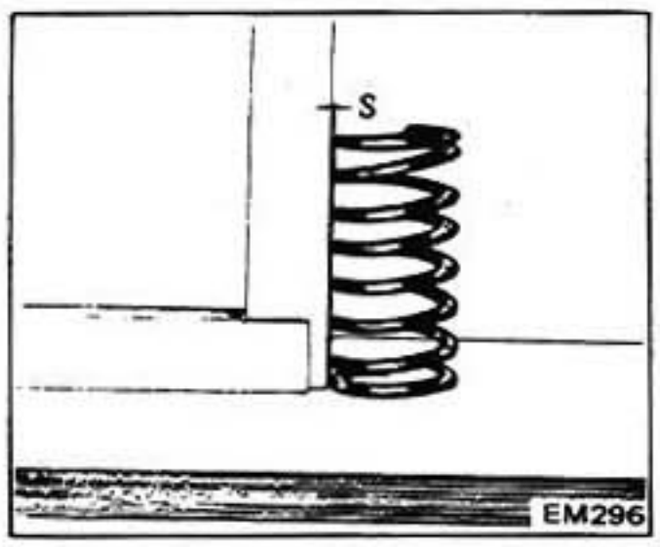
When valve head has been worn down to 0.5 mm (0.020 in) in thickness, replace the valve.

Grinding allowance for valve stem end surface is 0.5 mm (0.020 in) or less.



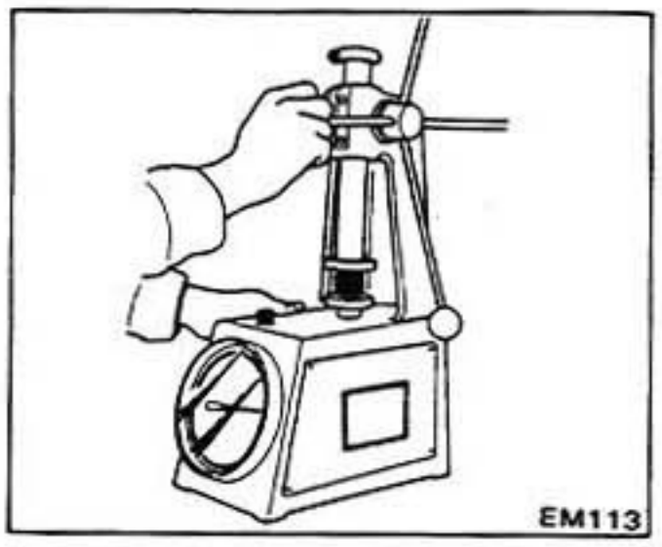
VALVE SPRING

1. Check valve spring for squareness using a steel square and surface plate. If spring is out of square "S" more than specified limit, replace with new ones. **Refer to S.D.S.**



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

Refer to S.D.S.



ROCKER ARM AND VALVE ROCKER PIVOT OF L28 ENGINE

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

ROCKER ARM AND ROCKER SHAFT OF P40 ENGINE

1. Check rocker arms and shaft for sign of wear or damage, and if worn excessively, replace the rocker arm or shaft.
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 bushing in rocker arm **using Tool ST1130S000. Refer to S.D.S.**

VALVE LIFTER AND PUSH ROD OF P40 ENGINE

1. Check valve lifter for sign of wear or damage, and if worn excessively, replace it.
2. Check clearance between valve lifter guide on cylinder block and valve lifter. If the clearance exceeds the specified limit, replace valve lifter.

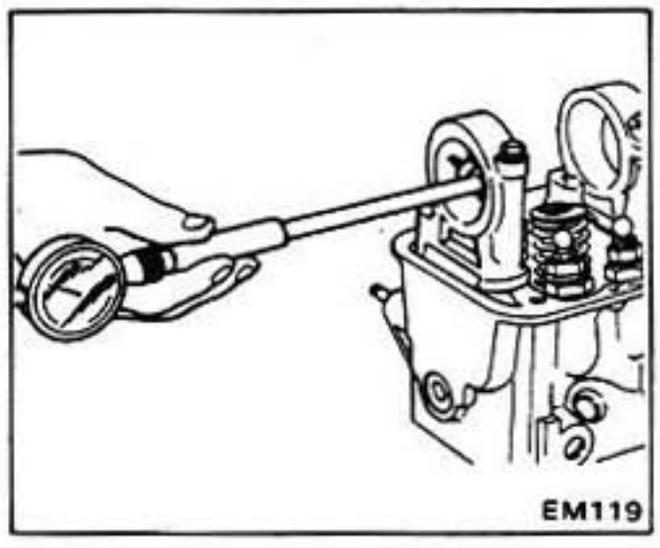
Clearance between valve lifter guide and valve lifter:
Limit 0.15 mm (0.0059 in)

CAMSHAFT AND CAMSHAFT BEARING

CAMSHAFT BEARING CLEARANCE OF L28 ENGINE

Measure the inside diameter of camshaft bearing with an inside dial gauge and the outside diameter of camshaft journal with a micrometer. If any malfunction is found, replace camshaft or cylinder head assembly.

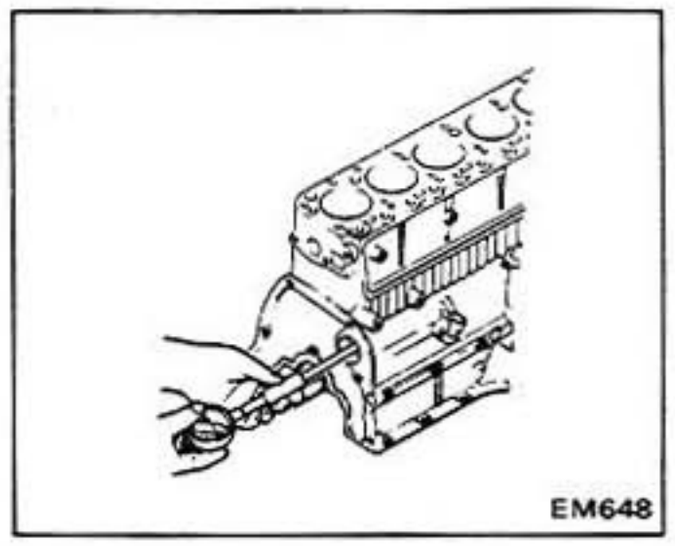
Max. tolerance of camshaft bearing clearance:
0.1 mm (0.004 in)



Do not remove camshaft brackets. If camshaft bracket were removed, install them by checking for a smooth rotation with the camshaft.

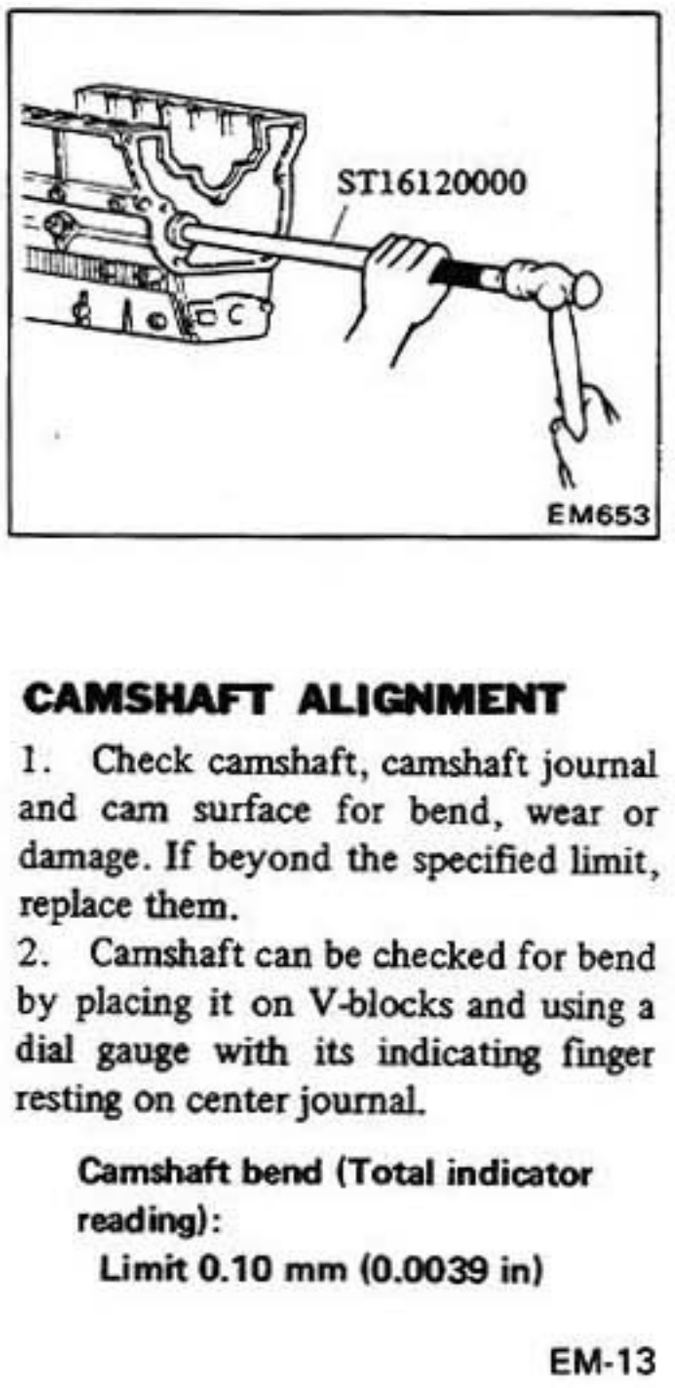
CAMSHAFT BEARING CLEARANCE OF P40 ENGINE

Check the inside diameter of camshaft bearing with an inside dial gauge and the outside diameter of camshaft journal with a micrometer.



Measurements should then be compared to determine whether bearings are worn. If the wear exceeds the specified limit, replace camshaft bearing **using Tool.**

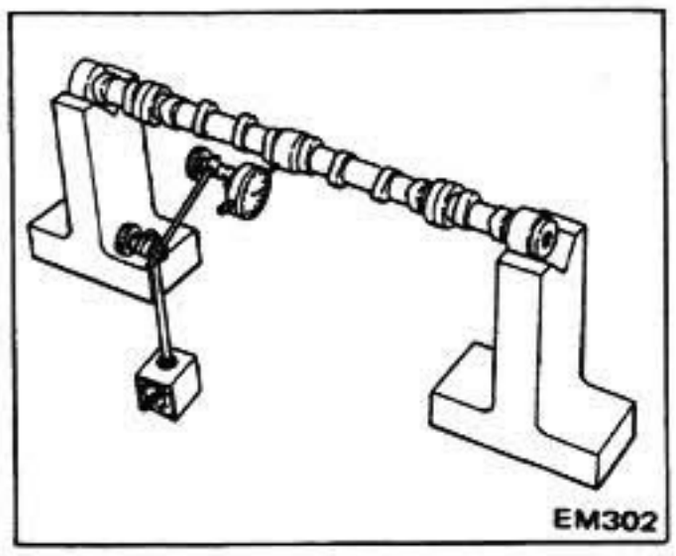
Max. tolerance of camshaft bearing clearance:
0.1 mm (0.004 in)



CAMSHAFT ALIGNMENT

1. Check camshaft, camshaft journal and cam surface for bend, wear or damage. If beyond the specified limit, replace them.
2. Camshaft can be checked for bend by placing it on V-blocks and using a dial gauge with its indicating finger resting on center journal.

Camshaft bend (Total indicator reading):
Limit 0.10 mm (0.0039 in)



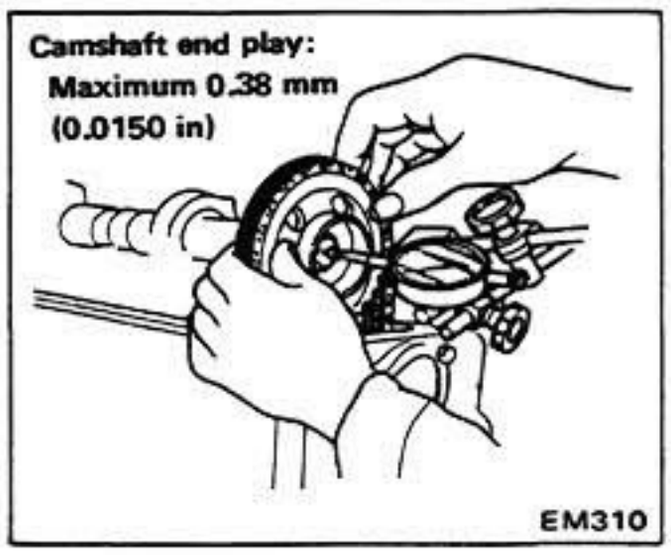
3. Measure camshaft cam height. If beyond the specified limit, replace camshaft.

Wear limit of cam height:
0.15 mm (0.0059 in)

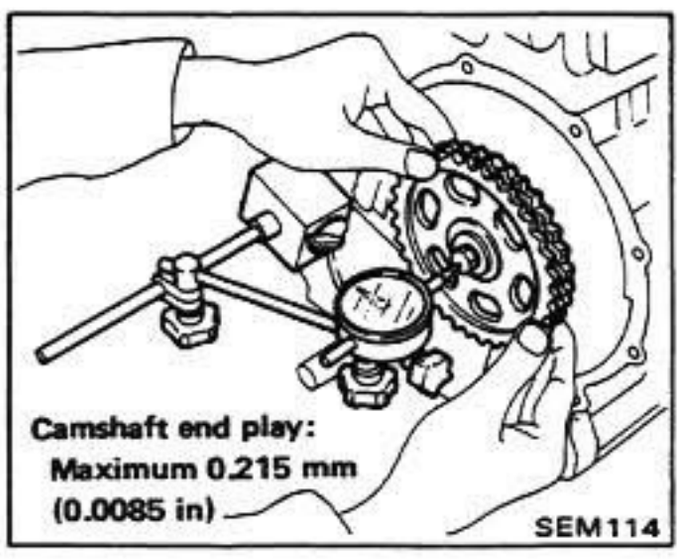
4. Measure camshaft end play. If beyond the specified limit, replace thrust/locating plate.

Camshaft end play:
L28 engine
Limit 0.38 mm (0.0150 in)
P40 engine
Limit 0.215 mm (0.0085 in)

L28 engine

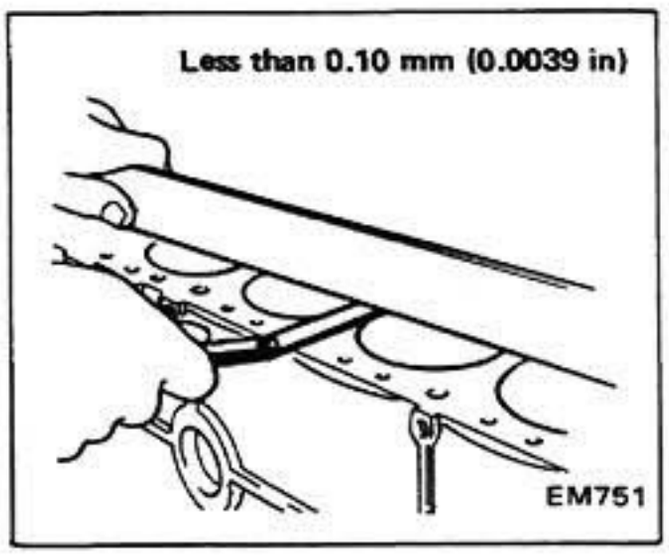


P40 engine



CYLINDER BLOCK

1. Visually check cylinder block for cracks or flaws.
2. Measure the top of cylinder block (cylinder head mating face) for warpage. If warpage exceeds the specified limit, correct with a grinder.

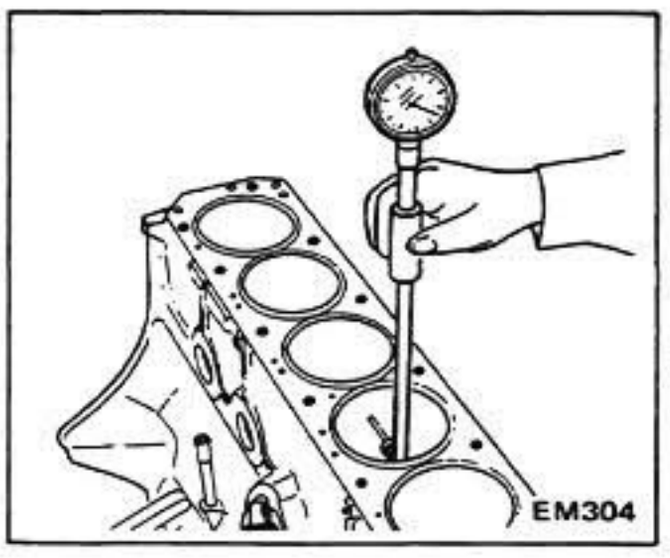


Surface grinding limit;
The grinding limit of cylinder block is determined by the cylinder head grinding in an engine.
Depth of cylinder head grinding is "A"
Depth of cylinder block grinding is "B"
The limit is as follows:
A + B = 0.2 mm (0.008 in)

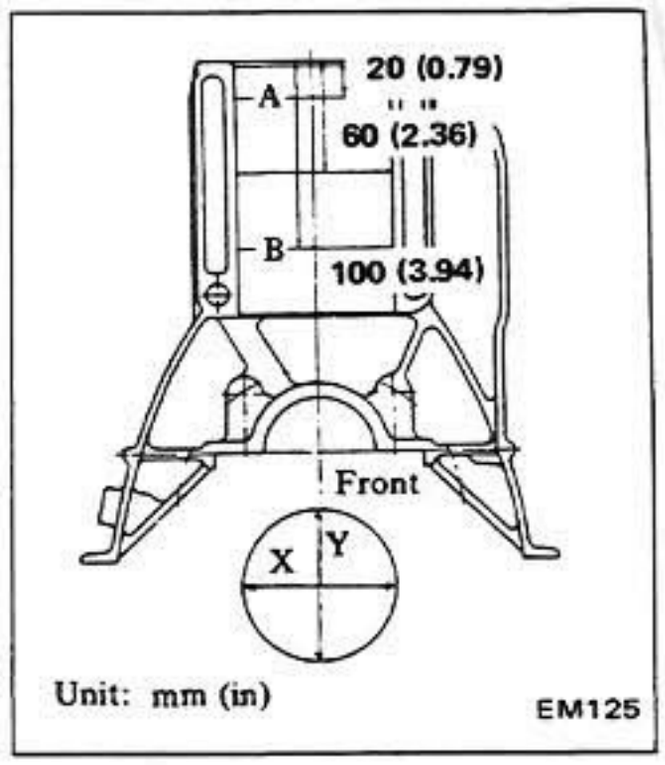
3. Using a bore gauge, measure cylinder bore for wear, out-of-round or taper. If they are excessive, rebore the cylinder walls with a boring machine. Measurement should be taken along bores for taper and around bores for out-of-round.

Refer to S.D.S.

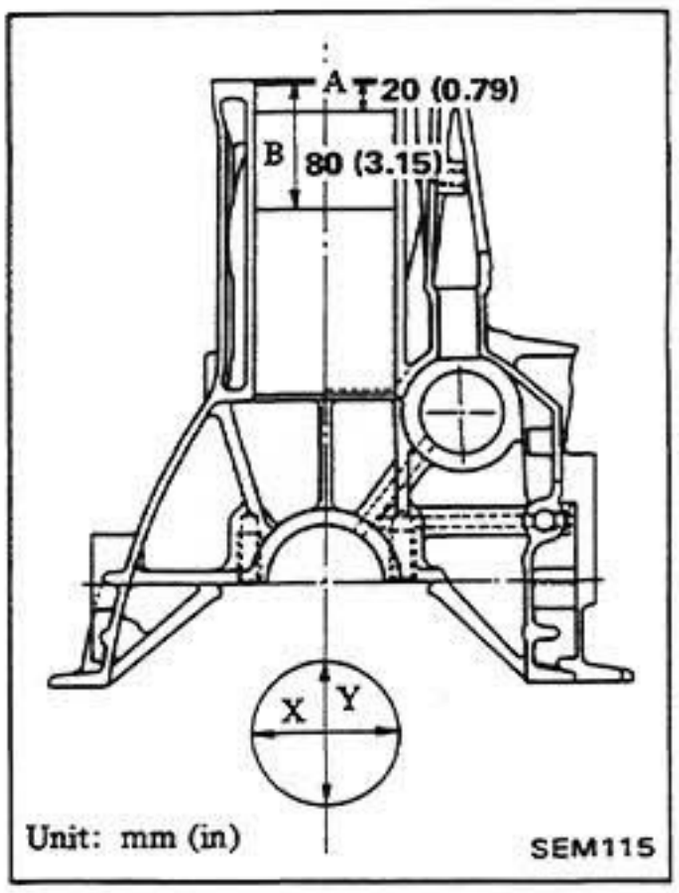
Out-of-round . . . . . X-Y
Taper . . . . . A-B



L28 engine



P40 engine



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

As for L28 engine, if cylinder bore has worn beyond the wear limit, use cylinder liner.

Undersize cylinder liners are available for service. Refer to S. D. S.

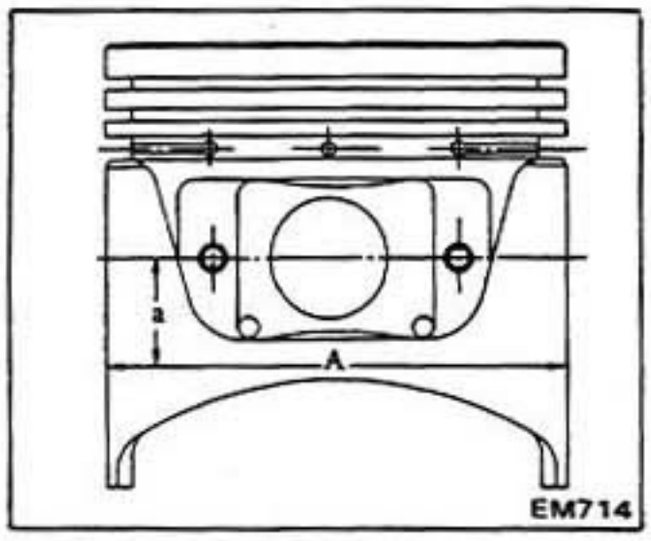
Interference fit of cylinder liner in cylinder block should be 0.075 to 0.085 mm (0.0030 to 0.0033 in).

