TOYOTA

B SERIES ENGINE

REPAIR MANUAL

Aug., 1980

INCLUDES
B, 2B & 3B

TOYOTA MOTOR SALES CO., LTD

Pub. No. 36047

FOREWORD

This repair manual has been prepared to provide information covering general service repair for the B, 2B and 3B engines equipped on the TOYOTA DYNA, COASTER and LAND CRUISER

Applicable models: *BU 20, 30 series*
BB 10 series
BJ 40, 42, 43, 45, 46, 60 series

For instructions on how to use this manual, please refer to page 1–4.
Specifications contained herein are based on the August, 1980 production model For specifications on other models, please refer to the respective Service Specification Manual

TOYOTA MOTOR SALES CO.,LTD.

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GENERAL REPAIR INSTRUCTIONS

1. Use fender, seat and floor covers to keep the car clean and prevent damage.
2. During disassembly, keep parts in order to facilitate reassembly.
3. Before performing electrical work, disconnect the cable from the battery terminal.
4. Always replace cotter pins, gaskets and O rings with new ones.
5. When necessary, use a sealer on gaskets to prevent leaks.
6. Carefully observe all specifications for bolt tightening torques. Always use a torque wrench.
7. Use genuine Toyota parts.
8. When replacing fuses, be sure the new fuse is the correct amperage rating. DO NOT exceed the fuse amp rating or use one of a lower rating.
9. If the vehicle is to be jacked up only at the front or rear end, be sure to block the wheels in order to ensure safety.
10. After the vehicle is jacked up, be sure to support it on stands. It is extremely dangerous to do any work on the vehicle raised on a jack alone, even for a small job that can be finished quickly.
11. Use of a special service tool (SST) may be required, depending on the nature of the repair. Be sure to use SST where specified and follow the proper work procedure. A list of SST can be found at the back of this manual.

ABBREVIATIONS USED IN TOYOTA REPAIR MANUALS

For convenience, the following abbreviations are used in Toyota repair manuals

Abbreviation	Term	Abbreviation	Term
A/T	Automatic Transmission	OPT	Option
BDC	Bottom Dead Center	O/S	Oversize
BTDC	Before Top Dead Center	RH	Right-hand
DHAC	Diesel High Altitude Compensator	RHD	Right-hand Drive
EDIC	Electrical Diesel Injection Control	SST	Special Service Tool
EX	Exhaust	STD	Standard
IN	Intake	T	Tightening Torque
LH	Left-hand	TDC	Top Dead Center
LHD	Left-hand Drive	U/S	Undersize
MP	Multipurpose	W/	With
M/T	Manual Transmission	W/O	Without

HOW TO USE THIS MANUAL

1. OVERVIEW ILLUSTRATION

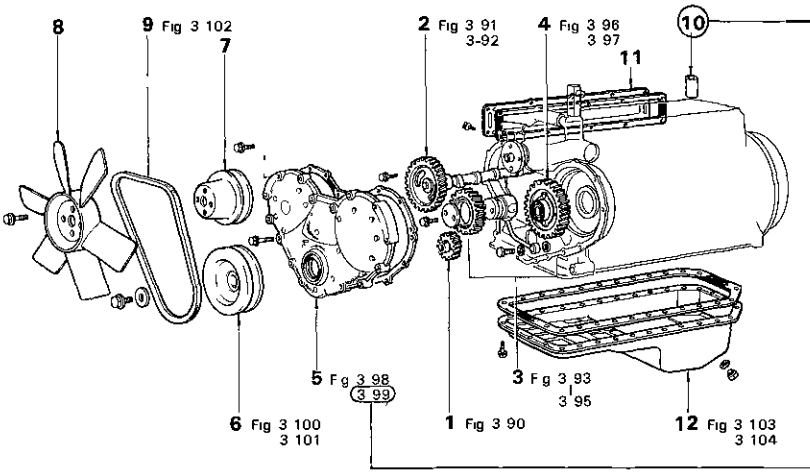
Many service operations begin with an overview illustration as a general guide

ASSEMBLY

Assemble the parts in the numerical order shown in the figure

Fig 3-89

–Note–
1 Thoroughly clean all parts to be assembled
2 Apply clean engine oil to all sliding and rotating surfaces of the parts before assembly



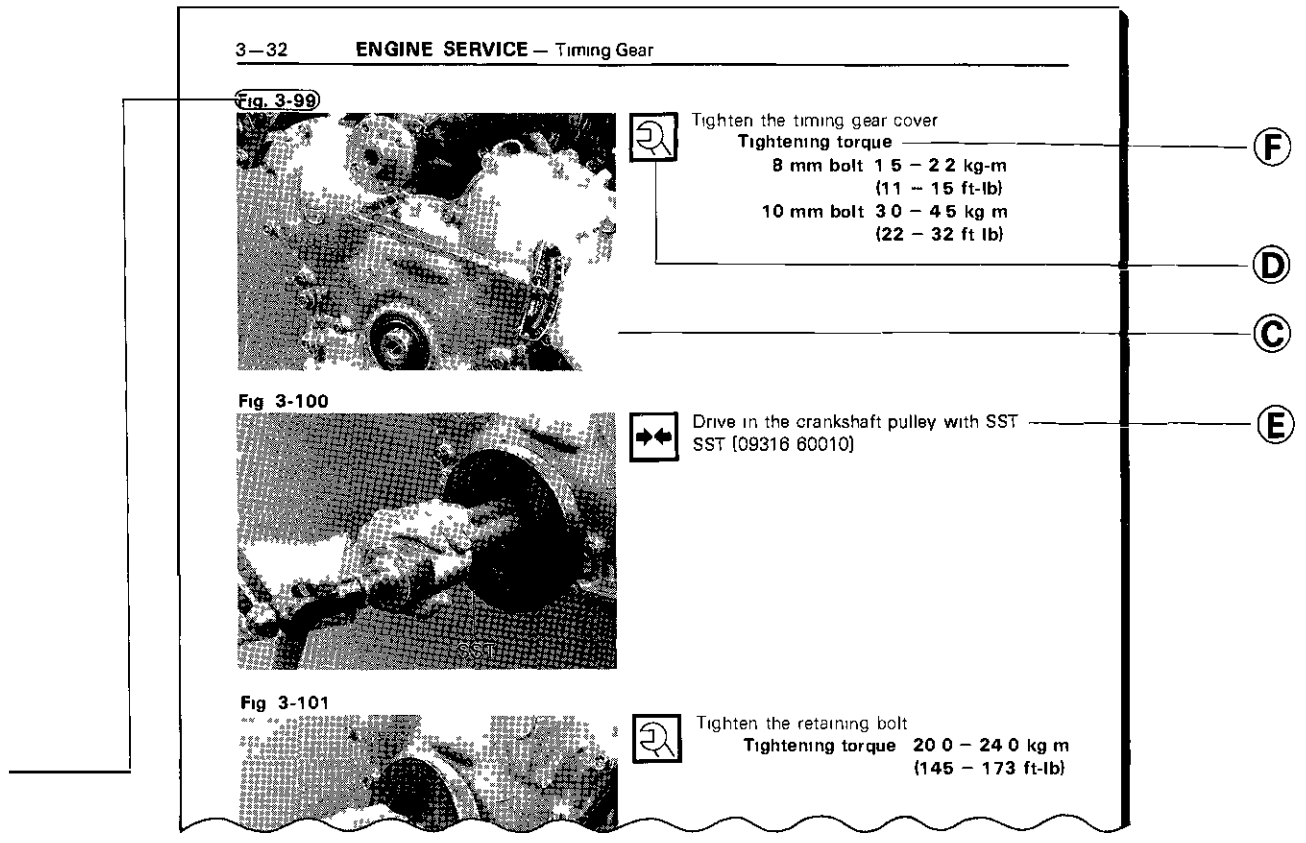
1	Crankshaft Timing Gear	7	Fan Pulley
2	Camshaft & Timing Gear	8	Cooling Fan
3	Idle Gear & Shaft	9	V Belt

Ⓐ : The bold numbers indicate the order in which the work is to be done

Ⓑ : The figure numbers refer you to more detailed instructions and specifications

2. ILLUSTRATED INSTRUCTIONS

All important steps in every service job are illustrated Obvious steps are omitted to save space Experienced technicians may only need to glance at the overview illustration and/ or specifications



Ⓒ : The pictures give basic information on what to do in each step

Ⓓ : A symbol is often used to explain the action required

Ⓔ : The text explains how to perform the step

Ⓕ : Specifications, Notes and Cautions are given in bold type so you won t miss them

SYMBOLS

The following symbols have been adopted for simplicity and for easy comprehension

REMOVE or DISASSEMBLE

INSTALL or ASSEMBLE

INSPECT

MEASURE

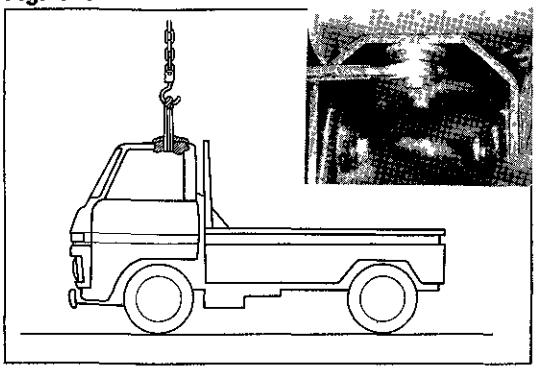
TIGHTEN

CLEAN

IMPORTANT

FRONT CAB TILT PROCEDURE (FOR DYNA SERIES)

Fig. 1-1



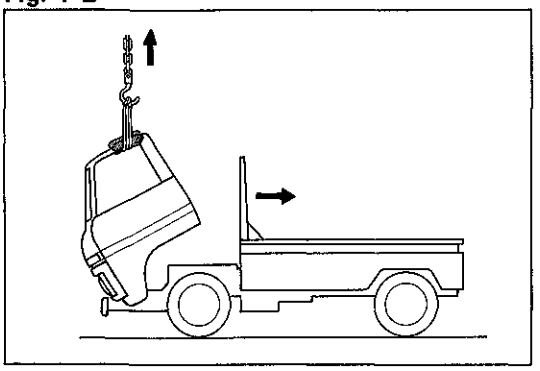
When it is necessary to tilt the cab to perform major maintenance procedures, either of the following two methods may be used

—Note—
Insure working safety at all times.

HOIST METHOD

1 Remove the cab mounting bolts
2 Install the hoist to the cab

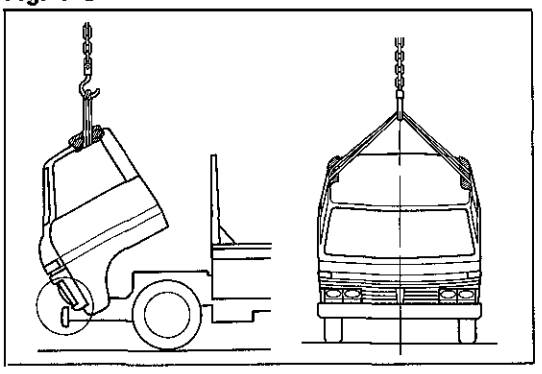
Fig. 1-2



3 Insuring that the hoist is kept perpendicular, tilt the cab by slowly pushing the vehicle backwards

—Note—
Be careful not to damage any wiring or hoses.

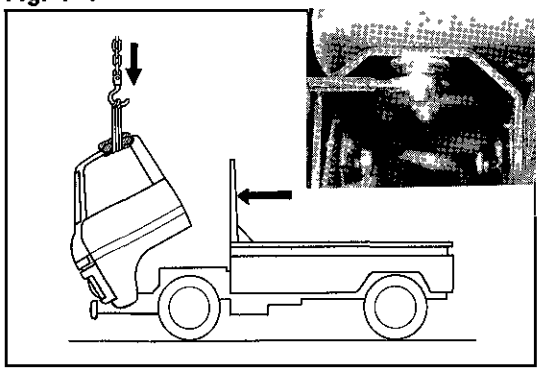
Fig. 1-3



4 Insure that there is no interference between the front grill and bumper

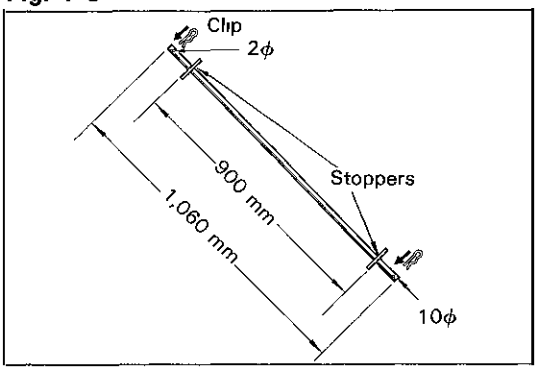
—Note—
Always keep the cab supported by the hoist during work.

Fig. 1-4



5 To lower the cab, slowly push the vehicle forward
6 Install the mounting bolts after the cab has fully returned to its original position

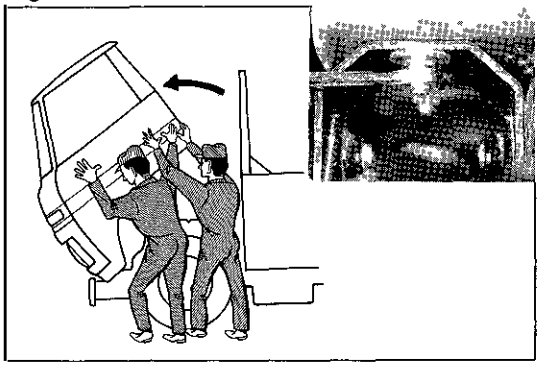
Fig. 1-5



LOCKING STAY METHOD

1 In advance prepare a locking stay as shown in the figure
- Thickness 10 mm (0 39 in)
- Length 1,060 mm (41 73 in)
- Clip (clutch release bearing clip) part no 31232 30010
- Weld two stoppers positioned 900 mm (35 43 in) apart
- Drill a 2 mm hole at each end

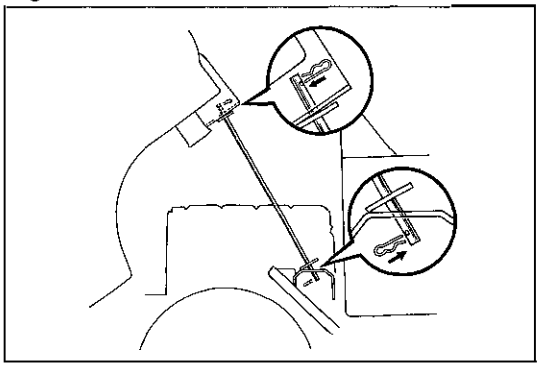
Fig. 1-6



2 Remove the cab mounting bolts
3 With 2 persons on both the left and right side, lift the upward

—Note—
Be careful not to damage any wiring or hoses.

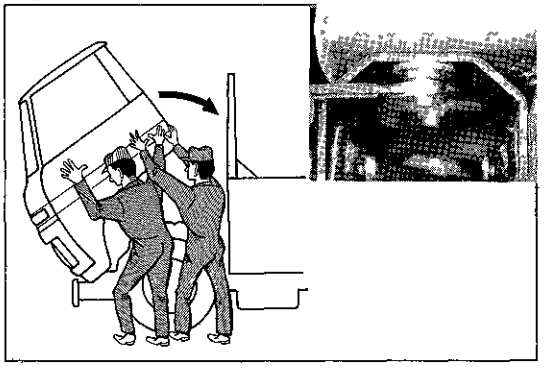
Fig. 1-7



4 Insuring that there is no interference between the front bumper and grill install the locking stay in the mounting bolt holes

—Note—
Be careful that the cab does not overturn.

Fig. 1-8



5 After necessary work is completed the cab should be lowered slowly by four persons
6 Install the mounting bolts after the cab has been fully lowered to its original position

ENGINE TUNE-UP

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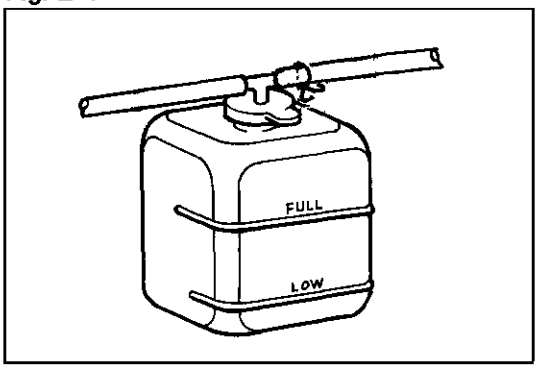
ENGINE TUNE-UP ITEMS

	ITEM		REMARKS
1	COOLING SYSTEM	Coolant level	Full line
		Coolant quality	
		Leakage	
		Radiator cap valve opening pressure STD	0.75 – 1.05 kg/cm² (10.7 – 14.9 psi)
		Limit	0.6 kg/cm² 8.5 psi
		Coolant capacity (w/ Heater)	
		BJ40, 42, 43, 45 & 46 Series	12.5 liters 13.2 US qt 11.0 Imp.qt
		BJ60 Series	13.3 liters 14.1 US qt 11.7 Imp.qt
		BU20, 30 Series	13.1 liters 13.8 US qt 11.5 Imp.qt
		BB10 Series	14.5 liters 15.3 US qt 12.8 Imp.qt
2	DRIVE BELT	(For General)	
		Deflection at 10kg (22lb) force	
		w/o Air con.	
		New belt	8 – 12 mm 0.31 – 0.47 in.
		Used belt	11 – 14 mm 0.43 – 0.55 in.
		w/ Air con. (BB10)	
		New belt	10 – 13 mm 0.39 – 0.51 in.
		Used belt	12 – 15 mm 0.47 – 0.59 in.
		(For Canada)	
		Borroughs belt tension gauge	
		No. BT-33-73F New belt	120 – 170 lb
		Used belt	80 – 120 lb
3	AIR CLEANER	Clean element	
		Oil capacity (Oil bath type)	Indicated level
4	BATTERY	Specific gravity	1.25 – 1.27 at 20°C (68°F)
		Electrolyte level	
5	OIL FILTER	Replacement	
		Cartridge type	SST [09228-44010]
		Paper element type	
6	ENGINE OIL	Oil level	F line
		Oil quality	
		Replenishment	
		Oil capacity	API service CC-CD classification
		Dry fill	7.3 liters 7.7 US qt 6.4 Imp.qt
		Drain & refill w/ Oil filter	6.7 liters 7.1 US qt 5.9 Imp.qt
		w/o Oil filter	5.8 liters 6.1 US qt 5.1 Imp.qt

	ITEM			REMARKS	
7	FUEL FILTER	Replacement			
		Cartridge type		SST [09228-34010]	
		Element type			
		Air bleeding			
8	INJECTION PUMP	Lubricate diaphragm housing		3 or 4 drops of diaphragm oil	
9	COMPRESSION PRESSURE				
		at 250 rpm	STD	30.0 kg/cm^2	427 psi
			Limit	20.0 kg/cm^2	284 psi
		Difference between each cylinder		Less than 2.0 kg/cm^2	(28 psi)
10	INJECTION NOZZLE	Opening pressure			
		New nozzle		115 – 125 kg/cm^2	
				(1,636 – 1,778 psi)	
		Reused nozzle		105 – 125 kg/cm^2	
				(1,493 – 1,778 psi)	
		Spray condition		4°conical form	
		Leakage test		at 90 kg/cm^2	1,280 psi
		Cleaning			
11	INJECTION TIMING	Stationary		14° BTDC	
		Air bleeding			
		Fuel filter			
		Injection pump			
		High pressure pipe			
12	VALVE CLEARANCE	Hot	Intake	0.20 mm	0.008 in.
			Exhaust	0.36 mm	0.014 in.
13	IDLE SPEED			650 rpm	
14	MAXIMUM SPEED	No-load		4,050-4,100 rpm	
15	PREHEATING SYSTEM	Glow time at 0°C (32°F)		About 15 seconds	
		Load current per			
		one glow plug			
		BJ60	12V type	7.2 – 9.8 A	
			24V type	3.8 – 5.2 A	
		others	12V type	7.6 – 10.4 A	
			24V type	4.1 – 5.5 A	
		Glow plug resistance			
		BJ60	12V type	1.2 Ω	
			24V type	5.1 Ω	
		others	12V type	0.9 Ω	
			24V type	4.3 Ω	

COOLING SYSTEM

Fig. 2-1



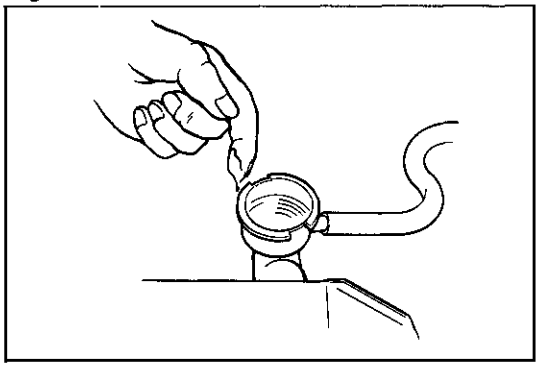
CHECK COOLANT LEVEL

If low, fill reservoir to FULL line

—Note—

To maintain freeze protection, use a recommended anti-freeze.

Fig. 2-2

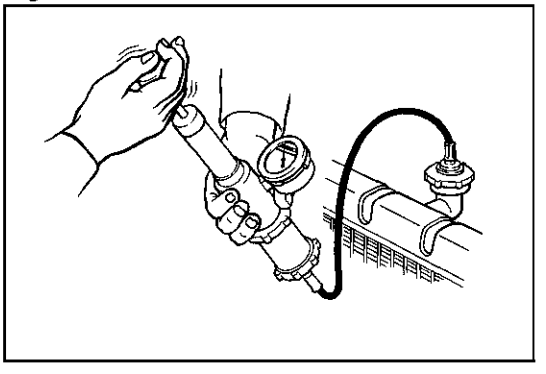


CHECK COOLANT QUALITY

Check for

1 Coolant cleanliness
2 Rust or scale deposits around the radiator cap and filler neck
3 Entry of oil

Fig. 2-3

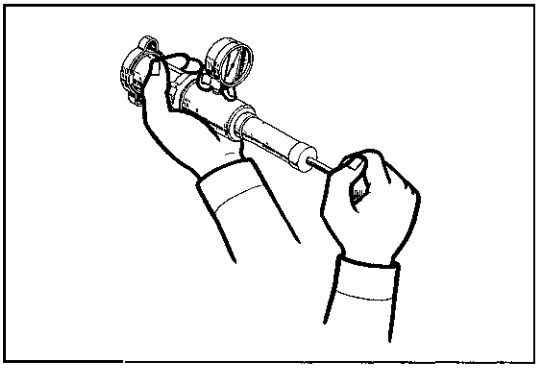


CHECK COOLING SYSTEM PARTS

Check for

1 Damaged or deteriorated radiator and water hoses
2 Loose hose clamps
3 Damaged or corroded radiator core
4 Leakage from the water pump radiator core or loose water drain cock

Fig. 2-4



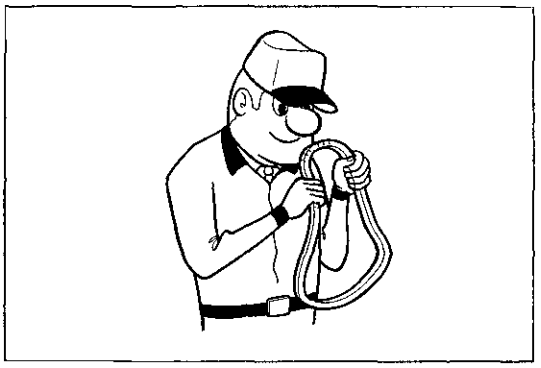
5 Faulty operation of radiator cap

Inspect the spring tension and seating condition of the radiator cap vacuum valves If the valve opens at a pressure below specification or is otherwise defective replace the radiator cap

Valve opening pressure:

STD	**0.75 – 1.05 kg/cm² (10.7 – 14.9 psi)**
Limit	**0.6 kg/cm² (8.5 psi)**

Fig. 2-5



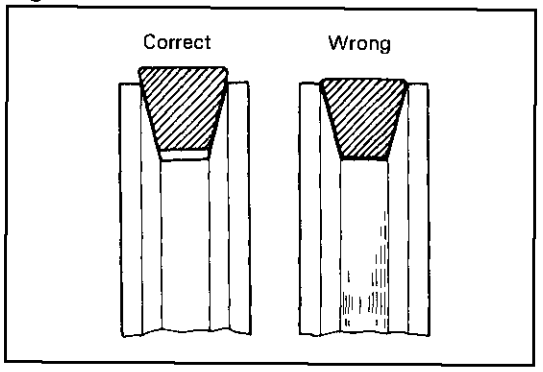
DRIVE BELT

VISUAL CHECK

Check for

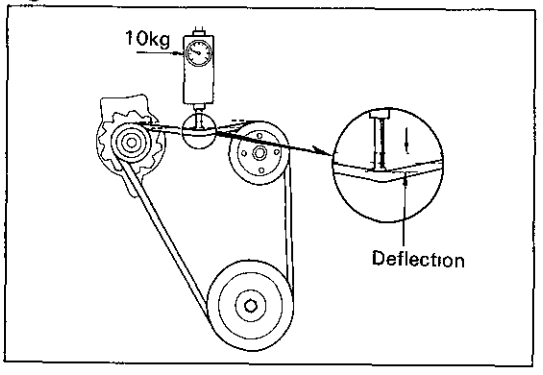
1 Cracks, deterioration, stretching or wear
2 Adherence of oil or grease

Fig. 2-6



3 Improper belt-to-pulley contact

Fig. 2-7



CHECK BELT TENSION

For General Destination

Press on the belt at the point indicated in the figure with 10 kg (22 lb) of force. The belt should deflect the amount specified

Drive belt tension:

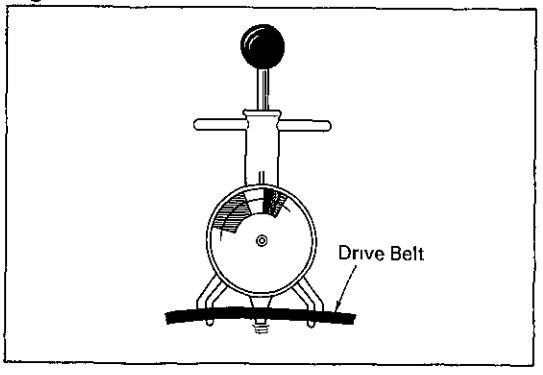
w/o Air con.

New belt	**8 – 12 mm (0.31 – 0.47 in.)**
Used belt	**11 – 14 mm (0.43 – 0.55 in.)**

w/ Air con. (BB10)

New belt	**10 – 13 mm (0.39 – 0.51 in.)**
Used belt	**12 – 15 mm (0.47 – 0.59 in.)**

Fig. 2-8



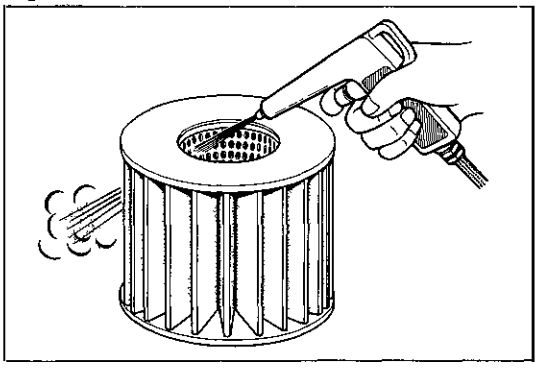
For Canada

Using a time borroughs tension gauge BT-33-73F adjust the following value

Drive belt tension:

New belt	**120 – 170 lb**
Used belt	**80 – 120 lb**

Fig. 2-9



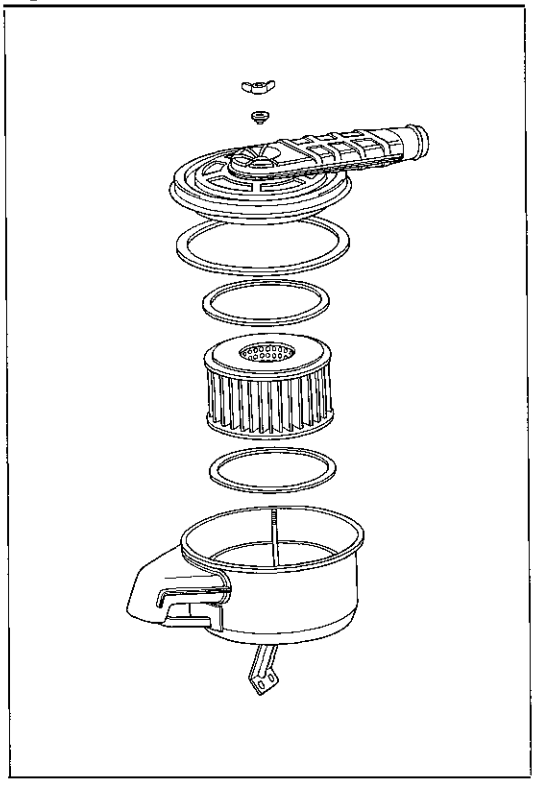
AIR CLEANER

[Paper Element & Cyclone Type]

CLEAN ELEMENT

1 Remove the air cleaner
2 Remove the element and blow compressed air from inside
3 Replace the element with a new one if torn or excessively dirty

Fig. 2-10



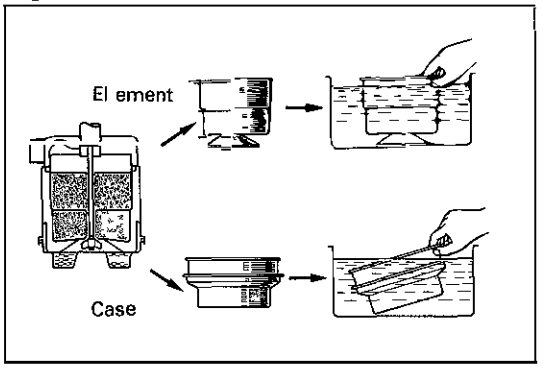
VISUAL CHECK

Check for
1 Damaged worn or deteriorated gaskets
2 Damaged or worn seal washer

INSTALL AIR CLEANER

1 Install the gaskets
2 Finger tighten the stay
3 After installing the element, set the air cleaner cap
4 Tighten the wing nut and stay
5 Connect the hoses to air cleaner

Fig. 2-11

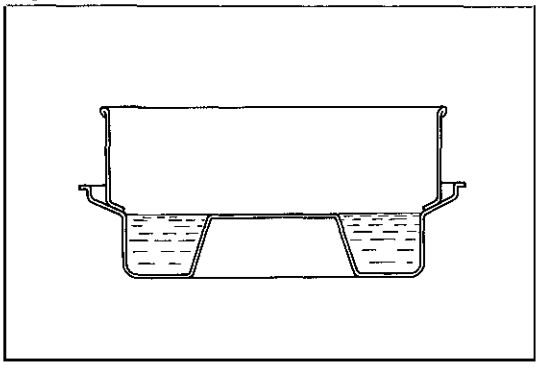


[Oil Bath Type]

CLEAN ELEMENT

1 Remove the air cleaner and element
2 Wash the element and case with kerosene and dry them thoroughly

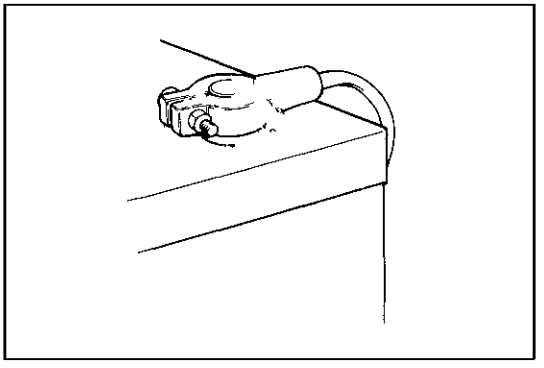
Fig. 2-12



INSTALL AIR CLEANER

1 Refill the cap up to the indicated level with clean engine oil
2 Saturate the element with clean engine oil
3 Install the cap and element
4 Tighten the air cleaner on the air cleaner support and connect the hoses to air cleaner

Fig. 2-13



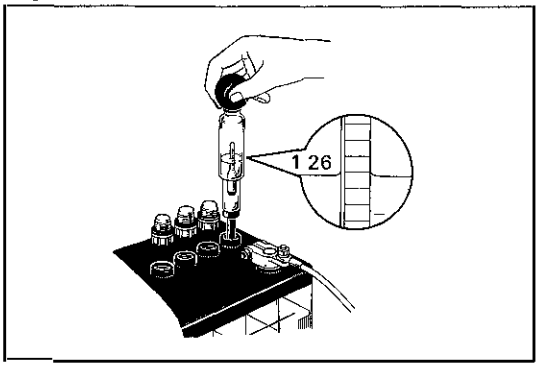
BATTERY

VISUAL CHECK

Check for

1 Rusted battery support
2 Loose terminal connections
3 Rusted or deteriorated terminals
4 Damaged or leaking battery

Fig. 2-14

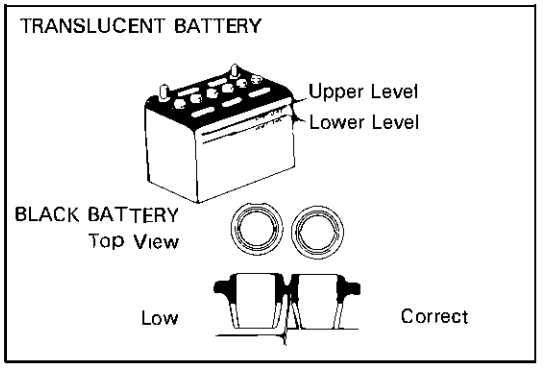


MEASURE SPECIFIC GRAVITY

Check the specific gravity of electrolyte with a hydrometer

Specific gravity:
1.25 – 1.27 at 20°C (68°F)

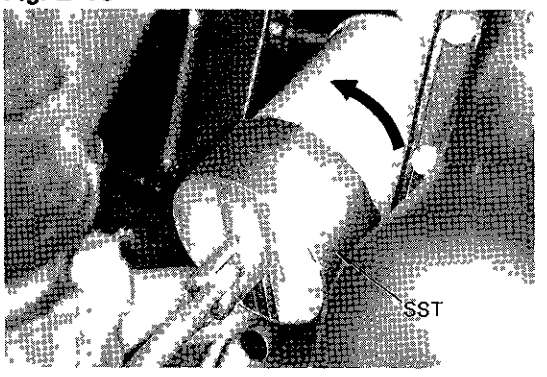
Fig. 2-15



CHECK ELECTROLYTE LEVEL

Check the electrolyte quantity
Refill with distilled water, if insufficient

Fig. 2-16



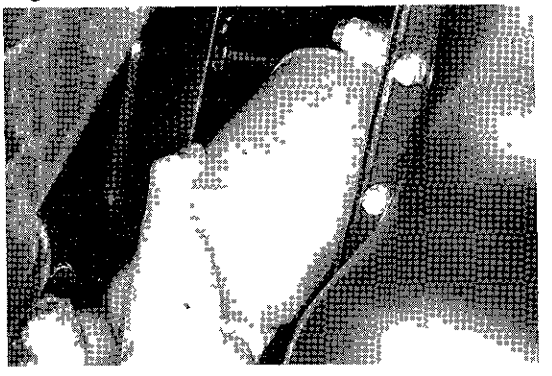
OIL FILTER

REPLACEMENT

[Cartridge Type]

1 Remove the oil filter with SST
SST [09228-44010]

Fig. 2-17

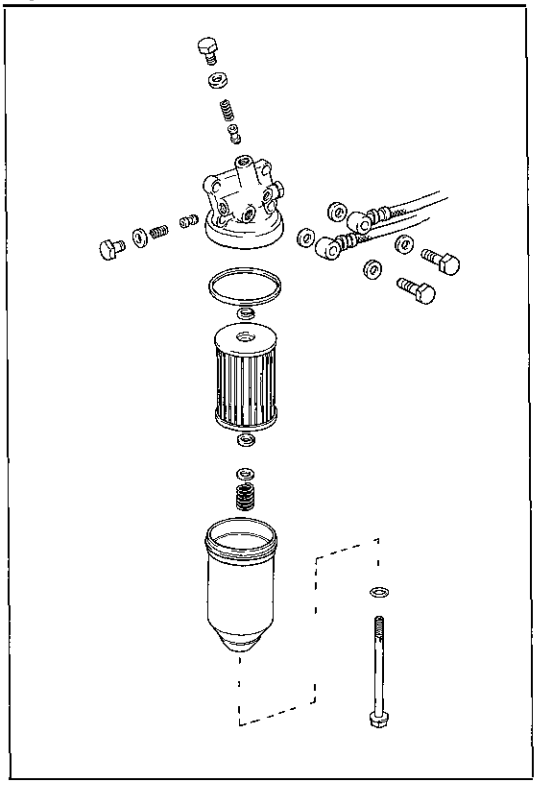


2 Install a new filter and tighten it firmly by hand

—Note—
Do not tighten the filter with SST or a wrench.

3 Start the engine and check for oil leakage
4 Stop the engine and recheck the oil level

Fig. 2-18



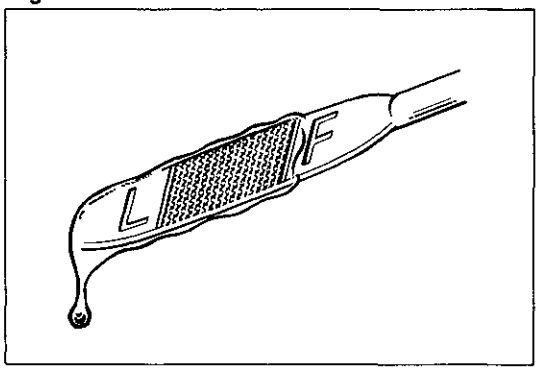
[Paper Element Type]

Refer to LUBRICATION SYSTEM section

—Note—

1. **Use new gaskets. Assemble the filter body gasket with the rounded end facing upward (toward cap).**
2. **After starting the engine, check for oil leaks and recheck the oil level.**

Fig. 2-19



ENGINE OIL

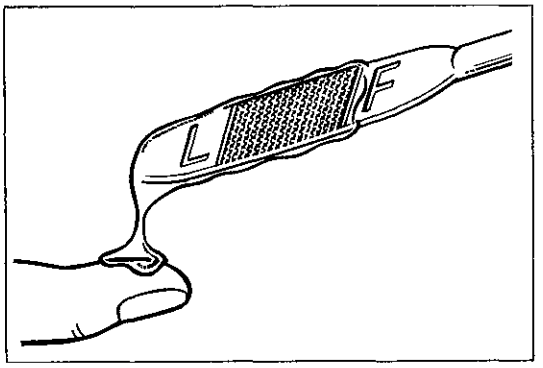
CHECK OIL LEVEL

The oil level should be between the L and F lines If low check for leakage and add oil up to the F mark

–Note–

Use API service CC-CD classification engine oil.

Fig. 2-20

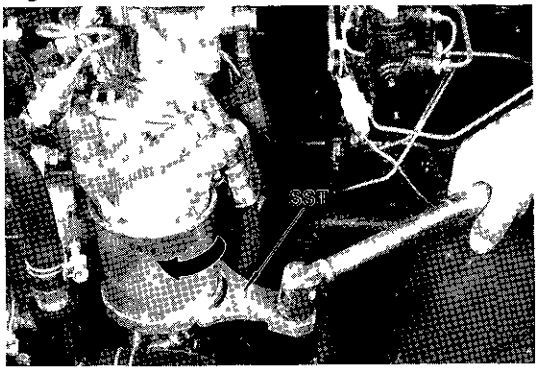


CHECK OIL QUALITY

Check for

1 Deterioration
2 Entry of water
3 Discoloration or thinning

Fig. 2-21



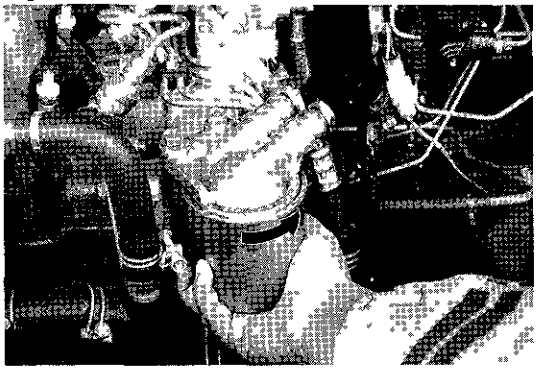
FUEL FILTER

REPLACE FUEL FILTER

[Cartridge Type]

1 Remove the fuel filter with SST
SST [09228 34010]

Fig. 2-22

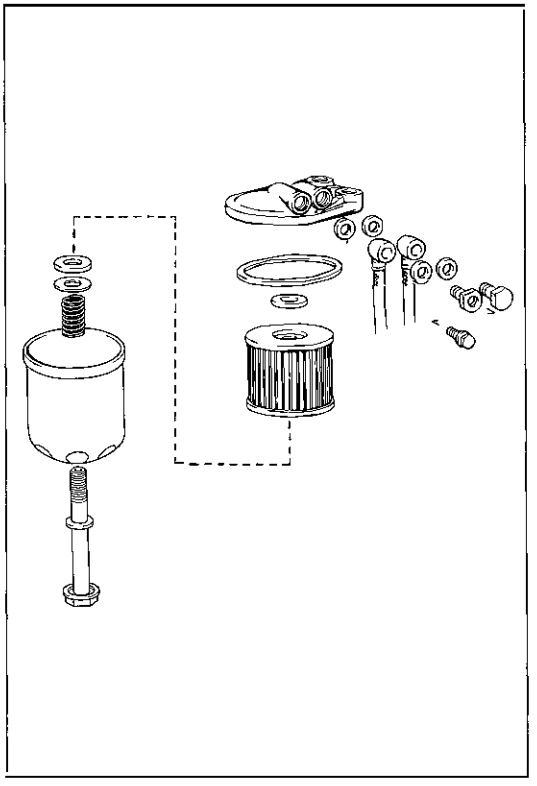


2 Install a new filter and tighten it by hand

–Note–

1. **After bleeding the air, tighten the filter firmly by hand.**
2. **Be careful that fuel does not splash onto the radiator hose.**

Fig. 2-23



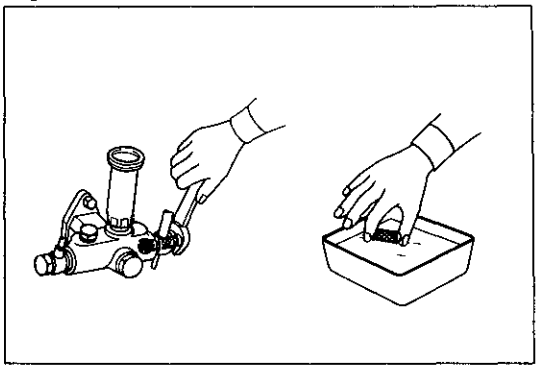
[Element Type]
Refer to FUEL SYSTEM section

—Note—
1. **Use new gaskets.**
2. **Do not damage the element by over-tightening the filter case set bolt.**

Fig. 2-24

BLEED AIR
[for Both Types]
1 Bleed the air from fuel filter by operating the priming pump
2 After starting the engine check for oil leaks

Fig. 2-25



[Feed Pump Filter]
Remove the inlet union and clean the filter

Fig. 2-26

INJECTION PUMP

LUBRICATE DIAPHRAGM HOUSING

Place 3 or 4 drops of diaphragm oil to the diaphragm

—Note—

Before lubricating the diaphragm, make sure that there is no fuel nor engine oil in the governor chamber. If necessary, drain the fuel or engine oil by loosening the drain bolt.

Fig. 2-27

COMPRESSION PRESSURE

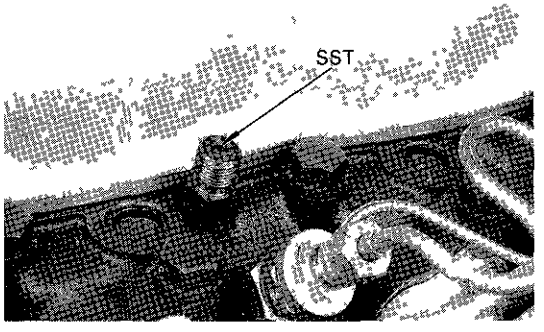
⚠

1 Warm-up the engine
2 Remove all glow plugs

—Note—

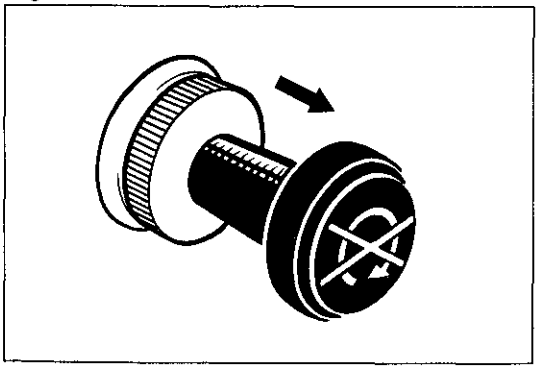
Make sure that the lead wire is not grounded.

Fig. 2-28



3 Install SST to the glow plug mounting hole and insert a compression gauge
SST [09992 00021]

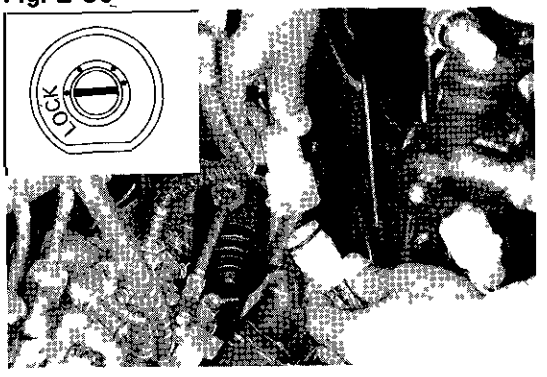
Fig. 2-29



[Without EDIC System]

4 Pull the stop button all the way out

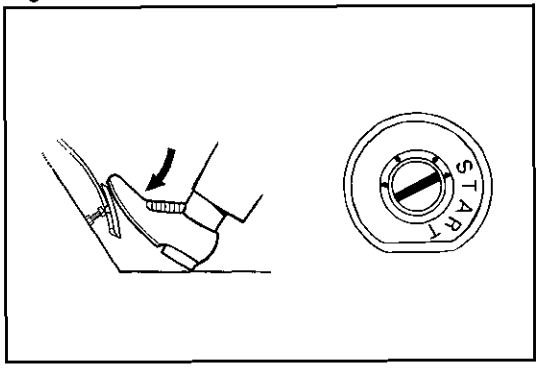
Fig. 2-30



[With EDIC System]

4 Turn the starter switch to LOCK position and then disconnect the EDIC motor wire connector

Fig. 2-31



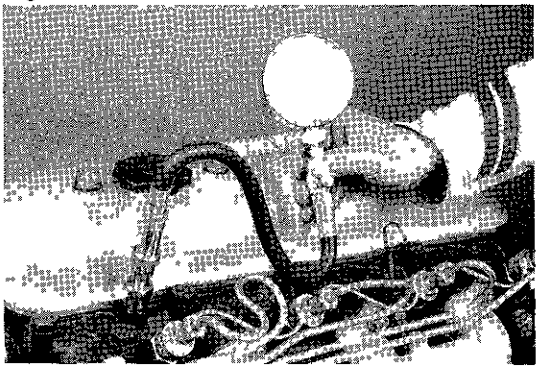
5 Depress the accelerator pedal all the way down

6 Measure the compression pressure while cranking the engine with the starter motor

—Note—

Keep pressure measuring time to a minimum.

Fig. 2-32



Cranking speed: 250 rpm

Compression pressure:

STD 30.0 kg/cm² (427 psi)

Limit 20.0 kg/cm² (284 psi)

Difference between each cylinder:

Less than 2.0 kg/cm² (28 psi)

Fig. 2-33

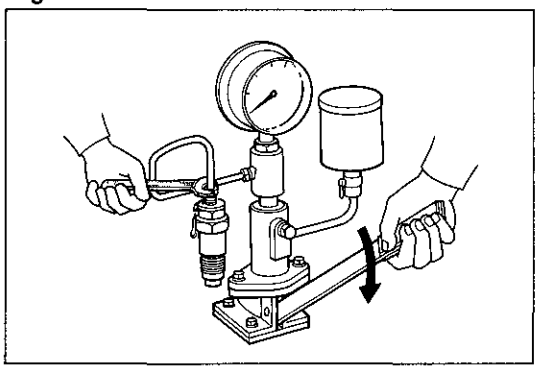


Fig. 2-34

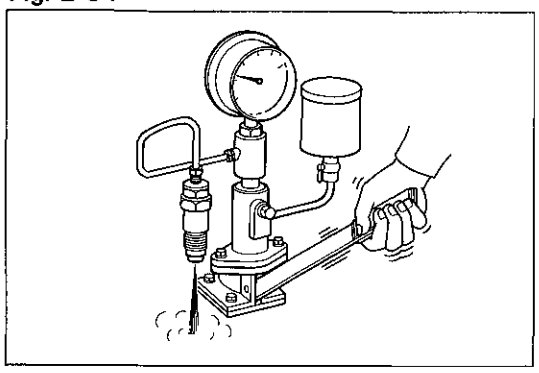


Fig. 2-35

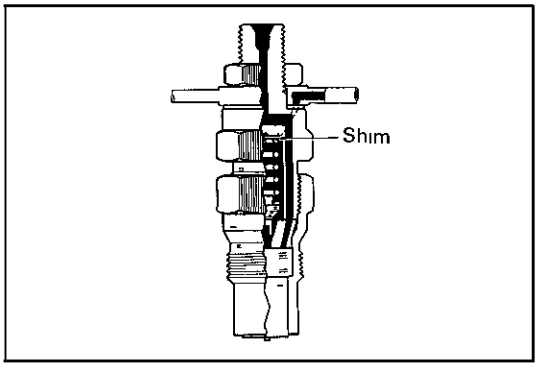
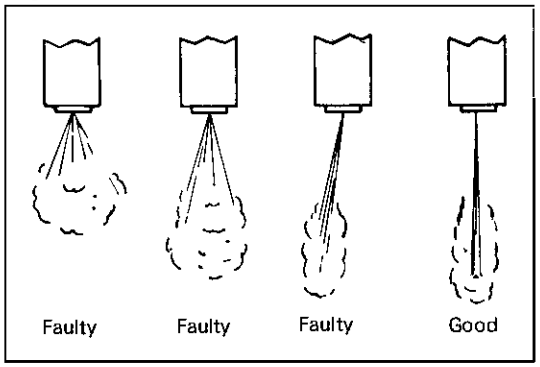


Fig. 2-36



INJECTION NOZZLE

(SPRAY TEST)

1 Install the nozzle to an injection nozzle hand tester and bleed air from the union nut

2 Check injection pressure
- (1) Pump the tester handle 50 – 60 times per minute by hand
- (2) Read the injection starting pressure

Opening pressure:
New nozzle
115 – 125 kg/cm² (1,636 – 1,778 psi)
Reused nozzle
105 – 125 kg/cm² (1,493 – 1,778 psi)

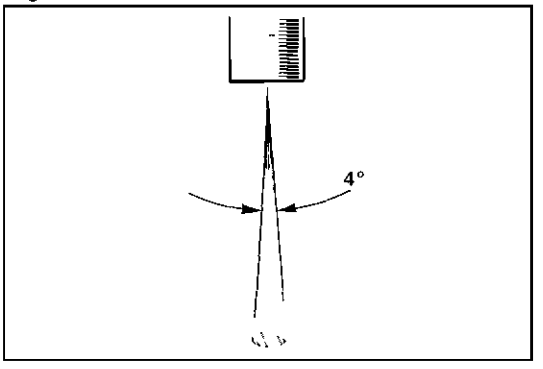
–Note–
1. **Proper nozzle operation can be determined by a swishing sound.**
2. **If an overhauled nozzle is being used, adjust the injection starting pressure to 110 – 125 kg/cm² (1,565 – 1,778 psi).**

3 To adjust the injection pressure, change the shim on the top of pressure spring

–Note–
1. **Shims are available in 20 sizes, in increments of 0.05 mm (0.0020 in.), from 1.00 – 1.95 mm (0.0394 – 0.0768 in.).**
2. **Varying the adjusting shim thickness by 0.05 mm (0.0020 in.) changes the injection pressure by about 5 kg/cm² (71 psi).**

4 Check spray patterns
- (1) Check the spray patterns when pumping the tester handle 50 – 60 times per minute by hand

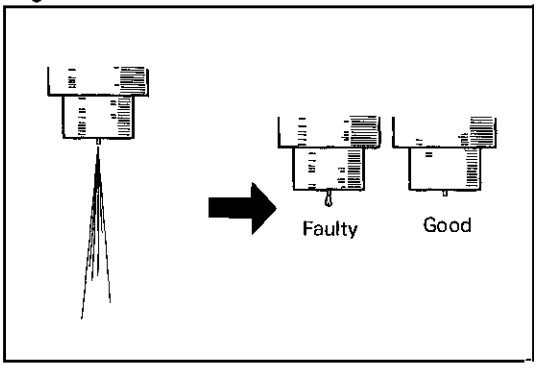
Fig. 2-37



(2) Spray should spread evenly down the nozzle center line in 4° conical form

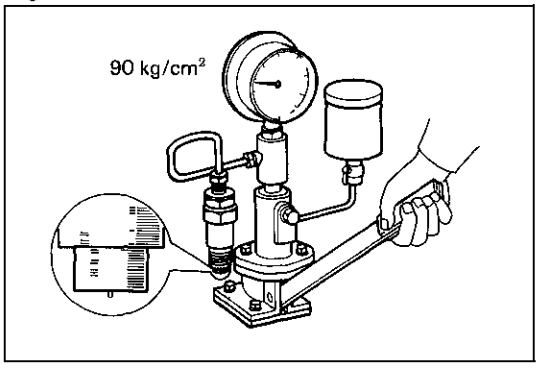
(3) Place a white sheet of paper about 30 cm (11.8 in) away from the nozzle to check if spray pattern is in circular form

Fig. 2-38



5 There should be no dripping after injection

Fig. 2-39



6 Test leakage
Apply 90 kg/cm² (1 280 psi) of fuel pressure and check for leaks at the nozzle valve seat and retaining nut

Fig. 2-40

SEE

FUEL SYSTEM

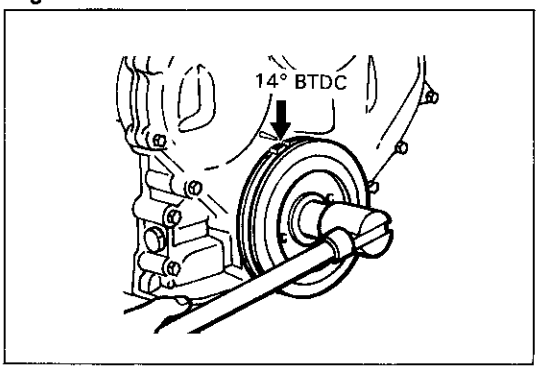
NOZZLE CLEANING SECTION

Fig. 6-32 to 6-38

NOZZLE CLEANING

Disassemble the nozzle holder and clean it with a nozzle cleaning kit

Fig. 2-41



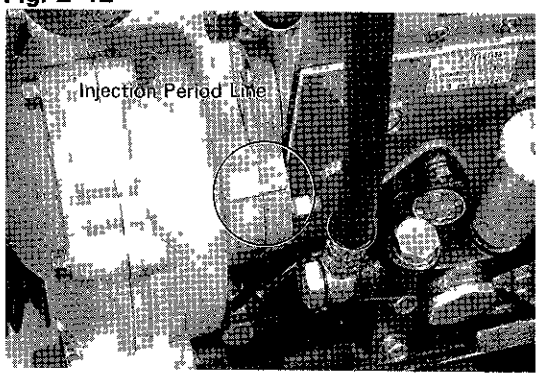
INJECTION TIMING

INSPECTION & ADJUSTMENT

1 Set the No 1 cylinder piston to the specified position

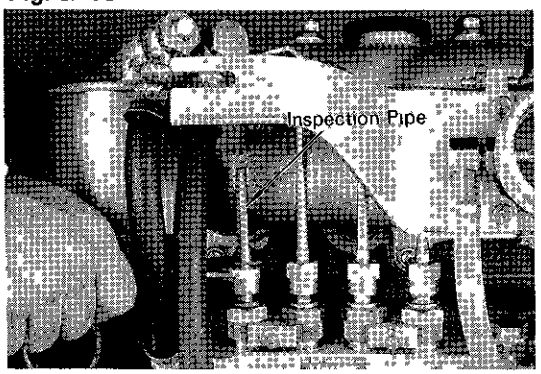
Injection timing:
14° BTDC/compression

Fig. 2-42



2 Set the aligning mark on the injection pump flange against the index mark on the timing gear case

Fig. 2-43



3 Check the injection timing
(1) Install the inspection pipe on the No 1 delivery valve holder

—Note—
Use as short an inspection pipe as possible.

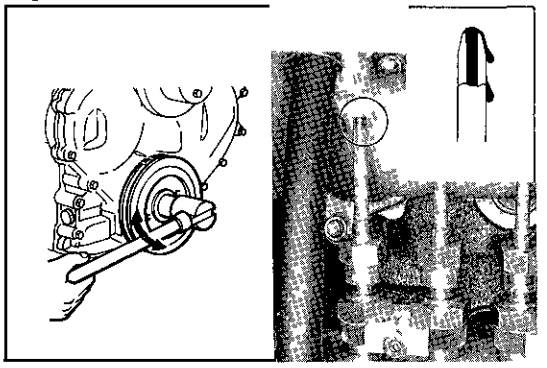
Fig. 2-44

(2) Bleed air from the fuel filter by operating the priming pump

Fig. 2-45

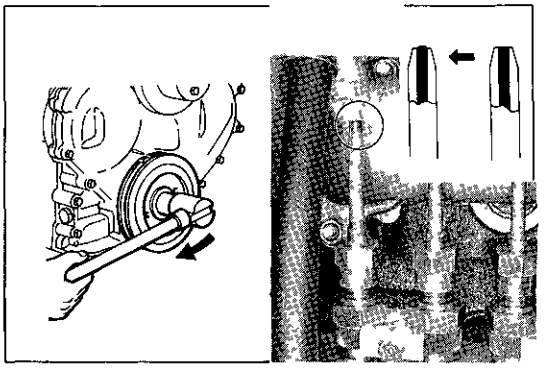
(3) Bleed air from the injection pump by operating the priming pump

Fig. 2-46



(4) Rotate the crank pulley slightly to left and right Repeat this action until fuel surfaces from the inspection pipe

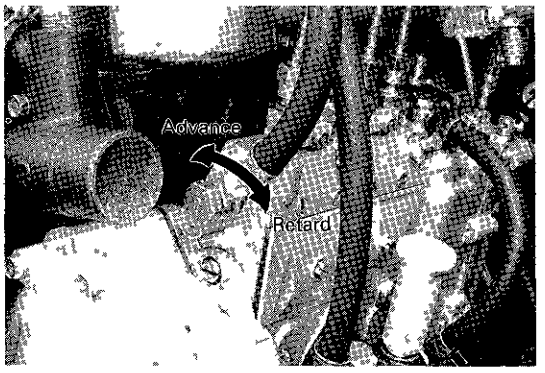
Fig. 2-47



(5) Slowly rotate the crank pulley The fuel level in the inspection pipe should start to rise when the No 1 piston is at the specified position

Injection timing:
14° BTDC/Compression

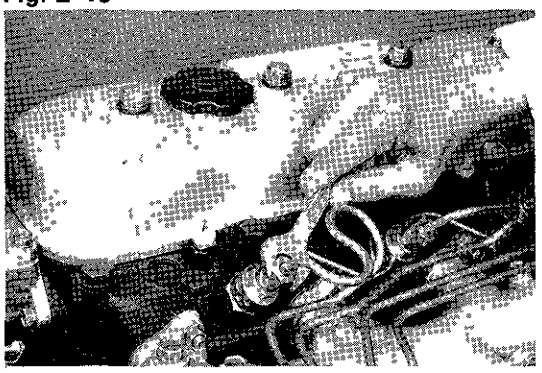
Fig. 2-48



4 Adjust the injection timing by tilting the injection pump body slightly
   To advance → Push upper part of the pump
   To retard → Pull upper part of the pump
5 Recheck the injection timing

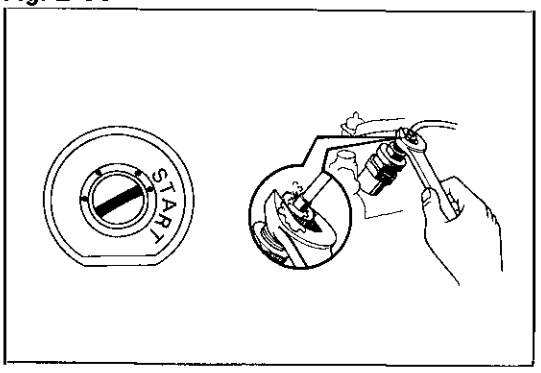
—Note—
This operation should be repeated at least two or three times.

Fig. 2-49



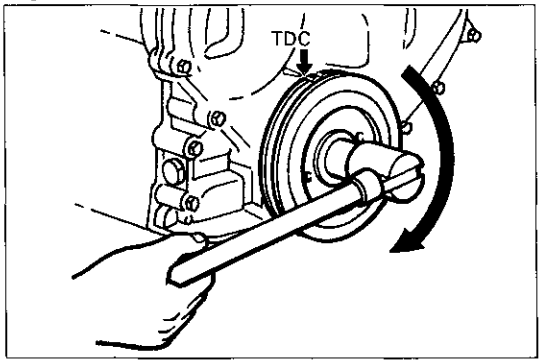
6 Remove the inspection pipe and install the No 1 injection pipe

Fig. 2-50



7 Bleed air from the injection pipe by activating the starter motor
8 Start the engine and inspect all pipe lines for fuel leaks

Fig. 2-51



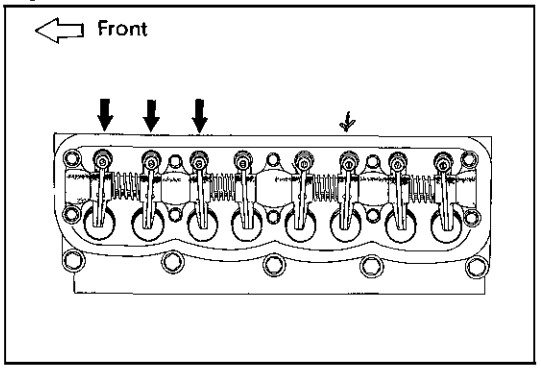
VALVE CLEARANCE

ADJUSTMENT

1 Warm-up the engine
2 Set No 1 cylinder to TDC/compression
3 Retighten the head bolts and rocker support bolts

Tightening torque:
Cylinder head bolts
11.5 – 12.0 kg-m
(84 – 86 ft-lb)
Rocker support bolts
1.5 – 2.2 kg-m
(11 – 15 ft-lb)

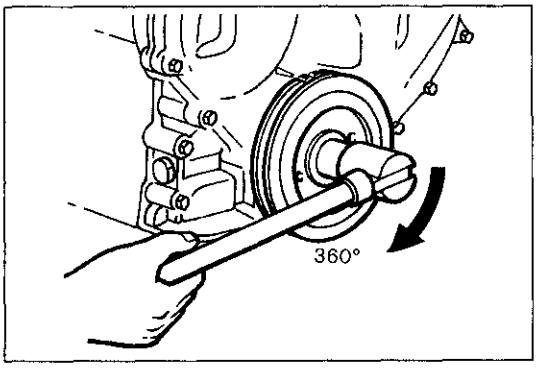
Fig. 2-52



4 Adjust the valve clearance
The valve clearance is measured between the valve stem and rocker arm adjusting screw
Adjust only the valves indicated by arrows

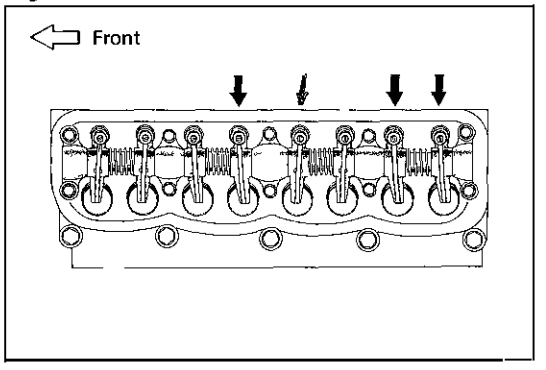
Valve clearance:
IN 0.20 mm
(0.008 in.)
EX 0.35 mm
(0.014 in.)

Fig. 2-53



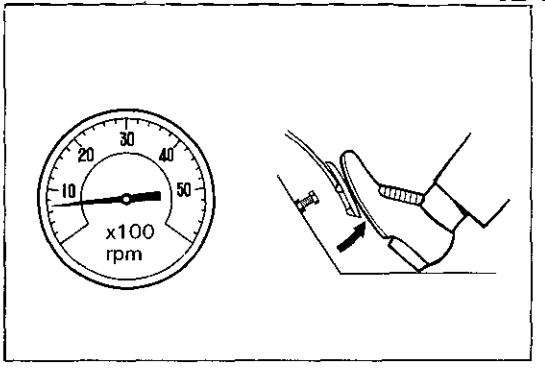
5 Rotate the crankshaft 360°

Fig. 2-54



6 Adjust the remaining valves indicated by arrows

Fig. 2-55



IDLE SPEED & MAXIMUM SPEED

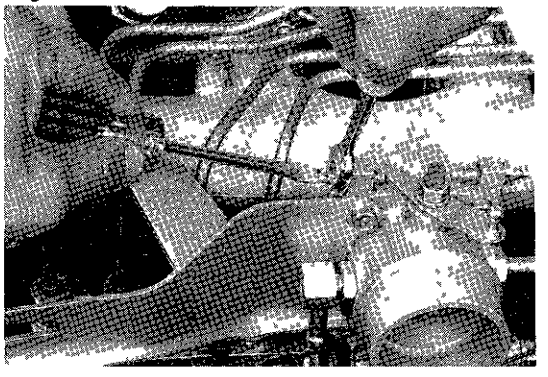
INSPECTION & ADJUSTMENT

1 Warm-up the engine

2 Check the engine idle speed

Idle speed: 650 rpm

Fig. 2-56



3 If necessary adjust the idle speed by turning the stop plate adjusting screw

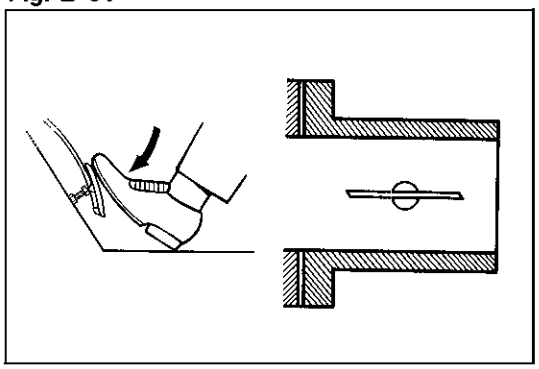
To rev up ——→Screw in

To reduce ——→Screw out

—Note—

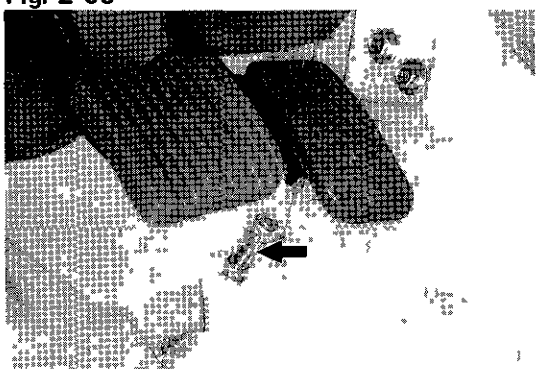
After adjusting, be sure to lock the stop plate adjusting screw with a lock nut.

Fig. 2-57



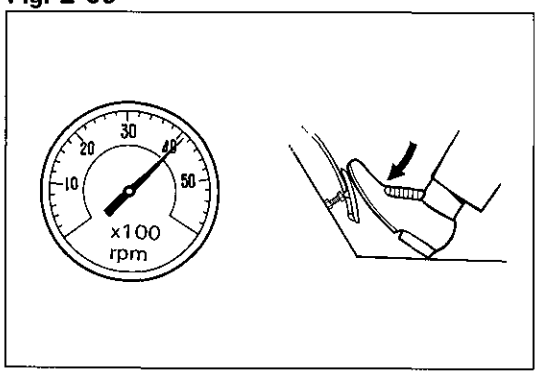
4 Make sure that the throttle valve is fully open when the accelerator pedal is depressed all the way

Fig. 2-58



5 Make the full open adjustment through the accelerator pedal stop bolt

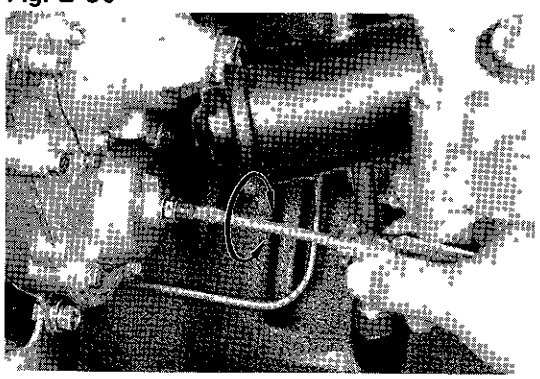
Fig. 2-59



6 Check the engine maximum speed when the accelerator pedal is depressed all the way

Maximum speed:
4,050 – 4,100 rpm

Fig. 2-60



Adjust the maximum speed by turning the adjusting bolt if necessary

To increase rpm —→Screw in
To decrease rpm —→Screw out

—Note—
After adjusting, be sure to lock the adjusting bolt with the lock nut and tighten the cap nut.
Then, seal the cap nut with wire.

ENGINE SERVICE

	Page
CUTAWAY VIEW	3-2
CYLINDER HEAD	3-4
TIMING GEAR	3-23
CYLINDER BLOCK	3-34

CUTAWAY VIEW

Fig. 3-1

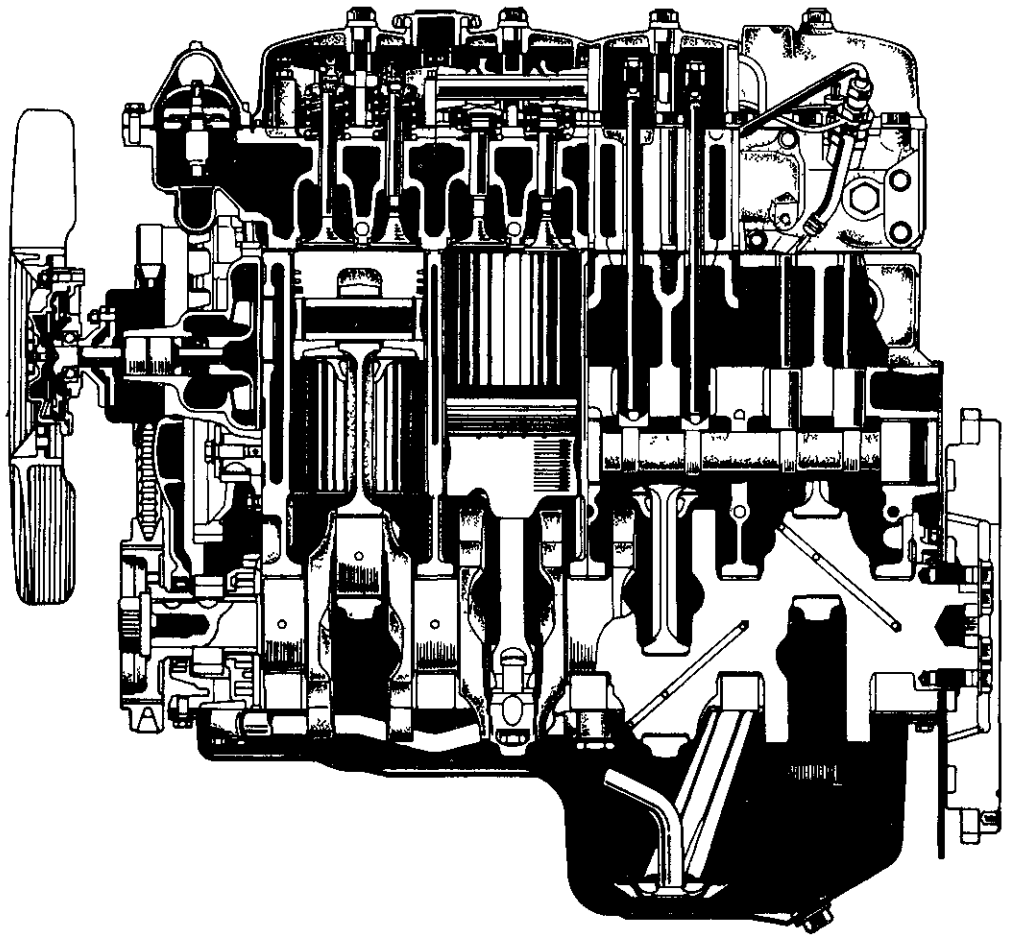
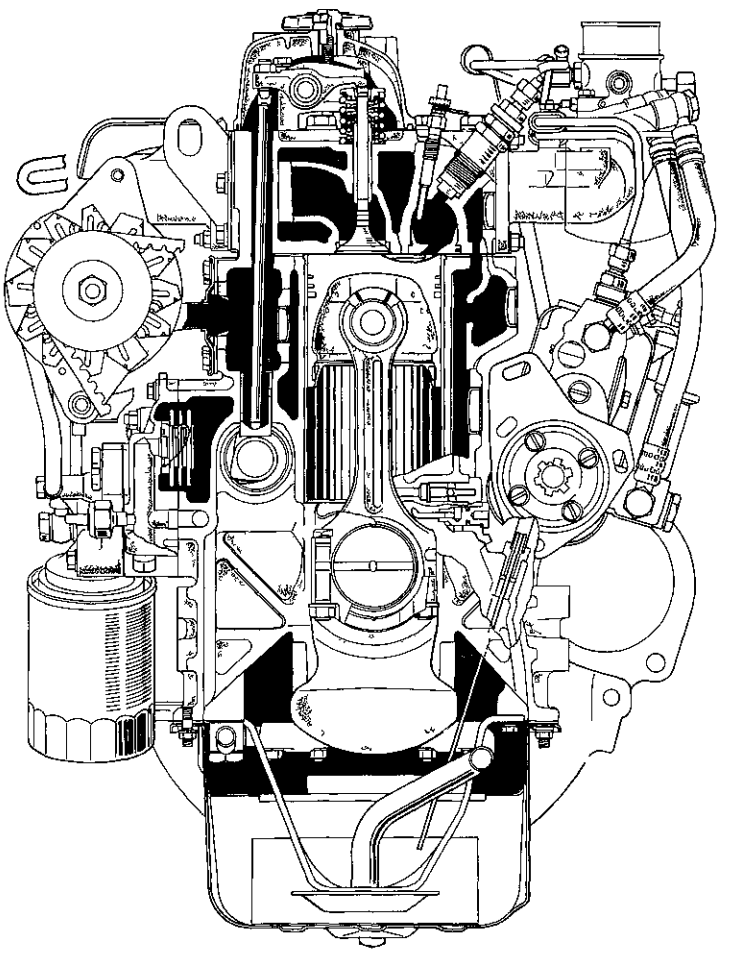


Fig. 3-2

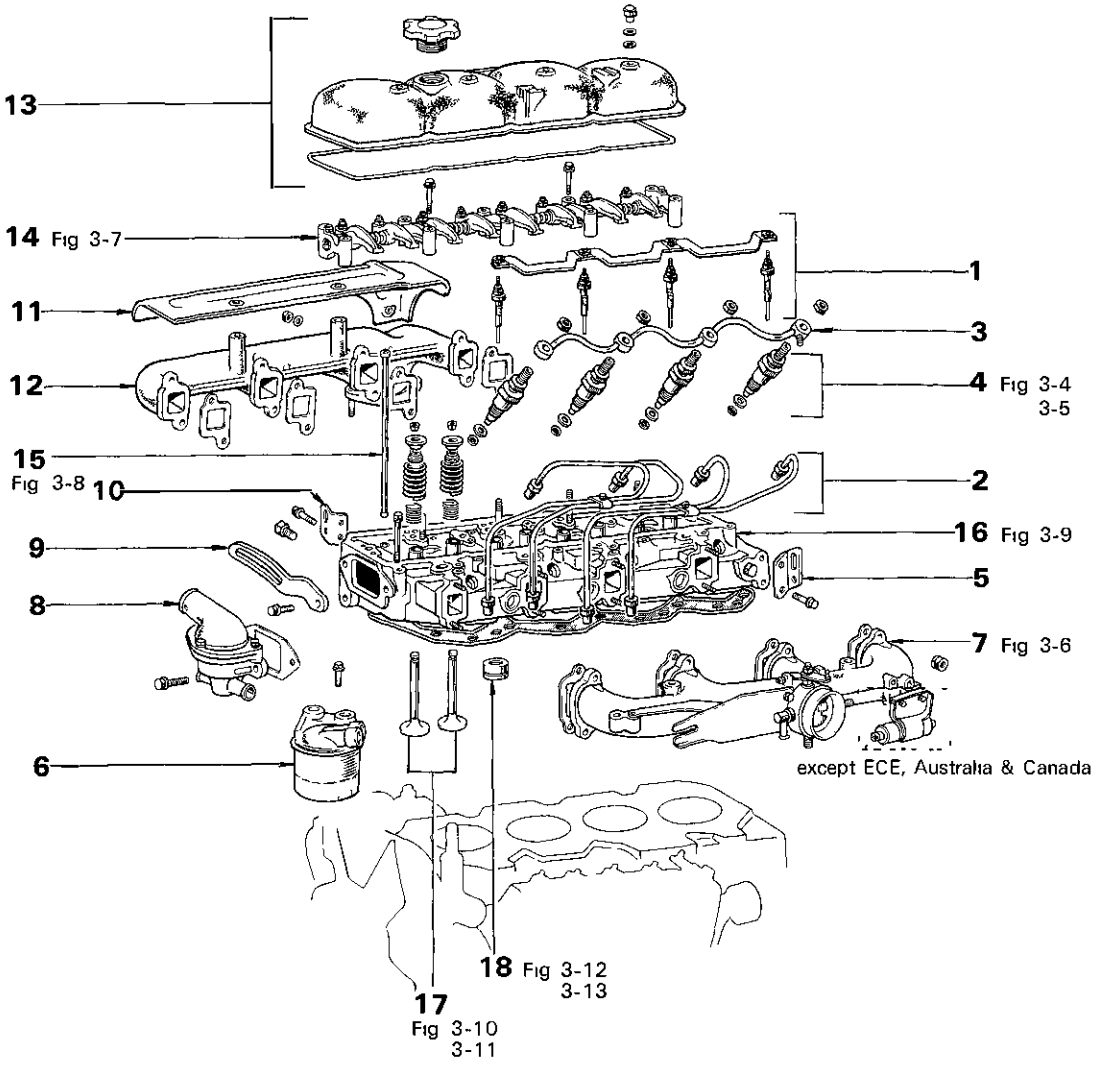


CYLINDER HEAD

DISASSEMBLY

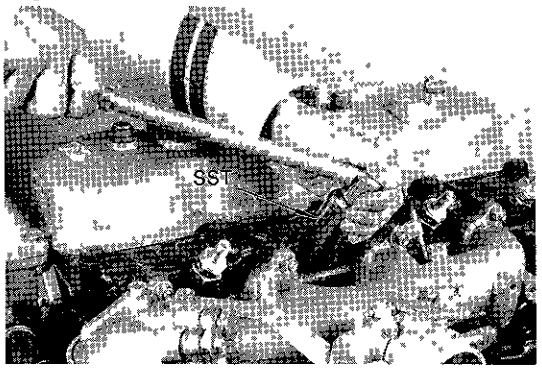
Disassemble the parts in the numerical order shown in the figure

Fig. 3-3



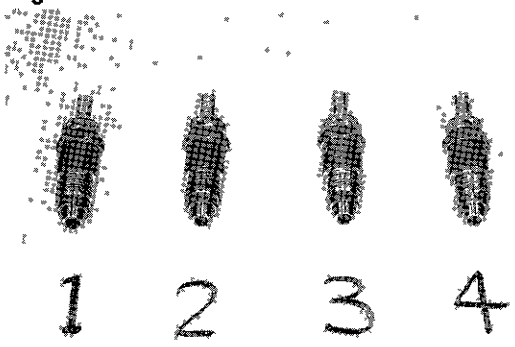
1	Glow Plug & Glow Plug Connector	10	Front Engine Hanger
2	Injection Pipe	11	Heat Insulator (for 3B)
3	Leakage Pipe	12	Exhaust Manifold
4	Injection Nozzle Holder & Gasket	13	Cylinder Head Cover & Gasket
5	Rear Engine Hanger	14	Valve Rocker Shaft Assembly
6	Fuel Filter	15	Valve Push Rod
7	Intake Manifold with Overinjection Magnet	16	Cylinder Head
8	Water Outlet Housing	17	Valve & Compression Spring
9	V Belt Adjusting Bar	18	Combustion Chamber

Fig. 3-4



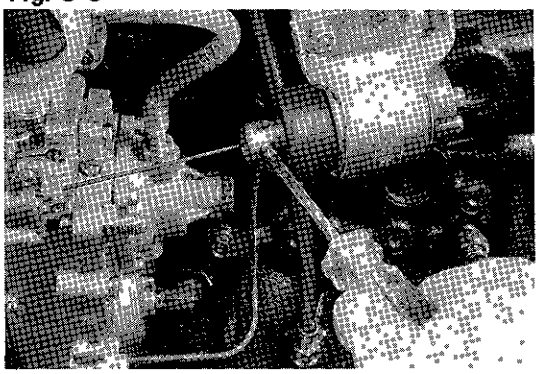
Remove the injection nozzle holders with SST
SST (09268-46011) of set [09260-46011]

Fig. 3-5



Keep the nozzle holders in correct order

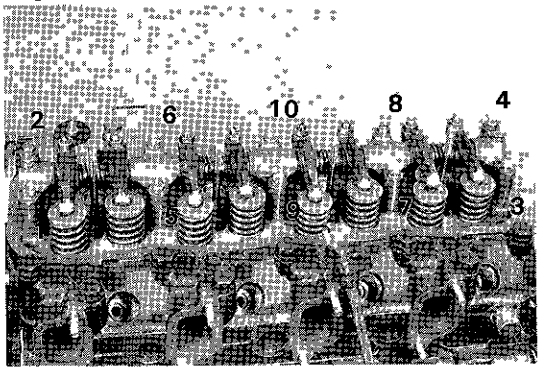
Fig. 3-6



Disconnect the overinjection magnet connecting wire and remove the intake manifold

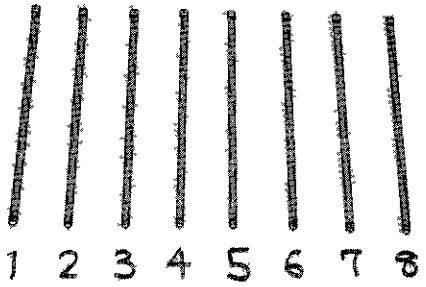
—Note—
The overinjection magnet is not equipped on vehicles for ECE, Australia and Canada.

Fig. 3-7



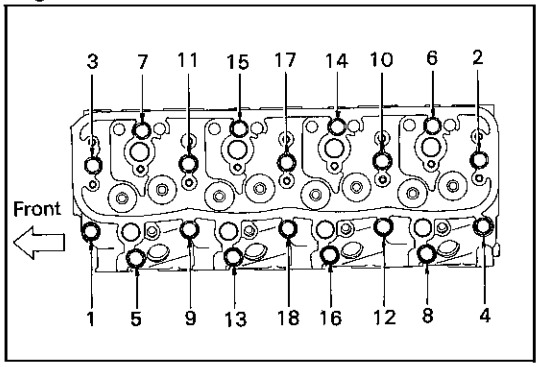
Loosen each rocker support bolt a little at a time in the sequence shown in the figure

Fig. 3-8



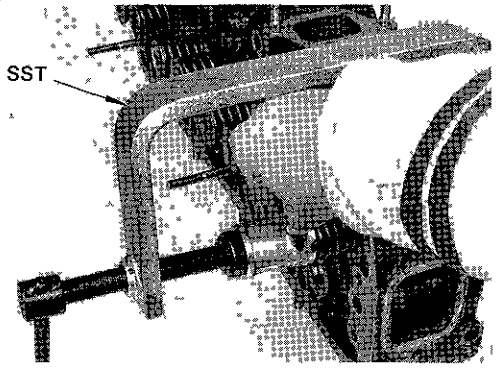
Keep the push rods in correct order

Fig. 3-9



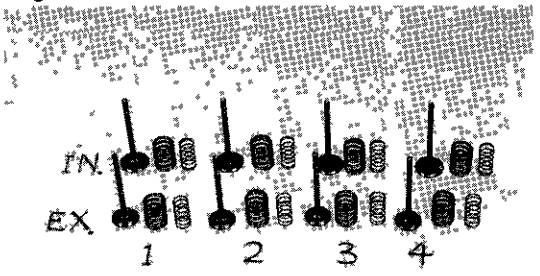
Loosen each cylinder head bolt a little at a time in the sequence shown in the figure

Fig. 3-10



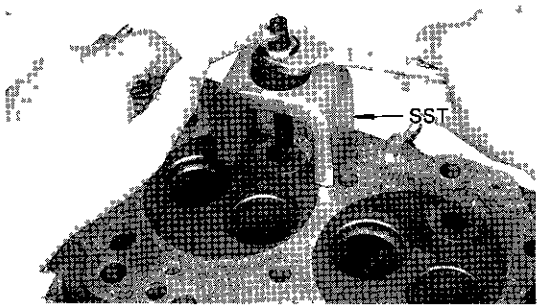
Compress the valve spring with SST and remove the spring retainer locks
SST [09202-43012]

Fig. 3-11



Keep the valves and springs in correct order

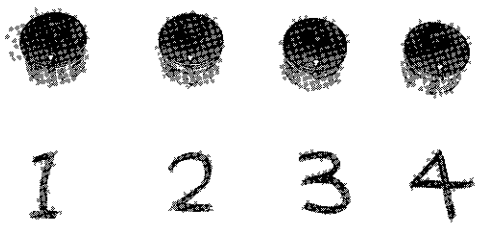
Fig. 3-12



Pull out the combustion chamber with SST
SST [09208-48010]

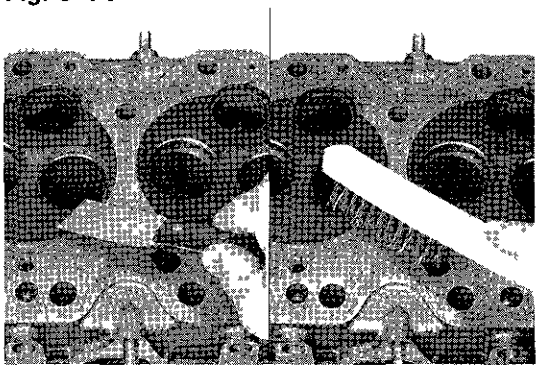
–Note–
Be careful not to damage the hole.

Fig. 3-13



Keep the combustion chambers in correct order

Fig. 3-14

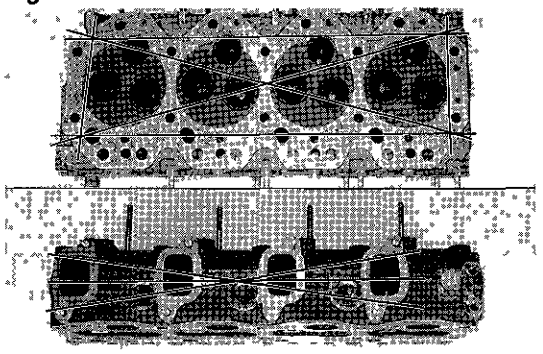


INSPECTION & REPAIR

Cylinder Head

1 Clean the combustion chamber and remove any gasket material from the manifold and head surface
Check the cylinder head for cracks or scoring

Fig. 3-15

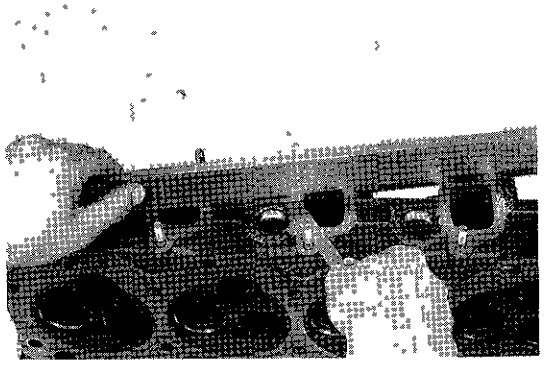


2 Check the surface along the indicated areas for warp

Fig. 3-16

(1) Using a precision straight-edge and thickness gauge, check the cylinder head surface for warpage
Underside surface warpage:
Limit 0.2 mm (0.008 in.)

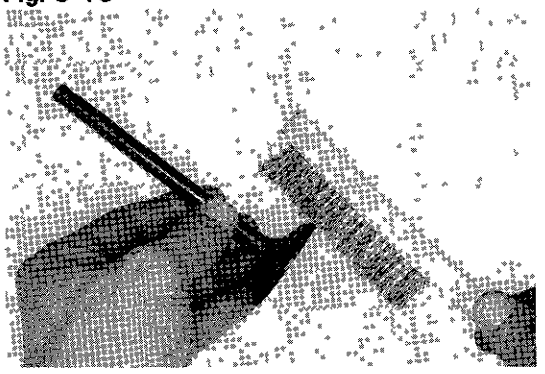
Fig. 3-17



(2) Check the intake and exhaust manifold mounting surfaces for warpage
Manifold mounting surface warpage:
Limit 0.2 mm (0.008 in.)

3 If the warp exceeds the limit, replace the cylinder head

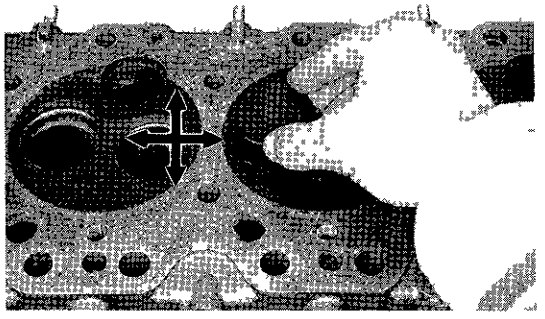
Fig. 3-18



Valve & Guide

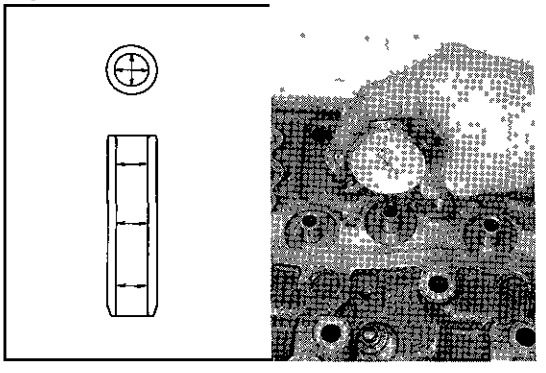
1 Clean the valve and check for wear scor ing and bending

Fig. 3-19



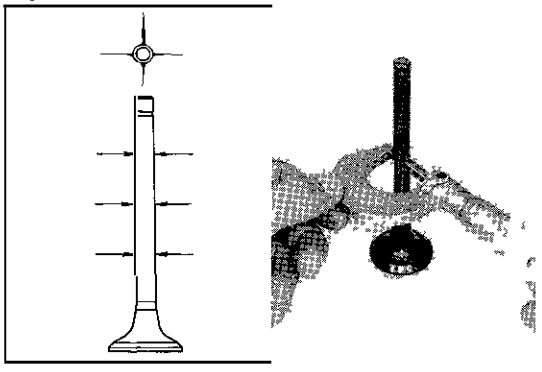
2 Check the valve stem to valve guide clearance
   (1) Insert the valve stem into the guide
   (2) Move the valve back and forth and check the clearance as shown in the figure

Fig. 3-20



3 Check the valve stem oil clearance
   (1) Measure the inside diameter of the valve guide at several places with an inside dial gauge
   Guide inside diameter:
   STD IN & EX
   9.01 – 9.03 mm
   (0.3547 – 0.3555 in.)
   (2) Measure the valve stem diameter
   Stem diameter:
   STD IN 8.968 – 8.984 mm
   (0.3531 – 0.3537 in.)
   EX 8.954 – 8.970 mm
   (0.3525 – 0.3531 in.)

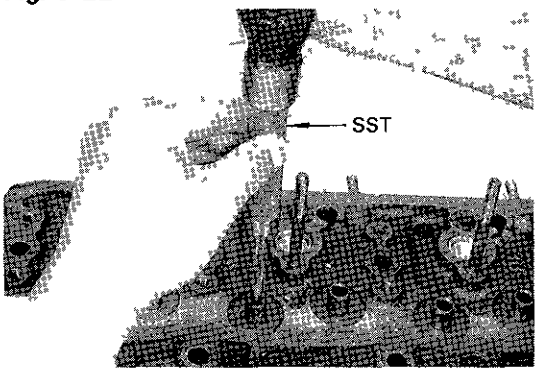
Fig. 3-21



   (3) Calculate the valve stem oil clearance
   Stem oil clearance:
   STD IN 0.026 – 0.062 mm
   (0.0010 – 0.0024 in.)
   EX 0.040 – 0.076 mm
   (0.0016 – 0.0030 in.)
   Limit IN 0.10 mm (0.0039 in.)
   EX 0.12 mm (0.0047 in.)

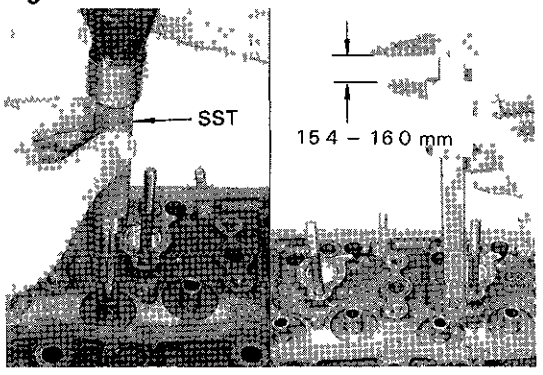
–Note–
Measure at several places and use the maximum wear for calculation.

Fig. 3-22



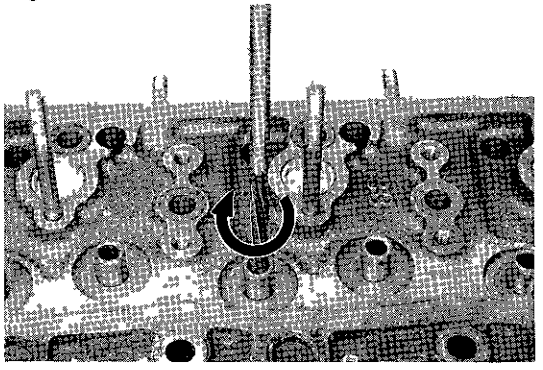
4 If the oil clearance exceeds the limit replace both the guide and valve
(1) Using SST drive out the valve guide from the top end toward the combustion chamber
SST [09201-60011]

Fig. 3-23



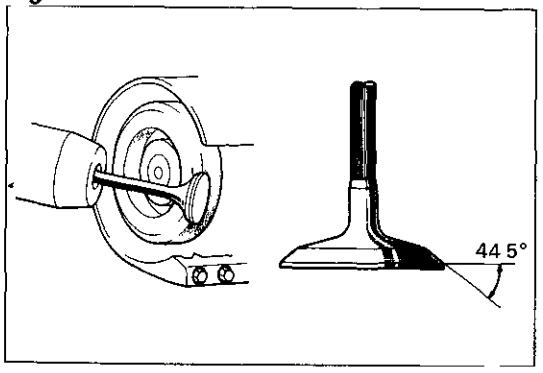
(2) Drive in the new valve guide with SST until its tip projects from the top of the cylinder head by the length specified below
SST [09201-60011]
Protrusion from cylinder head:
15.4 – 16.0 mm
(0.606 – 0.630 in.)

Fig. 3-24



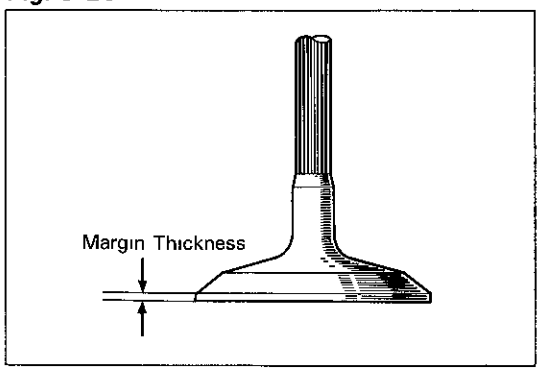
(3) With a sharp reamer ream the valve guide to obtain specified clearance
Oil clearance:
IN 0.026 – 0.062 mm
(0.0010 – 0.0024 in.)
EX 0.040 – 0.076 mm
(0.0016 – 0.0030 in.)

