

ENGINE MECHANICAL

SECTION **EM**



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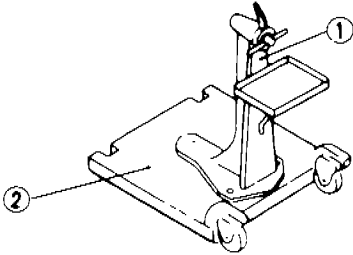
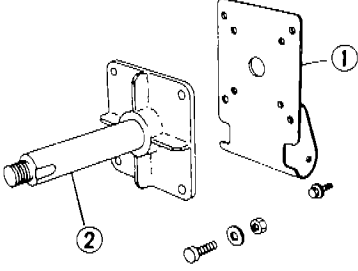
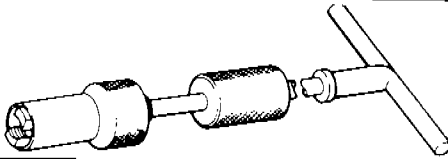
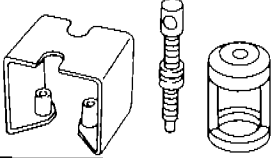
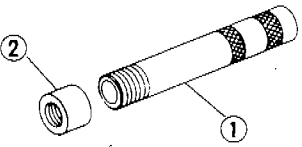
ENGINE REMOVAL EM-31

CYLINDER BLOCK EM-33

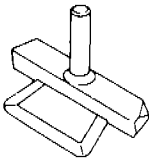
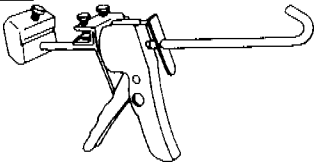
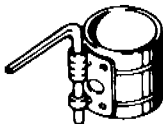
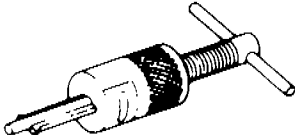
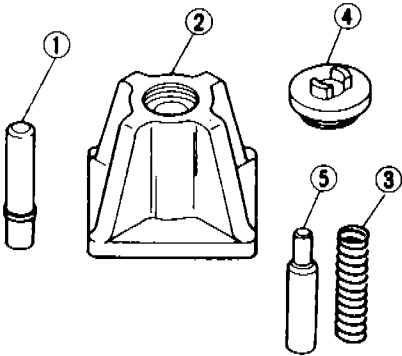
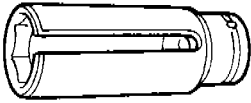
SERVICE DATA AND SPECIFICATIONS (S.D.S.) EM-44

PREPARATION

SPECIAL SERVICE TOOLS

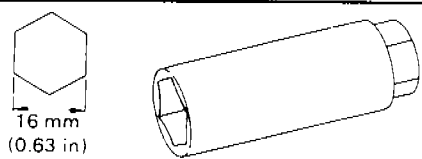
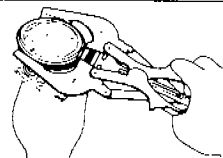
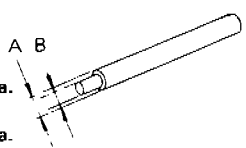
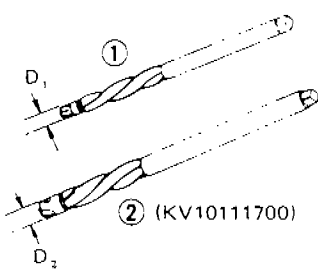
Tool number Tool name	Description
ST0501S000 Engine stand assembly ① ST05011000 Engine stand ② ST05012000 Base	 When overhauling engine
Engine attachment assembly ① KV10108101 Engine attachment ② KV10106500 Sub-attachment	
KV10107901 Valve lip seal puller	 Displacement valve lip seal
KV10111300 Valve spring compressor	 Disassembling and assembling valve components
① KV10107501 Valve lip seal drift ② KV10111400 Valve oil seal drift attachment	 Installing valve lip seal

PREPARATION

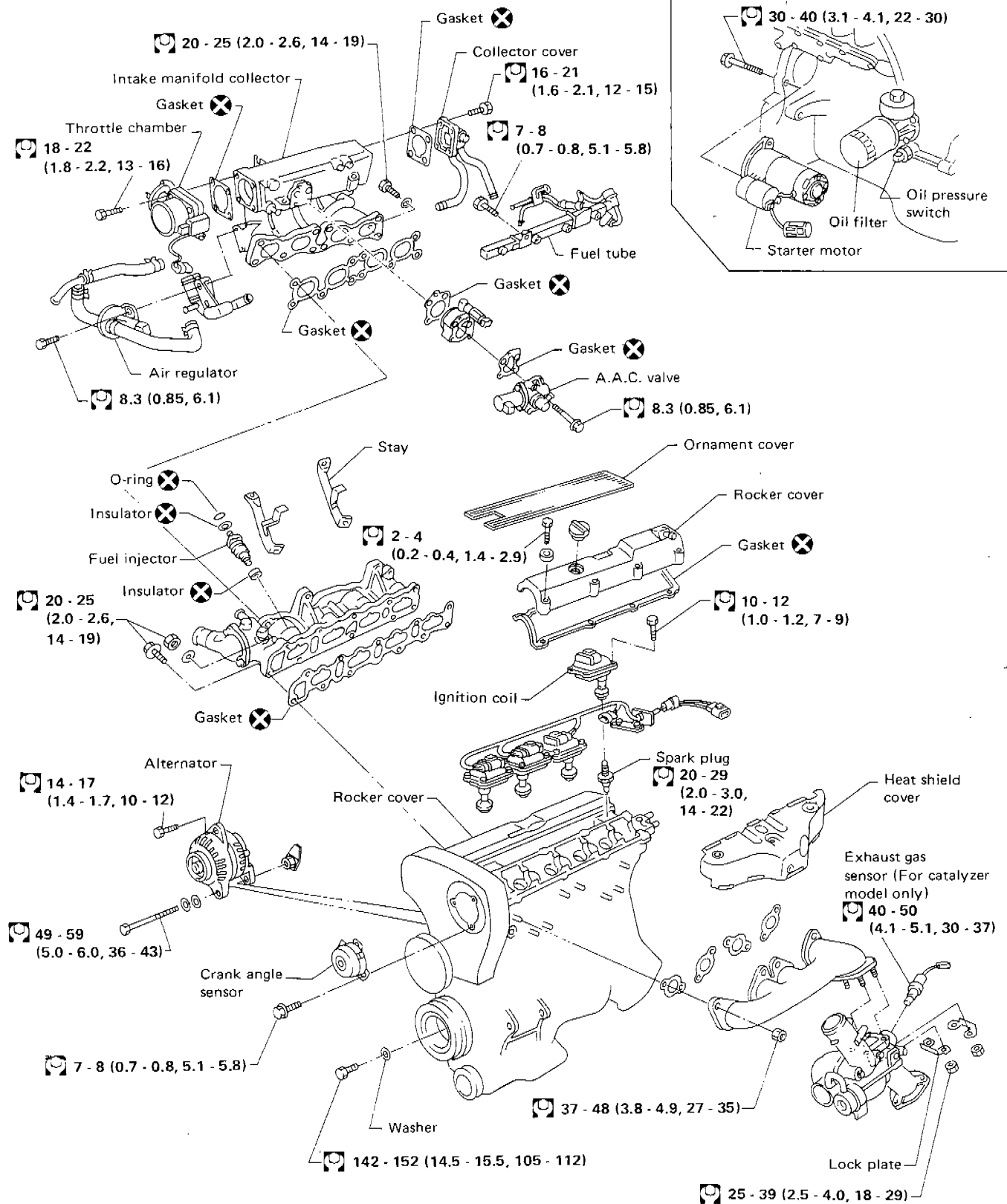
Tool number Tool name	Description
KV10111100 Seal cutter	 Removing oil pan
WS39930000 Tube presser	 Pressing the tube of liquid gasket
EM03470000 Piston ring compressor	 Installing piston assembly into cylinder bore
ST16610001 Pilot bushing puller	 Removing crankshaft pilot bushing
KV101070S0 Piston pin press stand ① KV10107010 Center shaft ② ST13030020 Stand ③ ST13030030 Spring ④ KV10107020 Cap ⑤ ST13030051 Drift	 Disassembling and assembling piston with connecting rod
KV10113700 Exhaust gas sensor wrench	 Removing and installing exhaust gas sensor

PREPARATION

COMMERCIAL SERVICE TOOLS

Tool name	Description
Spark plug wrench	 16 mm (0.63 in) Removing and installing spark plug
Pulley holder	 Holding camshaft pulley while tightening or loosening camshaft bolt
Valve seat cutter set	 Finishing valve seat dimensions
Piston ring expander	 Removing and installing piston ring
Valve guide drift	Intake & Exhaust: A = 9.5 mm (0.374 in) dia. B = 5.5 mm (0.217 in) dia.  Removing and installing valve guide
Valve guide reamer	 ① D₁ ② (KV10111700) D₂ Intake & Exhaust: D₁ = 6.0 mm (0.236 in) dia. D₂ = 10.2 mm (0.402 in) dia. Reaming cylinder head for oversize valve guide ①. Reaming valve guide inner ②.

OUTER COMPONENT PARTS

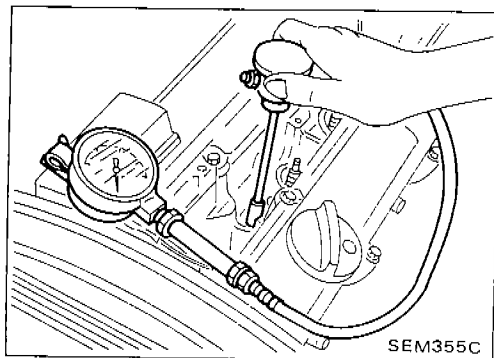
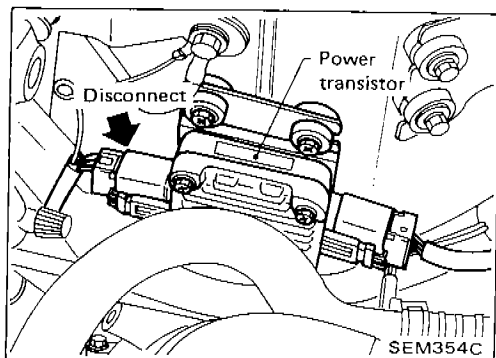


□ : N·m (kg-m, ft-lb)

SEM352C

EM-5

COMPRESSION PRESSURE



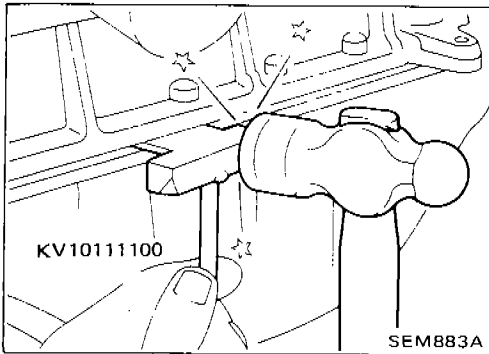
Measurement of Compression Pressure

1. Warm up engine.
 2. Turn ignition switch off.
 3. Release fuel pressure.
Refer to "Releasing Fuel Pressure" in section EF & EC.
 4. Remove all spark plugs.
 5. Disconnect power transistor harness connector.
 6. Attach a compression tester to No. 1 cylinder.
 7. Depress accelerator pedal fully to keep throttle valve wide open.
 8. Crank engine and record highest gauge indication.
 9. Repeat the measurement on each cylinder as shown above.
 - **Always use a fully-charged battery to obtain specified engine revolution.**
- Compression pressure:
- kPa (bar, kg/cm², psi)/rpm
- Standard
1,177 (11.77, 12.0, 171)/350
- Minimum
981 (9.81, 10.0, 142)/350
- Differential limit between cylinders
98 (0.98, 1.0, 14)/350
10. If cylinder compression in one or more cylinders is low, pour a small amount of engine oil into cylinders through spark plug holes and retest compression.
 - **If adding oil helps compression, piston rings may be worn or damaged. If so, replace piston rings after checking piston.**
 - **If pressure stays low, a valve may be sticking or seating improperly. Inspect and repair valve and valve seat. (Refer to S.D.S.) If valve or valve seat is damaged excessively, replace them.**
 - **If compression in any two adjacent cylinders is low and if adding oil does not help compression, there is leakage past the gasket surface. If so, replace cylinder head gasket.**

OIL PAN

Removal

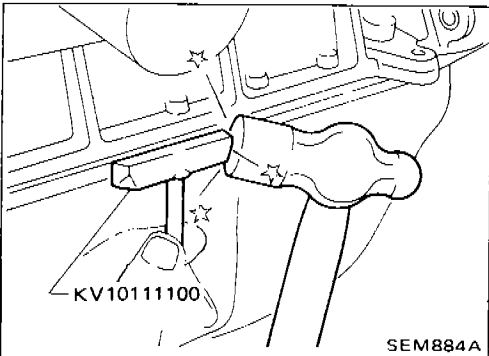
1. Drain engine oil.
2. Remove front stabilizer bar.
3. Loosen front engine mounting nuts. (Do not loosen completely.)
4. Lift up engine slightly using engine slingers.



