TOYOTA

2H ENGINE

REPAIR MANUAL

Aug., 1980

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FOREWORD

This repair manual has been prepared to provide information covering general service repair for the 2H engine equipped on the TOYOTA LAND CRUISER.

Applicable models: HJ 47, 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 CORPORATION

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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 jacks 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

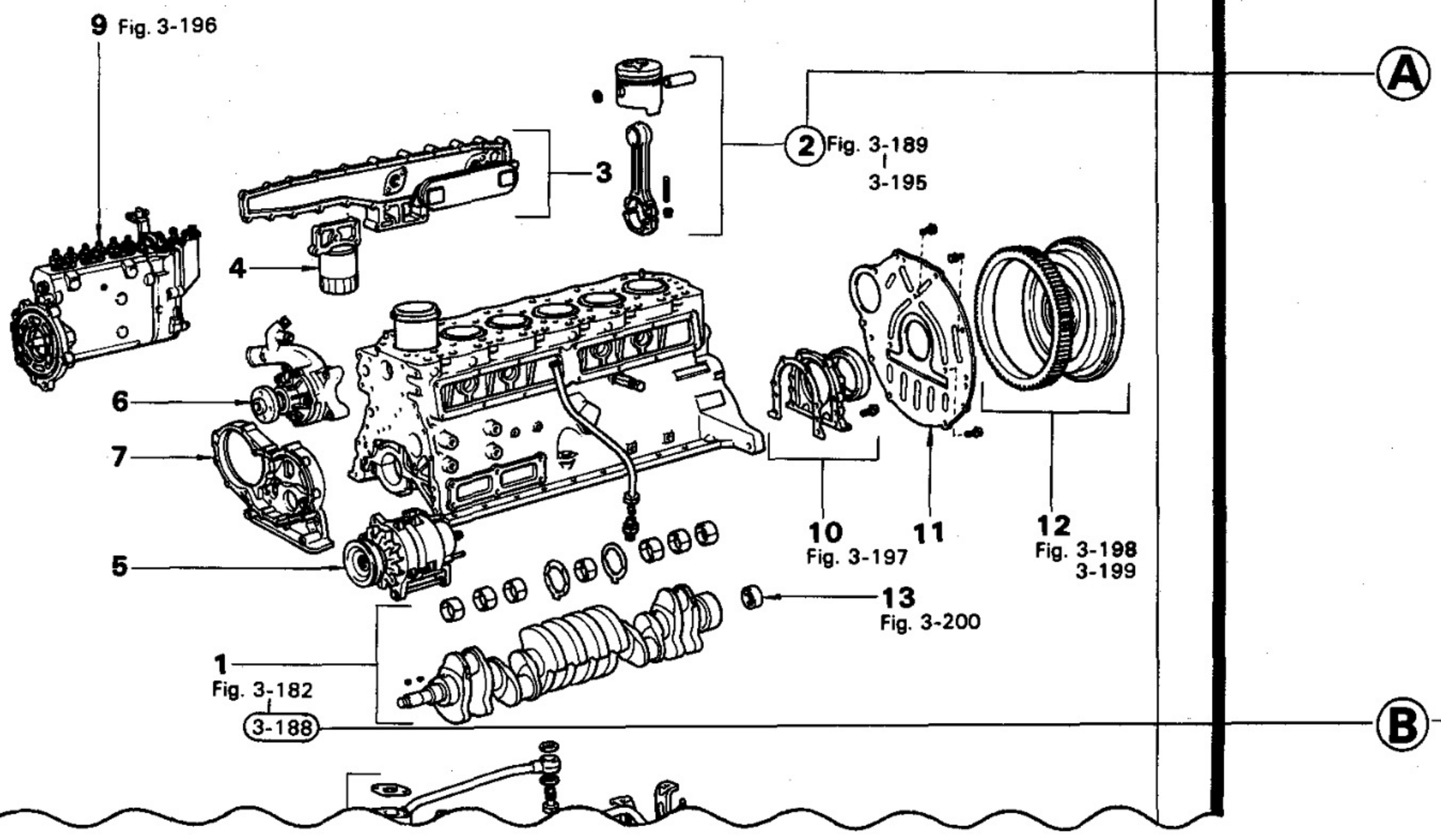
Assemble the parts in the numerical order shown in the figure.

Fig. 3-181

– 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.



Ⓐ : The bold numbers show 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.

Fig. 3-186



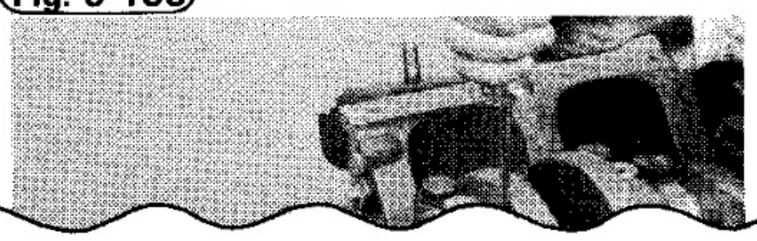
Tighten the bearing caps to specified torque.
Tightening torque: 12.8 – 14.2 kg-m (93 – 102 ft-lb)

Fig. 3-187



– Note –
Check for tightness of crankshaft rotation after each time a bearing cap is tightened.

Fig. 3-188



Measure the crankshaft thrust clearance.
Thrust clearance:
STD 0.04 – 0.24 mm (0.0016 – 0.0094 in.)
Limit 0.3 mm

Ⓒ : 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 quick recognition



REMOVE or DISASSEMBLE



INSTALL or ASSEMBLE



INSPECT



MEASURE



TIGHTEN



CLEAN



IMPORTANT

ENGINE TUNE-UP

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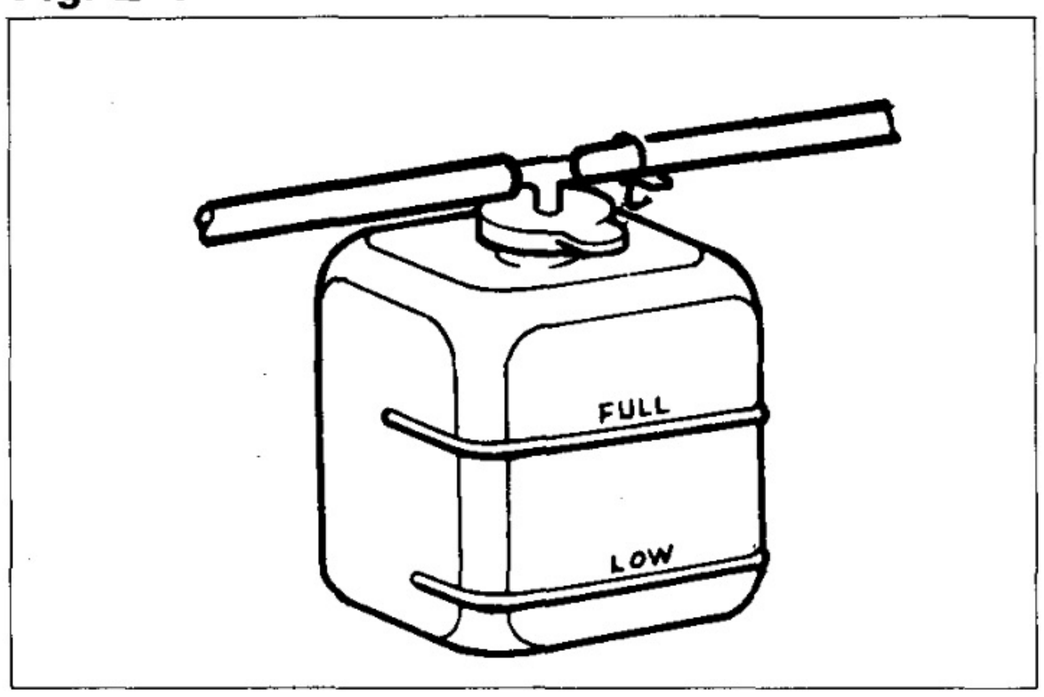
ENGINE TUNE-UP ITEMS

	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)	
		HJ60	15.4 liters 16.3 US qt 13.6 Imp.qt
		HJ47	14.1 liters 14.9 US qt 12.4 Imp.qt
2	DRIVE BELT	Tension	
		Fan – Alternator New	8 – 9 mm 0.31 – 0.35 in.
		Used	10 – 11mm 0.39 – 0.43 in.
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	SST [09228-60010]
6	CENTRIFUGAL OIL FILTER		
		Cleaning	
7	ENGINE OIL	Oil level	F line
		Oil quality	
		Replenishment	API service CC-CD classification
		Oil capacity	
		Dry fill	10.3 liters 10.9 US qt 9.1 Imp.qt
		Drain & refill w/ Oil filter	9.7 liters 10.3 US qt 8.5 Imp.qt
		w/o Oil filter	8.1 liters 8.6 US qt 7.1 Imp.qt
8	FUEL FILTER	Replacement	
		Air bleeding	
9	INJECTION PUMP	Lubricate diaphragm housing	3 or 4 drops of diaphragm oil
10	COMPRESSION PRESSURE		
		at 250 rpm STD	28.0 kg/cm² 398 psi
		Limit	20.0 kg/cm² 284 psi
		Difference between each cylinder	Less than 2.0 kg/cm² (28 psi)
11	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

	ITEM			REMARKS	
11	INJECTION NOZZLE (Cont'd)				
		Spray condition		4°conical form	
		Leakage test		at 90kg/cm^2 (1,280 psi)	
		Cleaning			
12	INJECTION TIMING	Stationary		16°BTDC	
		Air bleeding			
		Fuel filter			
		Injection pump			
		High pressure pipe			
13	VALVE CLEARANCE	Hot	Intake	0.20 mm	0.008 in.
			Exhaust	0.36 mm	0.014 in.
14	IDLE SPEED			625 – 675 rpm	
15	MAXIMUM SPEED	No-load			
		Direct fan type		4,050 – 4,100 rpm	
		w/ Fluid coupling type		4,120 – 4,170 rpm	
16	PREHEATING SYSTEM				
		Glow time		15 – 30 seconds	
		Load current per one glow plug			
		HJ60			
		12V type		7.2 – 9.8 A	
		24V type		3.8 – 5.2 A	
		HJ47			
		12V type		7.6 – 10.4 A	
		Glow plug resistance			
		HJ60			
		12V type		0.2 Ω	
		24V type		1.0 Ω	
		HJ47			
		12V type		0.2 Ω	

COOLING SYSTEM

Fig. 2-1

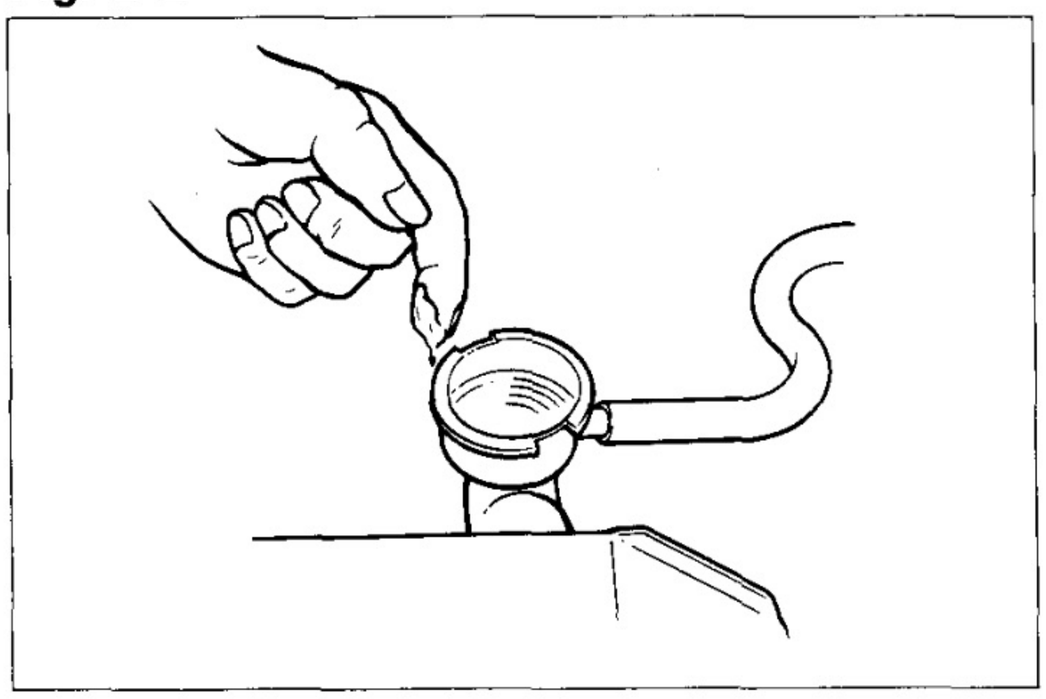


CHECK COOLANT LEVEL

If low, fill reservoir to FULL line.

