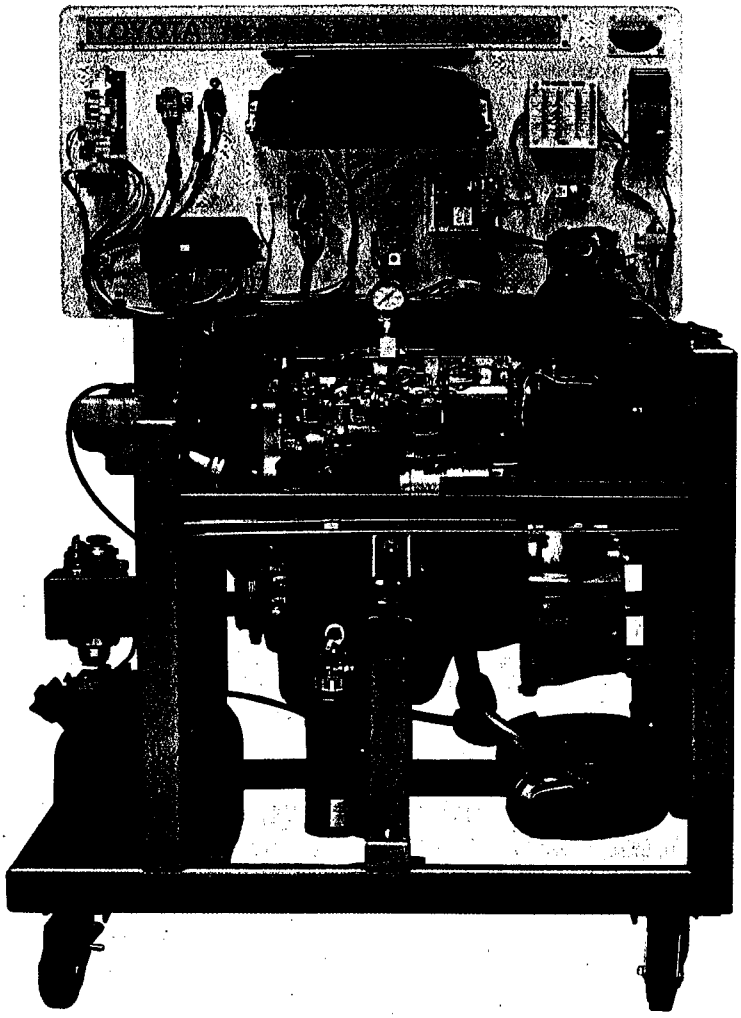
TOYOTA

2C ENGINE SIMULATOR

Training Manual



TECHNICAL EDUCATION PROGRAM

TOYOTA MOTOR CORPORATION

OVERSEAS SERVICE DIVISION

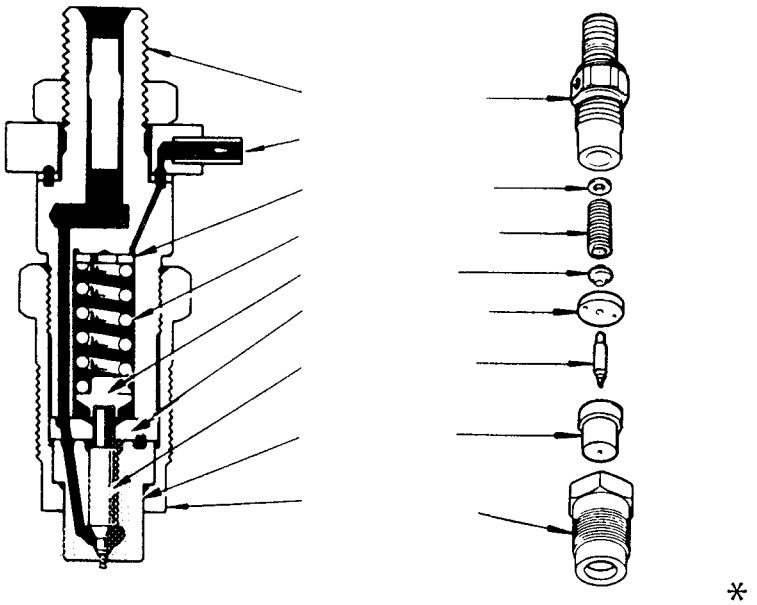
FOREWORD

- This training manual allows study of the basic features of the Diesel Engine and its mechanisms. Utilizing the 2C Engine Simulator and Diesel Engine Cutaway Parts Kit explained in the Toyota Training Manual will facilitate a thorough understanding of this manual, permitting more effective training.

- **Some illustrations used in this manual (those bearing an asterisk at the bottom right, as in the example below) appear separately on the last page of this manual, and can be prepared as overhead transparency projections (OHP) for easy reference.**

- A large number of illustrations used in this manual are drawn in such a way that trainees can add colors themselves for their better understanding.

EXAMPLE



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TOYOTA MOTOR CORPORATION

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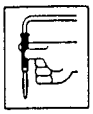
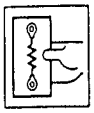
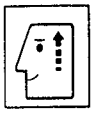
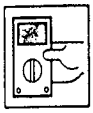
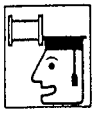
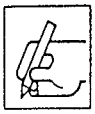
EXPLANATORY NOTES

SYMBOLS

Some or all of the following symbols are used in this manual:

NO.	SYMBOL	MEANING
1		Subject to be studied
2		Making a circuit
3		Practice piece (used in the electrical circuit following the symbol)
4		Practice
5		Inspection or measurement
6		Answer, result of measurement, etc.
7		Experiment
8		Comment, hint, etc.
9		Law, general principle, etc.
10		Explanation of actual operation
11		Explanation of actual use on vehicle
12		Quiz

RELATED MATERIALS

The following related materials are also available for use with the 2C engine simulator:

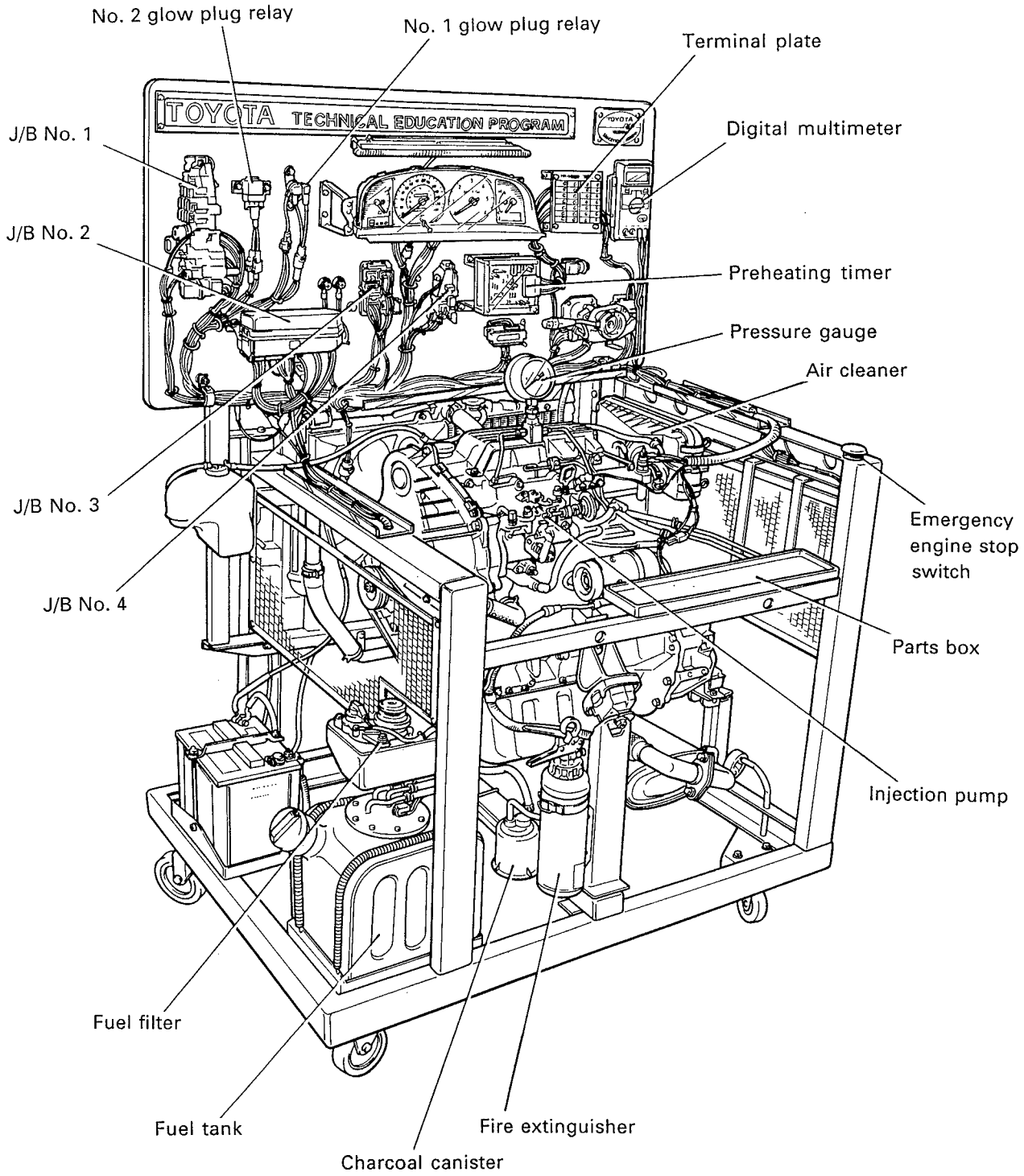
1. TEAM Training Manual:
   - Diesel Engine ..... Pub. No. TTM206E
   - Diesel Injection Pump ..... Pub. No. TTM303E
2. Repair Manual:
   - Electrical Wiring Diagram for Corona & Carina II ..... Pub. No. EWD049E

ABBREVIATIONS USED IN THIS MANUAL

A/C	Air Conditioner	P/S	Power Steering
A/T	Automatic Transmission	STD	Standard
BTDC	Before Top Dead Center	SST	Special Service Tool
BVSV	Bi-metal Vacuum Switching Valve	TDC	Top Dead Center
DP	Dash Pot	TEMP	Temperature
FL	Fusible Link	U/S	Undersized
J/B	Junction Block	VSV	Vacuum Switching Valve
M/T	Manual Transmission	VTV	Vacuum Transmitting Valve
O/S	Oversized	w/	With
PCV	Positive Crankcase Ventilation	w/o	Without

HOW TO USE 2C ENGINE SIMULATOR

LAYOUT OF PARTS



SPECIFICATIONS OF MAIN COMPONENTS

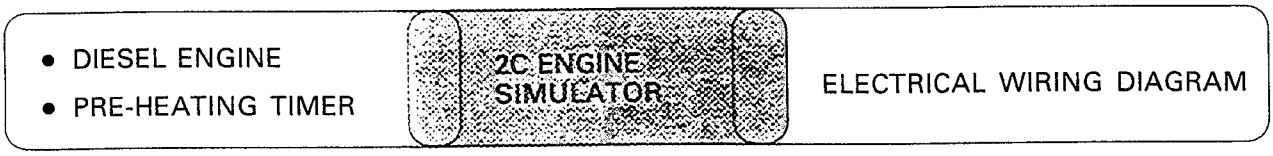
The simulator is comprised of components and parts that are primarily found on Corona and Carina II passenger cars, which have a solid worldwide reputation. It also contains some parts found on other vehicles made by Toyota. The primary components, parts, and specifications are listed below.

MAIN COMPONENT	BASIC VEHICLE MODEL		DESTINATION	REMARKS
	CODE	YEAR		
Engine	CT170	—	Europe	Cold spec.
Starter	CT170	'90	Europe	Cold spec.
Fuel filter element	CT170	'90	Europe	
Air cleaner	CT170	'90	Europe	
Charcoal canister	AL25	'84	Australia	

MAIN FEATURES

The 2C Engine Simulator has been designed based on the 1991 Corona (vehicle model code CT170) and has the following features:

1. Makes it easy to obtain fundamental knowledge of Diesel engines.
2. Mounted wire harnesses and connectors are the same as those used on actual vehicles. This aids in learning how to read the Electrical Wiring Diagram (EWD) Manual, Pub. No. EWD049E.
3. The preheating timer system provided on the 2C engine allows technicians to view system operating conditions.
4. The incoming and outgoing voltages, etc. to/from the preheating timer can easily be measured at the built-in terminal plate.
   Resistances across this timer can also be measured here.



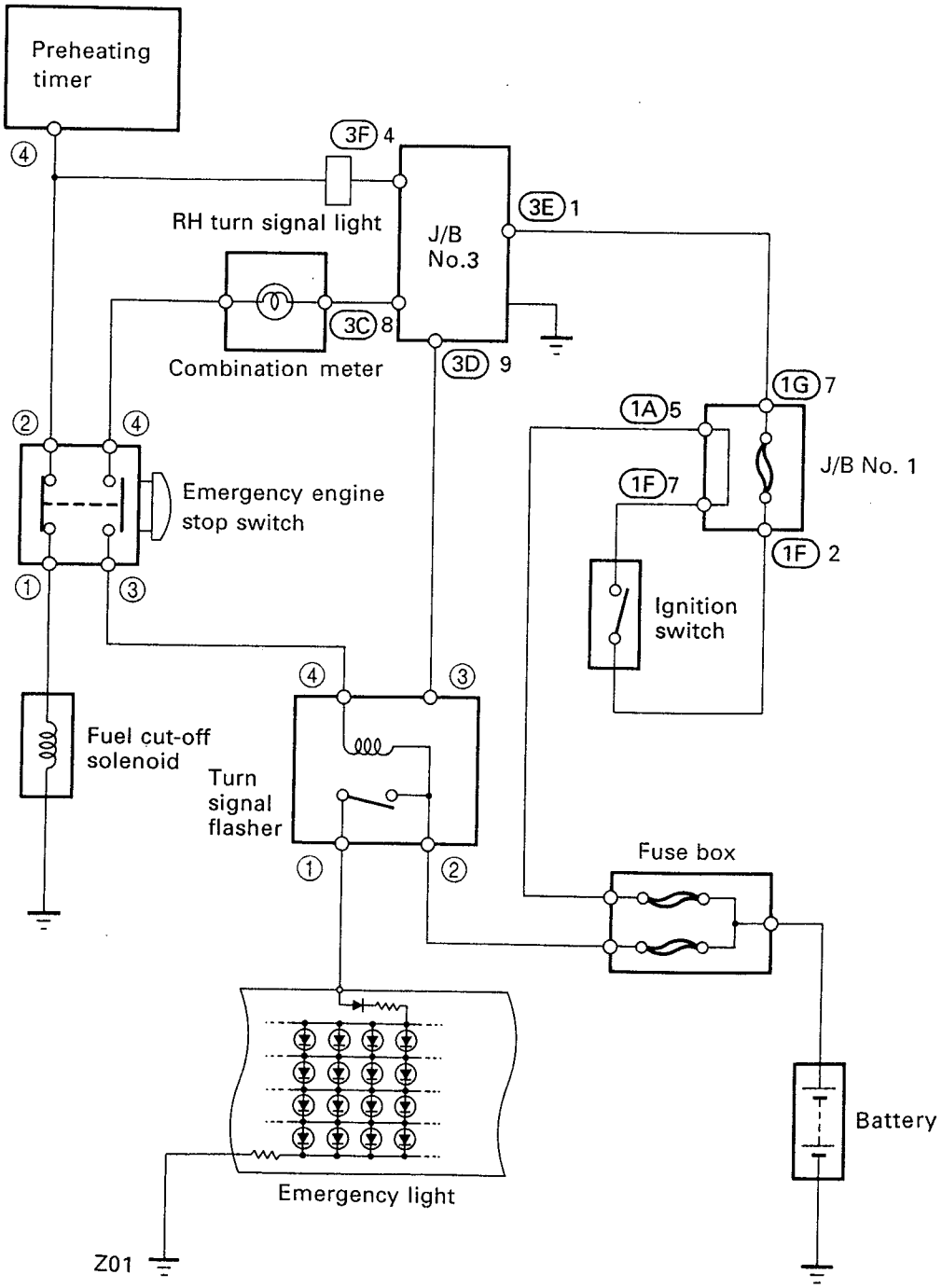
CAUTION ON USING SIMULATOR

SPECIAL PARTS & CIRCUITS

The following special parts and circuits have been added to ensure the durability and usability of the simulator:

EMERGENCY ENGINE STOP SWITCH

When the emergency engine stop switch is pressed, the engine stops and the flasher relay operates, causing the emergency light to blink.
When the emergency engine stop switch is pressed again, the emergency light stops blinking, and the engine can be restarted (see wiring diagram below).

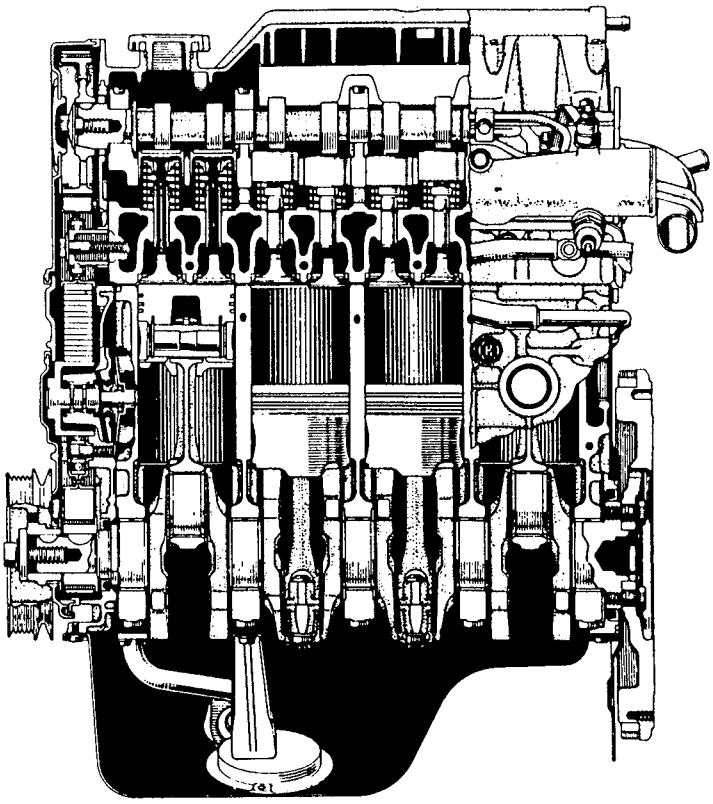


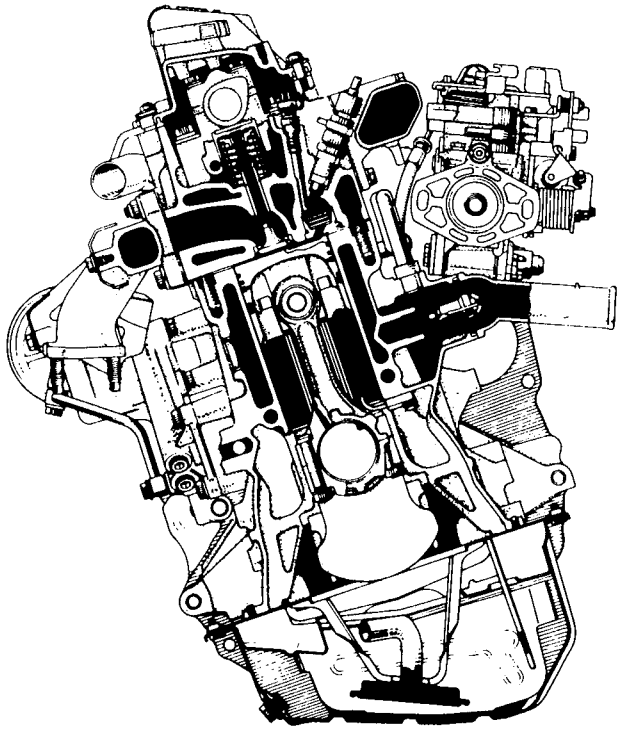
2C ENGINE

SPECIFICATIONS

ITEM \ ENGINE		2C
No. of cylinders & arrangement		4-cylinder, in-line
Valve mechanism		2 valves, OHC, belt drive
Combustion chamber		Swirl chamber
Manifold layout		Cross-flow
Displacement	cc (cu.in.)	1974 (120.5)
Bore × stroke	mm (in.)	86 × 85 (3.39 × 3.35)
Compression ratio		23.0 : 1
Max. output	(EEC) (SAE-NET)	54 kW @ 4700 rpm 54 kW @ 4700 rpm
Max. torque	(EEC) (SAE-NET)	132 N·m @ 3000 rpm 132 N·m @ 3000 rpm

The 2C engine is a dependable, lightweight and compact diesel engine.





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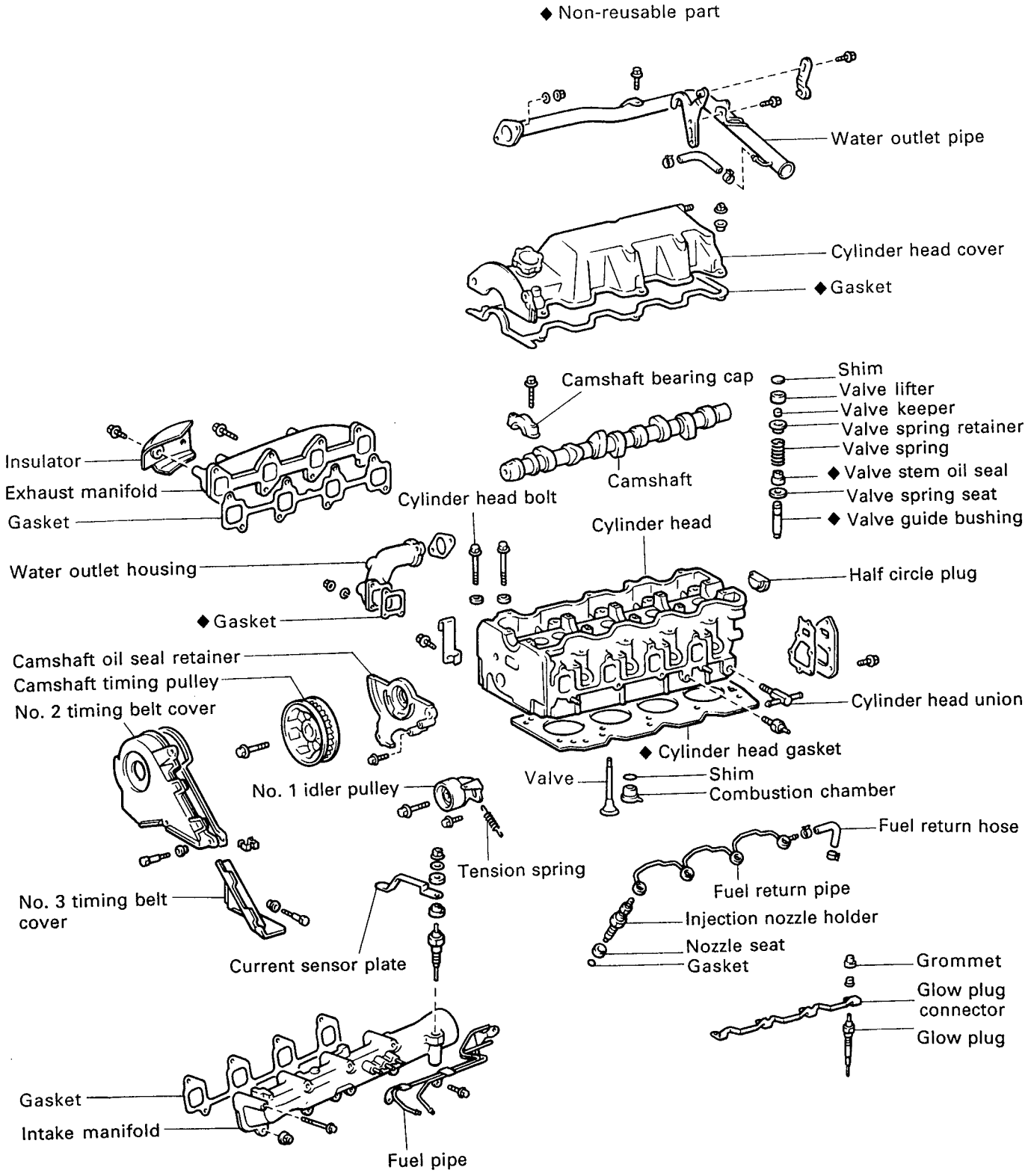
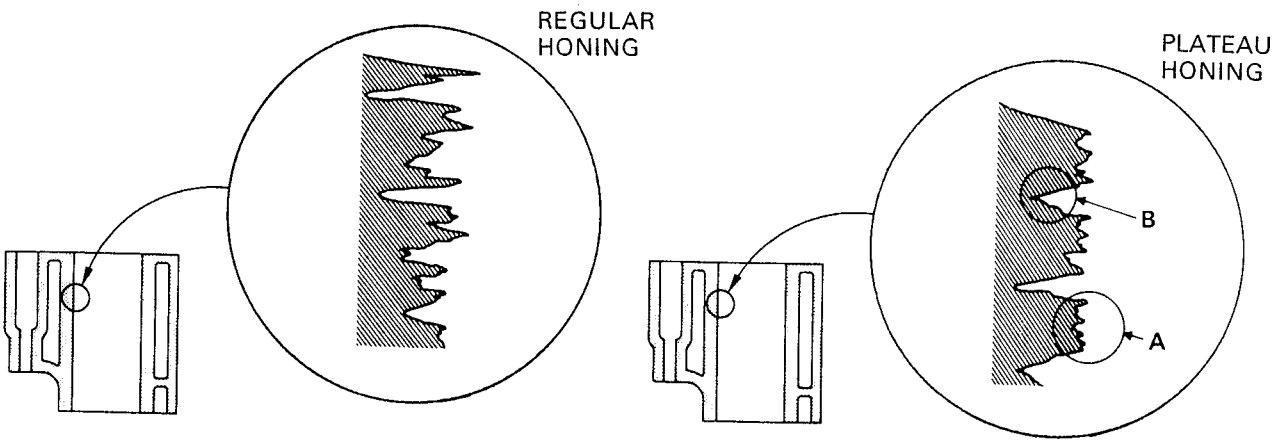
MAIN SERVICE POINTS

COMPONENTS



CYLINDER BLOCK

As with modern gasoline engines, the use of special alloy cast iron with good anti-wear features eliminates the need for cylinder liners. Lack of liners allows cylinders to be placed closer together, resulting in a shorter, lighter cylinder block.
The cylinder walls have been finished with plateau honing* to increase smoothness.



REFERENCE

* Plateau Honing
In regular honing, the surface of the finishing of the bore is comparatively rough, as shown in the illustration above. In plateau honing, however, the cylinder is more finely bored so that microscopic "plateaus" are created, as shown aboue. These plateaus (one of which is labeled "A" in the illustration), take up the expansive force of the piston rings, while oil accumulates in the grooves ("B") between them. The result of this is less wearing of piston rings and cylinders.

– NOTE –

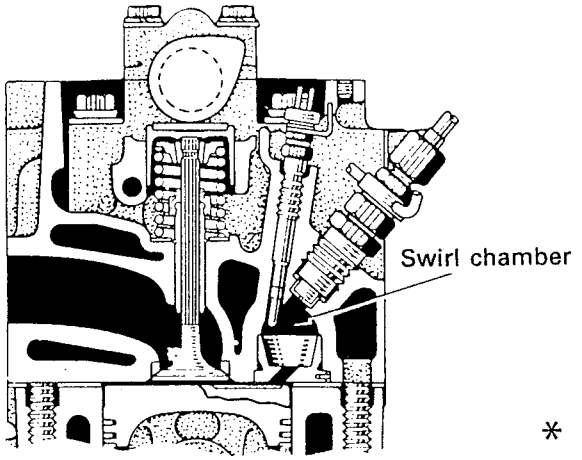
It is recommended that a honing stone of grit #200 or finer be used to hone the cylinder after it is bored out.

CYLINDER HEAD

① Good heat radiation is provided by a lightweight aluminum alloy cylinder head (weight is about 2/3 that of a cast iron head).

② Sufficient intake efficiency even at high speeds is assured by a cross-flow intake and exhaust port arrangement, and by the adoption of intake and exhaust valves that are directly operated by an overhead camshaft.

③ Improved output power, startability, and fuel efficiency, as well as quieter operation, are provided by the highly-efficient swirl type combustion chamber.



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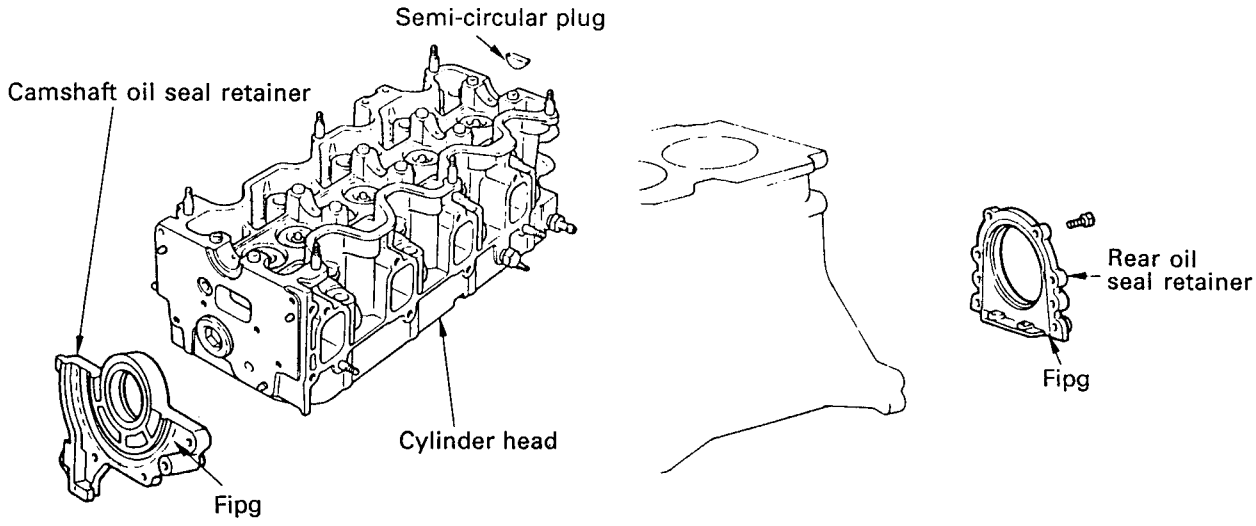
④ Adoption of a liquid gasket (FIPG = formed-in-place Gasket) with superior sealing characteristics, is utilized for the camshaft oil seal retainer and semi-circular plug installed to the cylinder head.



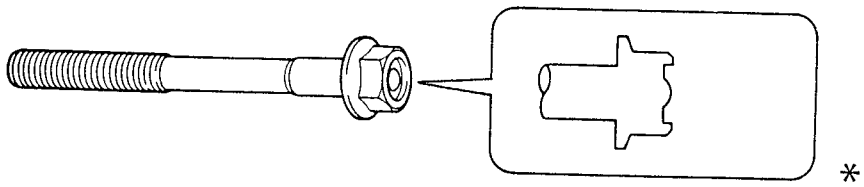
– NOTE –

In C-series engines, FIPG is used in three other places besides the cylinder head:

- **Cylinder block × Rear oil seal retainer**
- **Cylinder block × Oil pan No. 2**
- **Oil pan No. 2 × Oil pan No. 1**

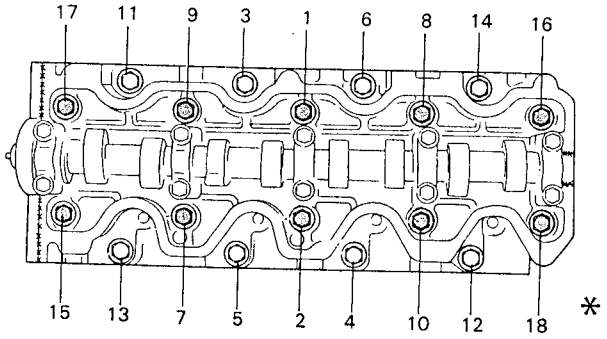
CYLINDER HEAD BOLTS

Cylinder head bolts are made of a special type of steel that can stand up well to stretching. Also, a new bolt tightening method called "plastic region tightening*" has been adopted for the 2C engine.
The cylinder head bolts with which this plastic rigion tightening method is to be used are provided with a protrusion in the head to distinguish them from ordinary cylinder head bolts.



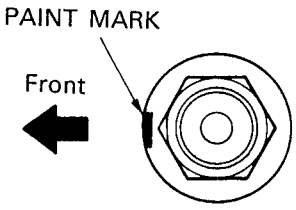
The bolts are tightened as follows:

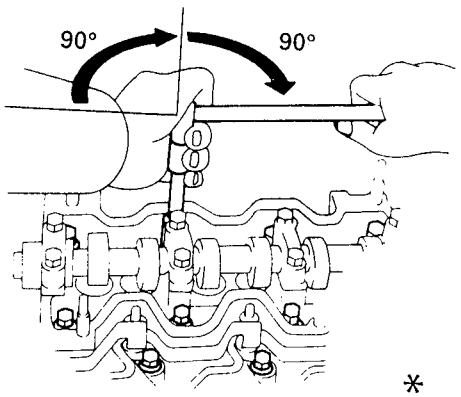
① Apply a small amount of engine oil to the threaded section of each bolt.
② Tighten the bolts, in the order shown below, to 450 kg-cm. (NEVER completely tighten this type of bolt down in one operation – tighten all bolts evenly, in several passes.)



Length of Cylinder-head Bolts:
Those marked with " ○ " in the illustration at left ..... 145 mm
All others ..... 123 mm

③ Mark the front side of the top of each head bolt with paint.
④ Tighten the eighteen head bolts 90° in the numerical order shown.
⑤ Then tighten each bolt by an additional 90°.
⑥ Check that the paint mark is now facing rearward.