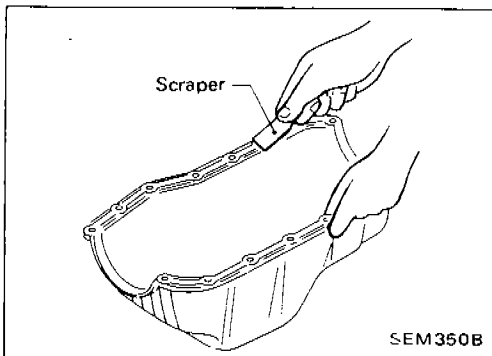
5. Remove oil pan.

(1) Insert Tool between cylinder block and oil pan.

- Do not insert Tool into oil pump or rear oil seal retainer portion, or aluminum mating face will be damaged.
- Do not insert screwdriver, or oil pan flange will be deformed.

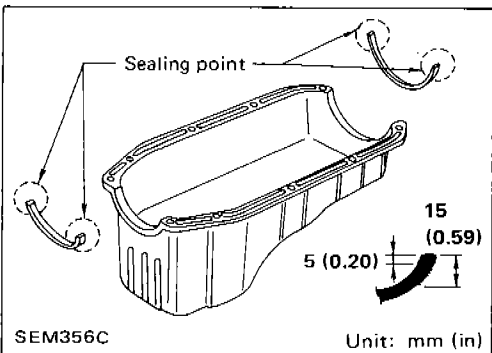


(2) Slide Tool by tapping its side with a hammer, and remove oil pan.



Installation

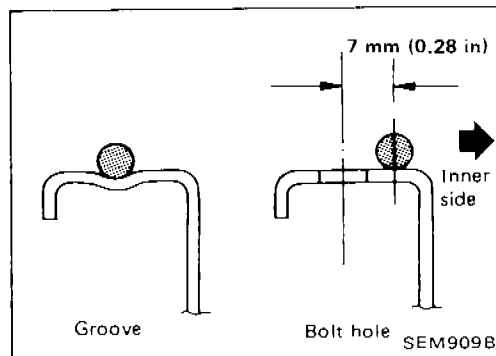
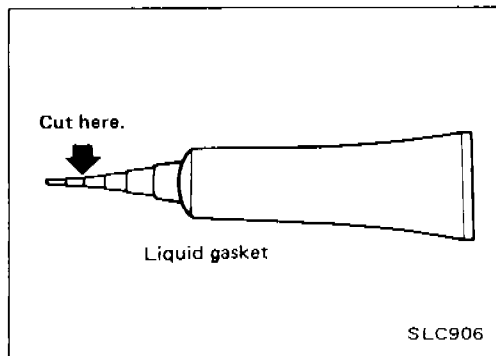
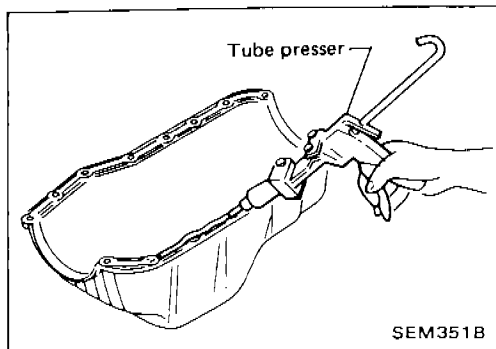
1. Before installing oil pan, remove all traces of liquid gasket from mating surface using a scraper.
 - Also remove traces of liquid gasket from mating surface of cylinder block.



2. Apply liquid gasket to oil pump gasket and rear oil seal retainer gasket.

OIL PAN

Installation (Cont'd)



3. Apply a continuous bead of liquid gasket to mating surface of oil pan.

- Use Genuine Liquid Gasket or equivalent.

- Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) wide.

4. Apply liquid gasket to inner sealing surface as shown in figure.

- Attaching should be done within 5 minutes after coating.

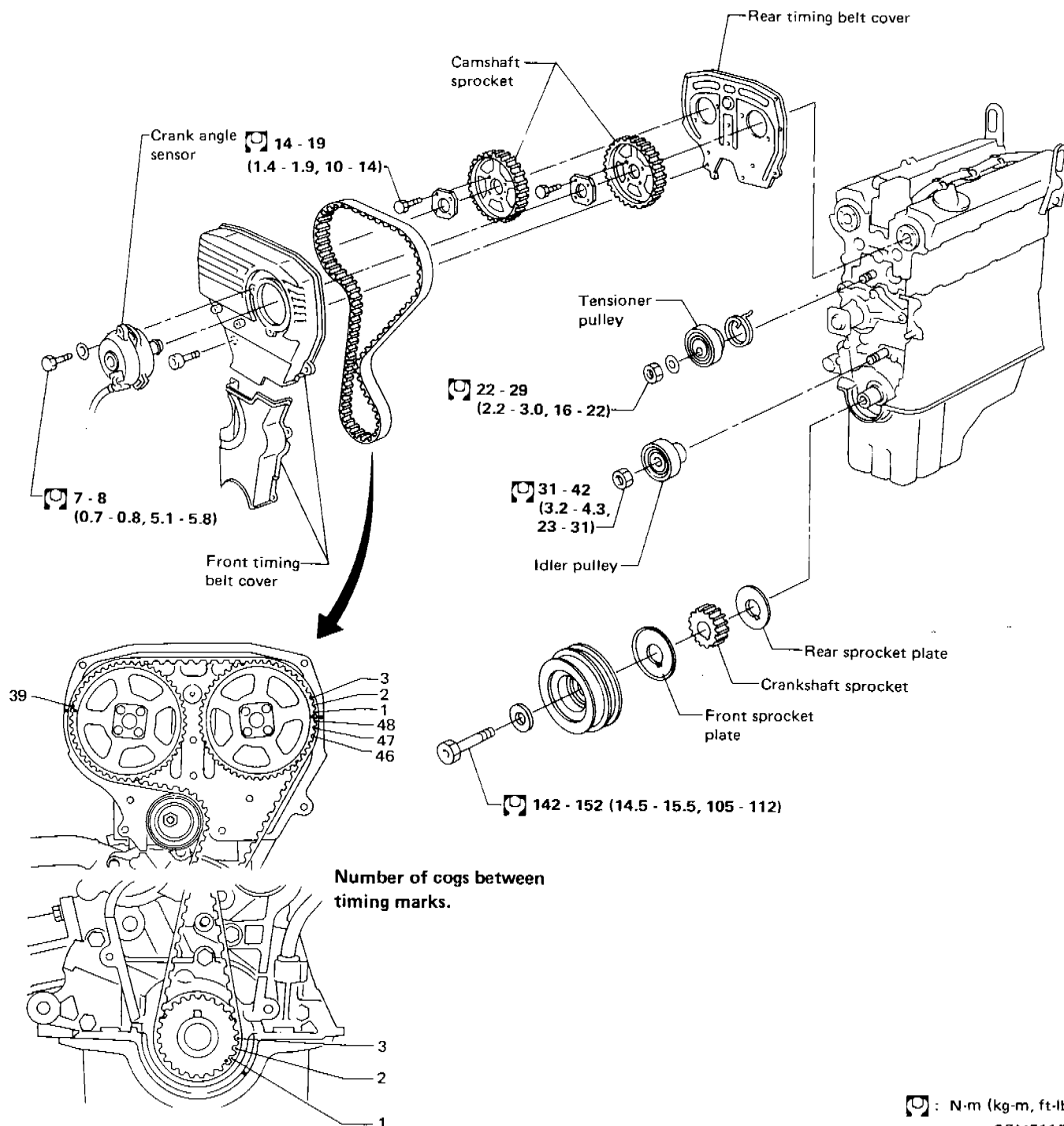
5. Install oil pan.

- Wait at least 30 minutes before refilling engine oil.

TIMING BELT

CAUTION:

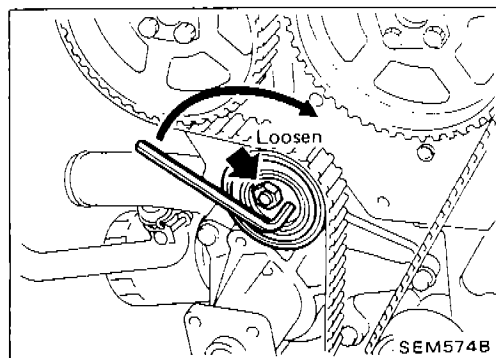
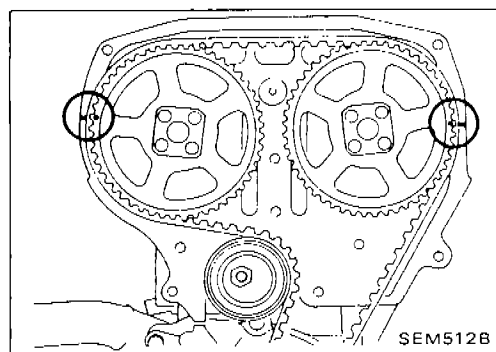
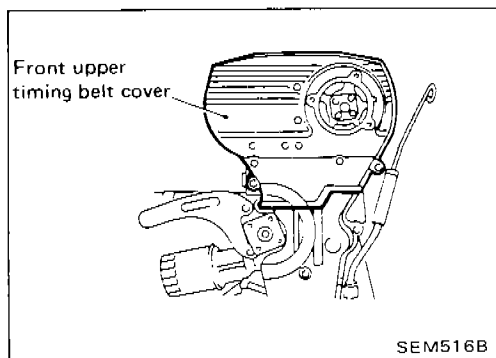
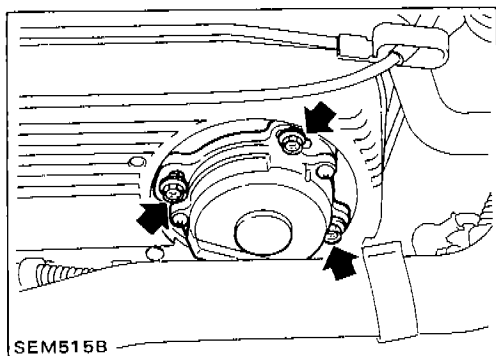
- a. Do not bend or twist timing belt.
- b. After removing timing belt, do not turn crankshaft and camshaft separately because valves will strike piston heads.
- c. Make sure that timing belt, camshaft sprocket, crankshaft sprocket and belt tensioner are clean and free from oil and water.



TIMING BELT

Removal

1. Drain engine coolant from radiator.
 2. Remove air duct, upper radiator hose, radiator shroud and under cover.
 3. Remove the following belts.
 - Power steering pump drive belt
 - Compressor drive belt
 - Alternator drive belt
 4. Remove water pump pulley, fan and fan coupling.
 5. Remove crank angle sensor.
- Put aligning mark on crank angle sensor and timing belt cover.**

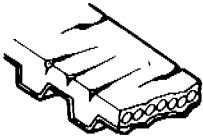
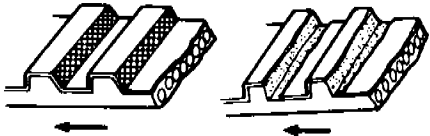


6. Remove front upper timing belt cover.
7. Remove all spark plugs.
8. Set No. 1 piston at T.D.C. on its compression stroke.
9. Remove crankshaft pulley.
10. Remove front lower timing belt cover.
11. Loosen timing belt tensioner nut, turn tensioner, then remove timing belt.

TIMING BELT

Inspection

Visually check the condition of timing belt.
Replace if any abnormality is found.

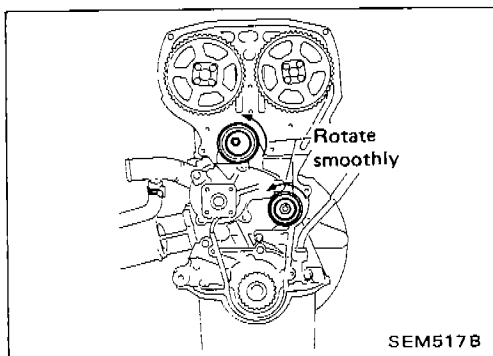
Item to check	Problem	Cause
Tooth is broken/ tooth root is cracked.	 SEM394A	• Camshaft jamming • Distributor jamming • Damaged camshaft/crankshaft oil seal
Back surface is cracked/worn.	 SEM395A	• Tensioner jamming • Overheated engine • Interference with belt cover
Side surface is worn.	 SEM396A • Belt corners are worn and round. • Wicks are frayed and coming out.	• Improper installation of belt • Malfunctioning crankshaft pulley plate/ timing belt plate
Teeth are worn.	 Rotating direction SEM397A • Canvas on tooth face is worn down. • Canvas on tooth is fluffy, rubber layer is worn down and faded white, or weft is worn down and invisible.	• Poor belt cover sealing • Coolant leakage at water pump • Camshaft not functioning properly • Distributor not functioning properly • Excessive belt tension
Oil/Coolant or water is stuck to belt.		• Poor oil sealing of each oil seal • Coolant leakage at water pump • Poor belt cover sealing

TIMING BELT

Inspection (Cont'd)