Fig. 3-25



5 Reface the valve seating face with a valve refacer
Valve face angle: 44.5°

Fig. 3-26



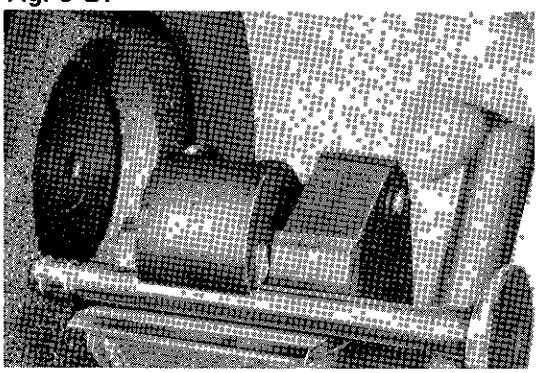
6 Check the valve head margin thickness

Margin thickness:

Limit IN 0.9 mm (0.035 in.)

EX 1.3 mm (0.051 in.)

Fig. 3-27



7 Check the valve stem tip

If necessary resurface the valve stem tip with a valve grinder

Stem tip resurfacing:

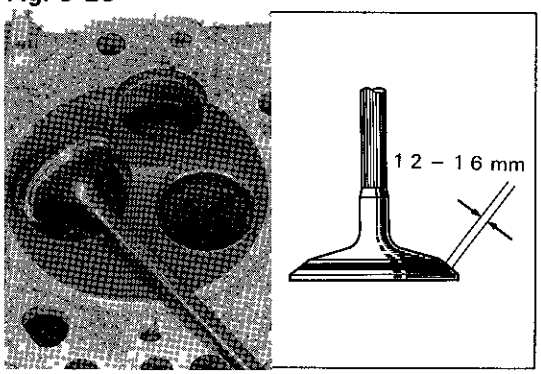
Limit 0.5 mm (0.020 in.)

Overall length:

IN 127.95 mm (5.0374 in.)

EX 127.75 mm (5.0295 in.)

Fig. 3-28



Valve Seat

1 Check the valve seat contact Coat the valve face with prussian blue or red lead Locate contact point on valve by rotating the valve against seat

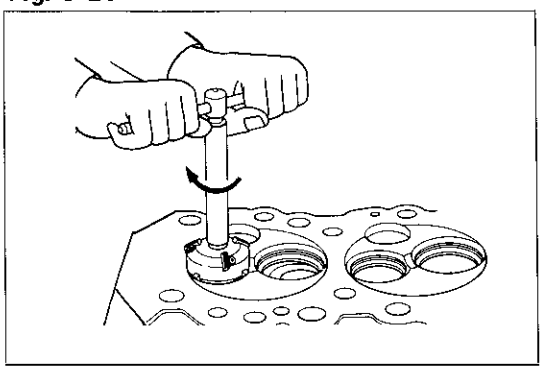
Contact width:

1.2 – 1.6 mm (0.047 – 0.063 in.)

Contact position:

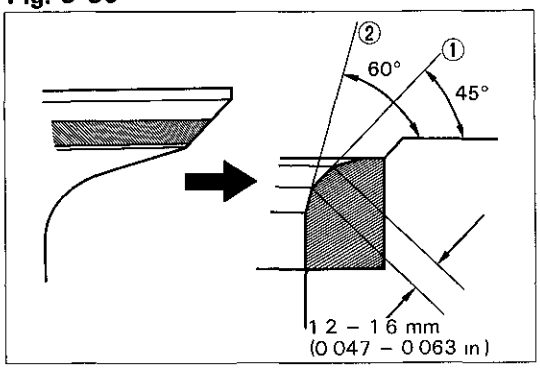
Middle of valve face

Fig. 3-29



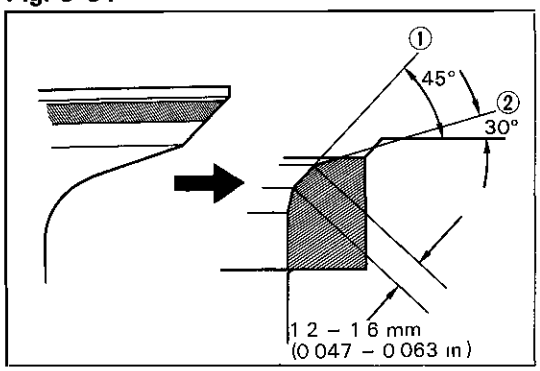
2 Resurface the valve seat with a 45° cutter

Fig. 3-30



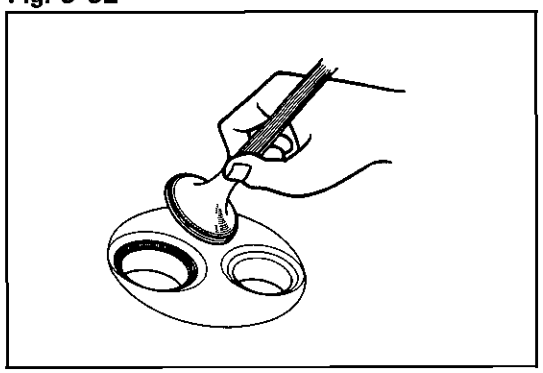
3 Correct the seat position
(1) If the seat position is too high, use 45° and 60° cutters in the order indicated in the figure

Fig. 3-31



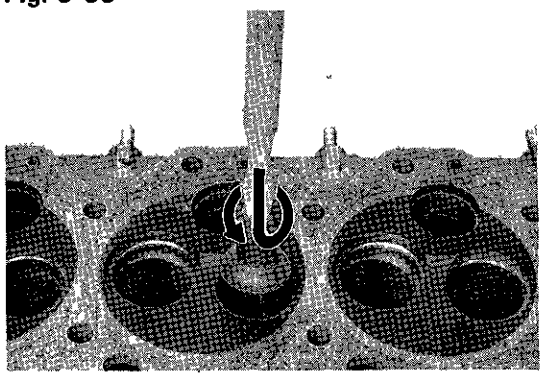
(2) If the seat position is too low, use 45° and 30° cutters in the order indicated in the figure

Fig. 3-32



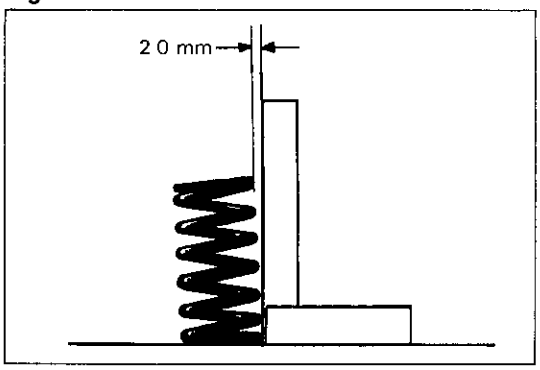
4 Check the valve concentricity
(1) Lightly coat the seat with prussian blue
(2) Install the valve and rotate it If blue appears 360° around face, the valve stem and face are concentric If not, replace the valve

Fig. 3-33



5 After correction the valve and valve seat should be lapped lightly with a lapping compound

Fig. 3-34

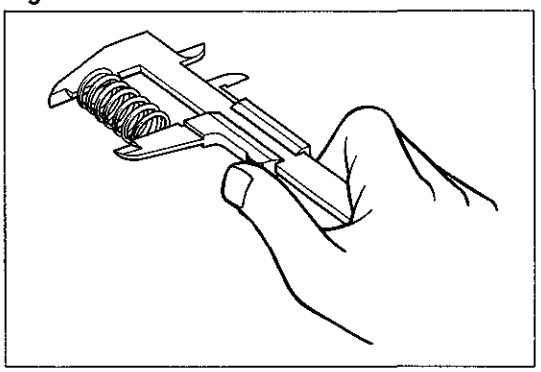


Valve Spring

1 Check the squareness of the valve spring with a square

Squareness:
Limit 2.0 mm (0.079 in.)

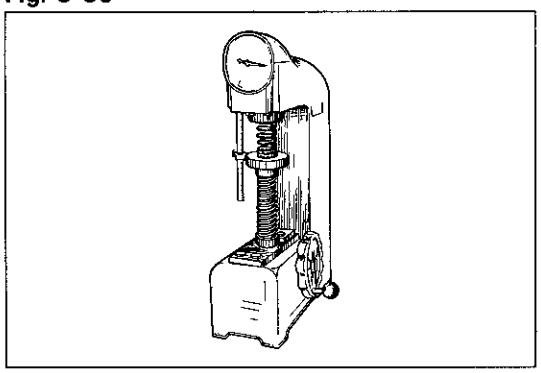
Fig. 3-35



2 Measure free length of the spring

Free length:
Outer 45.5 mm (1.791 in.)
Inner 47.5 mm (1.870 in.)

Fig. 3-36



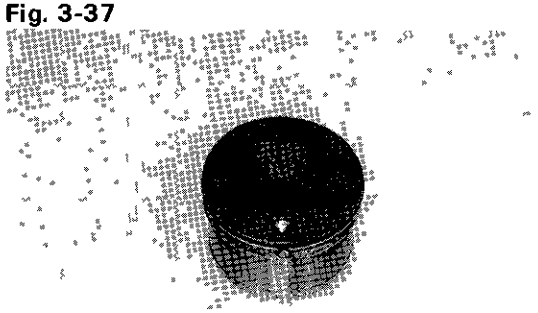
3 Using a spring tester measure the tension of each spring at the specified installed length Replace any spring that does not meet specification

Installed length:
Outer 39.6 mm (1.559 in.)
Inner 36.1 mm (1.421 in.)

Installed load:

STD	**Outer**	**25.6kg**	**(56.4 lb)**
	Inner	**5.95kg**	**(13.1 lb)**
Limit	**Outer**	**21.0kg**	**(46.3 lb)**
	Inner	**4.9kg**	**(10.8 lb)**

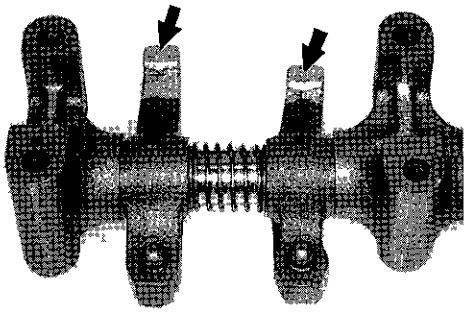
Fig. 3-37



Combustion Chamber

Clean or check for cracks or damages

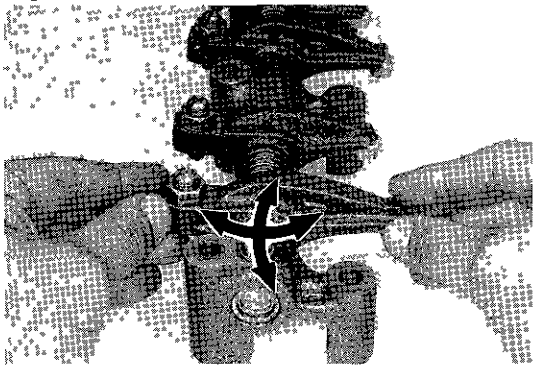
Fig. 3-38



Rocker Arm & Shaft

1 Check the valve contacting surface of the rocker arm for wear
Correct or replace if necessary

Fig. 3-39



2 Check the rocker arm to shaft clearance If worn excessively disassemble and inspect

3 Disassemble the valve rocker shaft assembly in the numerical order shown in the figure

—Note—
Keep the rocker arms in correct order.

Fig. 3-40

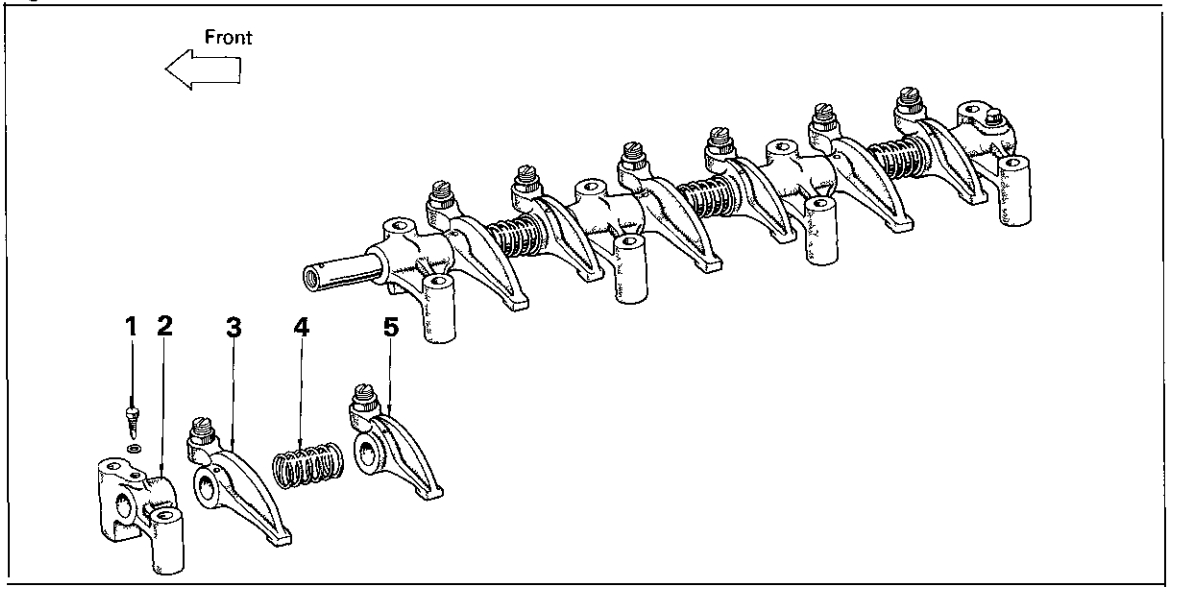
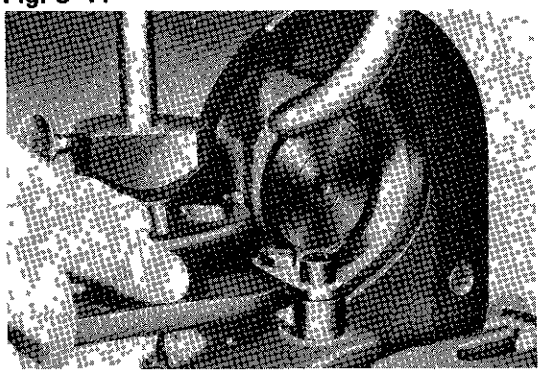
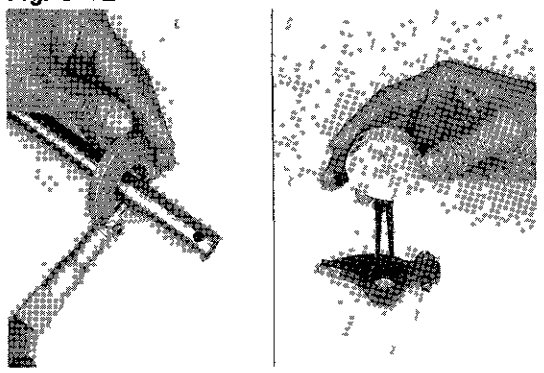


Fig. 3-41



4 If only a light ridged wear, correct the valve contacting surface of the rocker arm with a valve refacer and oil stone

Fig. 3-42



5 Measure oil clearance between the rocker arm and shaft

Shaft diameter:
Limit 18.44 mm (0.7260 in.)
Rocker arm bore:
Limit 18.60 mm (0.7323 in.)
Oil clearance:
STD 0.02 — 0.06 mm (0.0008 — 0.0024 in.)
Limit 0.1 mm (0.004 in.)

6 Assemble the valve rocker shaft assembly in the numerical order shown in the figure

—Note—
Align the oil hole of front rocker support with the oil hole of the shaft.

Fig. 3-43

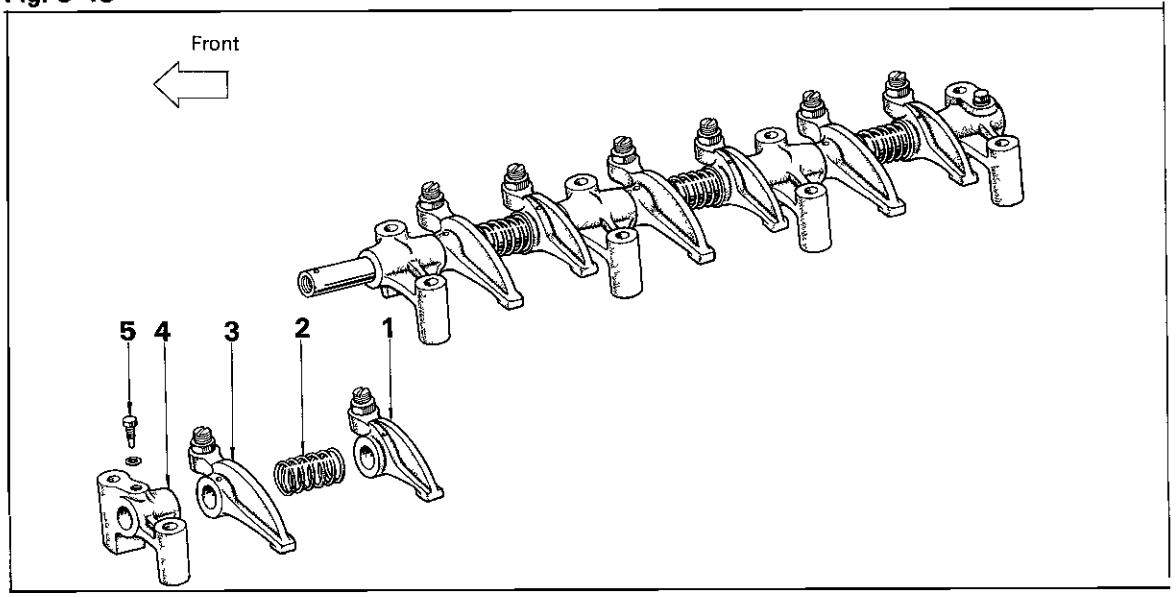
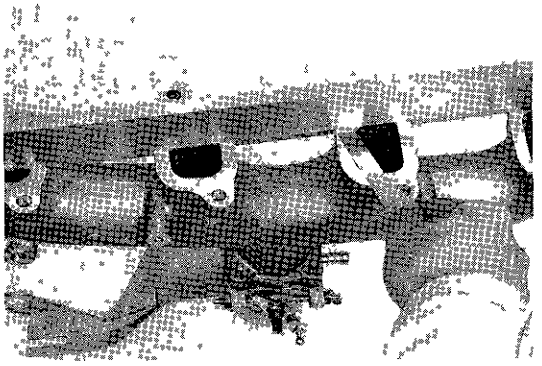


Fig. 3-44

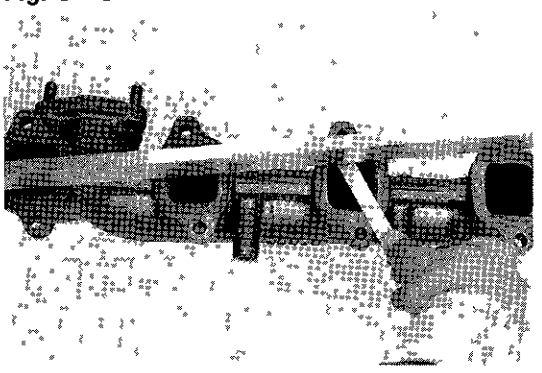


Manifold

Using a straight edge and thickness gauge check the cylinder head contacting surfaces for warpage

Replace the manifold if it exceeds the limit

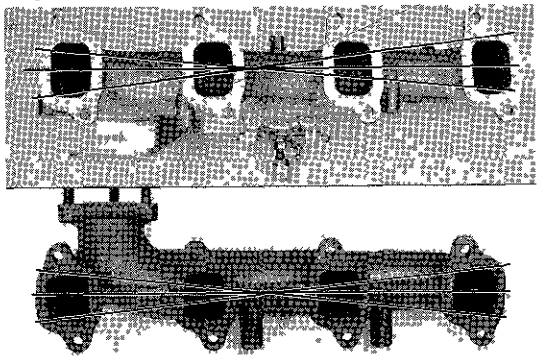
Fig. 3-45



Installing surface warpage:

Limit 0.4 mm (0.016 in.)

Fig. 3-46



–Note–

Check at three positions as shown in the figure.

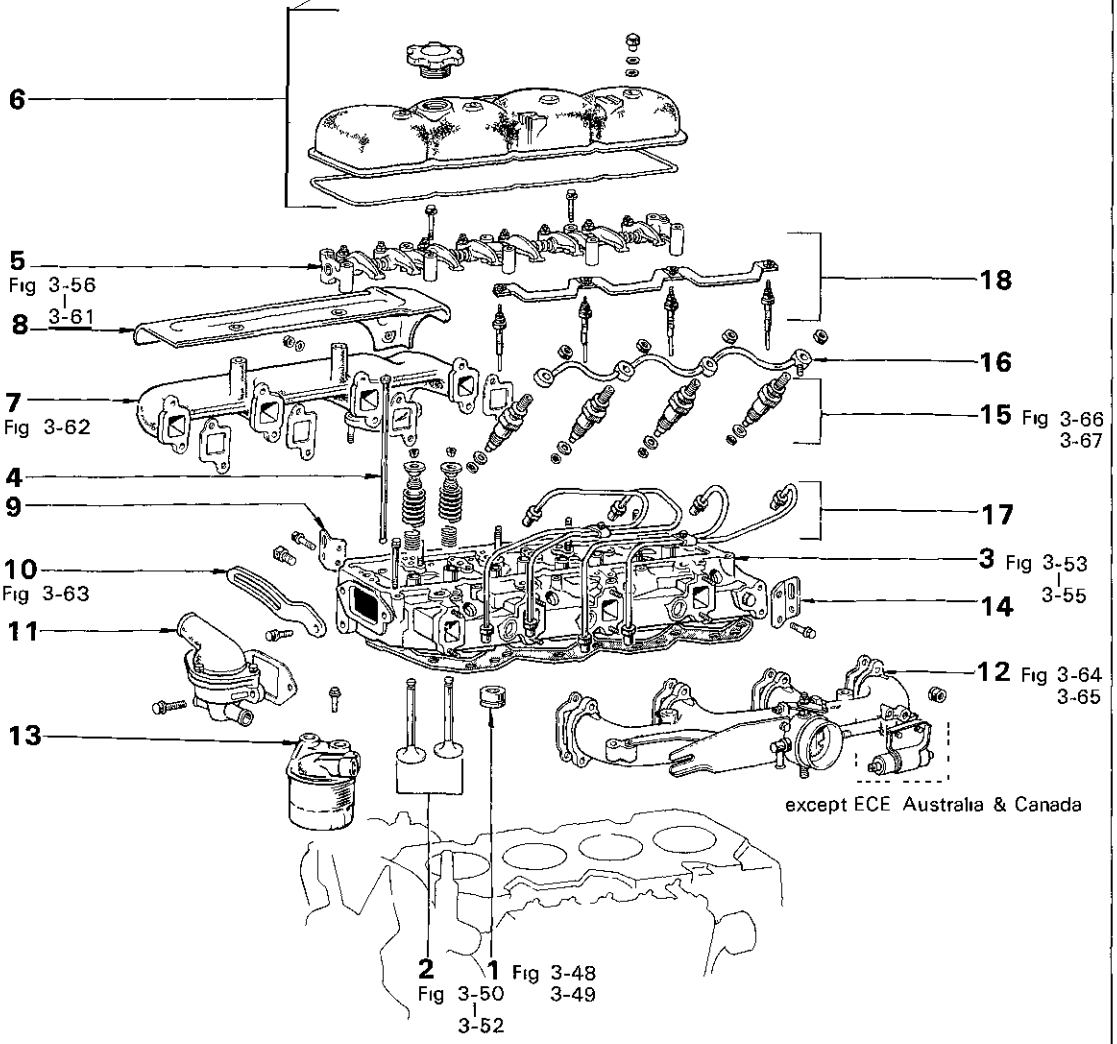
ASSEMBLY

Assemble the parts in the numerical order shown in the figure

Fig. 3-47

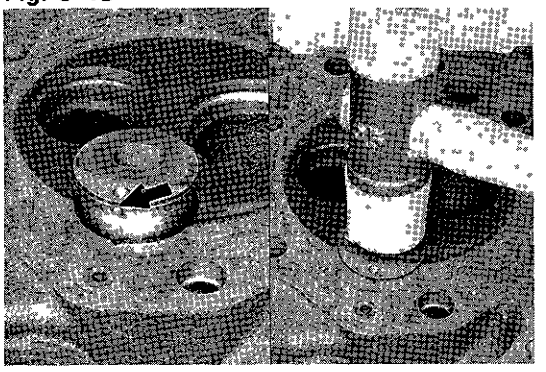
–Note–

1. **Thoroughly clean all parts to be assembled.**
2. **Apply clean engine oil to all sliding and rotating surfaces of the parts before assembly.**



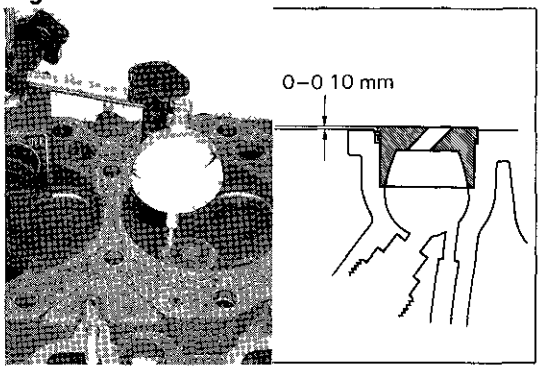
1	Combustion Chamber	11	Water outlet Housing
2	Valve & Compression Spring	12	Intake Manifold with Overinjection Magnet
3	Cylinder Head	13	Fuel Filter
4	Valve Push Rod	14	Rear Engine Hanger
5	Valve Rocker Shaft Assembly	15	Injection Nozzle Holder & Gasket
6	Cylinder Head Cover & Gasket	16	Leakage Pipe
7	Exhaust Manifold	17	Injection Pipe
8	Heat Insulator (for 3B)	18	Glow Plug & Glow Plug Connector
9	Front Engine Hanger		
10	V Belt Adjusting Bar		

Fig. 3-48



Match the combustion chamber knock pin with the cylinder head cutout and drive in the combustion chamber

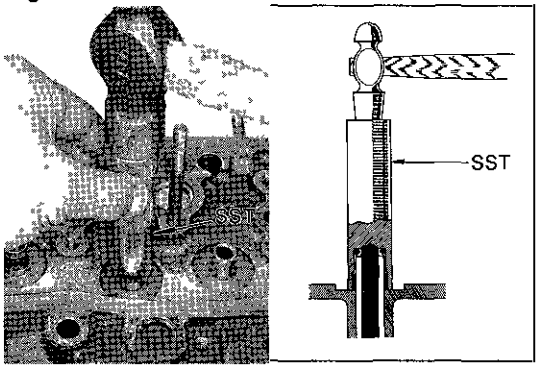
Fig. 3-49



Check the combustion chamber protrusion

Combustion chamber protrusion:
0 – 0.10 mm
(0 – 0.0039 in.)

Fig. 3-50

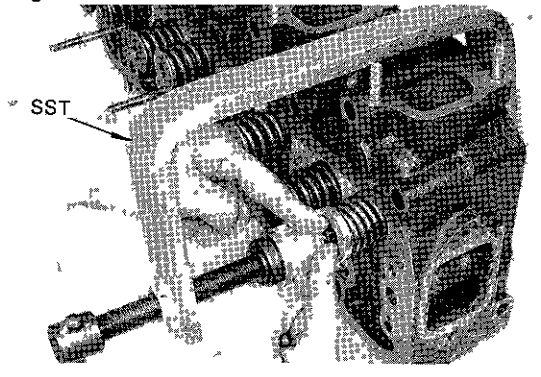


Drive in the oil seal with SST
SST [09201-54010]

–Note–

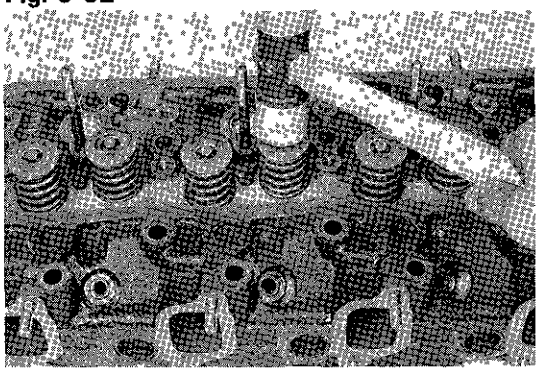
1. **A new oil seal should be used whenever the valve is disassembled.**
2. **Coat the oil seal lip with engine oil.**

Fig. 3-51



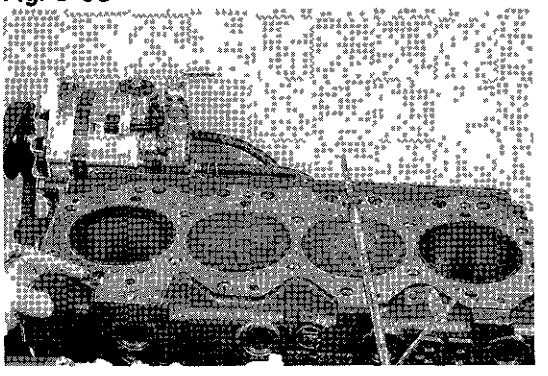
Compress the valve spring with SST and insert the spring retainer locks
SST [09202-43012]

Fig. 3-52



After installing the springs lightly tap on the stem ends and allow the springs to settle down snugly

Fig. 3-53

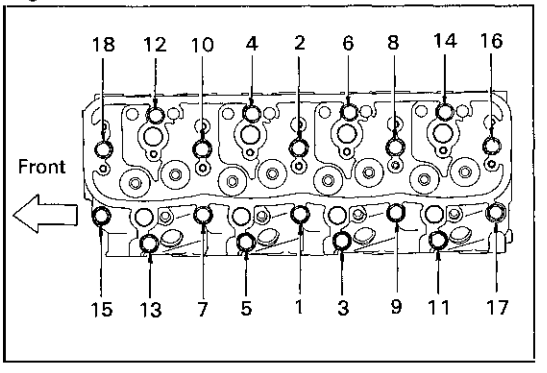


Place the cylinder head gasket on the cylinder block and align the bolt holes

–Note–

1. **Clean the cylinder block bolt holes with compressed air.**
2. **Clean the cylinder block upper surface with a scraper before installing the head gasket.**

Fig. 3-54

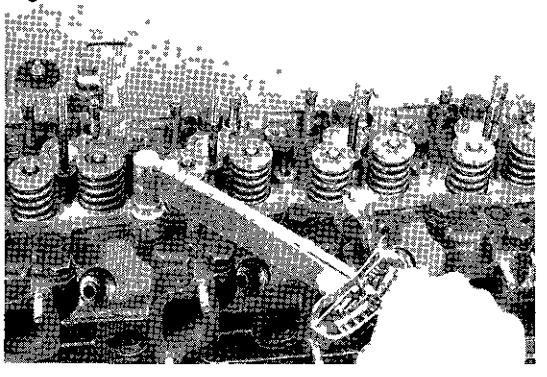


Tighten each cylinder head bolt a little at a time in the sequence shown in the figure

–Note–

Apply a light coating of engine oil on the bolt threads and under the bolt head before installing.

Fig. 3-55



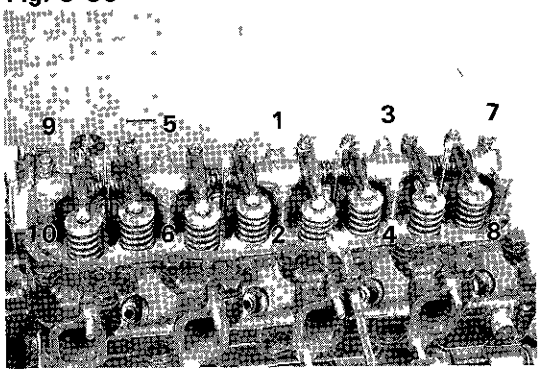
Tighten the cylinder head bolts to specified torque

Tightening torque:

11.5 – 12.0 kg-m

(84 – 86 ft-lb)

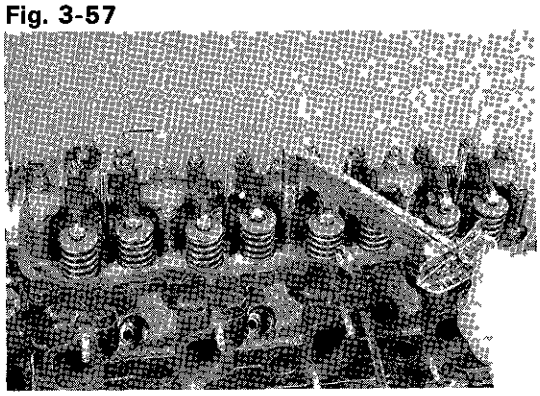
Fig. 3-56



Tighten the valve rocker support bolts to specified torque

—Note—
Do not keep the valve push rods apart from the adjusting screws while tightening the bolts.

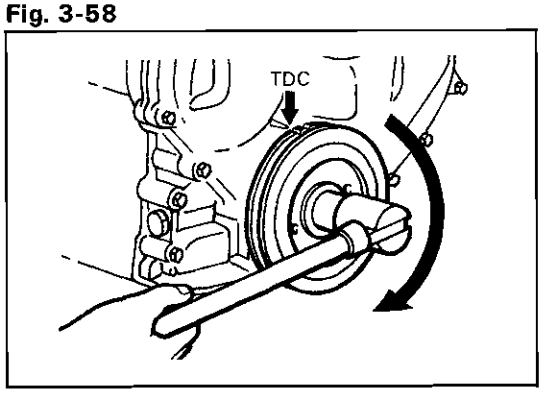
Fig. 3-57



Tighten the valve rocker support bolts to specified torque

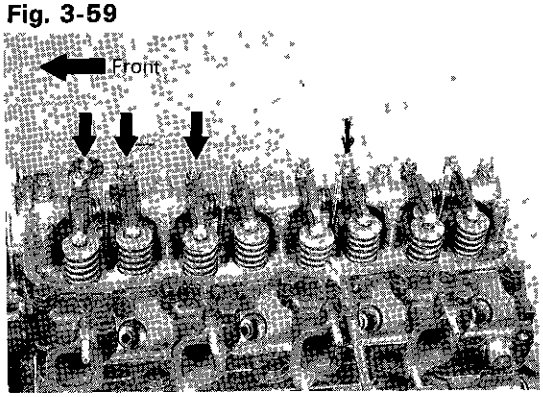
Tightening torque: 1.5 — 2.2 kg-m (11 — 15 ft-lb)

Fig. 3-58



Temporarily adjust the valve clearance
1 Set No 1 cylinder to TDC/compression

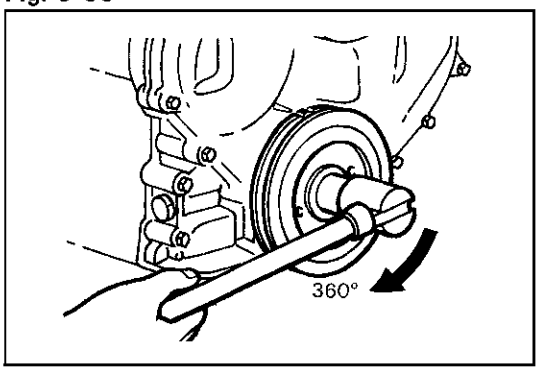
Fig. 3-59



2 Adjust the valve clearance
The valve clearance is measured between the valve stem and rocker arm adjusting screw
Adjust only the valves indicated by arrows

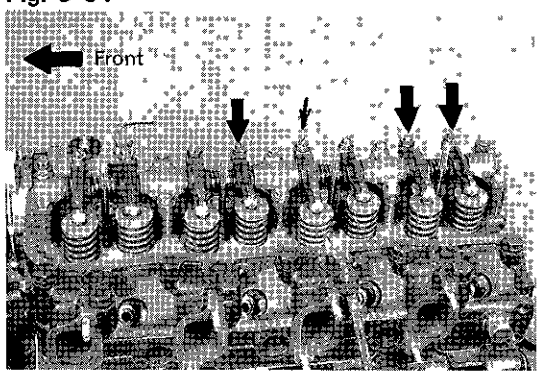
Valve clearance:
IN 0.20 mm (0.008 in.)
EX 0.36 mm (0.014 in.)

Fig. 3-60



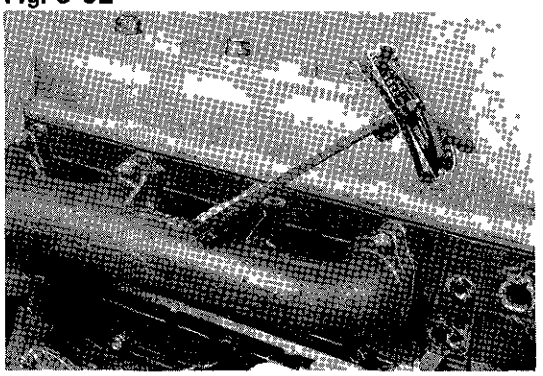
3 Rotate the crankshaft 360°

Fig. 3-61



4 Adjust the remaining valves indicated by arrows

Fig. 3-62



Install the exhaust manifold

Tightening torque: 3.0 – 4.5 kg-m (22 – 32 ft-lb)

Fig. 3-63

SEE

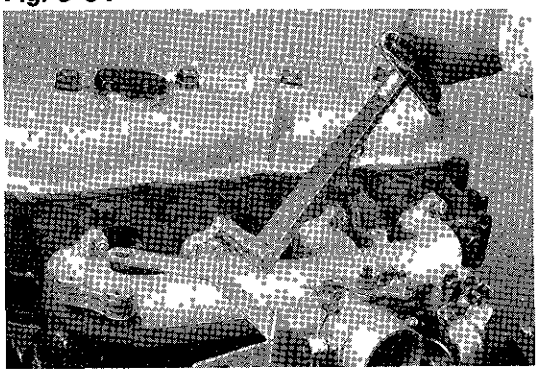
ENGINE TUNE-UP

SECTION

Fig. 2-7 & 2-8

Adjust drive belt tension

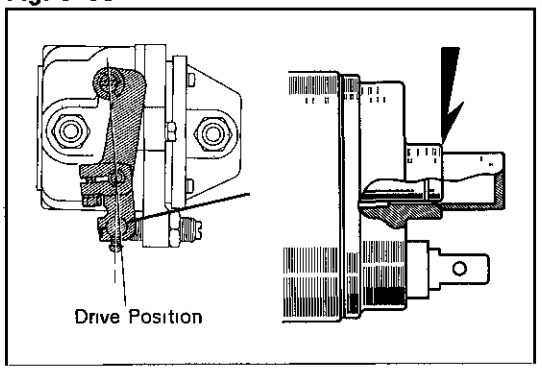
Fig. 3-64



Install the intake manifold

Tightening torque: 1.5 – 2.2 kg-m (11 – 15 ft-lb)

Fig. 3-65

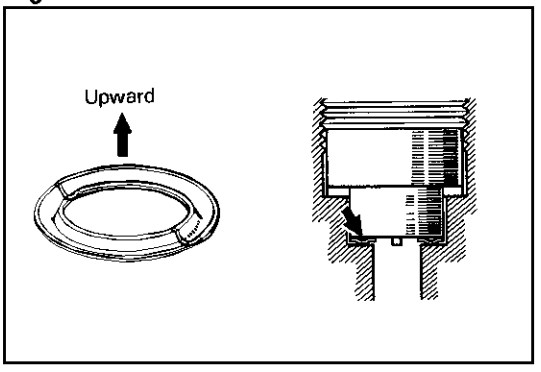


Connect and adjust the overinjection magnet connecting wire with the magnet core end surface positioned as shown in the figure

–Note–

The overinjection magnet is not equipped on vehicles for ECE, Australia and Canada.

Fig. 3-66

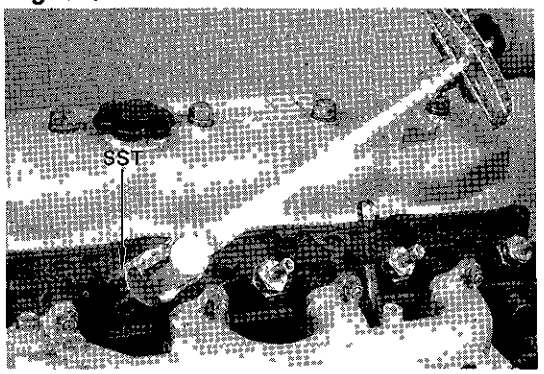


Note the orientation of the nozzle seat gasket as shown in the figure

–Note–

Be sure to check the gasket before installing the nozzle holder.

Fig. 3-67



Tighten the nozzle holders with SST

SST (09268-46011) of set [09260 46011]

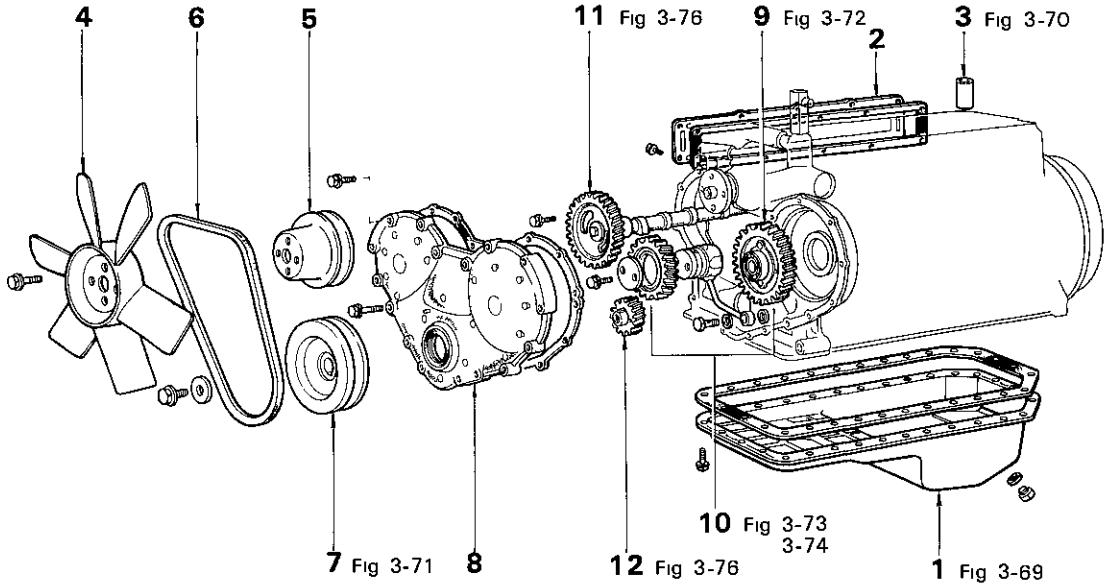
Tightening torque: 6.0 – 8.0 kg-m (44 – 57 ft-lb)

TIMING GEAR

DISASSEMBLY

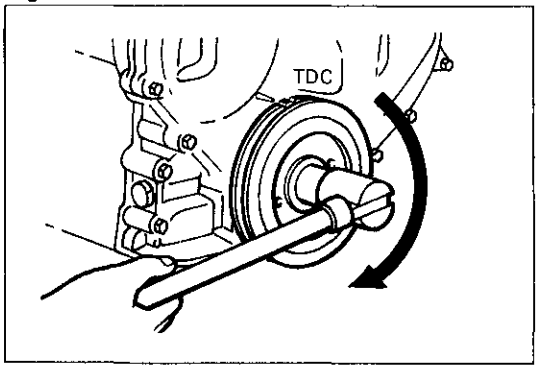
Disassemble the parts in the numerical order shown in the figure

Fig. 3-68



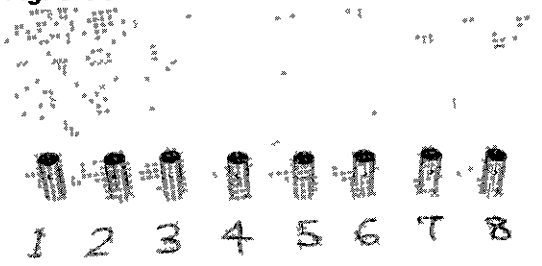
1	Oil Pan	7	Crankshaft Pulley
2	Valve Push Rod Cover	8	Timing Gear Cover
3	Valve Lifter	9	Automatic Timer
4	Cooling Fan	10	Idle Gear & Shaft
5	Fan Pulley	11	Camshaft & Timing Gear
6	V Belt	12	Crankshaft Timing Gear

Fig. 3-69



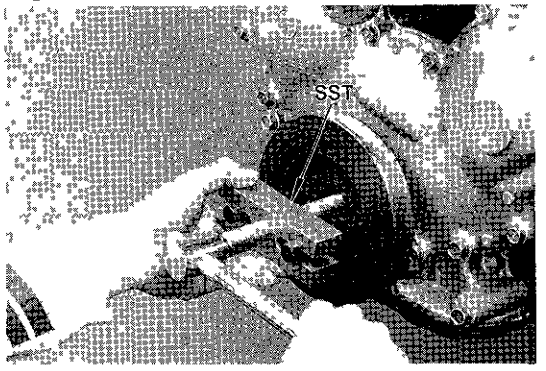
⚠ Before starting work set No 1 cylinder piston to TDC/compression

Fig. 3-70



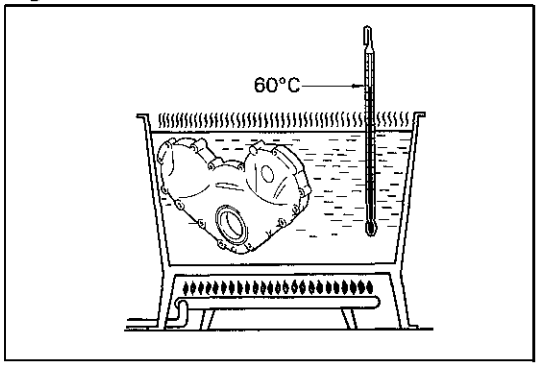
Keep the valve lifters in correct order

Fig. 3-71



Pull out the crankshaft pulley with SST
SST [09213 60016]

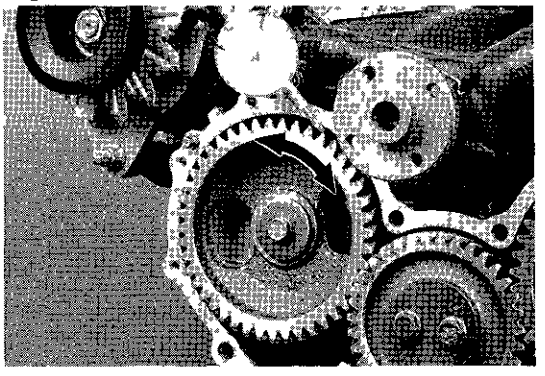
Fig. 3-72



Remove the automatic timer from the timing gear cover after heating the cover to about 60°C (140°F)

—Note—
For disassembly and assembly of the automatic timer, refer to the FUEL SYSTEM section.

Fig. 3-73



Install the automatic timer to the injection pump spline shaft and measure the timing gear backlashes

Gear backlash:

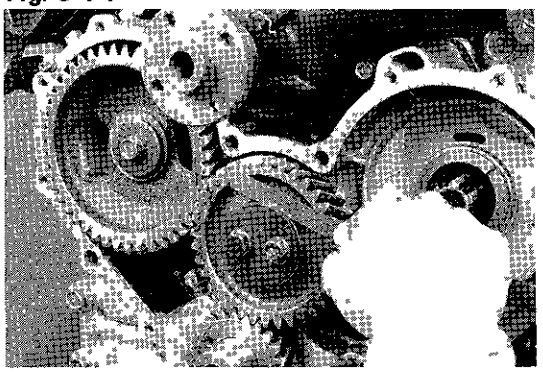
Idle gear to cam gear, timer drive gear

STD	**0.06 – 0.09 mm (0.0024 – 0.0035 in.)**
Limit	**0.3 mm (0.012 in.)**

Crankshaft to idle gear

STD	**0.06 – 0.10 mm (0.0024 – 0.0039 in.)**
Limit	**0.3 mm (0.012 in.)**

Fig. 3-74

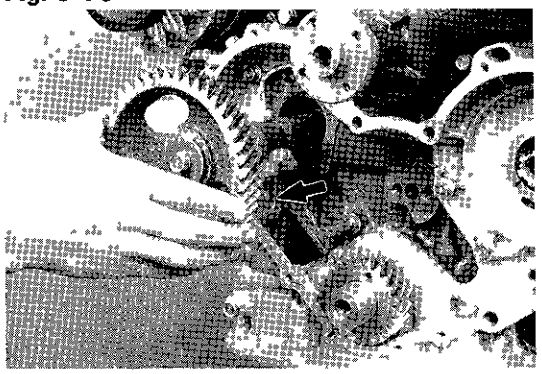


Measure the idle gear thrust clearance

Thrust clearance:

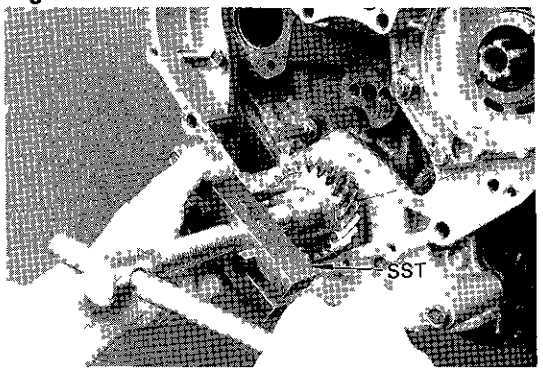
STD	**0.08 – 0.20 mm (0.0031 – 0.0079 in.)**
Limit	**0.3 mm (0.012 in.)**

Fig. 3-75



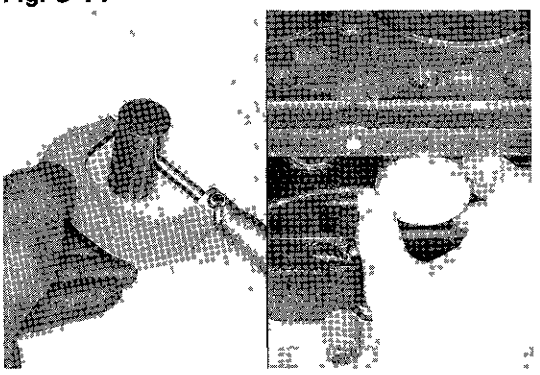
Pull out the camshaft using care not to damage the camshaft bearings

Fig. 3-76



Pull out the crankshaft timing gear with SST
SST [09213-60016]

Fig. 3-77



INSPECTION & REPAIR

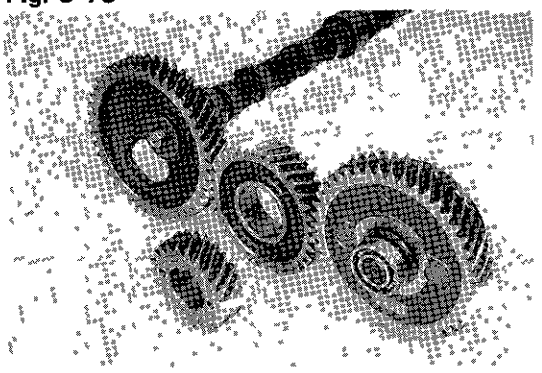
Valve Lifter

Check the lifters and lifter bores for wear or damage

Measure the oil clearance

Valve lifter outer diameter:
23.972 – 23.985 mm
(0.9438 – 0.9443 in.)
Valve lifter bore diameter:
24.00 – 24.02 mm
(0.9449 – 0.9457 in.)
Oil clearance:
STD 0.02 – 0.05 mm
(0.0008 – 0.0020 in.)
Limit 0.1 mm (0.004 in.)

Fig. 3-78

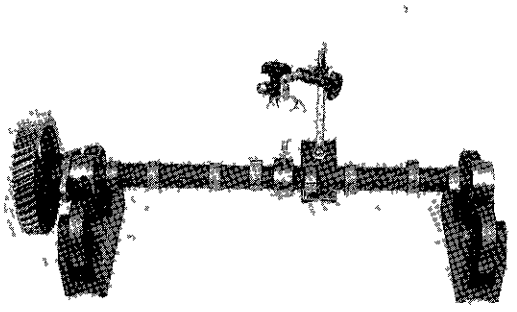


Timing Gears

Check for cracks wear and chipped teeth

If damaged replace the gear along with its mate

Fig. 3-79



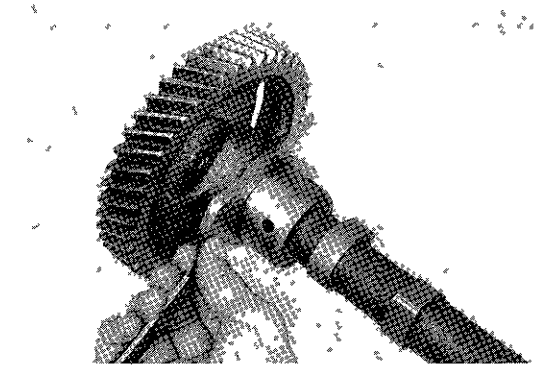
Camshaft

1 Check for straightness and for wear or damage

2 Measure the runout

Circle runout:
Limit 0.04 mm
(0.0016 in.)

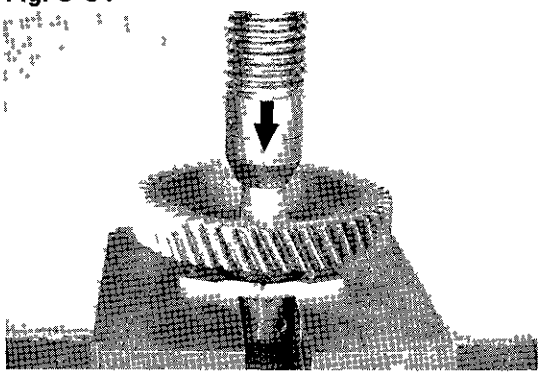
Fig. 3-80



3 Measure the camshaft thrust clearance

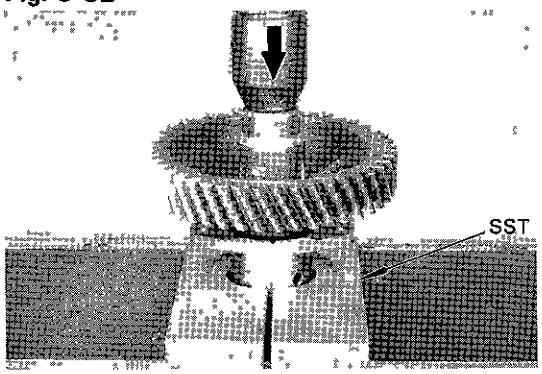
Thrust clearance:
STD 0.06 – 0.13 mm
(0.0024 – 0.0051 in.)
Limit 0.3 mm
(0.012 in.)

Fig. 3-81



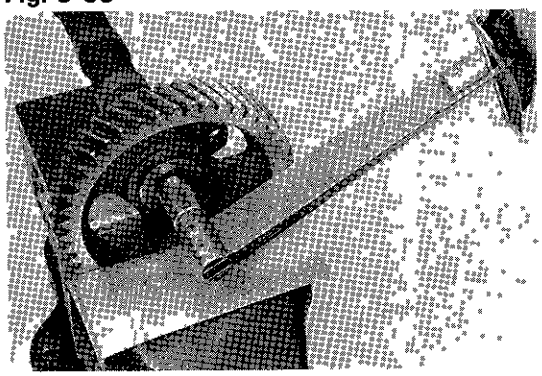
4 Replace the thrust plate if the thrust clearance exceeds the limit
(1) Using a press and 19 mm socket wrench press out the timing gear from the camshaft

Fig. 3-82



(2) Using a press 29 mm socket wrench and SST press in the timing gear
SST [09527-21011]

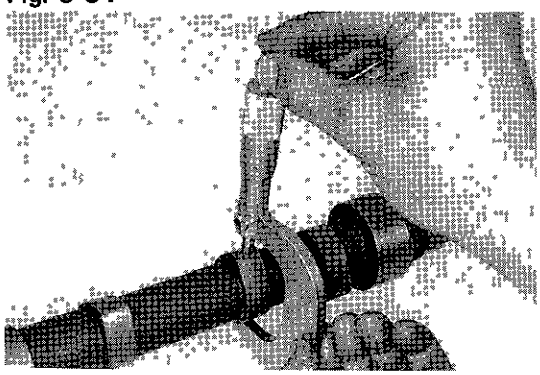
Fig. 3-83



(3) Tighten the retaining bolt
Tightening torque:
3.0 – 4.5 kg-m
(22 – 32 ft-lb)

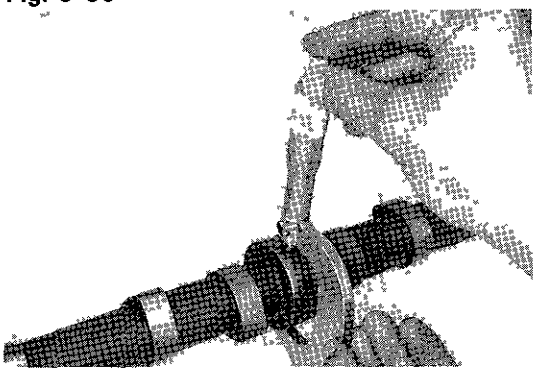
–Note–
Apply a light coat of engine oil on the bolt threads and under the bolt head before installing.

Fig. 3-84



5 Measure the cam height
Cam height:
STD 39.47 – 39.56 mm
(1.5539 – 1.5575 in.)
Limit 39.0 mm
(1.535 in.)

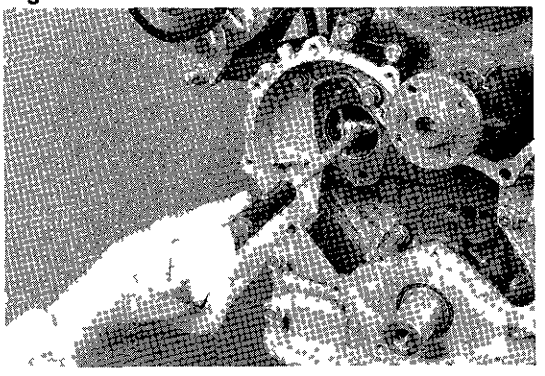
Fig. 3-85



5 Measure the journal oil clearance
(1) Measure the camshaft journal diameter

Journal diameter:
No.1 47.16 – 47.18 mm (1.8567 – 1.8575 in.)
No.2 46.96 – 46.98 mm (1.8488 – 1.8496 in.)
No.3 46.76 – 46.78 mm (1.8409 – 1.8417 in.)

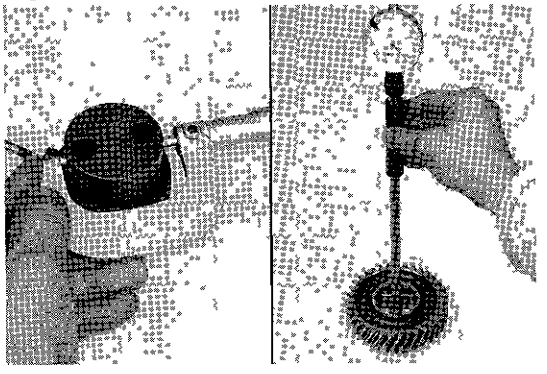
Fig. 3-86



(2) Measure the bearing inner diameter referring to CYLINDER BLOCK section

Oil clearance:
STD 0.03 – 0.07 mm (0.0012 – 0.0028 in.)
Limit 0.1 mm (0.004 in.)

Fig. 3-87

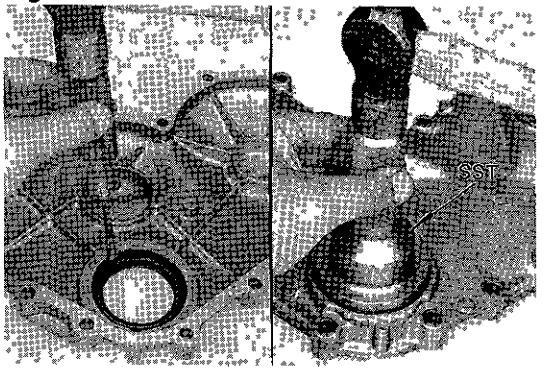


Idle Gear

Measure the idle gear oil clearance

Idle gear shaft diameter:
44.94 – 44.96 mm (1.7693 – 1.7701 in.)
Idle gear bore:
45.00 – 45.03 mm (1.7717 – 1.7728 in.)
Oil clearance:
STD 0.04 – 0.09 mm (0.0016 – 0.0035 in.)
Limit 0.3 mm (0.012 in.)

Fig. 3-88



Crankshaft Front Oil Seal

1 Check for wear or damage
2 Replace the oil seal with SST
(1) Remove the oil seal with a screwdriver
(2) Install a new oil seal with SST
SST [09223-46011]

–Note–
Coat the oil seal lip with MP grease.

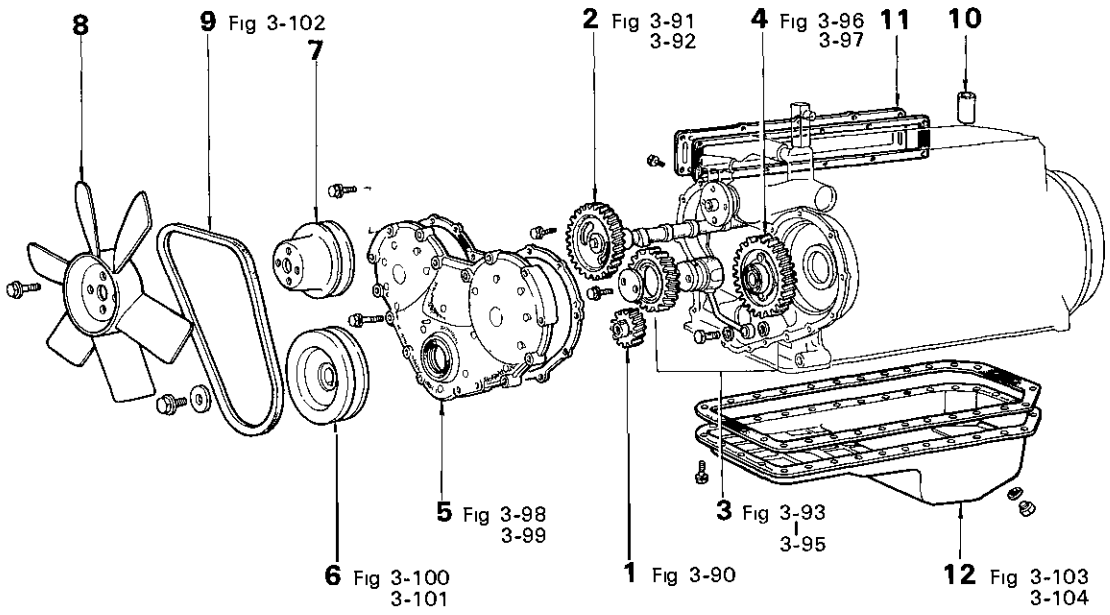
ASSEMBLY

Assemble the parts in the numerical order shown in the figure

Fig. 3-89

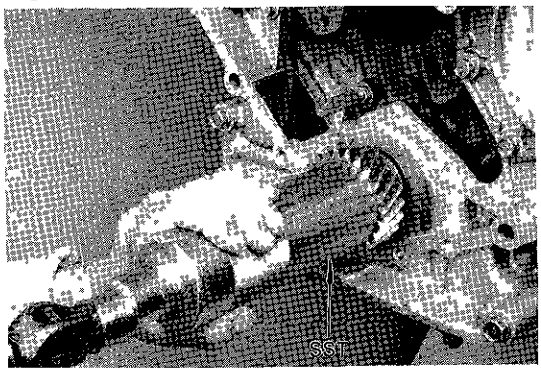
—Note—

1. **Thoroughly clean all parts to be assembled.**
2. **Apply clean engine oil to all sliding and rotating surfaces of the parts before assembly.**



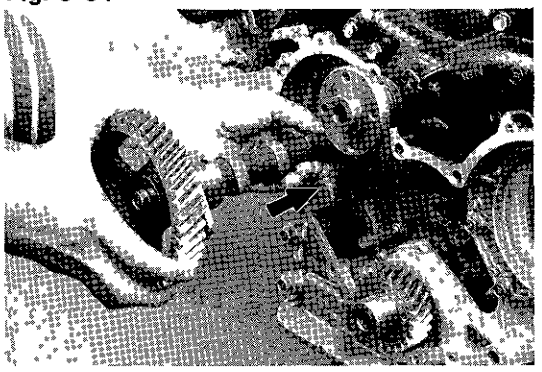
1	Crankshaft Timing Gear	7	Fan Pulley
2	Camshaft & Timing Gear	8	Cooling Fan
3	Idle Gear & Shaft	9	V Belt
4	Automatic Timer	10	Valve Lifter
5	Timing Gear Cover	11	Valve Push Rod Cover
6	Crankshaft Pulley	12	Oil Pan

Fig. 3-90



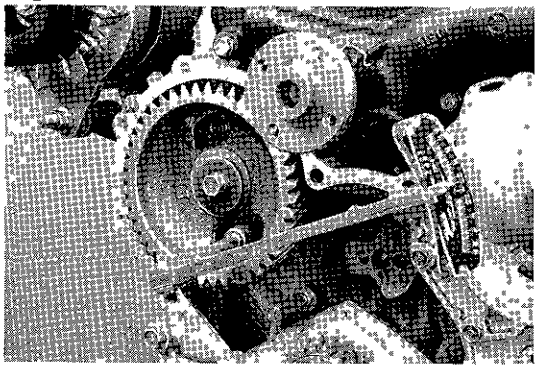
Drive in the crankshaft timing gear with SST
SST [09316-60010]

Fig. 3-91



Insert the camshaft using care not to damage the camshaft bearings

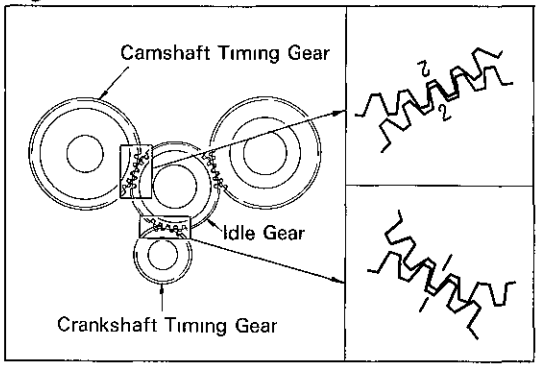
Fig. 3-92



Tighten the camshaft thrust plate

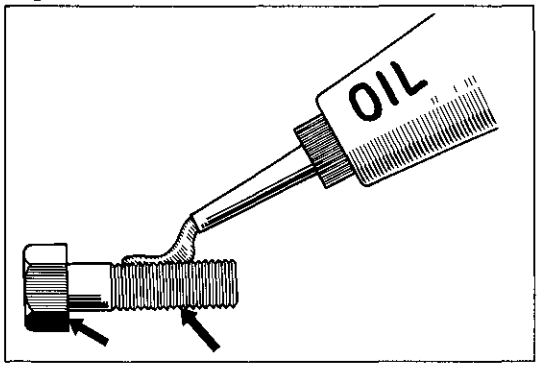
Tightening torque: 1.5 – 2.2 kg-m (11 – 15 ft-lb)

Fig. 3-93



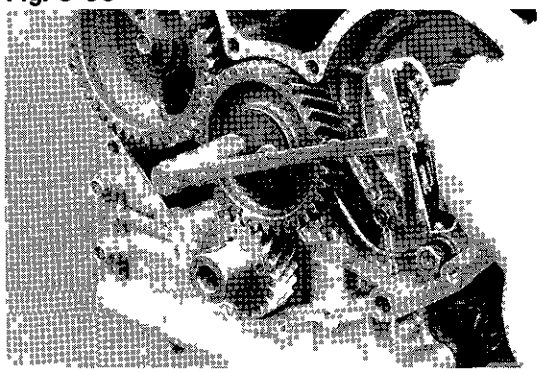
Set the idle gear aligning marks 1 and 2 respectively against crankshaft gear mark 1 and camshaft gear mark 2

Fig. 3-94



Apply a light coat of engine oil on the bolt threads and under the bolt head before installing

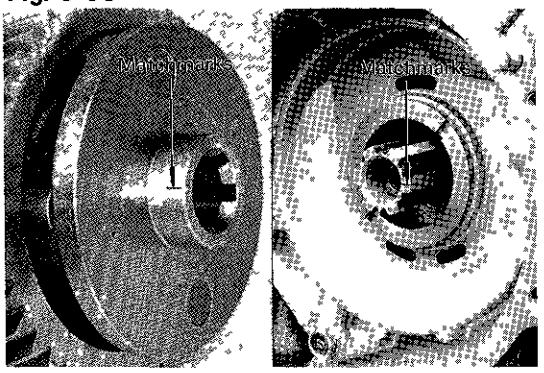
Fig. 3-95



Tighten the idle gear and shaft

Tightening torque: 4.0 – 5.5 kg-m (29 – 39 ft-lb)

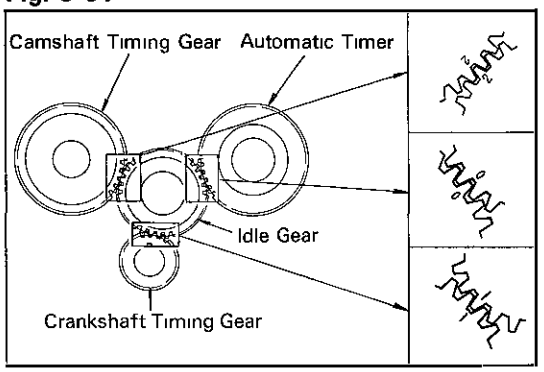
Fig. 3-96



When installing the automatic timer align the matchmarks on injection pump spline shaft and timer drive shaft

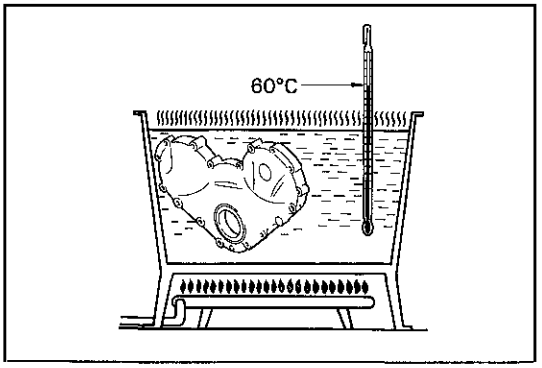
–Note–
Coat the splines and bearing with MP grease.

Fig. 3-97



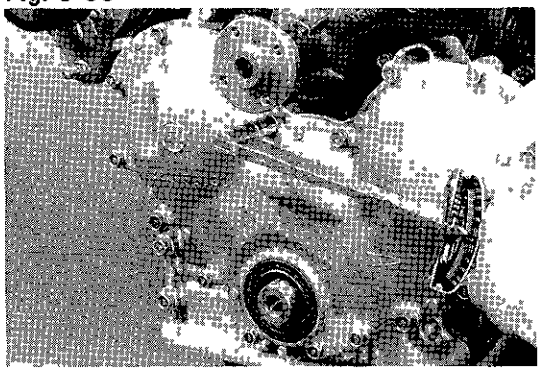
Align the idle gear 0 mark against the timer drive gear 0 mark

Fig. 3-98



Heat the timing gear cover to about 60°C (140°F) before installing

Fig. 3-99



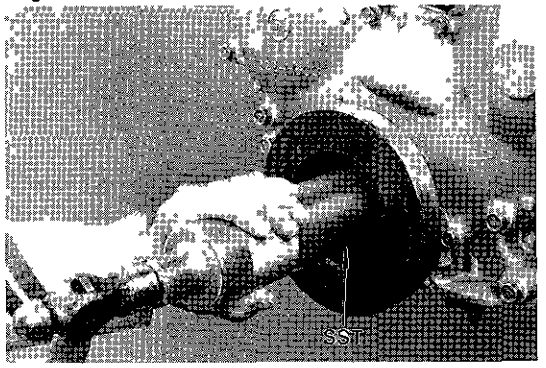
Tighten the timing gear cover

Tightening torque:

8 mm bolt 1.5 – 2.2 kg-m (11 – 15 ft-lb)

10 mm bolt 3.0 – 4.5 kg-m (22 – 32 ft-lb)

Fig. 3-100



Drive in the crankshaft pulley with SST

SST [09316-60010]

Fig. 3-101

Tighten the retaining bolt

Tightening torque: 20.0 – 24.0 kg-m (145 – 173 ft-lb)

–Note–

Apply a light coat of engine oil on the bolt threads and under the bolt head before installing.

Fig. 3-102

Adjust drive belt tension

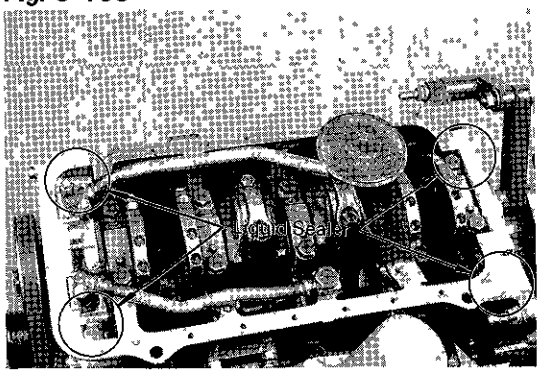
SEE

ENGINE TUNE-UP

SECTION

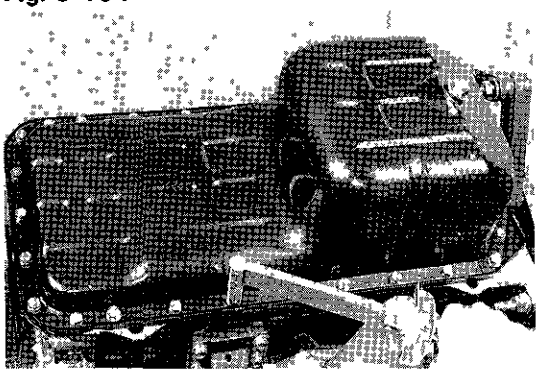
Fig. 2-7 & 2-8

Fig. 3-103



Apply liquid sealer to the cylinder block and gear cover at the areas shown in the figure

Fig. 3-104



Install the oil pan

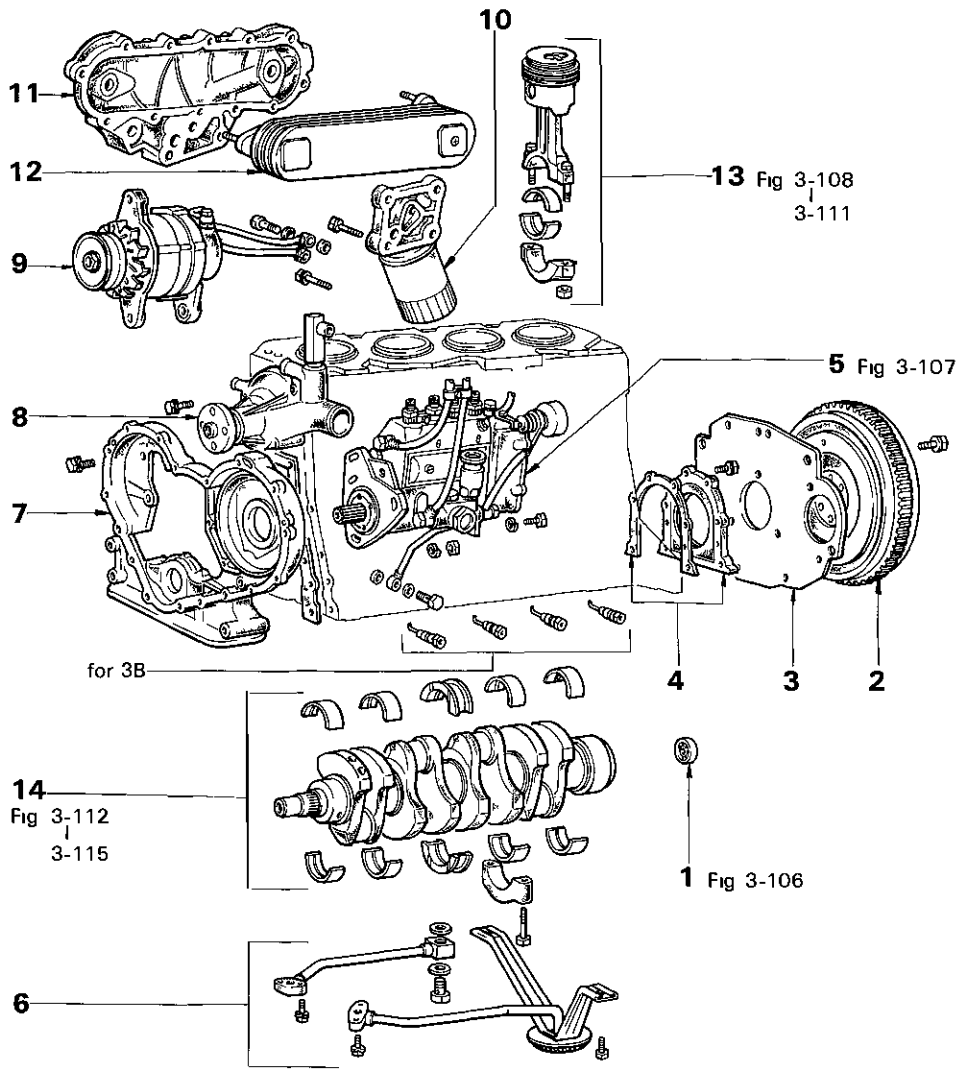
Tightening torque: 0.7 – 1.3 kg-m (61 – 112 in.-lb)

CYLINDER BLOCK

DISASSEMBLY

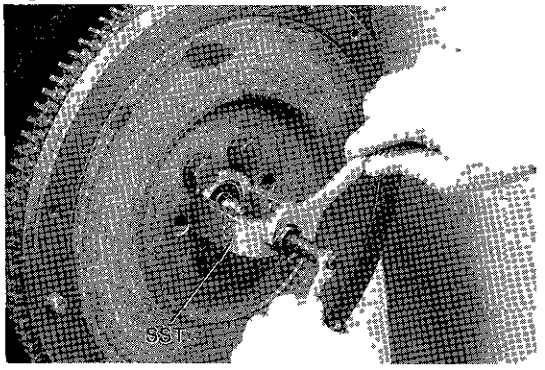
Disassemble the parts in the numerical order shown in the figure

Fig. 3-105



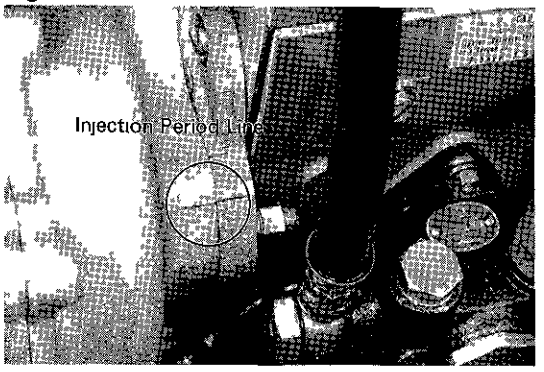
1	Input Shaft Bearing	8	Water Pump
2	Flywheel	9	Alternator
3	Rear End Plate	10	Oil Filter
4	Rear Oil Seal	11	Oil Cooler Cover
5	Injection Pump	12	Oil Cooler
6	Oil Strainer & Pipe	13	Piston & Connecting Rod
7	Timing Gear Case	14	Crankshaft

Fig. 3-106



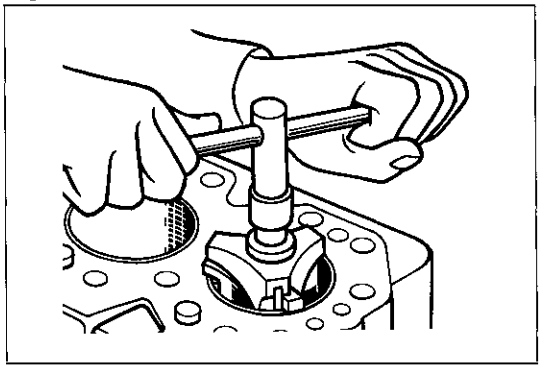
Remove the input shaft bearing with SST
SST [09303-35010]

Fig. 3-107



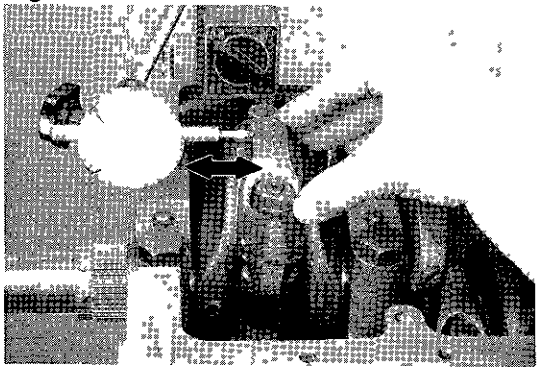
Check the position of injection period line before removing the injection pump

Fig. 3-108



–Note–
If carbon has accumulated on the top of the bore, remove it with a ridge reamer before removing the piston.

Fig. 3-109



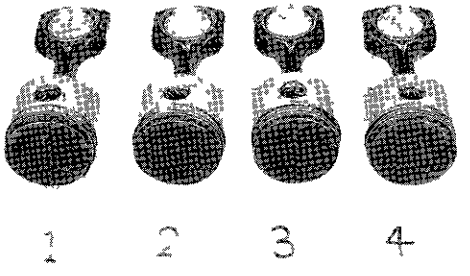
Measure the connecting rod thrust clearance
If it exceeds the limit, replace the connecting rod

Thrust clearance:
STD 0.08 – 0.20 mm
(0.0031 – 0.0079 in.)
Limit 0.3 mm
(0.012 in.)

Fig. 3-110

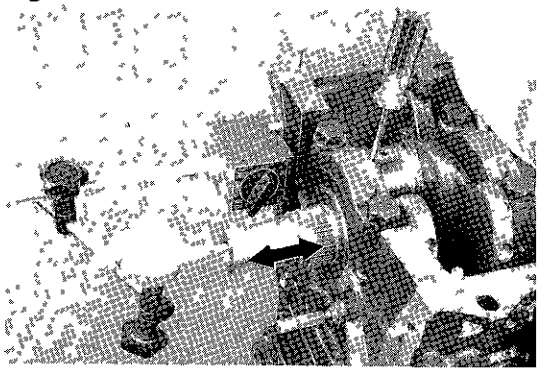
Cover the connecting rod bolts with short hoses to protect the crankshaft pins from damage

Fig. 3-111



Keep the pistons and connecting rod caps in correct order

Fig. 3-112

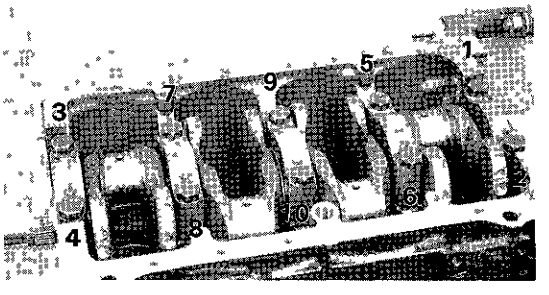


Measure the crankshaft thrust clearance
If it exceeds the limit, replace the bearings as a set

Thrust clearance:

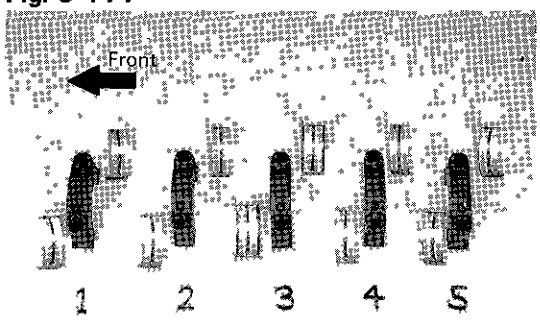
STD	**0.07 – 0.18 mm (0.0028 – 0.0071 in.)**
Limit	**0.3 mm (0.012 in.)**
U/S bearing type	**0.25, 0.50, 1.00**

Fig. 3-113



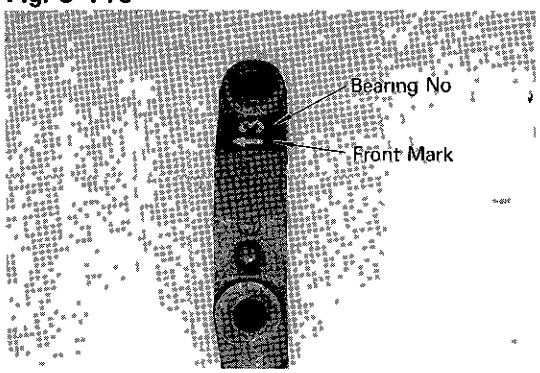
Loosen each crankshaft bearing bolt a little at a time in the sequence shown in the figure

Fig. 3-114



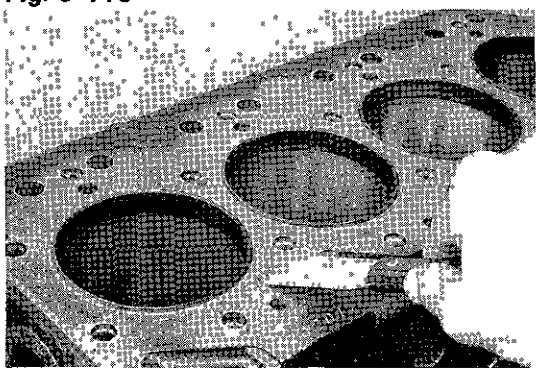
⚠ Keep the crankshaft bearings and caps in correct order

Fig. 3-115



⚠ **—Note—**
The number and front side of each bearing should be marked.

Fig. 3-116

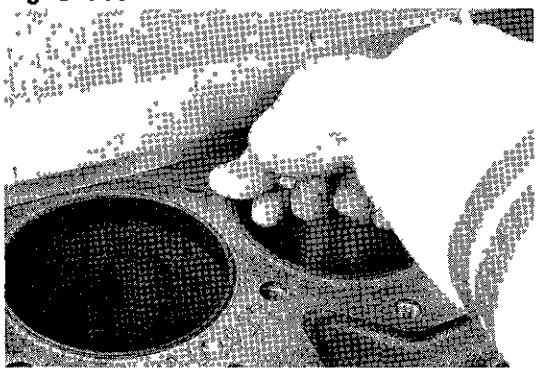


INSPECTION & REPAIR

Cylinder Block & Liner

1 Clean and check the cylinder block for cracks or scoring

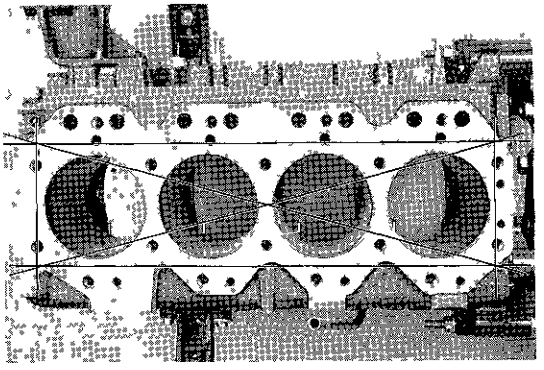
Fig. 3-117



2 Using a precision straight edge and thickness gauge check the cylinder block topside surface for warpage

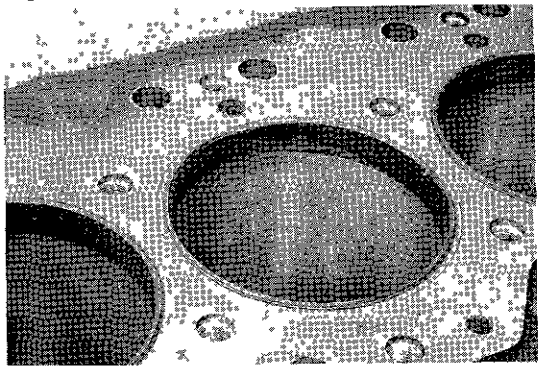
Topside surface warpage:
Limit 0.2 mm
(0.008 in.)

Fig. 3-118



3 Check for warp along the indicated lines

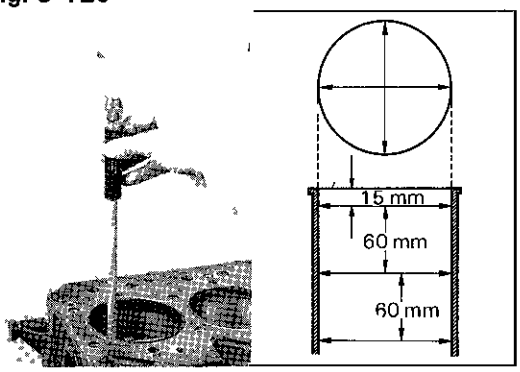
Fig. 3-119



4 Visually check the cylinder for vertical scratches If there are deep scratches the cylinder liner must be rebored or replaced Refer to Fig 3-123 to 3 132

—Note—
When reboring the liner, rebore all cylinders to the same size.

Fig. 3-120



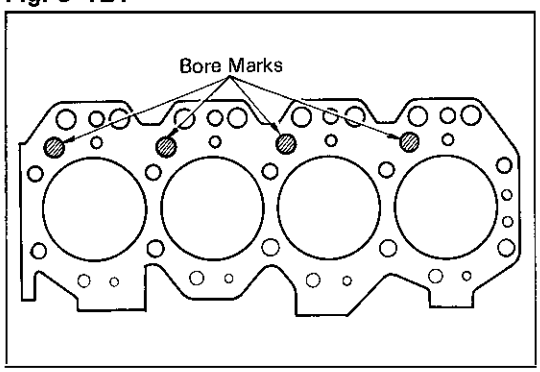
5 Measure the cylinder bore at the top middle and bottom as shown in the figure If wear exceeds the limit the liner must be rebored or replaced Refer to Fig 3 123 to 3 132

Wear:

Limit 0.3 mm (0.012 in.)

Mark	Size mm (in)		
	B	2B	3B
1	95 00 95 01 (3 7402 3 7405)	98 00 98 01 (3 8583 3 8587)	102 00 102 01 (4 0157 4 0161)
2	95 01 95 02 (3 7405 3 7409)	98 01 98 02 (3 8587 3 8590)	102 01 102 02 (4 0161 4 0165)
3	95 02 95 03 (3 7409 3 7413)	98 02 98 03 (3 8590 3 8594)	102 02 102 03 (4 0165 4 0169)

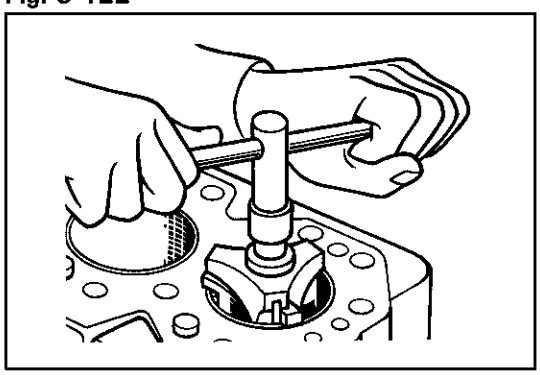
Fig. 3-121



—Note—

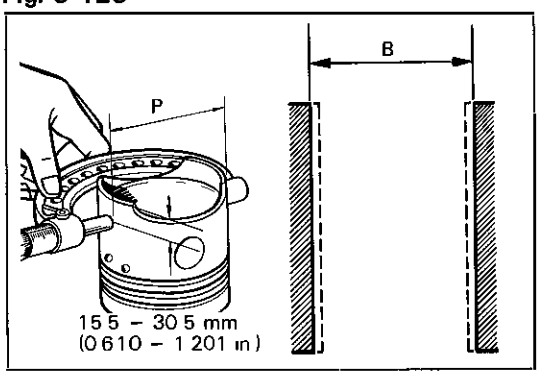
The bore marks are stamped on cylinder block top surface as shown in the figure.

Fig. 3-122



6 If wear is less than 0 3 mm (0 012 in) machine the piston ring ridge at the top of the bore with a ridge reamer

Fig. 3-123



7 If wear exceeds the limit rebore the cylinder liner (for B engine)

(1) Use following equation to determine the reboring diameter

B = P + C – H

B: Reboring diameter

P: O/S piston diameter

C: Piston oil clearance

0.11 – 0.13 mm

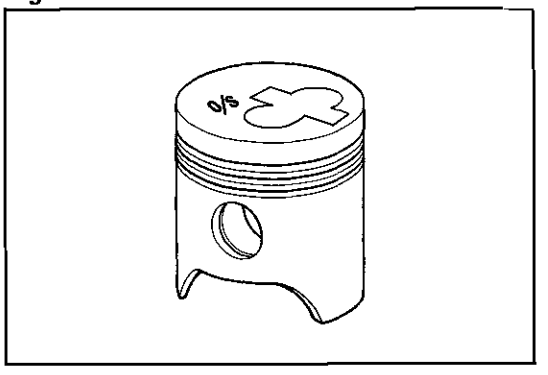
(0.0043 – 0.0051 in.)

H: Honing allowance

Less than 0.02 mm

(0.0008 in.)

Fig. 3-124

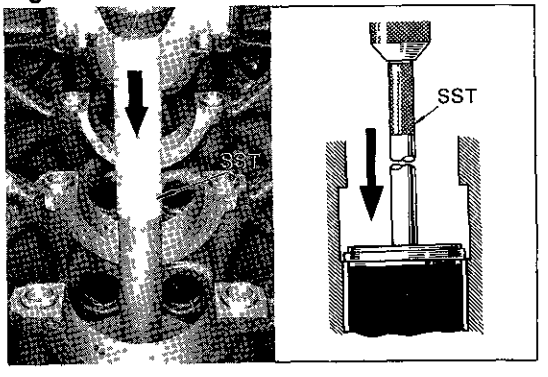


(2) Use oversize piston after reboring the liner

Oversize piston diameter:
O/S 1.00
95.88 – 95.91 mm
(3.7748 – 3.7760 in.)

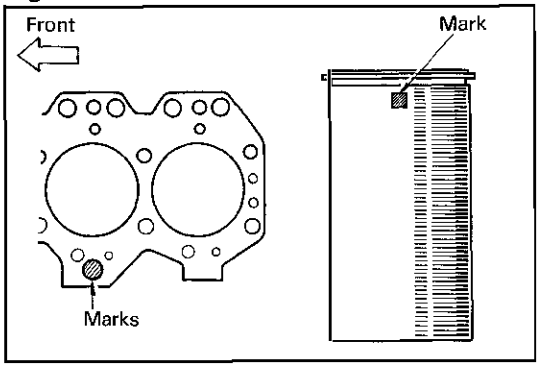
–Note–
If wear is excessive, replace the cylinder liner.

Fig. 3-125



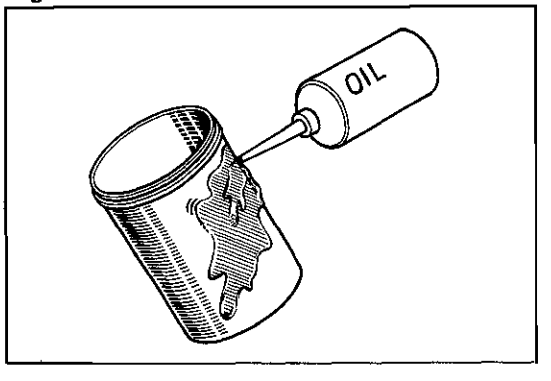
8 If wear exceeds the limit, replace the cylinder liner with SST
For B & 2B
(1) Press out the cylinder liner with SST
SST [09218-56020]

Fig. 3-126



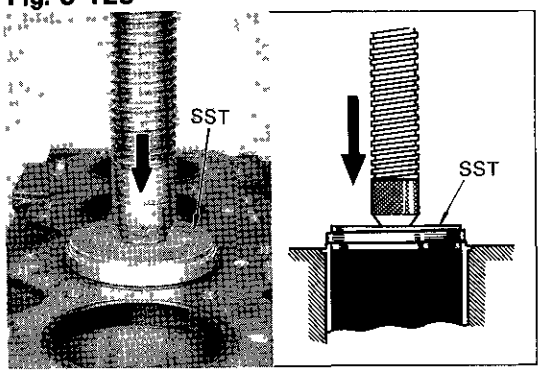
(2) Select the liner having the same mark as the cylinder block A or B

Fig. 3-127



(3) Lubricate the outside surface of the cylinder liner with engine oil before installing

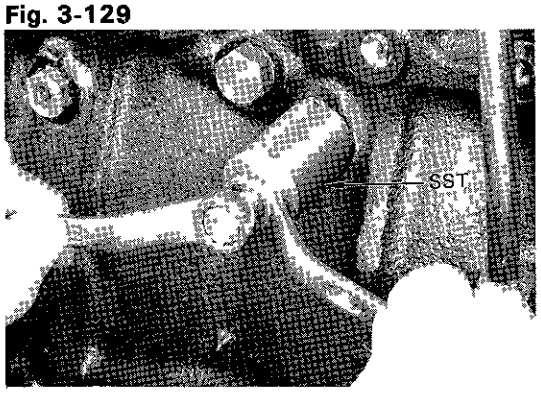
Fig. 3-128



(4) Press in the cylinder liner with SST
SST [09218-56020]
Pressing force: 2,500 kg (5,500 lb)

—Note—
After pressing in the liner, rebore and hone the liner bore to fit a standard piston.