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

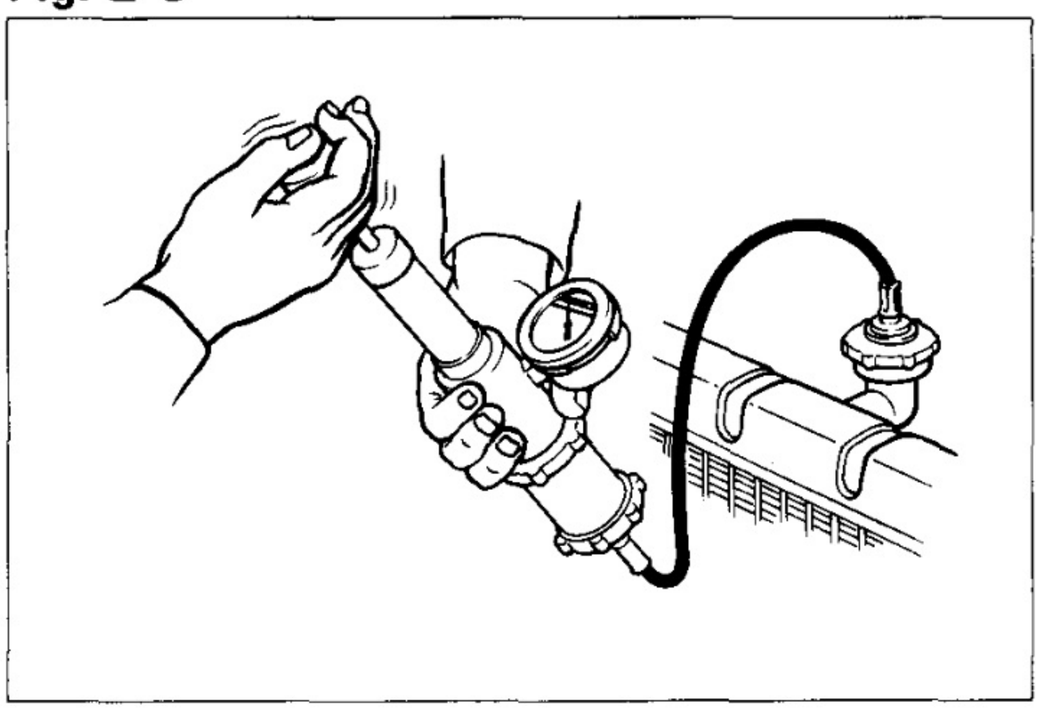
Fig. 2-2



CHECK COOLANT QUALITY

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

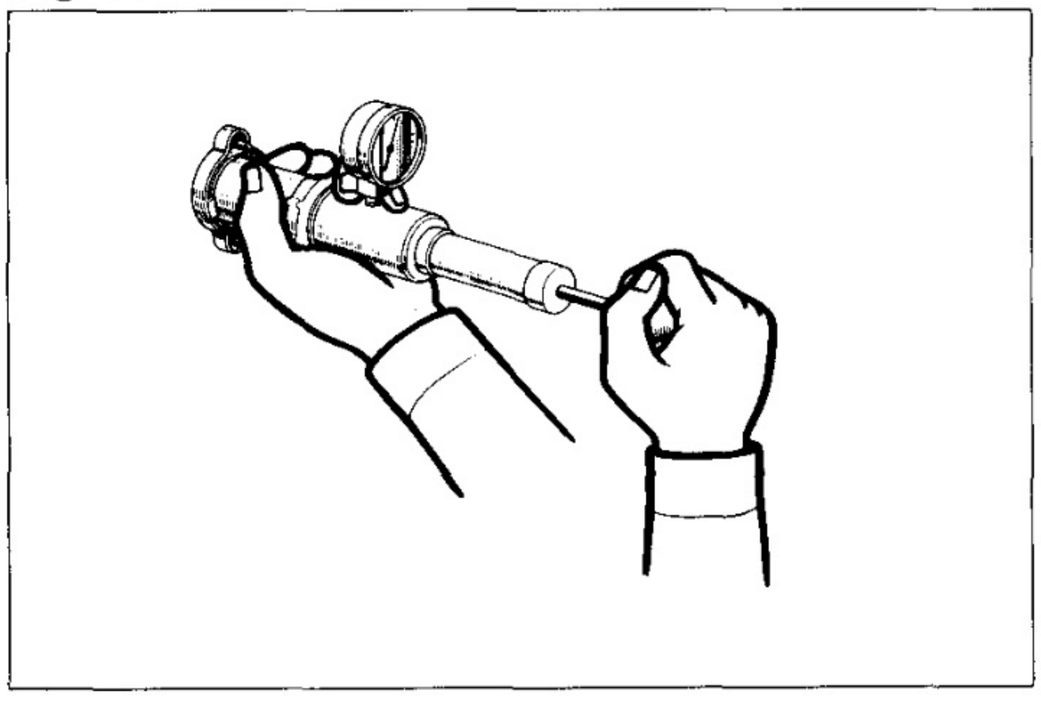
Fig. 2-3



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

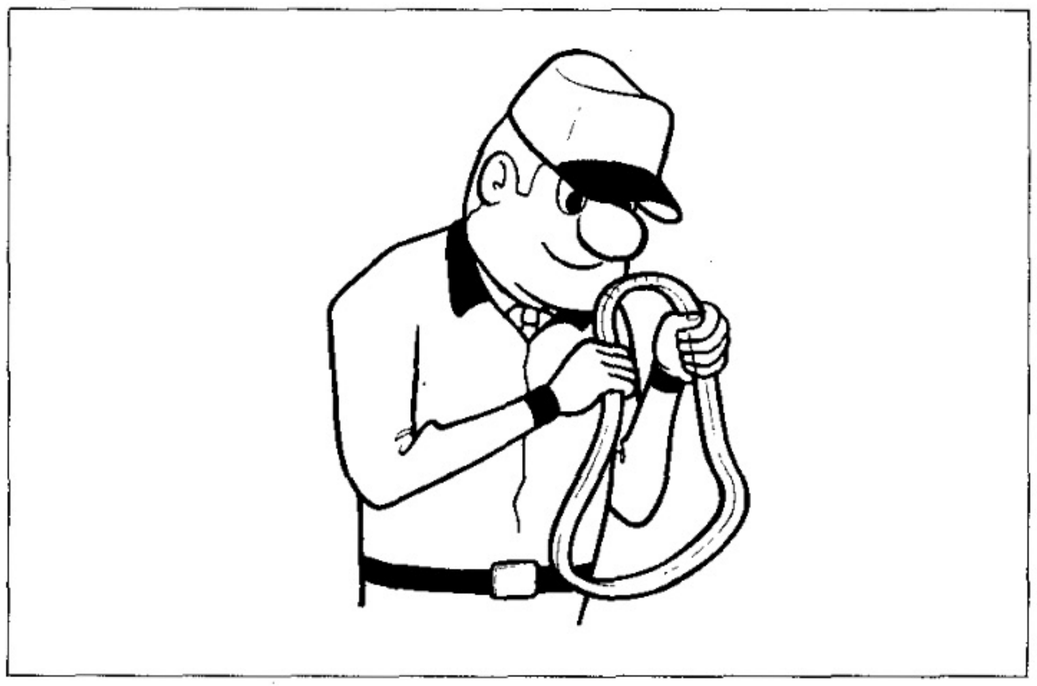


5. Faulty operation of radiator cap.
Inspect the spring tension and seating condition of the radiator cap vacuum valves. If the valve opens at a pressure below specification or is otherwise defective, replace the radiator cap.

Valve opening pressure:

STD	**0.75 – 1.05 kg/cm^2 (10.7 – 14.9 psi)**
Limit	**0.6 kg/cm^2 (8.5 psi)**

Fig. 2-5



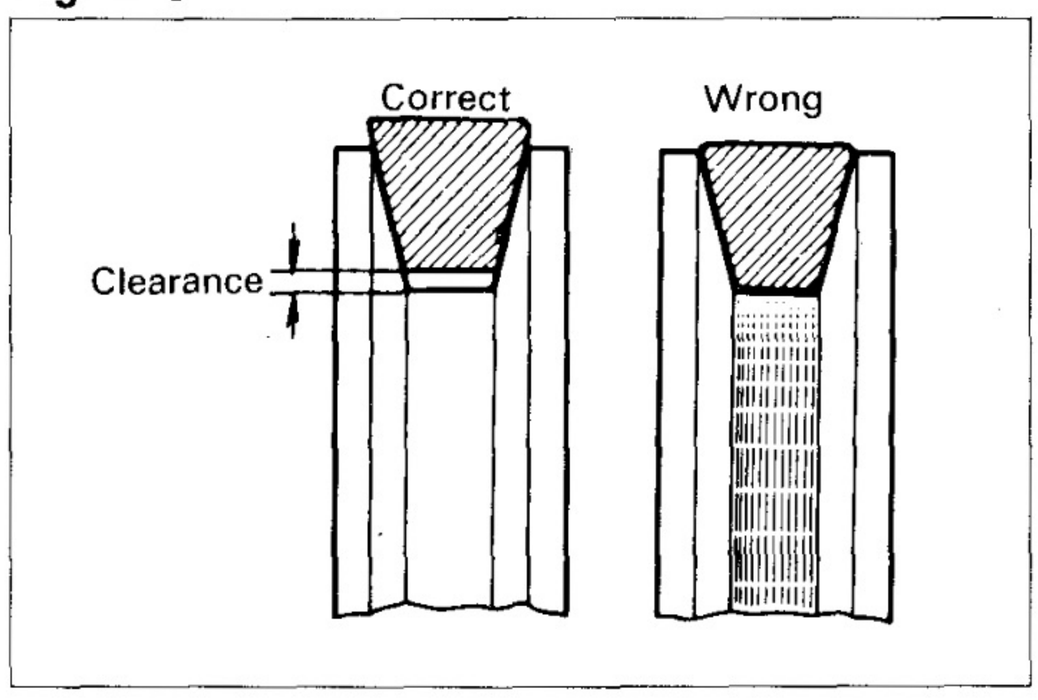
DRIVE BELT

VISUAL CHECK

Check for:

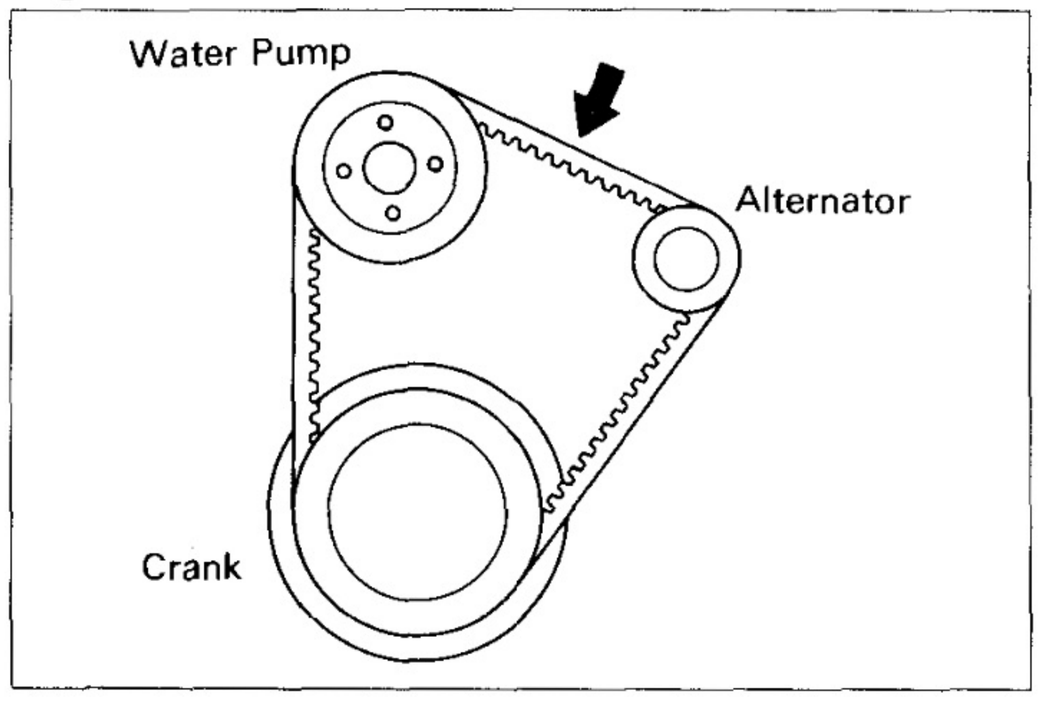
1. Cracks, deterioration, stretching or wear.
2. Adherence of oil or grease.

Fig. 2-6



3. Improper belt-to-pulley contact.

Fig. 2-7



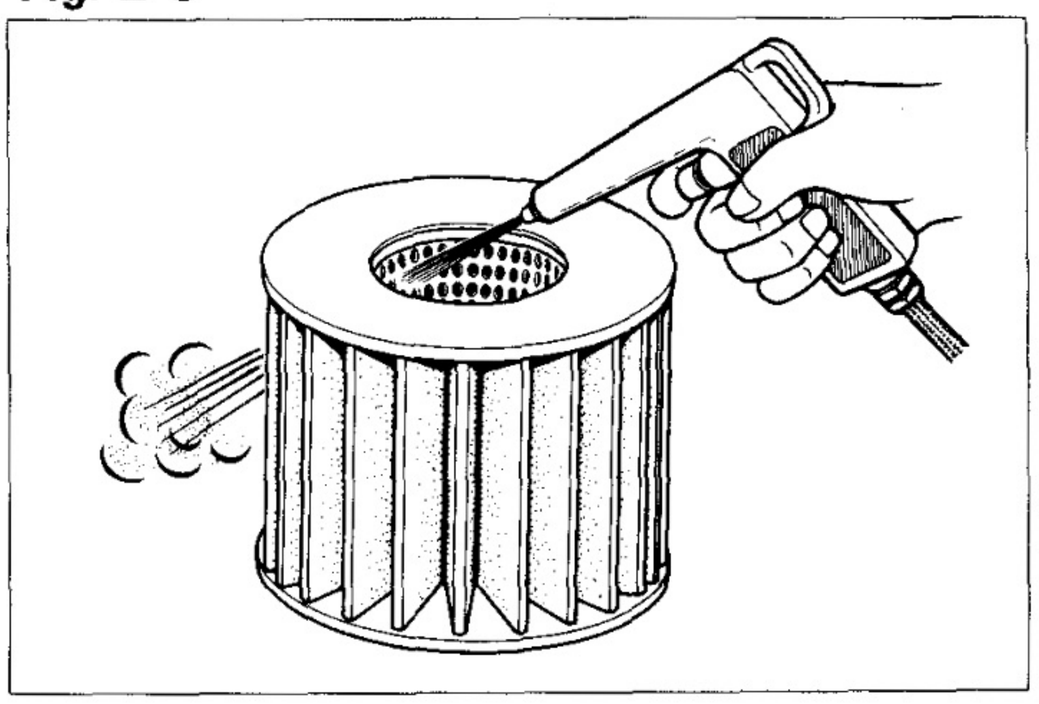
CHECK BELT TENSION

With 10 kg (22 lb) of force, press on the belts at the points indicated in the figure. The belts should deflect as specified.

Drive belt tension:

New belt	**8 – 9 mm (0.31 – 0.35 in.)**
Used belt	**10 – 11 mm (0.39 – 0.43 in.)**