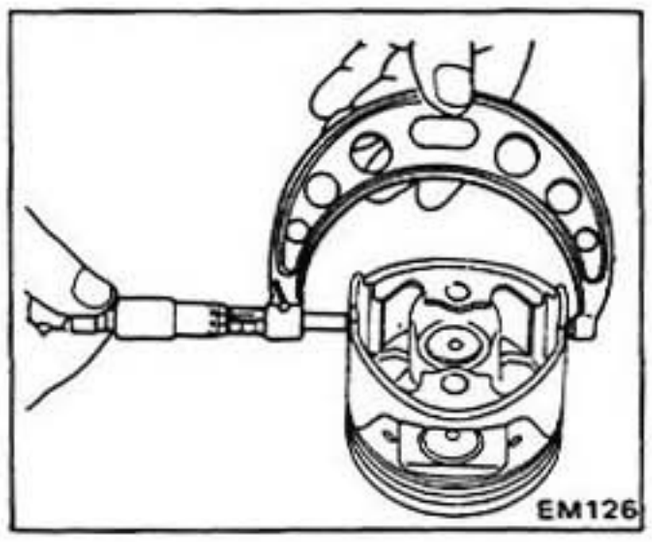
CYLINDER BORING

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

Determining bore size

1. Determine piston oversize according to amount of cylinder wear.
   Refer to S.D.S.
2. The size to which cylinders must be honed is determined by adding piston-to-cylinder clearance to the piston skirt diameter "A".





Dimension "a"
(distance from center of pin):
L28 engine
Approximately
20 mm (0.79 in)
P40 engine
Approximately
40 mm (1.57 in)
Rebored size calculation
L28 engine
D = A + B – C = A + [0.005 to 0.025 mm (0.0002 to 0.0010 in)]
P40 engine
D = A + B – C = A + [0.003 to 0.023 mm (0.0001 to 0.0009 in)]
Where,
D : Honed diameter
A : Skirt diameter as measured
B : Piston-to-wall clearance
C : Machining allowance
0.02 mm (0.0008 in)

Boring

1. Install main bearing caps in place, and tighten to the specified torque to prevent distortion of the cylinder bores in final assembly.
2. Cut cylinder bores.

- **Do not cut too much out of the cylinder bore at a time. Cut only 0.05 mm (0.0020 in) or so in diameter at a time.**
- **Bore the cylinders in the order of 1-5-3-6-2-4 to prevent heat strain due to cutting.**

3. Hone the cylinders to the required size **referring to S.D.S.**

- **Use clean sharp stones of proper grade.**
- **Cross-hatch pattern should be approximately 45°.**

4. Measure the finished cylinder bore for out-of-round and taper.

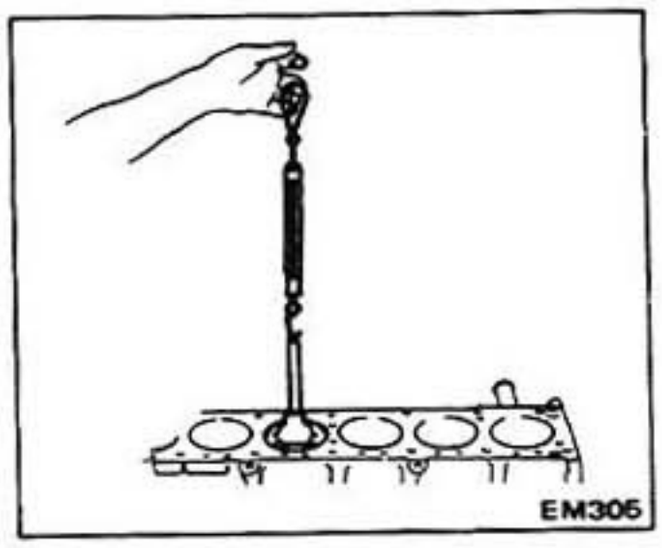
Measurement of a just machined cylinder bore requires utmost care since it is expanded by cutting heat.

Measuring piston-to-cylinder clearance

Measure the extracting force, and pull feeler gauge straight upward.

Feeler gauge thickness:
L28 engine
0.04 mm (0.0016 in)
P40 engine
0.063 mm (0.0025 in)
Extracting force:
L28 engine
2.0 - 14.7 N
(0.2 - 1.5 kg, 0.4 - 3.3 lb)
P40 engine
10 - 29 N
(1 - 3 kg, 2 - 7 lb)

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

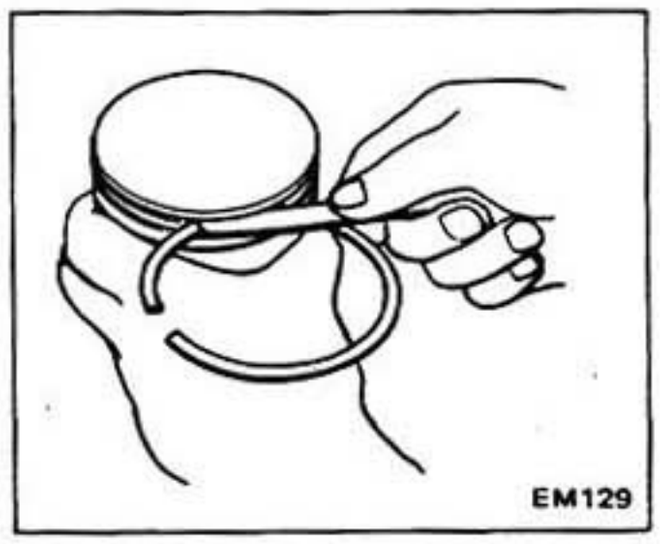


PISTON, PISTON PIN AND PISTON RING

PISTON

1. Scrape carbon off piston and ring grooves with a carbon scraper and a curved steel wire. Clean out oil slots in bottom land of oil ring groove.
2. Check for damage, scratches and wear. Replace if such a fault is detected.
3. Measure the side clearance of rings in ring grooves as each ring is installed.

Max. tolerance of side clearance:
0.1 mm (0.004 in)



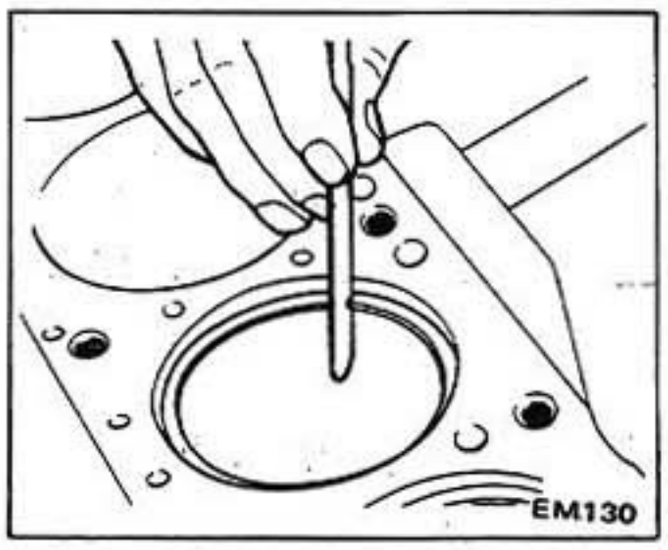
If side clearance exceeds the specified limit, replace piston together with piston ring.

PISTON RING

Measure ring gap with a feeler gauge, placing ring squarely in cylinder using piston.

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

Max. tolerance of ring gap:
1.0 mm (0.039 in)


EM130

a. **When piston ring only is to be replaced, without cylinder bore being corrected, measure the gap at the bottom of cylinder where the wear is minor.**
b. **Oversize piston rings are available for service.**

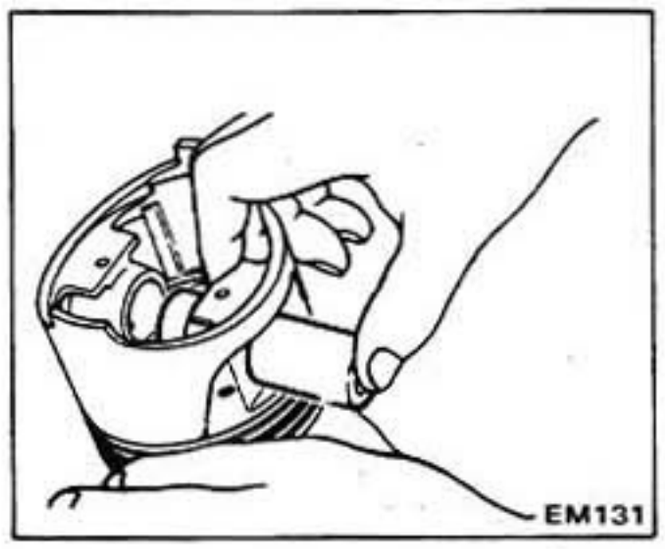
L28 engine:
0.5 mm (0.020 in), 1.0 mm (0.039 in) oversize.
P40 engine:
0.5 mm (0.020 in), 1.0 mm (0.039 in), 1.5 mm (0.059 in) oversize.

PISTON PIN

1. Check piston pin and piston pin hole for signs of sticking and other abnormalities.
2. Measure piston pin hole in relation to the outer diameter of pin. If wear exceeds the limit, replace such piston pin together with piston on which it is installed.

Piston pin to piston clearance:
L28 engine
0.006 - 0.013 mm (0.0002 - 0.0005 in)
P40 engine
0.004 - 0.006 mm (0.00016 - 0.00024 in)

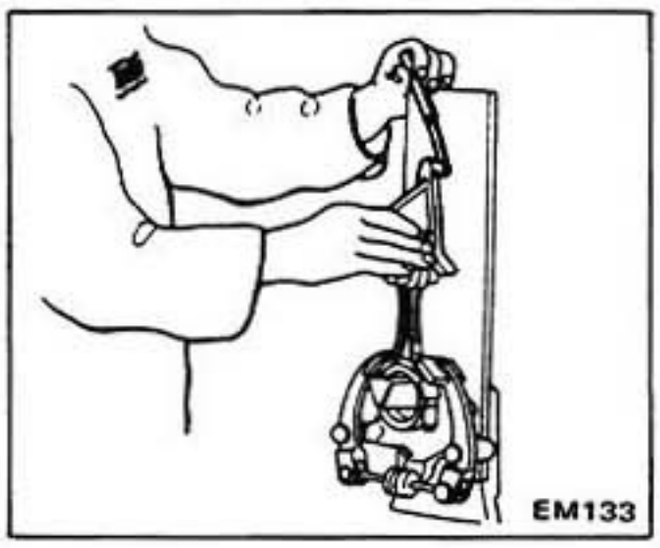
Determine the fitting of piston pin into piston pin hole to such an extent that it can be pressed smoothly by finger at room temperature.


EM131

CONNECTING ROD

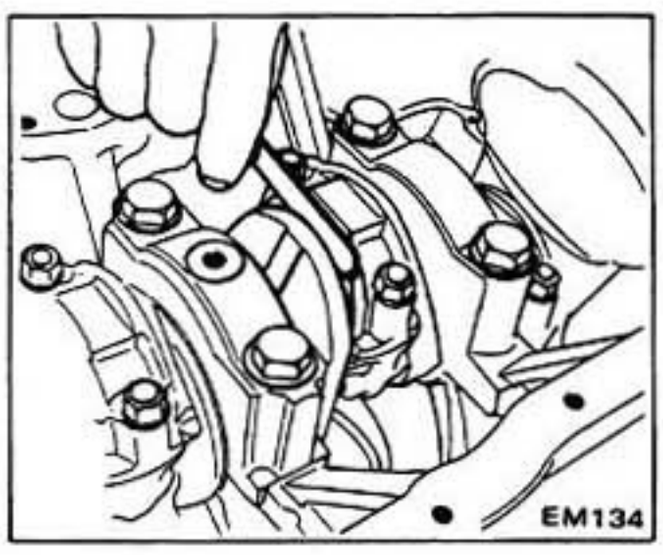
1. If a connecting rod has any flaw on both sides of the thrust face and the large end, correct or replace it.
2. Check connecting rod for bend or torsion using a connecting rod aligner. If bend or torsion exceeds the limit, correct or replace.

Bend and torsion
[per 100 mm (3.94 in) length]:
Less than
0.05 mm (0.0020 in)


EM133

3. Install connecting rods with bearings on to corresponding crank pins and measure the thrust clearance. If the measured value exceeds the limit, replace such connecting rod.

Max. tolerance of big end play:
0.6 mm (0.024 in)


EM134

When replacing connecting rod, select so that weight difference between each cylinder is within the specified limit in the condition of piston and connecting rod assembly.

Connecting rod weight difference:
L28 engine
Limit 7 g (0.25 oz)
P40 engine
Limit 5 g (0.18 oz)

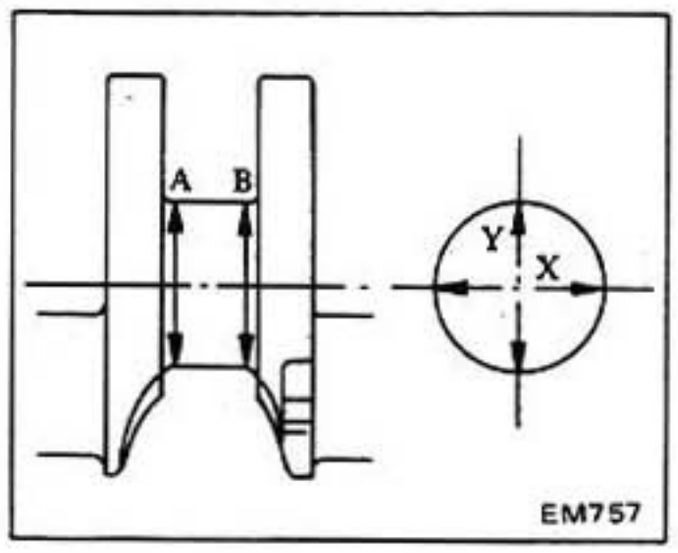
CRANKSHAFT

CRANK JOURNAL AND PIN

1. Repair or replace as required. If faults are minor, correct with fine crocus cloth.
2. Check journals and crank pins with a micrometer for taper and out-of-round. Measurement should be taken along journals for taper and around journals for out-of-round.

If out-of-round or taper exceeds the specified limit, replace or repair.

Out-of-round (X-Y):
Less than 0.03 mm (0.0012 in)
Taper (A-B):
Less than 0.03 mm (0.0012 in)



EM757

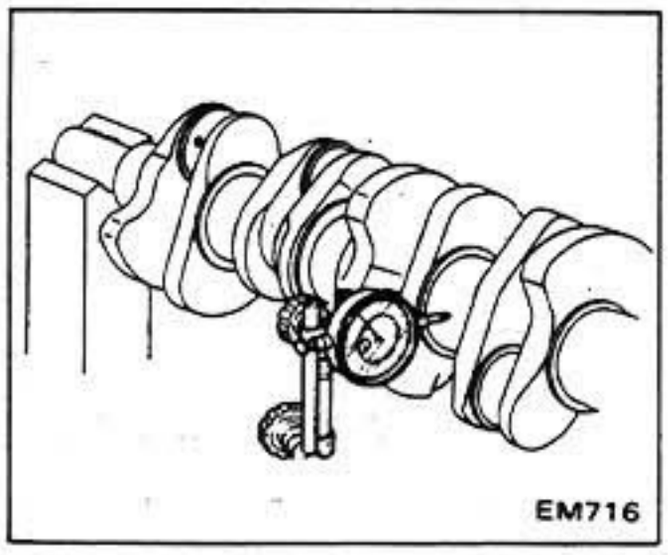
3. After regrinding crankshaft, finish it to the necessary size indicated in the chart under S. D. S. by using an adequate undersize bearing according to the extent of required repair.

BEND AND END PLAY

1. 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.

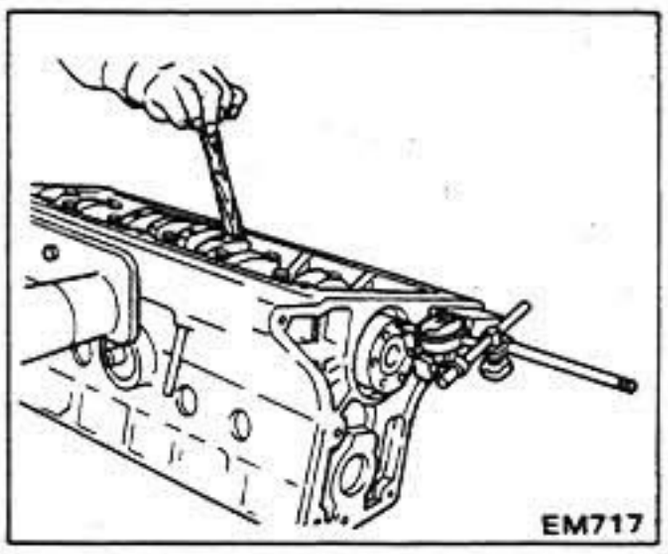
If bend exceeds the specified limit, replace or repair.

Bend:
Less than
0.10 mm (0.0039 in)



2. Install crankshaft in cylinder block and measure crankshaft free end play at the center bearing.

Max. tolerance of end play:
0.30 mm (0.0118 in)

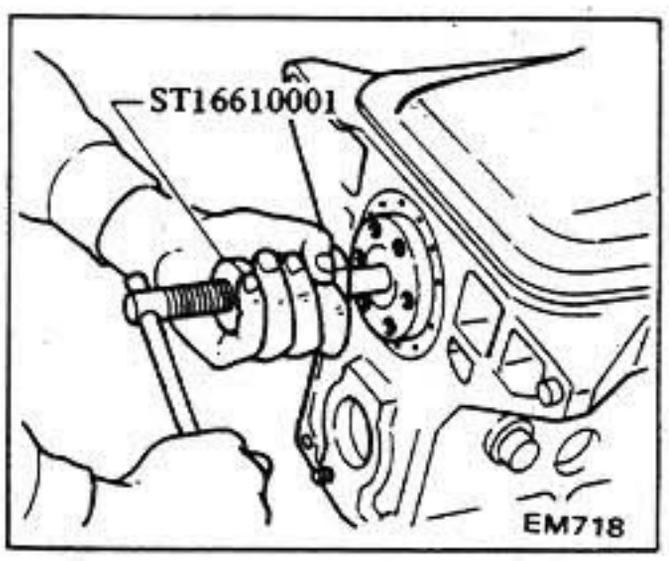


REPLACING PILOT BUSHING

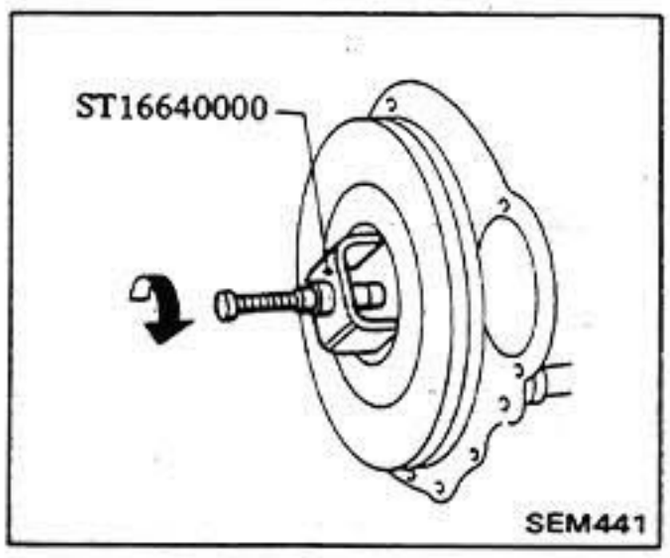
To replace crankshaft rear pilot bushing, proceed as follows:

1. Pull out bushing **using Tool.**

L28 engine



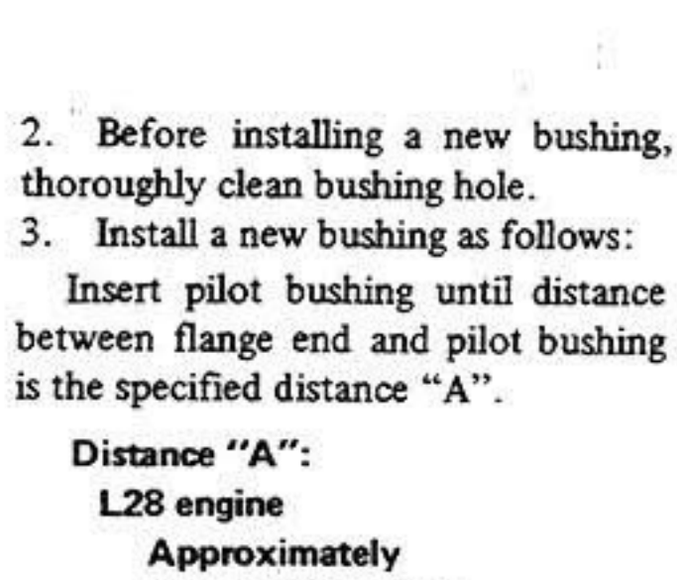
P40 engine



2. Before installing a new bushing, thoroughly clean bushing hole.
3. Install a new bushing as follows:

Insert pilot bushing until distance between flange end and pilot bushing is the specified distance "A".

Distance "A":
L28 engine
Approximately
4.0 mm (0.157 in)
P40 engine
Approximately
0.6 mm (0.024 in)



When installing pilot bushing, be careful not to damage edge of pilot bushing and not to insert excessively.