Fig. 3-129



For 3B
(1) Pull out the oil nozzle from the cylinder block with SST
SST [09219-56010]

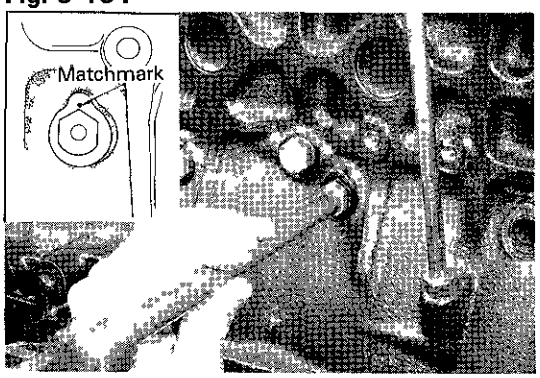
—Note—
1. **Use care not to damage the nozzle point.**
2. **Check the nozzle for clogging and, if necessary, replace it with new one.**

Fig. 3-130

SEE
CYLINDER LINER
REPLACEMENT SECTION
Fig. 3-125 to 3-128

(2) Replace the cylinder liner with SST in the same manner as for B and 2B engines
SST [09218-56030]

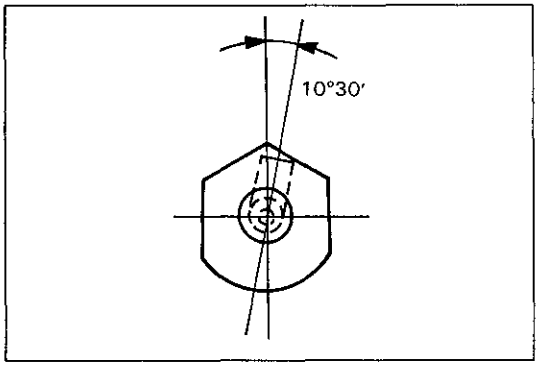
Fig. 3-131



(3) Drive in the oil nozzle facing its head point toward the matchmark of the cylinder block as shown in the figure

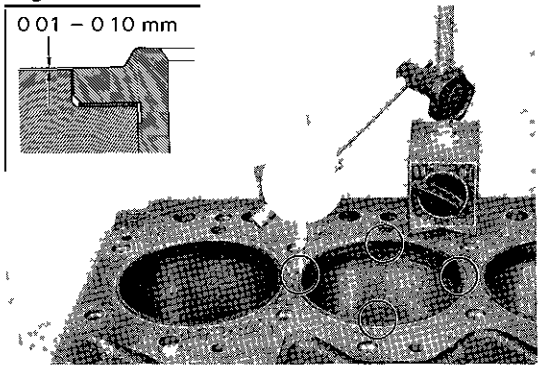
—Note—
1. **When installing the oil nozzle, be sure to replace the O ring with new one.**

Fig. 3-132



2. **Make sure that the nozzle point faces the direction indicated in the figure. If not, the piston may be deformed, resulting in excessive oil consumption and possibly a stuck piston.**

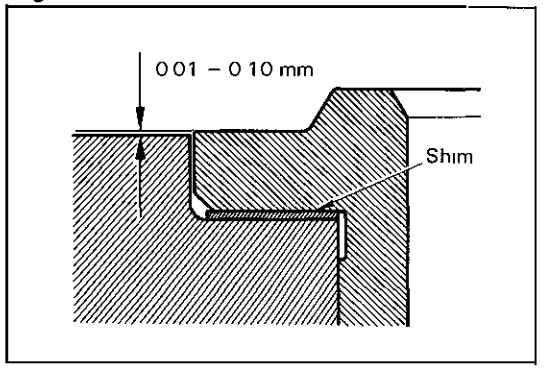
Fig. 3-133



9 After replacing the cylinder liner, measure the protrusion of liner above the cylinder block top surface at four positions

Protrusion: 0.01 – 0.10 mm (0.0004 – 0.0039 in.)

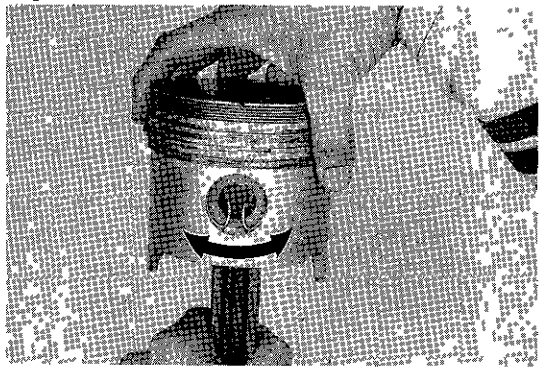
Fig. 3-134



10 Adjust the protrusion of cylinder liner with the cylinder liner shims

Cylinder liner shim thickness:
0.05, 0.10 mm
(0.0020, 0.0039 in.)

Fig. 3-135

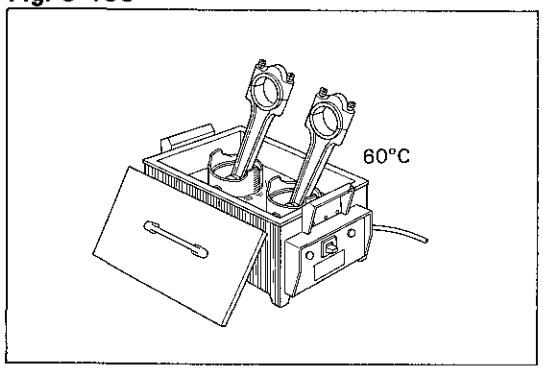


Piston Pin & Connecting Rod

1 Check pin fit by rocking the piston at right angle to the pin

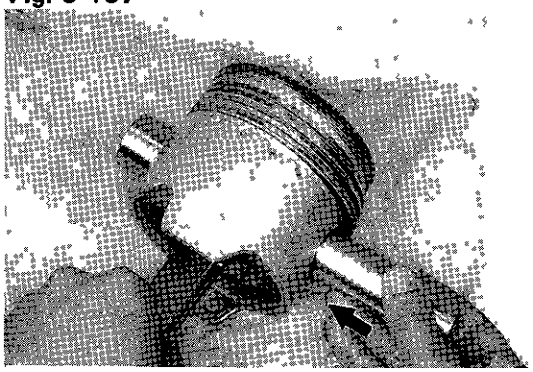
If any movement is felt, replace the piston and pin

Fig. 3-136



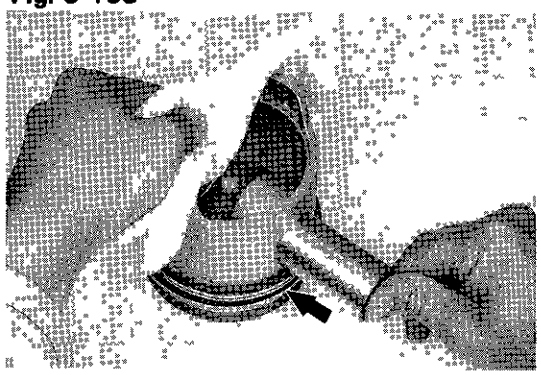
2 Heat the piston in a piston heater to about 60°C (140°F) before removing the piston pin

Fig. 3-137



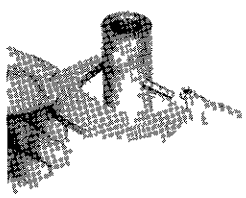
3 Normally, the pin can be pushed out by hand, but if difficult drive it out with a brass bar or such

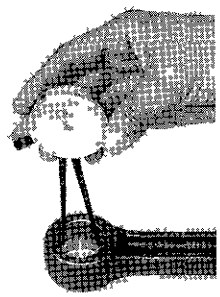
Fig. 3-138



4 Check piston pin fitness
Heat the piston to about 60°C (140°F) and coat the piston pin with engine oil It should be possible to push the pin into the piston hole with your thumb

Fig. 3-139



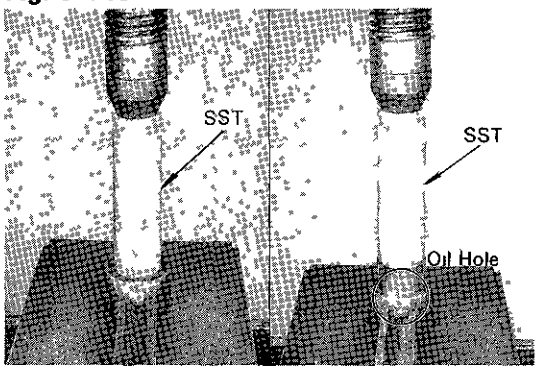


5 Measure the oil clearance between the bushing and piston pin

Bushing oil clearance:

STD	**0.004 – 0.014 mm (0.0002 – 0.0006 in.)**
Limit	**0.05 mm (0.0020 in.)**

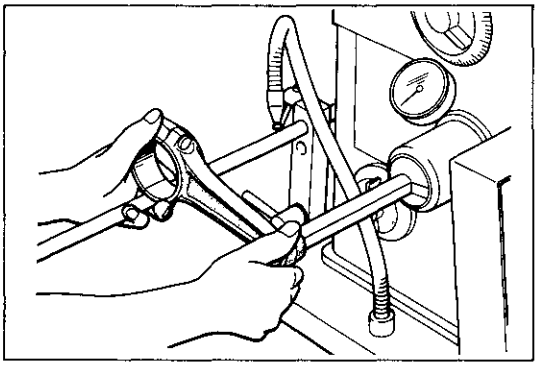
Fig. 3-140



6 Replace the bushing with SST
SST [09222-66010]

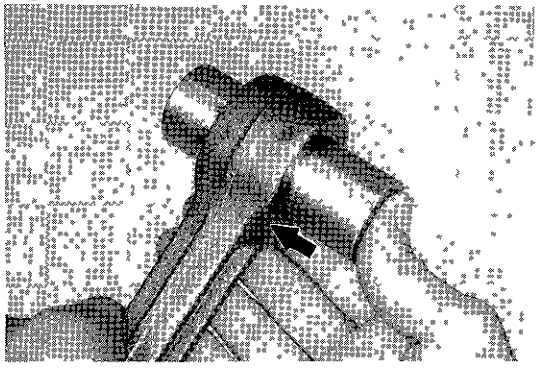
– Note –
Align the oil hole of the bushing with that of the connecting rod.

Fig. 3-141



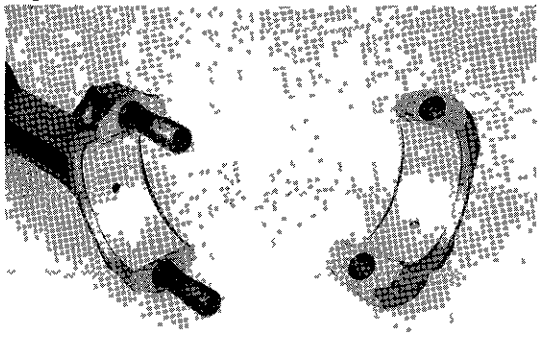
7 After installing the bushing, finish the bushing bore with a pin hole grinder

Fig. 3-142



8 Check the fitness between the bushing and pin
Coat the piston pin with engine oil At room temperature, the pin can be pushed in with your thumb

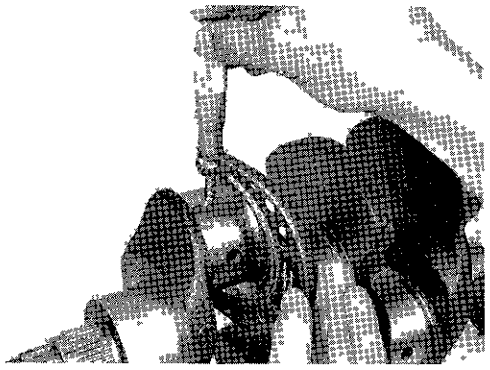
Fig. 3-143



Crankpin Bearing

1 Check for flaking or scoring
If damaged, replace

Fig. 3-144

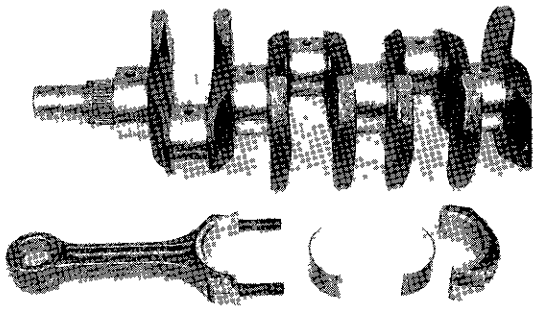


2 Measure the crankpin diameter
If wear is excessive, the crankshaft must be reground or replaced

Crankpin diameter:

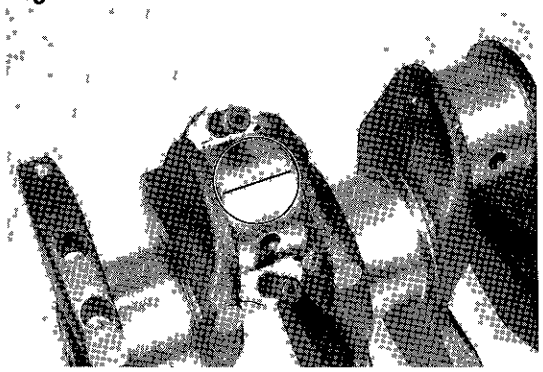
STD	
B & 2B	**58.98 – 59.00 mm (2.3220 – 2.3228 in.)**
3B	**60.98 – 61.00 mm (2.4008 – 2.4016 in.)**

Fig. 3-145



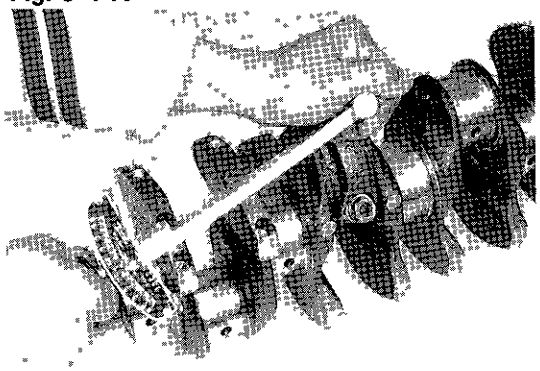
3 Measure the crankpin oil clearance
(1) Clean the crankshaft pin, connecting rod cap and bearings

Fig. 3-146



(2) Lay a strip of plastigage across the pin

Fig. 3-147



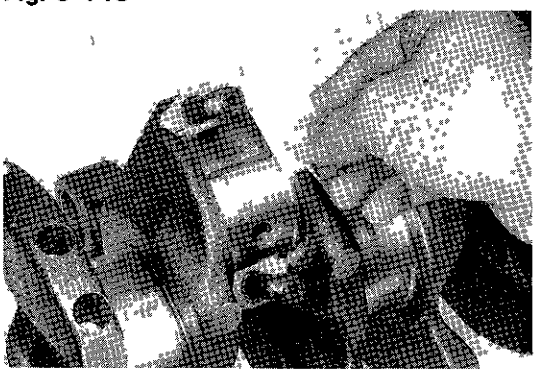
(3) Tighten the cap nuts to specified torque

Tightening torque

B & 2B	**6.5 – 7.5 kg-m (48 – 54 ft-lb)**
3B	**8.5 – 9.5 kg-m (62 – 68 ft-lb)**

–Note–
Do not turn the connecting rod or crankshaft.

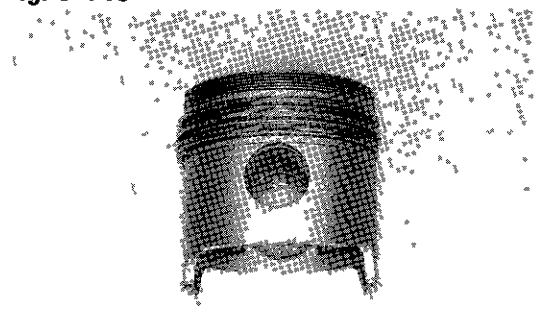
Fig. 3-148



(4) Measure the plastigage at its widest point
If clearance is not within specification, replace the bearings

Oil clearance:
STD 0.03 — 0.07 mm (0.0012 — 0.0028 in.)
Limit 0.1 mm (0.004 in.)
U/S bearing type 0.25, 0.50, 1.00

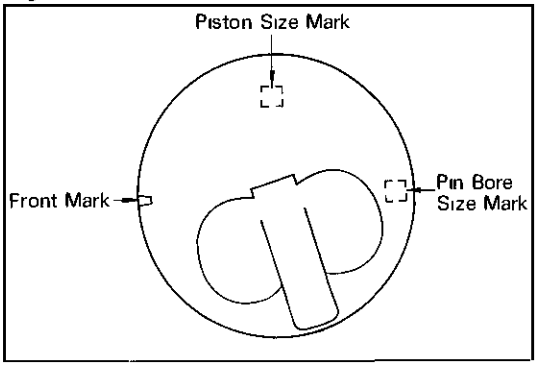
Fig. 3-149



Piston

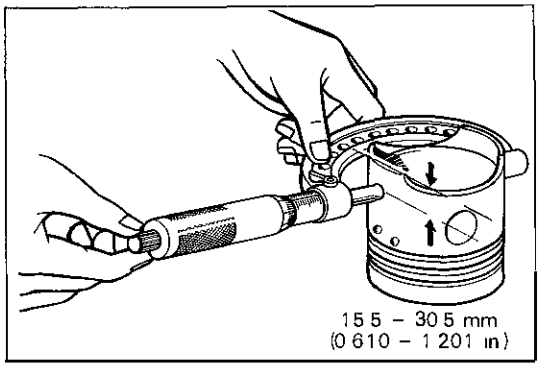
1 Check for wear or damage especially in the piston ring grooves and ring lands

Fig. 3-150



—Note—
At the piston top surface there is a mark indicating the front side and stamped codes indicating piston diameter and piston pin bore.

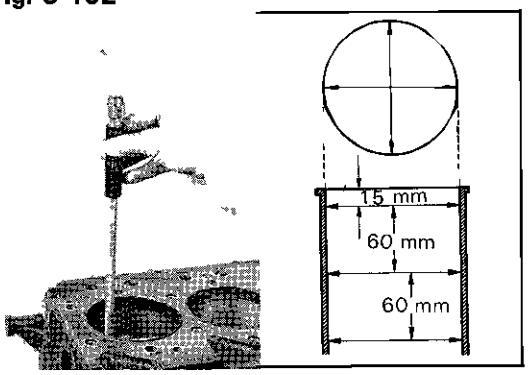
Fig. 3-151



2 Check the piston clearance
(1) Measure the piston diameter in the thrust direction about 15 5 — 30 5 mm (0 610 — 1 201 in) up from skirt bottom edge
This measurement must be made at room temperature, 20°C (68°F)

Mark	Piston size mm (in)		
	B	2B	3B
1	94 88 94 89 (3 7354 3 7358)	97 88 97 89 (3 8535 3 8539)	101 90 101 91 (4 0118-4 0122)
2	94 89 94 90 (3 7358 3 7362)	97 89 97 90 (3 8539 3 8543)	101 91 101 92 (4 0122-4 0126)
3	94 90 94 91 (3 7362 3 7366)	97 90 97 91 (3 8543 3 8547)	101 92 101 93 (4 0126-4 0130)

Fig. 3-152

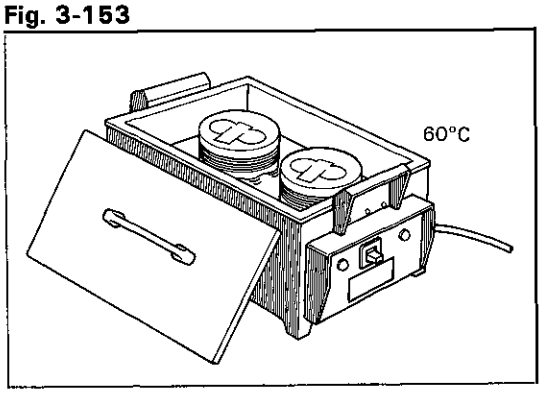


(2) Measure the cylinder bore and subtract the piston size

Mark	Size		mm (in)
	B	2B	3B
1	95.00 95.01 (3.7402 3.7405)	98.00 98.01 (3.8583 3.8587)	102.00 102.01 (4.0157 4.0161)
2	95.01 95.02 (3.7405 3.7409)	98.01 98.02 (3.8587 3.8590)	102.01 102.02 (4.0161 4.0165)
3	95.02 95.03 (3.7409 3.7413)	98.02 98.03 (3.8590 3.8594)	102.02 102.03 (4.0165 4.0169)

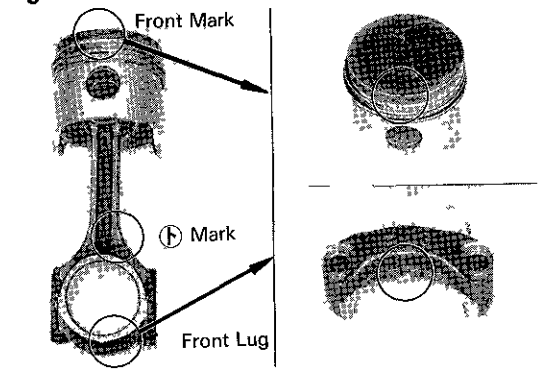
Piston oil clearance:
0.09 – 0.11 mm
(0.0035 – 0.0043 in.)

Fig. 3-153



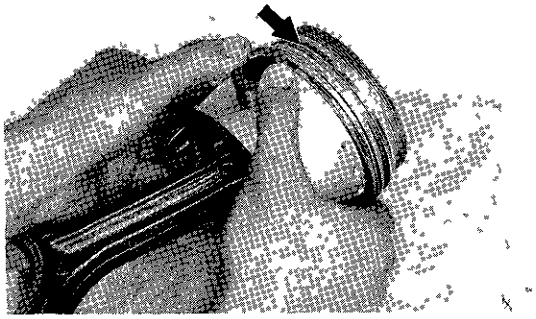
3 Assemble the piston and connecting rod as follows
(1) Heat the piston to about 60°C (140°F) before installing the piston pin

Fig. 3-154



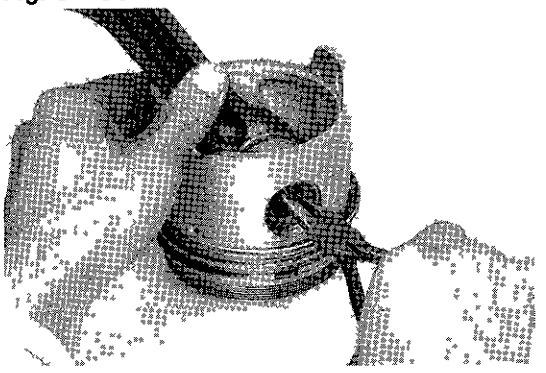
(2) Align the front mark of the piston and Ⓕ mark of the connecting rod as shown in the figure

Fig. 3-155



(3) Normally the pin can be pushed in by hand but if difficult drive it in with a brass bar or such

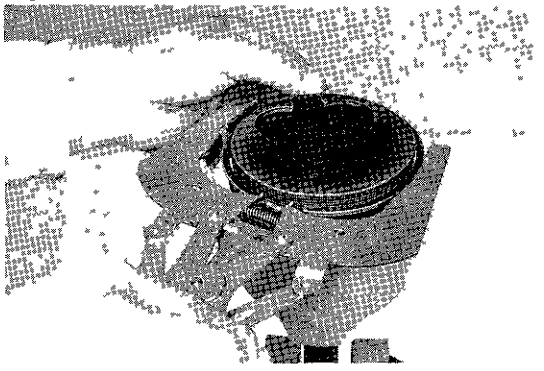
Fig. 3-156



(4) Install the snap rings on both sides

—Note—
Make sure that the snap rings are installed correctly in the grooves.

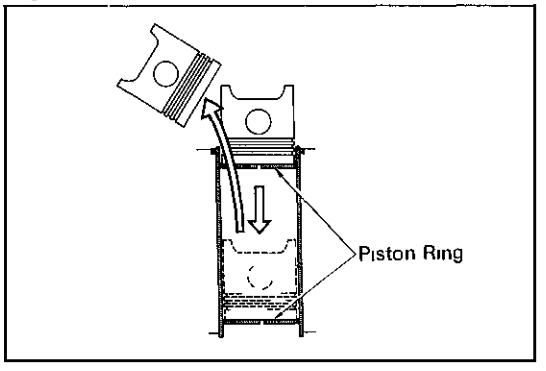
Fig. 3-157



Piston Ring

1 Remove the piston ring with a piston ring expander

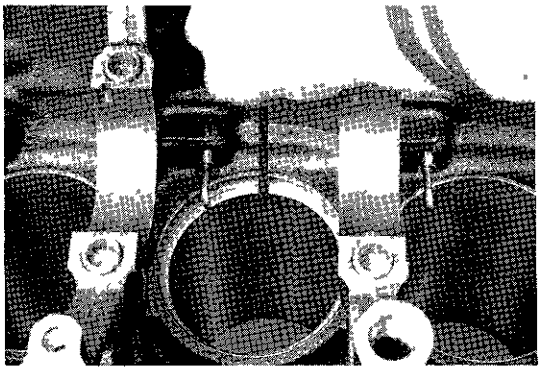
Fig. 3-158



2 Measure the piston ring end gap with the ring at the lower part of the cylinder bore where the wear is least

—Note—
Use the correct size rings to match the piston size.

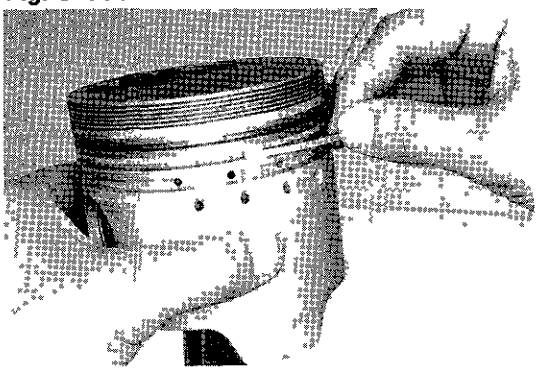
Fig. 3-159



3 Measure the end gaps of No 1, No 2 and oil rings

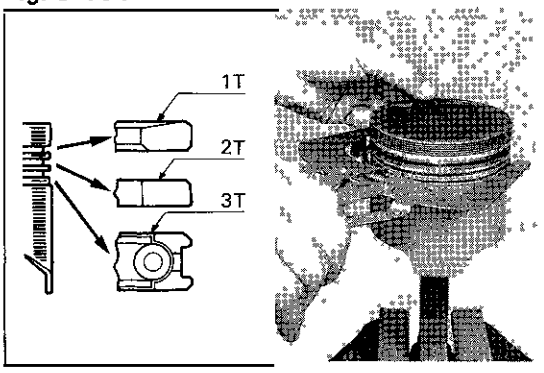
End gap:
B engine
0.35 — 0.55 mm
(0.0138 — 0.0217 in.)
2B & 3B engine
0.40 — 0 60 mm
(0.0157 — 0.0236 in.)

Fig. 3-160



4 Clean the ring grooves with a groove cleaning tool or broken ring

Fig. 3-161

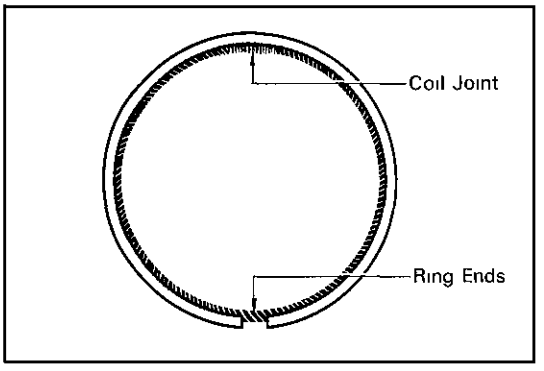


5 Install the piston ring with a piston ring expander

–Note–

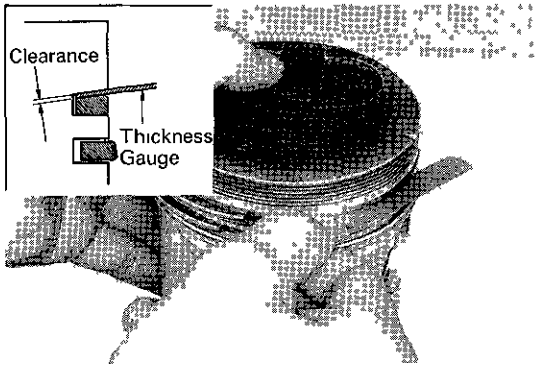
1. **Always install the rings with the code marks facing up.**

Fig. 3-162



2. **To assemble the oil ring and expander coil, make sure that the expander coil joint is at the opposite side of the ring ends.**

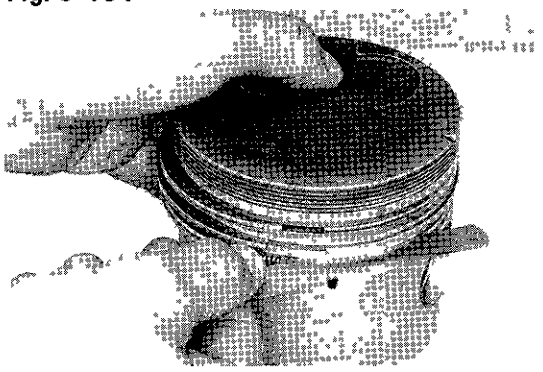
Fig. 3-163



6 Measure the No 1 ring groove clearance with a thickness gauge when the ring is flush with the piston surface If it exceeds specification replace the ring and/or piston

No.1 ring to groove clearance:
0.04 – 0.06 mm
(0.0016 – 0.0024 in.)

Fig. 3-164

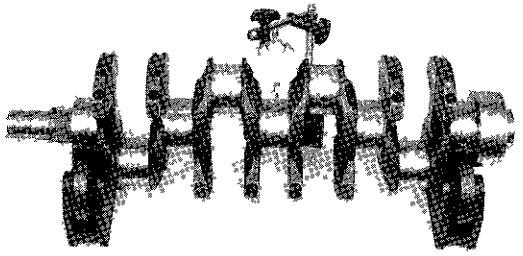


7 Measure the No.2 and oil ring groove clearance
If it exceeds specification replace the ring and/or piston

Ring to groove clearance:

No.2	**0.04 — 0.06 mm (0.0016 — 0.0024 in.)**
Oil ring	**0.03 — 0.07 mm (0.0012 — 0.0028 in.)**

Fig. 3-165



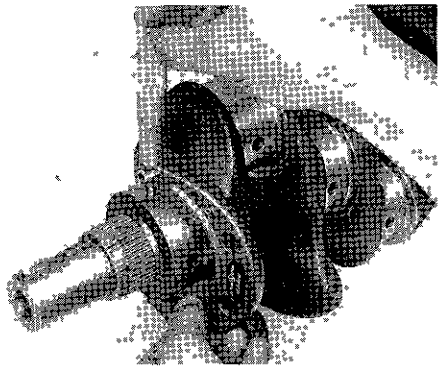
Crankshaft & Bearing

1 Check the crankshaft for runout and if it exceeds limit replace

Circle runout:

Limit	**0.06 mm (0.0024 in.)**

Fig. 3-166

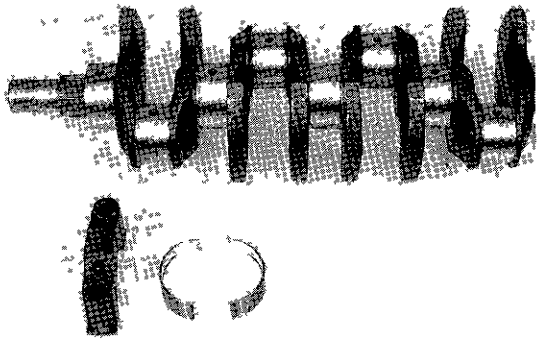


2 Measure the crankshaft main journal
If wear is excessive the crankshaft must be reground or replaced

Main journal diameter:

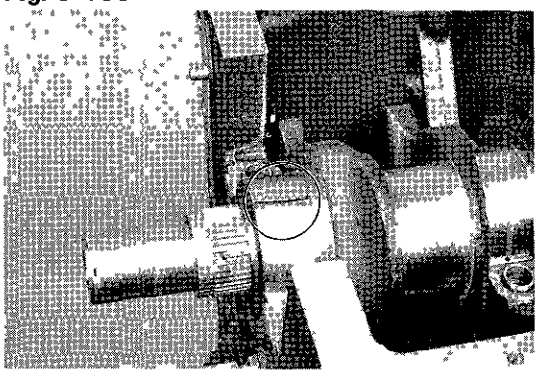
STD	**69.98 — 70.00 mm (2.7551 — 2.7559 in.)**

Fig. 3-167



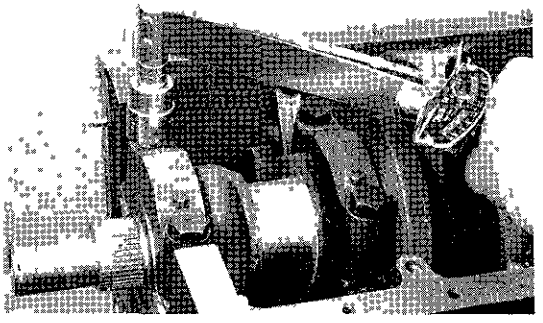
3 Measure the main journal oil clearance
(1) Clean the journal, cap and bearing

Fig. 3-168



(2) Lay a strip of plastigage across the journal

Fig. 3-169

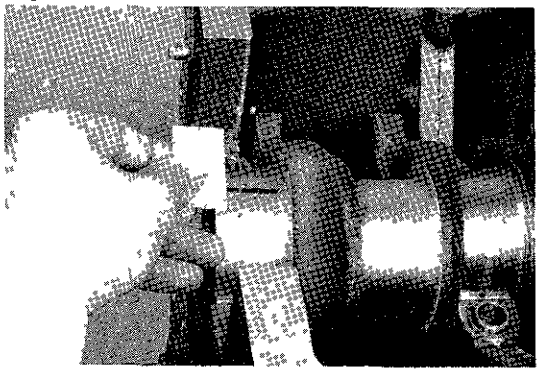


(3) Tighten the cap bolts to specified torque

Tightening torque:
12.8 – 14.2 kg-m
(93 – 102 ft-lb)

–Note–
Do not turn the crankshaft.

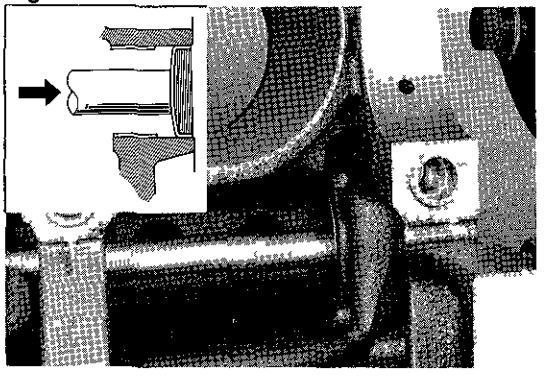
Fig. 3-170



(4) Measure the plastigage at its widest point If clearance is not within specification replace the bearings

Oil clearance:
STD 0.03 – 0.07 mm
(0.0012 – 0.0028 in.)
Limit 0.1 mm
(0.004 in.)
U/S bearing type
0.25, 0.50, 1.00

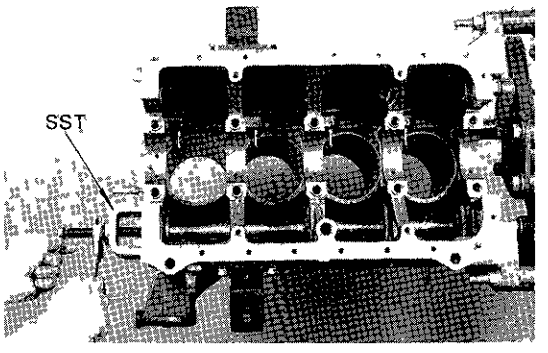
Fig. 3-171



Camshaft Bearing

1 Remove the camshaft rear expansion plug

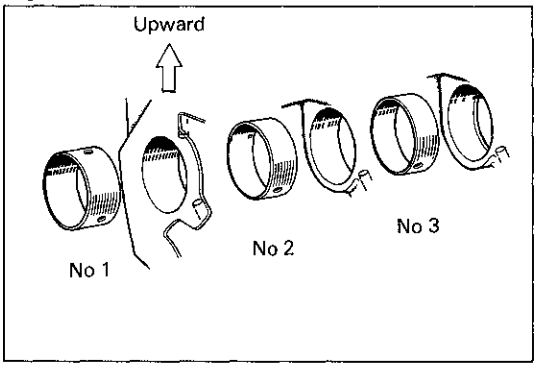
Fig. 3-172



2 Remove the camshaft bearings with SST
SST [09215-56010]

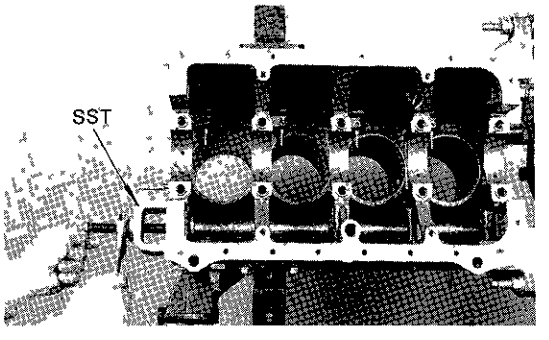
—Note—
Remove the bearings one at a time.

Fig. 3-173



3 Align the bearing oil holes

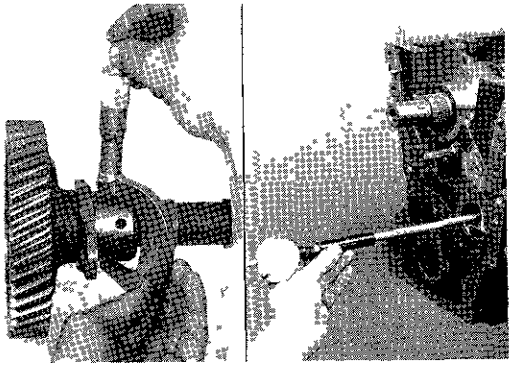
Fig. 3-174



4 Install new bearings with SST
SST [09215-56010]

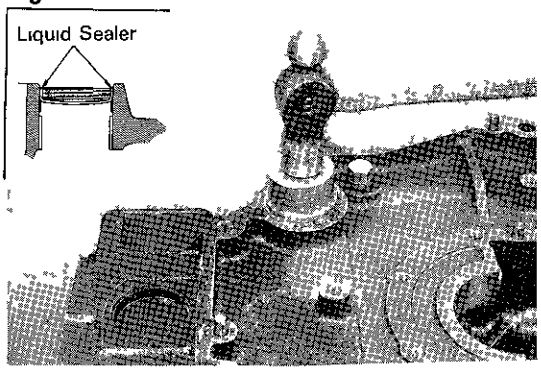
—Note—
Install each bearing one at a time.

Fig. 3-175



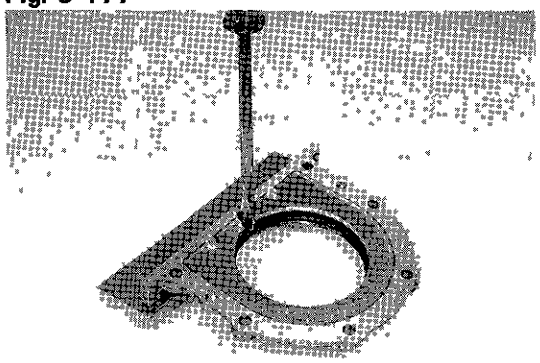
5 Check the bearing oil clearance
Oil clearance:
STD 0.03 – 0.07 mm
(0.0012 – 0.0028 in.)
Limit 0.1 mm
(0.004 in.)

Fig. 3-176



6 Install a new expansion plug with liquid sealer

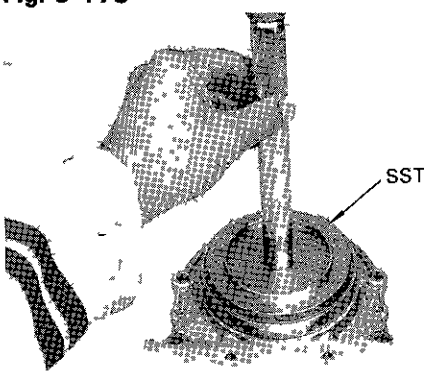
Fig. 3-177



Crankshaft Rear Oil Seal

1 Remove the oil seal with a screwdriver

Fig. 3-178



2 Install a new oil seal with SST
SST [09550-55010]

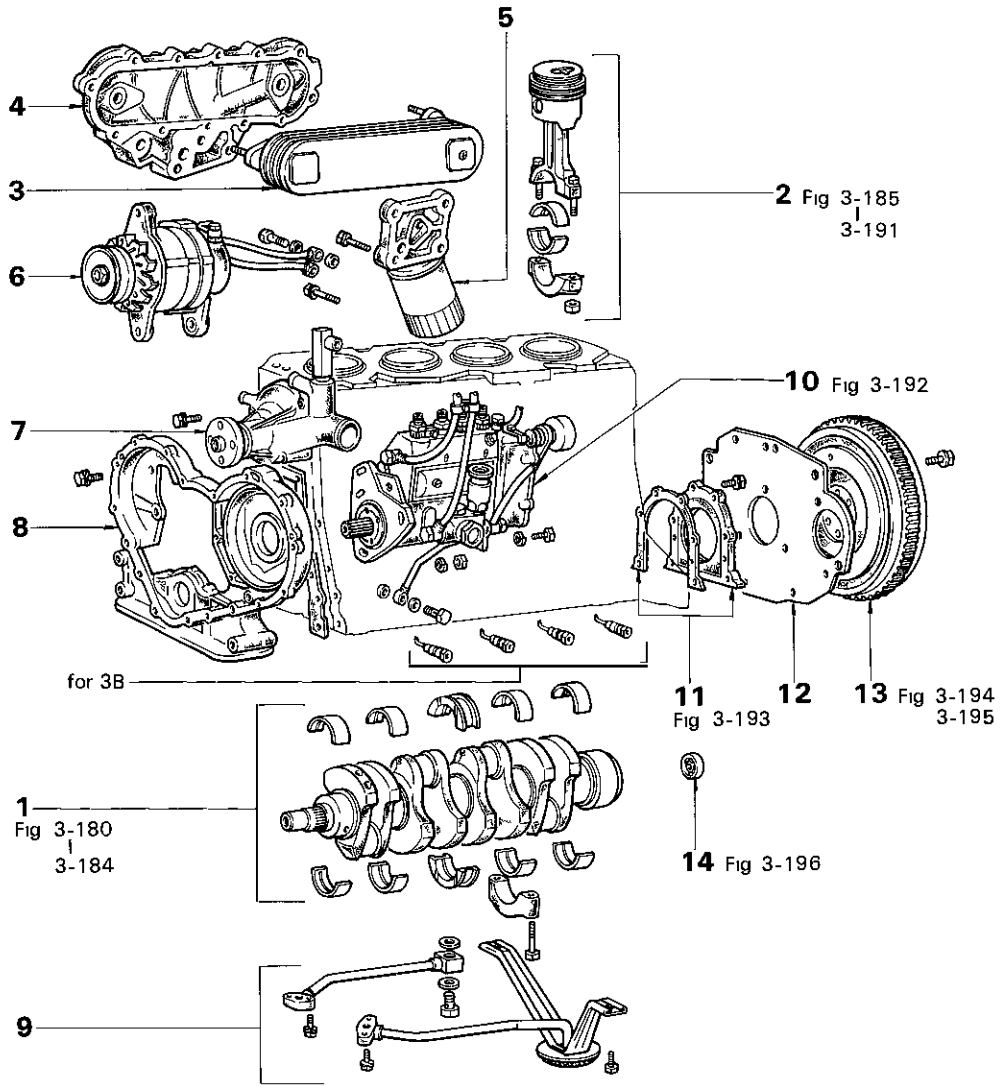
ASSEMBLY

Assemble the parts in the numerical order shown in the figure

Fig. 3-179

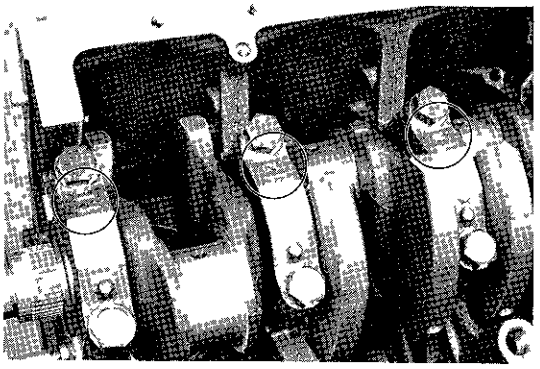
–Note–

1. **Thoroughly clean all parts to be assembled.**
2. **Apply clean engine oil to all sliding and rotating surfaces of the parts before assembly.**



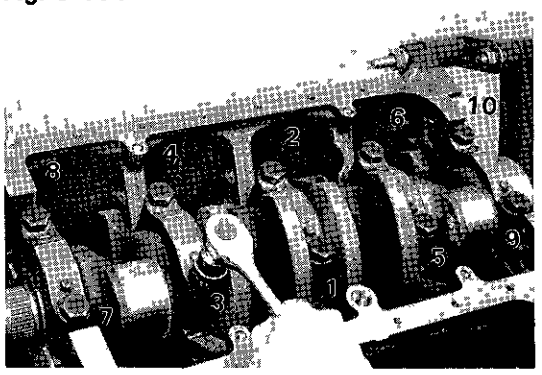
1	Crankshaft	8	Timing Gear Case
2	Piston & Connecting Rod	9	Oil Strainer & Connecting Rod
3	Oil Cooler	10	Injection Pump
4	Oil Cooler Cover	11	Rear Oil Seal
5	Oil Filter	12	Rear End Plate
6	Alternator	13	Flywheel
7	Water Pump	14	Input Shaft Bearing

Fig. 3-180



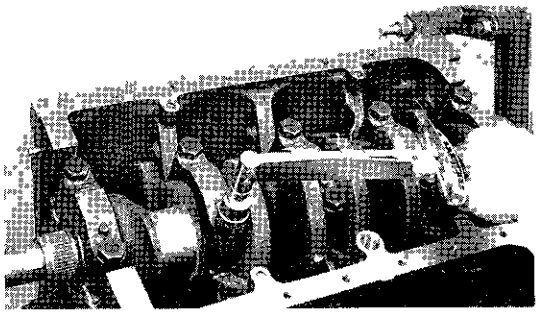
Face the arrow marks toward the front

Fig. 3-181



Tighten each bearing cap bolt a little at a time in the sequence shown in the figure

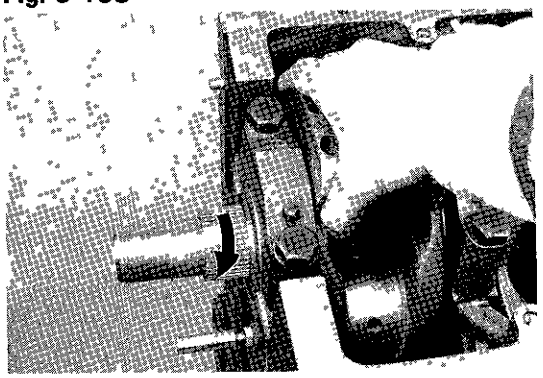
Fig. 3-182



Tighten the bearing caps to specified torque

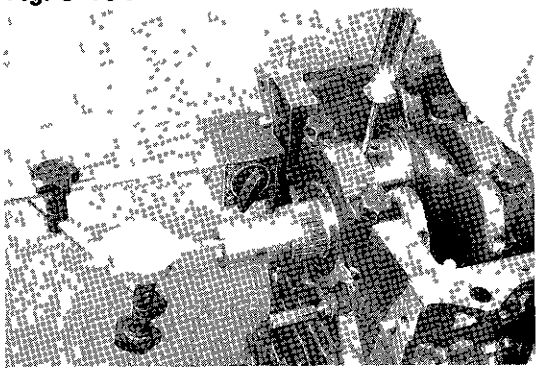
Tightening torque:
12.8 – 14.2 kg-m
(93 – 102 ft-lb)

Fig. 3-183



–Note–
Check for tightness of crankshaft rotation after tightening each bearing.

Fig. 3-184



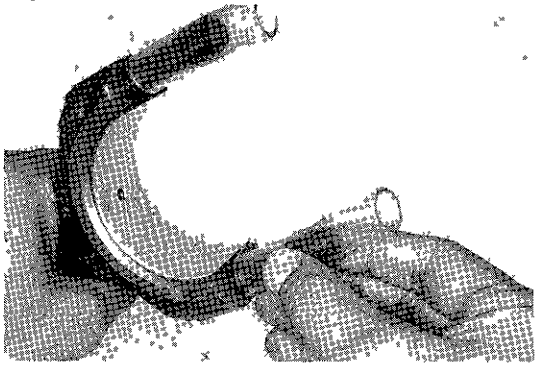
Measure the crankshaft thrust clearance

Thrust clearance:

STD 0.07 – 0.18 mm (0.0028 – 0.0071 in.)

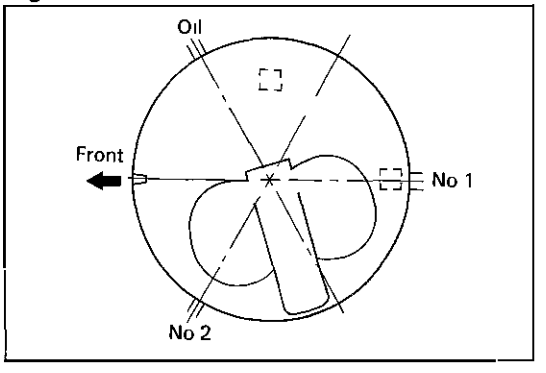
Limit 0.3 mm (0.012 in.)

Fig. 3-185



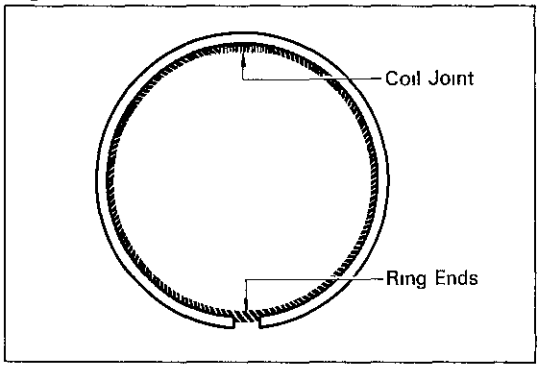
Cover the rod bolts with short hoses to protect crankpins from damage

Fig. 3-186



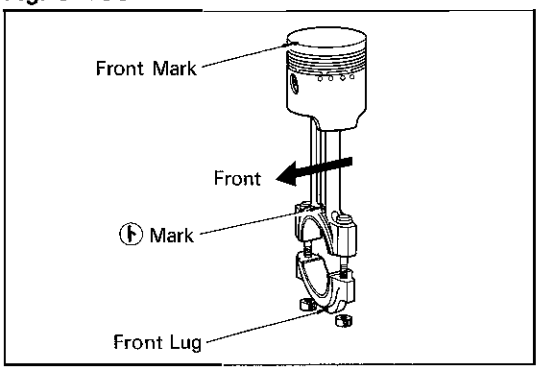
Position the ring gaps in the direction shown in the figure

Fig. 3-187



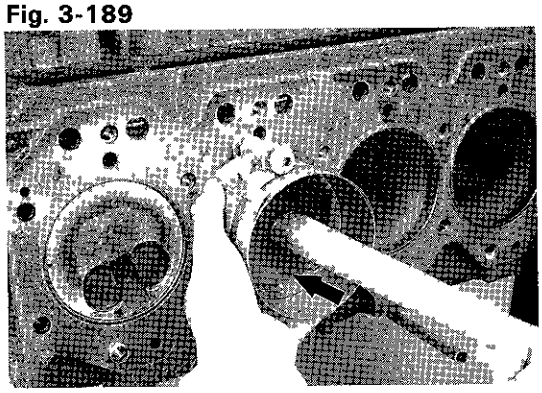
The oil ring ends should be at the opposite side of the expander coil joint

Fig. 3-188



Assemble matching numbered piston/rod assemblies with the notch on the piston and the Ⓕ mark on the connecting rod facing the front

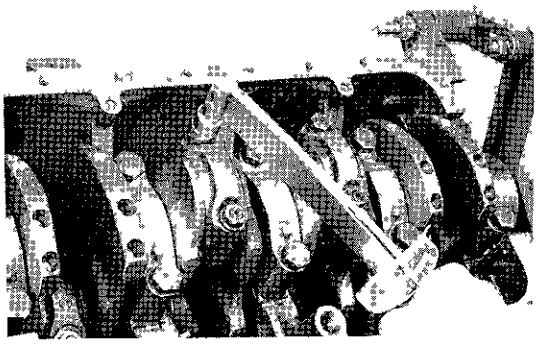
Fig. 3-189



Insert the piston into the cylinder while compressing the rings with a piston ring compressor

—Note—
Use care not to break the piston ring. And, as for 3B engine, be careful not to damage the oil nozzle point.

Fig. 3-190



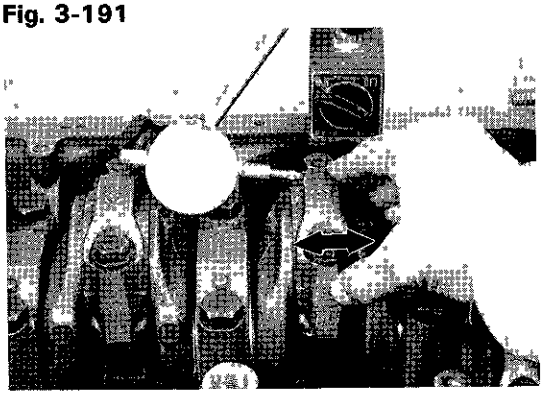
Tighten the connecting rod caps to specified torque

Tightening torque:

B, 2B	**6.5 – 7.5 kg-m (48 – 54 ft-lb)**
3B	**8.5 – 9.5 kg-m (62 – 68 ft-lb)**

—Note—
Check for tightness of crankshaft rotation after tightening each bearing.

Fig. 3-191

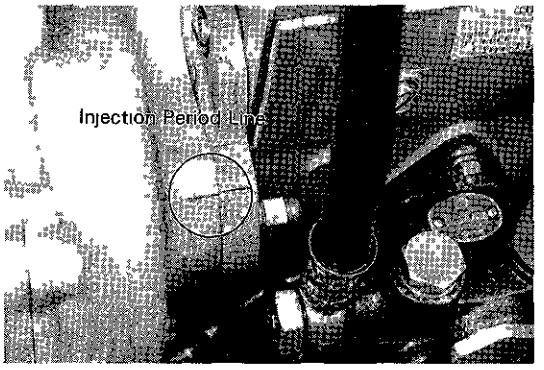


Check the connecting rod thrust clearance

Thrust clearance:

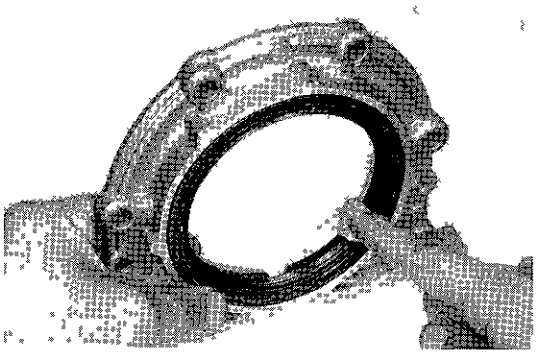
STD	**0.08 – 0.20 mm (0.0031 – 0.0079 in.)**
Limit	**0.3 mm (0.012 in.)**

Fig. 3-192



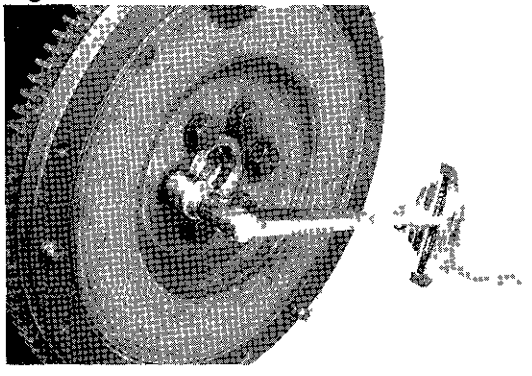
Set the injection period line back to the former position

Fig. 3-193



Apply MP grease on the oil seal lip before assembling

Fig. 3-194

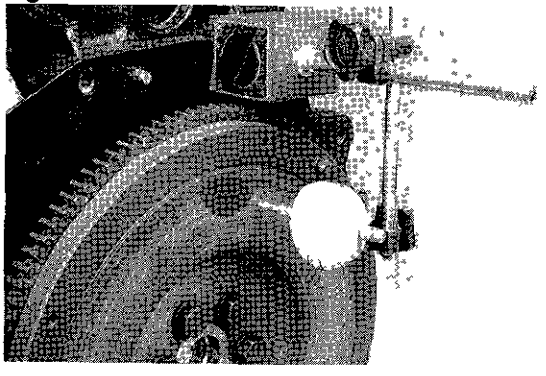


Tighten the bolts to specified torque

Tightening torque:
12.8 – 14.2 kg-m
(93 – 102 ft-lb)

–Note–
Apply a light coat of engine oil on the bolt threads and under the bolt head before installing.

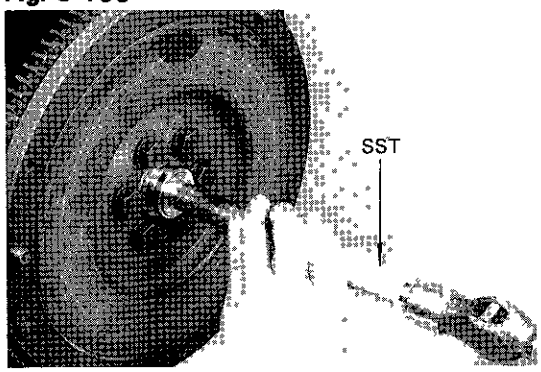
Fig. 3-195



Check the flywheel for runout

Runout:
Limit 0 2 mm
(0.008 in)

Fig. 3-196



Drive in the input shaft bearing with SST
SST [09608-20011]

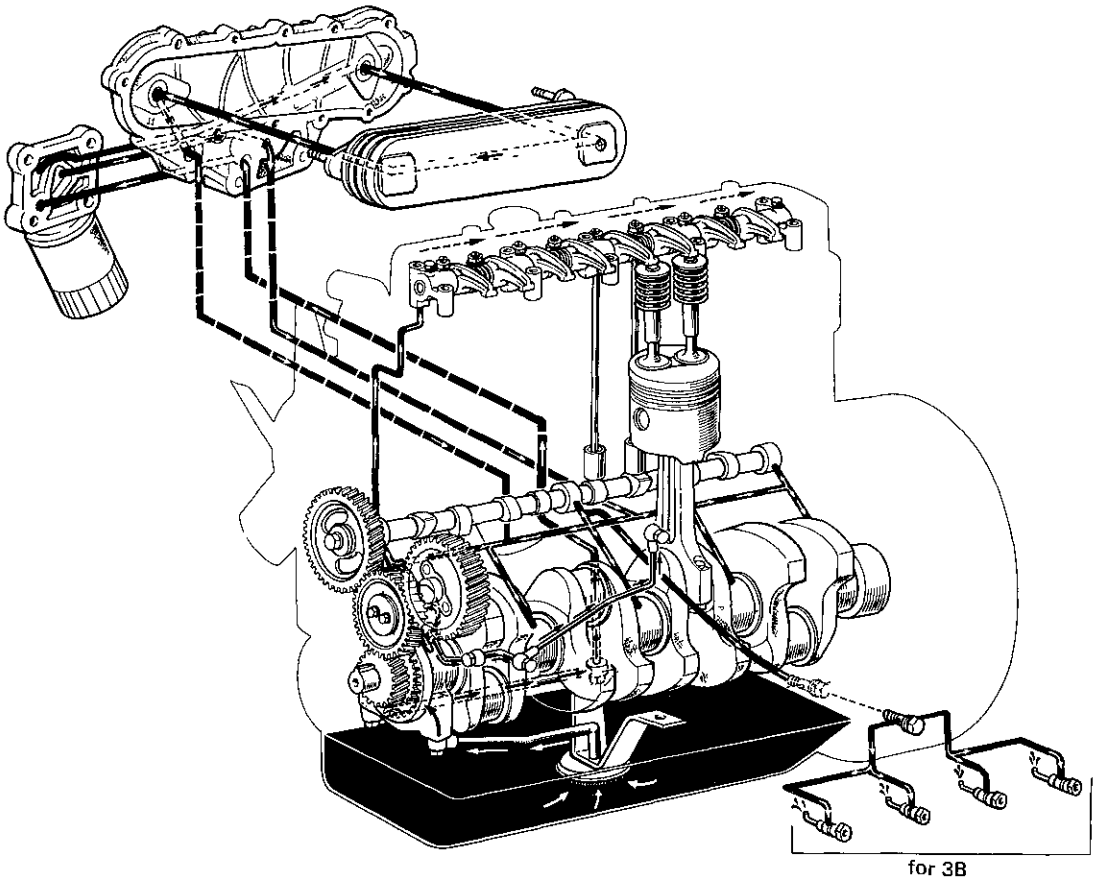
LUBRICATION SYSTEM

Page

LUBRICATION SYSTEM CIRCUIT 4-2
OIL FILTER 4-3
OIL PUMP 4-7

LUBRICATION SYSTEM CIRCUIT

Fig. 4-1

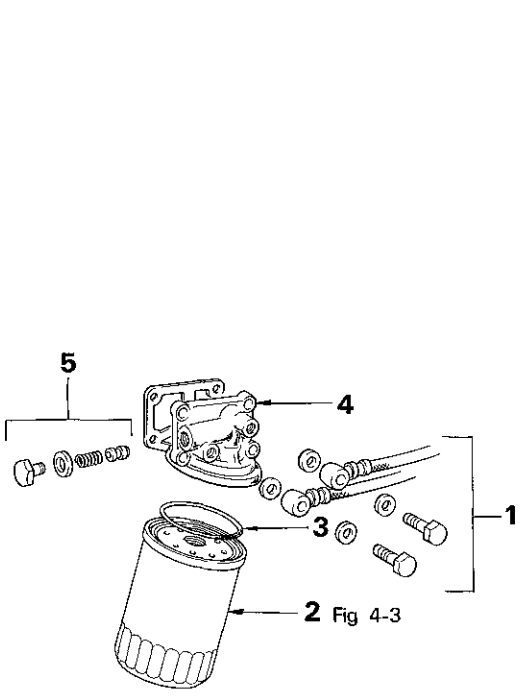


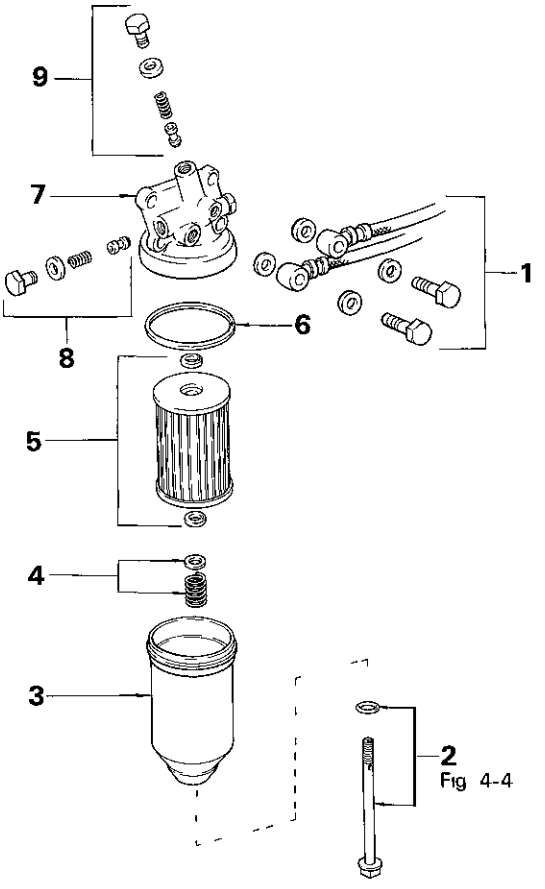
OIL FILTER

DISASSEMBLY

Disassemble the parts in the numerical order shown in the figure

Fig. 4-2





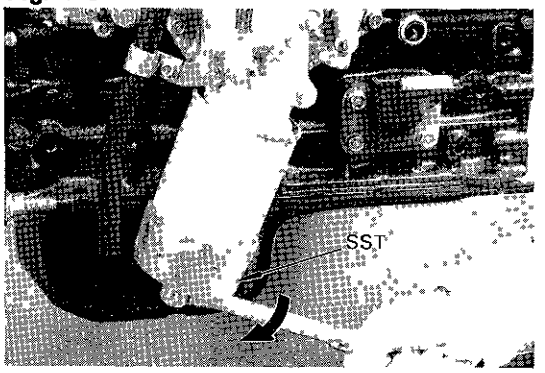
[Cartridge Type]

1 Oil Hose
2 Oil Filter Element
3 Oil Filter Body Gasket
4 Oil Filter Cap
5 Oil Cooler By-pass Valve

[Paper Element Type]

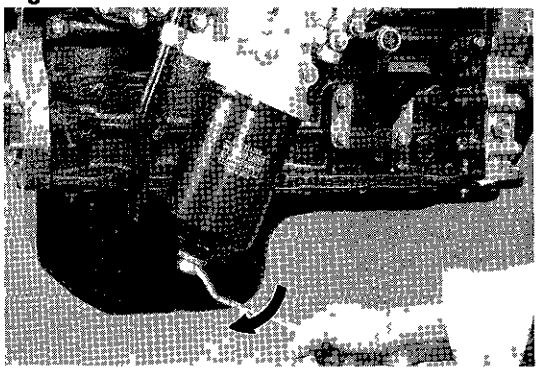
1 Oil Hose
2 Oil Filter Cartridge Guide & Gasket
3 Oil Filter Case
4 Oil Filter Element Support Spring & Washer
5 Oil Filter Element & Gasket
6 Oil Filter Body Gasket
7 Oil Filter Cap
8 Oil Cooler Bypass Valve
9 Oil Filter Bypass Valve

Fig. 4-3



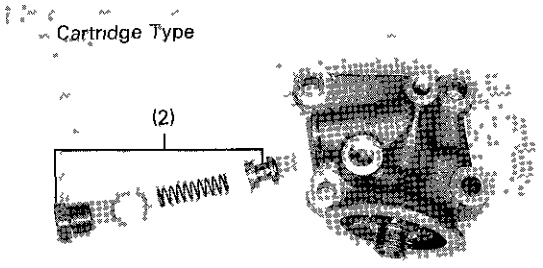
[Cartridge Type]
Remove the oil filter with SST
SST [09228-44010]

Fig. 4-4



[Paper Element Type]
Remove the oil filter cartridge guide

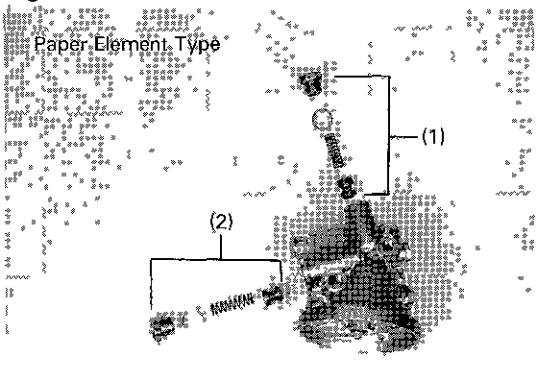
Fig. 4-5



INSPECTION

1 Check the contacting surface of the oil filter cap for scoring and cracks
2 Check the sliding condition of the following valves
   (1) Oil filter bypass valve (for Paper Element Type)
   (2) Oil cooler bypass valve (for both types)

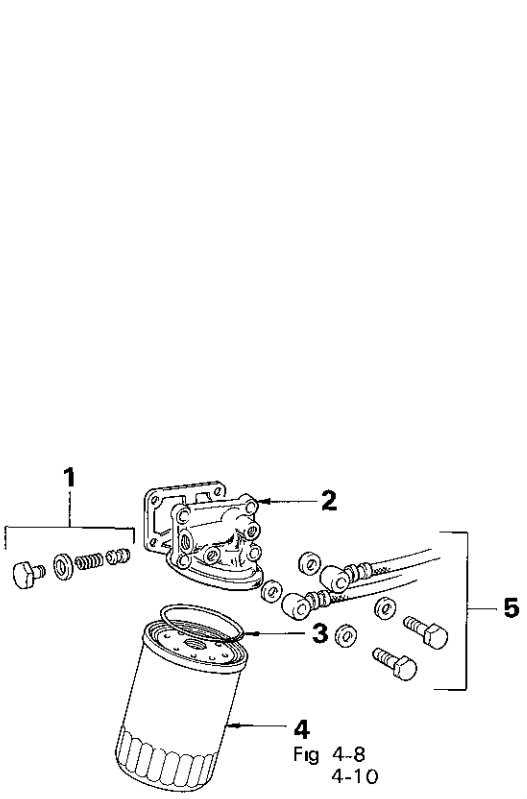
Fig. 4-6

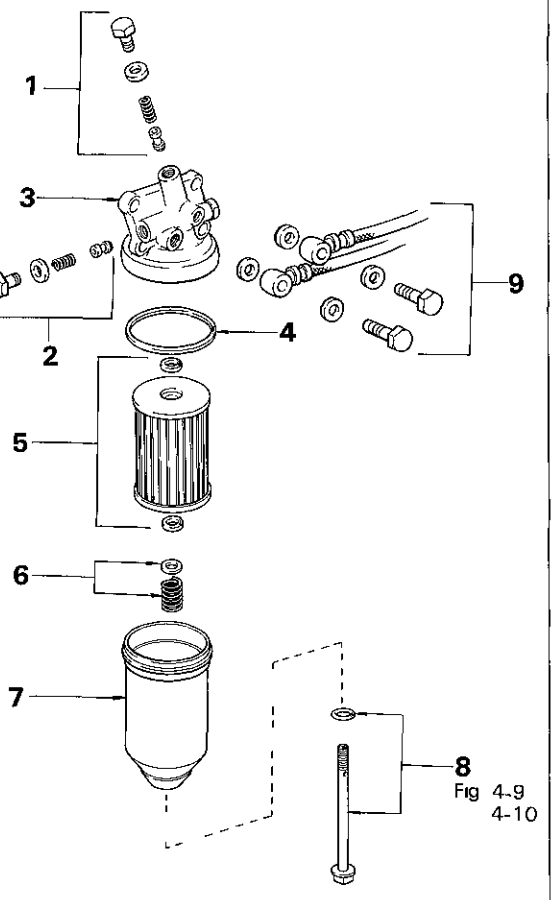


ASSEMBLY

Assemble the parts in the numerical order shown in the figure

Fig. 4-7





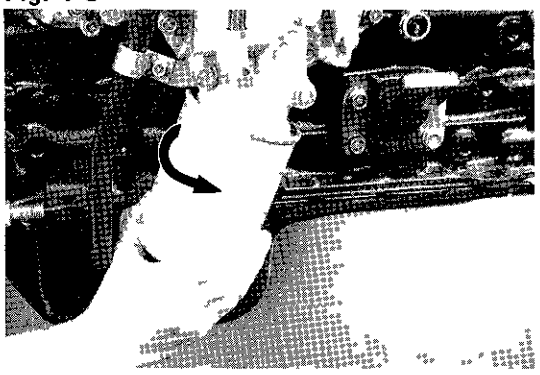
[Cartridge Type]

1 Oil Cooler By-pass Valve
2 Oil Filter Cap
3 Oil Filter Body Gasket
4 Oil Filter Element
5 Oil Hose

[Paper Element Type]

1 Oil Filter Bypass Valve
2 Oil Cooler Bypass Valve
3 Oil Filter Cap
4 Oil Filter Body Gasket
5 Oil Filter Element & Gasket
6 Oil Filter Element Support Spring & Washer
7 Oil Filter Case
8 Oil Filter Cartridge Guide & Gasket
9 Oil Hose

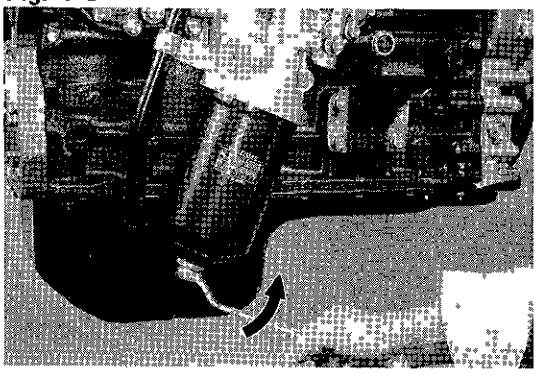
Fig. 4-8



[Cartridge Type]
Install the oil filter and tighten it firmly by hand

–Note–
Do not tighten the filter with SST or a wrench.

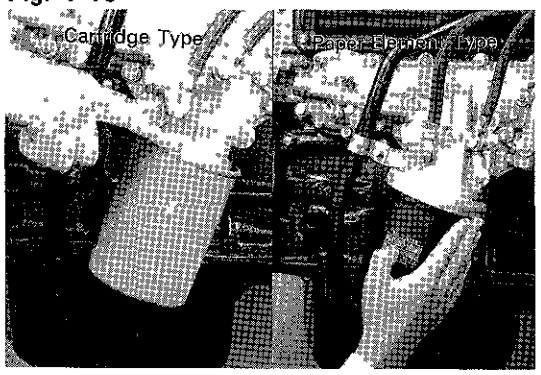
Fig. 4-9



[Paper Element Type]
Tighten the oil filter cartridge guide

–Note–
1. **Make sure that the gasket is installed correctly in the groove of the filter cap.**
2. **Do not damage the element by over-tightening the oil filter cartridge guide.**

Fig. 4-10



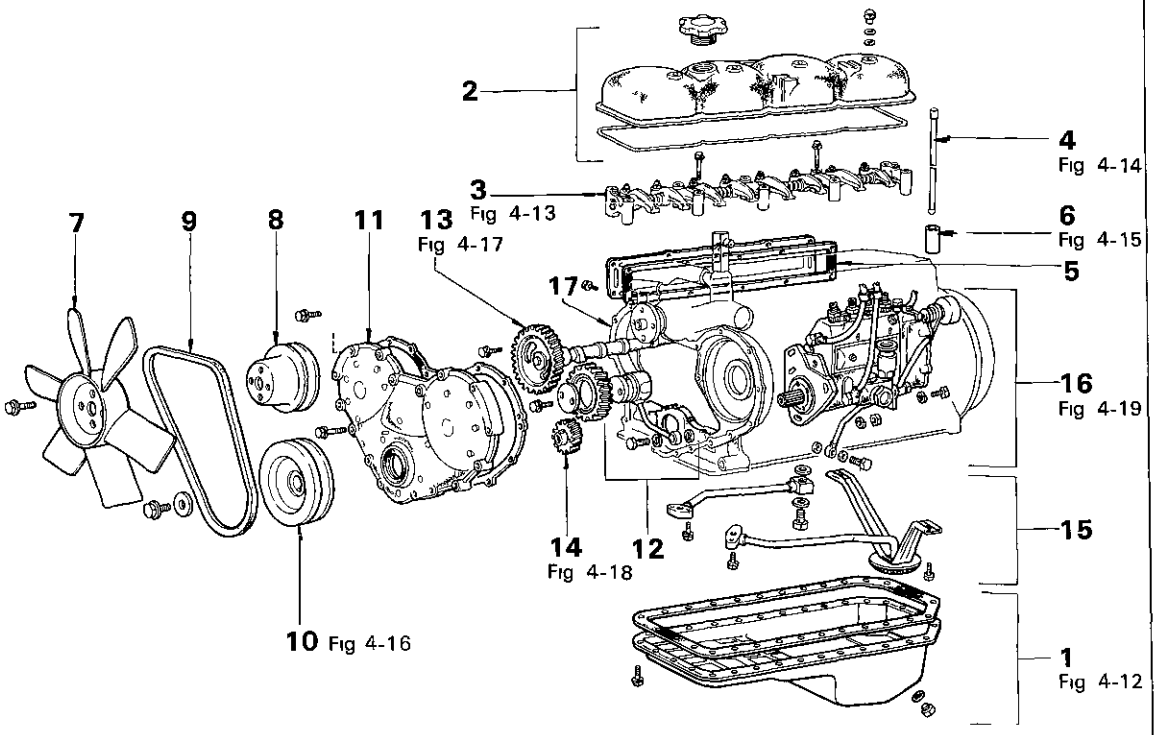
–Note–
After installing, start the engine and check for oil leakage.
Then, stop the engine and recheck the oil level.

OIL PUMP

REMOVAL

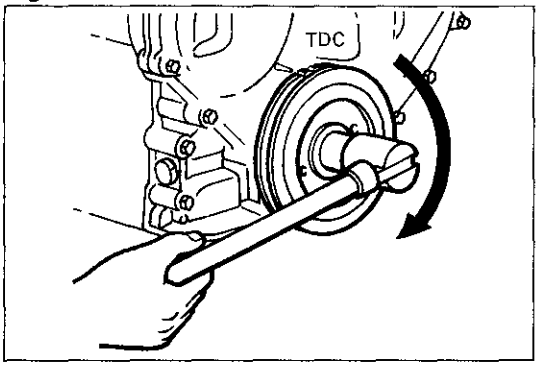
Remove the parts in the numerical order shown in the figure

Fig. 4-11



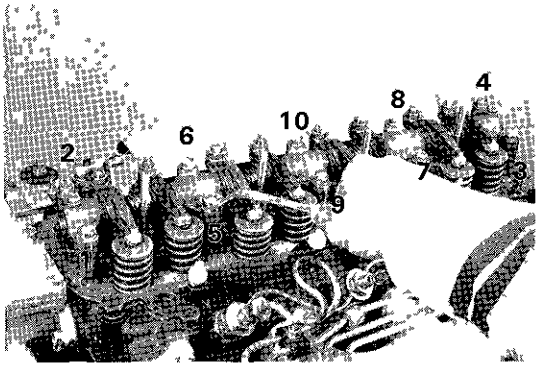
1 Oil Pan
2 Cylinder Head Cover
3 Valve Rocker Shaft Assembly
4 Valve Push Rod
5 Valve Push Rod Cover
6 Valve Lifter
7 Cooling Fan
8 Fan Pulley
9 V Belt
10 Crankshaft Pulley
11 Timing Gear Cover & Automatic Timer
12 Idle Gear & Shaft
13 Camshaft & Timing Gear
14 Crankshaft Timing Gear
15 Oil Strainer & Pipe
16 Injection Pump & Oil Pipe
17 Timing Gear Case & Oil Pump

Fig. 4-12



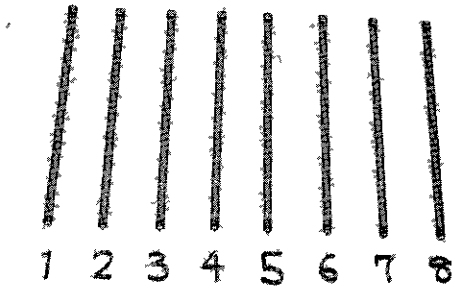
Before starting work set No 1 cylinder piston to TDC/compression

Fig. 4-13



Loosen each rocker support bolt a little at a time in the sequence shown in the figure

Fig. 4-14

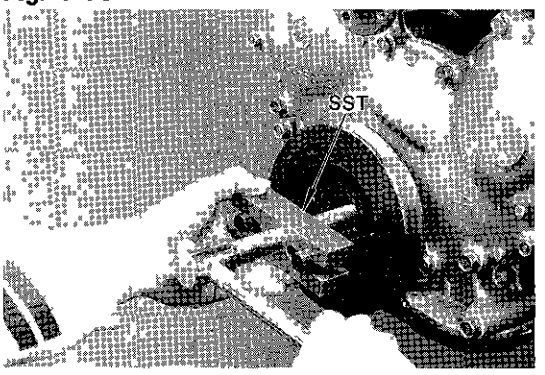


Keep the push rods in correct order

Fig. 4-15

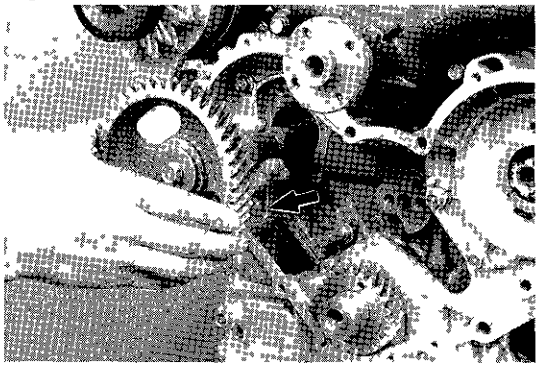
Keep the valve lifters in correct order

Fig. 4-16



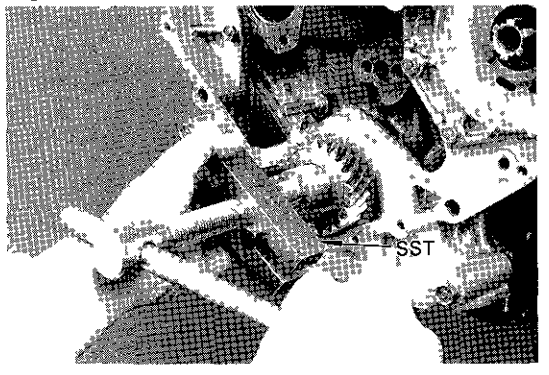
Pull out the crankshaft pulley with SST
SST [09213-60016]

Fig. 4-17



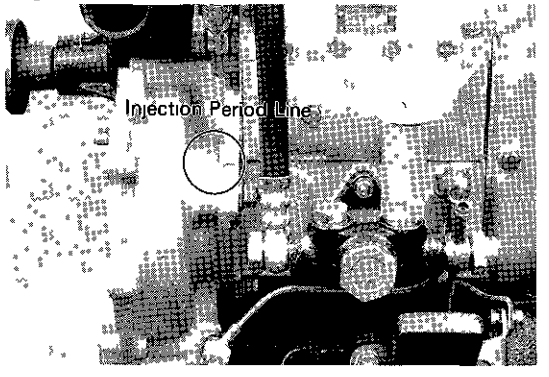
Pull out the camshaft using care not to damage the camshaft bearings

Fig. 4-18



Pull out the crankshaft timing gear with SST
SST [09213-60016]

Fig. 4-19

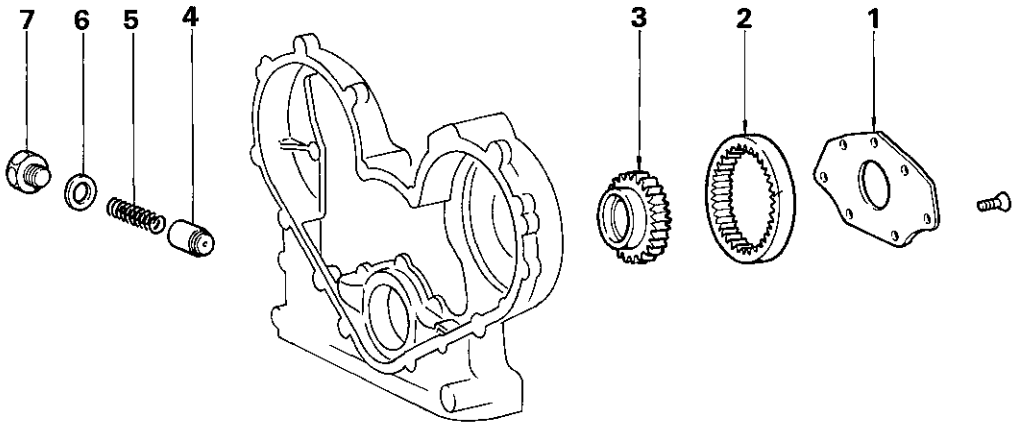


Check the position of the injection period line, and remove the three injection pump mount ing nuts and oil pipe union bolt

DISASSEMBLY

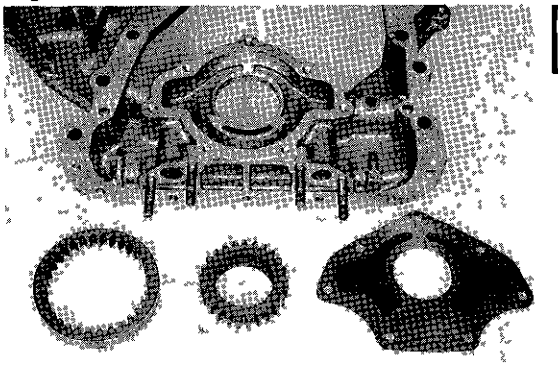
Disassemble the parts in the numerical order shown in the figure

Fig. 4-20



1 Oil Pump Plate
2 Driven Gear
3 Drive Gear
4 Relief Valve
5 Relief Valve Spring
6 Relief Valve Gasket
7 Relief Valve Plug

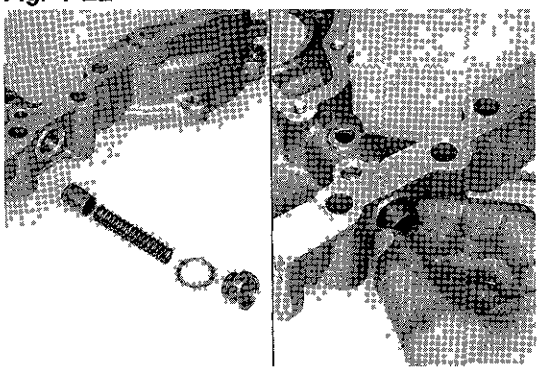
Fig. 4-21



INSPECTION

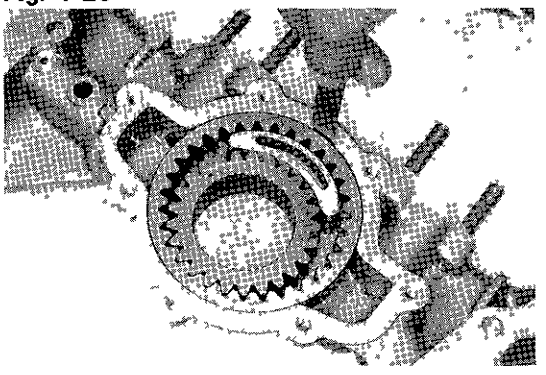
1 Check disassembled parts for wear or damage

Fig. 4-22



2 Check the relief valve for wear or scoring and see if it slides smoothly

Fig. 4-23

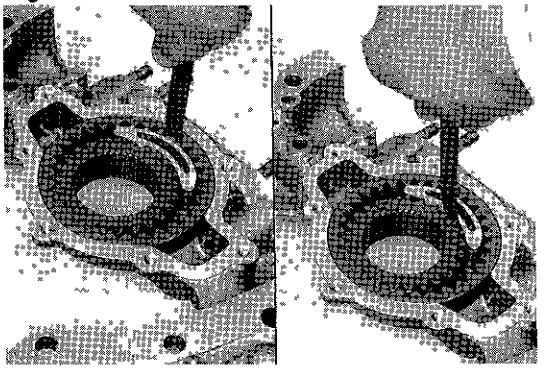


3 Measure the body clearance

Body clearance:

STD	**0.06 – 0.15 mm (0.0024 – 0.0059 in.)**
Limit	**0.3 mm (0.012 in.)**

Fig. 4-24



4 Measure the tip clearances

Tip clearance:

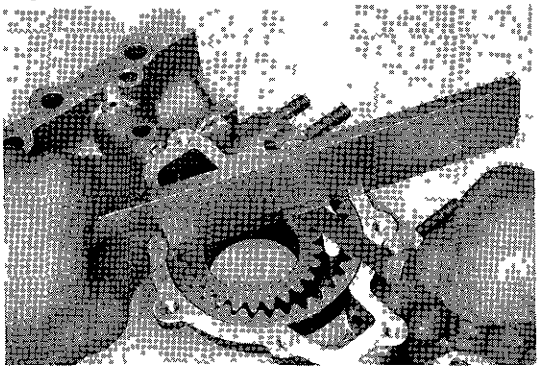
STD

Driven gear-crescent
0.15 – 0.21 mm (0.0059 – 0.0083 in.)

Drive gear-crescent
0.22 – 0.25 mm (0.0087 – 0.0098 in.)

Limit **0.3 mm (0.012 in.)**

Fig. 4-25



5 Measure the side clearance

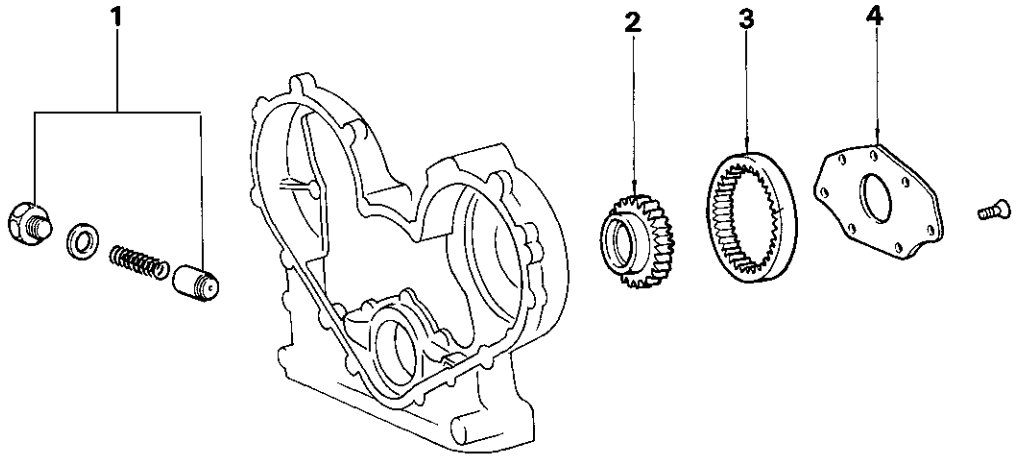
Side clearance:

STD	**0.03 – 0.09 mm (0.0012 – 0.0035 in.)**
Limit	**0.15 mm (0.0059 in.)**

ASSEMBLY

Assemble the parts in the numerical order shown in the figure

Fig. 4-26

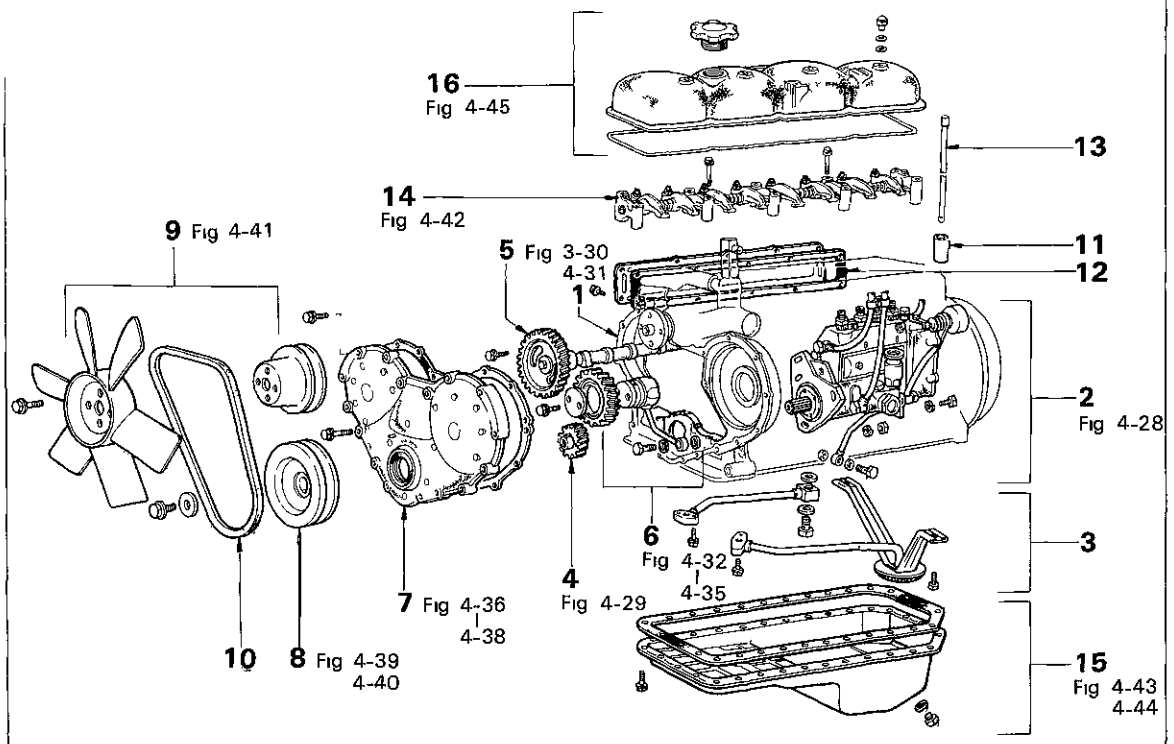


1 Relief Valve
2 Drive Gear
3 Driven Gear
4 Oil Pump Plate

INSTALLATION

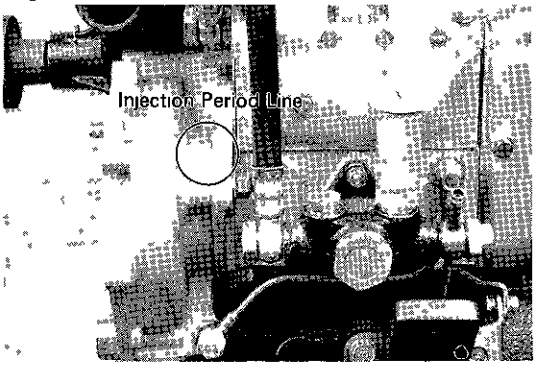
Install the parts in the numerical order shown in the figure

Fig. 4-27



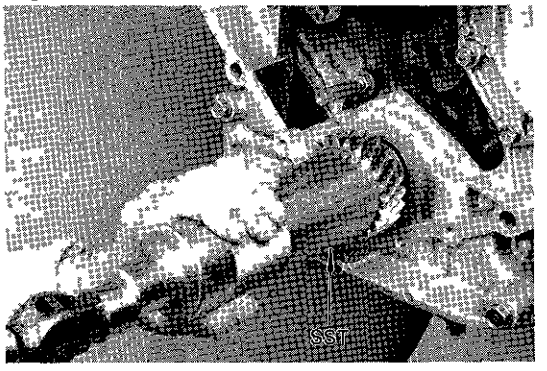
1	Timing Gear Case & Oil Pump	9	Cooling Fan & Fan Pulley
2	Injection Pump & Oil Pipe	10	V Belt
3	Oil Strainer & Pipe	11	Valve Lifter
4	Crankshaft Timing Gear	12	Valve Push Rod Cover
5	Camshaft & Timing Gear	13	Valve Push Rod
6	Idle Gear & Shaft	14	Valve Rocker Shaft Assembly
7	Timing Gear Cover & Automatic Timer	15	Oil Pan
8	Crankshaft Pulley	16	Cylinder Head Cover

Fig. 4-28



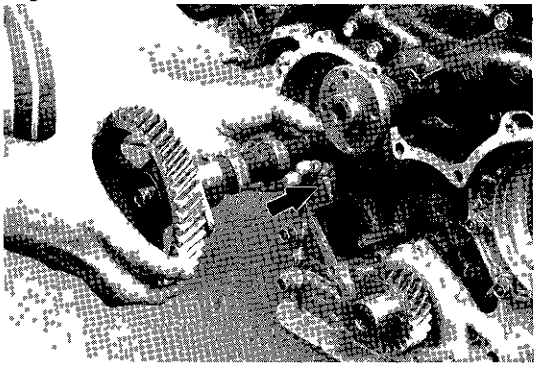
Set the injection period line back to the former position

Fig. 4-29



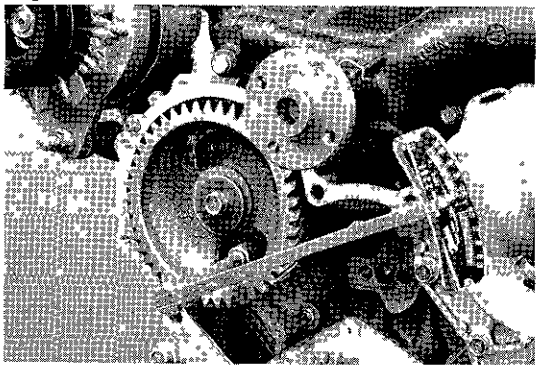
Drive in the crankshaft timing gear with SST
SST [09316-60010]

Fig. 4-30



Insert the camshaft, using care not to damage the camshaft bearings

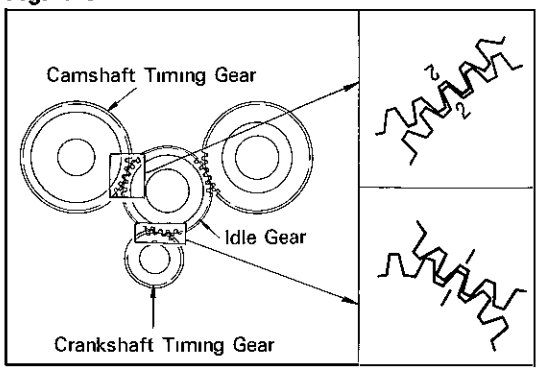
Fig. 4-31



Tighten the camshaft thrust plate

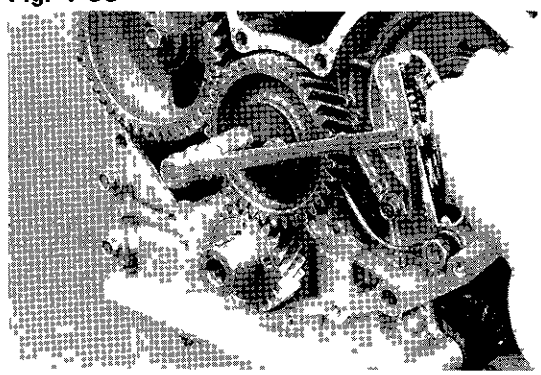
Tightening torque: 1.5 – 2.2 kg-m (11 – 15 ft-lb)

Fig. 4-32



Set the idle gear aligning marks 1 and 2 respectively against crankshaft gear mark 1 and camshaft gear mark 2

Fig. 4-33



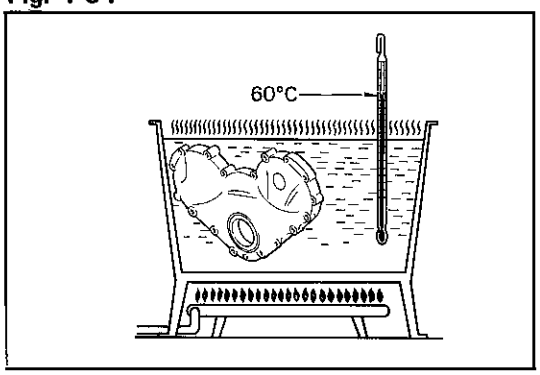
Tighten the idle gear and shaft

Tightening torque: 4.0 – 5.5 kg-m (29 – 39 ft-lb)

–Note–

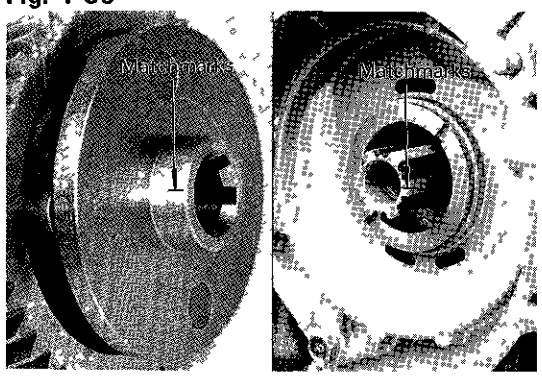
Apply a light coat of engine oil on the bolt threads and under the bolt head before installing.

