ENGINE MECHANICAL

SECTION EM

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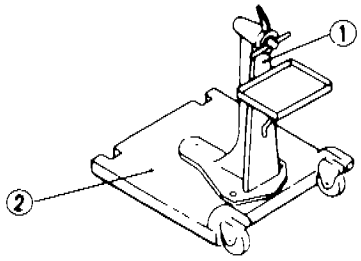
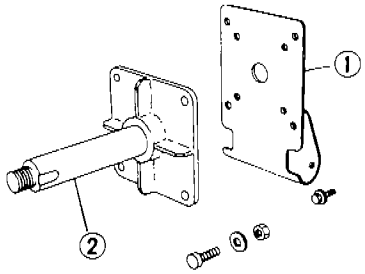
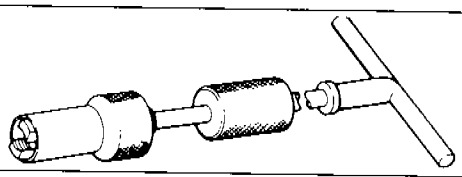
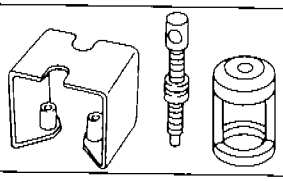
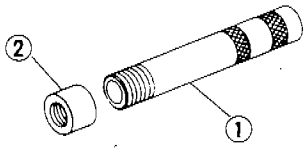
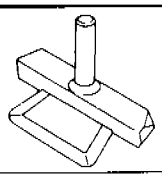
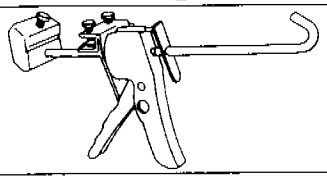
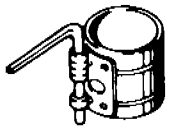
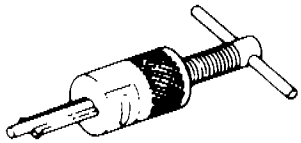
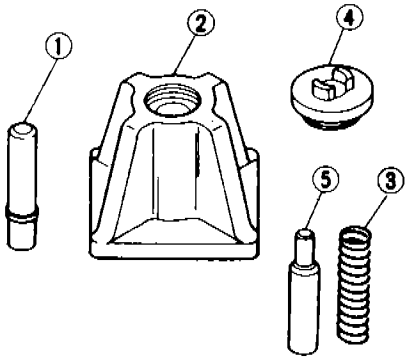
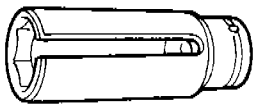
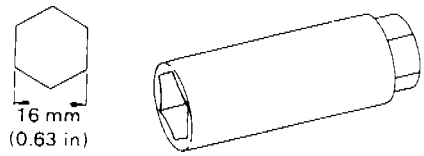
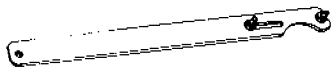
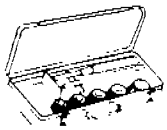
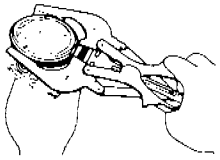
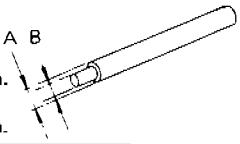
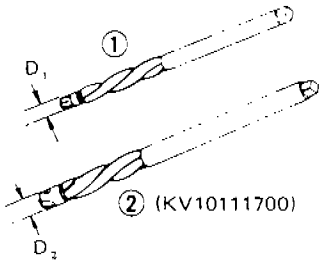
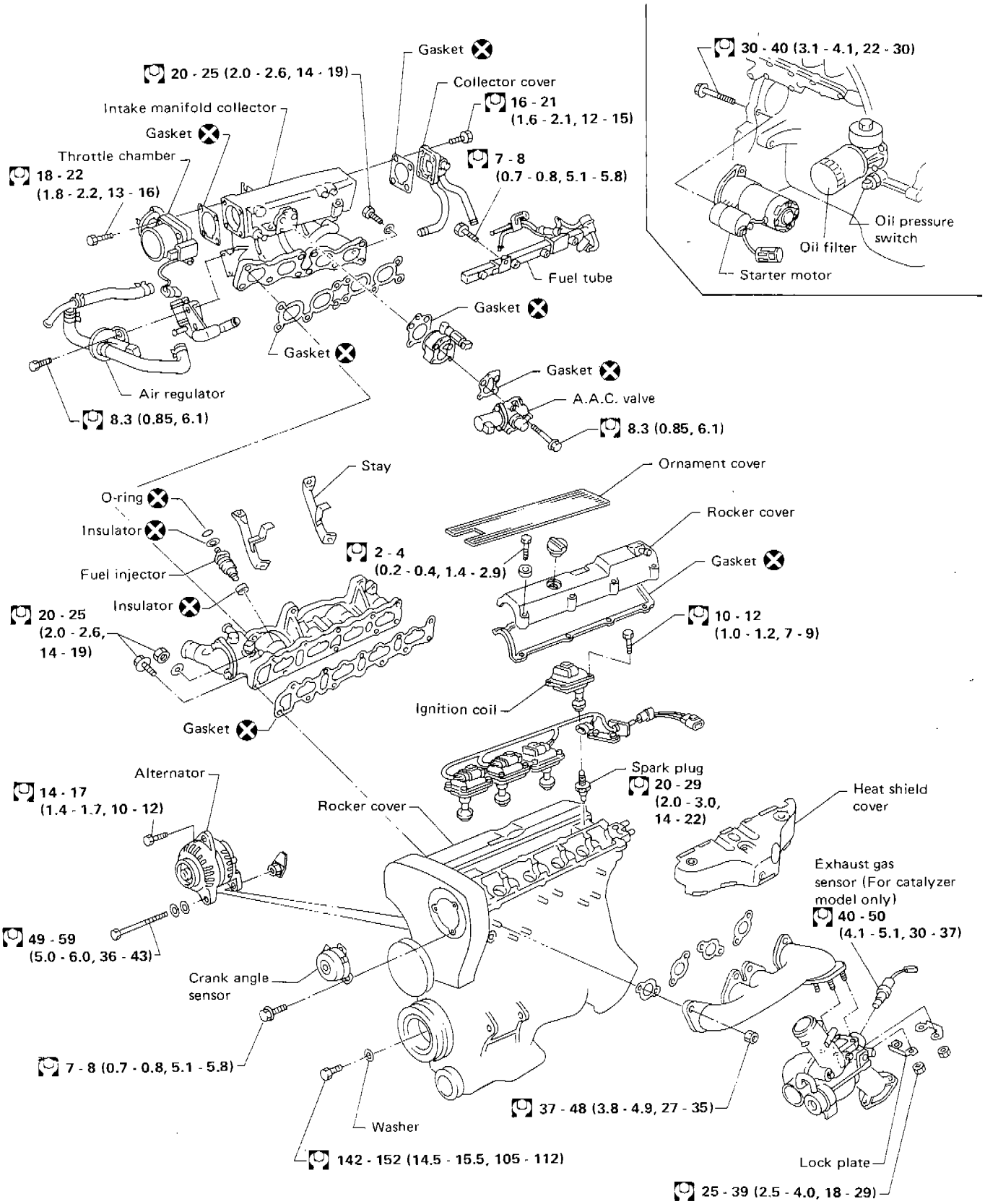
SPECIAL SERVICE TOOLS

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 

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

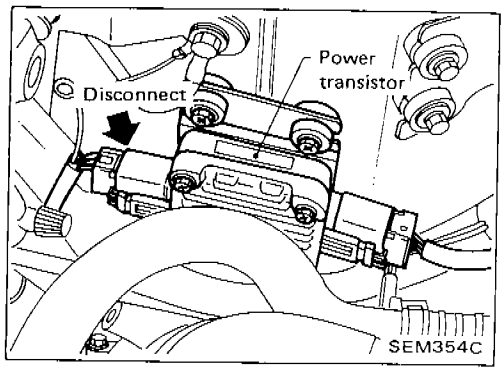
COMMERCIAL SERVICE TOOLS

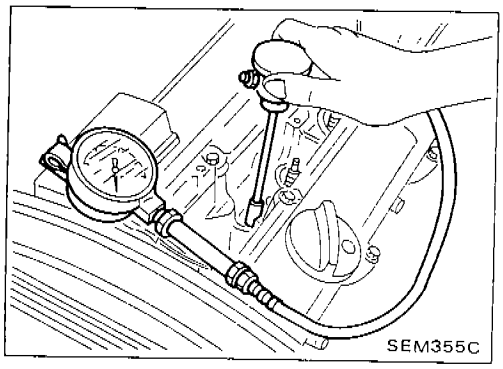
Tool name	Description	
Spark plug wrench		Removing and installing spark plug
Pulley holder		Holding camshaft pulley while tightening or loosening camshaft bolt
Valve seat cutter set		Finishing valve seat dimensions
Piston ring expander		Removing and installing piston ring
Valve guide drift	 **Intake & 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	 **Intake & Exhaust:** **D_1 = 6.0 mm (0.236 in) dia.** **D_2 = 10.2 mm (0.402 in) dia.**	Reaming cylinder head for oversize valve guide ①. Reaming valve guide inner ②.



: N·m (kg-m, ft-lb)

SEM352C





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.**

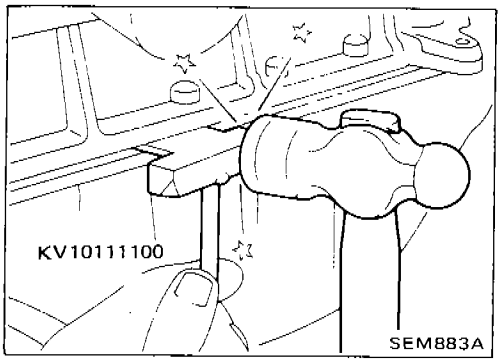
Compression pressure:
kPa (bar, kg/cm^2, psi)/rpm
Standard
1,177 (11.77, 12.0, 171)/350
Minimum
981 (9.81, 10.0, 142)/350
Differential limit between cylinders
98 (0.98, 1.0, 14)/350

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.**

Removal

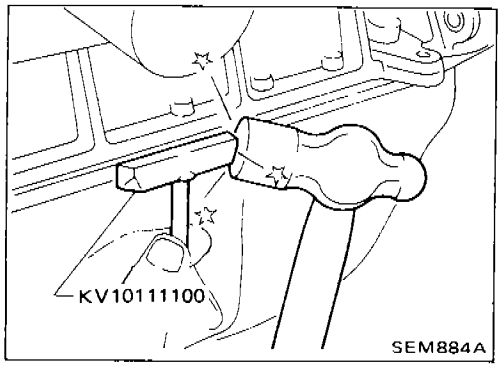
1. Drain engine oil.
2. Remove front stabilizer bar.
3. Loosen front engine mounting nuts. (Do not loosen completely.)
4. Lift up engine slightly using engine slingers.



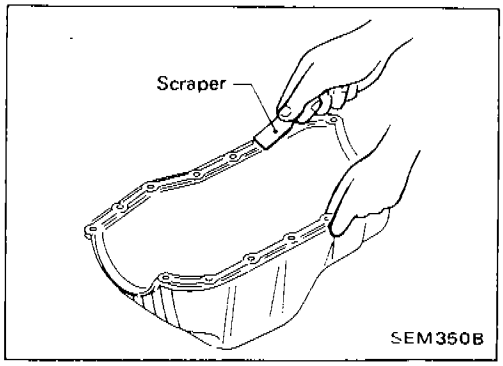
5. Remove oil pan.

(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.**



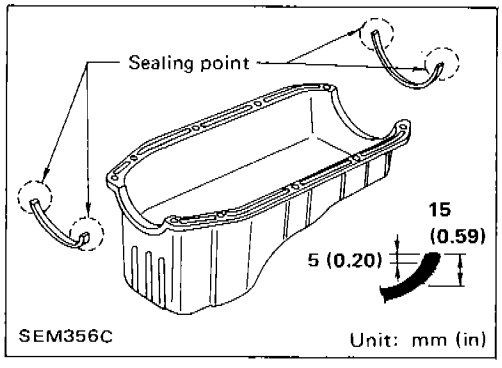
(2) Slide Tool by tapping its side with a hammer, and remove oil pan.



Installation

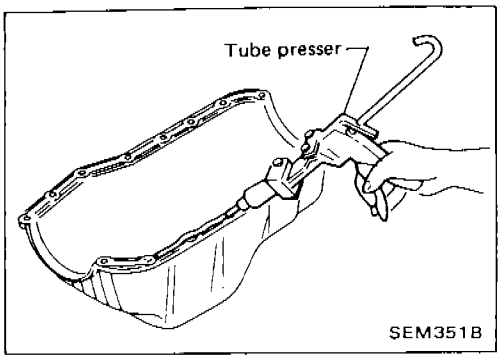
1. Before installing oil pan, remove all traces of liquid gasket from mating surface using a scraper.

- Also remove traces of liquid gasket from mating surface of cylinder block.

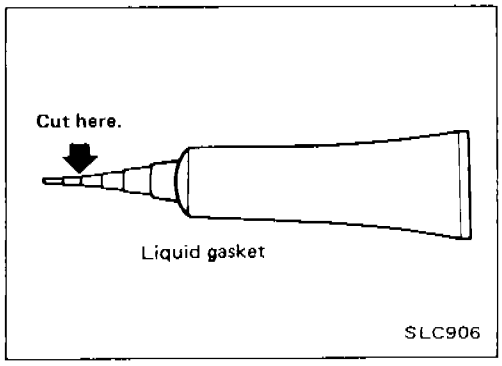


2. Apply liquid gasket to oil pump gasket and rear oil seal retainer gasket.

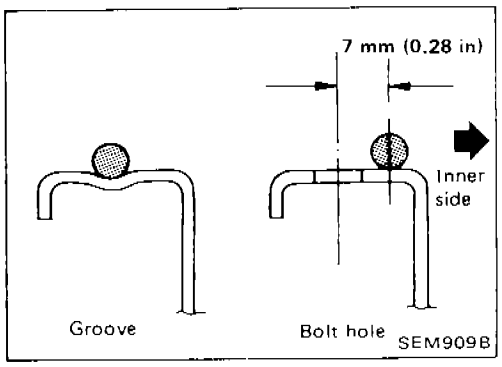
Installation (Cont'd)



3. Apply a continuous bead of liquid gasket to mating surface of oil pan.
- **Use Genuine Liquid Gasket or equivalent.**



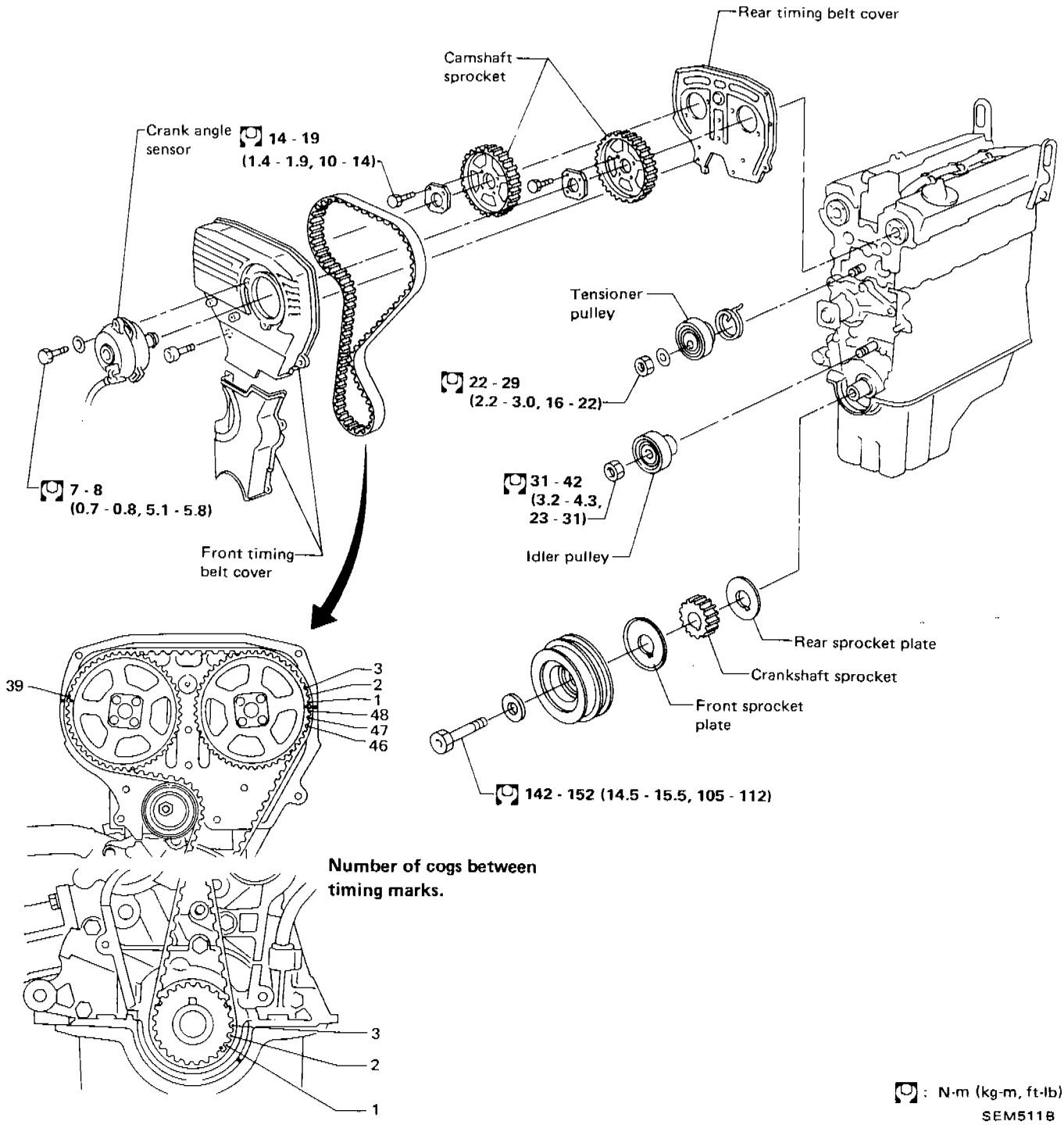
- Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) wide.



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.

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.



: N·m (kg-m, ft-lb)

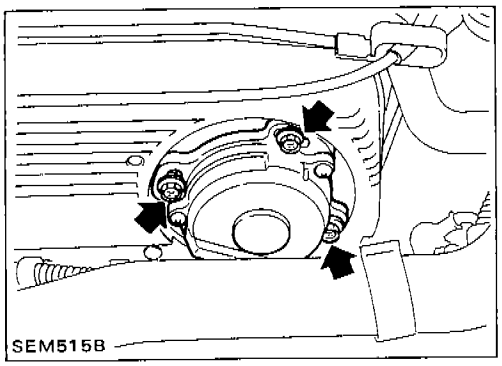
SEM511B

Removal

1. Drain engine coolant from radiator.

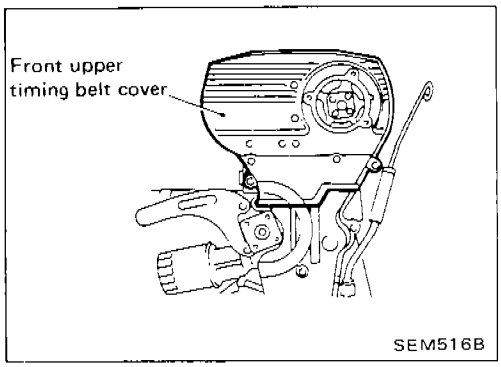
Be careful not to spill coolant on drive belts.

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.

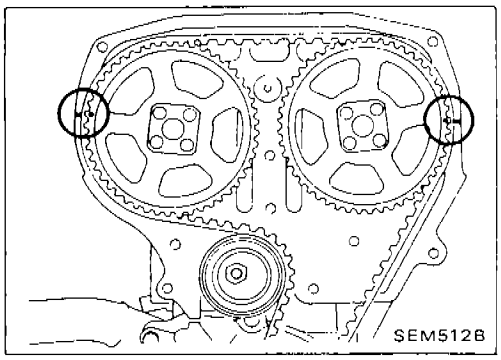


5. Remove crank angle sensor.

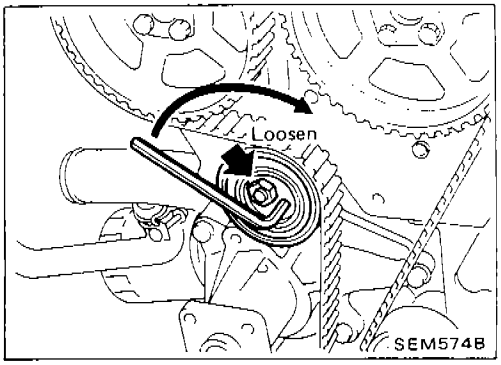
Put aligning mark on crank angle sensor and timing belt cover.



6. Remove front upper timing belt cover.
7. Remove all spark plugs.



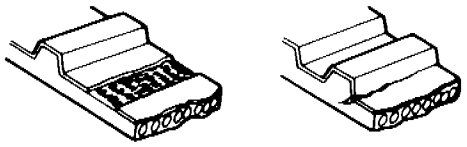
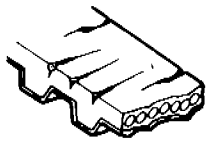
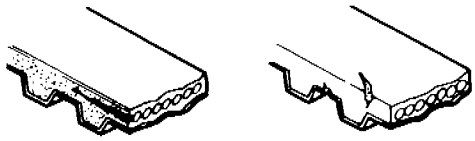
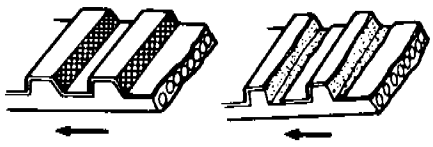
8. Set No. 1 piston at T.D.C. on its compression stroke.
9. Remove crankshaft pulley.



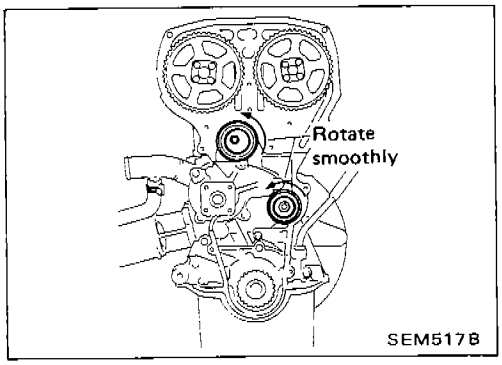
10. Remove front lower timing belt cover.
11. Loosen timing belt tensioner nut, turn tensioner, then remove timing belt.

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.	 • Belt corners are worn and round. • Wicks are frayed and coming out. SEM396A	• Improper installation of belt • Malfunctioning crankshaft pulley plate/ timing belt plate
Teeth are worn.	 Rotating direction • 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. SEM397A	• 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

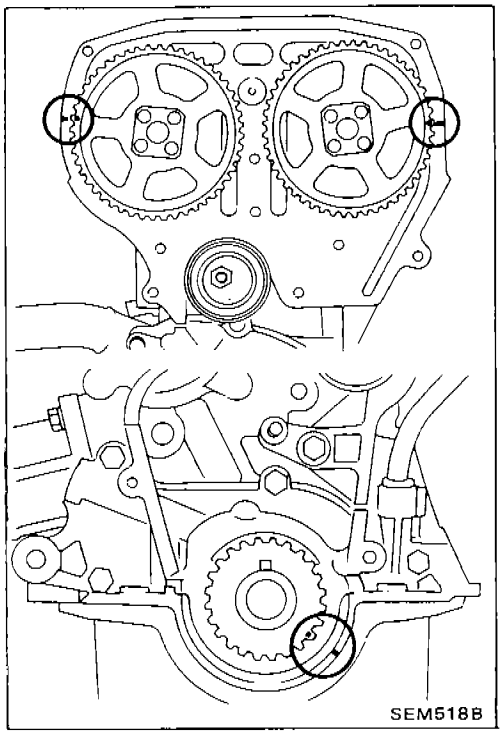
Inspection (Cont'd)



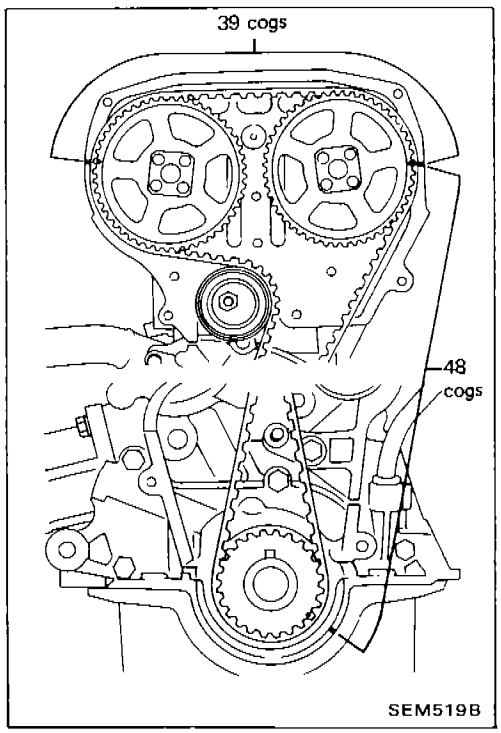
BELT TENSIONER, IDLER PULLEY AND TENSIONER SPRING

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

Installation



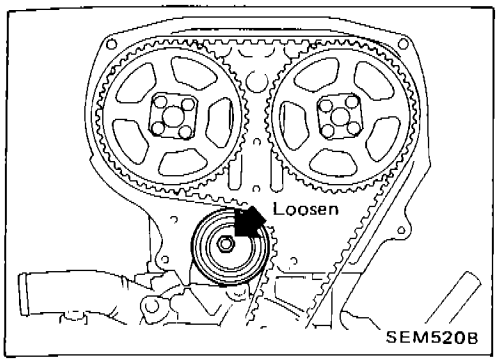
1. Confirm that No. 1 piston is set at T.D.C. on its compression stroke.
2. Install tensioner and tensioner spring.
- **Turn tensioner fully clockwise with hexagon wrench, and temporarily tighten lock nut.**



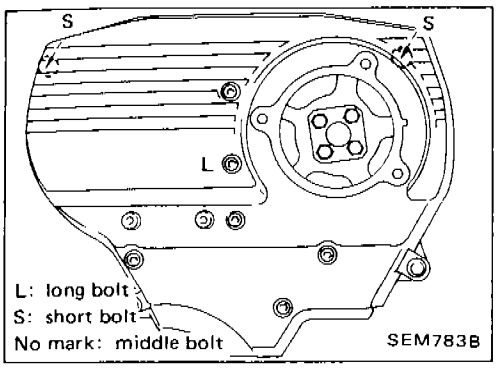
3. Set timing belt.

Align timing marks on timing belt and sprockets.

Installation (Cont'd)



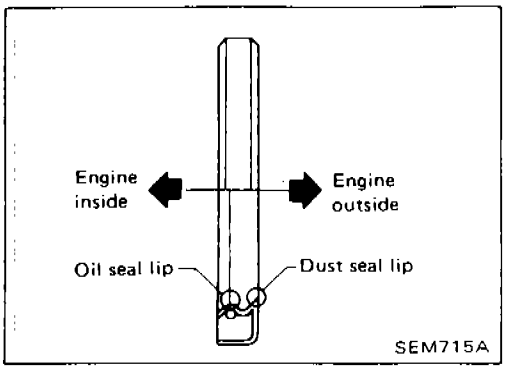
4. Loosen tensioner lock nut, keeping tensioner steady with hexagon wrench.
5. Rotate crankshaft at least two turns clockwise.
6. Adjust belt tension.
   Slowly swing tensioner with hexagon wrench clockwise and counterclockwise two or three times.
7. Tighten tensioner lock nut.



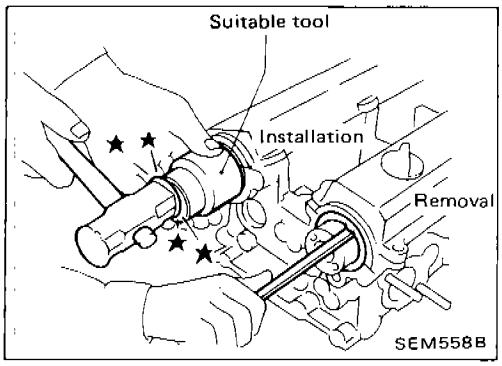
8. Install lower and upper timing belt covers.

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 INSTALLING DIRECTION

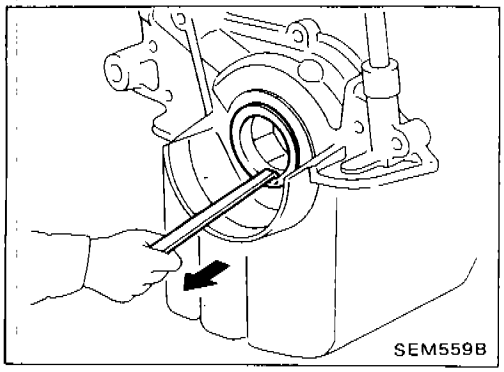


CAMSHAFT OIL SEAL

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.