Fig. 2-8



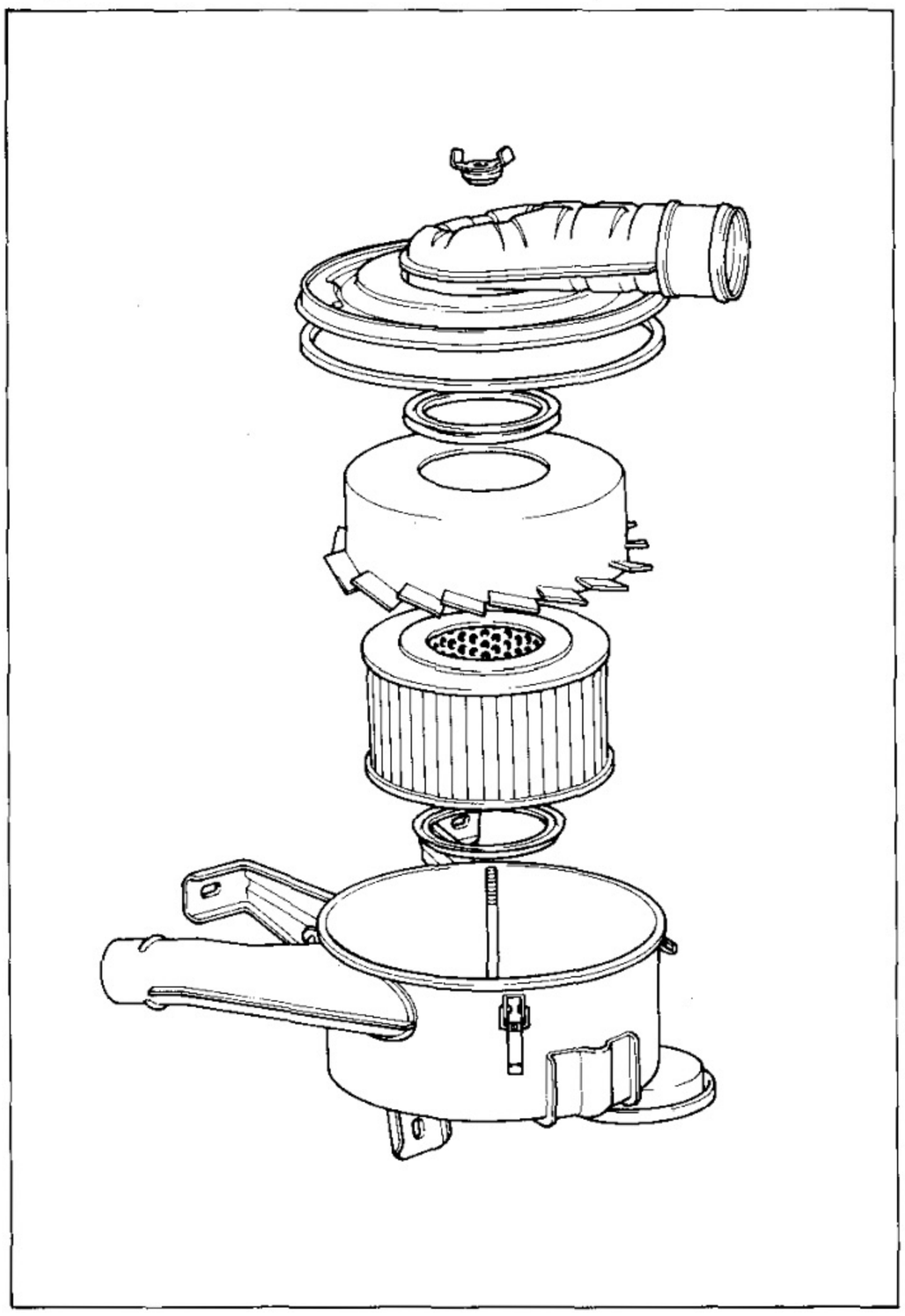
AIR CLEANER

[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. 2-9



VISUAL CHECK

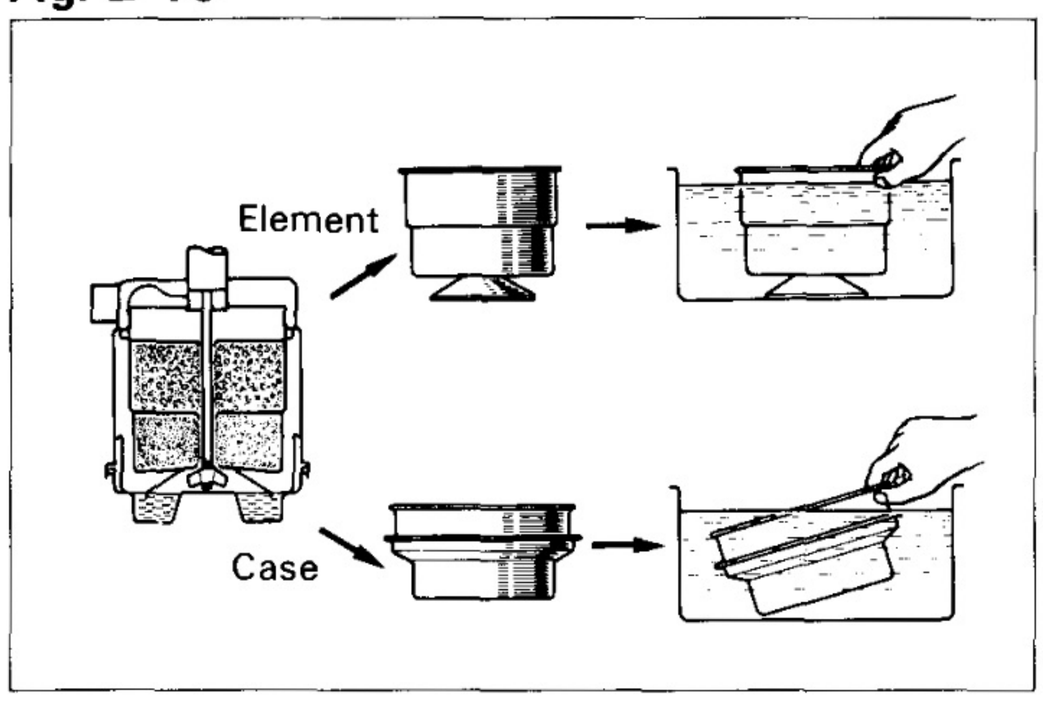
Check for:

1. Damaged, worn or deteriorated gaskets.
2. Damaged or worn seal washer.

INSTALL AIR CLEANER

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

Fig. 2-10

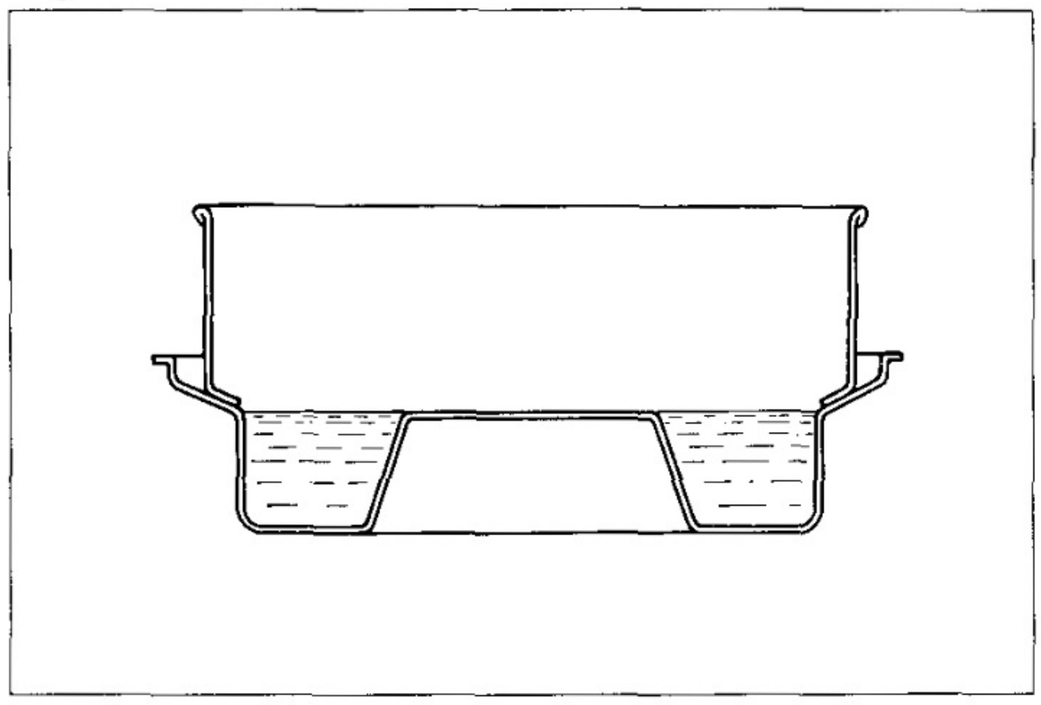


[Oil Bath Type]

CLEAN ELEMENT

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

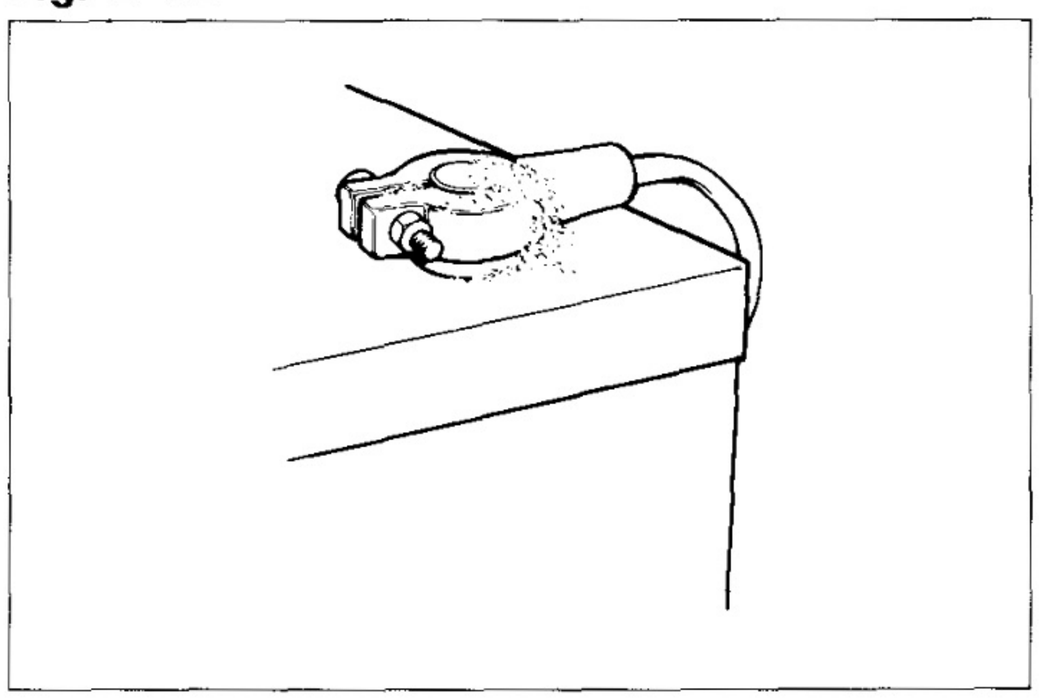
Fig. 2-11



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 the air cleaner.

Fig. 2-12



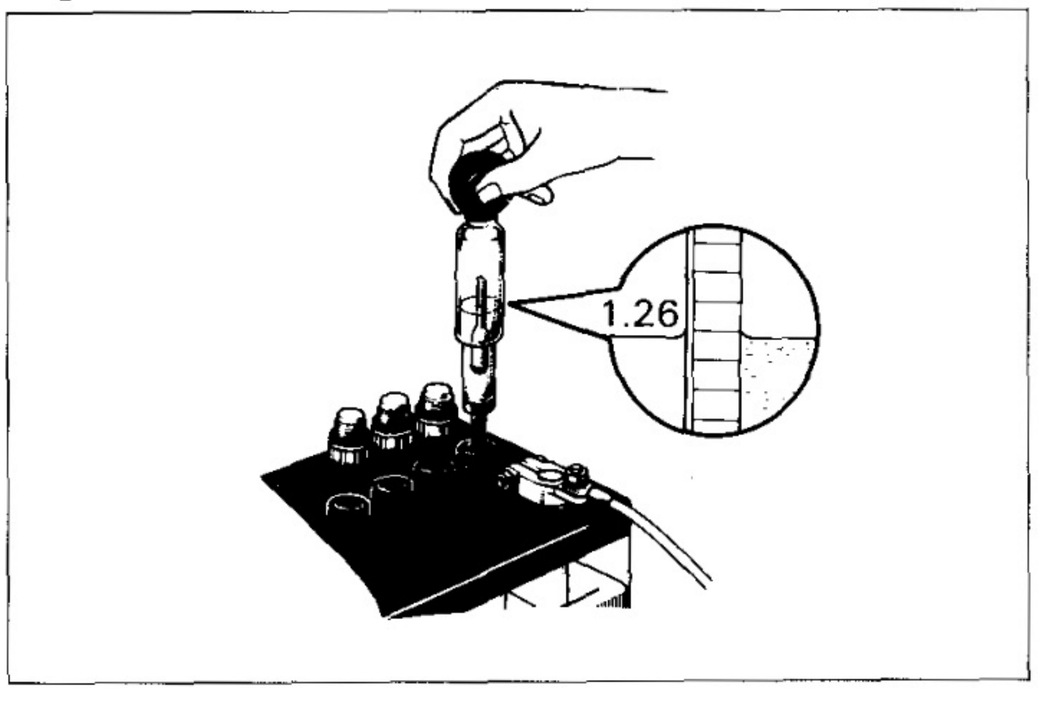
BATTERY

VISUAL CHECK

Check for:

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

Fig. 2-13

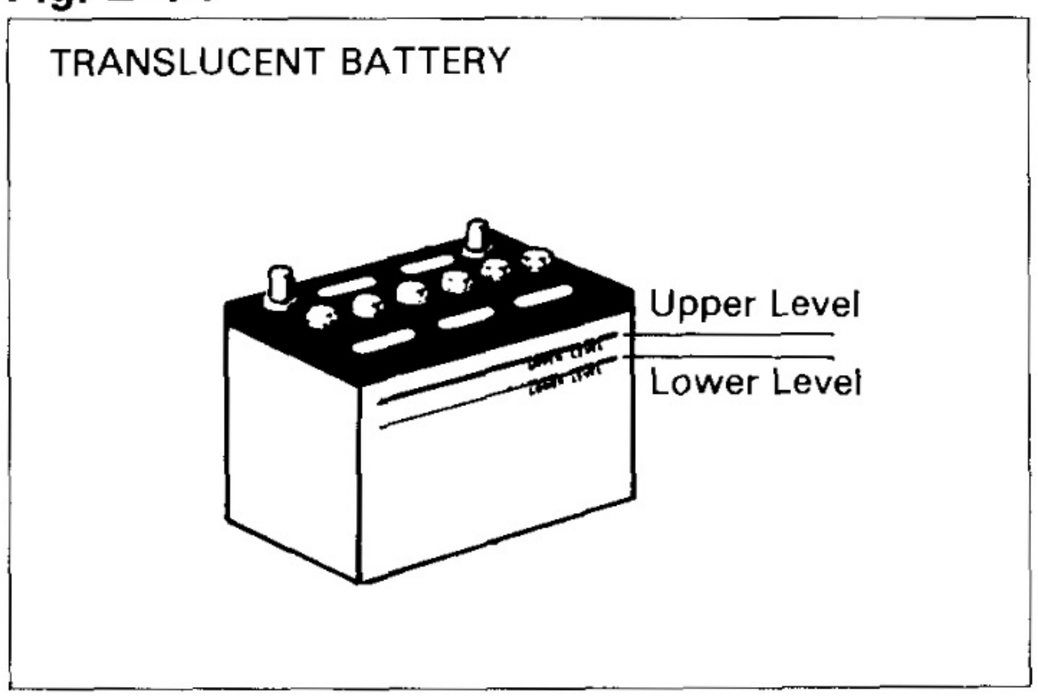


MEASURE SPECIFIC GRAVITY

Check the specific gravity of electrolyte with a hydrometer.

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

Fig. 2-14



CHECK ELECTROLYTE LEVEL

Check the electrolyte quantity.
If insufficient, refill with distilled water.