Fig. 4-34



Remove the automatic timer from the timing gear cover after heating the cover to about 60°C (140°F)

Fig. 4-35

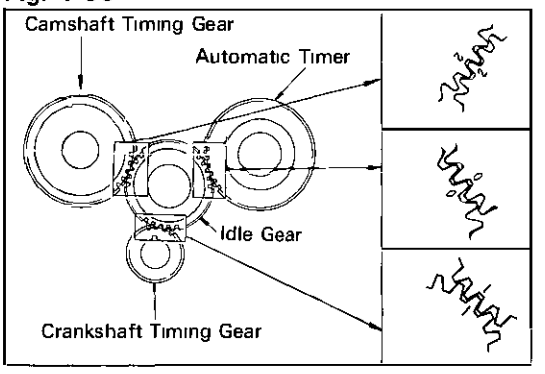


Align the matchmarks on the injection pump spline shaft and timer drive shaft when installing the automatic timer

–Note–

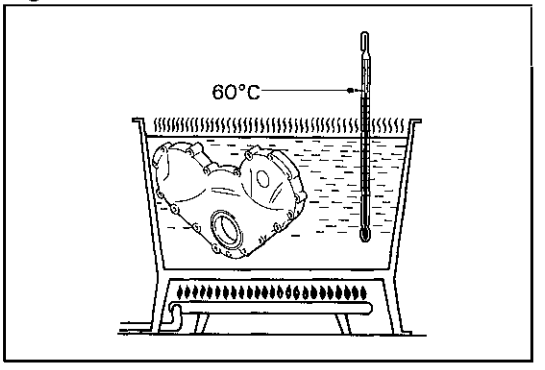
Coat the splines and bearing with MP grease.

Fig. 4-36



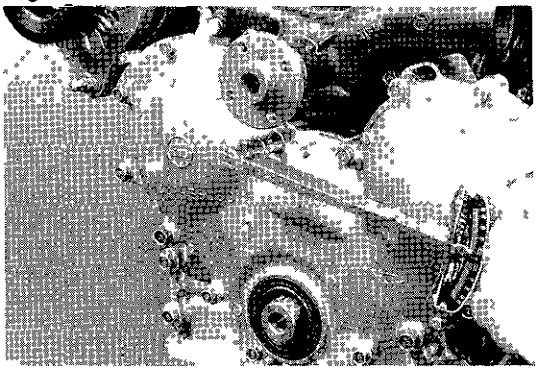
Align the idle gear 0 mark against the timer drive gear 0 mark

Fig. 4-37



Heat the timing gear cover to about 60°C (140°F) before installing

Fig. 4-38

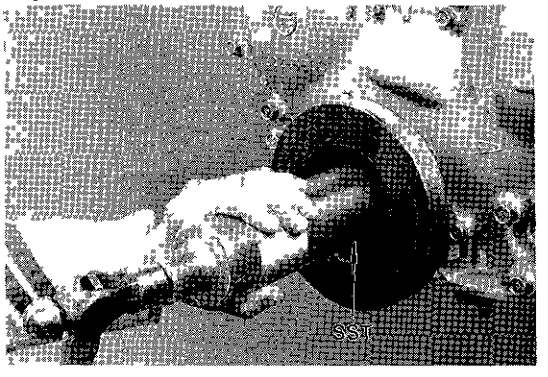


Tighten the timing gear cover

Tightening torque:

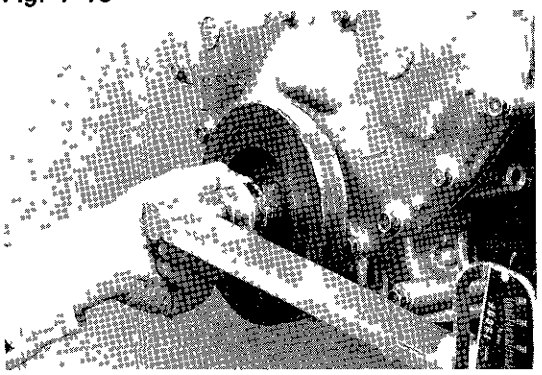
8 mm bolt	**1.5 – 2.2 kg-m (11 – 15 ft-lb)**
10 mm bolt	**3.0 – 4.5 kg-m (22 – 32 ft-lb)**

Fig. 4-39



Drive in the crankshaft pulley with SST
SST [09316-60010]

Fig. 4-40



Tighten the retaining bolt
Tightening torque: 20.0 – 24.0 kg-m (145 – 173 ft-lb)

–Note–
Apply a light coat of engine oil on the bolt threads and under the bolt head before installing.

Fig. 4-41

SEE
ENGINE TUNE-UP
SECTION
Fig. 2-7 & 2-8

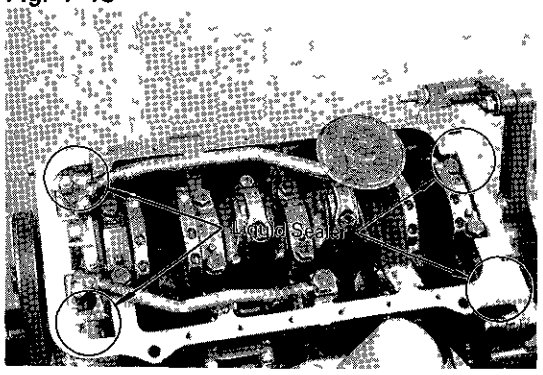
Adjust drive belt tension

Fig. 4-42

SEE
ENGINE SERVICE
SECTION
Fig. 3-56 to 3-61

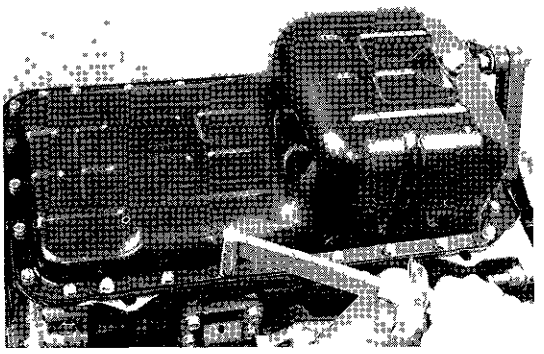
Adjust the valve clearance

Fig. 4-43



Apply liquid sealer to the cylinder block and gear cover at the areas shown in the figure

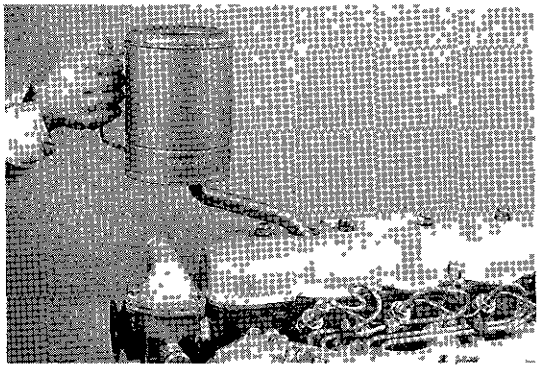
Fig. 4-44



Install the oil pan

Tightening torque: 0.7 — 1.3 kg-m (61 — 112 in.-lb)

Fig. 4-45



Fill the engine with engine oil

Oil grade: API service CC-CD

Oil capacity:

(Dry refill, w/ Oil filter)

7.3 liters

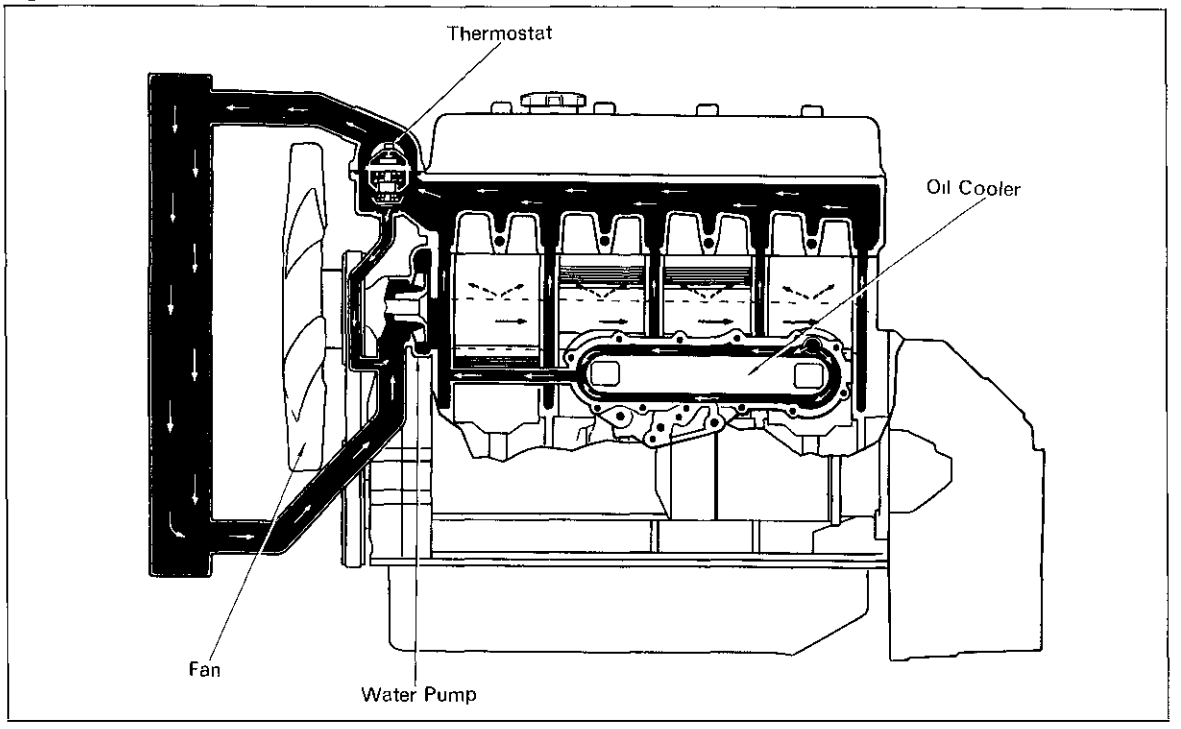
(7.7 US qt, 6.4 Imp.qt)

COOLING SYSTEM

	Page
COOLING SYSTEM CIRCUIT	5-2
WATER PUMP CUTAWAY VIEW	5-2
WATER PUMP	5-3
RADIATOR	5-8
THERMOSTAT	5-8

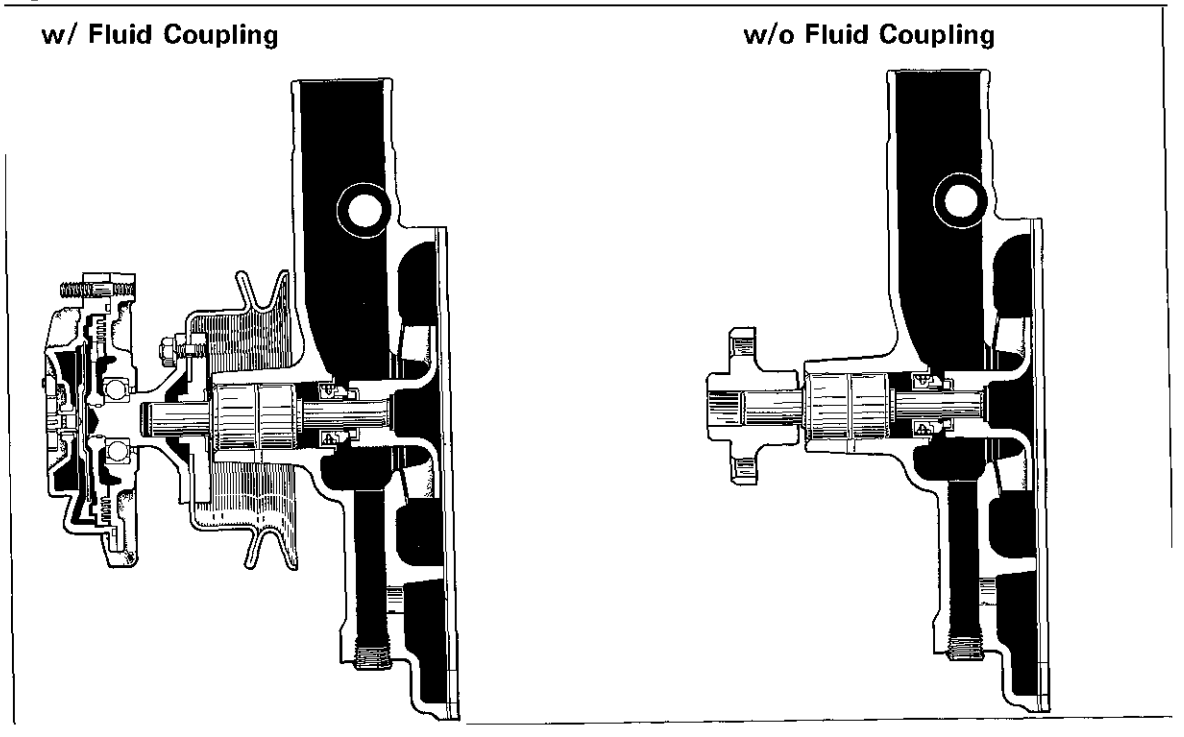
COOLING SYSTEM CIRCUIT

Fig. 5-1



WATER PUMP CUTAWAY VIEW

Fig. 5-2



WATER PUMP

DISASSEMBLY

Disassemble the parts in the numerical order shown in the figure

Fig. 5-3

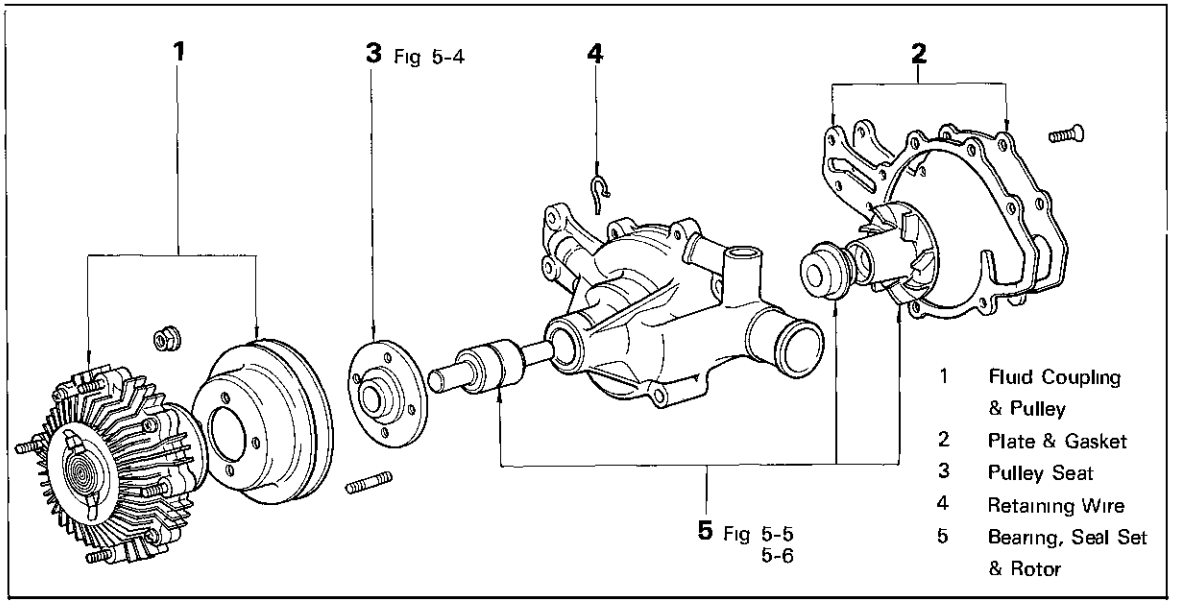
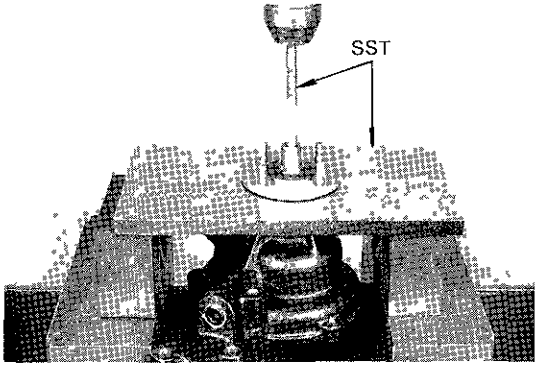
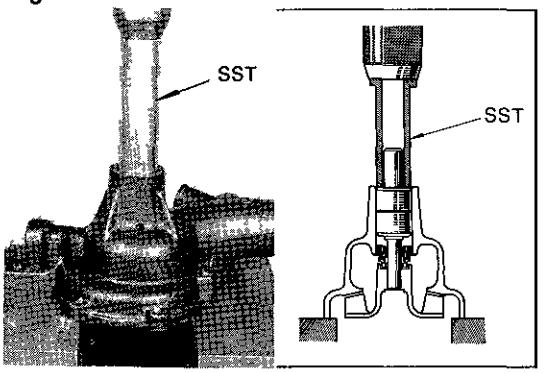


Fig. 5-4



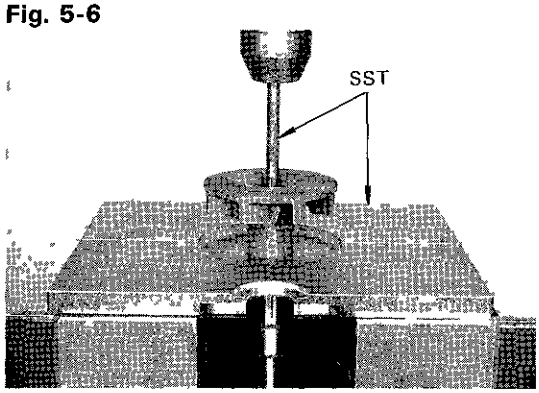
While supporting the pulley seat, press out the shaft with SST
SST [09236 36010]
[09527 10010]

Fig. 5-5



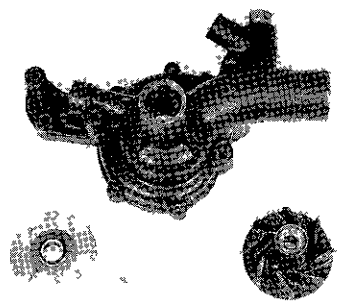
Press out the bearing together with the rotor with SST
SST [09236-28011] — **Bearing diameter 30 mm (1.18 in.) Type**
[09236 36010] — **Bearing diameter 38 mm (1.50 in.) Type**

Fig. 5-6



Press out the pump bearing from the rotor with SST
SST [09236-28011]
[09236-36010]

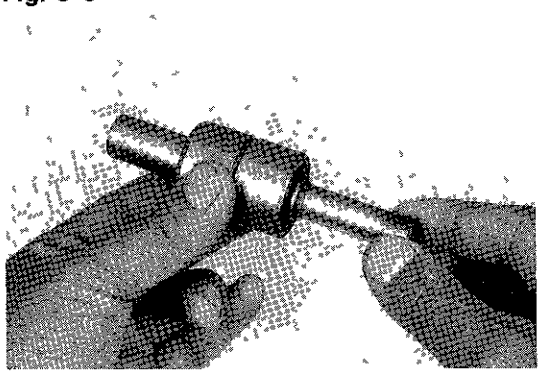
Fig. 5-7



INSPECTION

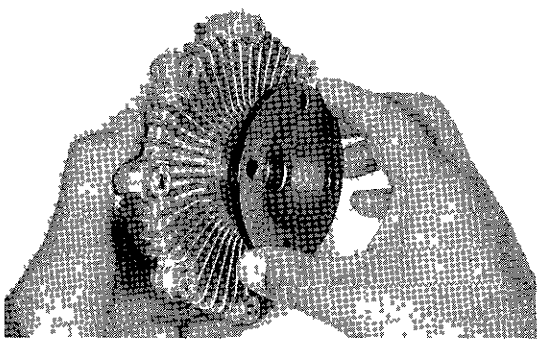
1 Check the disassembled parts for cracks, wear or damage and replace if defective

Fig. 5-8



2 Check the bearing
If it is damaged, makes noise or does not turn properly, replace

Fig. 5-9



3 Check the fluid coupling for damage and leakage of silicone oil
If necessary, replace the coupling assembly

ASSEMBLY

Assemble the parts in the numerical order shown in the figure

Fig. 5-10

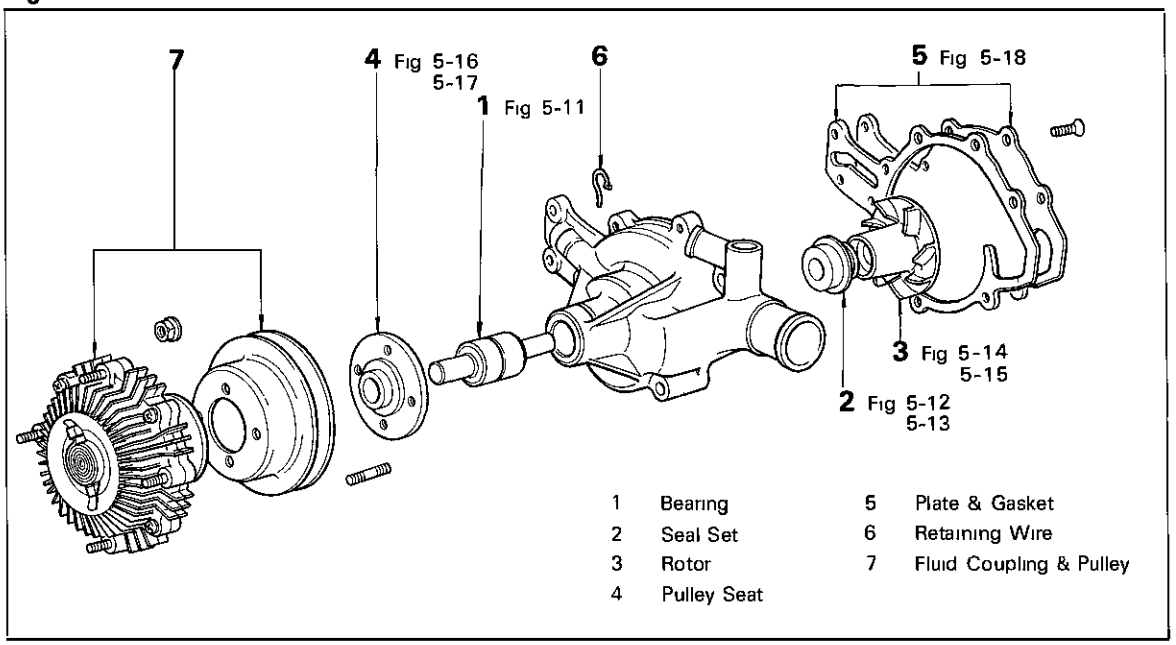
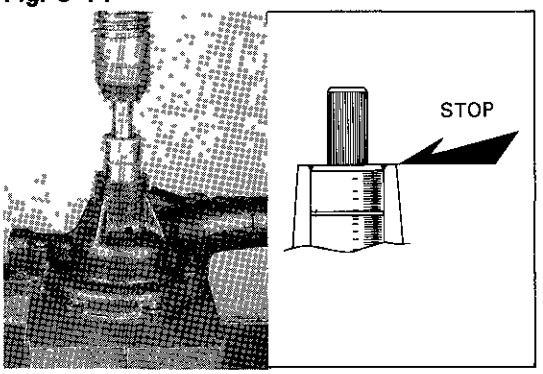


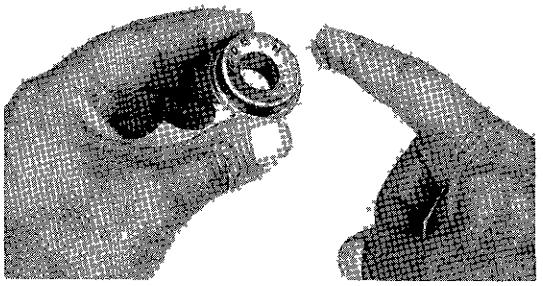
Fig. 5-11



Press in the bearing

–Note–
The bearing end face should be flush with the body top surface.

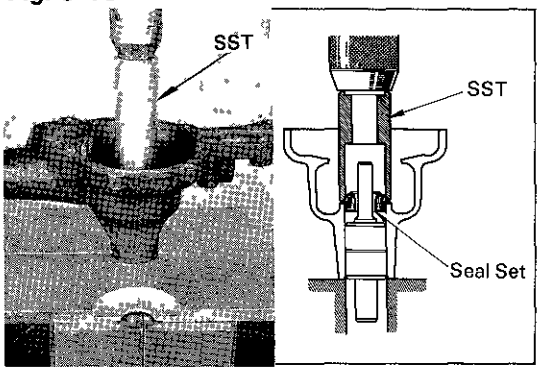
Fig. 5-12



Apply a little liquid sealer to the seal

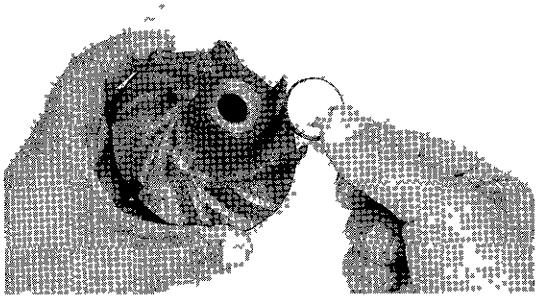
– Note –
Always replace the seal set before reassembly.

Fig. 5-13



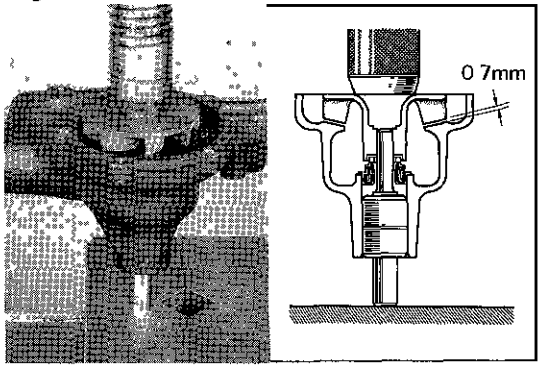
Press the seal set into the pump body with SST
SST [09223-50010]
[09236-28011] —**Bearing diameter 38 mm (1.50 in.) Type**
[09236 36010] —**Bearing diameter 30 mm (1.18 in.) Type**

Fig. 5-14



Install the seal set into the rotor

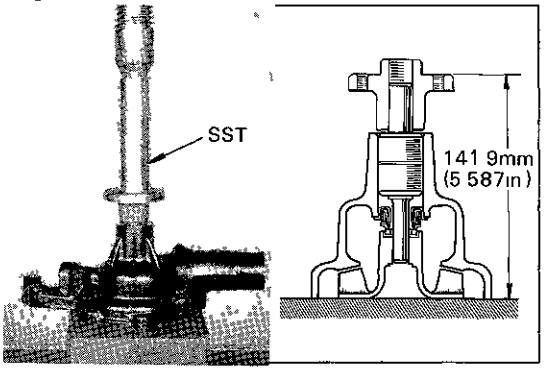
Fig. 5-15



Press in the rotor

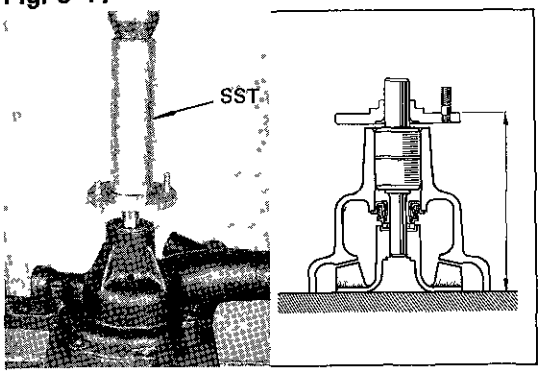
—Note—
The gap between the pump body and rotor should be 0.7 mm (0.028 in.).

Fig. 5-16



Press in the pulley seat to the specified depth with SST (w/o fluid coupling type)
SST [09236-36010]

Fig. 5-17



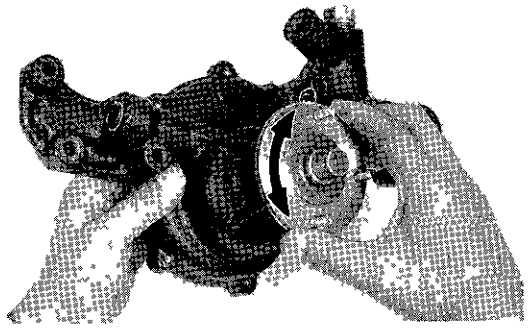
Press in the pulley seat to the specified depth with SST (w/ fluid coupling type)
SST [09236 36010]

Distance between pulley seat end and pump body end:

Bearing diameter 38 mm (1.50 in.)
Type 134.3 mm (5.287 in.)

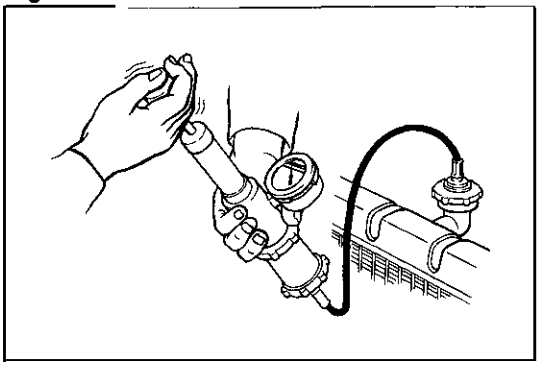
Bearing diameter 30 mm (1.18 in.)
Type 112.3 mm (4.421 in.)

Fig. 5-18



After assembly make sure that the rotor rotates smoothly

Fig. 5-19



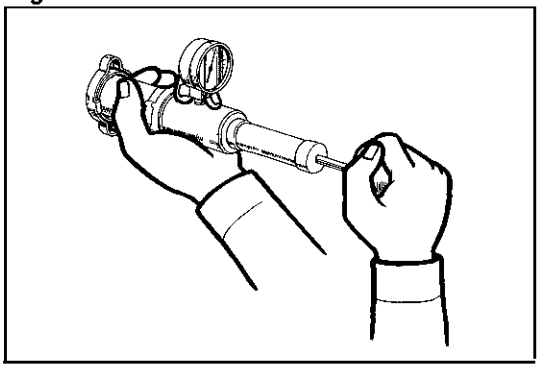
RADIATOR

INSPECTION

1 Install the radiator cap tester to the radiator apply pressure and check for leakage in the cooling system under normal operating temperature

Applicable pressure: 1.5 kg/cm² (21 psi)

Fig. 5-20



2 Check the pressure sealing and vacuum relief valve operation

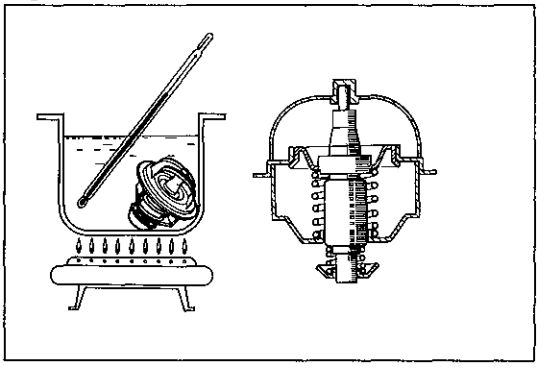
Valve opening pressure:

STD 0.75 – 1.05 kg/cm² (10.7 – 14.9 psi)

Limit 0.6 kg/cm² (8.5 psi)

3 If readings are not within acceptable limits, replace the radiator cap

Fig. 5-21



THERMOSTAT

INSPECTION

1 Immerse the thermostat in water, and check the valve opening temperature by gradually heating the water

2 Replace the thermostat if the valve remains open at normal temperature or is not very tight when fully closed

Low temp. type:

Valve starts to open at 80.5 – 83.5°C (177 – 182°F)

Valve fully opens at 95°C (203°F)

Valve opening travel at 95°C (203°F) 10 mm (0.39 in.)

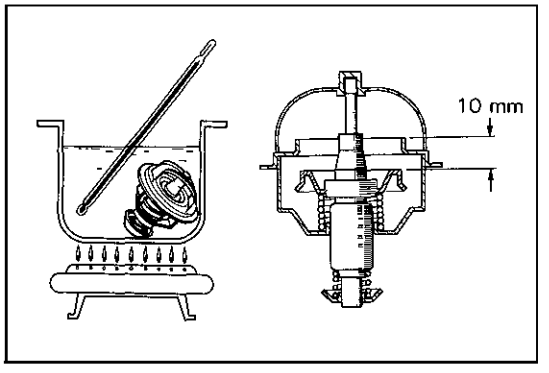
High temp. type:

Valve starts to open at 86.5 – 89.5°C (188 – 193°F)

Valve fully opens at 100°C (212°F)

Valve opening travel at 100°C (212°F) 10 mm (0.39 in.)

Fig. 5-22



FUEL SYSTEM

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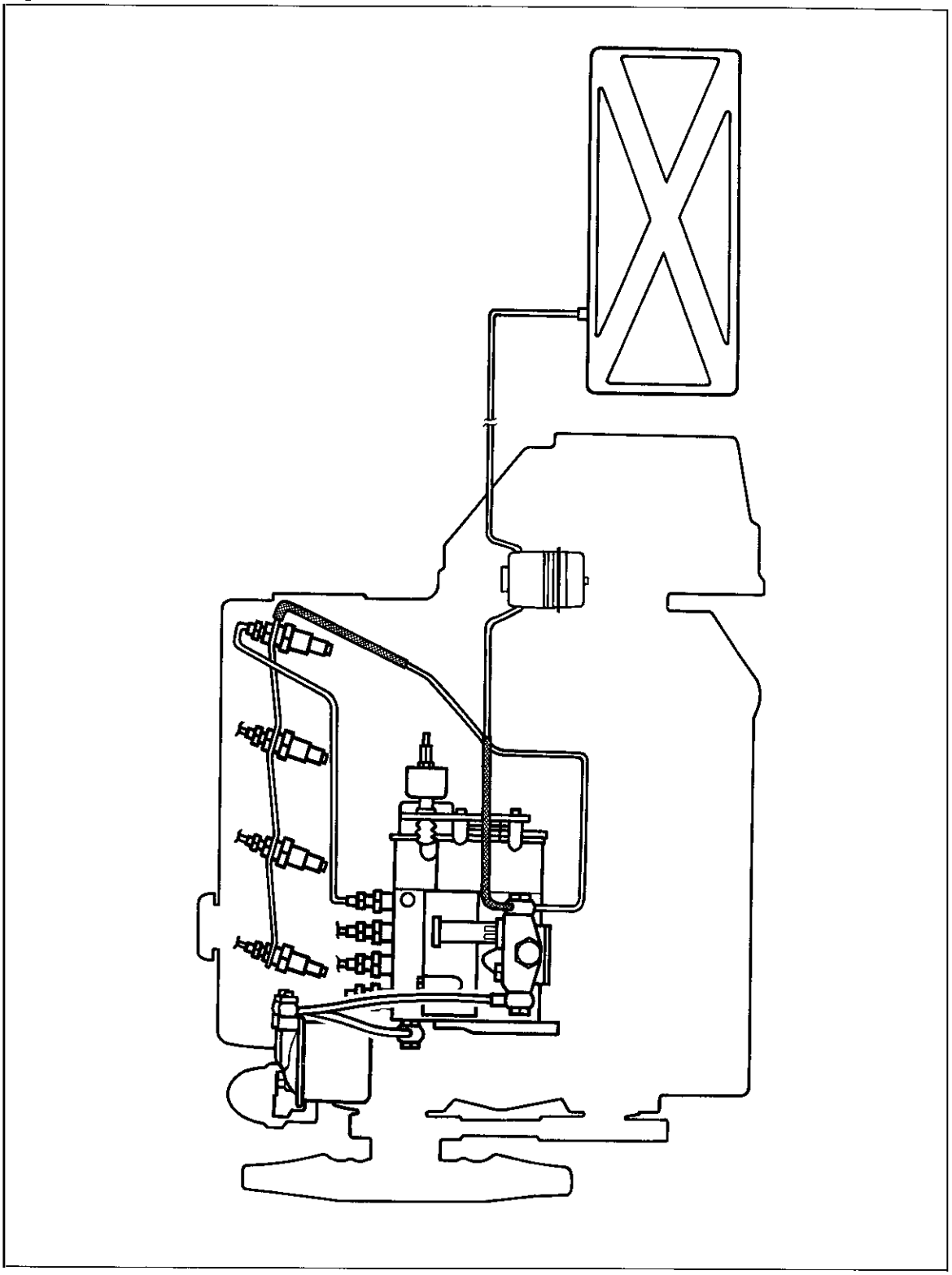
FUEL SYSTEM CIRCUIT	6-2
FUEL FILTER	6-3
SEDIMENTER	6-8
INJECTION NOZZLE	6-9
FUEL FEED PUMP	6-17
AUTOMATIC TIMER	6-22
INJECTION PUMP	6-29

FUEL SYSTEM CIRCUIT

Fig. 6-1



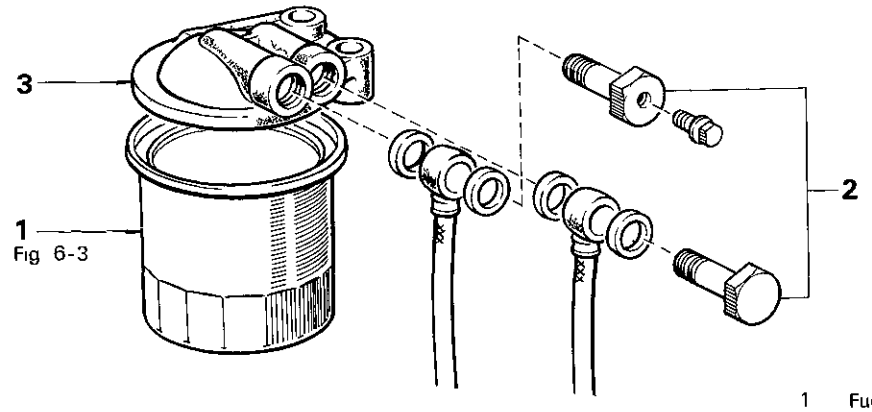
FUEL FILTER

CARTRIDGE TYPE

DISASSEMBLY

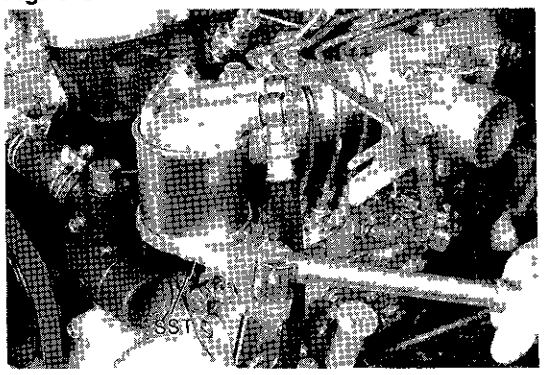
Disassemble the parts in the numerical order shown in the figure

Fig. 6-2



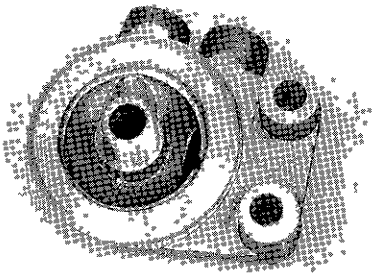
1 Fuel Filter Lower Body
2 Fuel Pipe Follow Screw
3 Fuel Filter Upper Body

Fig. 6-3



Remove the fuel filter with SST
SST [09228 34010]

Fig. 6-4



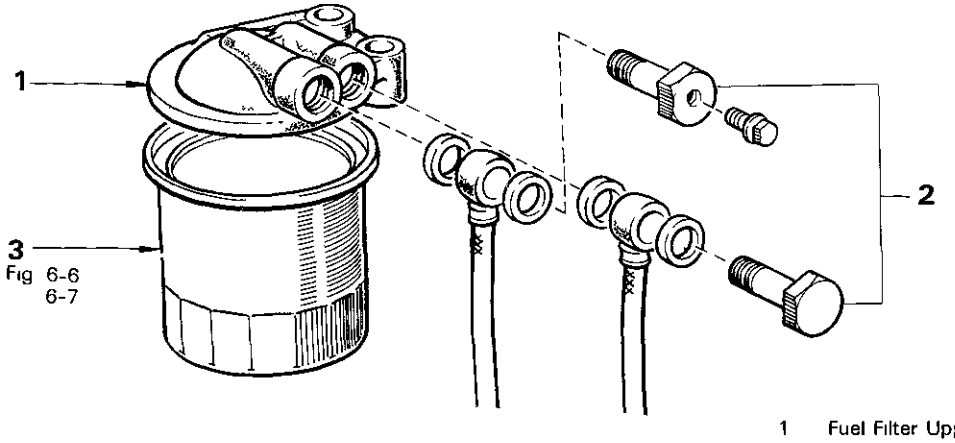
INSPECTION

Check the connecting surface for scoring or cracks

ASSEMBLY

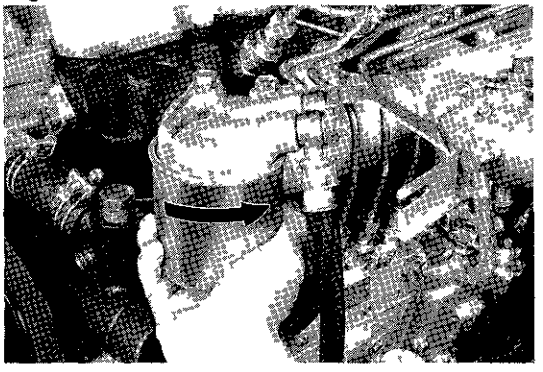
Assemble the parts in the numerical order shown in the figure

Fig. 6-5



1 Fuel Filter Upper Body
2 Fuel Pipe Follow Screw
3 Fuel Filter Lower Body

Fig. 6-6



Install the fuel filter by hand

–Note–
Do not use SST to install the filter.

Fig. 6-7

After installing bleed air from fuel filter

SEE
INJECTION PUMP
INSTALLATION
SECTION
Fig. 6-212 to 6-217

ELEMENT TYPE

DISASSEMBLY

Disassemble the parts in the numerical order shown in the figure

Fig. 6-8

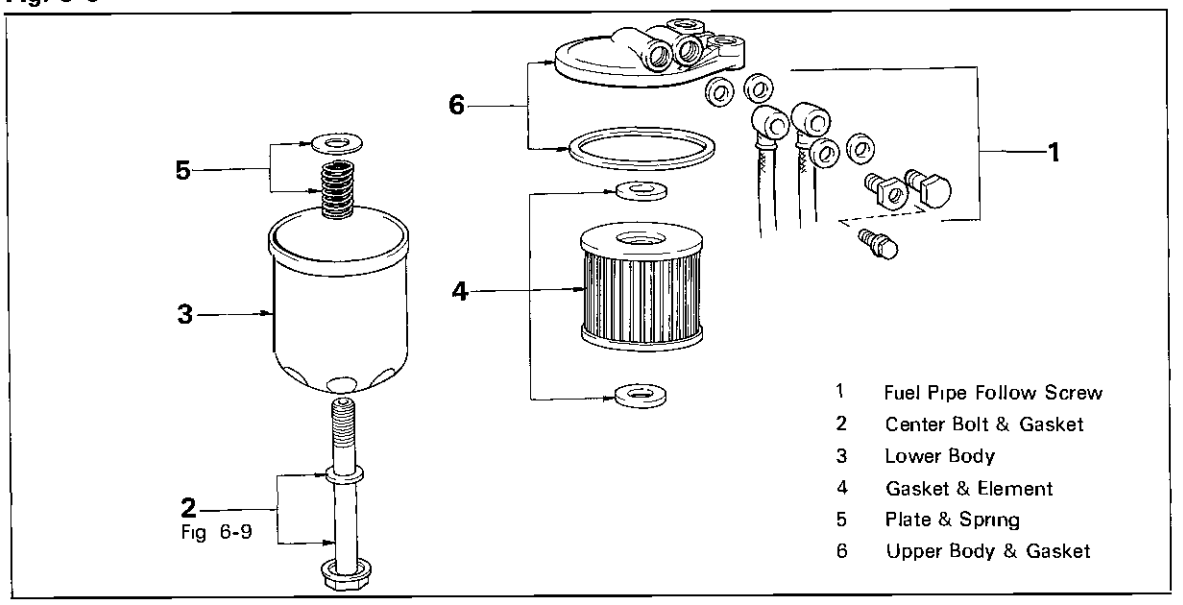
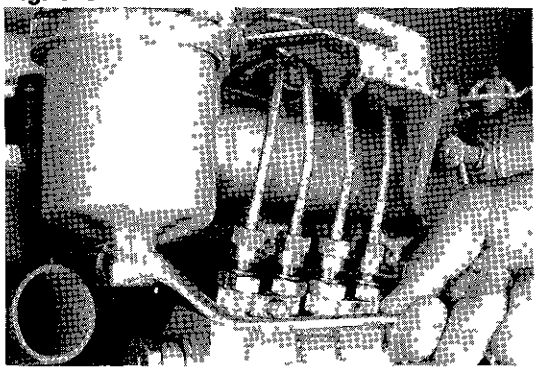
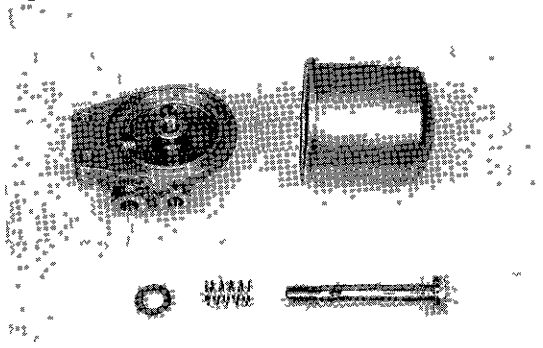


Fig. 6-9



Loosen the bolt and take off the lower body

Fig. 6-10



INSPECTION

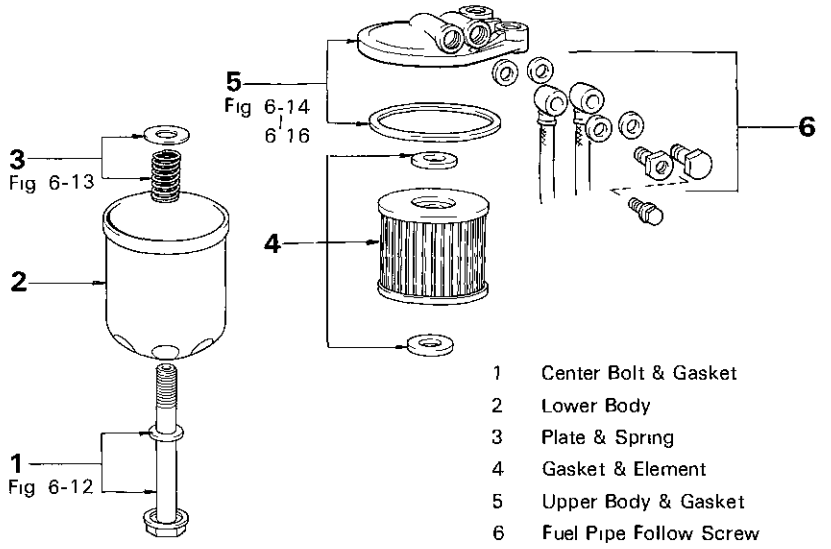
Clean all disassembled parts

Check the disassembled parts for wear or damage

ASSEMBLY

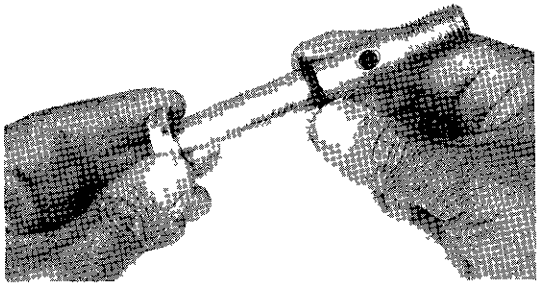
Assemble the parts in the numerical order shown in the figure

Fig. 6-11



1 Center Bolt & Gasket
2 Lower Body
3 Plate & Spring
4 Gasket & Element
5 Upper Body & Gasket
6 Fuel Pipe Follow Screw

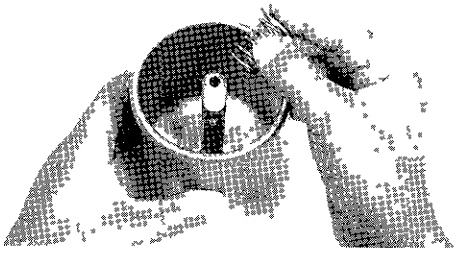
Fig. 6-12



Install an O ring facing its flat side toward the bolt head

—Note—
Use a new gasket.

Fig. 6-13



Install the spring, plate and gasket to the lower body

Fig. 6-14

Install the gasket

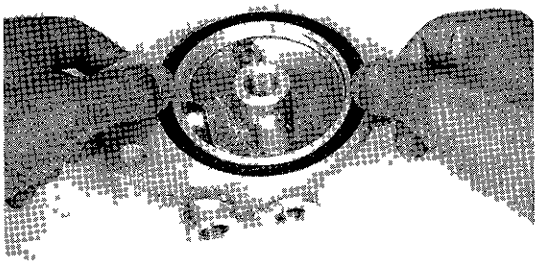


Fig. 6-15

Assemble the lower body and tighten the bolt

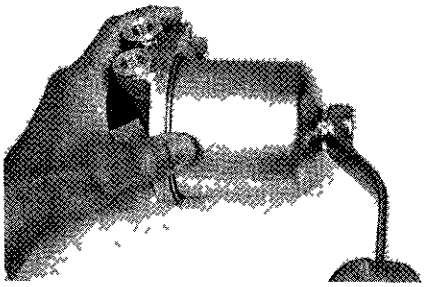


Fig. 6-16

After installing, bleed air from fuel filter

SEE
INJECTION PUMP
INSTALLATION
SECTION
Fig. 6-218 to 6-223

SEDIMENTER

FILTER WARNING SYSTEM

Fig. 6-17

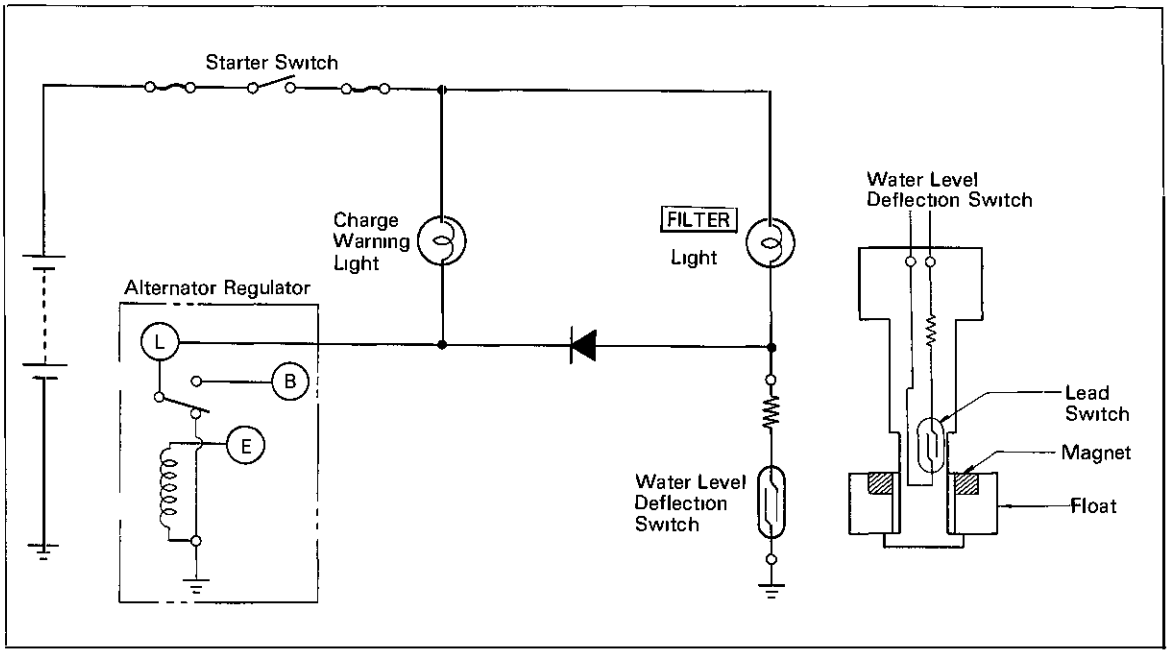
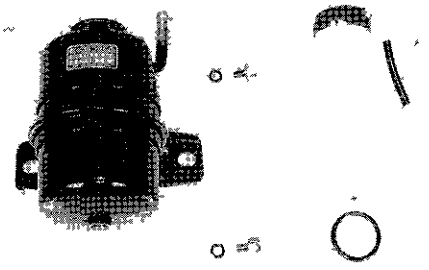


Fig. 6-18



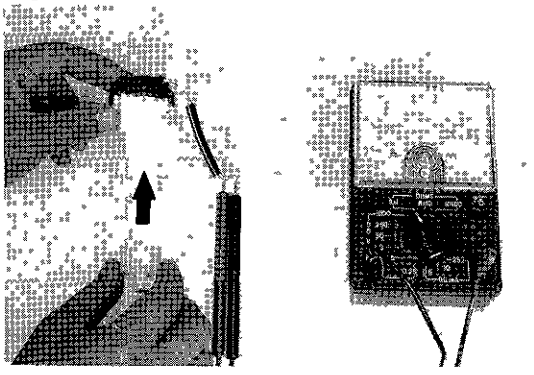
INSPECTION

Check each part for damage cracks or defor mation

—Note—

When assembling, be sure to replace the oil seal with new one.

Fig. 6-19



Check the level warning switch

Connect a circuit tester to the switch connector and check the conduity when the float is raised

INJECTION NOZZLE

REMOVAL

Remove the parts in the numerical order shown in the figure

Fig. 6-20

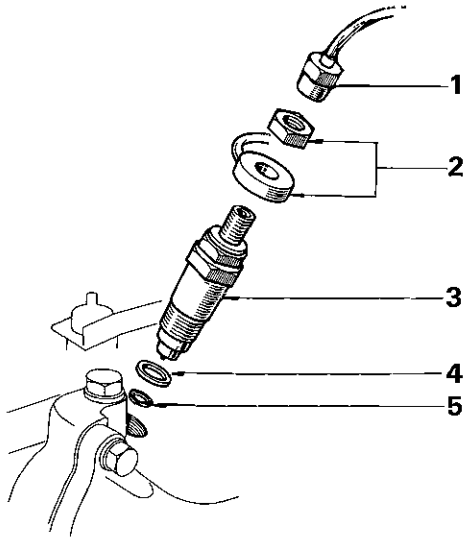
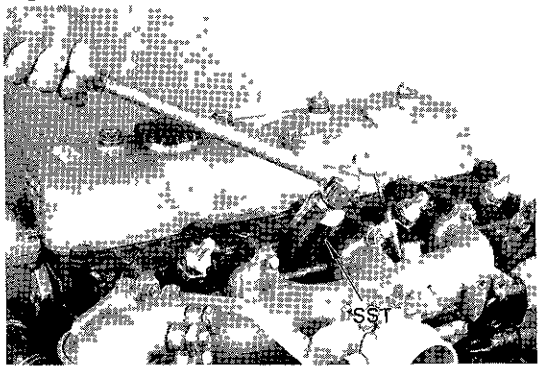


Fig 6-21
6-22

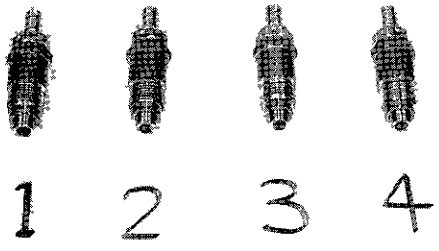
1 Injection Pipe
2 Leakage Pipe
3 Injection Nozzle Holder
4 Injection Nozzle Seat
5 Injection Nozzle Seat Gasket

Fig. 6-21



Remove the injection nozzle holders with SST
SST (09268 46011) of set [09260-46011]

Fig. 6-22



Arrange the injection nozzle holders in correct order to facilitate reassembly

Fig. 6-23

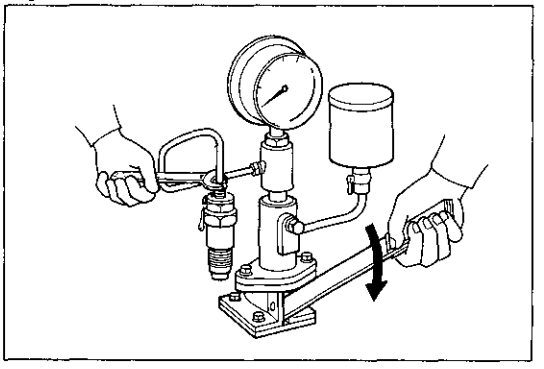


Fig. 6-24

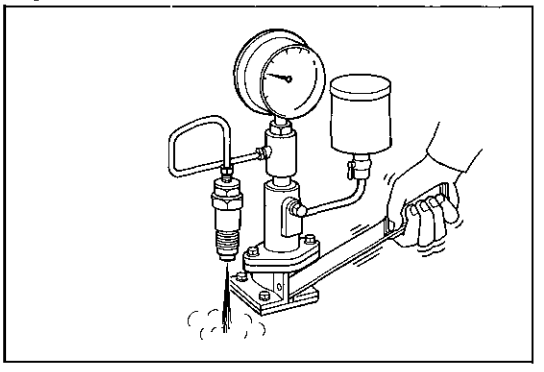


Fig. 6-25

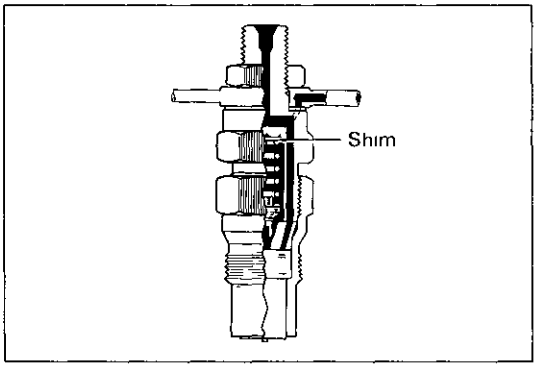
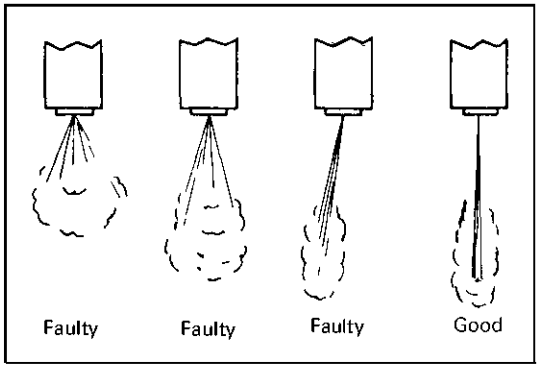


Fig. 6-26



SPRAY TEST

1 Install the nozzle to the injection nozzle hand tester and bleed air from the union nut

2 Injection pressure
   (1) Pump the tester handle 50 — 60 times per minute by hand
   (2) Read the injection starting pressure

Opening pressure:
New nozzle
115 — 125 kg/cm² (1,636 — 1,778 psi)
Reused nozzle
105 — 125 kg/cm² (1,493 — 1,778 psi)

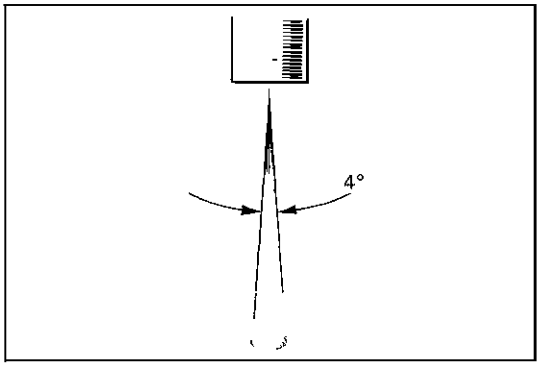
—Note—
1. **Proper nozzle operation can be determined by a hissing sound.**
2. **Adjust the injection starting pressure to 110 — 125 kg/cm² (1,565 — 1,778 psi), if the reused nozzle has been overhauled.**

3 To adjust the injection pressure change the shim on the top of the pressure spring

—Note—
1. **Shims are available in 20 sizes, in increments of 0.05 mm (0.0020 in.), from 1.00 — 1.95 mm (0.0394 — 0.0768 in.)**
2. **Varying the adjusting shim thickness by 0.05 mm (0.0020 in.) changes the injection pressure by about 5 kg/cm² (71 psi).**

4 Spray patterns
   (1) Check the spray patterns by pumping the tester handle 50 — 60 times per minute by hand

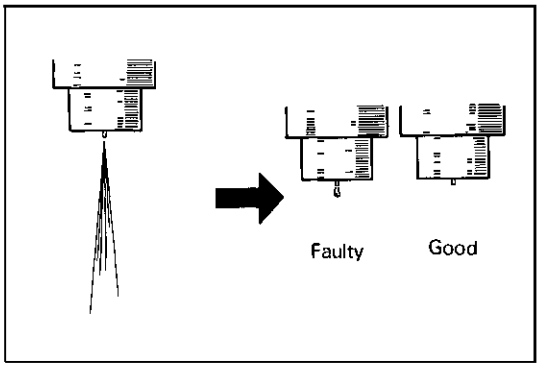
Fig. 6-27



(2) Spray should spread evenly down the nozzle center line in a 4° conical form

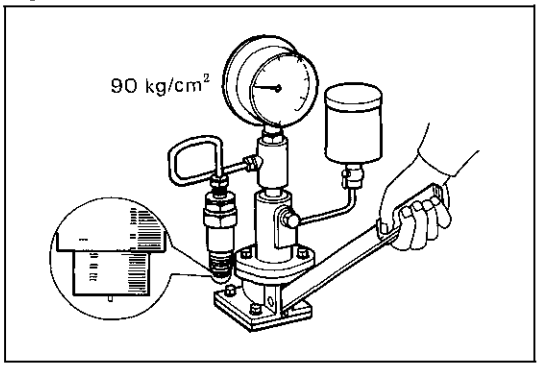
(3) Place a white sheet of paper about 30 cm (11 8 in) away from the nozzle to check if spray pattern is in circular form

Fig. 6-28



5 There should be no dripping after injection

Fig. 6-29

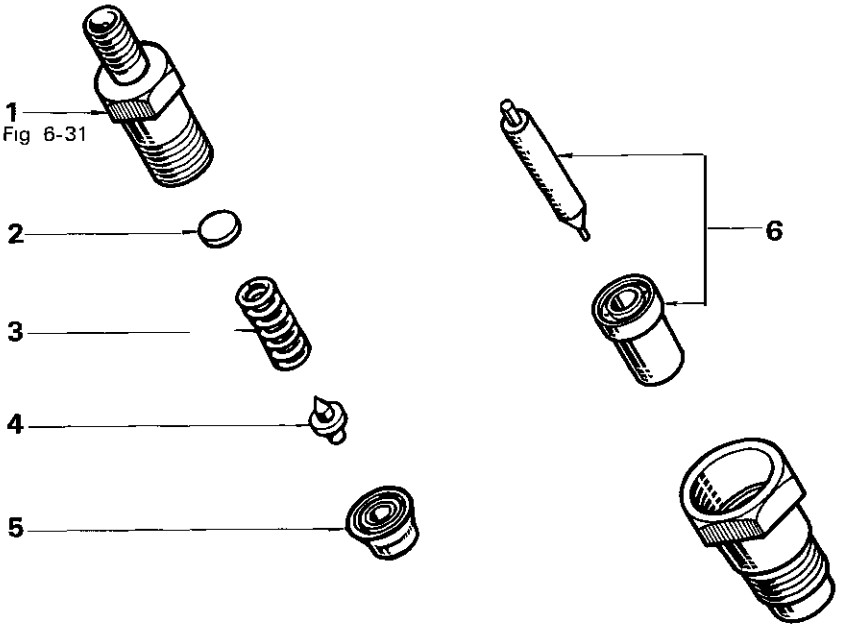


6 Leakage test
Apply 90 kg/cm² (1,280 psi) of fuel pressure, and check for leaks at nozzle valve seat and retaining nut

DISASSEMBLY

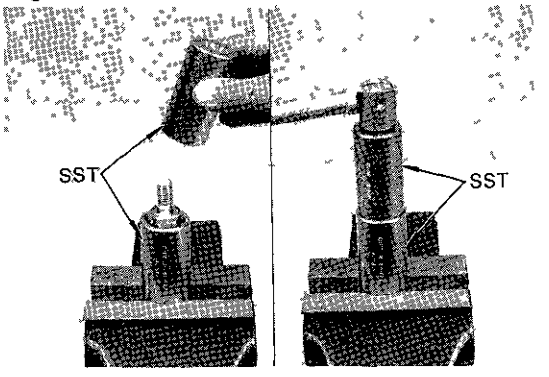
Disassemble the parts in the numerical order shown in the figure

Fig. 6-30



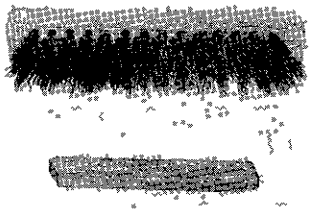
1 Nozzle Holder Retaining Nut
2 Adjusting Shim
3 Pressure Spring
4 Pressure Pin
5 Distance Piece
6 Injection Nozzle

Fig. 6-31



Unscrew the nozzle holder retaining nut with SST
SST (09268-46011) &
(09268-46021) of set [09260-46011]

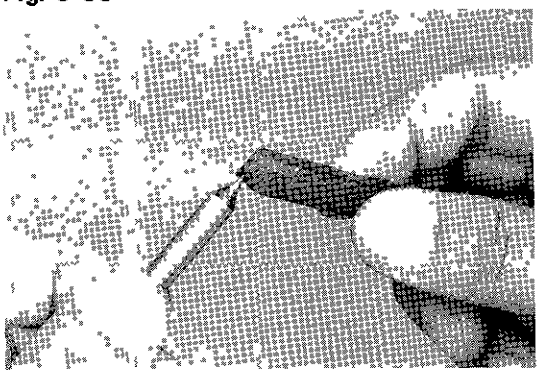
Fig. 6-32



NOZZLE CLEANING

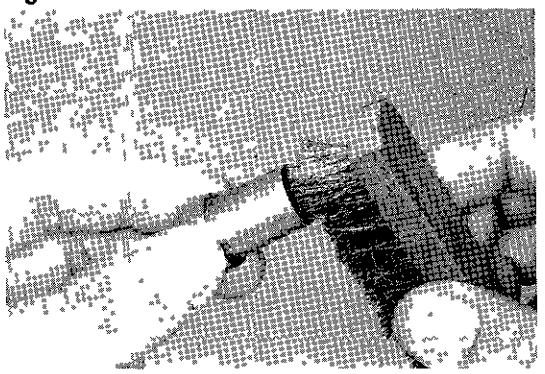
1 To wash the nozzles use a wooden stick and brass brush Wash in clean diesel fuel or light oil

Fig. 6-33



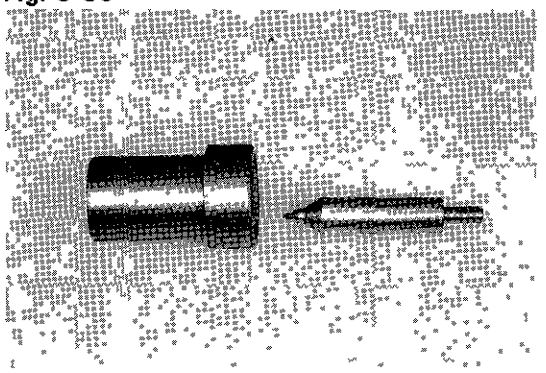
2 Remove the carbon adhering to the nozzle needle tip with a wooden stick

Fig. 6-34



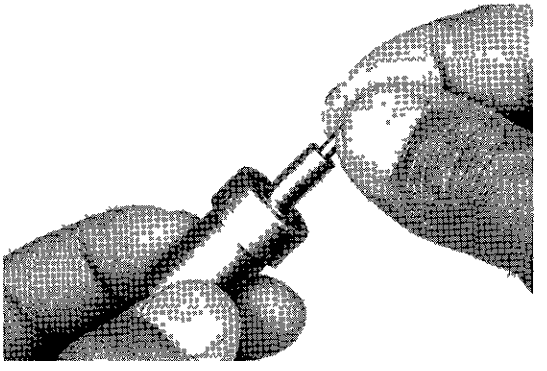
3 Remove the carbon from the exterior of the nozzle body (except wrapping angle) with a brass brush

Fig. 6-35



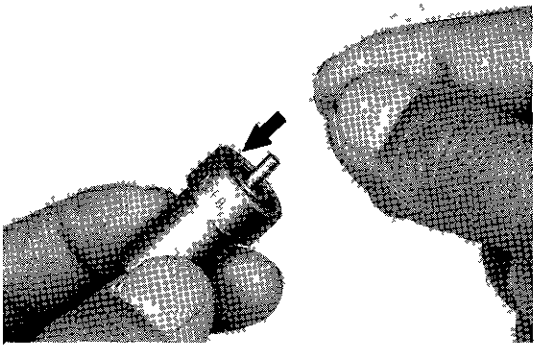
4 Wash the nozzle in clean diesel fuel or light oil

Fig. 6-36



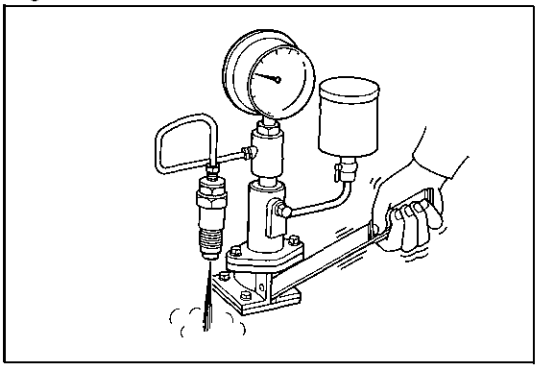
5 Perform a sinking test
(1) Pull the needle out about half way from the body and release it

Fig. 6-37



(2) The needle should sink down into the body vent smoothly by its own weight
(3) Repeat this test rotating the needle slightly each time

Fig. 6-38



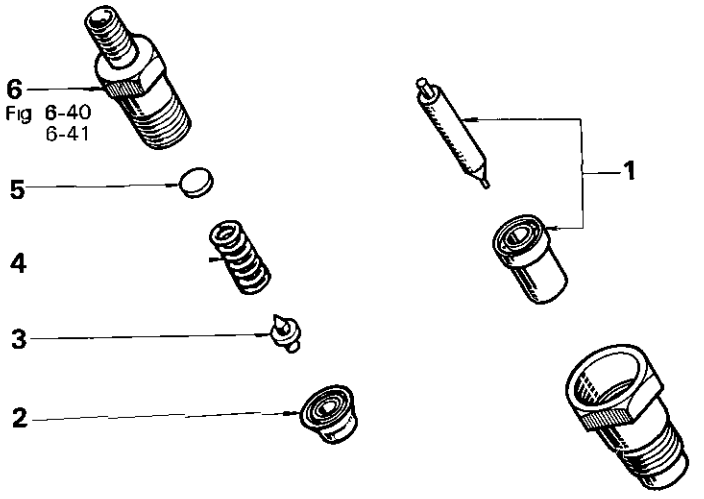
6 Perform a spray test

—Note—
If the nozzle fails the sinking and spray tests, replace both the needle and the body as a unit.

ASSEMBLY

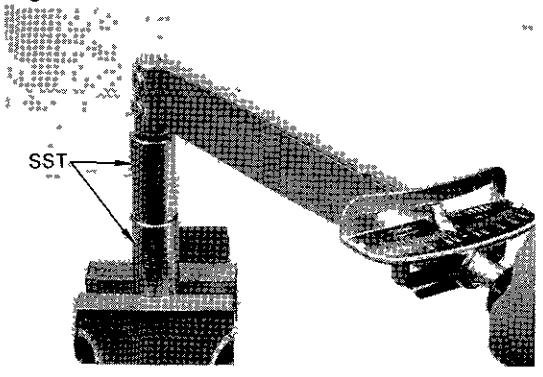
Assemble the parts in the numerical order shown in the figure

Fig. 6-39



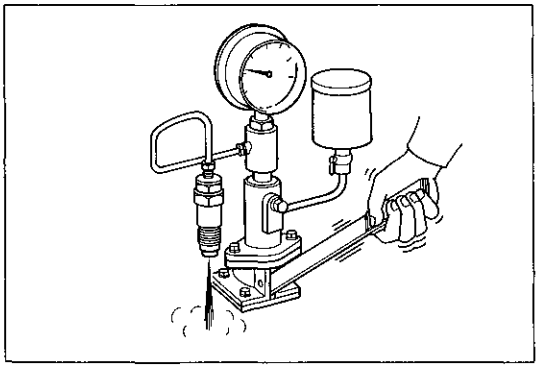
1	Injection Nozzle	4	Pressure Spring
2	Distance Piece	5	Adjusting Shim
3	Pressure Pin	6	Nozzle Holder Retaining Nut

Fig. 6-40



Tighten the retaining nut with SST
SST (09268-46011) &
(09268 46021) of set [09260 46011]
Tightening torque: 5.0 — 7.0 kg-m (37 — 50 ft-lb)

Fig. 6-41

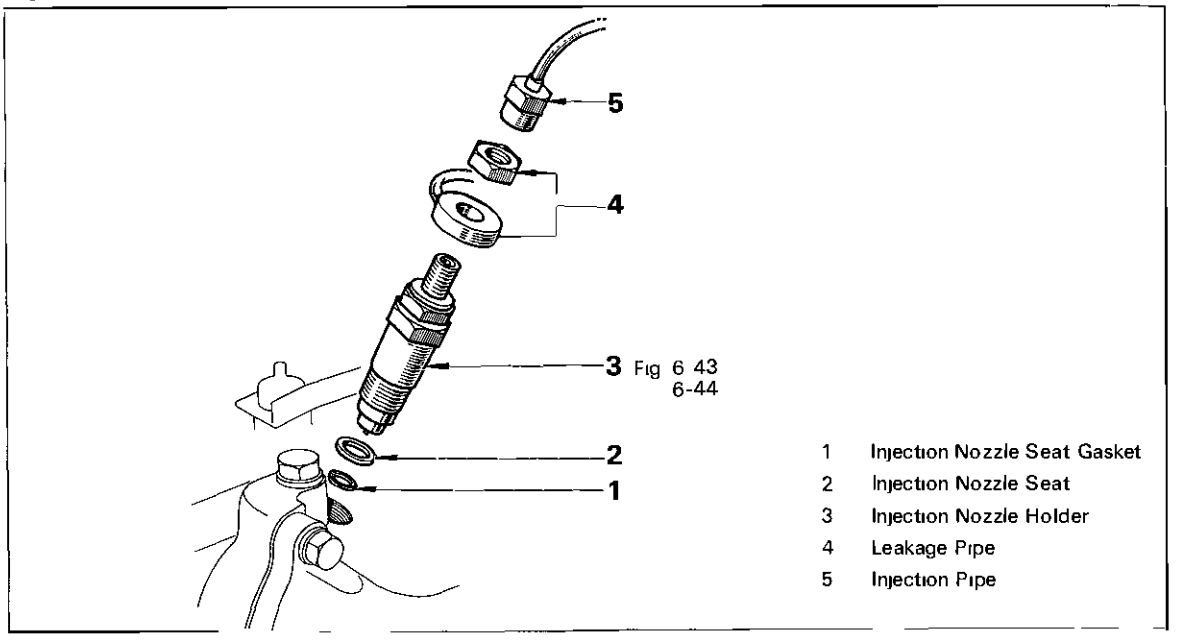


After assembling the injection nozzle perform a spray test and adjust if necessary

INSTALLATION

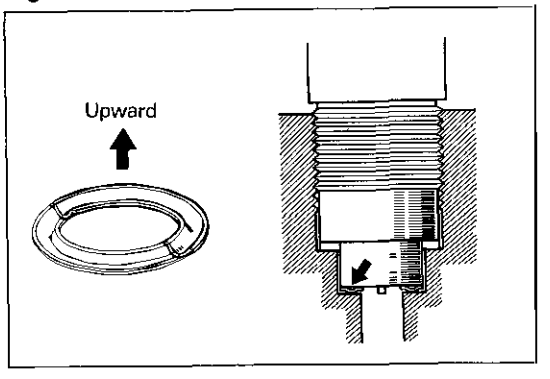
Install the parts in the numerical order shown in the figure

Fig. 6-42



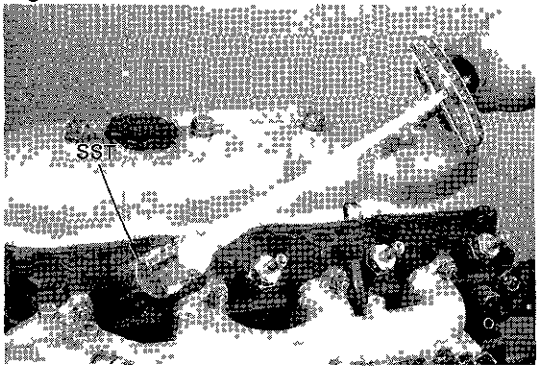
1 Injection Nozzle Seat Gasket
2 Injection Nozzle Seat
3 Injection Nozzle Holder
4 Leakage Pipe
5 Injection Pipe

Fig. 6-43



Note the orientation of the nozzle seat gasket as shown in the figure

Fig. 6-44



Tighten the nozzle holder with SST
SST (09268-46011) of set [09260 46011]

Tightening torque: 6.0 – 8.0 kg-m (44 – 57 ft-lb)

–Note–
After installing, bleed the air.

FUEL FEED PUMP

CUTAWAY VIEW

Fig. 6-45

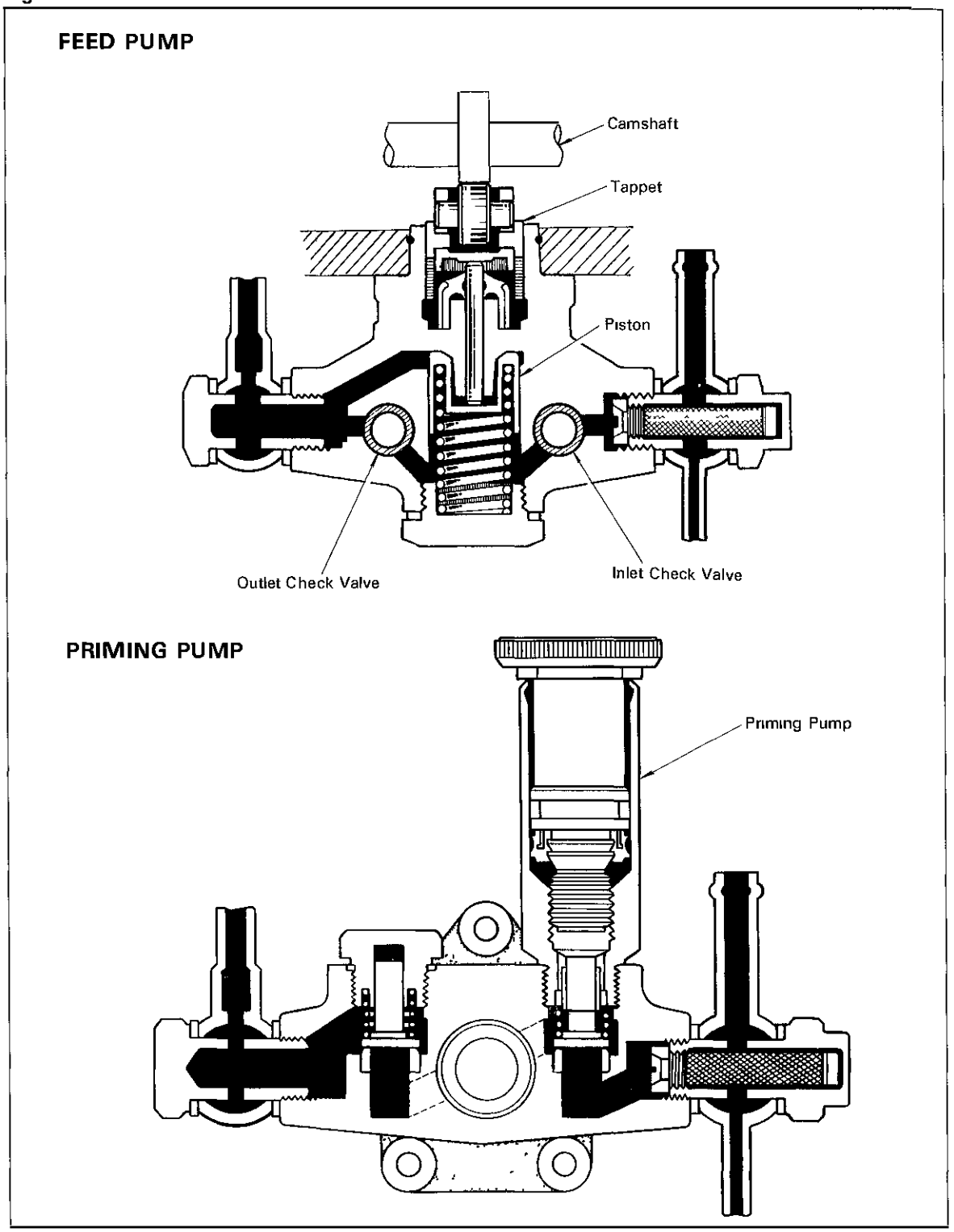
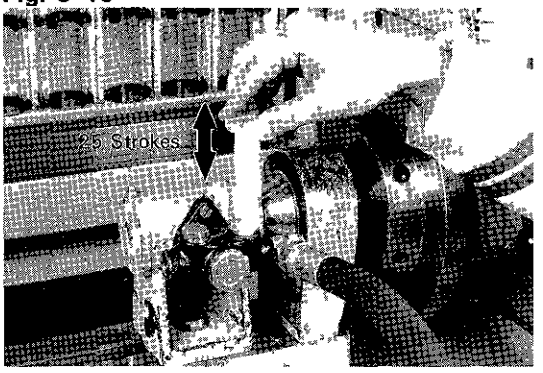


Fig. 6-46



FEED PUMP TEST

1 Suction capacity test

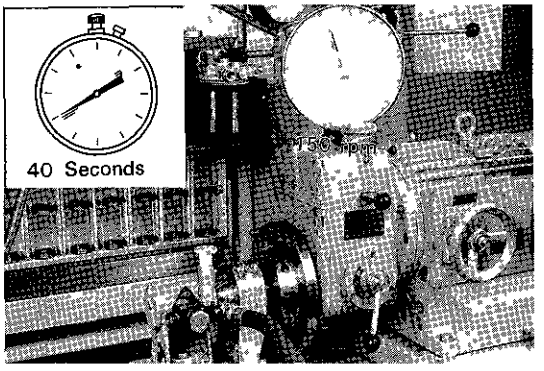
The size of the suction pipes should be

Pipe inner diameter:
8 mm (0.31 in.)
Pipe length: 2 m (78.7 in.)
Suction height: 1 m (39.4 in.)

(1) Operate the priming pump for one minute at 60 strokes per minute

Suction capacity
Fuel must discharge within:
25 strokes

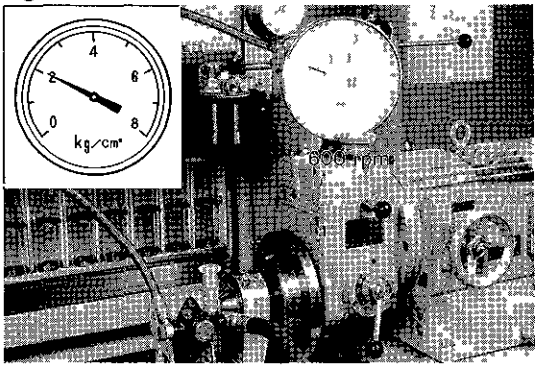
Fig. 6-47



(2) Set the feed pump tester at 150 rpm and test the feed pump suction capacity

Suction capacity
Fuel must discharge within:
40 seconds

Fig. 6-48



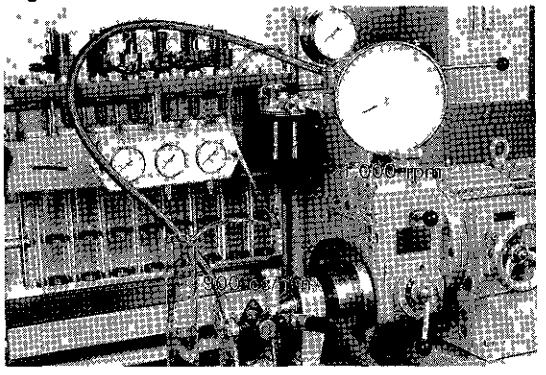
2 Discharge performance test

Connect the pressure gauge to the feed pump discharge side

(1) Operate the feed pump at 600 rpm

Discharge pressure:
1.8 – 2.2 kg/cm² (26 – 31 psi)

Fig. 6-49



(2) Operate the feed pump at 1 000 rpm Measure discharge volume from the discharge side nozzle

Discharge side nozzle diameter:
1.54 mm (0.0606 in.)
Discharge volume capacity:
More than 900 cc/min. (54.9 cu in.)

DISASSEMBLY

Disassemble the parts in the numerical order shown in the figure

Fig. 6-50

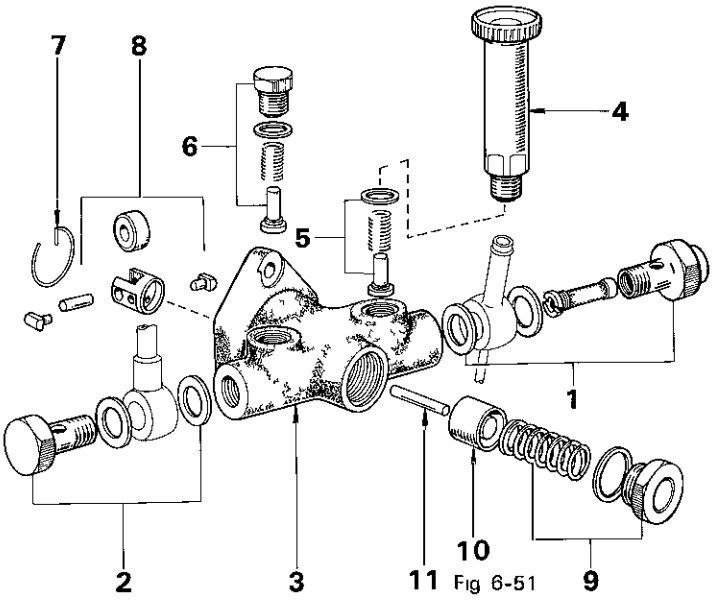
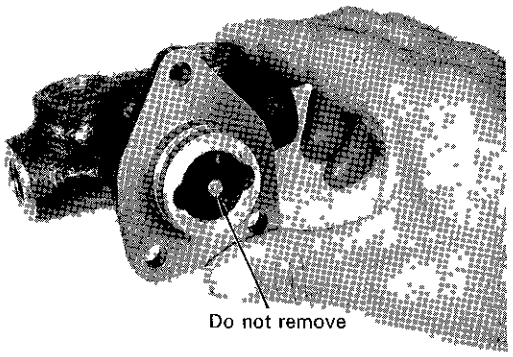


Fig 6-51

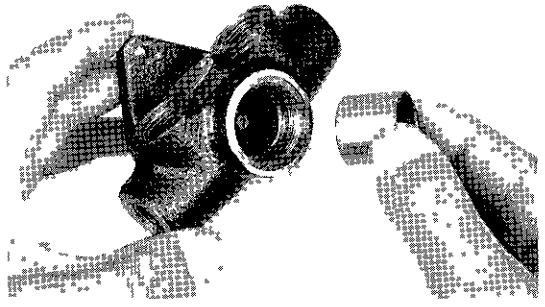
1	Inlet Hose
2	Outlet Hose
3	Feed Pump Assembly
4	Priming Pump
5	Inlet Check Valve & Spring
6	Outlet Check Valve & Spring
7	Snap Ring
8	Tappet
9	Piston Chamber Plug & Spring
10	Piston
11	Push Rod

Fig. 6-51



Since the push rod is precisely fitted into the feed pump housing, do not remove the rod unless necessary If removed, be sure to con firm assembly direction

Fig. 6-52



INSPECTION

Inspect the piston push rod and feed pump housing for wear or damage

Clearance (Reference):

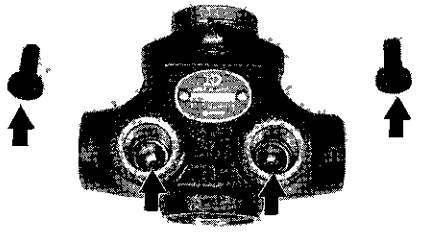
STD Piston

0.009 – 0.013 mm
(0.0004 – 0.0005 in.)

Push rod

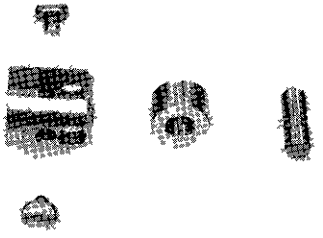
0.003 – 0.006 mm
(0.0001 – 0.0002 in.)

