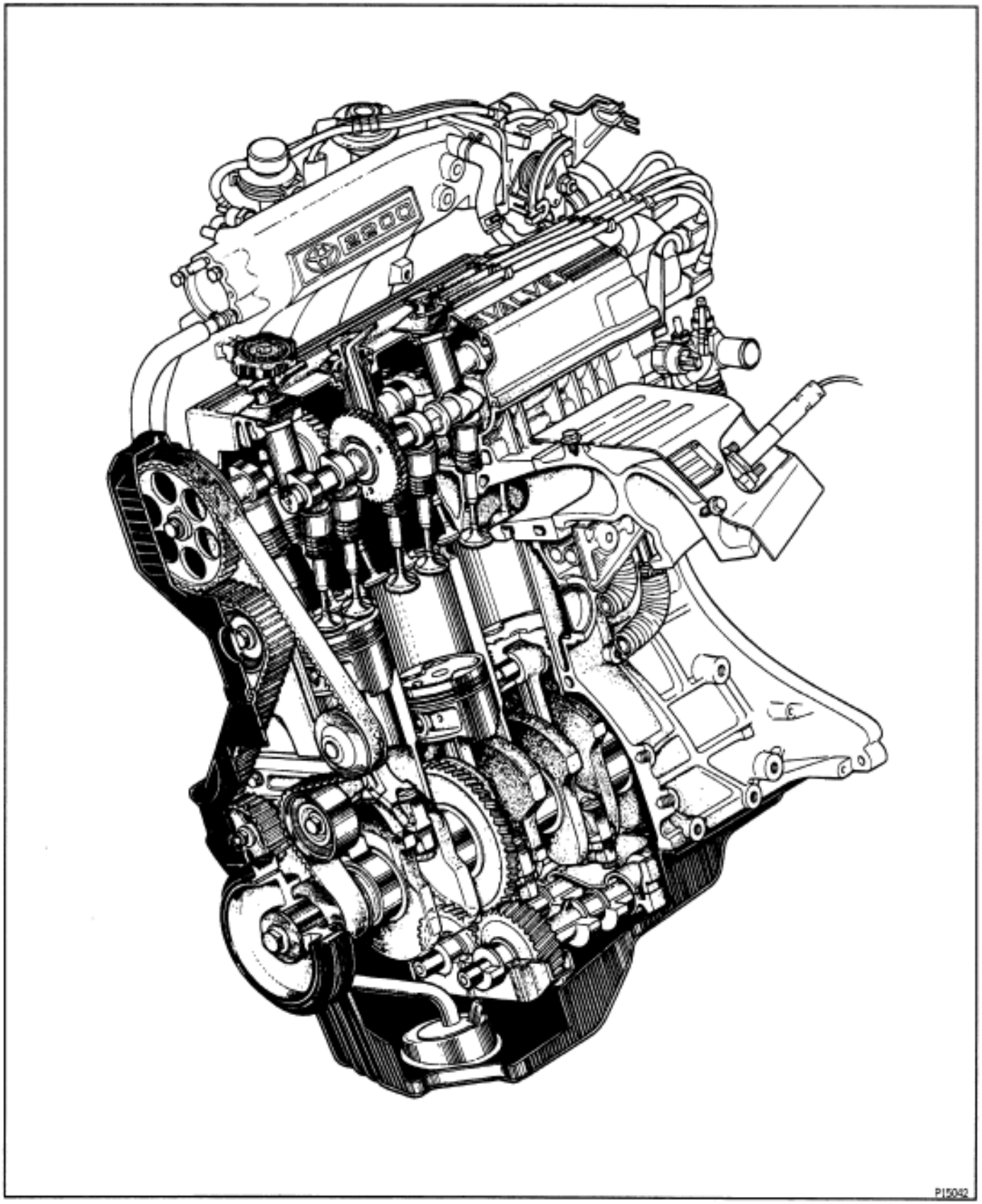
ENGINE MECHANICAL

DESCRIPTION

The 5S–FE engine is an in–line, 4–cylinder, 2.2 liter DOHC 16–valve engine.



The 5S–FE engine is an in–line, 4–cylinder engine with the cylinders numbered 1–2–3–4 from the front. The crankshaft is supported by five bearings inside the crankcase. These bearings are made of aluminum alloy.

The crankshaft is integrated with eight weights for balance. Oil holes are placed in the center of the crankshaft to supply oil to the connecting rods, bearing, pistons and other components.

The firing order is 1–3–4–2. The cylinder head is made of aluminum alloy, with a cross flow type intake and exhaust layout and with pent–roof type combustion chambers. The spark plugs are located in the center of the combustion chambers.

The intake manifold has four independent long ports and utilizes the inertial supercharging effect to improve engine torque at low and medium speeds.

Exhaust and intake valves are equipped with irregular pitch springs made of special valve spring carbon steel which are capable of functioning no matter what the engine speed.

The intake camshaft is driven by a timing belt, and a gear on the intake camshaft engages with a gear on the exhaust camshaft to drive it. The cam journal is supported at five places between the valve lifters of each cylinder and on the front end of the cylinder head. Lubrication of the cam journals and gears is accomplished by oil being supplied through the oiler port in the center of the camshaft.

Adjustment of the valve clearance is done by means of an outer shim type system, in which valve adjusting shims are located above the valve lifters. This permits replacement of the shims without removal of the camshafts.

Pistons are made of high temperature–resistant aluminum alloy, and a depression is built into the piston head to prevent interference with the valves.

Piston pins are the full–floating type, with the pins fastened to neither the piston boss nor the connecting rods. Instead, snap rings are fitted on both ends of the pins, preventing the pins from falling out.

The No.1 compression ring is made of steel and the No.2 compression ring is made of cast iron. The oil ring is made of a combination of steel and stainless steel. The outer diameter of each piston ring is slightly larger than the diameter of the piston and the flexibility of the rings allows them to hug the cylinder walls when they are mounted on the piston. Compression rings No.1 and No.2 work to prevent gas leakage from the cylinder and the oil ring works to scrape oil off the cylinder walls to prevent it from entering the combustion chambers.

The cylinder block is made of cast iron. It has four cylinders which are approximately twice the length of the piston stroke. The top of each cylinder is closed off by the cylinder head and the lower end of the cylinders becomes the crankcase, in which the crankshaft is installed. In addition, the cylinder block contains a water jacket, through which coolant is pumped to cool the cylinders.

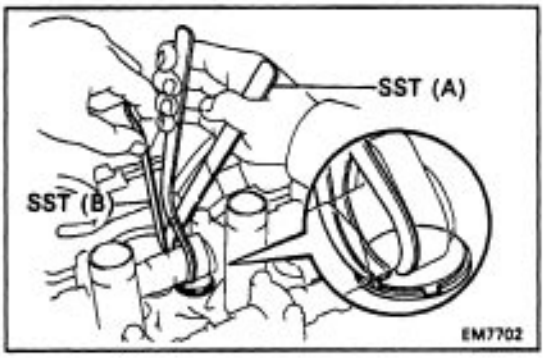
The oil pan is bolted onto the bottom of the cylinder block. The oil pan is an oil reservoir made of pressed sheet steel. A dividing plate is included ’inside the oil pan to keep sufficient oil in the bottom of the pan even when the vehicle is tilted. This dividing plate also prevents the oil from making waves when the vehicle is stopped suddenly and the oil shifts away from the oil pump suction pipe.