REFERENCE

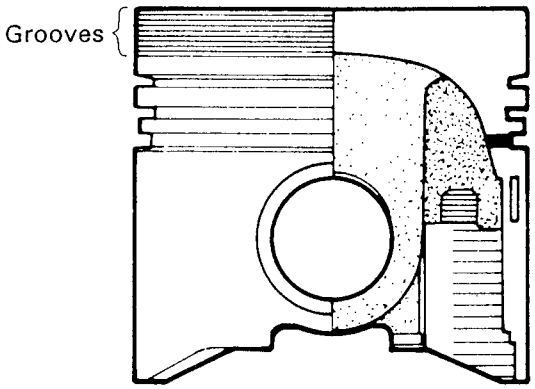
* Plastic Region Tightening
In the plastic region tightening method, the bolt is tightened to a point slightly beyond the yield point (the limit at which the bolt is permanently stretched in the axial derection) to obtain the required axial tension. Since this ensures a nearly identical axial tension for all bolts, this method improves sealing.

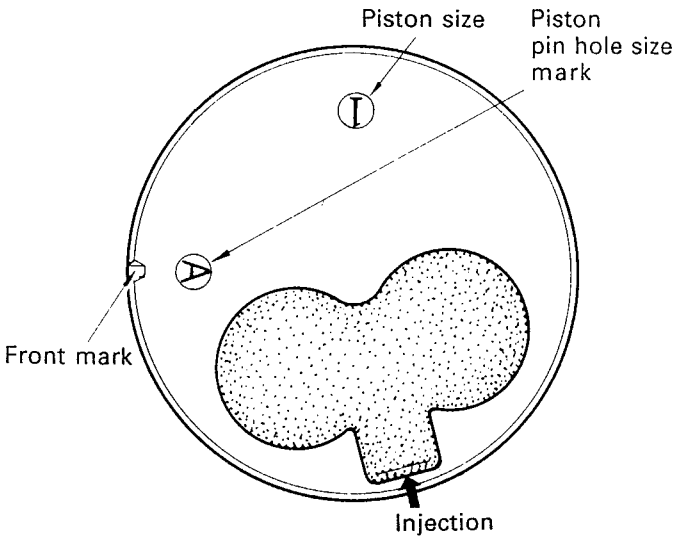
PISTON & PISTON RINGS

1. PISTON

① Heat expansion (causing a change in the outer diameter) of the piston is reduced by the adoption of steel struts in the pistons. Consequently, pistons operate more quietly because less piston clearance is required.

② On the 2C engine, piston scuffing is prevented by grooves at the top of the land.



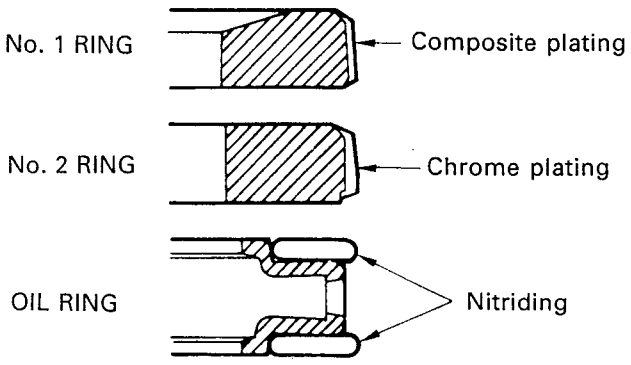


PISTON HEAD *

2. PISTON RINGS

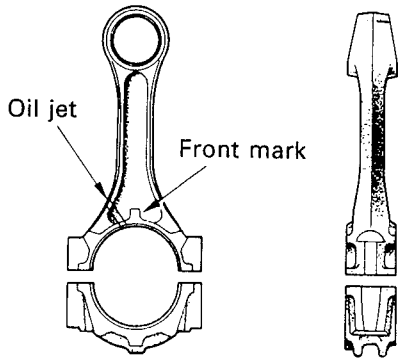
While a semi-keystone type ring is used for the No. 1 piston ring to ensure sealability, a tapered-face type is employed for the No. 2 piston ring.

A three-piece segmented oil ring has been adopted for better oil control.



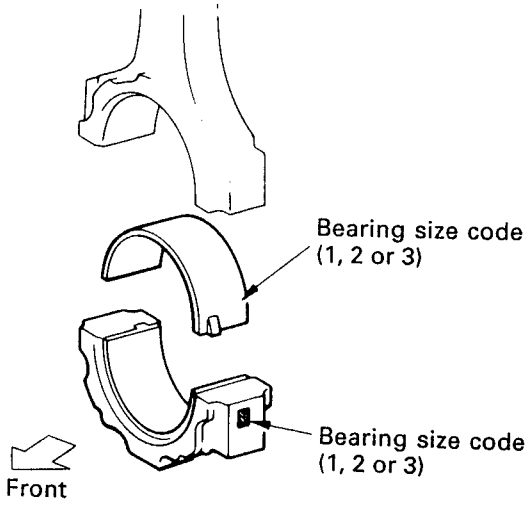
CONNECTING RODS

① The connecting rods are made of highly rigid forged steel.
② To ensure cooling of the piston and lubrication of the piston, cylinder and piston pin, an oil jet is provided in the shoulder of the big end of each rod.
③ The small end of the connecting rod has been tapered, and more unnecessary metal has been removed, a rib being added in its place. All of this has resulted in a stronger yet lighter connecting rod.



CONNECTING ROD BEARING

The 2C engine use narrow connecting rod bearings in order reduce friction loss. There are three standard sizes of connecting rod bearing, and a code number (1, 2, or 3) is printed on the outside of each bearing to indicate the size. A code number is also printed on the big end of each connecting rod bearing cap to indicate the inner diameter of the cap.
Use of bearings and bearing caps of the same size will assure correct oil clearance.



– NOTE –

No undersized connecting rod bearings are provided as regular supply parts.

CRANKSHAFT

A crankshaft with five main bearings and eight balance weights has been adopted to provide rigidity, insure proper balance between each cylinder, and reduce vibration and noise.

– NOTE –

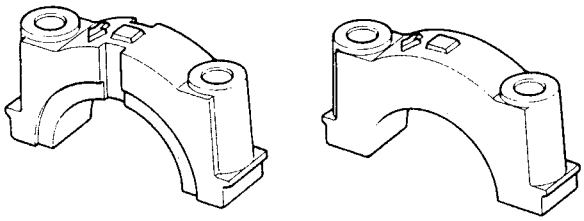
Because the holes in the crankshaft flange (driveplate), which are used for mounting the flywheel, now pass completely through the flange, oil may leak through the holes from the engine if the holes and bolts are not cleaned properly prior to installation of the flywheel, or if the sealant is not properly applied.

Anaerobic adhesive and sealant (Three Bond 1324, TMC P/No. 08833-00070) can damage resin and rubber, so be sure to wipe it off immediately if it comes into contact with anything made of these materials.

1. CRANKSHAFT BEARING CAPS

① Two types of bearing caps (No. 1 and No. 2) are used. Cap No. 1 is used for the 1st, 2nd, 4th and 5th journals, while cap No. 2 is used for the 3rd journal.

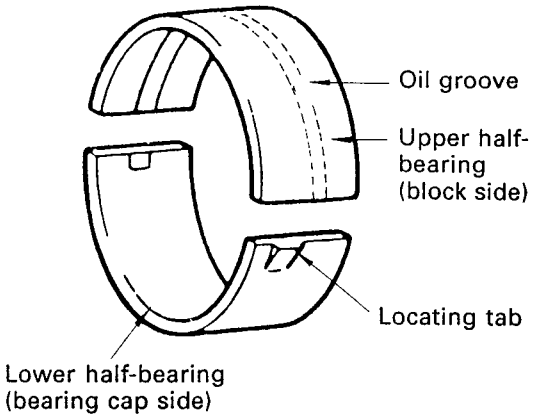
② A thrust washer is used for the No. 3 (center) journal.



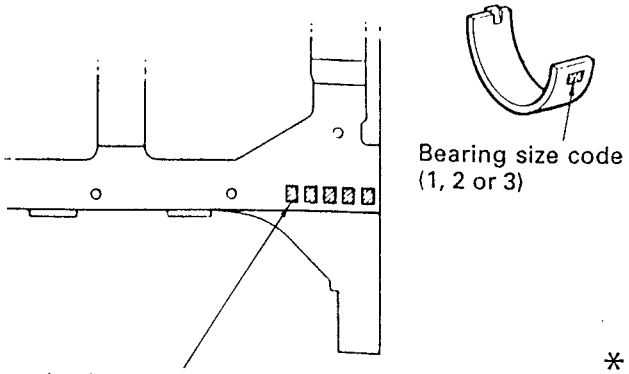
No. 2 No. 1

2. CRANKSHAFT BEARINGS

The upper half-bearing has an oil groove around its circumference but the lower half does not.



There are three standard sizes of crankshaft bearing, and a code number (1, 2, or 3) is printed on the outside of each bearing to indicate the size. Code numbers (1, 2, or 3) indicating the inside diameters of the journal bores are stamped into the metal of the lower right rear of the cylinder block. Use of journals and bearings of the same size will assure correct oil clearance.



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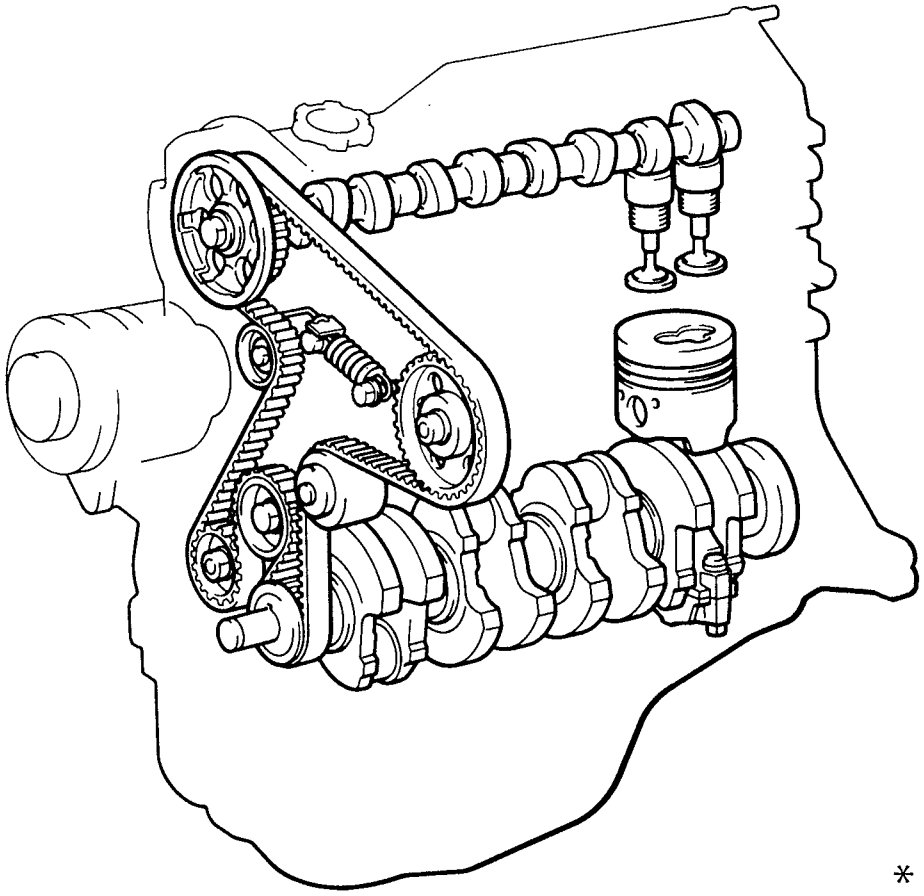
– NOTE –

No undersized crankshaft bearings are provided as regular supply parts.

VALVE MECHANISM

1. TIMING BELT DRIVE

① A timing belt having rounded teeth has been employed to drive the camshaft, assuring silent operation.
② The injection pump, camshaft, and oil pump are driven by the toothed side of the belt, while the water pump is driven by the back (smooth) side.
③ Belt tension is determined by the tension of the No. 1 idler tension spring.



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2. TIMING BELT

The timing belt has a strong fiber-glass core that will not stretch or shrink with changes in temperature, etc. To improve its reliability, the belt itself is made of heat-resistant chloroprene rubber covered with nylon canvas having good anti-wear features.

HANDLING PRECAUTIONS

① Do not bend or twist the belt, or turn it inside out.
② Do not allow the belt to come into contact with oil, water, or steam.
③ Do not exert excessive tension on the belt when installing or removing the set bolts of the crank pulley, camshaft timing pulley, or pump drive pulley.

REMOVAL OF TIMING BELT

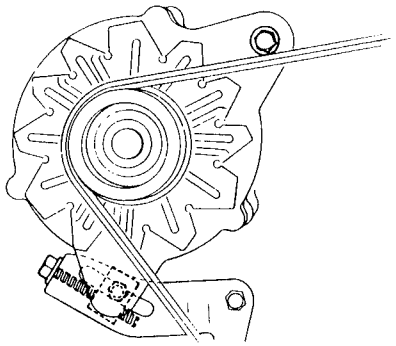
① REMOVE DRIVE BELT

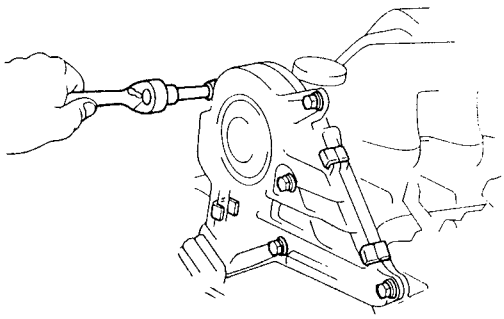
(a) Loosen the alternator pivot, adjusting lock bolt, and adjusting nut or bolt.

(b) Swing the alternator toward the engine and remove the drive belt.

② REMOVE NO. 2 TIMING BELT COVER

Remove the three clips, the five bolts, and the No. 2 timing belt cover with the gasket.





③ REMOVE GLOW PLUGS

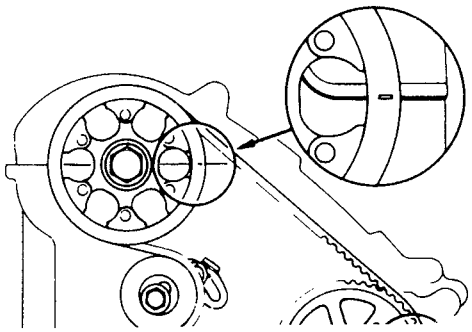
(a) Remove the four grommets from the glow plugs.

(b) Remove the four nuts, current senser plate, and glow plug connector.

(c) Remove the four glow plugs.

NOTE: It is necessary to remove the glow plugs so that the crankshaft will turn smoothly, enabling the belt to be adjusted properly.

④ SET NO. 1 CYLINDER AT TDC/COMPRESSION



⑤ REMOVE CRANKSHAFT PULLEY

(a) Install the SST to the crankshaft pulley.

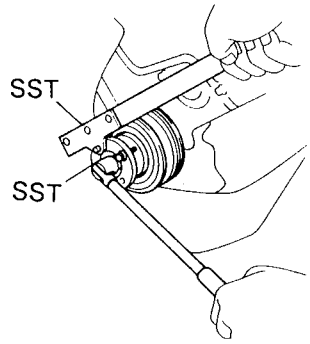
SST 09213-14010

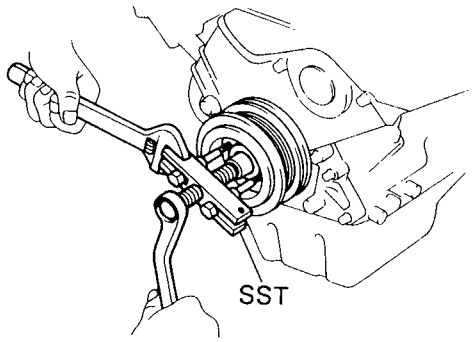
(b) Using the SST to hold the crankshaft pulley, remove the pulley bolt.

SST 09330-00020

(c) Using the SST, remove the crankshaft pulley.

SST 09213-31021

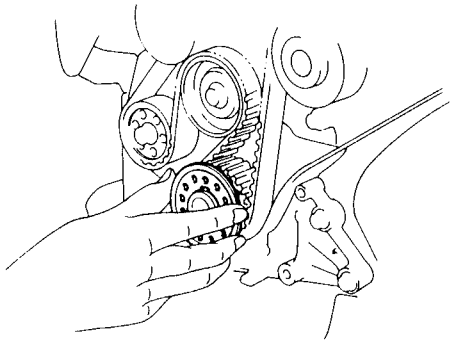


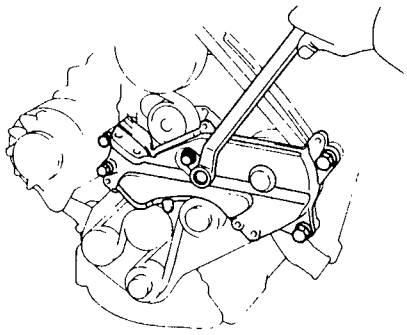


⑥ REMOVE NO. 1 TIMING BELT COVER AND BELT GUIDE

Remove five bolts and the No. 1 timing cover with the gasket and belt guide.

⑦ REMOVE ENGINE MOUNTING BRACKET





⑧ REMOVE TIMING BELT

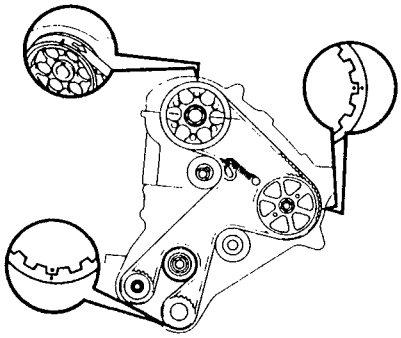
NOTE: If the timing belt will be reused, draw a directional arrow on the belt (in the direction of cranshaft rotation), and place matchmarks on the pulleys and timing belt.

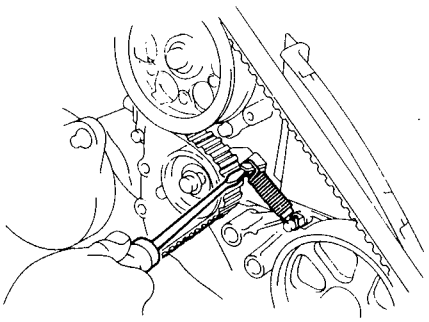
(a) Using a screwdriver, remove the tension spring.

CAUTION: Do not pinch the tension spring with pliers.

(b) Loosen the No. 1 idler pulley bolt.

(c) Remove the timing belt from each pulley.





⑨ REMOVE NO. 1 IDLER PULLEY

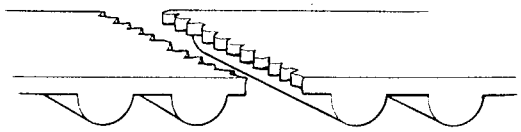
INSPECTION OF COMPONENTS

① INSPECT TIMING BELT

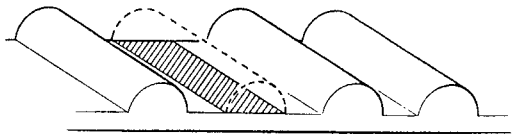
If there are defects as shown in the figures below, check the following and replace the timing belt if necessary.

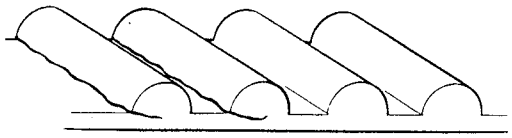
(a) Premature severance

- Check for proper installation.
- Check the timing cover gasket for damage or improper installation.

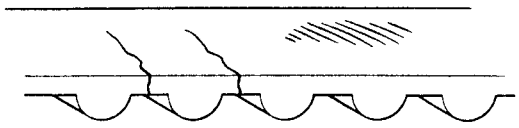


(b) If the belt teeth are cracked or damaged, check to see whether the camshaft, water pump, or oil pump is locked.

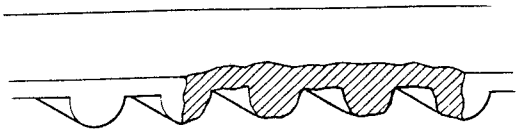




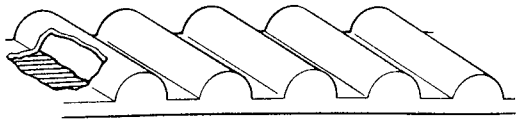
(c) If there is noticeable belt wear, or cracks on the belt face, check to see whether the idler pulley is damaged.



(d) If there is wear or damage on only one side of the belt, check the belt guide and the alignment of each pulley.

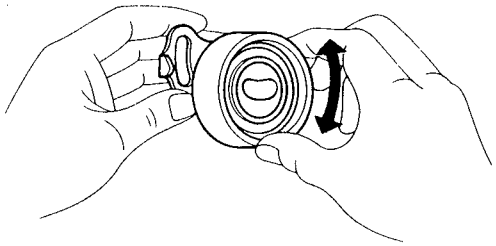


(e) If there is noticeable wear on the belt teeth, check the timing cover gasket for damage or improper installation. Check for foreign material adhering to the pulley teeth.



② INSPECT IDLER PULLEYS

Check the smoothness of rotation of the timing belt idler pulleys. If necessary, replace the idler pulleys.



③ INSPECT TENSION SPRING

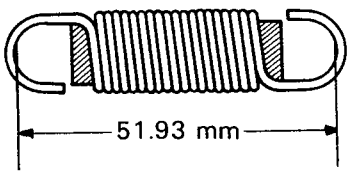
(a) Check the free length of the spring.

Free length: 51.93 mm (2.0445 in.)

(b) Check the tension of the spring at the specified installed length.

Installed tension: 4.3 kg (9.5 lb, 42 N) at 63 mm (2.48 in.)

If not as specified, replace the spring.



① TEMPORARILY INSTALL NO. 1 IDLER PULLEY

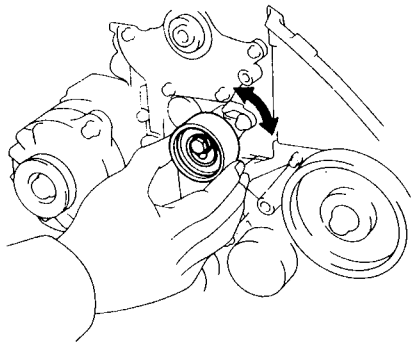
(a) Place the idler pulley on the cylinder head and finger-tighten the pulley bolt, but not so tight that the pulley cannot be turned.

(b) Install and torque the pulley guide bolt.

Torque: 75 kg-cm (65 in.-lb., 7.4 N·m)

(c) Check that the idler pulley bracket can be moved to the left and right by hand.

② INSTALL CAMSHAFT TIMING PULLEY



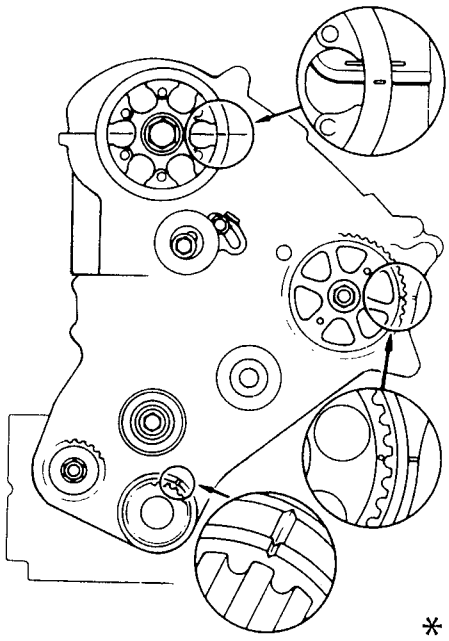
③ SET TIMING AND DRIVE PULLEYS

(a) Align the alignment mark of the camshaft timing pulley with the top end of the cylinder head.

(b) Align the alignment marks of the crankshaft timing pulley and oil pump.

CAUTION: When you turn the crankshaft or camshaft, the valves will hit against the pistons, so turn them slowly and carefully.

(c) Align the alignment marks of the injection pump drive pulley and water pump pulley.



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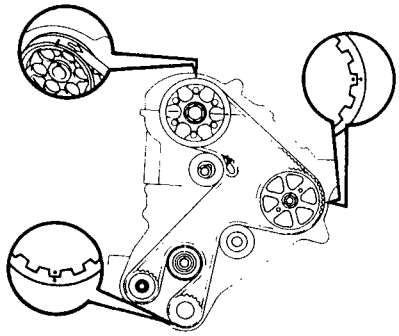
④ INSTALL TIMING BELT

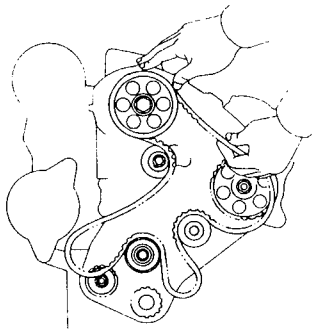
HINT: The engine should be cold.

NOTES:

- **If the timing belt will be reused, align the points marked during removal and install the timing belt with the arrow pointing in the direction of crankshaft rotation.**
- **Install the new belt so the numbers and letters printed on it can be read from the rear end of the engine.**

(a) Place the timing belt on the camshaft timing pulley.



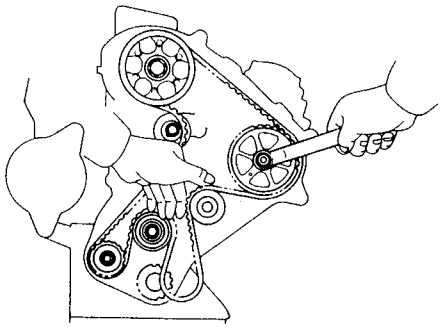


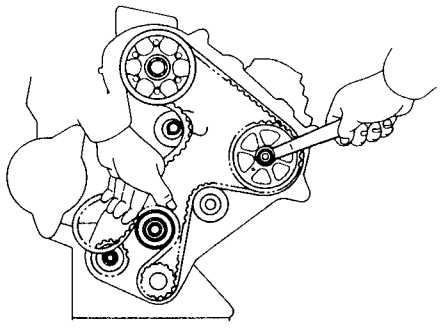
(b) Place the timing belt on the pump drive pulley while holding the pulley stationary with a wrench.

CAUTION: Be sure the timing belt is securely meshed and not loose.

(c) Place the timing belt on the water pump pulley and crankshaft timing pulley.

CAUTION: Be sure the timing belt is securely meshed and not loose.





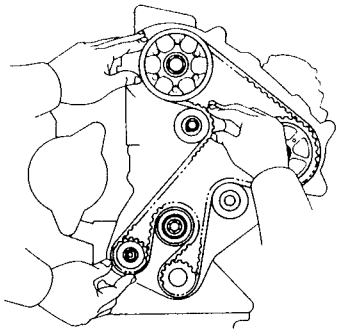
(d) Place the timing belt on the No. 2 idler pulley and oil pump drive pulley.

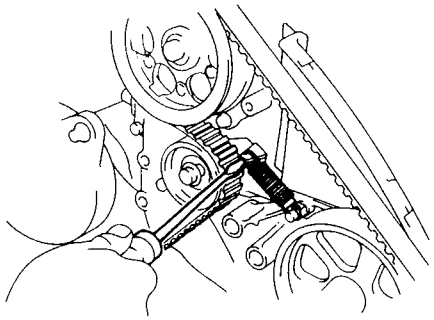
CAUTION: Be sure the belt is not twisted or too tight.

(e) Using a screwdriver, install the tension spring.

CAUTION:

- **Do not pinch the tension spring with pliers .**
- **Loosen the No. 1 idler pulley bolt to just enough so that the idle pulley is moved slightly by the tension spring.**





⑤ CHECK VALVE TIMING

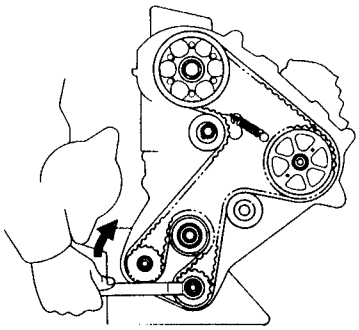
(a) Temporarily install the crankshaft pulley bolt.

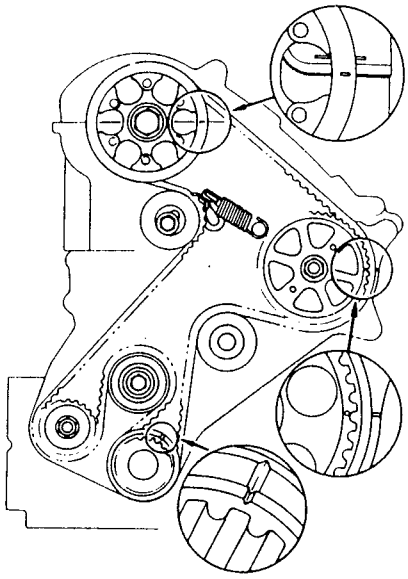
(b) Turn the crankshaft two revolutions to where the alignment mark of the camshaft pulley and the upper surface of the cylinder are again aligned.

CAUTION: Always turn the crankshaft clockwise. If turned counterclockwise, the belt teeth may become unmeshed, causing the belt tension to change.

(c) After turning the crankshaft, insure that each pulley aligns with the marks as shown. If the marks do not align, repeat the above procedure from Step ③ .

(d) Remove the crankshaft pulley bolt.





⑥ TORQUE NO. 1 IDLER PULLEY

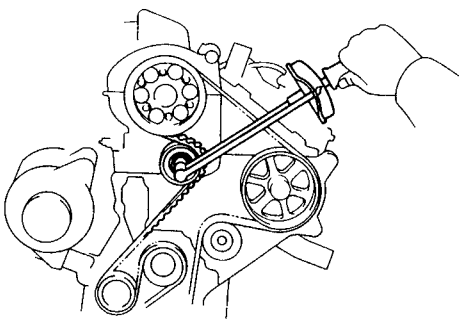
Torque: 375 kg-cm (27 ft-lb, 37 N·m)

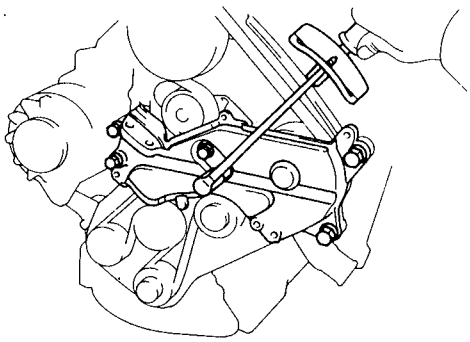
CAUTION: While tightening the pulley bolt, be sure not to move the idler pulley bracket.

⑦ INSTALL ENGINE MOUNTING BRACKET

Torque: 14 mm bolt head: 375 kg-cm (27 ft-lb, 37 N·m)

17 mm bolt head: 650 kg-cm (47 ft-lb, 64 N·m)





⑧ INSTALL BELT GUIDE AND NO. 1 TIMING BELT COVER

(a) Place the belt guide on the crankshaft timing pulley, facing the concave side outward.

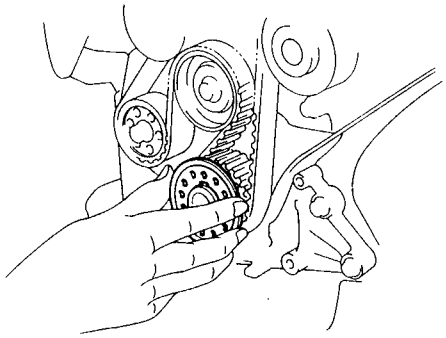
(b) Install the No. 1 timing belt cover and gasket with the five bolts.

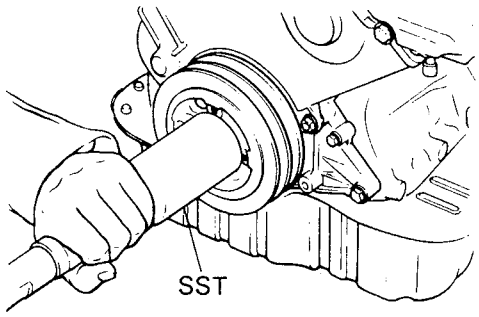
⑨ INSTALL CRANKSHAFT PULLEY

(a) Align the Woodruff key groove of the crankshaft pulley with the Woodruff key on the crankshaft.

(b) Using the SST and a hammer, drive in the crankshaft pulley.

SST 09214-60010





(c) Install the SST to the crankshaft pulley.

SST 09213-14010

(d) Using the SST to hold the crankshaft pulley, install and torque the pulley bolt with the plate washer.

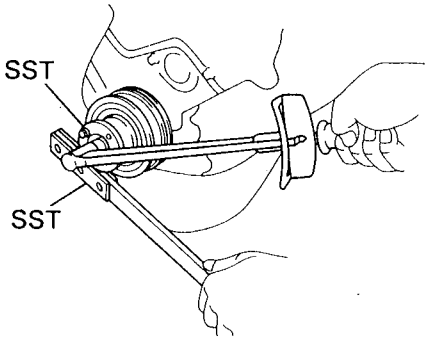
SST 09330-00020

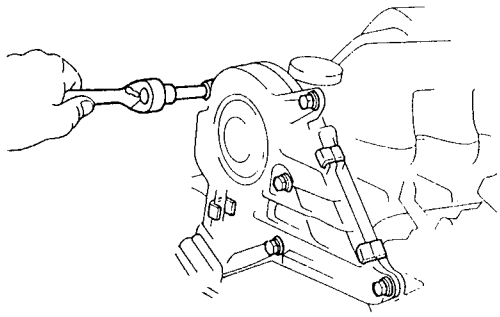
Torque: 1,000 kg-cm (72 ft-lb, 98 N·m)

⑩ INSTALL FOUR GLOW PLUGS

⑪ INSTALL NO. 2 TIMING BELT COVER

Install the No. 2 timing belt cover and gasket with the three clips and five bolts.