MAIN BEARING AND CONNECTING ROD BEARING

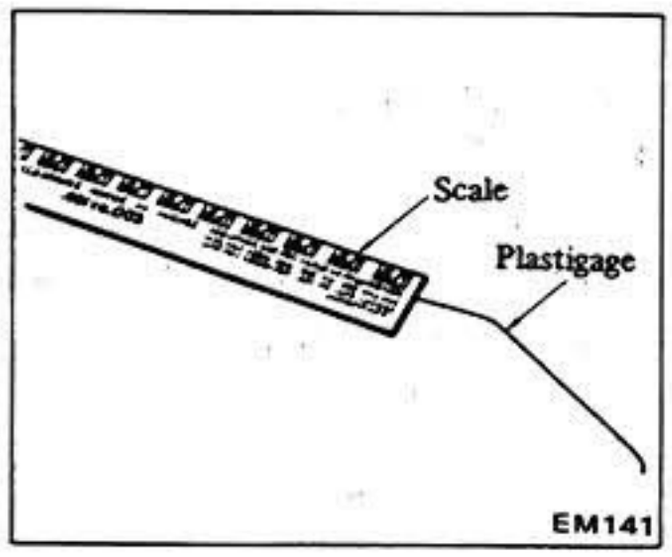
MAIN BEARING

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

Replace bearings, if any fault is detected.

2. Measure bearing clearance as follows:

(1) Cut a plastigage to the width of bearing and place it in parallel with crank journal, getting clear of the oil hole.



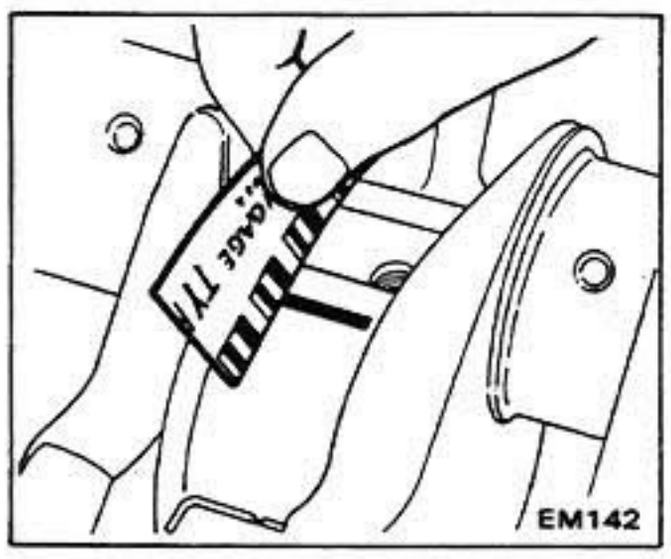
(2) Install crankshaft, bearings and bearing cap, with the bolts tightened to the specified torque.

Ⓣ : Main bearing cap
L28 engine
44 - 54 N·m
(4.5 - 5.5 kg-m,
33 - 40 ft-lb)
P40 engine
98 - 118 N·m
(10.0 - 12.0 kg-m,
72 - 87 ft-lb)

Do not turn crankshaft while the plastigage is being inserted.

(3) Remove cap, and compare width of the plastigage at its widest part with the scale printed in the plastigage envelope.

Max. tolerance of main bearing clearance:
0.12 mm (0.0047 in)



3. If clerance exceeds the specified value, replace bearing with an undersize bearing and grind crankshaft journal adequately.
Refer to S.D.S.

CONNECTING ROD BEARING

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

Ⓣ: **Connecting rod bearing cap**
L28 engine
44 - 54 N-m
(4.5 - 5.5 kg-m,
33 - 40 ft-lb)
P40 engine
44 - 59 N-m
(4.5 - 6.0 kg-m,
33 - 43 ft-lb)

Max. tolerance of connecting rod bearing clearance:
0.12 mm (0.0047 in)

2. If clearance exceeds the specified value, replace bearing with an undersize bearing and grind the crankshaft journal adequately. **Refer to S.D.S.**

MISCELLANEOUS COMPONENTS

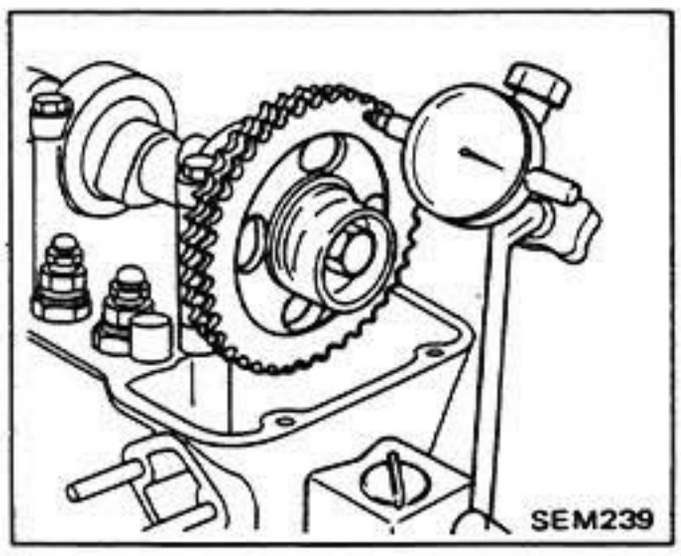
CAMSHAFT SPROCKET

1. Check tooth surface for flaws or wear. Replace sprocket if any fault is found.
2. Install camshaft sprocket in position and check for runout.

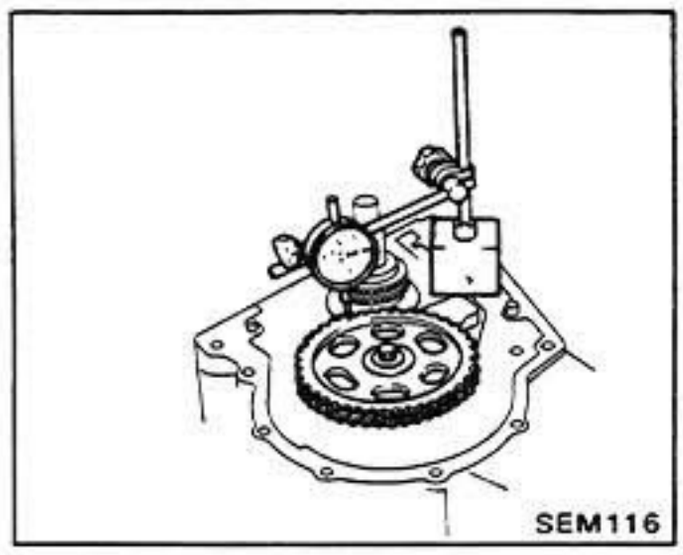
If runout exceeds the specified limit, replace camshaft sprocket.

Runout (Total indicator reading):
L28 engine
Less than 0.1 mm (0.004 in)
P40 engine
Less than 0.08 mm (0.0031 in)

L28 engine



P40 engine



CHAIN

Check chain for damage and excessive wear at roller links. Replace if faulty.

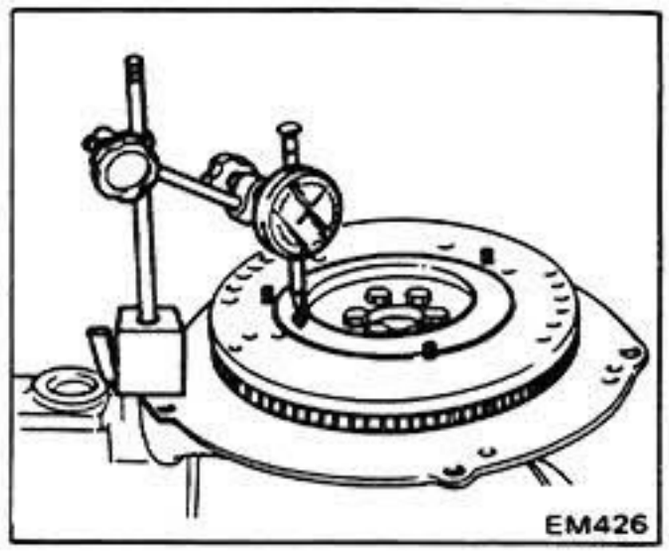
CHAIN TENSIONER AND CHAIN GUIDE

Check for wear and breakage. Replace if necessary.

FLYWHEEL (M/T models)

1. Check the clutch disc contact surface on flywheel for damage or wear. Repair or replace if necessary.
2. Measure runout of the clutch disc contact surface with a dial gauge. If it exceeds the specified limit, replace it.

Runout (Total indicator reading):
L28 engine
Less than 0.15 mm (0.0059 in)
P40 engine
Less than 0.10 mm (0.0039 in)



3. Check tooth surfaces of ring gear for flaws or wear.

Replace if necessary.

Install ring gear on fly wheel, heating ring gear to about 180 to 220°C (356 to 428°F)

DRIVE PLATE (A/T models)

1. Check drive plate for cracks or distorsion.
2. Check tooth surfaces of ring gear for flaws or wear.

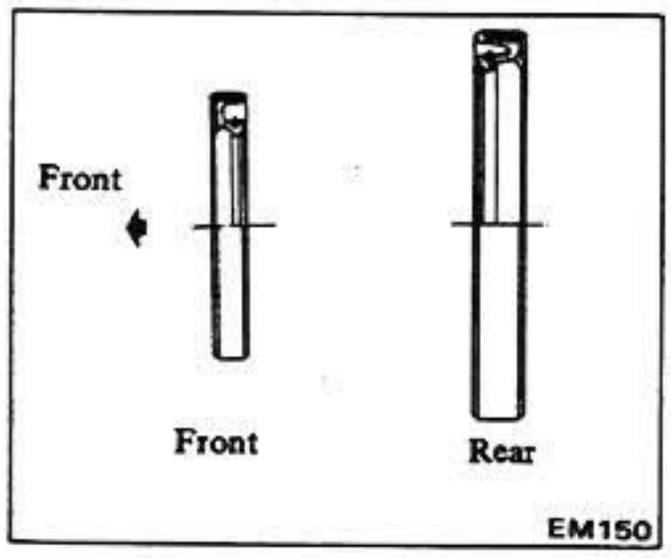
Replace drive plate assembly if necessary.

FRONT AND REAR OIL SEALS

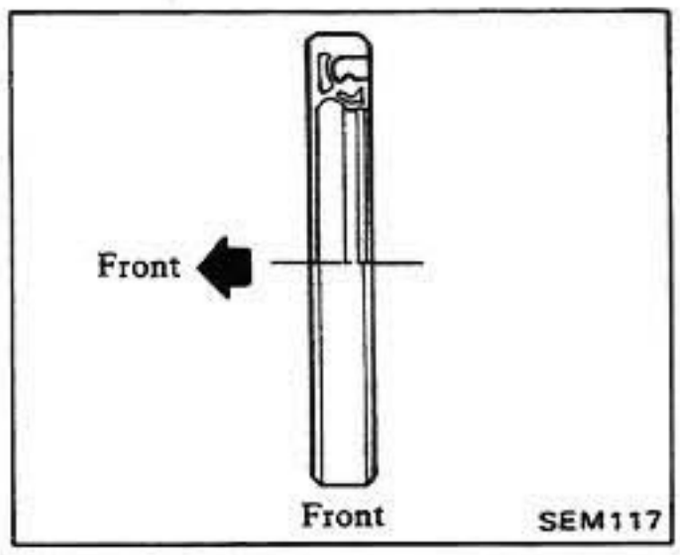
Check front and rear oil seals for worn or folded over sealing lip and oil leakage. If necessary, replace with a new seal. When installing a new seal, pay attention to its mounting direction.

It is good practice to renew oil seal whenever engine is overhauled.

L28 engine



P40 engine



ENGINE ASSEMBLY

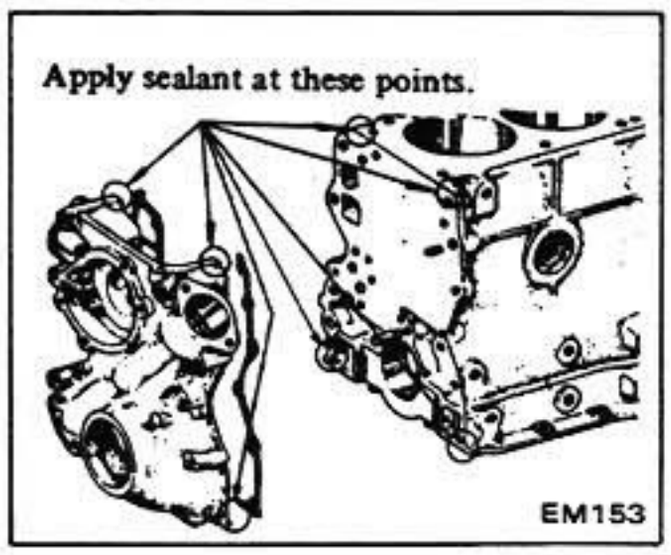
PRECAUTIONS

1. When installing sliding parts such as bearings, be sure to apply engine oil on the sliding surfaces.
2. Use new packings and oil seals.
3. Be sure to follow the specified order and tightening torque.
4. Applying sealant

Use sealant to eliminate water and oil leaks. **Do not apply too much sealant.** Parts requiring sealant are as follows.

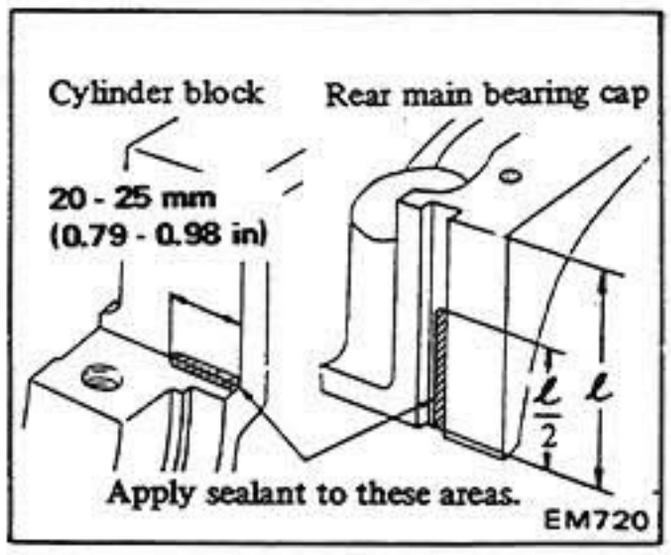
L28 engine

(1) Front cover gasket.
(2) Front cover.



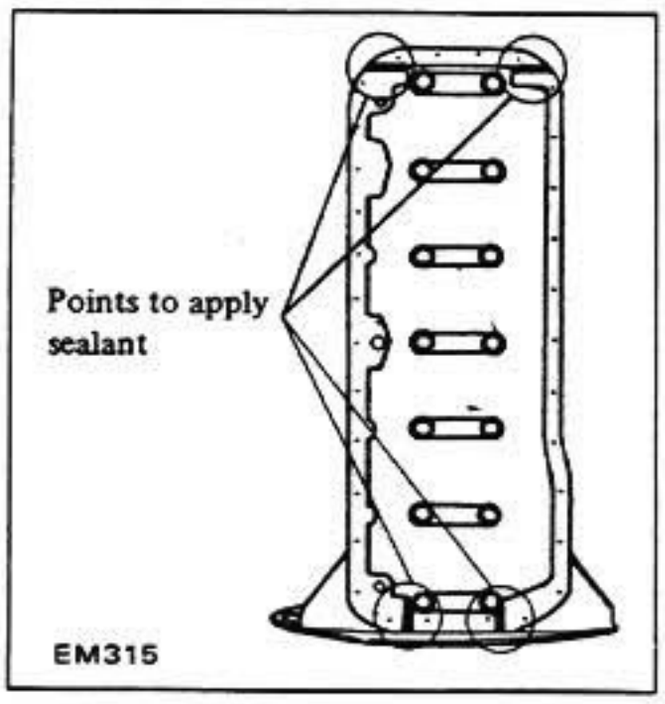
(3) Main bearing cap and cylinder block:

Each side of rear main bearing cap and each corner of cylinder block.



(4) Cylinder block:

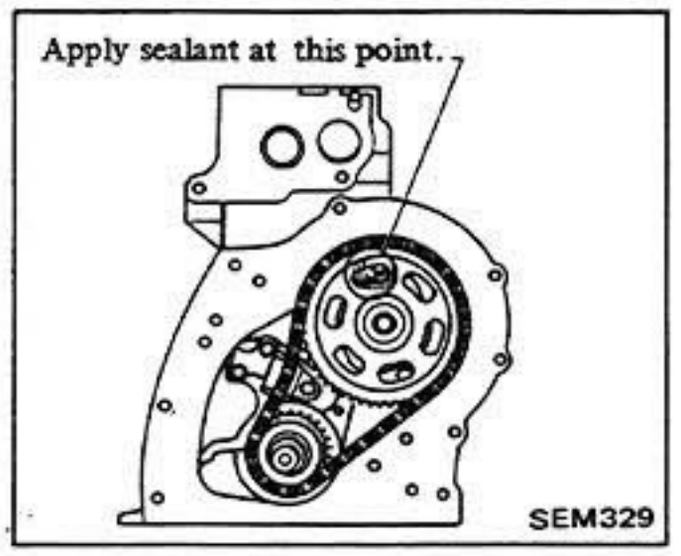
Step portions on the bottom and at four mating surfaces (cylinder block to front cover and cylinder block to rear main bearing cap).



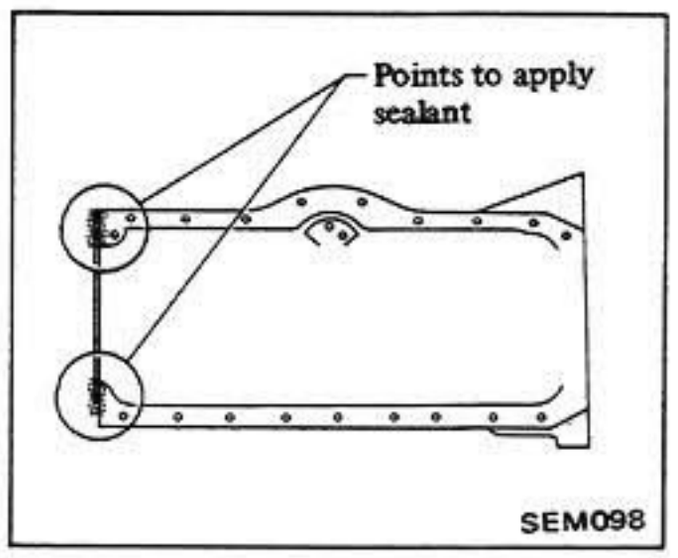
After inserting rear bearing cap side seals, apply sealant to rear main bearing cap.

P40 engine

(1) Cylinder block.



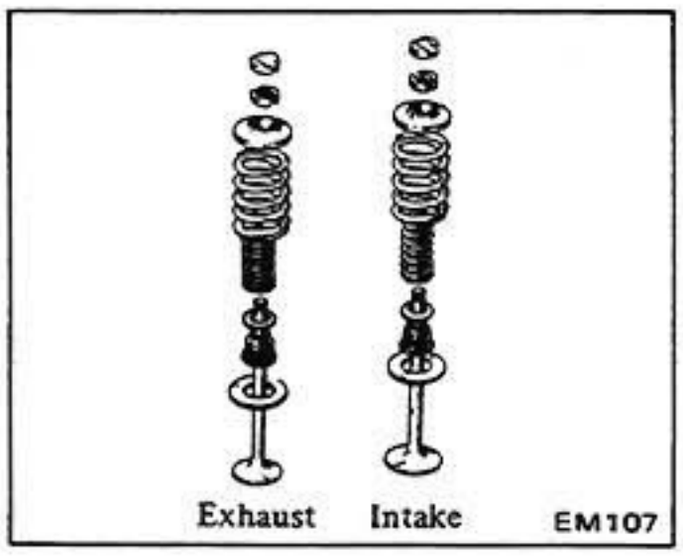
(2) Front plate.

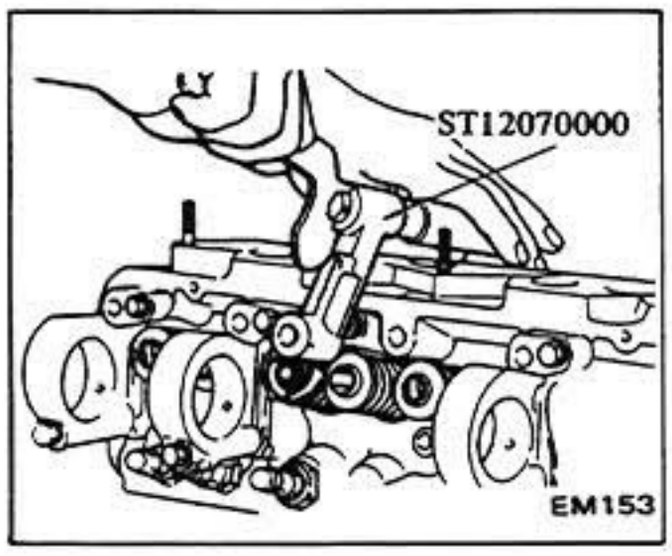


(3) Cylinder side cover and gasket.

ASSEMBLING CYLINDER HEAD OF L28 ENGINE

1. Install valve and valve spring.
(1) Set valve spring inner and outer seat and install valve oil seal to valve guide.
(2) Install valve, inner and outer valve spring, valve spring retainer and valve spring collet by **using Tool.**





a. When installing valve, apply engine oil on the valve stem and lip of valve oil seal.
b. Check whether the valve face is free from foreign matter.
c. Outer valve spring is of an uneven pitch type. Install valve spring with its narrow pitch side (painted) at cylinder head side.

2. Install valve rocker pivot assembly.
Screw valve rocker pivots joined with lock nuts into pivot bushing.
Install valve rocker spring retainer.

Fully screw in valve rocker pivot.