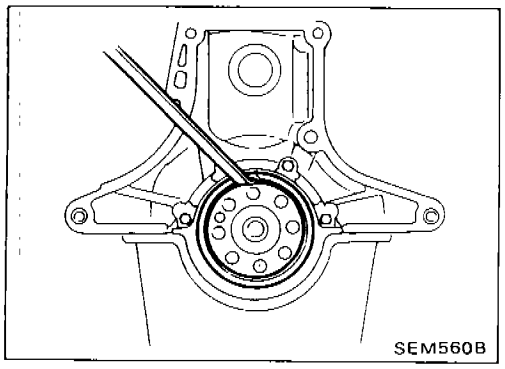
Be careful not to scratch camshaft.

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



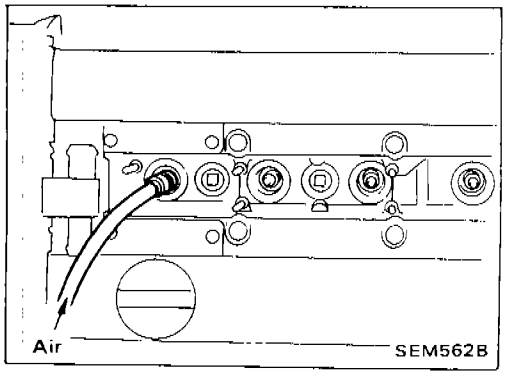
FRONT OIL SEAL

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.

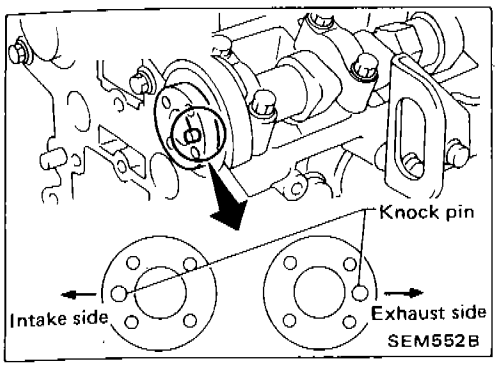


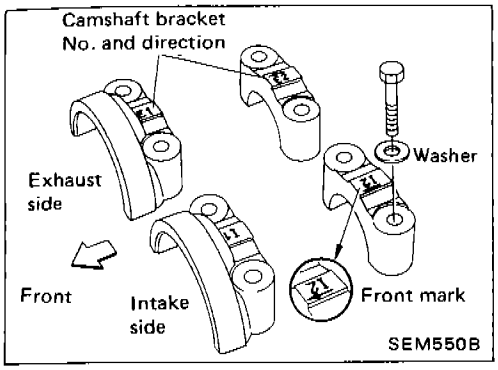
VALVE OIL SEAL

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/cm^2, 71 psi)].

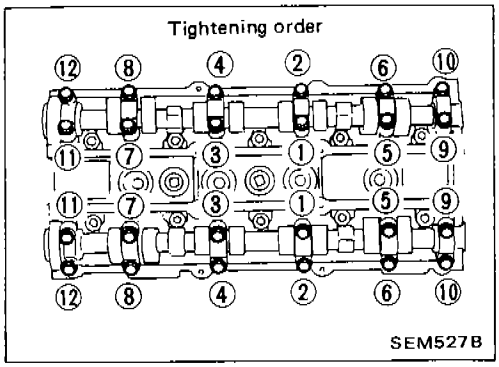
Assembly (Cont'd)

Install camshaft as shown.

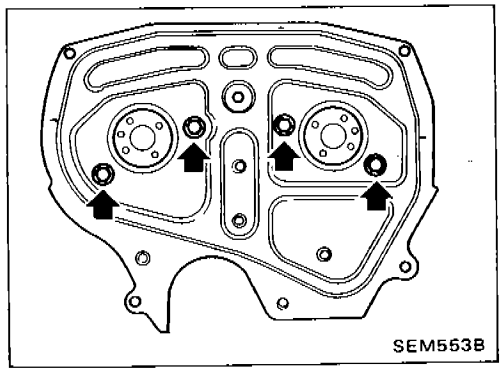




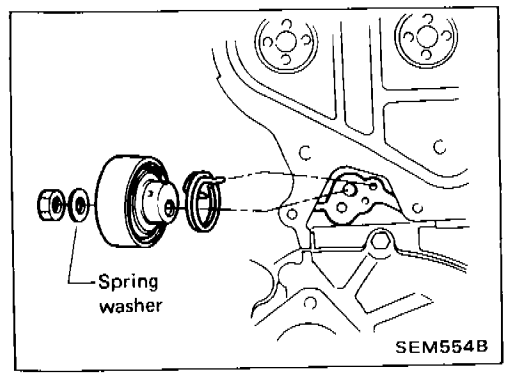
3. Install camshaft brackets.
Front mark is punched on the camshaft bracket.
4. Apply engine oil to camshaft oil seal lip and install it in place.
Always use new camshaft oil seal.
: 9 - 12 N·m (0.9 - 1.2 kg-m, 6.5 - 8.7 ft-lb)



Tighten camshaft bracket bolts gradually in two or three stages.

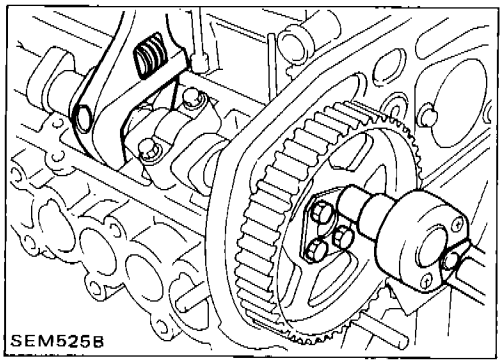


5. Install rear timing cover.
: 7 - 8 N·m (0.7 - 0.8 kg-m, 5.1 - 5.8 ft-lb)



6. Install timing belt tensioner.
Tensioner nut:
: 22 - 29 N·m (2.2 - 3.0 kg-m, 16 - 22 ft-lb)

Assembly (Cont'd)

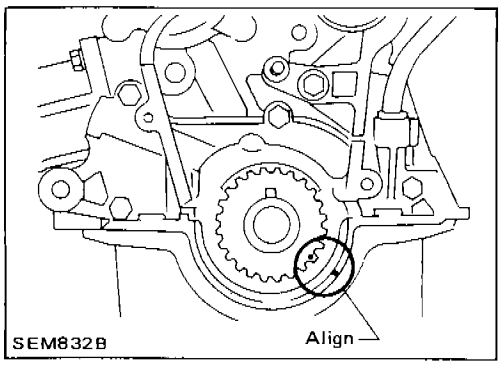


7. Install camshaft sprockets.
   Sprocket bolt:
   : 14 - 19 N·m (1.4 - 1.9 kg-m, 10 - 14 ft-lb)

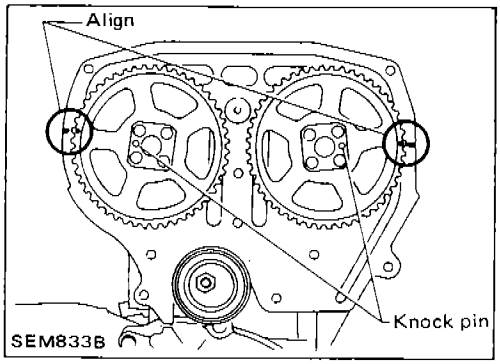
When tightening bolts, fix camshaft to prevent it from rotating.

8. Adjust timing belt tension.
   Refer to TIMING BELT.
9. Reinstall remaining parts.

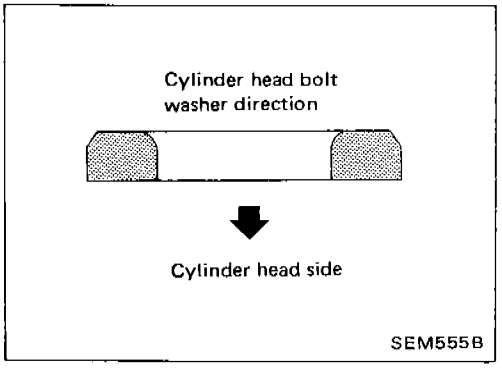
Installation



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.**

Inspection

Condition 1: Low engine power

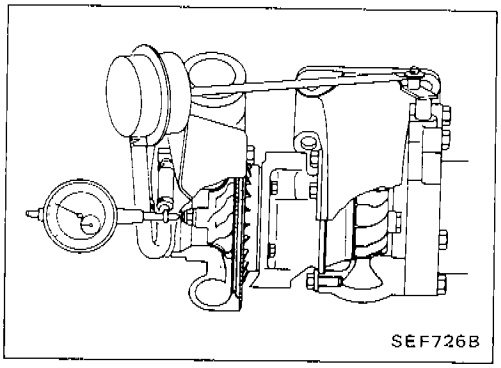
Probable cause	Corrective action
Air leak at the connection of compressor housing and suction hose/inlet tube, or inlet tube and intake manifold	Correct the connection.
Exhaust gas leak at the connection of turbine housing and exhaust manifold, connecting tube or exhaust outlet	Correct the connection or replace gasket.
By-pass valve is stuck open.	Replace turbocharger assembly.
Stuck or worn journal or bearing	
Broken shaft	
Sludge on back of tubine wheel	
Broken turbine wheel	

Condition 2: Excessively high engine power

Probable cause	Corrective action
Disconnected or cracked rubber hose of by-pass valve controller	Correct or replace rubber hose.
By-pass valve is stuck closed.	Replace turbocharger assembly.
Controller diaphragm is broken.	

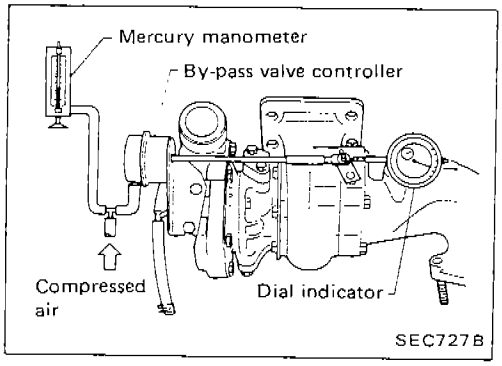
Inspection (Cont'd)

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	Replace turbocharger assembly.
Oil leak at oil seal of compressor	
Worn journal or bearing	


SEF726B

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)

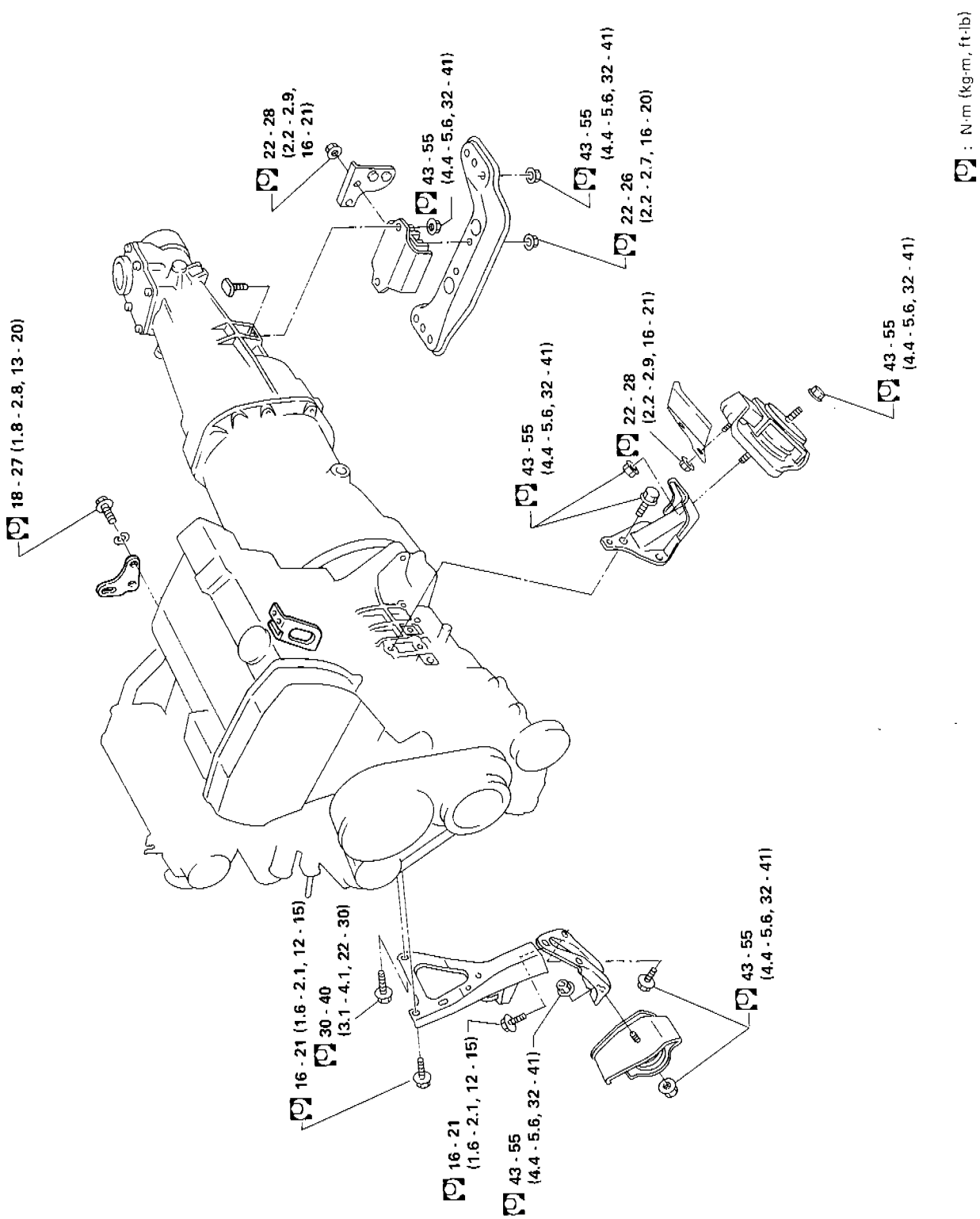


2. Check operation of by-pass valve controller.
- Move by-pass valve to make sure that it is not sticking or scratched.
- Measure rod end play of the by-pass valve controller.

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.


: N·m (kg-m, ft-lb)
22 - 28 (2.2 - 2.9, 16 - 21)
43 - 55 (4.4 - 5.6, 32 - 41)
43 - 55 (4.4 - 5.6, 32 - 41)
22 - 26 (2.2 - 2.7, 16 - 20)
43 - 55 (4.4 - 5.6, 32 - 41)
22 - 28 (2.2 - 2.9, 16 - 21)
43 - 55 (4.4 - 5.6, 32 - 41)
18 - 27 (1.8 - 2.8, 13 - 20)
16 - 21 (1.6 - 2.1, 12 - 15)
30 - 40 (3.1 - 4.1, 22 - 30)
16 - 21 (1.6 - 2.1, 12 - 15)
43 - 55 (4.4 - 5.6, 32 - 41)
43 - 55 (4.4 - 5.6, 32 - 41)

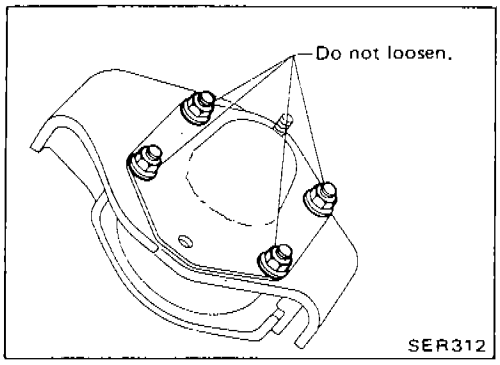
SEM358C

WARNING:

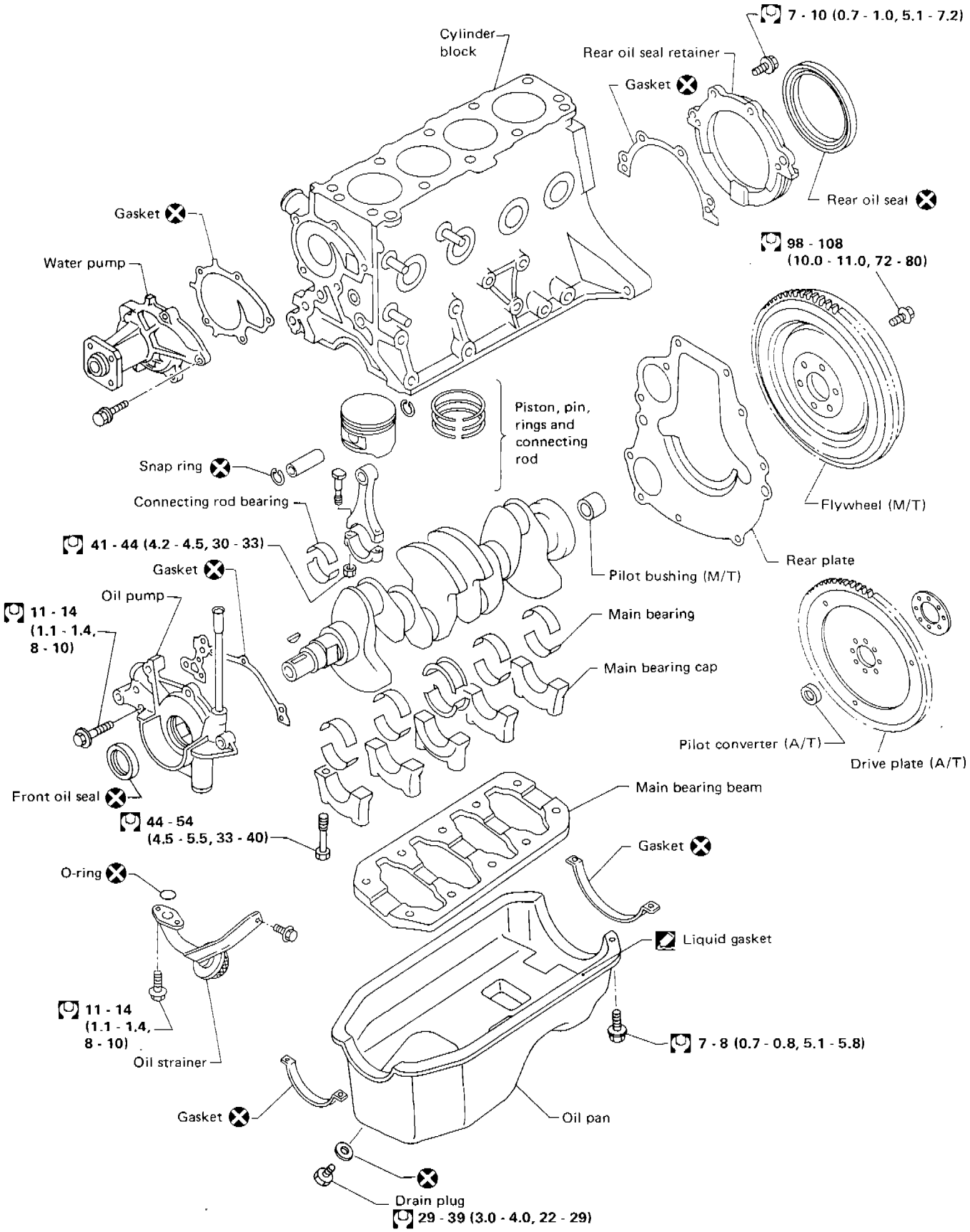
a. Situate vehicle on a flat and solid surface.
b. Place chocks at front and back of rear wheels.
c. Do not remove engine until exhaust system has completely cooled off.
   Otherwise, you may burn yourself and/or fire may break out in fuel line.
d. For safety during subsequent steps, the tension of wires 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.

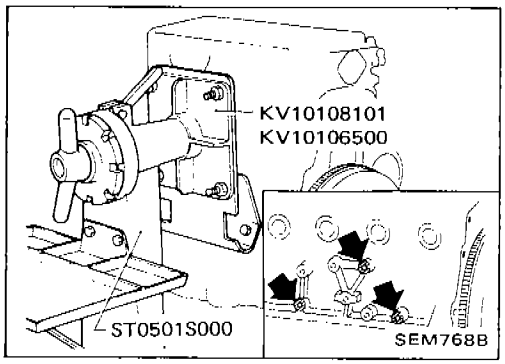


: N·m (kg-m, ft-lb)

SEM359C

CAUTION:

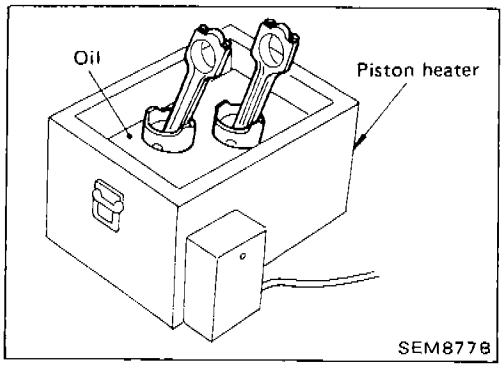
- **When installing sliding parts such as bearings and pistons, be sure to apply engine oil on the sliding surfaces.**
- **Place removed parts such as bearings and bearing caps in their proper order and direction.**
- **When tightening connecting rod bolts and main bearing cap bolts, apply engine oil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



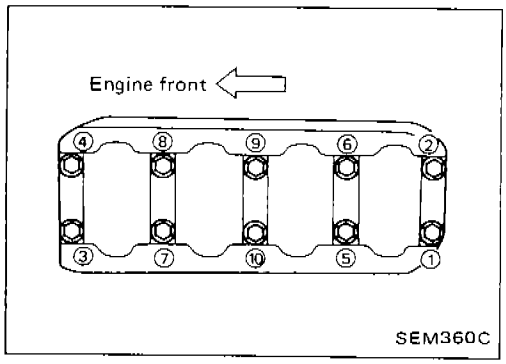
Disassembly

PISTON AND CRANKSHAFT

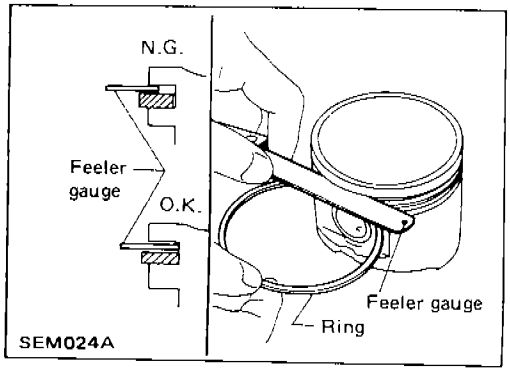
1. Place engine on a work stand.
2. Remove timing belt.
3. Drain coolant and remove water pump.
4. Drain oil.
5. Remove oil pan and oil pump.
6. Remove cylinder head.



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

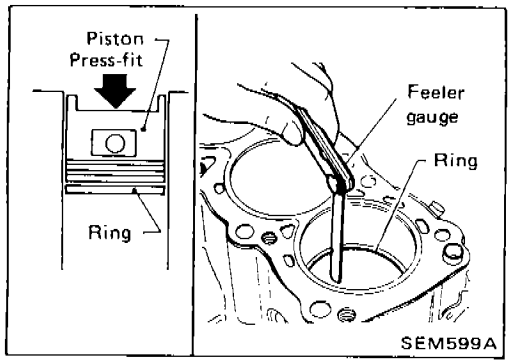
0.030 - 0.063 mm (0.0012 - 0.0025 in)

Max. limit of side clearance:

0.1 mm (0.004 in)

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

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

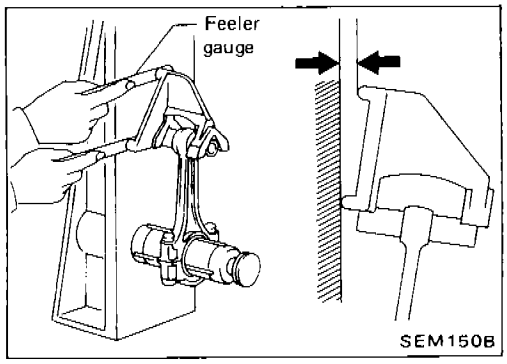
0.20 - 0.76 mm (0.0079 - 0.0299 in)

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.



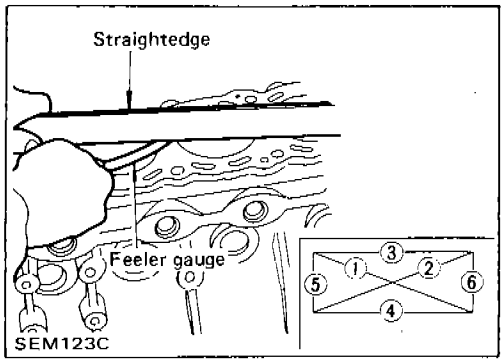
CONNECTING ROD BEND AND TORSION

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 mm (0.008 in)

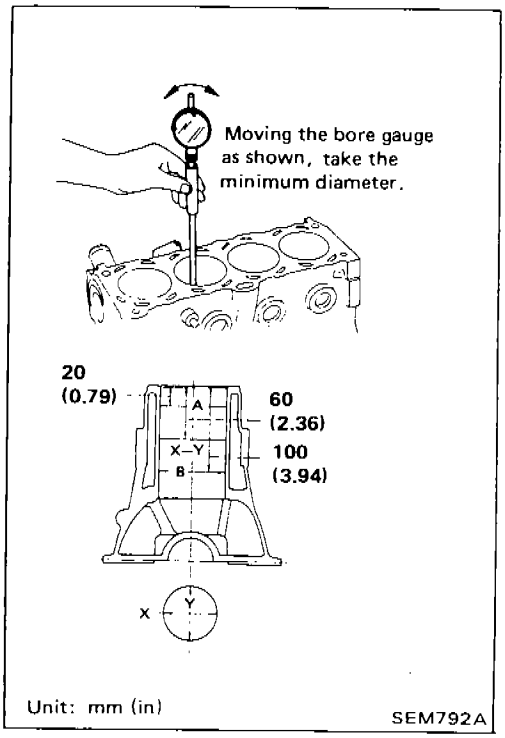
Nominal cylinder block height from crankshaft center:

204.75 - 204.85 mm (8.0610 - 8.0649 in)

3. If necessary, replace cylinder block.

Inspection (Cont'd)

PISTON-TO-BORE CLEARANCE



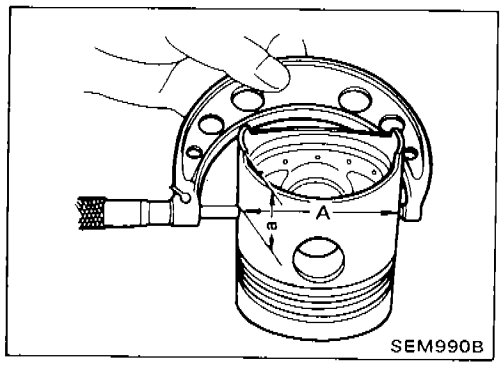
1. Using a bore gauge, measure cylinder bore for wear, out-of-round and taper.

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.**



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)

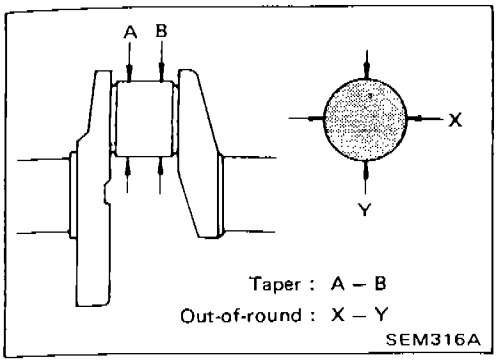
7. Install main bearing caps, and tighten to the specified torque to prevent distortion of cylinder bores in final assembly.
8. Cut cylinder bores.

- **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.**

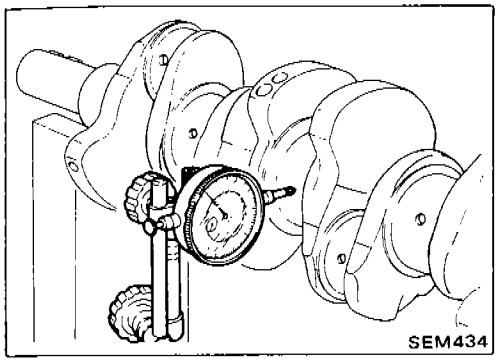
Inspection (Cont'd)



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)



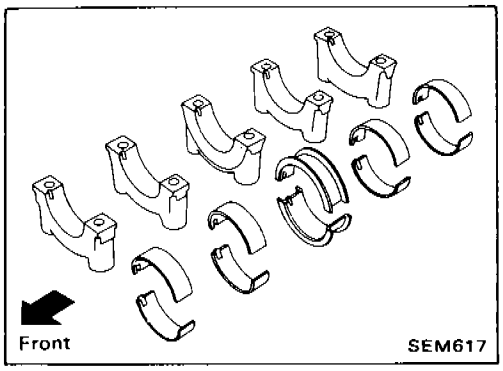
3. Measure crankshaft runout.

Runout (Total indicator reading):
Less than 0.025 mm (0.0010 in)

BEARING CLEARANCE

Method A (Using bore gauge & micrometer)
Main bearing

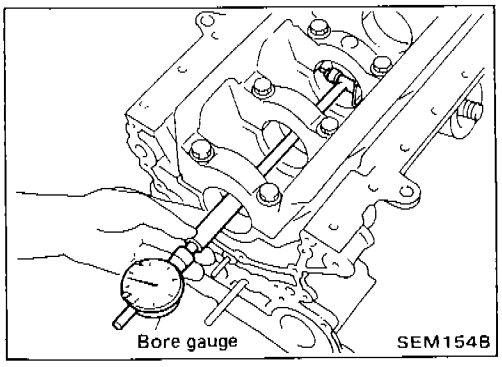
1. Set main bearings in their proper positions on cylinder block and main bearing cap.