⑫ INSTALL AND ADJUST DRIVE BELT

Drive belt deflection at 10 kg (22.1 lb, 98 N)

New belt: 5 – 6 mm (0.20 – 0.24 in.) **Used belt: 6 – 7 mm (0.24 – 0.28 in.)**

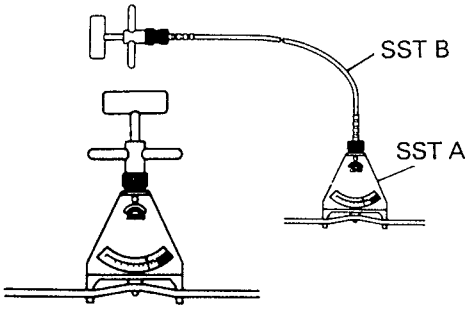
Reference

Using the SST, check the drive belt tension.

SST A: 09216-00020

SST B: 09216-00030

New belt: 45 – 55 kg Used belt: 20 – 35 kg



NOTES:

- **"New belt" refers to a brand-new belt which has never before been used.**
- **"Used belt" refers to a belt which has been used on a running engine for 5 minutes or more.**
- **After installing the drive belt, check that it fits properly in the ribbed grooves.**
- **Check by hand to confirm that the belt has not slipped out of the grooves on the bottom of the crankshaft pulley.**
- **After installing the belt, run the engine for about 5 minutes and then recheck the belt tension.**

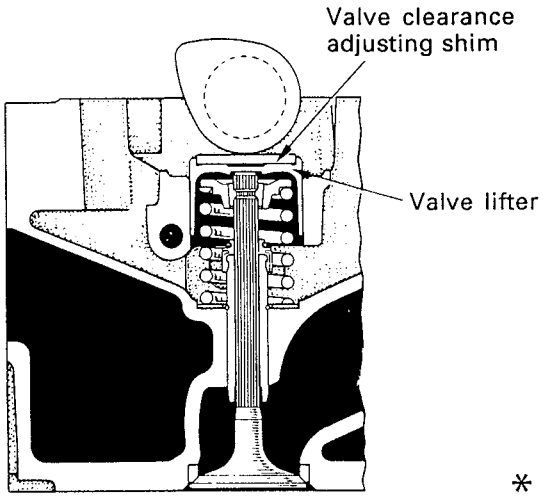
CORRECT WRONG WRONG

3. VALVE TRAIN

① An overhead camshaft (OHC) type valve system, which is driven by a timing belt, is used.

② The adoption of a direct-driven type valve mechanism (i.e., one without rocker arms) insures follow-up at high engine rpm.

③ The adjusting shim is located on the upper surface of the valve lifter so that valve clearance can be adjusted without removal of the camshaft.



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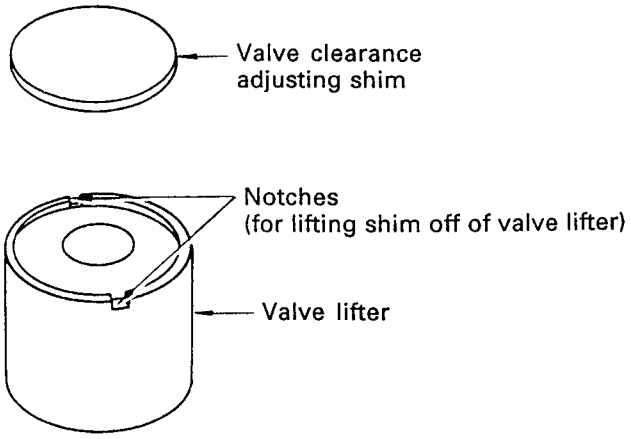
VALVE LIFTERS & VALVE ADJUSTING SHIMS

① The valve lifters are provided with two notches to ease shim replacement.

② There are 49 sizes of shims increasing in size from 2.20 mm to 3.40 mm, in increments of 0.025 mm. However, supply parts come in 25 sizes, increasing in increment of 0.050 mm.



INSPECTION AND ADJUSTMENT OF VALVE CLEARANCE

Valve clearance can be adjusted without removing the camshaft. This is done by simply changing the size of the shim with an SST as explained below:

① REMOVE CYLINDER HEAD COVER

② MEASURE VALVE CLEARANCE

(a) Set the No. 1 cylinder to TDC/compression.

- Turn the crankshaft pulley and align its groove with the timing pointer on the oil pump.
- Check that the valve lifters on the No. 1 cylinder are loose and valve lifters on the No. 4 are tight.

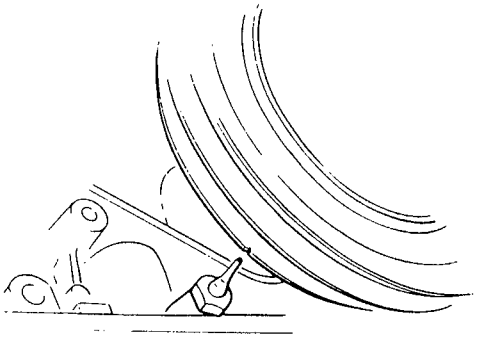
If not, turn the crankshaft one complete revolution.

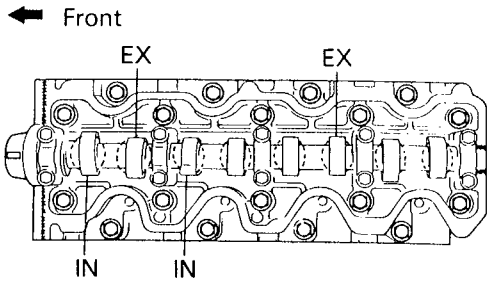
(b) Measure the clearance of half of the valves.

- Measure only those valves indicated in the figure.
- Record the measurements which are out of specification. They will be used later to determine the required replacement shims.

Valve clearance (cold):

Intake	**0.20 – 0.30 mm (0.008 – 0.012 in.)**
Exhaust	**0.25 – 0.35 mm (0.010 – 0.014 in.)**





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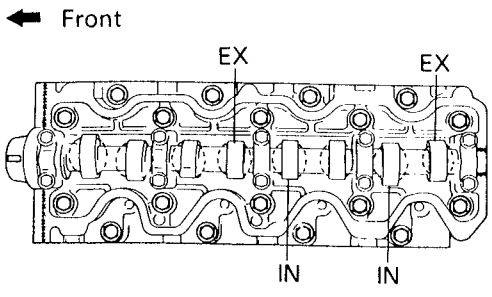
(c) Turn the crankshaft pulley one revolution and measure the other valves.

- Turn the crankshaft pulley one revolution and align its groove with the timing pointer on the oil pump.
- Measure only the valves indicated in the figure.



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③ ADJUST VALVE CLEARANCE

NOTE: Valve clearance is adjusted one cylinder at a time.

(a) Turn the crankshaft pulley to position the lobe of the intake camshaft upward.

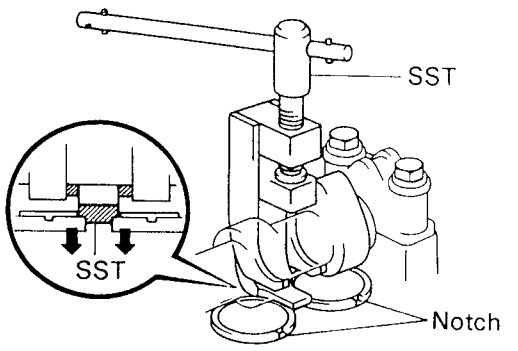
(b) Position the notch of the lifter so that it is accessible with a small screwdriver.

(c) Place the SST between the two cams and turn the handle to press down the valve lifters.

SST 09248-64010

NOTE: Make sure the SST is installed so that it presses evenly on both lifters. The SST can be inserted more easily from the injection nozzle side.

(d) Using a small screwdriver and magnet, remove the shims.



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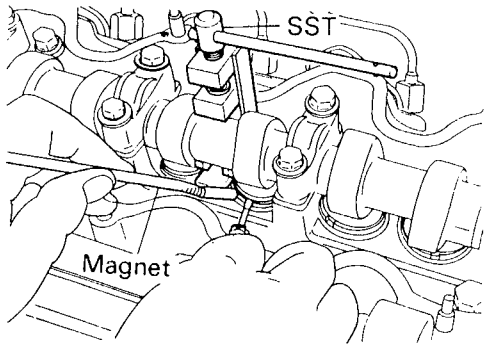

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(e) Determine the replacement shim size using the following formulas and charts.

- Using a micrometer, measure the thickness of the shim that was removed.
- Calculate the thickness of a new shim so that the valve clearance comes within the specified value.

T ..... Thickness of shim used

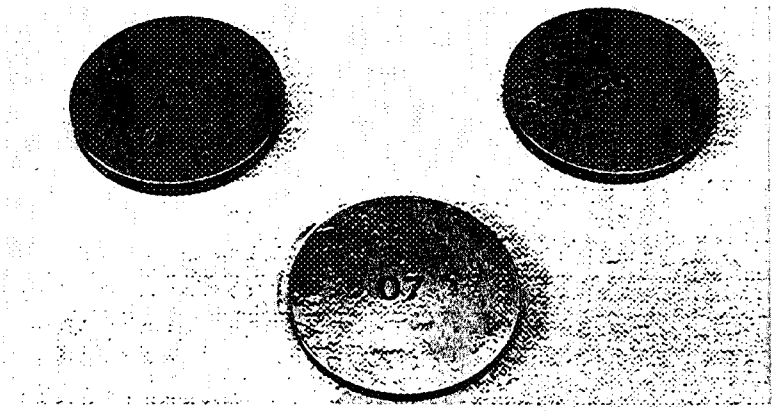
A ..... Valve clearance measured

Intake side: New shim thickness = T + [A – 0.25 mm (0.0098 in.)]

Exhaust side: New shim thickness = T + [A – 0.30 mm (0.0118 in.)]

- Select a shim with a thickness that is as close as possible to the valve clearance calculated.

NOTE: Shims are available in 25 sizes, in increments of 0.050 mm (0.0020 in.), from 2.200 mm (0.0866 in.) to 3.400 mm (0.1339 in.). Thickness is stamped on the new shims.



ADJUSTING SHIM SELECTION CHART

Intake Shims

Installed Shim Thickness (mm)

Measured Clearance (mm)	2.200	2.225	2.250	2.275	2.300	2.325	2.350	2.375	2.400	2.425	2.450	2.475	2.500	2.525	2.550	2.575	2.600	2.625	2.650	2.675	2.700	2.725	2.750	2.775	2.800	2.825	2.850	2.875	2.900	2.925	2.950	2.975	3.000	3.025	3.050	3.075	3.100	3.125	3.150	3.175	3.200	3.225	3.250	3.275	3.300	3.325	3.350	3.375	3.400
0.000-0.025									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	37	37	39	39
0.026-0.050								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	37	37	39	39	41
0.051-0.075							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	37	37	39	39	41	41
0.076-0.100						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	37	37	39	39	41	41	43
0.101-0.125					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	37	37	39	39	41	41	43	43
0.126-0.150				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	37	37	39	39	41	41	43	43	45
0.151-0.175			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	37	37	39	39	41	41	43	43	45	45
0.176-0.199		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	37	37	39	39	41	41	43	43	45	45	47
0.200-0.300																																																	
0.301-0.325	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	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49	
0.326-0.350	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	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49		
0.351-0.375	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	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49			
0.376-0.400	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	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49				
0.401-0.425	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	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49					
0.426-0.450	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	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49						
0.451-0.475	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	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49							
0.476-0.500	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	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49								
0.501-0.525	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	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49									
0.526-0.550	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49										
0.551-0.575	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49											
0.576-0.600	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49												
0.601-0.625	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49													
0.626-0.650	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49														
0.651-0.675	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49															
0.676-0.700	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																
0.701-0.725	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																	
0.726-0.750	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																		
0.751-0.775	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																			
0.776-0.800	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																				
0.801-0.825	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																					
0.826-0.850	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																						
0.851-0.875	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																							
0.876-0.900	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																								
0.901-0.925	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																									
0.926-0.950	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																										
0.951-0.975	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																											
0.976-1.000	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																												
1.001-1.025	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																													
1.026-1.050	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																														
1.051-1.075	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																															
1.076-1.100	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																																
1.101-1.125	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																																	
1.126-1.150	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																																		
1.151-1.175	37	39	39	41	41	43	43	45	45	47	47	49	49	49																																			
1.176-1.200	39	39	41	41	43	43	45	45	47	47	49	49	49																																				
1.201-1.225	39	41	41	43	43	45	45	47	47	49	49	49																																					
1.226-1.250	41	41	43	43	45	45	47	47	49	49	49																																						
1.251-1.275	41	43	43	45	45	47	47	49	49	49																																							
1.276-1.300	43	43	45	45	47	47	49	49	49																																								
1.301-1.325	43	45	45	47	47	49	49	49																																									
1.326-1.350	45	45	47	47	49	49	49																																										
1.351-1.375	45	47	47	49	49	49																																											
1.376-1.400	47	47	49	49	49																																												
1.401-1.425	47	49	49	49																																													
1.426-1.450	49	49	49																																														
1.451-1.475	49	49																																															
1.476-1.500	49																																																

Intake valve clearance (cold):
0.20 – 0.30 mm (0.008 – 0.012 in.)

Example: 2.700 mm (0.1063 in.) shim installed
Measured clearance is 0.350 mm (0.0138 in.)
Replace 2.700 mm (0.1063 in.) shim with shim No. 25.

New Shim Thickness

Shim No.	Thickness mm (in.)	Shim No.	Thickness mm (in.)
01	2.20 (0.0866)	27	2.85 (0.1122)
03	2.25 (0.0886)	29	2.90 (0.1142)
05	2.30 (0.0906)	31	2.95 (0.1161)
07	2.35 (0.0925)	33	3.00 (0.1181)
09	2.40 (0.0945)	35	3.05 (0.1201)
11	2.45 (0.0965)	37	3.10 (0.1220)
13	2.50 (0.0984)	39	3.15 (0.1240)
15	2.55 (0.1004)	41	3.20 (0.1260)
17	2.60 (0.1024)	43	3.25 (0.1280)
19	2.65 (0.1043)	45	3.30 (0.1299)
21	2.70 (0.1063)	47	3.35 (0.1319)
23	2.75 (0.1083)	49	3.40 (0.1339)
25	2.80 (0.1102)		

ADJUSTING SHIM SELECTION CHART

Exhaust Shims

Installed Shim Thickness (mm)

Measured Clearance (mm)	2.200	2.225	2.250	2.275	2.300	2.325	2.350	2.375	2.400	2.425	2.450	2.475	2.500	2.525	2.550	2.575	2.600	2.625	2.650	2.675	2.700	2.725	2.750	2.775	2.800
0.000-0.025											01	01	01	03	03	05	05	07	07	09	09	11	11	13	13
0.026-0.050										01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15
0.051-0.075									01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15
0.076-0.100								01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17
0.101-0.125							01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17
0.126-0.150						01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19
0.151-0.175					01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19
0.176-0.200				01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21
0.201-0.225			01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21
0.226-0.249		01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23
0.250-0.350																									
0.351-0.375	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
0.376-0.400	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
0.401-0.425	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
0.426-0.450	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
0.451-0.475	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
0.476-0.500	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
0.501-0.525	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
0.526-0.550	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
0.551-0.575	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
0.576-0.600	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37
0.601-0.625	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37
0.626-0.650	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39
0.651-0.675	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39
0.676-0.700	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41
0.701-0.725	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41
0.726-0.750	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43
0.751-0.775	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43
0.776-0.800	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45
0.801-0.825	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45
0.826-0.850	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47
0.851-0.875	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47
0.876-0.900	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49
0.901-0.925	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49
0.926-0.950	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49
0.951-0.975	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49	
0.976-1.000	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49		
1.001-1.025	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49			
1.026-1.050	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49				
1.051-1.075	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49					
1.076-1.100	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49						
1.101-1.125	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49							
1.126-1.150	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49								
1.151-1.175	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49									
1.176-1.200	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49										
1.201-1.225	37	39	39	41	41	43	43	45	45	47	47	49	49	49											
1.226-1.250	39	39	41	41	43	43	45	45	47	47	49	49	49												
1.251-1.275	39	41	41	43	43	45	45	47	47	49	49	49													
1.276-1.300	41	41	43	43	45	45	47	47	49	49	49														
1.301-1.325	41	43	43	45	45	47	47	49	49	49															
1.326-1.350	43	43	45	45	47	47	49	49	49																
1.351-1.375	43	45	45	47	47	49	49	49																	
1.376-1.400	45	45	47	47	49	49	49																		
1.401-1.425	45	47	47	49	49	49																			
1.426-1.450	47	47	49	49	49																				
1.451-1.475	47	49	49	49																					
1.476-1.500	49	49	49																						
1.501-1.525	49	49																							
1.526-1.550	49																								

Measured Clearance (mm)	2.825	2.850	2.875	2.900	2.925	2.950	2.975	3.000	3.025	3.050	3.075	3.100	3.125	3.150	3.175	3.200	3.225	3.250	3.275	3.300	3.325	3.350	3.375	3.400
0.000-0.025	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37
0.026-0.050	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39
0.051-0.075	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39
0.076-0.100	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41
0.101-0.125	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41
0.126-0.150	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43
0.151-0.175	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43
0.176-0.200	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45
0.201-0.225	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45
0.226-0.249	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47
0.250-0.350																								
0.351-0.375	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49	
0.376-0.400	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49		
0.401-0.425	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49			
0.426-0.450	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49				
0.451-0.475	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49					
0.476-0.500	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49						
0.501-0.525	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49							
0.526-0.550	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49								
0.551-0.575	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49									
0.576-0.600	37	39	39	41	41	43	43	45	45	47	47	49	49	49										
0.601-0.625	39	39	41	41	43	43	45	45	47	47	49	49	49											
0.626-0.650	39	41	41	43	43	45	45	47	47	49	49	49												
0.651-0.675	41	41	43	43	45	45	47	47	49	49	49													
0.676-0.700	41	43	43	45	45	47	47	49	49	49														
0.701-0.725	43	43	45	45	47	47	49	49	49															
0.726-0.750	43	45	45	47	47	49	49	49																
0.751-0.775	45	45	47	47	49	49	49																	
0.776-0.800	45	47	47	49	49	49																		
0.801-0.825	47	47	49	49	49																			
0.826-0.850	47	49	49	49																				
0.851-0.875	49	49	49																					
0.876-0.900	49	49																						
0.901-0.925	49																							

Exhaust valve clearance (cold):

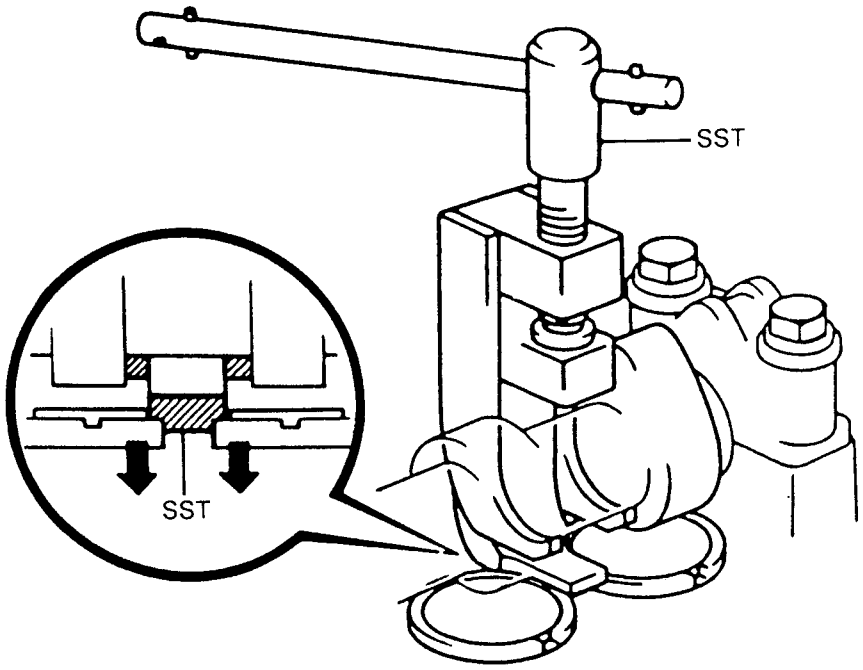
0.25 – 0.35 mm (0.010 – 0.014 in.)

Example: 2.700 mm (0.1063 in.) shim installed
Measured clearance is 0.450 mm (0.0177 in.)
Replace 2.700 mm (0.1063 in.) shim with shim No. 27.

New Shim Thickness

Shim No.	Thickness mm (in.)	Shim No.	Thickness mm (in.)
01	2.20 (0.0866)	27	2.85 (0.1122)
03	2.25 (0.0886)	29	2.90 (0.1142)
05	2.30 (0.0906)	31	2.95 (0.1161)
07	2.35 (0.0925)	33	3.00 (0.1181)
09	2.40 (0.0945)	35	3.05 (0.1201)
11	2.45 (0.0965)	37	3.10 (0.1220)
13	2.50 (0.0984)	39	3.15 (0.1240)
15	2.55 (0.1004)	41	3.20 (0.1260)
17	2.60 (0.1024)	43	3.25 (0.1280)
19	2.65 (0.1043)	45	3.30 (0.1299)
21	2.70 (0.1063)	47	3.35 (0.1319)
23	2.75 (0.1083)	49	3.40 (0.1339)
25	2.80 (0.1102)		

(f) Remove the SST.
(g) Recheck the valve clearance.
(h) Adjust the valve clearance of the remaining cylinders as required.



④ INSTALL CYLINDER HEAD COVER

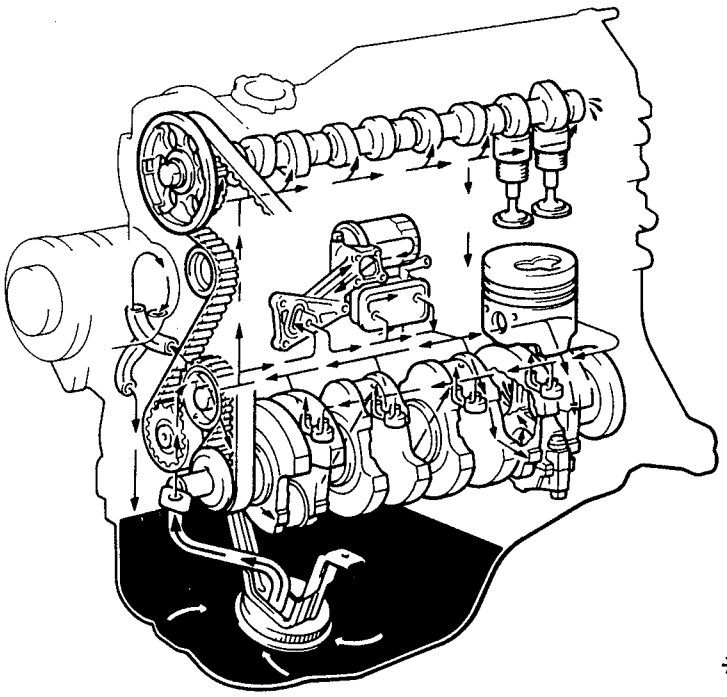
LUBRICATION SYSTEM

1. GENERAL

① On most vehicle models mounting a C-series engine, an oil cooler has been adopted as standard equipment to increase the cooling efficiency.

② The 2C engine is provided with oil nozzles to cool the inside of the pistons, allowing them to withstand the extra heat load.

③ The oil pump capacity of the 2C engine has been made larger than that of the 1C engine due to the adoption of the oil nozzles for piston cooling.



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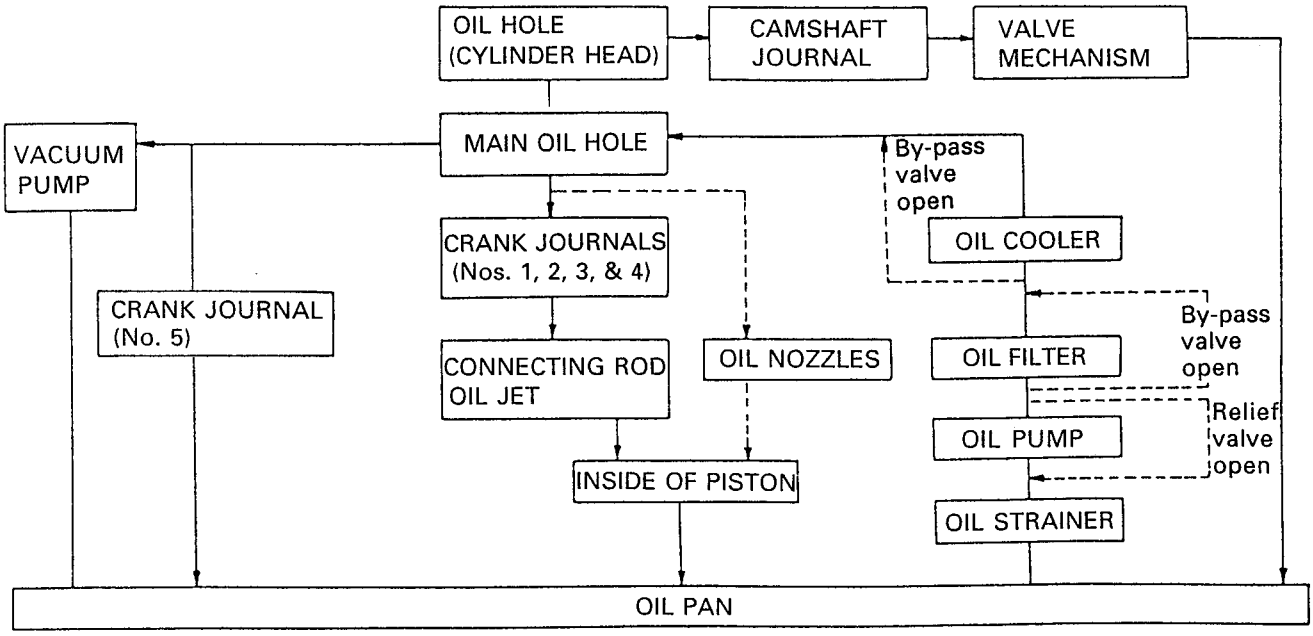
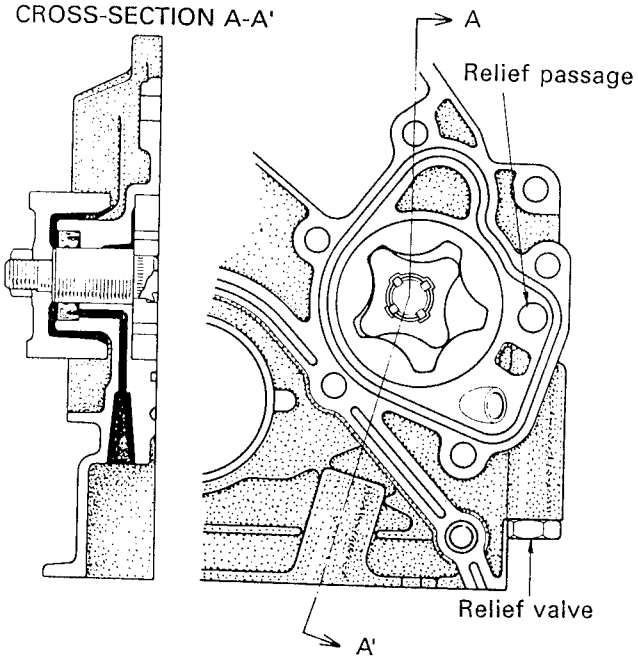


2. OIL PUMP

① A trochoidal type oil pump driven by the timing belt has been adopted.
② On the 2C engine, the thickness of the trochoidal pump rotors is 16 mm.
③ A rubber ring is used for sealing off the oil pump from the pump body.



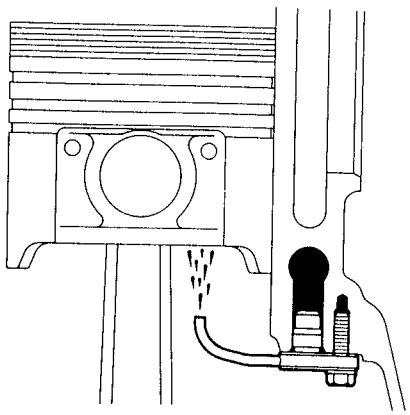
SPECIFICATIONS

PUMP SPEED	DISCHARGE VOLUME	DISCHARGE PRESSURE
600 rpm	5.5 ℓ /min	1.5 kg/cm²
3000 rpm	34.5 ℓ /min	3.0 kg/cm²

RELIEF VALVE OPENING PRESSURE	5.0 ± 0.5 kg/cm²

3. OIL NOZZLES

① To cool the inside of the pistons, the cylinder block of the 2C engine has been provided with oil nozzles. Part of the oil flowing from the main oil hole passes through the check valve and is squirted under pressure from the oil nozzles to cool the inside of the pistons.



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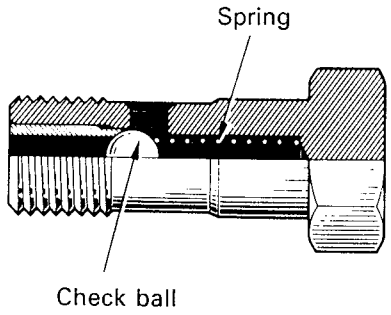
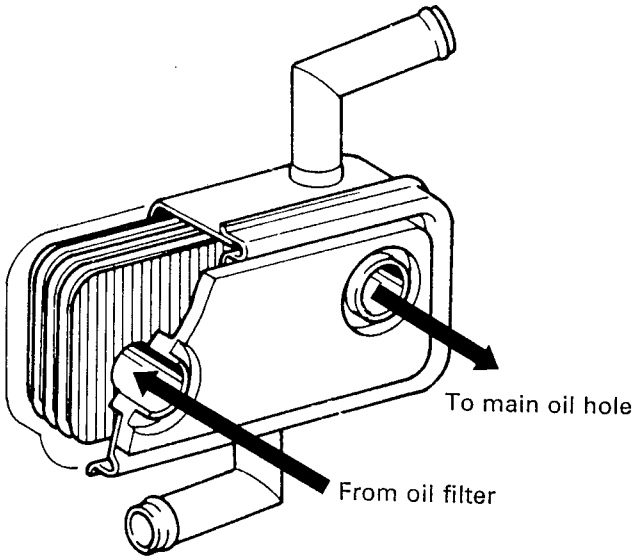
② A spring and check ball are built to the check valve and act to cut off the supply of oil to the oil nozzles should the oil pressure drop below 1.4 ± 0.3 kg/cm². This is to prevent the oil pressure in the lubrication circuitry from dropping to low.



CHECK VALVE OPENING PRESSURE	1.4 ± 0.3 kg/cm²

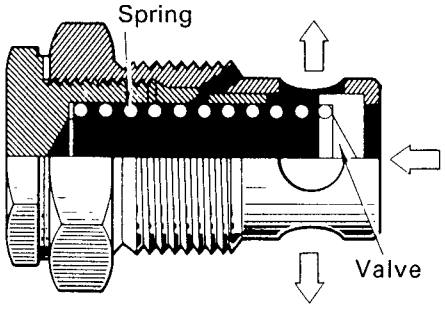
4. OIL COOLER

① A water-cooled type oil cooler is used for positive dissipation of the heat from the engine oil to reduce the increased heat load.



OIL COOLER

② A by-pass valve is provided at the entrance of the oil cooler. This valve opens whenever the oil pressure rises above a certain level in cold weather, and diverts the oil around the oil cooler, sending it directly to the main oil hole.