Fig. 2-15

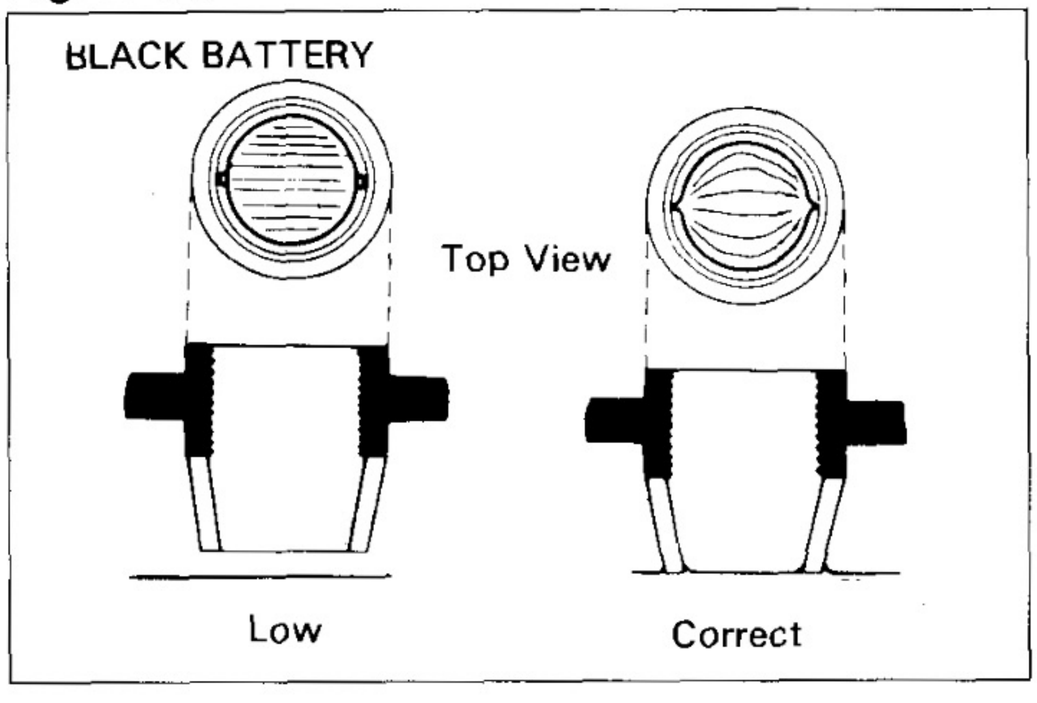


Fig. 2-16



OIL FILTER

REPLACEMENT

1. Remove the oil filter with SST.
   SST [09228-60010]
2. Install a new filter and tighten it firmly by hand.

—Note—

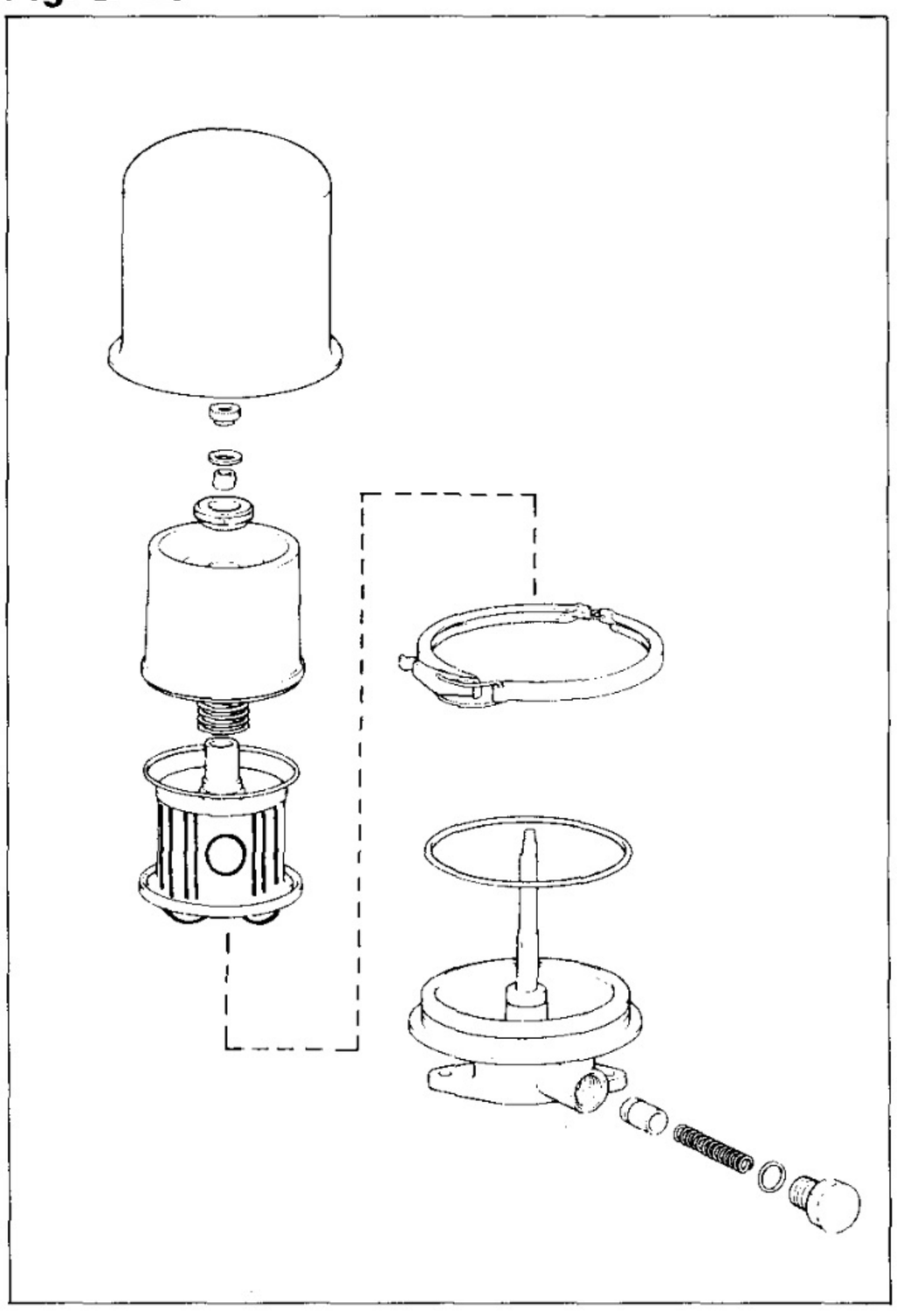
Do not tighten the filter with SST or a wrench.

Fig. 2-17



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

Fig. 2-18

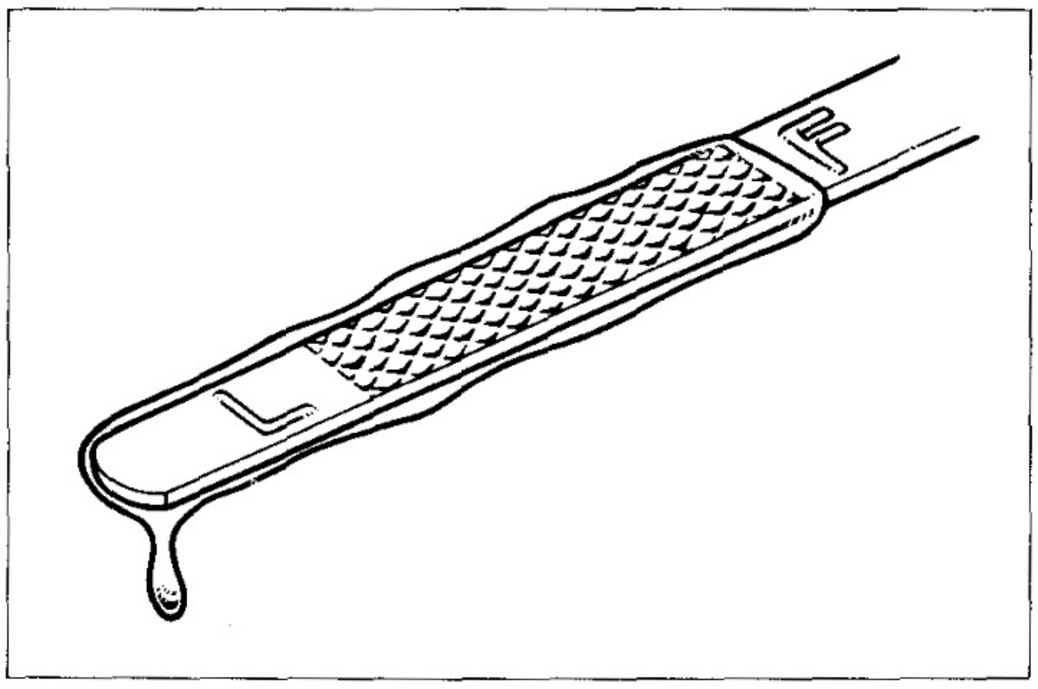


CENTRIFUGAL OIL FILTER

CLEANING

Refer to LUBRICATION SYSTEM section.

Fig. 2-19



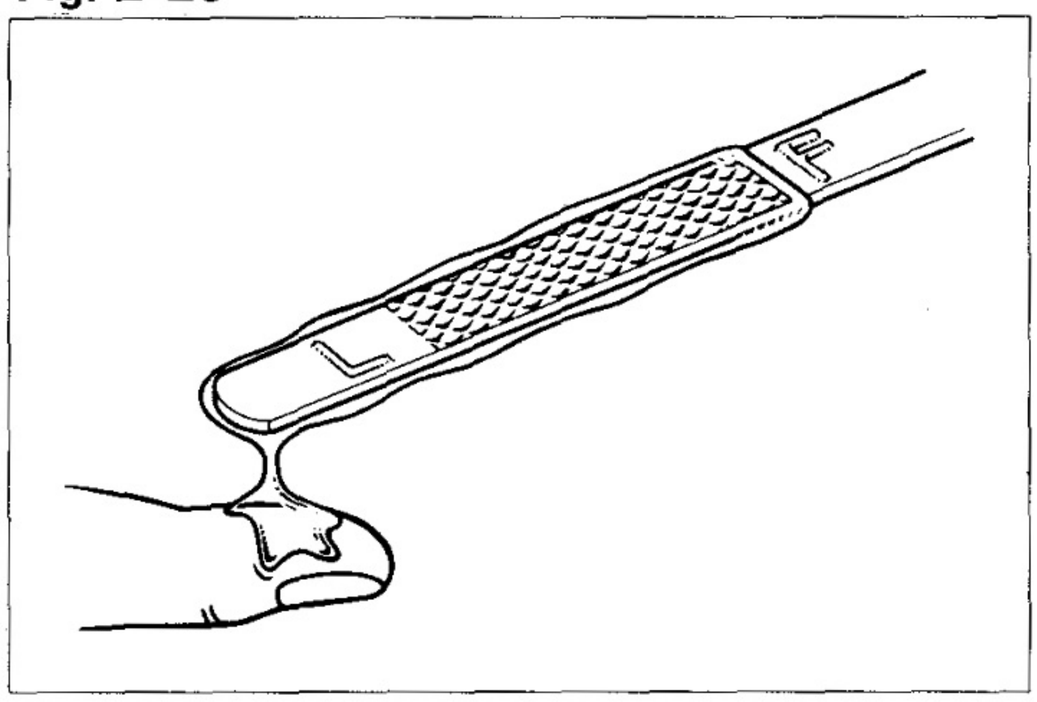
ENGINE OIL

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 line.

—Note—
Use API service CC-CD classification engine oil.

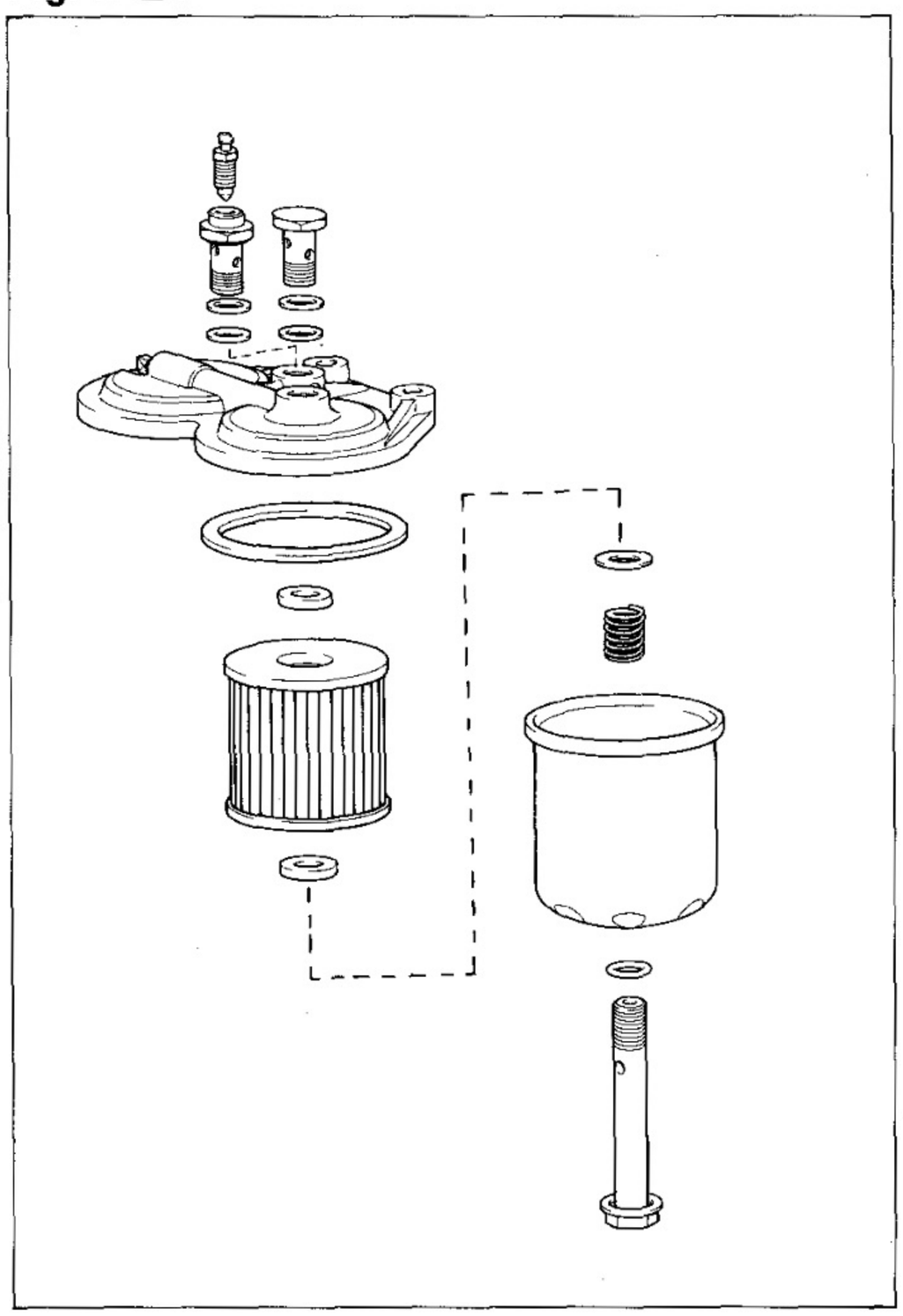
Fig. 2-20



CHECK OIL QUALITY

Check for:
1. Deterioration.
2. Entry of water.
3. Discoloration or thinning.

Fig. 2-21

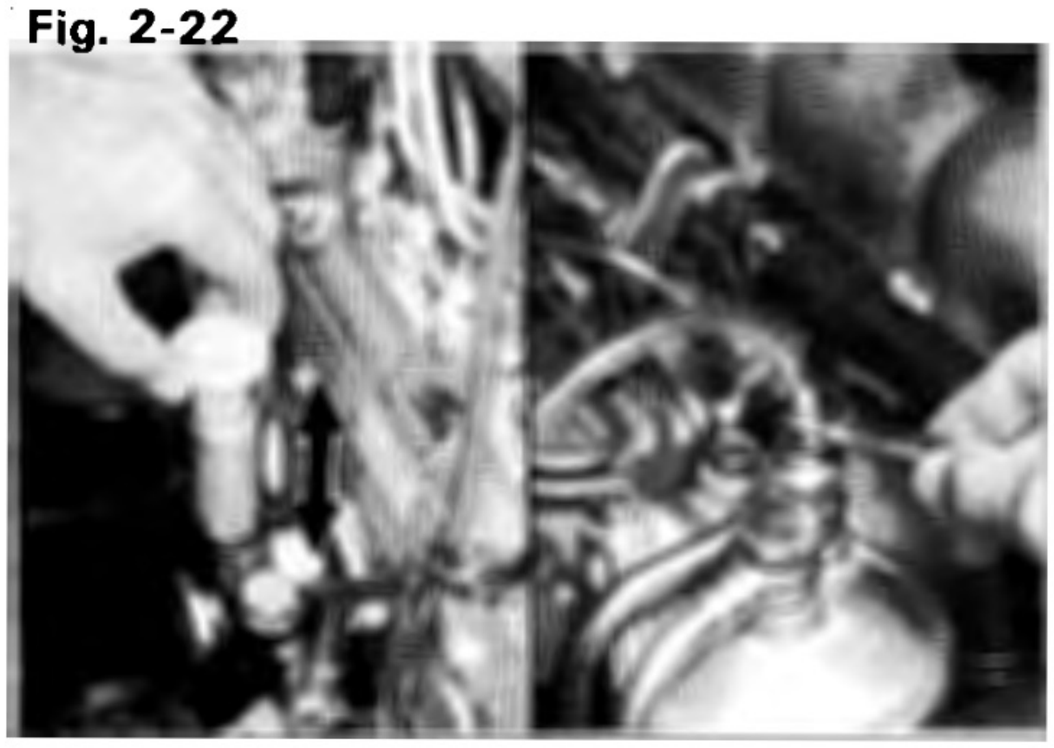


FUEL FILTER

REPLACEMENT

Refer to FUEL SYSTEM section.