2. Install main bearing cap to cylinder block.

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

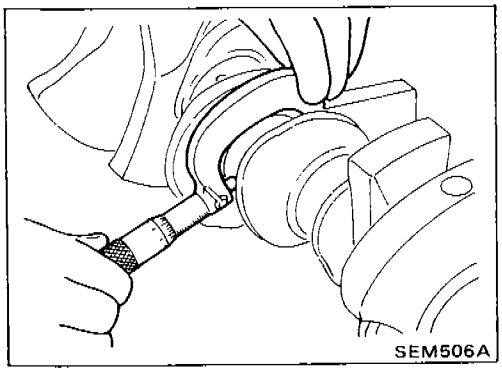
3. Measure inner diameter "A" of each main bearing.



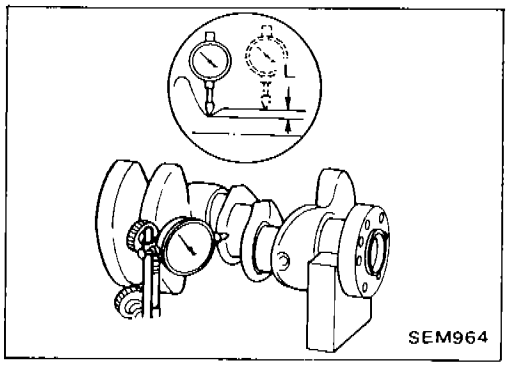
4. Measure outer diameter "Dm" of each crankshaft main journal.
5. Calculate main bearing clearance.
   Main bearing clearance = A – Dm

Standard:
0.021 - 0.048 mm (0.0008 - 0.0019 in)
Limit: 0.1 mm (0.004 in)

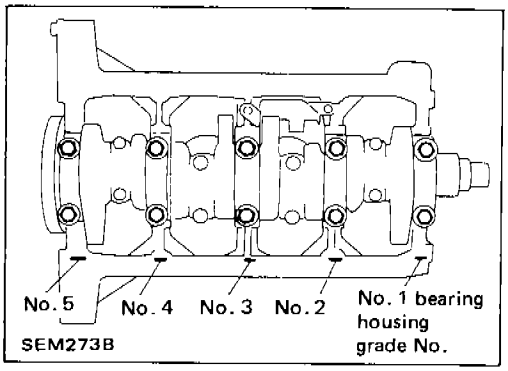
6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing.



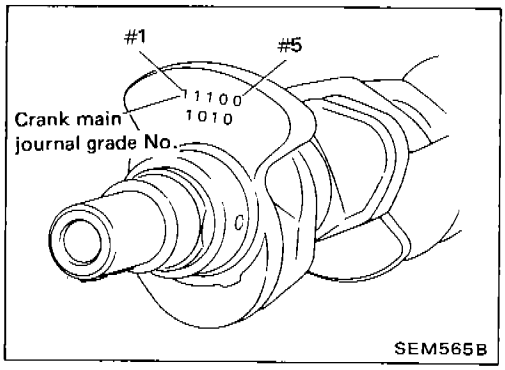
Inspection (Cont'd)



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.

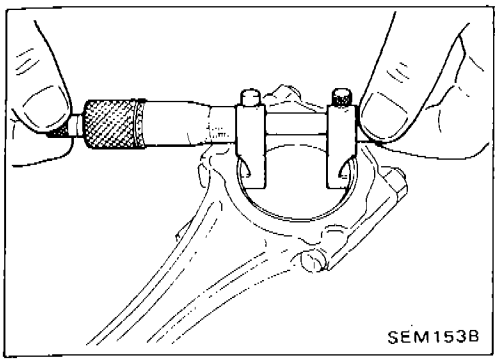
c. Select main bearing with suitable thickness according to the following table.

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

Inspection (Cont'd)

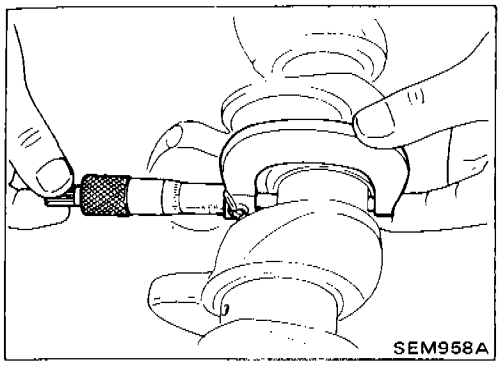

SEM153B

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.


SEM958A

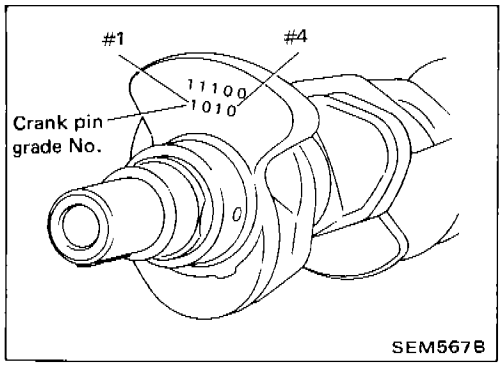
4. Measure outer diameter "Dp" of each crankshaft pin journal.
5. Calculate connecting rod bearing clearance.

   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".

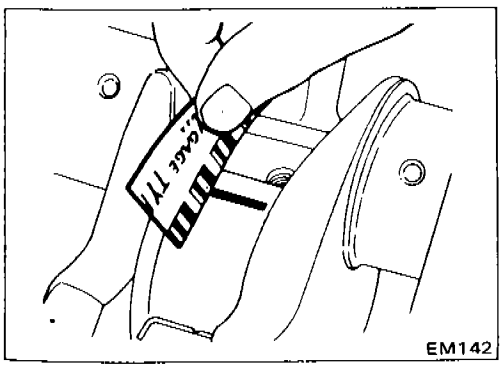


SEM567B

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


EM142

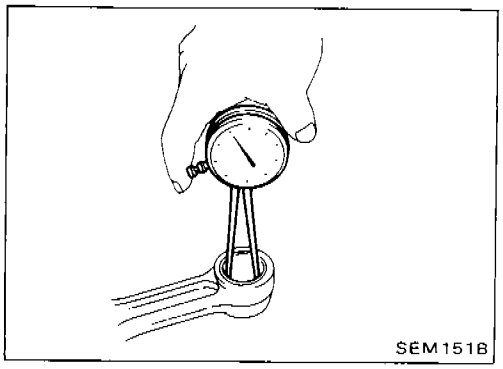
Method B (Using plastigage)

CAUTION:

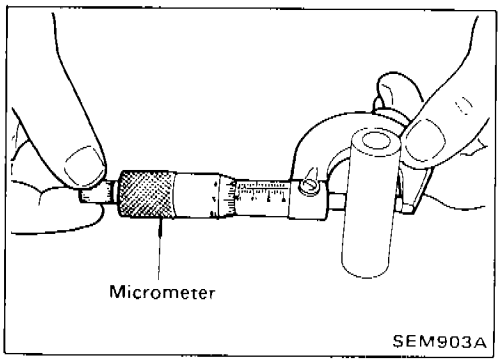
- **Do not turn crankshaft or connecting rod while the plastigage is being inserted.**
- **When bearing clearance exceeds the specified limit, ensure that the proper bearing has been installed. However, if excessive bearing clearance still exists, use thicker main bearing or undersized bearing so that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

Inspection (Cont'd)

CONNECTING ROD BUSHING CLEARANCE (Small end)



1. Measure inner diameter "C" of bushing.



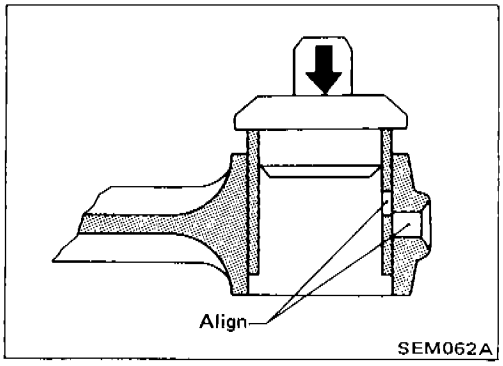
2. Measure outer diameter "Dp" of piston pin.
3. Calculate connecting rod bearing clearance.

   C – Dp = 0.005 - 0.017 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)

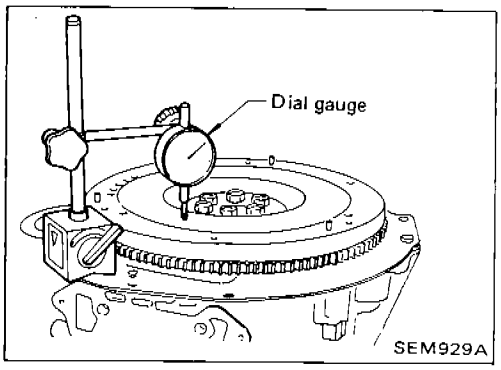


1. Drive in small end bushing until it is flush with end surface of rod.

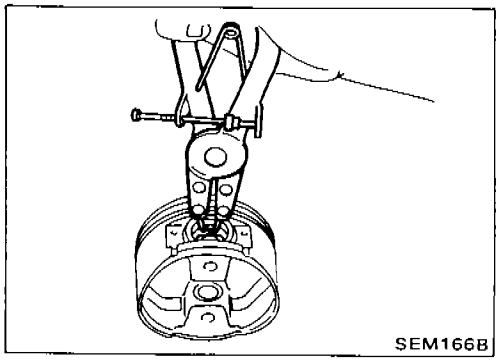
Be sure to align the oil holes.

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)

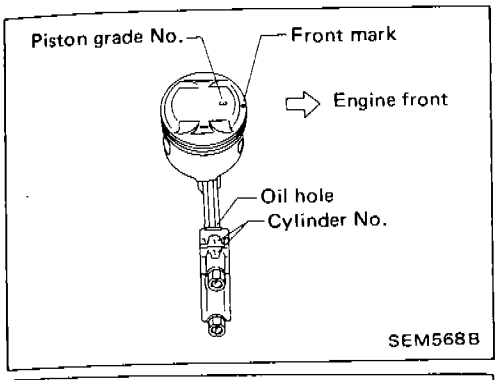


Assembly

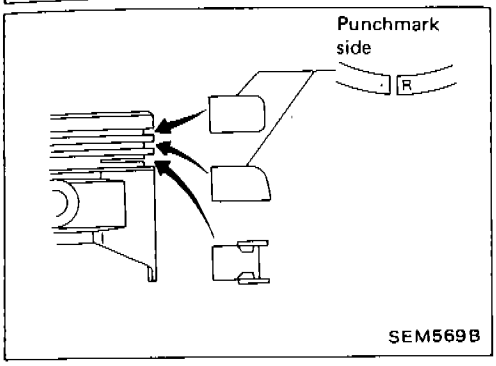
PISTON

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

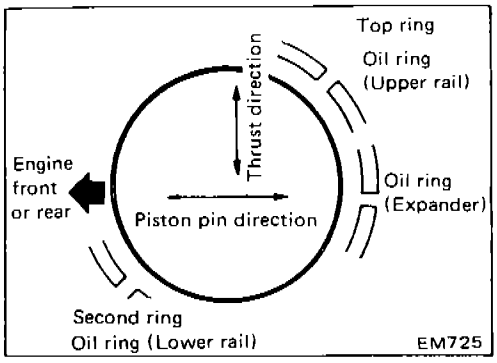
Assembly (Cont'd)



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.**

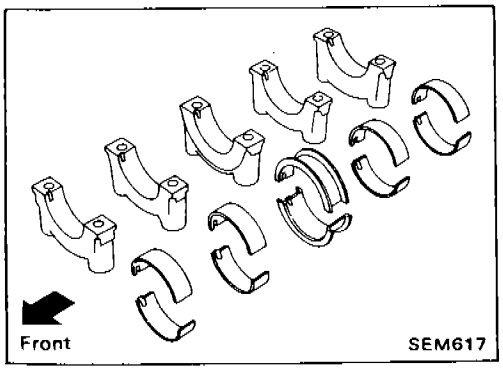


3. Set piston rings as shown.

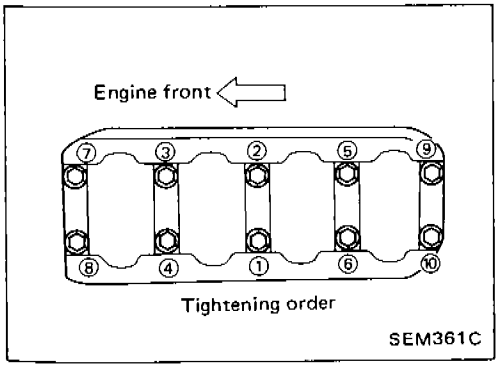


CRANKSHAFT

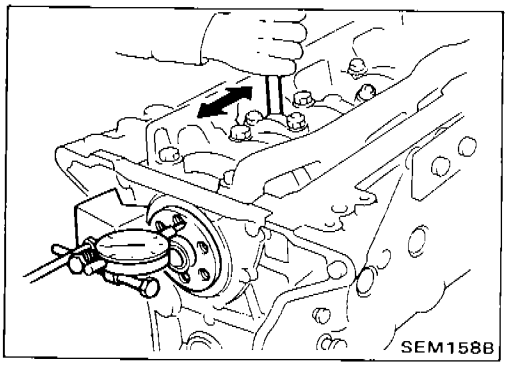
1. Set main bearings in their proper positions on cylinder block and main bearing cap.
- **Confirm that correct main bearings are used. Refer to "Inspection".**



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.**

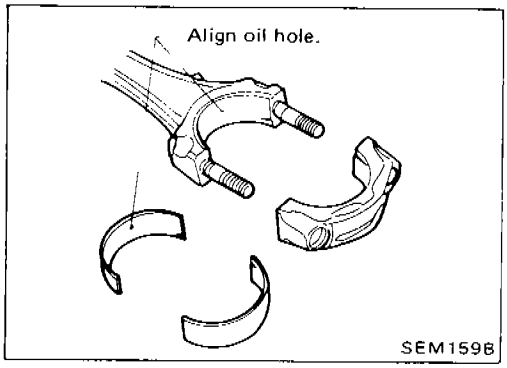


Assembly (Cont'd)

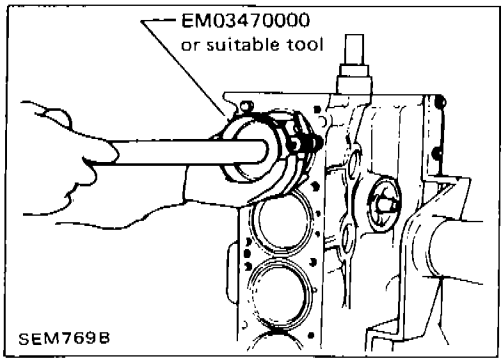


3. Measure crankshaft end play.
   Crankshaft end play:
   Standard
   0.05 - 0.18 mm (0.0020 - 0.0071 in)
   Limit
   0.3 mm (0.012 in)

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

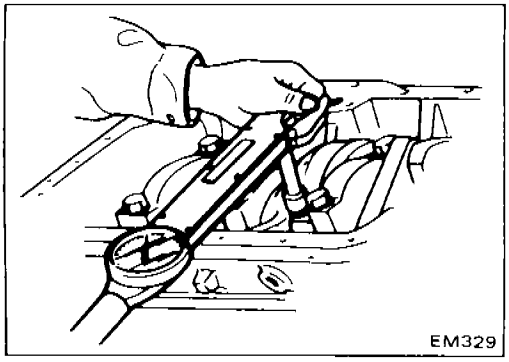


4. Install connecting rod bearings in connecting rods and connecting rod caps.
- Confirm that correct bearings are used.
  Refer to "Inspection".
- Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.

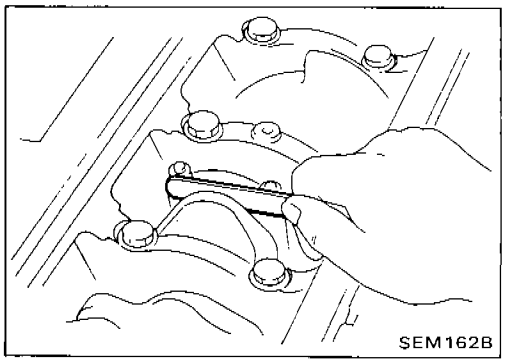


5. Install pistons with connecting rods.

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.

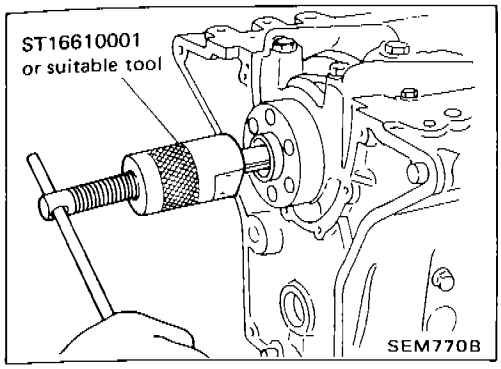


6. Measure connecting rod side clearance.
   Connecting rod side clearance:
   Standard
   0.20 - 0.35 mm (0.0079 - 0.0138 in)
   Limit
   0.4 mm (0.016 in)

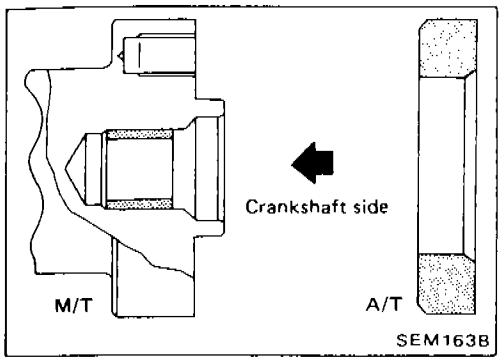
If beyond the limit, replace connecting rod and/or crankshaft.

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).

General Specifications

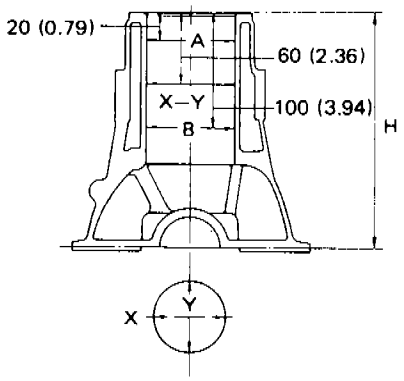
Engine model	CA18DET
Cylinder arrangement	4, in-line
Displacement cm^3 (cu in)	1,809 (110.39)
Bore x stroke mm (in)	83.0 x 83.6 (3.268 x 3.291)
Valve arrangement	D.O.H.C.
Firing order	1-3-4-2
Number of piston rings	
Compression	2
Oil	1
Number of main bearings	5
Compression ratio	8.5

Unit: kPa (bar, kg/cm^2, 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)

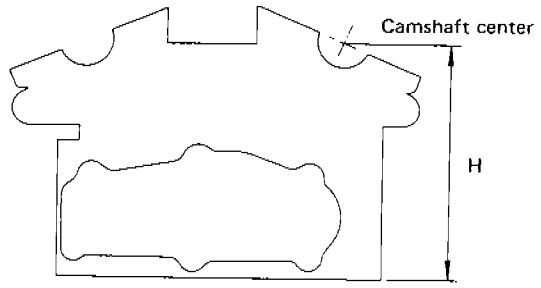
			Standard	Limit
Distortion			0.03 (0.0012)	0.1 (0.004)
Cylinder bore	Inner diameter	Grade 1	83.000 - 83.010 (3.2677 - 3.2681)	0.2 (0.008)*
		Grade 2	83.010 - 83.020 (3.2681 - 3.2685)	
		Grade 3	83.020 - 83.030 (3.2685 - 3.2689)	
		Grade 4	83.030 - 83.040 (3.2689 - 3.2693)	
		Grade 5	83.040 - 83.050 (3.2693 - 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

Inspection and Adjustment (Cont'd)

CYLINDER HEAD



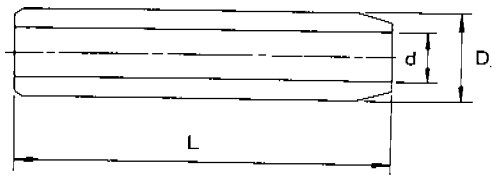
SEM570B

Unit: mm (in)

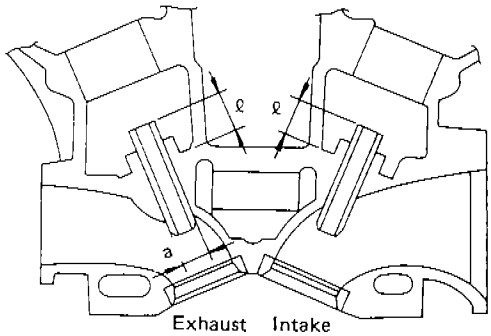
	Standard	Limit
Height (H)	125.9 - 126.1 (4.957 - 4.965)	0.2 (0.008)*
Surface distorsion	0.03 (0.0012)	0.1 (0.004)

* Total amount of cylinder head resurfacing and cylinder block resurfacing

VALVE GUIDE



SEM571B



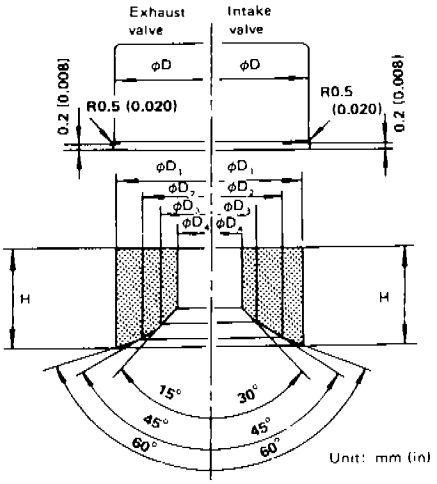
SEM572B

Unit: mm (in)

	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)				—

Inspection and Adjustment (Cont'd)

VALVE SEAT



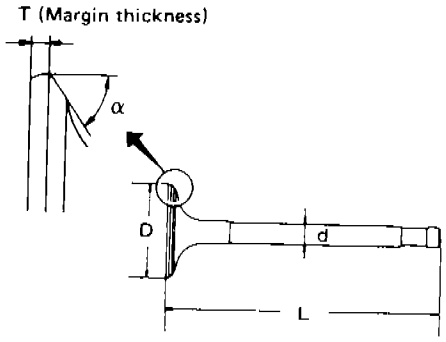
SEM573B

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)

Inspection and Adjustment (Cont'd)

VALVE



SEM188A

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 (α)	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)

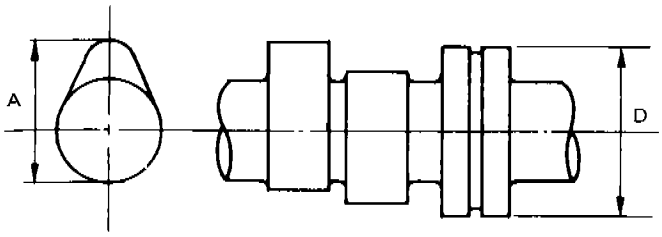
HYDRAULIC VALVE LIFTER

Unit: mm (in)

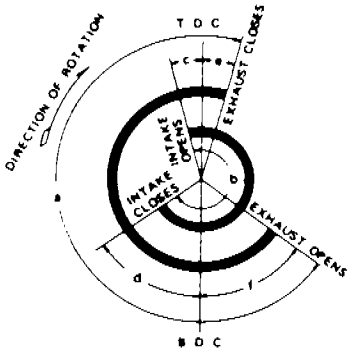
Valve lifter diameter	30.955 - 30.965 (1.2187 - 1.2191)
Lifter guide bore diameter	31.000 - 31.013 (1.2205 - 1.2210)

Inspection and Adjustment (Cont'd)

CAMSHAFT AND CAMSHAFT BEARING



SEM568A



EM120

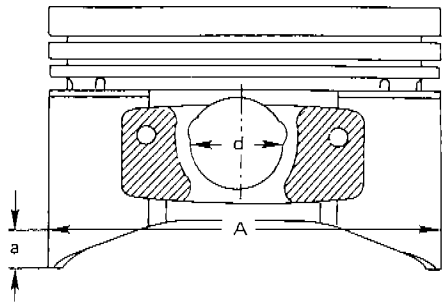
Unit: mm (in)

		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	–

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)

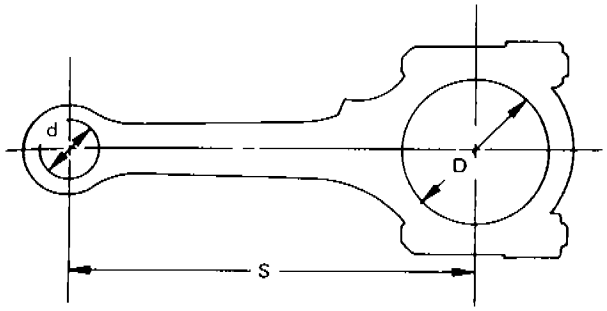
Piston ring

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)

Inspection and Adjustment (Cont'd)

ONNECTING ROD



SEM570A

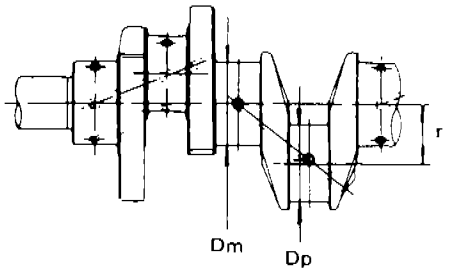
Unit: mm (in)

	Standard	Limit
ıter distance (S)	132.95 - 133.05 (5.2342 - 5.2382)	—
ıd ır 100 mm (3.94 in)]	—	0.1 (0.004)
ʳsion ır 100 mm (3.94 in)]	—	0.1 (0.004)
ton pin bore diameter *	22.987 - 23.000 (0.9050 - 0.9055)	—
arance between piston and bearing	0.005 - 0.017 (0.0002 - 0.0007)	—
nk pin bore diameter *	48.000 - 48.013 (1.8898 - 1.8903)	—
arance between crank and bearing	0.018 - 0.045 (0.0007 - 0.0018)	—
end play	—	0.4 (0.016)

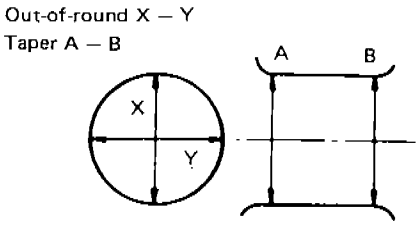
'ithout bearing

Inspection and Adjustment (Cont'd)

CRANKSHAFT



EM737



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

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

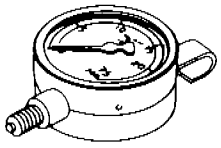
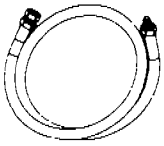
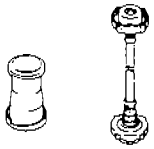
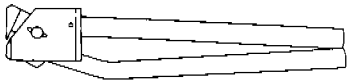
By-pass valve controller diaphragm	0.38 mm (0.0150 in)/ 83.3 - 88.6 kPa (833 - 886 mbar, 625 - 665 mmHg, 24.61 - 26.18 inHg)
Play	0.013 - 0.097 mm (0.0005 - 0.0038 in)

ENGINE LUBRICATION & COOLING SYSTEMS

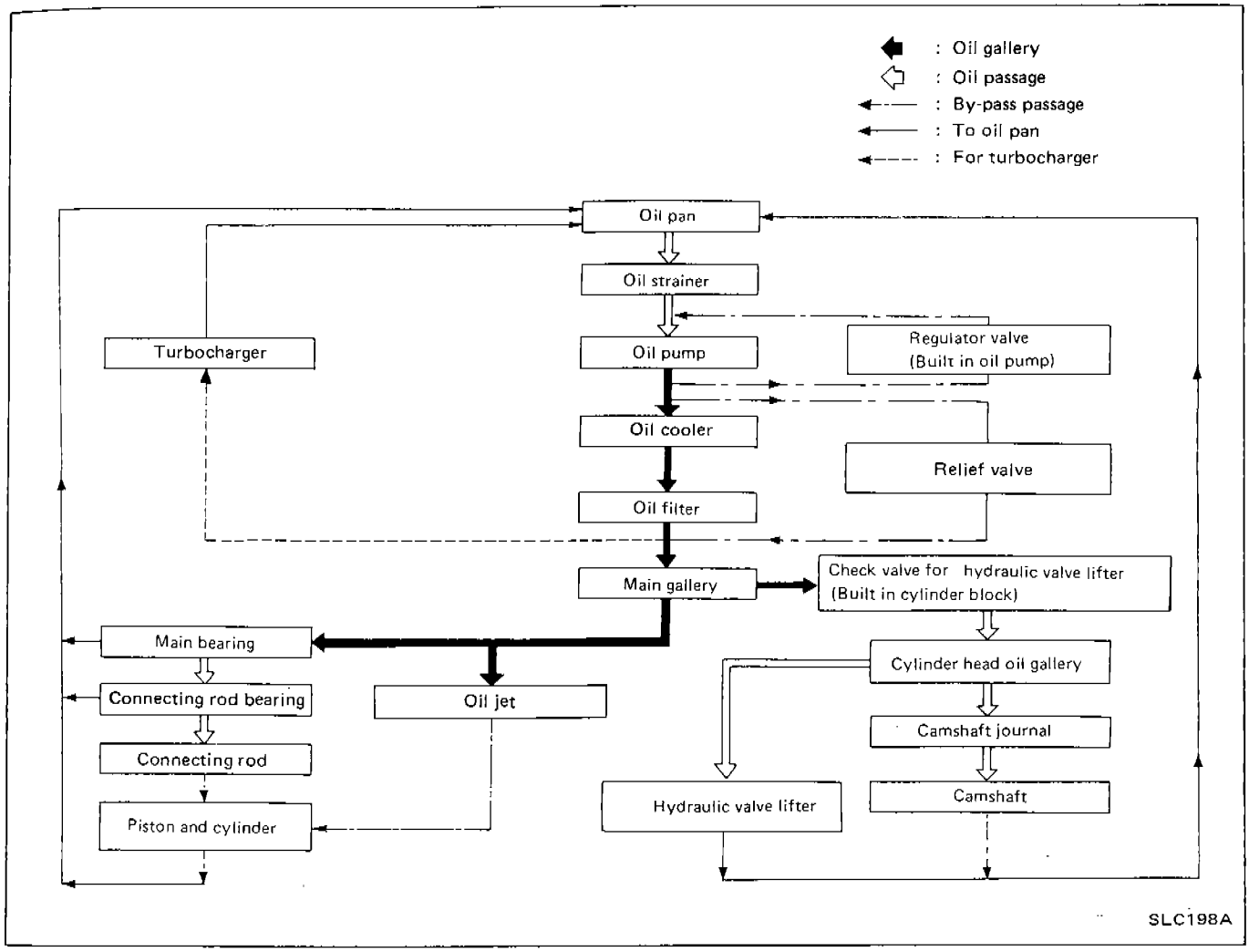
SECTION LC

CONTENTS

SPECIAL SERVICE TOOLS

Tool number Tool name	Description	
ST25051001 Oil pressure gauge		
ST25052000 Hose		Adapting oil pressure gauge to cylinder block
EG17650301 Radiator cap tester adapter		Adapting radiator cap tester to radiator filler neck
KV99103510 Radiator plate pliers A		Installing radiator upper and lower tanks
KV99103520 Radiator plate pliers B		Removing radiator upper and lower tanks

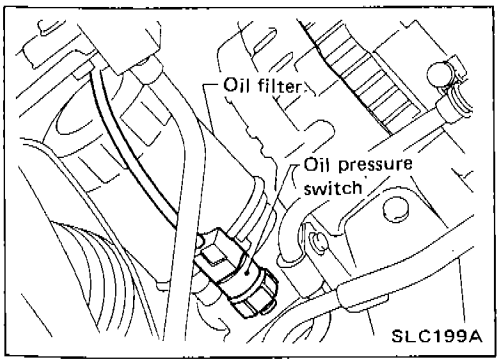
Lubrication Circuit



Oil Pressure Check

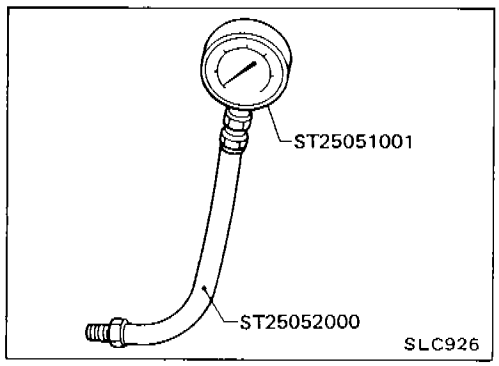
WARNING:

- **Be careful not to burn yourself, as the engine and oil may be hot.**
- **Oil pressure check should be done in "Neutral" gear position.**



1. Check oil level.
2. Remove oil pressure switch.

Oil Pressure Check (Cont'd)



3. Install pressure gauge.
4. Start engine and warm it up to normal operating temperature.
5. Check oil pressure with engine running under no-load.