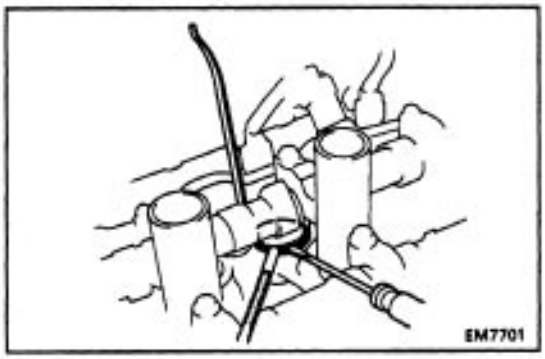
The 5S–FE engine uses two balance shafts. The balance shafts are fitted in balance shaft housings that are located at the bottom of the cylinder block. The No. 1 balance shaft is driven by the drive gear of the crankshaft No.3 counterweight at twice the speed of the crankshaft. The No. 2 balance shaft is driven by the No–1 balance shaft at the same speed in the same direction as the crankshaft. The balance shafts are designed to eliminate secondary inertia force from the engine, thereby reducing the engine noise (booming noise).

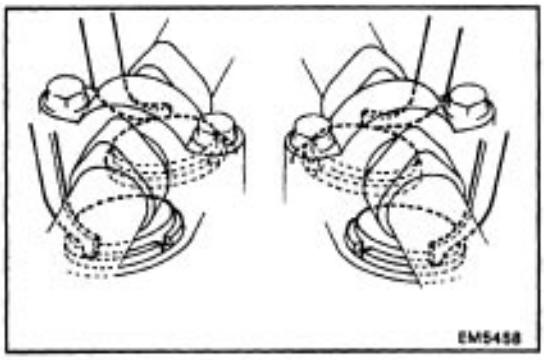
 09256–00030 Hose Plug Set	Plug for vacuum hose, fuel hose etc.
 09904–00010 Expander Set	

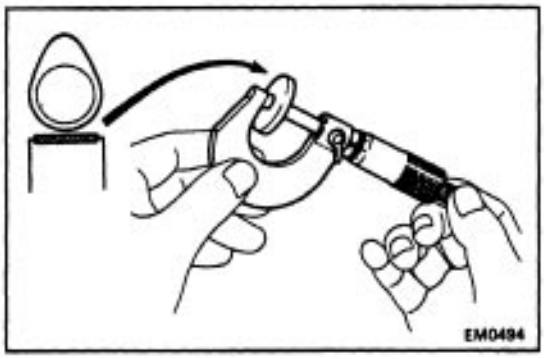
EQUIPMENT

Battery specific gravity gauge	
Caliper gauge	
CO/HC meter	
Compression gauge	
Connecting rod aligner	
Cylinder gauge	
Dial indicator	
Dye penetrant	
Engine tune–up tester	
Heater	
Magnetic finger	
Micrometer	
Piston ring compressor	
Piston ring expander	
Plastigage	
Precision straight edge	
Soft brush	
Spring tester	Valve spring
Steel square	Valve spring
Thermometer	
Torque wrench	









5. ADJUST VALVE CLEARANCE

(a) Remove the adjusting shim.

- Turn the crankshaft so that the cam lobe for the valve to be adjusted faces up.
- Using SST (A), press down the valve lifter and place SST (B) between the camshaft and valve lifter. Remove SST (A).

SST 09248 – 55020 (09248 – 05011, 09248–05021)

HINT: Before pressing down the valve lifter, position its notch toward the spark plug side.

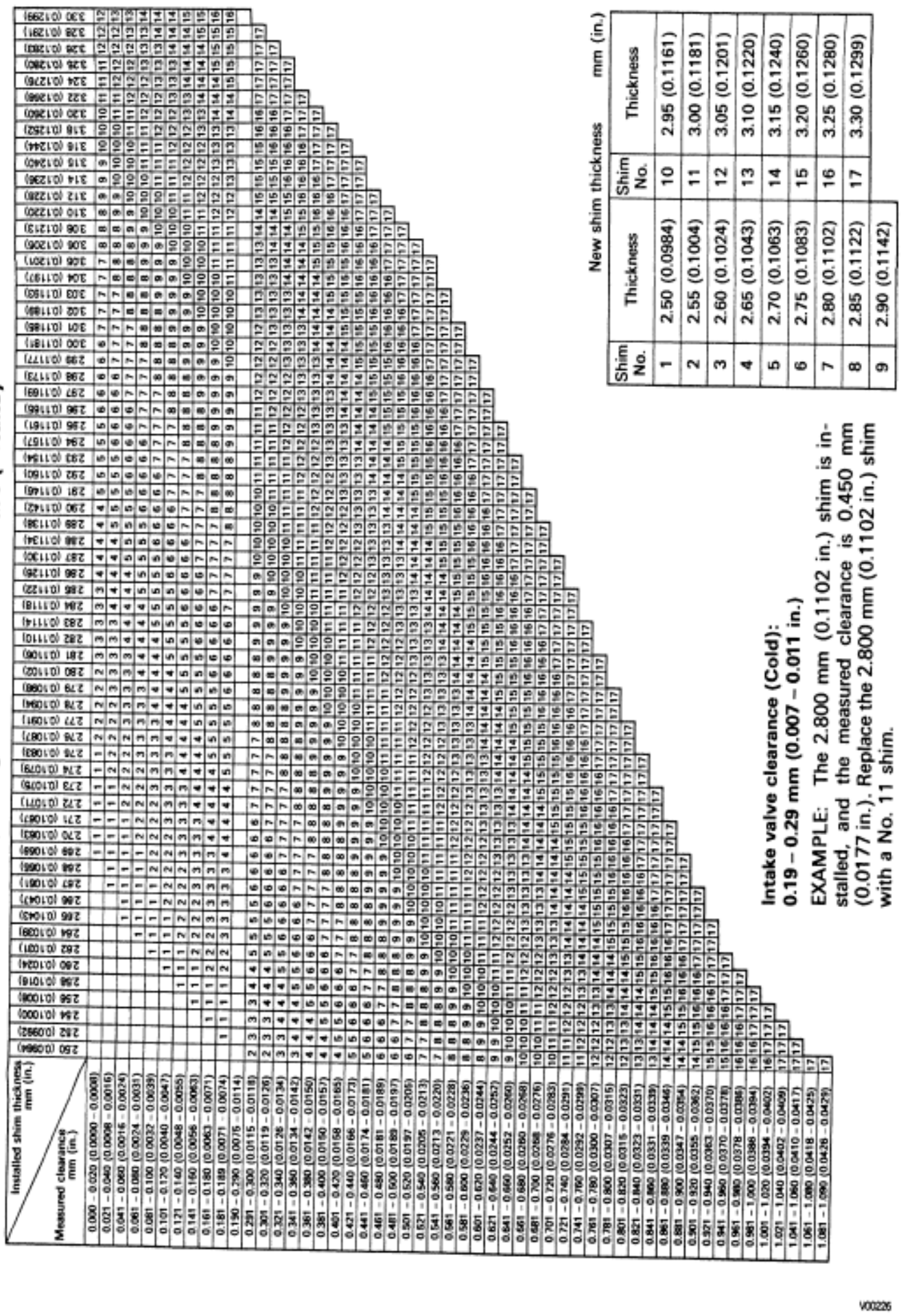
- Remove the adjusting shim with a' small screw–driver and magnetic finger.