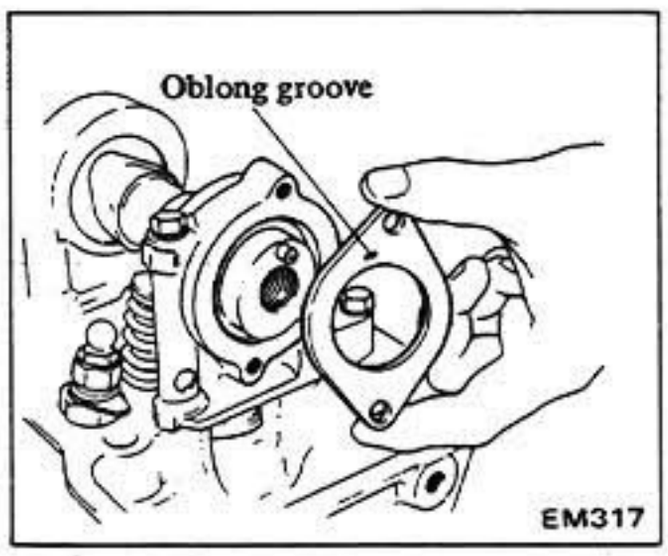
3. Install camshaft assembly in cylinder head carefully.

Do not damage the bearing inside.

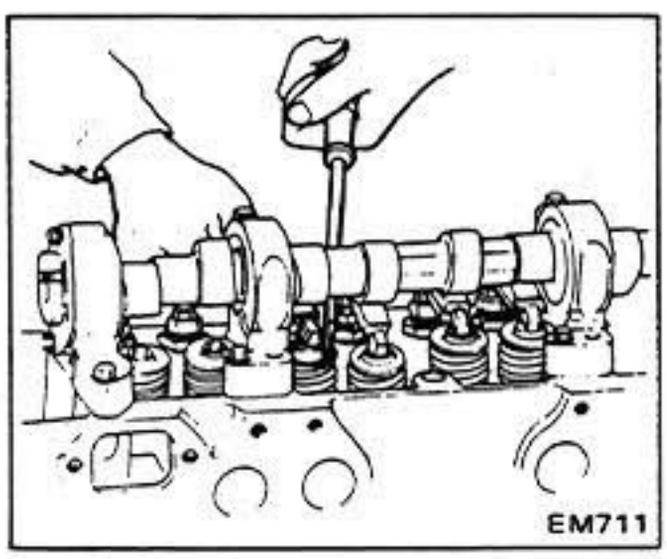
4. Set thrust plate.

Ⓣ : Camshaft thrust plate
6 - 10 N·m
(0.6 - 1.0 kg-m,
4.3 - 7.2 ft-lb)

The oblong groove must be directed toward the front side of engine.



5. Install valve rocker guides.
6. Install rocker arms by pressing down valve springs with a screwdriver, etc.

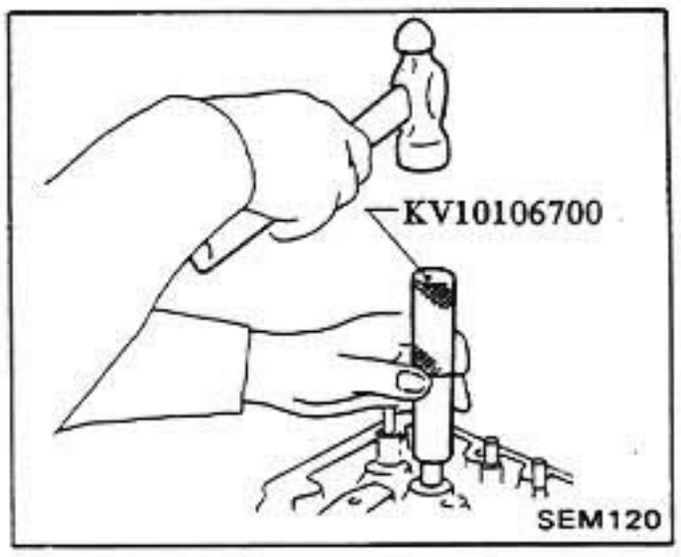


7. Install valve rocker springs.
8. After assembling cylinder head, turn camshaft until No. 1 piston is at T.D.C. on its compression stroke.

ASSEMBLING CYLINDER HEAD OF P40 ENGINE

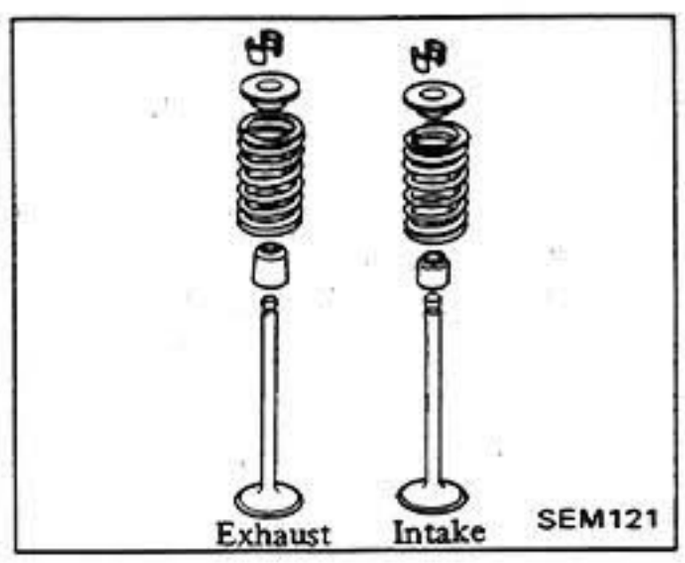
1. Install valve and valve spring.
(1) Install valve and valve oil seal.

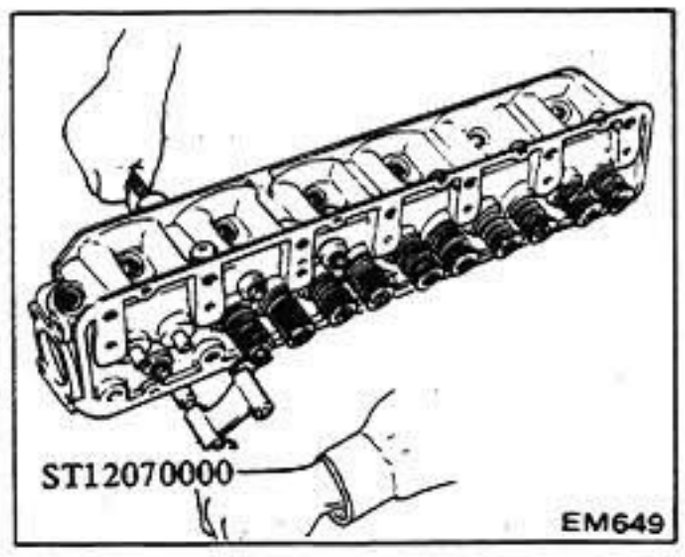
a. Apply engine oil on the valve stem and lip of valve oil seal.
b. Valve oil seals are different for intake and exhaust valves.
When installing valve oil seal on intake valve, tap valve oil seal with a plastic hammer on valve guide through Tool.



When installing valve oil seal on exhaust valve, set valve oil seal on valve stem.

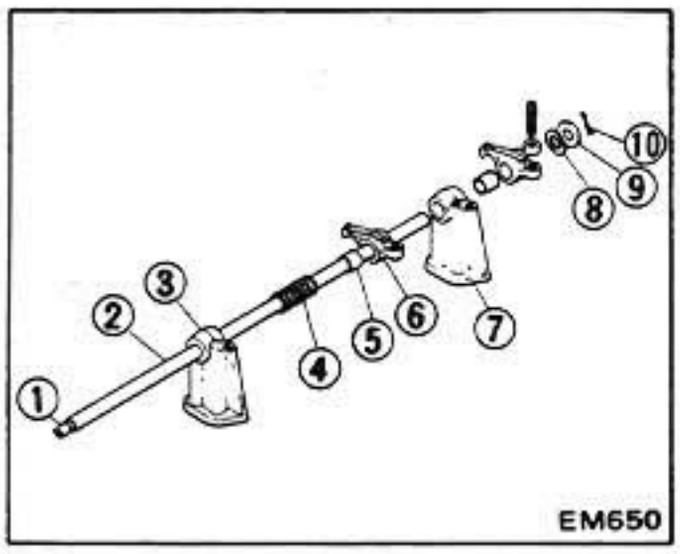
(2) Install valve spring, valve spring retainer and valve spring collet by **using Tool.**





a. Check whether the valve face is free from foreign matter.
b. Valve spring is of an uneven pitch type. Install valve spring with its narrow pitch side (painted) at cylinder head side.

2. If replacement of bushing in rocker arm is performed, assemble rocker arms, rocker shaft and relating parts.



1 Plug
2 Rocker shaft
3 Rocker shaft bracket–B
4 Spring
5 Bushing
6 Valve rocker arm
7 Rocker shaft bracket–A
8 Spring
9 Washer
10 Cotter pin

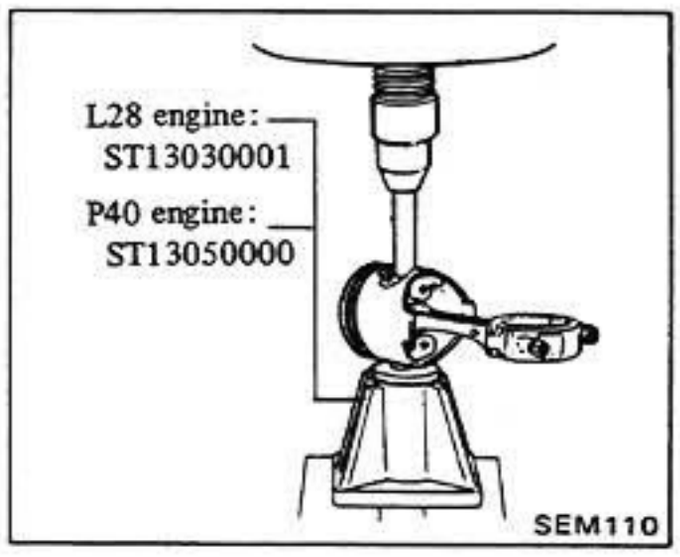
ASSEMBLING PISTON AND CONNECTING ROD

1. Assemble pistons, piston pins and connecting rods of the designated cylinder.

a. Piston pin is pressed into connecting rod, and fitting force should be within the specified limit and the aid of the following Tool is necessary.

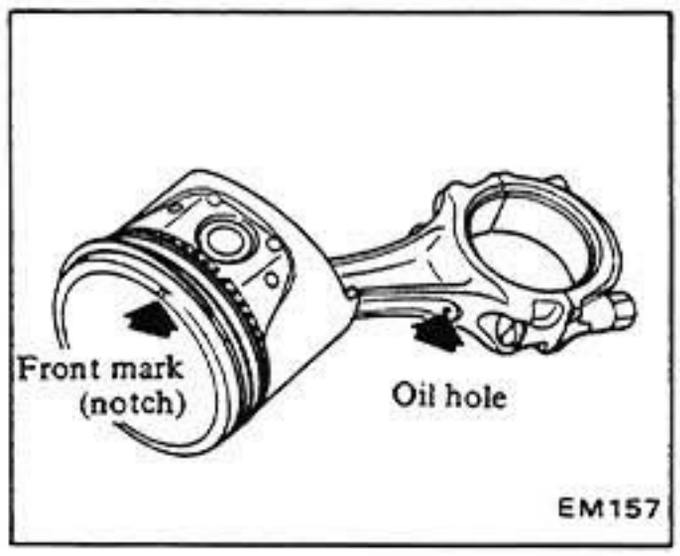
Piston pin fitting force:
L28 engine
4.9 - 14.7 kN
(0.5 - 1.5 t,
0.6 - 1.7 US ton,
0.49 - 1.48 Imp ton)
P40 engine
14.7 - 34.3 kN
(1.5 - 3.5 t,
1.7 - 3.9 US ton,
1.48 - 3.44 Imp ton)

When pressing piston pin in connecting rod, apply engine oil to pin and small end of connecting rod.

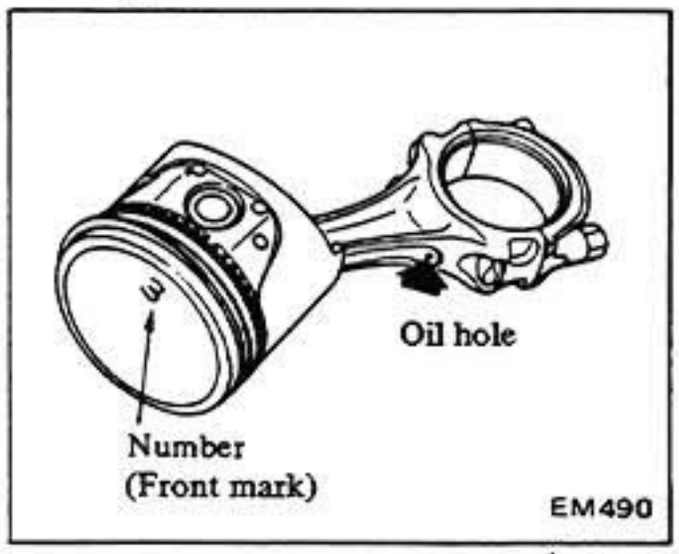


b. Arrange so that oil jet of connecting rod big end is directed toward the right side of cylinder block.

L28 engine



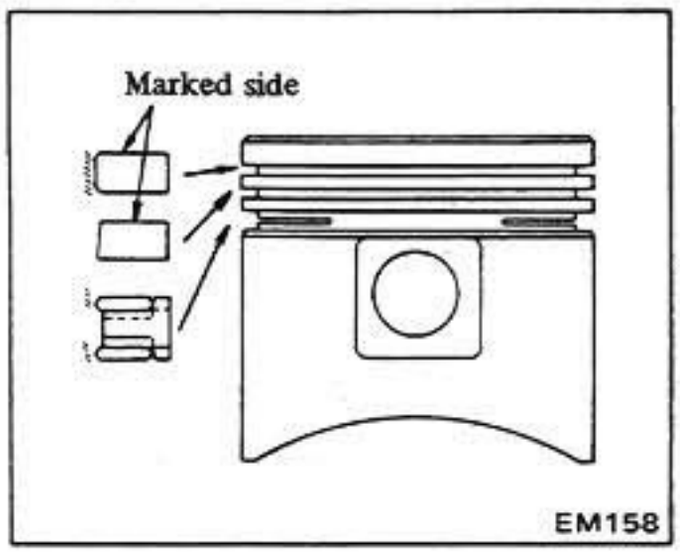
P40 engine



c. Connecting rods are marked at side of big end for identifying the designated cylinder.

2. Install piston rings.
Install so that stamped mark on ring faces upward.

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



ASSEMBLING ENGINE OVERALL

INSTALLING BODY PARTS OF L28 ENGINE

First, mount cylinder block on engine stand **(refer to Engine Disassembly)**.

Then install following parts:

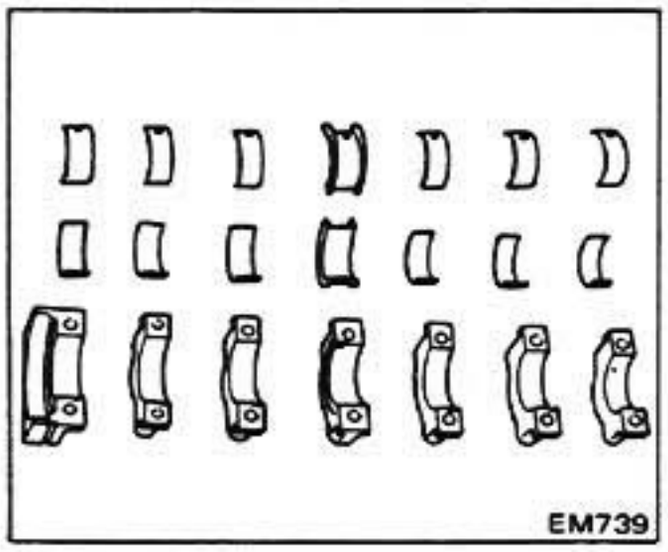
1. Baffle plate and steel net.

Install them into crankcase and tighten the screws applying Locktite.

2. Crankshaft.

(1) Set upper main bearings at the proper portion of cylinder block.

a. Upper bearings have oil hole and oil groove, however lower bearings do not.
b. Only center bearing (No. 4) is a flange type.
c. Front bearing (No. 1) is also the same type as rear bearing (No. 7).
d. Other inter bearings, except center bearing, are the same type.



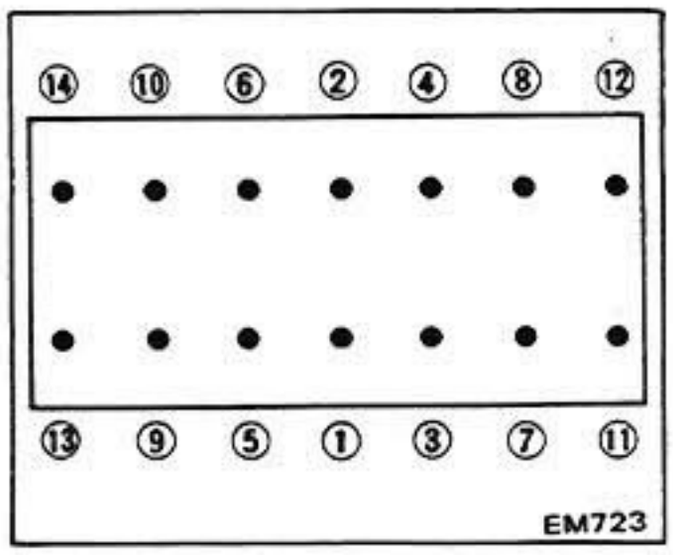
(2) Apply engine oil to main bearing surfaces on both sides of cylinder block and cap.

(3) Install crankshaft.

(4) Install main bearing cap and tighten bolts to specified torque.

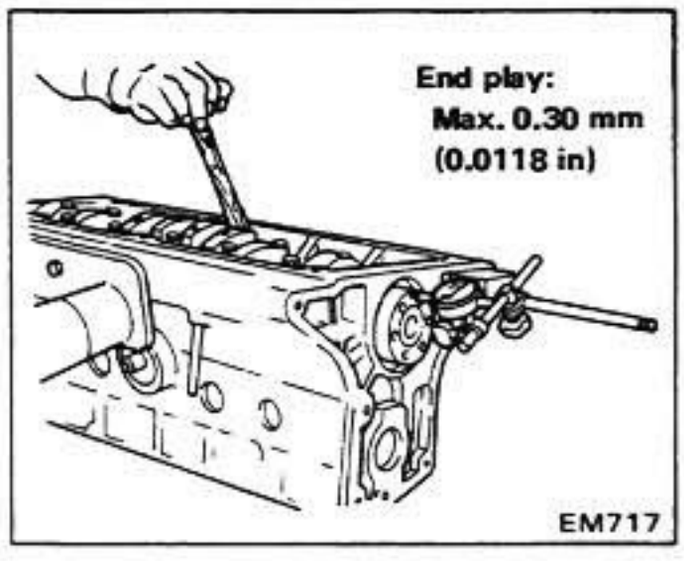
Ⓣ : **Main bearing cap bolts**
44 - 54 N·m
(4.5 - 5.5 kg-m,
33 - 40 ft-lb)

a. **Apply sealant to each side of rear main bearing cap and each corner of cylinder block. Refer to Precautions.**
b. **Arrange the parts so that the arrow mark on bearing cap faces toward the front of engine.**
c. **Prior to tightening bearing cap bolts, place bearing cap in proper position by shifting crankshaft in the axial direction.**
d. **Tighten bearing cap bolts gradually in separating two to three stages and in sequence outwardly from center bearing.**

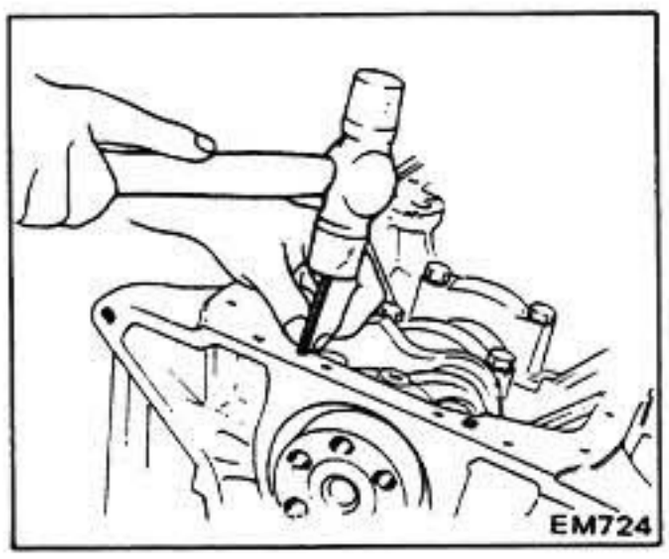


e. **After securing bearing cap bolts, ascertain that crankshaft turns smoothly.**

(5) Make sure that there exists proper end play at crankshaft.



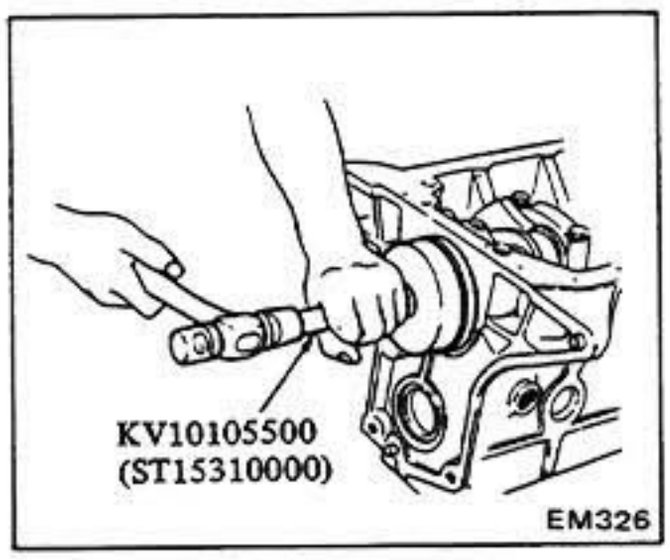
3. Side oil seals. Apply sealant to these seals. Then install them into main bearing cap.