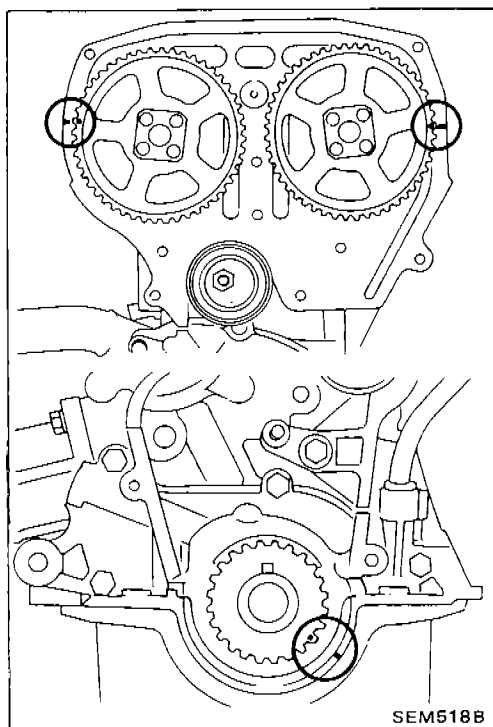
BELT TENSIONER, IDLER PULLEY AND TENSIONER SPRING

1. Check belt tensioner and idler pulley for smooth turning.
2. Check condition of tensioner spring.

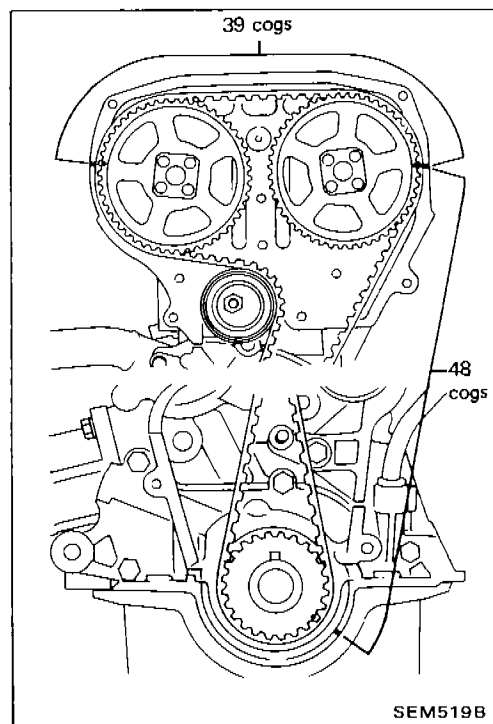


Installation

1. Confirm that No. 1 piston is set at T.D.C. on its compression stroke.
2. Install tensioner and tensioner spring.
 - Turn tensioner fully clockwise with hexagon wrench, and temporarily tighten lock nut.

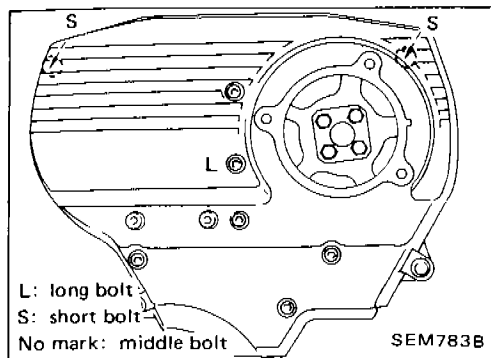
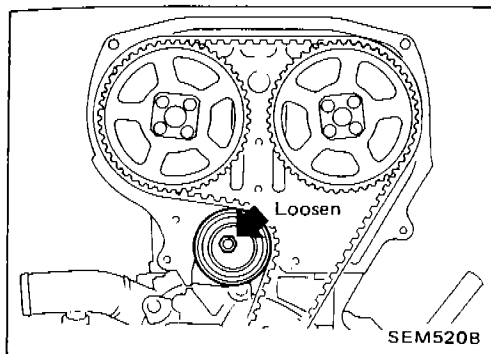


3. Set timing belt.
Align timing marks on timing belt and sprockets.



TIMING BELT

Installation (Cont'd)



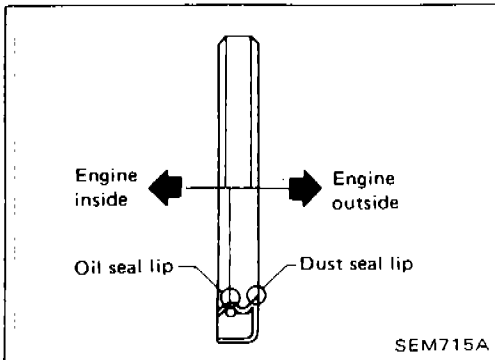
4. Loosen tensioner lock nut, keeping tensioner steady with hexagon wrench.
5. Rotate crankshaft at least two turns clockwise.
6. Adjust belt tension.
Slowly swing tensioner with hexagon wrench clockwise and counterclockwise two or three times.
7. Tighten tensioner lock nut.

8. Install lower and upper timing belt covers.

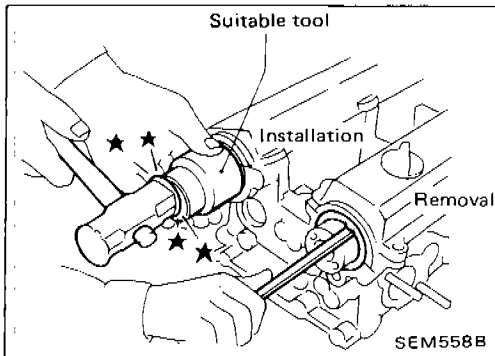
9. Install crankshaft pulley with washer.
10. Install engine mount bracket.
11. Install crank angle sensor and water pump pulley.

Align marks on crank angle sensor and front cover that were made when crank angle sensor was removed.

OIL SEAL REPLACEMENT

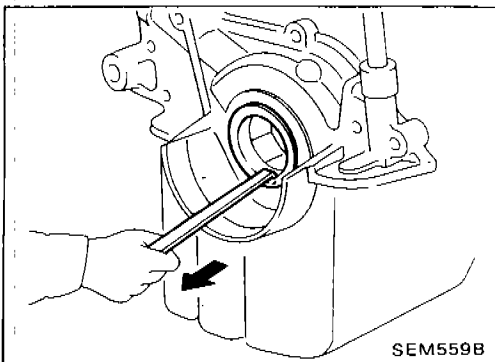


OIL SEAL INSTALLING DIRECTION



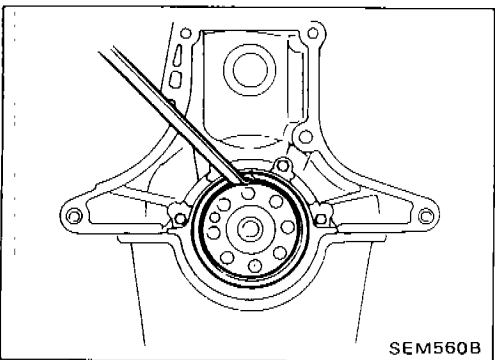
CAMSHAFT OIL SEAL

1. Set No. 1 piston at T.D.C. on its compression stroke.
 2. Remove crank angle sensor, front cover, timing belt, camshaft sprockets and rear dust cover.
 3. Remove camshaft oil seal.
- Be careful not to scratch camshaft.**
4. Apply engine oil to camshaft oil seal lip and install it in place.



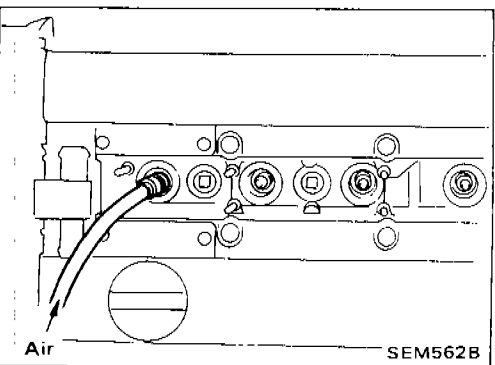
FRONT OIL SEAL

1. Set No. 1 piston at T.D.C. on its compression stroke.
2. Remove timing belt and crankshaft sprocket.
3. Remove front oil seal.
4. Apply engine oil to oil seal lip and install it in place using suitable tool.



REAR OIL SEAL

1. Remove transmission and flywheel.
2. Remove rear oil seal from the retainer.
3. Apply engine oil to oil seal lip and install it in place using suitable tool.



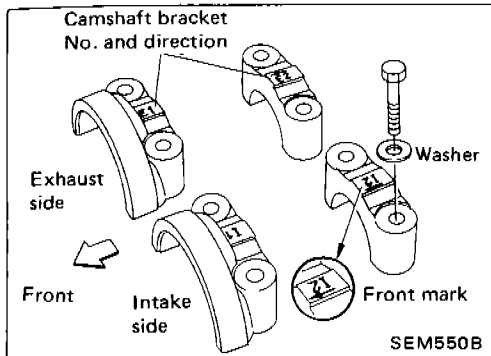
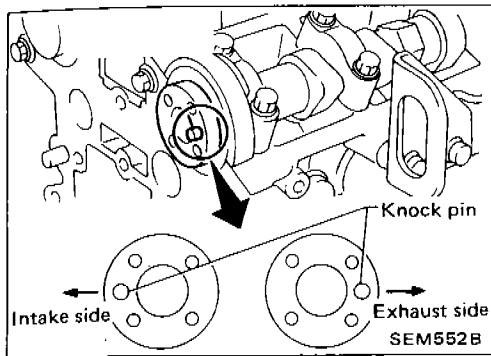
VALVE OIL SEAL

1. Set No. 1 piston at T.D.C. on its compression stroke.
2. Remove throttle chamber and rocker covers.
3. Remove camshafts and valve lifters.
4. Remove spark plug.
5. Install air hose adapter into spark plug hole and apply air pressure to hold valves in place. [Apply pressure of 490 kPa (4.9 bar, 5 kg/cm², 71 psi)].

CYLINDER HEAD

Assembly (Cont'd)

Install camshaft as shown.



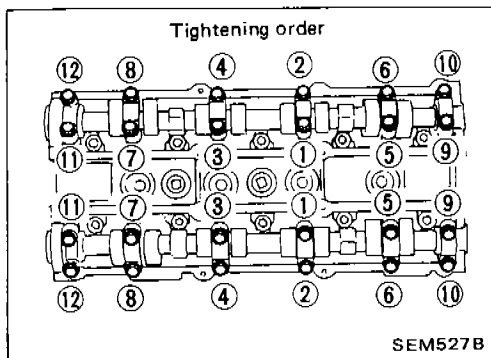
3. Install camshaft brackets.

Front mark is punched on the camshaft bracket.

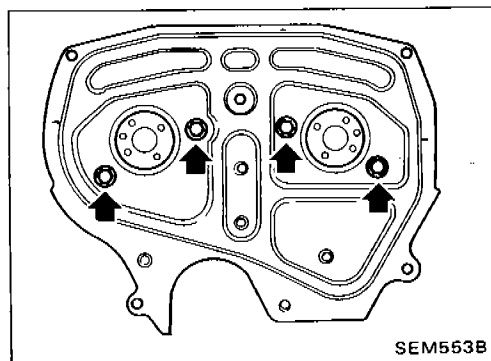
4. Apply engine oil to camshaft oil seal lip and install it in place.

Always use new camshaft oil seal.

$\square$: 9 - 12 N·m (0.9 - 1.2 kg-m, 6.5 - 8.7 ft-lb)

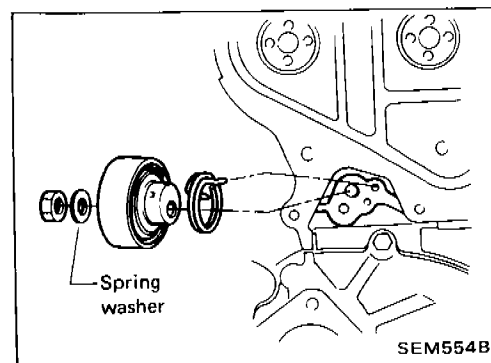


Tighten camshaft bracket bolts gradually in two or three stages.



5. Install rear timing cover.

$\square$: 7 - 8 N·m (0.7 - 0.8 kg-m, 5.1 - 5.8 ft-lb)



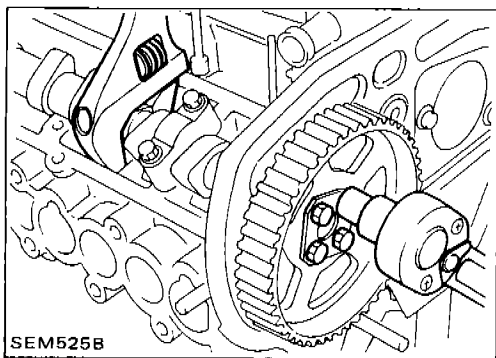
6. Install timing belt tensioner.

Tensioner nut:

$\square$: 22 - 29 N·m (2.2 - 3.0 kg-m, 16 - 22 ft-lb)

CYLINDER HEAD

Assembly (Cont'd)



7. Install camshaft sprockets.

Sprocket bolt:

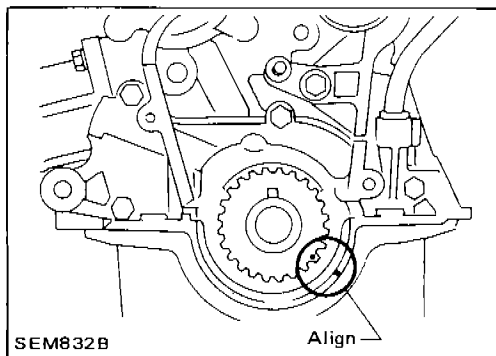
: 14 - 19 N·m (1.4 - 1.9 kg-m, 10 - 14 ft-lb)

When tightening bolts, fix camshaft to prevent it from rotating.

8. Adjust timing belt tension.

Refer to TIMING BELT.