HINT: For easy removed of the shim, when positioning SST (B), set it on the lifter so there is space enough to be able to remove the shim.

(b) Determine the replacement adjusting shim size by following the Formula or Charts:

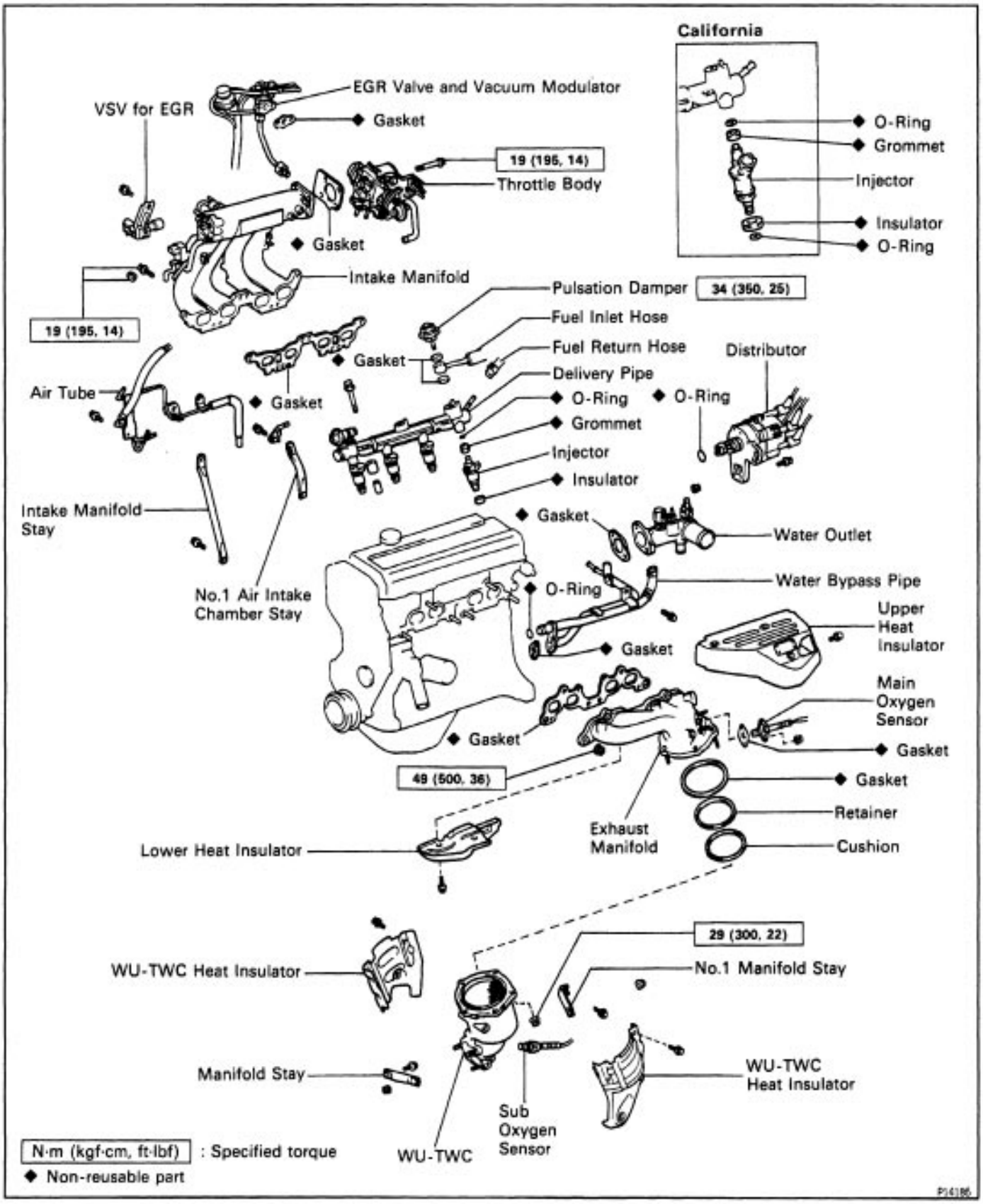
- Using a micrometer, measure the thickness of the removed shim.
- Calculate the thickness of a new shim so that the valve clearance comes within specified value.
  T ..... Thickness of removed shim
  A ..... Measured valve clearance
  N ..... Thickness of new shim
  Intake:
  N = T + (A – 0.24 mm (0.009 in.))
  Exhaust:
  N = T + (A – 0.33 mm (0.013 In.))
- Select a new shim with a thickness as close as possible to the calculated value.

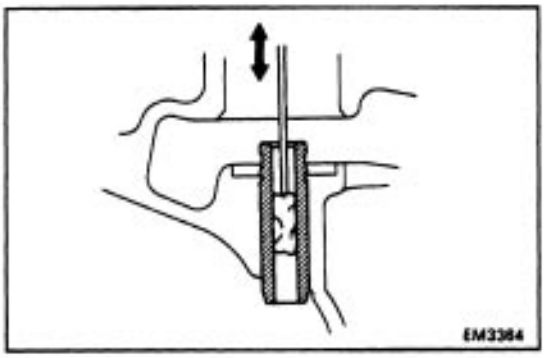
HINT: Shims are available in seventeen sizes in incre–ments of 0.05 mm (0.0020 in.), from 2.50 mm (0.0984 in.) to 3.30 mm (0.1299 in.).