Cut off projecting portion of seals with a putty knife, and apply sealer to cut edges of seals.

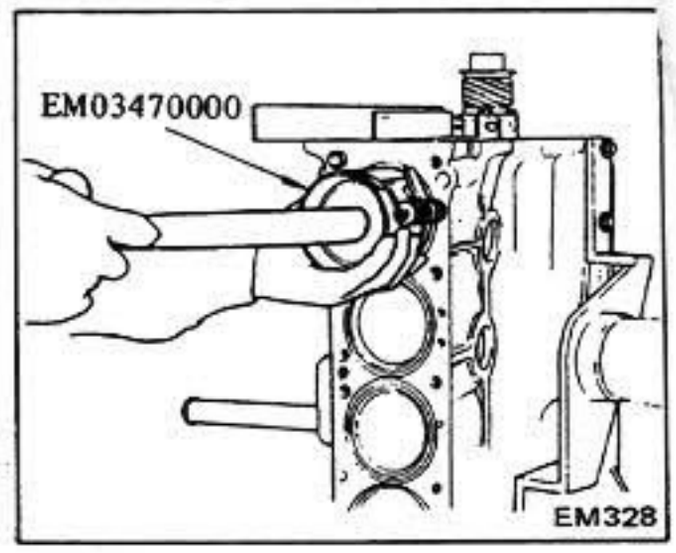
CAUTION:
Be careful not to apply an excessive amount of sealer to cut edges.

4. Rear oil seal. Install rear oil seal by **using Tool.**

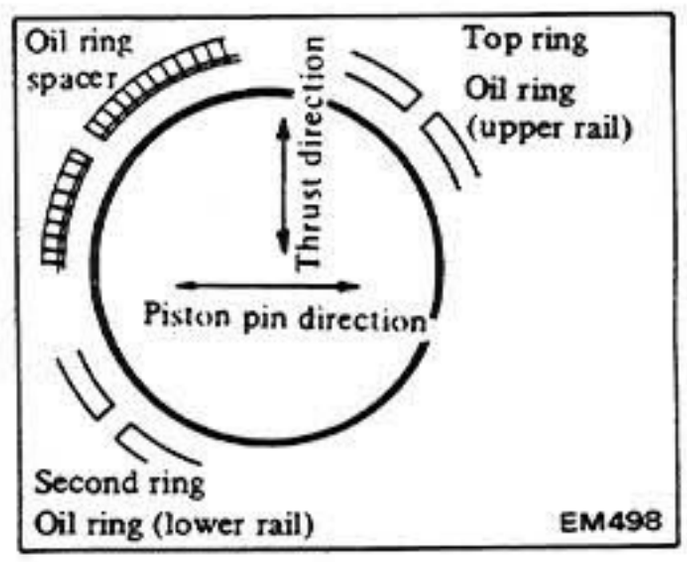


a. **When installing oil seal, give coating of engine oil to mating shaft to prevent scratches and folded lip. Also apply coating of oil to periphery of oil seal.**
b. **Install oil seal in the direction that dust seal lip faces to the outside of crankcase.**

5. Piston with connecting rod.
(1) Install them into corresponding cylinder **using Tool.**

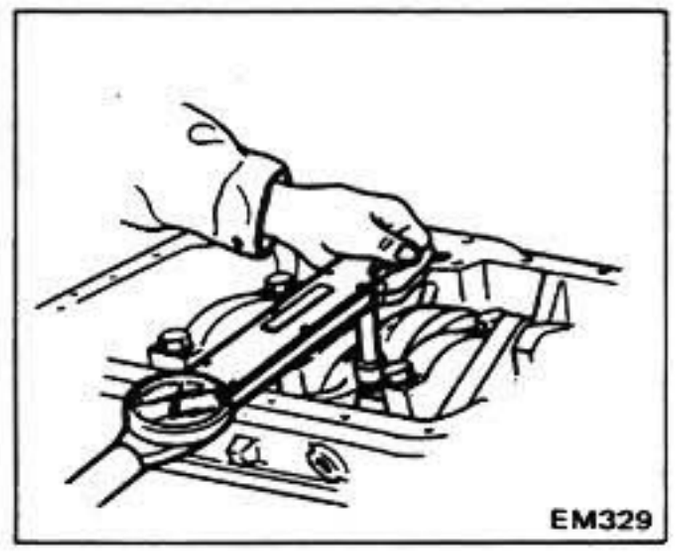


a. **Apply engine oil to sliding parts.**
b. **Arrange so that the front mark on piston head faces to the front of engine.**
c. **Set piston rings as shown below.**



(2) Install connecting rod caps.

Ⓣ : **Connecting rod cap nuts**
44 - 54 N·m
(4.5 - 5.5 kg-m,
33 - 40 ft-lb)

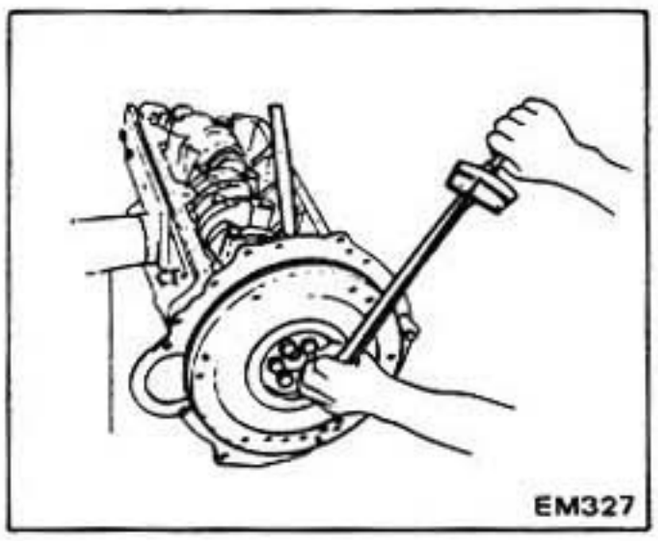


Arrange connecting rods and connecting rod caps so that the cylinder numbers face in the same direction.

(3) Make sure that there exists proper end play at connecting rod big end. **Refer to Inspection and Repair.**

6. Rear plate and flywheel or drive plate.

Ⓣ : **Flywheel or drive plate fixing bolts**
137 - 157 N·m
(14.0 - 16.0 kg-m,
101 - 116 ft-lb)



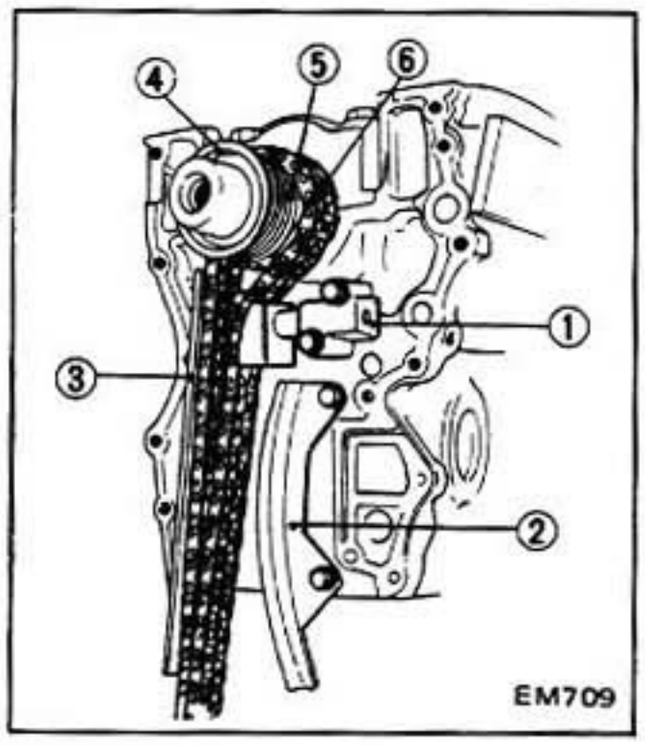
Do not lock at ring gear.

7. Cylinder head assembly. Install it through gasket by accommodating knock pin of cylinder block as follows:
(1) Thoroughly clean cylinder block and head surface.
Do not apply sealant to any other part of cylinder block and head surface.
(2) Turn crankshaft until No. 1 piston is at T.D.C. on its compression stroke.
(3) When installing cylinder head, make sure that all valves are apart from head of pistons. If necessary, loosen adjusting screws of rocker arm to draw valves in.
(4) Temporarily tighten two center bolts.

Ⓣ : **Cylinder head bolt**
20 N·m
(2 kg-m, 14 ft-lb)

a. **Final tightening operation should be carried out after installing chain and front cover.**
b. **Do not rotate crankshaft and camshaft separately, because valves will hit piston heads.**
c. **Always use new cylinder head gasket.**
d. **There are two kinds of cylinder head bolts with different lengths.**

8. Front side parts.



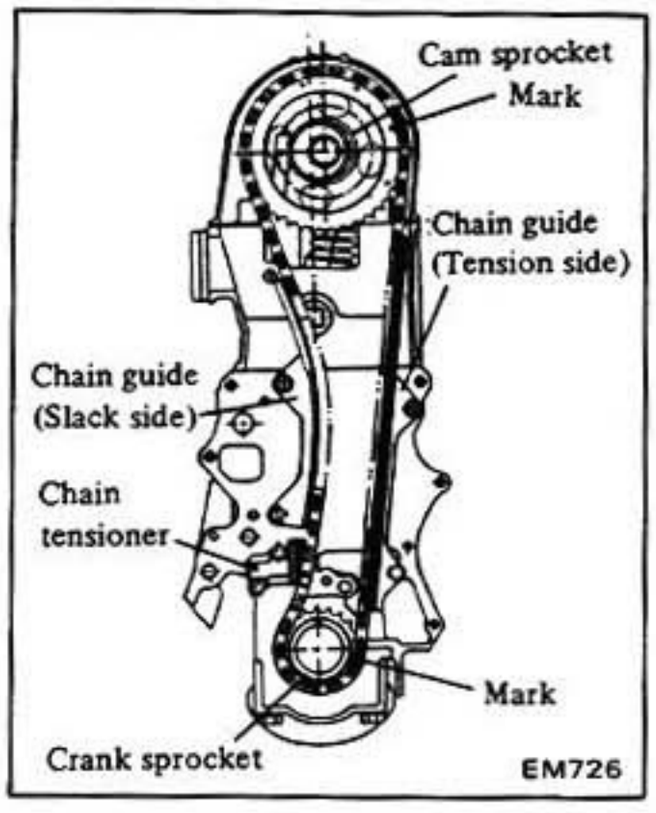
1 Chain tensioner
2 Slack side chain guide
3 Tension side chain guide
4 Oil thrower
5 Oil pump drive gear
6 Crankshaft sprocket

(1) Install crankshaft sprocket, oil pump drive gear and oil thrower.

a. **Make sure that the mating marks of crankshaft sprocket faces to the front.**
b. **Install oil pump drive gear so that large chamfered inner side faces rearward.**

(2) Install chain guide to cylinder block.
(3) Set chain by aligning mating mark on camshaft sprocket with that of crankshaft sprocket and install camshaft sprocket to camshaft.

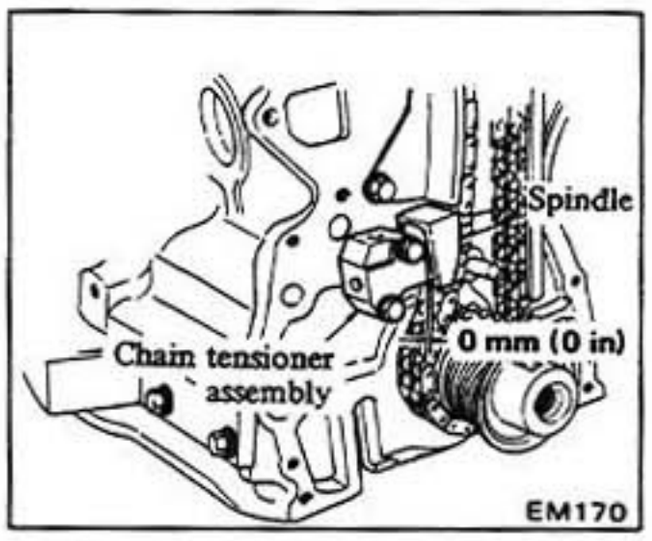
Ⓣ : **Camshaft sprocket bolt**
127 - 147 N·m
(13.0 - 15.0 kg-m,
94 - 108 ft-lb)



a. **Set timing chain by making its mating marks align with those of crankshaft sprocket and camshaft sprocket the right hand side.**
b. **Camshaft sprocket should be installed by accommodating its No. 1 hole to knock pin of camshaft.**

(4) Install chain guide and chain tensioner. Then tighten slack side chain guide mounting bolt so that protrusion of chain tensioner spindle is 0 mm (0 in).

Ⓣ : **Chain guide and chain tensioner mounting bolt.**
6 - 10 N·m
(0.6 - 1.0 kg-m,
4.3 - 7.2 ft-lb)



(5) Install front cover with gasket in place observing the following:

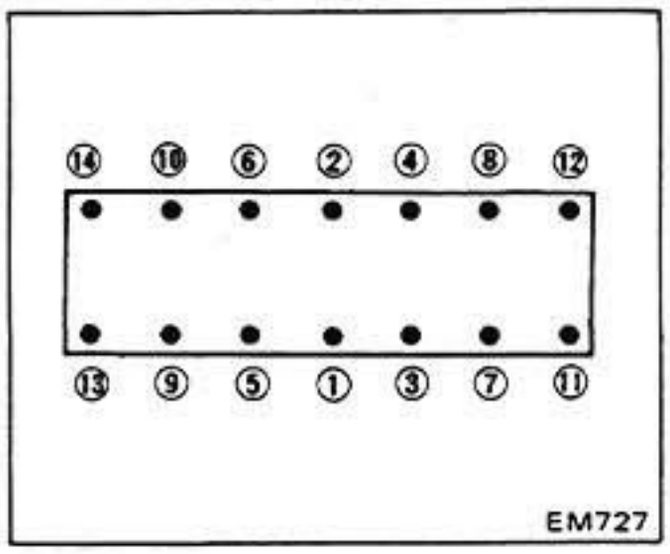
a. **Before installing front cover, press new oil seal in front cover in the direction that dust seal lip faces to the outside of front cover.**
b. **Apply sealant to gaskets and sealing portions designated. Refer to Precautions.**
c. **Apply coating of engine oil to periphery of oil seal.**

9. Tighten temporarily front cover to cylinder block bolts and cylinder head to front cover bolts.

Check the height difference between cylinder block upper face and front cover upper face. Its difference must be less than 0.15 mm (0.0059 in).

10. Tighten cylinder head bolts to the specified torque in several steps in the sequence as follows **using Tool ST10120000.**

Ⓣ : **Cylinder head bolt**
69 - 83 N-m
(7.0 - 8.5 kg-m,
51 - 61 ft-lb)



After engine has been operated for several minutes; if necessary, re-tighten.

11. Finally tighten front cover to cylinder block bolts and cylinder head to front cover bolts.

Ⓣ : **Front cover bolts**

	N-m	kg-m	ft-lb
M8 (7T)	20 - 29	2.0 - 3.0	14 - 22
M8 (4T)	12 - 16	1.2 - 1.6	9 - 12
M6 (4T)	5 - 10	0.5 - 1.0	3.6 - 7.2

Ⓣ : **Cylinder head to front cover bolts**
8 - 14 N-m
(0.8 - 1.4 kg-m,
5.8 - 10.1 ft-lb)

12. Install water pump assembly.

Ⓣ : **Water pump fixing bolt**
Same as the front cover bolts [M8 (4T), M6 (4T)].

13. Install crankshaft pulley and washer and tighten pulley bolt by locking crankshaft.

Ⓣ : **Crankshaft pulley bolt**
118 - 157 N-m
(12.0 - 16.0 kg-m,
87 - 116 ft-lb)

14. Install oil strainer and oil pan with new gasket.

Ⓣ : **Oil strainer bolts**
10 - 16 N-m
(1.0 - 1.6 kg-m,
7 - 12 ft-lb)
Oil pan bolts
6 - 10 N-m
(0.6 - 1.0 kg-m,
4.3 - 7.2 ft-lb)

a. **Apply sealant to the designated portions. Refer to Precautions.**
b. **Oil pan should be tightened in a criss-cross pattern. Do not over-tighten.**
c. **Always use new oil pan gasket.**

INSTALLING BODY PARTS OF P40 ENGINE

First, mount cylinder block on engine stand (**refer to Engine Disassembly**).
Then install following parts:

1. Camshaft
(1) Insert valve lifters.
(2) Insert camshaft in cylinder block from front side of engine.

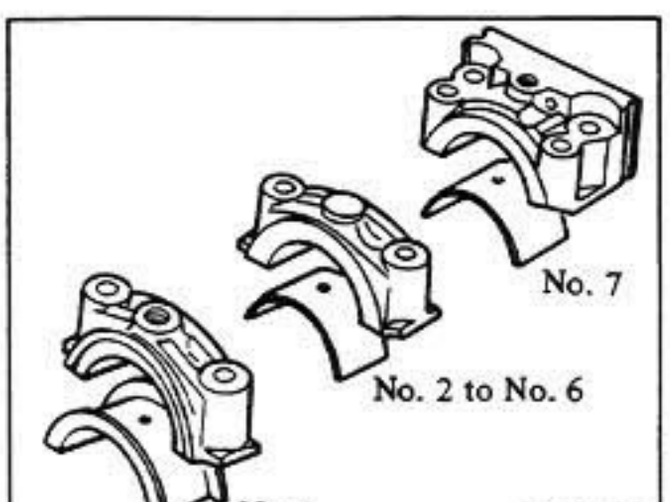
Do not damage camshaft bushings.

(3) Install camshaft locating plate.

Ⓣ : **Camshaft locating plate bolts**
6 - 8 N-m
(0.6 - 0.8 kg-m,
4.3 - 5.8 ft-lb)

2. Crankshaft
(1) Set upper main bearings at the proper portion of cylinder block.

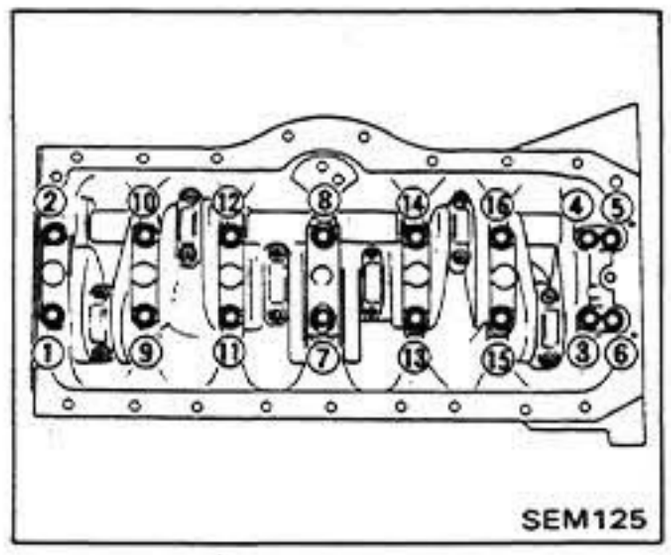
a. **Only front bearing (No. 1) is a flange type.**
b. **All inter-bearings are the same type.**
c. **All upper and lower bearings are interchangeable.**



(2) Apply engine oil to main bearing surfaces on both sides of cylinder block and cap.
(3) Install rear oil seal at block side.
(4) Install crankshaft.
(5) Install rear oil seal and main bearing cap and tighten bolts to specified torque.

Ⓣ : **Main bearing cap bolts**
98 - 118 N·m
(10.0 - 12.0 kg-m,
72 - 87 ft-lb)

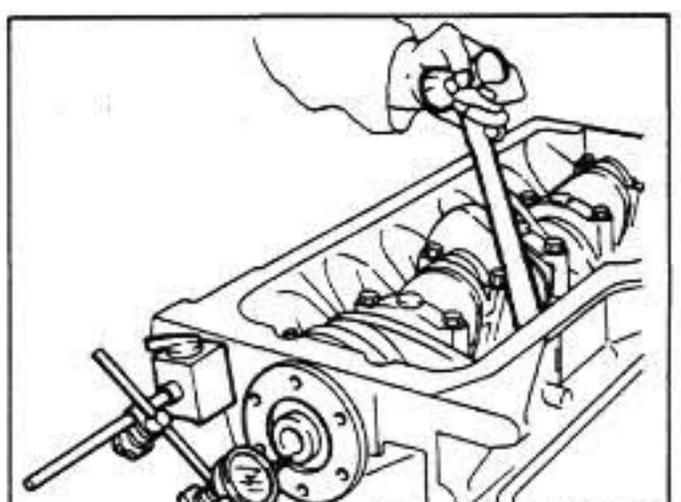
a. **Arrange the parts so that the "⏀" mark on bearing cap faces to camshaft.**
b. **Prior to tightening bearing cap bolts, place bearing cap in proper position by shifting crankshaft in the axial direction.**
c. **Tighten bearing cap bolts gradually in separating two to three stages, and outwardly from center bearing in sequence.**



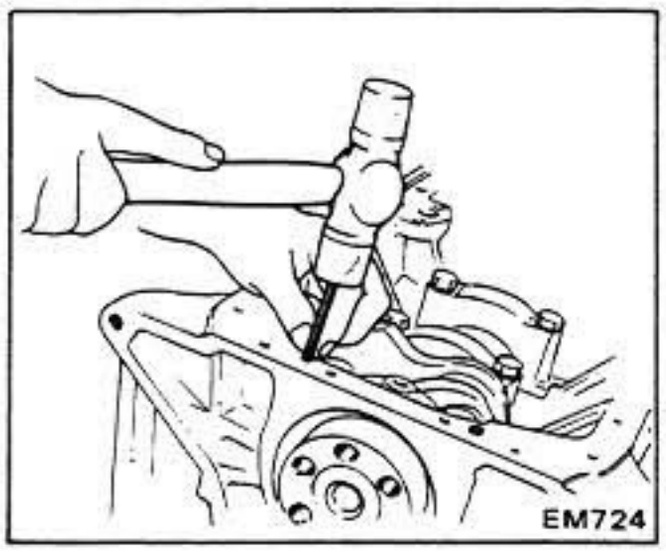
d. **After securing bearing cap bolts, ascertain that crankshaft turn smoothly.**

(6) Make sure that there exists proper end play at crankshaft.