Fig. 6-53



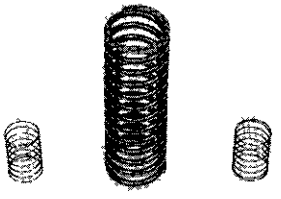
Inspect the check valve and valve seat for wear or damage

Fig. 6-54



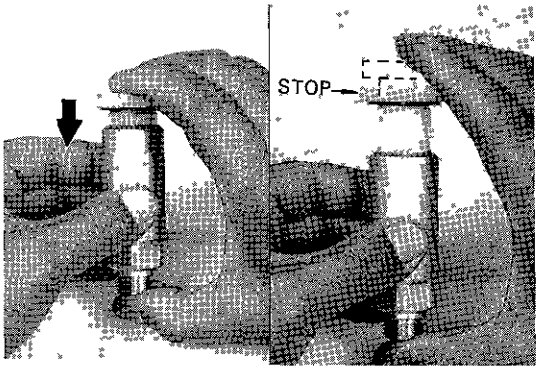
Inspect the tappet and roller for wear or damage

Fig. 6-55



Inspect the check valve and piston springs for wear or damage

Fig. 6-56

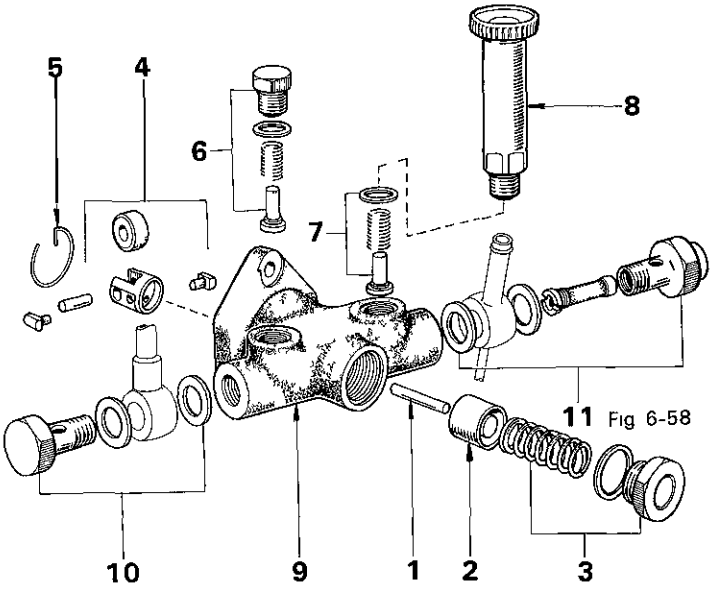


Strongly plug the priming pump inlet port with your finger and check that pressure and vacuum are created when the pump is operated

ASSEMBLY

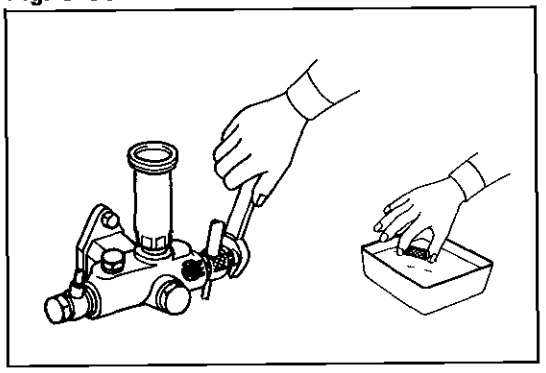
Assemble the parts in the numerical order shown in the figure

Fig. 6-57



1 Push Rod
2 Piston
3 Piston Chamber and Spring
4 Tappet
5 Snap Ring
6 Outlet Valve & Spring
7 Inlet Check Valve & Spring
8 Priming Pump
9 Feed Pump Assembly
10 Outlet Hose
11 Inlet Hose

Fig. 6-58



Before assembling, clean the filter inside the union bolt

AUTOMATIC TIMER

REMOVAL

Remove the parts in the numerical order shown in the figure

Fig. 6-59

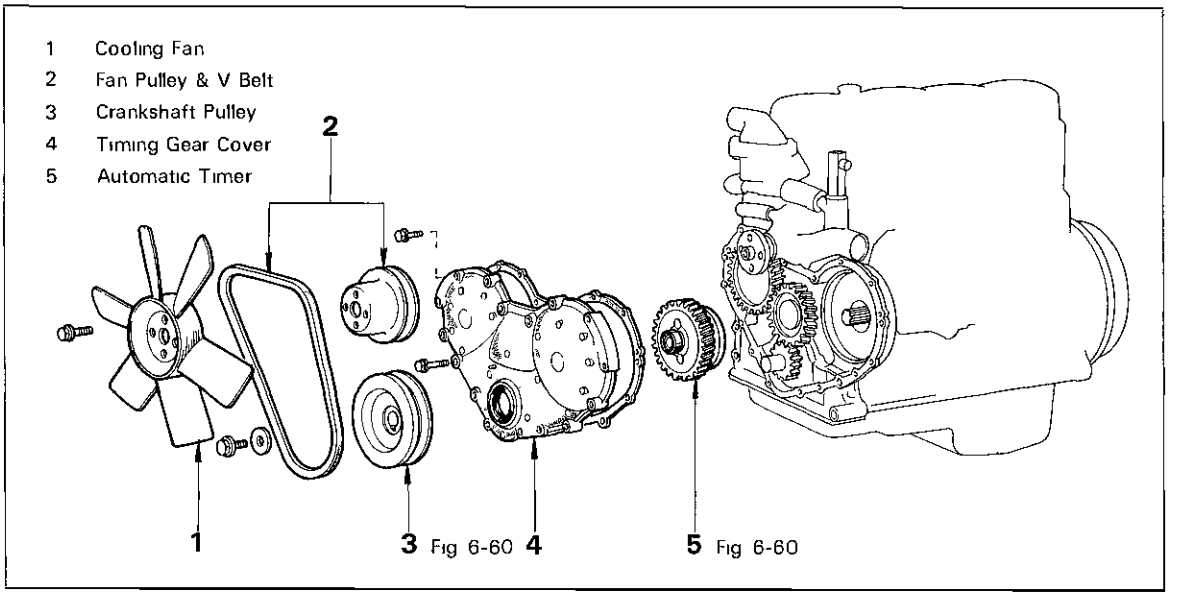
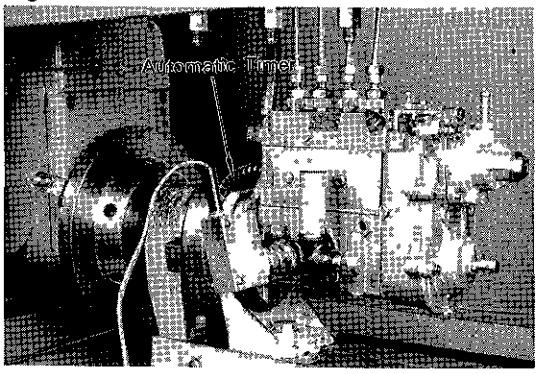


Fig. 6-60

Remove the automatic timer

SEE
TIMING GEAR
REMOVAL SECTION
Fig. 3-69, 3-71 & 3-72

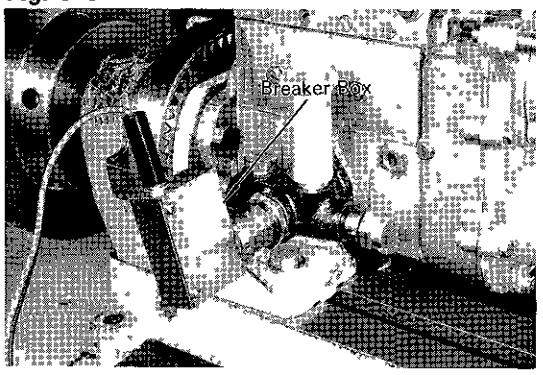
Fig. 6-61



INSPECT ADVANCE ANGLE

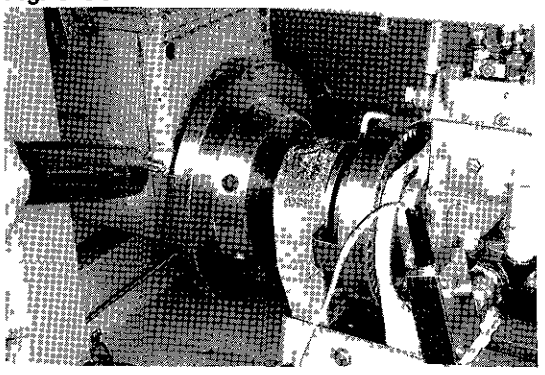
1 Install the automatic timer on the pump spline shaft and mount the injection pump on the pump tester
2 Fill the pump camshaft chamber with engine oil

Fig. 6-62



3 Using an adapter install the timer breaker box to the piston bore of the feed pump

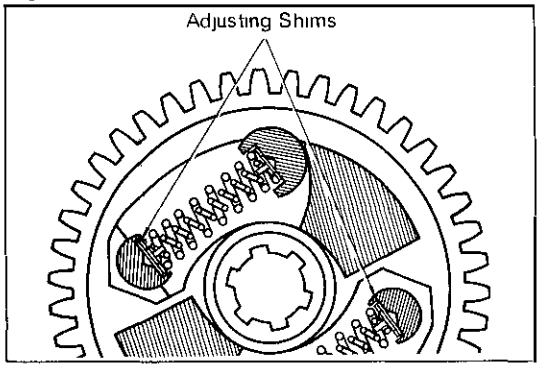
Fig. 6-63



4 Using the timing light, check advance angle

Pump (rpm)	Timer advance angle	
	B 2B	3B
700	Advance begins (≦0.5°)	Advance begins (≦0.5°)
900	2.7 – 3.7°	—
1 000	—	1.3 – 2.3°
1 100	3.5 – 4.5°	—
1 400	—	3.7 – 4.7°
1 450	4.8 – 5.8°	—
1 750	6.0 – 7.0°	6.0 – 7.0°
1 850	6.0 – 7.0°	—
1 900	—	6.0 – 7.0°

Fig. 6-64

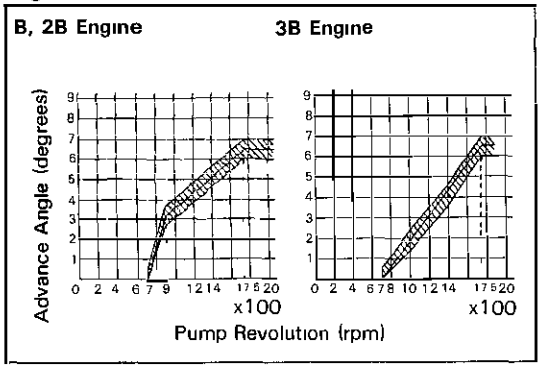


5 If the advance angle is not within specified range adjust by changing the inner and outer timer spring shims

–Note–

1. **The inner spring is not equipped with the automatic timer on 3B engines.**
2. **Use outer spring shim to adjust the timing advance characteristics in low speed range, and inner spring shim in high speed range.**
   Outer adjusting shim thickness:
   0.1, 0.2, 0.5 mm
   (0.004, 0.008, 0.020 in.)
   Inner adjusting shim thickness:
   0.1, 0.2, 0.5 mm
   (0.004, 0.008, 0.020 in.)
3. **When injection timing is retarded, decrease shim thickness.**
   When injection timing is advanced, increase shim thickness.

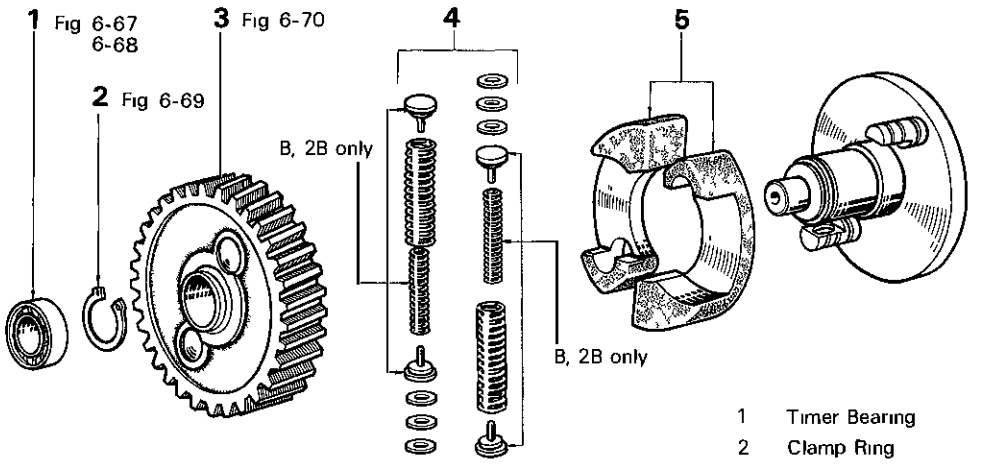
Fig. 6-65



DISASSEMBLY

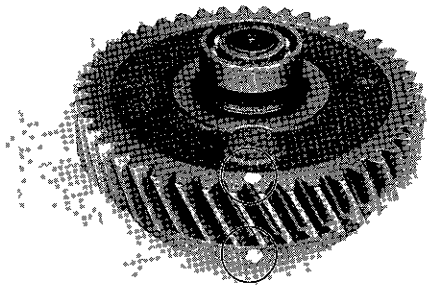
Disassemble the parts in the numerical order shown in the figure

Fig. 6-66



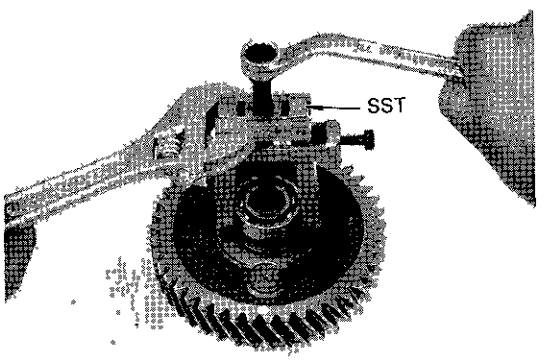
1 Timer Bearing
2 Clamp Ring
3 Drive Gear
4 Timer Spring & Adjusting Shim
5 Timer Weight

Fig. 6-67



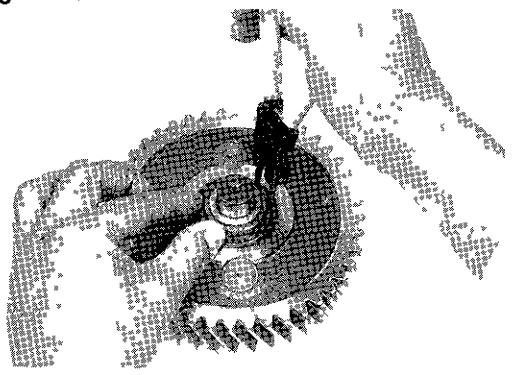
⚠ Place matchmarks on the timer hub and drive gear

Fig. 6-68



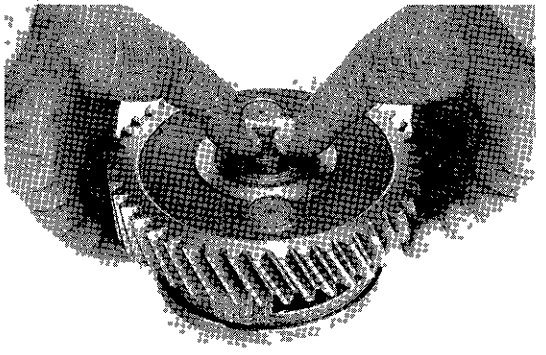
Pull out the timer bearing with SST
SST [09286-46011]

Fig. 6-69



Remove the clamp ring with a snap ring expander

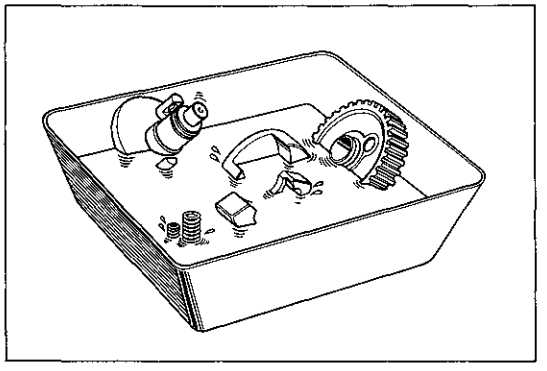
Fig. 6-70



Pull up the drive gear

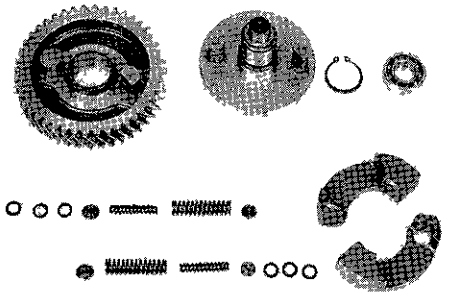
—Note—
Be careful that the springs and shims do not fly out.

Fig. 6-71



INSPECTION
Clean the parts

Fig. 6-72

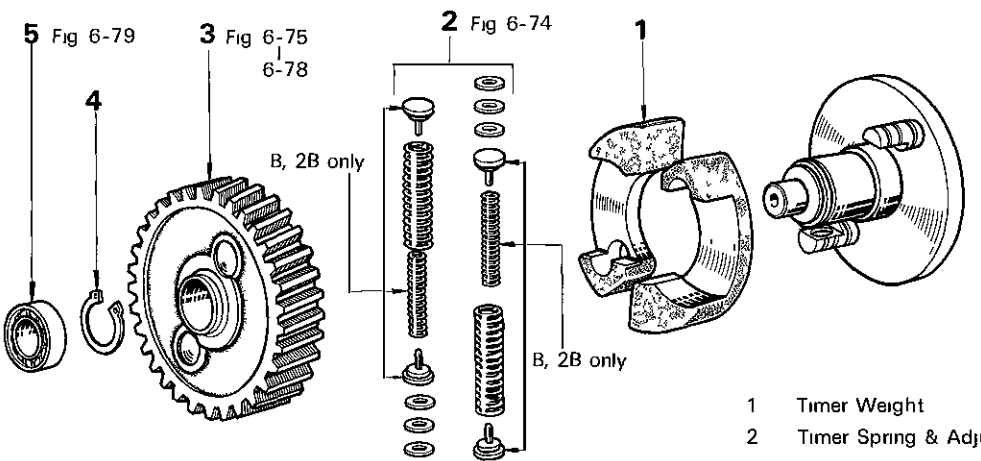


Check all parts for wear or damage

ASSEMBLY

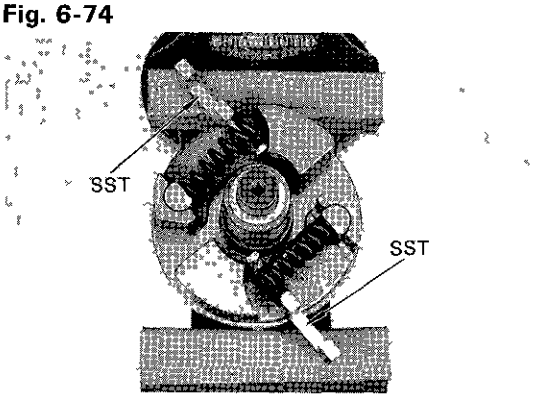
Assemble the parts in the numerical order shown in the figure

Fig. 6-73



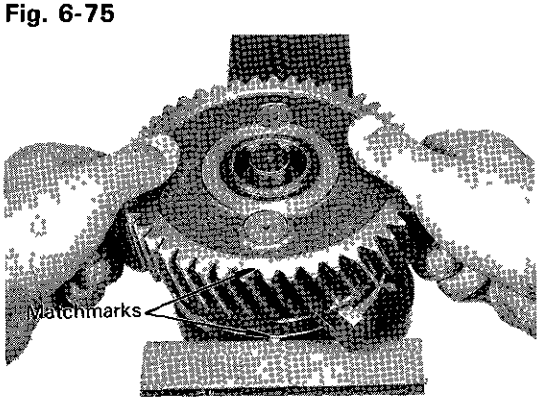
1 Timer Weight
2 Timer Spring & Adjusting Shim
3 Drive Gear
4 Clamp Ring
5 Timer Bearing

Fig. 6-74



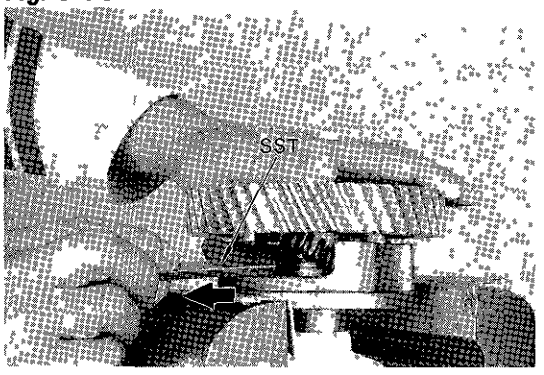
Set the timer springs adjusting shims and spring seats with SST
SST (09280-76010) of set [09260-76016]

Fig. 6-75



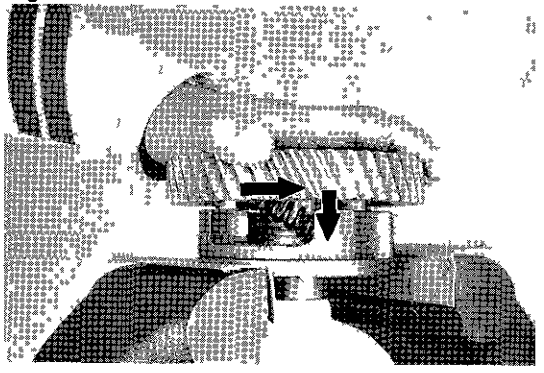
Align the matchmarks of the drive gear with that of the timer hub

Fig. 6-76



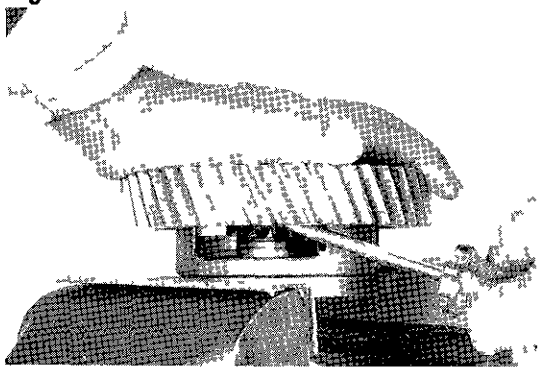
Remove the SST holding the drive gear so that the springs will not fall out

Fig. 6-77



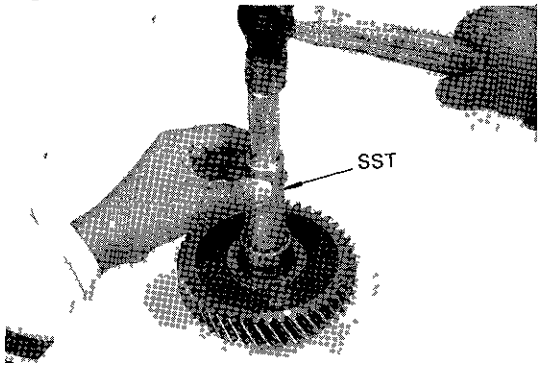
Press down and turn drive gear to install it on the hub

Fig. 6-78



Seat the timer spring snugly with a screw driver

Fig. 6-79



Drive the timer bearing into the timer hub with SST
SST [09620 30010]

INSTALLATION

Install the parts in the numerical order shown in the figure

Fig. 6-80

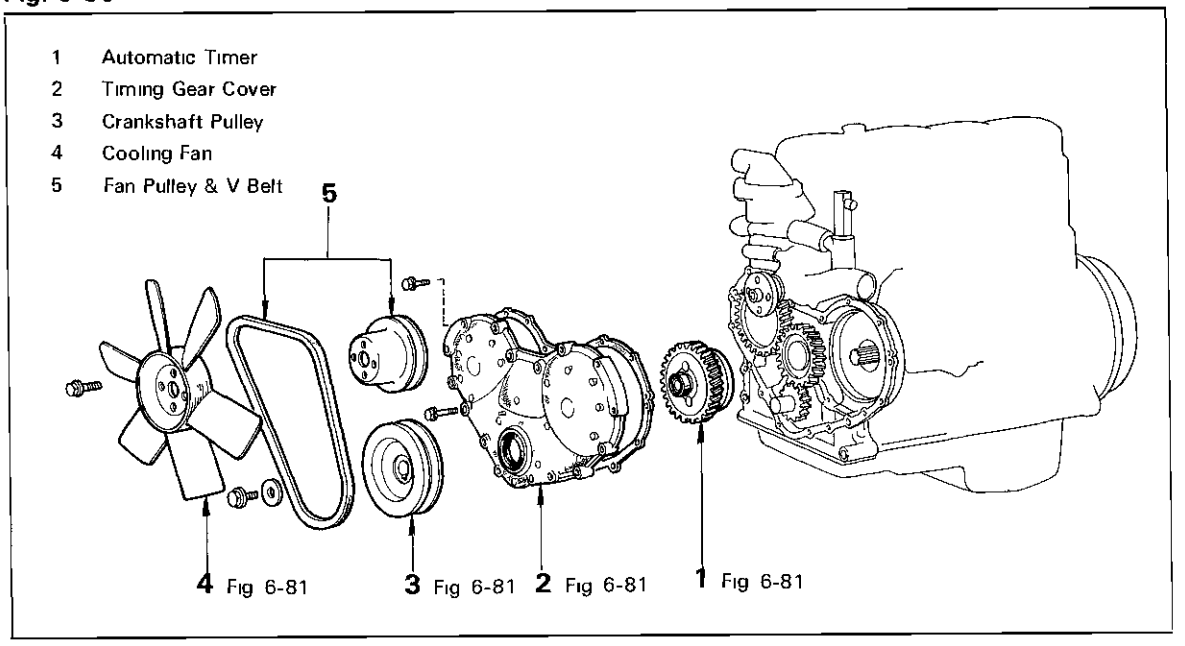


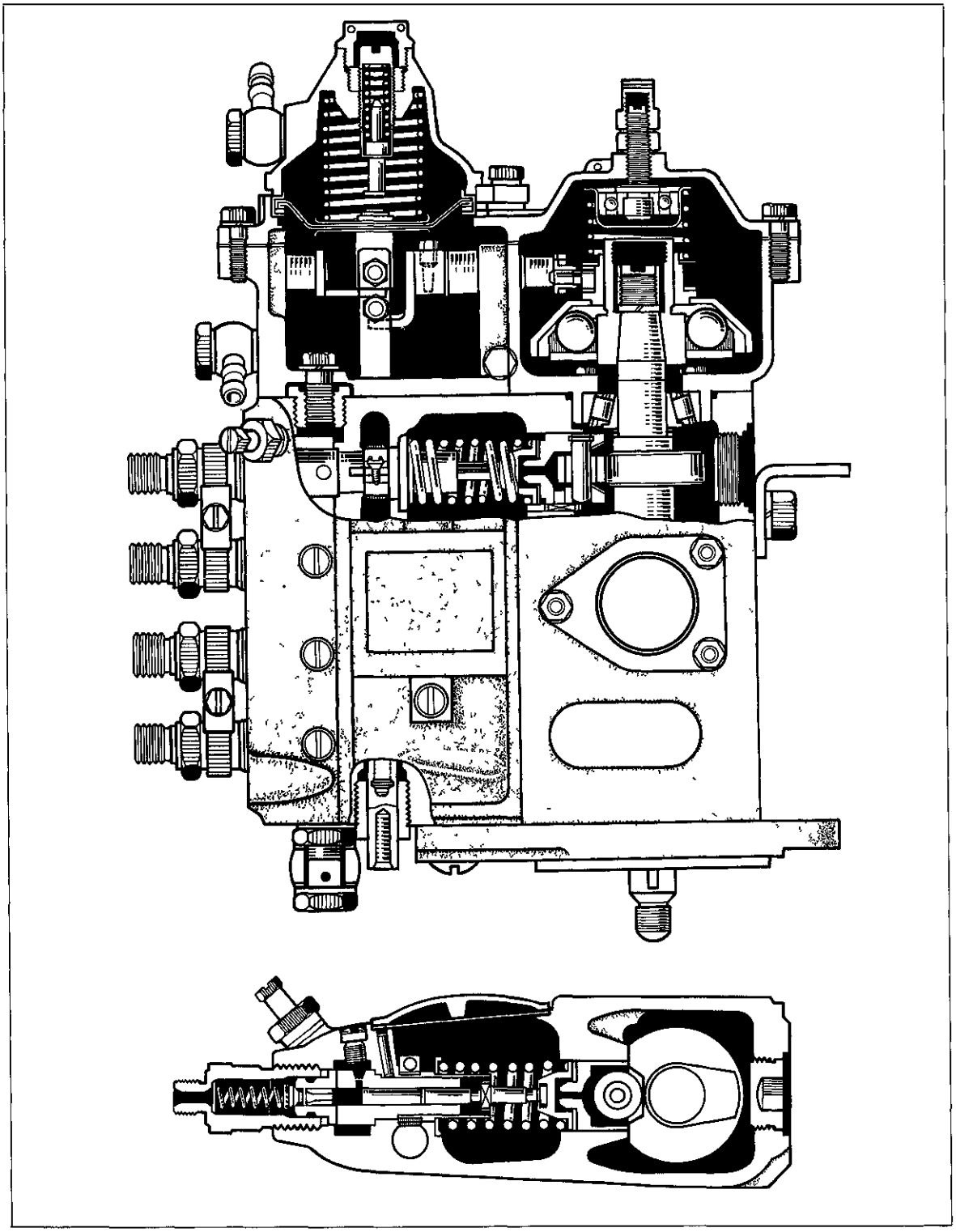
Fig. 6-81

Install the automatic timer

SEE
TIMING GEAR
INSTALLATION
SECTION
Fig. 3-96 to 3-102

INJECTION PUMP
CUTAWAY VIEW

Fig. 6-82



REMOVAL

Remove the parts in the numerical order shown in the figure

Fig. 6-83

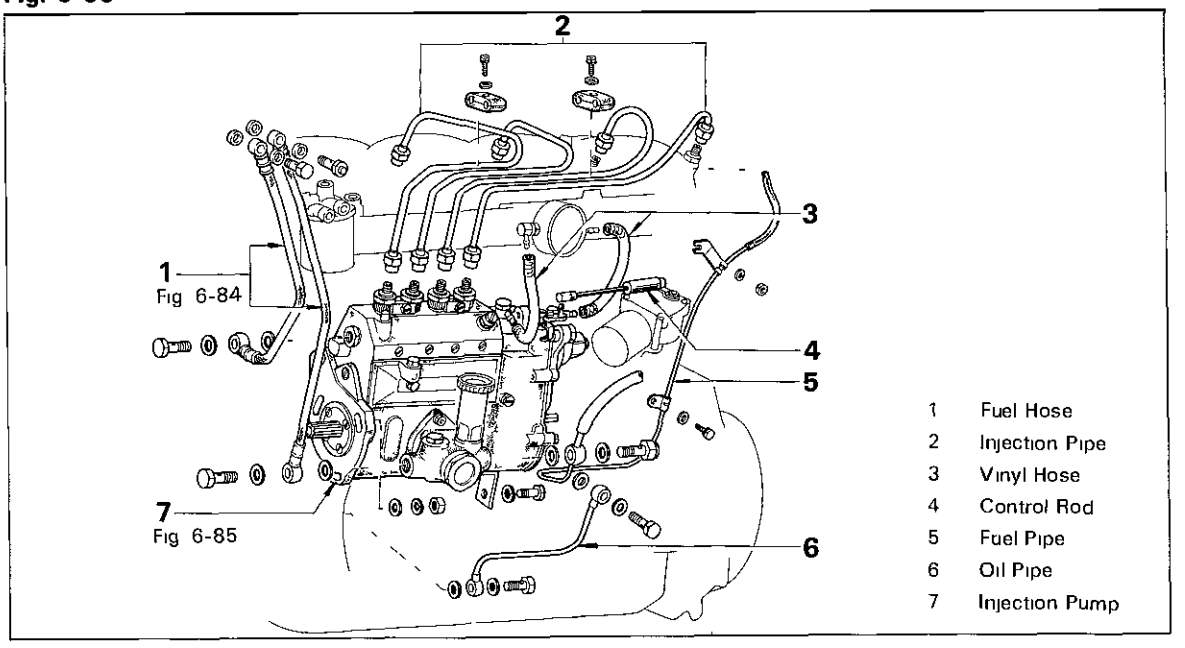
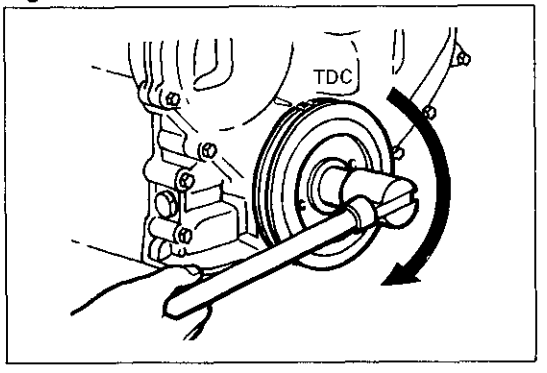
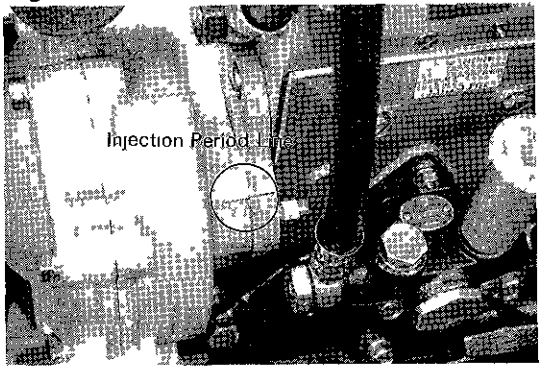


Fig. 6-84



⚠ Before starting work, set No 1 cylinder piston at TDC/compression

Fig. 6-85

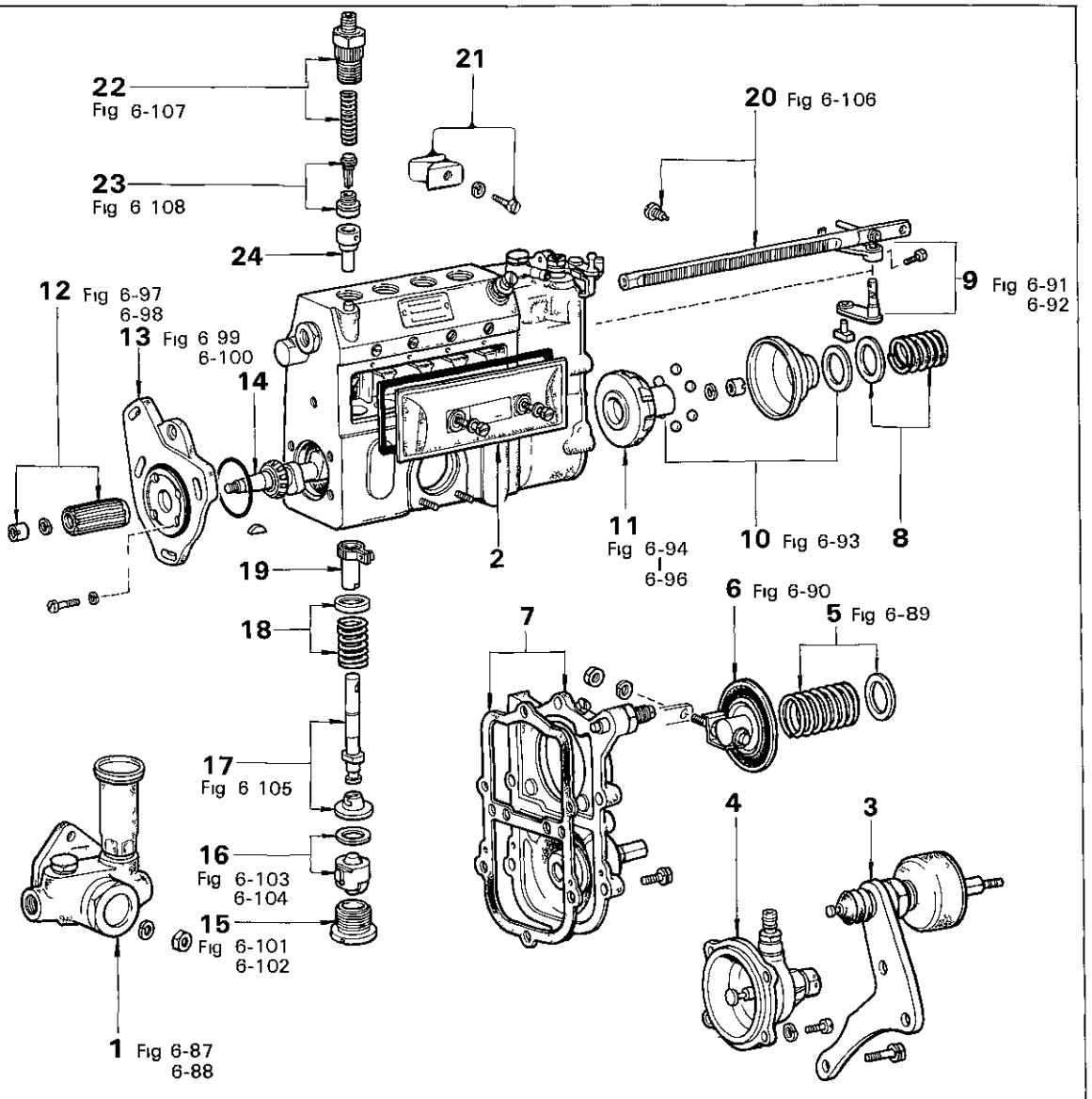


⚠ Check the position of the injection period line before removing the injection pump

DISASSEMBLY

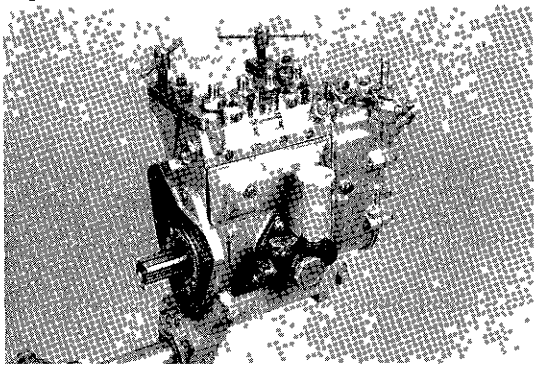
Disassemble the parts in the numerical order shown in the figure

Fig. 6-86



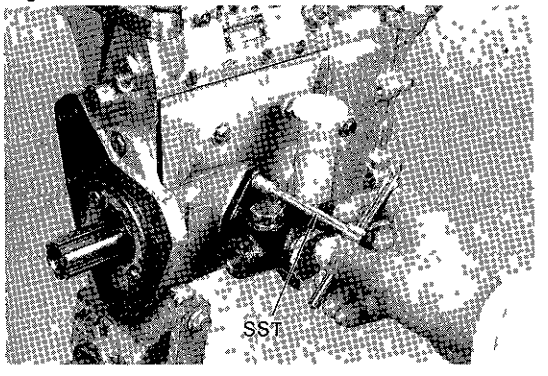
1	Fuel Feed Pump	9	Control Rack Lever	17	Plunger & Lower Seat
2	Injection Pump Cover	10	Slider & Steel Ball	18	Spring & Upper Seat
3	DHAC & Bracket	11	Ball Guide	19	Control Pinion & Sleeve
4	Diaphragm Housing	12	Spline Shaft	20	Control Rack
5	Main Spring & Adjusting Shim	13	Injection Pump Flange	21	Lock Plate
6	Diaphragm & Connecting Rod	14	Camshaft	22	Delivery Valve Holder & Spring
7	Governor Cover	15	Plug	23	Delivery Valve & Seat
8	Speed Control Spring	16	Tappet	24	Cylinder

Fig. 6-87



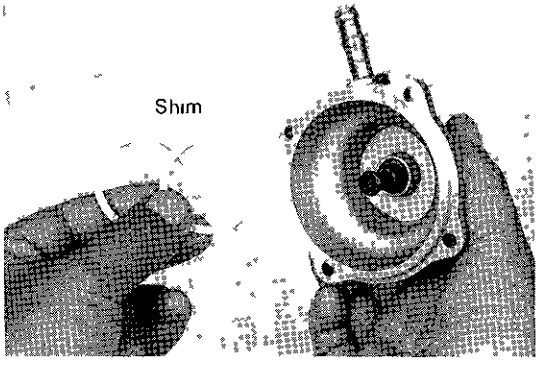
Install the injection pump to the SST
SST [09241-76021]

Fig. 6-88



Remove the fuel feed pump with SST
SST (09276-76010) of set [09260-76016]

Fig. 6-89



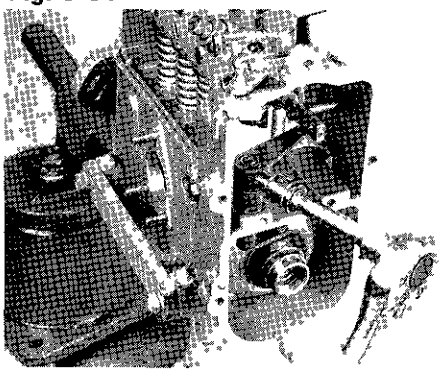
When a number of main spring shims are used use special care to prevent any from being misplaced or getting mixed up

Fig. 6-90

Disconnect the diaphragm from the control rack

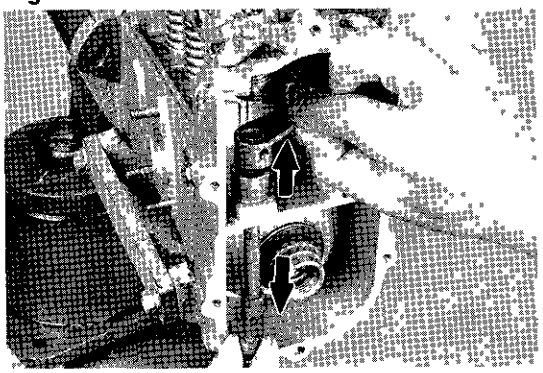
—**Note**—
Do not allow any engine oil, fuel or grease to get on the diaphragm.

Fig. 6-91



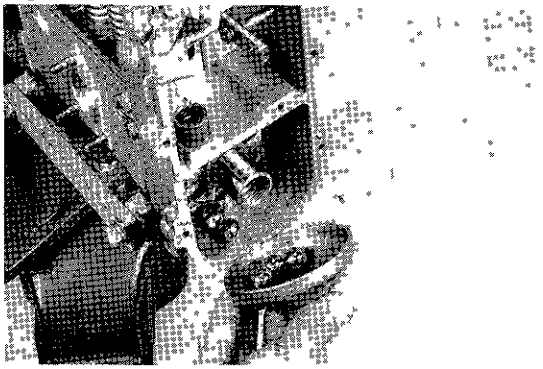
Remove the stop lever bolt with a 6 mm socket wrench

Fig. 6-92



Remove the two control rack levers by pulling upwards and downwards respectively

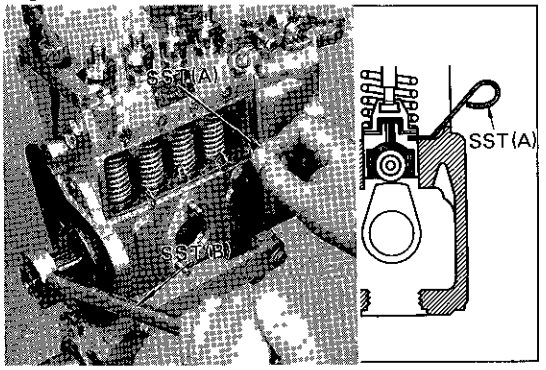
Fig. 6-93



Remove the spring seat and slider and then take out the six steel balls

—Note—
Take care not to drop the steel balls.

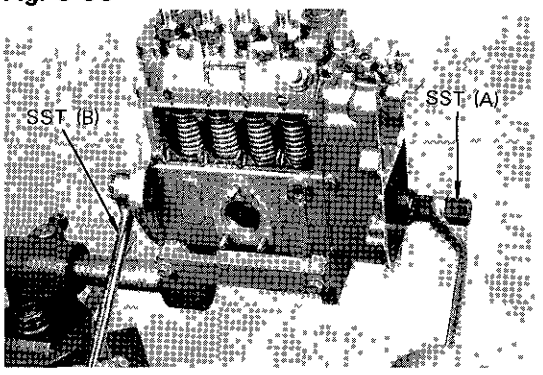
Fig. 6-94



Using SST (B), turn the camshaft and insert SST (A) into the respective tappet service openings when the tappets are at their highest positions

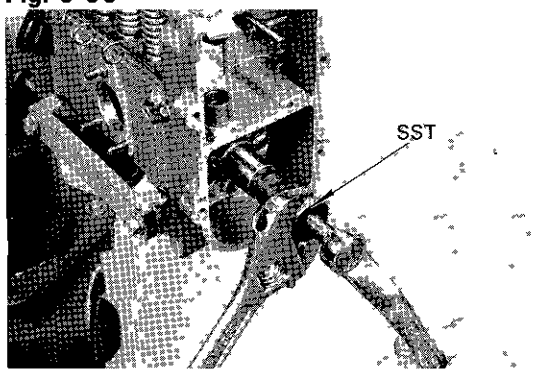
SST (A) (09274-46010) &
(B) (09278-46010) of set [09260-46011]

Fig. 6-95



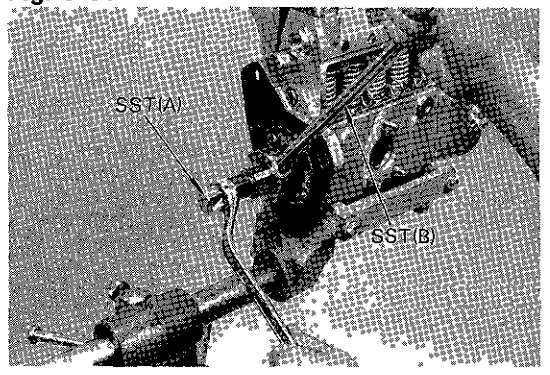
Hold the spline shaft with SST (B) and remove the round nut with SST (A)
SST (A) (09266-67011) of set [09260 76016]
(B) (09278 46010) of set [09260-46011]

Fig. 6-96



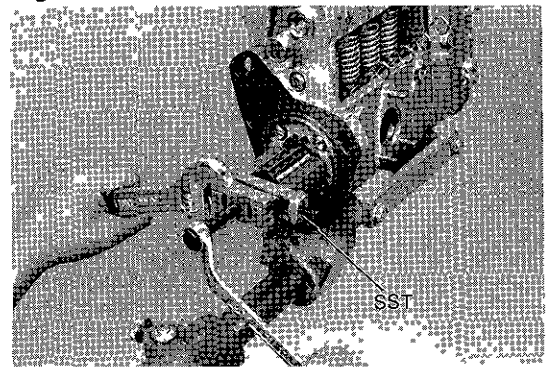
Pull out the ball guide with SST
SST (09267 76011) of set [09260 76016]

Fig. 6-97



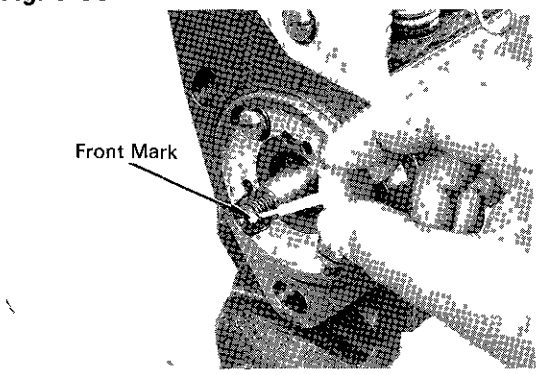
Hold the spline shaft with SST (B) and remove the round nut with SST (A)
SST (A) (09266 46011) &
(B) (09278 46010) of set [09260 46011]

Fig. 6-98



Pull out the spline shaft with SST
SST [09286 46011]

Fig. 6-99



Put a mark on the front side of the camshaft to facilitate work

Fig. 6-100

SEE

INJECTION PUMP

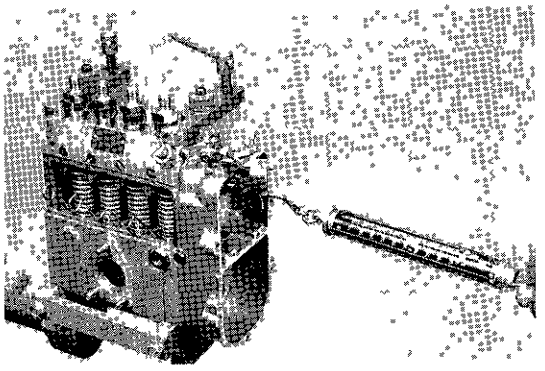
ASSEMBLY

SECTION

Fig. 6-149 to 6-153

Before removing the injection pump flange measure the thrust clearance and refer to this value when inspecting or reassembling

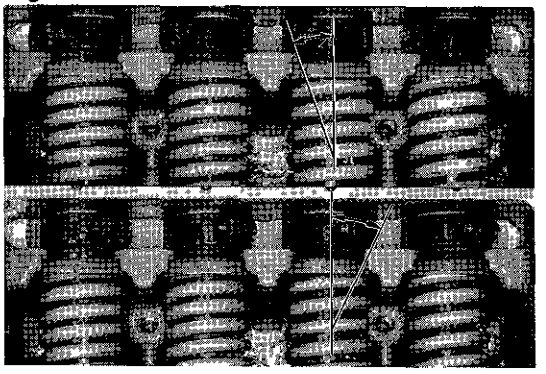
Fig. 6-101



Check the sliding resistance of the control rack

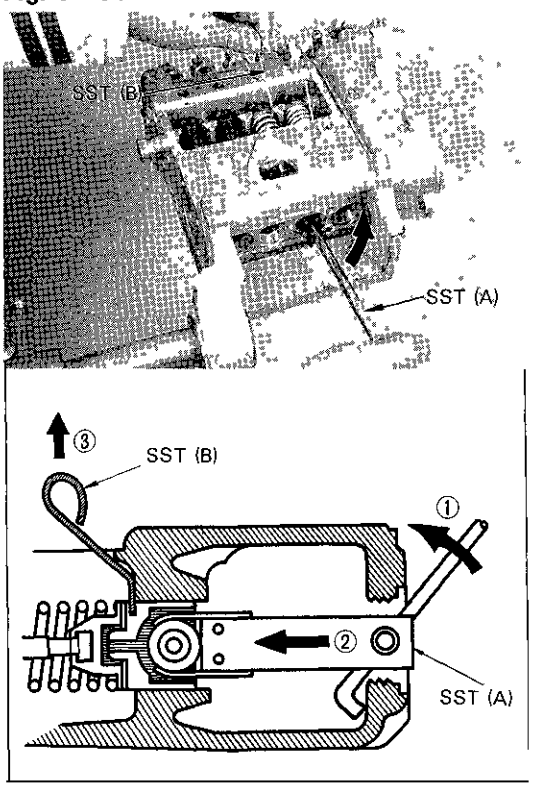
Sliding resistance:
Less than 120 g (4.2 oz)

Fig. 6-102



To prevent error when reassembling confirm the control pinion stop position by moving control rack fully to left and right

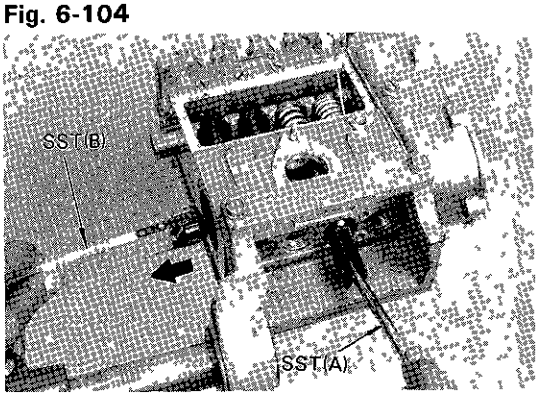
Fig. 6-103



Using SST (A) push the tappet to remove SST (B)
SST (A) (09272 76011) of set [09260 76016]
(B) (09274 46010) of set [09260-46011]

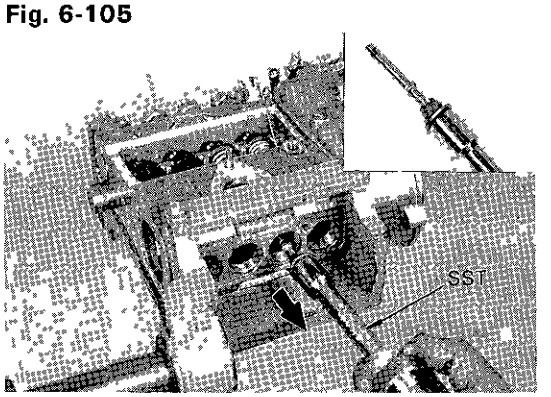
–Note–
Keep all parts for each cylinder in order in the disassembly pan.

Fig. 6-104



Hold the tappet in the camshaft chamber with SST (A) and take out the tappet through the camshaft bearing hole using SST (B)
SST (A) (09272-76011) &
(B) (09273-76011) of set [09260 76016]

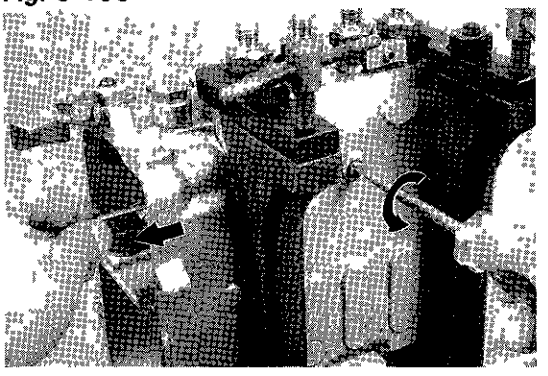
Fig. 6-105



Using SST, hold the spring lower seat and take it out together with the plunger
SST (09275-46010) of set [09260-46011]

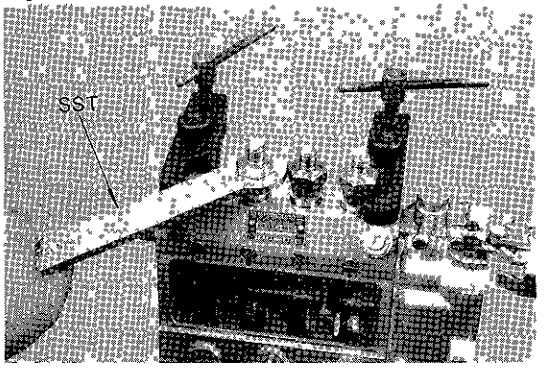
–Note–
Do not touch the sliding surfaces of the delivery valve with your hand.

Fig. 6-106



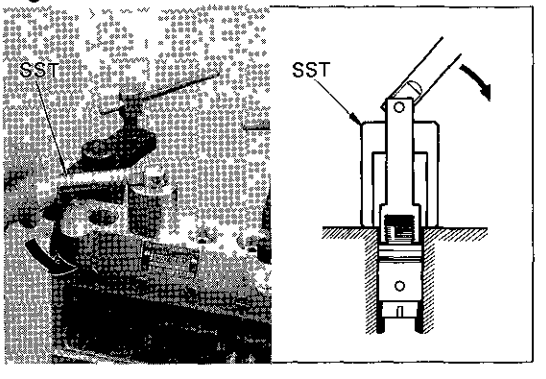
Loosen the rack guide screw and pull out the control rack

Fig. 6-107



Remove the delivery valve holder with SST
SST (09270-76010) of set [09260-76016]

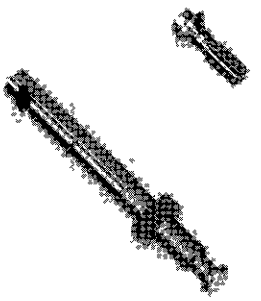
Fig. 6-108



Turn the handle of SST and screw it into the valve seat service thread
Using the handle as lever pull out the delivery valve seat and gasket together
SST (09271-76011) of set [09260 76016]

—Note—
Do not touch the sliding surfaces of the delivery valve with your hand.

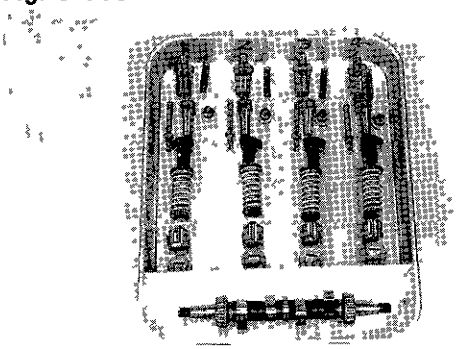
Fig. 6-109



INSPECTION & REPAIR

Do not touch the sliding surfaces of the pump plunger and delivery valves

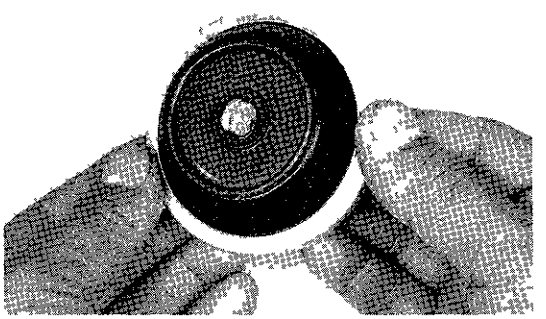
Fig. 6-110



Wash the parts in clean light oil before inspecting

Wash and clean the outer surfaces of the housings with a soft brush and blow out the tapped holes with compressed air

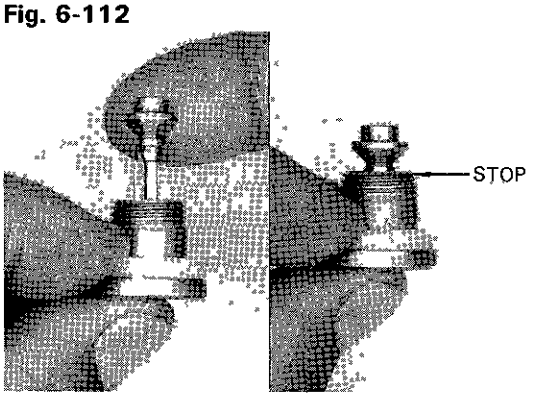
Fig. 6-111



Diaphragm

Wipe the diaphragm with cloth Do not allow gasoline light oil or other petroleum products to get on the diaphragm

Fig. 6-112

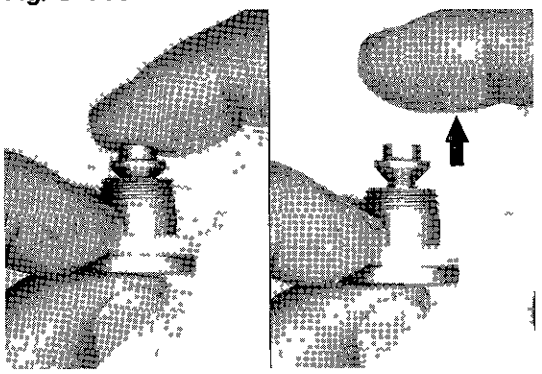


Delivery Valve

1 Pull up the valve and close the hole at the valve seat bottom end with your thumb When the valve is released it should sink down quickly and stop at the position where the relief ring closes the valve seat hole

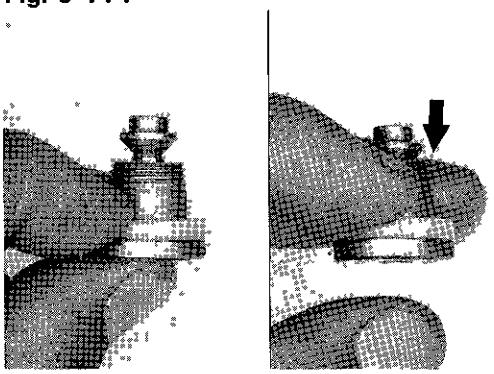
If defective replace the valve as a set

Fig. 6-113



2 Place your thumb over the hole at valve seat bottom end
Insert the valve into the valve seat and press down with your finger When your finger is released the valve should rise back to its original position
Replace if defective

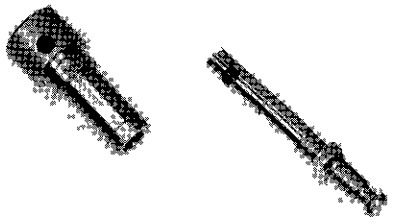
Fig. 6-114



3 Remove your thumb from the valve seat hole
The valve should close completely by its own weight
Replace if defective

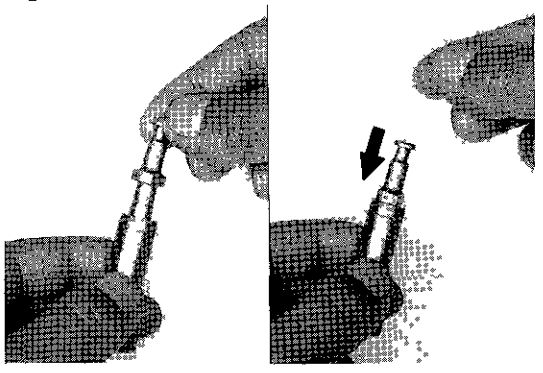
—Note—
Before using a new valve set, wash it with light oil and perform the above tests.

Fig. 6-115



Plunger & Cylinder
Check the sliding parts, and if damaged, replace the element as a set

Fig. 6-116



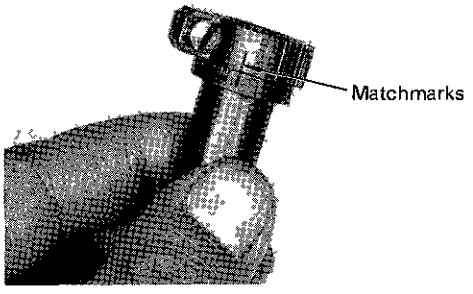
Test for fit (Sinking test)
1 Tilt the cylinder slightly and pull out the plunger
2 When released the plunger should sink down smoothly in the cylinder by its own weight
3 Rotate the plunger and repeat the test at various positions If the plunger sticks at any position, replace the element as a set

Fig. 6-117

Control Rack & Pinion

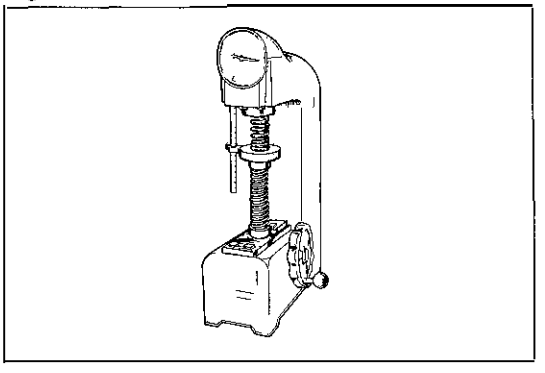
Check the tooth surfaces of the control rack and pinion for wear or damage and replace if defective

Fig. 6-118



If necessary to disassemble confirm the installed condition of the pinion and sleeve

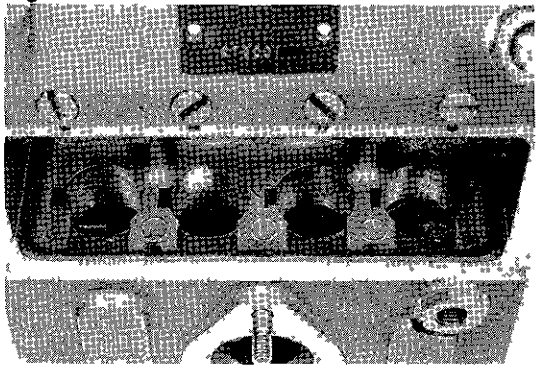
Fig. 6-119



Spring

Spring / Items	Plunger spring	Delivery valve spring	Governor main spring		Speed control spring
			B & 2B	3B	
Free length	49.4 mm (1.945 in.)	37.0 mm (1.457 in.)	45.6 mm (1.795 in.)	51.6 mm (2.031 in.)	38.0 mm (1.496 in.)
Installed length	44.0 mm (1.732 in.)	25.9 mm (1.020 in.)	35.0 mm (1.378 in.)	36.5 mm (1.437 in.)	27.0 mm (1.063 in.)
Installed load	15.1 kg (33 lb)	4.42 kg (10 lb)	0.954 kg (2.1 lb)	1.057 kg (2.3 lb)	3.30 kg (7 lb)

Fig. 6-120



Tappet

Check the tappet holes of the pump housing for wear or damage

Fig. 6-121

Check the tappet, roller bushing and pin for wear or damage

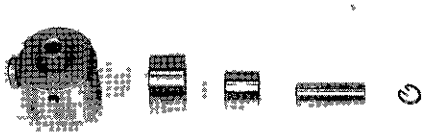
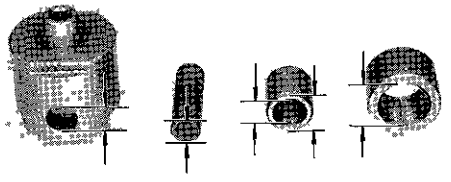


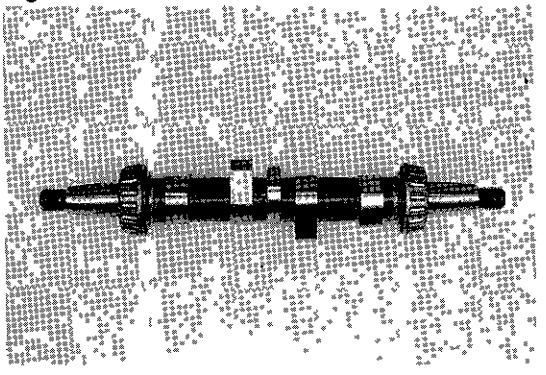
Fig. 6-122



Measure the overall looseness with the tappet roller in the assembled state, and replace if it exceeds the specified limit

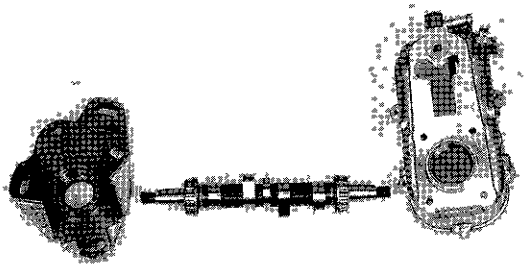
Overall looseness:
Limit 0.3 mm
(0.012 in.)

Fig. 6-123



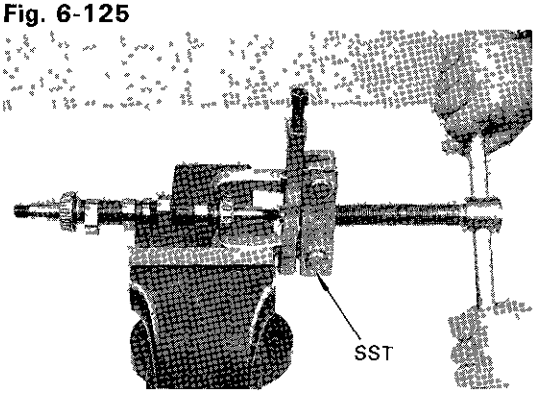
Camshaft
Check the cam surfaces for wear or damage

Fig. 6-124



Camshaft Bearing
Check the roller and race for wear or damage

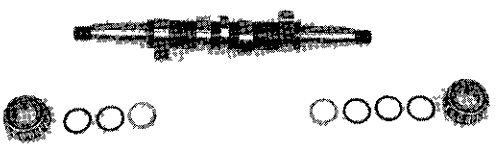
Fig. 6-125



Replace Camshaft Bearing

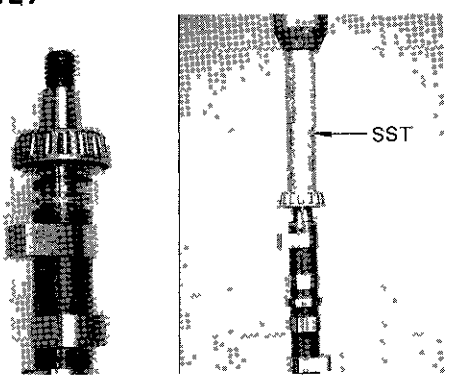
1 Pull out the front bearing with SST
SST [09950 20014]

Fig. 6-126



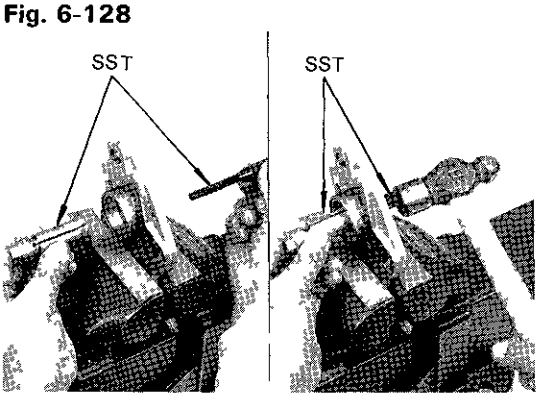
2 Keep the removed shims separately to prevent loss or getting them mixed up with other shims

Fig. 6-127



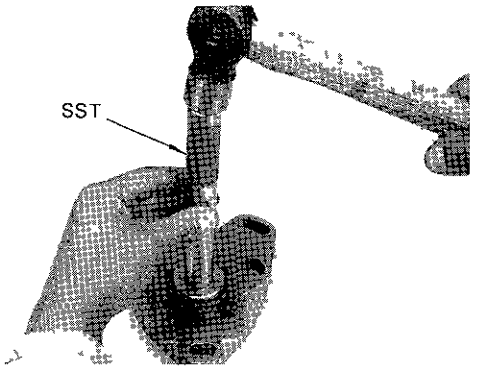
3 Using a press and SST press in the camshaft adjusting ring shims and bearing onto the camshaft
SST [09285 76010]

Fig. 6-128



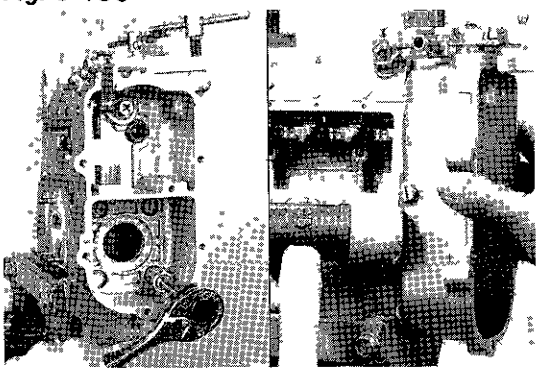
4 Install SST to the bearing cover and drive out the outer race
SST [09286-76011]

Fig. 6-129



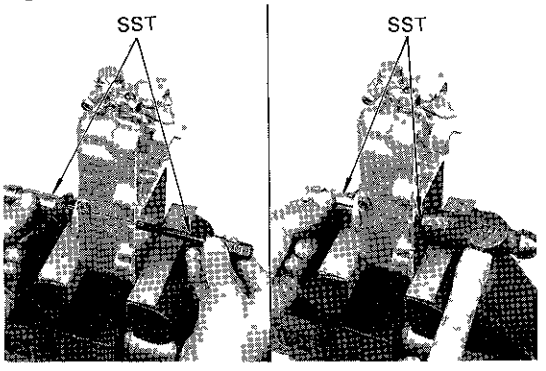
5 Drive a new bearing outer race into the cover with SST
SST [09608-12010]

Fig. 6-130



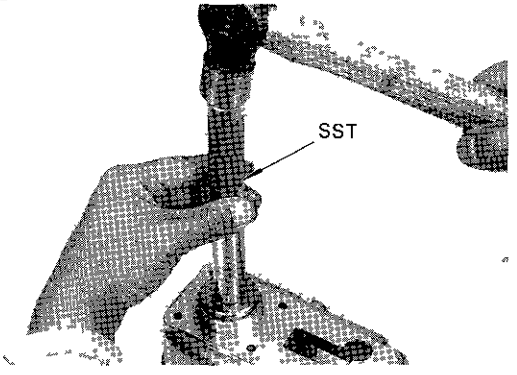
6 Remove the governor housing from the pump body

Fig. 6-131



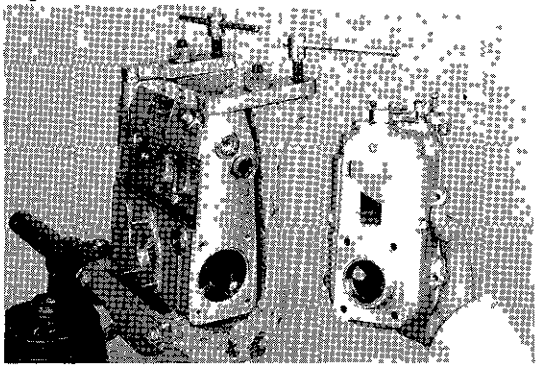
7 Install SST to the governor housing and drive out the outer race
SST [09286-76011]

Fig. 6-132



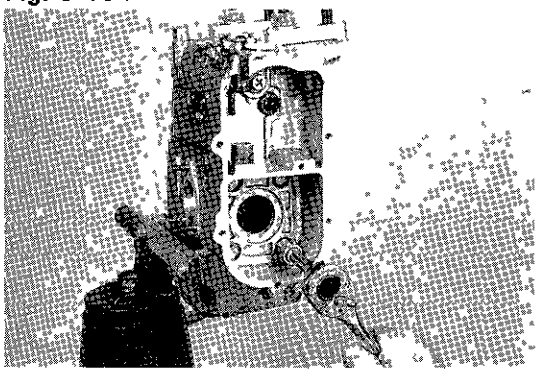
8 Drive a new bearing outer race into the governor housing with SST
SST [09608-12010]

Fig. 6-133



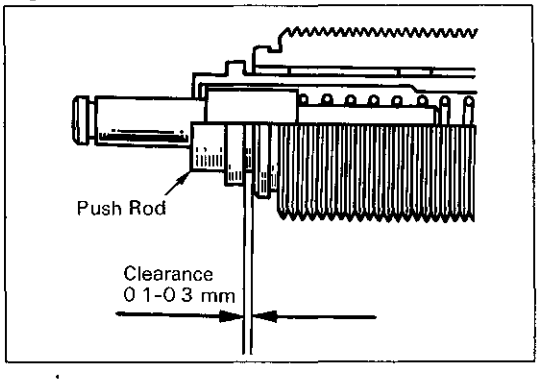
9 Clean the installing surfaces

Fig. 6-134



10 Install a new gasket and the governor housing

Fig. 6-135

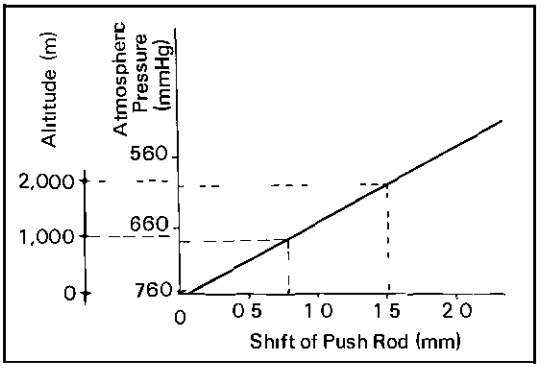


Diesel High Altitude Compensator (DHAC)

1 Check the DHAC for correct clearance between full stop capsule flange and DHAC body

Clearance at sea level:
0.1 – 0.3 mm
(0.004 – 0.012 in.)

Fig. 6-136

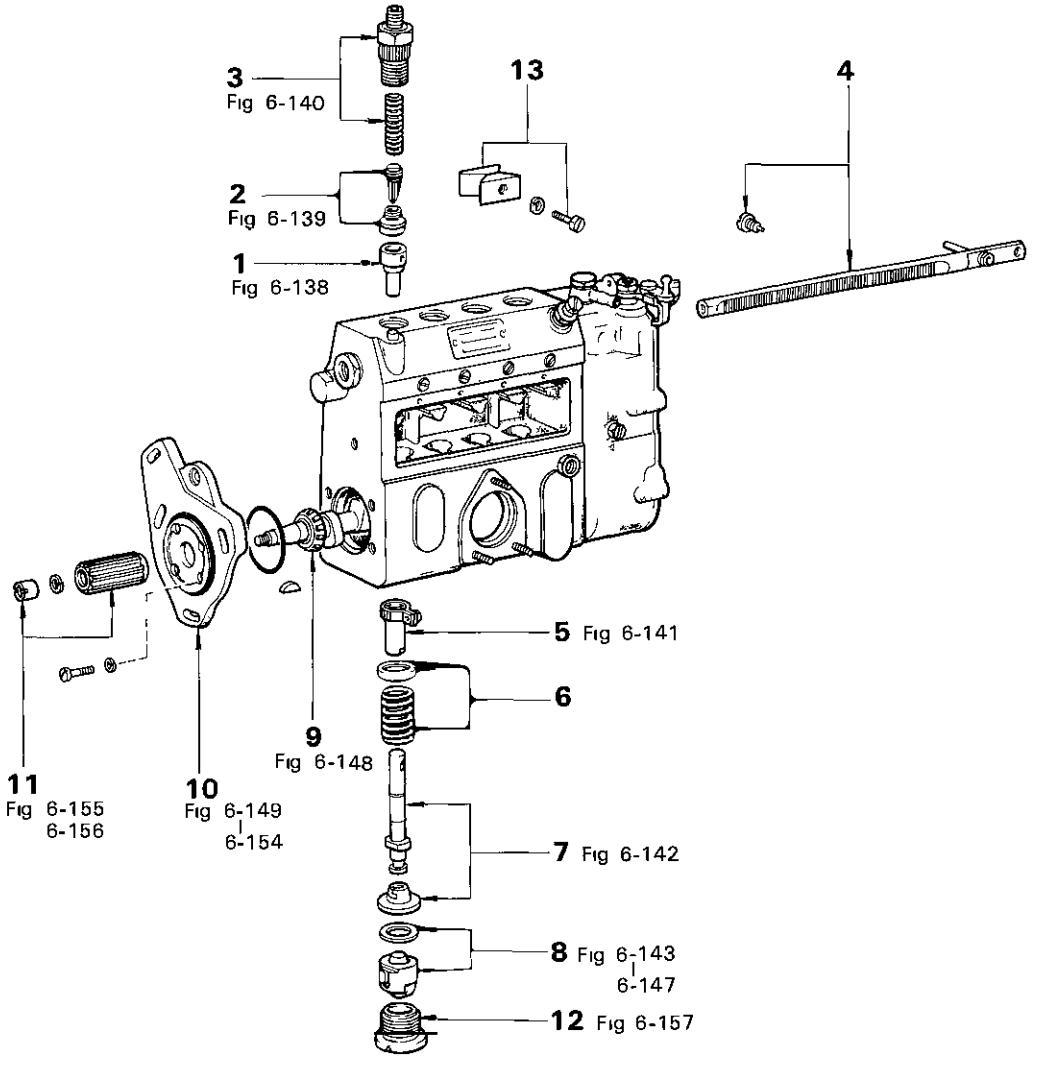


2 Since the position of the push rod depends on altitude the clearance mentioned above must be 0 1 – 0 3 mm (0 004 – 0 012 in) plus the amount of push rod shift as shown in the figure

ASSEMBLY (PUMP BODY)

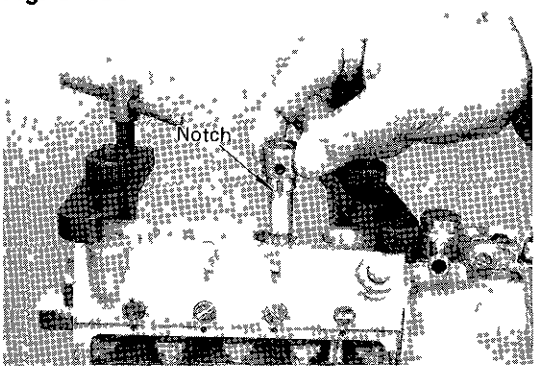
Assemble the parts in the numerical order shown in the figure

Fig. 6-137



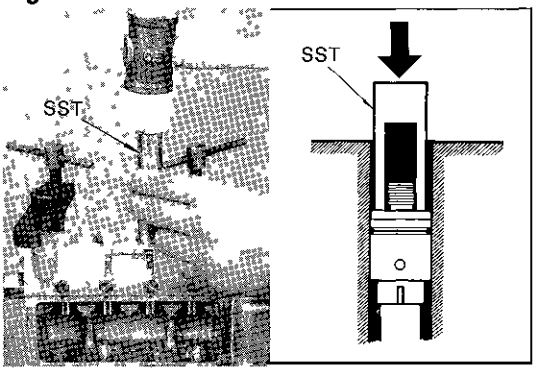
1	Cylinder	8	Tappet
2	Delivery Valve & Seat	9	Camshaft
3	Delivery Valve Holder & Spring	10	Injection Pump Flange
4	Control Rack	11	Spline Shaft
5	Control Pinion & Sleeve	12	Plug
6	Spring & Upper Seat	13	Lock Plate
7	Plunger & Lower Seat		

Fig. 6-138



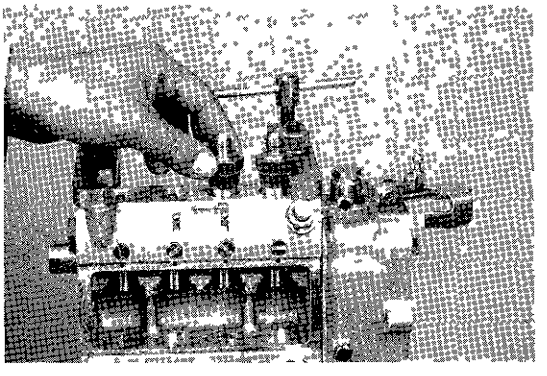
To assemble the cylinder match the pump cylinder notch with the pump housing knock pin

Fig. 6-139



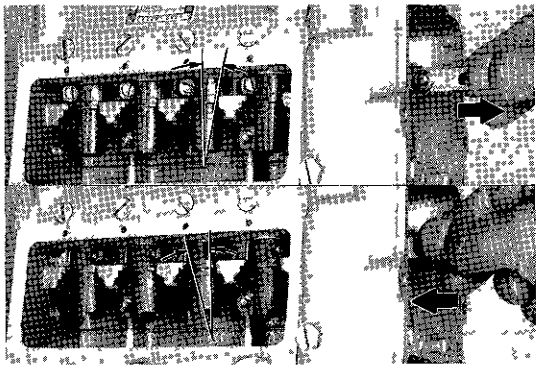
Drive in the pump cylinder lightly with SST SST (09262-76010) of set [09260-76016]

Fig. 6-140



Lightly tighten the delivery valve holder by hand

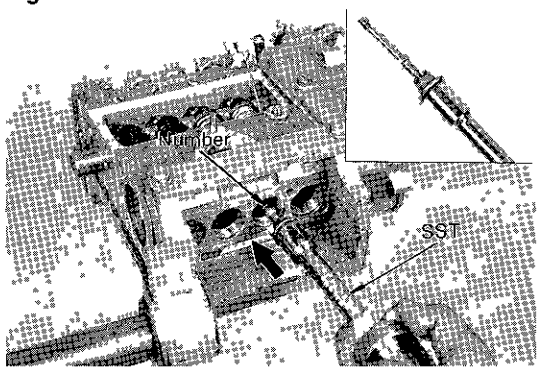
Fig. 6-141



Assemble so that the pinion swings evenly left and right when rack is moved to the right and left

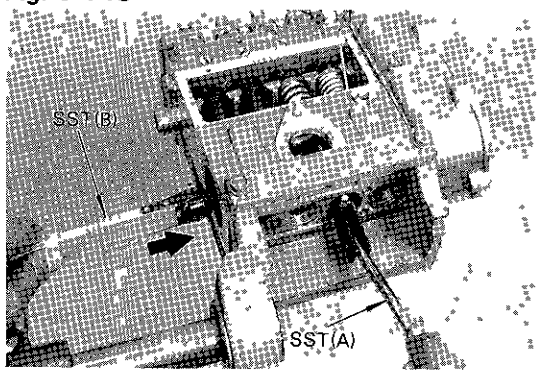
When assembling the sleeves inspect the fitting condition by moving the rack

Fig. 6-142



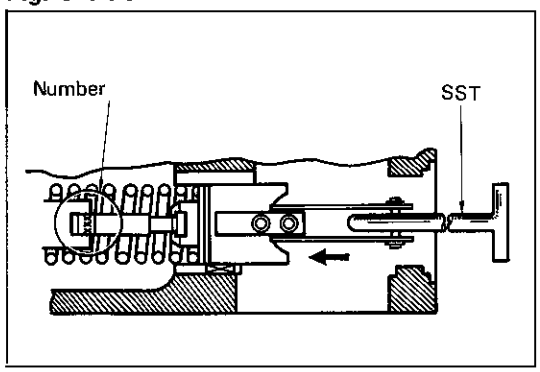
Using SST assemble the plunger and spring lower seat inserting the driving face marked with a number and lower seat notch part upward (cover plate side)
SST (09275-46010) of set [09260-46011]

Fig. 6-143



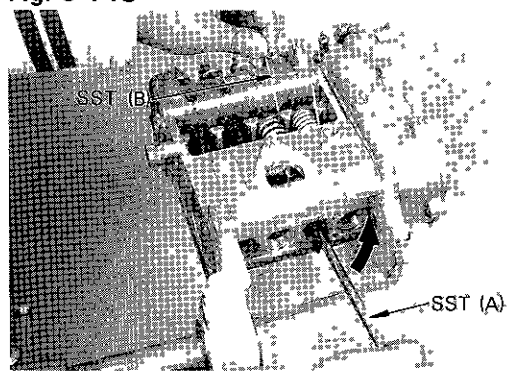
Insert the tappet into housing with SST (A) and (B)
SST (A) (09272-76011) &
(B) (09273-76011) of set [09260-76016]

Fig. 6-144



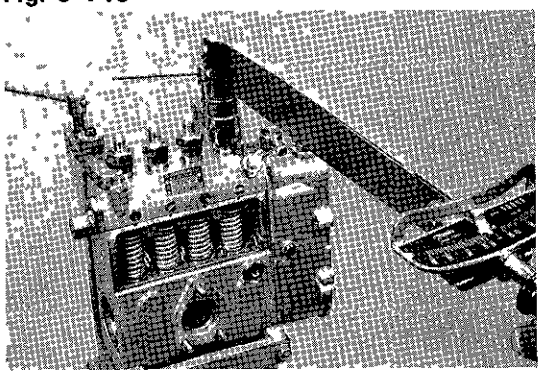
Fit the driving face into the cylinder groove facing its number toward pump cover side

Fig. 6-145



Press in the tappet with SST (A) and hold it with SST (B)
SST (A) (09272-76011) of set [09260-76016]
(B) (09274-46010) of set [09260-46011]

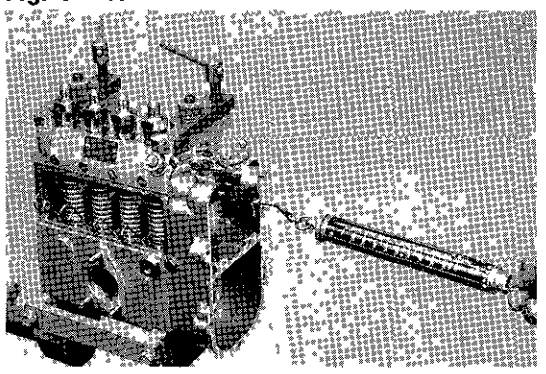
Fig. 6-146



When one delivery valve holder is tightened move the control rack to right and left and inspect the tightness of the rack

Tightening torque: 2.5 – 3.5 kg-m (19 – 25 ft-lb)

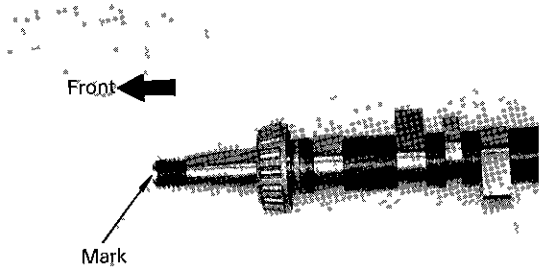
Fig. 6-147



Measure the control rack sliding resistance with a spring scale and confirm that the resistance is less than 120 g (4.2 oz) and the rack moves smoothly

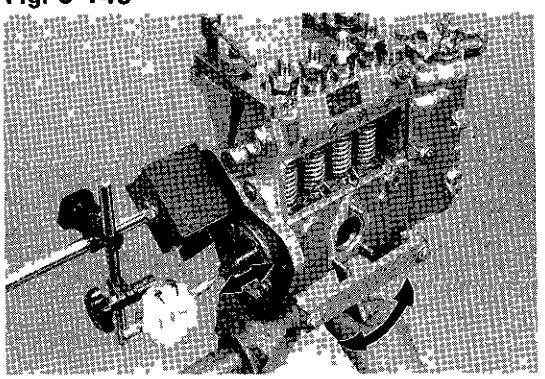
Sliding resistance:
Less than 120 g (4.2 oz)

Fig. 6-148



Assemble the camshaft facing the mark put on during removal toward front

Fig. 6-149

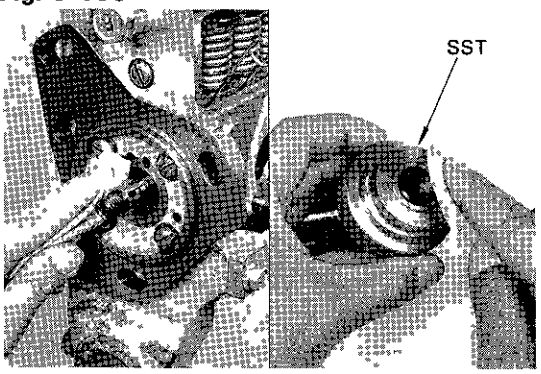


Measure Camshaft Thrust Clearance [When Dial Gauge is used]

1 Set the magnetic base on the injection pump flange and contact the dial gauge with the end of camshaft
2 Pry the camshaft with a wooden stick and check the thrust clearance

Thrust clearance:
STD 0.03 – 0.05 mm (0.0012 – 0.0020 in.)
Limit 0.1 mm (0.004 in.)

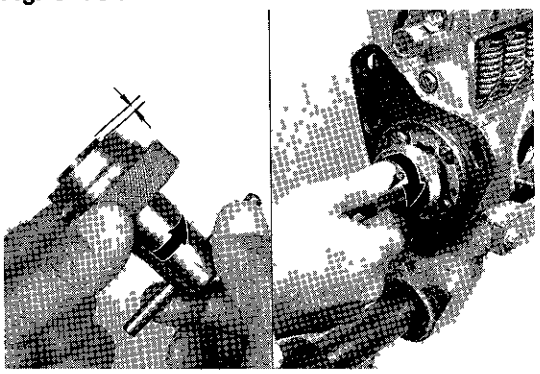
Fig. 6-150



Measure Camshaft Thrust Clearance [When SST [09287-76010] is used]

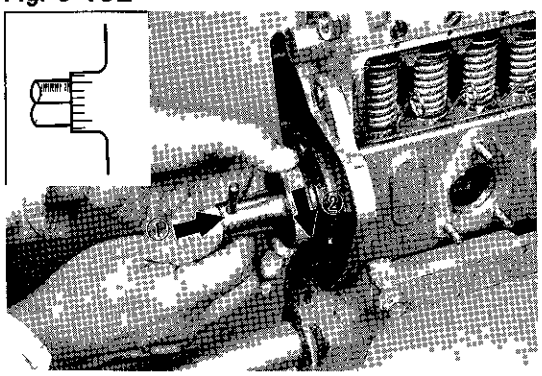
1 Clean the injection pump flange and SST

Fig. 6-151



2 Firmly install SST to the camshaft

Fig. 6-152

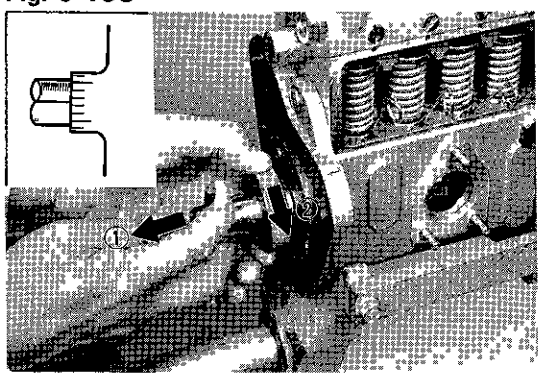


3 Push SST toward the pump side, and contact the outer dial with the pump flange by screwing in the outer dial

4 Read the scale on outer dial

—Note—
A unit on the outer dial scale is equivalent to 0.01 mm (0.0004 in.).

Fig. 6-153



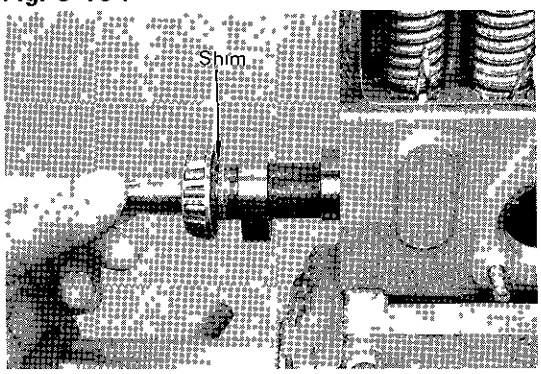
5 Pull SST toward the front side, and contact the outer dial with the pump flange by screwing in the outer dial

6 The screwing distance is the camshaft thrust clearance

Thrust clearance:

STD	**0.03 — 0.05 mm (0.0012 — 0.0020 in.)**
Limit	**0.1 mm (0.004 in.)**

Fig. 6-154



To adjust the thrust clearance, increase or decrease the number of camshaft adjusting shims

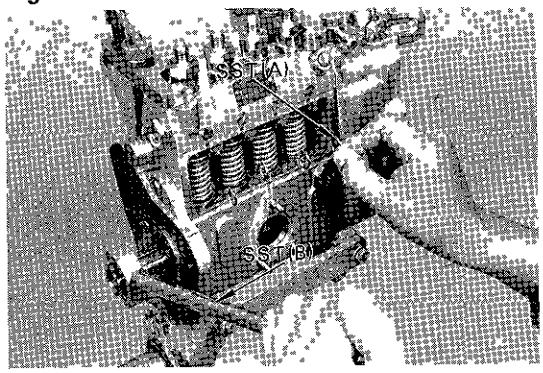
Shim thickness mm (in)	
0.10 (0.0039)	0.16 (0.0063)
0.12 (0.0047)	0.18 (0.0071)
0.14 (0.0055)	0.50 (0.0197)

—Note—
Refer to "Replace Camshaft Bearing" on Fig. 6-125 to 6-127 for replacement of adjusting shim.

Fig. 6-155

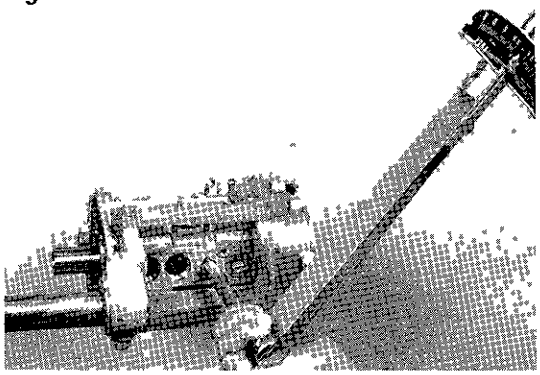
Hold the spline shaft with SST (B) and tighten the round nut with SST (A) and a torque wrench
SST (A) (09266 46011) &
(B) (09278 46010) of set [09260 46011]
Tightening torque: 6.0 — 7.0 kg-m (44 — 50 ft-lb)

Fig. 6-156



Using SST (B), rotate the camshaft and remove SST (A)
SST (A) (09274 46010) &
(B) (09278 46010) of set [09260 46011]

Fig. 6-157



Install the felt plate plugs
Tightening torque: 5.5 — 7.5 kg-m (40 — 54 ft-lb)

ADJUSTMENT (PUMP BODY)

Pump Body Adjustment Items

Preparations of Pump Tester

Nozzle type		ND-DN 4 SD 24A	
Nozzle	Opening pressure	115 — 125 kg/cm²	1 636 — 1 778 psi
Injection pipe	Outer diameter	6 0 mm	0 236 in
	Inner diameter	2 0 mm	0 079 in
	Length	600 mm	23 62 in
	Minimum bending radius	More than 25 mm	0 98 in
Fuel temperature		40 — 45°C	104 — 113°F
Fuel feeding pressure		0 5 kg/cm²	7 psi

Control Rack Sliding Resistance

Pump rpm	Sliding resistance
0	Less than 120 g (4 2 oz)
1 000	Less than 50 g (1 8 oz)

Injection Timing

Pre-stroke	1 9 — 2 0 mm 0 075 — 0 079 in [Control rack position at 8 0 mm (0 315 in)]
Injection interval	90° ± 30
Tappet clearance	More than 0 2 mm (0 008 in)

Injection Volume Adjustment

[For B Engine]

Rack position mm (in)	Pump revolution (rpm)	Measuring strokes	Injection volume cc (cu in)	Variation limit cc (cu in)
16 0 (0 630)	100	200	14 0 — 16 0 (0 85 — 0 98)	1 2 (0 07)
11 7 (0 461)	1 100	200	10 0 — 10 6 (0 61 — 0 65)	0 4 (0 02)
8 6 (0 339)	1 000	200	4 6 — 5 6 (0 28 — 0 34)	0 4 (0 02)
6 5 (0 256)	325	500	2 5 — 4 5 (0 15 — 0 27)	1 0 (0 06)

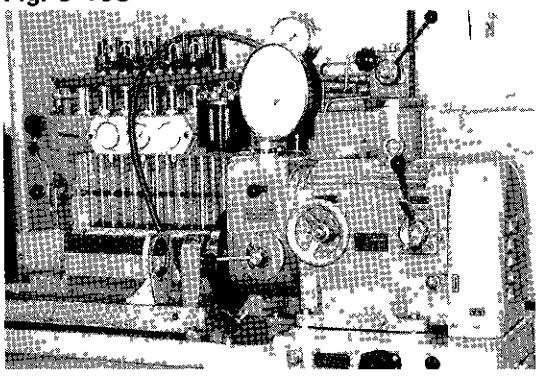
[For 2B Engine]

Rack position mm (in)	Pump revolution (rpm)	Measuring strokes	Injection volume cc (cu in)	Variation limit cc (cu in)
16.0 (0.630)	100	200	14.0 – 16.0 (0.85 – 0.98)	1.2 (0.07)
11.9 (0.469)	1 100	200	11.0 – 11.6 (0.67 – 0.71)	0.4 (0.02)
8.0 (0.315)	1 000	200	4.3 – 5.1 (0.26 – 0.31)	0.4 (0.02)
6.5 (0.256)	325	500	2.5 – 4.5 (0.15 – 0.27)	1.0 (0.06)

[For 3B Engine]

Rack position mm (in)	Pump revolution (rpm)	Measuring strokes	Injection volume cc (cu in)	Variation limit cc (cu in)
17.5 (0.689)	100	200	14.0 – 16.0 (0.85 – 0.98)	1.2 (0.07)
13.0 (0.512)	1 100	200	11.3 – 11.9 (0.69 – 0.73)	0.4 (0.02)
13.0 (0.512)	1 700	200	11.5 – 12.5 (0.70 – 0.76)	0.6 (0.04)
8.0 (0.315)	1 000	200	4.3 – 5.1 (0.26 – 0.31)	0.4 (0.02)
6.5 (0.256)	325	500	2.5 – 4.5 (0.15 – 0.27)	1.0 (0.06)

Fig. 6-158

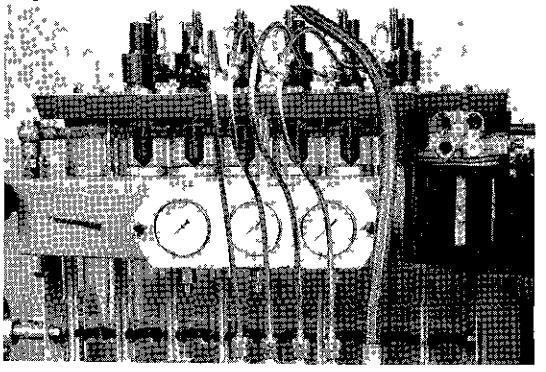


Pre-test Check & Preparations

1 Specifications for test nozzle and nozzle holder are as follows

Nozzle **ND-DN4 SD-24A**
Nozzle holder valve opening pressure:
115 – 125 kg/cm² (1,636 – 1,778 psi)

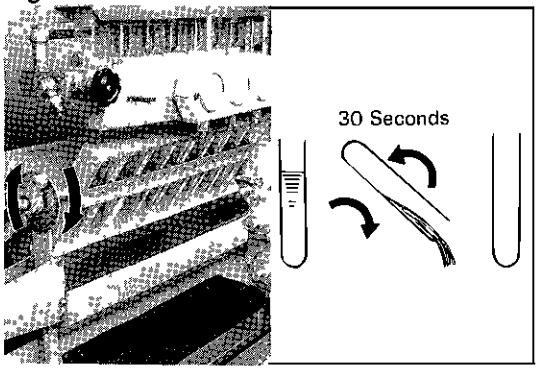
Fig. 6-159



2 Use injection pipes with the following specifications

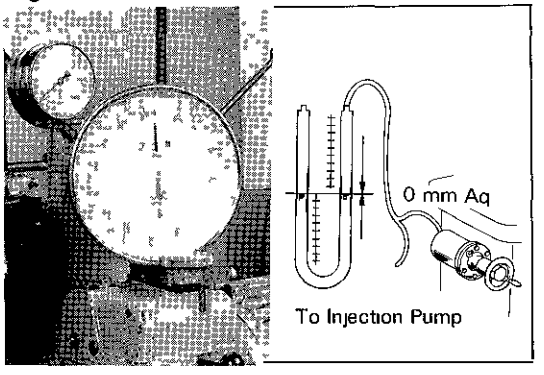
Outer diameter: **6.0 mm (0.236 in.)**
Inner diameter: **2.0 mm (0.079 in.)**
Length: **600 mm (23.62 in.)**
Minimum bending radius:
More than 25 mm (0.98 in.)