Adjusting Shim Selection Chart (Intake)
Installed shim thickness mm (in.)
Measured clearance mm (in.)
New shim thickness mm (in.)
Shim No. | Thickness | Shim No. | Thickness
1 | 2.50 (0.0984) | 10 | 2.95 (0.1161)
2 | 2.55 (0.1004) | 11 | 3.00 (0.1181)
3 | 2.60 (0.1024) | 12 | 3.05 (0.1201)
4 | 2.65 (0.1043) | 13 | 3.10 (0.1220)
5 | 2.70 (0.1063) | 14 | 3.15 (0.1240)
6 | 2.75 (0.1083) | 15 | 3.20 (0.1260)
7 | 2.80 (0.1102) | 16 | 3.25 (0.1280)
8 | 2.85 (0.1122) | 17 | 3.30 (0.1299)
9 | 2.90 (0.1142)
Intake valve clearance (Cold):
0.19 – 0.29 mm (0.007 – 0.011 in.)
EXAMPLE: The 2.800 mm (0.1102 in.) shim is installed, and the measured clearance is 0.450 mm (0.0177 in.). Replace the 2.800 mm (0.1102 in.) shim with a No. 11 shim.
V00226

CYLINDER HEAD

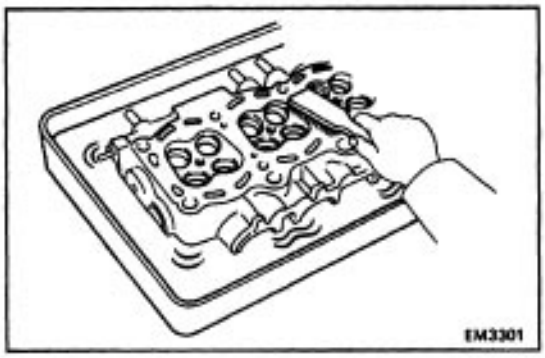
COMPONENTS FOR REMOVAL AND INSTALLATION





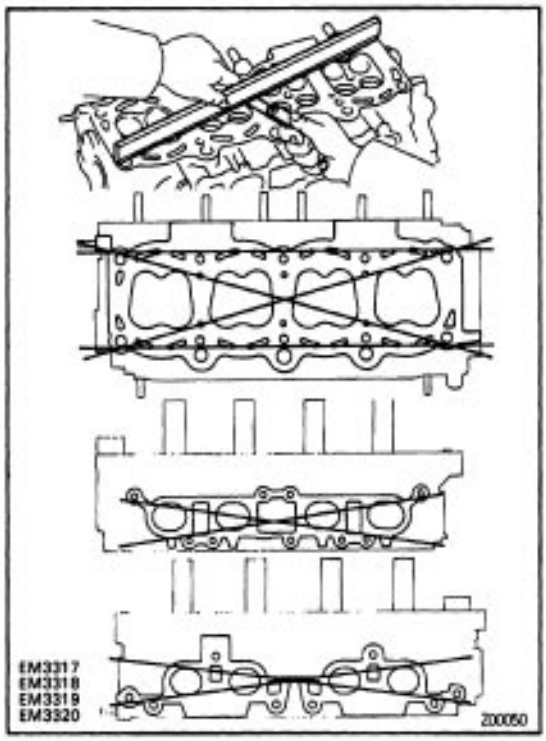
C. Clean valve guide bushings

Using a valve guide bushing brush and solvent, clean all the guide bushings.



D. Clean cylinder head

Using a soft brush and solvent, thoroughly clean the cylinder head.



3. INSPECT CYLINDER HEAD

A. Inspect for flatness

Using a precision straight edge and thickness gauge, measure the surfaces contacting the cylinder block and the manifolds for warpage.

Maximum warpage:

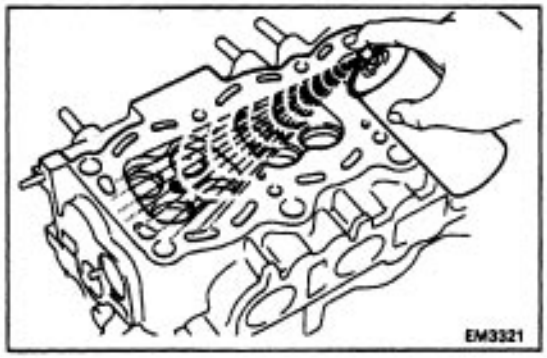
Cylinder block side

0.05 mm (0.0020 in.)

Manifold side

0.08 mm (0.0031 in.)

If warpage is greater than maximum, replace the cylin–der head.



B. Inspect for cracks

Using a dye penetrant, check the combustion cham–bers, intake ports, exhaust ports and cylinder block surface for cracks.

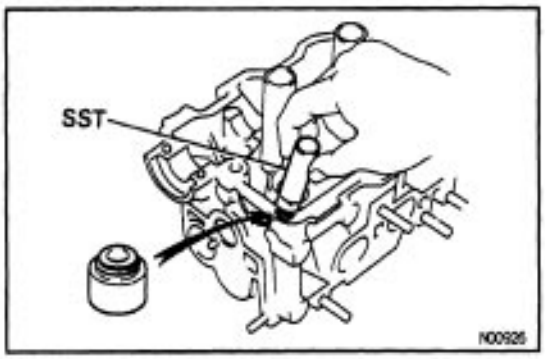
If cracked, replace the cylinder head.

CYLINDER HEAD ASSEMBLY

(See Components for Removal and Installation)

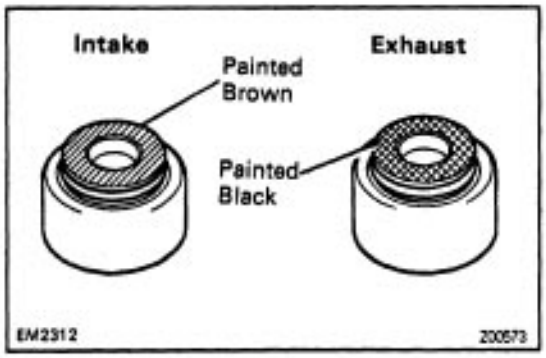
HINT:

- Thoroughly clean all parts to be assembled.
  Before installing the parts, apply new engine oil to all sliding and rotating surfaces.
- Replace all gaskets and oil seals with new ones.

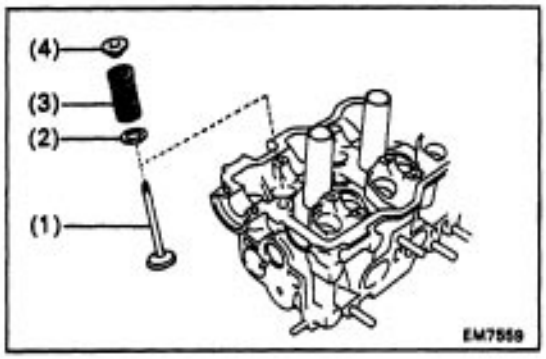


1. INSTALL VALVES

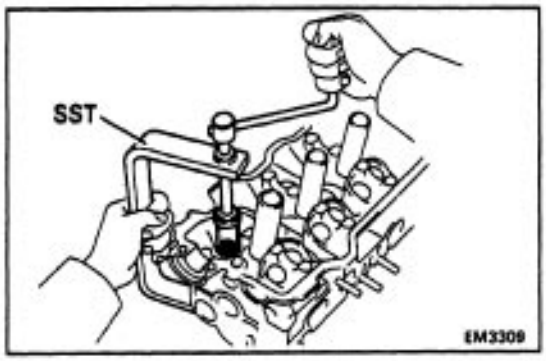
(a) Using SST, push in a new oil seal.
SST 09201 –41020



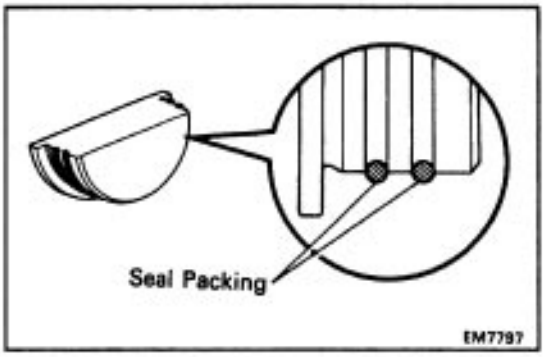
HINT: The intake valve oil seal is brown and the exhaust valve oil seal is black.