BY-PASS VALVE (CLOSED)

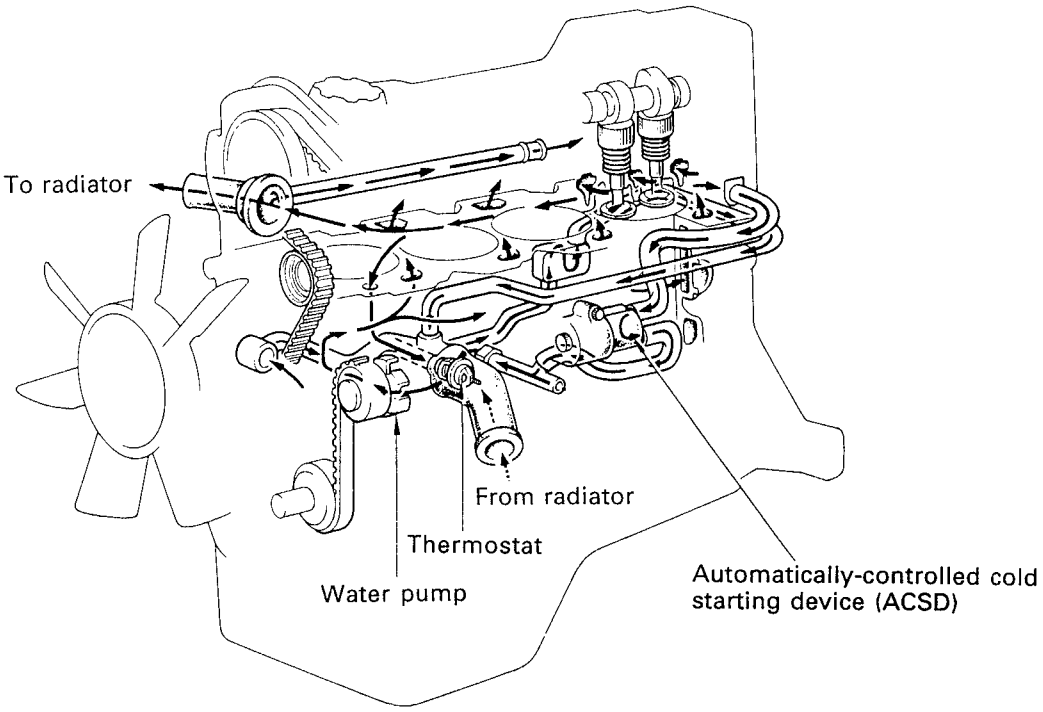
SPECIFICATIONS

OIL COOLER	RADIATION CAPACITY	2050 Kcal/h
	OIL CAPACITY	0.05ℓ
BY-PASS VALVE	OPENING PRESSURE	1.5 ± 0.4 kg/cm²

COOLING SYSTEM

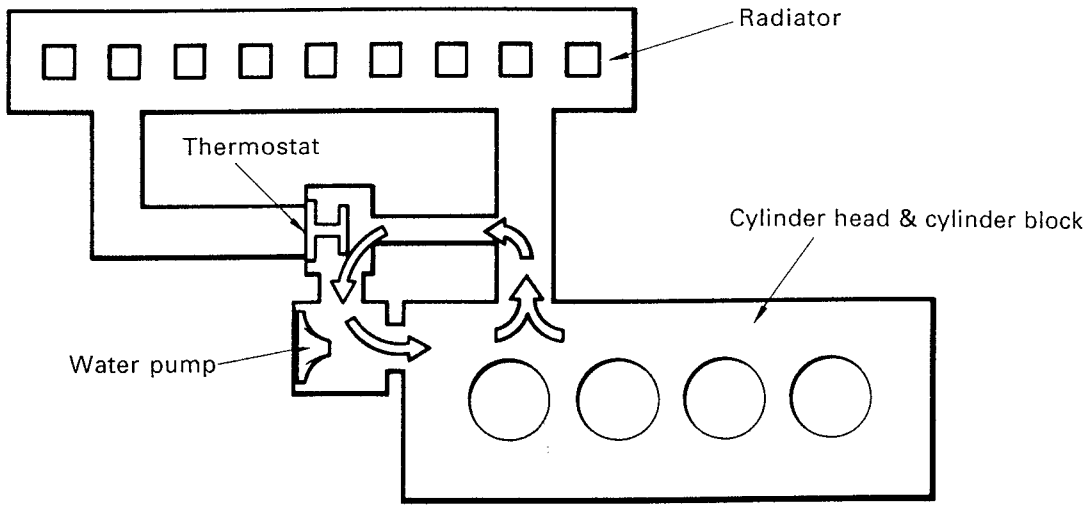
1. GENERAL

A forced-circulation, fully-pressurized cooling-system is used.
The thermostat with by-pass valve is located at the water pump suction side. This design prevents overshooting of the water temperature during warm-up because the thermo-wax is able to accurately sense the water temperature and regulate the valve opening according.



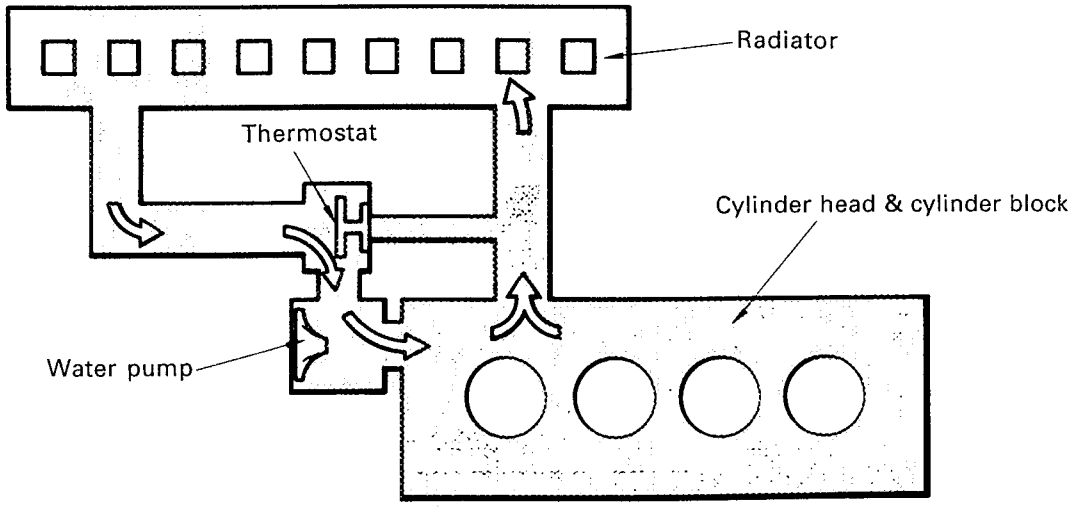
Coolant cold

When the engine coolant temperature is low, the thermostat is closed and the bypass valve is open. Coolant is pumped to the cylinder block and cylinder head by the water pump, then passes through the bypass circuit and returns to the water pump.



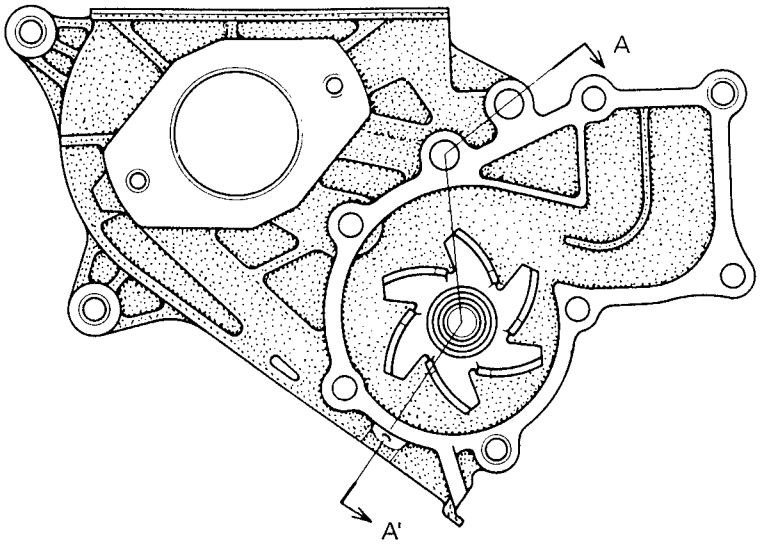
Coolant hot

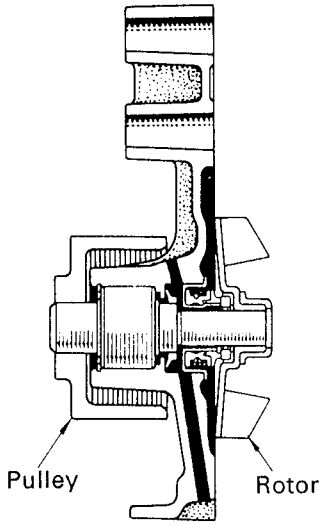
When the engine coolant temperature becomes high, the thermostat opens and the bypass valve closes. Heated coolant flows to the radiator where it is cooled. It then flows through the thermostat and back to the water pump.



2. WATER PUMP

The water pump body forms part of the timing belt case and is installed on the cylinder block. The pump pulley is driven by the back of the timing belt.

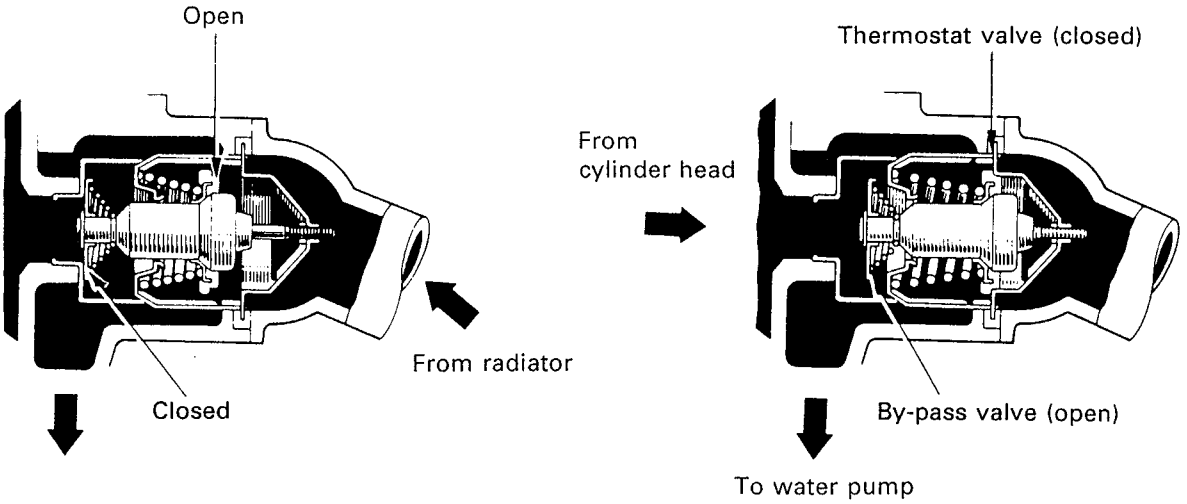




CROSS-SECTIONAL VIEW A-A'

3. THERMOSTAT

The thermostat is provided with a by-pass valve in addition to the thermostat valve. When the coolant is cold, the thermostat valve remains closed, and the by-pass valve opens, allowing coolant to circulate through the engine and heater unit, by-passing the radiator. When the coolant temperature rises, the thermostat valve opens while the by-pass valve closes off the by-pass port so that the coolant flows throught the radiator.



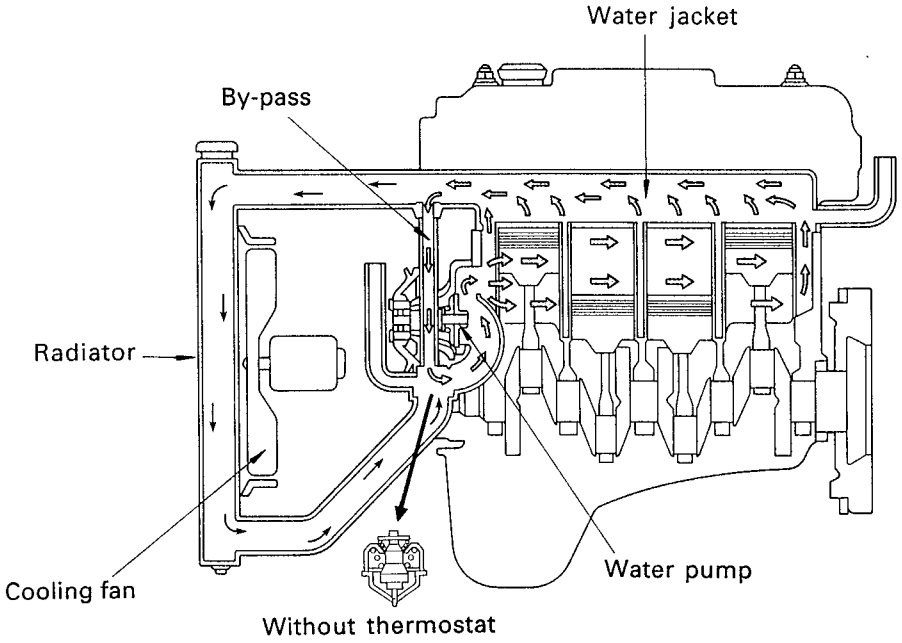
SPECIFICATIONS

VALVE OPENING TEMP.	82 ±2°C
VALVE CLOSING TEMP.	Below 77°C
VALVE LIFT (when fully open)	Above 8 mm

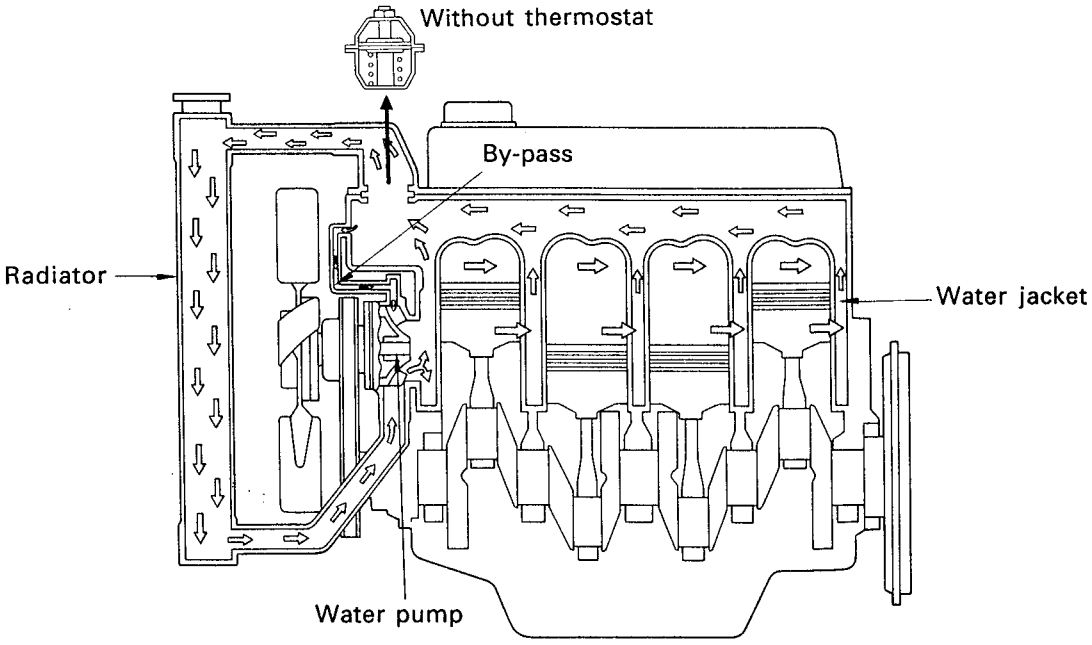
– NOTE –

An engine equipped with a thermostat with a built-in by-pass valve should not be run with the thermostat removed.

In engines with a by-pass valve in the by-pass circuit, the by-pass circuit is wider than in the type without a by-pass valve. If the engine is run with the thermostat with by-pass valve removed, most of the coolant will flow through the by-pass circuit, resulting in engine overheating. (This is because the radiator offers greater resistance to the flow of coolant than through the bypass circuit.)



THERMOSTAT IN WATER INLET TYPE (WITH BY-PASS VALVE)

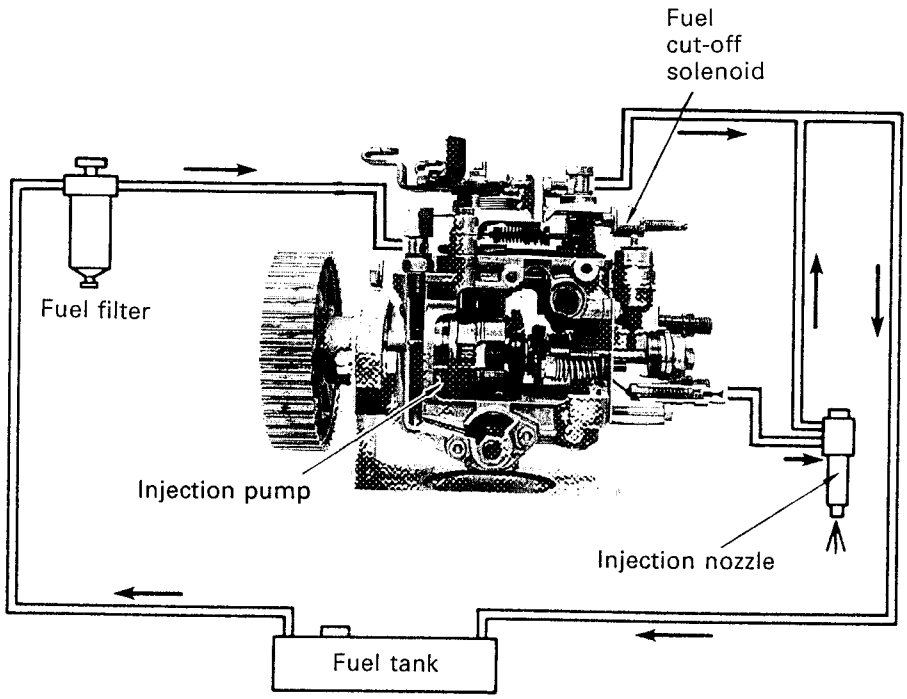


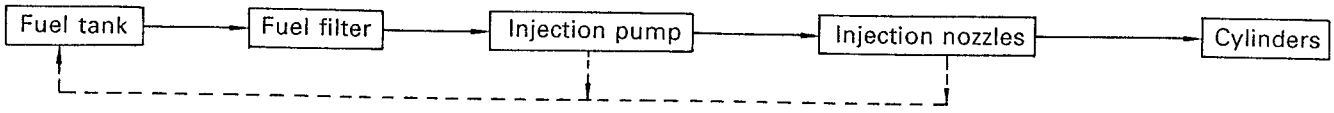
THERMOSTAT IN WATER OUTLET TYPE (WITHOUT BY-PASS VALVE)

FUEL SYSTEM

1. FUEL LINE

Fuel flow in the 2C engine is as follows:





2. FUEL FILTER AND SEDIMENTER

A simple-to-replace cartridge type fuel filter element, which fits into the water sedimenter, is used. A priming pump is incorporated into the fuel filter bracket to make it easier to bleed air from the fuel line. When replacing the fuel filter, be sure to remove the sedimenter switch assembly from the cartridge for re-use.

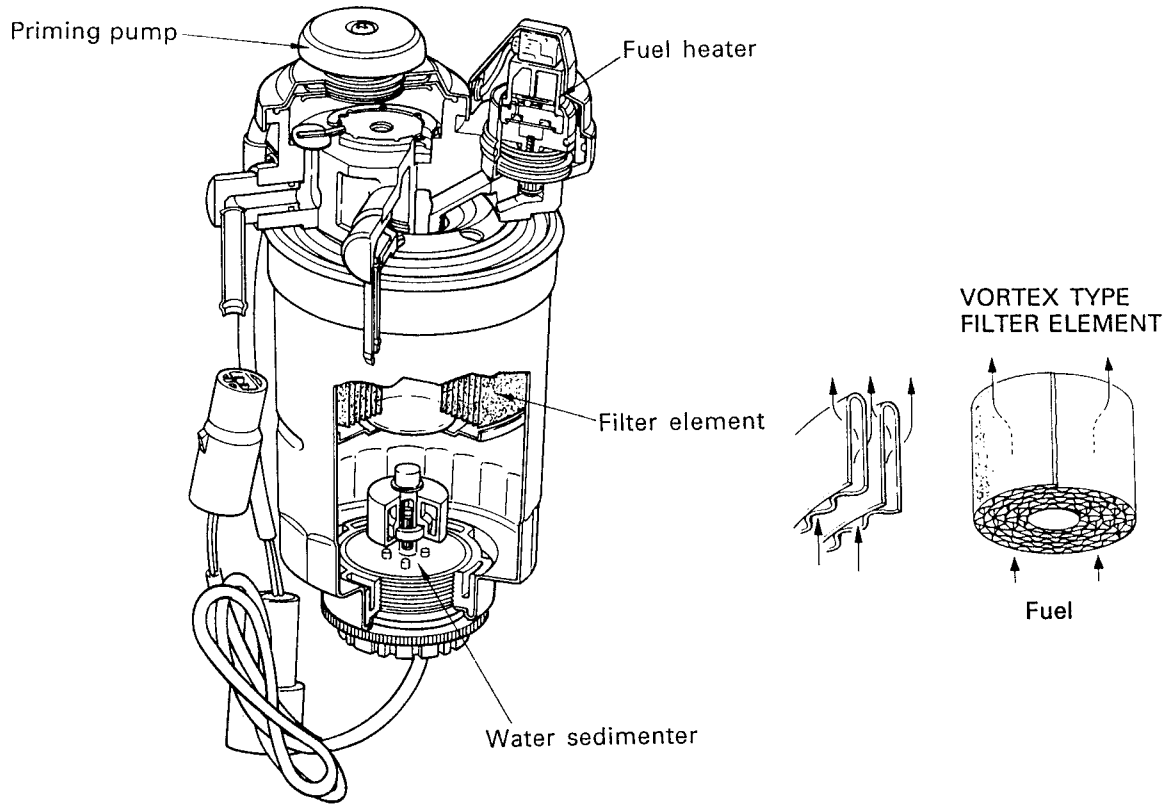
The capacity of the water sedimenter is 300 cc. When the volume of water of water reaches 100 cc, the switch will come on to activate the warning lamp and/or sound the warning buzzer.

The water can be drained by loosening the drain plug at the bottom of the sedimenter and pumping the priming pump by hand.

– NOTE –

Continuing to use the engine with the sedimenter too full of water will eventurally cause the injection pump and/or injection nozzles to stick.

A vortex type filter element has been used to enlarge the filtering area.

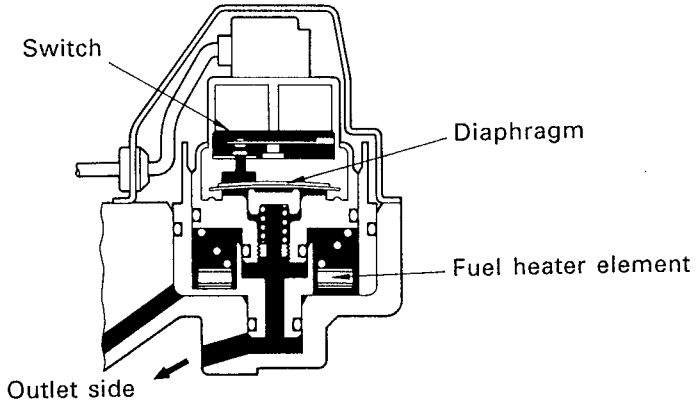


3. FUEL HEATER

The wax present in dissolved form in the diesel fuel will partially solidify in sub-zero (Celsius) weather, clogging the fuel filter. To prevent this, a fuel heater has been added to the fuel system.

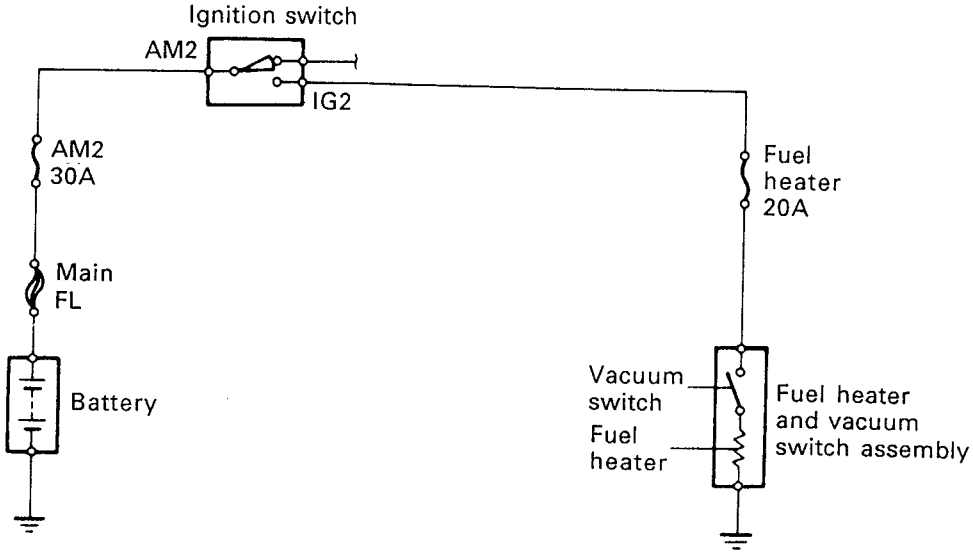
VACUUM SWITCH

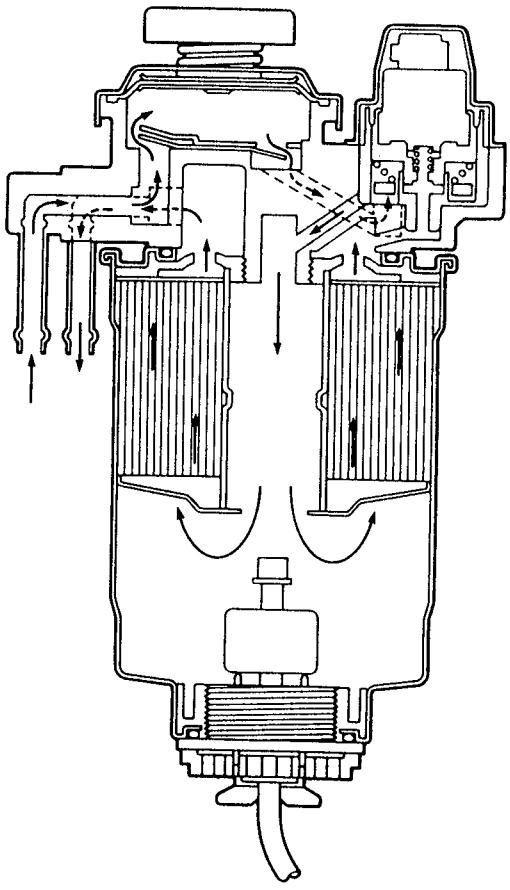
The vacuum switch is located on top of the fuel filter and senses differences in pressure between the inlet and outlet sides of the fuel filter.
If a difference in pressure develops that is higher than that specified, the diaphragm moves towards the outlet side, turning on the switch. This causes electric current to begin flowing through the fuel heater element.



OPERATION

When the temperature is low, the wax in the fuel will partially solidify, clogging the filter. This will cause a difference in pressure between the fuel at the inlet side and that at the outlet side. When this difference rises above 220 mmHg, the vacuum switch will go on, sending electrical current through the fuel heater element. This will melt the wax so that it does not clog the filter.
When the pressure difference drops below 205 mmHg, the vacuum switch goes off, halting the flow of current to the fuel heater.

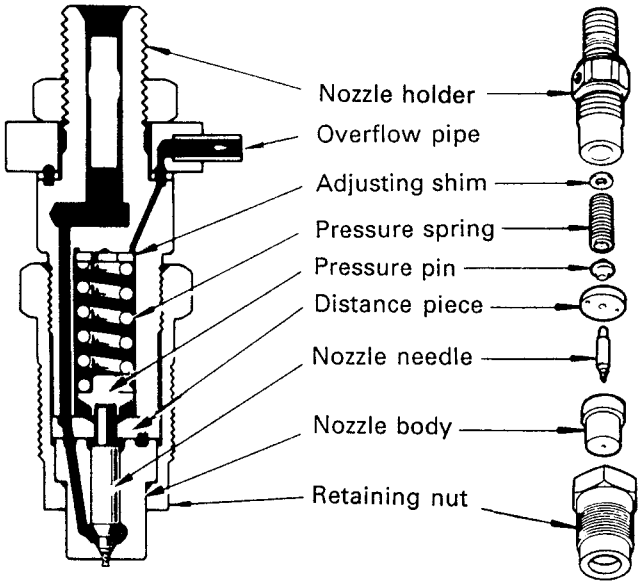




4. INJECTION NOZZLES

C-series engines use small, light-weight injection nozzles, one for each cylinder. The injection pressure is 150 kg/cm^2 (14,710 kPa), and the nozzles are of a type that more easily atomizes the fuel.

The injection pressure is adjusted by means of adjusting shims. There are 43 different thicknesses of shims, ranging from 0.90 mm (0.0035 in.) to 1.95 mm (0.0768 in.), increasing in increments of 0.025 mm (0.0010 in.). Each shim added increases the injection pressure by about 3.5 kg/cm^2 (343 kPa).



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REMOVAL OF INJECTION NOZZLE HOLDERS

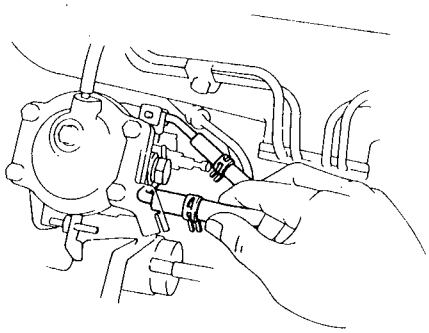
① DISCONNECT FUEL HOSES FROM INJECTION PUMP

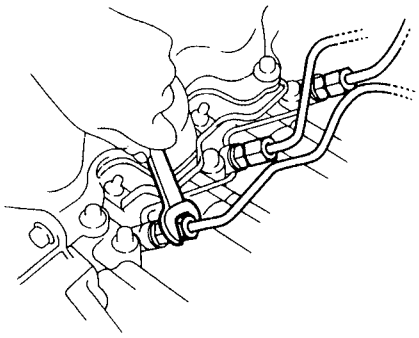
Loosen the clips and disconnect the fuel hoses between the injection pump and fuel pipes from the injection pump side.

② REMOVE INJECTION PIPES

(a) Remove the injection pipe clamps.

(b) Disconnect both ends of the injection pipes from the injection pump and injection holders.





③ REMOVE FUEL RETURN PIPE

(a) Disconnect the fuel hose from the return pipe.

(b) Remove the four lock nuts and return pipe with the four gaskets.

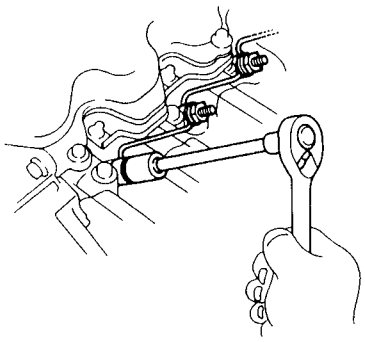
④ REMOVE INJECTION NOZZLE HOLDERS

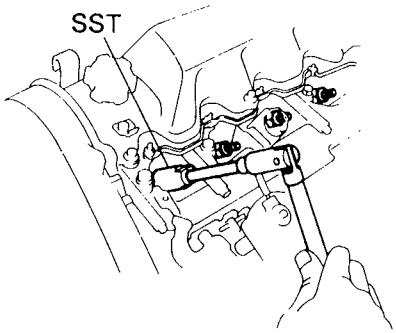
(a) Using the SST, remove the four injection nozzle holders.

SST 09268-64010

(b) Arrange the injection nozzle holders in order.

(c) Remove the nozzle seats and nozzle gaskets.





TEST OF INJECTION NOZZLE HOLDERS

① INJECTION PRESSURE TEST

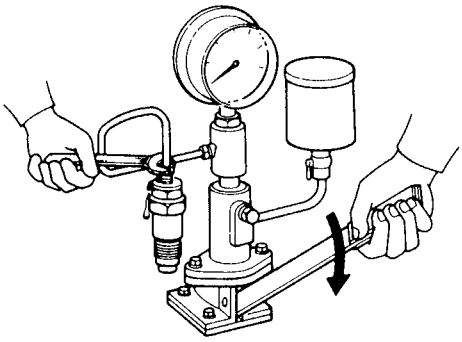
(a) Install the nozzle holder to the injection nozzle hand tester and bleed air from the union nut.

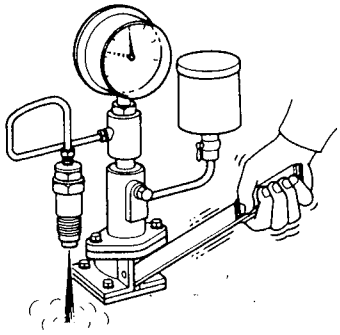
WARNING: Do not place your finger over the nozzle injection hole.

(b) Pump the tester handle few times as fast as possible to discharge the carbon from the injection hole.

(c) Pump the tester handle slowly and observe the pressure gauge.

(d) Read the pressure gauge just as the injection pressure begins to drop.



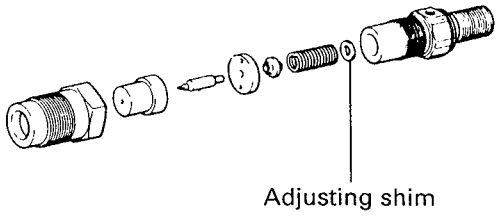


NOTE: The nozzle is operating properly if you can hear a swishing sound.

	Opening pressure kg/cm² (psi, kPa)
Reused nozzle	105-125 (1,493-1,778, 10,297-12,258)
New nozzle	115-125 (1,636-1,778, 11,278-12,258)

If the opening pressure is not within specification, disassemble the nozzle holder and change the shim on the top of the pressure spring.

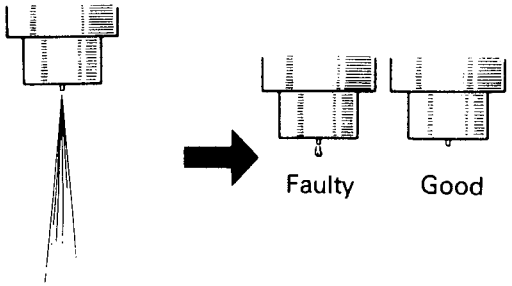
Adjusting shim thickness mm (in.)		
0.900 (0.0354)	1.275 (0.0502)	1.650 (0.0650)
0.925 (0.0364)	1.300 (0.0512)	1.675 (0.0659)
0.950 (0.0374)	1.325 (0.0522)	1.700 (0.0669)
0.975 (0.0384)	1.350 (0.0531)	1.725 (0.0679)
1.000 (0.0394)	1.375 (0.0541)	1.750 (0.0689)
1.025 (0.0404)	1.400 (0.0551)	1.775 (0.0699)
1.050 (0.0413)	1.425 (0.0561)	1.800 (0.0709)
1.075 (0.0423)	1.450 (0.0571)	1.825 (0.0719)
1.100 (0.0433)	1.475 (0.0581)	1.850 (0.0728)
1.125 (0.0443)	1.500 (0.0591)	1.875 (0.0738)
1.150 (0.0453)	1.525 (0.0600)	1.900 (0.0748)
1.175 (0.0463)	1.550 (0.0610)	1.925 (0.0758)
1.200 (0.0472)	1.575 (0.0620)	1.950 (0.0768)
1.225 (0.0482)	1.600 (0.0630)	
1.250 (0.0492)	1.625 (0.0640)	



NOTES:

- **Varying the adjusting shim thickness by 0.025 mm (0.0010 in.) changes the injection pressure by about 3.5 kg/cm^2 (50 psi, 343 kPa).**
- **Only one adjusting shim should be used.**
- **If adjusting the opening pressure, use the specification for a new nozzle.**

(e) There should be no dripping after injection.