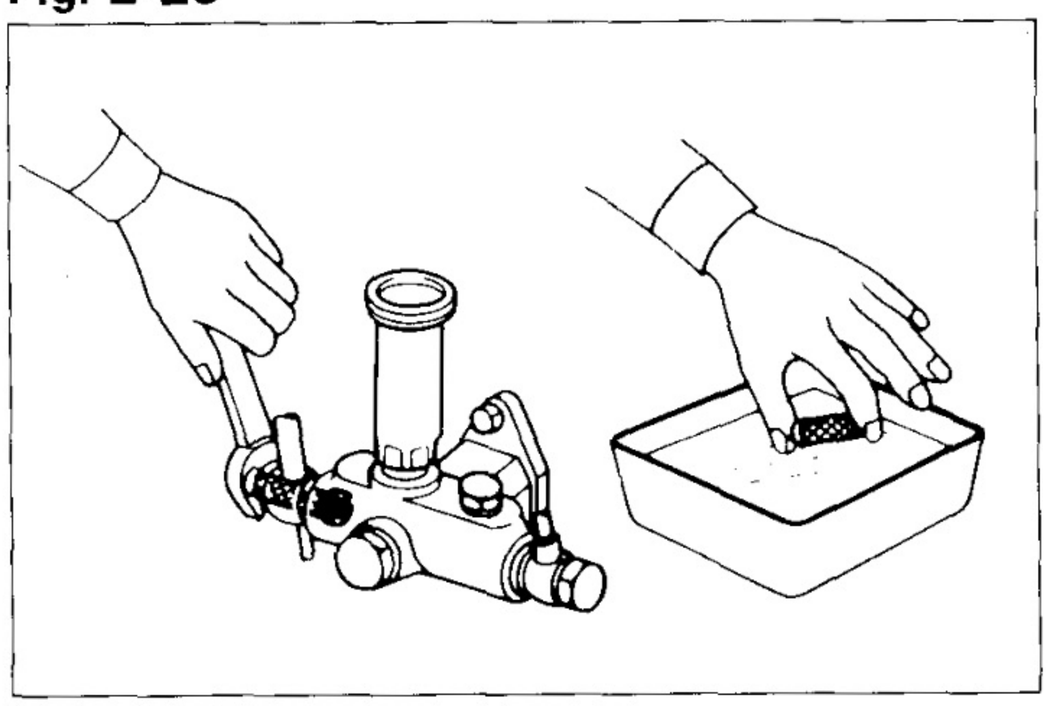
Fig. 2-22



BLEED AIR

1. Bleed the air from fuel filter by operating the priming pump.
2. After starting the engine, check for oil leaks.

Fig. 2-23



[Feed Pump Filter]

Remove the inlet union and clean the filter.

Fig. 2-24



INJECTION PUMP

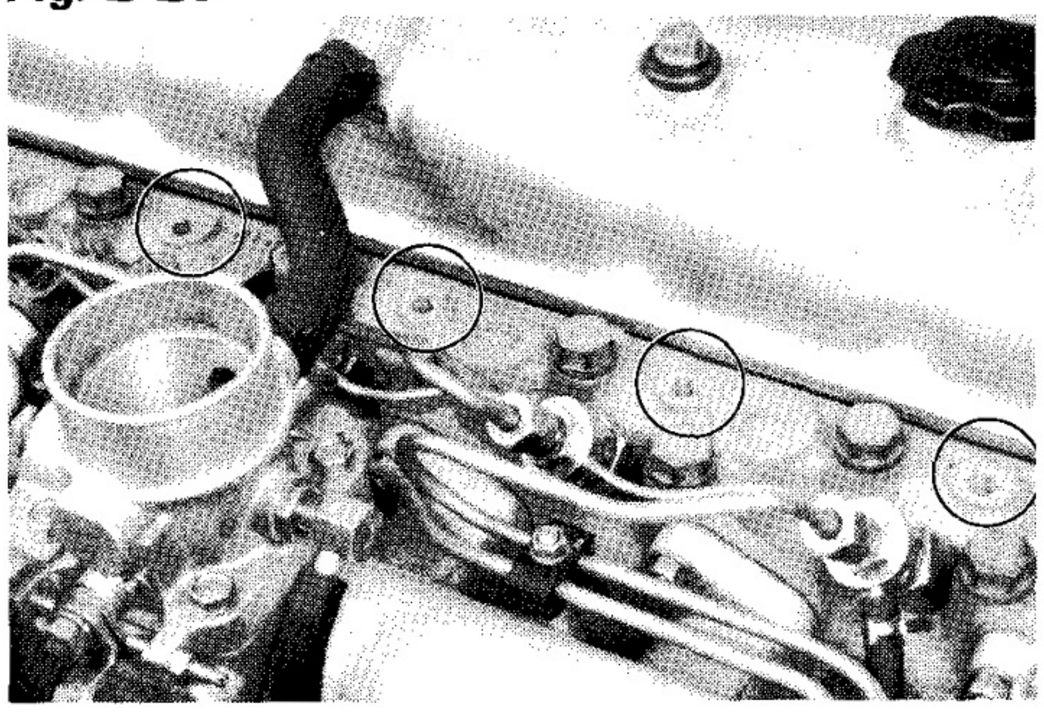
LUBRICATE DIAPHRAGM HOUSING

Place 3 or 4 drops of diaphragm oil on the diaphragm.

—Note—

Before lubricating the diaphragm, make sure that there is no fuel or engine oil in the governor chamber. If necessary, drain the fuel or engine oil by loosening the drain bolt.

Fig. 2-25



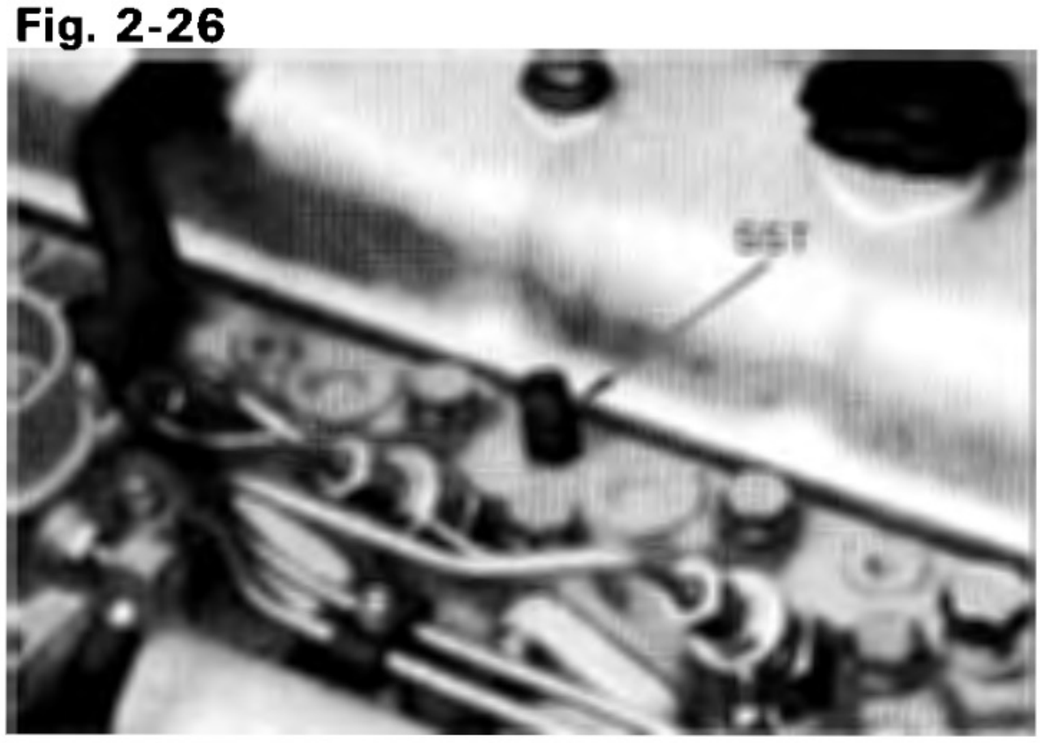
COMPRESSION PRESSURE

1. Warm-up the engine.
2. Remove all glow plugs.

—Note—

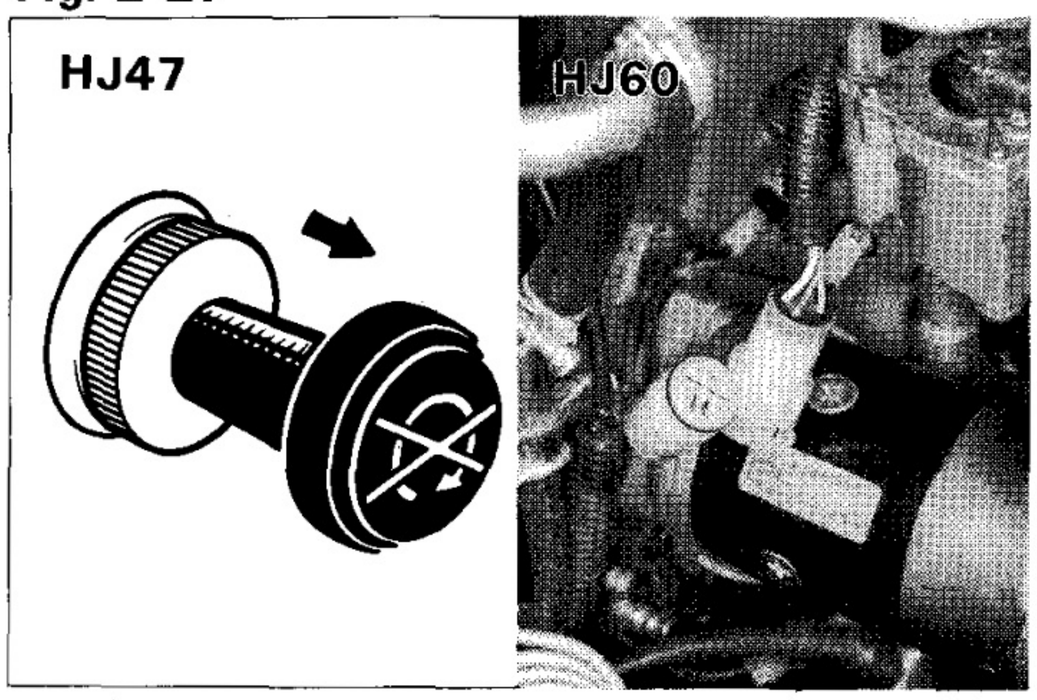
Make sure that the lead wire is not grounded.

Fig. 2-26



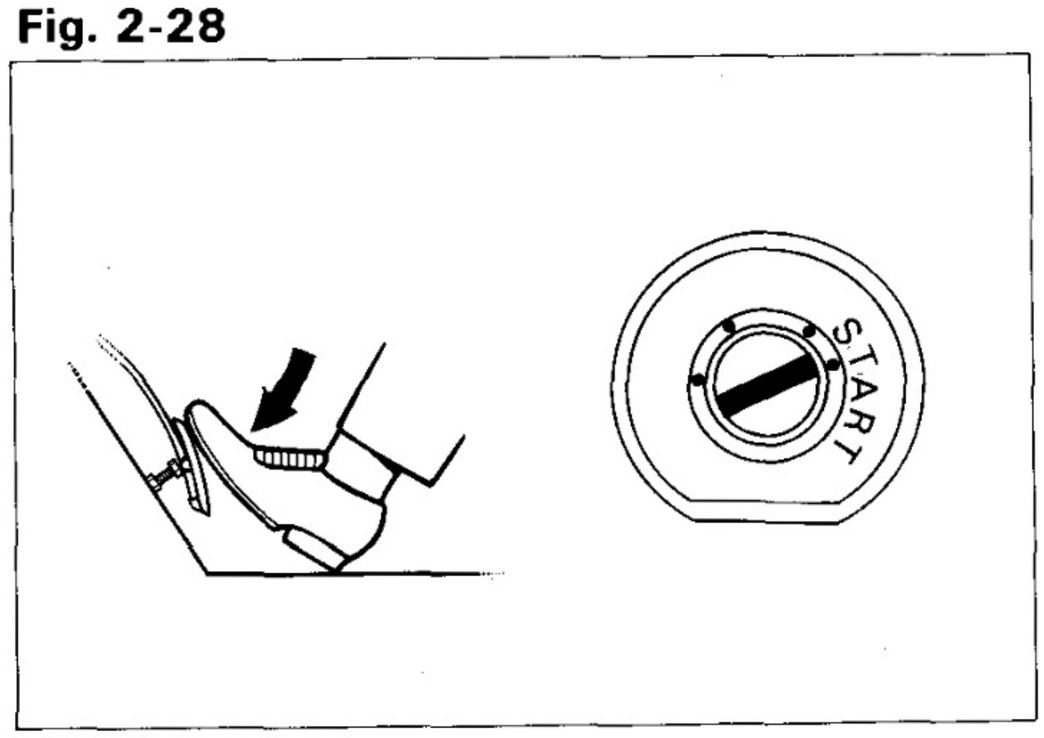
3. Install SST to the glow plug mounting hole and insert a compression gauge.
   SST [09992-00021]

Fig. 2-27



4. Pull the stop button all the way out or disconnect the connector of EDIC motor wires after turning the starter switch to LOCK position.

Fig. 2-28



5. Fully depress the accelerator pedal.
6. Measure the compression pressure while cranking the engine with the starter motor.

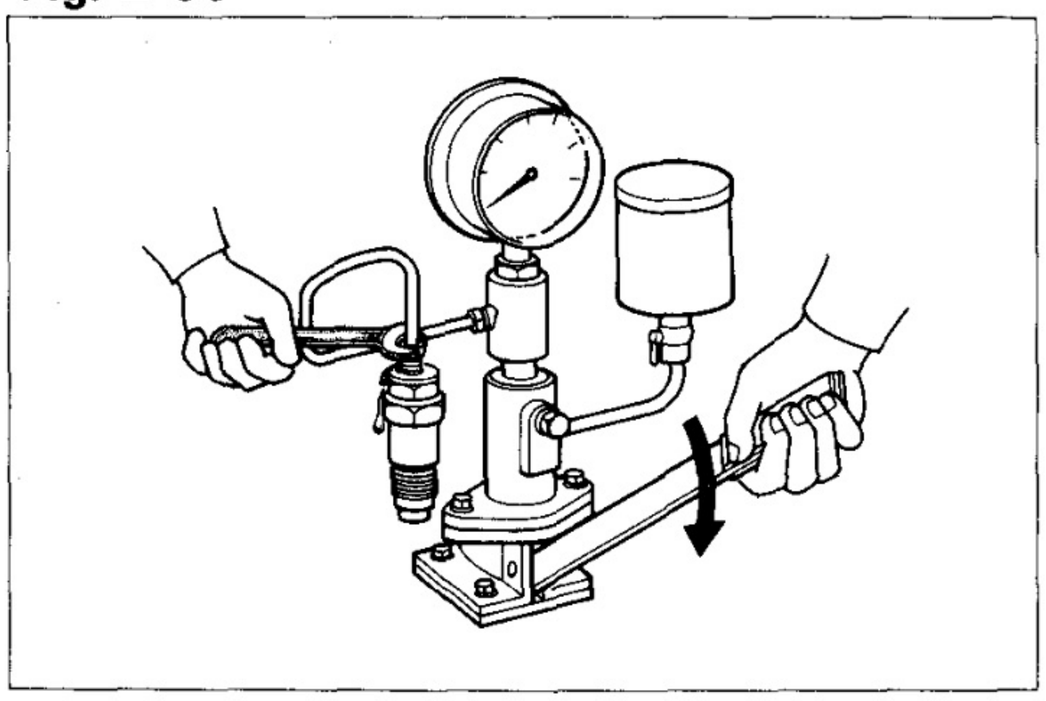
—Note—
Keep pressure measuring time to a minimum.