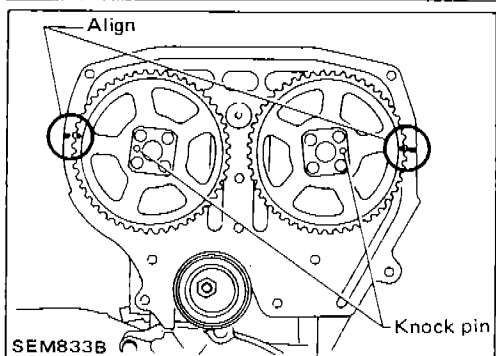
9. Reinstall remaining parts.



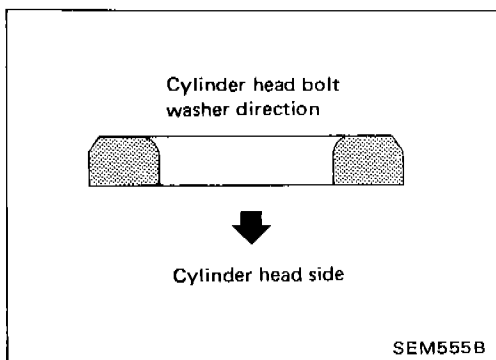
Installation

1. Set No. 1 piston at T.D.C. on its compression stroke as follows:

- (1) Align crankshaft sprocket aligning mark with mark on oil pump body.



- (2) Align camshaft sprocket aligning mark with mark on timing belt rear cover.



2. Install cylinder head with new gasket.

- Be sure to install washers between bolts and cylinder head.
- Do not rotate crankshaft and camshaft separately, or valves will hit piston heads.

TURBOCHARGER

Inspection

Condition 1: Low engine power

Probable cause

Air leak at the connection of compressor housing and suction hose/inlet tube, or inlet tube and intake manifold

Corrective action

Correct the connection.

Exhaust gas leak at the connection of turbine housing and exhaust manifold, connecting tube or exhaust outlet

Correct the connection or replace gasket.

By-pass valve is stuck open.

Stuck or worn journal or bearing

Broken shaft

Sludge on back of turbine wheel

Broken turbine wheel

Replace turbocharger assembly.

Condition 2: Excessively high engine power

Probable cause

Disconnected or cracked rubber hose of by-pass valve controller

By-pass valve is stuck closed.

Controller diaphragm is broken.

Corrective action

Correct or replace rubber hose.

Replace turbocharger assembly.

TURBOCHARGER

Inspection (Cont'd)

Condition 3: Excessively high oil consumption or exhaust shows pale blue smoke

Probable cause

Corrective action

Oil leak at the connection of lubricating oil passage

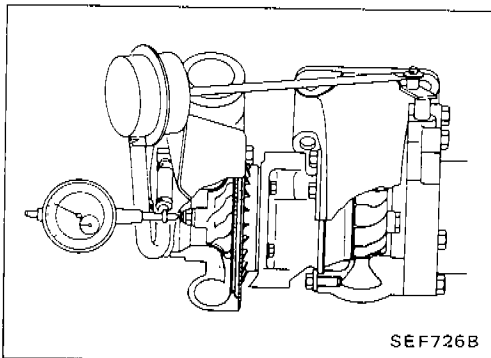
Correct the connection.

Oil leak at oil seal of turbine

Oil leak at oil seal of compressor

Worn journal or bearing

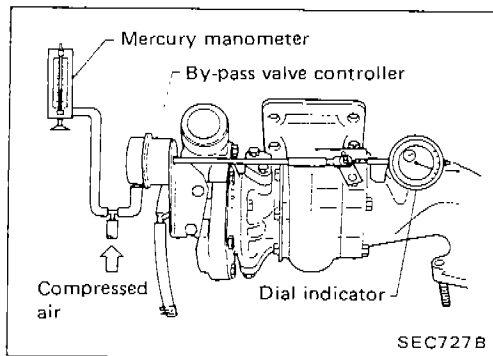
Replace turbocharger assembly.



1. Inspect turbine and compressor wheel as follows:
 - Visually check for cracks, clogging, deformity or other damage.
 - Revolve wheels to make sure that they turn freely without any abnormal noise or friction.
 - Measure play in axial direction.

Play (axial direction):

0.013 - 0.097 mm (0.0005 - 0.0038 in)



2. Check operation of by-pass valve controller.
 - Move by-pass valve to make sure that it is not sticking or scratched.
 - Measure rod end play of the by-pass valve controller.

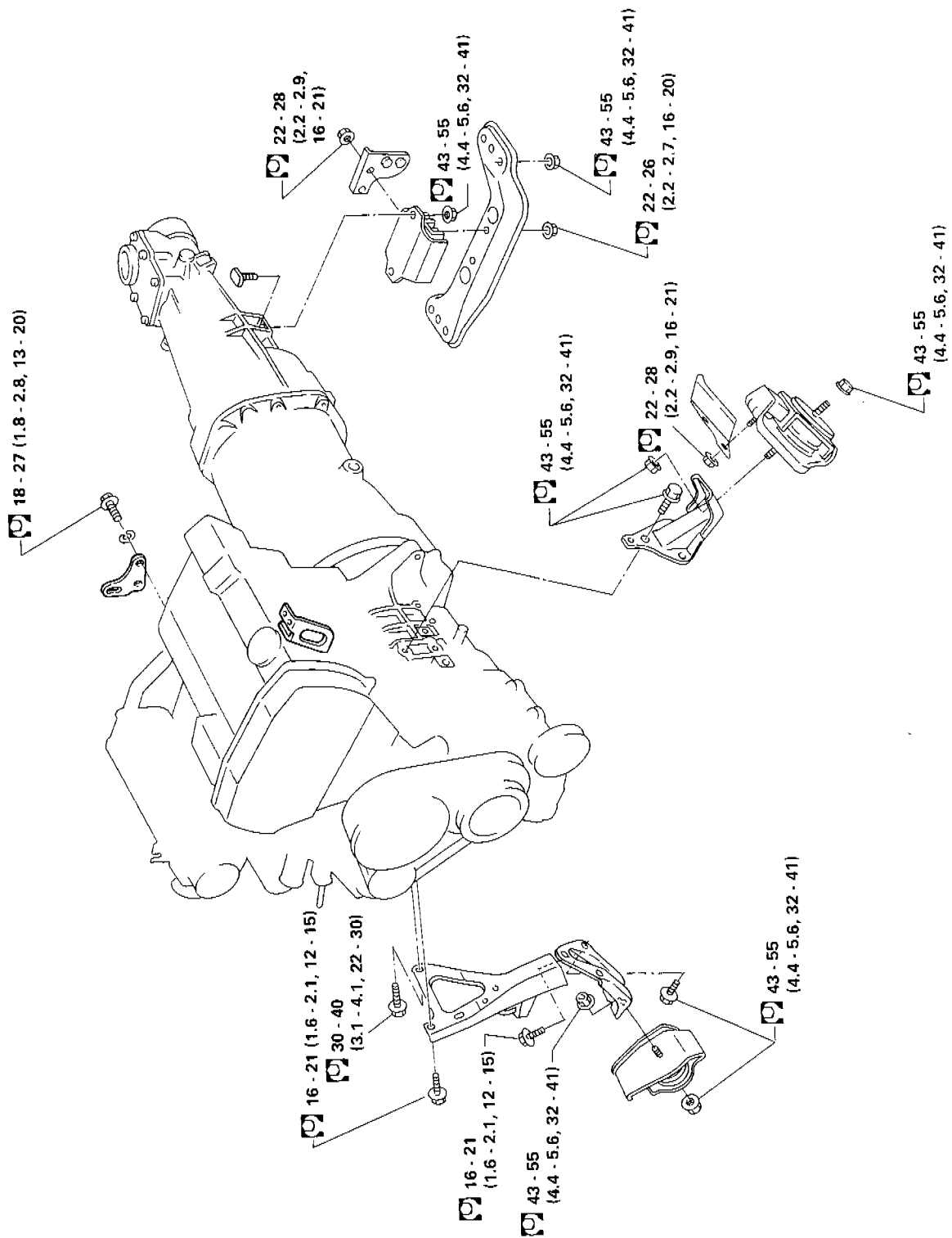
Do not apply excessively high pressure to controller diaphragm.

By-pass valve controller stroke/pressure:

0.38 mm (0.0150 in)/78.6 - 84.0 kPa (786 - 840 mbar,
590 - 630 mmHg, 23.23 - 24.80 inHg)

Always replace the turbocharger as an assembly if necessary.

ENGINE REMOVAL



□ : Nm (kg-m, ft-lb)

SEM358C

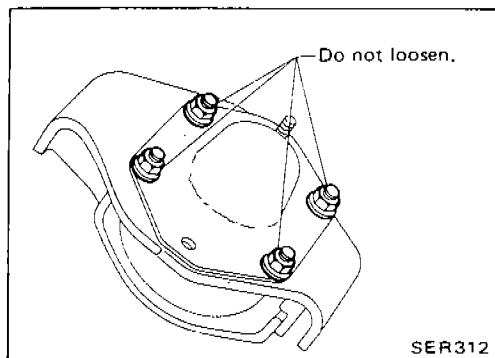
ENGINE REMOVAL

WARNING:

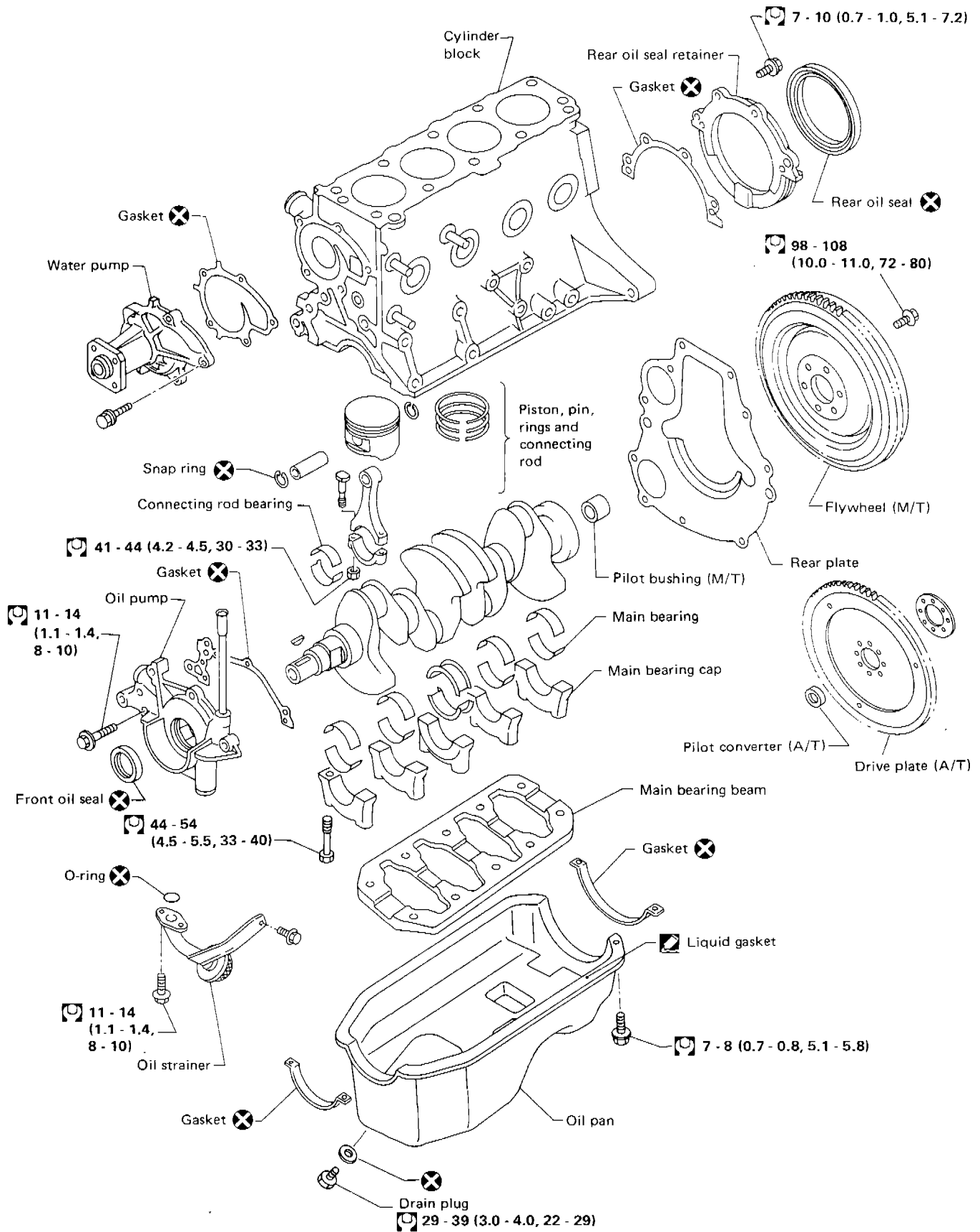
- a. Situate vehicle on a flat and solid surface.
- b. Place chocks at front and back of rear wheels.
- c. Do not remove engine until exhaust system has completely cooled off.
Otherwise, you may burn yourself and/or fire may break out in fuel line.
- d. For safety during subsequent steps, the tension of wires should be slackened against the engine.
- e. Before disconnecting fuel hose, release fuel pressure from fuel line.
Refer to "Releasing Fuel Pressure" in section EF & EC.
- f. Be sure to hoist engine and transmission in a safe manner.
- g. For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.