② LEAKAGE TEST

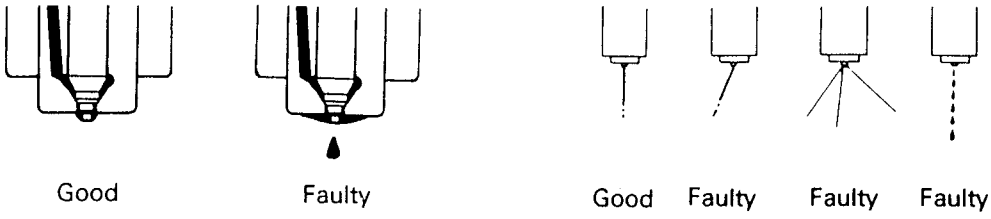
While maintaining the pressure at about 200 kg/cm^2 (2,845 psi, 19,613 kPa) below the opening pressure (adjust using the tester handle), check that there is no dripping for 10 seconds from the injection hole or around the retaining nut.

If the nozzle drips within 10 seconds, replace or clean and overhaul the nozzle assembly.

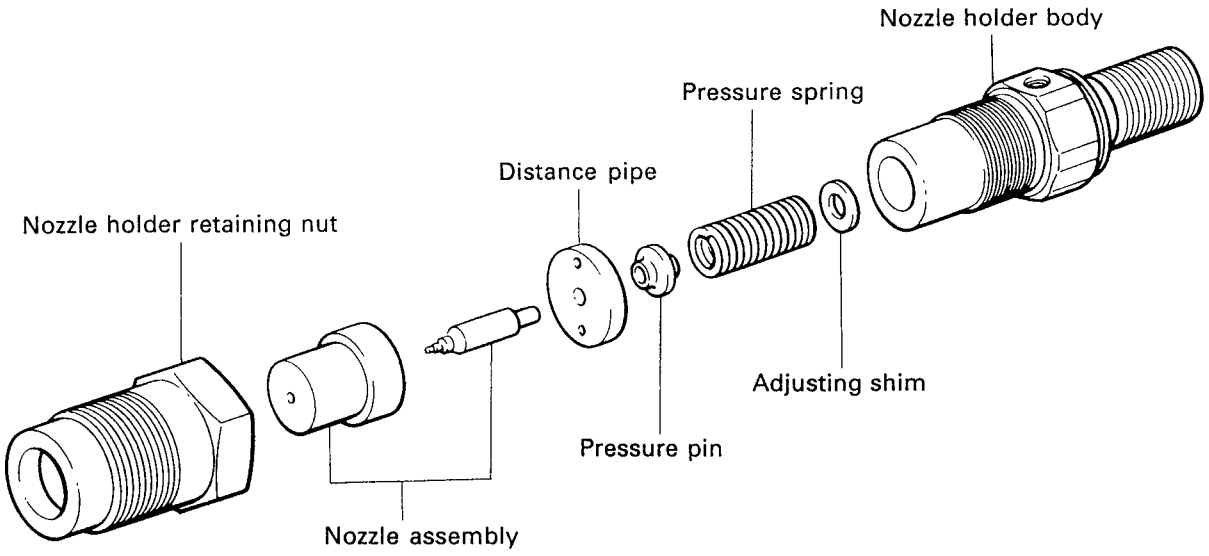
③ SPRAY PATTERN TEST

(a) The injection nozzle shudders at certain pumping speed between 15 – 60 times (old nozzle) or 30 – 60 times (new nozzle) per minute.

(b) Check the spray pattern while the nozzle is shuddering. If the spray pattern is not correct, the nozzle must be replaced or cleaned.



DISASSEMBLY, CLEANING, AND TESTING OF INJECTION NOZZLE HOLDER



① DISASSEMBLE INJECTION NOZZLE HOLDER

(a) Using the SST, unscrew the nozzle holder retaining nut.

SST 09168-64010

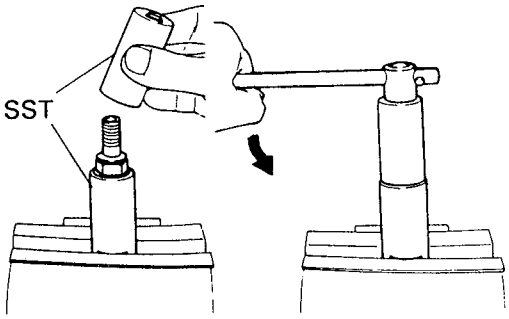
CAUTION: When disassembling the nozzle holder, be careful not to drop the inner parts.

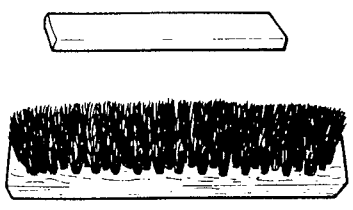
(b) Remove the pressure spring, shim, pressure pin, distance piece, and nozzle assembly.

② NOZZLE CLEANING

(a) Use a wooden stick and brass brush to wash the nozzles. Wash them in clean diesel fuel.

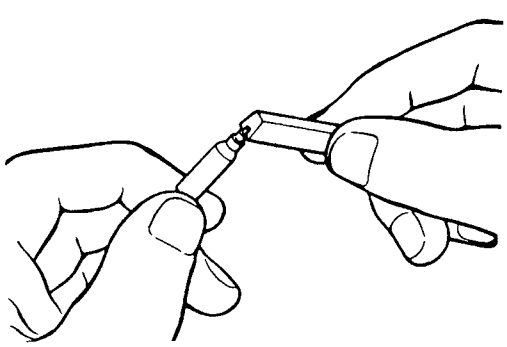
NOTE: Be sure not to touch the nozzle mating surfaces with your fingers.

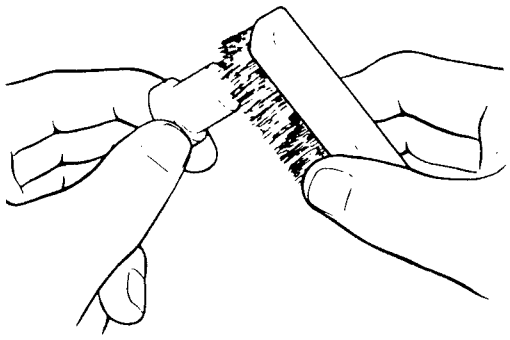




(b) Use a wooden stick to remove any carbon that may be adhering to the nozzle needle tip.

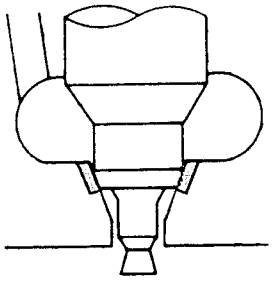
(c) Remove the carbon from the exterior of the nozzle body with a brass brush.





(d) Inspect the seat of the nozzle body for burns or corrosion.

(e) Inspect the nozzle needle tip for damage or corrosion.
If any of these conditons exist, replace the nozzle assembly.



③ SINKING TEST

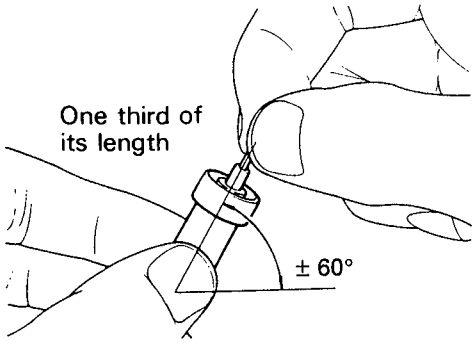
(a) Wash the nozzle in clean diesel fuel.

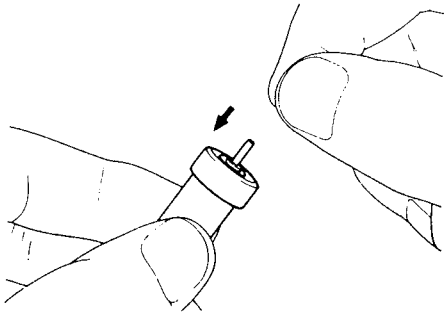
NOTE: Do not touch the nozzle mating surfaces with your fingers.

(b) Tilt the nozzle body about 60 degrees and pull the needle out about one third of its length.

(c) When released, the needle should sink down into the body vent smoothly by its own weight.

(d) Repeat this test, rotating the needle slightly each time. If the needle does not sink freely, replace the nozzle assembly.





ASSEMBLY AND INSTALLATION OF INJECTION NOZZLE HOLDERS

① ASSEMBLY INJECTION NOZZLE HOLDERS

(a) As shown in the figure, assemble the injection nozzle and finger tighten the retaining nut.

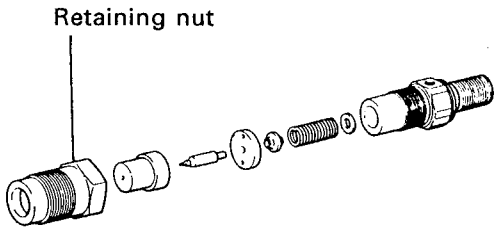
(b) Using the SST, torque the retaining nut.

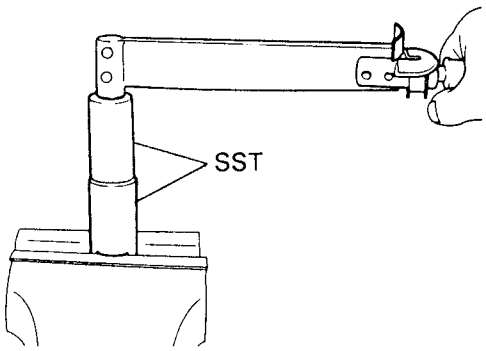
SST 09268-64010

Torque: 375 kg-cm (27 ft-lb, 37 N·m)

CAUTION: Over-torquing could cause nozzle deformation and needle adhesion or other defects.

② REFORM PRESSURE AND SPRAY PATTERN TEST





③ INSTALL INJECTION NOZZLE HOLDERS

(a) Place four new gaskets and the nozzle seats in the cylinder head.

(b) Using the SST, install and torque the four nozzles.

SST 09268-64012

Torque: 650 kg-cm (47 ft-lb, 64 N·m)

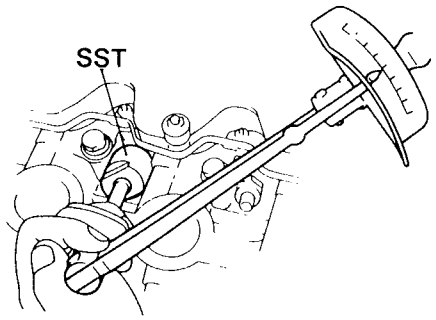
CAUTION: Over-torquing could cause nozzle deformation and needle adhesion of other defects.

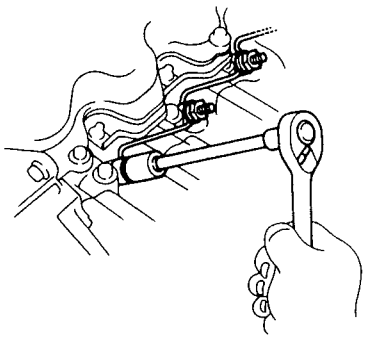
④ INSTALL FUEL RETURN PIPE

(a) Install four new gaskets and the return pipe with the four lock nuts.

Torque: 300 kg-cm (22 ft-lb, 29 N·m)

(b) Connect the fuel hose to the return pipe.





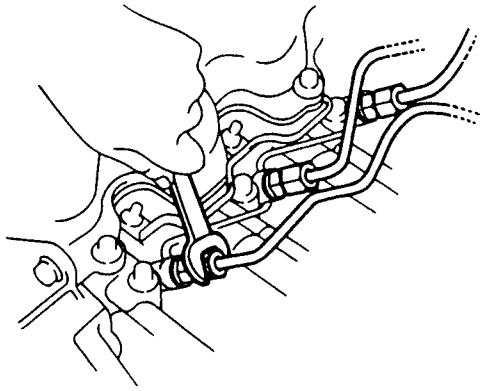
⑤ INSTALL INJECTION PIPES

(a) Connect both ends of the injection pipes to the injection pump and nozzle holder.

(b) Install the injection pipe clamps.

(c) Torque the injection pipe union nuts.

Torque: 300 kg-cm (22 ft-lb, 29 N·m)

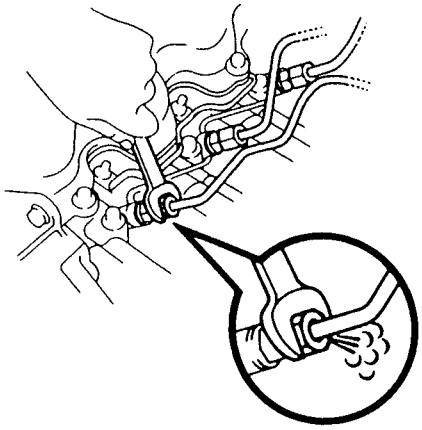


⑥ CONNECT FUEL HOSES TO INJECTION PUMP

⑦ BLEED INJECTION NOZZLES

(a) Loosen all union nuts of the injection pipe on the nozzle holder side.

(b) Crank the engine to bleed the air and force out a little fuel from the injection pipe.



⑧ START ENGINE AND CHECK FOR FUEL LEAKS

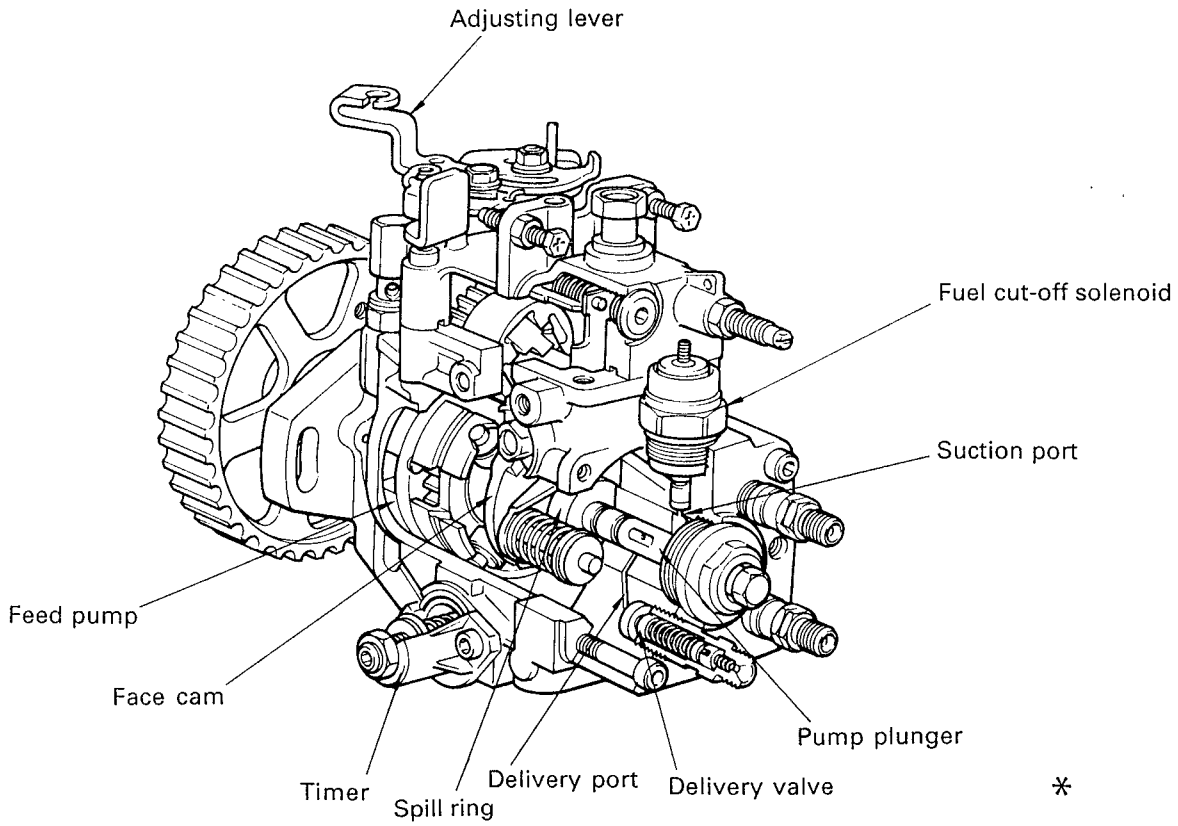
⑨ CHECK ENGINE IDLE SPEED AND MAXIMUM SPEED

VE TYPE INJECTION PUMP

The injection pump is a VE* distributor type pump having the following features:

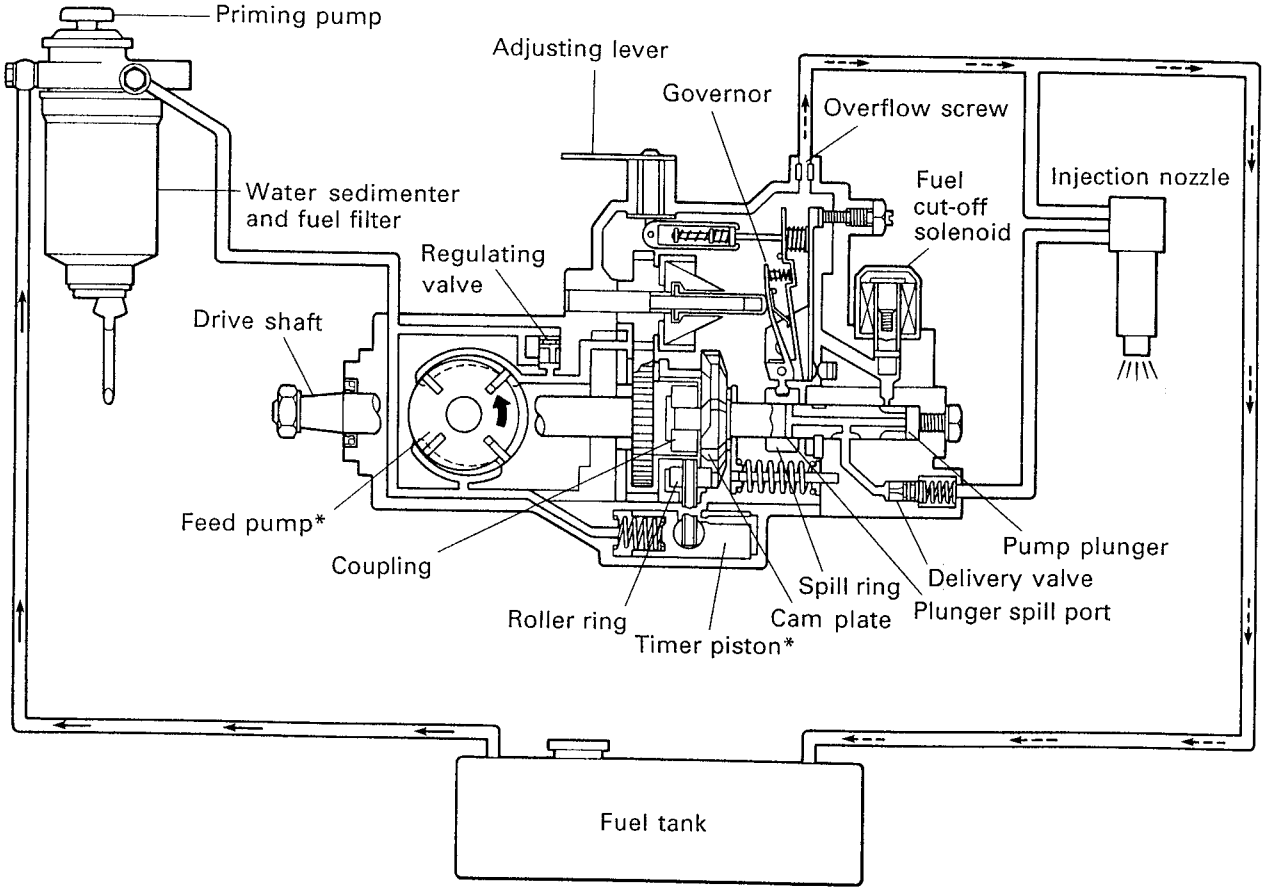
① Small, lightweight, and capable of high rpm.
② Fuel delivery means of a face cam and single plunger.
③ Built-in mechanical minimum-maximum speed governor.
④ Built-in injection timer, controlled by fuel pressure, and a vane type feed pump.
⑤ Fuel is automatically cut off when the starter switch is turned off.
⑥ Self-lubricating.
⑦ Injection timing is advanced in response to engine coolant temperature. An automatically-controlled cold starting device (ACSD) has been adopted for better cold-engine startablility.
⑧ This automatically-controlled cold starting device also controls the fast idle in accordance with the coolant temperature.

* VE is an abbreviation of the German "Verteiler Einspritz" or "distribution injection".



SUMMARY OF OPERATION

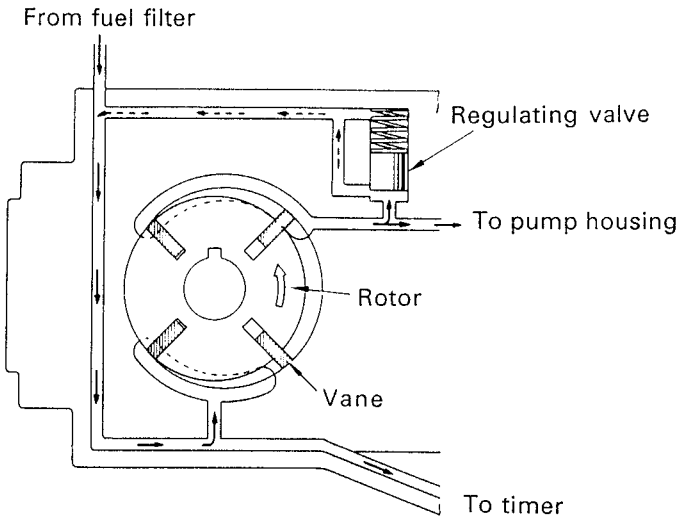
① A vane type feed pump draws fuel from the fuel tank through the water sedimenter and fuel filter, and sends it to the inner pump housing.
② A pressure regulating valve controls the fuel pressure inside the injection pump.
③ Excess fuel is returned to the fuel tank through the overflow screw. This helps to cool the moving parts of the injection pump.
④ The cam plate is driven by the pump drive shaft. The pump plunger fits into the cam plate and fuel is delivered by the rotating, reciprocating motion of this plunger.
⑤ Injection volume is controlled by the mechanical governor assembly.
⑥ Injection timing is controlled by the timer piston, which is operated by fuel pressure.
⑦ A fuel cut-off solenoid shuts off the fuel passage to the pump plunger when the engine starter switch is turned off.
⑧ The delivery valve performs the dual function of preventing the fuel in the injection pipe from flowing backward to the plunger and removing from the nozzle (by suction) the fuel remaining in it after injection.



* Rotated 90° so as to be seen from the side.

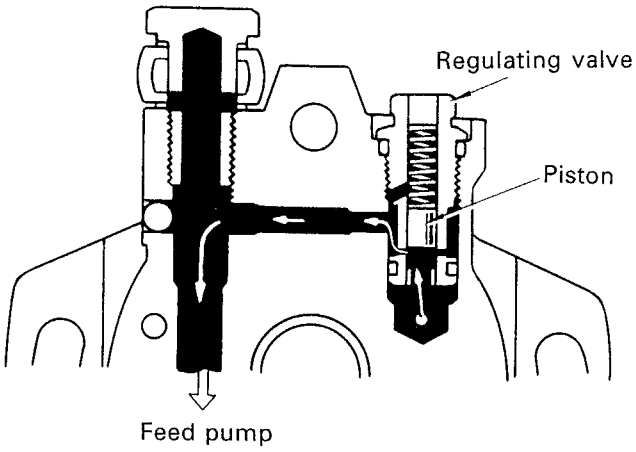
FEED PUMP

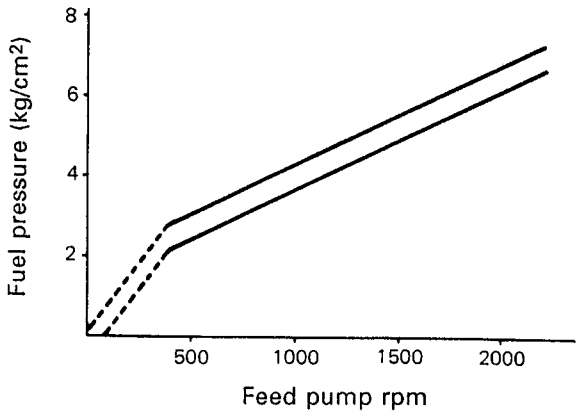
The vane type feed pump has four vanes and is driven by the crankshaft. It sends fuel into the pump housing under pressure.



REGULATING VALVE

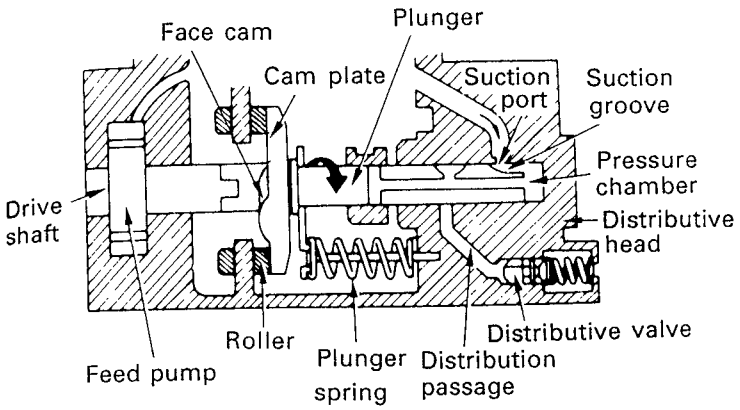
The regulating valve regulates the fuel pressure in proportion to engine rpm to operate the automatic timer.



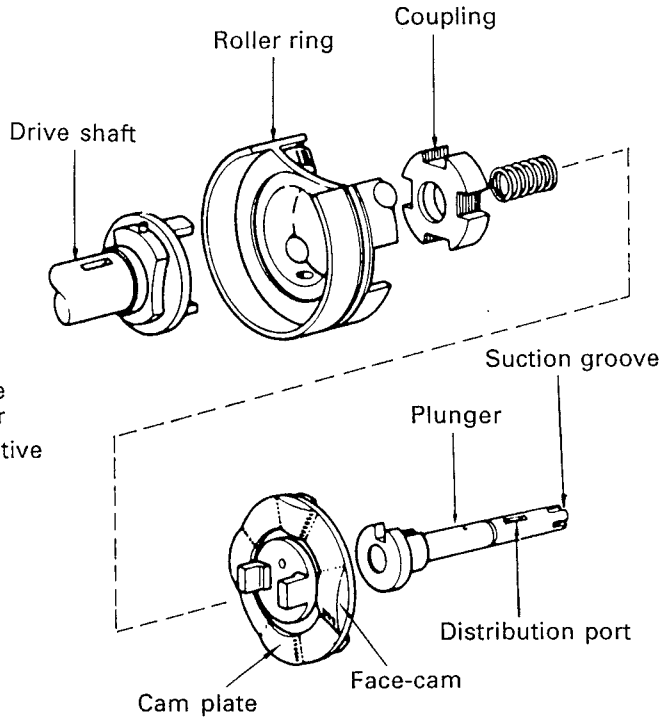


FUEL DELIVERY AND INJECTION

① The feed pump, cam plate, and plunger are driven by the drive shaft.
② Two plunger springs force the plunger and cam plate against the rollers.
③ As illustrated on the next page, the cam plate is provided with four face-cams (one for each cylinder). When the cam plate rotates, the face-cams ride on the rollers, simultaneously turning the plunger and pushing it in and out. Therefore, with one turn of the cam plate, the plunger makes one complete turn and reciprocates four times.



DISTRIBUTIVE HEAD

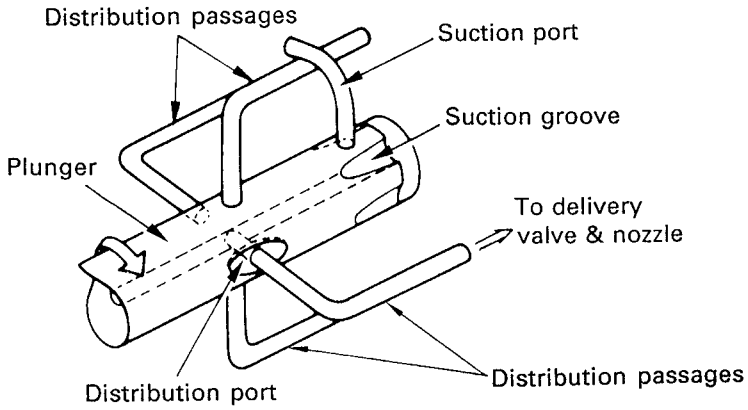


④ Fuel for one cylinder is delivered with each 1/4 turn and one reciprocating motion of the plunger.

⑤ The pump plunger has four suction grooves and one distribution port, and there are four distribution passages in the distributive head.

⑥ When one of the four suction grooves in the plunger is aligned with the suction port, suction is accomplished and fuel passes from the suction port to the suction groove.

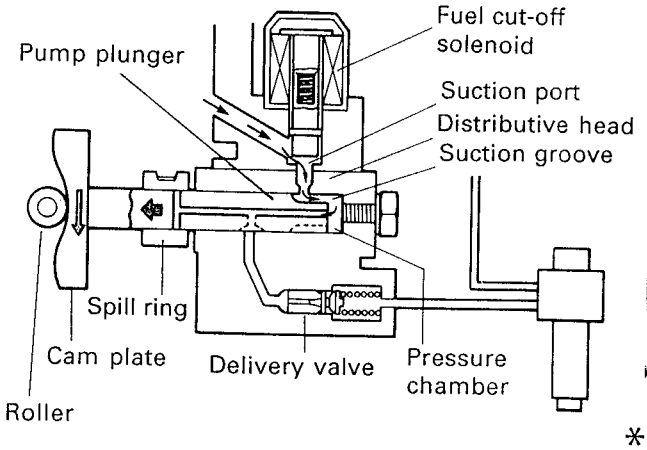
⑦ Fuel delivery is accomplished when the distribution port of the plunger is aligned with one of the four distribution passages. In this manner, fuel is delivered to each nozzle.

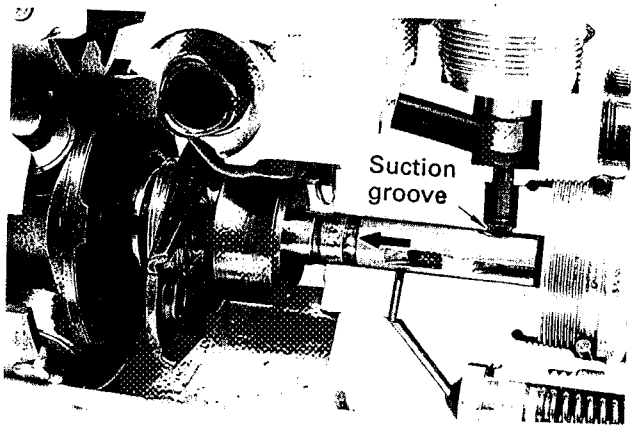


*

1. SUCTION

When the pump plunger moves to the left, one of the four suction grooves in the pump plunger will align with the suction port and fuel will be drawn into the pressure chamber and from there into the passage in the plunger.

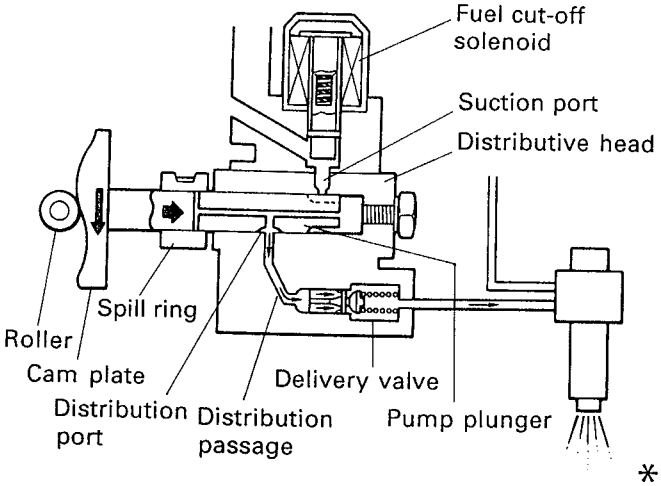


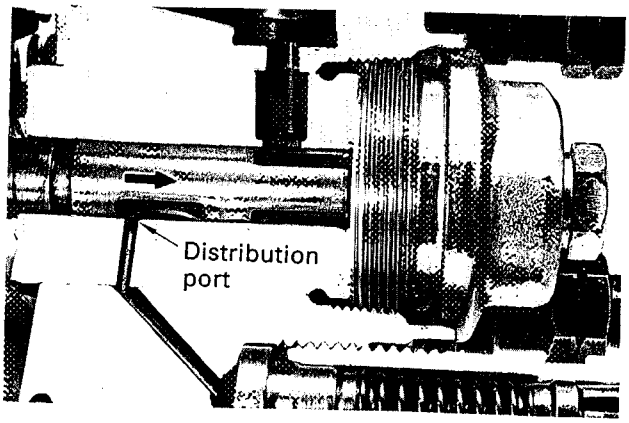


*

2. DELIVERY

As the cam plate and plunger turn, the suction port is closed off and the distribution port of the plunger will be aligned with one of the four distribution passages in the distributive head. As the cam plate rides onto the rollers, the plunger turns and moves to the right, causing the fuel to be pressurized. When the fuel is pressurized to the predetermined value, it is injected from the injection nozzle.