Fig. 2-29



Cranking speed: 250 rpm
Compression pressure:
STD 28.0 kg/cm² (398 psi)
Limit 20.0 kg/cm² (284 psi)
Difference between each cylinder:
2.0 kg/cm² (28 psi)

Fig. 2-30

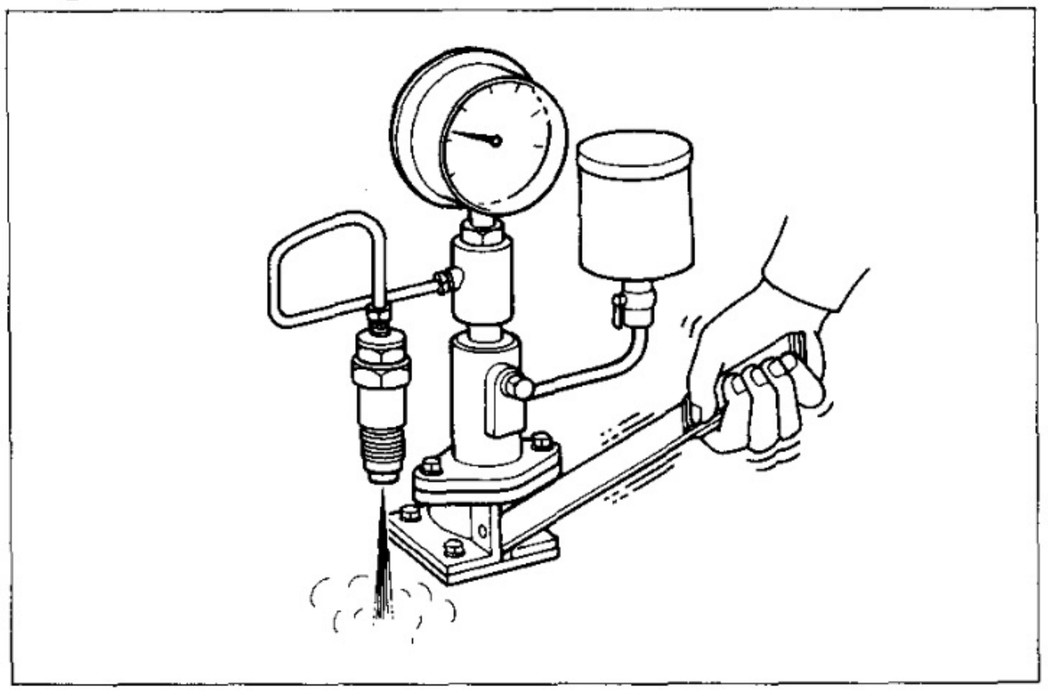


INJECTION NOZZLE

SPRAY TEST

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

Fig. 2-31

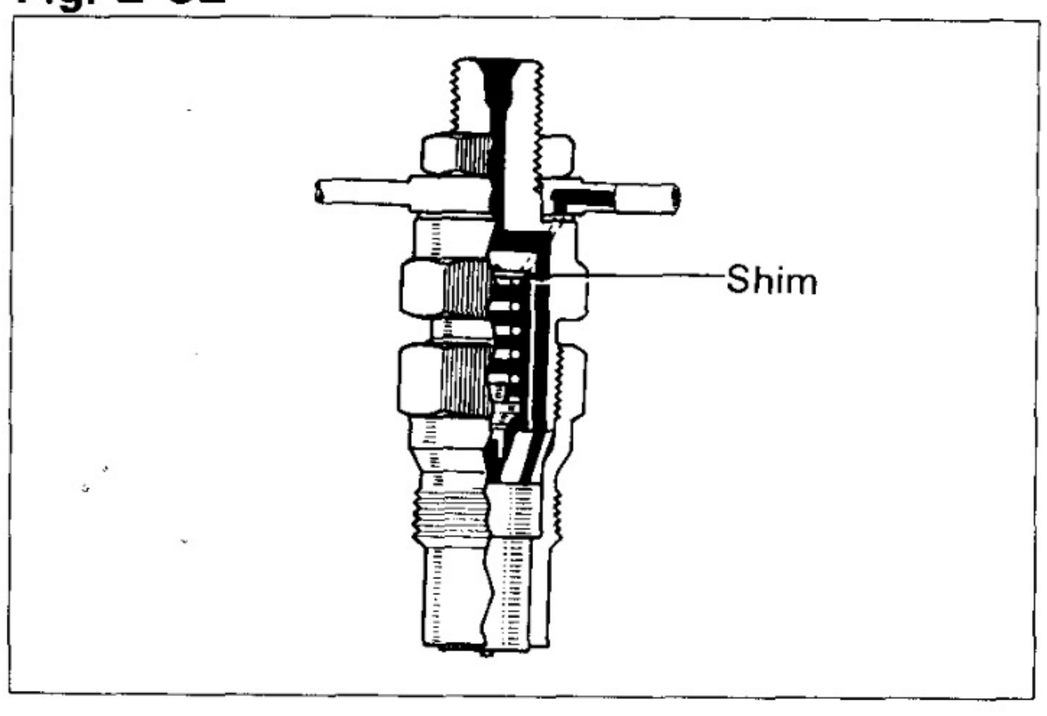


2. Check injection pressure.
   (1) Pump the tester handle 50 — 60 times per minute by hand.
   (2) Read the injection starting pressure.

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).**

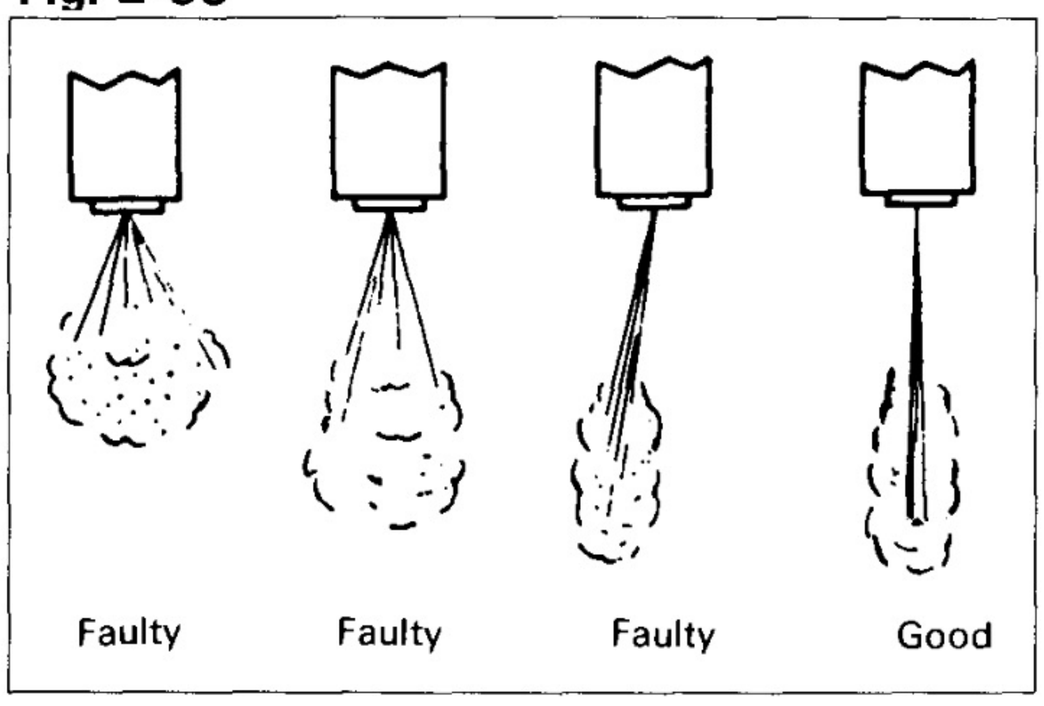
Fig. 2-32



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

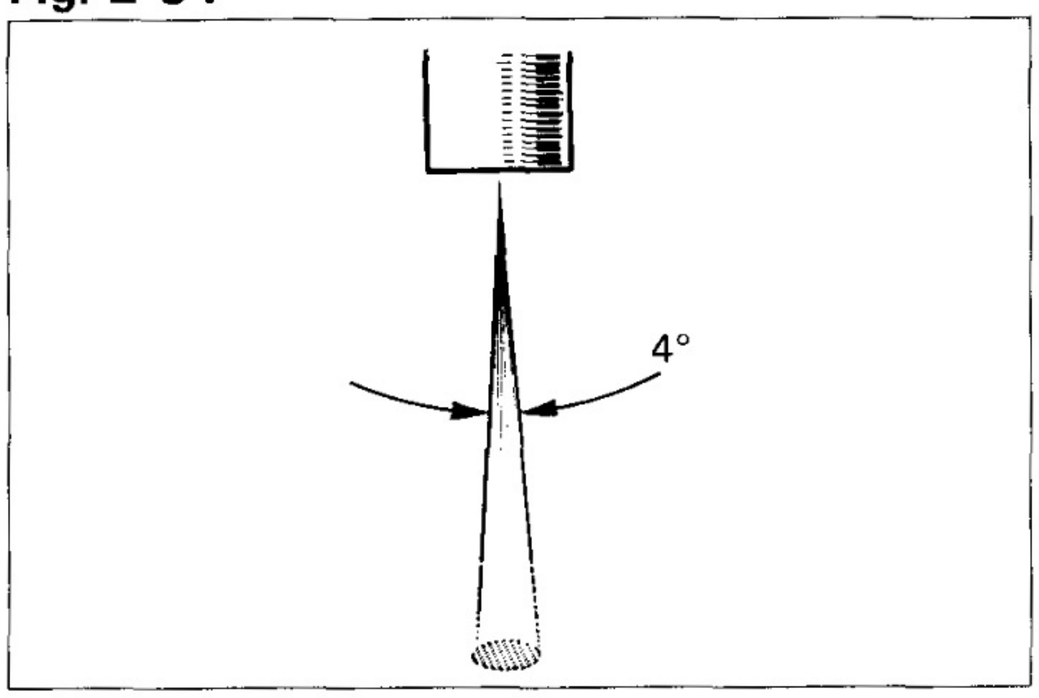
—Note—
1. **Shims are available in 20 sizes, in increments of 0.05 mm (0.0020 in.), from 1.00 — 1.95 mm (0.0394 — 0.0768 in.).**
2. **Varying the adjusting shim thickness by 0.05 mm (0.0020 in.) changes the injection pressure by about 5 kg/cm² (71 psi).**

Fig. 2-33



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

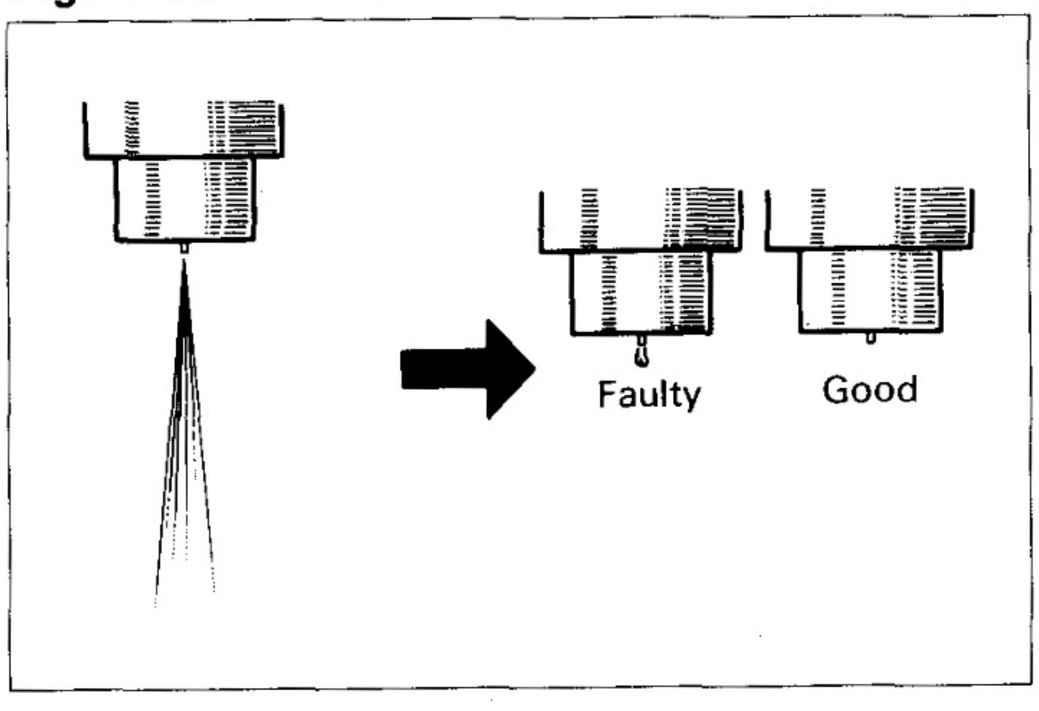
Fig. 2-34



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

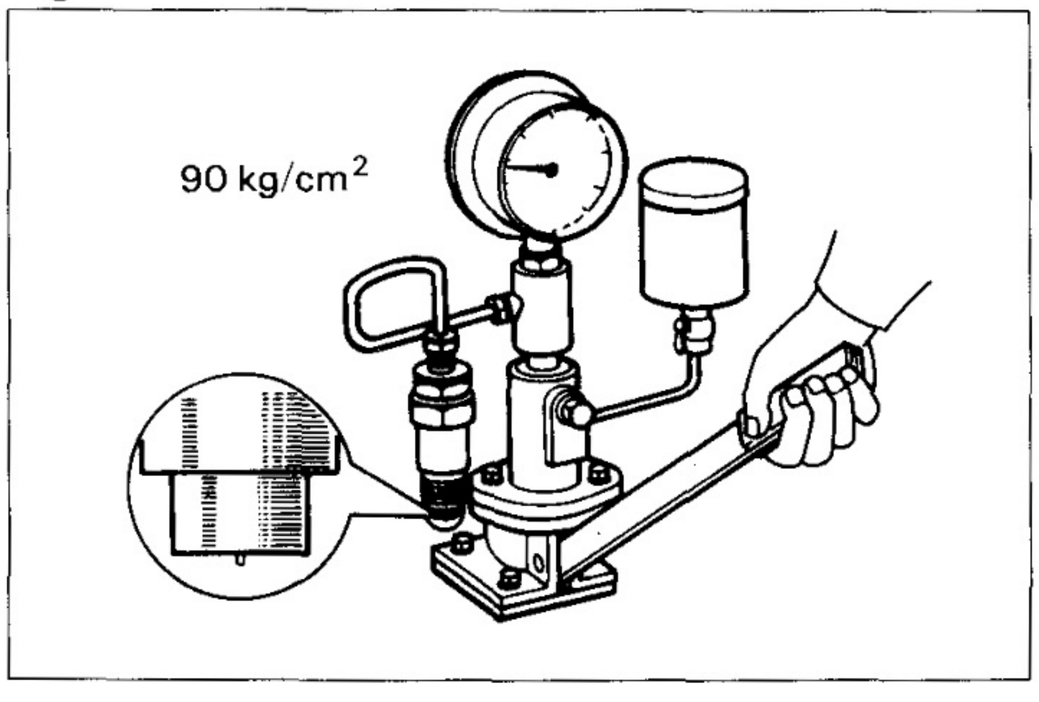
(3) Place a white sheet of paper about 30 cm (12 in.) away from the nozzle to check if spray pattern is in circular form.