Crankshaft end play:
Max. 0.30 mm (0.0118 in)



3. Side oil seals. Apply sealant to these seals. Then install them into rear main bearing cap.

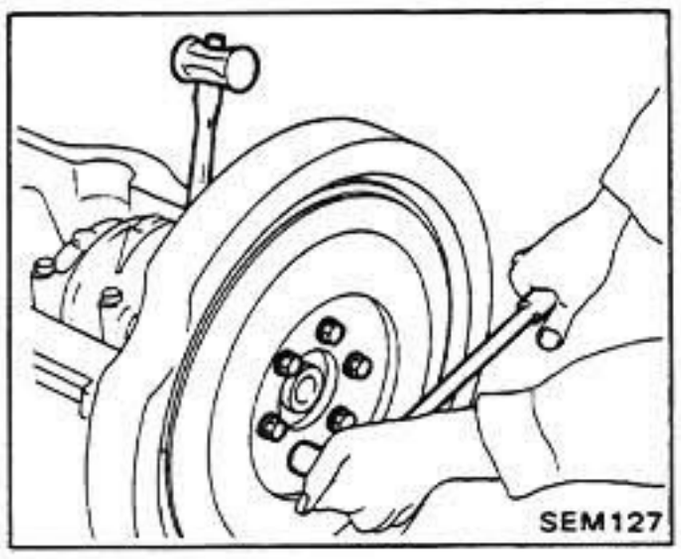


Cut off projecting portion of seals with a putty knife, and apply sealer to cut edges of seals.

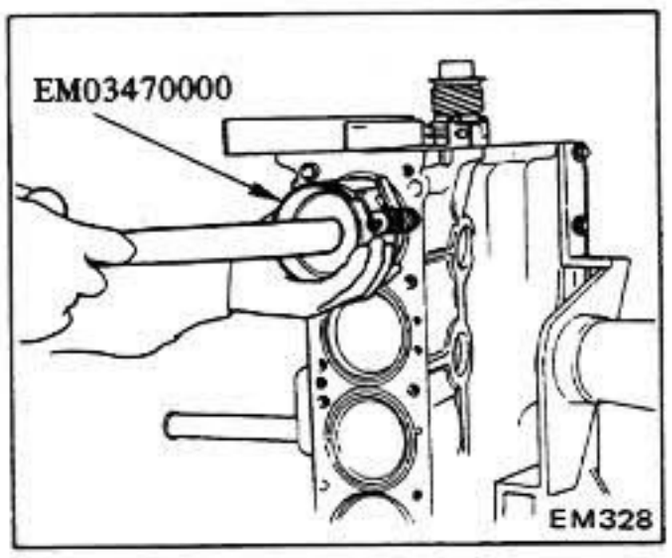
CAUTION:
Be careful not to apply an excessive amount of sealer to cut edges.

4. Flywheel housing and flywheel.

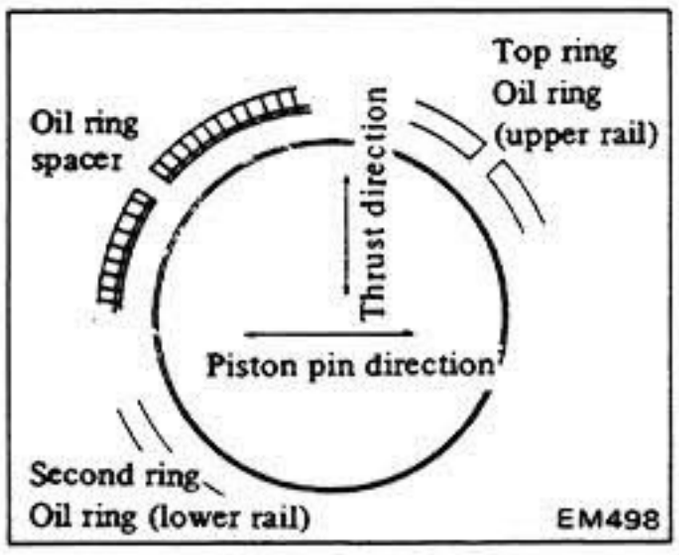
Ⓣ : **Flywheel fixing bolts**
78 - 98 N-m
(8.0 - 10.0 kg-m,
58 - 72 ft-lb)



5. Piston with connecting rod.
(1) Install them into corresponding cylinder **using Tool.**

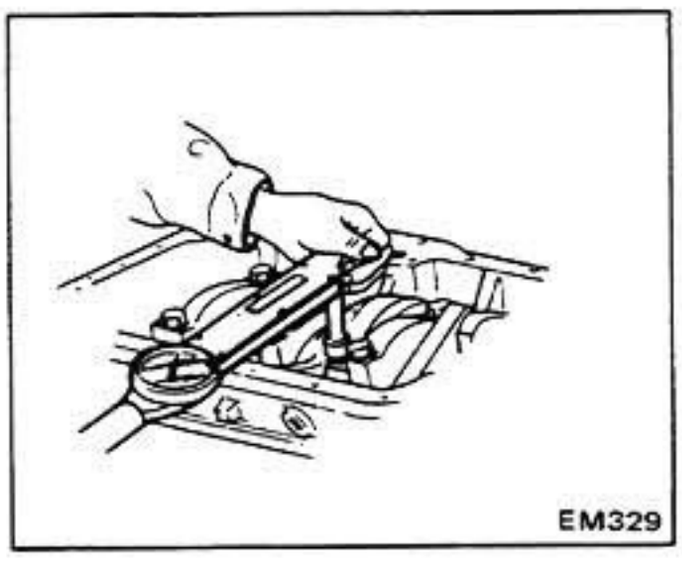


a. Apply engine oil to sliding parts.
b. Arrange so that the grade mark on piston head faces to the front of engine.
c. Install piston ring as shown below.



(2) Install connecting rod caps.

Ⓣ : **Connecting rod cap nuts**
44 - 59 N-m
(4.5 - 6.0 kg-m,
33 - 43 ft-lb)

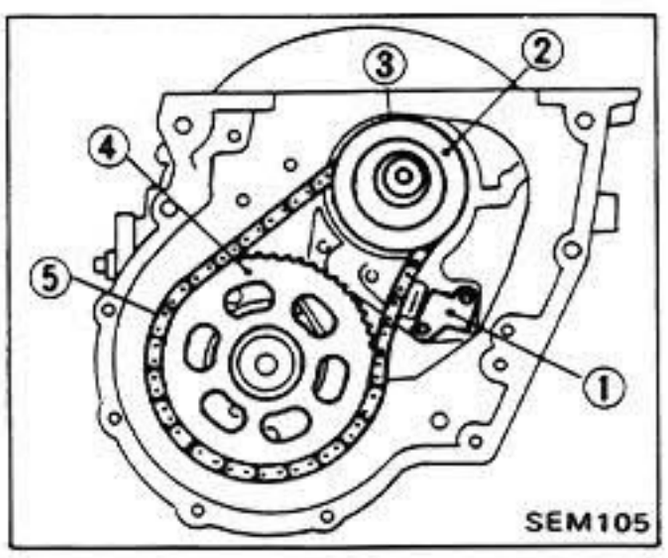


Arrange connecting rods and connecting rod caps so that the cylinder numbers face in the same direction.

(3) Make sure that there exists proper end play at connecting rod big end. **Refer to Inspection and Repair.**
(4) Install front plate.

Apply sealant on the bottom of front plate. Refer to Precautions.

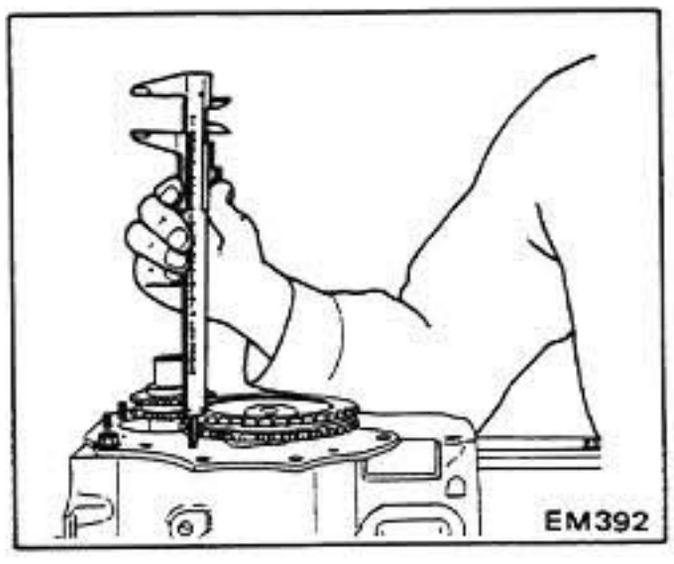
6. Front side parts.



1 Chain tensioner
2 Oil thrower
3 Crankshaft sprocket
4 Camshaft sprocket
5 Timing chain

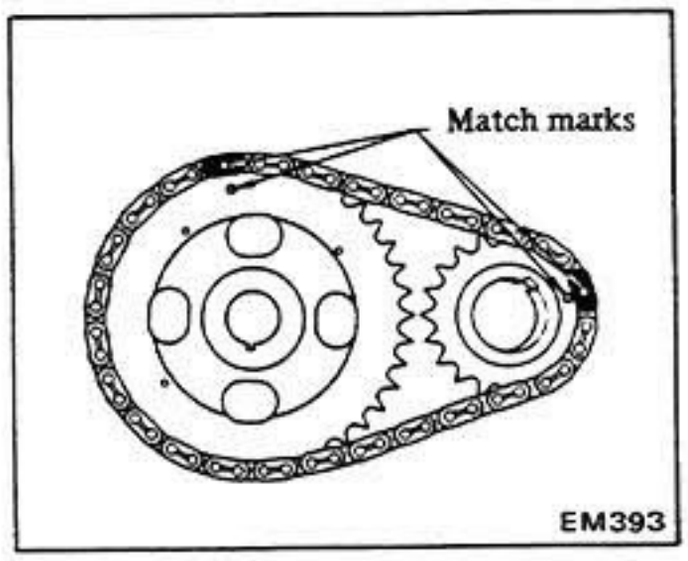
Turn crankshaft until No. 1 piston is at T.D.C. on its compression stroke.

Install crankshaft sprocket, camshaft sprocket and chain in the following manner:
(1) Insert keys in keyways. Temporarily install both crankshaft and camshaft sprockets and check to see that they are flush with each other. If difference in height falls below 0.5 mm (0.020 in), place a 0.15 mm (0.0059 in) washer under crankshaft sprocket.



(2) After above step has been completed, install crankshaft sprocket, chain and camshaft sprocket with their markings properly aligned. Oil sprocket teeth and chain with light engine oil.

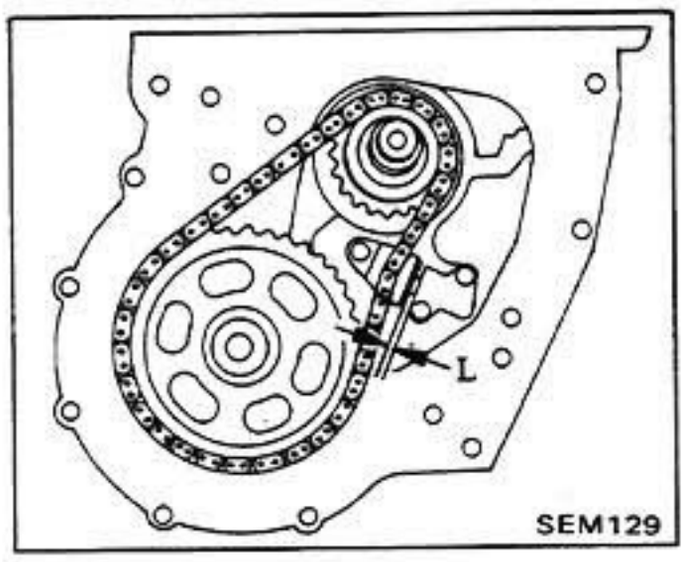
Ⓣ : **Camshaft sprocket bolt**
30 - 40 N·m
(3.1 - 4.1 kg-m,
22 - 30 ft-lb)



(3) Install chain tensioner. If projection "L" of spindle is below the specified limit, replace spindle.

Projection "L" of spindle:
Limit 2 mm (0.08 in)

Ⓣ : **Chain tensioner mounting bolt**
7 - 9 N·m
(0.7 - 0.9 kg-m,
5.1 - 6.5 ft-lb)



(4) Install oil thrower.
(5) Install front cover with gasket in place observing the followings:

a. Before installing front cover, press new oil seal in front cover in the direction that dust seal lip faces to the outside of timing chain case.
b. Apply sealant to sealing portion designated. Refer to Precautions.
c. Apply a lithium grease to sealing lip of oil seal.
d. Note that different lengths of bolts are used.

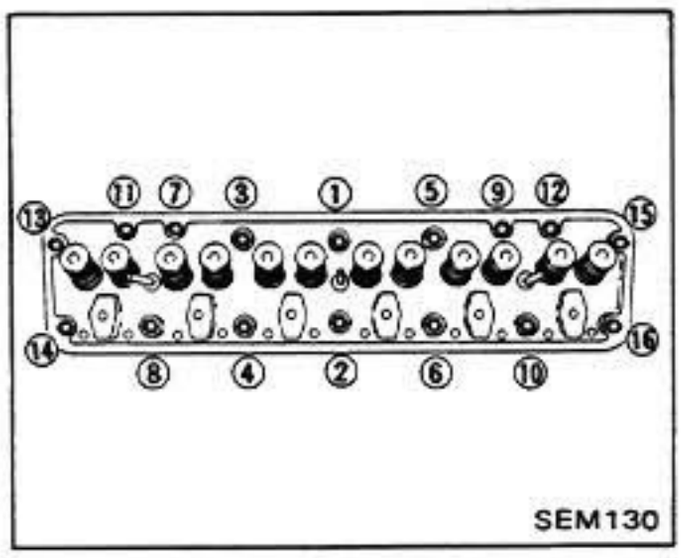
Ⓣ : **Front cover bolts**
Size M10
30 - 40 N·m
(3.1 - 4.1 kg-m,
22 - 30 ft-lb)
Size M8
11 - 21 N·m
(1.1 - 2.1 kg-m,
8 - 15 ft-lb)

7. Cylinder head assembly. Install it through gasket as follows:
(1) Thoroughly clean cylinder block and head surface.

Do not apply sealant to any other part of cylinder block and head surface.
(2) When installing cylinder head, make sure that all valves are apart from piston heads. If necessary loosen adjusting screws of rocker arm to draw valves in.

Always use new cylinder head gasket.

(3) Tighten head bolts to the specified torque in several steps in the sequence shown below.



Ⓣ : **Cylinder head bolts**
69 - 88 N·m
(7.0 - 9.0 kg-m,
51 - 65 ft-lb)

After engine has been operated for several minutes; if necessary, retighten.

8. Valve lifters and push rods Install them in original position.
9. Oil pump and oil pan with new gasket.

Ⓣ : **Oil pump bolts**
25 - 34 N·m
(2.5 - 3.5 kg-m,
18 - 25 ft-lb)
Oil pan bolts
15 - 20 N·m
(1.5 - 2.0 kg-m,
11 - 14 ft-lb)

a. Oil pan should be tightened in criss-cross pattern.
b. Always use new oil pan gasket.

DISMOUNTING ENGINE FROM ENGINE STAND

Dismount engine in reverse order of mounting and install engine right (or left) side and rear side parts.

Refer to Mounting Engine on Engine Stand.

a. When installing clutch assembly (or torque converter) and transmission, refer to sections CL and MT (or AT).
b. When installing oil cooler unit (for Middle East area) or oil filter, refer to section LC.
c. Fill engine oil and coolant to the specified level, after engine has been installed on vehicle. Refer to section MA.

ENGINE TUNE-UP

Referring to Section MA, adjust following items:
1. Fan belt deflection.
2. Idle adjustment.
3. Valve clearance.

(1) First, set clearance to the cold specifications.
(2) After engine has run for at least several minutes, finally adjust the clearance to the hot specifications.

When installing valve rocker cover, use new gasket and tighten bolts (or nuts) in a criss-cross pattern.

When adjusting valve clearance for L28 engine, use Tool ST10640001.

L28 engine
Ⓣ : Valve rocker cover bolts
10 - 16 N·m
(1.0 - 1.6 kg-m,
7 - 12 ft-lb)

P40 engine
Ⓣ : Valve rocker cover nuts
18 - 27 N·m
(1.8 - 2.8 kg-m,
13 - 20 ft-lb)

INSTALLING OUTER PARTS

Install the following parts in reverse order of disassembling and with the specified torque if designated.

Refer to Removing Outer Parts and S.D.S.

a. When installing oil pump (L28 engine) and distributor driving spindle, refer to section LC.
b. When connecting fuel pipes, refer to section EF.
c. When installing water outlet and thermostat, refer to section LC.

1. Engine bottom side parts (L28 engine).
2. Engine right side parts.
3. Engine left side parts.
4. Engine front side parts.

SERVICE DATA AND SPECIFICATIONS

GENERAL SPECIFICATIONS

Engine model		L28	P40
Cylinder arrangement		6, in-line	6, in-line
Displacement cm^3 (cu in)		2,753 (167.99)	3,956 (241.40)
Bore and stroke mm (in)		86.0 x 79.0 (3.386 x 3.110)	85.7 x 114.3 (3.374 x 4.500)
Valve arrangement		O.H.C.	O.H.V.
Firing order		1-5-3-6-2-4	1-5-3-6-2-4
Number of piston rings	Compression	2	2
	Oil	1	1
Number of main bearings		7	7
Compression ratio		8.6	7.8

INSPECTION AND ADJUSTMENT

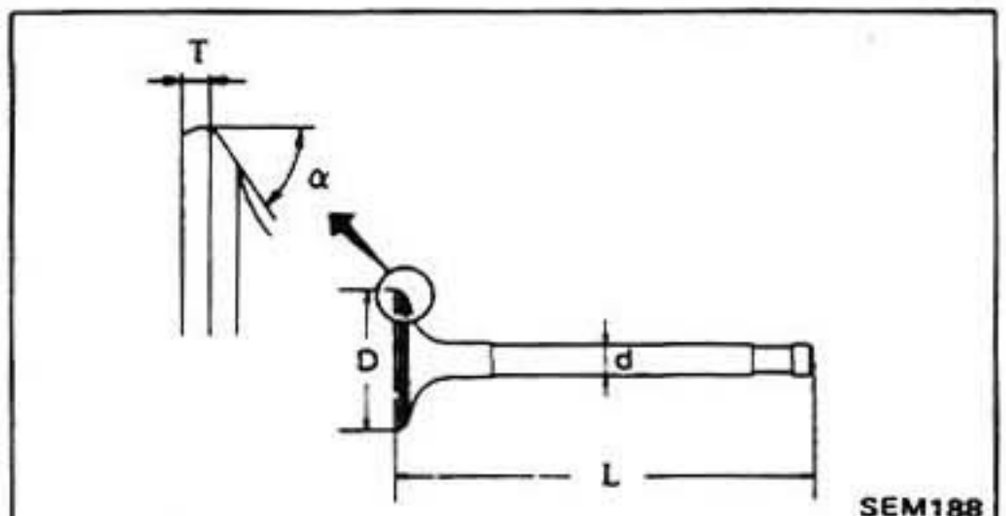
CYLINDER HEAD

Unit: mm (in)

	Standard	Limit
Head surface flatness	Less than 0.05 (0.0020)	0.1 (0.004)

VALVE

Unit: mm (in)



Engine model		L28	P40
Valve head diameter "D"	Intake	44.0 (1.732)	43.0 (1.693)
	Exhaust	35.0 (1.378)	36.2 (1.425)
Valve length "L"	Intake	116.15 - 116.55 (4.5728 - 4.5886)	130.05 - 130.35 (5.1201 - 5.1319)
	Exhaust	117.15 - 117.55 (4.6122 - 4.6279)	131.35 - 131.65 (5.1712 - 5.1831)
Valve stem diameter "d"	Intake	7.965 - 7.980 (0.3136 - 0.3142)	8.637 - 8.650 (0.3400 - 0.3406)
	Exhaust	7.945 - 7.960 (0.3128 - 0.3134)	8.627 - 8.640 (0.3396 - 0.3402)
Valve seat angle "α"		45°30′	45°
Valve margin "T" limit		0.5 (0.020)	0.5 (0.020)
Valve stem end surface grinding limit		0.5 (0.020)	0.5 (0.020)
Valve clearance Hot [*Cold]	Intake	0.25 (0.010) [0.17 (0.007)]	0.38 - 0.40 (0.015 - 0.016)
	Exhaust	0.30 (0.012) [0.24 (0.009)]	0.38 - 0.40) (0.015 - 0.016)

*Cold: Used as approximate values during engine assembly, clearances should ultimately be adjusted to the above hot values; refer to Section MA for procedures.