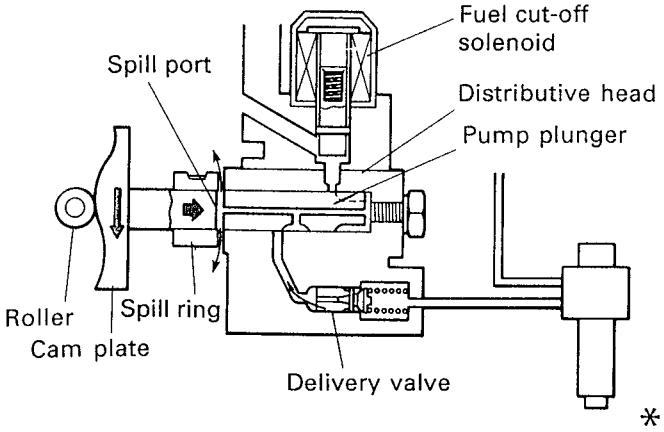


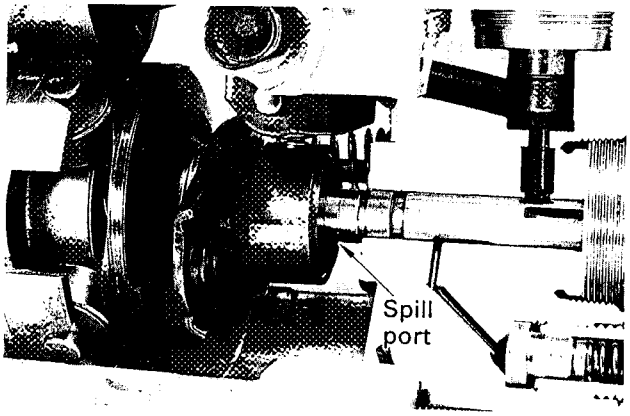


*

3. TERMINATION

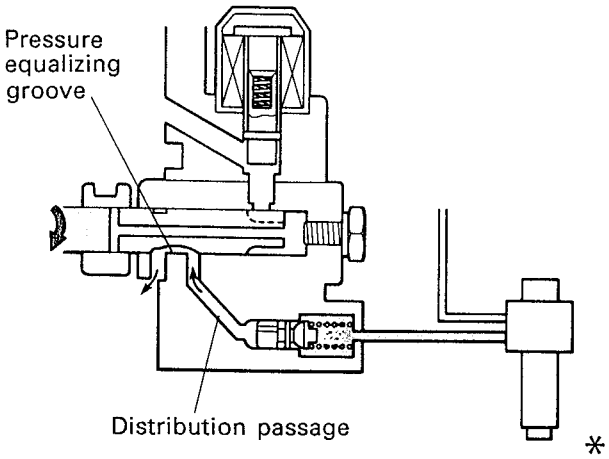
When the pump plunger moves even further toward the right, the two plunger spill ports will move out from under the spill ring and the fuel, under pressure, will be forced back into the pump housing through these spill ports. Thus, fuel pressure will suddenly drop and injection will be terminated.

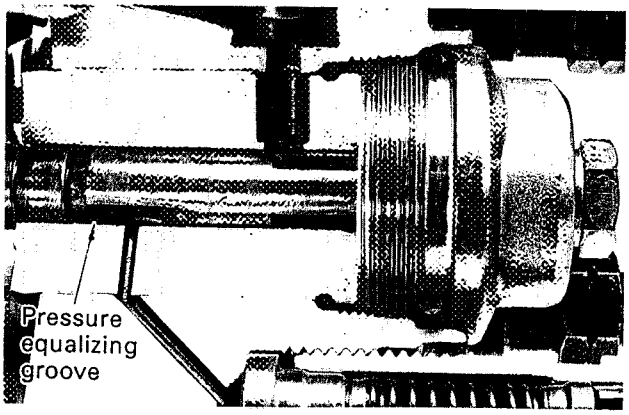




4. PRESSURE EQUALIZATION

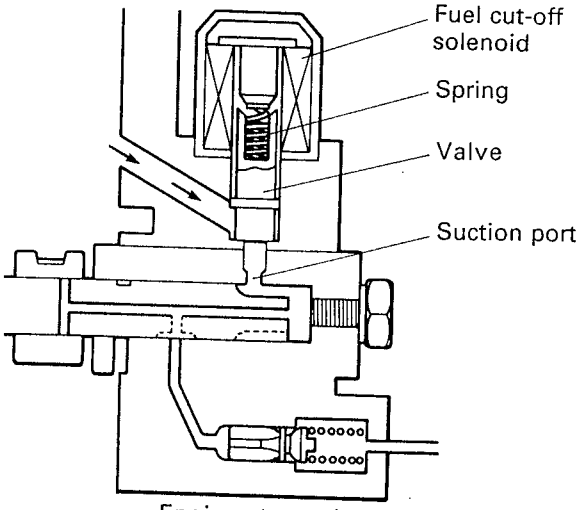
When the plunger has turned 180° after delivery, the pressure-equalizing groove of the plunger aligns with the distribution passage in order to equalize the pressure of the fuel in the passage and that in the pump housing.



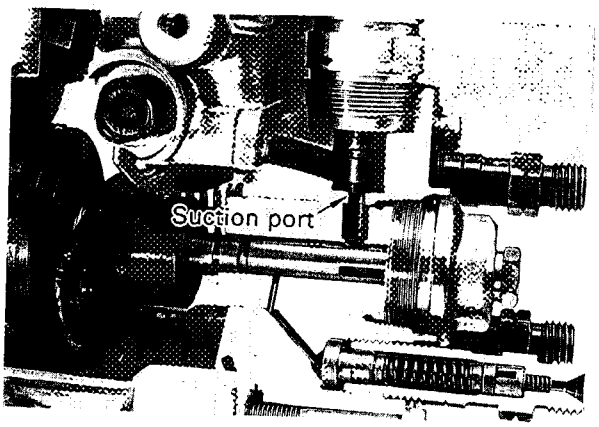


FUEL CUT-OFF SOLENOID

Engine shut-off is accomplished by stopping the fuel supply. The passage from the pump housing is closed and delivery of pressurized fuel is terminated by the fuel cut-off solenoid, which is designed to close the passage when the engine starter switch is turned off (to the LOCK position). This allows the engine to be turned off in the same manner as a gasoline engine.



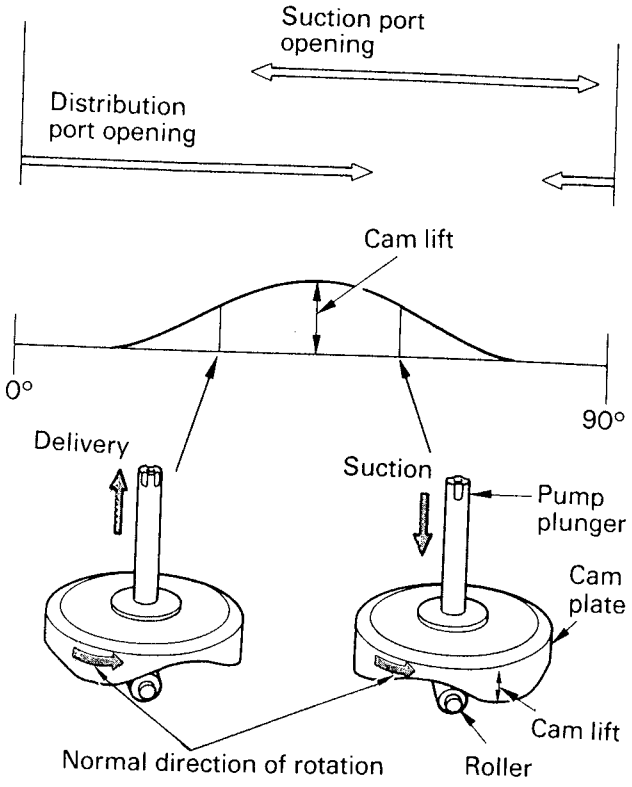
Engine stopped



ANTI-REVERSE ROTATION

A feature of the VE pump is that it prevents reverse rotation of the engine. The pump plunger movement and the opening and closing of each port are as illustrated at the right.

If the engine should happen to rotate in reverse, the suction ports will open and the distribution port will close when the pump plunger moves upward. Therefore, there will be no fuel injection and the engine will stop.



PORT TIMING
(for four-cylinder engines)

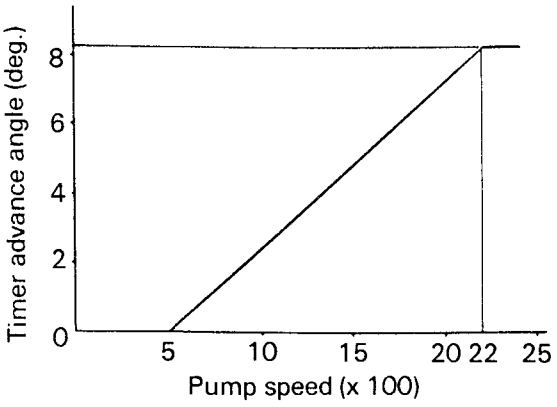
AUTOMATIC TIMER (INJECTION TIMING CONTROL)

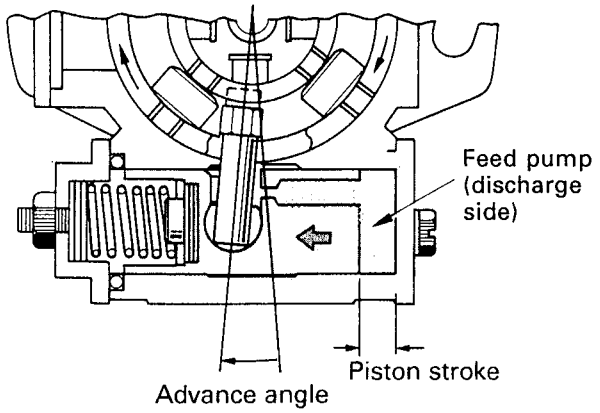
As in the case of gasoline engine injection timing, diesel engine injection timing must be advanced in accordance with the engine speed in order to obtain optimum performance. To do this, the VE injection pump incorporates an automatic timer, which is controlled by fuel pressure, advancing or retarding the injection timing in proportion to increases or decreases in engine speed.

CONSTRUCTION AND OPERATION

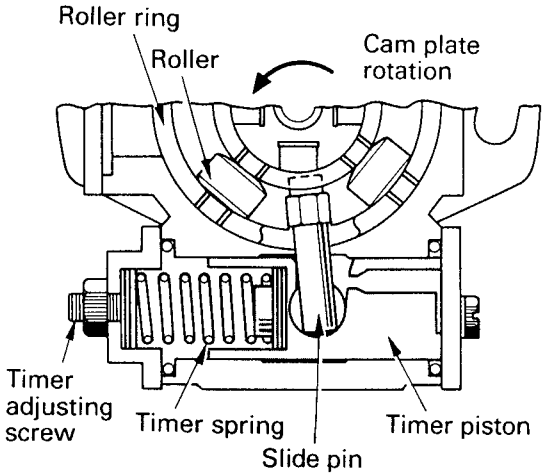
The timer piston is built into the timer housing, perpendicular to the pump drive shaft, and slides in accordance with the balance of the fuel pressure and timer spring tension. The slide pin converts the lateral motion of the timer piston into the rotational motion of the roller ring.

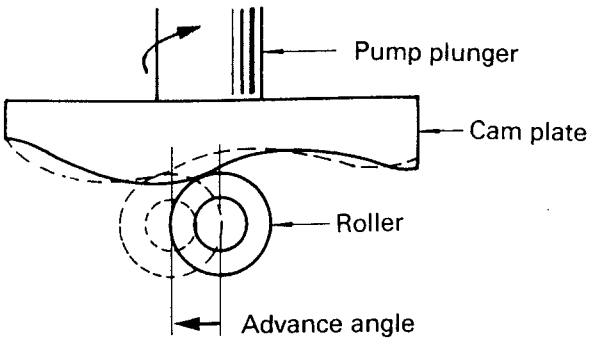
The timer spring attempts to force the timer piston to move in the injection "retard" direction (to the right). However, as engine rpm rises, fuel pressure also rises, so the piston overcomes the timer spring tension and moves to the left. In accordance with the piston movement, the roller ring moves in the direction opposite that of pump plunger rotation, thus advancing injection timing relative to the cam plate position.





INJECTION TIMING ADVANCED





INJECTION TIMING RETARDED

INSPECTION AND ADJUSTMENT OF INJECTION TIMING

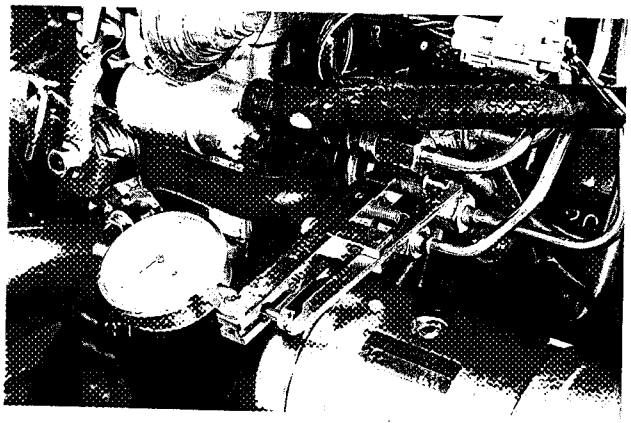
① INSTALL PLUNGER STROKE MEASURING TOOL (SST) AND DIAL INDICATOR

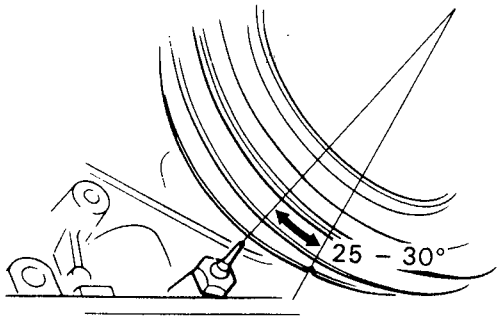
(a) Remove the distributive head plug bolt from the injection pump.

(b) Install the SST and the dial indicator into the distributive head plug hole.
SST 09275-54010

② SET NO. 1 OR NO. 4 CYLINDER TO 25 – 30° BTDC/COMPRESSION

Turn the crankshaft pulley clockwise until the pulley groove is 25 – 30° from the oil pump pointer.





③ DISABLE COLD STARTING SYSTEM

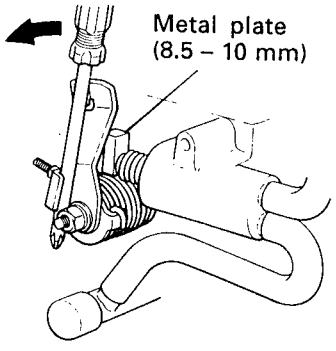
(a) Using a screwdriver, turn the cold starting lever counterclockwise about 20° as shown.

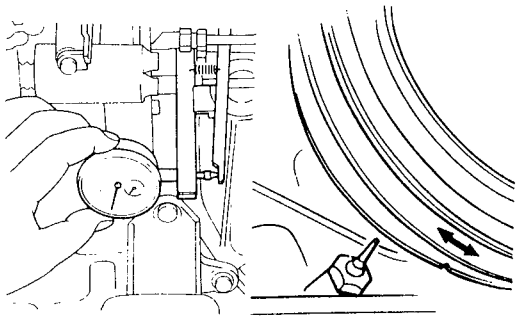
(b) Put a metal plate 8.5 – 10 mm (0.33 – 0.39 in.) thick between the cold starting lever and thermo wax plunger.

④ CHECK INJECTION TIMING

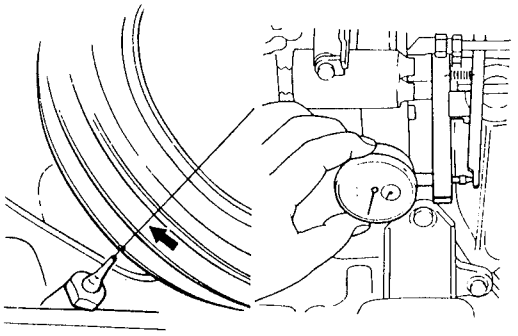
(a) Set the dial indicator to 0 mm.

(b) Recheck to see that the dial indicator remains at 0 mm while rotating the crankshaft pulley slightly to the left and right.



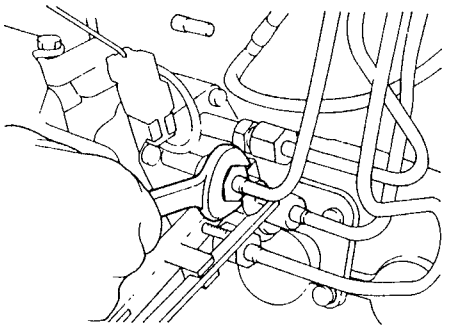


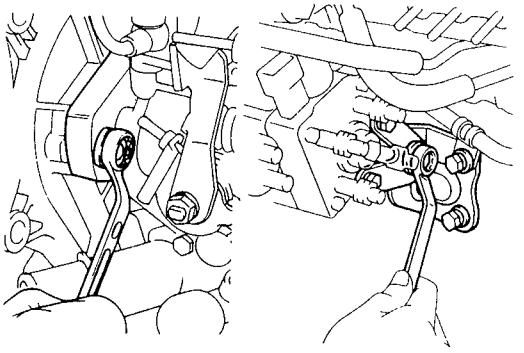
(c) Slowly rotate the crankshaft pulley clockwise until the pulley groove is aligned with the timing pointer.
(d) Measure the plunger stroke.



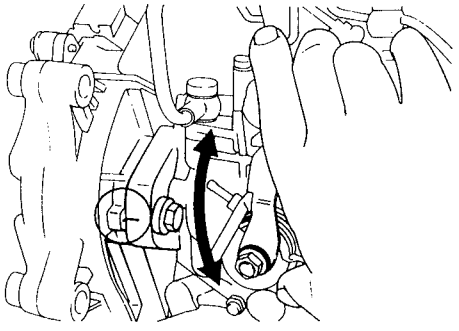
Plunger stroke:
0.77 – 0.83 mm (0.0303 – 0.0327 in.)

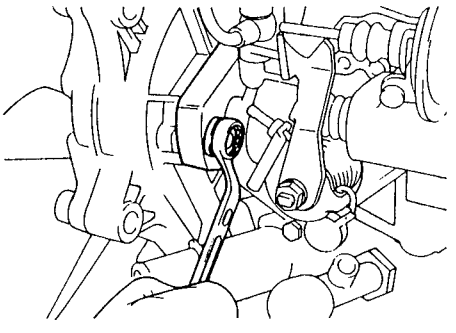
⑤ ADJUST INJECTION TIMING
(a) Loosen the four injection pipe union nuts on the pump side.
(b) Loosen the injection pump mounting bolt and nuts.



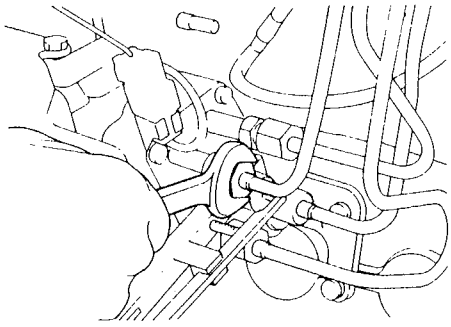


(c) Adjust the plunger stroke by slightly tilting the injection pump body.
If the stroke is less than specification, tilt the pump toward the engine.
If it is greater than specification, tilt the pump away from the engine.
Plunger stroke: 0.77 – 0.83 mm (0.0303 – 0.0327 in.)
(d) Tighten the injection pump mounting bolt and nuts, and torque them.
Torque: Bolt 475 kg-cm (34 ft-lb, 47 N·m)
Nut 180 kg-cm (13 ft-lb, 18 N·m)
(e) Recheck the plunger stroke.
Plunger stroke: 0.77 – 0.83 mm (0.0303 – 0.0327 in.)





(f) Torque all injection pipe union nuts.
Torque: 300 kg-cm (22 ft-lb, 29 N·m)



⑥ REMOVE METAL PLATE FROM COLD STARTING LEVER

⑦ REMOVE SST AND DIAL INDICATOR

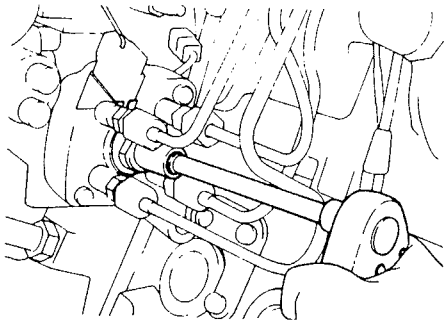
(a) Remove the SST and dial indicator.

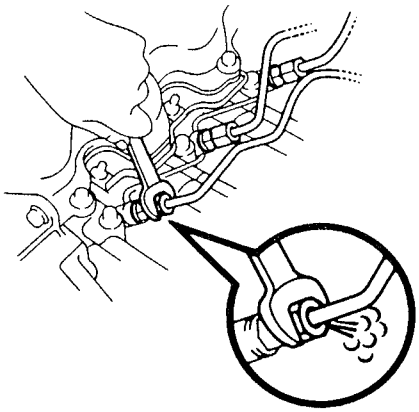
(b) Install the distributive head plug bolt with a new gasket. Torque the bolt.
Torque: 170 kg-cm (12 ft-lb, 17 N·m)

⑧ BLEED AIR FROM FUEL LINE

Bleed air from the injection pipe by activating the starter motor.

⑨ START ENGINE AND CHECK FOR LEAKS





INSPECTION AND ADJUSTMENT OF IDLE AND MAXIMUM SPEED

① INITIAL CONDITIONS:

(a) Air cleaner installed

(b) Engine coolant at normal operating temperature

(c) Accessories switched off

② CONNECT TACHOMETER TO ENGINE

③ CHECK AND ADJUST IDLE SPEED

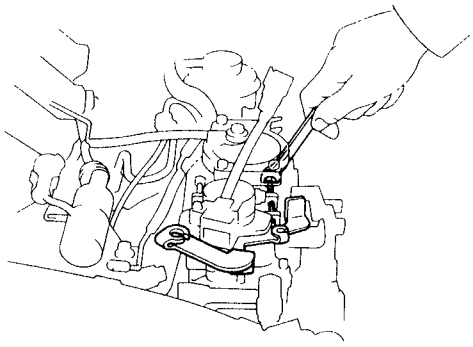
(a) Check that the adjusting lever is in contact with the idle speed adjusting screw.

(b) Start the engine and check the idle speed.

Idle speed: 750 – 850 rpm

(c) Loosen the lock nut and adjust the idle speed by turning the idle adjusting screw.

(d) Securely tighten the lock nut and recheck the idle speed.



④ CEHCK AND ADJUST MAXIMUM SPEED

(a) Check the engine maximum speed with the adjusting lever fully depressed.

Maximum speed: 5,300 – 5,400 rpm

CAUTION: This check should be preformed in as short a time as possible.

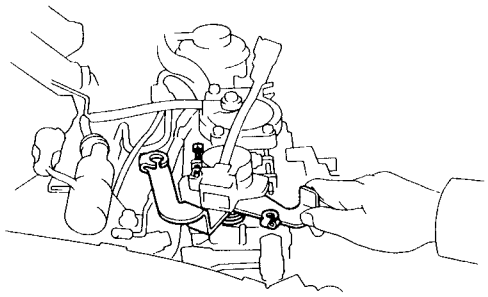
(b) Cut the maximum adjusting screw wire.

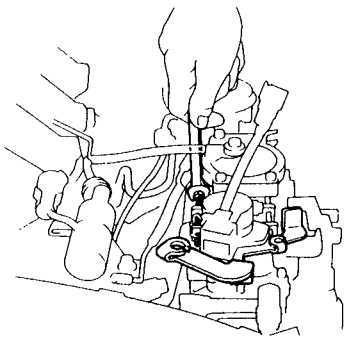
(c) Loosen the lock nut and adjust the maximum speed by turning the maximum speed adjusting screw.

CAUTION: Perform this adjustment at low rpm, then recheck it at maximum speed.

(d) Securely tighten the lock nut and recheck the maximum speed.

(e) Lock the maximum speed adjusting screw with a new wire.





⑤ DISCONNECT TACHOMETER

COMPRESSION CHECK

① WARM UP ENGINE

② DISCONNECT FUEL CUT-OFF SOLENOID WIRE CONNECTOR

③ REMOVE FOUR GLOW PLUGS

(a) Remove the four grommets from the glow plugs.

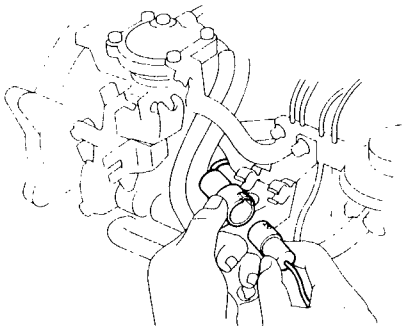
(b) Remove the four nuts, current sensor plate and glow plug connector.

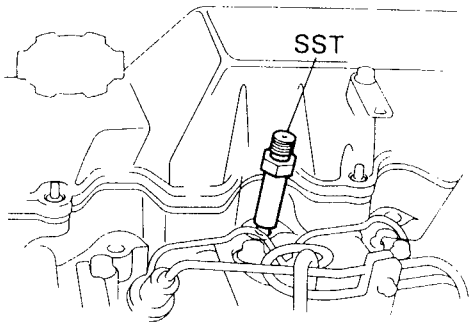
(c) Remove the four glow plugs.

CAUTION: Make sure the wire harness is not grounded.

④ INSTALL GAUGE ADAPTER (SST) INTO GLOW PLUG MOUTING HOLE

SST 09992-00160





⑤ MEASURE CYLINDER COMPRESSION PRESSURE

(a) Connect a compression gauge (SST) to the gauge adapter (SST).

SST 09992-00023

(b) While cranking the engine with the starter motor, measure the compression.

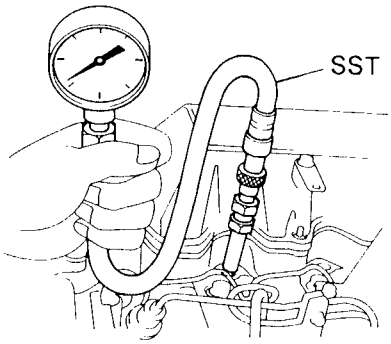
NOTE: A fully charged battery is necessary to obtain an engine speed of more than 250 rpm.

(c) Repeat steps (a) and (b) for each cylinder.

Compression pressure: 30.0 kg/cm^2 (427 psi; 2,942 kPa)

Minimum pressure: 25.0 kg/cm^2 (356 psi; 2,452 kPa)

Difference between each cylinder: Less than 5.0 kg/cm^2 (71 psi; 490 kPa)



(d) If the cylinder compression in one or more cylinders is low, pour a small amount of engine oil into the cylinder through the glow plug hole and repeat steps (a) and (b) for the cylinder having the low compression.

- If adding oil helps the compression, chances are that the piston rings and/or cylinder bore are worn or damaged.
- If the pressure stays low, a valve may be sticking or seating improperly, or there may be leakage past the gasket.

⑥ INSTALL FOUR GLOW PLUGS

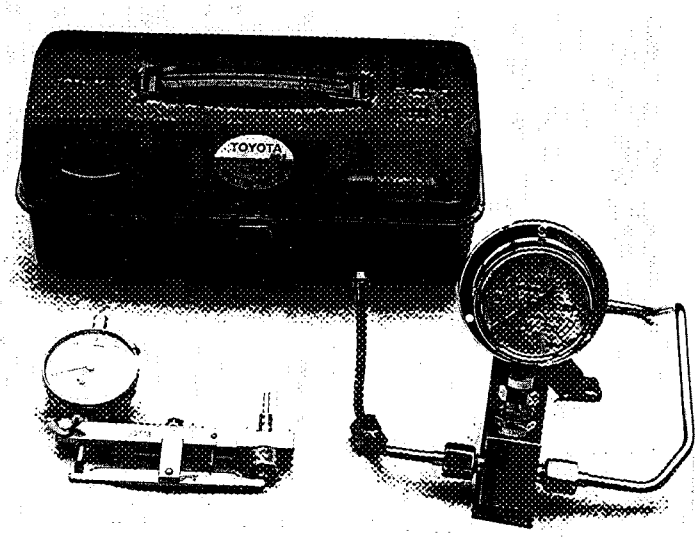
⑦ CONNECT FUEL CUT-OFF SOLENOID WIRE CONNECTOR

FUEL DELIVERY PRESSURE

Install a pressure gauge midway in the injection pipe and check the fuel delivery pressure while the engine is running.

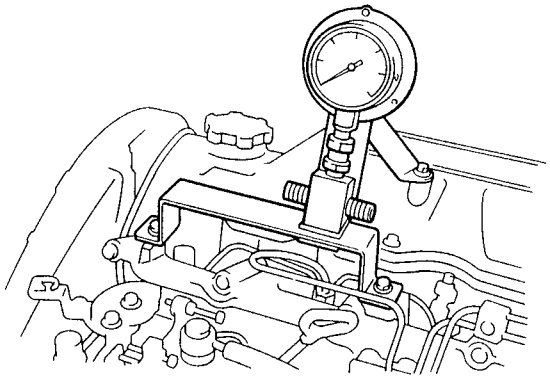
Pressure Gauge: T-TEP Training Materials (TEP-022)

A plunger stroke measuring tool (SST) and dial indicator used when checking and adjusting the injection timing, are included in these training materials.

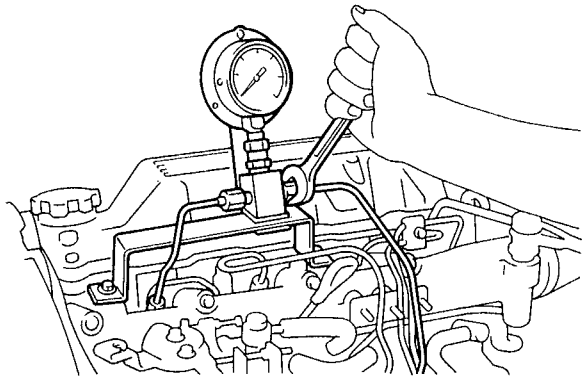


MOUNT PPRESSURE GAUGE

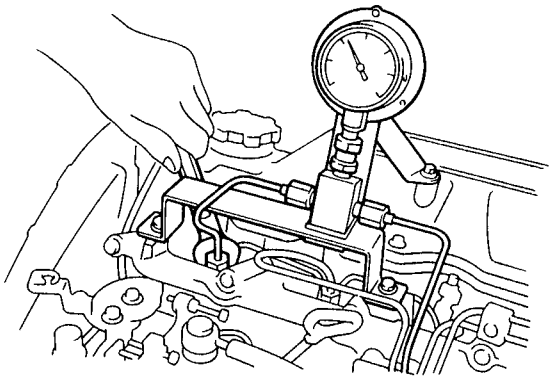
① Remove the injection pipe that runs between the No. 1 nozzle holder and injection pump.
② Mount the pressure gauge on the engine head cover with three bolts.

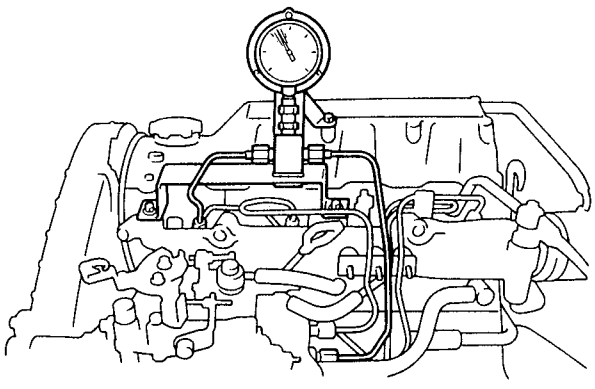


③ Install the injection pipe of the gauge between the injection pump and pressure gauge, and between the pressure gauge and nozzle holder.
Torque: 300 kg-cm (22 ft-lb, 29 N·m)
Tighten the union nut on the nozzle holder temporarily.
④ Tighten the three pressure gauge installation bolts.



⑤ Bleed the air from the injection pipe by activating the starter motor.
⑥ Start the engine and check for fuel leaks.
⑦ Read the fuel delivery pressure.





VE PUMP MECHANICAL GOVERNOR

There are two types of governors generally used with diesel engines: the minimum-maximum speed type and the all-speed type. The 2C engine uses the minimum-maximum speed type.

CONSTRUCTION AND FUNCTION

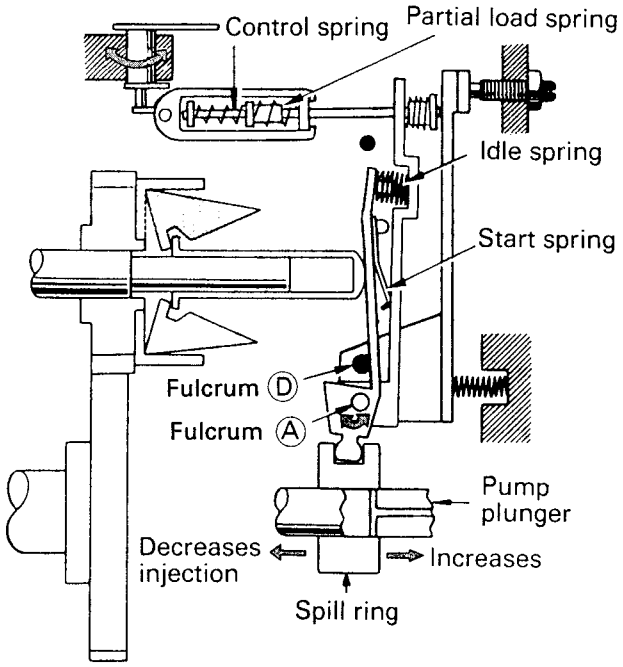
① The governor shaft gear and flyweight holder turn 1.6 times for every one turn of the drive shaft gear.