Fig. 2-35



5. There should be no dripping after injection.

Fig. 2-36



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. 2-37

SEE

FUEL SYSTEM

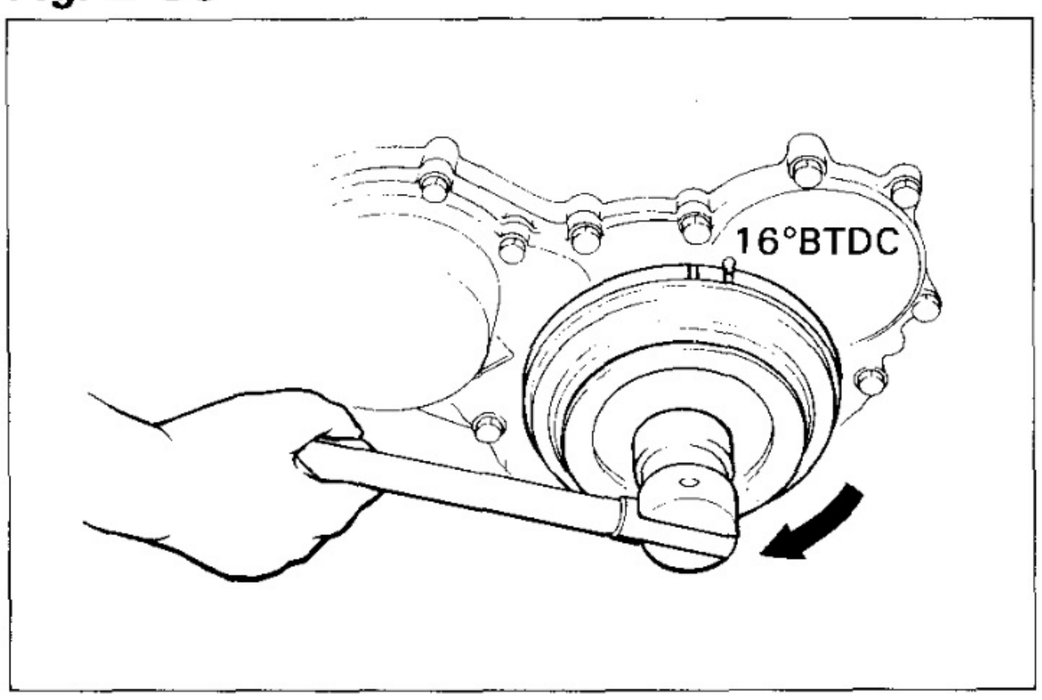
NOZZLE CLEANING SECTION

Fig. 6-26 to 6-32

NOZZLE CLEANING

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

Fig. 2-38



INJECTION TIMING

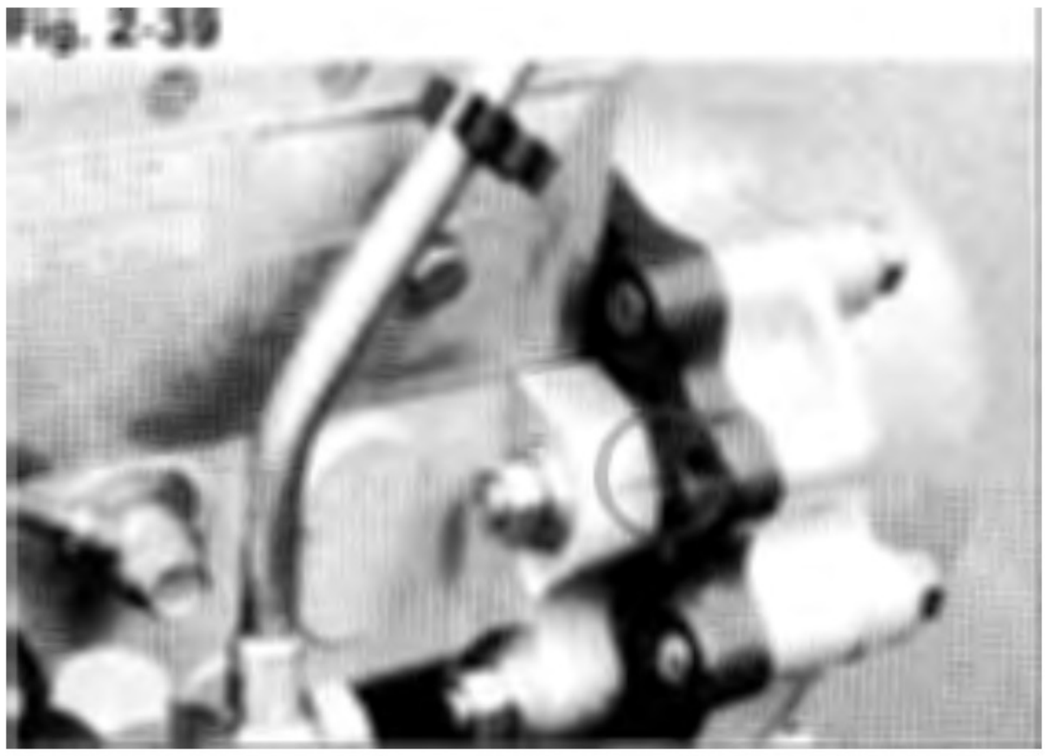
INSPECTION & ADJUSTMENT

1. Set the No.1 cylinder piston to the specified position.

   Injection timing:

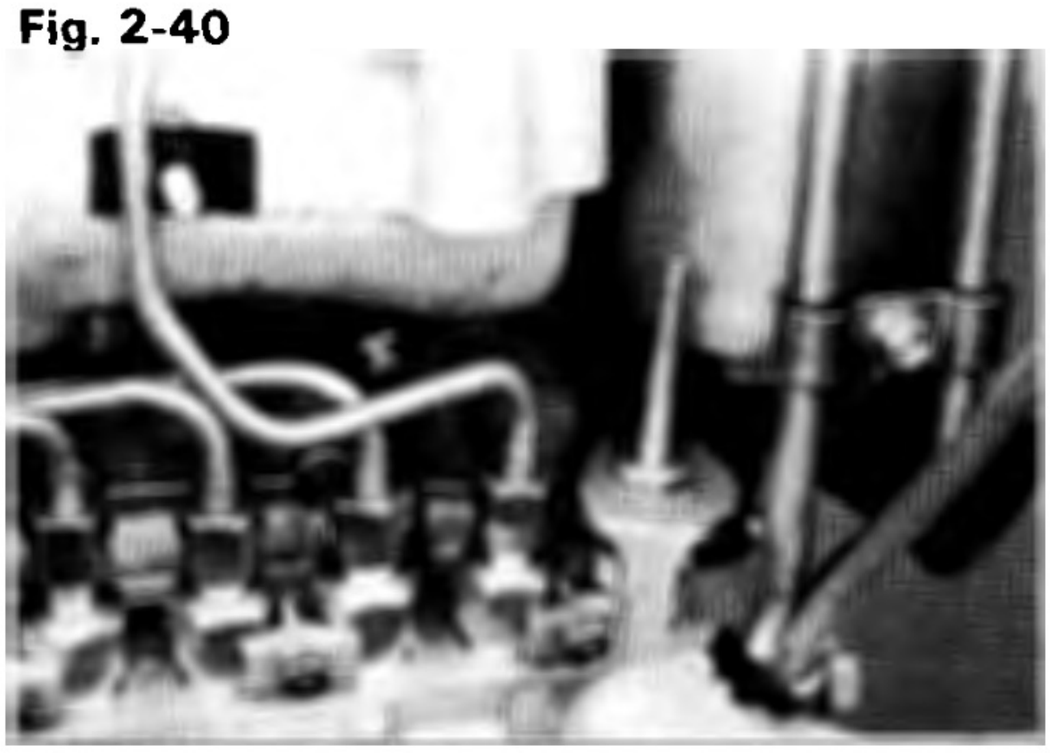
   16° BTDC/compression

Fig. 2-39



2. Set the aligning mark on the injection pump against the index mark on the pump retainer.

Fig. 2-40

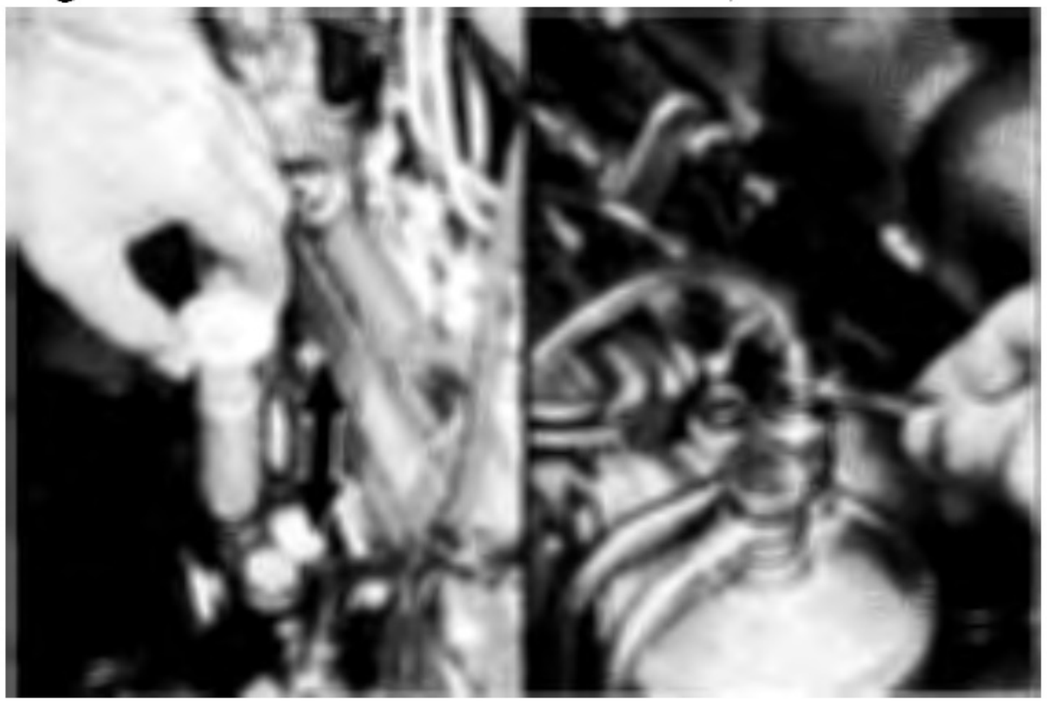


3. Check the injection timing.
   (1) Install the inspection pipe on the No.1 delivery valve holder.

—Note—

The length of inspection pipe should be kept as short as possible.

Fig. 2-41



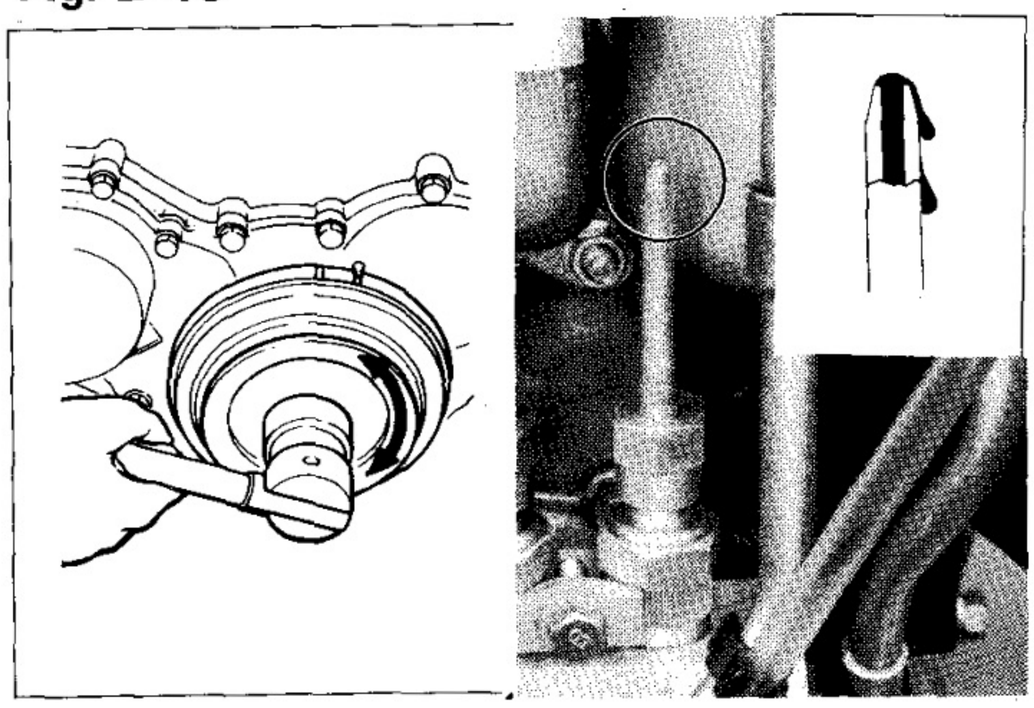
   (2) Bleed air from the fuel filter by operating the priming pump.

Fig. 2-42



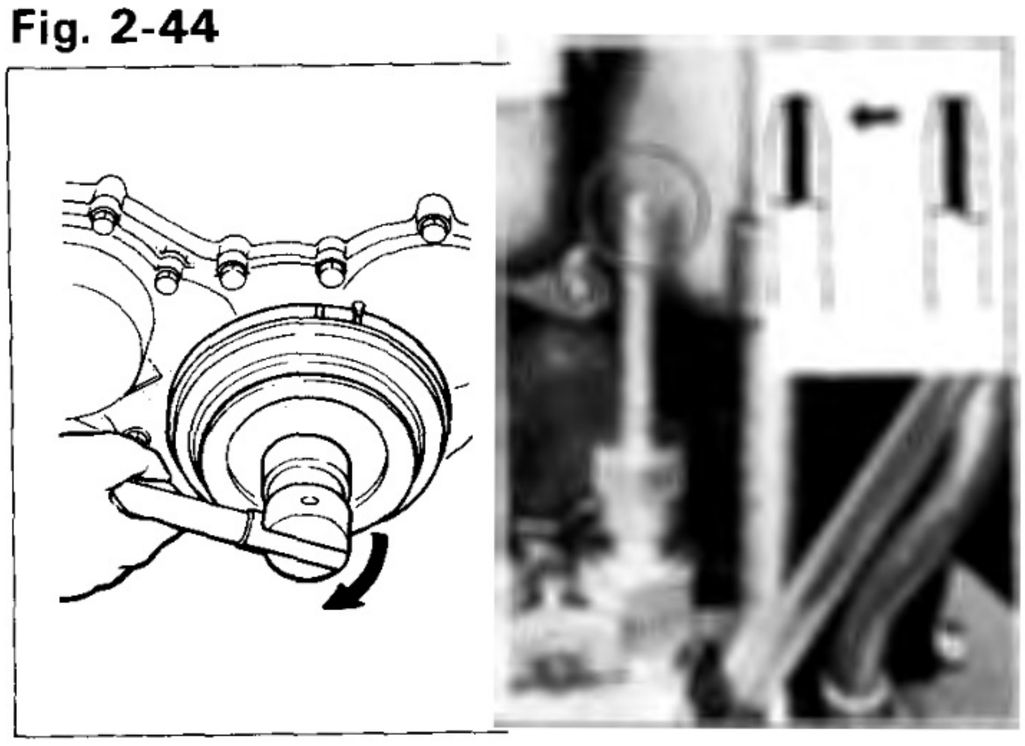
(3) Bleed air from the injection pump by operating the priming pump.