Valve spring

L28 engine

Free height mm (in)	Outer		49.98 (1.9677)
	Inner		44.85 (1.7657)
Pressure height mm/N (mm/kg, in/lb)	Outer	Intake	30.0/467.8 (30.0/47.7, 1.181/105.2)
		Exhaust	29.5/480.5 (29.5/49.0, 1.161/108.0)
	Inner	Intake	25.0/244.2 (25.0/24.9, 0.984/54.9)
		Exhaust	24.5/250.1 (24.5/25.5, 0.965/56.2)
Assembled height mm/N (mm/kg, in/lb)	Outer		40.0/208.9 (40.0/21.3, 1.575/47.0)
	Inner		35.0/120.6 (35.0/12.3, 1.378/27.1)
Out of square "S" mm (in)	Outer		2.2 (0.087)
	Inner		1.2 (0.047)

P40 engine

Free height	mm (in)	57.5 (2.264)
Pressure height	mm/N (mm/kg, in/lb)	40/588 (40/60, 1.57/132)
Out of square "S"	mm (in)	1.6 (0.063)

Valve guide

L28 engine

Unit: mm (in)

		Standard	Service
Valve guide Outer diameter		12.023 - 12.034 (0.4733 - 0.4738)	12.223 - 12.234 (0.4812 - 0.4817)
Valve guide Inner diameter [Finished size]		8.000 - 8.018 (0.3150 - 0.3157)	
Cylinder head valve guide hole diameter		11.985 - 11.996 (0.4718 - 0.4723)	12.185 - 12.196 (0.4797 - 0.4802)
Interference fit of valve guide		0.027 - 0.049 (0.0011 - 0.0019)	
		Standard	Max. tolerance
Stem to guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.1 (0.004)
	Exhaust	0.040 - 0.073 (0.0016 - 0.0029)	
Valve deflection limit		0.2 (0.008)	

P40 engine

Unit: mm (in)

Valve guide Outer diameter		14.313 - 14.326 (0.5635 - 0.5640)	
Valve guide Inner diameter [Finished size]		8.685 - 8.700 (0.3419 - 0.3425)	
Cylinder head valve guide hole diameter		14.281 - 14.300 (0.5622 - 0.5630)	
Interference fit of valve guide		0.013 - 0.045 (0.0005 - 0.0018)	
		Standard	Max. tolerance
Stem to guide clearance	Intake	0.035 - 0.063 (0.0014 - 0.0025)	0.1 (0.004)
	Exhaust	0.045 - 0.073 (0.0018 - 0.0029)	
Valve deflection limit		0.2 (0.008)	

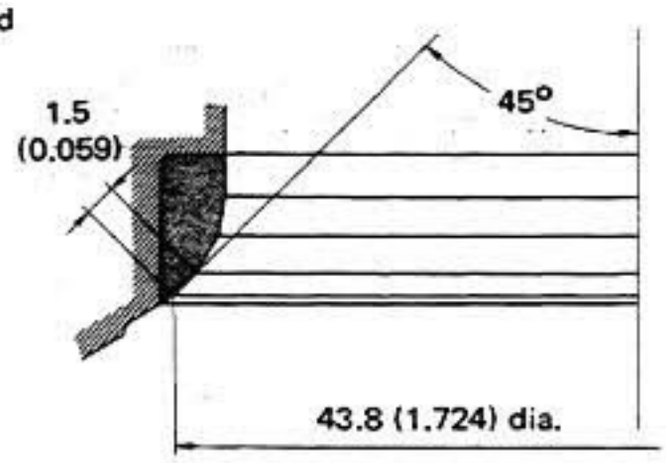
Valve seat

L28 engine

Unit: mm (in)

INTAKE

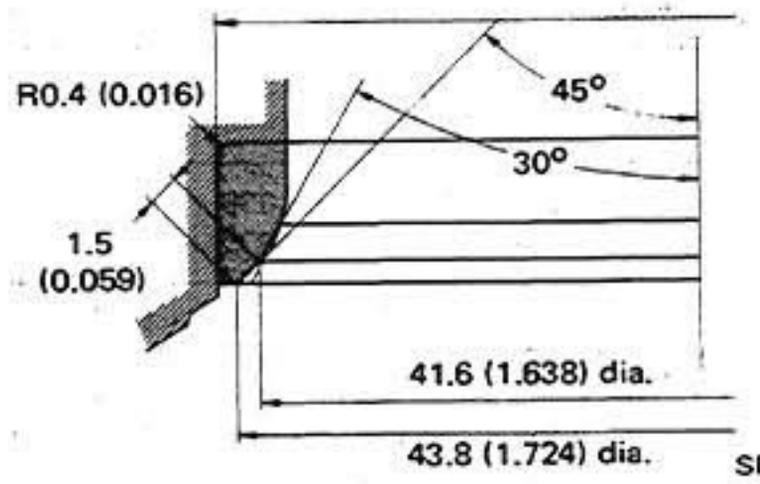
Standard



SEM224

Oversize
[0.5 (0.020)]

45.500 - 45.516 (1.7913 - 1.7920) dia.
[Cylinder head]



SEM225

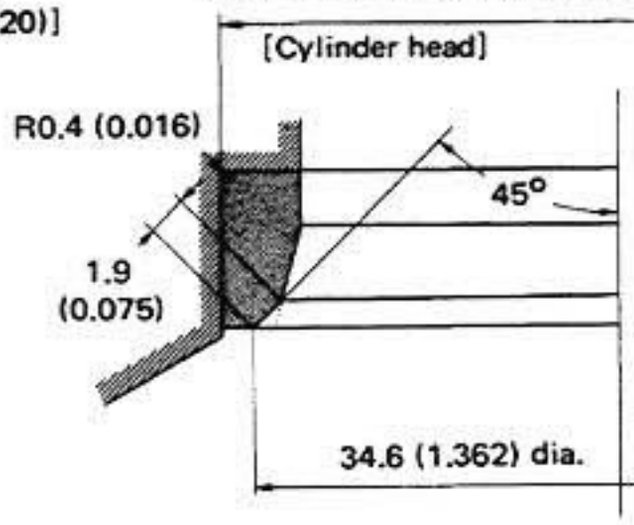
EXHAUST

Standard

SEM226

Oversize
[0.5 (0.020)]

37.500 - 37.516 (1.4764 - 1.4770) dia.
[Cylinder head]



SEM227

P40 engine

Contacting face angle		44.5°
Contacting face width mm (in)	Intake	1.5 - 1.7 (0.059 - 0.067)
	Exhaust	1.7 - 1.9 (0.067 - 0.075)

ROCKER ARM AND ROCKER SHAFT (P40 engine)

Unit: mm (in)

Rocker shaft outer diameter	19.975 - 20.000 (0.7864 - 0.7874)
Rocker arm bushing bore diameter [Finished size]	20.020 - 20.033 (0.7882 - 0.7887)
Rocker arm to rocker shaft clearance	0.020 - 0.063 (0.0008 - 0.0025)

VALVE LIFTER (P40 engine)

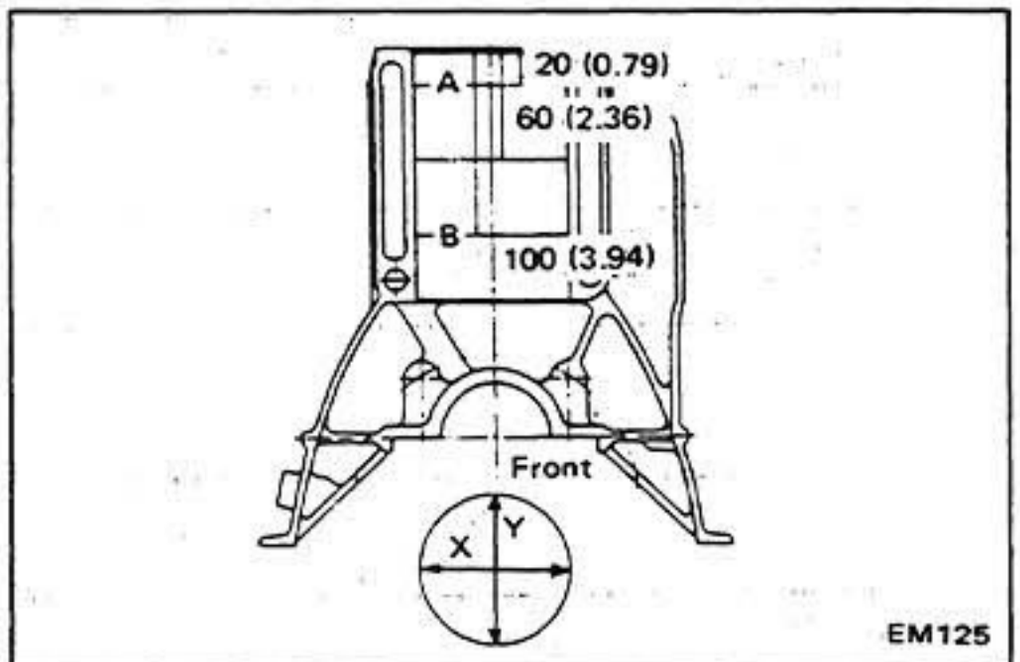
Unit: mm (in)

Valve lifter to guide clearance	Standard	0.02 - 0.05 (0.0008 - 0.0020)
	Limit	0.15 (0.0059)

CYLINDER BLOCK

L28 engine

Unit: mm (in)



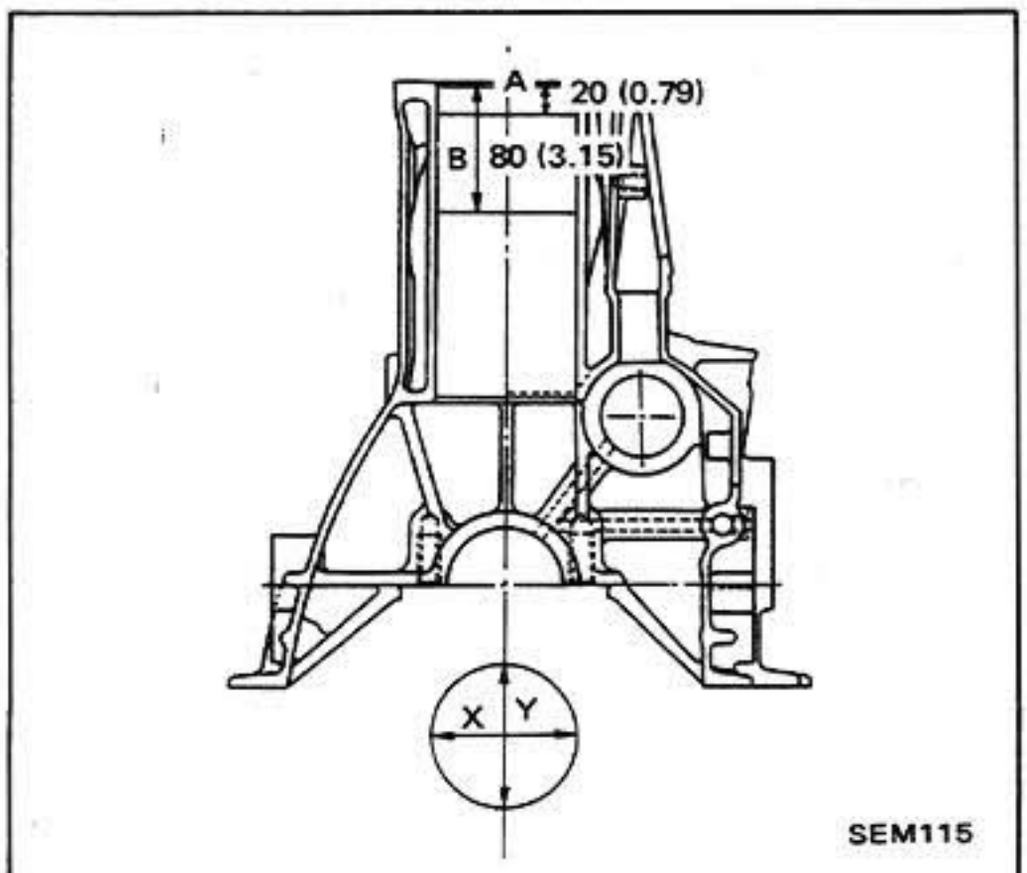
EM125

		Standard	Wear limit
Surface flatness		Less than 0.05 (0.0020)	0.10 (0.0039)
Cylinder bore	Inner diameter	86.000 - 86.050 (3.3858 - 3.3878)	–
	Out-of-round (X-Y)	Less than 0.02 (0.0008)	–
	Taper (A-B)	Less than 0.02 (0.0008)	–
Difference in inner diameter between cylinders		Less than 0.05 (0.0020)	–
Piston to cylinder clearance		0.025 - 0.045 (0.0010 - 0.0018)	–

		Outer diameter	Remarks
Outer diameter of cylinder liner for service	4.0 (0.157) Undersize	90.00 - 90.05 (3.5433 - 3.5453)	Interference fit cylinder liner to cylinder block 0.075 - 0.085 (0.0030 - 0.0033)
	4.5 (0.177) Undersize	90.50 - 90.55 (3.5630 - 3.5650)	
	5.0 (0.197) Undersize	91.00 - 91.05 (3.5827 - 3.5846)	

P40 engine

Unit: mm (in)



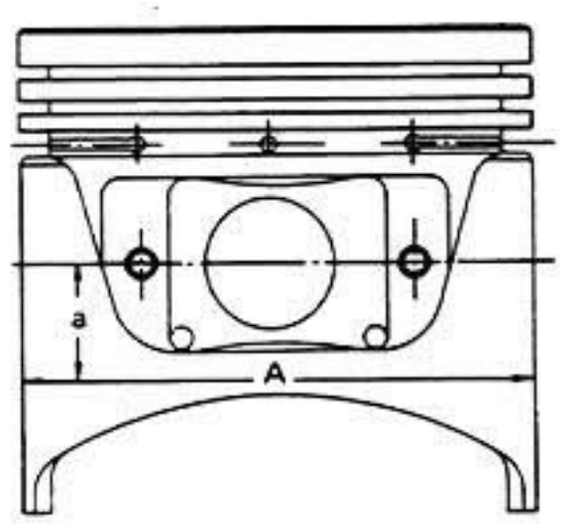
SEM115

		Standard	Wear limit
Surface flatness		Less than 0.07 (0.0028)	0.10 (0.0039)
Cylinder bore	Inner diameter	85.690 - 85.740 (3.3736 - 3.3756)	—
	Out-of-round (X-Y)	Less than 0.025 (0.0010)	—
	Taper (A-B)	Less than 0.025 (0.0010)	—
Difference in inner diameter between cylinders		Less than 0.05 (0.0020)	—
Piston to cylinder clearance		0.031 - 0.049 (0.0012 - 0.0019)	—

PISTON, PISTON RING AND PISTON PIN

Piston

Unit: mm (in)



EM714.

Engine model			L28	P40
Piston skirt diameter "A"	Standard		85.965 - 86.015 (3.3844 - 3.3864)	85.650 - 85.699 (3.3720 - 3.3740)
	Oversize	0.02 (0.0008)	85.985 - 86.035 (3.3852 - 3.3872)	—
		0.5 (0.020)	86.465 - 86.515 (3.4041 - 3.4061)	86.150 - 86.199 (3.3917 - 3.3937)
		1.0 (0.039)	86.965 - 87.015 (3.4238 - 3.4258)	86.650 - 86.699 (3.4114 - 3.4133)
		1.5 (0.059)	—	87.150 - 87.199 (3.4311 - 3.4330)
"a" dimension			Approximately 20 (0.79)	Approximately 40 (1.57)
Piston pin hole diameter			21.001 - 21.008 (0.8268 - 0.8271)	20.652 - 20.659 (0.8131 - 0.8133)
Piston clearance to cylinder block			0.025 - 0.045 (0.0010 - 0.0018)	0.031 - 0.049 (0.0012 - 0.0019)

Piston ring

Unit: mm (in)

Engine model			L28	P40
Side clearance	Top	Standard	0.040 - 0.073 (0.0016 - 0.0029)	0.031 - 0.078 (0.0012 - 0.0031)
		Limit	0.1 (0.004)	0.1 (0.004)
	2nd	Standard	0.030 - 0.063 (0.0012 - 0.0025)	0.031 - 0.078 (0.0012 - 0.0031)
		Limit	0.1 (0.004)	0.1 (0.004)
	Oil		Combined	Combined
Ring gap	Top	Standard	0.25 - 0.40 (0.0098 - 0.0157)	0.25 - 0.40 (0.0098 - 0.0157)
		Limit	1.0 (0.039)	1.0 (0.039)
	2nd	Standard	0.15 - 0.30 (0.0059 - 0.0118)	0.15 - 0.30 (0.0059 - 0.0118)
		Limit	1.0 (0.039)	1.0 (0.039)
	Oil (Rail ring)	Standard	0.3 - 0.9 (0.012 - 0.035)	0.2 - 0.9 (0.008 - 0.035)
		Limit	1.0 (0.039)	1.0 (0.039)

Piston pin

Unit: mm (in)

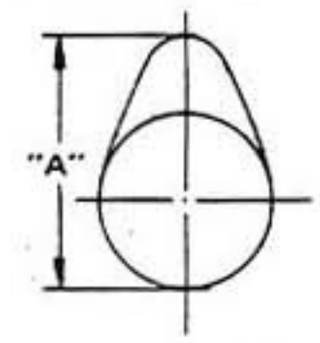
Engine model	L28	P40
Piston pin outer diameter	20.993 - 20.998 (0.8265 - 0.8267)	20.648 - 20.653 (0.8129 - 0.8131)
Piston pin to piston clearance	0.006 - 0.013 (0.0002 - 0.0005)	0.004 - 0.006 (0.00016 - 0.00024)
Interference fit of piston pin to connecting rod	0.015 - 0.033 (0.0006 - 0.0013)	0.018 - 0.035 (0.0007 - 0.0014)

CAMSHAFT AND CAMSHAFT BEARING

L28 engine

Unit: mm (in)

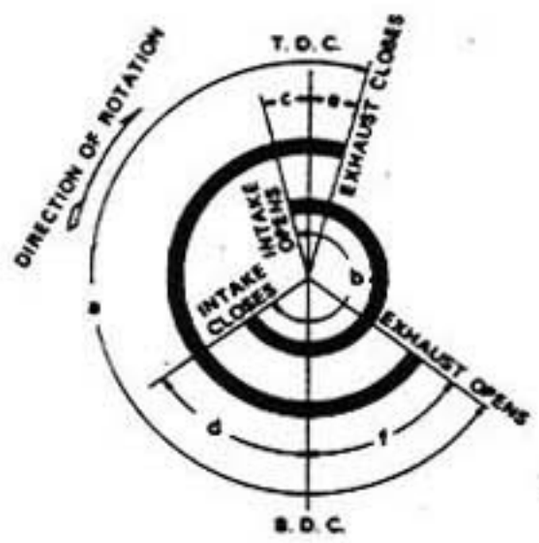
	Standard	Max. tolerance
Camshaft journal to bearing clearance	0.038 - 0.067 (0.0015 - 0.0026)	0.1 (0.004)
Inner diameter of camshaft bearing	48.000 - 48.016 (1.8898 - 1.8904)	–
Outer diameter of camshaft journal	47.949 - 47.962 (1.8878 - 1.8883)	–
Camshaft bend [T.I.R.]	Less than 0.04 (0.0016)	0.10 (0.0039)
Camshaft end play	0.08 - 0.38 (0.0031 - 0.0150)	



EM671

Cam height "A"	Intake	39.95 - 40.00 (1.5728 - 1.5748)
	Exhaust	40.30 - 40.35 (1.5866 - 1.5886)
Wear limit of cam height		0.15 (0.0059)

Valve timing



EM120

Unit: degree

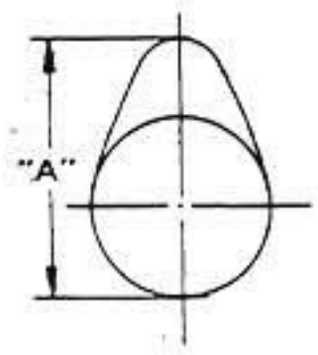
	a	b	c	d	e	f
①	248	240	16	44	10	58
②	248	240	12	48	14	54

① Except for Australia
② For Australia

P40 engine

Unit: mm (in)

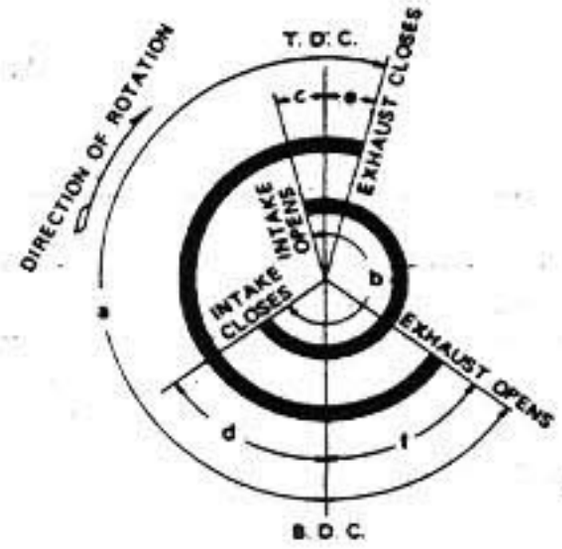
		Standard	Max. tolerance
Camshaft journal to bearing clearance		0.030 - 0.075 (0.0012 - 0.0030)	0.1 (0.004)
Inner diameter of camshaft bearing	1st	49.154 - 49.224 (1.9352 - 1.9379)	—
	2nd	48.950 - 49.020 (1.9272 - 1.9299)	—
	3rd	48.646 - 48.716 (1.9152 - 1.9179)	—
	4th	48.341 - 48.411 (1.9032 - 1.9059)	—
Outer diameter of camshaft journal	1st	49.124 - 49.149 (1.9340 - 1.9350)	—
	2nd	48.920 - 48.945 (1.9260 - 1.9270)	—
	3rd	48.616 - 48.641 (1.9140 - 1.9150)	—
	4th	48.311 - 48.336 (1.9020 - 1.9030)	—
Camshaft bend [T.I.R.]		Less than 0.025 (0.0010)	0.10 (0.0039)
Camshaft end play		0.045 - 0.215 (0.0018 - 0.0085)	