CAUTION:

- When lifting engine, be careful not to strike adjacent parts, especially accelerator wire casing, brake lines, and brake master cylinder.
- In hoisting the engine, always use engine slingers in a safe manner.
- Do not loosen front engine mounting insulator cover securing nuts.
When cover is removed, damper oil flows out and mounting insulator will not function.
For tightening torque, refer to sections AT, MT and PD.



CYLINDER BLOCK



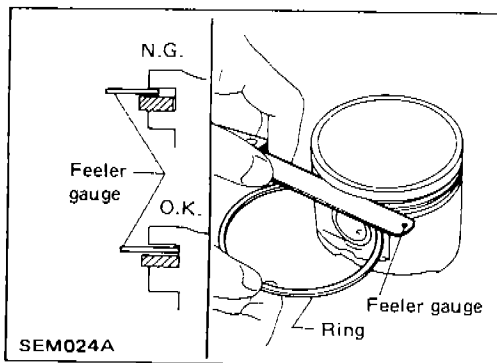
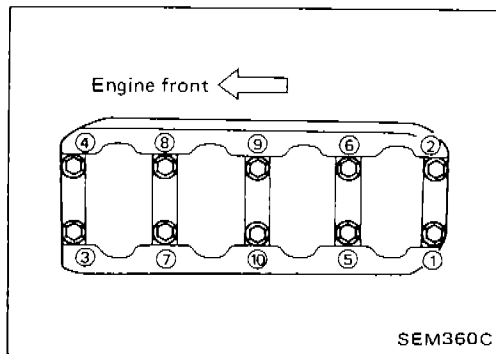
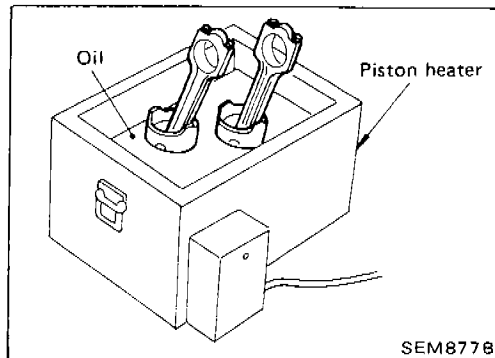
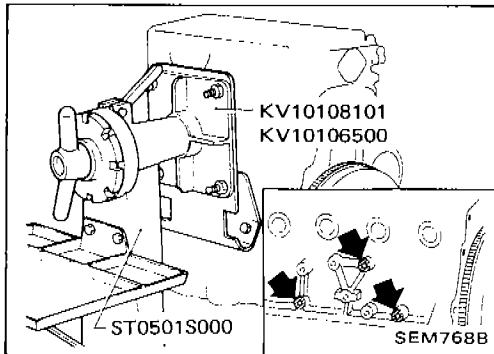
□ : N·m (kg-m, ft-lb)

SEM359C

CYLINDER BLOCK

CAUTION:

- When installing sliding parts such as bearings and pistons, be sure to apply engine oil on the sliding surfaces.
- Place removed parts such as bearings and bearing caps in their proper order and direction.
- When tightening connecting rod bolts and main bearing cap bolts, apply engine oil to thread portion of bolts and seating surface of nuts.



Disassembly

PISTON AND CRANKSHAFT

1. Place engine on a work stand.
2. Remove timing belt.
3. Drain coolant and remove water pump.
4. Drain oil.
5. Remove oil pan and oil pump.
6. Remove cylinder head.
7. Remove pistons.
 - When disassembling piston and connecting rod, remove snap ring first, then heat piston to 60 to 70°C (140 to 158°F) or use piston pin press stand at room temperature.
8. Remove bearing cap and crankshaft.
 - Before removing bearing cap, measure crankshaft end play.
 - Bolts should be loosened in two or three steps.

Inspection

PISTON RING SIDE CLEARANCE

Side clearance:

Top ring

0.040 - 0.073 mm (0.0016 - 0.0029 in)

2nd ring

0.030 - 0.063 mm (0.0012 - 0.0025 in)

Max. limit of side clearance:

0.1 mm (0.004 in)

If out of specification, replace piston and/or piston ring assembly.

CYLINDER BLOCK

Inspection (Cont'd)

PISTON RING END GAP

End gap:

Top ring

0.25 - 0.42 mm (0.0098 - 0.0165 in)

2nd ring

0.38 - 0.64 mm (0.0150 - 0.0252 in)

Oil ring

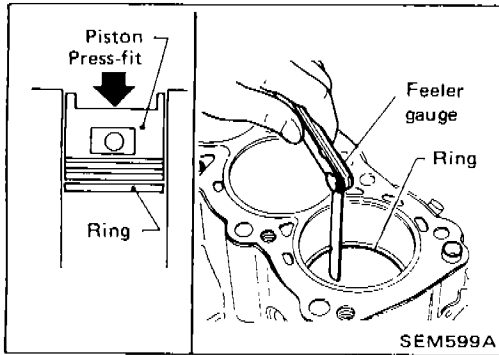
0.20 - 0.76 mm (0.0079 - 0.0299 in)

Max. limit of ring gap:

1.0 mm (0.039 in)

If out of specification, replace piston ring. If gap still exceeds the limit even with a new ring, rebore cylinder and use oversized piston and piston rings.

Refer to S.D.S.



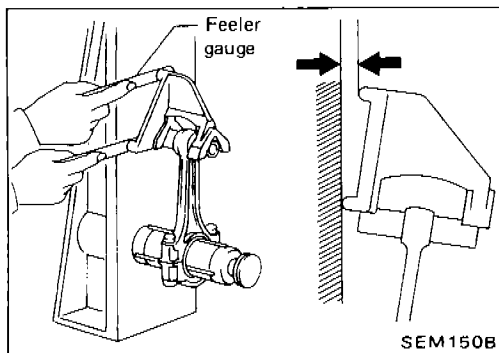
CONNECTING ROD BEND AND TORSION

Bend and torsion:

Limit 0.1 mm (0.004 in)

per 100 mm (3.94 in) length

If it exceeds the limit, replace connecting rod assembly.



CYLINDER BLOCK DISTORTION AND WEAR

1. Clean upper face of cylinder block and measure the distortion.

Limit:

0.10 mm (0.0039 in)

2. If out of specification, resurface it.

The resurfacing limit is determined by cylinder head resurfacing in engine.

Amount of cylinder head resurfacing is "A".

Amount of cylinder block resurfacing is "B".

The maximum limit is as follows:

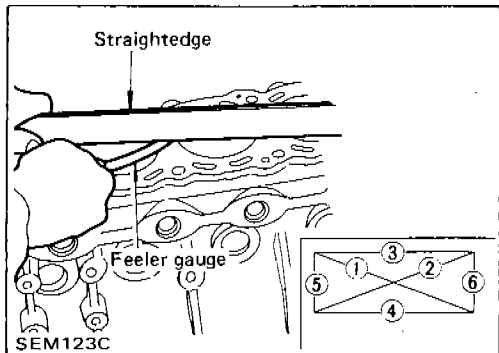
$A + B = 0.2 \text{ mm (0.008 in)}$

Nominal cylinder block height

from crankshaft center:

204.75 - 204.85 mm (8.0610 - 8.0649 in)

3. If necessary, replace cylinder block.



CYLINDER BLOCK

Inspection (Cont'd)

PISTON-TO-BORE CLEARANCE

1. Using a bore gauge, measure cylinder bore for wear, out-of-round and taper.

Standard inner diameter:

83.000 - 83.050 mm (3.2677 - 3.2697 in)

Wear limit:

0.20 mm (0.0079 in)

Out-of-round (X - Y) limit:

0.015 mm (0.0006 in)

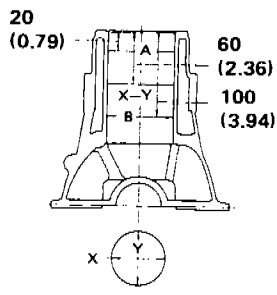
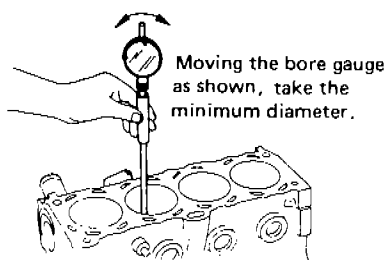
Taper (A - B) limit:

0.010 mm (0.0004 in)

If it exceeds the limit, rebore all cylinders. Replace cylinder block if necessary.

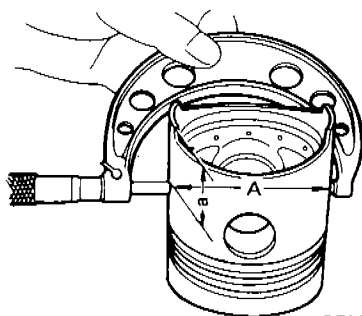
2. Check for scratches and seizure. If seizure is found, hone it.

- If both cylinder block and pistons are replaced with new ones, select pistons having the same piston grade numbers as those punched on the cylinder block upper surfaces.



Unit: mm (in)

SEM792A



SEM990B

3. Measure piston skirt diameter.

Piston diameter "A":

Refer to S.D.S.

Measuring point "a" (Distance from the bottom):

14 mm (0.55 in)

4. Check that piston-to-bore clearance is within specification.

Piston-to-bore clearance "B":

0.015 - 0.035 mm (0.0006 - 0.0014 in)

5. Determine piston oversize according to amount of cylinder wear.

Oversize pistons are available for service.

Refer to S.D.S.

6. Cylinder bore size is determined by adding piston-to-bore clearance to piston diameter "A".

Rebored size calculation:

$$D = A + B - C$$

where,

D: Bored diameter

A: Piston diameter as measured

B: Piston-to-bore clearance

C: Honing allowance 0.02 mm (0.0008 in)

7. Install main bearing caps, and tighten to the specified torque to prevent distortion of cylinder bores in final assembly.
8. Cut cylinder bores.
 - When any cylinder needs boring, all other cylinders must also be bored.
 - Do not cut too much out of cylinder bore at a time. Cut only 0.05 mm (0.0020 in) or so in diameter at a time.
9. Hone cylinders to obtain specified piston-to-bore clearance.
10. Measure finished cylinder bore for out-of-round and taper.
 - Measurement should be done after cylinder bore cools down.

CYLINDER BLOCK

Inspection (Cont'd)

CRANKSHAFT

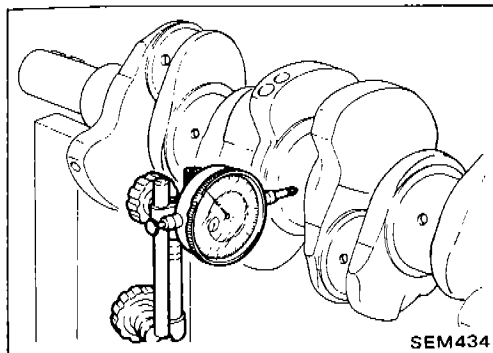
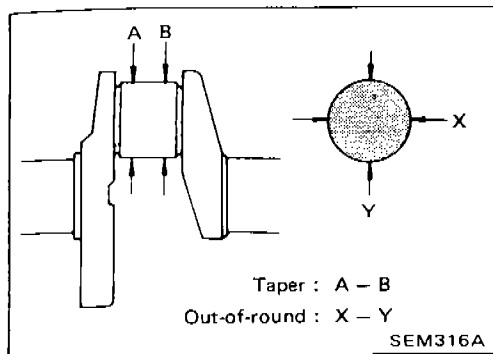
1. Check crankshaft main and pin journals for score, wear or cracks.
2. With a micrometer, measure journals for taper and out-of-round.

Out-of-round ($X - Y$):

Less than 0.005 mm (0.0002 in)

Taper ($A - B$):

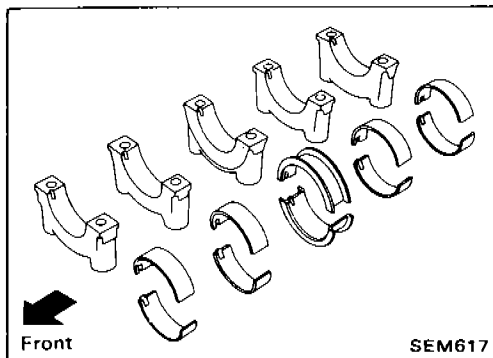
Less than 0.005 mm (0.0002 in)



3. Measure crankshaft runout.

Runout (Total indicator reading):

Less than 0.025 mm (0.0010 in)

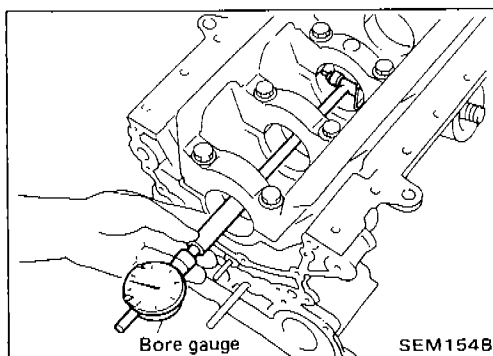


BEARING CLEARANCE

Method A (Using bore gauge & micrometer)

Main bearing

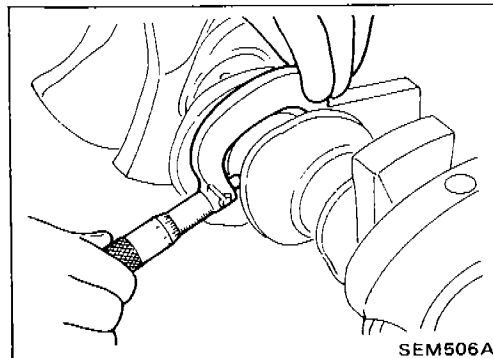
1. Set main bearings in their proper positions on cylinder block and main bearing cap.