Engine rpm	Approximate discharge pressure kPa (bar, kg/cm^2, psi)
Idle speed	More than 78 (0.78, 0.8, 11)
3,000	353 - 412 (3.53 - 4.12, 3.6 - 4.2, 51 - 60)

If difference is extreme, check oil passage and oil pump for oil leaks.

6. Install oil pressure switch with sealant.

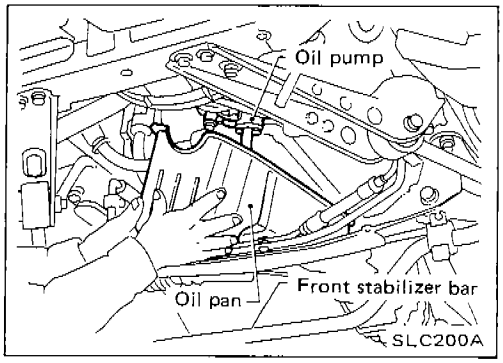
Use proper liquid sealant.

Oil pressure switch:

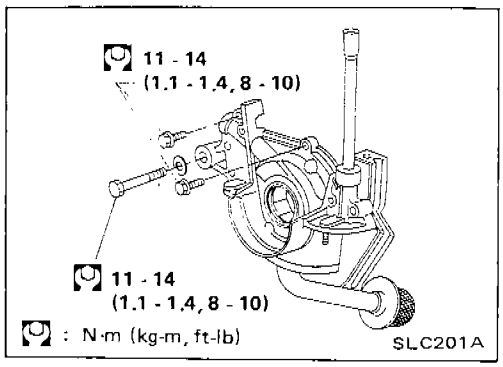
: 10 - 16 N·m (1.0 - 1.6 kg-m, 7 - 12 ft-lb)

Oil Pump

REMOVAL AND INSTALLATION



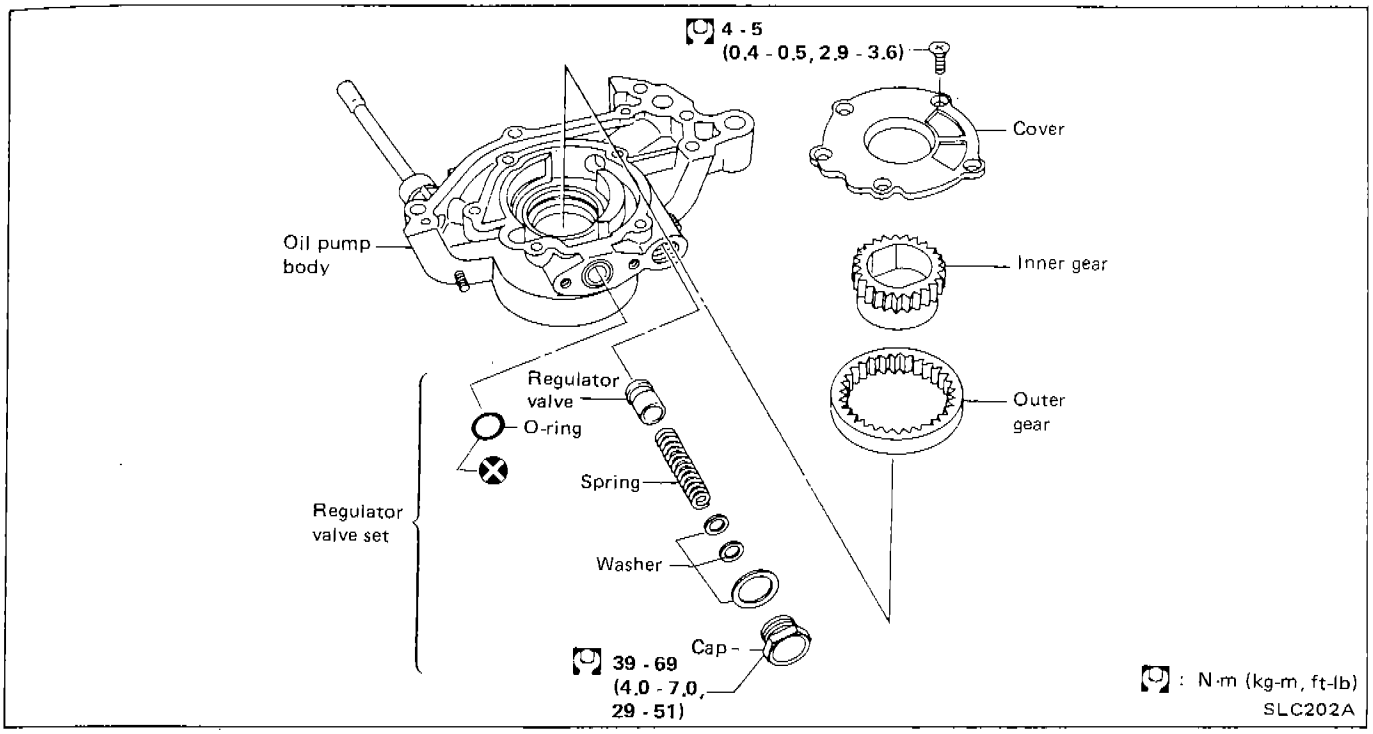
1. Remove drive belts.
2. Remove timing belt covers and timing belt.
3. Remove front stabilizer bar.
4. Loosen front engine mounting nuts. (Do not loosen nuts completely.)
5. Lift up engine slightly using engine slings.
6. Remove oil pan.



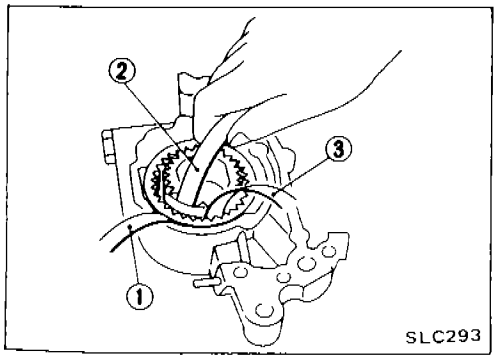
7. Remove oil pump assembly with oil strainer.
8. Installation is in reverse order of removal.

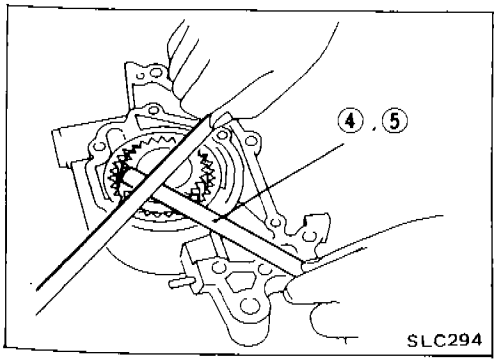
Oil Pump (Cont'd)

DISASSEMBLY AND ASSEMBLY



- **When installing oil pump, apply engine oil to inner and outer gear.**
- **Be sure that O-ring is properly fitted.**





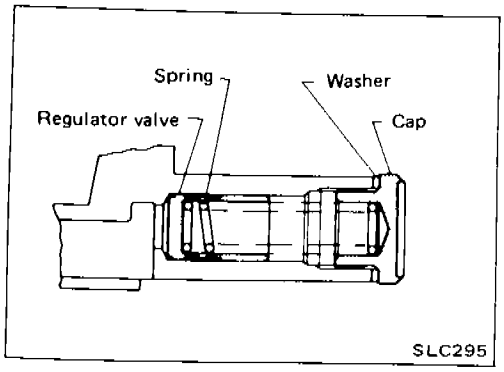
INSPECTION

Using a feeler gauge, check the following clearances.

Unit: mm (in)

Body to outer gear clearance ①	0.11 - 0.20 (0.0043 - 0.0079)
Inner gear to crescent clearance ②	0.15 - 0.26 (0.0059 - 0.0102)
Outer gear to crescent clearance ③	0.21 - 0.32 (0.0083 - 0.0126)
Housing to inner gear clearance ④	0.05 - 0.09 (0.0020 - 0.0035)
Housing to outer gear clearance ⑤	0.05 - 0.11 (0.0020 - 0.0043)

If it exceeds the limit, replace gear set or entire oil pump assembly.



Oil Pump (Cont'd)

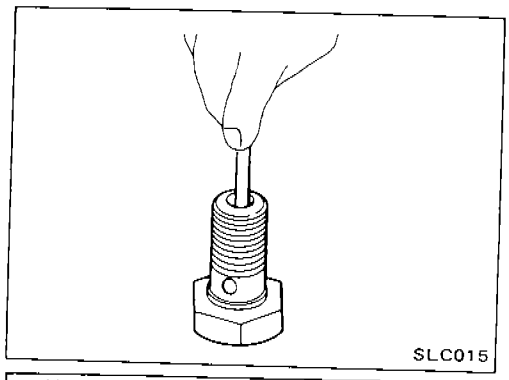
REGULATOR VALVE INSPECTION

1. Visually inspect components for wear and damage.
2. Check oil pressure regulator valve sliding surface and valve spring.
3. Coat regulator valve with engine oil and check that it falls smoothly into the valve hole by its own weight.

If damaged, replace regulator valve set or oil pump assembly.

OIL PRESSURE RELIEF VALVE INSPECTION

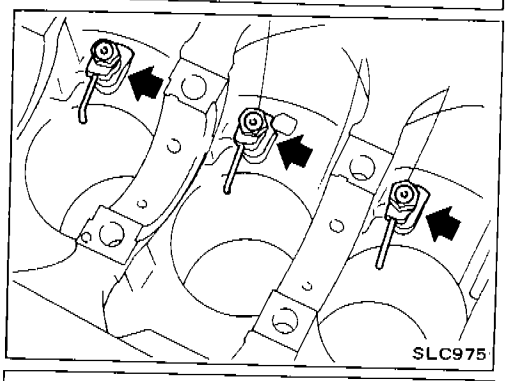
Inspect oil pressure relief valve for movement, cracks and breaks by pushing the ball, If replacement is necessary, remove valve by prying it out with a suitable tool. Install a new valve in place by tapping it.



Oil Jet

INSPECTION (For piston)

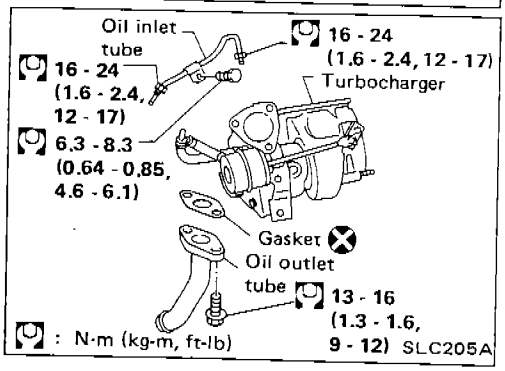
1. Blow through outlet of oil jet and make sure that air comes out of inlet.
2. Push cut-off valve of oil jet bolt with a clean resin or brass rod and make sure that cut-off valve moves smoothly with proper repulsion.



When installing oil jet, align oil jet's boss with hole on cylinder block.

Oil jet bolt:

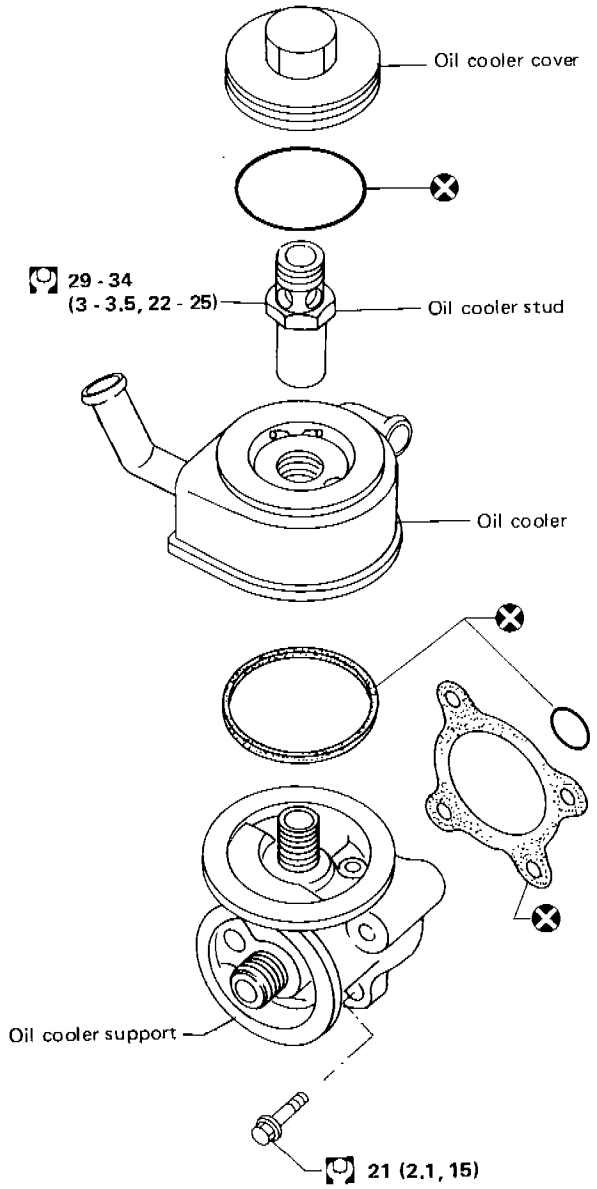
: 29 - 39 N·m (3.0 - 4.0 kg-m, 22 - 29 ft-lb)



Turbocharger

- **Before removing water tube, drain coolant first.**
- **After installation, run engine for a few minutes and check for leaks.**

Oil Cooler

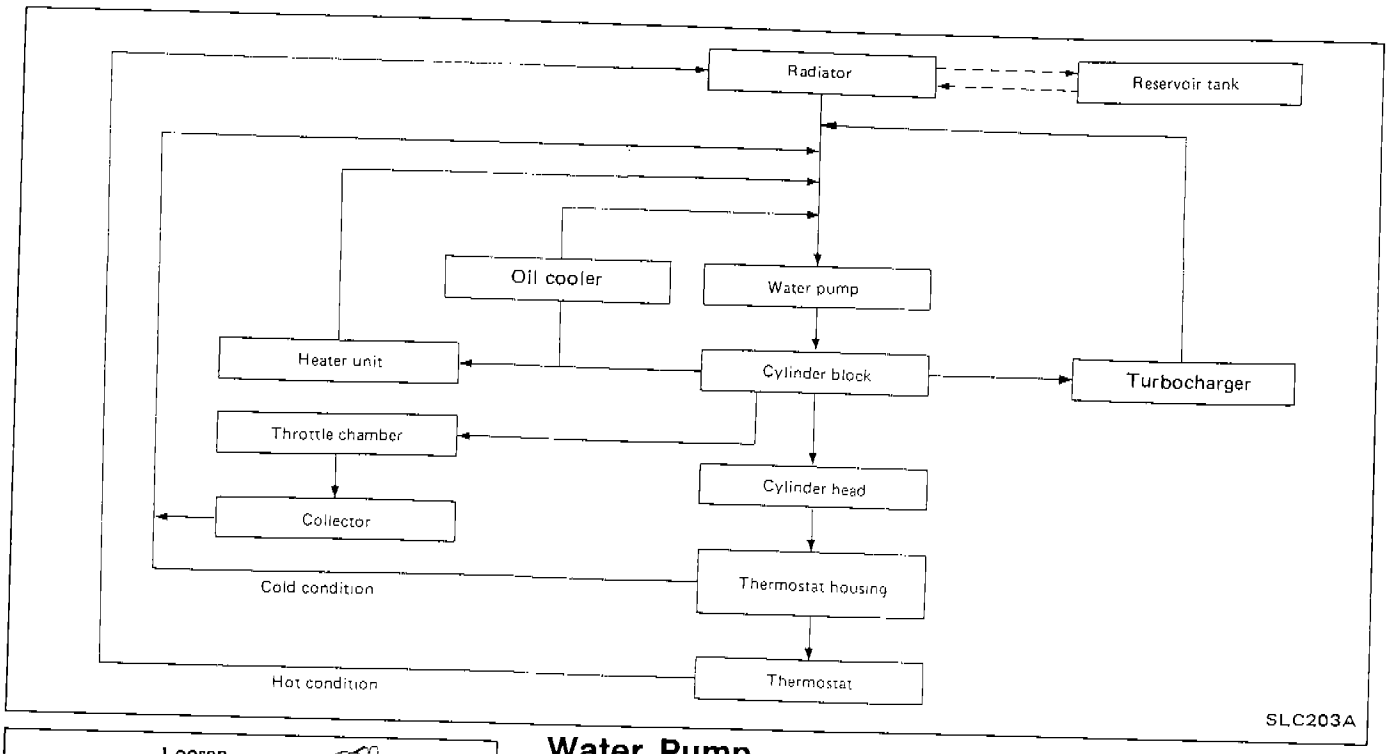


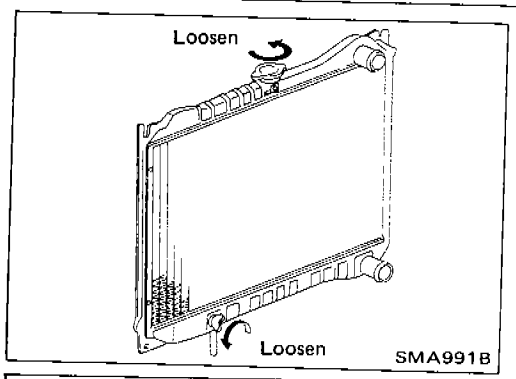
: N·m (kg-m, ft-lb)

INSPECTION

1. Check oil cooler element and housing for cracks.
2. Check oil cooler for clogging by blowing through coolant inlet.
   Replace it if necessary.

Cooling Circuit

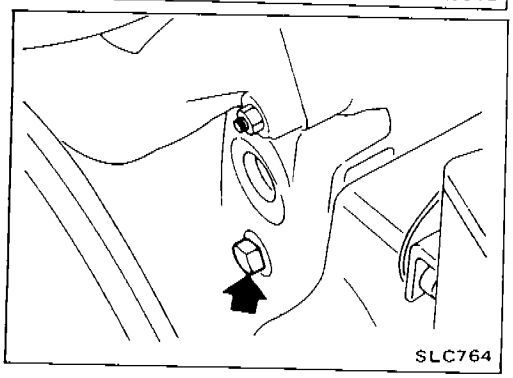




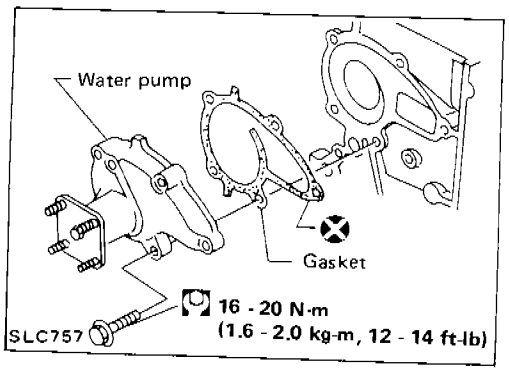
Water Pump

REMOVAL AND INSTALLATION

1. Drain coolant from radiator.



2. Remove cylinder block drain plug located at left rear of cylinder block and drain coolant.



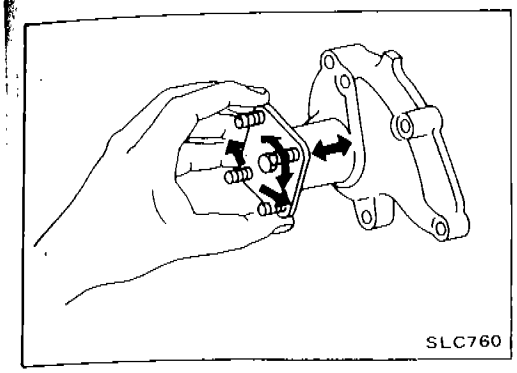
CAUTION:

- **When removing water pump assembly, be careful not to get coolant on timing belt.**
- **Water pump cannot be disassembled and should be replaced as a unit.**
- **After installing water pump, connect hose and clamp securely, then check for leaks using radiator cap tester.**

Water Pump (Cont'd)

INSPECTION

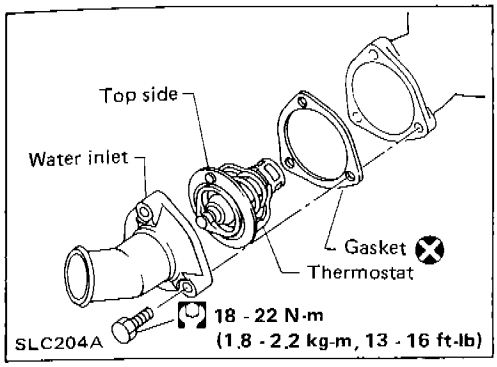
1. Check for badly rusted or corroded body assembly and vane.
2. Check for rough operation due to excessive end play.


SLC760

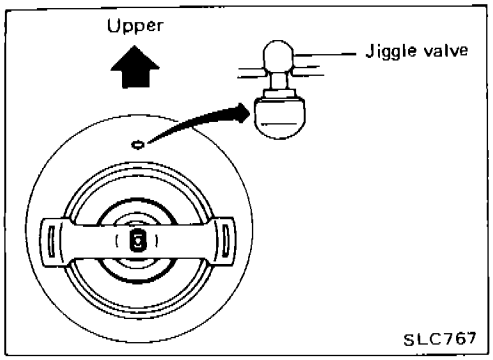
Thermostat

INSPECTION

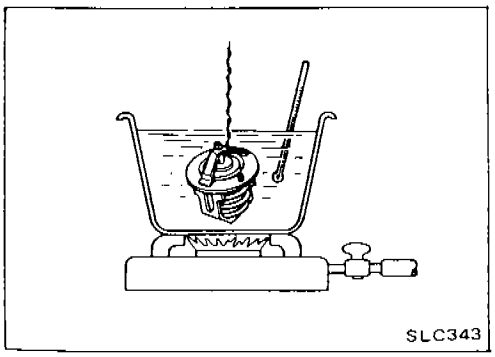
1. Check for valve seating condition at ordinary temperatures. It should seat tightly.