② There are four flyweights in the flyweight holder. These detect the governor shaft rpm by sensing the cetrifugal force that is developed, and the governor sleeve transmits this force to the control lever.

③ The control spring tension varies with the load (i.e., how far the accelerator pedal is depressed).

④ The damper spring and idle spring prevent governor "hunting" by pushing slightly against the tension lever and control lever (respectively) as these levers move to the right (i.e., in the direction of decreased injection).

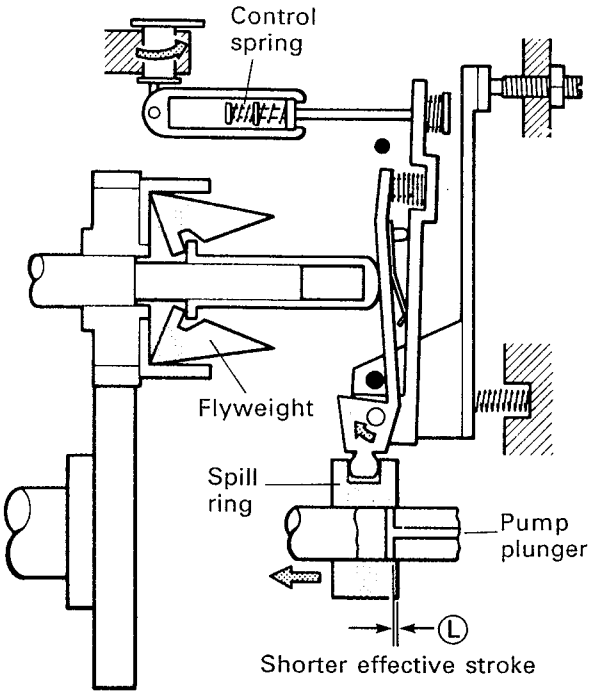
⑤ The governor lever assembly adjusts the position of the spill ring in accordance with engine speed and load. It is composed of the guide lever, the control lever, and the tension lever; these levers are all linked at fulcrum Ⓐ, which is free-floating. The guide lever further pivots around fulcrum Ⓓ, which is fixed to the governor housing.



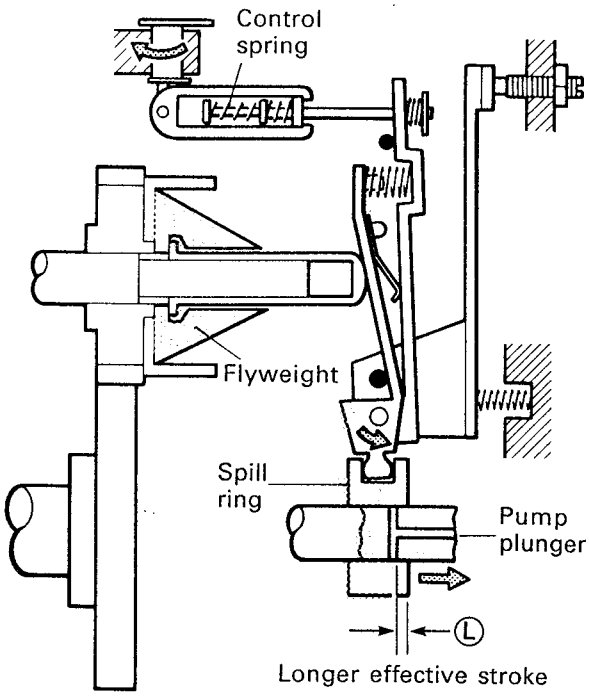
MINIMUM-MAXIMUM SPEED GOVERNOR

INJECTION VOLUME CONTROL

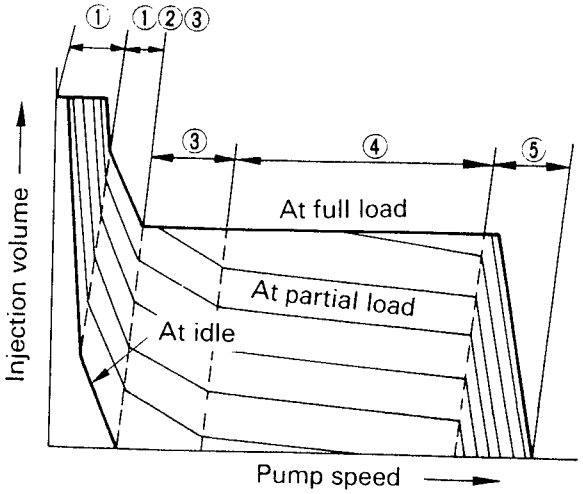
The injection volume can be controlled by changing the effective stroke of the pump plunger. As is shown in the figure, when the spill ring moves to the left, the effective stroke Ⓛ of the pump plunger decreases, decreasing the injection volume. When it moves to the right, the effective stroke Ⓛ, and thus the injection volume, increases.
The governor lever assembly controls the position of the spill ring by balancing the centrifugal force developed by the flyweights (which changes in accordance with engine speed), against the tension of the control spring (which changes in accordance with the engine load). The resulting balance of these two forces moves the spill ring to increase or decrease the injection volume as necessary.



DECREASED INJECTION VOLUME



INCREASED INJECTION VOLUME

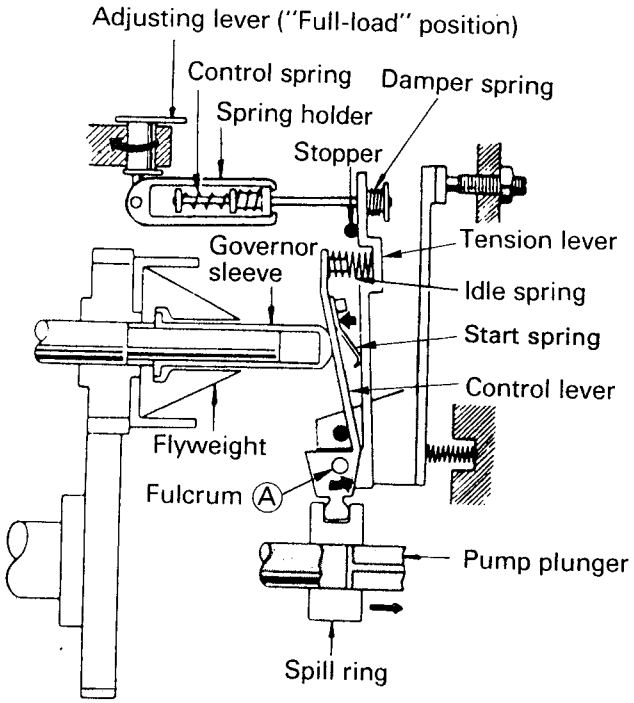


① Start spring
② Idle spring & damper spring
③ Damper spring
④ Partial load spring
⑤ Control spring

FUEL INJECTION VOLUME & SPRING OPERATING RANGE

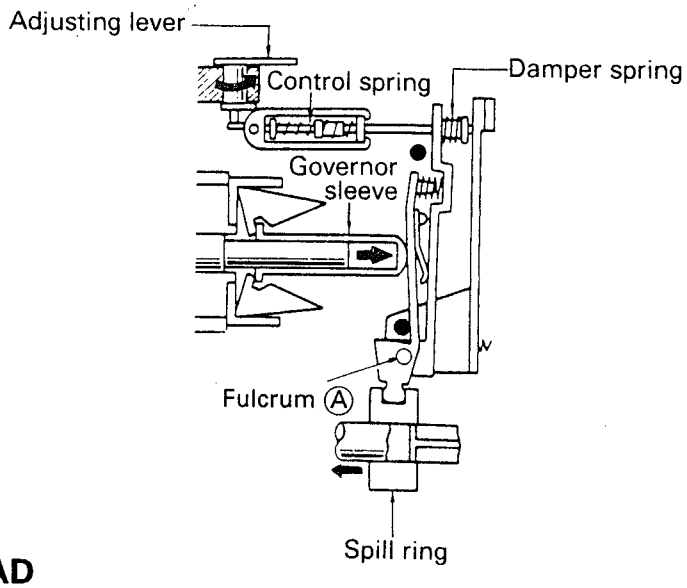
1. STARTING

As the accelerator pedal is depressed, the adjusting lever will move toward the "Full-load" position. The tension lever is pulled by the spring holder until it comes into contact with the stopper. Since the engine is still stopped, the flyweights are not in motion and the control lever is pushed against the governor sleeve by the slight tension of the start spring so that the flyweights are in the fully closed position. At this time, the control lever moves counterclockwise around fulcrum A , moving the spill ring to the start position. In this manner, the necessary quantity of fuel is supplied to the engine for starting.



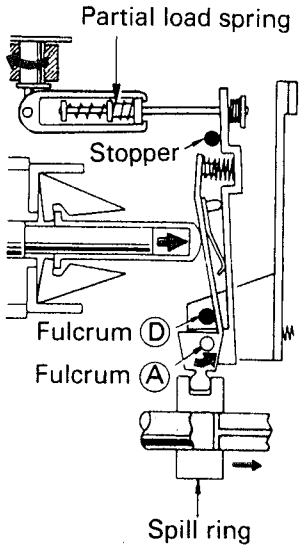
2. IDLING

After the engine is started, the accelerator pedal is released and the adjusting lever returns to the "Idle" position. In this position the control spring is fully extended, so it does not pull on the tension lever. Therefore, even though rpm is low, the flyweights begin to open, causing the governor sleeve to push the control and tension levers to the right against the tension of the start, idle, and damper springs. The control lever therefore moves clockwise around fulcrum Ⓐ, moving the spill ring to the idle position. The balance thus maintained between the centrifugal force of the flyweights and the tension of the start, idle, and damper springs provides stable rpm during idling.



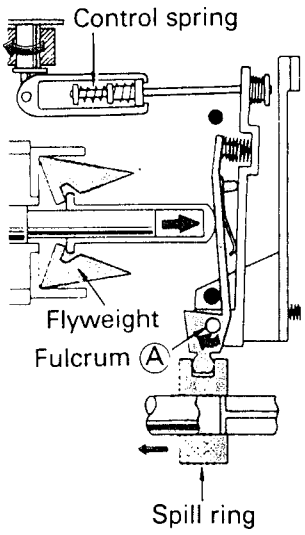
3. FULL LOAD

As the accelerator pedal is depressed, the adjusting lever moves to the "Full-load" position, the spring holder is pulled to the left and the partial load and damper springs are fully contracted. The tension lever therefore contacts the stopper and remains stationary. Furthermore, as the control lever is pushed by the governor sleeve, it contacts the tension lever so the spill ring remains in the "Full-load" position.



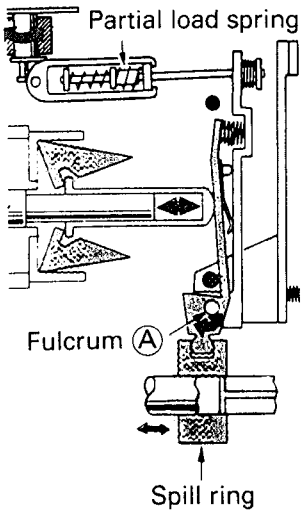
4. MAXIMUM SPEED

As the engine speed rises under a full load, the thrust of the flyweights become stronger than the control spring tension. The tension lever and control lever will therefore move clockwise together around fulcrum Ⓐ, thereby moving the spill ring to the left, decreasing injection volume in order to prevent engine overrun.



5. PARTIAL LOAD

When the adjusting lever is located between the "Full-load" and "Idle" positions, the partial load spring contracts due to the centrifugal force of the flyweights. The entire control lever therefore revolves clockwise around fulcrum Ⓐ, causing the spill ring to move to the left, decreasing injection volume.
For this reason, compared with the full-load chracteristics, the injection volume tends to gradually decrease toward the right of the graph (see page 68) so that the injection volume varies in closer accordance with the engine load.



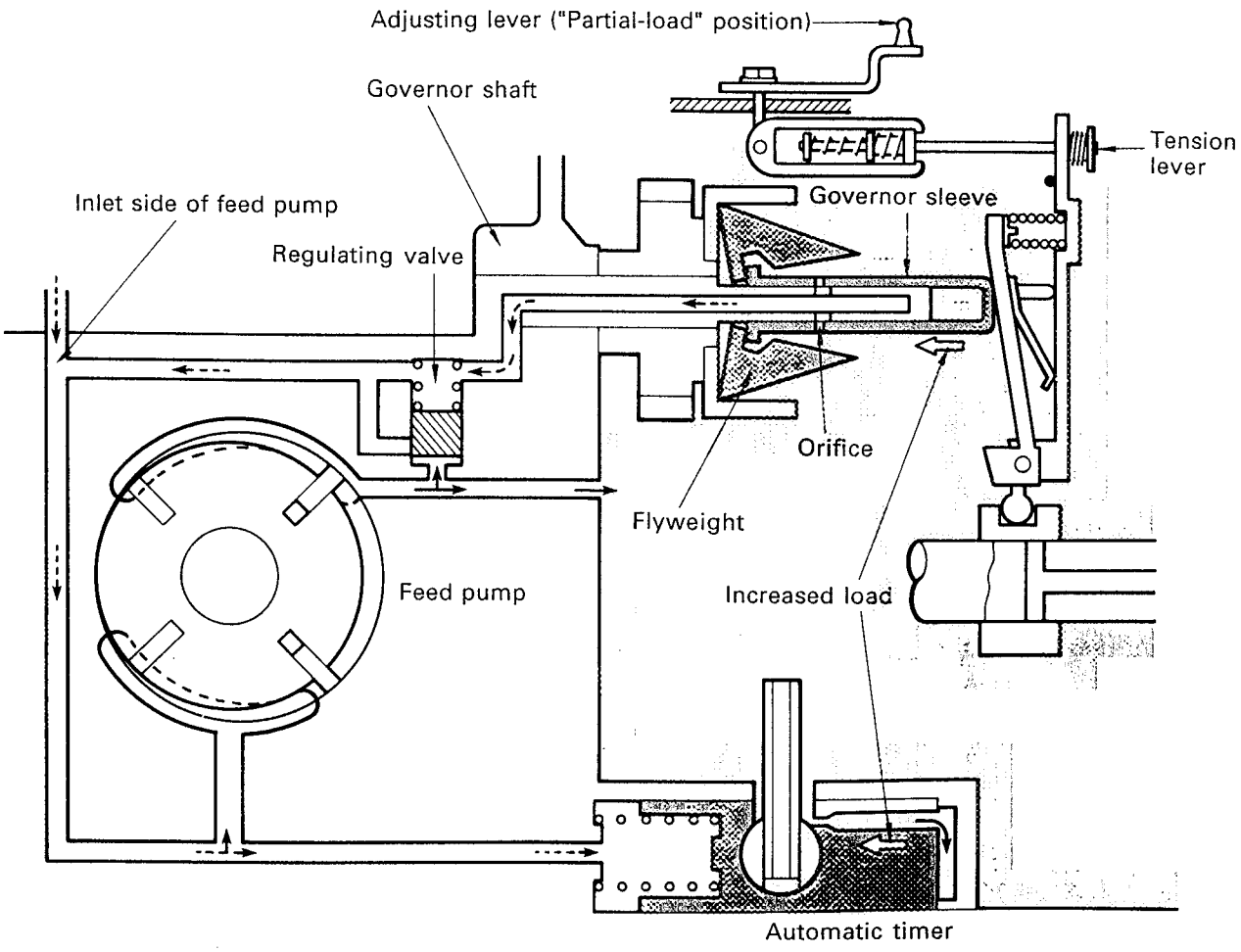
LOAD-SENSING TIMER

A load-sensing timer function is provided to adjust the injection timing (and thus the fuel pressure inside the pump housing) in accordance with engine load. When the engine is running under a partial load, the timer slightly retards injection timing to reduce engine noise. When the engine is running at full load, the timer slightly advances the timing to prevent power loss.

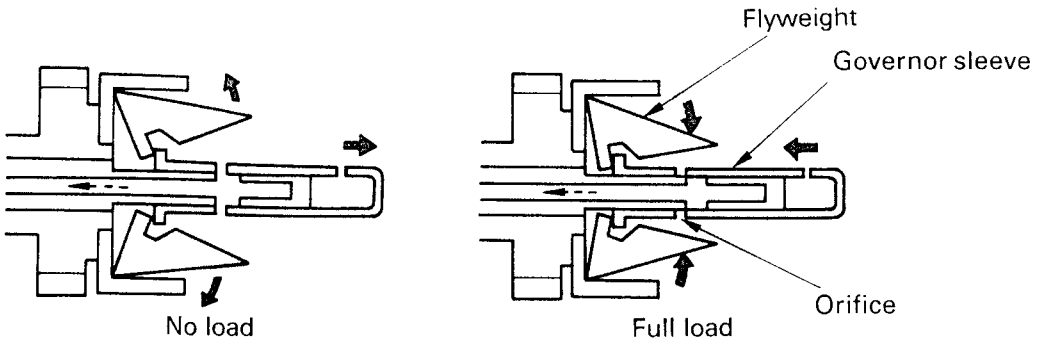
OPERATION

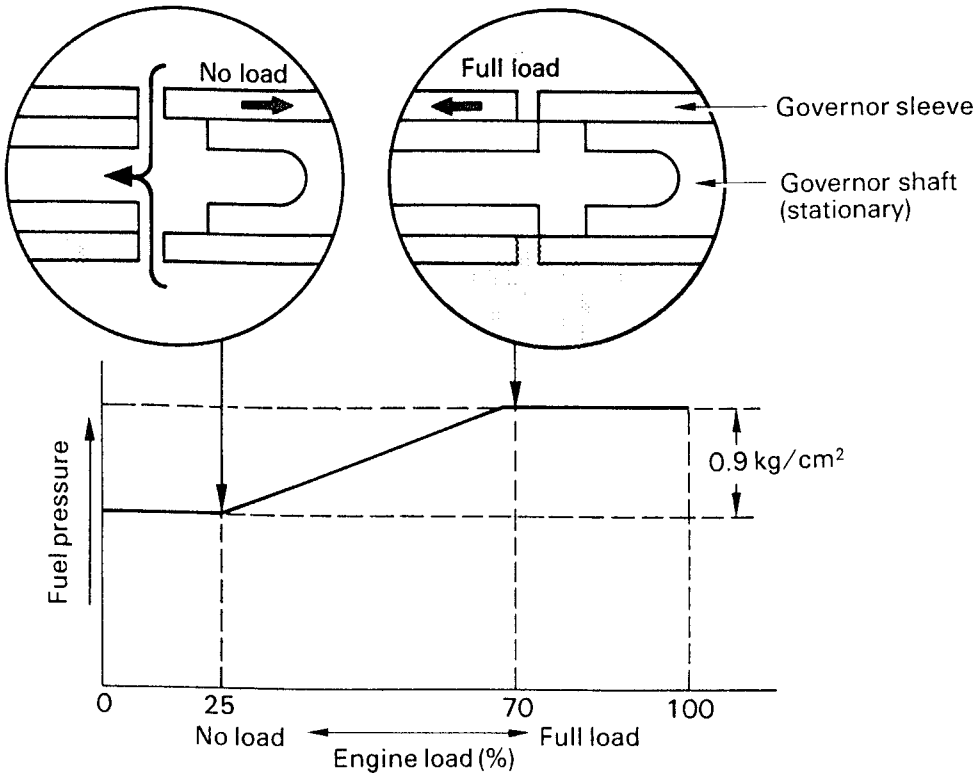
When the engine is operating under a partial load, the fuel pressure in the pump housing is released through the orifice in the governor sleeve to the inlet side of the feed pump. This causes the timer piston in the automatic timer to retard the injection timing.

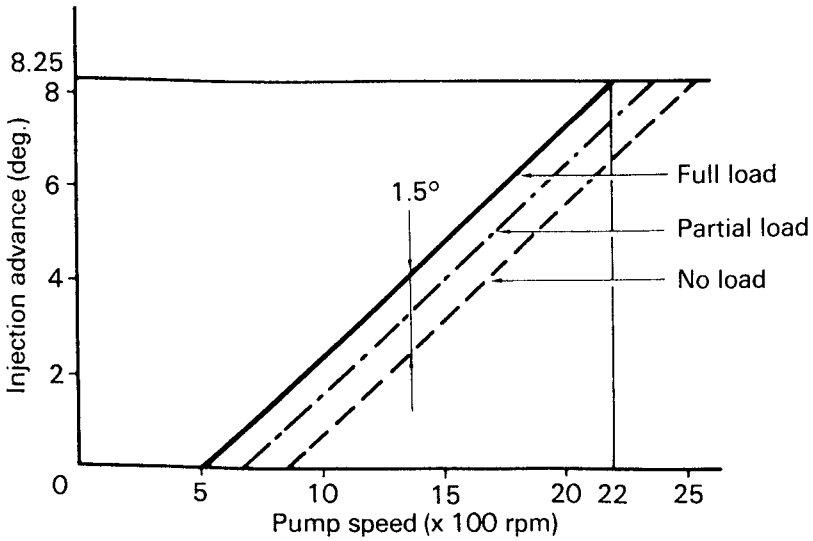
Conversely, when the load on the engine increases, the tension lever pushes the governor sleeve back (to the left). As a result, the orifice in the sleeve closes, so the pressure in the pump housing rises, causing the automatic timer to advance the injection timing again.



The load-sensing timer can operate under engine loads of between 25 and 70% of the full load as illustrated below. The maximum possible injection possible injection retard angle for most models is 1.5 degrees (this depends upon the size of the orifice).







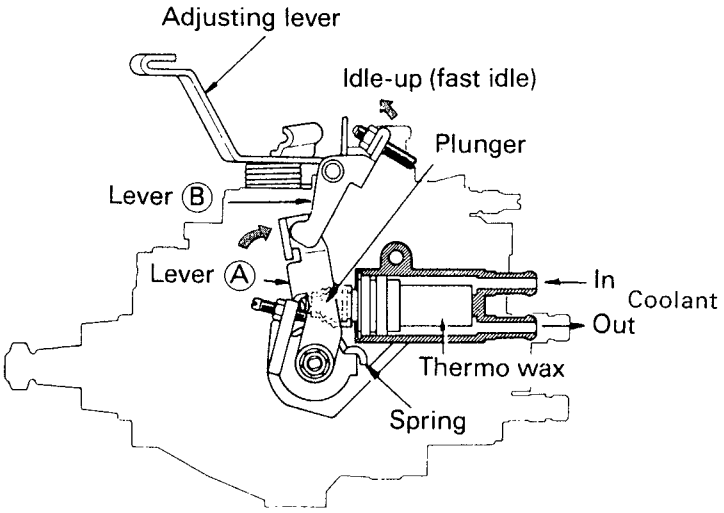
AUTOMATICALLY-CONTROLLED COLD STARTING DEVICE (ACSD)

To improve startability, this device both advances the injection timing and maintains a fast idle condition when the coolant temperature is low.

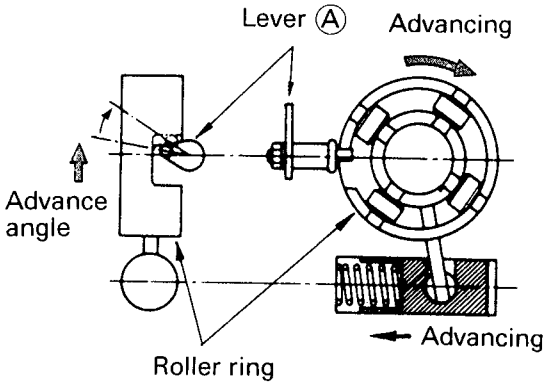
OPERATION

1. COLD ENGINE

When the engine is cold, the thermo wax contracts and pulls the plunger so that lever Ⓐ rotates clockwise. This causes: 1) lever Ⓑ to push the adjusting lever toward the idle-up position, resulting in fast idle; and 2) the roller ring to rotate, advancing the injection timing.



ACSD MECHANISM



ADVANCING OPERATION

2. WARM ENGINE

① As the coolant temperature rises, the thermo wax gradually expands and pushes out the plunger, causing lever Ⓐ to move counterclockwise, gradually lessening the advance angle and lowering the idle rpm.

② When the coolant temperature reaches about 50°C (120°F), both injection timing and idle speed return to normal.

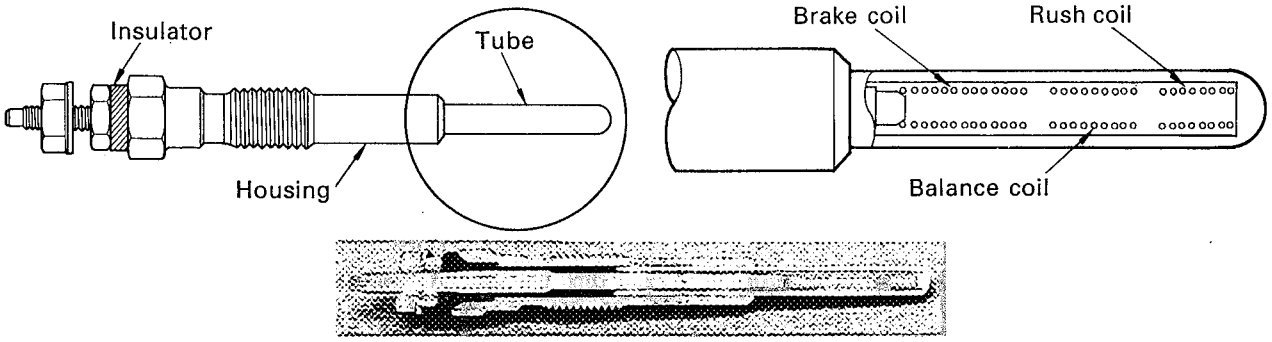
PREHEATING GLOW SYSTEM

NEW SUPER-GLOW SYSTEM

The new super-glow system is a system in which preheating is quickly completed by means of self-temperature-controlling glow plugs in order to shorten the time that the driver must wait to start the engine.
In addition to the quick preheating operation, an after-glow function is provided to improve combustion in cold weather in order to reduce white smoke and diesel knocking.
The new super-grow system is composed of the self-temperature-controlling glow plugs, two glow plug relays (No. 1 and No. 2), a glow plug resistor, a water temperature sensor, and a preheating timer.

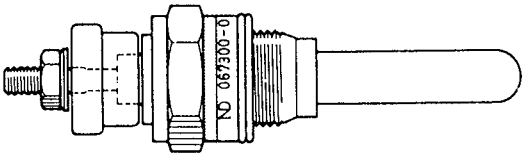
1. SELF-TEMPERATURE-CONTROLLING GLOW PLUGS

In many of the latest Toyota vehicles, self-temperature-controlling type glow plugs are used.
The glow plug has a heater coil, which actually consists of three coils – a brake coil, a balance coil, and a rush coil – hooked up in series.
When current is applied to the glow plug, the temperature of the rush coil in the tip of the glow plug first rises, causing the tip of the plug to glow red-hot. Since the electrical resistance of the balance and brake coils rises sharply as the temperature of the rush coil rises, the amount of current allowed to pass through the the rush coil is consequently reduced. This is how the glow plug controls its own temperature.
The self-temperature-controlling type glow plugs used in the new super-glow system do not require a current sensor, such as was used previously to sense the glow plug temperature. This permits a more simplified glow system.



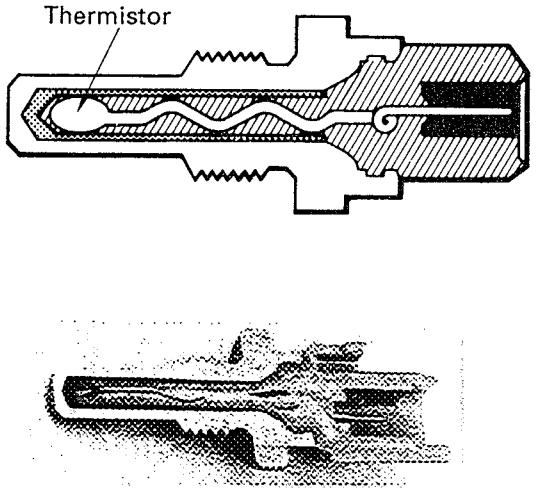
2. GLOW PLUG RESISTOR

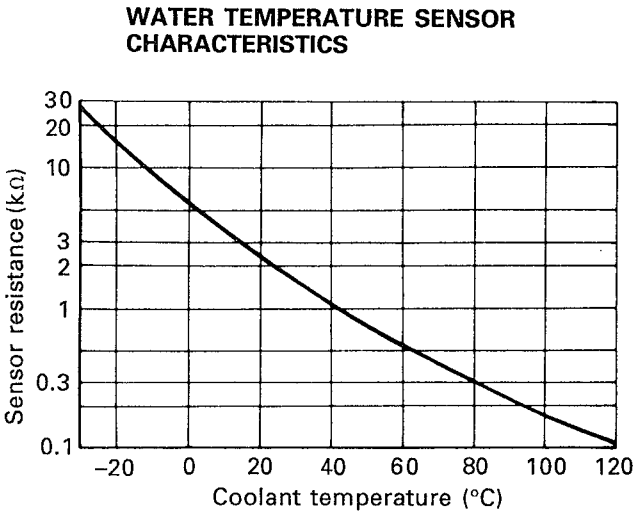
This resistor reduces the voltage applied to the glow plugs. When the No. 1 glow plug relay is off, current flows to the glow plugs through this resistor to maintain the temperature of the glow plugs at a level that will ensure engine starting.



3. WATER TEMPERATURE SENSOR

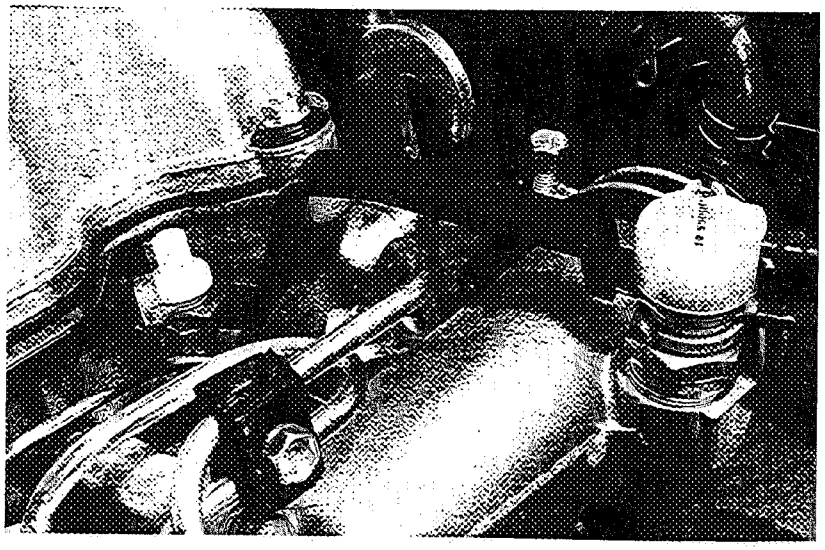
A water temperature sensor (consisting mainly of a thermistor in a housing) is mounted on the cylinder block. The electrical resistance of this thermistor changes with variations in the coolant temperature. The preheating timer detects these changes in resistance and controls the preheating time and indicator lighting time accordingly.





4. GLOW PLUG CURRENT SENSOR

This sensor maintains an almost constant resistance even during changes in temperature. Since the resistance value of the glow plugs greatly changes with variations in temperature, the preheating timer detects the voltage difference at each end of this sensor to maintain glow plug temperature between 750 (1,382) and 900°C (1,652°F).



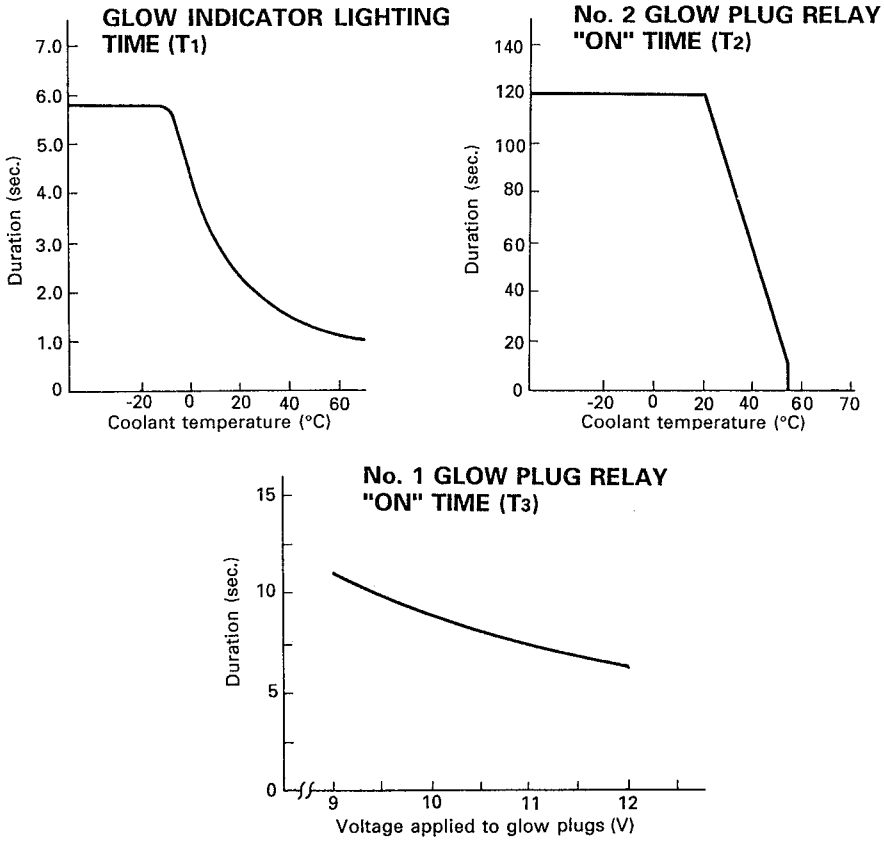
5. PREHEATING TIMER

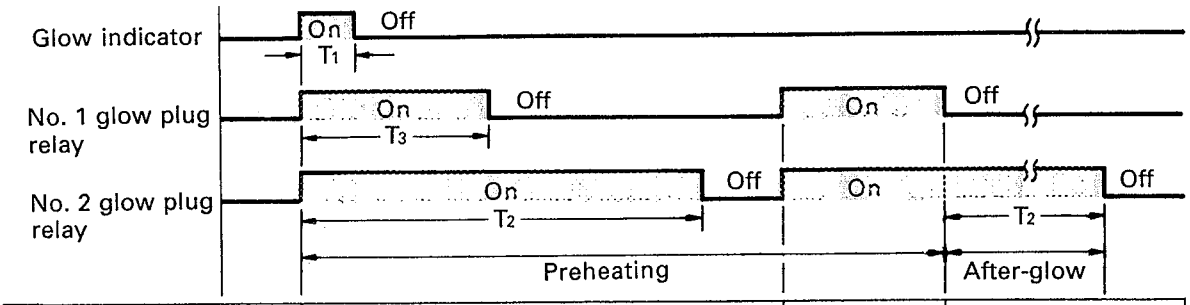
① The preheating timer is kept informed of coolant temperature by means of the water temperature sensor and causes the glow indicator light to light up in accordance with coolant temperature.