Fig. 6-160



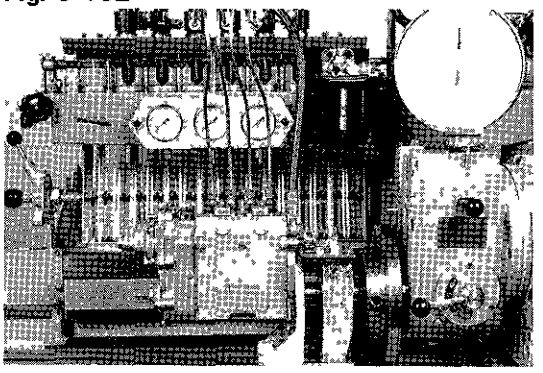
3 Measure injection of each cylinder with specified measuring cylinder
4 Tilt the measuring cylinders for 30 seconds to remove the diesel fuel and then raise the cylinders upright and measure

Fig. 6-161



5 Check tachometer accuracy
Allowable error: ±40 rpm
6 Confirm that both water columns of U tube are of the same height and align the zero point on the scale at that height

Fig. 6-162

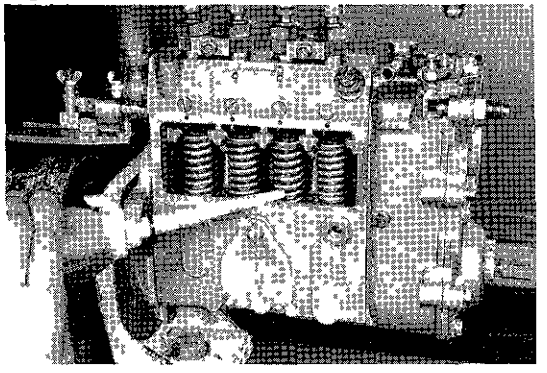


7 Mount the injection pump body on the pump tester

Fig. 6-163

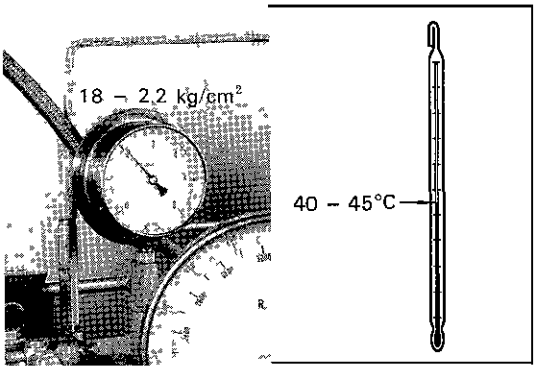
⚠ 8 Install the rack scale so that its zero point will be at the position where the control rack is pushed fully toward the governor side and set to allow easy reading of scale graduations

Fig. 6-164



⚠ 9 Install cover to the feed pump mounting surface and fill the pump camshaft chamber with engine oil

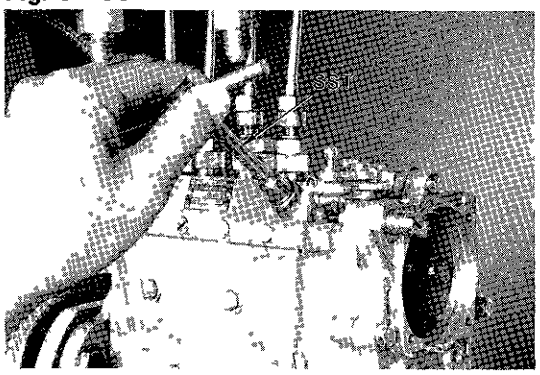
Fig. 6-165



10 Fuel feeding pressure to injection pump should be 1.8 – 2.2 kg/cm² (26 – 31 psi)

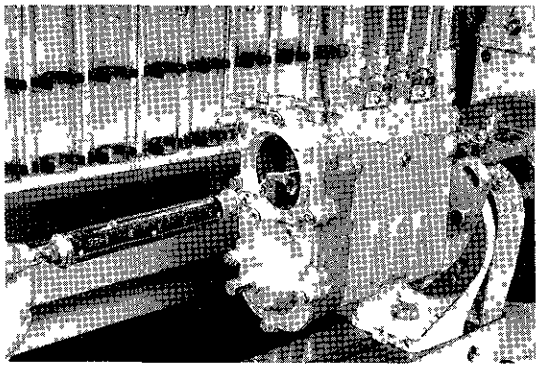
11 Fuel temperature for pump testing should be 40 – 45°C (104 – 113°F)

Fig. 6-166



12 Bleed air from pump housing

Fig. 6-167

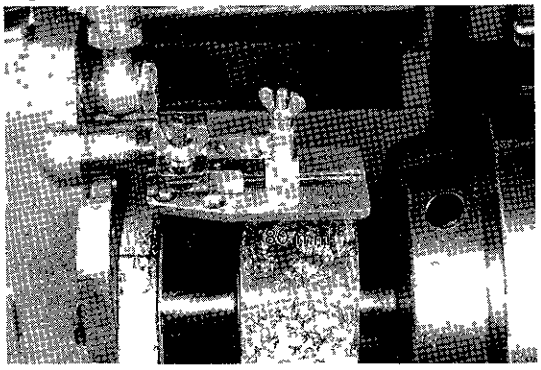


Control Rack Sliding Resistance

Measure the control rack sliding resistance with a spring scale (spring balancer)

Pump revolution	Sliding resistance
0 rpm	Less than 120 g (4 2 oz)
1 000 rpm	Less than 50 g (1 8 oz)

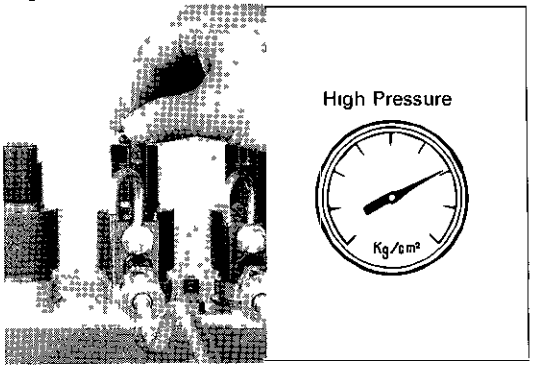
Fig. 6-168



Adjust Injection Timing

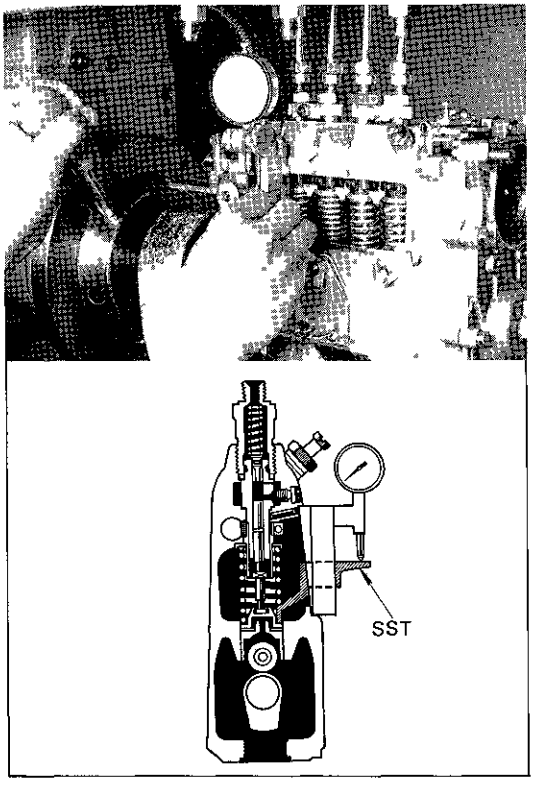
1 Pre-stroke (for No 1 plunger)
   (1) Set the control rack position at 8 0 mm (0 315 in)

Fig. 6-169



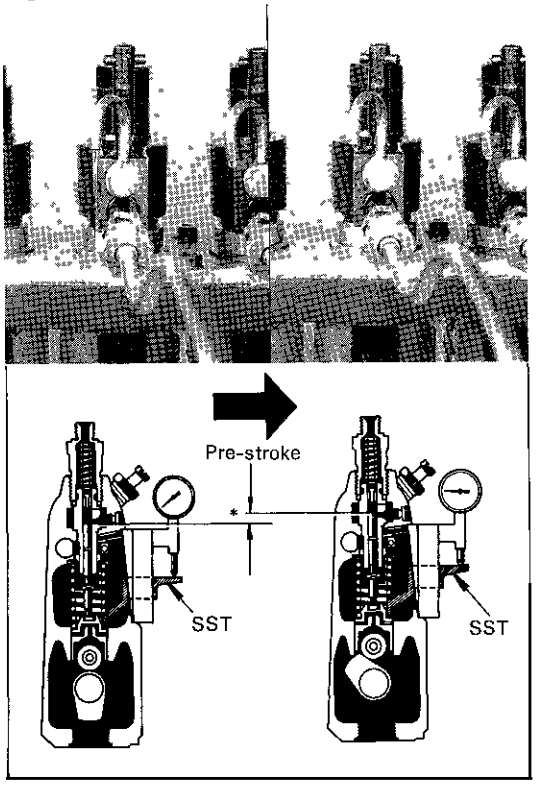
   (2) Loosen the overflow cock of the pump tester bench nozzle holder
   (3) Fuel feeding pressure to injection pump should be on the high side

Fig. 6-170



(4) Using SST set the No 1 tappet to BDC position and set the dial gauge on No 1 tappet
SST (09283 46010) of set
[09260-46011]

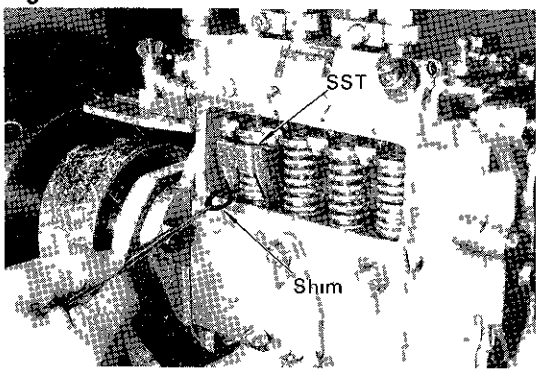
Fig. 6-171



(5) Rotate the camshaft clockwise and measure the lift of No 1 plunger when the plunger moves from BDC to injection starting position (To the point where fuel flowing from the overflow pipe stops)

Pre-stroke:
1.9 – 2.0 mm
(0.075 – 0.079 in.)

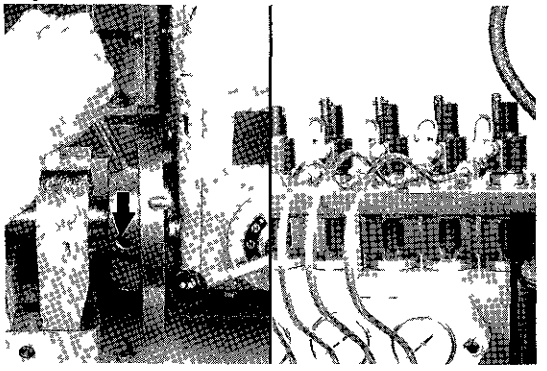
Fig. 6-172



(6) If the pre stroke is not within specification, use SST and adjust by changing the tappet adjusting shim
SST (09280-46010) of set
[09260 46011]

—Note—
15 shims are available, each varying in thickness by 0.1 mm (0.004 in.) from 0.1 — 1.4 mm (0.004 — 0.055 in.) and 0.15 mm (0.006 in.).

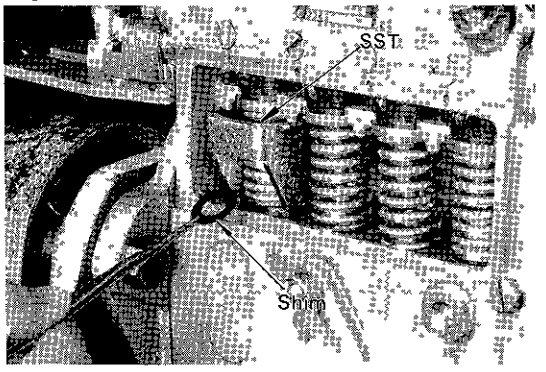
Fig. 6-173



2 Injection Interval
(1) Using No 1 cylinder injection starting time position as a base, inspect and adjust the injection starting angles in the order of injection
(2) Injection starting angle

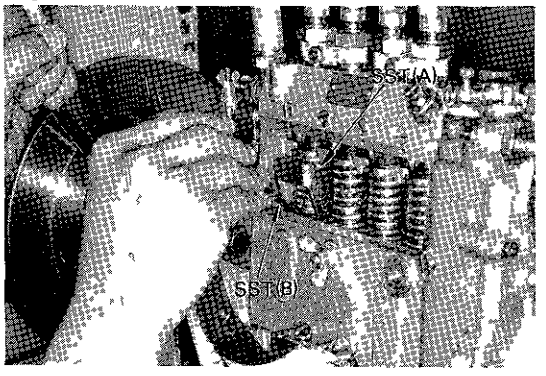
Cylinder No	Injection starting angle
1	0
3	89° 30 — 90° 30
4	179° 30 — 180° 30
2	269° 30 — 270° 30

Fig. 6-174



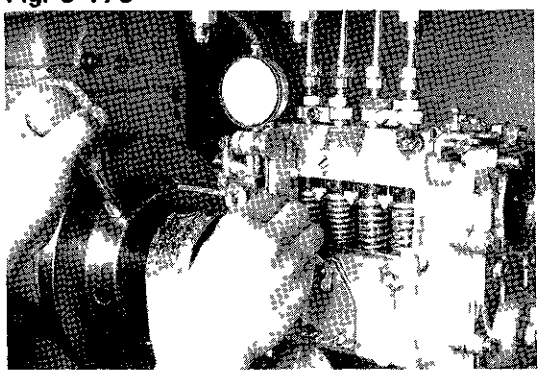
(3) If the injection starting angles are not within specification, adjust by using the same procedure as for pre-stroke adjustment

Fig. 6-175



3 Tappet Clearance
(1) Using SST (A) insert the 0.2 mm (0.008 in.) gauge of SST (B) between the spring lower seat and adjusting shim and rotate the camshaft slowly
SST (A) (09280-46011) of set
[09260-46011]
(B) [09288-46011]
(2) The camshaft should turn easily
Tappet clearance:
More than 0.2 mm (0.008 in.)

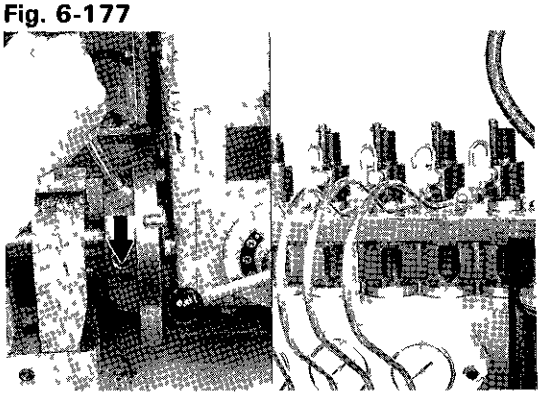
Fig. 6-176



(3) If the tappet clearance is less than 0.2 mm (0.008 in.), recheck and adjust the pre-stroke

Pre-stroke:
1.9 – 2.0 mm
(0.075 – 0.079 in.)

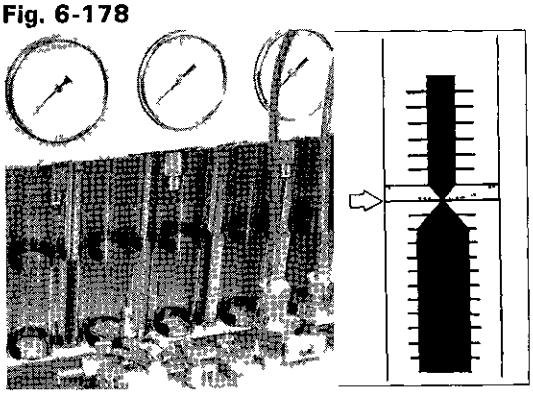
Fig. 6-177



(4) Recheck and adjust the injection starting angle

Cylinder No	Injection starting angle
1	0
3	89° 30 – 90° 30
4	179° 30 – 180° 30
2	269° 30 – 270° 30

Fig. 6-178



Adjust Injection Volume

1 Before measuring the injection volume operate the injection pump lever two or three times in order to stabilize the injection volume

2 Measure the injection volume for each control rack position and pump revolution

For B Engine

Rack Position mm (in.)	Pump rpm	Measuring Strokes	Injection Volume cc (cu in.)	Variation Limit cc (cu in.)
16.0 (0.630)	100	200	14.0 – 16.0 (0.85 – 0.98)	1.2 (0.07)
11.7 (0.461)	1 100	200	10.0 – 10.6 (0.61 – 0.65)	0.4 (0.02)
8.6 (0.339)	1 000	200	4.6 – 5.6 (0.28 – 0.34)	0.4 (0.02)
6.5 (0.256)	325	500	2.5 – 4.5 (0.15 – 0.27)	1.0 (0.06)

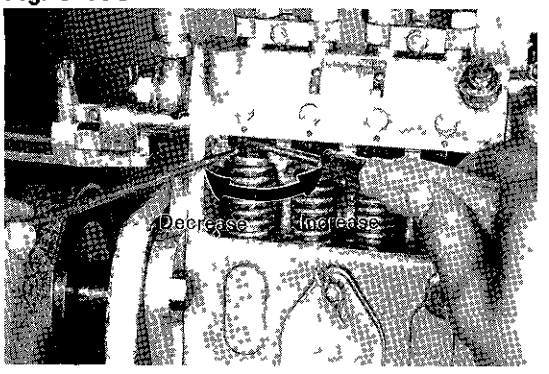
For 2B Engine

Rack Position mm (in.)	Pump rpm	Measuring Strokes	Injection Volume cc (cu in.)	Variation Limit cc (cu in.)
16.0 (0.630)	100	200	14.0 – 16.0 (0.85 – 0.98)	1.2 (0.07)
11.9 (0.469)	1 100	200	11.0 – 11.6 (0.67 – 0.71)	0.4 (0.02)
8.0 (0.315)	1 000	200	4.3 – 5.1 (0.26 – 0.31)	0.4 (0.02)
6.5 (0.256)	325	500	2.5 – 4.5 (0.15 – 0.27)	1.0 (0.06)

For 3B Engine

Rack Position mm (in.)	Pump rpm	Measuring Strokes	Injection Volume cc (cu in.)	Variation Limit cc (cu in.)
17.5 (0.689)	100	200	14.0 – 16.0 (0.85 – 0.98)	1.2 (0.07)
13.0 (0.512)	1 100	200	11.3 – 11.9 (0.69 – 0.73)	0.4 (0.02)
13.0 (0.512)	1 700	200	11.5 – 12.5 (0.70 – 0.76)	0.6 (0.04)
8.0 (0.315)	1 000	200	4.3 – 5.1 (0.26 – 0.31)	0.4 (0.02)
6.5 (0.256)	325	500	2.5 – 4.5 (0.15 – 0.27)	1.0 (0.06)

Fig. 6-179

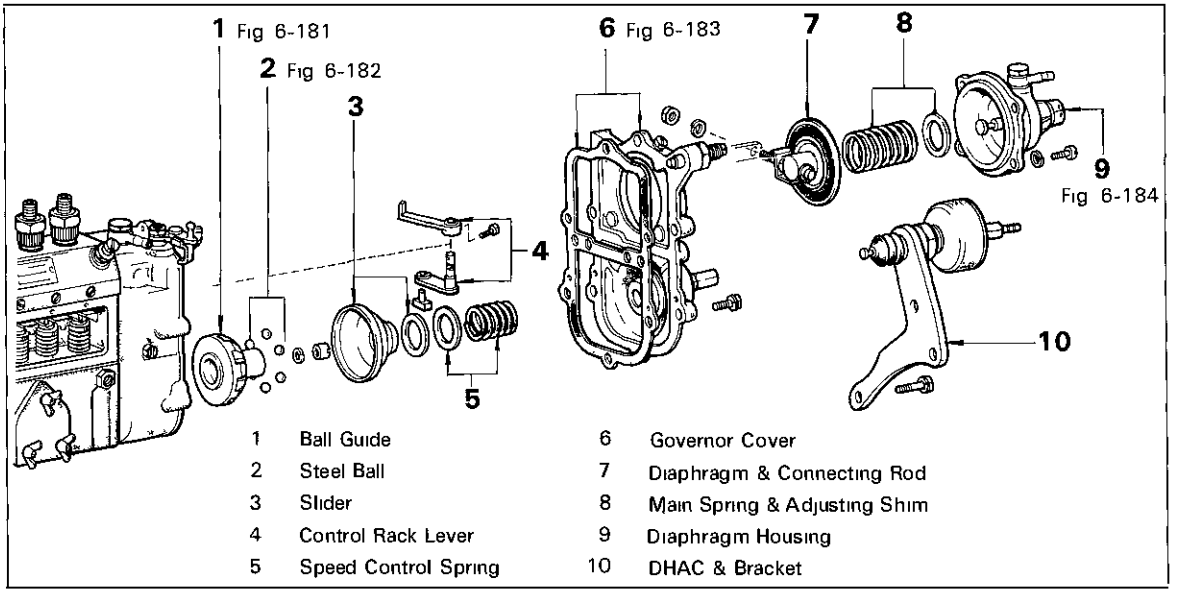


2 To adjust the injection volume, loosen the pinion clamp screw and rotate the control sleeve

ASSEMBLY (COMBINED GOVERNOR)

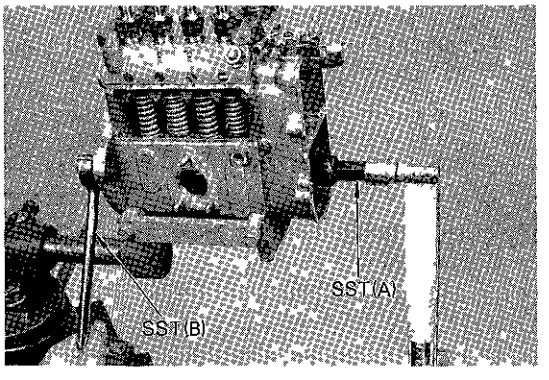
Assemble the parts in the numerical order shown in the figure

Fig. 6-180



1	Ball Guide	6	Governor Cover
2	Steel Ball	7	Diaphragm & Connecting Rod
3	Slider	8	Main Spring & Adjusting Shim
4	Control Rack Lever	9	Diaphragm Housing
5	Speed Control Spring	10	DHAC & Bracket

Fig. 6-181

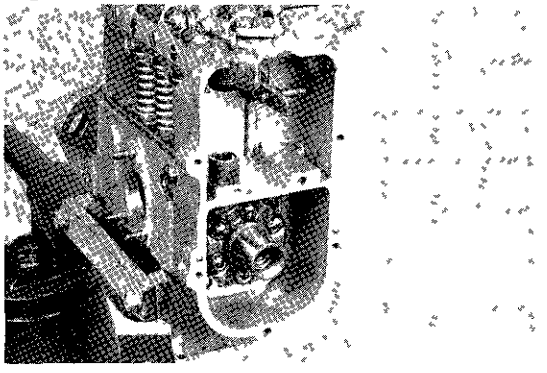


Hold the spline shaft with SST (B) and tighten the round nut with SST (A)

SST (A) (09266-67011) of set [09260-76016]
(B) (09278-46010) of set [09260 46011]

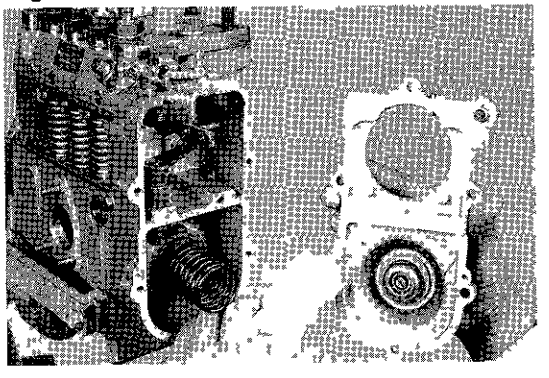
Tightening torque: 5.0 – 6.0 kg-m (37 – 43 ft-lb)

Fig. 6-182



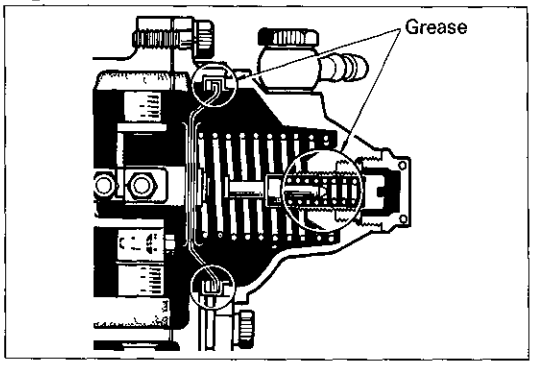
Apply grease to the ball guide groove and put six steel balls in the groove
Place slider onto the ball guide

Fig. 6-183



Lightly coat liquid sealer on the new governor cover gasket before installing

Fig. 6-184



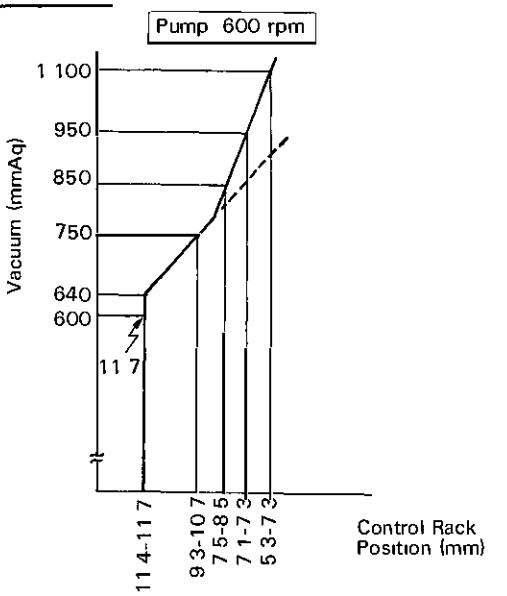
Coat the diaphragm housing and idling capsule with grease to keep the vacuum chamber airtight

ADJUSTMENT (COMBINED GOVERNOR)

Combined Governor Characteristic Diagram (For B Engine)

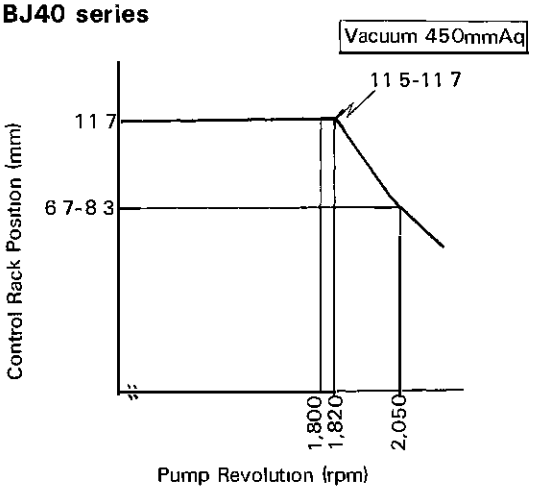
Fig. 6-185

PNEUMATIC GOVERNOR SECTION

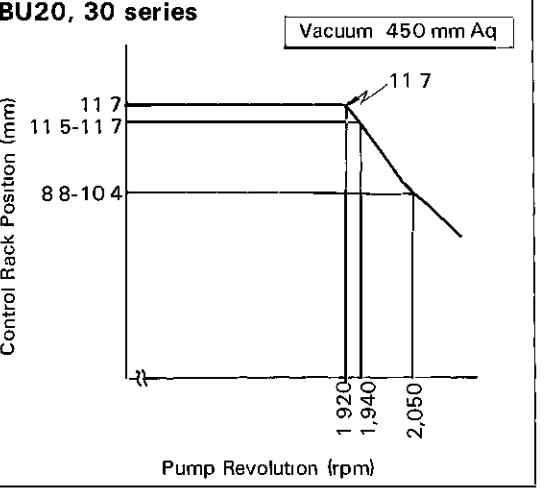


MECHANICAL GOVERNOR SECTION

BJ40 series



BU20, 30 series



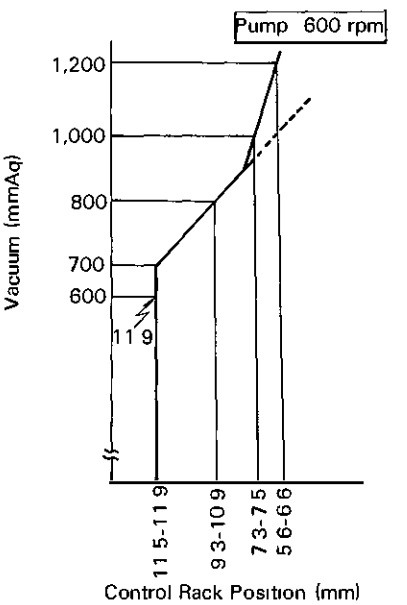
Total Injection Volume (For B Engine)

Model	Measuring strokes	Pump revolution	Vacuum	Total injection volume
BJ40	500	1 100 rpm	150 mm Aq (5 91 in Aq)	101 0 — 105 0 cc (6 16 — 6 41 cu in)
BU20 30	500	1 100 rpm	120 mm Aq (4 72 in Aq)	101 0 — 105 0 cc (6 16 — 6 41 cu in)

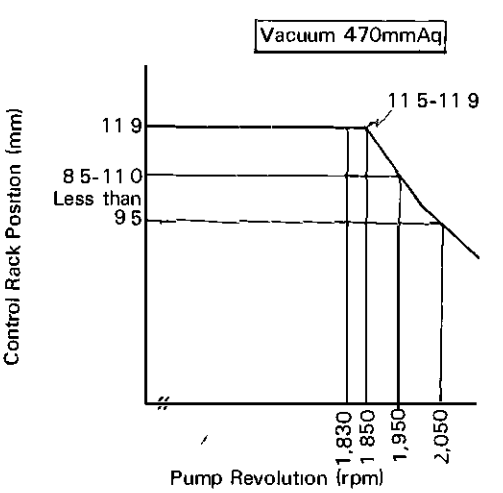
Combined Governor Characteristic Diagram (For 2B Engine)

Fig. 6-186

PNEUMATIC GOVERNOR SECTION



MECHANICAL GOVERNOR SECTION



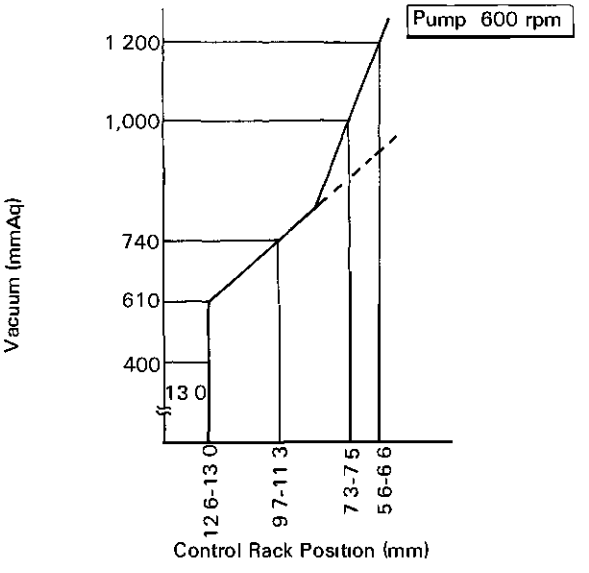
Total Injection Volume (For 2B Engine)

Measuring strokes	Pump revolution	Vacuum	Total injection volume
500	1 100 rpm	200 mm Aq (7 87 in Aq)	106 0 – 110 0 cc (6 47 – 6 71 cu in)

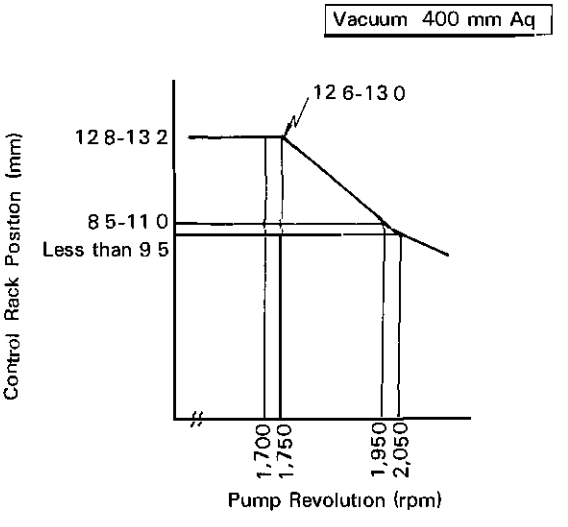
Combined Governor Characteristic Diagram (For 3B Engine)

Fig. 6-187

PNEUMATIC GOVERNOR SECTION



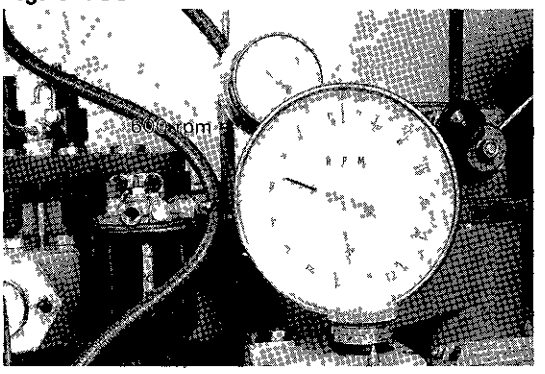
MECHANICAL GOVERNOR SECTION



Total Injection Volume (For 3B Engine)

Measuring strokes	Pump revolution	Vacuum	Total injection volume
500	1 100 rpm	260 mm Aq (10 24 in Aq)	114 0 – 118 0 cc (6 96 – 7 20 cu in)

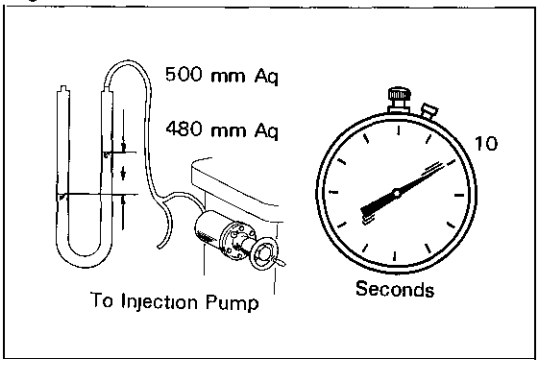
Fig. 6-188



Test Airtightness

1 Set the injection pump revolution at 600 rpm

Fig. 6-189

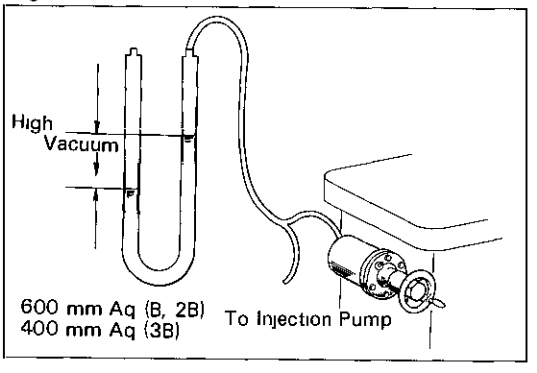


2 Measure the time it takes the vacuum chamber to reduce its vacuum to 480 mmAq (18 90 in Aq)

Vacuum loss	Time
From 500 mm Aq to 480 mmAq (19 69 in Aq) (18 90 in Aq)	More than 10 seconds

3 Retighten the diaphragm housing and inspect the diaphragm if airtightness is unsatisfactory

Fig. 6-190



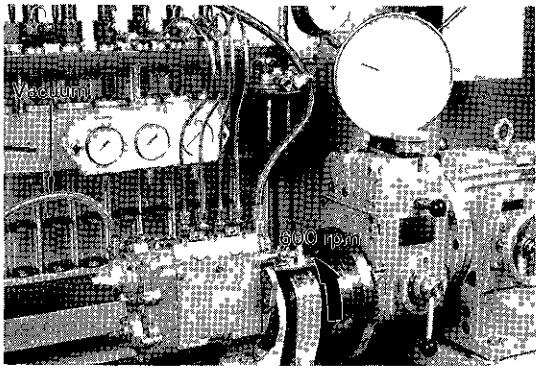
Adjust Initial Set of Control Rack

1 Set the vacuum to specified value

—Note—

When altering the vacuum, set to the specified value after altering largely, and read graduation when it becomes steady.

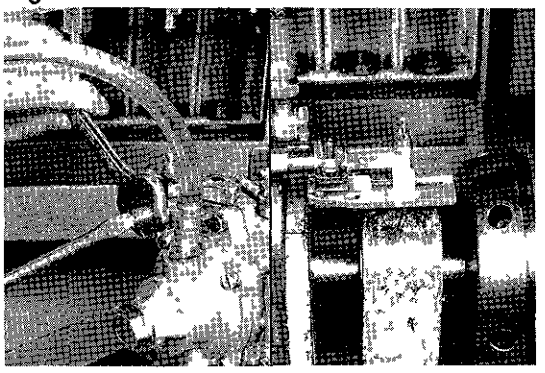
Fig. 6-191



2 Check the initial set point of the control rack

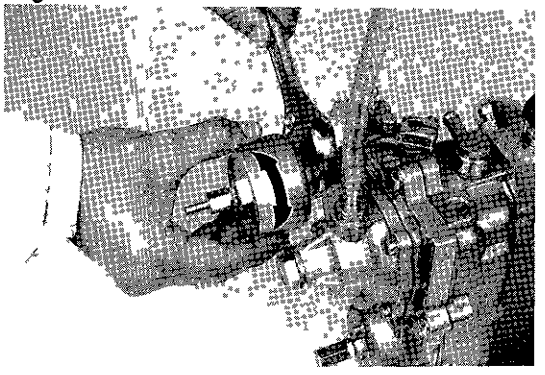
Model	Pump revolution (rpm)	Vacuum mm Aq (in Aq)	Control rack position mm (in)
B	600	600 (23 62)	11 7 (0 461)
2B	600	600 (23 62)	11 9 (0 469)
3B	600	400 (15 75)	13 0 (0 512)

Fig. 6-192



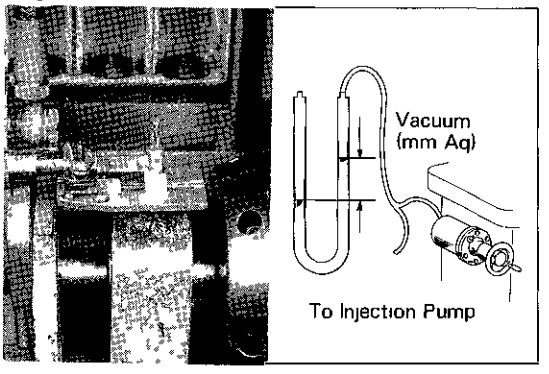
3 Adjust the initial set of the control rack by turning the full stop capsule

Fig. 6-193



4 If the governor is equipped with a Diesel High Altitude Compensator (DHAC) instead of full stop capsule adjust it

Fig. 6-194



Adjust Main Spring

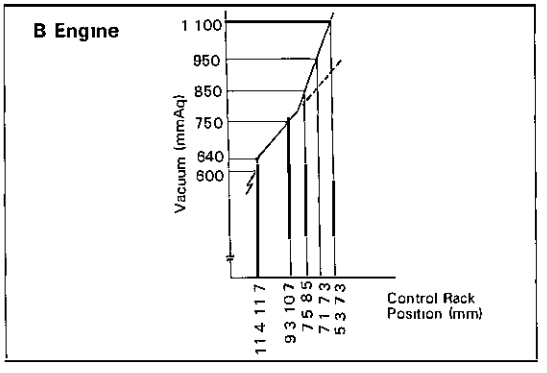
1 Check the control rack position

2 Adjust the control rack position by increasing the number of main spring shims

Shim thickness:
0.5, 1.0, 2.0, 3.0 mm
(0.020, 0.039, 0.079, 0.118 in.)

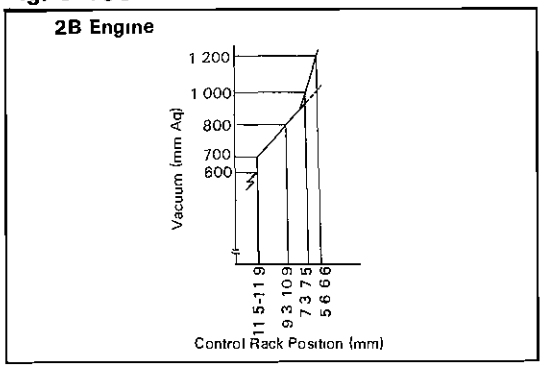
—Note—
To increase rack position.
Increase shim thickness.
To decrease rack position.
Decrease shim thickness.

Fig. 6-195



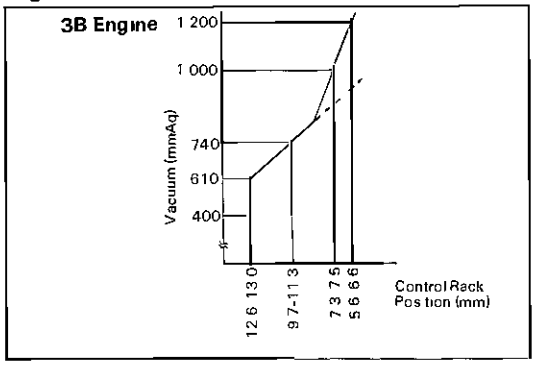
Engine model	Pump revolution (rpm)	Vacuum mmAq (in Aq)	Rack position mm (in)
B	600	640 (25 20)	114 – 117 (0 449 – 0 461)
		750 (29 53)	93 – 107 (0 366 – 0 421)

Fig. 6-196



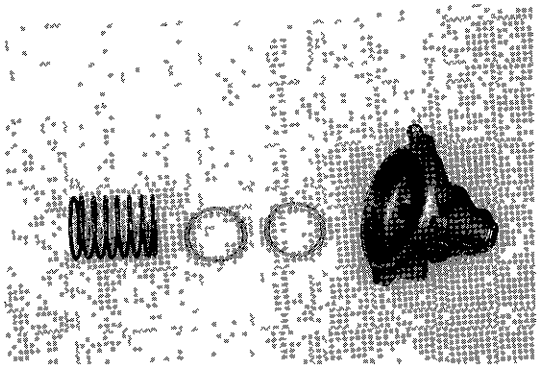
Engine model	Pump revolution (rpm)	Vacuum mmAq (in Aq)	Rack position mm (in)
2B	600	700 (27 56)	11 5 – 11 9 (0 453 – 0 469)
		800 (31 50)	9 3 – 10 9 (0 336 – 0 409)

Fig. 6-197



Engine model	Pump revolution (rpm)	Vacuum mmAq (in Aq)	Rack position mm (in)
3B	600	610 (24 02)	12 6 – 130 (0 496 – 0 512)
		740 (29 13)	9 7 – 11 3 (0382 – 0 445)

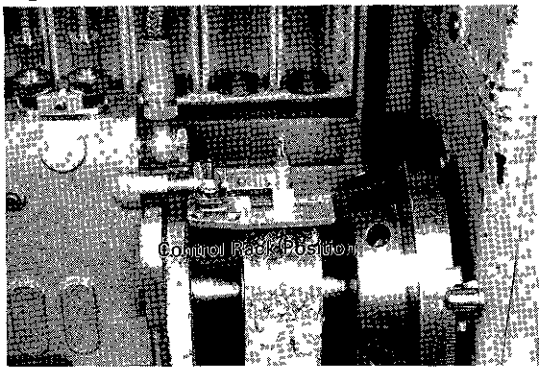
Fig. 6-198



3 If the control rack position is not within specification, check the main spring

Free length: B & 2B 45.6 mm (1.795 in.)
3B 51.6 mm (2.031 in.)

Fig. 6-199



4 When adjustment is completed reconfirm the initial setting

Initial set of control rack

Engine model	Pump revolution (rpm)	Vacuum mmAq (in Aq)	Control rack position mm (in)
B	600	600 (23 62)	11 7 (0 461)
2B	600	600 (23 62)	11 9 (0 469)
3B	600	400 (15 75)	13 0 (0 512)

Fig. 6-200

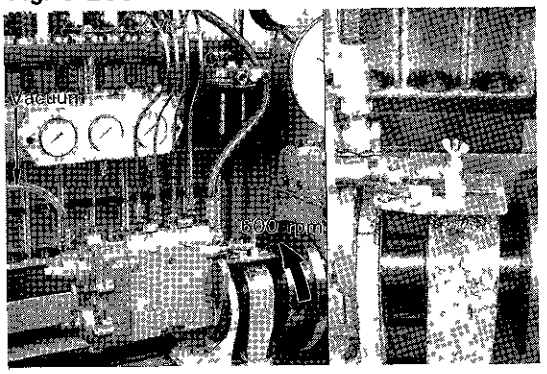
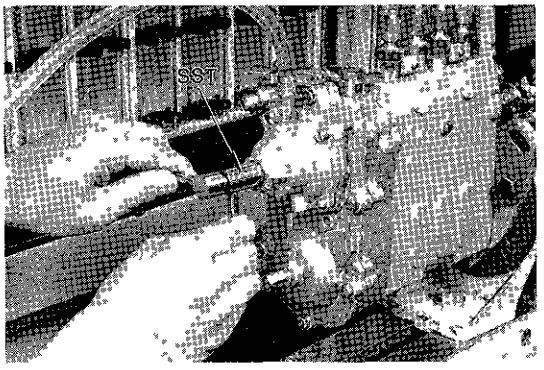


Fig. 6-201



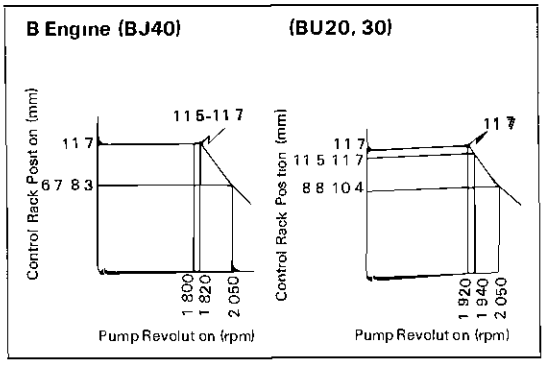
Adjust Idling Spring Capsule

1 Check the control rack position

Engine model	Pump revolution (rpm)	Vacuum mm Aq (in Aq)	Control rack position mm (in)
B	600	850 (33 46)	7 5 – 8 5 (0 295 –0 335)
		950 (37 40)	7 1 – 7 3 (0 280 – 0 287)
		1 100 (43 31)	5 3 – 7 3 (0 209 – 0 287)
2B	600	1 200 (47 24)	5 6 – 6 6 (0 220 – 0 260)
		1 000 (39 37)	7 3 – 7 5 (0 287 – 0 295)
3B	600	1 000 (39 37)	7 3 – 7 5 (0 287 – 0 295)
		1 200 (47 24)	5 6 – 6 6 (0 220 – 0 260)

2 Using SST adjust the control rack position by turning the idling capsule
SST (09282 76010) of set [09260 76016]

Fig. 6-202



Adjust Mechanical Governor Section

1 Set the vacuum to specified value
2 Check the control rack position

Engine model	Vacuum mm Aq (in Aq)	Pump revolution (rpm)	Control rack position mm (in)
B (BJ40)	450 (17 72)	1 800	11 7 (0 461)
		1 820	11 5 – 11 7 (0 453 – 0 461)
		2 050	6 7 – 8 3 (0 264 – 0 327)
B (BU20 30)	450 (17 72)	1 920	11 7 (0 461)
		1 940	11 5 – 11 7 (0 453 – 0 461)
		2 050	8 8 – 10 4 (0 346 – 0 409)
2B	470 (18 50)	1 830	11 9 (0 469)
		1 850	11 5 – 11 9 (0 453 – 0 469)
		1 950	8 5 – 11 0 (0 335 – 0 433)
		2 050	Less than 9 5 (0 374)

Fig. 6-203

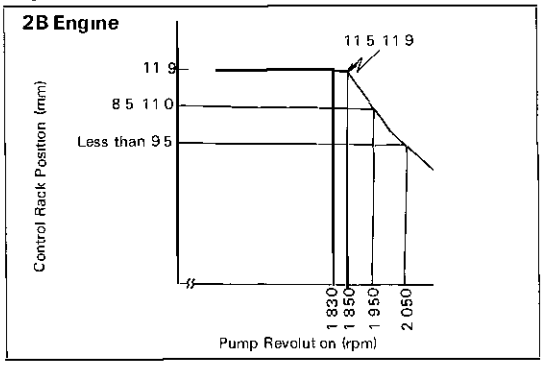
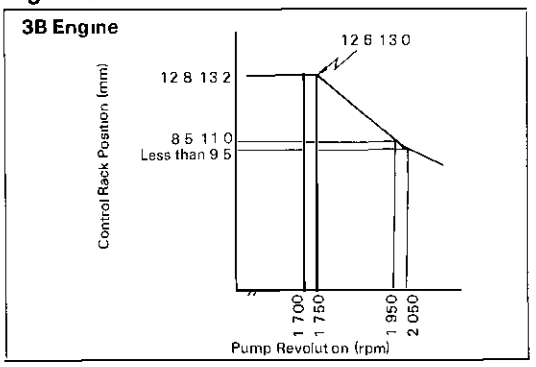
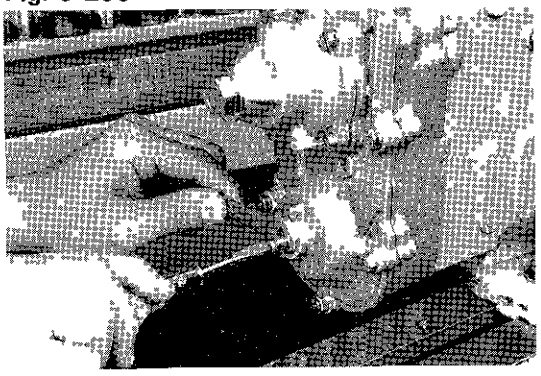


Fig. 6-204



Engine model	Vacuum mm Aq (in Aq)	Pump revolution (rpm)	Control rack position mm (in)
3B	400 (15 75)	1 700	128 – 132 (0 504 – 0520)
		1 750	126 – 130 (0 496 – 0512)
		1 950	85 – 110 (0 335 – 0433)
		2 050	Less than95 (0 374)

Fig. 6-205



3 Adjust the control rack position by turning the speed control screw

Fig. 6-206

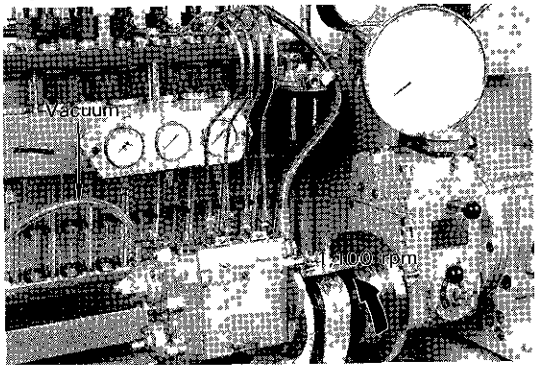
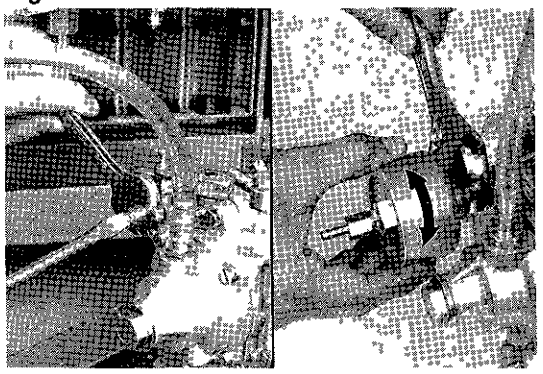


Fig. 6-207



Total Injection Volume

1 Before measuring the injection volume operate the injection pump lever two or three times in order to stabilize the injec tion volume

2 Measure the total injection volume at 500 strokes

Engine model	Pump revolution (rpm)	Vacuum mm Aq (in Aq)	Total injection volume cc (cu in)
B (BJ40)	1 100	150 (5 91)	101 0 – 105 0 (6 16 – 6 41)
B (BU20 30)	1 100	120 (4 72)	101 0 – 105 0 (6 16 – 6 41)
2B	1 100	200 (7 87)	106 0 – 110 0 (6 47 – 6 71)
3B	1 100	260 (10 24)	114 0 – 118 0 (6 96 – 7 20)

3 If the total injection volume is not within specification adjust it by turning full stop capsule or Diesel High Altitude Compen sator (DHAC)

INSTALLATION

Install the parts in the numerical order shown in the figure

Fig. 6-208

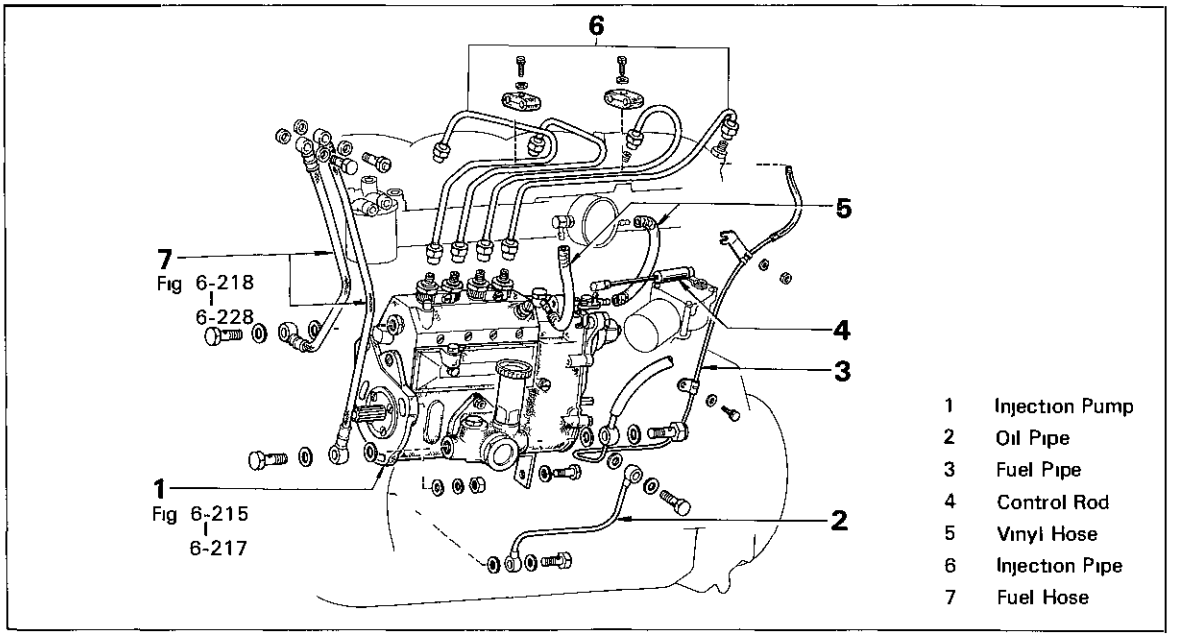
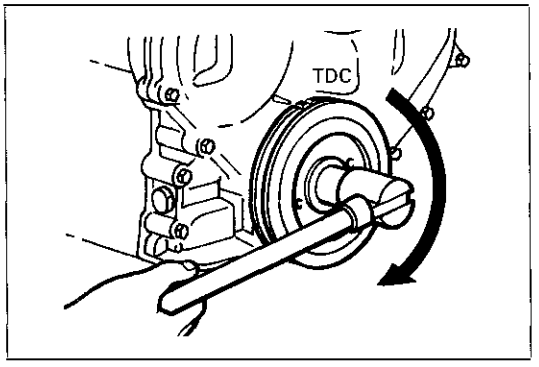
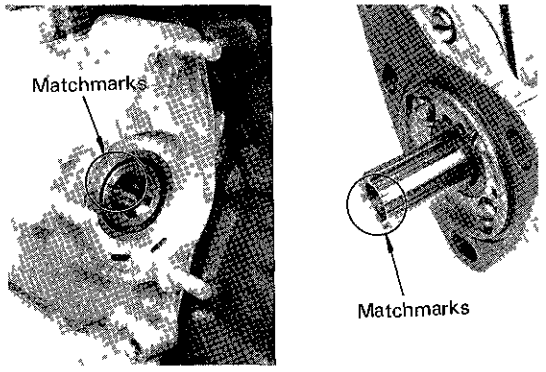


Fig. 6-209



Set the No 1 cylinder piston at TDC/compression

Fig. 6-210

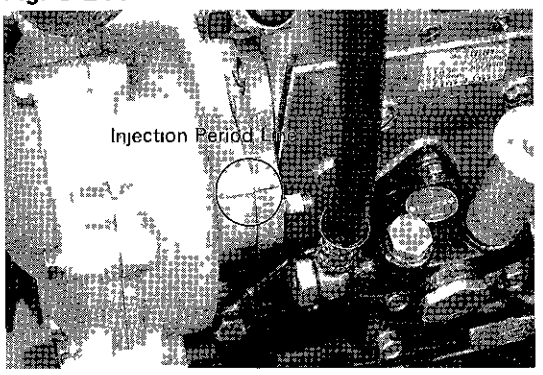


Align the matchmarks on the injection pump spline shaft and timer drive shaft when installing the injection pump

–Note–

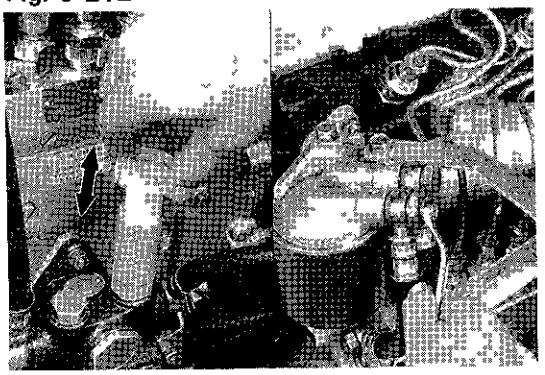
Coat MP grease on the splines.

Fig. 6-211



Set the injection period line to the former position

Fig. 6-212



Bleed the air from fuel system after installation is completed

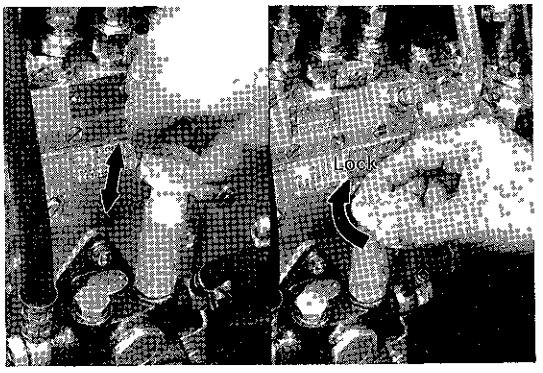
(1) Loosen the fuel filter bleeder plug and operate the priming pump until there is no air emission from the filter

(2) Tighten the fuel filter bleeder plug

—Note—

Be careful that fuel does not splash on the radiator hose.

Fig. 6-213



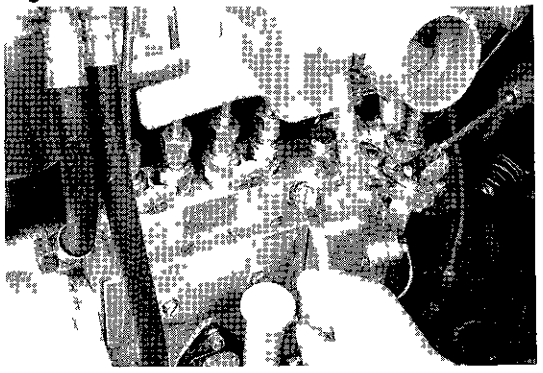
(3) Loosen the injection pump bleeder plug and operate the priming pump until there is no air emission from the injection pump

(4) Screw in the priming pump handle and lock it

—Note—

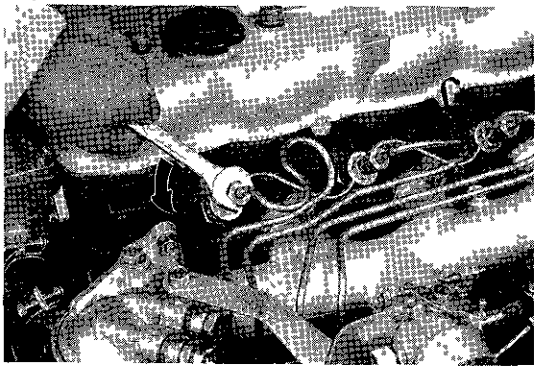
Be sure to lock the priming pump handle prior to the tightening the injection pump bleeder plug.

Fig. 6-214



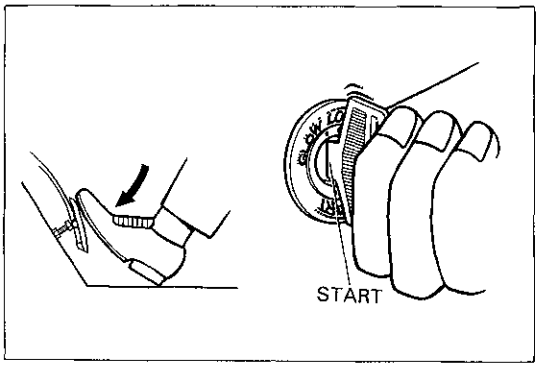
(5) Tighten the injection pump bleeder plug

Fig. 6-215



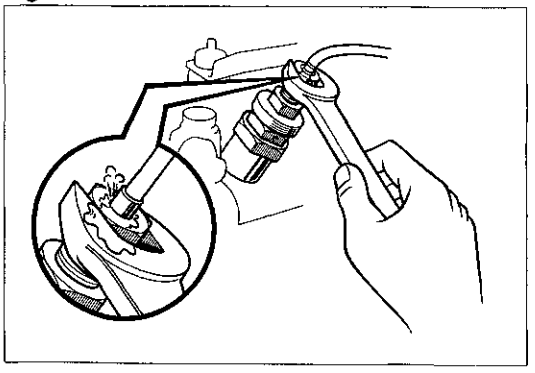
⚠ (6) Loosen all union nuts of the injection pipe on the nozzle holder side

Fig. 6-216



⚠ (7) Turn the engine with the accelerator pedal fully depressed

Fig. 6-217



⚠ (8) Crank the engine to bleed the air and force out the fuel from injection pipe

Tightening torque:
2.0 – 3.0 kg-m
(15 – 21 ft-lb)

—Note—
Start the engine and inspect all pipe lines for fuel leaks.

Fig. 6-218

SEE
ENGINE TUNE-UP
SECTION
Fig. 2-55 to 2-60

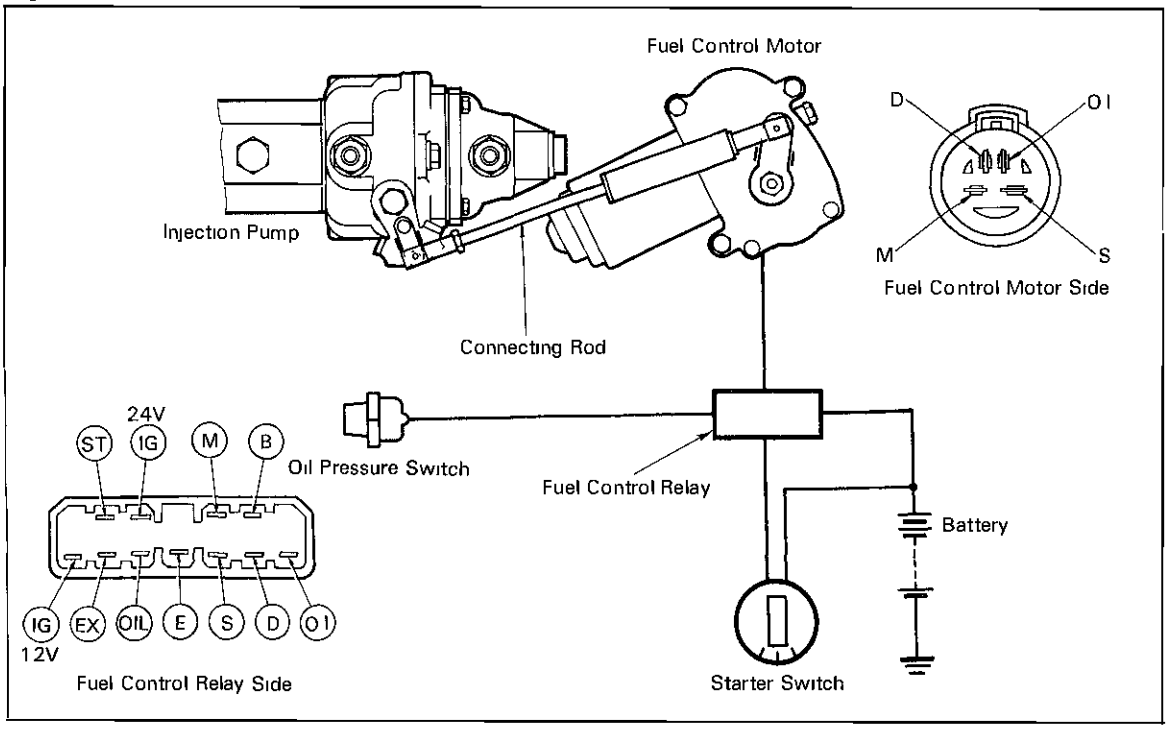
Check the engine idle speed and maximum speed

EDIC (ELECTRICAL DIESEL INJECTION CONTROL) SYSTEM

	Page
OPERATING DIAGRAM	7-2
EDIC SYSTEM CIRCUIT	7-2
OPERATIONAL CHECK	7-3
FUEL CONTROL MOTOR	7-4

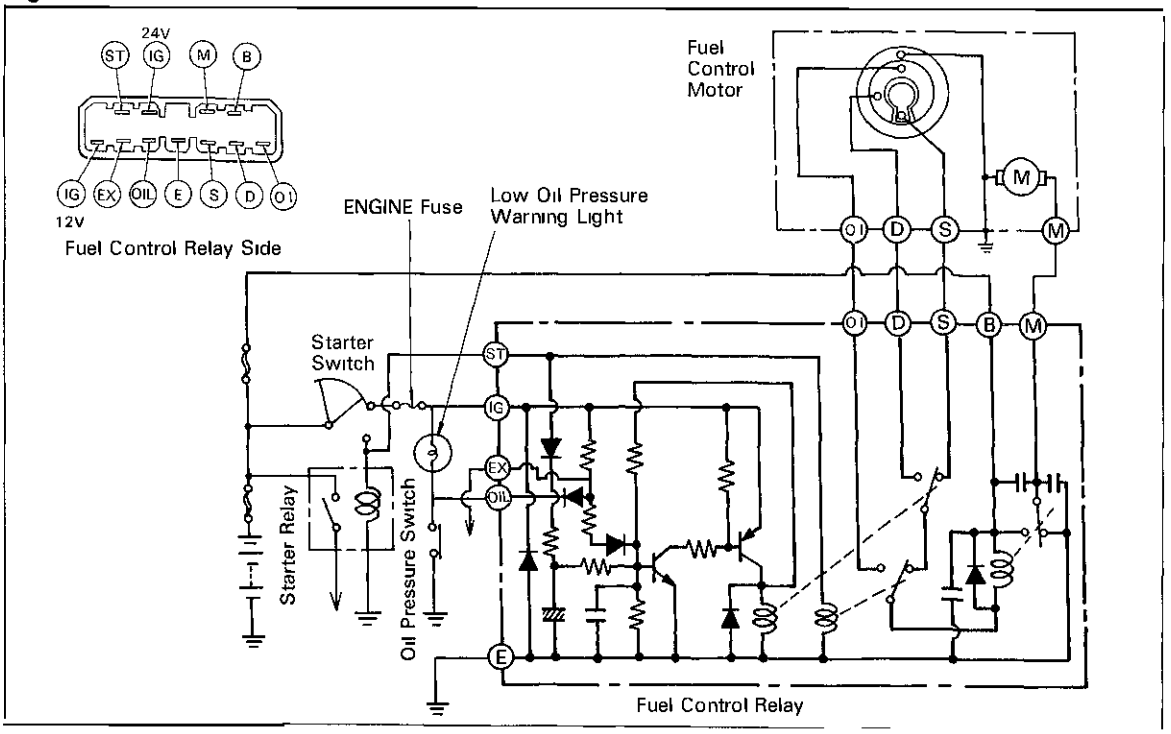
OPERATING DIAGRAM

Fig. 7-1



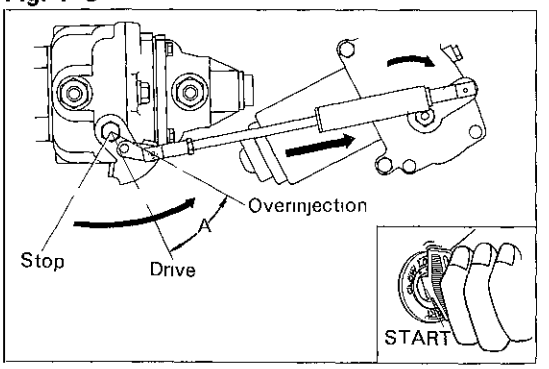
EDIC SYSTEM CIRCUIT

Fig. 7-2



OPERATIONAL CHECK

Fig. 7-3

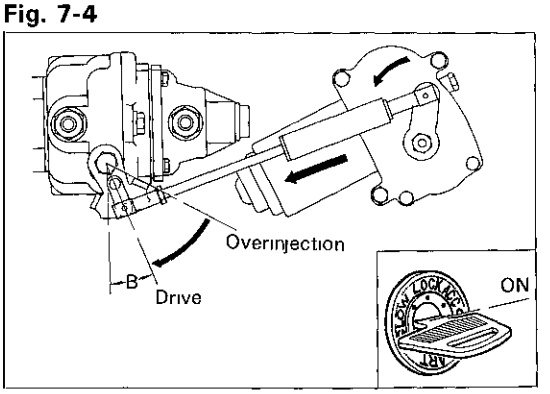


STARTING OVERINJECTION

When the starter is turned to START the injection pump lever should move to the over-injection position

A: 41°
35° (w/ DHAC)

Fig. 7-4

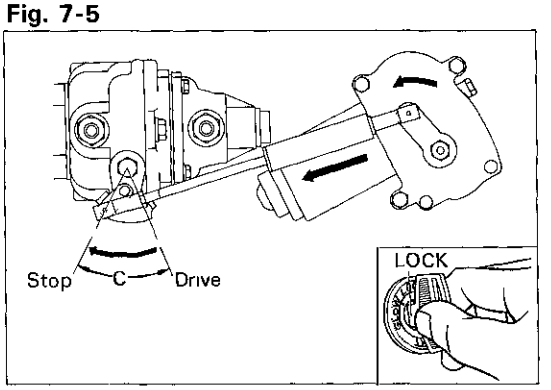


AFTER STARTING (DRIVE POSITION)

After starting the engine the fuel control motor lever and the injection pump lever should be positioned between the two marks

B: B, 2B Engine 19.5°
3B Engine 22.5°

Fig. 7-5

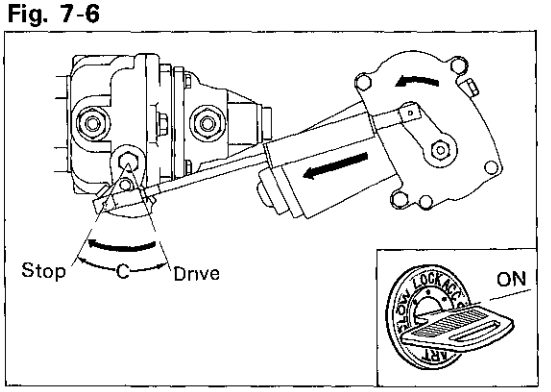


ENGINE STOP

When the starter switch is turned to LOCK the injection pump lever should move to the stop position and the engine should stop

C: B, 2B Engine 49°
3B Engine 52°

Fig. 7-6



REVERSE ROTATION PREVENTION

Start the engine and ground the oil pressure switch connector

Then the injection pump lever should move to the stop position and the engine should stop

FUEL CONTROL MOTOR

REMOVAL

Remove the connecting rod (1) and fuel control motor (2)

Fig. 7-7

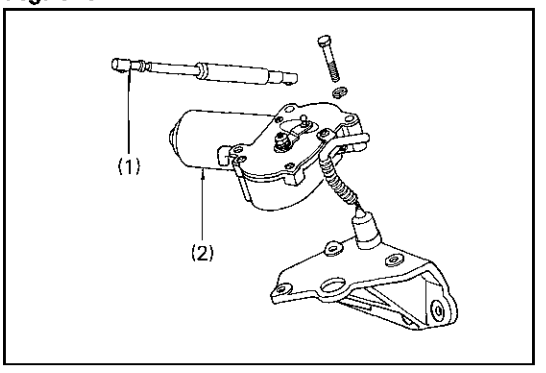
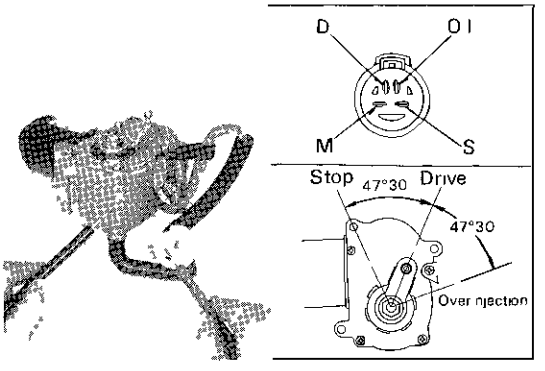


Fig. 7-8



INSPECTION

1 Measure resistance between terminal M and body

Resistance:

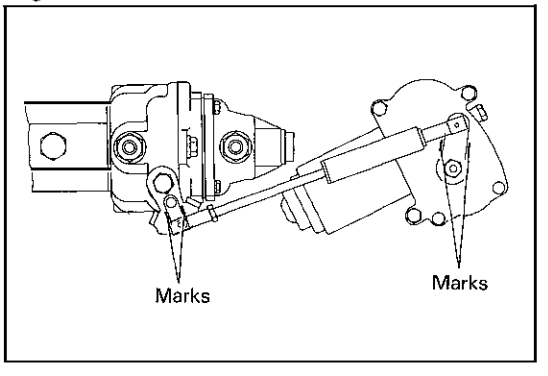
12V type **About 0.8Ω**

24V type **About 3.3Ω**

2 Check the continuity between D S and O I terminals at each motor lever position

Terminal / Motor lever position	S	D	O I
Stop position		○	○
Drive position	○		○
Overinjection position	○	○	

Fig. 7-9



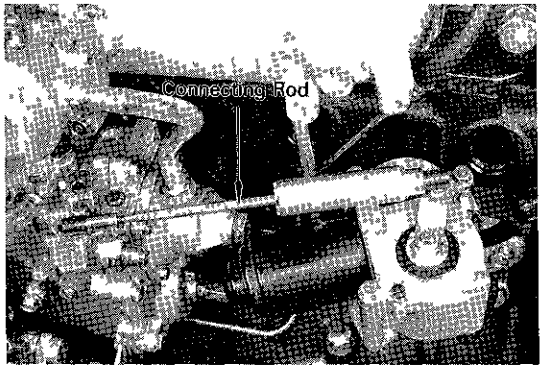
INSTALLATION

1 Install the motor and connecting rod in reverse order of removal

—Note—

The fuel control motor lever and injection pump lever should be positioned between the two marks.

Fig. 7-10



2 Adjust the connecting rod length if necessary

STARTING SYSTEM

	Page
STARTING SYSTEM CIRCUIT	8-2
PREHEATING SYSTEM	8-4
STARTER RELAY & OVERINJECTION MAGNET	8-7
STARTER	8-8

STARTING SYSTEM CIRCUIT

For BJ60

Fig. 8-1

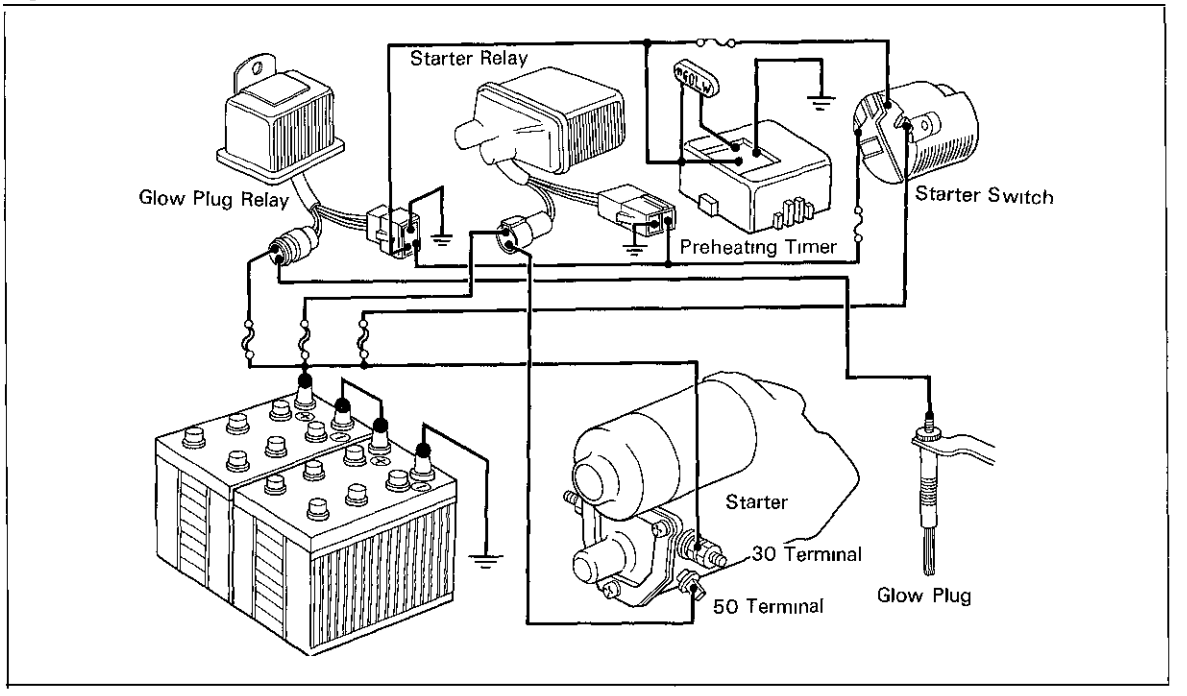
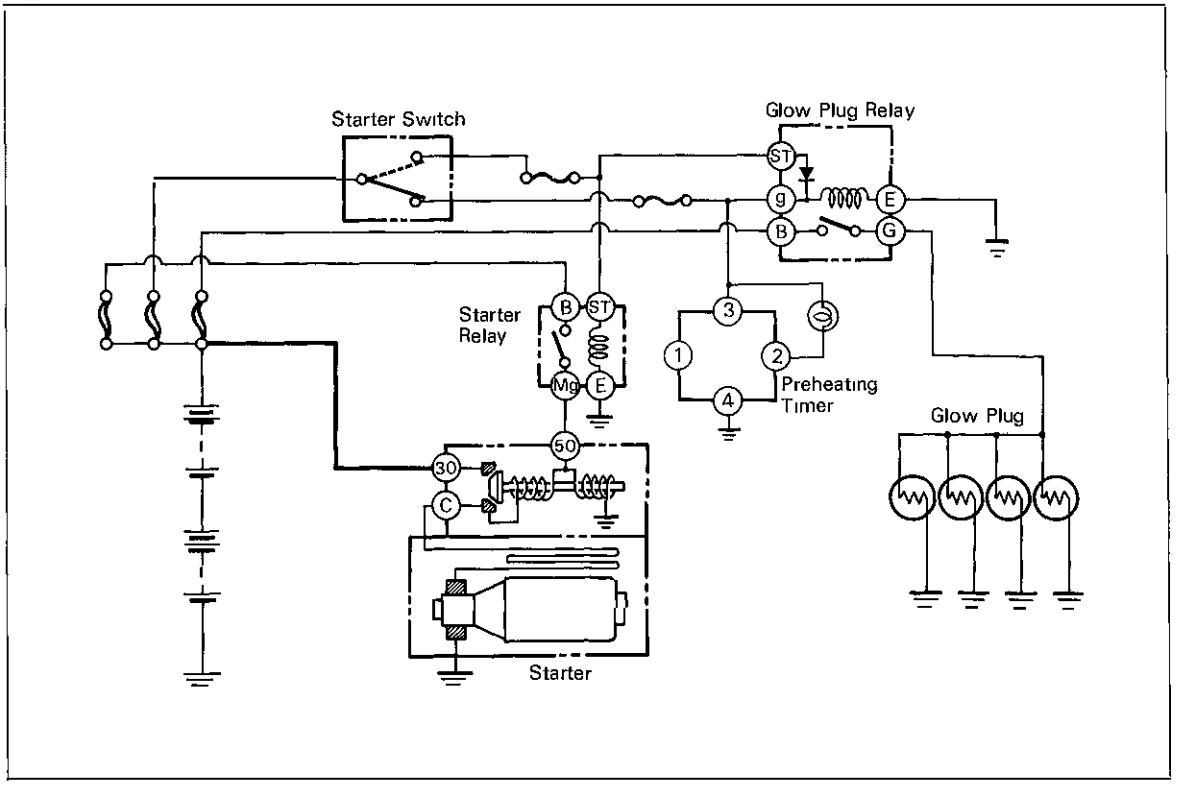


Fig. 8-2



Except BJ60

Fig. 8-3

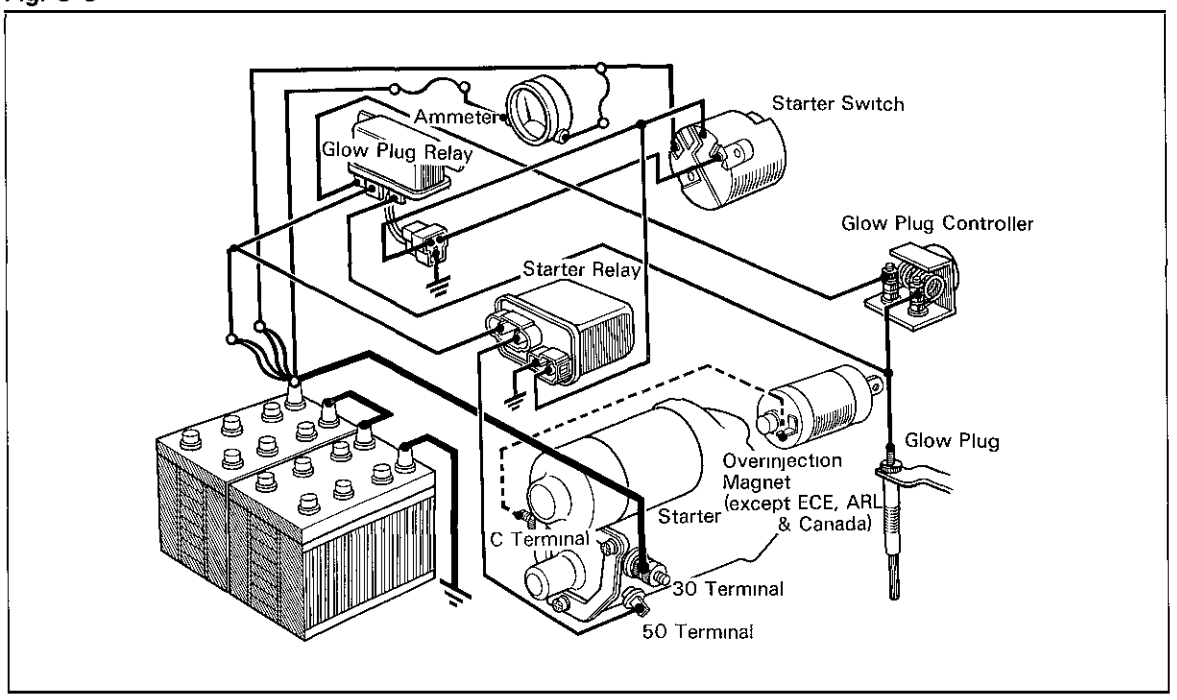
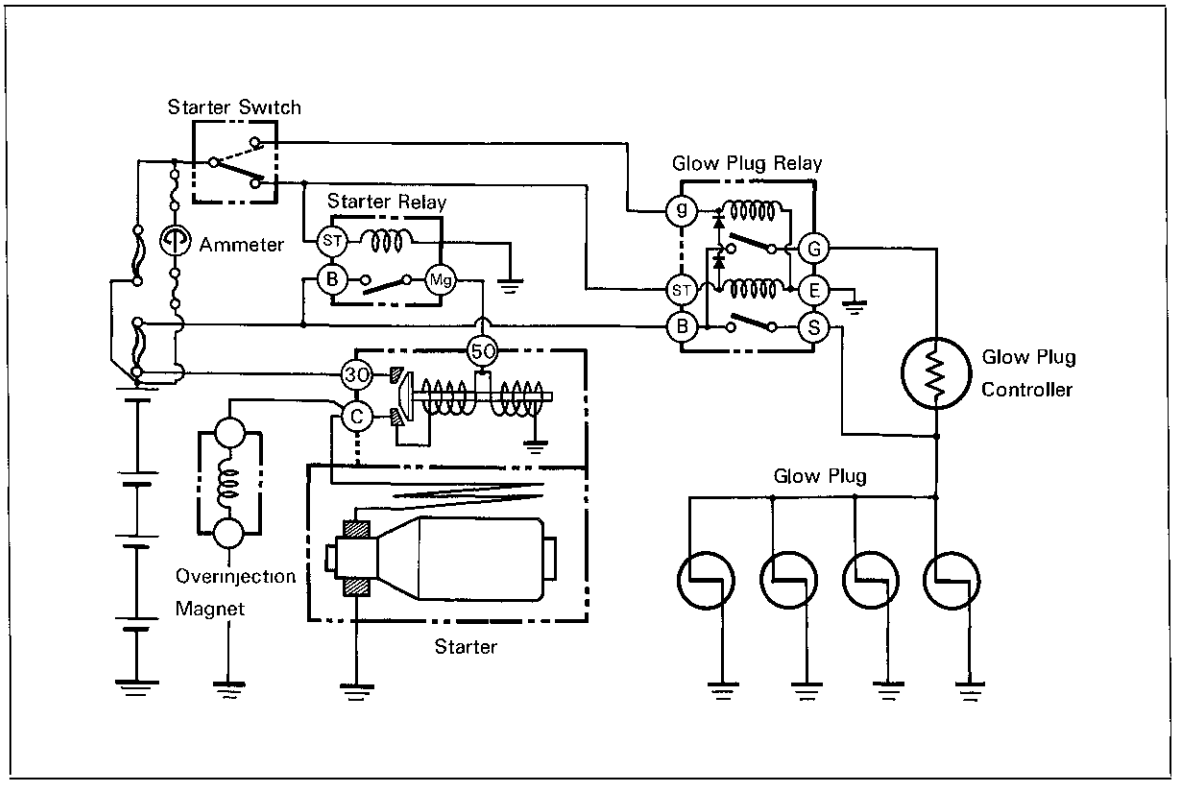


Fig. 8-4

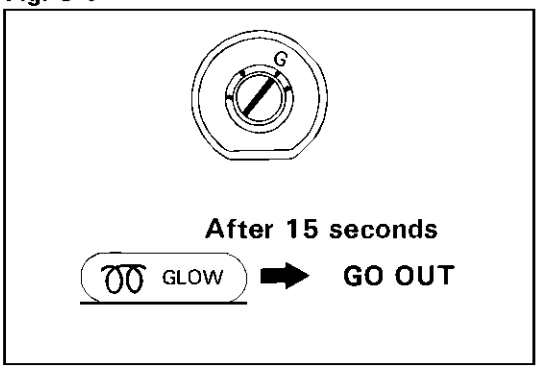


PREHEATING SYSTEM

INSPECTION

Preheating Timer (for BJ 60)

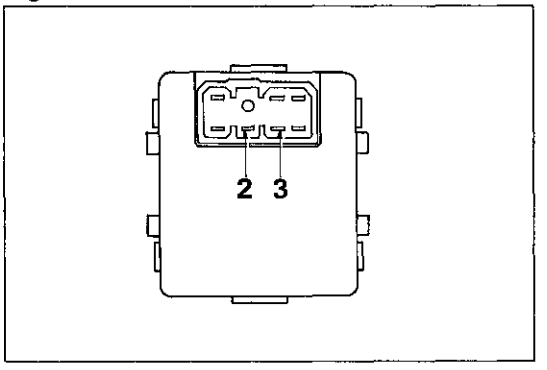
Fig. 8-5



1 With the starter switch in G position check to see how long it takes for the glow light to go out

Glow time at 0°C (32°F)
About 15 seconds

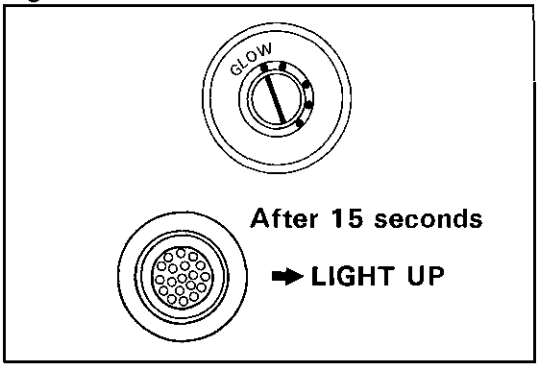
Fig. 8-6



2 When the engine is started with the timer in operation check to see that the continuity to 2nd and 3rd terminals of preheating timer is broken

Glow Plug Controller (except BJ 60)

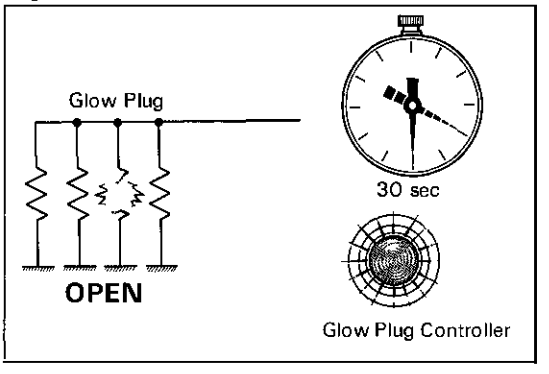
Fig. 8-7



1 With the starter switch in GLOW position check to see how long it takes for the glow indicator to light up

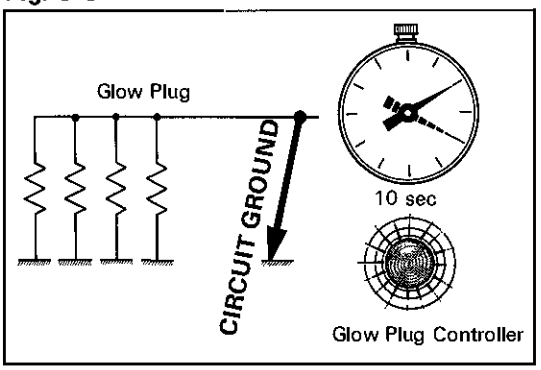
Glow time at 0°C (32°F)
About 15 seconds

Fig. 8-8



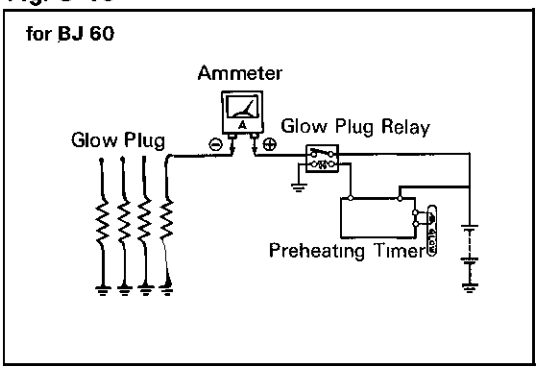
2 If glow time is more than 30 seconds check the following conditions
(1) Open circuit in wiring
(2) Loose terminal connection
(3) Burnt switch or relay points
(4) Open glow plug or controller

Fig. 8-9



3 If glow time is less than 15 seconds check the following conditions
(1) Short circuit in wiring
(2) Shorted glow plug or controller

Fig. 8-10

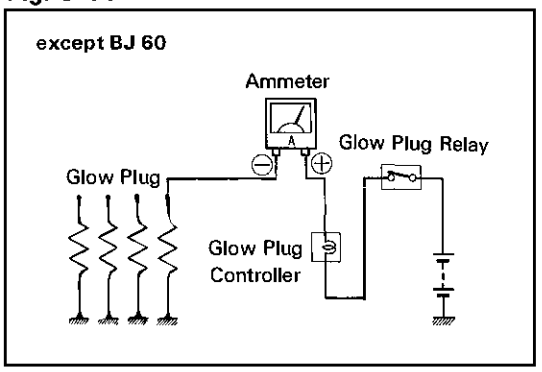


Load Current

1 Remove the glow plug connector
2 Connect the ammeter between the glow plug lead wire and one glow plug
3 Turn the starter switch to G (GLOW) position and measure the load current after about 40 seconds

Load current per one glow plug:
BJ60 12V type 7.2 – 9.8A
24V type 3.8 – 5.2A
ex. BJ60
12V type 7.6 – 10.4A
24V type 4.1 – 5.5A

Fig. 8-11

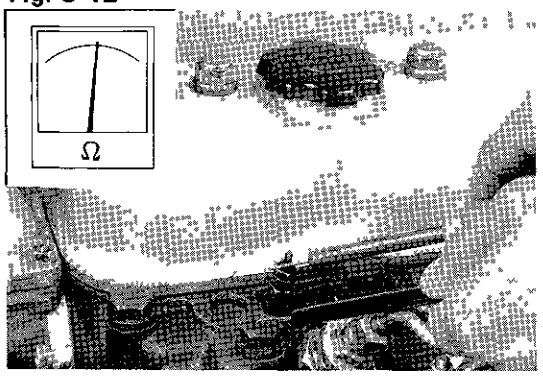


Glow Plug Resistance.