EM671

Cam height "A"	Intake	41.246 (1.6239)
	Exhaust	41.246 (1.6239)
Wear limit of cam height		0.15 (0.0059)

Valve timing



EM120

Unit: degree

a	b	c	d	e	f
244	244	14	50	12	52

CONNECTING ROD

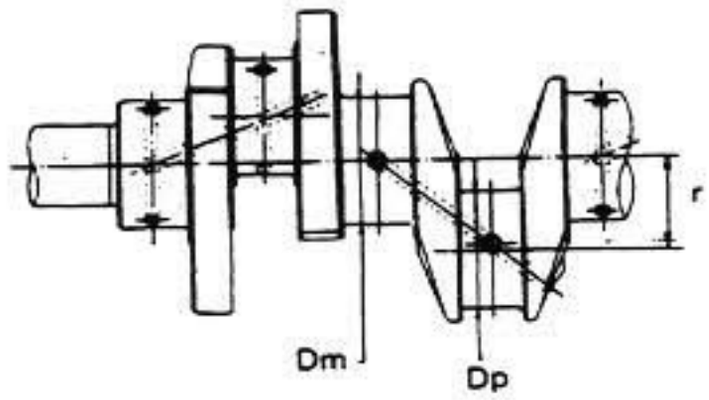
Unit: mm (in)

Engine model		L28	P40
Center distance		130.35 (5.13)	200 (7.87)
Bend, torsion [per 100 mm (3.94 in)]	Standard	Less than 0.025 (0.0010)	Less than 0.025 (0.0010)
	Limit	0.05 (0.0020)	0.05 (0.0020)
Piston pin bore dia.		20.965 - 20.978 (0.8254 - 0.8259)	20.618 - 20.630 (0.8117 - 0.8122)
Big end play	Standard	0.2 - 0.3 (0.008 - 0.012)	0.15 - 0.28 (0.0059 - 0.0110)
	Limit	0.6 (0.024)	0.6 (0.024)

CRANKSHAFT

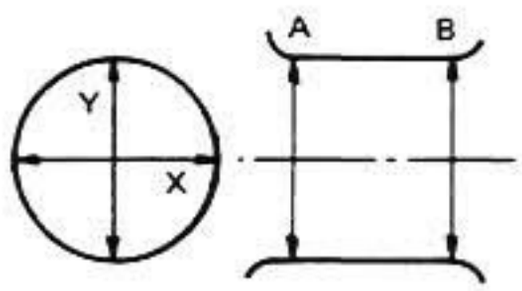
Unit: mm (in)

Engine model		L28	P40
Main journal dia. "Dm"		54.942 - 54.955 (2.1631 - 2.1636)	69.275 - 69.300 (2.7274 - 2.7283)
Pin journal dia. "Dp"		49.961 - 49.974 (1.9670 - 1.9675)	57.131 - 57.150 (2.2492 - 2.2500)
Center distance "r"		39.50 (1.5551)	57.150 (2.2500)
Out-of-round (X-Y) and taper (A-B)	Standard	Less than 0.01 (0.0004)	Less than 0.01 (0.0004)
	Limit	0.03 (0.0012)	0.03 (0.0012)
Bend [T.I.R.]	Standard	Less than 0.05 (0.0020)	Less than 0.075 (0.0030)
	Limit	0.10 (0.0039)	0.10 (0.0039)
Free end play	Standard	0.05 - 0.18 (0.0020 - 0.0071)	0.08 - 0.20 (0.0031 - 0.0079)
	Limit	0.30 (0.0118)	0.30 (0.0118)
Pilot bushing insert distance		Approximately 4.0 (0.157)	Approximately 0.6 (0.024)



EM737

Out-of-round X-Y
Taper A-B



EM715

BEARING

Bearing clearance

Unit: mm (in)

Engine model		L28	P40
Main bearing clearance	Standard	0.020 - 0.072 (0.0008 - 0.0028)	0.030 - 0.106 (0.0012 - 0.0042)
	Limit	0.12 (0.0047)	0.12 (0.0047)
Connecting rod bearing clearance	Standard	0.014 - 0.066 (0.0006 - 0.0026)	0.014 - 0.068 (0.0006 - 0.0027)
	Limit	0.12 (0.0047)	0.12 (0.0047)

Main bearing undersize

L28 engine

Unit: mm (in)

	Crank journal diameter
Standard	54.942 - 54.955 (2.1631 - 2.1636)
0.25 (0.0098) Undersize	54.692 - 54.705 (2.1532 - 2.1537)
0.50 (0.0197) Undersize	54.442 - 54.455 (2.1434 - 2.1439)
0.75 (0.0295) Undersize	54.192 - 54.205 (2.1335 - 2.1341)

P40 engine

Unit: mm (in)

	Crank journal diameter
Standard	69.275 - 69.300 (2.7274 - 2.7283)
0.12 (0.0047) Undersize	69.155 - 69.180 (2.7226 - 2.7236)
0.25 (0.0098) Undersize	69.025 - 69.050 (2.7175 - 2.7185)
0.50 (0.0197) Undersize	68.775 - 68.800 (2.7077 - 2.7087)
0.75 (0.0295) Undersize	68.525 - 68.550 (2.6978 - 2.6988)
1.00 (0.0394) Undersize	68.275 - 68.300 (2.6880 - 2.6890)
1.25 (0.0492) Undersize	68.025 - 68.050 (2.6781 - 2.6791)
1.50 (0.0591) Undersize	67.775 - 67.800 (2.6683 - 2.6693)

Connecting rod bearing undersize

L28 engine

Unit: mm (in)

	Crank journal diameter
Standard	49.961 - 49.974 (1.9670 - 1.9675)
0.25 (0.0098) Undersize	49.711 - 49.724 (1.9571 - 1.9576)
0.50 (0.0197) Undersize	49.461 - 49.474 (1.9473 - 1.9478)
0.75 (0.0295) Undersize	49.211 - 49.224 (1.9374 - 1.9379)

P40 engine

Unit: mm (in)

	Crank journal diameter
Standard	57.131 - 57.150 (2.2492 - 2.2500)
0.25 (0.0098) Undersize	56.881 - 56.900 (2.2394 - 2.2402)
0.50 (0.0197) Undersize	56.631 - 56.650 (2.2296 - 2.2303)
0.75 (0.0295) Undersize	56.381 - 56.400 (2.2197 - 2.2205)
1.00 (0.0394) Undersize	56.131 - 56.150 (2.2099 - 2.2106)

MISCELLANEOUS COMPONENTS

Unit: mm (in)

Engine model	L28	P40
Camshaft sprocket Runout [T.I.R.]	Less than 0.1 (0.004)	Less than 0.08 (0.0031)
Flywheel Runout [T.I.R.]	Less than 0.15 (0.0059)	Less than 0.10 (0.0039)

TIGHTENING TORQUE

L28 engine

Unit		N-m	kg-m	ft-lb
Main bearing cap bolt		44 - 54	4.5 - 5.5	33 - 40
Connecting rod big end nut		44 - 54	4.5 - 5.5	33 - 40
Flywheel bolt (M/T)		137 - 157	14.0 - 16.0	101 - 116
Drive plate bolt (A/T)		137 - 157	14.0 - 16.0	101 - 116
Front cover bolt	M8 (7T)	20 - 29	2.0 - 3.0	14 - 22
	M8 (4T)	12 - 16	1.2 - 1.6	9 - 12
	M6 (4T)	5 - 10	0.5 - 1.0	3.6 - 7.2
Cylinder head		69 - 83	7.0 - 8.5	51 - 61
Cylinder head to front cover bolt		8 - 14	0.8 - 1.4	5.8 - 10.1
Camshaft thrust plate bolt		6 - 10	0.6 - 1.0	4.3 - 7.2
Pivot bushing bolt		78 - 118	8.0 - 12.0	58 - 87
Pivot lock nut		49 - 59	5.0 - 6.0	36 - 43
Camshaft sprocket bolt		127 - 147	13.0 - 15.0	94 - 108
Chain guide bolt		6 - 10	0.6 - 1.0	4.3 - 7.2
Chain tensioner bolt		6 - 10	0.6 - 1.0	4.3 - 7.2
Oil pump bolt		11 - 15	1.1 - 1.5	8 - 11

Unit		N·m	kg-m	ft-lb
Water pump bolt	M8	12 - 16	1.2 - 1.6	9 - 12
	M6	5 - 10	0.5 - 1.0	3.6 - 7.2
Water pump pulley stud		6 - 10	0.6 - 1.0	4.3 - 7.2
Water inlet bolt		10 - 16	1.0 - 1.6	7 - 12
Crank pulley bolt		118 - 157	12.0 - 16.0	87 - 116
Oil strainer bolt		10 - 16	1.0 - 1.6	7 - 12
Oil pan bolt		6 - 10	0.6 - 1.0	4.3 - 7.2
Oil pan drain plug		20 - 29	2.0 - 3.0	14 - 22
Clutch cover bolt		20 - 29	2.0 - 3.0	14 - 22
Rocker cover bolt		10 - 16	1.0 - 1.6	7 - 12
Spark plug		15 - 20	1.5 - 2.0	11 - 14
Manifold Bolt and Nut	M8 Bolt	15 - 25	1.5 - 2.5	11 - 18
	M8 Nut	12 - 16	1.2 - 1.6	9 - 12
Water outlet bolt		12 - 20	1.2 - 2.0	9 - 14
Thermostat housing		10 - 16	1.0 - 1.6	7 - 12
Distributor support bolt		4 - 8	0.4 - 0.8	2.9 - 5.8
Oil pressure sending unit		10 - 16	1.0 - 1.6	7 - 12
Alternator bracket		39 - 59	4.0 - 6.0	29 - 43
Alternator to adjusting bar bolt		20 - 29	2.0 - 3.0	14 - 22
Engine mounting bracket		69 - 81	7.0 - 8.3	51 - 60
Carburetor nut		12 - 18	1.2 - 1.8	9 - 13
Fuel pump nut		12 - 18	1.2 - 1.8	9 - 13

P40 engine

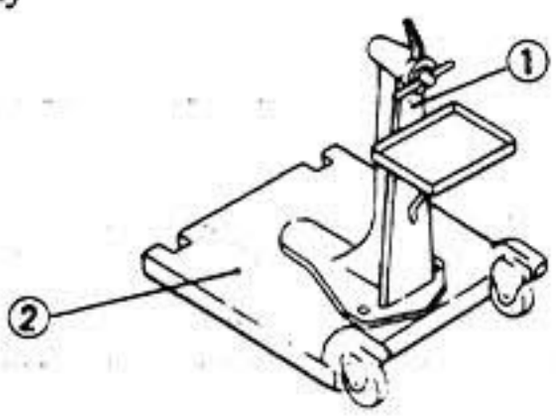
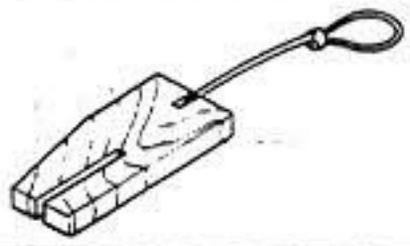
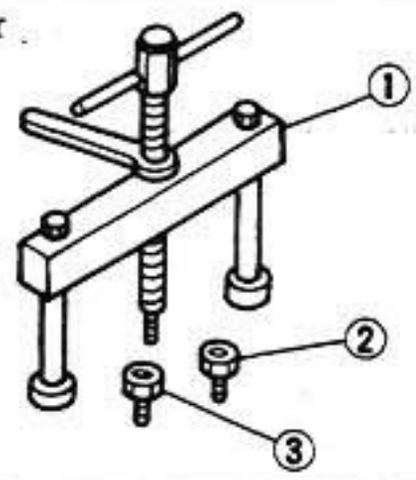
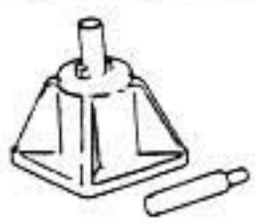
Unit		N·m	kg-m	ft-lb
Main bearing cap bolt		98 - 118	10.0 - 12.0	72 - 87
Connecting rod big end nut		44 - 59	4.5 - 6.0	33 - 43
Flywheel bolt		78 - 98	8.0 - 10.0	58 - 72
Front cover bolt	M10 (7T)	30 - 40	3.1 - 4.1	22 - 30
	M8 (4T)	11 - 21	1.1 - 2.1	8 - 15
Front plate bolt		30 - 40	3.1 - 4.1	22 - 30
Flywheel housing bolt		51 - 73	5.2 - 7.4	38 - 54
Cylinder head bolt		69 - 88	7.0 - 9.0	51 - 65
Rocker shaft bracket bolt		34 - 48	3.5 - 4.9	25 - 35
Valve rocker adjusting screw		30 - 38	3.1 - 3.9	22 - 28
Camshaft sprocket bolt		30 - 40	3.1 - 4.1	22 - 30
Camshaft locating plate bolt		6 - 8	0.6 - 0.8	4.3 - 5.8
Oil pump bolt		25 - 34	2.5 - 3.5	18 - 25
Water pump bolt and nut		25 - 34	2.5 - 3.5	18 - 25
Crank pulley nut		149 - 163	15.2 - 16.6	110 - 120
Oil pan bolt and nut		15 - 20	1.5 - 2.0	11 - 14
Oil pan drain plug		20 - 39	2.0 - 4.0	14 - 29
Rocker cover nut		18 - 27	1.8 - 2.8	13 - 20
Spark plug		18 - 24	1.8 - 2.4	13 - 17
Manifold bolt and nut		25 - 34	2.5 - 3.5	18 - 25
Water outlet bolt		10 - 12	1.0 - 1.2	7 - 9
Thermostat housing		10 - 12	1.0 - 1.2	7 - 9
Distributor support bolt		10 - 12	1.0 - 1.2	7 - 9
Alternator bracket		22 - 29	2.2 - 3.0	16 - 22
Alternator to adjusting bar bolt		14 - 21	1.4 - 2.1	10 - 15
Engine mounting bracket		36.7 - 49.6	3.74 - 5.06	27.1 - 36.6
Carburetor nut		14 - 18	1.4 - 1.8	10 - 13
Fuel pump nut		11 - 21	1.1 - 2.1	8 - 15

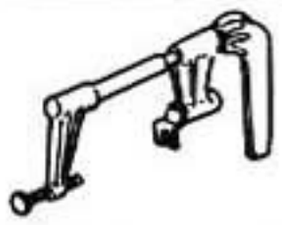
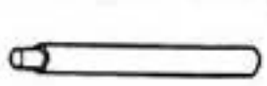
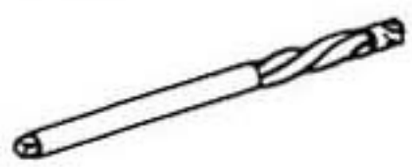
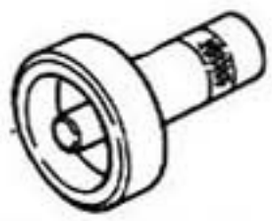
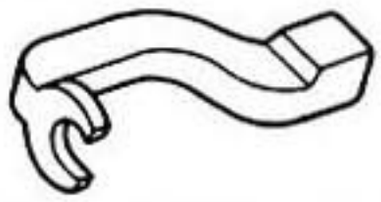
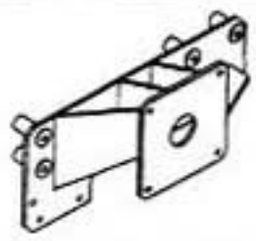
TROUBLE DIAGNOSES AND CORRECTIONS

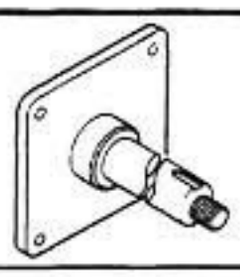
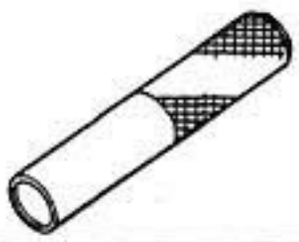
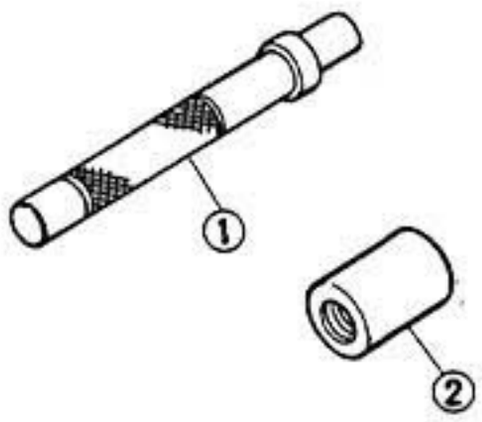
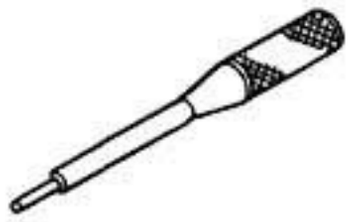
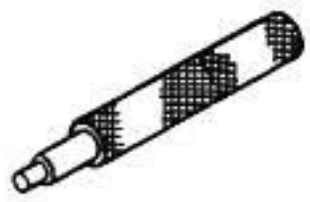
Condition	Probable cause	Corrective action
I. Noisy engine		
Piston and connecting rod knocking.	Seized piston pin.	Replace piston with pin.
	Seized piston in cylinder.	Recondition cylinder and replace piston with pin.
	Broken piston ring.	Replace ring and/or recondition cylinder.
	Improper connecting rod alignment.	Realign or replace connecting rod.
	Seized or loose connecting rod bearing.	Replace.
Knocking of crankshaft and bearing.	Seized or loose main bearing	Replace.
	Bent crankshaft.	Repair or replace.
	Uneven wear of journal.	Correct.
	Excessive crankshaft end play.	Replace center bearing.
Timing chain noise.	Improper chain tension.	Adjust.
	Worn and/or damaged chain.	Replace.
	Worn sprocket.	Replace.
	Worn and/or broken chain guide and/or tension adjusting mechanism.	Replace.
	Excessive camshaft 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.	Replace.
Camshaft knocking.	Excessive camshaft clearance.	Replace.
	Excessive axial play.	Replace thrust plate.
	Worn cam gear.	Replace.
Water pump knocking.	Improper shaft end play.	Replace water pump assembly.
	Broken impeller.	Replace water pump assembly.
II. Other mechanical troubles		
Stuck valve.	Improper valve clearance.	Adjust.
	Insufficient clearance between valve stem and guide.	Clean stem or ream guide.
	Weakened or broken valve spring.	Replace.
	Seized or damaged valve stem.	Replace or clean.
	Poor quality fuel.	Use good fuel.

Condition	Probable cause	Corrective action
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.
	Stuck valve guide.	Repair or replace.
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 proper oil.
	Overheating	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.
	Mixture too lean.	Adjust carburetor mixture ratio and check intake air leakage.
	Engine over run.	Drive at proper speeds.
Faulty connecting rod.	Shortage of engine oil.	Add oil.
	Low oil pressure.	Correct.
	Poor quality engine oil.	Use proper oil.
	Rough surface of crankshaft.	Repair crankshaft and replace bearing.
	Clogged oil passage.	Clean.
	Bearing worn or eccentric.	Replace.
	Bearing improperly assembled.	Correct.
	Loose bearing.	Replace.
	Incorrect connecting rod alignment.	Repair or replace.
Faulty crankshaft bearing.	Shortage of engine oil.	Add or replace.
	Low oil pressure.	Correct.
	Poor quality engine oil.	Use specified oil.
	Crankshaft journal worn or out-of-round.	Repair.
	Clogged oil passage in crankshaft.	Clean.
	Bearing worn or eccentric.	Replace.
	Bearing improperly assembled.	Correct.
	Eccentric crankshaft or bearing.	Replace.

SPECIAL SERVICE TOOLS

Tool number	Tool name	Unit application	
		L28	P40
ST19320000	Oil filter wrench 	X	X
ST05340001	Engine attachment 	X	–
ST0501S000 ① ST05011000 ② ST05012000	Engine stand assembly Engine stand Base 	X	X
ST16540000	Puller crank pulley 	X	–
KV10105800 (ST17420001)	Chain stopper 	X	–
ST10120000	Cylinder head bolt wrench 	X	–
KV101041S0 ① ST16511000 ② ST16512001 ③ ST16701001	Crankshaft main bearing cap puller Crankshaft main bearing puller Adapter Adapter 	X	–
ST13030001	Piston pin press stand 	X	–

Tool number	Tool name	Unit application	
		L28	P40
ST12070000	Valve lifter 	X	X
KV101039S0 ① ST11081000 ② ST11032000 ③ ST11320000	Valve guide reamer set ①  Reamer [12.2 mm (0.480 in) dia.] ②  Reamer [8.0 mm (0.315 in) dia.] Drift ③ 	X	–
HT56900870	Valve guide reamer 	–	X
ST11650001	Valve seat cutter set 	X	X
ST16610001	Pilot bushing puller 	X	–
KV10105500 (ST15310000)	Crankshaft rear oil seal drift 	X	–
EM03470000	Piston ring compressor 	X	X
ST10640001	Pivot adjuster 	X	–
KV30100100	Clutch aligning bar 	X	–
KV10106400	Engine attachment 	–	X

Tool number	Tool name	Unit application	
		L28	P40
KV10106500	Engine stand shaft 	–	X
ST13050000	Piston pin press stand 	–	X
KV10106700	Valve oil seal drift 	–	X
ST1130S000 ① ST11301000 ② ST11302000	Valve rocker bushing drift Drift Bushing support ring 	–	X
KV10106600	Valve guide drift 	–	X
ST16120000	Camshaft bearing drift 	–	X
ST16520000	Crankshaft main bearing cap puller 	–	X
ST16640000	Pilot bushing puller 	–	X
KV30100600	Clutch aligning bar 	–	X