(b) Install the following parts:
(1) Valve
(2) Spring seat
(3) Valve spring
(4) Spring retainer



(c) Using SST, compress the valve spring and place the 2 keepers around the valve stem.
SST 09202 – 70010

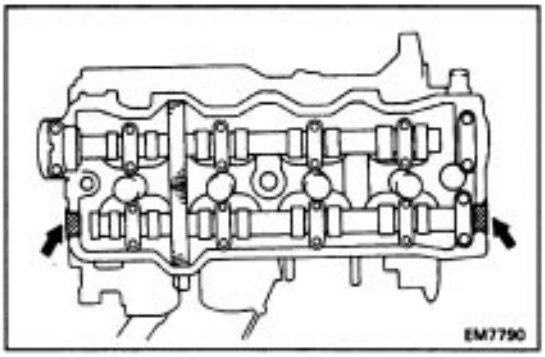


6. INSTALL SEMI–CIRCULAR PLUGS

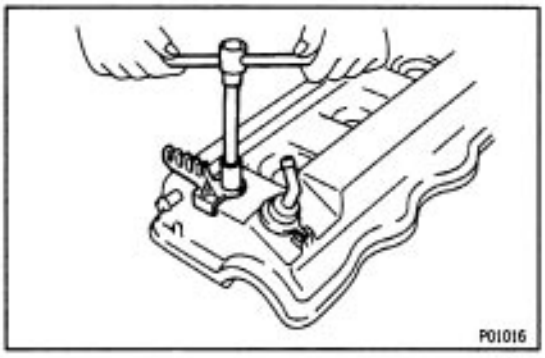
(a) Remove any old packing (FIPG) material.

(b) Apply seal packing to the semi–circular plug grooves.

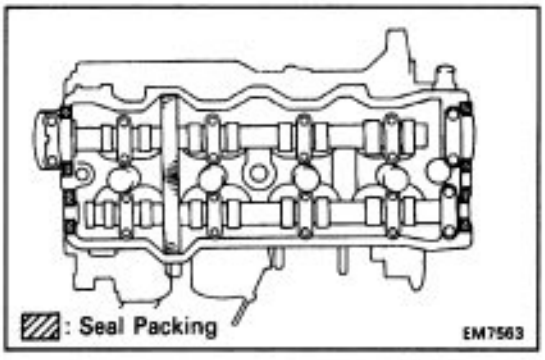
Seal packing:
Part No.08826–00080 or equivalent



(c) Install the 2 semi–circular plugs to the cylinder head.



7. INSTALL PCV VALVE AND HIGH–TENSION CORDS CLAMP

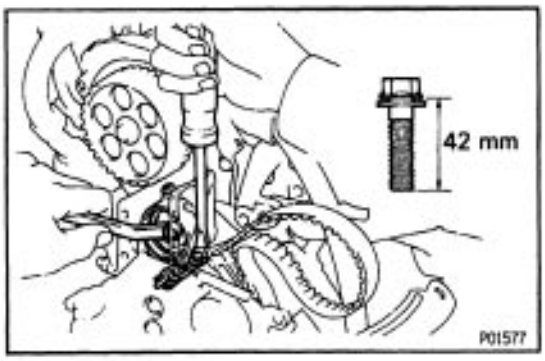


8. INSTALL CYLINDER HEAD COVER

(a) Remove any old packing (FIPG) material.

(b) Apply seal packing to the cylinder head as shown in the illustration.

Seal packing:
Part No.08826–00080 or equivalent



13. TEMPORARILY INSTALL NO.1 IDLER PULLEY AND TENSION SPRING

(a) Install the pulley with the bolt. Do not tighten the bolt yet.

HINT: Use bolt 42 mm (1.65 in.) in length.

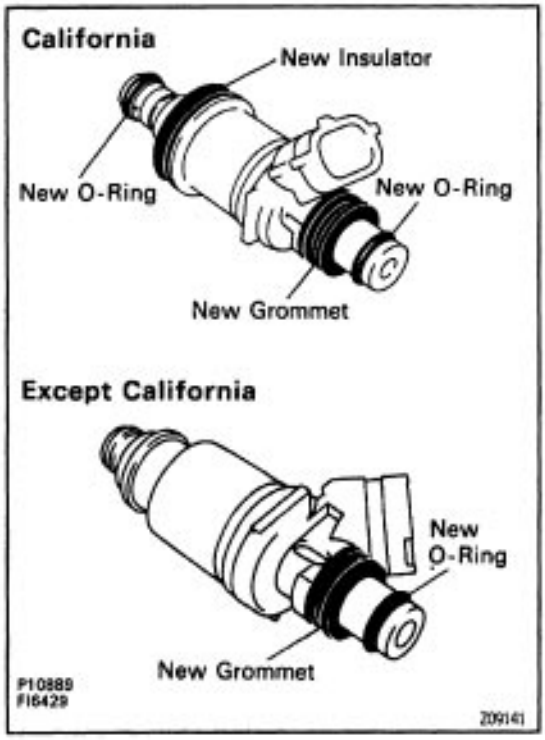
(b) Install the tension spring.

(c) Pry the pulley toward the left as far as it will go and tighten the bolt.

(d) Check that the idler pulley moves smoothly.

14. INSTALL CAMSHAFT TIMING PULLEY AND TIMING BELT

(See page EG1–33**)**



15. INSTALL INJECTORS AND DELIVERY PIPE

(a) California:

Install new insulator and grommet to each injector.

(b) Except California:

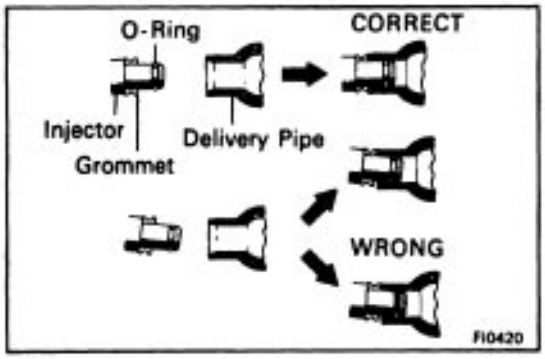
Install a new grommet to each injector.