Measure the glow plug resistance

Resistance at 20°C (68°F):
BJ60 12V type 1.2Ω
24V type 5.1Ω
ex. BJ60
12V type 0.9Ω
24V type 4.3Ω

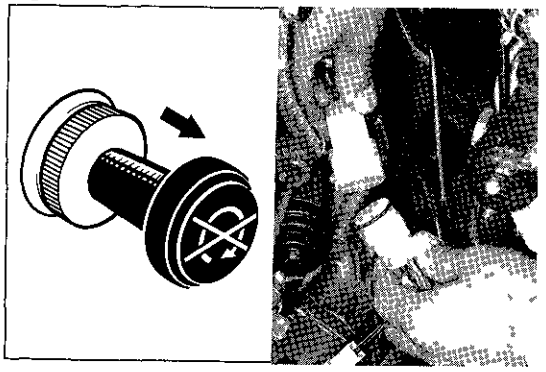
Fig. 8-12



–Note–

1. **Be careful not to damage the glow plug pipes.**
   This might cause open circuit or shorten life of the plugs.
2. **Avoid getting oil and gasoline on the glow plug when cleaning.**
3. **After inspection, wipe oil off glow plug terminals and bakelite washer with a dry cloth.**

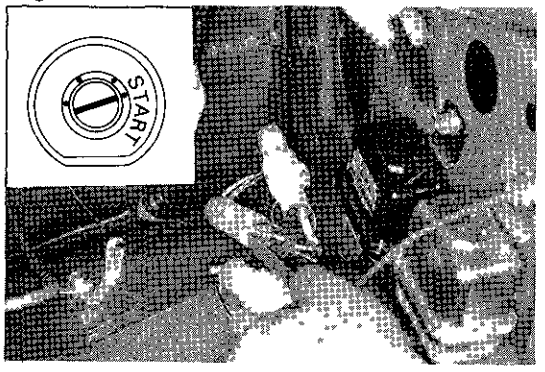
Fig. 8-13



Glow Plug Relay

1 Pull the stop button all the way out or disconnect the connector of the EDIC motor wires to prevent accidental starting of the engine

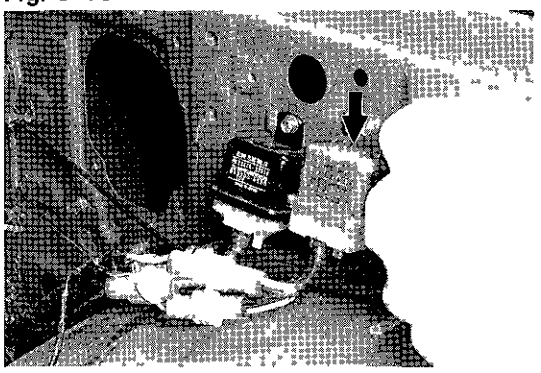
Fig. 8-14



2 When the starter switch is turned to the START position voltage should register at the ST terminal

STARTER RELAY & OVERINJECTION MAGNET

Fig. 8-15

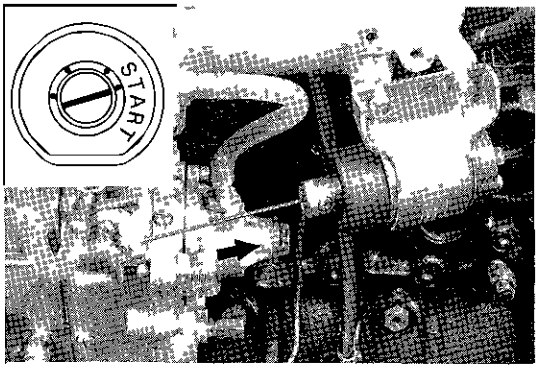


INSPECTION

Starter Relay

Check the contact click noise when the starter switch is turned to the START position

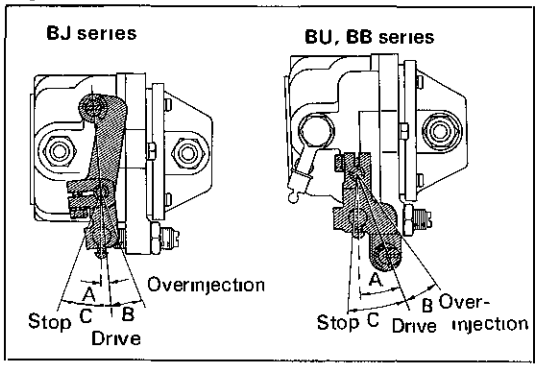
Fig. 8-16



Overinjection Magnet (except for ECE, ARL & Canada)

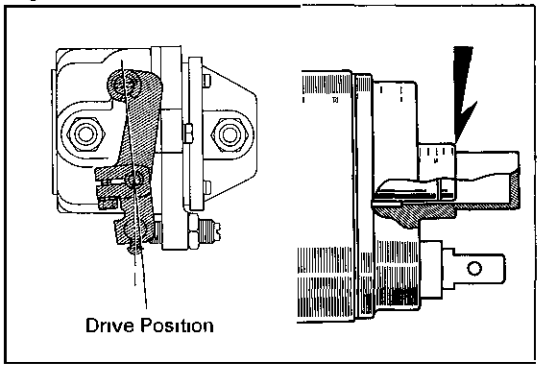
Check to see if the injection pump lever moves to the overinjection position when the starter switch is turned to START position

Fig. 8-17



A: 4.5° (BJ series)
20° (BU, BB series)
B: 15°
C: 25°

Fig. 8-18



When connecting the overinjection magnet connecting wire position the magnet core end surface as shown in the figure

STARTER

CUTAWAY VIEW

Fig. 8-19

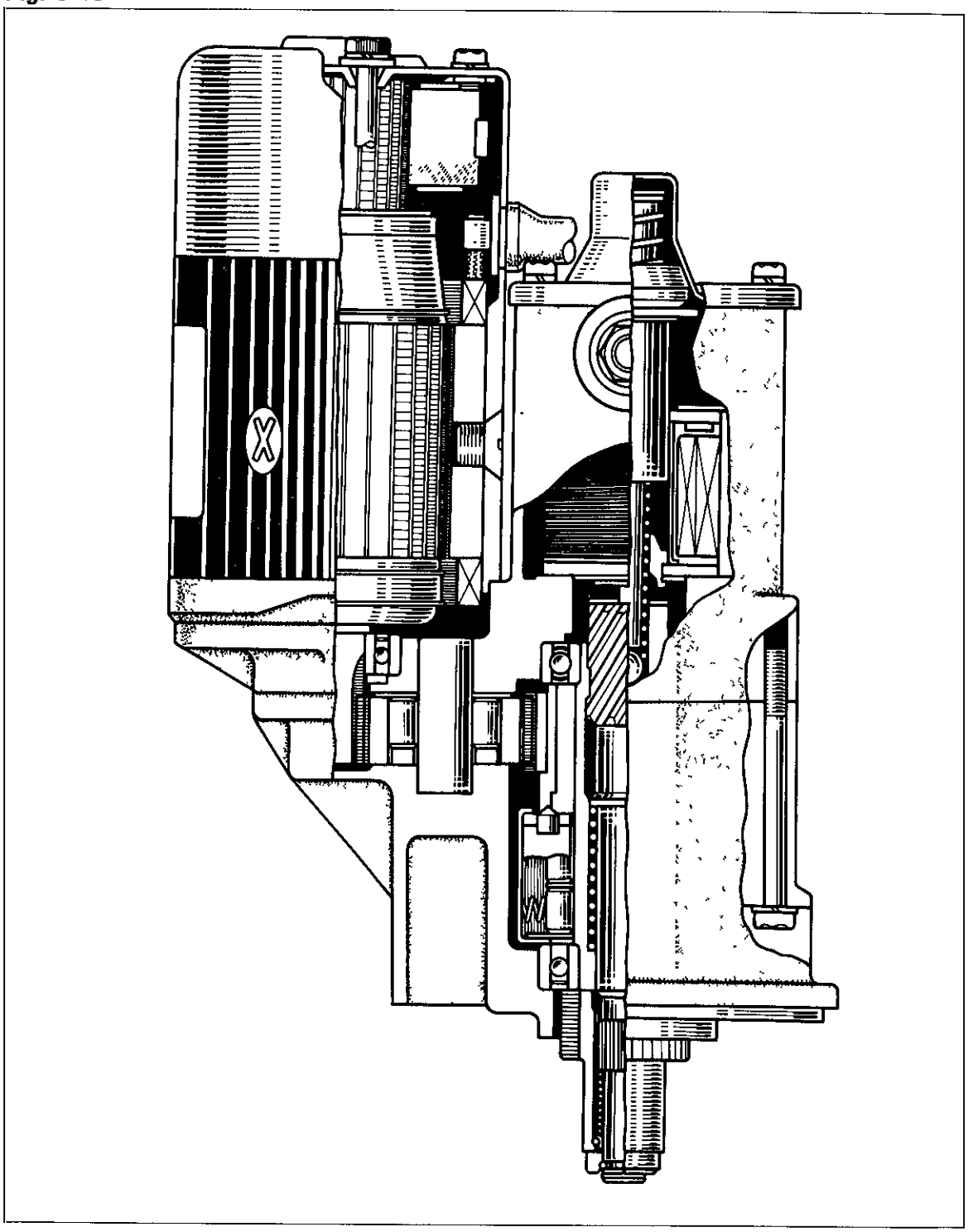
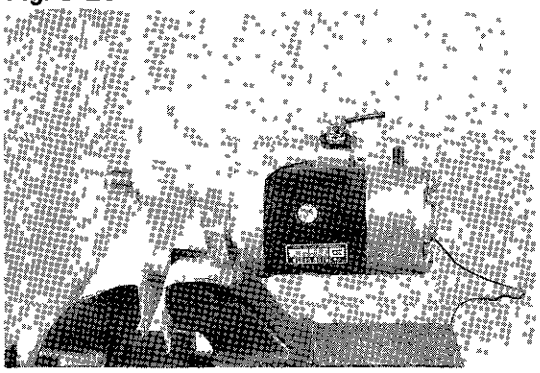


Fig. 8-20

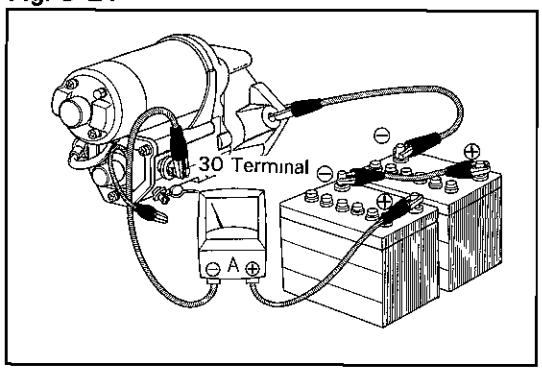


PERFORMANCE TEST

No-Load Performance Test

1 Secure the starter in a vise to avoid an accident

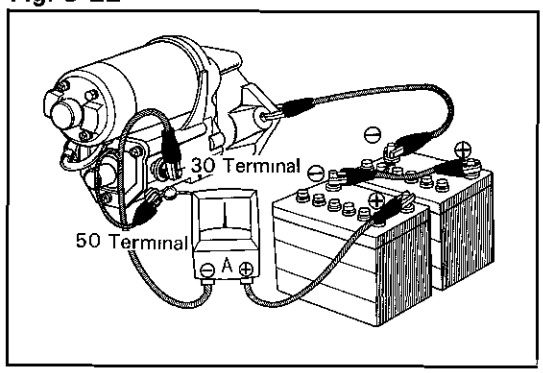
Fig. 8-21



2 Connect the starter to battery as shown in the figure

Positive side
Battery (+) ——→ Ammeter (+)
Ammeter (–) ——→ 30 Terminal
Negative side
Battery (–) ——→ Starter housing

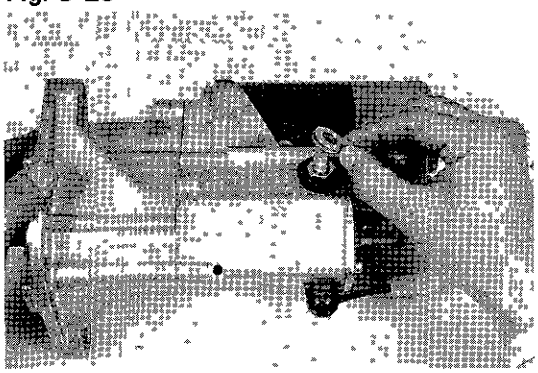
Fig. 8-22



3 Connect the positive wire to the 50 terminal
If the starter shows smooth and steady rotation with the pinion jumping out and drawing less than specified current it is satisfactory

Specified current:
12V type Less than 180A
24V type Less than 90A

Fig. 8-23

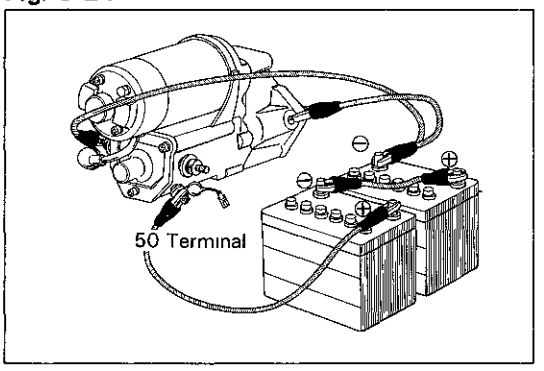


Magnetic Switch Test

–Note–
Each test must be performed within a short time (3 – 5 seconds) to prevent the coil from burning out.

1 Disconnect terminal C

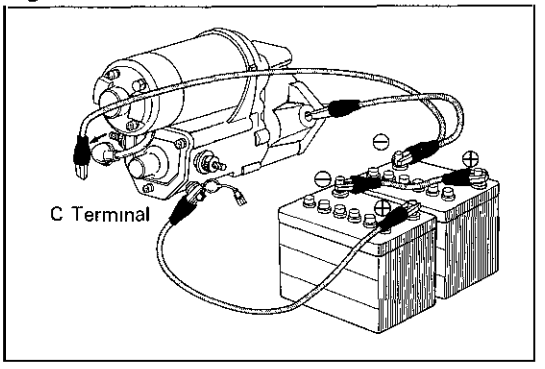
Fig. 8-24



2 Test pull-in coil
Connect the magnetic switch to the bat tery as shown in the figure The pinion should jump out

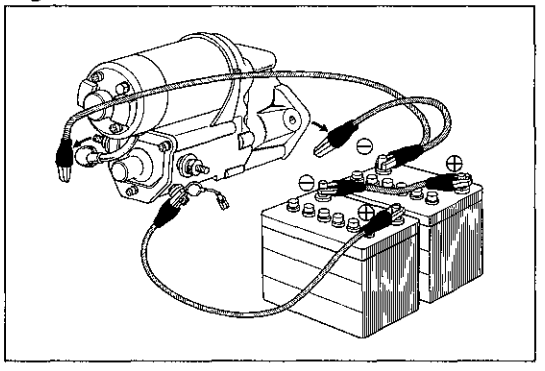
Negative side
Battery (—)———→Starter housing and C terminal
Positive side
Battery (+)———→50 terminal

Fig. 8-25



3 Test hold-in coil
With the same connections as in the Test pull-in coil disconnect terminal C
At this time the pinion should remain in protruding out condition

Fig. 8-26

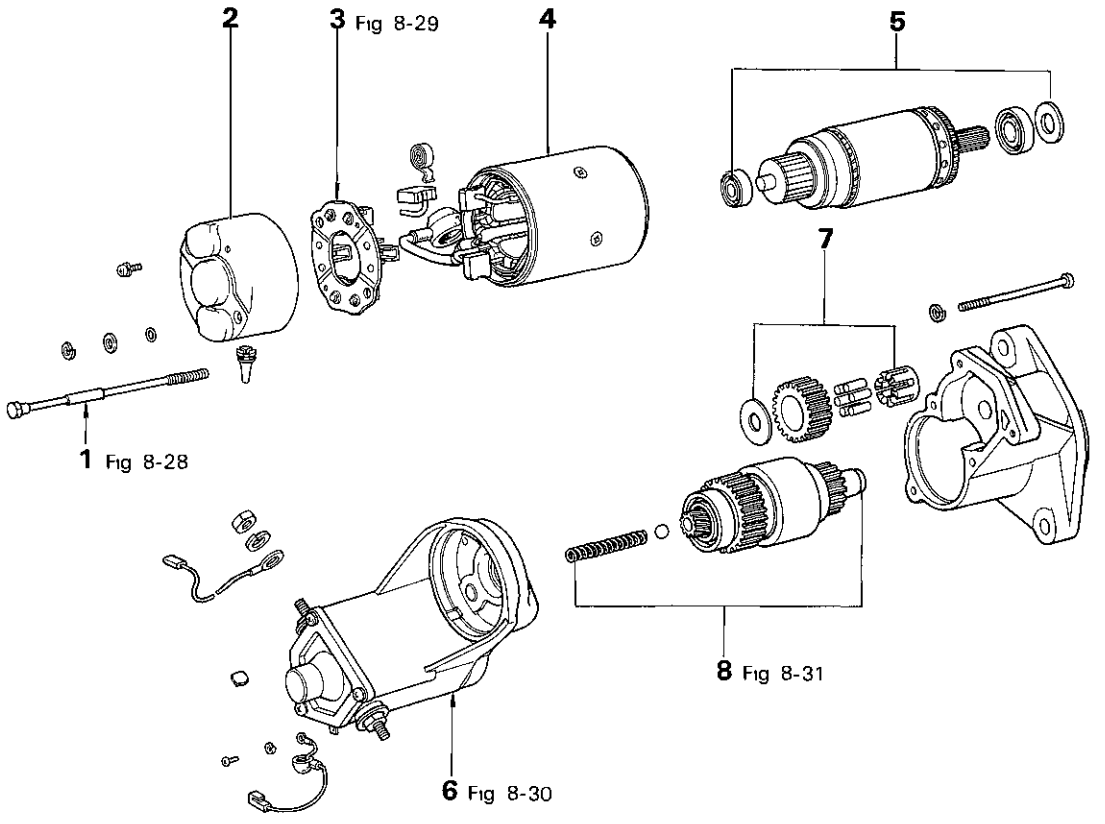


4 Check pinion return
When disconnecting the cable from the starter housing the protruding pinion should return quickly

DISASSEMBLY

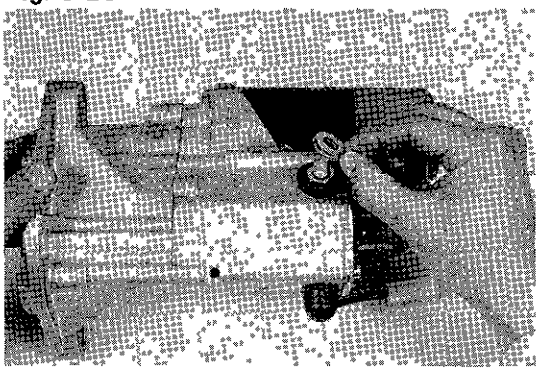
Disassemble the parts in the numerical order shown in the figure

Fig. 8-27



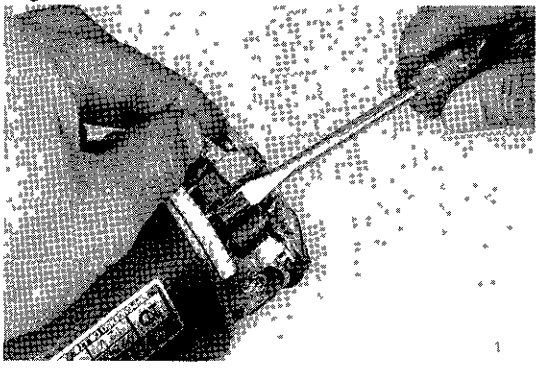
1 Through Bolt
2 End Frame
3 Brush Holder
4 Yoke
5 Armature
6 Magnetic Switch
7 Pinion, Roller & Retainer
8 Clutch Spring & Steel Ball

Fig. 8-28



Disconnect the lead wires from the magnetic switch

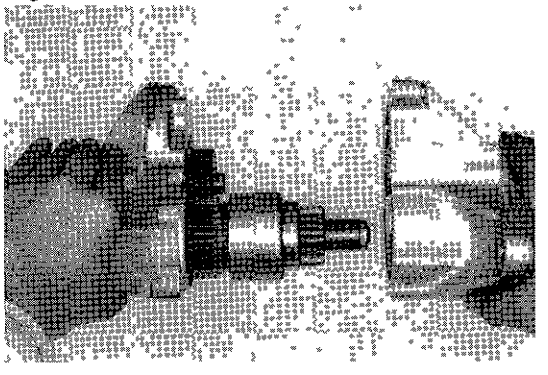
Fig. 8-29



Lift up the brush spring and pull out the brush from the brush holder

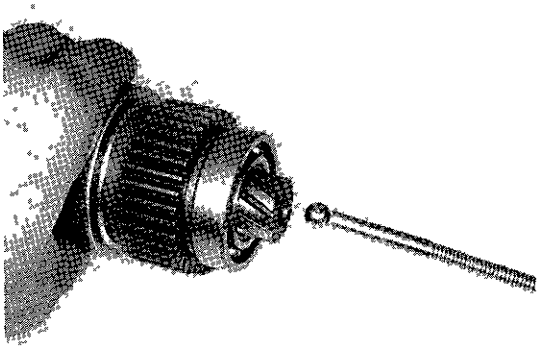
—Note—
Use care not to damage the brush and commutator. Also avoid contact with oil or grease.

Fig. 8-30



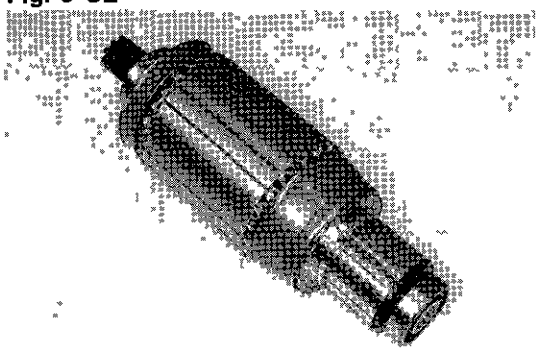
Remove the starter housing together with the idler gear and clutch

Fig. 8-31



Take the steel ball out of the clutch shaft hole

Fig. 8-32



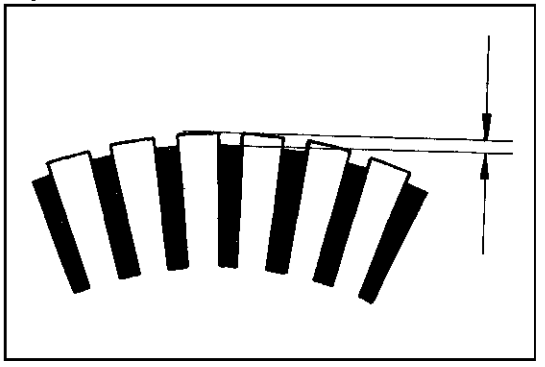
INSPECTION & REPAIR

Commutator

Check for the following, and repair or replace if necessary

1 Dirty or burnt surface
Correct with sandpaper

Fig. 8-33

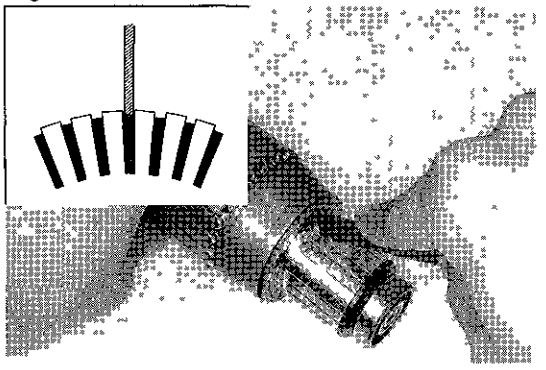


2 Depth of segment mica

Mica depth:

STD	**0.7 — 0.9 mm (0.028 — 0.035 in.)**
Limit	**0.2 mm (0.008 in.)**

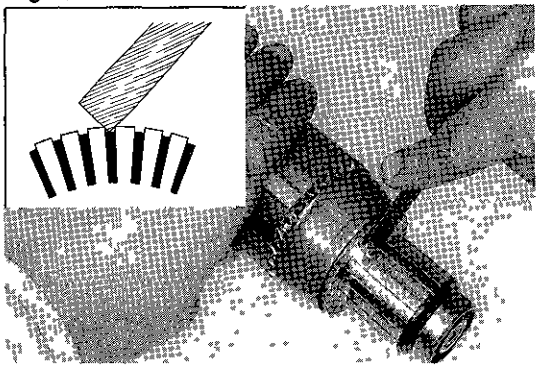
Fig. 8-34



3 Repair the segment mica

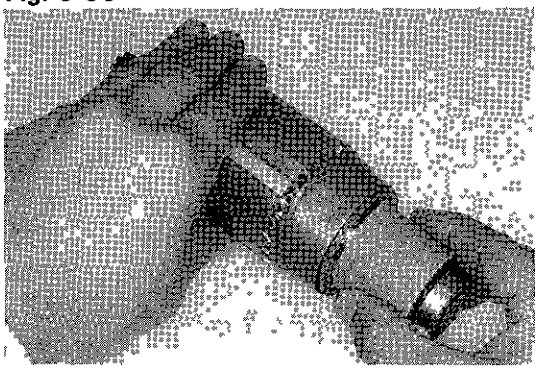
(1) If the mica depth is below the limit, correct with a hacksaw blade

Fig. 8-35



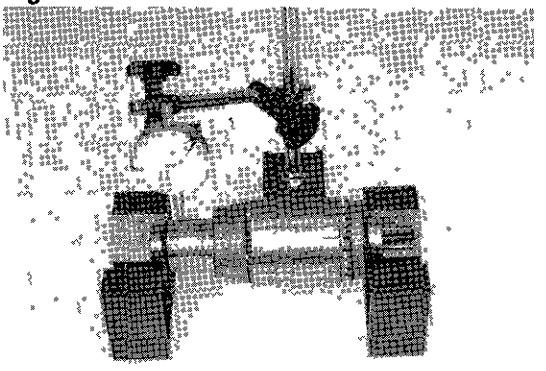
(2) Smooth out the edges with a hac ksaw blade

Fig. 8-36



(3) After correcting use #400 sandpaper to smooth the commutator surface

Fig. 8-37



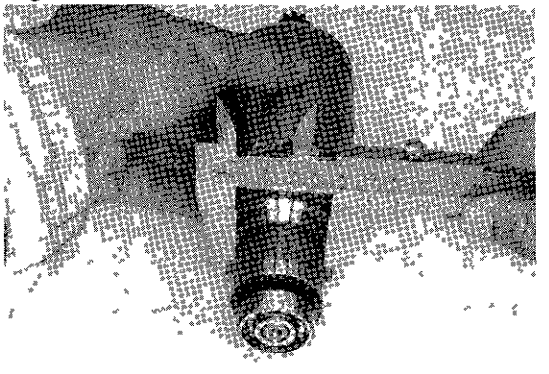
4 Runout

Correct on a lathe if it exceeds the limit

Runout:

STD	**Less than 0.05 mm (0.002 in.)**
Limit	**0.05 mm (0.002 in.)**

Fig. 8-38



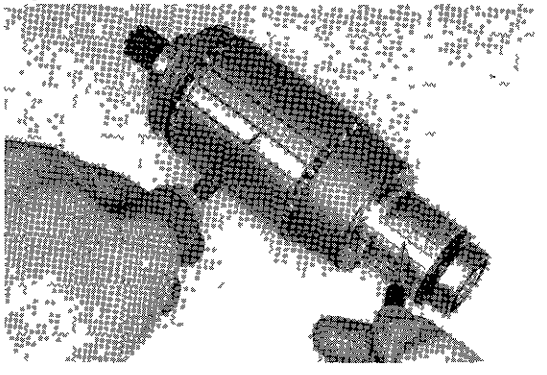
5 Surface wear

Replace the armature if excessively worn

Commutator outer diameter:

STD	**36 mm (1.42 in.)**
Limit	**35 mm (1.38 in.)**

Fig. 8-39



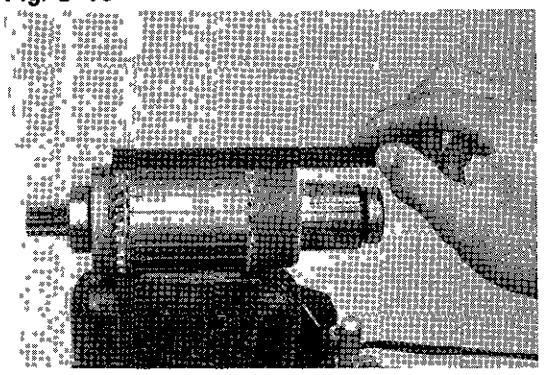
Armature Coil

1 Ground test

Check for continuity between the commutator and armature coil core

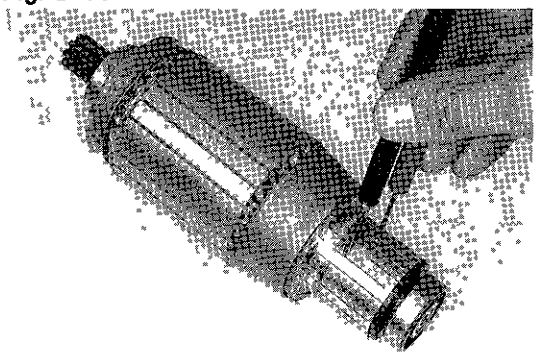
If there is continuity the armature is grounded and must be replaced

Fig. 8-40



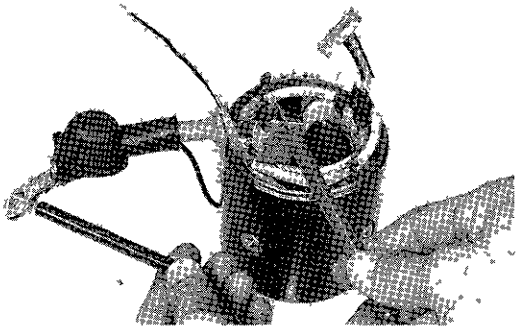
2 Short circuit test
Place the armature on an armature tester and hold a hacksaw blade against the armature core while turning the armature
If the hacksaw blade is attracted or vibrates the armature is shorted and must be replaced

Fig. 8-41



3 Open circuit test
Using an armature tester or a circuit tester, check for continuity between the segments
If there is no continuity at any test point, there is an open-circuit and the armature must be replaced

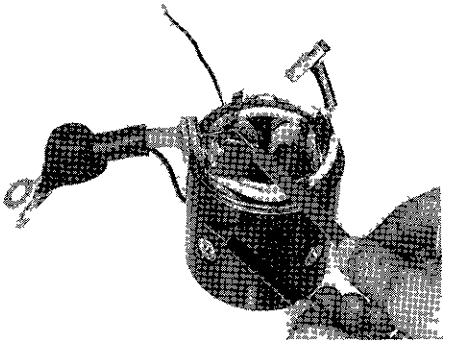
Fig. 8-42



Field Coil

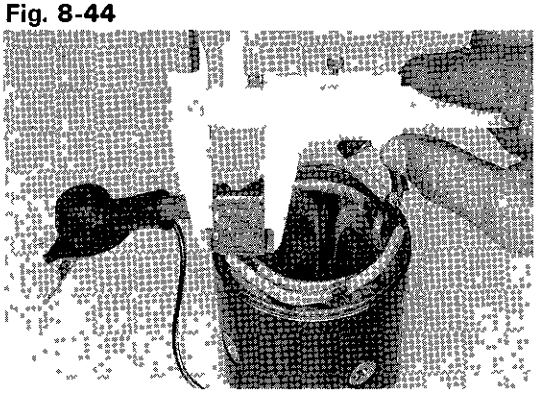
1 Open circuit test
Check for continuity between the terminal C lead wire and field coil brush
If there is no continuity there is an open circuit in the field coil and it should be replaced

Fig. 8-43



2 Ground test
Check for continuity between the brush and yoke core
If there is continuity, repair or replace the field coil

Fig. 8-44



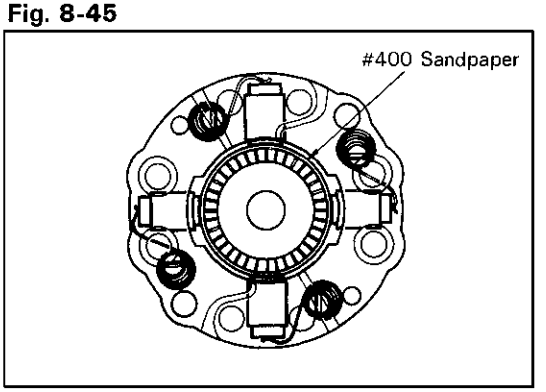
Brushes

1 Measure the brush length and replace if below the limit

Brush length:

STD	**20.5 mm (0.807 in.)**
Limit	**12 mm (0.47 in.)**

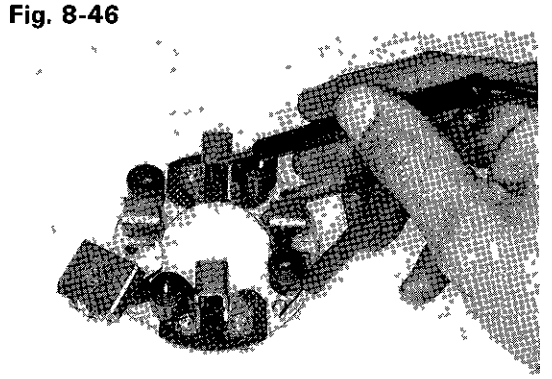
Fig. 8-45



2 Using #400 sandpaper clean the brushes so they make proper contact with the commutator

—Note—
Secure the armature gear in a vise or such.

Fig. 8-46

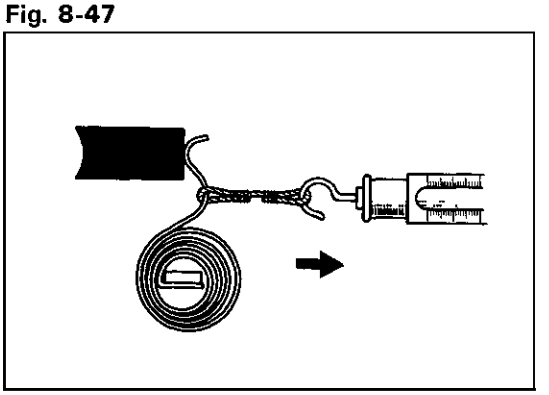


Brush Holder

Check the insulation between the (+) side brush holder and holder plate

If there is continuity repair or replace the brush holder

Fig. 8-47



Brush Spring

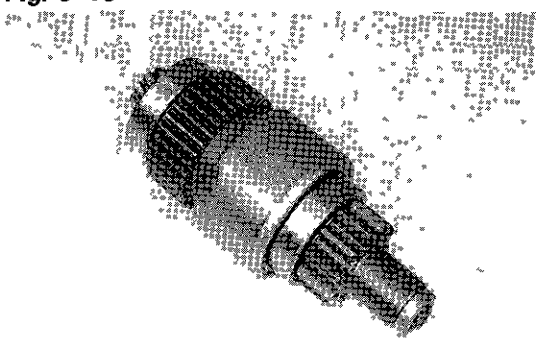
Measure the brush spring load with a pull scale

If the reading is below standard replace the spring

—Note—
Take the pull-scale reading at the very instant the brush spring separates from the brush.

Tension: 3.2 – 4.0 kg (7 – 9 lb)

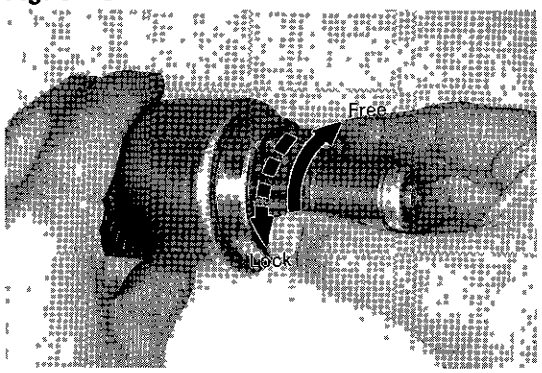
Fig. 8-48



Clutch & Gears

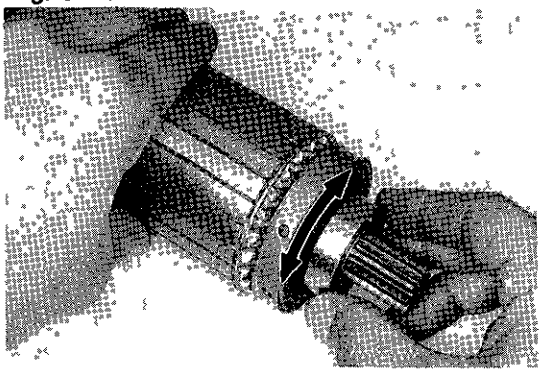
1 Check the gear teeth for wear or damage If damaged replace and inspect the fly wheel ring gear for same

Fig. 8-49



2 Rotate the pinion It should turn freely in clockwise direction and lock when turned counterclockwise

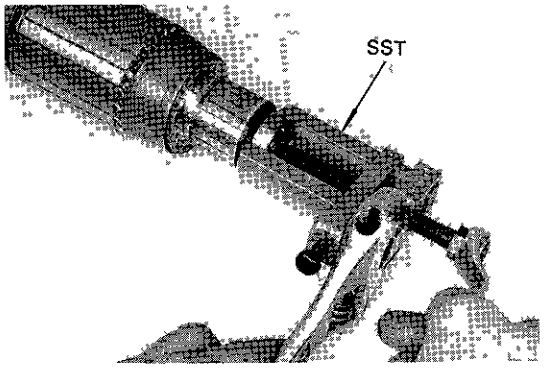
Fig. 8-50



Bearings

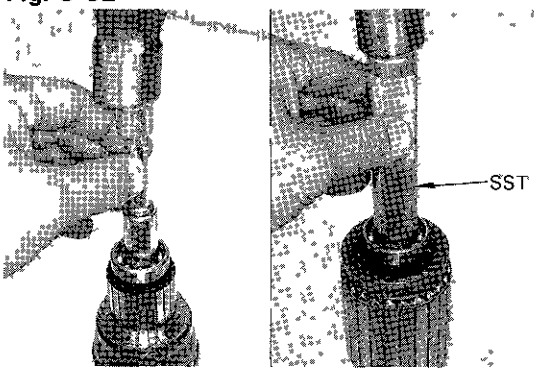
1 Check for sticking and abnormal noise while turning rapidly

Fig. 8-51



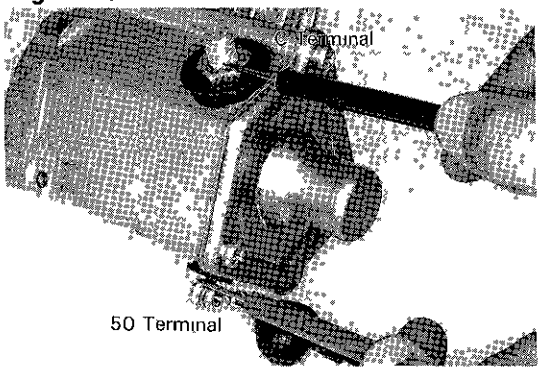
2 Replace the armature bearing if defective
(1) Remove the bearing with SST
SST [09286-46011]

Fig. 8-52



(2) Replace the front bearing and drive in the rear bearing with SST
SST [09285-76010]

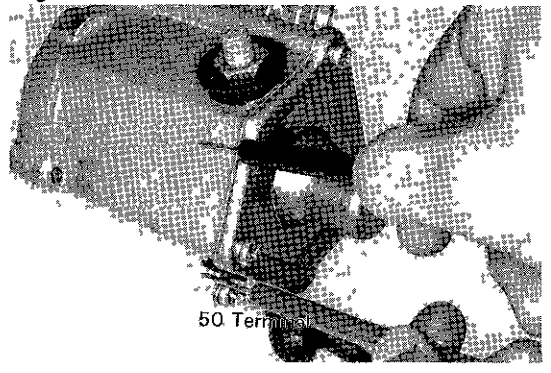
Fig. 8-53



Magnetic Switch

1 Pull-in coil open circuit test
Check for continuity between the 50 terminal and terminal C

Fig. 8-54



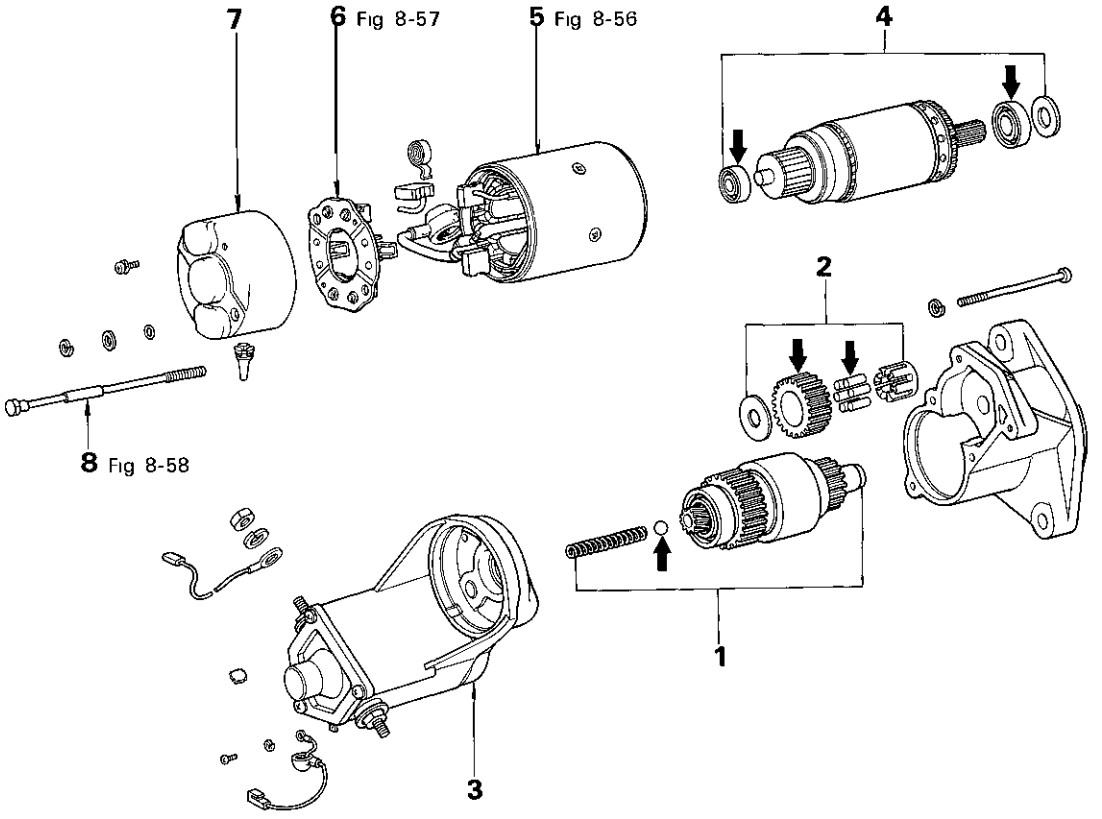
2 Hold-in coil open circuit test
Check for continuity between the 50 terminal and magnetic switch body

ASSEMBLY

Assemble the parts in the numerical order shown in the figure

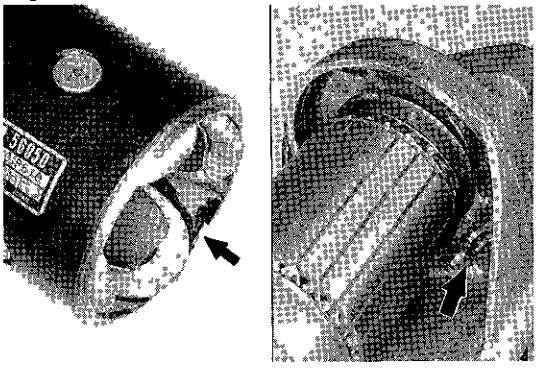
Fig. 8-55

–Note–
Use high temperature grease to lubricate the bearings and gears indicated by arrows in the figure.



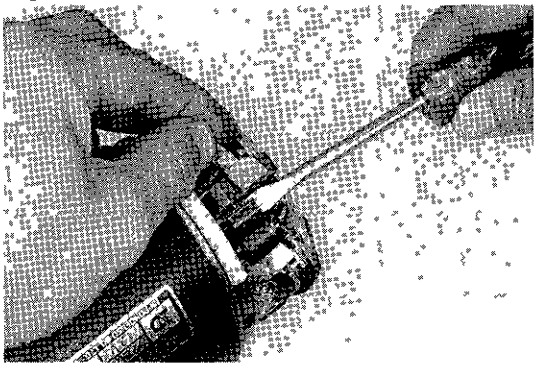
1 Clutch, Spring & Steel Ball
2 Pinion, Roller & Retainer
3 Magnetic Switch
4 Armature
5 Yoke
6 Brush Holder
7 End Frame
8 Through Bolt

Fig. 8-56



Match the protrusion (small metal plate) of the starter housing with the cutout of the yoke core

Fig. 8-57

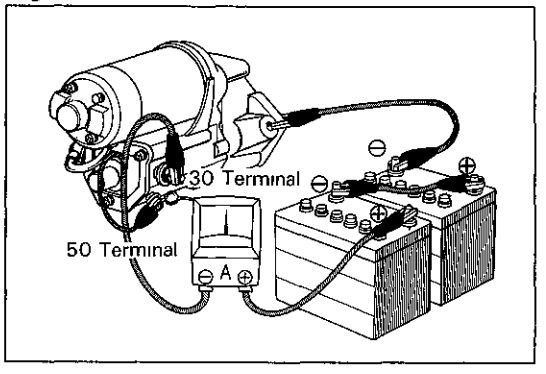


Assemble the brush holder

—Note—

Use care not to damage or get oil on the brushes and commutator.

Fig. 8-58



Check performance of the starter after assembling

Specified current:

12V type	**Less than 180A**
24V type	**Less than 90A**

CHARGING SYSTEM

	Page
CHARGING SYSTEM CIRCUITS	9-2
ON-VEHICLE INSPECTION	9-5
ALTERNATOR	9-12
ALTERNATOR REGULATOR	9-26
WARNING LIGHT RELAY	9-29

CHARGING SYSTEM CIRCUITS

TIRRILL REGULATOR TYPE

Fig. 9-1

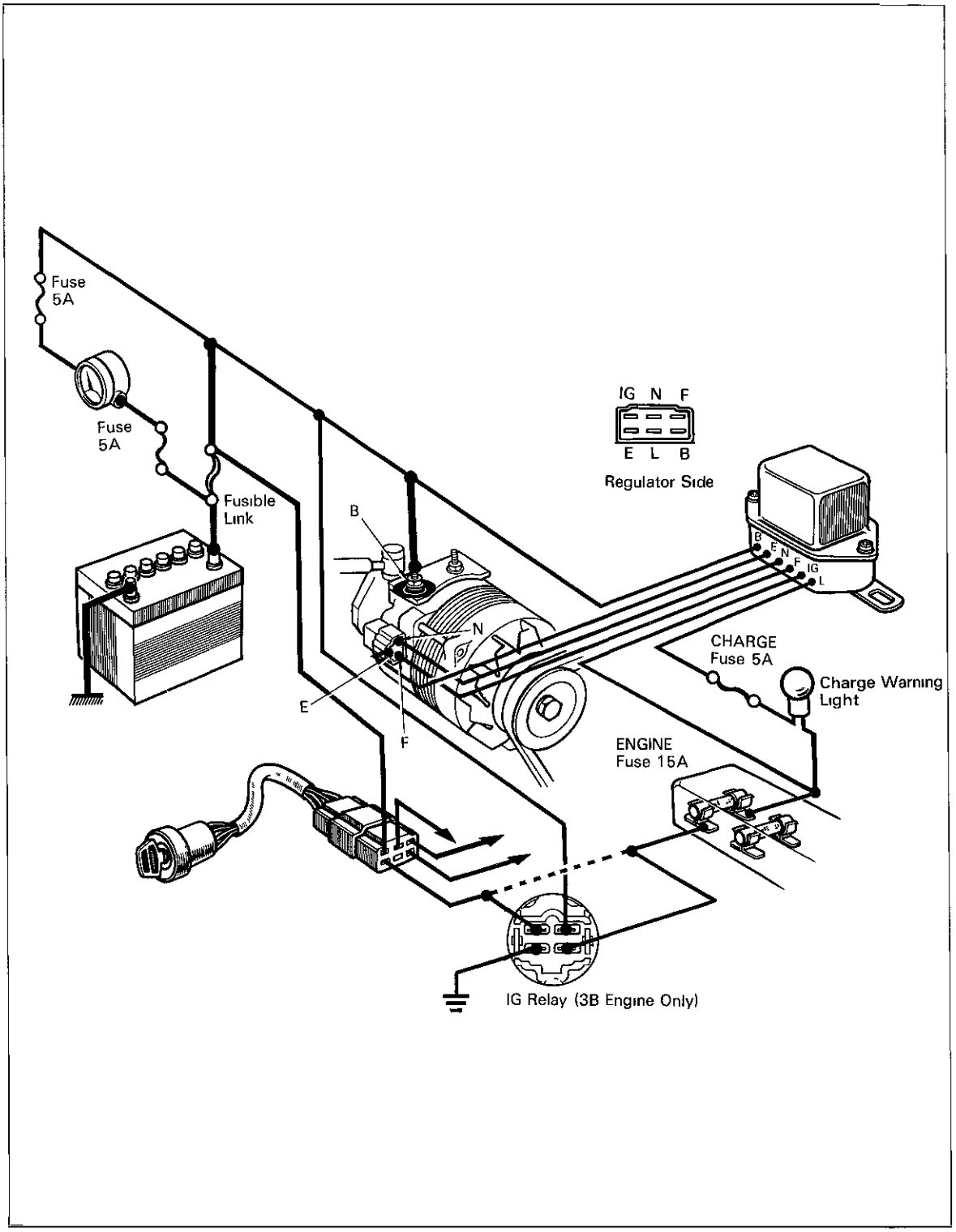


Fig. 9-2

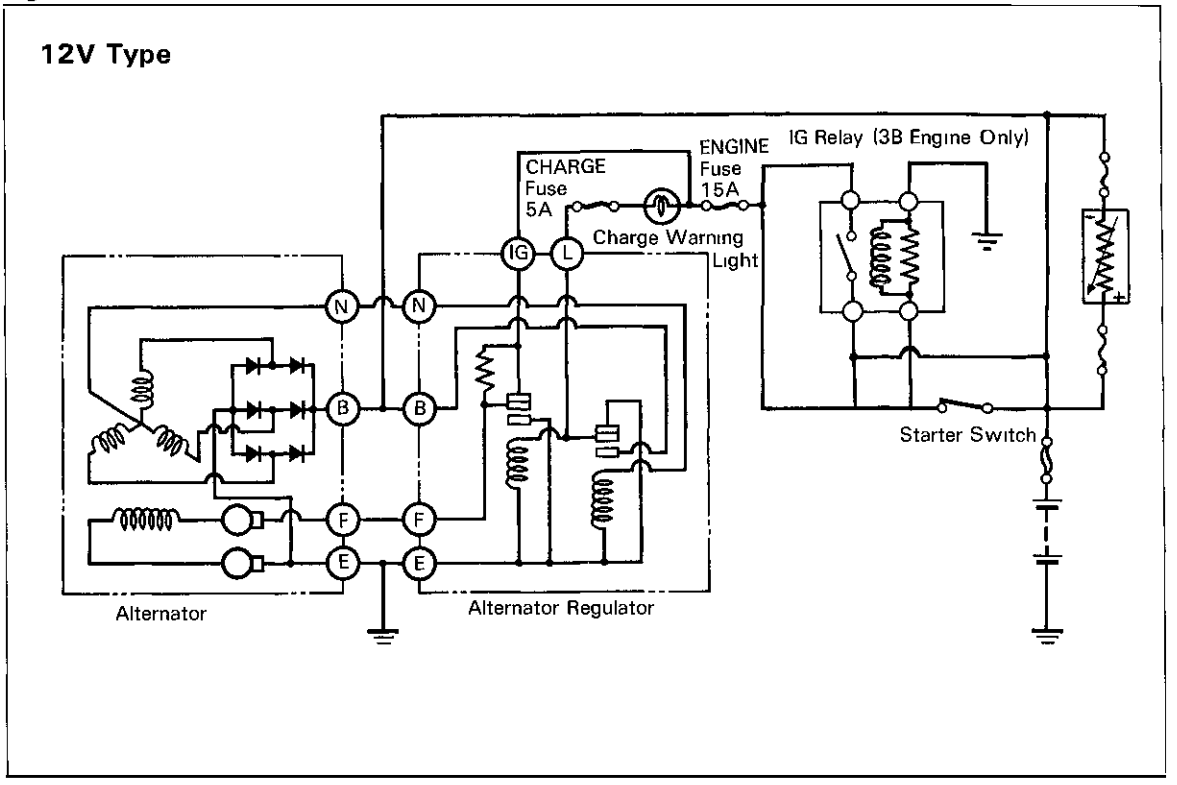

12V Type
CHARGE
Fuse
5A
ENGINE
Fuse
15A
IG Relay (3B Engine Only)
Charge Warning
Light
IG
L
N
N
B
B
F
F
E
E
Starter Switch
Alternator
Alternator Regulator

Fig. 9-3

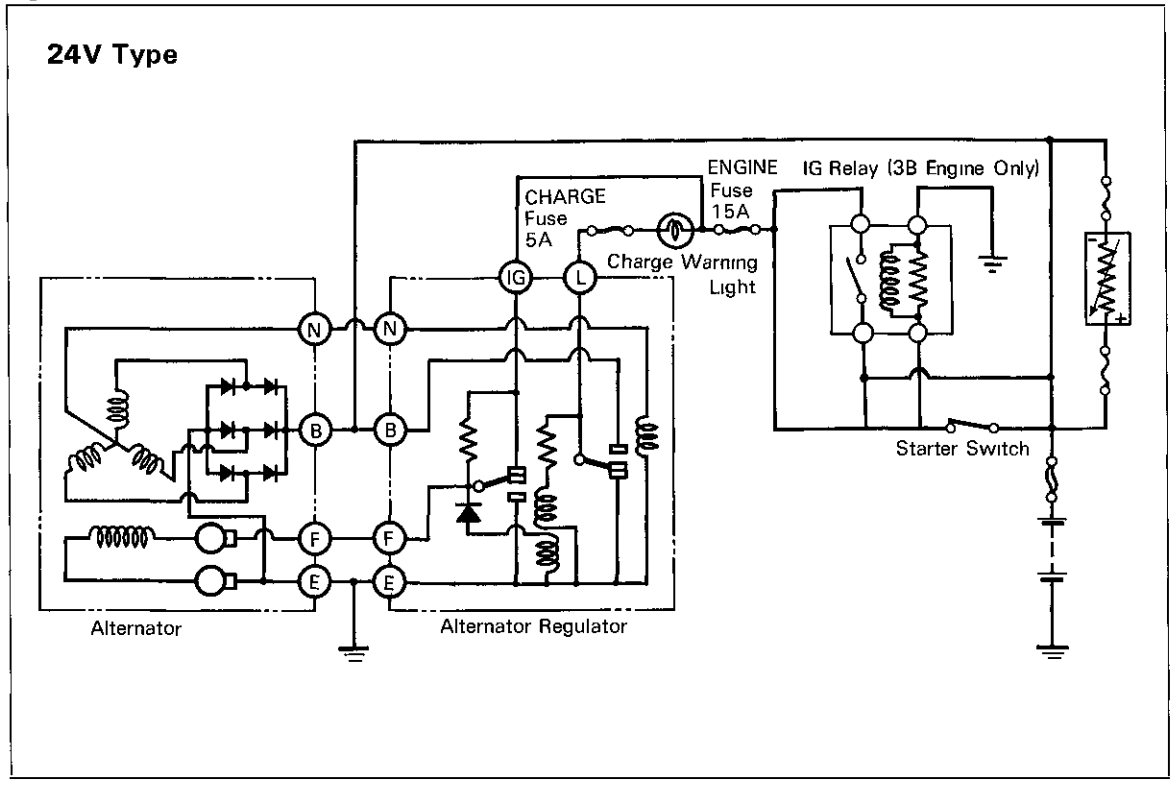

24V Type
CHARGE
Fuse
5A
ENGINE
Fuse
15A
IG Relay (3B Engine Only)
Charge Warning
Light
IG
L
N
N
B
B
F
F
E
E
Starter Switch
Alternator
Alternator Regulator

Fig. 9-4 **With IC Regulator Type**

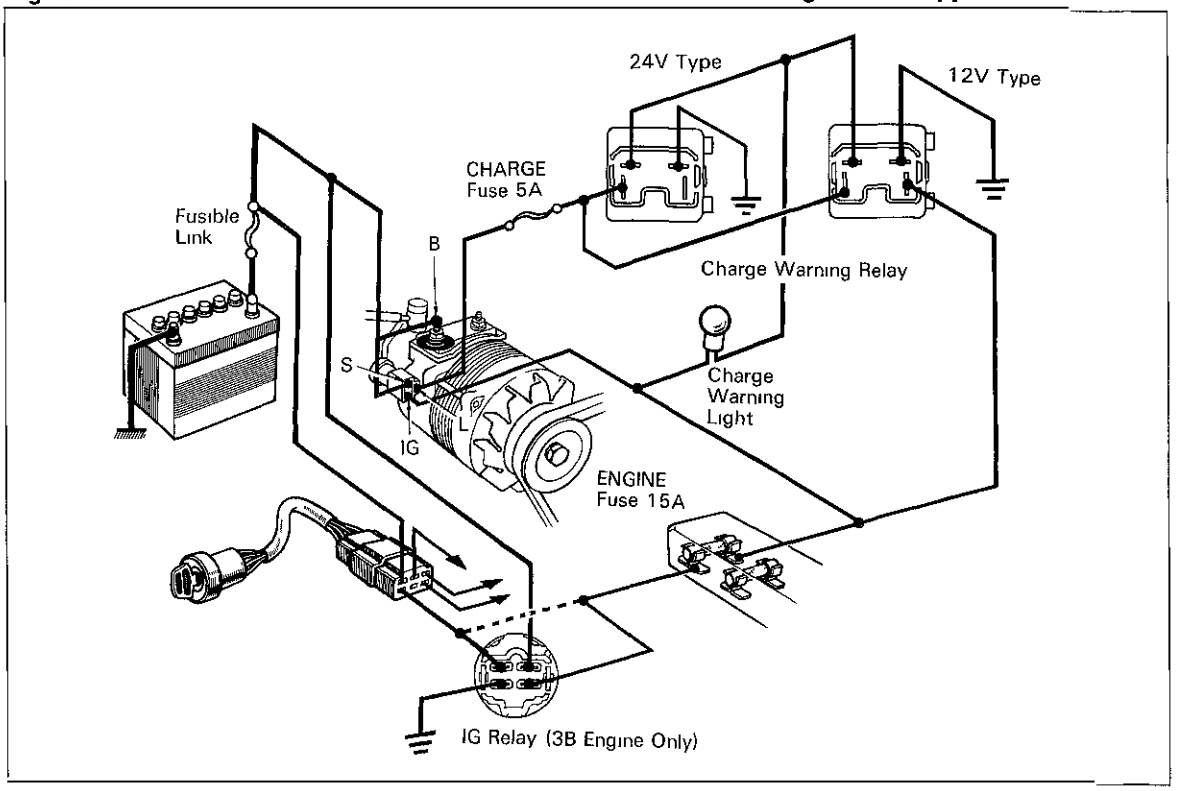


Fig. 9-5

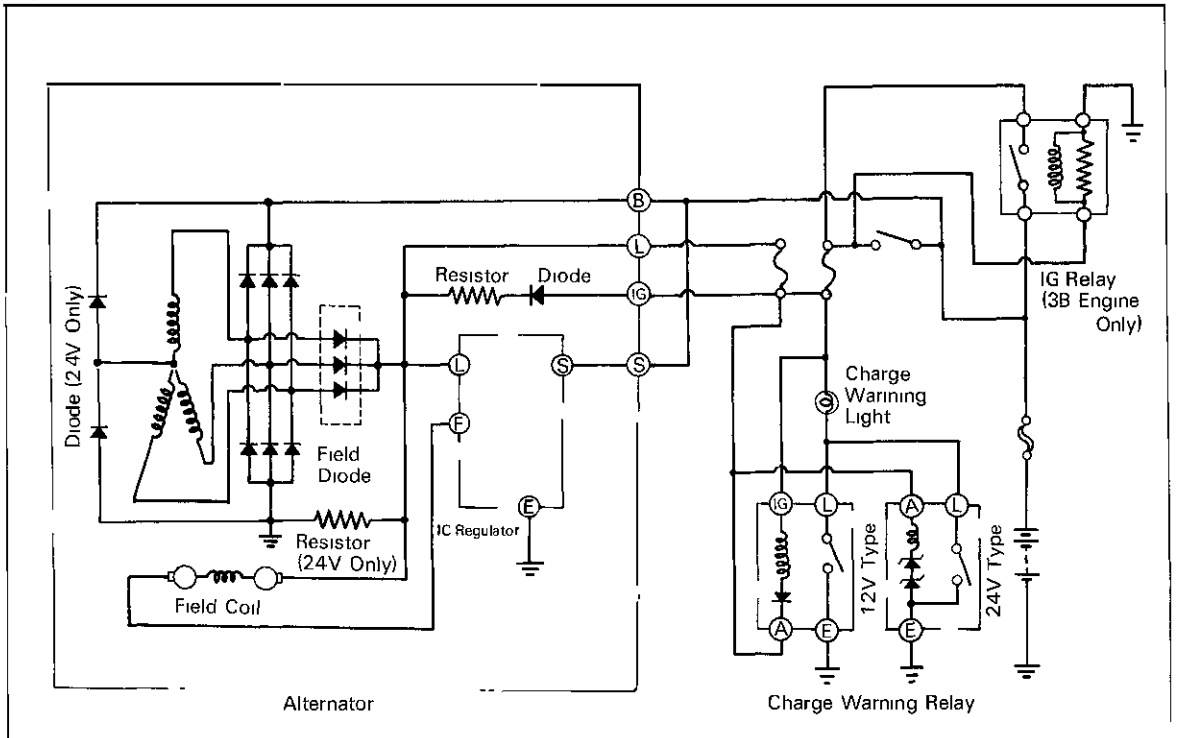
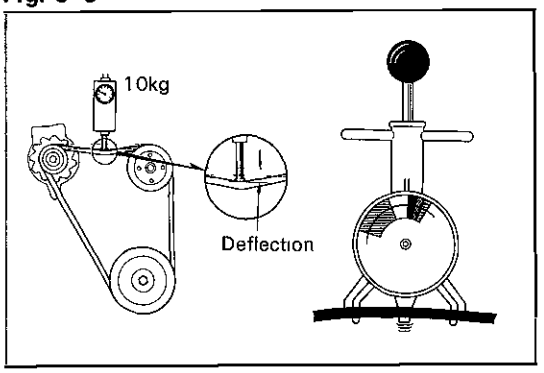


Fig. 9-6



ON-VEHICLE INSPECTION

[Tirrill Regulator Type]

CHECK FOLLOWING ITEMS

1 Drive belt tension

For General

Drive belt tension:

w/o Air cond.

New belt 8 — 12 mm at 10 kg (0.31 — 0.47 in.) (22 lb)

Used belt 11 — 14 mm at 10 kg (0.43 — 0.55 in.) (22lb)

w/ Air cond. (BB10)

New belt 10 — 13 mm at 10 kg (0.39 — 0.51 in.) (22lb)

Used belt 12 — 15 mm at 10 kg (0.47 — 0.59 in.) (22lb)

For Canada

Using a borroughs tension gauge, BT 33 73F, adjust as follows

Driven belt tension:

New belt 120 — 170 lb

Used belt 80 — 120 lb

Fig. 9-7

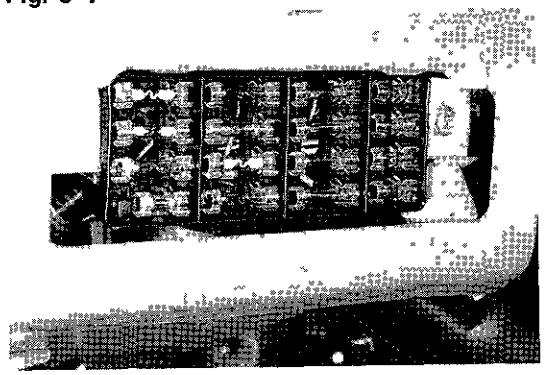
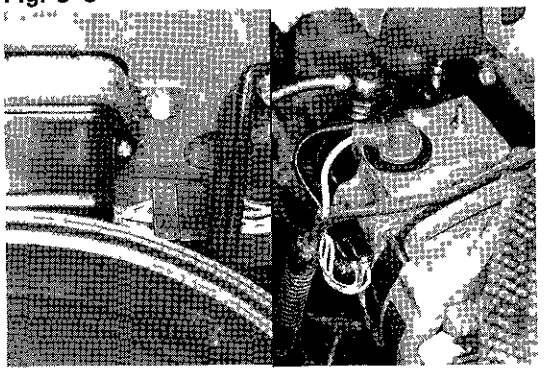


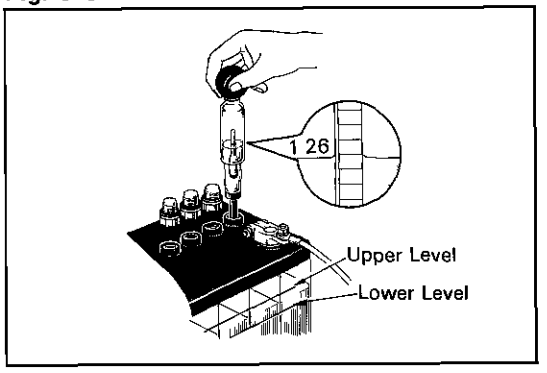
Fig. 9-8



2 Fuses

3 Installed condition of wiring for alternator and regulator

Fig. 9-9



4 Battery terminal and fusible link

Loose

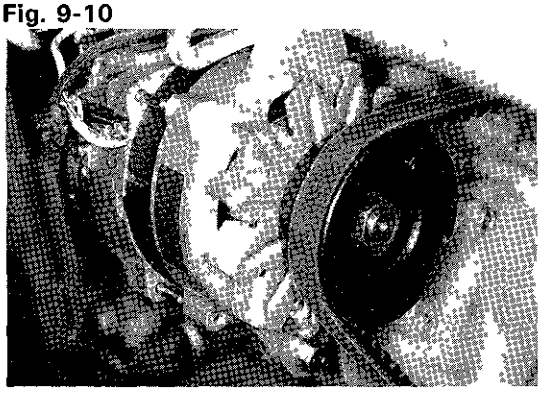
Corroded

Burnt

Specific gravity

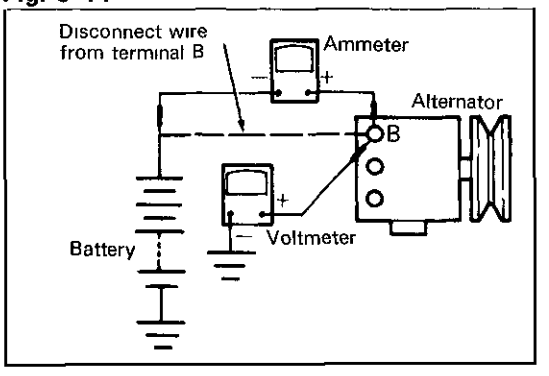
1.25 — 1.27 at 20°C (68°F)

Fig. 9-10



5 Alternator on-vehicle condition
Abnormal noise from alternator when engine is running

Fig. 9-11



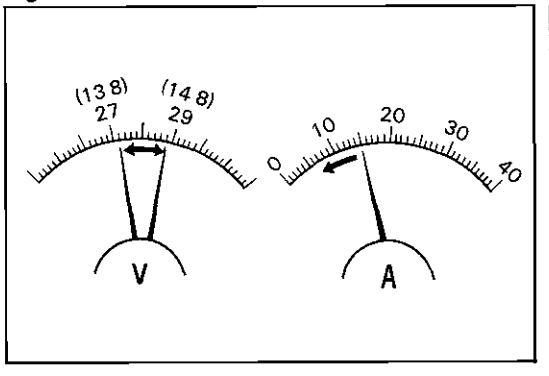
PERFORMANCE TEST BY VOLTMETER & AMMETER

Connect the voltmeter and ammeter as follows

Ammeter (+) ——→ Alternator terminal B
Ammeter (—) ——→ Wire terminal B
Voltmeter (+) ——→ Alternator terminal B
Voltmeter (—) ——→ Ground

—Note—
Be careful not to cause a short.

Fig. 9-12

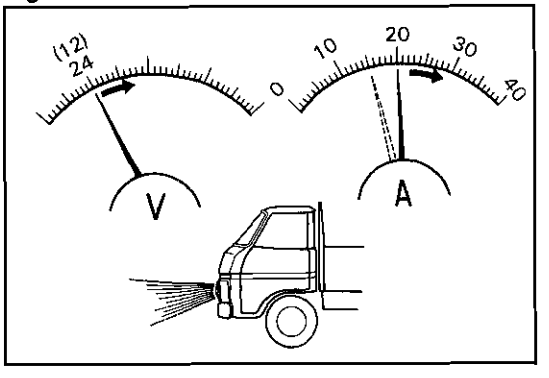


No-load Performance Test

Check the current and voltage

Voltage:
12V Type 13.8 – 14.8V
24V Type 27 – 29V
Current: Less than 15A
Engine speed: Idling to 2,000 rpm

Fig. 9-13

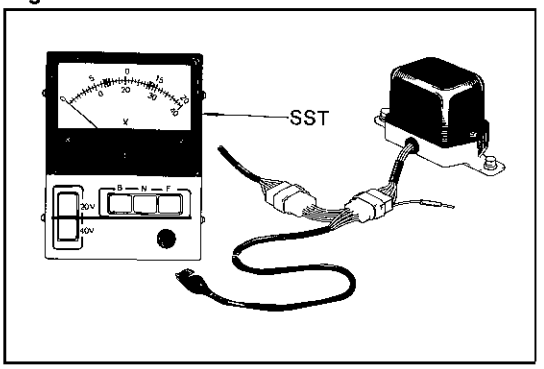


Load Performance Test

1 Run engine at 2 000 rpm
2 Turn on headlights and all accessories

Voltage:
12V Type 13.8 – 14.8V
24V Type 27 – 29V
Current:
24V, 20A Type
More than 15A
Others
More than 20A

Fig. 9-14



PERFORMANCE TEST WITH SST (ALTERNATOR CHECKER)

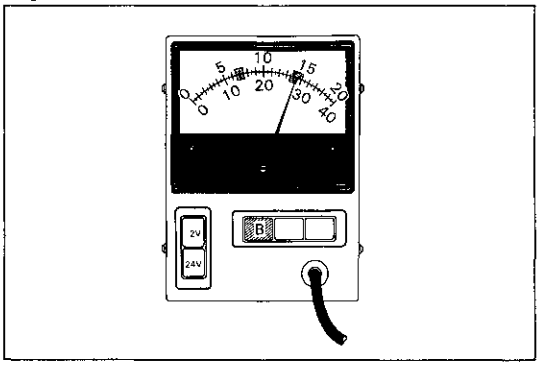
Disconnect the alternator regulator connector and connect SST

SST [09081-00011]

12V Type alternator
Push 20V switch.

24V Type alternator
Push 40V switch.

Fig. 9-15



1 Check terminal B voltage

Push B switch.

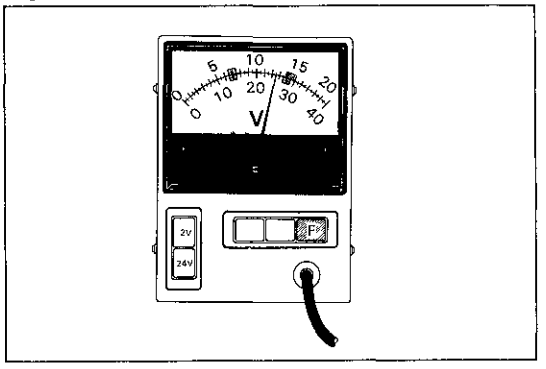
Raise engine speed from idling to 2 300 rpm

Voltage:

STD 12V Type 13.8 – 14.8V
24V Type 27 – 29V

If not within standard probable cause is the alternator regulator

Fig. 9-16



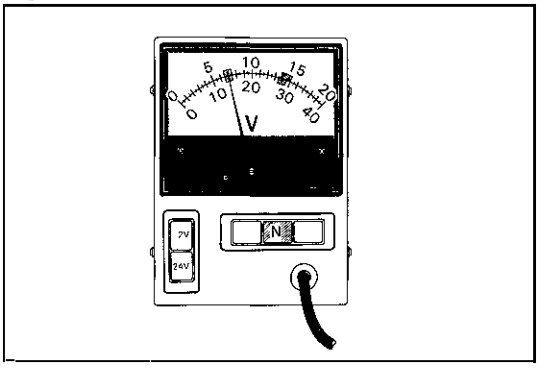
2 Check terminal F voltage

Push F switch.

Raise engine speed from idling to 2 000 rpm The checker reading should gradually decrease to 3V

If no decrease probable cause is alternator regulator

Fig. 9-17



3 Check terminal N voltage

Push N switch.

Maintain engine speed at approximately 1 500 rpm The pointer should be at about half of the terminal B voltage

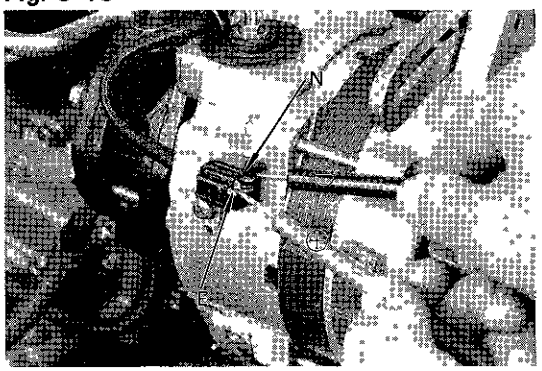
Voltage:

STD 12V Type 6.9 – 7.4 V
24V Type 13.5 – 14.5 V

If the voltage is higher the cause is the (+) rectifier

If the voltage is lower the cause is the (–) rectifier

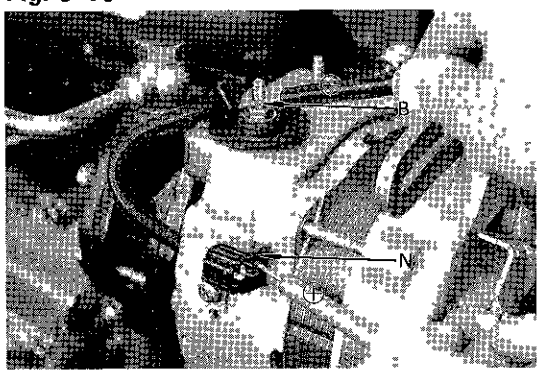
Fig. 9-18



ALTERNATOR INSPECTION

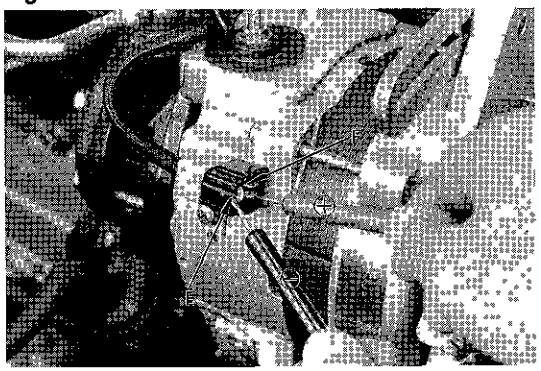
1 Negative side rectifier short test
Connect an ohmmeter ⊖ lead to terminal N and the ⊕ lead to terminal E
The meter should indicate infinity

Fig. 9-19



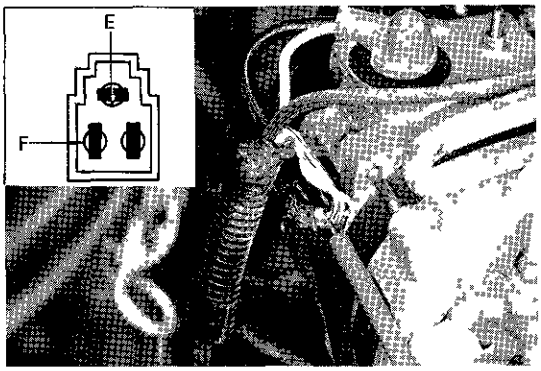
2 Positive side rectifier short test
Connect an ohmmeter ⊖ lead to terminal B and the ⊕ lead to terminal N
The meter should indicate infinity

Fig. 9-20



3 Check the rotor coil resistance
Resistance:
12V Type 2.8 — 3.0 Ω
24V Type 19.0 Ω

Fig. 9-21



4 Turn the starter switch to ON position, and check to see if there is battery voltage at terminal F
If not, check the ENGINE fuse

Fig. 9-22

SEE

CHARGING SYSTEM

ON-VEHICLE INSPECTION

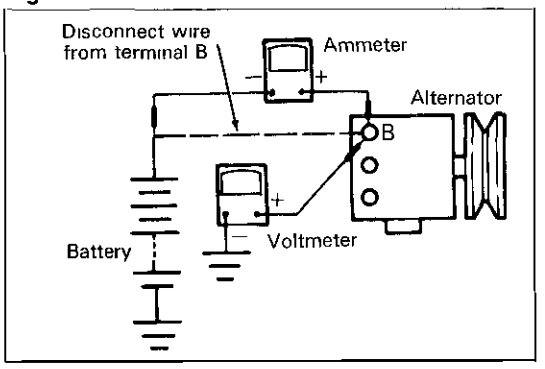
Fig. 9-6 to 9-10

[With IC Regulator Type]

CHECK FOLLOWING ITEMS

1 Drive belt tension
2 Fuses
3 Installed condition of wiring for alternator
4 Battery terminal and fusible link

Fig. 9-23



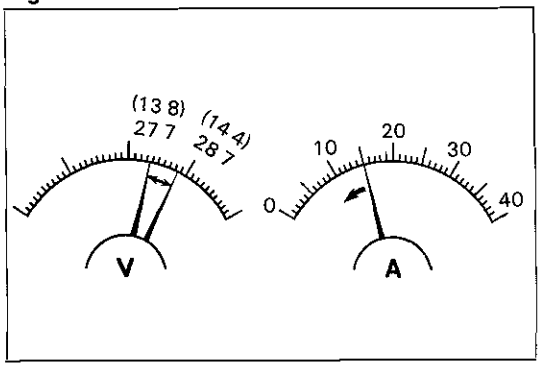
PERFORMANCE TEST

Connect the voltmeter and ammeter as follows

Ammeter (+) ——→ Alternator terminal B
Ammeter (—) ——→ Wire terminal B
Voltmeter (+) ——→ Alternator terminal B
Voltmeter (—) ——→ Ground

—Note—
Be careful not cause a short.

Fig. 9-24

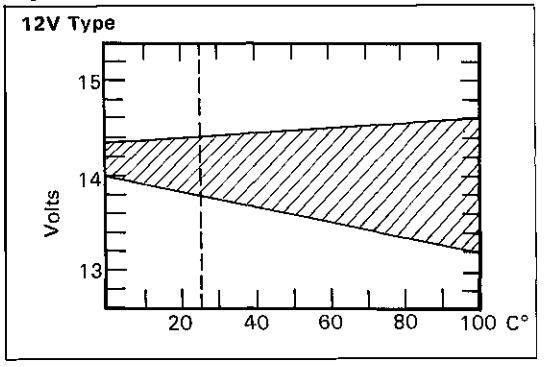


No-load Performance Test

Check the current and voltage

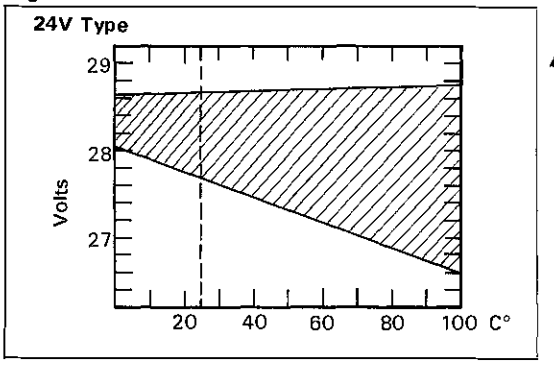
Voltage:
12V Type 13.8 —14.4V
24V Type 27.7 — 28.7V
Current: Less than 15A
Engine speed: Idling to 2,000 rpm

Fig. 9-25



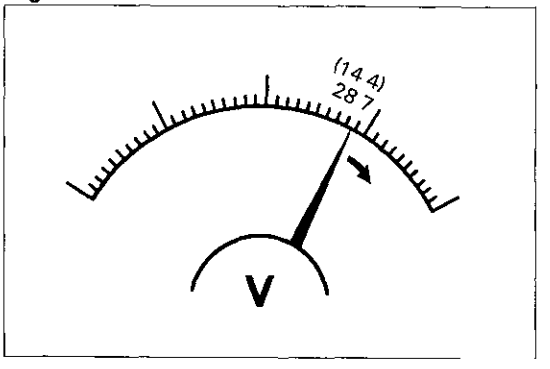
—Note—
If the temperature is not 25°C (77°F), find the voltage limits in the chart for the correct temperature.

Fig. 9-26



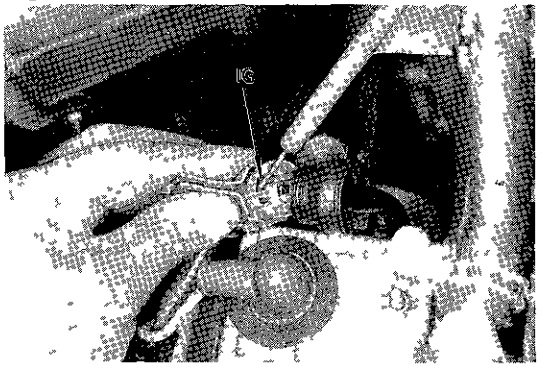
—Note—
If the temperature is not 25°C (77°F), find the voltage limits in the chart for the correct temperature.

Fig. 9-27



If the voltage reading is greater than 14.4 (12V Type) or 28.7V (24V Type), replace the IC regulator

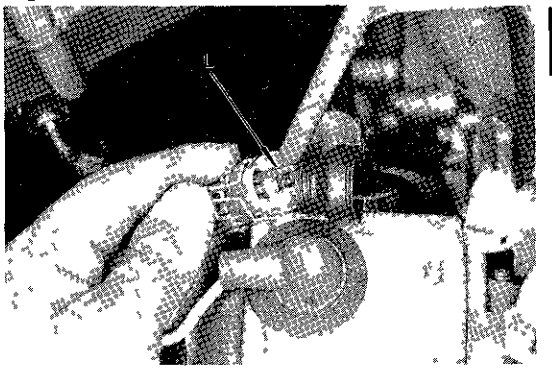
Fig. 9-28



If the voltage reading is less than 13.8 (12V Type) or 27.7V (24V Type), check the alternator and IC regulator

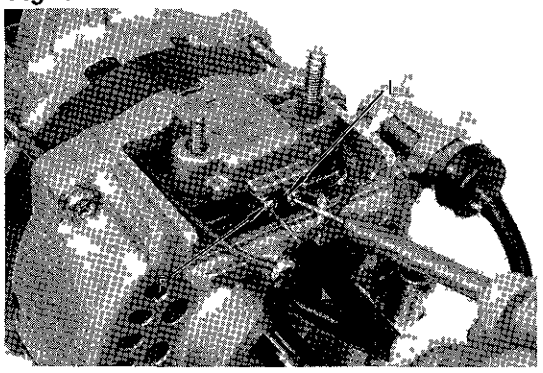
1 Turn the starter switch to ON position
2 Check the voltage reading at the alternator terminal IG
If no voltage, check the engine fuse and/or starter switch

Fig. 9-29



3 Check the voltage reading at the alternator terminal L
If the voltage reading is less than 4V, check the alternator

Fig. 9-30



4 If the voltage is same as battery voltage disassemble the alternator and check the continuity between terminals L and F

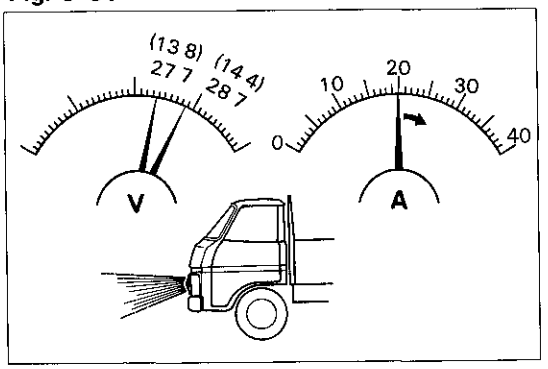
No continuity—Check the alternator

Continuity

(12V Type Approx: 2.8 – 3.0Ω
24V Type Approx: 19.0Ω)

– Replace the IC regulator

Fig. 9-31



Load Performance Test

1 Run engine at 2 000 rpm

2 Turn on headlights and all accessories

Voltage:

12V Type 13.8 – 14.4V

24V Type 27.7 – 28.7V

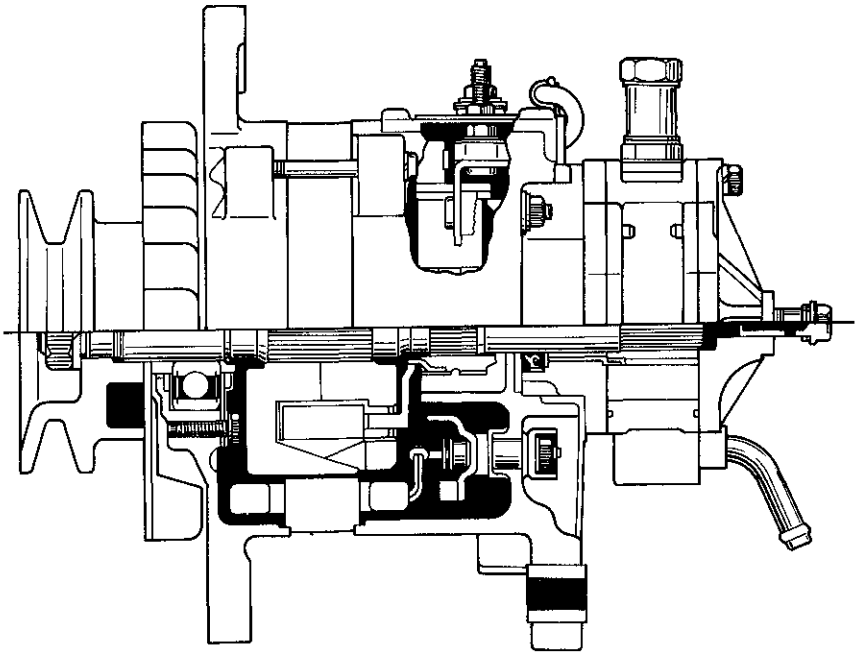
Current: More than 20A

ALTERNATOR

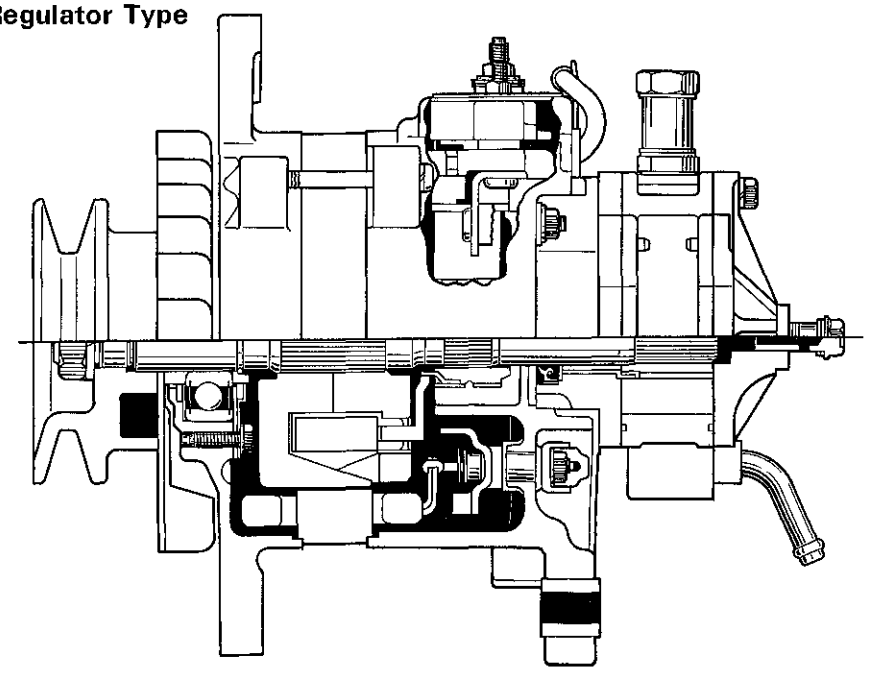
CUTAWAY VIEW

Fig. 9-32

Tirrill Regulator Type



With IC Regulator Type

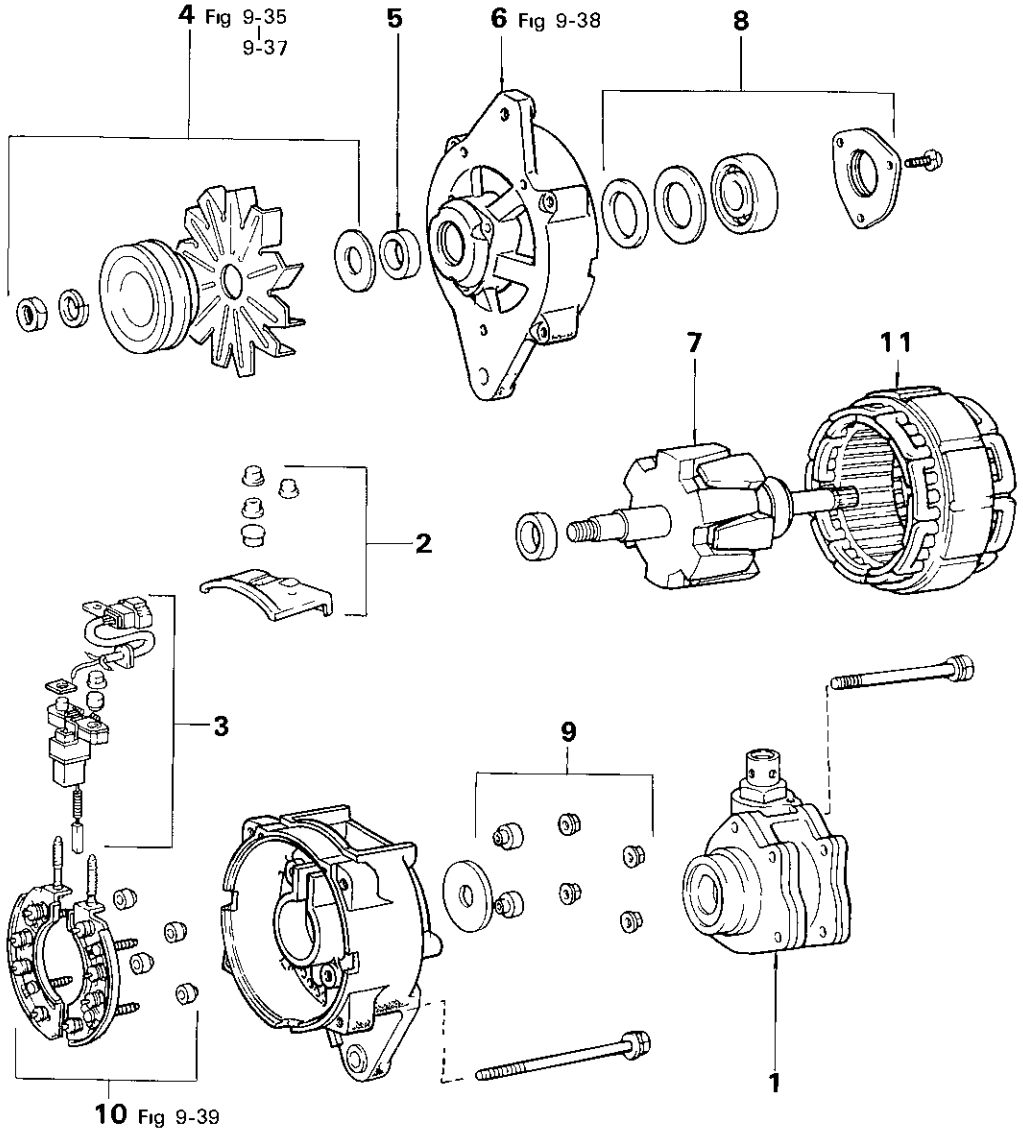


DISASSEMBLY

Disassemble the parts in the numerical order shown in the figure

Fig. 9-33

For Tirrill Regulator Type

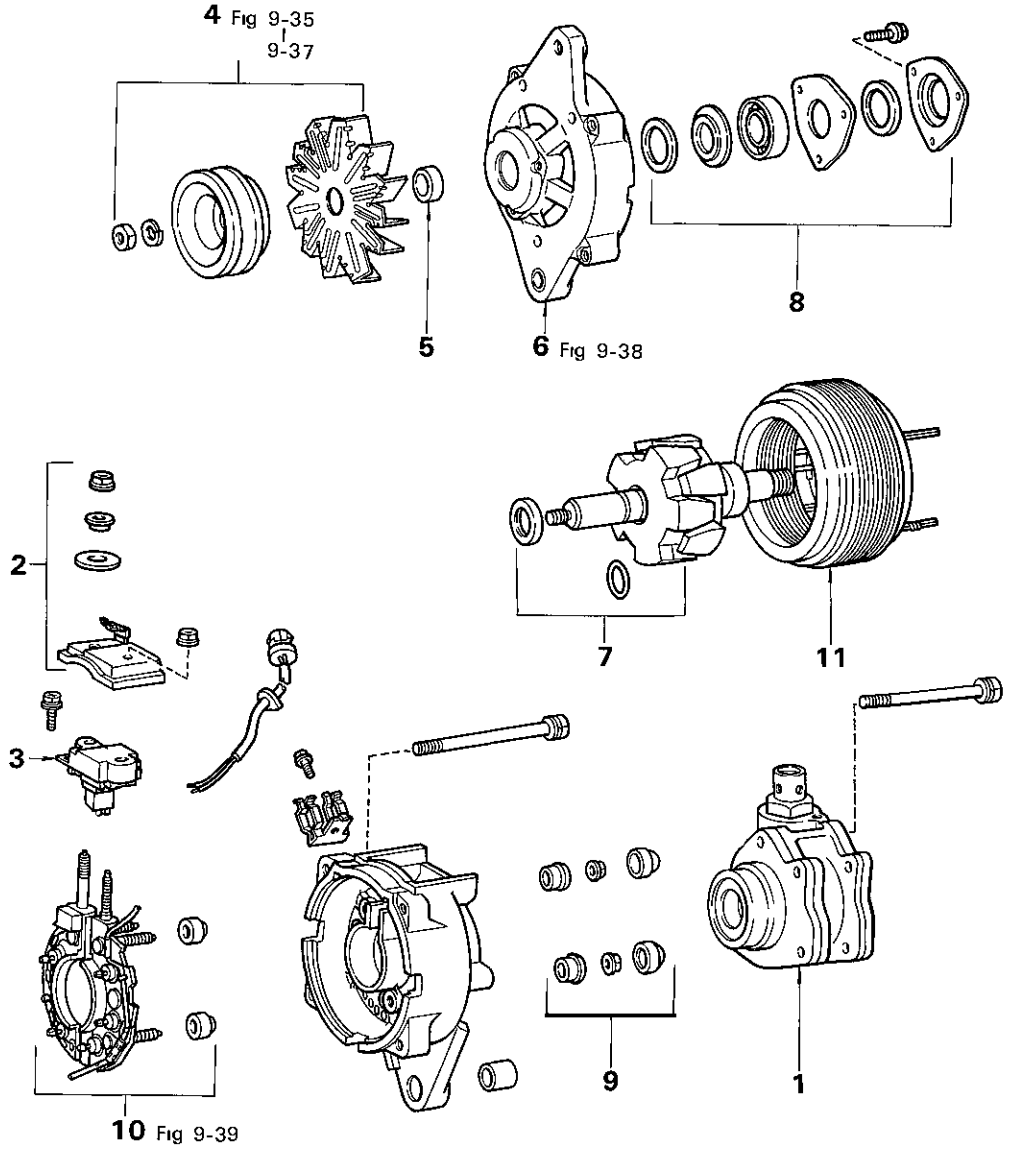


1	Vacuum Pump	7	Rotor
2	Brush Cover	8	Front Bearing
3	Brush Holder & Terminal	9	Insulator & Nut
4	Pulley & Fan	10	Rectifier Holder & Insulator
5	Collar	11	Stator Coil
6	Drive End Frame		

Disassemble the parts in the numerical order shown in the figure

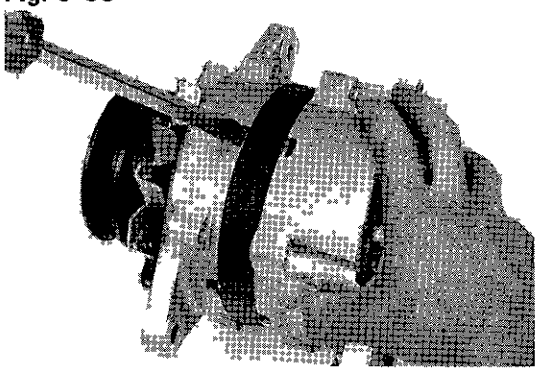
Fig. 9-34

For Alternator with IC Regulator Type



1	Vacuum Pump	7	Rotor
2	Brush Cover	8	Front Bearing
3	Brush Holder with IC Regulator	9	Insulator & Nut
4	Pulley & Fan	10	Rectifier Holder & Insulator
5	Collar	11	Stator Coil
6	Drive End Frame		

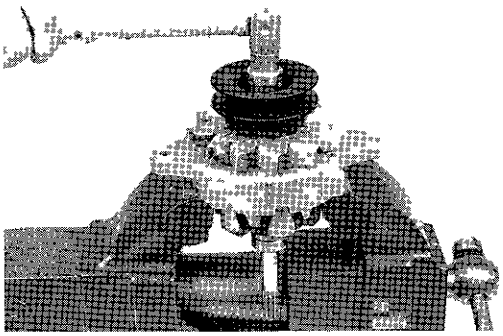
Fig. 9-35



Pry off the drive end frame from the stator

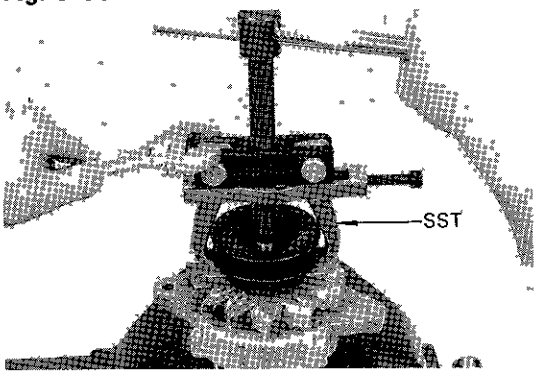
–Note–
Do not damage the coil wires.

Fig. 9-36



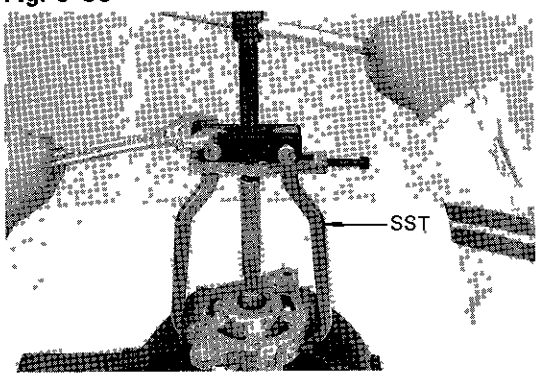
Using a soft jaw vise, loosen the pulley nut

Fig. 9-37



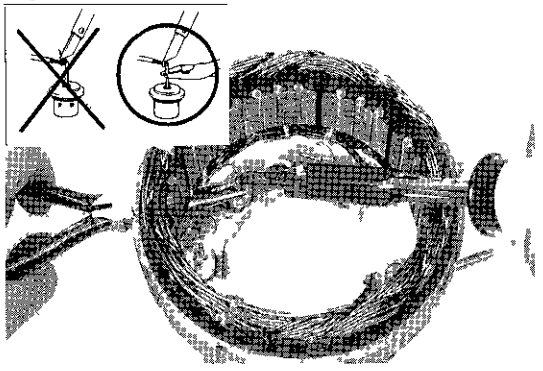
Remove the pulley with SST
SST [09950-20014]

Fig. 9-38



Remove the drive end frame with SST
SST [09950 20014]

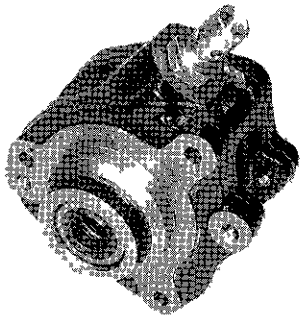
Fig. 9-39



Disconnect the stator coil from the rectifier holder by melting the solder

—Note—
When unsoldering the leads, hold the rectifier lead with a long nose pliers to protect the rectifier from heat.