② The preheating timer controls the preheating time, which is the length of time (T2) that the No. 2 glow plug relay is on (in accordance with the coolant temperature) or the length of time (T3) that the No. 1 glow plug relay is on (in accordance with the voltage applied to the glow plugs).

③ The preheating timer also controls the after-glow time, which is the length of time (T2) that the No. 2 glow plug relay is on.

④ While the engine is cranking, the preheating timer turns both the No. 1 and No. 2 glow plug relays on.

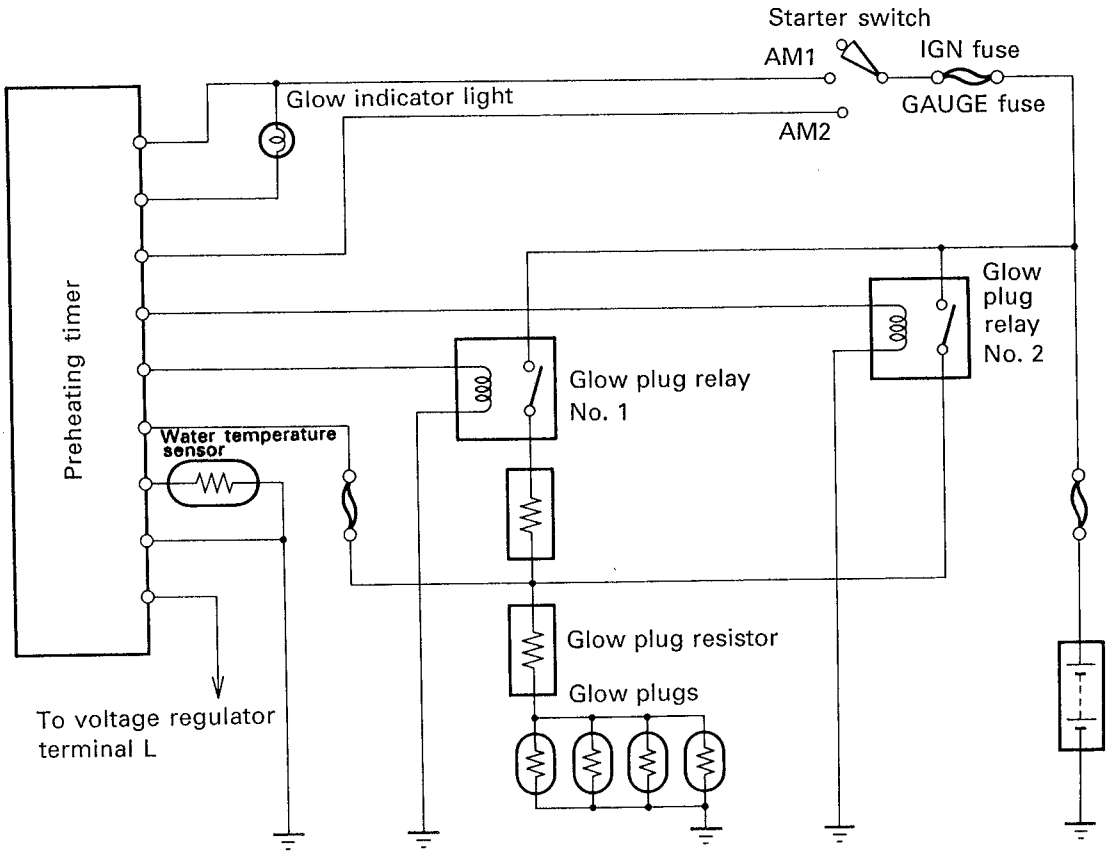




Starter switch		ON	START	ON
Engine	Off		Cranking	Running

SUMMARY OF PREHEATING & AFTER-GLOW OPERATIONS

6. OPERATION



① IGNITION SWITCH ON

a. When the ignition switch is turned on, the preheating timer is activated and lights the glow indicator light. It also turns on the No. 1 and No. 2 glow plug relays. The No. 1 and No. 2 glow plug relays cause current to flow to the glow plugs, and the glow plugs quickly heat up.

b. The preheating timer turns off the glow indicator light after the period of time determined by the coolant temperature has passed. The glow plug temperature rises to a high enough level to start the engine.

c. When a period of time determined by the voltage applied to the glow plugs passes, the preheating timer turns off the No. 1 glow plug relay. However, current flows from the No. 2 glow plug relay through the resistor in order to continue glow plug heating to maintain their temperature at a level which can start the engine.

d. Even if the ignition switch is accidentaly left in the ON position while the engine is not operating, preheating is stopped after 120 sec. when the coolant temperature is below 20°C (68°F). (The glow plugs are not heated under these circumstances when the coolant temperature is above 55°C (131°F). In this case, the glow indicator light goes on for only a moment.)

② ENGINE STARTING (CRANKING)

Turning the ignition switch to the START position causes the preheating timer to turn the No. 1 and No. 2 glow plug relays on, preventing the temperature of the glow plugs from dropping during starting, thus improving startability.

③ AFTER ENGINE STARTS

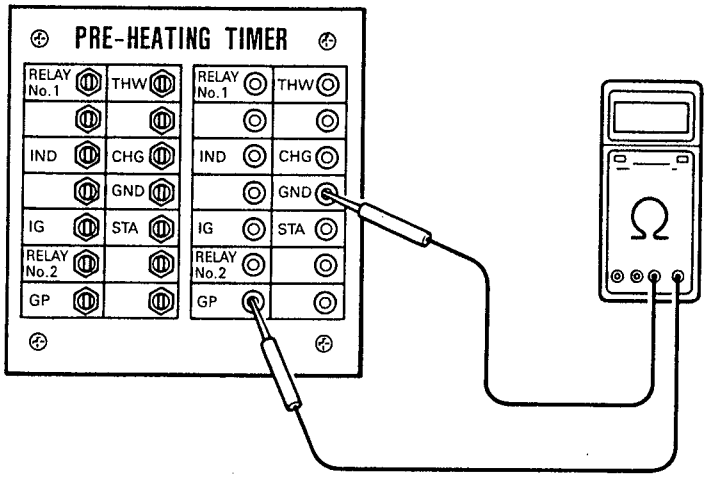
When the engine starts, the discharge warning light goes off. At this time, the preheating timer detects the signal from terminal L of the alternator and turns off the No. 1 glow plug relay. Because the preheating timer is still keeping the No. 2 glow plug relay on, current continues to flow from the battery to the glow plugs through the glow plug resistor to effect after-glow.

After-glow lasts for a period of time determined by the coolant temperature: it is maintained for 120 sec. after the engine starts when the coolant temperature is below 20°C (68°F). If the coolant temperature is 55°C (131°F) or higher, after-glow does not occur.

PRACTICE

MEASURE THE VOLTAGE

Measure the voltage at each of the terminals shown below under the specified conditions.



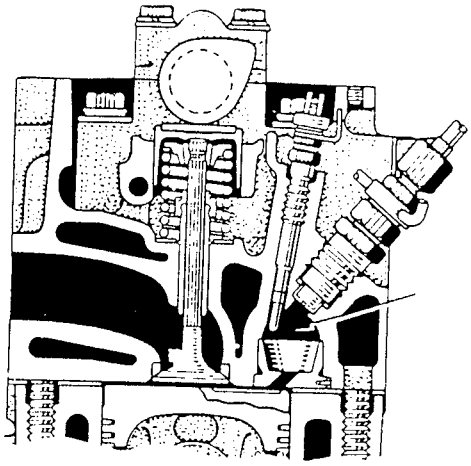
No.	TERMINAL	STD VOLTAGE (V)	LENGTH OF TIME AFTER IGNITION SWITCH ON	(V)
1	Relay No. 1 – GND	10 – 14	~ 10 ± 2 sec.	
		0	10 ± 2 sec. ~	
2	Relay No. 2 – GND	10 – 14	~ 120 ± 20 sec.*1	
		0	120 ± 20 sec. ~	
2	GP – GND	10 – 14	~ 10 ± 2 sec.	
		5 – 7	10 ± 2 ~ 120 ± 20 sec.*2	
		0	120 ± 20 sec. ~ *3	

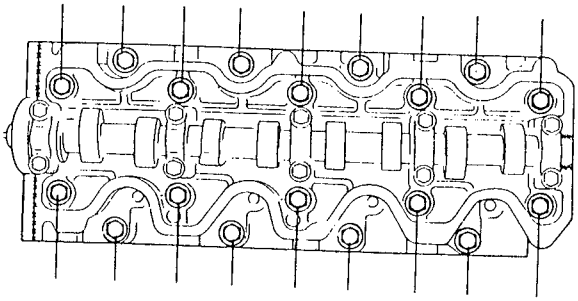
*1 Coolant temperature must be 20°C (68°F) or lower

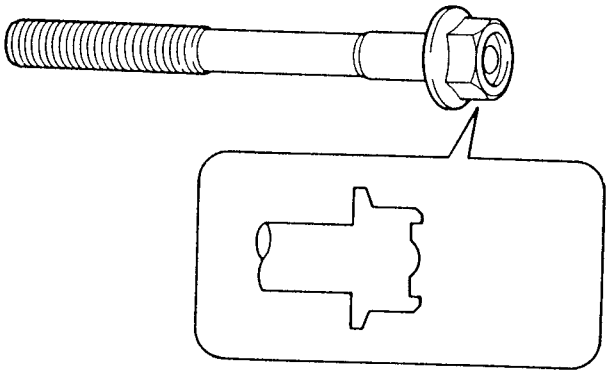
*2 Voltage changes in direct proportion to the voltage of Relay No. 1.

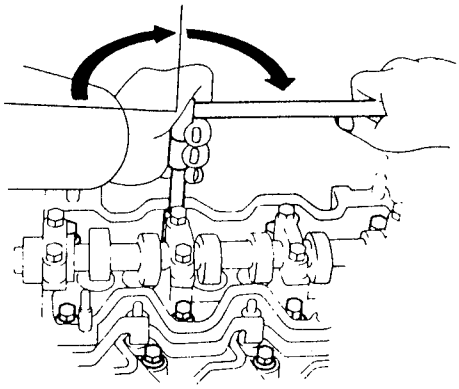
*3 Voltage changes in direct proportion to the voltage of Relay No. 2.

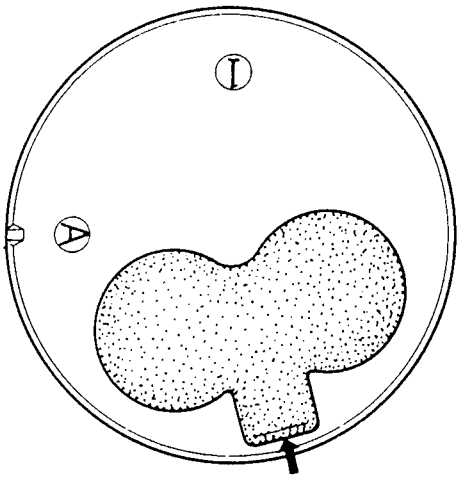
ILLUSTRATIONS

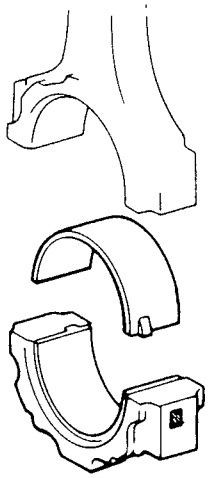


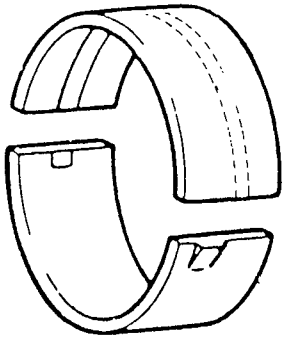


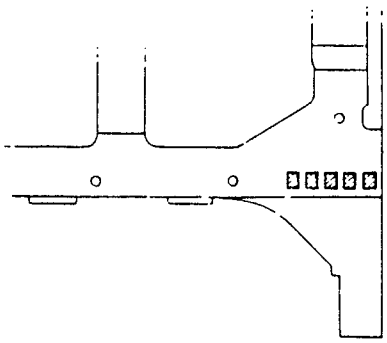


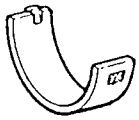


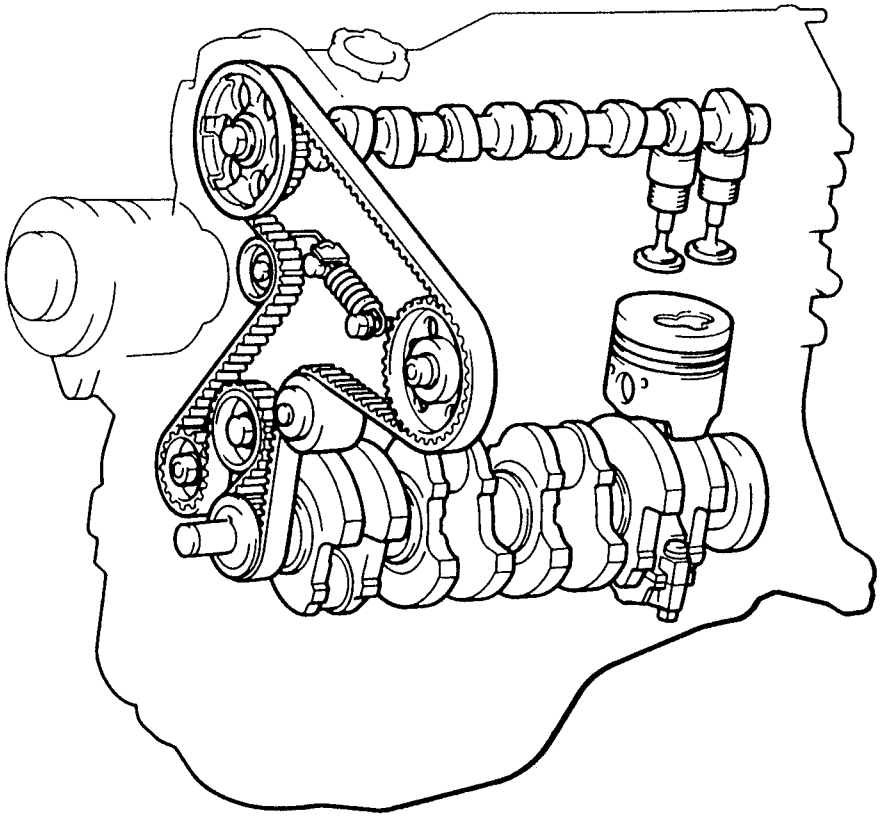












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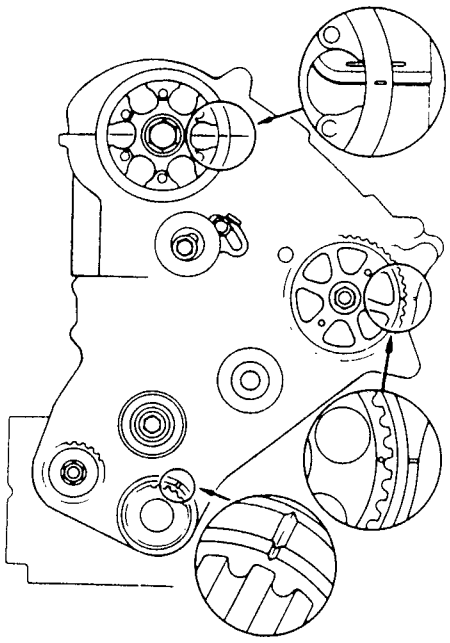

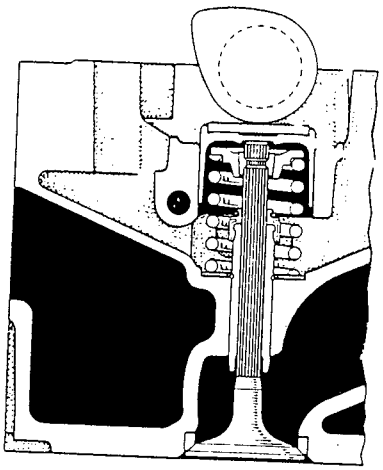

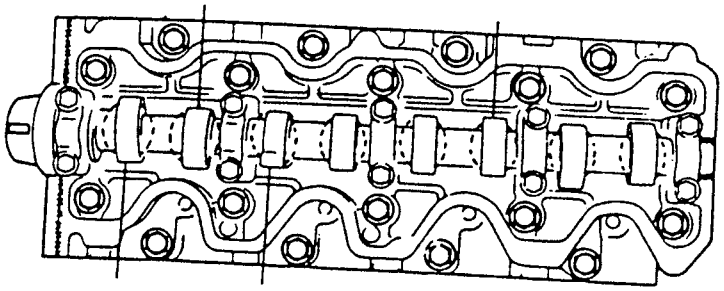

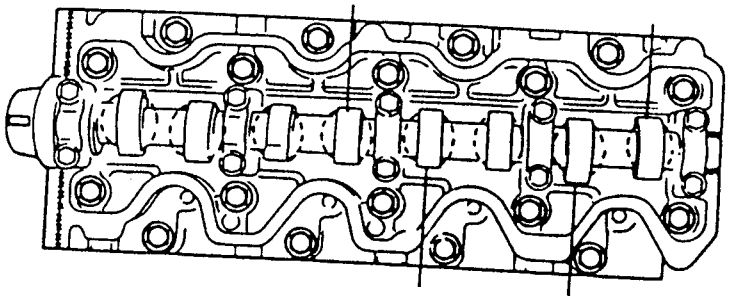

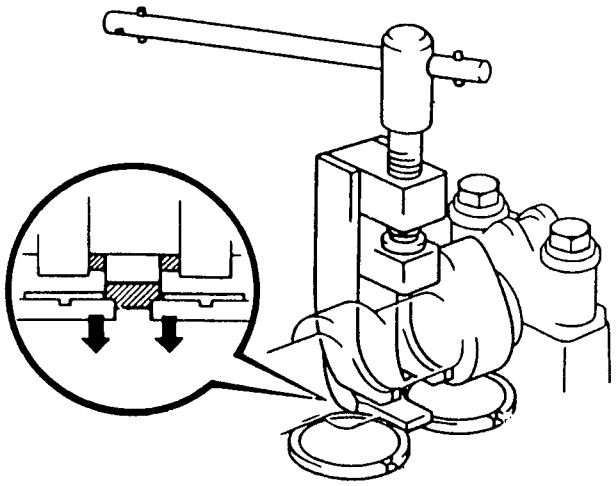

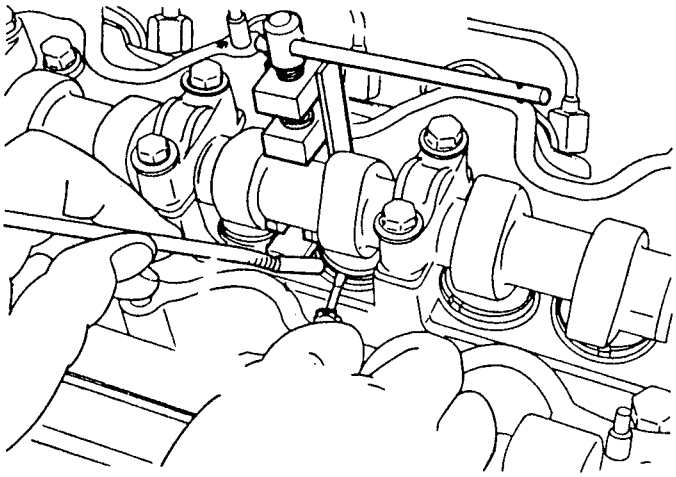

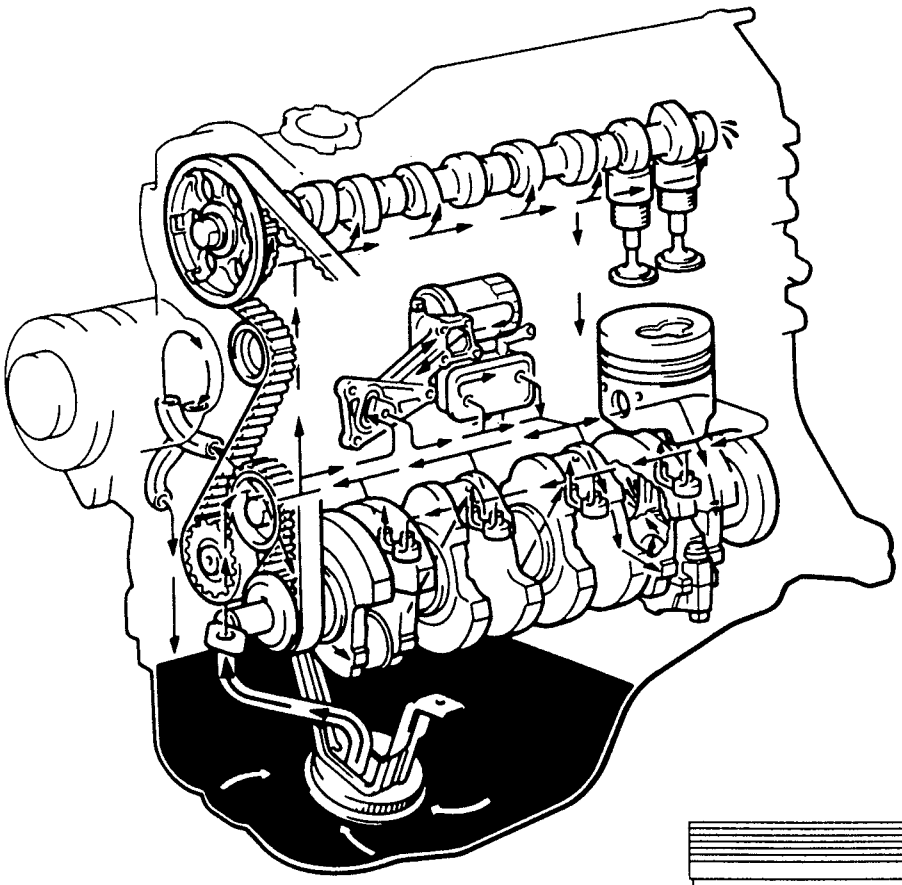

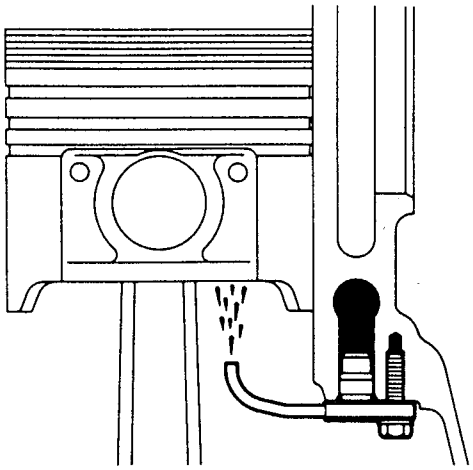

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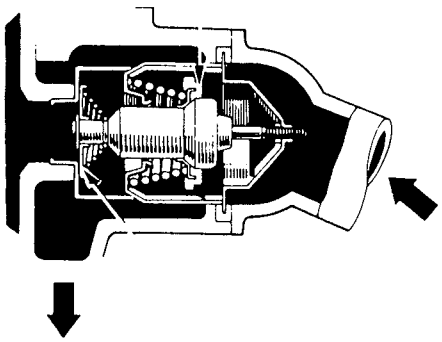

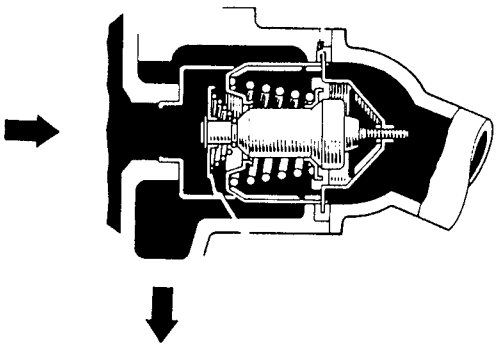

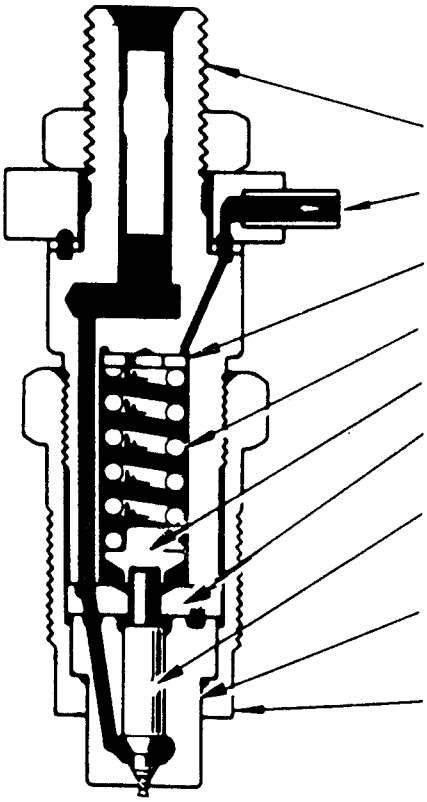

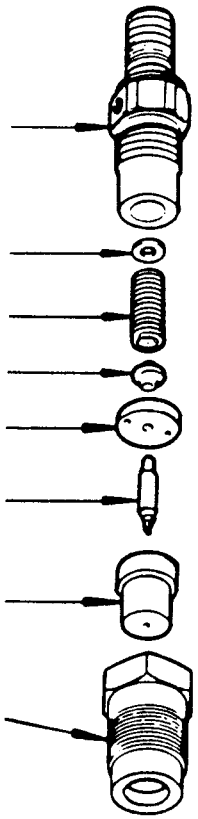

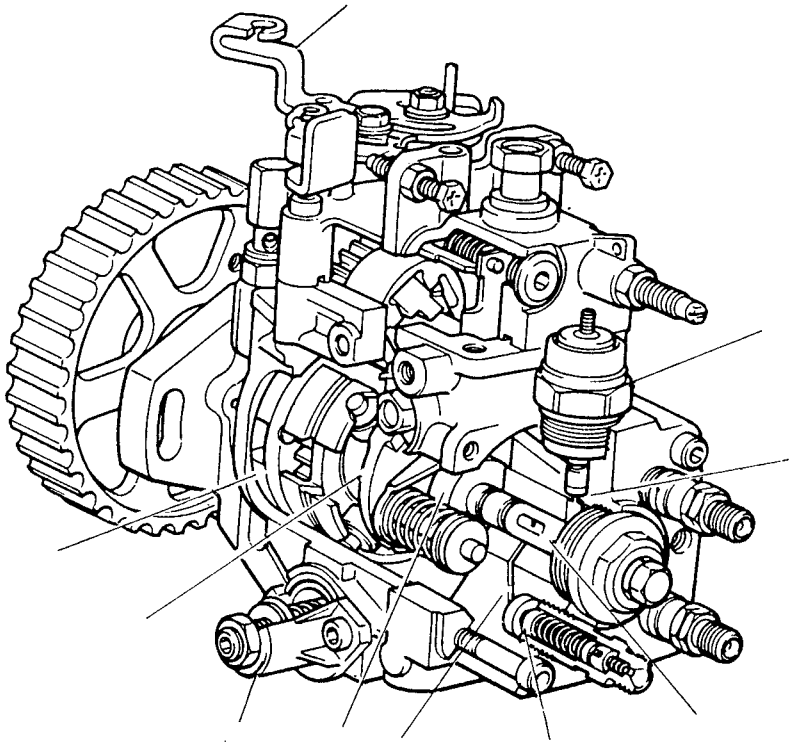

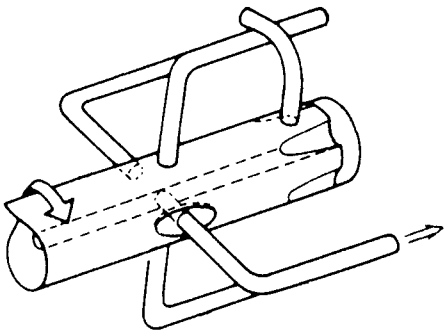

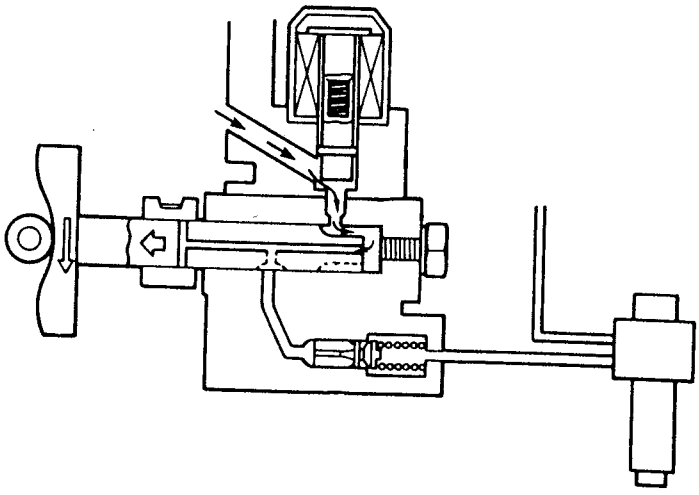

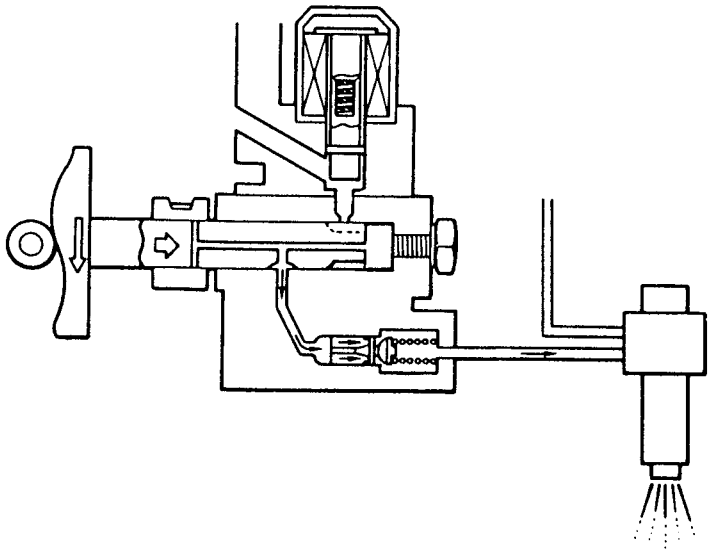

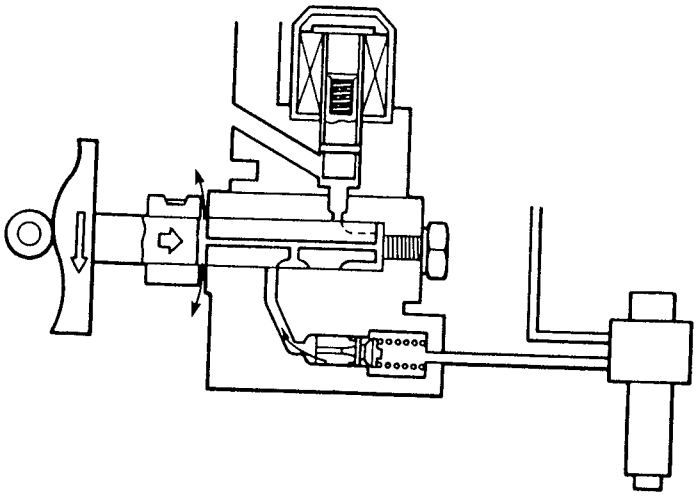

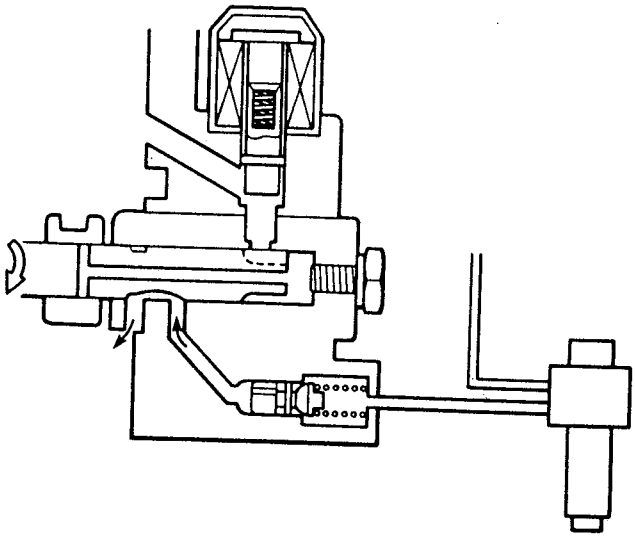

ELECTRICAL WIRING DIAGRAM FOR 2C ENGINE SIMULATOR