(c) California:

Apply a light coat of gasoline to 2 new 0–rings, and install them to each injector.

(d) Except California:

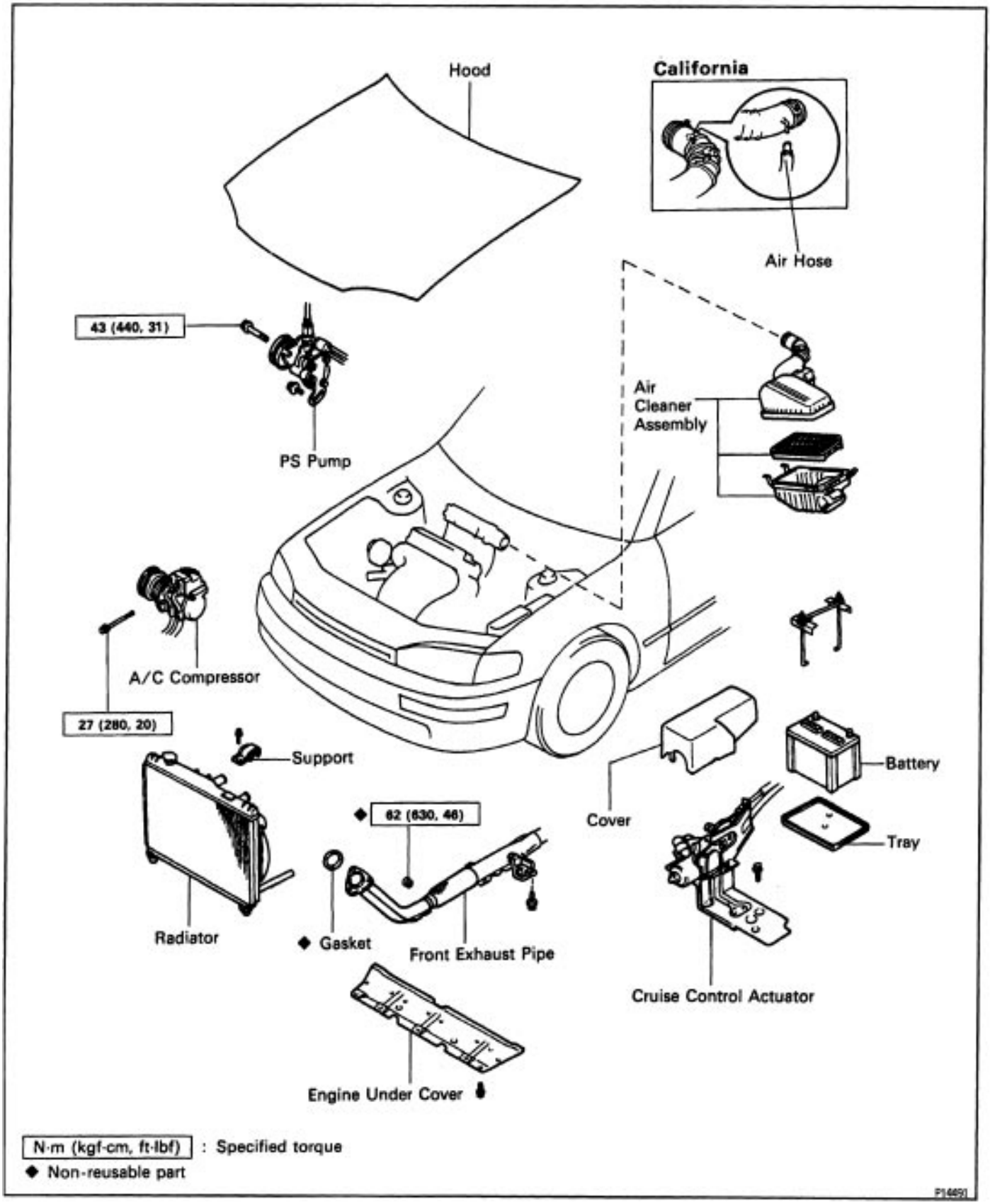
Apply a light coat of gasoline to a new 0–ring, and install it to each injector.



(e) While turning the injector left and right, install it to the delivery pipes. Install the 4 injectors.

CYLINDER BLOCK

COMPONENTS FOR ENGINE REMOVAL AND INSTALLATION



Adjusting Spacer Selection Chart

Measured clearance mm (in.) \ Installed spacer No.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
0.000 – 0.060 (0.0000 – 0.0022)																																								
0.061 – 0.067 (0.0023 – 0.0025)		01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35
0.068 – 0.074 (0.0025 – 0.0027)			01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35
0.075 – 0.081 (0.0028 – 0.0030)				01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33
0.082 – 0.088 (0.0030 – 0.0033)					01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	
0.089 – 0.095 (0.0033 – 0.0035)						01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	
0.096 – 0.102 (0.0035 – 0.0038)							01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	
0.103 – 0.109 (0.0038 – 0.0040)								01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	
0.110 – 0.116 (0.0040 – 0.0043)									01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	
0.117 – 0.123 (0.0043 – 0.0045)										01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	
0.124 – 0.130 (0.0046 – 0.0048)											01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	
0.131 – 0.137 (0.0048 – 0.0051)												01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	
0.138 – 0.144 (0.0051 – 0.0053)													01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	
0.145 – 0.151 (0.0054 – 0.0056)														01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	
0.152 – 0.158 (0.0056 – 0.0058)															01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	
0.159 – 0.165 (0.0059 – 0.0061)																01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	
0.166 – 0.172 (0.0061 – 0.0064)																	01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	
0.173 – 0.179 (0.0064 – 0.0066)																		01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	
0.180 – 0.186 (0.0067 – 0.0069)																			01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	
0.187 – 0.193 (0.0069 – 0.0071)																				01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	
0.194 – 0.200 (0.0072 – 0.0074)																					01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	
0.201 – 0.207 (0.0074 – 0.0077)																						01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	
0.208 – 0.214 (0.0077 – 0.0079)																							01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	
0.215 – 0.221 (0.0079 – 0.0082)																								01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	
0.222 – 0.228 (0.0082 – 0.0084)																									01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	13	
0.229 – 0.235 (0.0085 – 0.0087)																										01	01	01	01	01	03	03	05	05	07	07	09	09	11	11	
0.234 – 0.242 (0.0087 – 0.0089)																											01	01	01	01	03	03	05	05	07	07	09	09	11	
0.243 – 0.249 (0.0090 – 0.0092)																												01	01	01	01	01	03	03	05	05	07	07	09	09
0.250 – 0.256 (0.0092 – 0.0095)																													01	01	01	01	01	03	03	05	05	07	07	09
0.257 – 0.263 (0.0095 – 0.0097)																														01	01	01	01	01	03	03	05	05	07	07
0.264 – 0.270 (0.0098 – 0.0100)																															01	01	01	01	01	03	03	05	05	07
0.271 – 0.277 (0.0100 – 0.0102)																																01	01	01	01	01	03	03	05	05
0.278 – 0.284 (0.0103 – 0.0105)																																	01	01	01	01	01	03	03	05
0.285 – 0.291 (0.0105 – 0.0108)																																		01	01	01	01	01	03	03
0.292 – 0.298 (0.0108 – 0.0110)																																			01	01	01	01	01	03
0.299 – 0.305 (0.0110 – 0.0113)																																				01	01	01	01	01
0.306 – 0.312 (0.0113 – 0.0115)																																					01	01	01	01
0.313 – 0.319 (0.0116 – 0.0118)																																						01	01	01
0.320 – 0.326 (0.0118 – 0.0120)																																							01	01
0.327 – 0.333 (0.0120 – 0.0123)																																								01

Backlash of crankshaft and No. 1 balance shaft gear:
0 – 0.60 mm (0 – 0.0022 in.)