2. Install main bearing cap to cylinder block.

Tighten all bolts in correct order in two or three stages.

3. Measure inner diameter "A" of each main bearing.



4. Measure outer diameter "Dm" of each crankshaft main journal.

5. Calculate main bearing clearance.

Main bearing clearance = $A - Dm$

Standard:

0.021 - 0.048 mm (0.0008 - 0.0019 in)

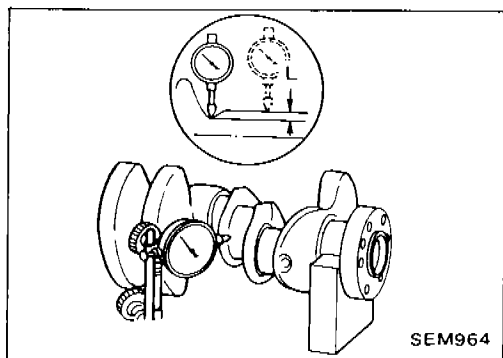
Limit: 0.1 mm (0.004 in)

6. If it exceeds the limit, replace bearing.

7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing.

CYLINDER BLOCK

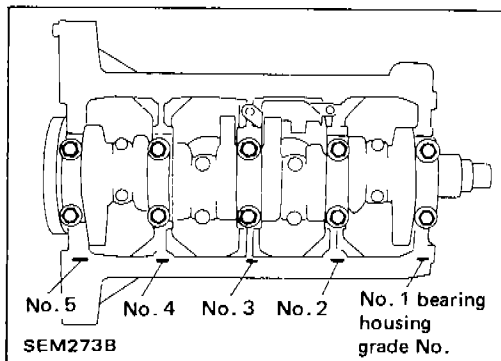
Inspection (Cont'd)



- a. When grinding crankshaft journal, confirm that "L" dimension in fillet roll is more than the specified limit.

"L": 0.1 mm (0.004 in)

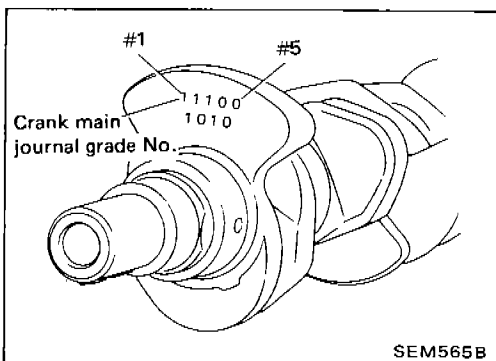
- b. Refer to S.D.S. for grinding crankshaft and available service parts.



8. If crankshaft, cylinder block or main bearing is reused again, measure main bearing clearance.

If crankshaft, cylinder block and main bearings are replaced with new ones, it is necessary to select thickness of main bearings as follows:

- a. Grade number of each cylinder block main journal is punched on the respective cylinder block.



- b. Grade number of each crankshaft main journal is punched on the respective crankshaft.

- c. Select main bearing with suitable thickness according to the following table.

Main bearing grade number:

		Main bearing housing grade number		
		0	1	2
		Main bearing grade number		
Crankshaft main journal grade number	0	0	1	2
	1	1	2	3
	2	2	3	4

For example:

Main journal grade number: 1

Crankshaft journal grade number: 2

Main bearing grade number = 1 + 2
= 3

CYLINDER BLOCK

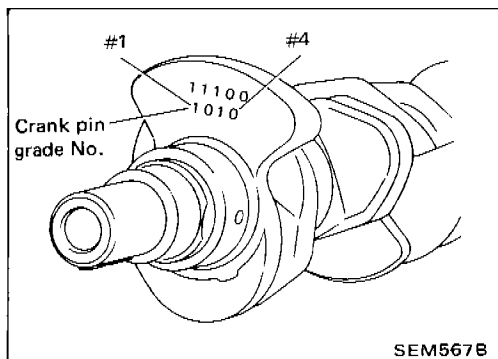
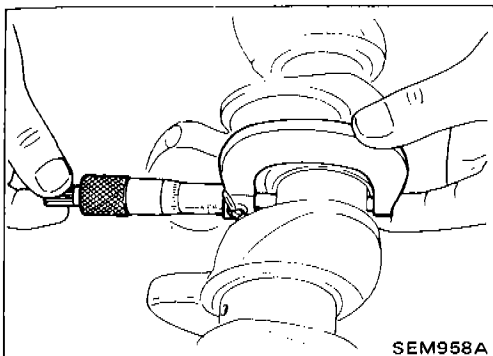
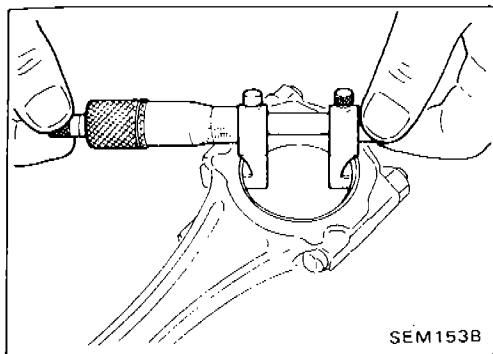
Inspection (Cont'd)

Connecting rod bearing (Big end)

1. Install connecting rod bearing to connecting rod and cap.
2. Install connecting rod cap to connecting rod.

Tighten bolts to the specified torque.

3. Measure inner diameter "C" of each bearing.



4. Measure outer diameter "Dp" of each crankshaft pin journal.
5. Calculate connecting rod bearing clearance.

$$\text{Connecting rod bearing clearance} = C - Dp$$

Standard:

0.018 - 0.045 mm (0.0007 - 0.0018 in)

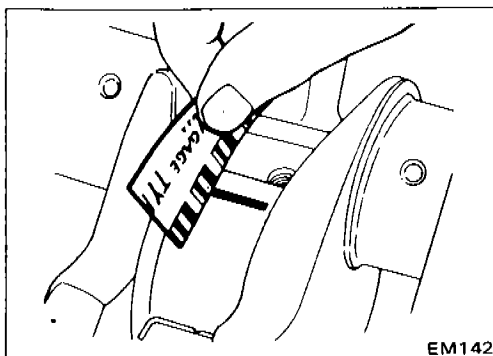
Limit: 0.1 mm (0.004 in)

6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing. Refer to step 7 of "BEARING CLEARANCE — Main bearing".

8. If bearing, crankshaft or connecting rod is replaced with a new one, select connecting rod bearing according to the following table.

Connecting rod bearing grade number:

Crank pin grade number	Connecting rod bearing grade number
0	0
1	1
2	2



Method B (Using plastigage)

CAUTION:

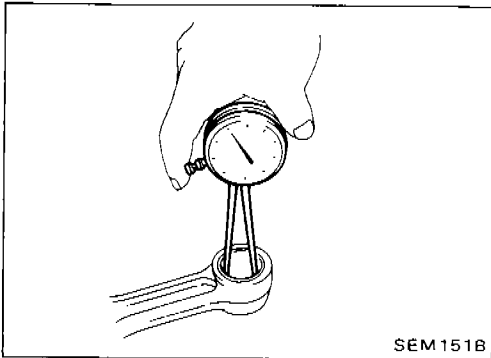
- Do not turn crankshaft or connecting rod while the plastigage is being inserted.
- When bearing clearance exceeds the specified limit, ensure that the proper bearing has been installed. However, if excessive bearing clearance still exists, use thicker main bearing or undersized bearing so that the specified bearing clearance is obtained.

CYLINDER BLOCK

Inspection (Cont'd)

CONNECTING ROD BUSHING CLEARANCE (Small end)

1. Measure inner diameter "C" of bushing.



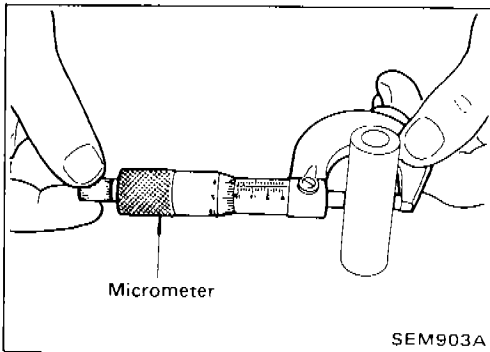
2. Measure outer diameter "Dp" of piston pin.

3. Calculate connecting rod bearing clearance.

$$C - Dp = 0.005 - 0.017 \text{ mm (0.0002 - 0.0007 in)}$$

If it exceeds the limit, replace connecting rod assembly and/or piston set with pin.

Connecting rod bushing cannot be removed from connecting rod.

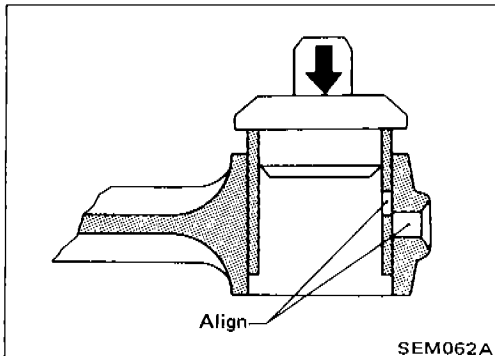


REPLACEMENT OF CONNECTING ROD BUSHING (Small end)

1. Drive in small end bushing until it is flush with end surface of rod.

Be sure to align the oil holes.

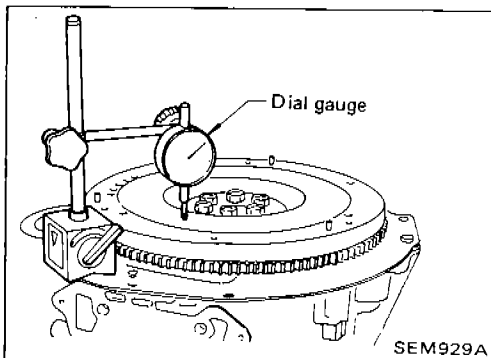
2. After driving in small end bushing, ream the bushing.



FLYWHEEL/DRIVE PLATE RUNOUT

Runout (Total indicator reading):

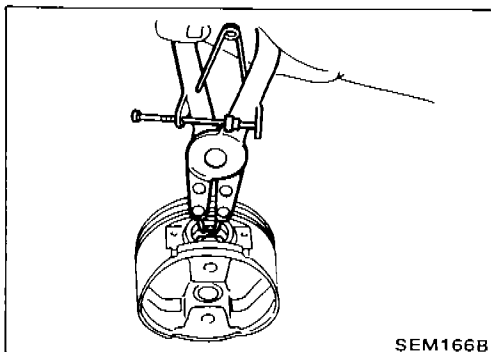
Less than 0.15 mm (0.0059 in)



Assembly

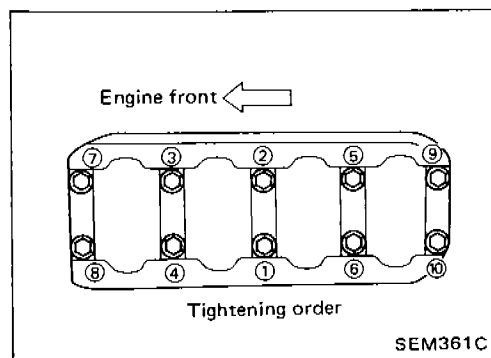
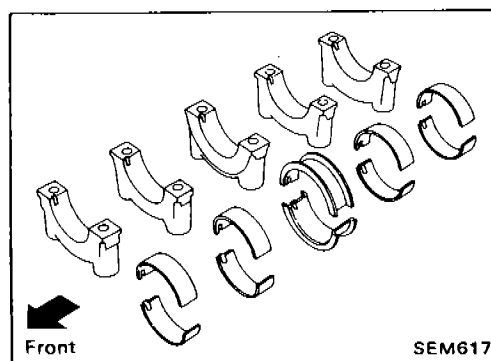
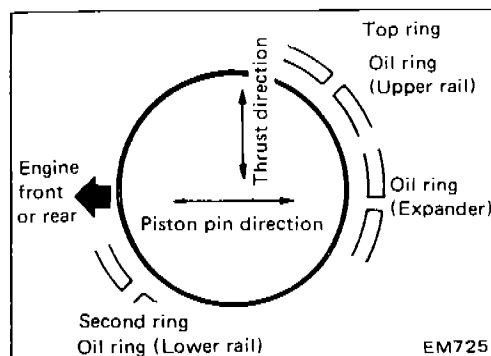
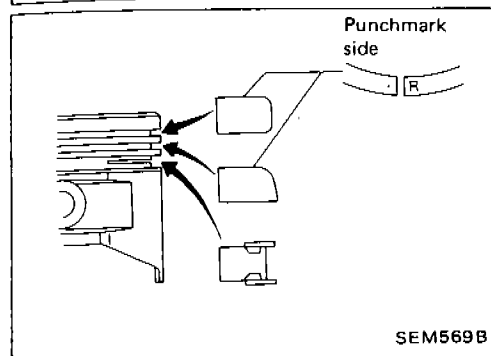
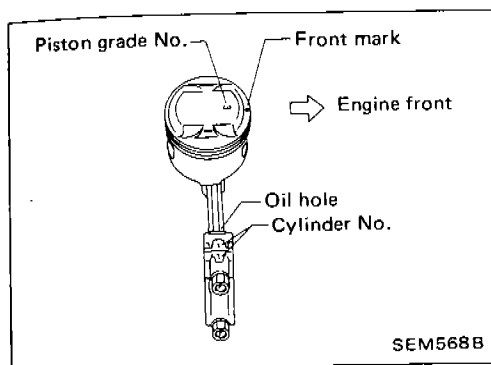
PISTON

1. Install new snap ring on one side of piston pin hole.



CYLINDER BLOCK

Assembly (Cont'd)



2. Heat piston to 60 to 70°C (140 to 158°F) and assemble piston, piston pin, connecting rod and new snap ring.

- Align the direction of piston and connecting rod.
- Numbers stamped on connecting rod and cap correspond to each cylinder.
- After assembly, make sure connecting rod swings smoothly.