SLC204A



SLC767


SLC343

2. Check valve opening temperature and maximum valve lift.

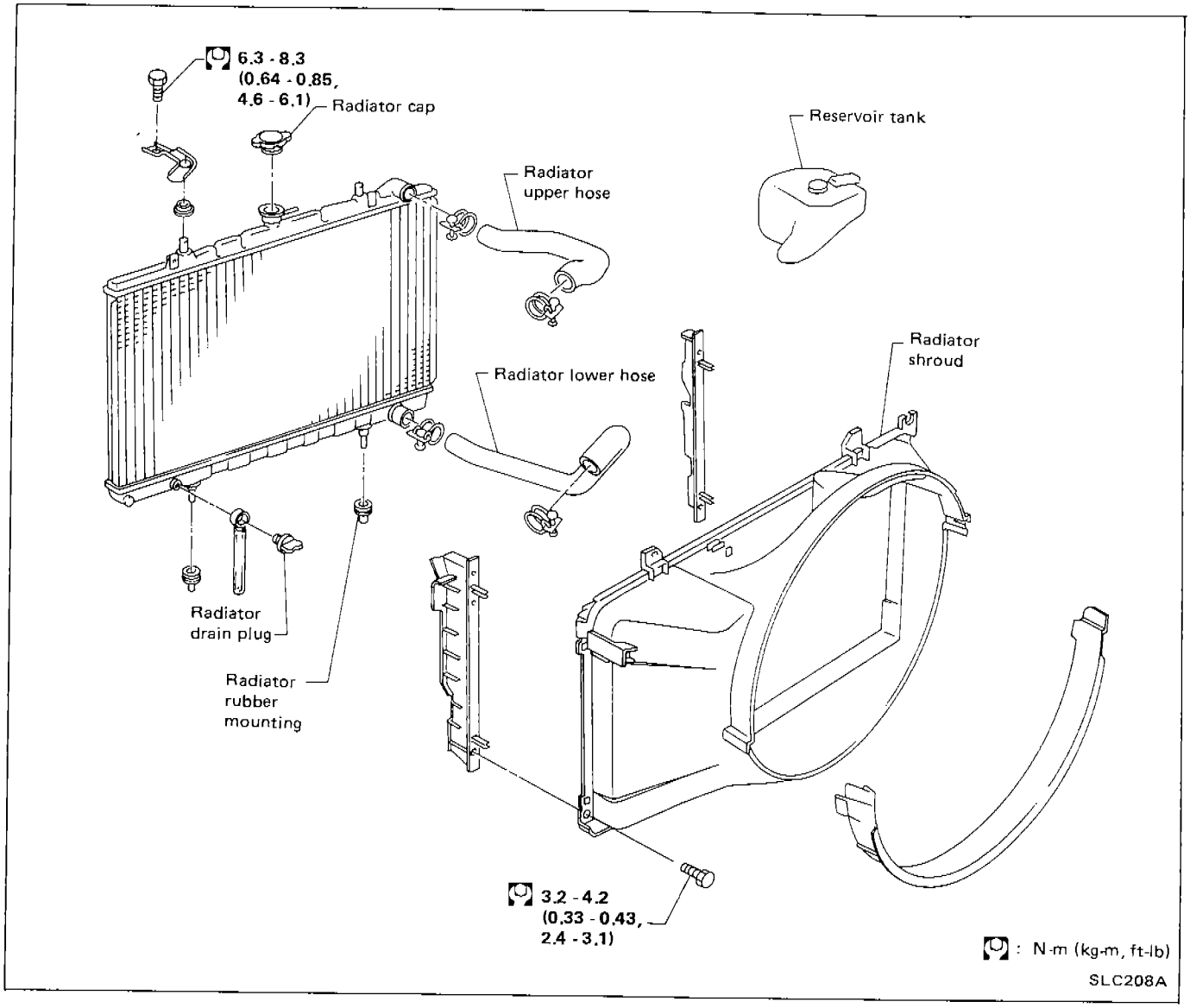
	Standard	Cold type	Hot type*
Valve opening temperature °C (°F)	82 (180)	88 (190)	76.5 (170)
Max. valve lift mm/°C (in/°F)	8/95 (0.31/203)	8/100 (0.31/212)	8/90 (0.31/194)

*For general areas only

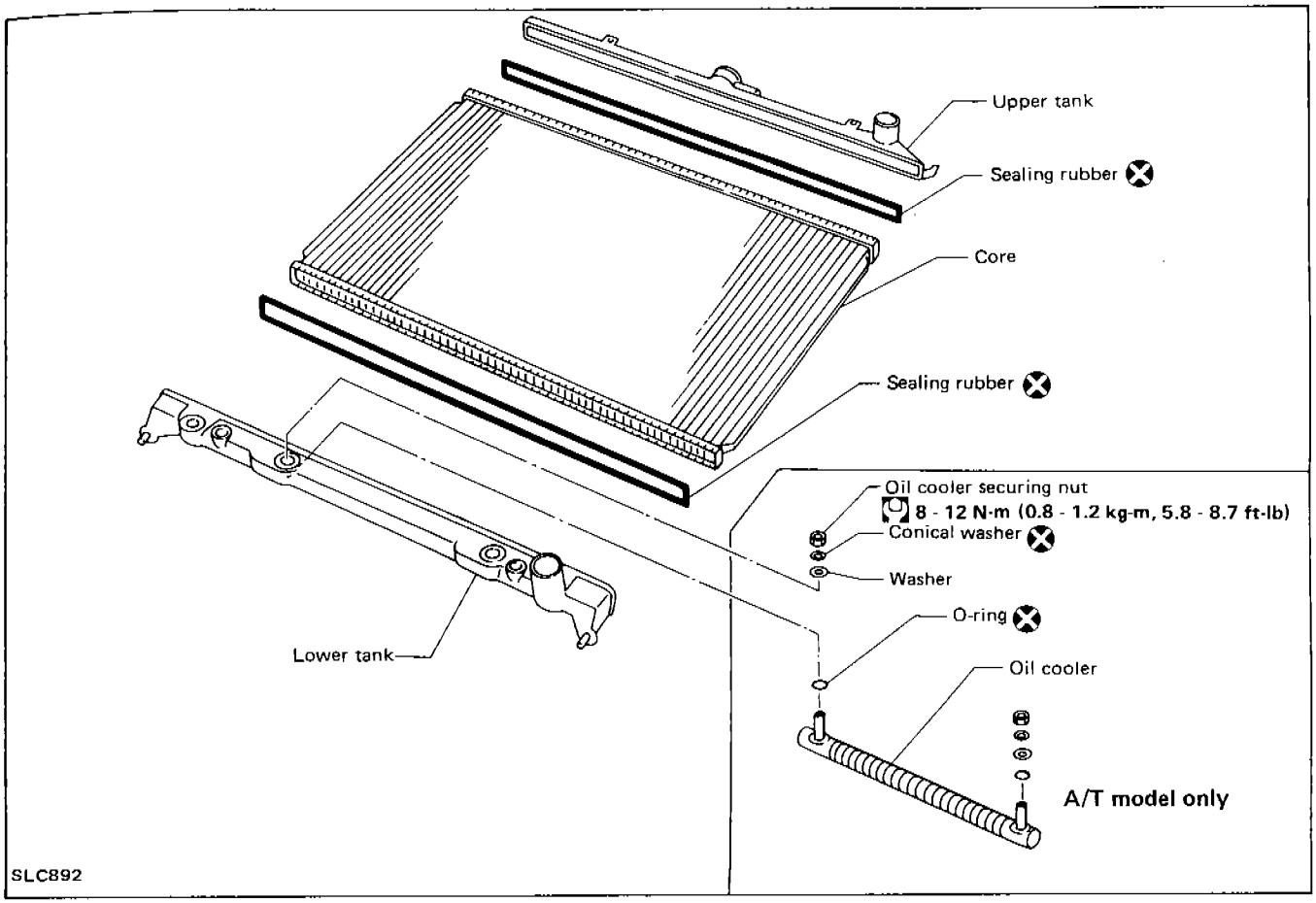
3. Then check if valve closes at 5°C (9°F) below valve opening temperature.

- **After installation, run engine for a few minutes, and check for leaks.**

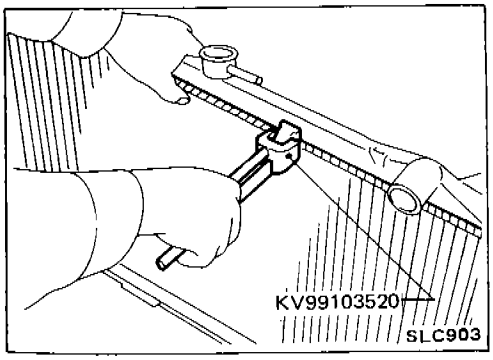
Radiator


6.3 - 8.3
(0.64 - 0.85,
4.6 - 6.1)
Radiator cap
Reservoir tank
Radiator
upper hose
Radiator lower hose
Radiator
shroud
Radiator
drain plug
Radiator
rubber
mounting
3.2 - 4.2
(0.33 - 0.43,
2.4 - 3.1)
: N·m (kg-m, ft-lb)
SLC208A

Radiator (Aluminum type)

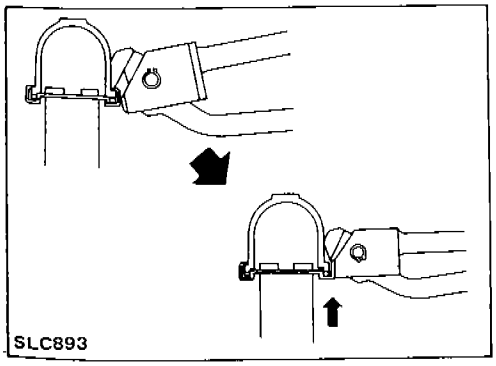


Aluminum radiator can be disassembled by using special procedures and special service tools.



DISASSEMBLY

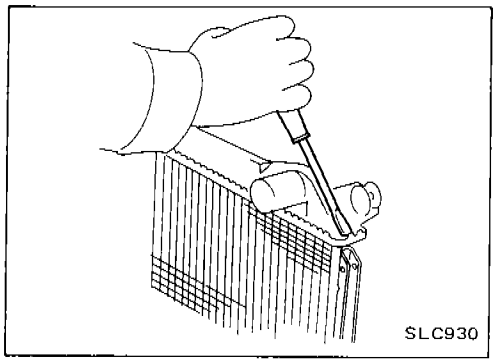
1. Remove tank with Tool.



- Grip the crimped edge and bend it upwards so that Tool slips off.

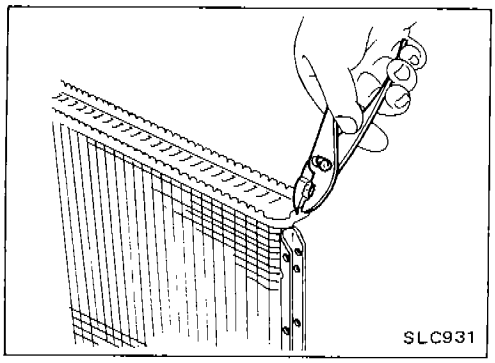
Do not bend excessively.

Radiator (Aluminum type)(Cont'd)

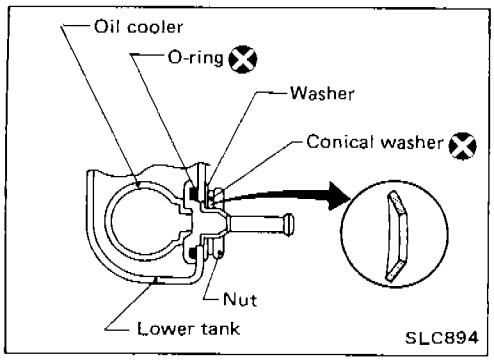


- In areas where Tool cannot be used, use a screwdriver to bend the edge up.

Be careful not to damage tank.



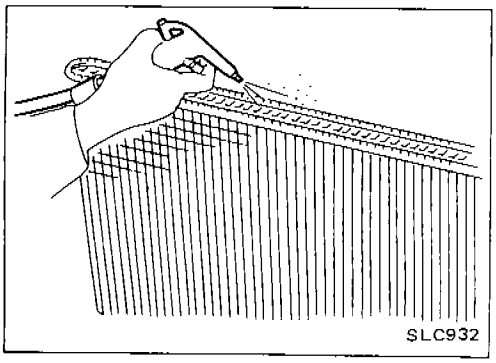
2. Make sure the edge stands straight up.
3. Remove oil cooler from tank. (A/T model only)



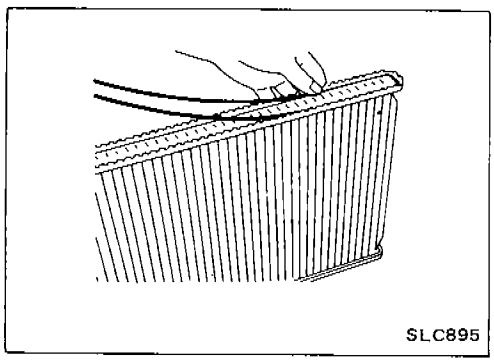
ASSEMBLY

1. Install oil cooler. (A/T model only)

Pay attention to direction of conical washer.



2. Clean contact portion of tank.



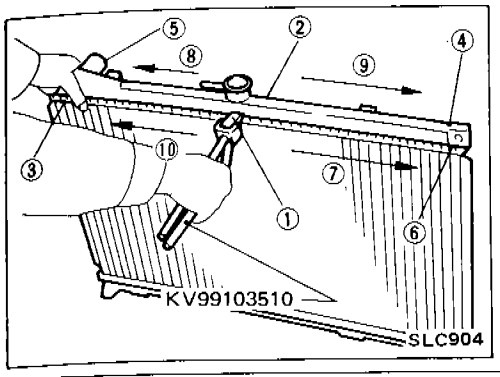
3. Install sealing rubber.

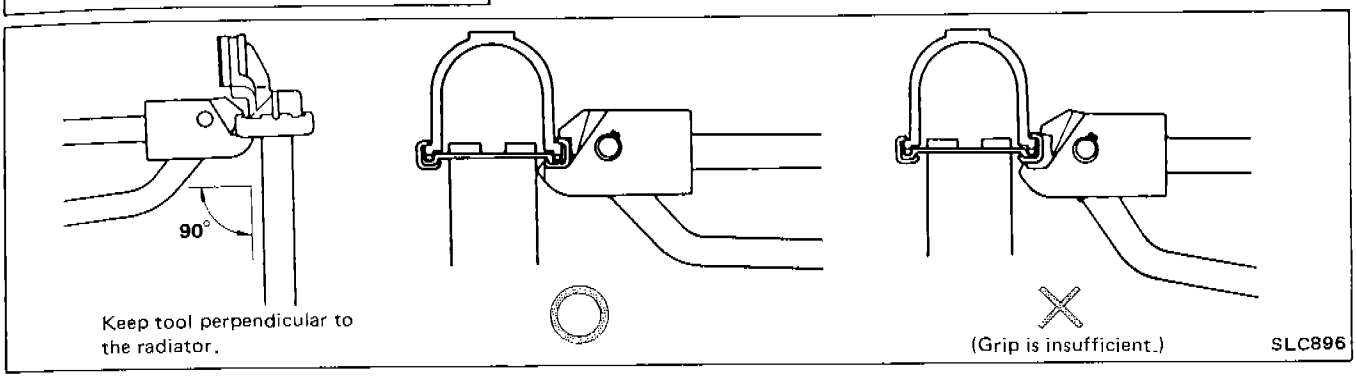
Push it in with fingers.

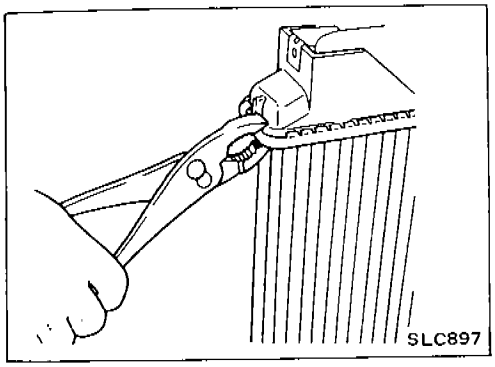
Be careful not to twist sealing rubber.

Radiator (Aluminum type)(Cont'd)

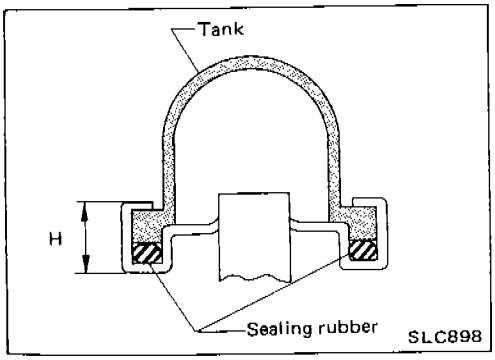
4. Caulk tank in specified sequence with Tool.





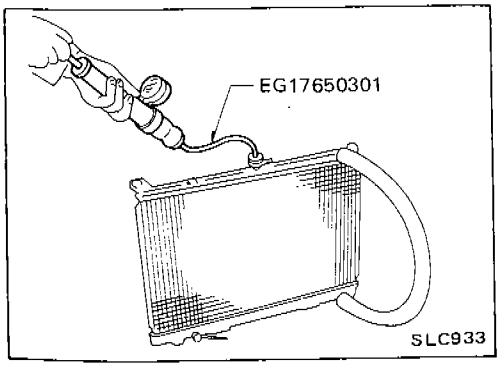


- Use pliers in the locations where Tool cannot be used.



5. Make sure that the rim is completely crimped down.
   Standard height "H":
   11.5 mm (0.453 in)
6. Confirm that there is no leakage.

Refer to "INSPECTION".

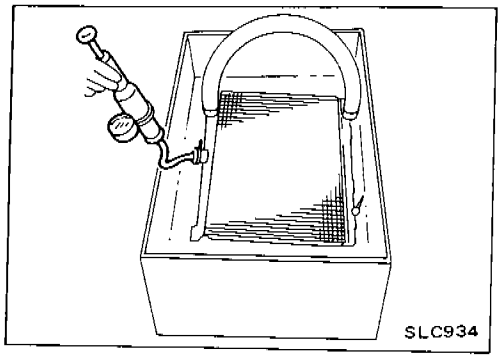


INSPECTION

1. Apply pressure with Tool.
   Specified pressure value:
   157 kPa (1.57 bar, 1.6 kg/cm^2, 23 psi)

WARNING:
To prevent the risk of the hose coming undone while under pressure, securely fasten it down with a hose clamp.
Attach a hose to the oil cooler as well. (A/T model only)

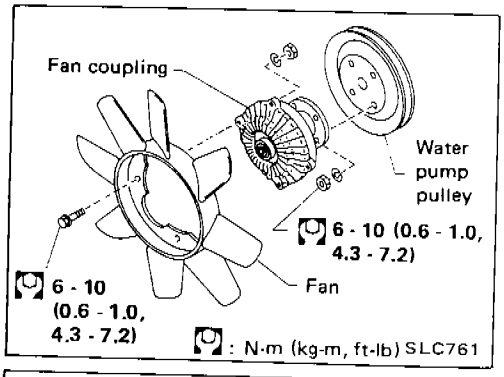
Radiator (Aluminum type)(Cont'd)



2. Check leakage.

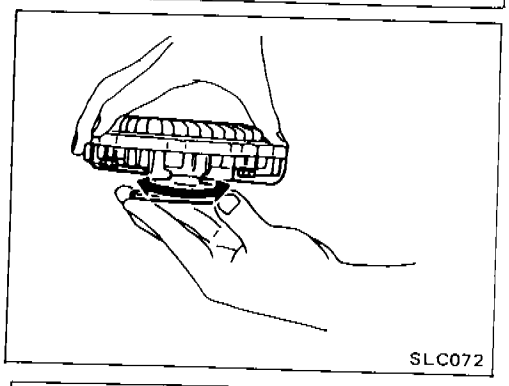
Cooling Fan

DISASSEMBLY AND ASSEMBLY

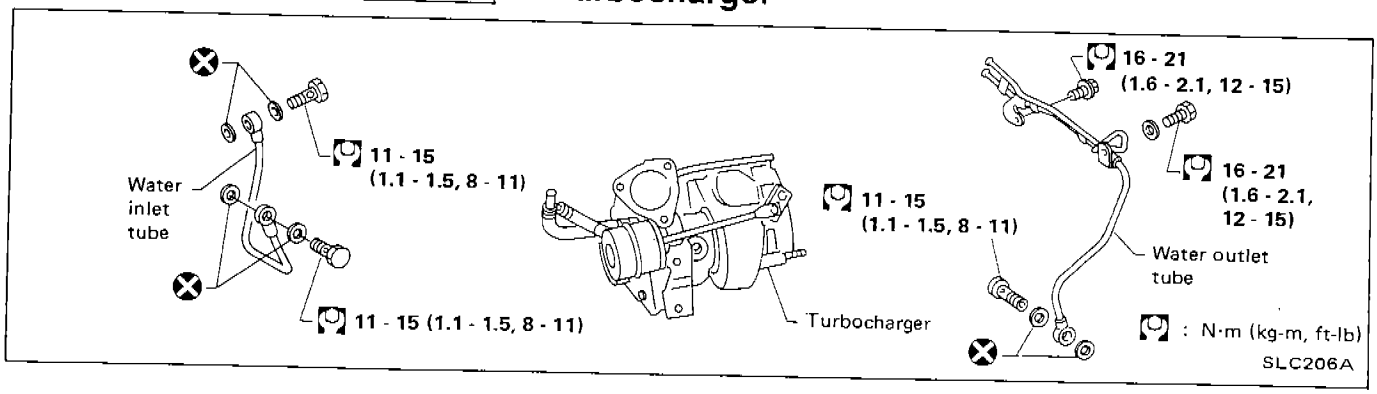


INSPECTION

Check fan coupling for rough operation, oil leakage or bent bimetal.



Turbocharger



- **When installing oil tubes, first hand-tighten nuts connecting tubes, then slightly tighten bracket securing bolts, and tighten nuts and bolts securely.**
- **Be careful not to deform tubes.**
- **After installation, run engine for a few minutes, and check for oil leakage.**

Engine Lubrication System

OIL PRESSURE CHECK

Engine rpm	Approximate discharge pressure kPa (bar, kg/cm², psi)
Idle speed	More than 78 (0.78, 0.8, 11)
3,000	353 - 412 (3.53 - 4.12, 3.6 - 4.2, 51 - 60)

OIL PUMP INSPECTION

Unit: mm (in)

Body to outer gear clearance	0.11 - 0.20 (0.0043 - 0.0079)
Inner gear to crescent clearance	0.15 - 0.26 (0.0059 - 0.0102)
Outer gear to crescent clearance	0.21 - 0.32 (0.0083 - 0.0126)
Housing to inner gear clearance	0.05 - 0.09 (0.0020 - 0.0035)
Housing to outer gear clearance	0.05 - 0.11 (0.0020 - 0.0043)

Engine Cooling System

THERMOSTAT

	Standard	Cold type	Hot type*
Valve opening temperature °C (°F)	82 (180)	88 (190)	76.5 (170)
Max. valve lift mm/°C (in/°F)	8/95 (0.31/203)	8/100 (0.31/212)	8/90 (0.31/194)

*For general areas only

RADIATOR

Leakage test pressure	157 kPa (1.57 bar, 1.6 kg/cm², 23 psi)

ENGINE FUEL & EMISSION CONTROL SYSTEM

SECTION EF & EC

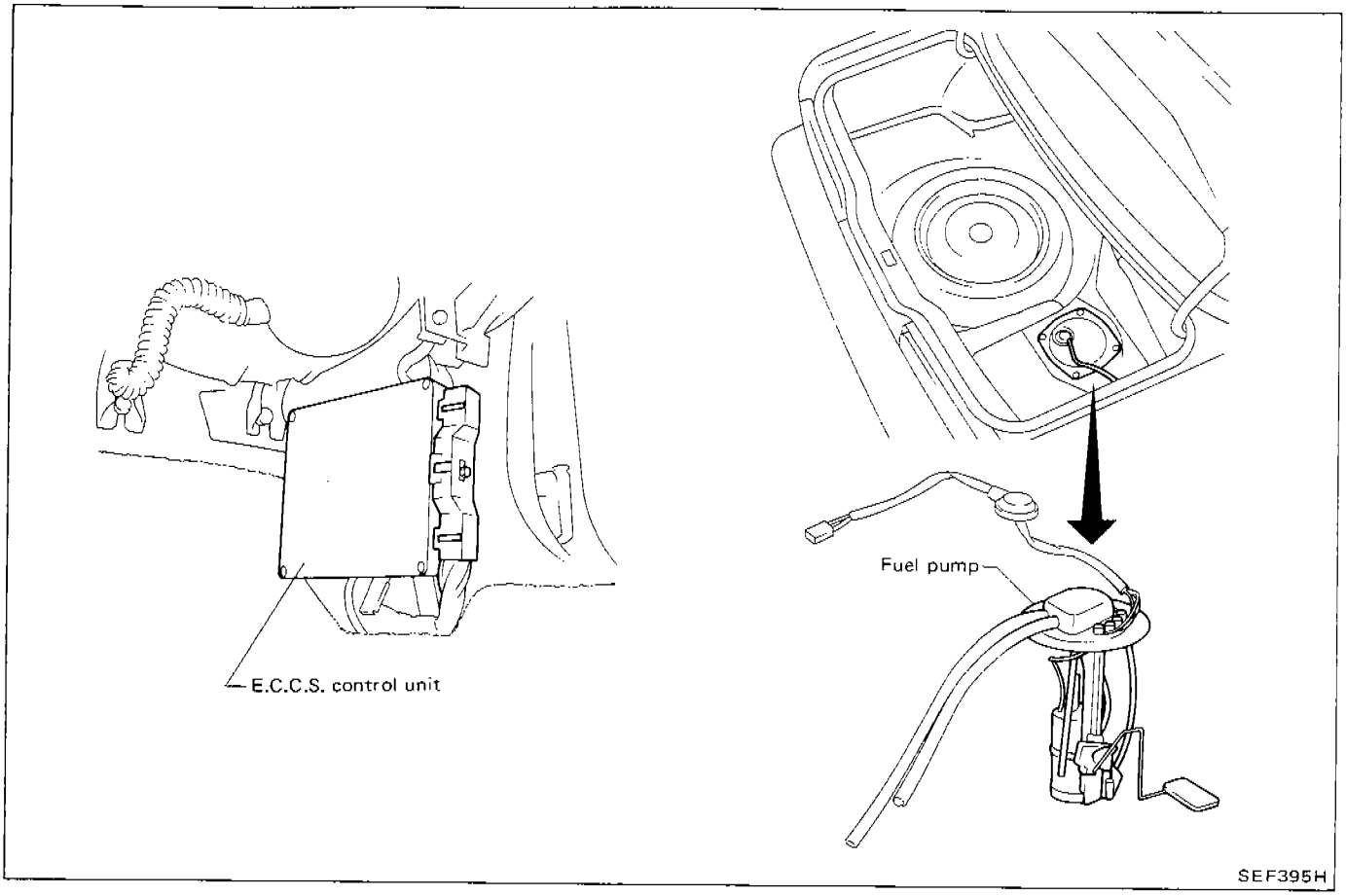
CONTENTS

When you read wiring diagrams:
- **Read GI section, "HOW TO READ WIRING DIAGRAMS".**
- **See EL section, "POWER SUPPLY ROUTING" for power distribution circuit.**

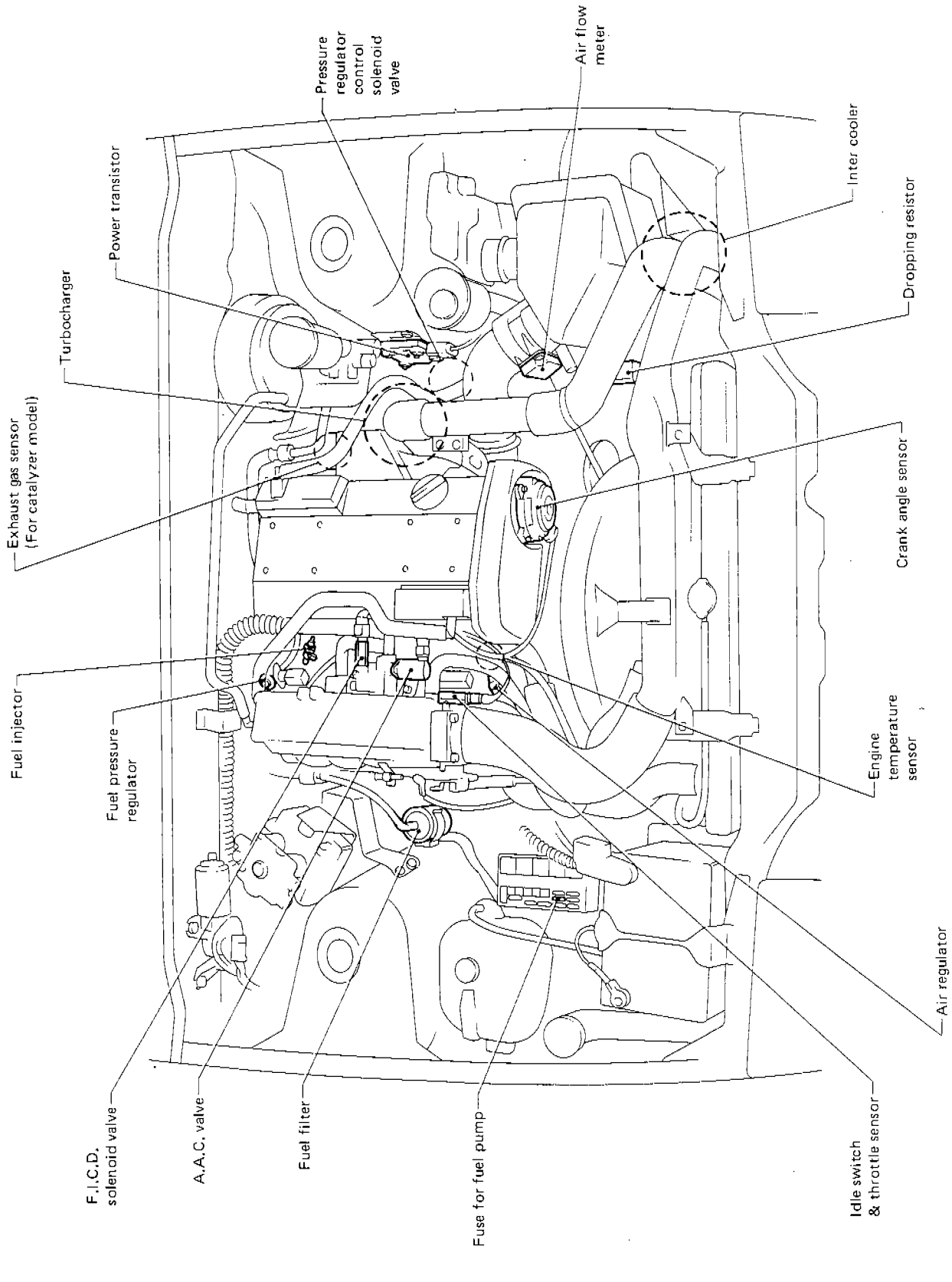
When you perform trouble diagnoses, read GI section, "HOW TO FOLLOW FLOW CHART IN TROUBLE DIAGNOSES".

E.C.C.S Wiring Diagram — See pull-out following EL section.