EXAMPLE: The No. 25 spacers are installed and the measured clearance is 0.140 mm (0.0055 in.). Replace the No. 25 spacers with No. 9 spacers.

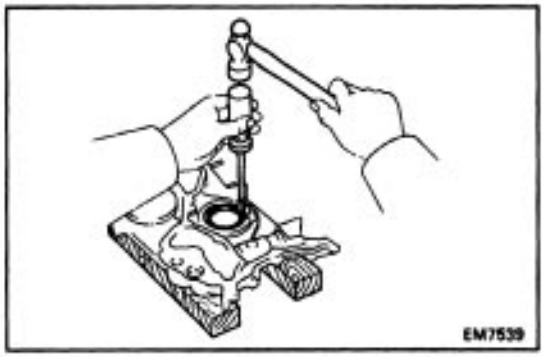
New spacer thickness mm (in.)

No.	Thickness	No.	Thickness	No.	Thickness	No.	Thickness
01	1.74 (0.0685)	11	1.84 (0.0724)	21	1.94 (0.0764)	31	2.04 (0.0803)
03	1.76 (0.0693)	13	1.86 (0.0732)	23	1.96 (0.0772)	33	2.06 (0.0811)
05	1.78 (0.0701)	15	1.88 (0.0740)	25	1.98 (0.0780)	35	2.08 (0.0819)
07	1.80 (0.0709)	17	1.90 (0.0748)	27	2.00 (0.0787)	37	2.10 (0.0827)
09	1.82 (0.0717)	19	1.92 (0.0756)	29	2.02 (0.0795)	39	2.12 (0.0835)

V00096

CRANKSHAFT OIL SEALS REPLACEMENT

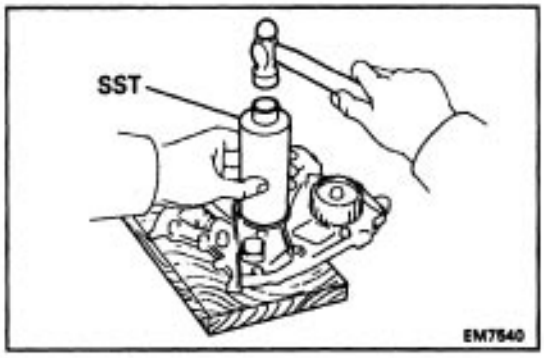
HINT: There are 2 methods (A and B) to replace the oil seal which are as follows:



1. REPLACE CRANKSHAFT FRONT OIL SEAL

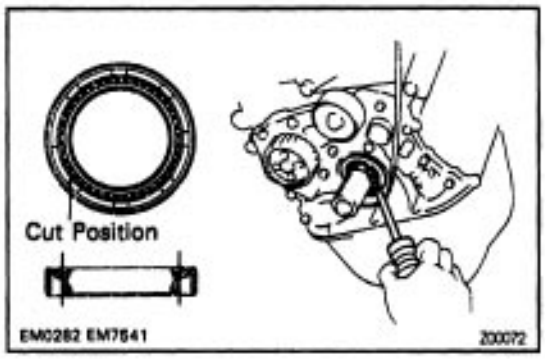
A. If oil pump is removed from cylinder block:

(a) Using a screwdriver and a hammer, tap out the oil seal.



(b) Using SST and a hammer, tap in a new oil seal until its surface is flush with the oil pump case edge.
SST 09223 – 63010

(c) Apply MP grease to the oil seal lip.

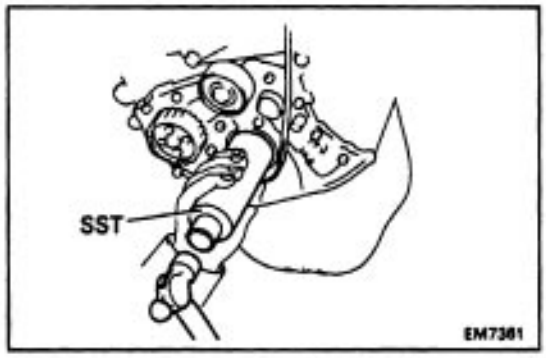


B. If oil pump is installed to the cylinder block:

(a) Using a knife, cut off the oil seal lip.

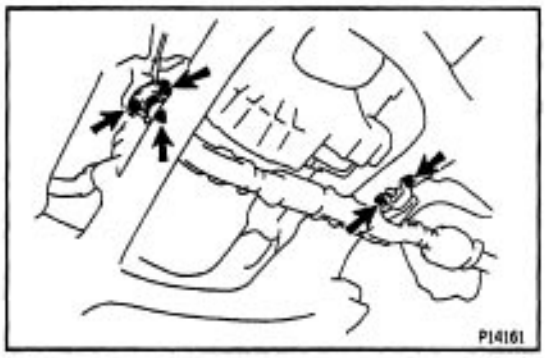
(b) Using a screwdriver, pry out the oil seal.

NOTICE: Be careful not to damage the crankshaft. Tape the screwdriver tip.



(c) Apply MP grease to a new oil seal lip.

(d) Using SST and a hammer, tap in the oil seal until its surface is flush with the oil pump case edge.
SST 09226 –10010



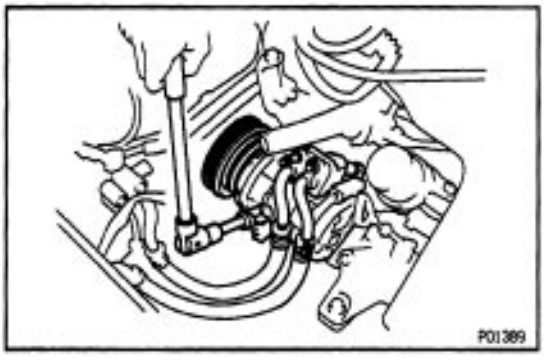
14. CONNECT FRONT EXHAUST PIPE

(a) Place a new gasket on the front exhaust pipe.

(b) Using a 14 mm deep socket wrench, install the 3 new nuts holding the front exhaust pipe to the WU–TWC.