3. Set piston rings as shown.

CRANKSHAFT

1. Set main bearings in their proper positions on cylinder block and main bearing cap.

- Confirm that correct main bearings are used. Refer to "Inspection".

2. Install crankshaft, main bearing caps and main bearing beam and tighten bolts to the specified torque.

- Prior to tightening bearing cap bolts, place bearing cap in its proper position by shifting crankshaft in the axial direction.
- Tighten bearing cap bolts gradually in two or three stages. Start with center bearing and move outward sequentially.
- After securing bearing cap bolts, make sure crankshaft turns smoothly by hand.

CYLINDER BLOCK

Assembly (Cont'd)

3. Measure crankshaft end play.

Crankshaft end play:

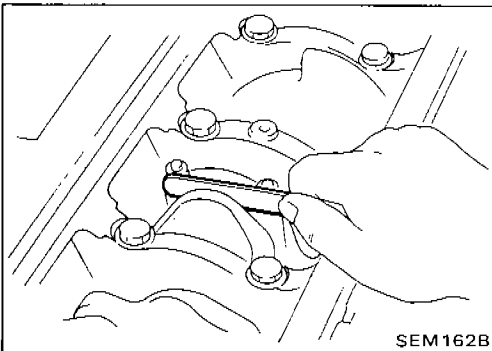
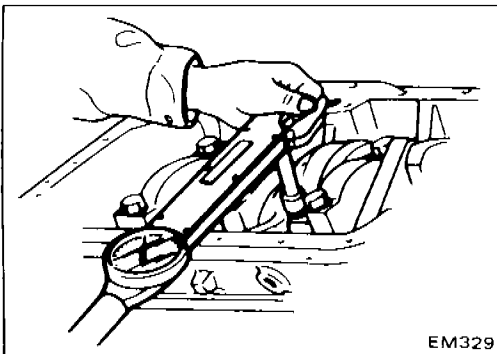
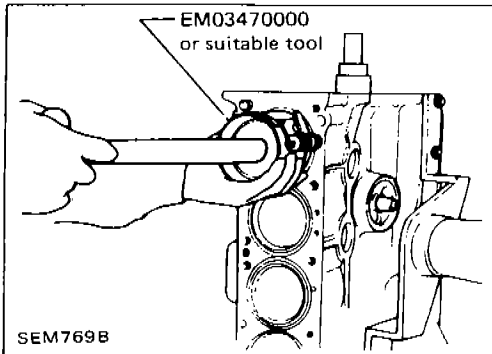
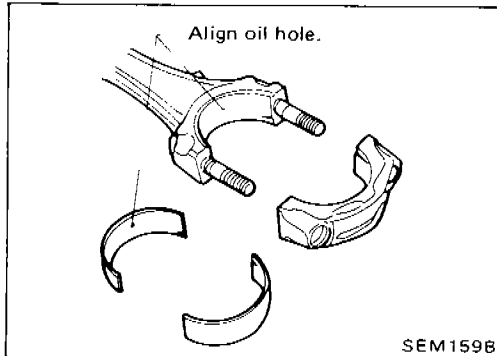
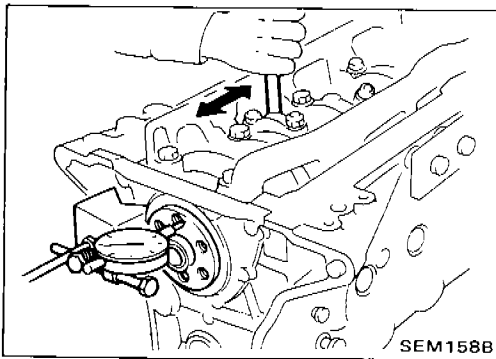
Standard

0.05 - 0.18 mm (0.0020 - 0.0071 in)

Limit

0.3 mm (0.012 in)

If beyond the limit, replace bearing with a new one.



4. Install connecting rod bearings in connecting rods and connecting rod caps.

- Confirm that correct bearings are used.

Refer to "Inspection".

- Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.

5. Install pistons with connecting rods.

- a. Install them into corresponding cylinders with Tool.

- **Be careful not to scratch cylinder wall by connecting rod.**
- **Arrange so that front mark on piston head faces toward front of engine.**

- b. Install connecting rod bearing caps.

Tighten connecting rod bearing cap nuts to the specified torque.

Connecting rod bearing nut:

- (1) Tighten to 14 to 16 N·m
(1.4 to 1.6 kg-m, 10 to 12 ft-lb).

- (2) Tighten to 41 to 44 N·m
(4.2 to 4.5 kg-m, 30 to 33 ft-lb)
or if you have an angle wrench,
tighten bolts 60 to 65 degrees
clockwise.

6. Measure connecting rod side clearance.

Connecting rod side clearance:

Standard

0.20 - 0.35 mm (0.0079 - 0.0138 in)

Limit

0.4 mm (0.016 in)

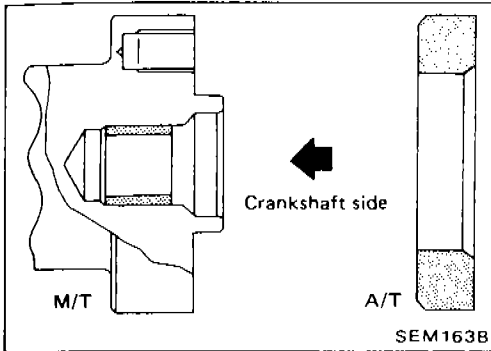
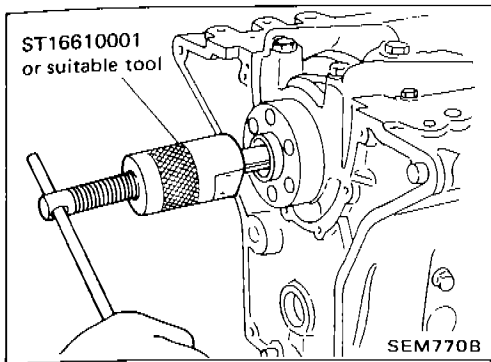
If beyond the limit, replace connecting rod and/or crankshaft.

CYLINDER BLOCK

Assembly (Cont'd)

REPLACING PILOT BUSHING

1. Remove pilot bushing (M/T)/pilot converter (A/T).
2. Install pilot bushing (M/T)/pilot converter (A/T).



SERVICE DATA AND SPECIFICATIONS (S.D.S.)

General Specifications

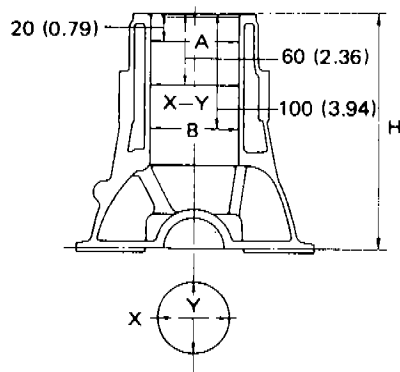
Engine model	CA18DET
Cylinder arrangement	4, in-line
Displacement cm ³ (cu in)	1,809 (110.39)
Bore x stroke mm (in)	83.0 x 83.6 (3.268 x 3.291)
Valve arrangement	D.O.H.C.
Firing order	1-3-4-2
Number of piston rings	
Compression	2
Oil	1
Number of main bearings	5
Compression ratio	8.5

Unit: kPa (bar, kg/cm², psi)/rpm

Compression pressure	
Standard	1,177 (11.77, 12.0, 171)/350
Minimum	981 (9.81, 10.0, 142)/350
Differential limit between cylinders	98 (0.98, 1.0, 14)/350

Inspection and Adjustment

CYLINDER BLOCK



SEM528A

Unit: mm (in)

			Standard	Limit
Distortion			0.03 (0.0012)	0.1 (0.004)
Cylinder bore	Inner diameter	Grade 1	83.000 - 83.010 (3.2677 - 3.2681)	0.2 (0.008) *
		Grade 2	83.010 - 83.020 (3.2681 - 3.2685)	
		Grade 3	83.020 - 83.030 (3.2685 - 3.2689)	
		Grade 4	83.030 - 83.040 (3.2689 - 3.2693)	
		Grade 5	83.040 - 83.050 (3.2693 - 3.2697)	
	Out-of-round (X – Y)		Less than 0.015 (0.0006)	—
	Taper (A – B)		Less than 0.010 (0.0004)	—
Difference in inner diameter between cylinders			Less than 0.05 (0.0020)	0.2 (0.008)
Piston-to-cylinder clearance			0.015 - 0.035 (0.0006 - 0.0014)	—
Cylinder block height (From crankshaft center)			204.75 - 204.85 (8.0610 - 8.0649)	0.2 (0.008) **

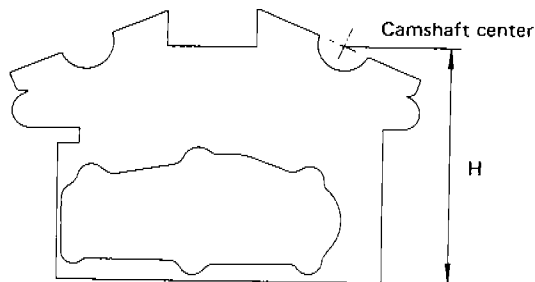
* Wear limit

** Total amount of cylinder head resurfacing and cylinder block resurfacing

SERVICE DATA AND SPECIFICATIONS (S.D.S.)

Inspection and Adjustment (Cont'd)

CYLINDER HEAD



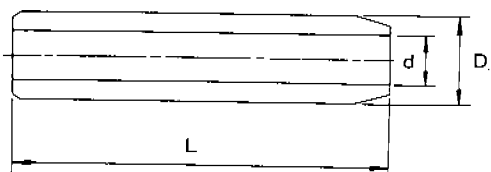
SEM570B

Unit: mm (in)

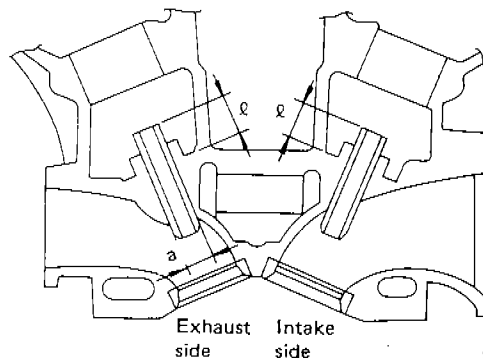
	Standard	Limit
Height (H)	125.9 - 126.1 (4.957 - 4.965)	0.2 (0.008)*
Surface distortion	0.03 (0.0012)	0.1 (0.004)

* Total amount of cylinder head resurfacing and cylinder block resurfacing

VALVE GUIDE



SEM571B



SEM572B

Unit: mm (in)

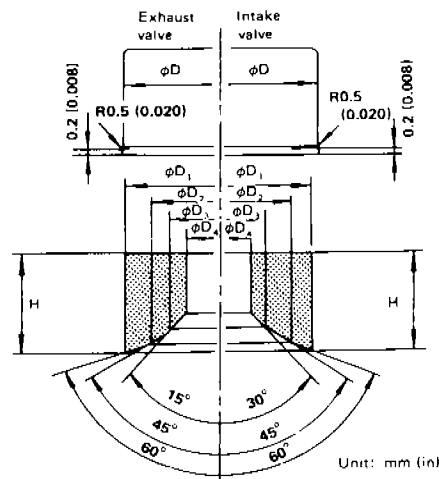
Unit: mm (in)

	Standard		Service		Limit
	Intake	Exhaust	Intake	Exhaust	
Length (L)	40.1 (1.579)	43.1 (1.697)	40.1 (1.579)	43.1 (1.697)	—
Outer diameter (D)	10.023 - 10.034 (0.3946 - 0.3950)		10.223 - 10.234 (0.4025 - 0.4029)		—
Inner diameter (d) (Finished size)	6.000 - 6.018 (0.2362 - 0.2369)				—
Cylinder head hole diameter (a)	9.975 - 9.996 (0.3927 - 0.3935)		10.175 - 10.196 (0.4006 - 0.4014)		—
Interference fit	0.027 - 0.059 (0.0011 - 0.0023)				—
Stem to guide clearance	0.020 - 0.053 (0.0008 - 0.0021)	0.040 - 0.073 (0.0016 - 0.0029)	0.020 - 0.053 (0.0008 - 0.0021)	0.040 - 0.073 (0.0016 - 0.0029)	0.1 (0.004)
Tapping length (ℓ)	15.1 - 15.3 (0.594 - 0.602)				—

SERVICE DATA AND SPECIFICATIONS (S.D.S.)