E.C.C.S. Component Parts Location

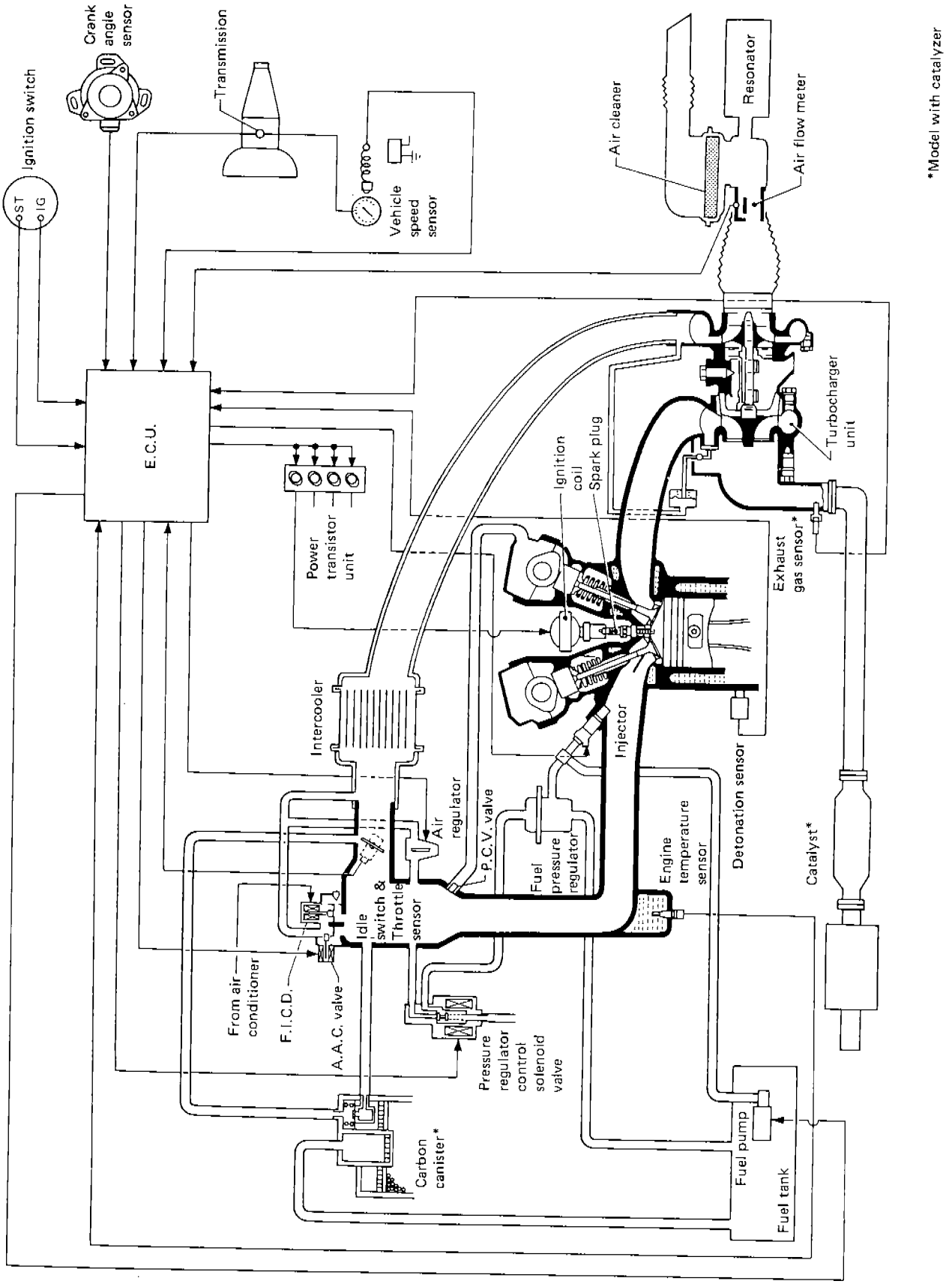


E.C.C.S. Component Parts Location (Cont'd)



SEF396H

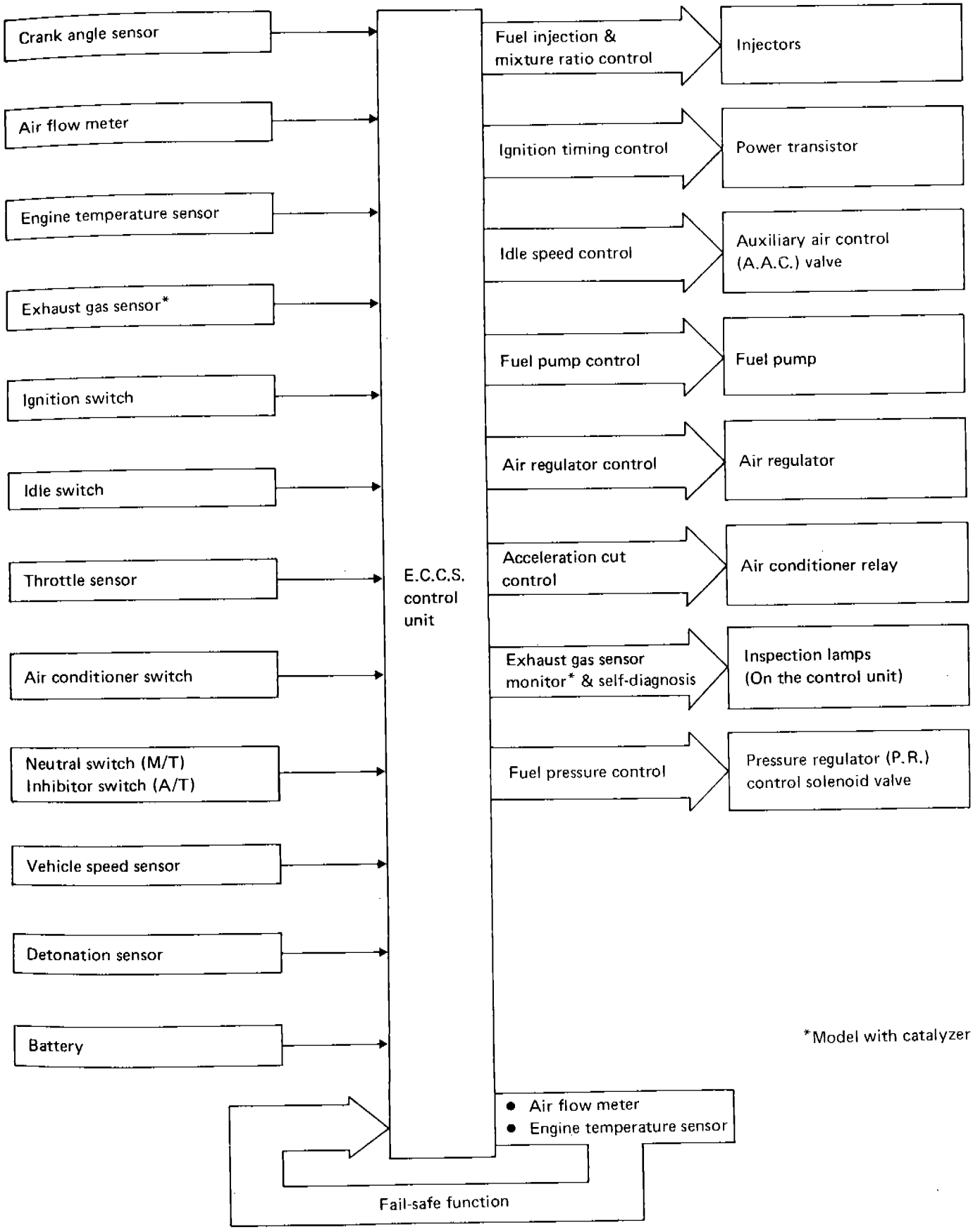
System Diagram



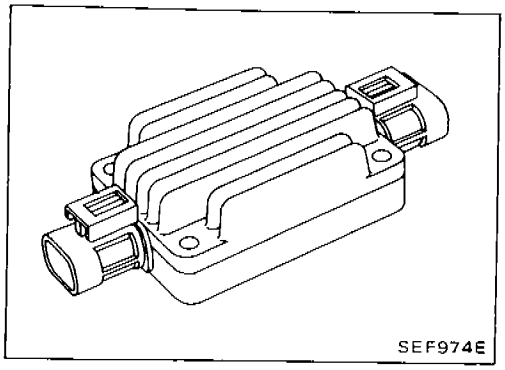
SEF397H

System Chart

E.C.C.S. CONTROL

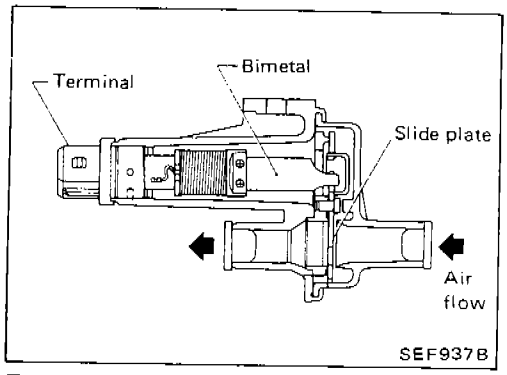


*Model with catalyzer


SEF974E

Power Transistor

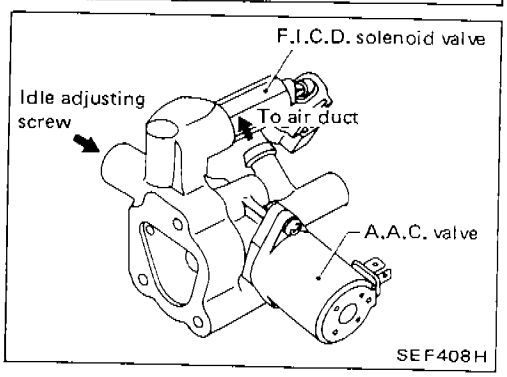
The ignition signal from the E.C.U. is amplified by the power transistor, which turns the ignition coil primary circuit on and off, inducing the proper high voltage in the secondary circuit.



SEF937B

Air Regulator

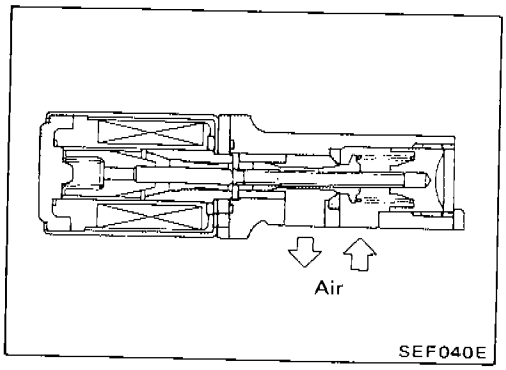
The air regulator provides an air by-pass when the engine is cold for a fast idle during warm-up.
A bimetal, heater and rotary shutter are built into the air regulator. When the bimetal temperature is low, the air by-pass port opens. As the engine starts and electric current flows through a heater, the bimetal begins to turn the shutter to close the by-pass port. The air passage remains closed until the engine stops and the bimetal temperature drops.



SEF408H

Idle Air Adjusting (I.A.A.) Unit

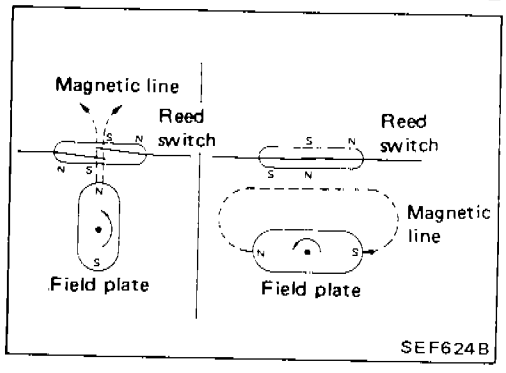
The I.A.A. unit is made up of the A.A.C. valve, F.I.C.D. solenoid valve and idle adjust screw. It receives the signal from the E.C.U. and controls the idle speed at the preset value.
The F.I.C.D. solenoid valve compensates for changes in idle speed caused by the operation of the air compressor.



SEF040E

Auxiliary Air Control (A.A.C.) Valve

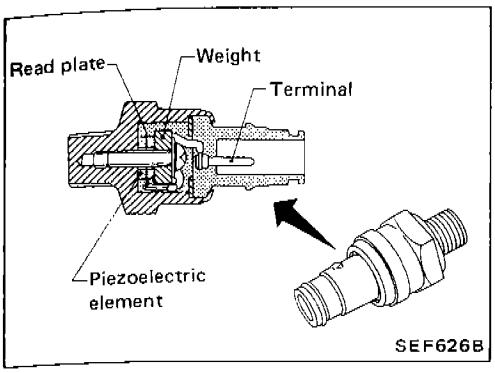
The E.C.U. actuates the A.A.C. valve by an ON/OFF pulse. The longer that ON duty is left on, the larger the amount of air that will flow through the A.A.C. valve.



SEF624B

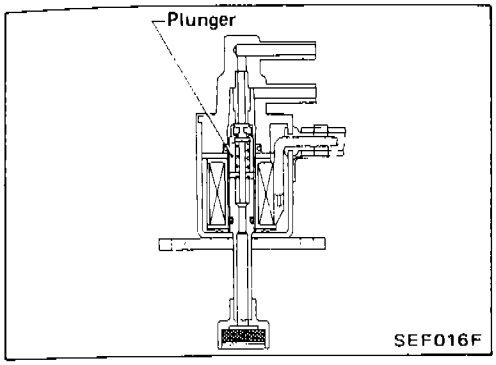
Vehicle Speed Sensor

The vehicle speed sensor provides a vehicle speed signal to the E.C.U.
The speed sensor consists of a reed switch and a speedometer pinion, which are installed in the transmission, and transforms vehicle speed into pulse signals.



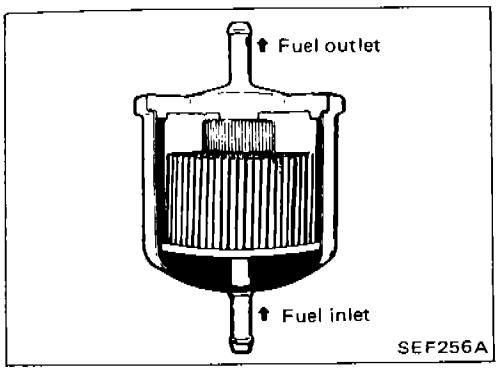
Detonation Sensor

The detonation sensor is attached to the cylinder block and senses engine knocking conditions.
A knocking vibration from the cylinder block is applied as pressure to the piezoelectric element. This vibrational pressure is then converted into a voltage signal which is delivered as output.



Pressure Regulator (P.R.) Control Solenoid Valve

The solenoid valve responds to the ON/OFF signal from the E.C.U. When it is off, a vacuum signal from the intake manifold is fed into the pressure regulator. When the control unit sends an ON signal, the coil pulls the plunger downward and cuts the vacuum signal.

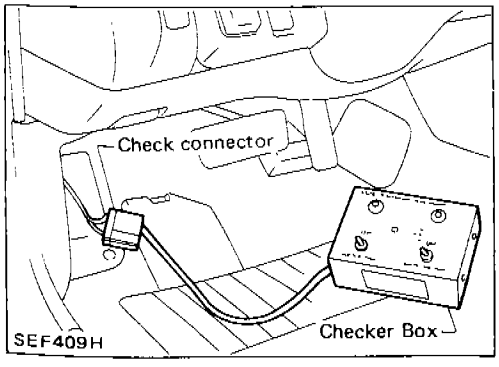


Fuel Filter

The specially designed fuel filter has a metal case in order to withstand high fuel pressure.

Carbon Canister (For catalyzer model)

The carbon canister is filled with active charcoal to absorb evaporative gases produced in the fuel tank. These absorbed gases are then delivered to the intake manifold by manifold vacuum for combustion purposes.

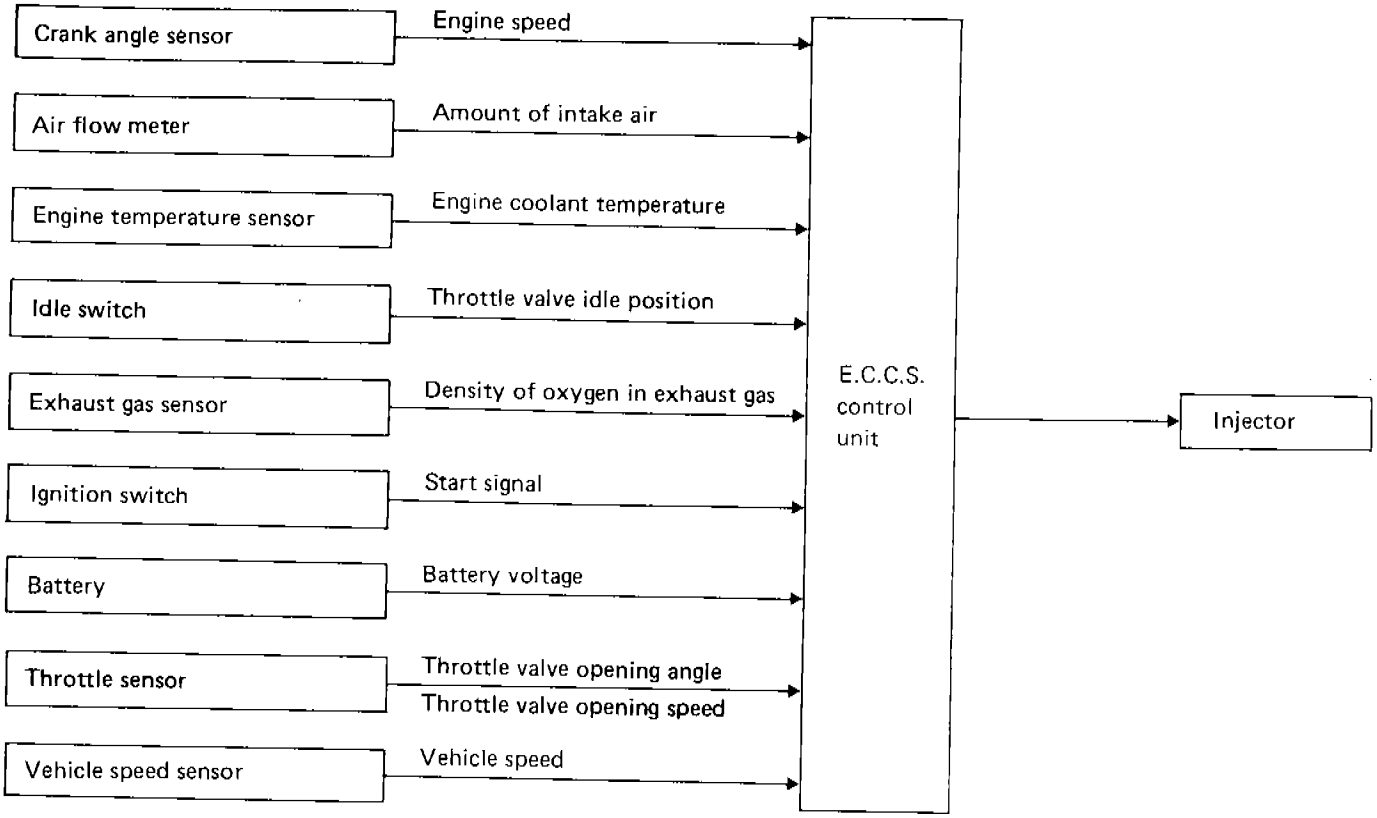


Check Connector for E.C.C.S. Checker Box

The check connector for E.C.C.S. Checker Box is in the vicinity of the fuse box.

Fuel Injection Control

INPUT/OUTPUT SIGNAL LINE



BASIC FUEL INJECTION CONTROL

The amount of fuel injected from the fuel injector, or the length of time the valve remains open, is determined by the E.C.U. The basic amount of fuel injected is a program value mapped in the E.C.U. ROM memory. In other words, the program value is preset by engine operating conditions determined by input signals (for engine rpm and air intake) from both the crank angle sensor and the air flow meter.

VARIOUS FUEL INJECTION INCREASE/DECREASE COMPENSATION

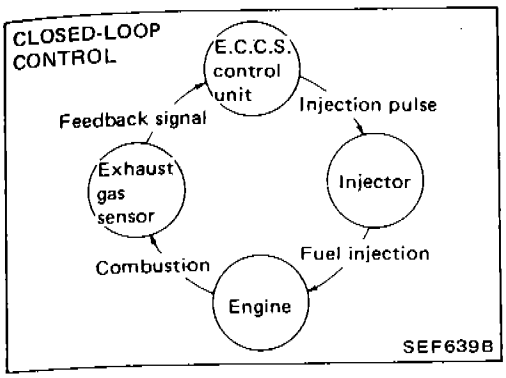
In addition, the amount of fuel injection is compensated for to improve engine performance under various operating conditions as listed below:

<Fuel increase>

1) During warm-up
2) When starting the engine
3) During acceleration
4) Hot-engine operation

<Fuel decrease>

1) During deceleration



Fuel Injection Control (Cont'd)

MIXTURE RATIO FEEDBACK CONTROL (For catalyzer model)

Mixture ratio feedback system is designed to precisely control the mixture ratio to the stoichiometric point so that the three-way catalyst can reduce CO, HC and NOx emissions. This system uses an exhaust gas sensor in the exhaust manifold to check the air-fuel ratio. The control unit adjusts the injection pulse width according to the sensor voltage so the mixture ratio will be within the range of the stoichiometric air-fuel ratio.

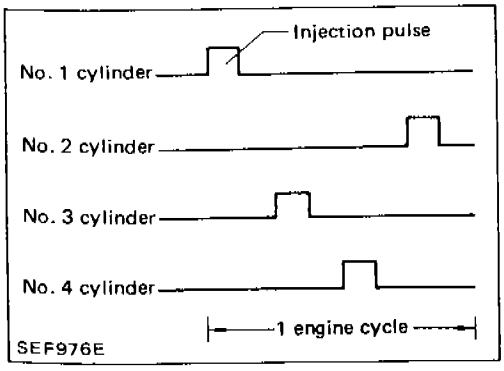
This stage refers to the closed-loop control condition. The open-loop control condition refers to that under which the E.C.U. detects any of the following conditions and feedback control stops in order to maintain stabilized fuel combustion.

1) Deceleration
2) High-load, high-speed operation
3) Engine idling
4) Malfunctioning of exhaust gas sensor or its circuit
5) Insufficient activation of exhaust gas sensor at low engine temperature
6) Engine starting

MIXTURE RATIO SELF-LEARNING CONTROL (For catalyzer model)

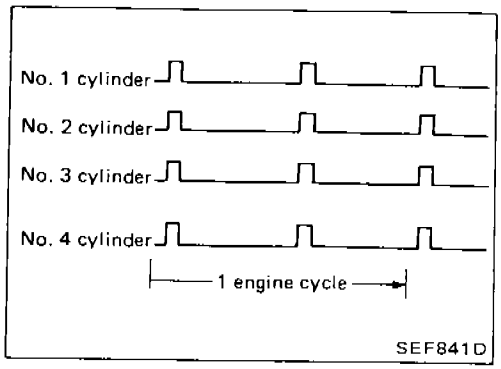
The air-fuel ratio feedback control system monitors the air-fuel signal transmitted from the exhaust gas sensor. This feedback signal is then sent to the E.C.U. to control the amount of fuel injection to provide a basic air-fuel ratio as close to the theoretical air-fuel ratio as possible. However, the basic air-fuel ratio is not necessarily controlled as originally designed. This is due to manufacturing errors (e.g., air flow meter hot wire) and changes during operation (injector clogging, etc.) of E.C.C.S. parts which directly affect the air-fuel ratio.

Accordingly, a difference between the basic and theoretical air-fuel ratios is quantitatively monitored in this system. It is then computed in terms of "fuel injection duration" to automatically compensate for the difference between the two ratios.



FUEL INJECTION TIMING

Fuel is injected once a cycle for each cylinder in the firing order.



Fuel Injection Control (Cont'd)

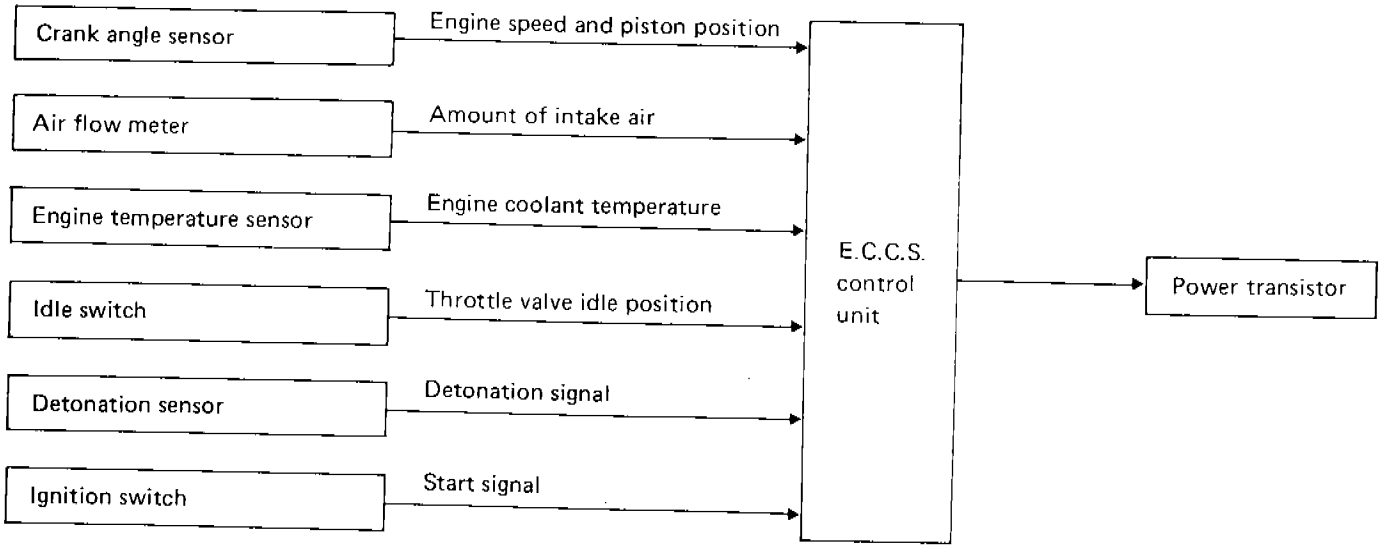
When engine temperature is low, engine starts, or engine load is heavy, fuel is injected into all four cylinders simultaneously twice a cycle.

FUEL SHUT-OFF

Fuel to all cylinders is cut off during deceleration or high-speed operation.

Ignition Timing Control

INPUT/OUTPUT SIGNAL LINE



Ignition Timing Control (Cont'd)

SYSTEM DESCRIPTION

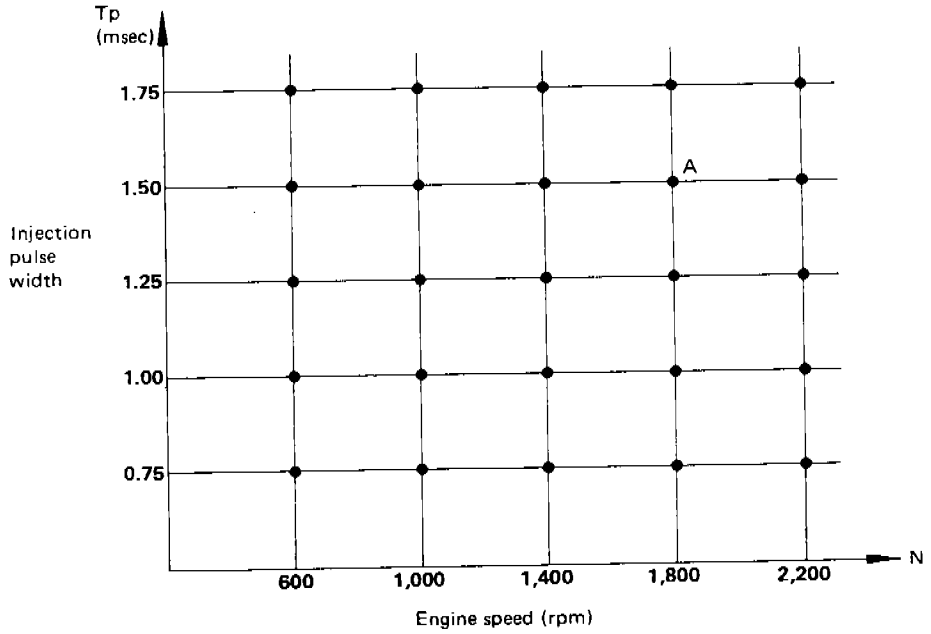
The ignition timing is controlled by the E.C.U. in order to maintain the best air-fuel ratio in response to every running condition of the engine.
The ignition timing data is stored in the ROM located in the E.C.U., in the form of the map shown below.
The E.C.U. detects information such as the injection pulse width and crank angle sensor signal which varies every moment. Then responding to this information, ignition signals are transmitted to the power transistor.

e.g. N: 1,800 rpm, Tp: 1.50 msec.
A °B.T.D.C.

In addition to this,
1 At starting
2 During warm-up
3 At idle
4 At low battery voltage
the ignition timing is revised by the E.C.U. according to the other data stored in the ROM.

The retard system by detonation sensor is designed only for emergencies. The basic ignition timing is pre-programmed within the anti-knocking zone, even if recommended fuel is used under dry conditions. Consequently, the retard system does not operate under normal driving conditions.

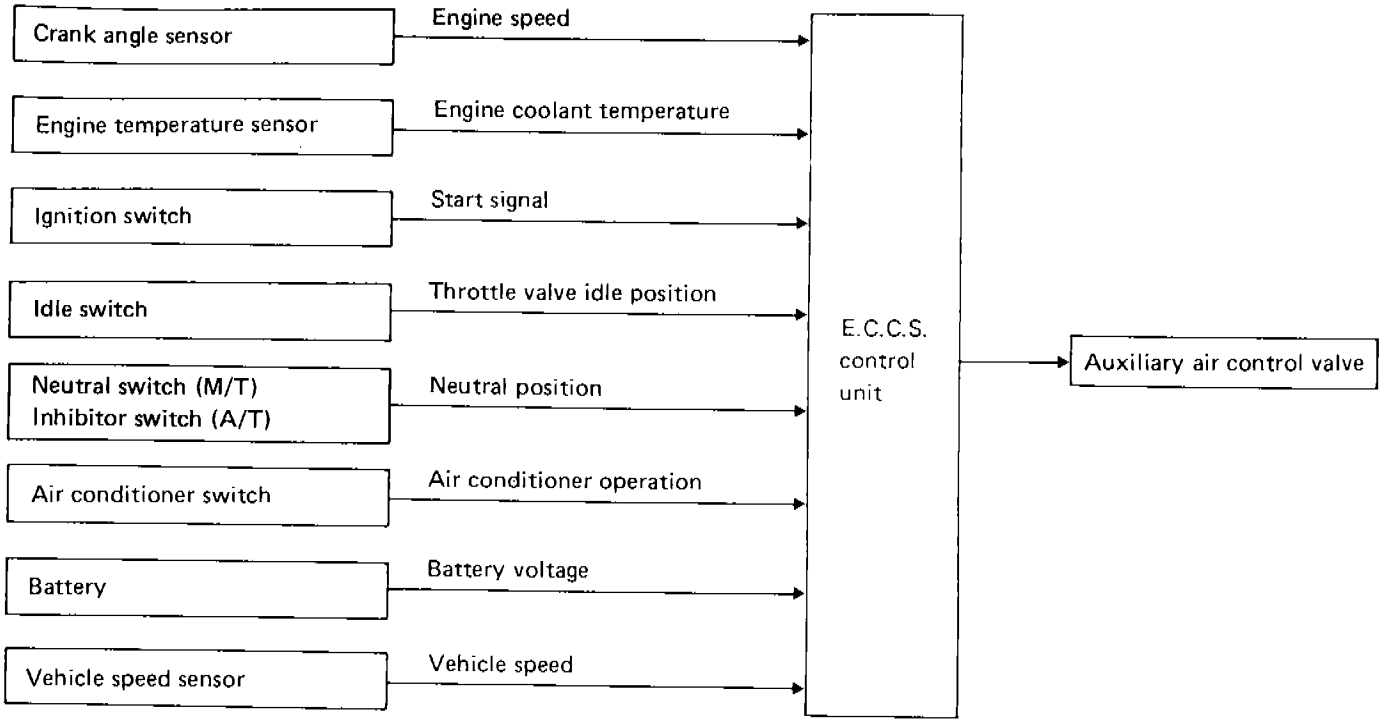
However, if engine knocking occurs, the detonation sensor monitors the condition and the signal is transmitted to the E.C.C.S. control unit. After receiving it, the control unit retards the ignition timing to avoid the knocking condition.