Torque: 82 N–m (630 kgf–cm, 46 ft–lbf)

(c) Install the bracket with the 2 bolts.



15. w/ A/C:

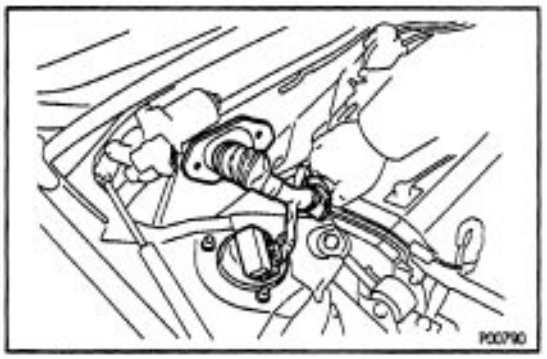
INSTALL A/C COMPRESSOR

(a) Install the compressor with the 3 bolts.

Torque: 27 N–m (280 kgf–cm, 20 ft–lbf)

(b) Install the drive belt.

(c) Connect the A/C compressor connector.



16. CONNECT ENGINE WIRE TO CABIN

(a) Push in the engine wire through the cowl panel. Install the 2 nuts.

(b) Connect the following connectors:

(1) 2 ECM connectors

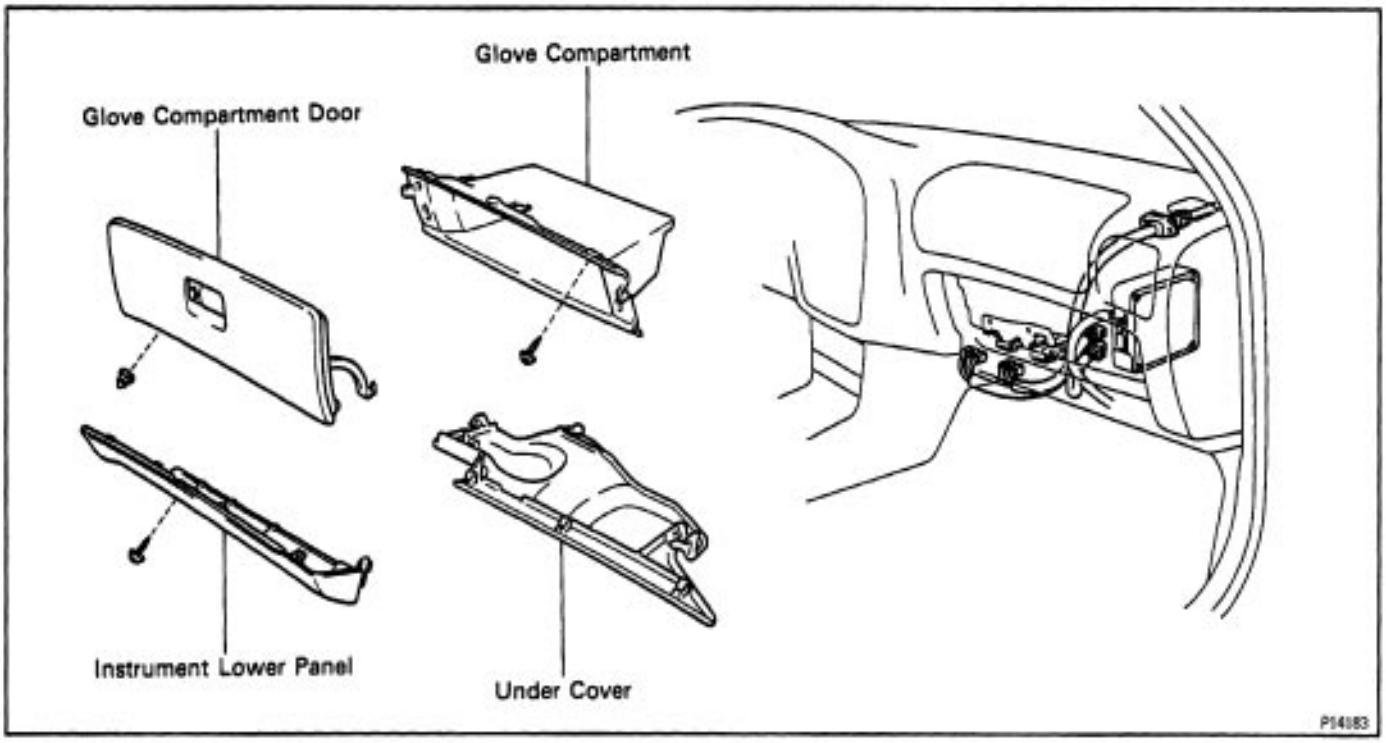
(2) 2 cowl wire connectors

(c) Install the glove compartment.

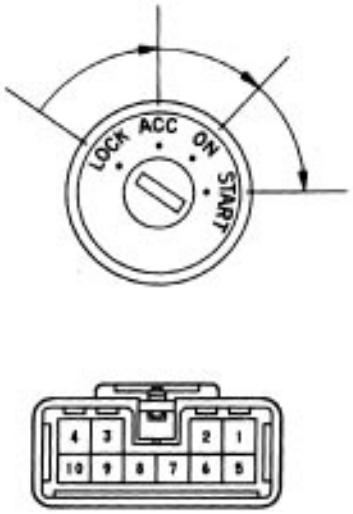
(d) Install the glove compartment door.

(e) Install the lower instrument panel.

(f) Install the under cover.



5 **Check ignition switch.**



P Remove under cover and finish panel.

C Check continuity between terminals.

OK

○—○ continuity

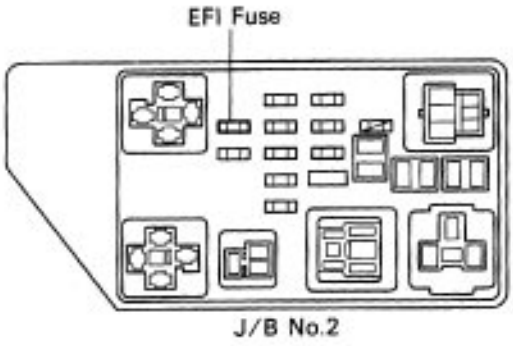
Terminal / Switch position	2 IG1	3 ACC	4 AM1	6 ST2	7 ST1	9 IG2	10 AM2
LOCK							
ACC		○—○	○—○				
ON	○—○	○—○	○—○			○—○	○—○
START	○—○		○—○	○—○	○—○	○—○	○—○

OK → **NG** → Replace ignition switch.

6 **Check for open in harness and connector between IG switch and EFI main relay, EFI main relay and body ground (See page IN–31).**

OK → **NG** → **Repair or replace harness or connector.**

7 **Check EFI fuse.**



P Remove EFI fuse from J/B No.2.

C Check continuity of EFI fuse.
Continuity

OK

OK → **NG** → **Check for short in all the harness and components connected to EFI fuse (See attached wiring diagram).**

Check for open in harness and connector between EFI main relay and battery, EFI main relay and engine control module.