Fig. 9-40

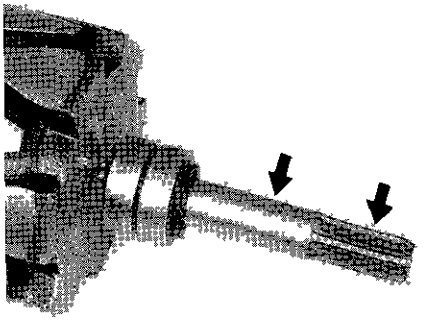


INSPECTION

Vacuum Pump

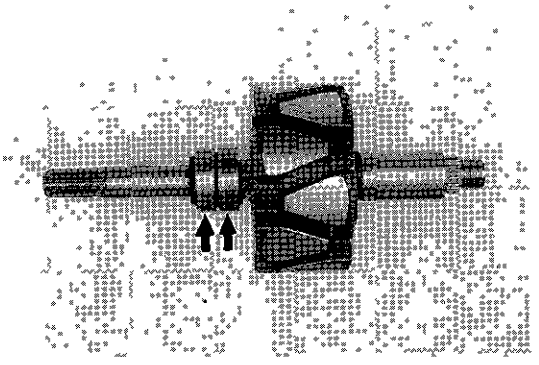
1 Check the oil seal spline and bushing for wear or damage

Fig. 9-41



2 Check the journal and spline teeth for wear

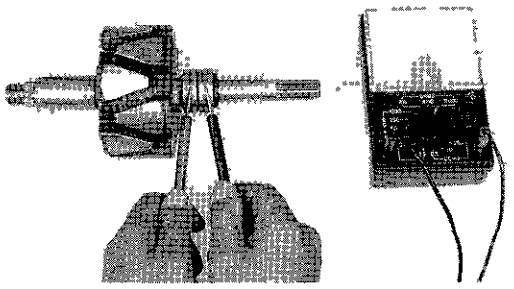
Fig. 9-42



Rotor

1 Check the slip ring for dirt or burns

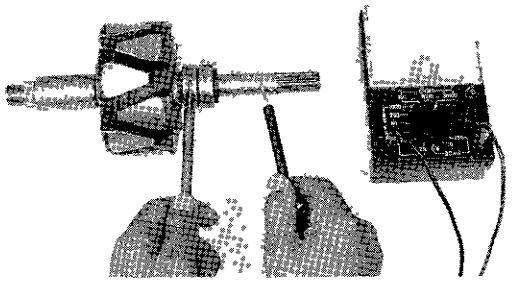
Fig. 9-43



2 Open circuit test
Measure the resistance between both slip rings

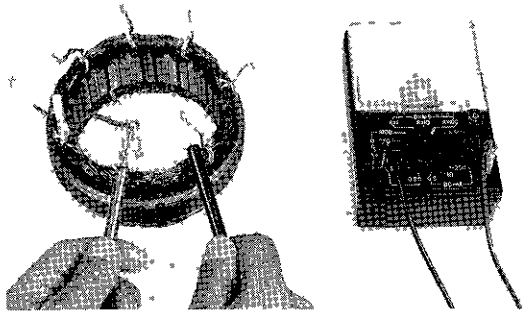
Resistance:
12V Type 2.8 – 3.0 Ω
24V Type 19.0 Ω

Fig. 9-44



3 Ground test
Check that there is no continuity between the slip ring and rotor

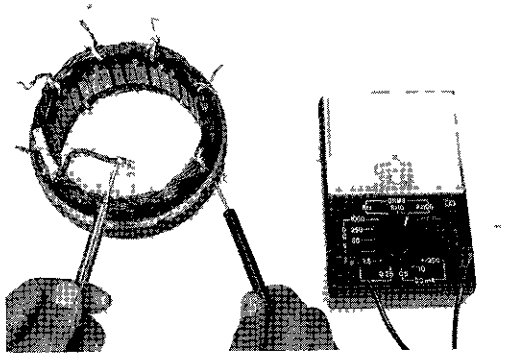
Fig. 9-45



Stator

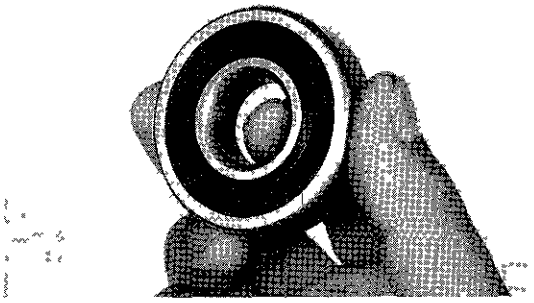
1 Open circuit test
Check that there is continuity between each coil lead

Fig. 9-46



2 Ground test
Check that there is no continuity between each coil lead and stator core

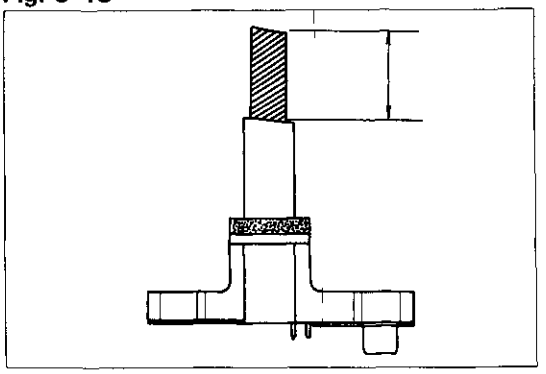
Fig. 9-47



Bearing

Check the bearing for wear or roughness

Fig. 9-48

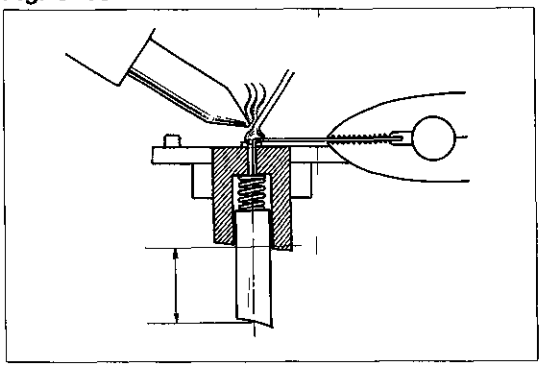


Brush & Brush Holder

1 Measure the exposed brush length

Exposed length:
Minimum 5.5 mm
(0.217 in.)

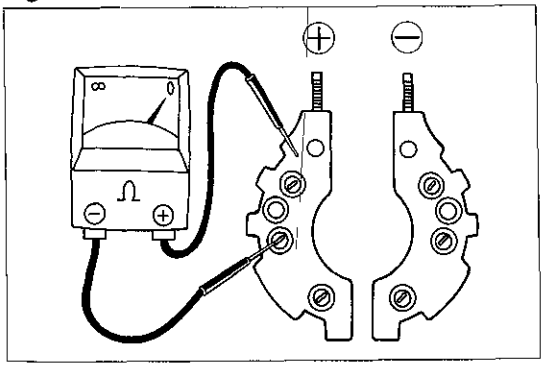
Fig. 9-49



2 When replacing the brushes assemble them as shown in the figure

Exposed length: 20.0 mm
(0.787 in.)

Fig. 9-50



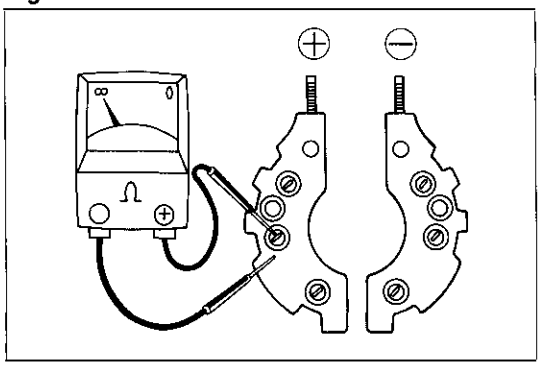
Rectifier

1 Rectifier holder positive side

Connect an ohmmeter ⊕ lead to the rectifier holder and the ⊖ lead to the rectifier terminal

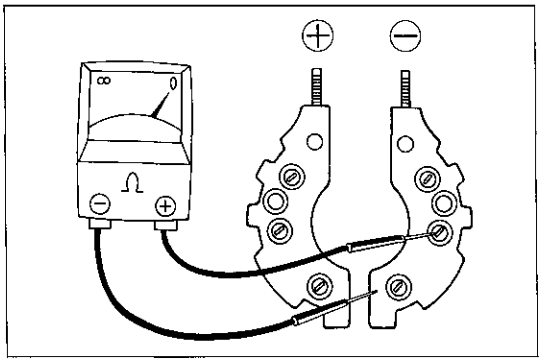
If there is no continuity the rectifier assembly must be replaced

Fig. 9-51



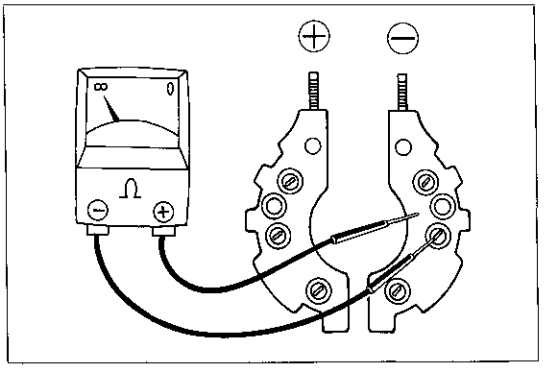
2 Reverse the polarity of the test leads and check again
If there is continuity the rectifier assembly must be replaced

Fig. 9-52



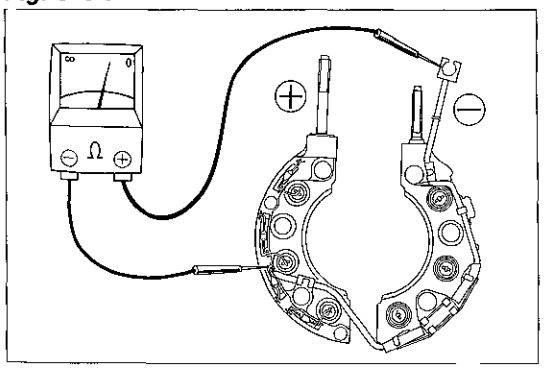
3 Rectifier holder negative side
Connect an ohmmeter ⊕ lead to the rectifier terminal and the ⊖ lead to the rectifier holder
If there is no continuity the rectifier assembly must be replaced

Fig. 9-53



4 Reverse polarity of the test leads and check again
If there is continuity the rectifier assembly must be replaced

Fig. 9-54

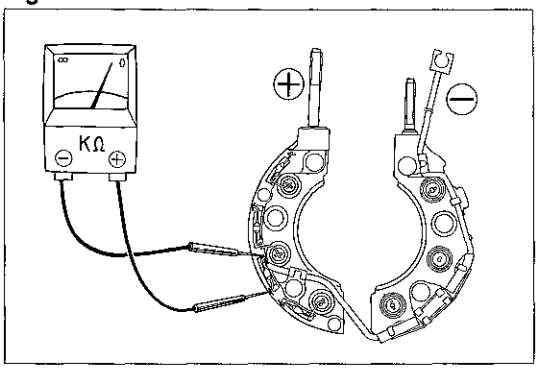


Resistor (for Alternator with IC Regulator)
Measure the resistance with an ohmmeter

Resistance:

12V Type	**19Ω**
24V Type	**150Ω**

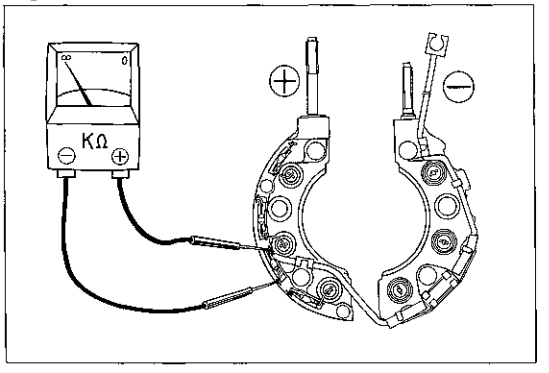
Fig. 9-55



Diode (for Alternator with IC Regulator)

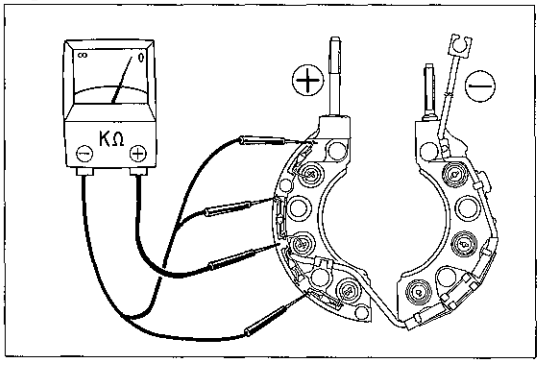
1 Connect an ohmmeter ⊕ lead to the resistor side and the ⊖ lead of the meter to the other side of the diode If there is no continuity rectifier assembly must be replaced

Fig. 9-56



2 Reverse polarity of test leads and check again If there is continuity the rectifier assembly must be replaced

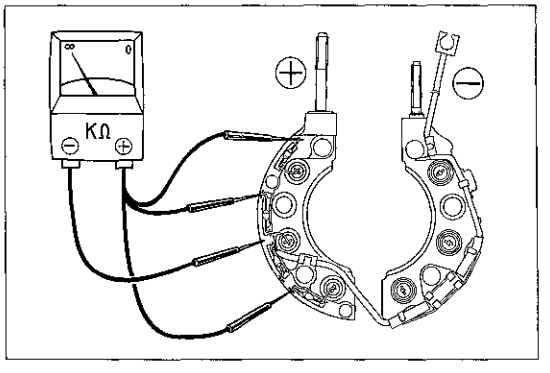
Fig. 9-57



Field Diodes (for Alternator with IC Regulator)

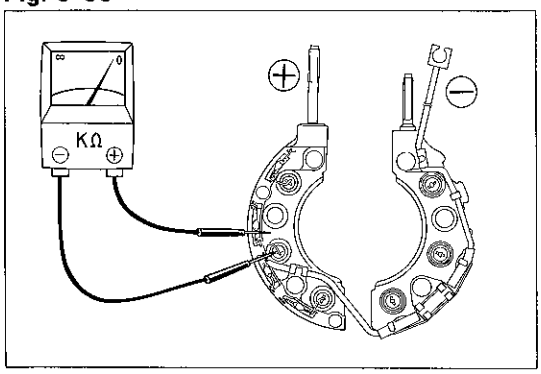
1 Connect an ohmmeter ⊕ lead to the rectifier holder and the ⊖ lead of the meter to the field diode terminal If there is no continuity rectifier assembly must be replaced

Fig. 9-58



2 Reverse polarity of test leads and check again If there is continuity the rectifier assembly must be replaced

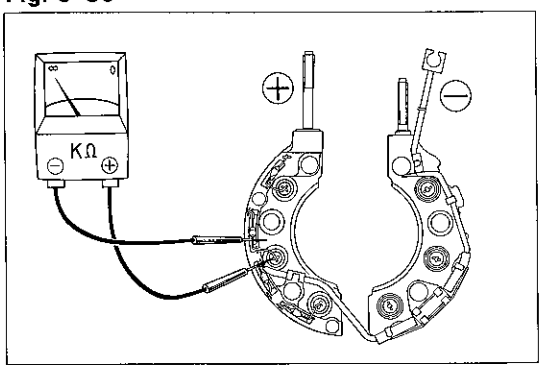
Fig. 9-59



Rectifier (for Alternator with IC Regulator)

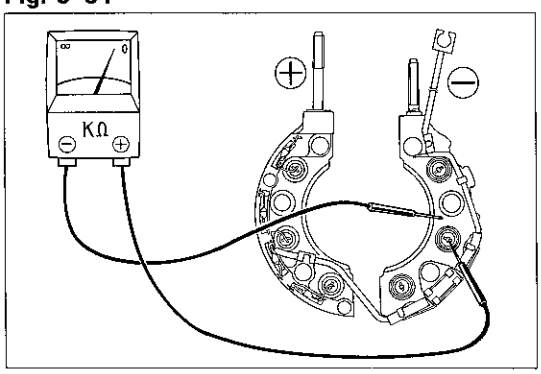
1 Rectifier holder positive side
Connect an ohmmeter ⊕ lead to the rectifier holder and the ⊖ lead of the meter to the rectifier terminal If there is no continuity the rectifier assembly must be replaced

Fig. 9-60



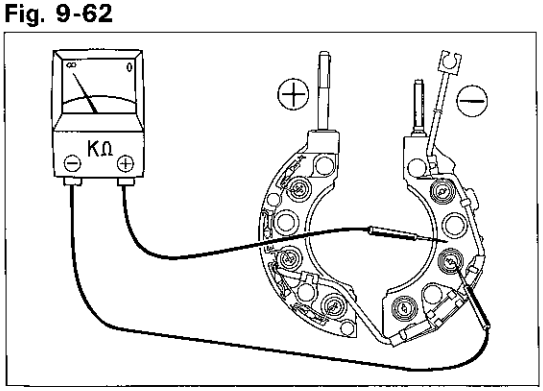
2 Reverse polarity of test leads and check again If there is continuity the rectifier assembly must be replaced

Fig. 9-61



3 Rectifier holder negative side
Connect an ohmmeter ⊕ lead to the rectifier terminal and the ⊖ lead of the meter to the rectifier holder If there is no continuity the rectifier assembly must be replaced

Fig. 9-62



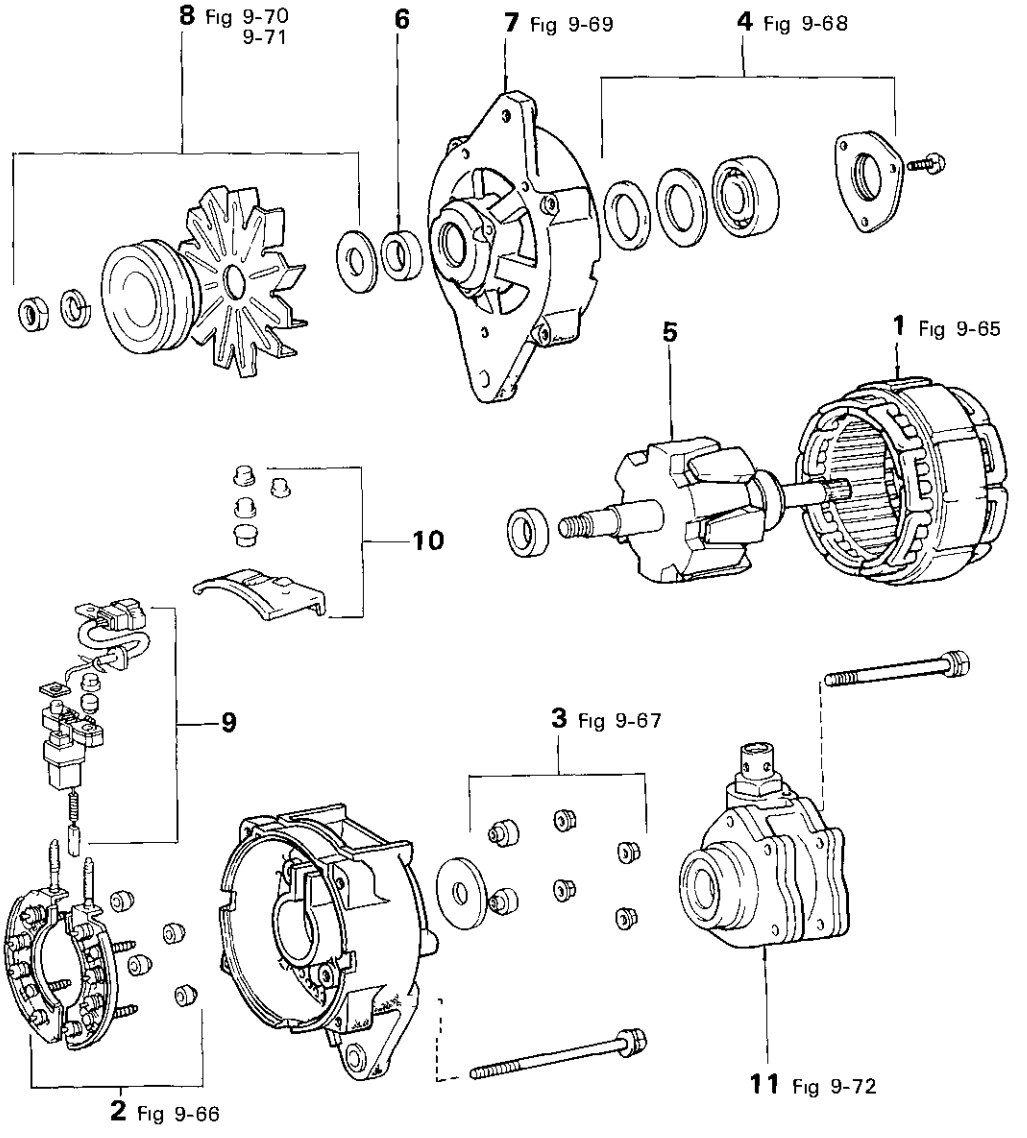
4 Reverse polarity of test leads and check again If there is continuity the rectifier assembly must be replaced

ASSEMBLY

Assemble the parts in the numerical order shown in the figure

Fig. 9-63

For Tirrill Regulator Type

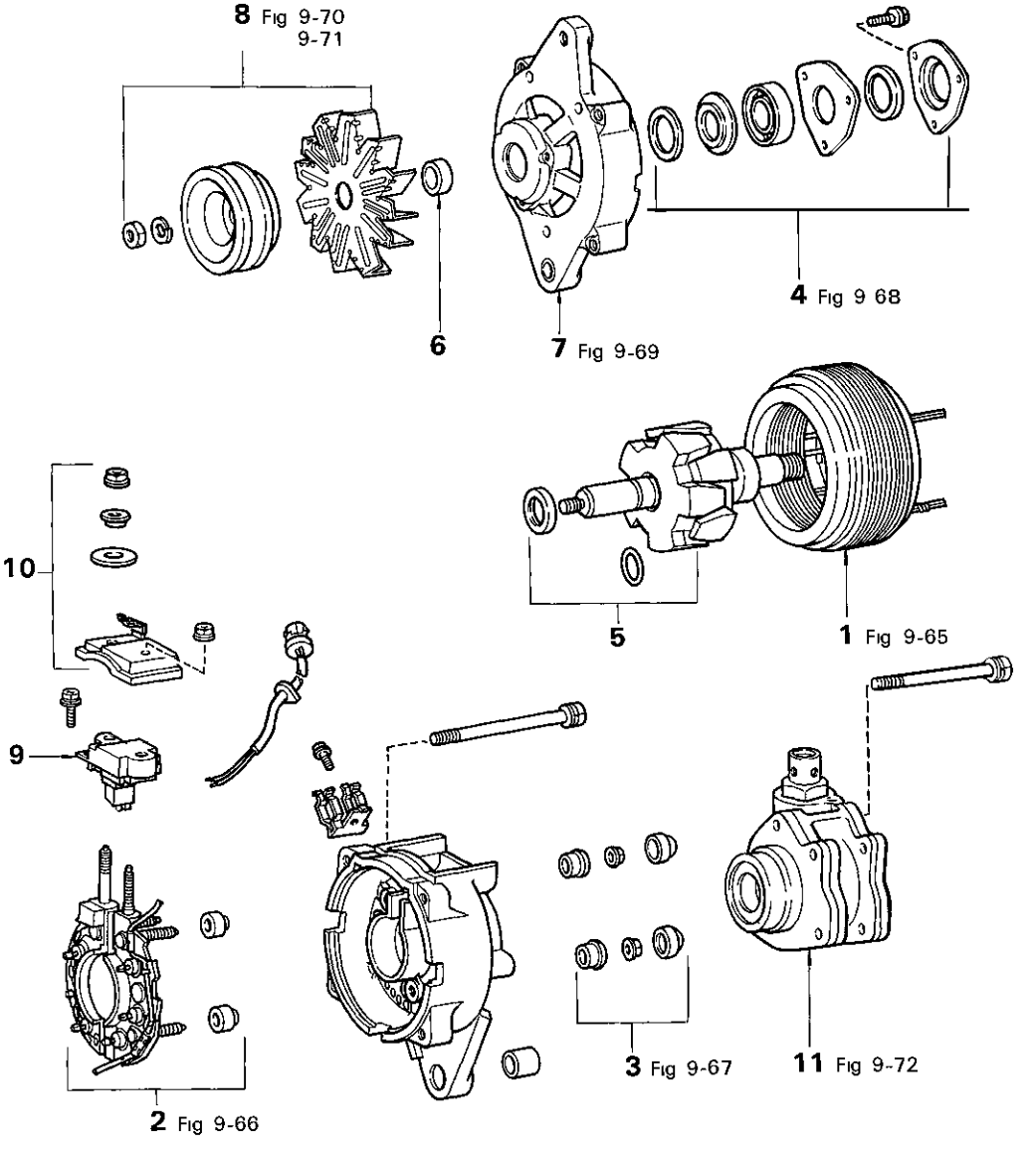


1	Stator Coil	7	Drive End Frame
2	Rectifier Holder & Insulator	8	Pulley & Fan
3	Insulator & Nut	9	Brush Holder & Terminal
4	Front Bearing	10	Brush Cover
5	Rotor	11	Vacuum Pump
6	Collar		

Assemble the parts in the numerical order shown in the figure

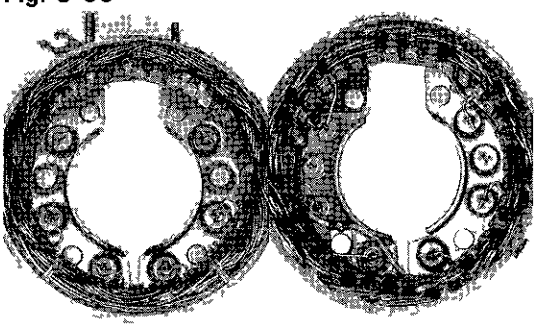
Fig. 9-64

For Alternator with IC Regulator



1	Stator Coil	7	Drive End Frame
2	Rectifier Holder & Insulator	8	Pulley & Fan
3	Insulator & Nut	9	Brush Holder with IC Regulator
4	Front Bearing	10	Brush Cover
5	Rotor	11	Vacuum Pump
6	Collar		

Fig. 9-65

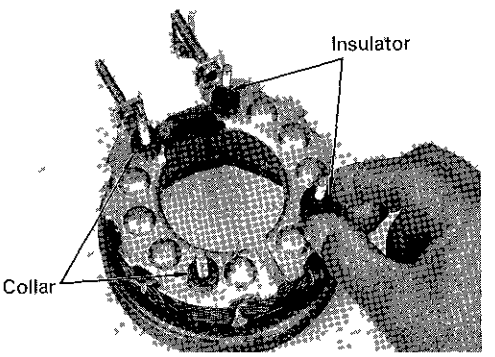


Tirrill Regulator Type w/ IC Regulator Type

Solder each lead wire onto the rectifier or terminal as shown in the figure

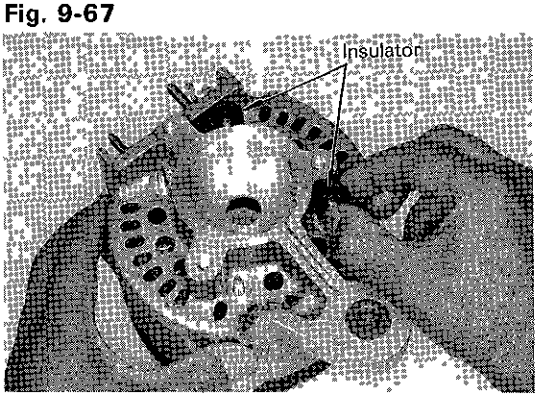
–Note–
When soldering the leads, hold the rectifier terminal with a long nose pliers to protect the rectifier from heat.

Fig. 9-66



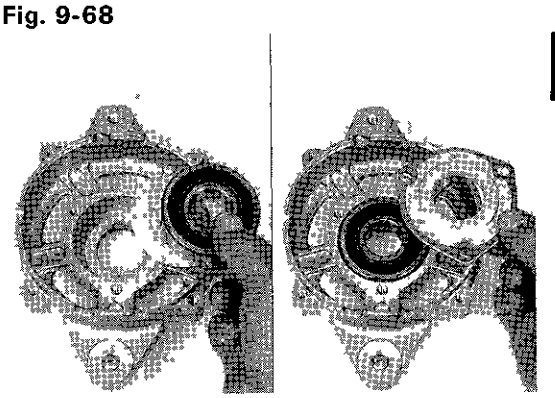
Install the insulator to the rectifier ⊕ holder and the collar to ⊖ holder

Fig. 9-67



Assemble the rectifier end frame with the insulators

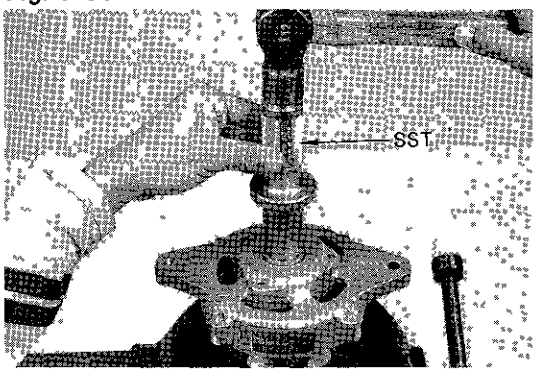
Fig. 9-68



Install the bearing and retainers

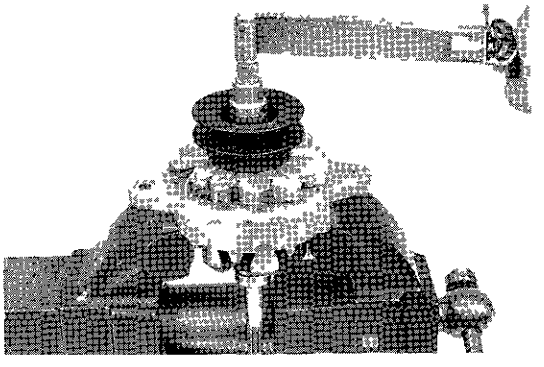
–Note–
Tap the bearing lightly with a plastic hammer if necessary.

Fig. 9-69



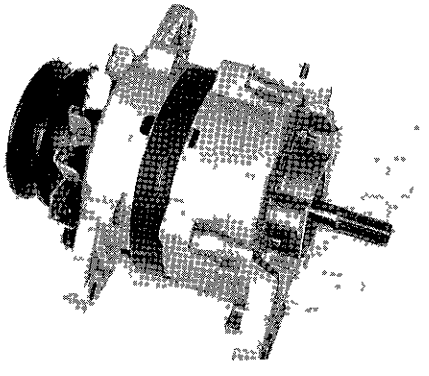
Insert the drive end frame together with a collar into the rotor with SST
SST [09325-12010]

Fig. 9-70



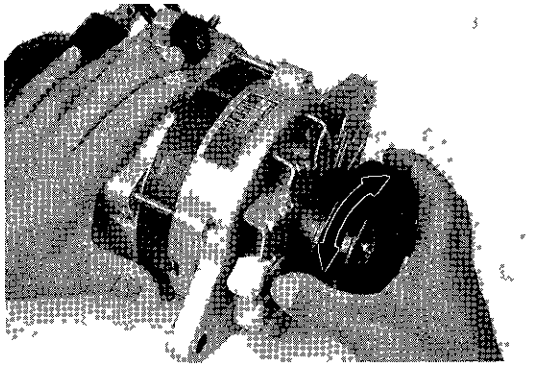
Using a soft jaw vise tighten the pulley nut
Tightening torque: 8.0 – 10.0 kg-m (58 – 72 ft-lb)

Fig. 9-71



Align the bolt hole of the drive end frame with that of rectifier end frame

Fig. 9-72



Check the rotor for smooth rotation after assembly is completed

ALTERNATOR REGULATOR

Fig. 9-73

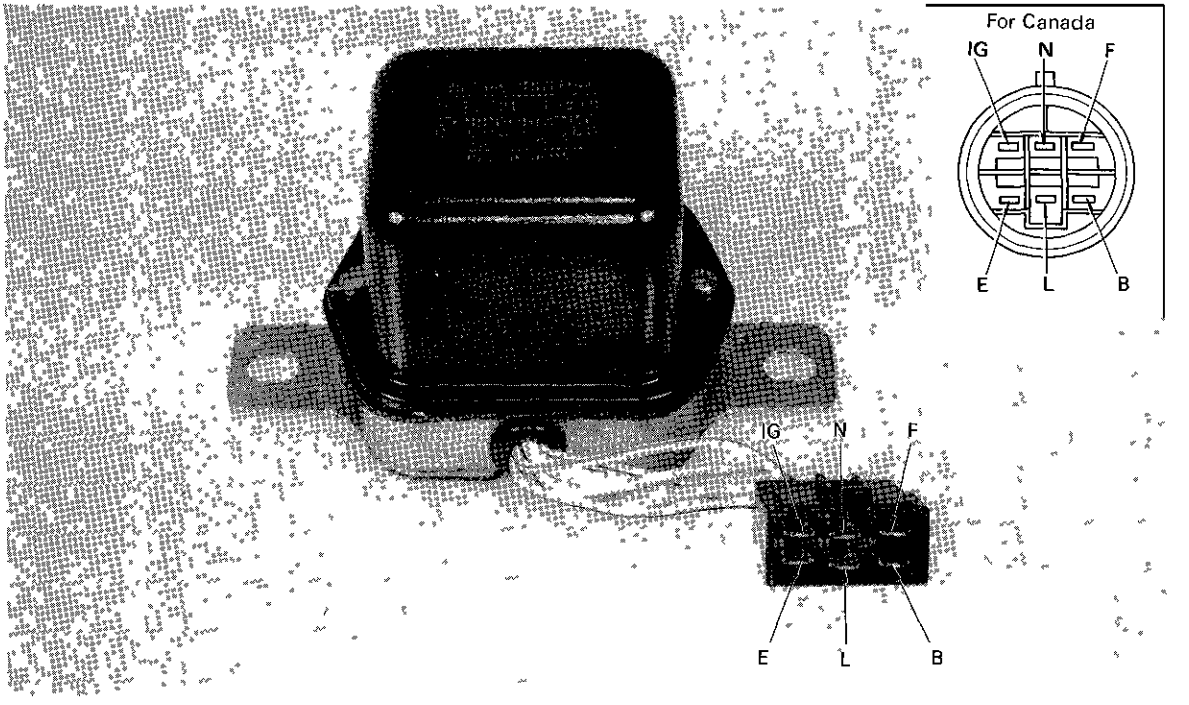
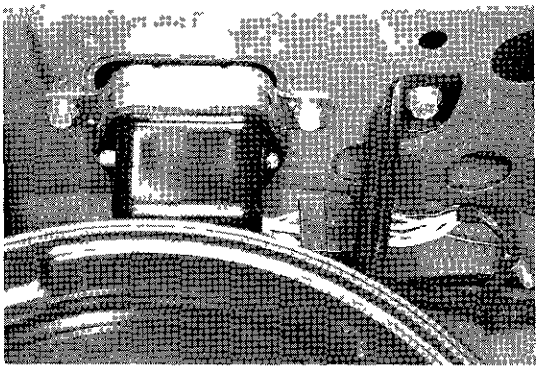


Fig. 9-74



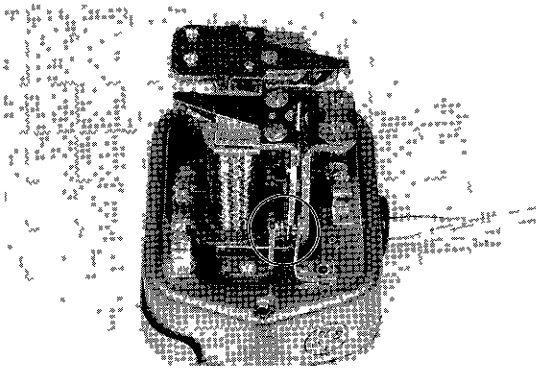
INSPECTION & ADJUSTMENT

Check the connector fitting condition before inspecting the regulator

—Note—

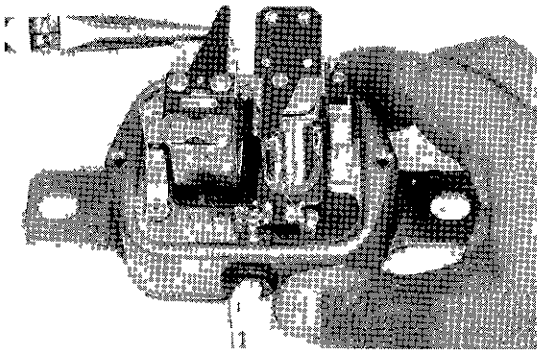
Always make sure that regulator connector is pulled out when inspecting and adjusting.

Fig. 9-75



Inspect each point surface for burns or damage. Replace if defective.

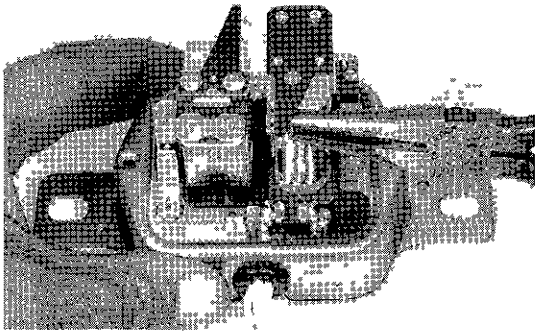
Fig. 9-76



Voltage adjustment
To adjust bend the voltage regulator adjusting arm

Regulated voltage:
12V Type 13.8 – 14.8V
24V Type 27 – 29V

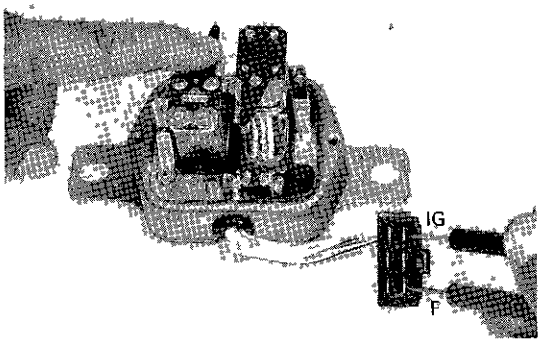
Fig. 9-77



To adjust the voltage relay, bend the relay adjusting arm

Relay actuating voltage:
12V Type 4.0 – 5.8V
24V Type 8.0 – 11.6V

Fig. 9-78

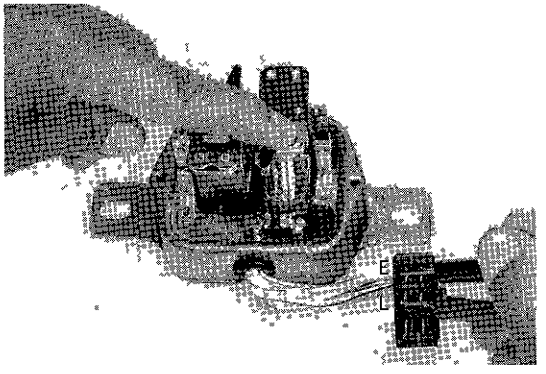


Resistance measurement between the terminals

IG – F

Voltage regulator	12V Type	24V Type
Open	0Ω	0Ω
Closed	Approx 11Ω	Approx 200Ω

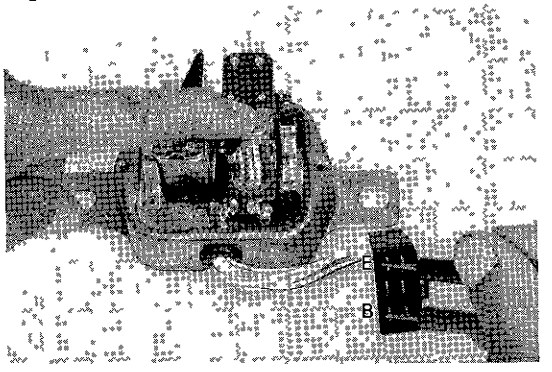
Fig. 9-79



L – E

Voltage relay	12V Type	24V Type
Open	0Ω	0Ω
Closed	Approx 100Ω	Approx 200Ω

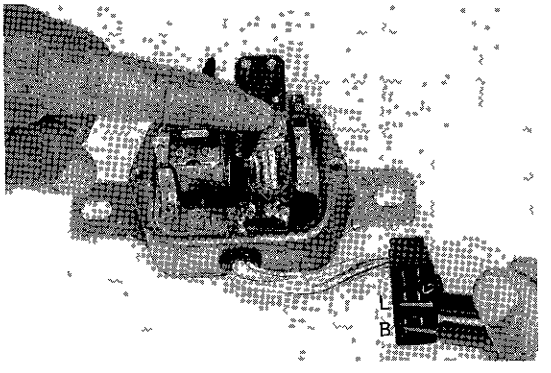
Fig. 9-80



B — E

Voltage relay	12V Type	24V Type
Open	Infinity	Infinity
Closed	Approx 100Ω	Approx 200Ω

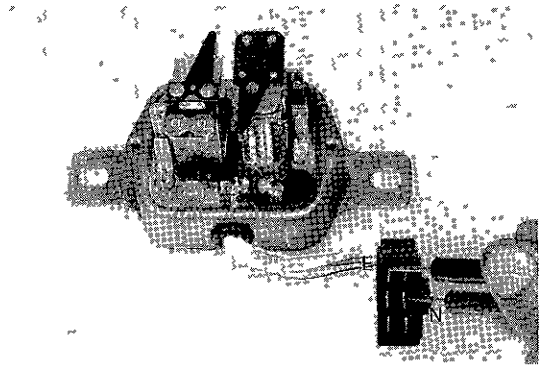
Fig. 9-81



B — L

Voltage relay	12V Type	24V Type
Open	Infinity	Infinity
Closed	0Ω	0Ω

Fig. 9-82



N — E
12V Type Approx 24Ω
24V Type Approx 100Ω

WARNING LIGHT RELAY

CIRCUIT

Fig. 9-83

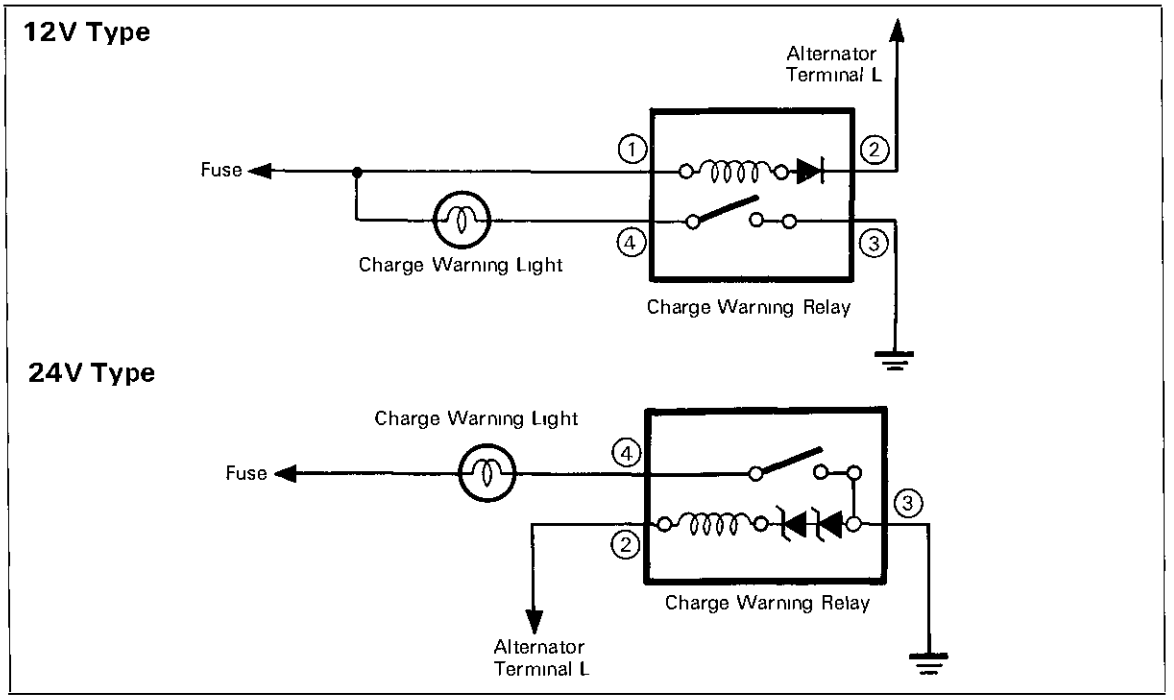
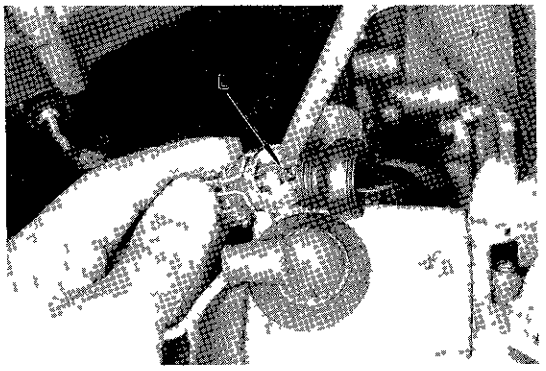


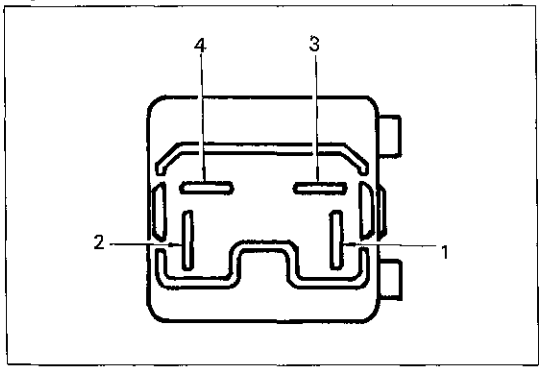
Fig. 9-84



1 After turning the starter switch to ON position measure the voltage at alternator terminal L

Voltage: Below 1 – 2V than battery voltage

Fig. 9-85



2 Measure the resistance between the terminals as indicated below

12V Type—Between 1st and 2nd terminals

24V Type—Between 3rd and 4th terminals

Resistance:

12V Type 75 – 120 Ω

24V Type 200 – 400 Ω

SST & SERVICE SPECIFICATIONS

Page

SST (SPECIAL SERVICE TOOLS) 10-2

STANDARD BOLT TIGHTENING TORQUE 10-12

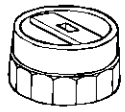
TIGHTENING TORQUE FOR MAIN PARTS 10-14

SERVICE SPECIFICATIONS 10-15

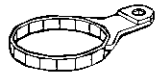
SST (SPECIAL SERVICE TOOLS)

ENGINE TUNE-UP

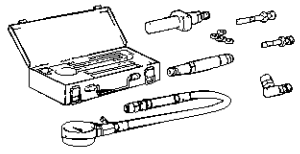
Oil Filter

Illustration	Tool No.	Tool Name
	09228-44010	Oil Filter Wrench

Fuel Filter

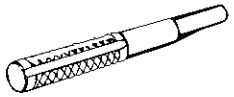
Illustration	Tool No.	Tool Name
	09228-34010	Oil Filter Wrench

Compression Pressure

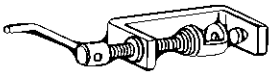
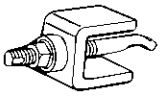
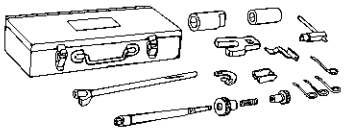
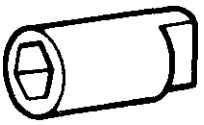
Illustration	Tool No.	Tool Name
	09992-00021	Cylinder Compression Check Gauge Set

ENGINE SERVICE

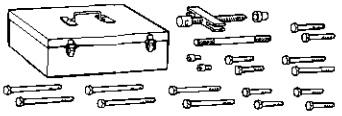
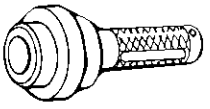
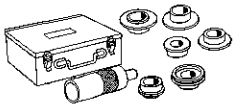
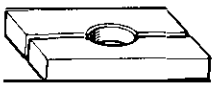
Cylinder Head

Illustration	Tool No.	Tool Name
	09201-60011	Valve Stem Guide Remover & Replacer

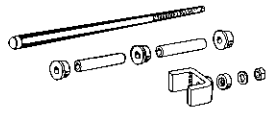
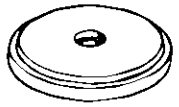
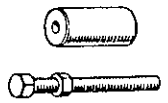
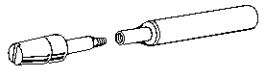
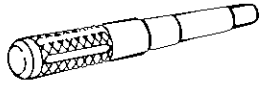
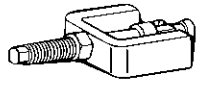
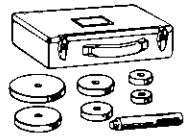
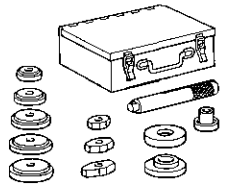
Cylinder Head (Cont'd)

Illustration	Tool No.	Tool Name
	09202-43012	Valve Spring Compressor
	09208-48010	Combustion Chamber Remover
	09260-46011	Injection Pump Tool Set
	(09268-46011)	(Nozzle Holder Body Wrench)

Timing Gear

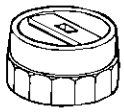
Illustration	Tool No.	Tool Name
	09213-60016	Crankshaft Pulley & Gear Puller
	09223-46011	Crankshaft Front Oil Seal Replacer
	09316-60010	Transmission & Transfer Bearing Replacer
	09527-21011	Rear Axle Shaft Bearing Remover

Cylinder Block

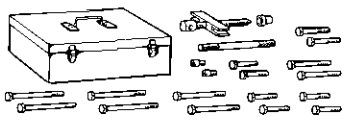
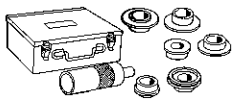
Illustration	Tool No.	Tool Name
	09215-56010	Camshaft Bearing Remover & Replacer
	09218-56020	Cylinder Liner Remover & Replacer
	09218-56030	Cylinder Liner Remover & Replacer
	09219-56010	Piston Cooler Remover
	09221-46010	Piston Pin Remover & Replacer
	09222-66010	Connecting Rod Bushing Remover & Replacer
	09303-35010	Input Shaft Front Bearing Puller
	09550-55010	Differential Replacer Set
	09608-20011	Front Hub & Drive Pinion Bearing Tool Set

LUBRICATION SYSTEM

Oil Filter

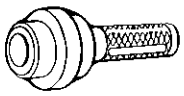
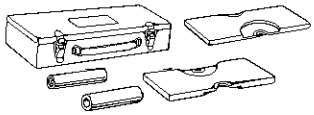
Illustration	Tool No.	Tool Name
	09228-44010	Oil Filter Wrench

Oil Pump

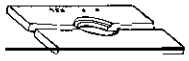
Illustration	Tool No.	Tool Name
	09213-60016	Crankshaft Pulley & Gear Puller
	09316-60010	Transmission & Transfer Bearing Replacer

COOLING SYSTEM

Water Pump

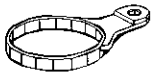
Illustration	Tool No.	Tool Name
	09223-50010	Crankshaft Front Oil Seal Replacer
	09236-28011	Water Pump Overhaul Tool
	09236-36010	Water Pump Overhaul Tool

Water Pump (Cont'd)

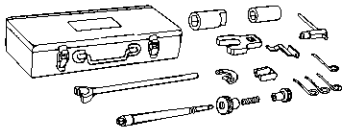
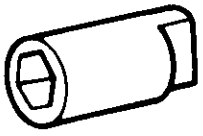
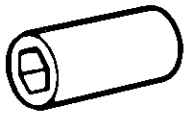
Illustration	Tool No.	Tool Name
	09527-10010	Rear Axle Shaft Bearing Remover

FUEL SYSTEM

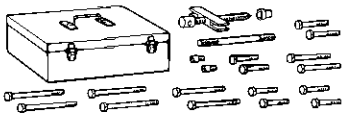
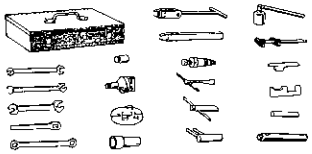
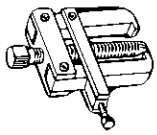
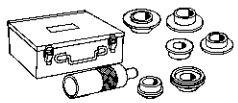
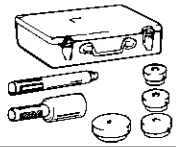
Fuel Filter

Illustration	Tool No.	Tool Name
	09228-34010	Oil Filter Wrench

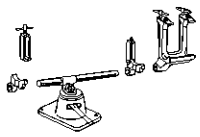
Injection Nozzle

Illustration	Tool No.	Tool Name
	09260-46011	Injection Pump Tool Set
	(09268-46011)	(Nozzle Holder Body Wrench)
	(09268-46021)	(Nozzle Holder Retaining Nut Wrench)

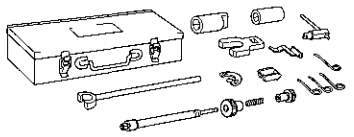
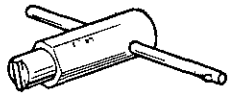
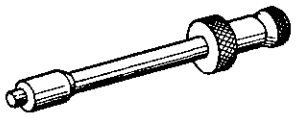
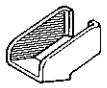
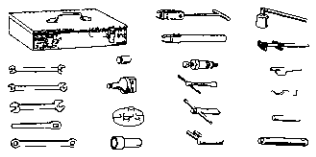
Automatic Timer

Illustration	Tool No.	Tool Name
	09213-60016	Crankshaft Pulley & Gear Puller
	09260-76016	Injection Pump Tool Set
	(09280-76010)	(Automatic Timer Spring Holder)
	09286-46011	Injection Pump Spline Shaft Puller
	09316-60010	Transmission & Transfer Bearing Replacer
	09620-30010	Steering Gear Box Replacer Set

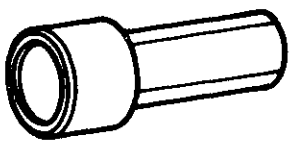
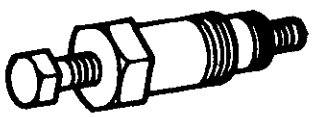
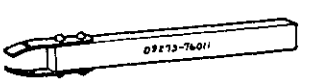
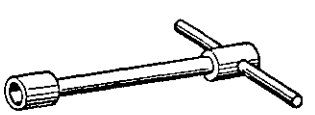
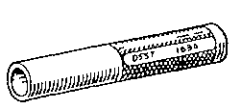
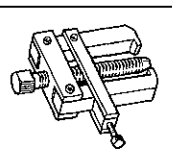
Injection Pump

Illustration	Tool No.	Tool Name
	09241-76021	Injection Pump Stand Set

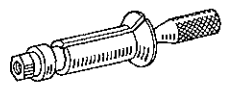
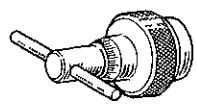
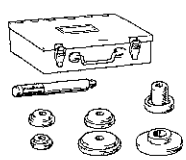
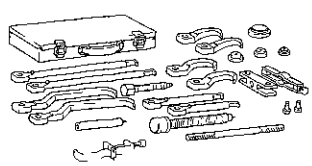
Injection Pump (Cont'd)

Illustration	Tool No.	Tool Name
	09260-46011	Injection Pump Tool Set
	(09266-46011)	(Round Nut Wrench)
	(09274-46010)	(Tappet Insert)
	(09275-46010)	(Plunger Clamp)
	(09278-46010)	(Spline Shaft Holding Tool)
	(09280-46010)	(Plunger Spring Holder)
	(09283-46010)	(Tappet Holder Attachment Gauge)
	09260-76016	Injection Pump Tool Set
	(09262-76010)	(Delivery Valve Gasket Replacer)

Injection Pump (Cont'd)

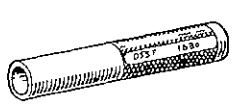
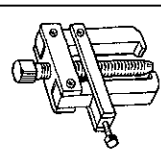
Illustration	Tool No.	Tool Name
	(09266-67011)	(Fly Weight Round Nut Wrench)
	(09267-76011)	(Automatic Timer Extractor)
	(09270-76010)	(Delivery Valve Holder)
	(09271-76011)	(Delivery Valve Extractor)
	(09272-76011)	(Tappet Roller Clamp)
	(09273-76011)	(Tappet Clamp)
	(09276-76010)	(T Type Box Wrench)
	09285-76010	Injection Camshaft Bearing Cone Replacer
	09286-46011	Injection Pump Spline Shaft Puller

Injection Pump (Cont'd)

Illustration	Tool No.	Tool Name
	09286-76011	Injection Pump Camshaft Bearing Cup Puller
	09287-76010	Injection Pump Camshaft Bearing Micrometer
	09288-46011	Tappet Adjusting Gauge
	09608-12010	Front Hub & Drive Pinion Bearing Replacer Set
	09950-20014	Universal Puller

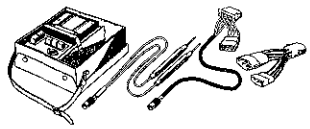
STARTING SYSTEM

Starter

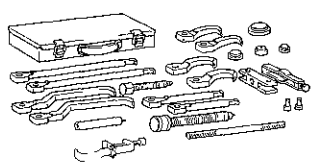
Illustration	Tool No.	Tool Name
	09285-76010	Injection Camshaft Bearing Cone Replacer
	09286-46011	Injection Pump Spline Shaft Puller

CHARGING SYSTEM

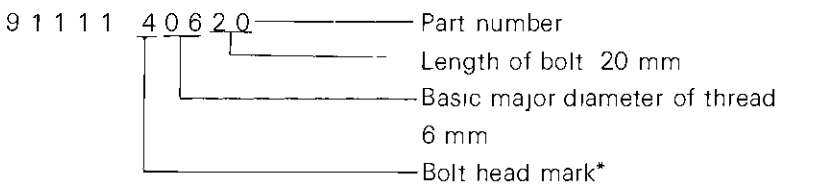
On-Vehicle Inspection

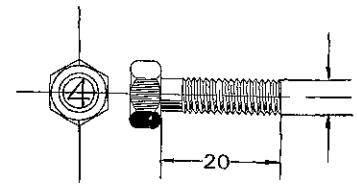
Illustration	Tool No.	Tool Name
	09081-00011	Alternator Checker

Alternator

Illustration	Tool No.	Tool Name
	09325-12010	Transmission Oil Plug
	09950-20014	Universal Puller

STANDARD BOLT TIGHTENING TORQUE





* Explanation of bolt head marks are as indicated in the following table

SPECIFIED TORQUE FOR STANDARD BOLTS

Class	Basic diameter mm	Pitch mm	Torque limit	kg-m (ft-lb)
4T	6	1	0.4 – 0.7	(3 – 5)
	8	1.25	1.0 – 1.6	(8 – 11)
	10	1.25	1.9 – 3.1	(14 – 22)
	10	1.5	1.8 – 3.0	(14 – 21)
	12	1.25 (ISO)	3.5 – 5.5	(26 – 39)
	12	1.5	3.5 – 5.5	(26 – 39)
	12	1.75	3.0 – 5.0	(22 – 36)
	13	1.5	4.5 – 7.0	(33 – 50)
	14	1.5	5.0 – 8.0	(37 – 57)
	14	2	4.7 – 7.7	(34 – 55)
	16	1.5	7.5 – 11.0	(55 – 79)
	16	2	7.1 – 10.6	(52 – 76)
5T	6	1	0.6 – 0.9	(5 – 6)
	8	1.25	1.5 – 2.2	(11 – 15)
	10	1.25	3.0 – 4.5	(22 – 32)
	10	1.5	2.7 – 4.2	(20 – 30)
	12	1.25 (ISO)	5.0 – 8.0	(37 – 57)
	12	1.5	5.0 – 7.0	(37 – 50)
	12	1.75	4.8 – 6.8	(35 – 49)
	13	1.5	6.5 – 9.0	(48 – 65)
	14	1.5	7.5 – 11.0	(55 – 79)
	14	2	7.0 – 10.5	(51 – 75)
	16	1.5	12.0 – 17.0	(87 – 122)
	16	2	11.5 – 16.5	(84 – 119)
6T	6	1	0.6 – 0.9	(5 – 6)
	8	1.25	1.5 – 2.2	(11 – 15)
	10	1.25	3.0 – 4.5	(22 – 32)
	10	1.5	2.7 – 4.2	(20 – 30)
	12	1.25 (ISO)	5.0 – 8.0	(37 – 57)
	12	1.5	5.0 – 7.0	(37 – 50)
	12	1.75	4.8 – 6.8	(35 – 49)

SPECIFIED TORQUE FOR STANDARD BOLTS (Cont'd)

Class	Basic diameter mm	Pitch mm	Torque limit	kg-m (ft lb)
7T	6	1	0.8 – 1.2	(6 – 8)
	8	1.25	2.0 – 3.0	(15 – 21)
	10	1.25	4.0 – 5.5	(29 – 39)
	10	1.5	3.7 – 5.2	(27 – 37)
	12	1.25 (ISO)	7.5 – 10.5	(55 – 75)
	12	1.5	7.0 – 9.0	(51 – 65)
	12	1.75	6.0 – 8.5	(44 – 61)
	13	1.5	8.0 – 12.0	(58 – 86)
	14	1.5	10.0 – 15.0	(73 – 108)
	14	2	9.5 – 14.0	(69 – 101)
	16	1.5	15.0 – 23.0	(109 – 166)
	16	2	14.0 – 22.0	(102 – 159)

– Note –

These torque specifications are applicable only for steel (female) threads. They do not apply to other types of material or if the tightening surface is subjected to heat or vibration.

TIGHTENING TORQUE FOR MAIN PARTS

Tightening part		kg m	ft-lb
Cylinder head x Cylinder block		115 – 120	84 – 87
Rocker arm support x Cylinder head		15 – 22	11 – 15
Intake manifold x Cylinder head		15 – 22	11 – 15
Exhaust manifold x Cylinder head		30 – 45	22 – 32
Camshaft timing gear x Camshaft		30 – 45	22 – 32
Camshaft thrust plate x Cylinder block		15 – 22	11 – 15
Idle gear x Idle gear shaft		40 – 55	29 – 39
Timing gear cover bolt	8 mm bolt	15 – 22	11 – 15
	10 mm bolt	30 – 45	22 – 32
Crankshaft pulley x Crankshaft		200 – 240	145 – 173
Crankshaft bearing cap x Cylinder block		128 – 142	93 – 102
Connecting rod cap x Connecting rod			
	B 2B	65 – 75	48 – 54
	3B	85 – 95	62 – 68
Oil pan x Cylinder block		07 – 13	61 – 112 in lb
Flywheel x Crankshaft		128 – 142	93 – 102
Nozzle holder x Cylinder head		60 – 80	44 – 57
Nozzle retaining nut		50 – 70	36 – 50
Injection pipe union nut		10 – 16	8 – 11
Delivery valve holder		25 – 35	19 – 25

SERVICE SPECIFICATIONS

ENGINE TUNE-UP

Coolant capacity	BJ40 42, 43, 45 & 46 Series		12 5 liters	13 2 US qt	11 0 Imp qt
	BJ60 Series		13 3 liters	14 1 US qt	11 7 Imp qt
	BU20, 30 Series		13 1 liters	13 8 US qt	11 5 Imp qt
	BB10 Series		14 5 liters	15 3 US qt	12 8 Imp qt
Drive belt tension	at 10 kg (22 lb)				
	w/o Air con				
		New belt	8 — 12 mm		0 31 — 0 47 in
		Used belt	11 — 14 mm		0 43 — 0 55 in
	w/ Air con (BB10)				
		New belt	10 — 13 mm		0 39 — 0 51 in
		Used belt	12 — 15 mm		0 47 — 0 59 in
For borroughs belt tension No BT-33-73F					
		New belt	120 — 170 lb		
		Used belt	80 — 120 lb		
Battery electrolyte specific gravity					
When fully charged	at 20°C (68°F)		1 25 — 1 27		
Engine oil capacity					
Dry fill			7 3 liters	7 7 US qt	6 4 Imp qt
Drain & refill	w/ Oil filter change		6 7 liters	7 1 US qt	5 9 Imp qt
	w/o Oil filter change		5 8 liters	6 1 US qt	5 1 Imp qt
Compression pressure	at 250 rpm				
		STD	30 0 kg/cm²		427 psi
		Limit	20 0 kg/cm²		284 psi
Difference between each cylinder			Less than 2 0 kg/cm² (28 psi)		
Injection nozzle opening pressure					
		New nozzle	115 — 125 kg/cm²		1,636 — 1,778 psi
		Reused nozzle	105 — 125 kg/cm²		1 493 — 1,778 psi
Injection timing	Stationary		14° BTDC		
Injection order			1 — 3 — 4 — 2		
Valve clearance	Hot	Intake	0 20 mm		0 008 in
		Exhaust	0 36 mm		0 014 in
Idle speed			650 rpm		
Maximum speed	No-load		4,050 — 4,100 rpm		

ENGINE

Cylinder Head

Surface warpage	Limit	0 2 mm	0 008 in
Manifold mounting surface warpage	Limit	0 2 mm	0 008 in
Valve seat			
Contacting surface angle		45°	
Contacting width		1 2 — 1 6 mm	0 047 — 0 063 in
Refacing angle		30°, 45° 60°	

Combustion Chamber

Protrusion amount	0 – 0.10 mm	0 – 0.0039 in

Valve & Guide Bushing

Valve				
Head edge thickness	Limit	Intake	0.9 mm	0.035 in
		Exhaust	1.3 mm	0.051 in
Face angle		IN & EX	44.5°	
Overall length	STD	Intake	127.95 mm	5.0374 in
		Exhaust	127.75 mm	5.0295 in
Stem end refacing	Limit	IN & EX	0.5 mm	0.020 in
Stem diameter		Intake	8.968 – 8.984 mm	0.3531 – 0.3537 in
		Exhaust	8.954 – 8.970 mm	0.3525 – 0.3531 in
Stem oil clearance	STD	Intake	0.026 – 0.062 mm	0.0010 – 0.0024 in
		Exhaust	0.040 – 0.076 mm	0.0016 – 0.0030 in
	Limit	Intake	0.10 mm	0.0039 in
		Exhaust	0.12 mm	0.0047 in
Guide bushing				
Inner diameter			9.01 – 9.03 mm	0.3547 – 0.3555 in
Protrusion from cylinder head			15.4 – 16.0 mm	0.61 – 0.63 in

Valve Spring

Free length		Outer	45.5 mm	1.791 in
		Inner	47.5 mm	1.870 in
Installed length		Outer	39.6 mm	1.559 in
		Inner	36.1 mm	1.421 in
Installed load	STD	Outer	25.6 kg	56 lb
		Inner	5.95 kg	13 lb
	Limit	Outer	21.0 kg	46.3 lb
		Inner	4.9 kg	10.8 lb
Squareness		Limit	2.0 mm	0.079 in

Valve Rocker Arm & Shaft

Shaft diameter	Limit	18.44 mm	0.7260 in
Rocker arm bore	Limit	18.60 mm	0.7323 in
Oil clearance	STD	0.02 – 0.06 mm	0.0008 – 0.0024 in
	Limit	0.1 mm	0.004 in

Valve Lifter

Oil clearance	STD	0.02 — 0.05 mm	0.0008 — 0.0020 in
	Limit	0.1 mm	0.004 in
Outer diameter	STD	23.972 — 23.985 mm	0.9438 — 0.9443 in

Camshaft

Circle runout	Limit	0.04 mm	0.0016 in
Thrust clearance	STD	0.06 — 0.13 mm	0.0024 — 0.0051 in
	Limit	0.3 mm	0.012 in
Oil clearance	STD	0.03 — 0.07 mm	0.0012 — 0.0028 in
	Limit	0.1 mm	0.004 in
Journal diameter	No.1	47.16 — 47.18 mm	1.8567 — 1.8575 in
	No.2	46.96 — 46.98 mm	1.8488 — 1.8496 in
	No.3	46.76 — 46.78 mm	1.8409 — 1.8417 in
Cam height	STD	39.47 — 39.56 mm	1.5539 — 1.5575 in
	Limit	39.0 mm	1.535 in

Timing & Idle Gear

Gear backlash			
Idle gear to cam gear timer drive gear			
	STD	0.06 — 0.09 mm	0.0024 — 0.0035 in
	Limit	0.3 mm	0.012 in
Crankshaft to idle gear	STD	0.06 — 0.10 mm	0.0024 — 0.0039 in
	Limit	0.3 mm	0.012 in
Idle gear thrust clearance	STD	0.08 — 0.20 mm	0.0031 — 0.0079 in
	Limit	0.3 mm	0.012 in
Idle gear oil clearance	STD	0.04 — 0.09 mm	0.0016 — 0.0035 in
	Limit	0.3 mm	0.012 in
Idle gear bore	STD	45.00 — 45.03 mm	1.7717 — 1.7728 in
Idle gear shaft diameter	STD	44.94 — 44.96 mm	1.7693 — 1.7701 in
	Limit	44.91 mm	1.7681 in

Manifold

Installing surface warpage	Limit	0.4 mm	0.016 in

Cylinder Block

Warpage	Limit		0 2 mm	0 008 in
Valve lifter bore diameter	STD		24 00 — 24 02 mm	0 9449 — 0 9457 in
Cylinder bore diameter	STD	B	95 00 — 95 03 mm	3 7402 — 3 7413 in
		2B	98 00 — 98 03 mm	3 8583 — 3 8594 in
		3B	102 00 — 102 03 mm	4 0157 — 4 0169 in
Liner				
Max wear	Limit		0 3 mm	0 012 in
Pressing force			2 500 kg	5 500 lb
Protrusion			0 01 — 0 10 mm	0 0004 — 0 0039 in
Shim thickness			0 05 0 10 mm	0 0020 0 0039 in

Piston & Piston Ring

Piston diameter	STD	B	94 88 — 94 91 mm	3 7354 — 3 7366 in
		2B	97 88 — 97 91 mm	3 8535 — 3 8547 in
		3B	101 90 — 101 93 mm	4 0118 — 4 0130 in
	O/S 1 00	B	95 88 — 95 91 mm	3 7748 — 3 7760 in
Piston oil clearance			0 11 — 0 13 mm	0 0043 — 0 0051 in
Piston ring end gap	No 1	B	0 35 — 0 55 mm	0 0138 — 0 0217 in
		2B & 3B	0 40 — 0 60 mm	0 0157 — 0 0236 in
	No 2	B	0 35 — 0 55 mm	0 0138 — 0 0217 in
		2B & 3B	0 40 — 0 60 mm	0 0157 — 0 0236 in
	Oil	B	0 35 — 0 55 mm	0 0138 — 0 0217 in
		2B & 3B	0 40 — 0 60 mm	0 0157 — 0 0236 in
Piston ring to ring groove clearance				
	No 1		0 04 — 0 08 mm	0 0016 — 0 0031 in
	No 2		0 04 — 0 08 mm	0 0016 — 0 0031 in
	Oil		0 03 — 0 07 mm	0 0012 — 0 0028 in
Piston pin diameter		B & 2B	29 00 — 29 01 mm	1 1417 — 1 1421 in
		3B	32 00 — 32 01 mm	1 2598 — 1 2602 in
Piston pin installing temperature			60°C	140°F

Connecting Rod

Thrust clearance	STD	0 08 — 0 20 mm	0 0031 — 0 0079 in
	Limit	0 3 mm	0 012 in
Bushing oil clearance	STD	0 004 — 0 014 mm	0 0002 — 0 0006 in
	Limit	0 05 mm	0 0020 in

Crankshaft

Circle runout		Limit	0 06 mm	0 0024 in
Thrust clearance		STD	0 07 — 0 18 mm	0 0028 — 0 0071 in
		Limit	0 3 mm	0 012 in
Main journal				
Diameter		STD	69 98 — 70 00 mm	2 7551 — 2 7559 in
U/S finished diameter		U/S 0 25	69 74 — 69 75 mm	2 7457 — 2 7461 in
		U/S 0 50	69 49 — 69 50 mm	2 7358 — 2 7362 in
		U/S 1 00	68 99 — 69 00 mm	2 7161 — 2 7165 in
Taper and out-of-round		Limit	0 02 mm	0 0008 in
Oil clearance		STD	0 03 — 0 07 mm	0 0012 — 0 0028 in
		Limit	0 1 mm	0 004 in
Bearing type			STD U/S (0 25 0 50 1 00)	
Crank pin journal				
Diameter	STD	B & 2B	58 98 — 59 00 mm	2 3220 — 2 3228 in
		3B	60 98 — 61 00 mm	2 4008 — 2 4016 in
U/S finished diameter	B & 2B	U/S 0 25	58 74 — 58 75 mm	2 3126 — 2 3130 in
		U/S 0 50	58 49 — 58 50 mm	2 3028 — 2 3031 in
		U/S 1 00	57 99 — 58 00 mm	2 2831 — 2 2835 in
	3B	U/S 0 25	60 74 — 60 75 mm	2 3913 — 2 3917 in
		U/S 0 50	60 49 — 60 50 mm	2 3815 — 2 3819 in
		U/S 1 00	59 99 — 60 00 mm	2 3618 — 2 3622 in
Taper and out-of-round		Limit	0 02 mm	0 0008 in
Oil clearance		STD	0 03 — 0 07 mm	0 0012 — 0 0028 in
		Limit	0 1 mm	0 004 in
Bearing type			STD U/S (0 25 0 50 1 00)	

Flywheel

Runout	Limit	0 2 mm	0 008 in

LUBRICATION SYSTEM

Oil Pump

Tip clearance			
Driven gear to crescent	STD	0.15 — 0.21 mm	0.0059 — 0.0083 in
	Limit	0.3 mm	0.012 in
Drive gear to crescent	STD	0.22 — 0.25 mm	0.0087 — 0.0098 in
	Limit	0.3 mm	0.012 in
Side clearance	STD	0.03 — 0.09 mm	0.0012 — 0.0035 in
	Limit	0.15 mm	0.0059 in
Body clearance	STD	0.06 — 0.15 mm	0.0024 — 0.0059 in
	Limit	0.3 mm	0.012 in

COOLING SYSTEM

Water Pump

Bearing installing temperature	Normal temperature

Radiator

Radiator cap relief valve opening pressure			
	STD	0.75 — 1.05 kg/cm²	10.7 — 14.9 psi
	Limit	0.6 kg/cm²	8.5 psi

Thermostat

Valve opening temperature	Low temp type		High temp type	
Starts to open at	80.5 — 83.5°C	177 — 182°F	86.5 — 89.5°C	188 — 193°F
Fully opens at	95°C	203°F	100°C	212°F
Valve opening travel	10 mm	0.39 in	10 mm	0.39 in

FUEL SYSTEM

Fuel Pump

Housing to piston clearance	0.009 — 0.013 mm	0.0004 — 0.0005 in
Housing to push rod clearance	0.003 — 0.006 mm	0.0001 — 0.0002 in

Fuel Pump Performance Test

Suction test			
Suction pipe			
Inner diameter		8 mm	0.31 in
Length		2 m	78.74 in
Suction height		1 m	39.37 in
Feed pump	at 150 rpm	Fuel must discharge within 40 seconds	
Priming pump	at 60 strokes/min	Fuel must discharge within 25 strokes	
Discharge test			
Discharge nozzle diameter		1.54 mm	0.0606 in
Pressure	at 600 rpm	1.8 – 2.2 kg/cm²	26 – 31 psi
Volume	at 1 000 rpm	More than 900 cc/min (54.9 cu in/min)	

Injection Nozzle & Nozzle Holder

Nozzle opening pressure	New nozzle	115 – 125 kg/cm²	1 636 – 1 778 psi
	Reused nozzle	105 – 125 kg/cm²	1 493 – 1 778 psi
Nozzle injection angle		About 4°	
Adjusting shim thickness		1.00, 1.95 mm	0.0394, 0.0768 in
(For adjusting nozzle opening pressure)		[20 sizes in 0.05 mm (0.0020 in) increments]	

Automatic Timer

Timer installing temperature		60°C	140°F
Timer advance angle	B & 2B	700 rpm	Advance begins (≦0.5°)
		900 rpm	2.7 – 3.7°
		1 100 rpm	3.5 – 4.5°
		1 450 rpm	4.8 – 5.8°
		1 750 rpm	6.0 – 7.0°
		1 850 rpm	6.0 – 7.0°
	3B	700 rpm	Advance begins (≦0.5°)
		1 000 rpm	1.3 – 2.3°
		1 400 rpm	3.7 – 4.7°
		1 750 rpm	6.0 – 7.0°
		1 900 rpm	6.0 – 7.0°
Adjusting shim thickness		0.1, 0.2, 0.5 mm	0.004, 0.008, 0.020 in

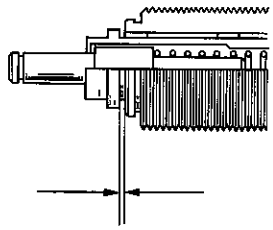
Injection Pump

Direction of rotation		Clockwise as seen from drive side	
Cam lift		8 0 mm	0 315 in
Injection order		1 – 3 – 4 – 2	
Control rack sliding resistance			
	Pump at 0 rpm	Less than 120g (4 2 oz)	
	Pump at 1 000 rpm	Less than 50g (1 8 oz)	
Pre-stroke			
Control rack at 8 0 mm (0 315 in)		1 9 – 2 0 mm	0 075 – 0 079 in
Injection interval		89 5 – 90 5°	
Tappet clearance		More than 0 2 mm (0 008 in)	
Tappet adjusting shim thickness		0 1 1 4 & 0 15 mm (0 004 0 055 & 0 006 in)	
		(14 sizes in 0 1 mm (0 004 in) increments and 0 15 mm (0 0059 in))	
Tappet overall looseness	Limit	0 3 mm	0 012 in
Camshaft thrust clearance	STD	0 03 – 0 05 mm	0 0012 – 0 0020 in
	Limit	0 1 mm	0 004 in
Camshaft adjusting shim thickness		0 10 0 12 0 14 0 16 0 18 0 50 mm	
		(0 0039 0 0047 0 0055 0 0063 0 0071 0 0197 in)	
Plunger spring			
Free length		49 4 mm	1 945 in
Installed length		44 0 mm	1 732 in
Installed load		15 1 kg	33 lb
Delivery valve spring			
Free length		37 0 mm	1 457 in
Installed length		25 9 mm	1 020 in
Installed load		4 4 2 kg	10 lb

Combined Governor

Main spring			
Free length	B & 2B	45 6 mm	1 795 in
	3B	51 6 mm	2 031 in
Installed length	B & 2B	35 0 mm	1 378 in
	3B	36 5 mm	1 437 in
Installed load	B & 2B	0 954 kg	2 1 lb
	3B	1 057 kg	2 3 lb
Adjusting shim thickness		0 5 1 0 2 0 3 0 mm	
		(0 020 0 039 0 079 0 118 in)	
Speed control spring			
Free length		38 0 mm	1 496 in
Installed length		27 0 mm	1 063 in
Installed load		3 3 0 kg	7 lb

Diesel High Altitude Compensator (DHAC)

Clearance (at sea level) 	0.1 — 0.3 mm	0.004 — 0.012 in

INJECTION PUMP ADJUSTMENT & TEST

Preparations of Pump Tester

Nozzle type	ND-DN4 SD-24A	
Nozzle opening pressure	115 — 125 kg/cm²	1 636 — 1 779 psi
Outer diameter	6.0 mm	0.236 in
Inner diameter	2.0 mm	0.079 in
Length	600 mm	23.62 in
Minimum bending radius	More than 25 mm (1.0 in)	
Fuel temperature	40 — 45°C	104 — 113°F
Fuel feeding pressure	0.5 kg/cm²	7 psi

Control Rack

Sliding resistance	Pump at 0 rpm	Less than 120g (4.2 oz)
	Pump at 1 000 rpm	Less than 50g (1.8 oz)

Injection Timing

Pre-stroke		
Control rack position at 8.0 mm (0.315 in)	1.9 — 2.0 mm	0.075 — 0.079 in
Injection interval	89.5 — 90.5°	
Tappet clearance	More than 0.2 mm (0.008 in)	

Injection Volume Adjustment

[For B Engine]

Rack position mm (in)	Pump revolution (rpm)	Measuring strokes	Injection volume cc (cu in)	Variation limit cc (cu in)
16.0 (0.630)	100	200	14.0 – 16.0 (0.85 – 0.98)	1.2 (0.07)
11.7 (0.461)	1 100	200	10.0 – 10.6 (0.61 – 0.65)	0.4 (0.02)
8.6 (0.339)	1 000	200	4.6 – 5.6 (0.28 – 0.34)	0.4 (0.02)
6.5 (0.256)	325	500	2.5 – 4.5 (0.15 – 0.27)	1.0 (0.06)

[For 2B Engine]

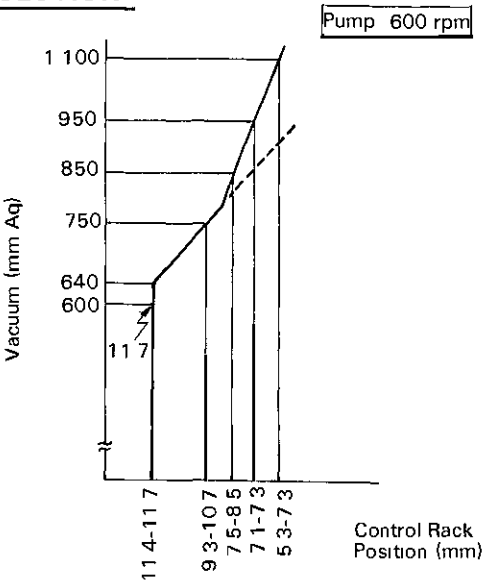
Rack position mm (in)	Pump revolution (rpm)	Measuring strokes	Injection volume cc (cu in)	Variation limit cc (cu in)
16.0 (0.630)	100	200	14.0 – 16.0 (0.85 – 0.98)	1.2 (0.07)
11.9 (0.469)	1 100	200	11.0 – 11.6 (0.67 – 0.71)	0.4 (0.02)
8.0 (0.315)	1 000	200	4.3 – 5.1 (0.26 – 0.31)	0.4 (0.02)
6.5 (0.256)	325	500	2.5 – 4.5 (0.15 – 0.27)	1.0 (0.06)

[For 3B Engine]

Rack position mm (in)	Pump revolution (rpm)	Measuring strokes	Injection volume cc (cu in)	Variation limit cc (cu in)
17.5 (0.689)	100	200	14.0 – 16.0 (0.85 – 0.98)	1.2 (0.07)
13.0 (0.512)	1 100	200	11.3 – 11.9 (0.69 – 0.73)	0.4 (0.02)
13.0 (0.512)	1 700	200	11.5 – 12.5 (0.70 – 0.76)	0.6 (0.04)
8.0 (0.315)	1 000	200	4.3 – 5.1 (0.26 – 0.31)	0.4 (0.02)
6.5 (0.256)	325	500	2.5 – 4.5 (0.15 – 0.27)	1.0 (0.06)

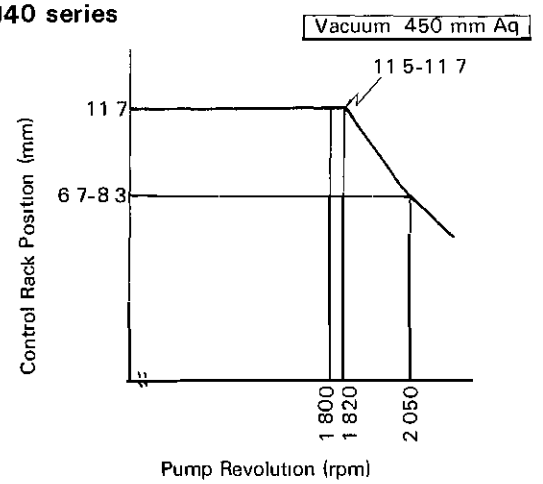
GOVERNOR ADJUSTMENT & TEST
[For B Engine]
Characteristic Diagram

PNEUMATIC GOVERNOR SECTION

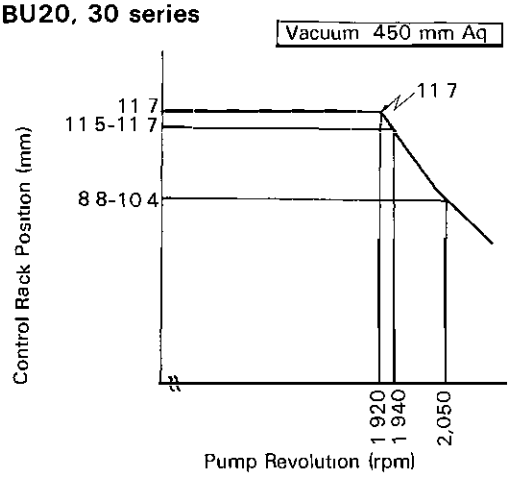


MECHANICAL GOVERNOR SECTION

BJ40 series



BU20, 30 series

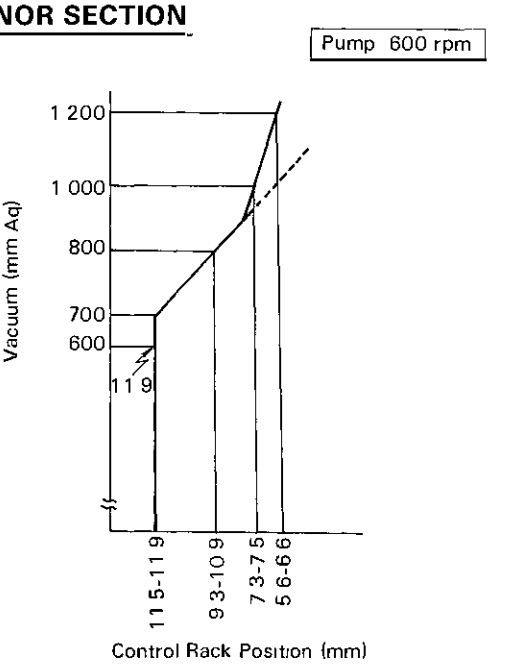


Total Injection Volume

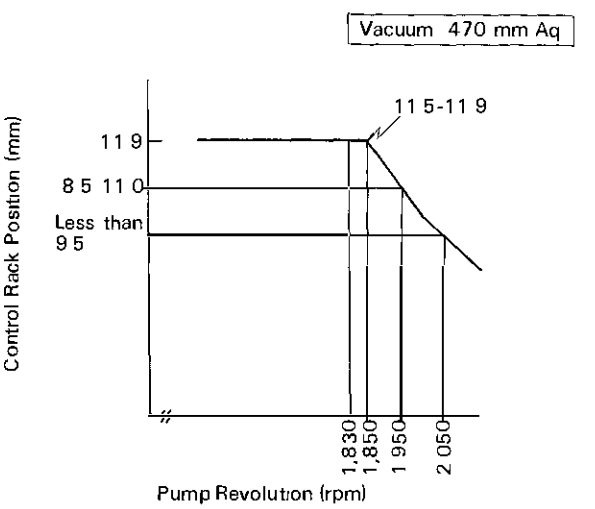
Model	Measuring strokes	Pump revolution	Vacuum	Total injection volume
BJ40	500	1 100 rpm	150 mm Aq (5 91 in Aq)	101 0 – 105 0 cc (6 16 – 6 41 cu in)
BU20 30	500	1 100 rpm	120 mm Aq (4 72 in Aq)	101 0 – 105 0 cc (6 16 – 6 41 cu in)

[For 2B Engine]
Characteristic Diagram

PNEUMATIC GOVERNOR SECTION



MECHANICAL GOVERNOR SECTION

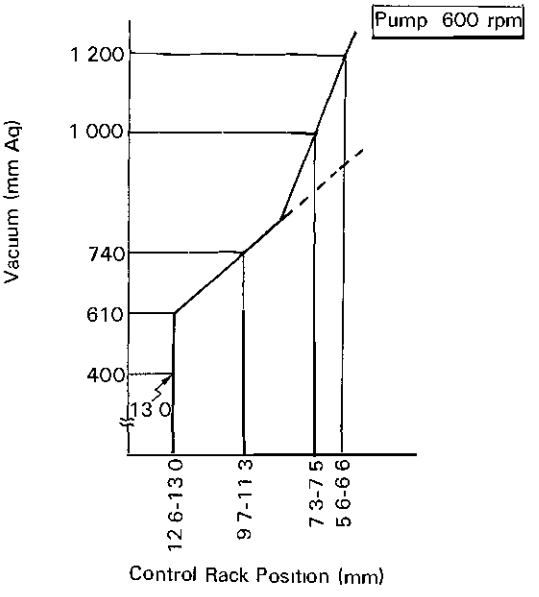


Total Injection Volume

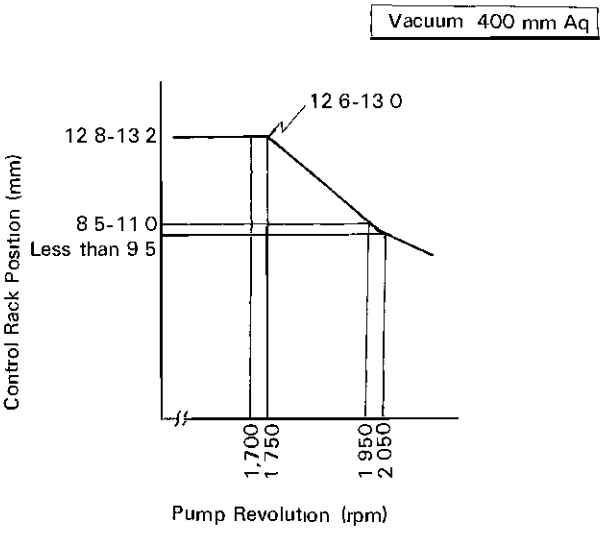
Measuring strokes	Pump revolution	Vacuum	Total injection volume
500	1 100 rpm	200 mm Aq (7 87 in Aq)	106 0 – 110 0 cc (6 47 – 6 71 cu in)

[For 3B Engine]
Characteristic Diagram

PNEUMATIC GOVERNOR SECTION



MECHANICAL GOVERNOR SECTION



Total Injection Volume

Measuring strokes	Pump revolution	Vacuum	Total injection volume
500	1 100 rpm	260 mm Aq (10 24 in Aq)	114 0 – 118 0 cc (6 96 – 7 20 cu in)

Governor Adjustment

Adjustment & test		Pump revolution (rpm)	Vacuum mm Aq (in Aq)	Control rack position mm (in)	Time/second
Governor air tightness		600	500 → 480 (19 69 → 18 90)	—	More than 10
Control rack initial set	B	600	600 (23 62)	11 7 (0 461)	—
	2B	600	600 (23 62)	11 9 (0 469)	
	3B	600	400 (15 75)	13 0 (0 512)	
Main spring	B	600	640 (25 20) 750 (29 53)	11 4 – 11 7 (0 449 – 0 461) 9 3 – 10 7 (0 366 – 0 421)	—
	2B	600	700 (27 56) 800 (31 50)	11 5 – 11 9 (0 453 – 0 469) 9 3 – 10 9 (0 336 – 0 409)	
	3B	600	610 (24 02) 740 (29 13)	12 6 – 13 0 (0 496 – 0 512) 9 7 – 11 3 (0 382 – 0 445)	
Idling spring capsule	B	600	850 (33 46) 950 (37 40) 1 100 (43 31)	7 5 – 8 5 (0 295 – 0 335) 7 1 – 7 3 (0 280 – 0 287) 5 3 – 7 3 (0 209 – 0 287)	—
	2B	600	1 000 (39 37) 1 200 (47 24)	7 3 – 7 5 (0 287 – 0 295) 5 6 – 6 6 (0 220 – 0 260)	
	3B	600	1 000 (39 37) 1 200 (47 24)	7 3 – 7 5 (0 287 – 0 295) 5 6 – 6 6 (0 220 – 0 260)	

Governor Adjustment (Cont'd)

Adjustment & test		Vacuum mm Aq (in Aq)	Pump revolution (rpm)	Control rack position mm (in)	Time/seconds
Speed control spring	B (BJ40)	450 (17 72)	1 800	11 7 (0 461)	—
			1 820	11 5 – 11 7 (0 453 – 0 461)	
			2 050	6 7 – 8 3 (0 264 – 0 327)	
	B (BU20 30)	450 (17 72)	1 920	11 7 (0 461)	
			1 940	11 5 – 11 7 (0 453 – 0 461)	
			2 050	8 8 – 10 4 (0 346 – 0 409)	
	2B	470 (18 50)	1 830	11 9 (0 469)	
			1 850	11 5 – 11 9 (0 453 – 0 469)	
			1 950	8 5 – 11 0 (0 335 – 0 433)	
			2 050	Less than 9 5 (0 374)	
	3B	400 (15 75)	1 700	12 8 – 13 2 (0 504 – 0 520)	
			1 750	12 6 –13 0 (0 496 – 0 512)	
			1 950	8 5 – 11 0 (0 335 – 0 443)	
			2 050	Less than 9 5 (0 374)	

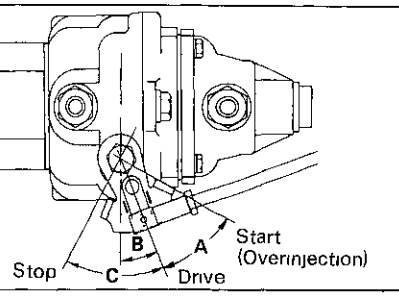
Total Injection Volume

Engine	Model	Measuring strokes	Pump revolution (rpm)	Vacuum mm Aq (in Aq)	Total injection volume cc (cu in)
B	BJ40	500	1 100	150 (5 91)	101 0 – 105 0 (6 16 – 6 41)
	BU20 30	500	1 100	120 (4 72)	101 0 – 105 0 (6 16 – 6 41)
2B		500	1 100	200 (7 87)	106 0 – 110 0 (6 47 – 6 71)
3B		500	1 100	260 (10 24)	114 0 – 118 0 (6 96 – 7 20)

EDIC (ELECTRICAL DIESEL INJECTION CONTROL) SYSTEM

Operational Check

Injection pump lever position		
A		41°
		35° (w/ DHAC)
B	B & 2B	19.5°
	3B	22.5°
C	B & 2B	49°
	3B	52°



STARTING SYSTEM

Preheating System

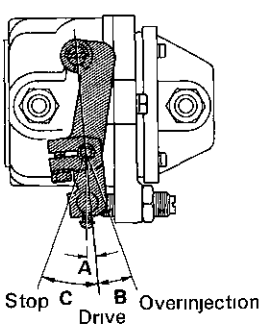
Type		12V	24V
Glow time	at 0°C (32°F)	About 15 seconds	←
Load current per one glow plug			
	BJ60	7.2 – 9.8A	3.8 – 5.2A
	ex BJ60	7.6 – 10.4A	4.1 – 5.5A
Glow plug resistance	at 20°C (68°F)		
	BJ60	1.2Ω	5.1Ω
	ex BJ60	0.9Ω	4.3Ω

Overinjection Magnet (Operational Check)

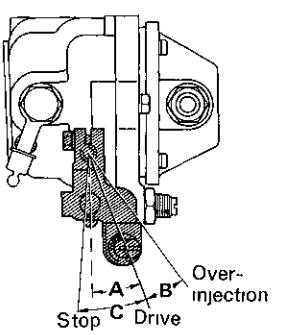
Injection pump lever position

A	45° (BJ)
	20° (BU, BB)
B	15°
C	25°

BJ Series



BU, BB Series



Starter

Type		12V	24V
Rating output		2.5 kw	4.5 kw
No load characteristics		180 A max and 3 500 rpm min at 11V	90 A max and 3 500 rpm min at 23V
Mica depth	STD	0.7 – 0.9 mm	0.028 – 0.035 in
	Limit	0.2 mm	0.008 in
Commutator runout	STD	Less than 0.05mm (0.0020 in)	
	Limit	0.05 mm	0.0020 in
Commutator outer diameter	STD	36 mm	1.42 in
	Limit	35 mm	1.38 in
Brush length	STD	20.5 mm	0.807 in
	Limit	12 mm	0.47 in
Brush spring tension	STD	3.2 – 4.0 kg	7 – 9 lb

CHARGING SYSTEM

Alternator

Type		12V	24V
Rating output		12V – 40A	24V – 20A 25A
Rotor coil resistance		2.8 – 3.0Ω	19.0Ω
Brush exposed length	STD	20.0 mm	0.787 in
	Limit	5.5 mm	0.217 in

Alternator Regulator

Type	12V	24V
Regulating voltage	13.8 – 14.8V	27 – 29V
Voltage relay actuating voltage	4 – 5.8V	8 – 11.6V

Alternator with IC Regulator

Type		12V	24V
Rating output		12V – 55A	24V – 55A
Rotor coil resistance		2.8 – 3.0Ω	19.0Ω
Brush exposed length	STD	20.0 mm	0.787 in
	Limit	5.5 mm	0.217 in
Regulating voltage		13.8 – 14.4V	27.7 – 28.7V