SEC750A

Idle Speed Control

INPUT/OUTPUT SIGNAL LINE

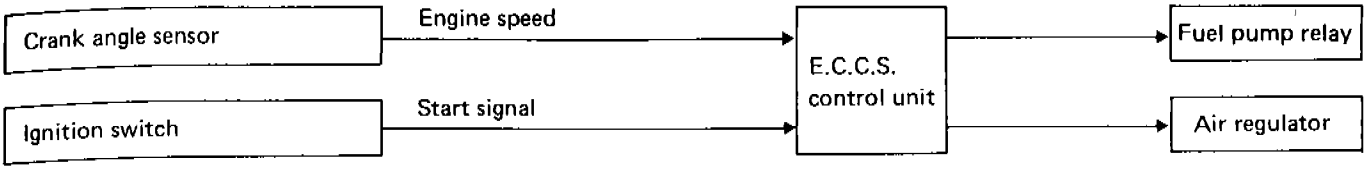


SYSTEM DESCRIPTION

This system automatically controls engine idle speed to a specified level. Idle speed is controlled through fine adjustment of the amount of air which by-passes the throttle valve via A.A.C. valve. The A.A.C. valve repeats ON/OFF operation according to the signal sent from the E.C.U. The crank angle sensor detects the actual engine speed and sends a signal to the E.C.U. The E.C.U. then controls the ON/OFF time of the A.A.C. valve so that engine speed coincides with the target value memorized in ROM. The target engine speed is the lowest speed at which the engine can operate steadily. The optimum value stored in the ROM is determined by taking into consideration various engine conditions, such as noise and vibration transmitted to the compartment, fuel consumption, and engine load.

Fuel Pump Control

INPUT/OUTPUT SIGNAL LINE



SYSTEM DESCRIPTION

The E.C.U. activates the fuel pump for several seconds after the ignition switch is turned on to improve engine startability. If the E.C.U. receives a 1° signal from the crank angle sensor, it knows that the engine is rotating, and causes the pump to rotate. If the 1° signal is not received when the ignition switch is on, the engine stalls. The E.C.U. stops pump operation and prevents battery discharging, thereby improving safety. The E.C.U. does not directly drive the fuel pump. It controls ON/OFF of the fuel pump relay, which in turn controls the fuel pump.

Fuel pump and air regulator ON-OFF control

Ignition switch position	Engine condition	Fuel pump/ Air regulator operation
ON	Stopped	Operates for 5 seconds
	Running	Operates
	After stopped	Stops after 1 second
START	Starting	Operates

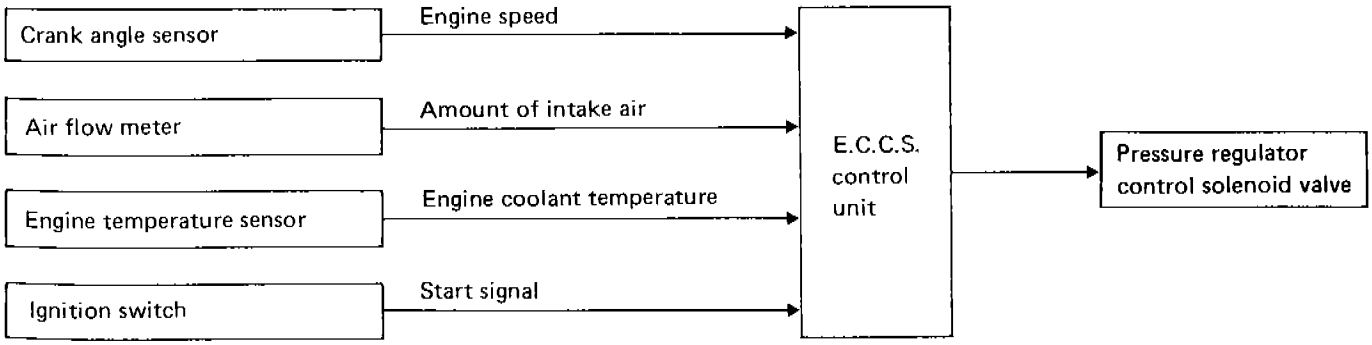
Air Regulator Control

SYSTEM DESCRIPTION

The air regulator is controlled by the E.C.U. at the same time as fuel pump ON-OFF control.

Fuel Pressure Regulator Control

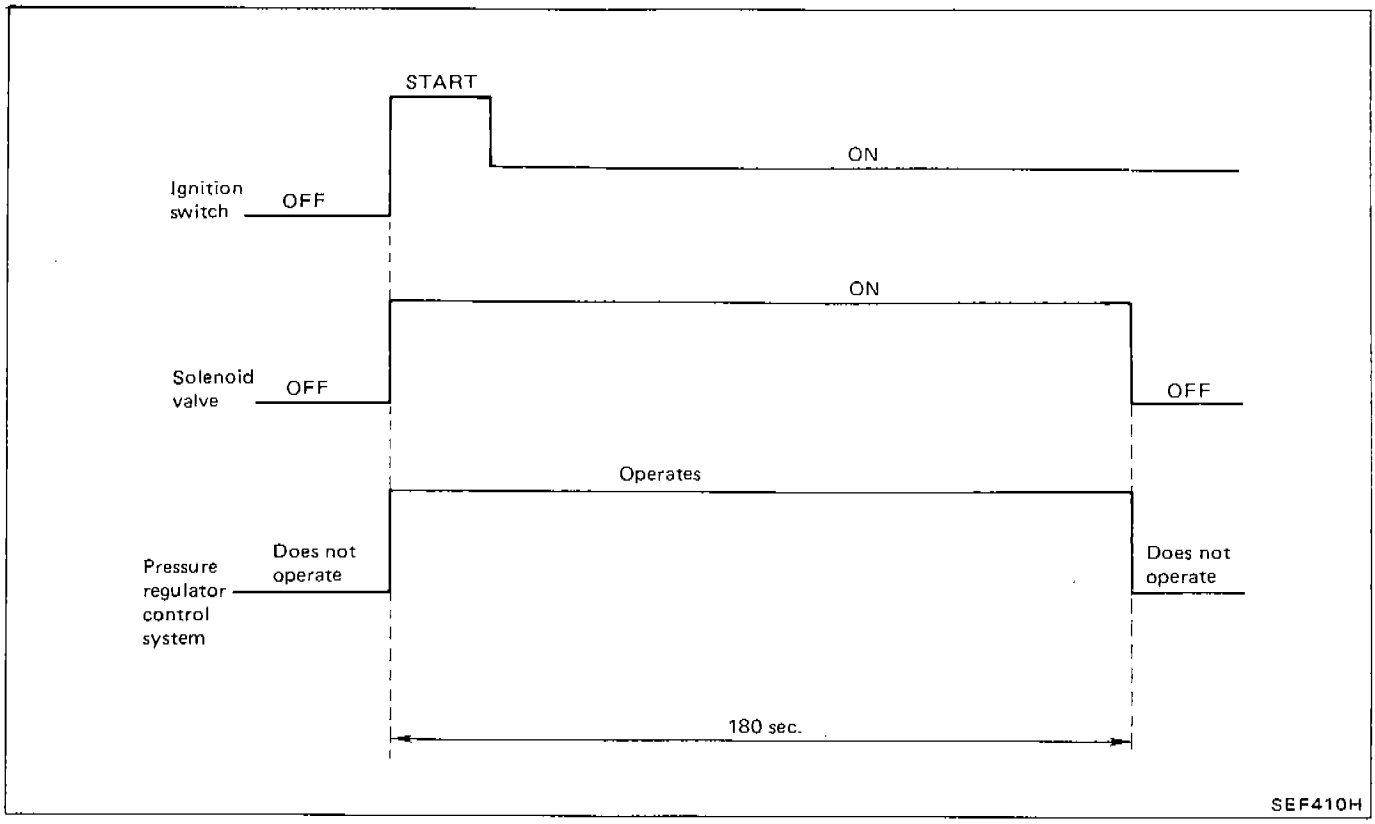
INPUT/OUTPUT SIGNAL LINE



Fuel Pressure Regulator Control (Cont'd)

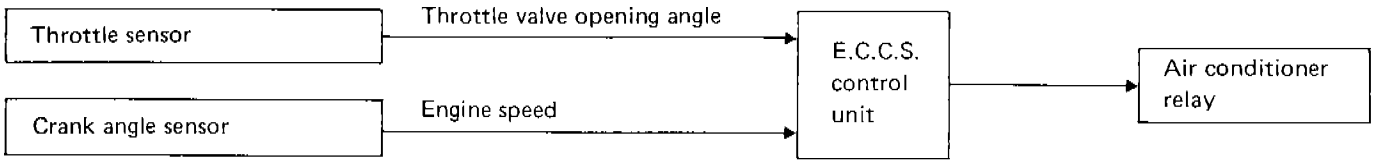
SYSTEM DESCRIPTION

The fuel "pressure-up" control system briefly increases fuel pressure for improved starting performance of a hot engine. Under normal operating conditions, manifold vacuum is applied to the fuel pressure regulator. When starting the engine, however, the E.C.U. allows current to flow through the ON/OFF solenoid valve in the control vacuum line, opening this line to the atmosphere. As a result, atmospheric pressure is applied, throttling the fuel passage to increase fuel pressure.



Acceleration Cut Control

INPUT/OUTPUT SIGNAL LINE

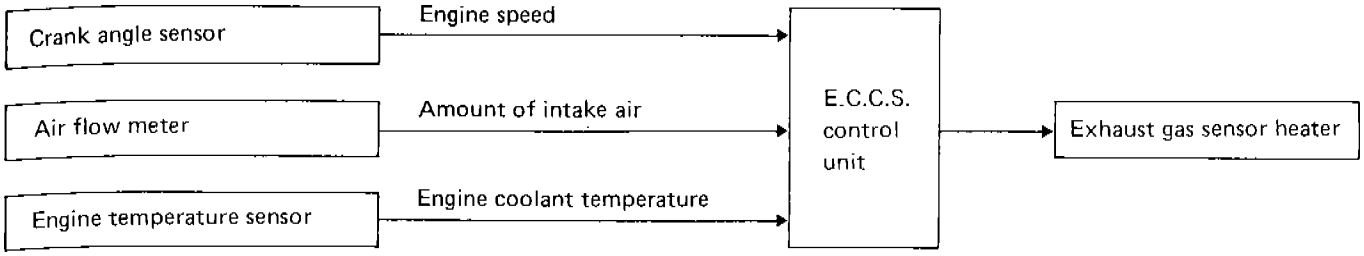


SYSTEM DESCRIPTION

When E.C.U. detects heavy load conditions, air conditioner is turned off for a few seconds.
This system improves acceleration when air conditioner is used.

Exhaust Gas Sensor Heater Control (For catalyzer model)

INPUT/OUTPUT SIGNAL LINE



SYSTEM DESCRIPTION

The exhaust gas sensor heater helps activate the sensor quickly to stabilize closed-loop control under all operating conditions.

Fail-safe System

AIR FLOW METER MALFUNCTION

If the air flow meter output voltage is above or below the specified value, the E.C.U. senses an air flow meter malfunction. In case of a malfunction, the throttle sensor substitutes for the air flow meter.

Though air flow meter is malfunctioning, it is possible to drive the vehicle and start the engine. But engine speed will not rise more than 2,000 rpm in order to inform the driver of fail-safe system operation while driving.

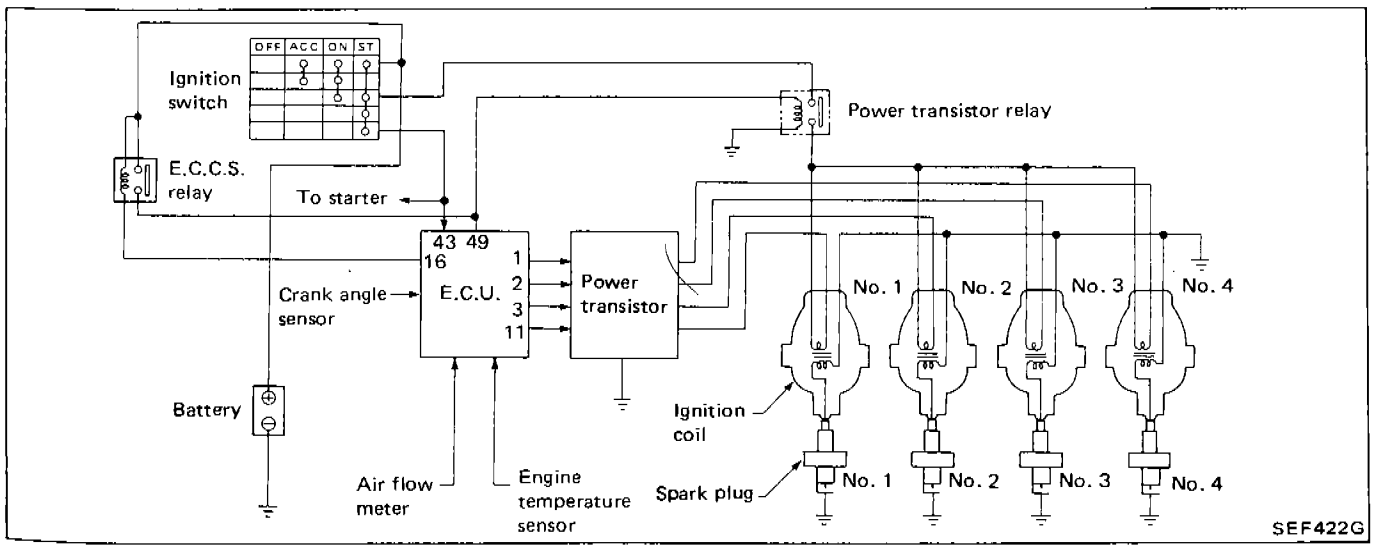
ENGINE TEMPERATURE SENSOR MALFUNCTION

When engine temperature sensor output voltage is below or above the specified value, engine temperature is fixed at the preset value as follows:

Engine condition	Engine temperature preset value °C (°F)
Start	20 (68)
Running	80 (176)

Direct Ignition System

This system has no conventional distributor and high-tension wires. Small, very efficient ignition coils are fitted directly to each spark plug.



Direct Ignition System (Cont'd)

CHECKING IGNITION TIMING AND IDLE SPEED

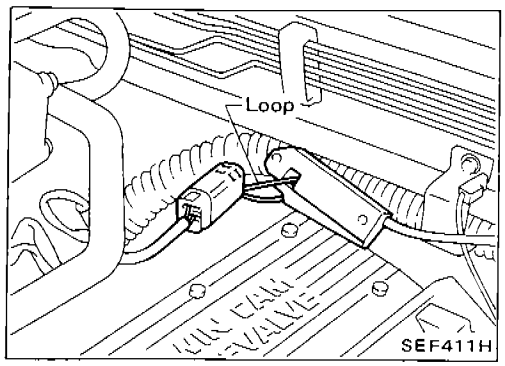
Checking idle speed

Idle speed:

M/T: 850 ± 50 rpm

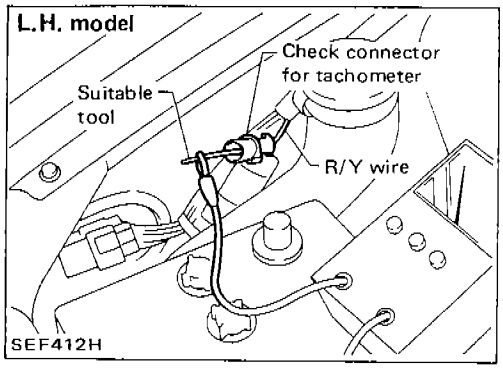
A/T: 850 ± 50 rpm (in "N" position)

If idle speed is not within specific value, refer to IDLE SPEED/IGNITION TIMING/IDLE MIXTURE RATIO INSPECTION.



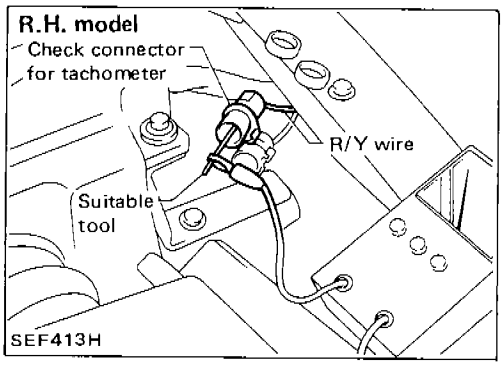
- METHOD A (With pulse type tachometer)

Clamp loop wire as shown.



- METHOD B (With voltage type tachometer)

1. Disconnect check connector for tachometer.

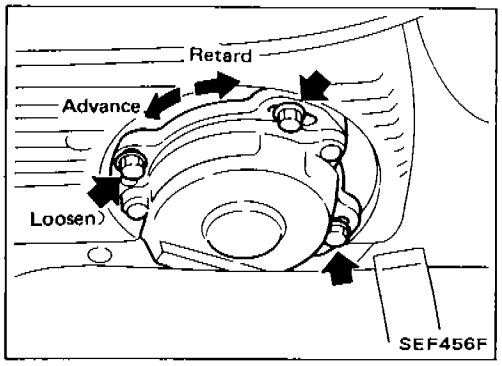


2. Connect tachometer using suitable tool.

Checking ignition timing

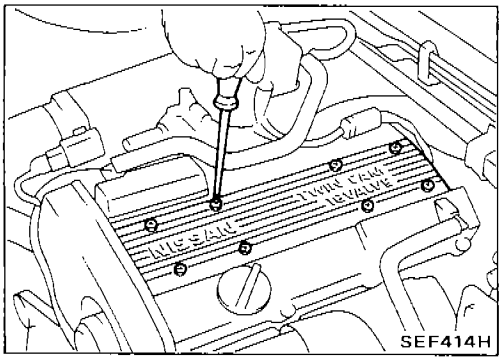
Ignition timing: 15° ± 2° B.T.D.C.

If ignition timing is not within specific value, adjust ignition timing as shown.

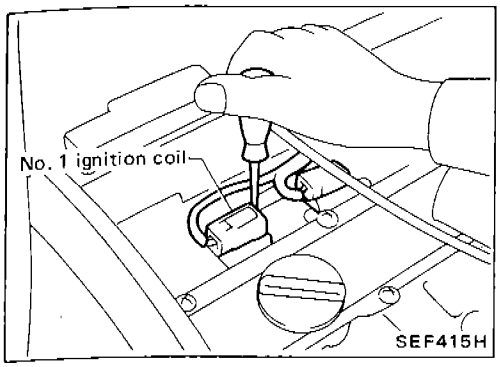


- METHOD A (Without Tool)

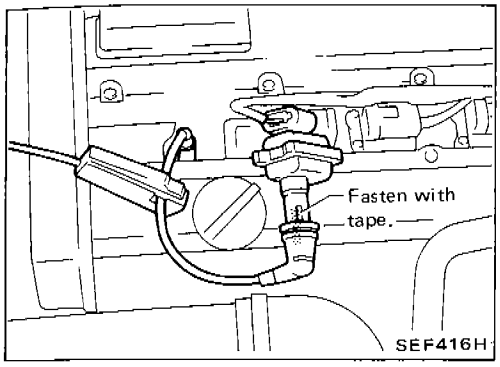
1. Remove ornament cover.



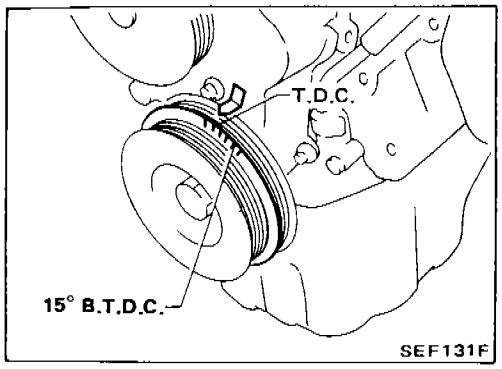
Direct Ignition System (Cont'd)



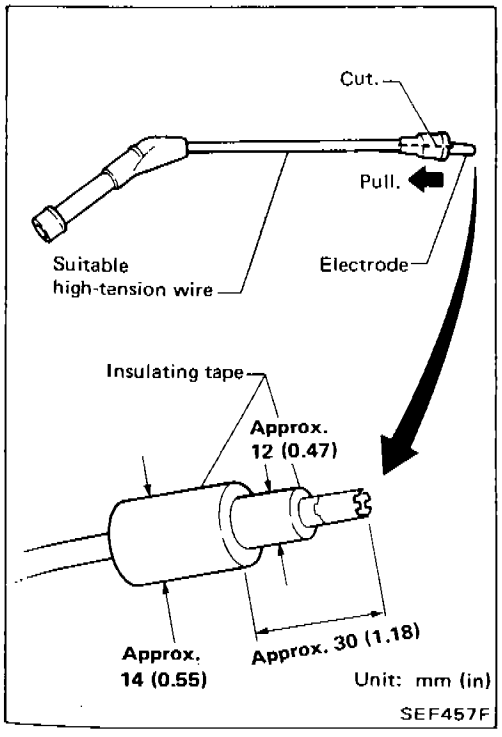
2. Remove No. 1 ignition coil.



3. Connect No. 1 ignition coil and No. 1 spark plug with suitable high-tension wire as shown, and clamp this wire with timing light clamp.

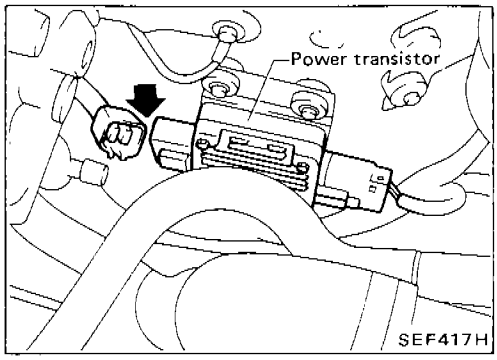


4. Check ignition timing.
5. Install No. 1 ignition coil and ornament cover.



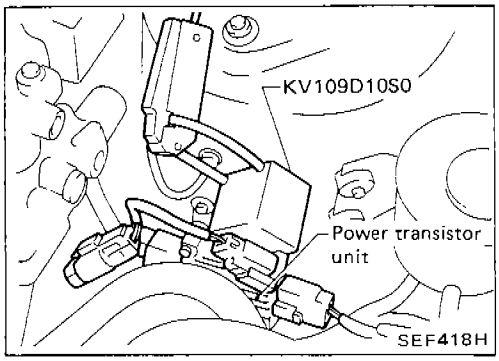
For above procedures, enlarge suitable high-tension wire end with insulating tape as shown.

Direct Ignition System (Cont'd)

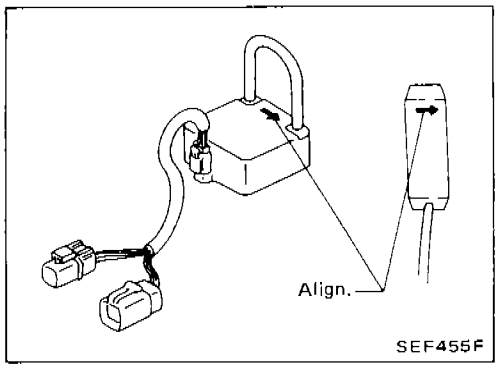


- METHOD B (With Tool KV109D10S0)

1. Disconnect connector of power transistor unit.



2. Connect Tool and clamp wire as shown.



Align direction marks on Tool and timing light clamp if aligning mark is punched.

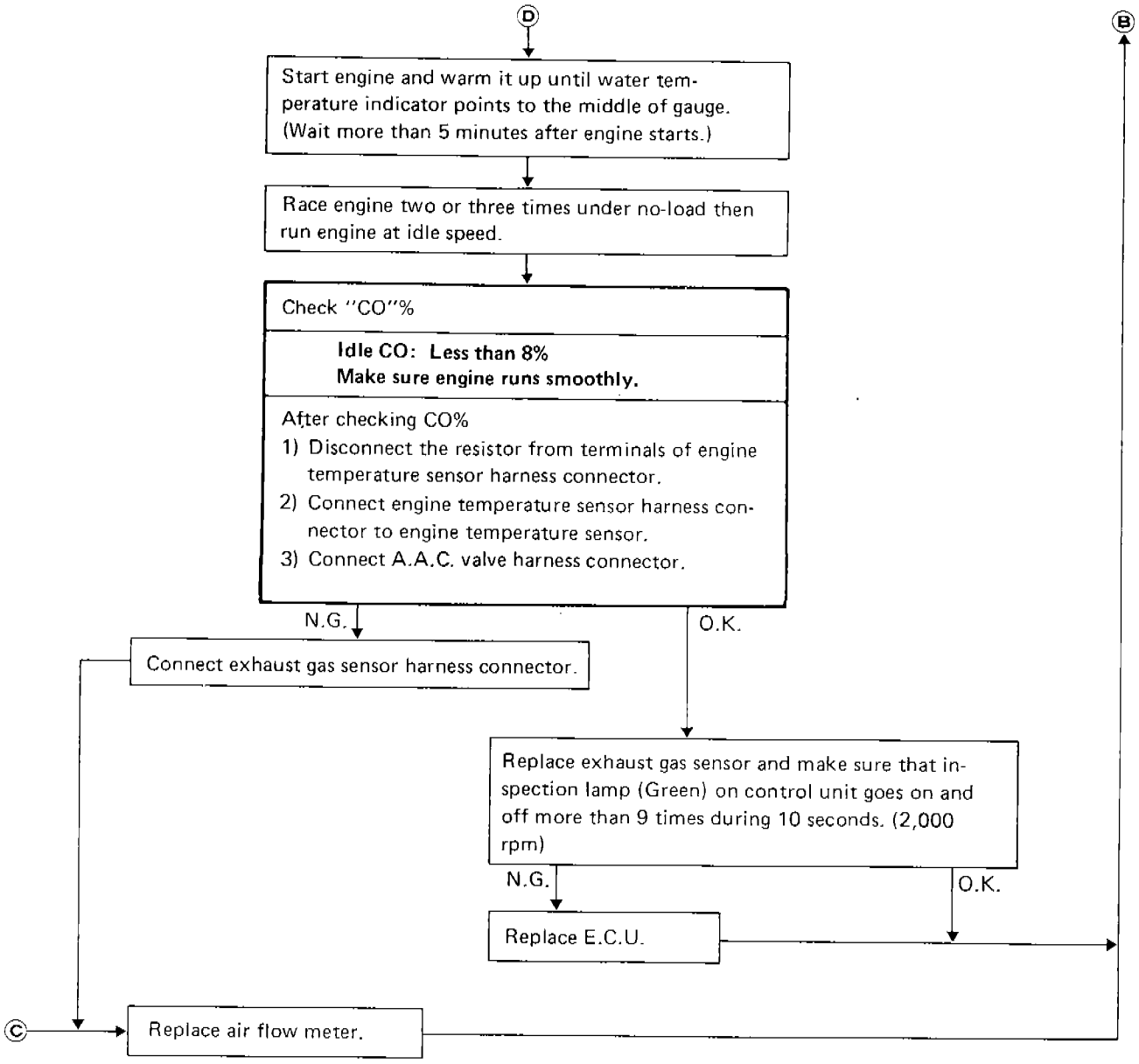
Preparation

Make sure that the following parts are in good condition.

- **Battery**
- **Ignition system**
- **Engine oil and coolant levels**
- **Fuses**
- **E.C.C.S. harness connectors**
- **Vacuum hoses**
- **Air intake system (oil filler cap, oil level gauge, etc.)**
- **Fuel pressure**
- **Engine compression**
- **Throttle valve**
- **Fuel pressure regulator control system**

Notice

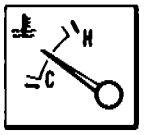
1. Turn off air conditioner and headlamps.
2. During checking and adjusting, make sure engine is at normal operating temperature.
3. Set shift lever in "Neutral" position ("N" or "P" position for automatic transmission).
4. Engage parking brake and lock both front and rear wheels with wheel chocks.
5. Measure "CO"% with air cleaner installed.
6. When measuring "CO" percentage, insert probe more than 40 cm (15.7 in) into tailpipe.
7. Make sure fuel pressure regulator control system does not operate.