Inspection and Adjustment (Cont'd)

VALVE SEAT



Unit: mm (in)

SEM573B

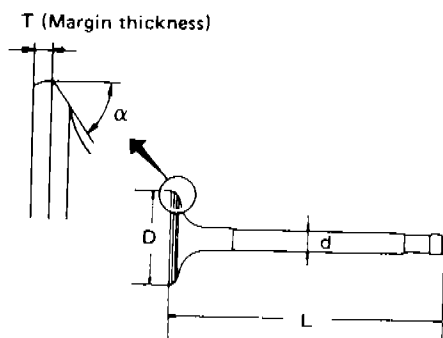
Unit: mm (in)

	Standard		Service	
	Intake	Exhaust	Intake	Exhaust
Cylinder head seat recess diameter (D)	36.000 - 36.016 (1.4173 - 1.4179)	30.000 - 30.016 (1.1811 - 1.1817)	36.500 - 36.516 (1.4370 - 1.4376)	30.500 - 30.516 (1.2008 - 1.2014)
Valve seat outer diameter (D_1)	36.097 - 36.113 (1.4211 - 1.4218)	30.080 - 30.096 (1.1842 - 1.1849)	36.597 - 36.613 (1.4408 - 1.4415)	30.580 - 30.596 (1.2039 - 1.2046)
Face outer diameter (D_2)	33.6 - 33.8 (1.323 - 1.331)	27.4 - 27.6 (1.079 - 1.087)	33.6 - 33.8 (1.323 - 1.331)	27.4 - 27.6 (1.079 - 1.087)
Face inner diameter (D_3)	31.5 (1.240)	24.9 (0.980)	31.5 (1.240)	24.9 (0.980)
Valve seat inner diameter (D_4)	29.85 - 30.15 (1.1752 - 1.1870)	22.85 - 23.15 (0.8996 - 0.9114)	29.9 - 30.1 (1.177 - 1.185)	22.85 - 23.15 (0.8996 - 0.9114)
Height (H)	5.9 - 6.0 (0.232 - 0.236)	6.4 - 6.5 (0.252 - 0.256)	5.35 - 5.45 (0.2106 - 0.2146)	5.75 - 5.85 (0.2264 - 0.2303)

SERVICE DATA AND SPECIFICATIONS (S.D.S.)

Inspection and Adjustment (Cont'd)

VALVE



SEM188A

HYDRAULIC VALVE LIFTER

Unit: mm (in)

Valve lifter diameter	30.955 - 30.965 (1.2187 - 1.2191)
Lifter guide bore diameter	31.000 - 31.013 (1.2205 - 1.2210)

Unit: mm (in)

		Standard	Limit
Valve head diameter (D)	In.	34.0 - 34.2 (1.339 - 1.346)	—
	Ex.	28.0 - 28.2 (1.102 - 1.110)	—
Valve length (L)	In.	88.8 - 89.0 (3.496 - 3.504)	—
	Ex.	89.2 - 89.4 (3.512 - 3.520)	—
Valve stem diameter (d)	In.	5.965 - 5.980 (0.2348 - 0.2354)	—
	Ex.	5.945 - 5.960 (0.2341 - 0.2346)	—
Valve face angle (alpha)	In.	45° 30'	—
	Ex.	45° 30'	—
Valve head margin (T)	In.	1.3 (0.051)	0.5 (0.020)
	Ex.	1.5 (0.059)	

VALVE SPRING

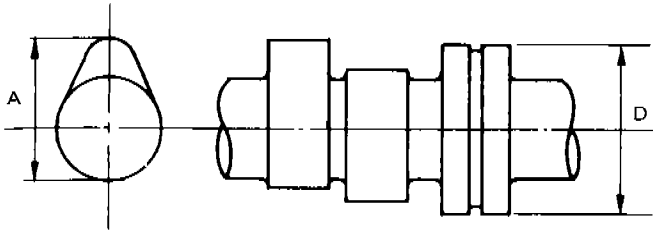
Unit: mm (in)

	Standard	Limit
Free height (H)	43.1 (1.697)	—
Spring constant N/mm (kg/mm, lb/in)	28.4 (2.9, 162)	—
Out-of-square (S)	—	1.8 (0.071)

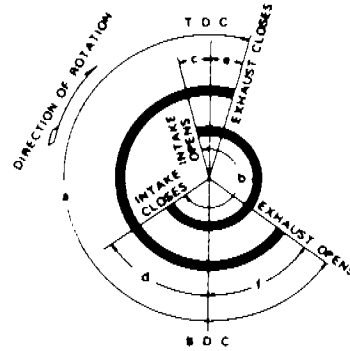
SERVICE DATA AND SPECIFICATIONS (S.D.S.)

Inspection and Adjustment (Cont'd)

CAMSHAFT AND CAMSHAFT BEARING



SEM568A



EM120

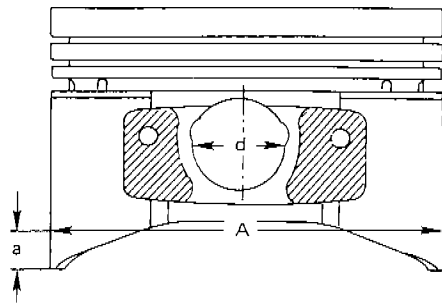
Unit: mm (in)

		Standard	Limit
Cam height (A)	In.	39.785 - 39.815 (1.5663 - 1.5675)	—
	Ex.	40.485 - 40.515 (1.5939 - 1.5951)	—
Valve lift	In.	7.8 (0.307)	—
	Ex.	8.5 (0.335)	—
Wear limit of cam height		—	0.2 (0.008)
Camshaft journal to bearing clearance		0.045 - 0.090 (0.0018 - 0.0035)	0.15 (0.0059)
Inner diameter of camshaft bearing		28.000 - 28.025 (1.1024 - 1.1033)	—
Outer diameter of camshaft journal (D)		27.935 - 27.955 (1.0998 - 1.1006)	—
Camshaft runout		—	0.05 (0.0020)
Camshaft end play		0.07 - 0.15 (0.0028 - 0.0059)	0.2 (0.008)
Valve timing (Degree on crankshaft)	a	248	—
	b	240	—
	c	0	—
	d	60	—
	e	9	—
	f	59	—

SERVICE DATA AND SPECIFICATIONS (S.D.S.)

Inspection and Adjustment (Cont'd)

PISTON, PISTON RING AND PISTON PIN Piston



SEM493C

Unit: mm (in)

Piston skirt diameter (A)	Service (Standard)	Grade No. 1	82.975 - 82.985 (3.2667 - 3.2671)
		Grade No. 2	82.985 - 82.995 (3.2671 - 3.2675)
		Grade No. 3	82.995 - 83.005 (3.2675 - 3.2679)
		Grade No. 4	83.005 - 83.015 (3.2679 - 3.2683)
		Grade No. 5	83.015 - 83.025 (3.2683 - 3.2687)
	Service (Oversize)	0.5 (0.020)	83.475 - 83.525 (3.2864 - 3.2884)
		1.0 (0.039)	83.975 - 84.025 (3.3061 - 3.3081)
Dimension (a)		Approximately 14 (0.55)	
Piston pin hole diameter (d)		19.987 - 19.999 (0.7869 - 0.7874)	
Piston-to-cylinder bore clearance		0.015 - 0.035 (0.0006 - 0.0014)	

Piston pin

Unit: mm (in)

Piston pin outer diameter	19.989 - 20.001 (0.7870 - 0.7874)
Interference fit of piston pin to piston pin hole clearance	0 - 0.004 (0 - 0.0002)
Piston pin to connecting rod bearing clearance	0.005 - 0.017 (0.0002 - 0.0007)

Piston ring

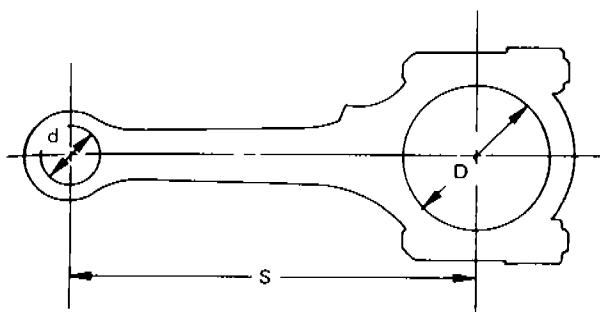
Unit: mm (in)

		Standard	Limit
Side clearance	Top	0.040 - 0.073 (0.0016 - 0.0029)	0.1 (0.004)
	2nd	0.030 - 0.063 (0.0012 - 0.0025)	0.1 (0.004)
End gap	Top	0.25 - 0.42 (0.0098 - 0.0165)	1.0 (0.039)
	2nd	0.38 - 0.64 (0.0150 - 0.0252)	1.0 (0.039)
	Oil (rail ring)	0.20 - 0.76 (0.0079 - 0.0299)	1.0 (0.039)

SERVICE DATA AND SPECIFICATIONS (S.D.S.)

Inspection and Adjustment (Cont'd)

CONNECTING ROD



SEM570A

Unit: mm (in)

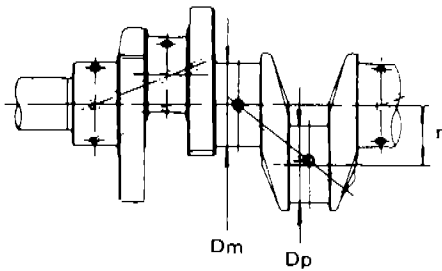
	Standard	Limit
Center distance (S)	132.95 - 133.05 (5.2342 - 5.2382)	—
Twist per 100 mm (3.94 in)]	—	0.1 (0.004)
Twist per 100 mm (3.94 in)]	—	0.1 (0.004)
Pin bore diameter *	22.987 - 23.000 (0.9050 - 0.9055)	—
Clearance between piston and bearing	0.005 - 0.017 (0.0002 - 0.0007)	—
Pin bore diameter *	48.000 - 48.013 (1.8898 - 1.8903)	—
Clearance between crank and bearing	0.018 - 0.045 (0.0007 - 0.0018)	—
End play	—	0.4 (0.016)

*Without bearing

SERVICE DATA AND SPECIFICATIONS (S.D.S.)

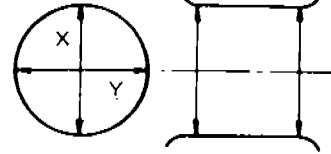
Inspection and Adjustment (Cont'd)

CRANKSHAFT



EM737

Out-of-round X — Y
Taper A — B



EM715

Unit: mm (in)

Main journal diameter (Dm)	52.951 - 52.975 (2.0847 - 2.0856)	
Pin journal diameter (Dp)	44.954 - 44.974 (1.7698 - 1.7706)	
Center distance (r)	41.77 - 41.83 (1.6445 - 1.6468)	
	Standard	Limit
Taper of journal and pin (A — B)	—	0.005 (0.0002)
Out-of-round of journal and pin (X — Y)	—	0.005 (0.0002)
Runout [T.I.R.] *	—	0.025 (0.0010)
Free end play	0.05 - 0.18 (0.0020 - 0.0071)	0.3 (0.012)

* Total indicator reading

SERVICE DATA AND SPECIFICATIONS (S.D.S.)

Inspection and Adjustment (Cont'd)

BEARING CLEARANCE

Unit: mm (in)

	Standard	Limit
Main bearing clearance	0.021 - 0.048 (0.0008 - 0.0019)	0.1 (0.004)
Connecting rod bearing clearance	0.018 - 0.045 (0.0007 - 0.0018)	0.1 (0.004)

AVAILABLE MAIN BEARING

Standard

Grade number	Thickness mm (in)	Identification color
0	1.825 - 1.829 (0.0719 - 0.0720)	Black
1	1.829 - 1.833 (0.0720 - 0.0722)	Brown
2	1.833 - 1.837 (0.0722 - 0.0723)	Green
3	1.837 - 1.841 (0.0723 - 0.0725)	Yellow
4	1.841 - 1.845 (0.0725 - 0.0726)	Blue

Undersize (service)

Unit: mm (in)

	Thickness	Main journal diameter "Dm"
0.25 (0.0098)	1.947 - 1.960 (0.0767 - 0.0772)	Grind so that bearing clearance is the specified value.

AVAILABLE CONNECTING ROD BEARING

Standard

Grade number	Thickness mm (in)	Identification color
0	1.501 - 1.504 (0.0591 - 0.0592)	—
1	1.504 - 1.507 (0.0592 - 0.0593)	Brown
2	1.507 - 1.510 (0.0593 - 0.0594)	Green

Undersize (service)

Unit: mm (in)

	Thickness	Crank pin journal diameter "Dp"
0.08 (0.0031)	1.540 - 1.548 (0.0606 - 0.0609)	Grind so that bearing clearance is the specified value.
0.12 (0.0047)	1.560 - 1.568 (0.0614 - 0.0617)	
0.25 (0.0098)	1.625 - 1.633 (0.0640 - 0.0643)	

MISCELLANEOUS COMPONENTS

Unit: mm (in)

Camshaft sprocket runout [T.I.R.] *	Less than 0.1 (0.004)
Flywheel runout [T.I.R.] *	Less than 0.15 (0.0059)

* Total indicator reading

TURBOCHARGER

By-pass valve controller diaphragm	0.38 mm (0.0150 in)/ 83.3 - 88.6 kPa (833 - 886 mbar, 625 - 665 mmHg, 24.61 - 26.18 inHg)
Play	0.013 - 0.097 mm (0.0005 - 0.0038 in)