D
Start engine and warm it up until water temperature indicator points to the middle of gauge. (Wait more than 5 minutes after engine starts.)
Race engine two or three times under no-load then run engine at idle speed.
Check "CO"%
Idle CO: Less than 8%
Make sure engine runs smoothly.
After checking CO%
1) Disconnect the resistor from terminals of engine temperature sensor harness connector.
2) Connect engine temperature sensor harness connector to engine temperature sensor.
3) Connect A.A.C. valve harness connector.
N.G.
O.K.
Connect exhaust gas sensor harness connector.
Replace exhaust gas sensor and make sure that inspection lamp (Green) on control unit goes on and off more than 9 times during 10 seconds. (2,000 rpm)
N.G.
O.K.
Replace E.C.U.
C
Replace air flow meter.
B

For non-catalyzer model
[With "CO"-meter]

INSPECTION START

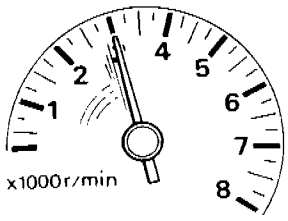
Confirm that engine is at normal operating temperature.



SEF457C

Check and adjust idle speed and ignition timing.

Idle speed: rpm M/T 850±50
A/T 850±50 (in "N" position)
Ignition timing: 15° ±2° B.T.D.C.
Refer to page EF & EC-22.



SMA957A

Race engine (2,000 - 3,000 rpm) 2 or 3 times under no-load, then run engine at idle speed.

Check "CO" with "CO"-meter.

Idle "CO"%:
2.0 or lower

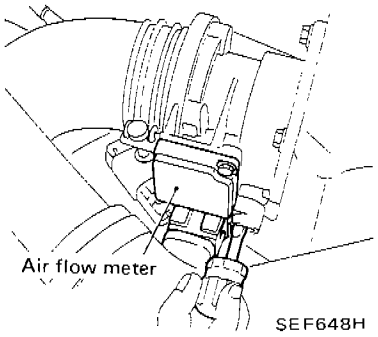
O.K.

N.G.

Turn off engine and remove air flow meter from vehicle.

Drill a hole in seal plug which seals air flow meter variable resister and remove seal plug.

Install air flow meter on vehicle.
Start engine and warm it up untill water temperature indicator points to the middle of gauge.



SEF648H

Adjust "CO"% by turning variable resistor on air flow meter.

Idle "CO"%:
2.0 or lower

Race engine two or three times under no-load, then run engine at idle speed.

Check idle speed.

Idle speed: rpm M/T 850±50
A/T 850±50 (in "N" position)

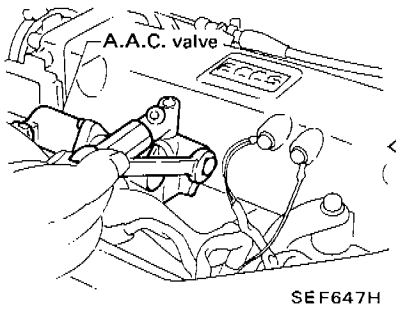
N.G.

O.K.

Stop engine.

INSPECTION END

Ⓐ Ⓑ



SEF647H

Ⓐ

Disconnect A.A.C. valve harness connector.

Adjust idle speed to 800 rpm by turning idle speed adjusting screw.

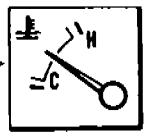
Connect A.A.C. valve harness connector.

Ⓑ

For non-catalyzer model
[Without "CO"-meter]

INSPECTION START

Confirm that engine is at normal operating temperature.



SEF457C

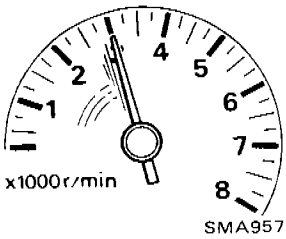
Check and adjust idle speed and ignition timing.

Idle speed: rpm M/T 850±50
A/T 850±50 (in "N" position)
Ignition timing: 15°±2° B.T.D.C.
Refer to page EF & EC-22.

Turn off engine and remove air flow meter from vehicle.

Drill a hole in seal plug which seals air flow meter variable resister and remove seal plug.

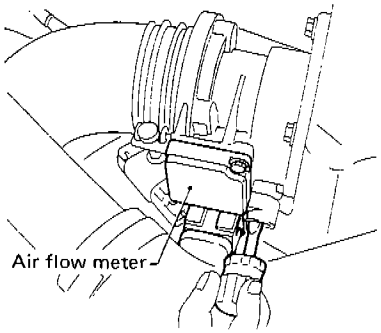
Install air flow meter on vehicle.
Start engine and warm it up untill water temperature indicator points to the middle of gauge.



SMA957A

Race engine two or three times under no-load, then run engine at idle.

Adjust mixture ratio with engine speed set at maximum by turning variable resistor.



SEF648H

Turn variable resistor of air flow meter 2 full turns counterclockwise.

Check idle speed.

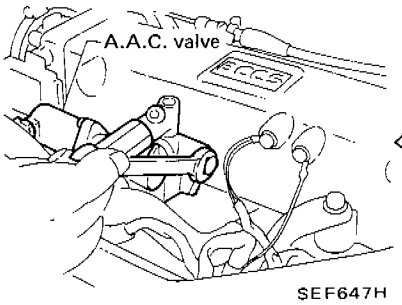
Idle speed: rpm M/T 850±50
A/T 850±50 (in "N" position)

N.G.

O.K.

Stop engine.

INSPECTION END



SEF647H

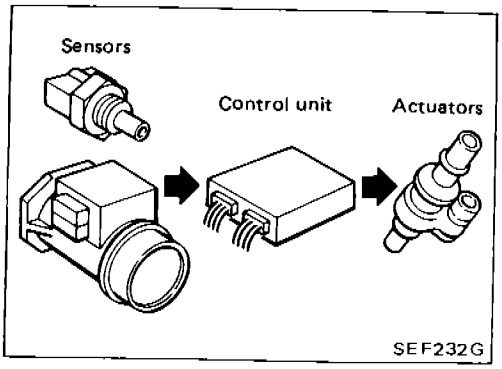
Disconnect A.A.C. valve harness connector.

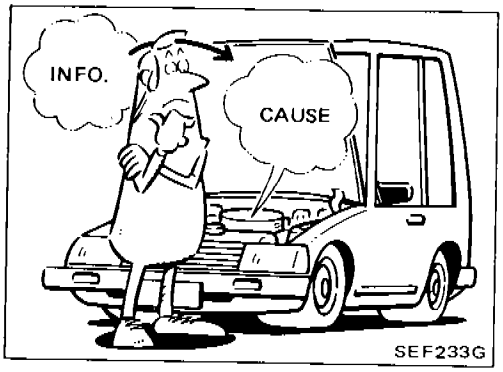
Adjust idle speed to 800 rpm by turning idle speed adjusting screw.

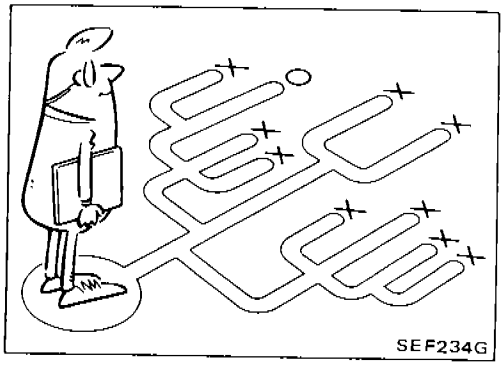
Connect A.A.C. valve harness connector.

Contents

Contents (Cont'd)







How to Perform Trouble Diagnoses for Quick and Accurate Repair

INTRODUCTION

The engine has an electronic control unit to control major systems such as fuel control, ignition control, idle speed control, etc. The control unit accepts input signals from sensors and instantly drives actuators. It is essential that both kinds of signals are proper and stable. At the same time, it is important that there are no conventional problems such as vacuum leaks, fouled spark plugs, or other problems with the engine.

It is much more difficult to diagnose a problem that occurs intermittently rather than continuously. Most intermittent problems are caused by poor electric connections or faulty wiring. In this case, careful checking of suspicious circuits may help prevent the replacement of good parts.

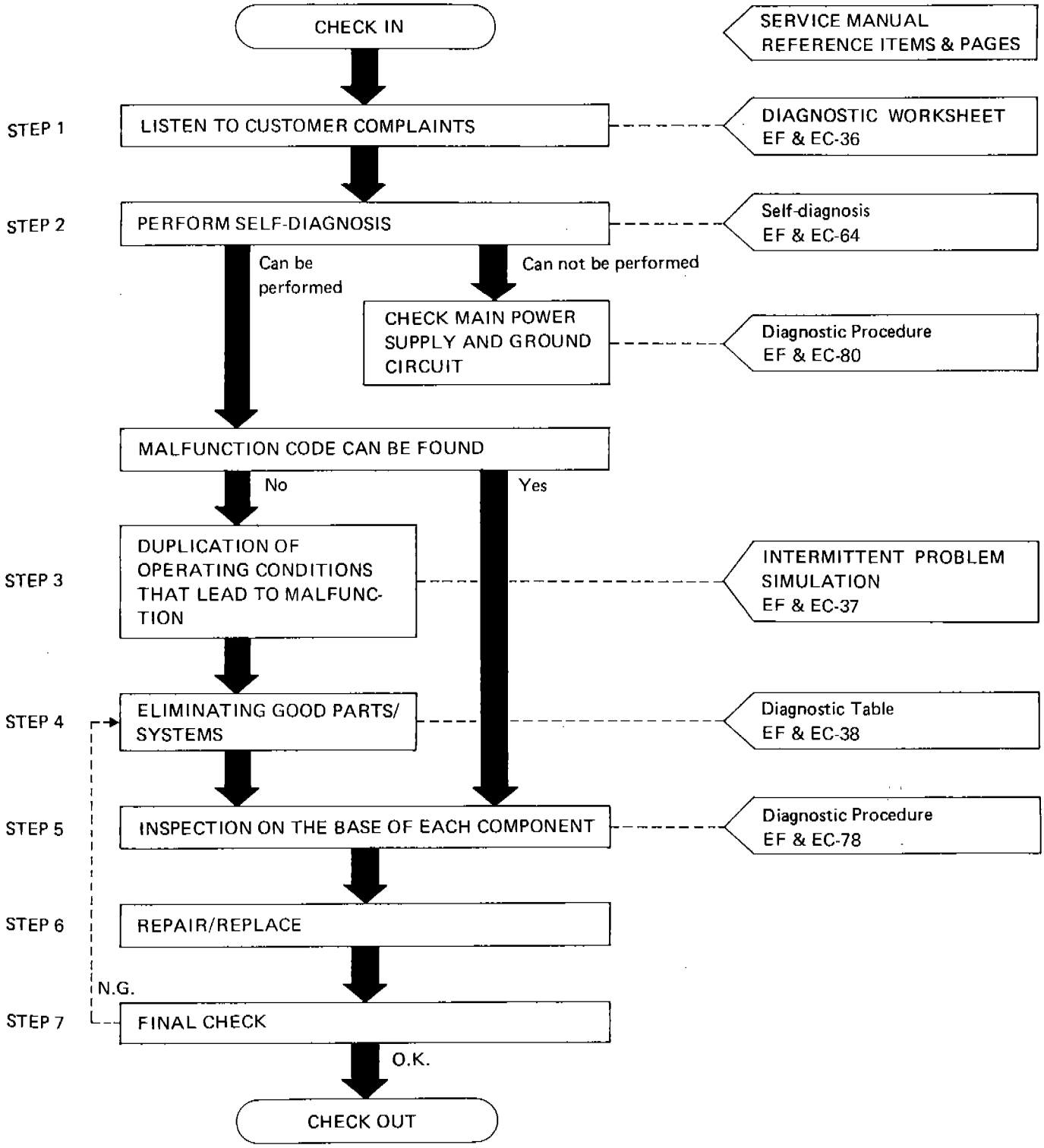
A visual check only may not find the cause of the problems. A road test with a circuit tester connected to a suspected circuit should be performed.

Before undertaking actual checks, take just a few minutes to talk with a customer who approaches with a driveability complaint. The customer is a very good supplier of information on such problems, especially intermittent ones. Through the talks with the customer, find out what symptoms are present and under what conditions they occur.

Start your diagnosis by looking for "conventional" problems first. This is one of the best ways to troubleshoot driveability problems on an electronically controlled engine vehicle.

How to Perform Trouble Diagnoses for Quick and Accurate Repair (Cont'd)

WORK FLOW



KEY POINTS

WHAT ..... Vehicle & engine model
WHEN ..... Date, Frequencies
WHERE ..... Road conditions
HOW ..... Operating conditions, Weather conditions, Symptoms

How to Perform Trouble Diagnoses for Quick and Accurate Repair (Cont'd)

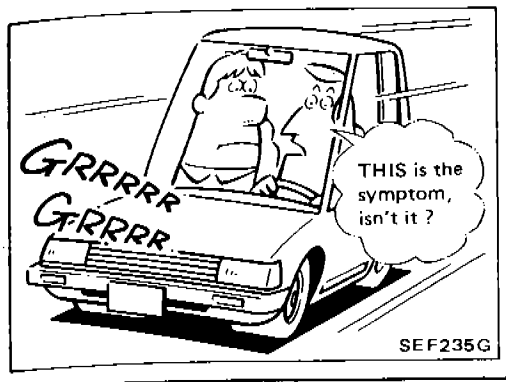
DIAGNOSTIC WORKSHEET

There are many kinds of operating conditions that lead to malfunctions on engine components.
A good grasp of such conditions can make trouble-shooting faster and more accurate.
In general, feelings for a problem depend on each customer. It is important to fully understand the symptoms or under what conditions a customer complains.
Make good use of a diagnostic worksheet such as the one shown below in order to utilize all the complaints for trouble-shooting.

Worksheet sample

Customer name MR/MS	Model & Year	VIN
Engine #	Trans.	Mileage (kilometer)
Incident Date	Manuf. Date	In Service Date

Symptoms	☐ Startability	☐ Impossible to start ☐ No combustion ☐ Partial combustion ☐ Partial combustion affected by throttle position ☐ Partial combustion NOT affected by throttle position ☐ Possible but hard to start ☐ Others [ ]
	☐ Idling	☐ No fast idle ☐ Unstable ☐ High idle ☐ Low idle ☐ Others [ ]
	☐ Driveability	☐ Stumble ☐ Surge ☐ Detonation ☐ Lack of power ☐ Intake backfire ☐ Exhaust backfire ☐ Others [ ]
	☐ Engine stall	☐ At the time of start ☐ While idling ☐ While accelerating ☐ While decelerating ☐ Just after stopping ☐ While loading
Incident occurrence		☐ Just after delivery ☐ Recently ☐ In the morning ☐ At night ☐ In the daytime
Frequency		☐ All the time ☐ Under certain conditions ☐ Sometimes
Weather conditions		☐ Not effected
	Weather	☐ Fine ☐ Raining ☐ Snowing ☐ Others [ ]
	Temperature	☐ Hot ☐ Warm ☐ Cool ☐ Cold ☐ Humid °F
Engine conditions		☐ Cold ☐ During warm-up ☐ After warm-up Engine speed 0 2,000 4,000 6,000 8,000 rpm
Road conditions		☐ In town ☐ In suburbs ☐ Highway ☐ Off road (up/down)
Driving conditions		☐ Not affected ☐ At starting ☐ While idling ☐ At racing ☐ While accelerating ☐ While cruising ☐ While decelerating ☐ While turning (RH/LH) Vehicle speed 0 10 20 30 40 50 60 MPH
Check engine light		☐ Turned on ☐ Not turned on



How to Perform Trouble Diagnoses for Quick and Accurate Repair (Cont'd)

INTERMITTENT PROBLEM SIMULATION

In order to duplicate an intermittent problem, it is effective to create similar conditions for component parts, under which the problem might occur.

Perform the activity listed under Service procedure and note the result.

	Variable factor	Influential part	Target condition	Service procedure
1	Mixture ratio	Pressure regulator	Made lean	Remove vacuum hose and apply vacuum.
			Made rich	Remove vacuum hose and apply pressure.
2	Ignition timing	Crank angle sensor	Advanced	Rotate crank angle sensor counterclockwise.
			Retarded	Rotate crank angle sensor clockwise.
3*	Mixture ratio feedback control	Exhaust gas sensor	Suspended	Disconnect exhaust gas sensor harness connector.
		Control unit	Operation check	Perform self-diagnosis (Mode I/II) at 2,000 rpm.
4	Idle speed	I.A.A. unit	Raised	Turn idle adjust screw counterclockwise.
			Lowered	Turn idle adjust screw clockwise.
5	Electric connection (Electric continuity)	Harness connectors and wires	Poor electric connection or faulty wiring	Tap or wiggle.
				Race engine rapidly. See if the torque reaction of the engine unit causes electric breaks.
6	Temperature	Control unit	Cooled	Cool with an icing spray or similar device.
			Warmed	Heat with a hair drier. **[WARNING: Do not overheat the unit.]**
7	Moisture	Electric parts	Damp	Wet **[WARNING: Do not directly pour water on components. Use a mist sprayer.]**
8	Electric loads	Load switches	Loaded	Turn on head lights, air conditioner, rear defogger, etc.
9	Idle switch condition	Control unit	ON-OFF switching	Perform self-diagnosis (Mode IV).
10	Ignition spark	Timing light	Spark power check	Try to flash timing light for each cylinder.

***For catalyzer model**

Diagnostic Table

To assist with your trouble diagnoses, some typical diagnostic procedures for the following symptoms are described.

REMARKS

In the following pages, the numbers such as ❶, ❷ in the above chart correspond to those in the service procedure described below.
Possible causes can be checked through the service procedure shown by the mark "○".

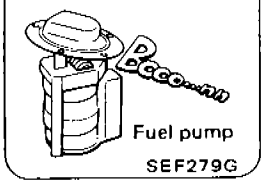
Diagnostic Table (Cont'd)

SYMPTOM & CONDITION 1 **Impossible to start – no combustion**

POSSIBLE CAUSES		❶	❷	❸	❹	❺	❻	❼
SPECIFICATIONS	Mixture ratio (too lean)	○	○					
	Ignition sparks (weak, missing)				○	○		
	Ignition timing						○	
FUEL SYSTEM	Fuel pump (no operation)	○						
	Fuel pump relay (open circuited)	○						
	Injectors (no operation, clogged)		○					
IGNITION SYSTEM	Ignition switch	○	○	○	○		○	
	E.C.C.S. relay	○	○	○	○		○	
	Power transistor			○	○		○	
	Ignition coil				○		○	
	Spark plugs					○		
CONTROL SYSTEM	Crank angle sensor	○	○		○		○	○

SERVICE PROCEDURE

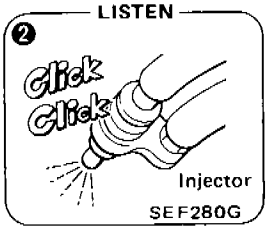
❶ **LISTEN**



Listen for fuel pump operating sound.

N.G. → Check fuel pump and/or related circuits. [See page EF & EC-102.]

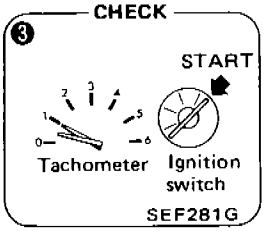
❷ **LISTEN**



Listen for injector operating sound.

N.G. → Check injector circuit. [See page EF & EC-112.]

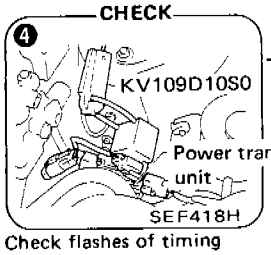
❸ **CHECK**



Make sure tachometer needle moves when cranking.

N.G. →

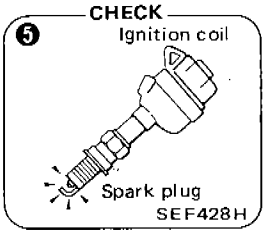
❹ **CHECK**



Check flashes of timing light for weakness.

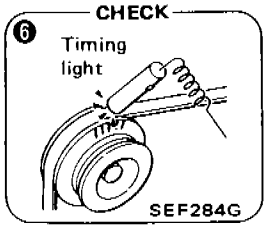
N.G. → Check ignition signal circuit. [See page EF & EC-90.]

❺ **CHECK** Ignition coil



Remove spark plugs and check their ignition sparks.

❻ **CHECK**

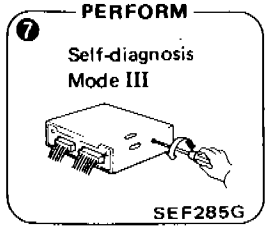


Check ignition timing.

N.G. → Adjust ignition timing. [See page EF & EC-22.]

❼ **PERFORM**

Self-diagnosis Mode III



Perform self-diagnosis Mode III (for crank angle sensor).

N.G. → Check crank angle sensor and/or related circuits. [See page EF & EC-82.]

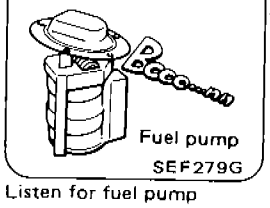
Diagnostic Table (Cont'd)

SYMPTOM & CONDITION 2 **Impossible to start — partial combustion**

POSSIBLE CAUSES		❶	❷	❸	❹	❺
SPECIFICATIONS	Mixture ratio	○	○	○		
	Fuel pressure (too low)				○	
	Ignition timing					○
FUEL SYSTEM	Fuel pump	○				
	Fuel pump relay (open circuited)	○				
	Injectors (clogged)		○			

SERVICE PROCEDURE

❶ **LISTEN**

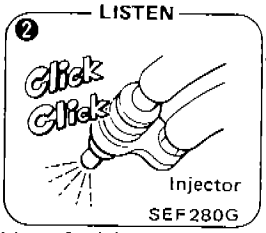


Listen for fuel pump operating sound.

N.G. → Check fuel pump and/or related circuits. [See page EF & EC-102.]

O.K. →

❷ **LISTEN**

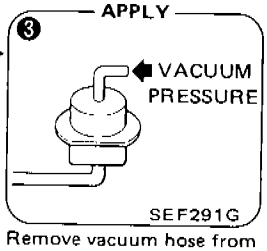


Listen for injector operating sound.

N.G. → Check injector circuit. [See page EF & EC-112.]

O.K. →

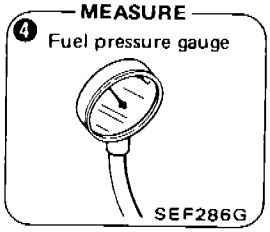
❸ **APPLY**



Remove vacuum hose from pressure regulator, and apply vacuum and/or pressure, and try to start.

Improved →

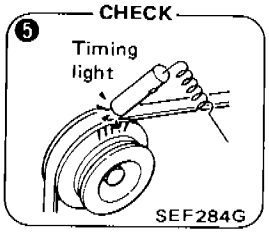
❹ **MEASURE** Fuel pressure gauge



Connect vacuum hose to pressure regulator and measure fuel pressure.

Check idle mixture ratio. [See page EF & EC-25.]

❺ **CHECK**



Check ignition timing.

Adjust ignition timing. [See page EF & EC-22.]

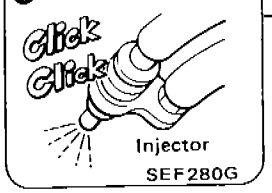
Diagnostic Table (Cont'd)

SYMPTOM & CONDITION 3 | **Impossible to start – partial combustion (not affected by throttle position)**

	POSSIBLE CAUSES	❶	❷	❸	❹	❺	❻	❼	❽	❾	❿	⓫
SPECIFICATIONS	Mixture ratio	○		○	○							
	Fuel pressure (too low)			○	○	○						
	Ignition timing						○					
FUEL SYSTEM	Fuel filter (clogged)					○						
	Fuel line (clogged)					○						
	Injectors (clogged)	○										
	Pressure regulator				○							
	Pressure regulator vacuum hose (clogged)			○								
IGNITION SYSTEM	Spark plugs (wet with fuel)								○			
	Ignition switch	○						○		○		
INTAKE SYSTEM	Throttle chamber (with ports clogged)		○									
	Throttle valve (clogged)		○									
CONTROL SYSTEM	Engine temperature sensor										○	○
	Crank angle sensor	○						○			○	

SERVICE PROCEDURE

❶ **LISTEN**

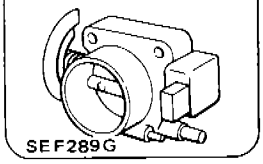


Listen for injector operating sound.

N.G. → Check injector circuit. [See page EF & EC-112.]

O.K. ↓

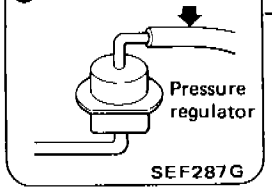
❷ **CHECK** Throttle chamber



Check throttle chamber ports and valve for clogging.

N.G. → Clean the ports and/or throttle valve.

❸ **CHECK**

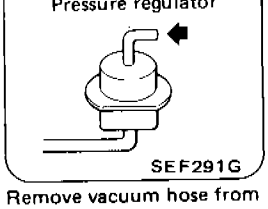


Check vacuum hose of pressure regulator for clogging.

N.G. ↓

Repair or replace the hose.

O.K. → ❹ **REMOVE** Pressure regulator



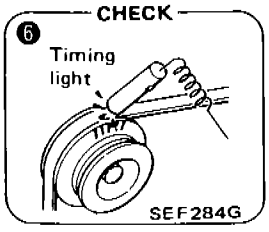
Remove vacuum hose from pressure regulator, and try to start.

Improved → ❺ **MEASURE** Fuel pressure

Connect vacuum hose to pressure regulator and measure fuel pressure.

→ Check idle mixture ratio. [See page EF & EC-25.]

❻ **CHECK**

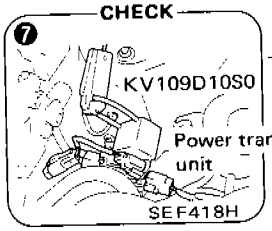


Check ignition timing.

N.G. ↓

Adjust ignition timing. [See page EF & EC-22.]

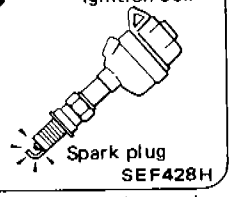
❼ **CHECK**



Check flashes of timing light for weakness.

N.G. → Check ignition signal circuit. [See page EF & EC-90.]

❽ **CHECK** Ignition coil



Remove spark plugs and check their ignition sparks by cranking.

❾ **PERFORM** Self-diagnosis Mode IV

Perform self-diagnosis Mode IV (for start signal).

N.G. → Check starter circuit. [See page EF & EC-104.]

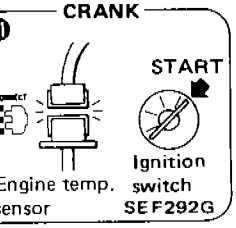
❿ **PERFORM** Self-diagnosis Mode III

Perform self-diagnosis Mode III (for engine temp. sensor and crank angle sensor).

For crank angle sensor → Check the sensor circuits. [See page EF & EC-86 (engine temp. sensor), page EF & EC-82 (crank angle sensor).]

For engine temp. sensor →

⓫ **CRANK**



Start with engine temp. sensor connector disconnected.

N.G. →

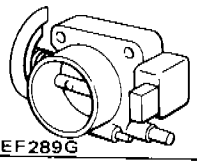
Diagnostic Table (Cont'd)

SYMPTOM & CONDITION 4 **Impossible to start — partial combustion (throttle position changes combustion quality)**

POSSIBLE CAUSES		❶	❷	❸	❹	❺
INTAKE SYSTEM	Throttle chamber (with ports clogged)	○				
	Throttle valve (clogged)		○			
	Air regulator (stuck closed)			○		
CONTROL SYSTEM	Engine temperature sensor				○	
	Idle switch				○	
	Neutral switch					○

SERVICE PROCEDURE

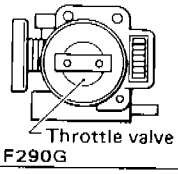
❶ **CHECK** Throttle chamber



N.G. → Clean the ports.

Check throttle chamber ports for clogging.

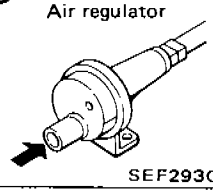
❷ **CHECK** Throttle chamber



N.G. → Clean the valve.

Check throttle valve for clogging.

❸ **CHECK** Air regulator



N.G. → Check air regulator and/or its circuit. [See page EF & EC-110.]

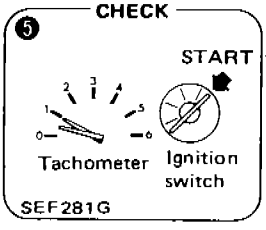
Make sure air regulator stays open before warm-up

❹ **PERFORM**

Self-dragnosis Mode III/IV

Perform self-diagnosis Mode III (for engine temp. sensor), Mode IV (for idle switch).

❺ **CHECK**



N.G. → Check neutral switch and/or its circuit. [See page EF & EC-116.]

Make sure tachometer indicates about 300 rpm while cranking.