Fig. 2-43



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

Fig. 2-44



(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:
16° BTDC/compression

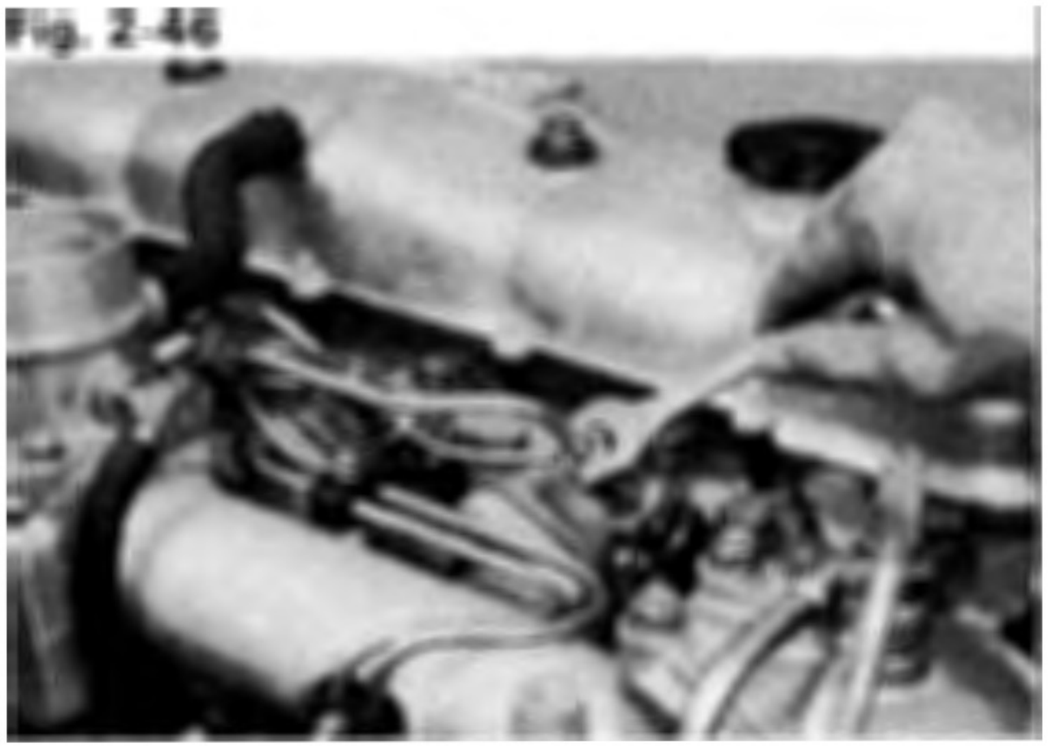
Fig. 2-45



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

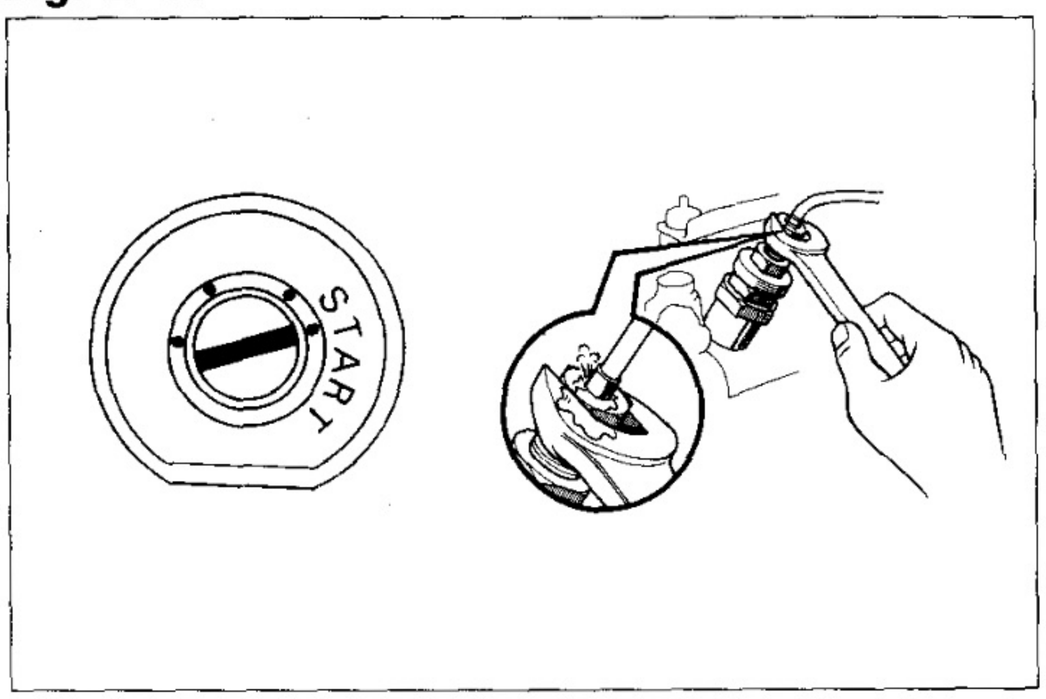
—Note—
This operation should be repeated at least two or three times.

Fig. 2-46



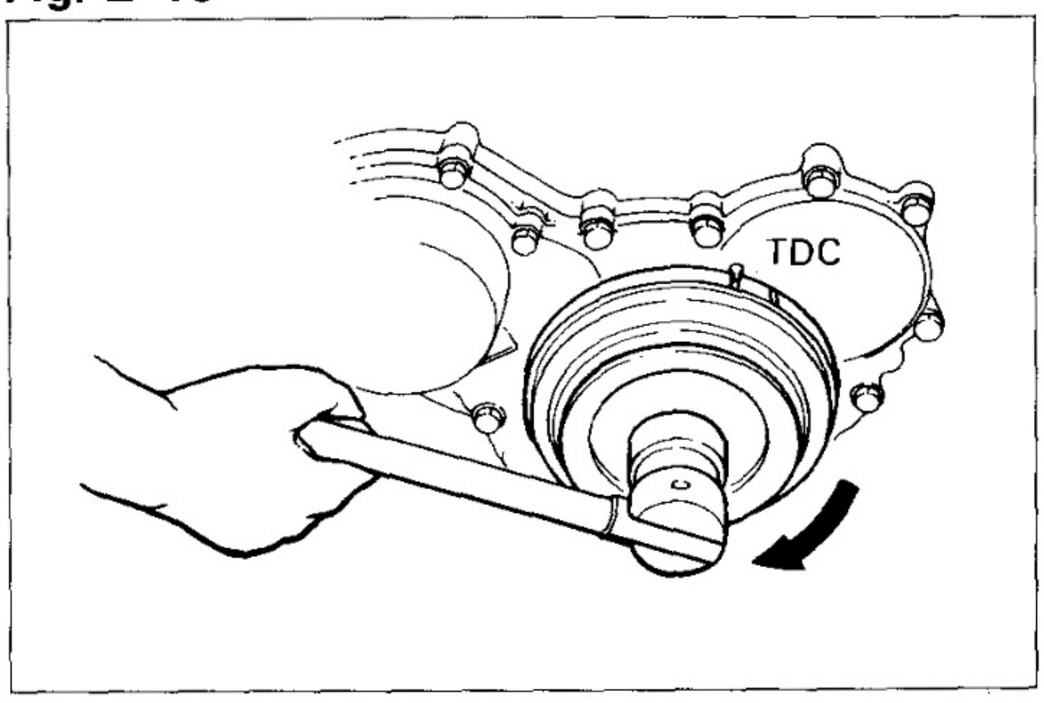
6. Remove the inspection pipe and install the No.1 injection pipe.

Fig. 2-47



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. 2-48



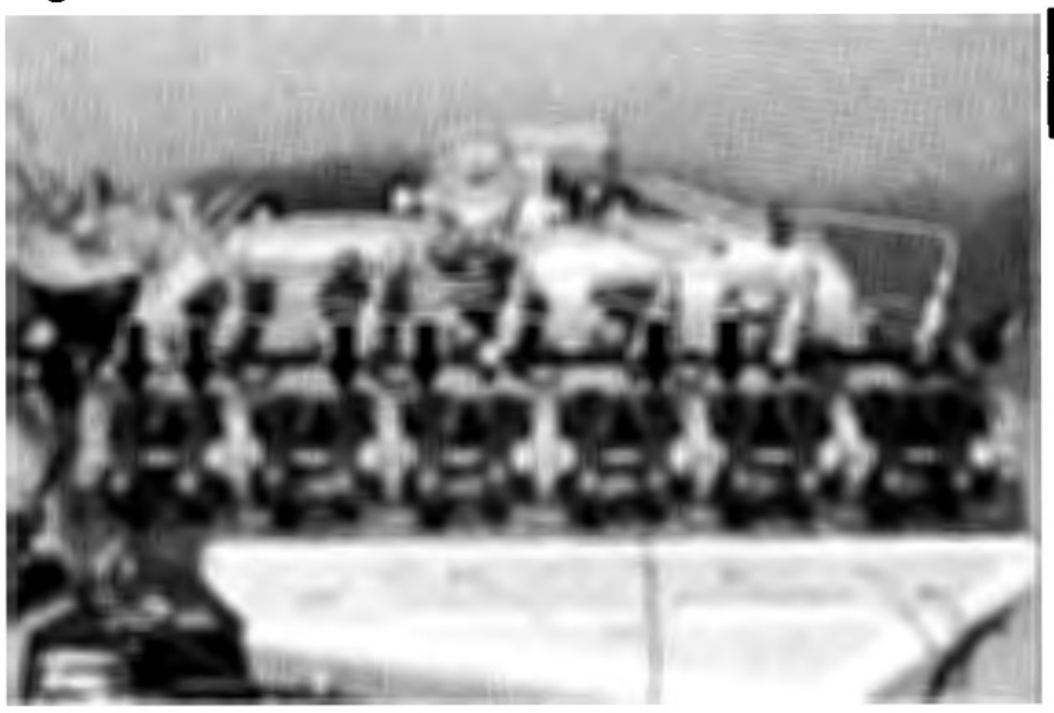
VALVE CLEARANCE

ADJUSTMENT

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

Cylinder head bolts
11.0 – 12.0 kg-m
(80 – 87 ft-lb)
Rocker support bolts
1.5 – 2.2 kg-m
(11 – 15 ft-lb)

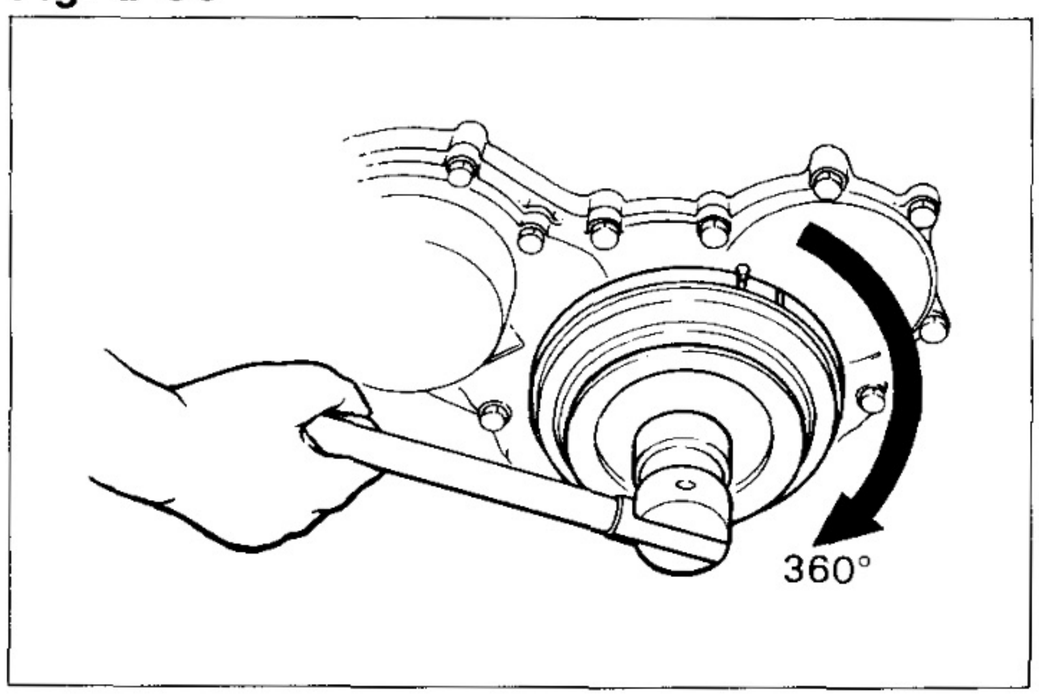
Fig. 2-49



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 0.36 mm
(0.014 in.)

Fig. 2-50



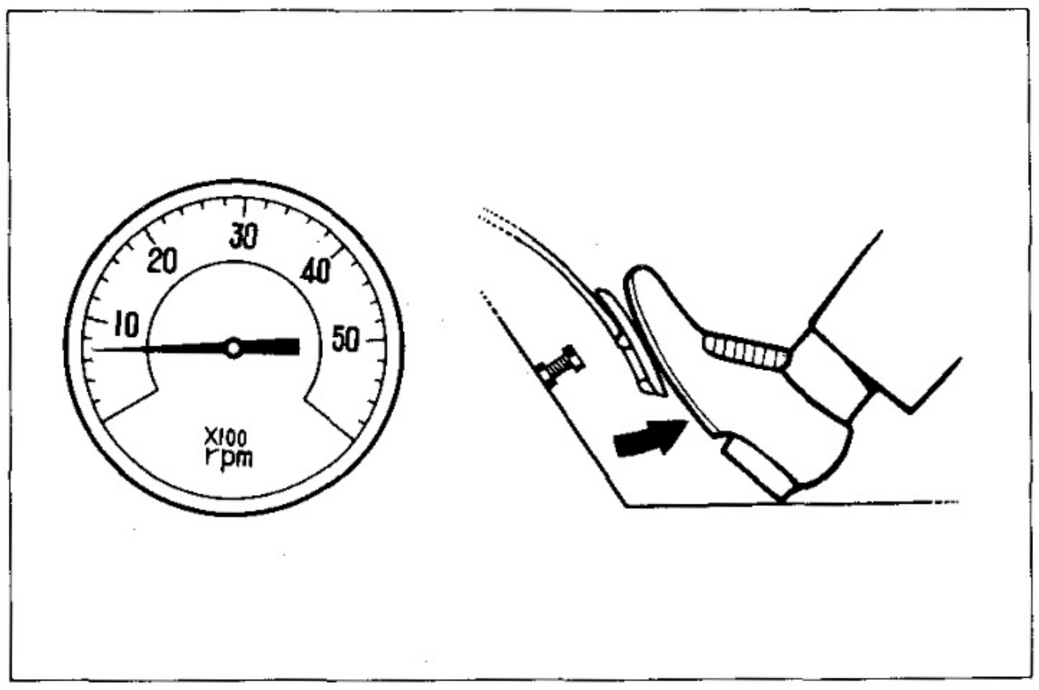
5. Rotate the crankshaft 360°.

Fig. 2-51



6. Adjust the remaining valves indicated by arrows.

Fig. 2-52



IDLE SPEED & MAXIMUM SPEED

INSPECTION & ADJUSTMENT

1. Warm-up the engine.
2. Check the engine idle speed.

   Idle speed: 625 – 675 rpm

Fig. 2-53



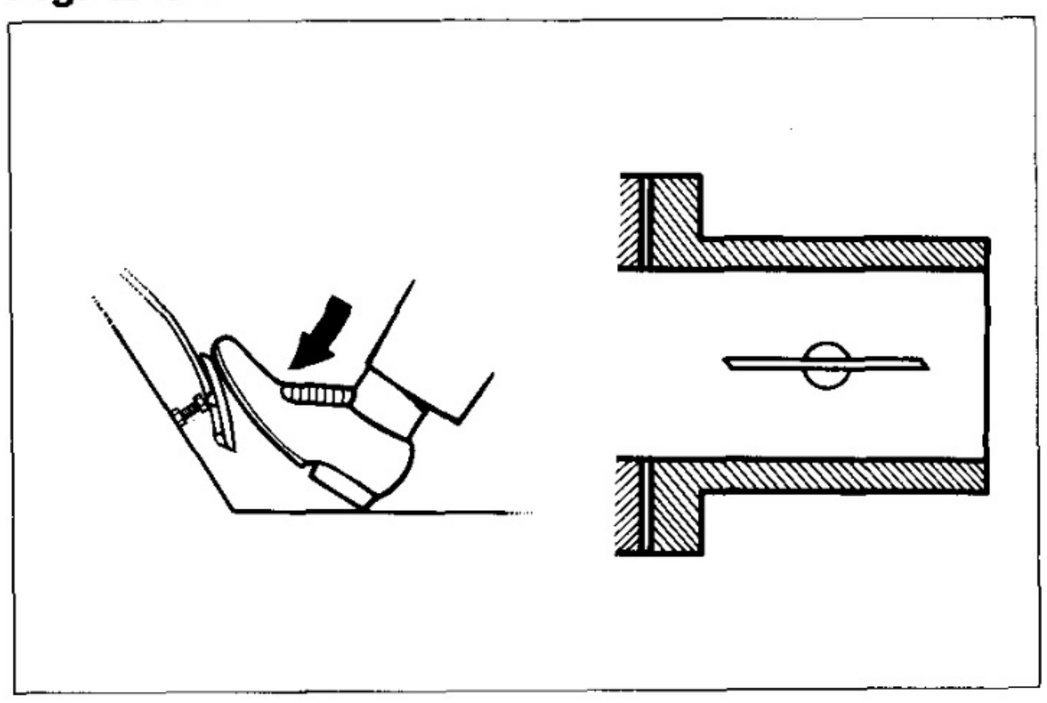
3. If necessary, adjust the idle speed by turning the stop plate adjusting screw.

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

–Note–

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

Fig. 2-54



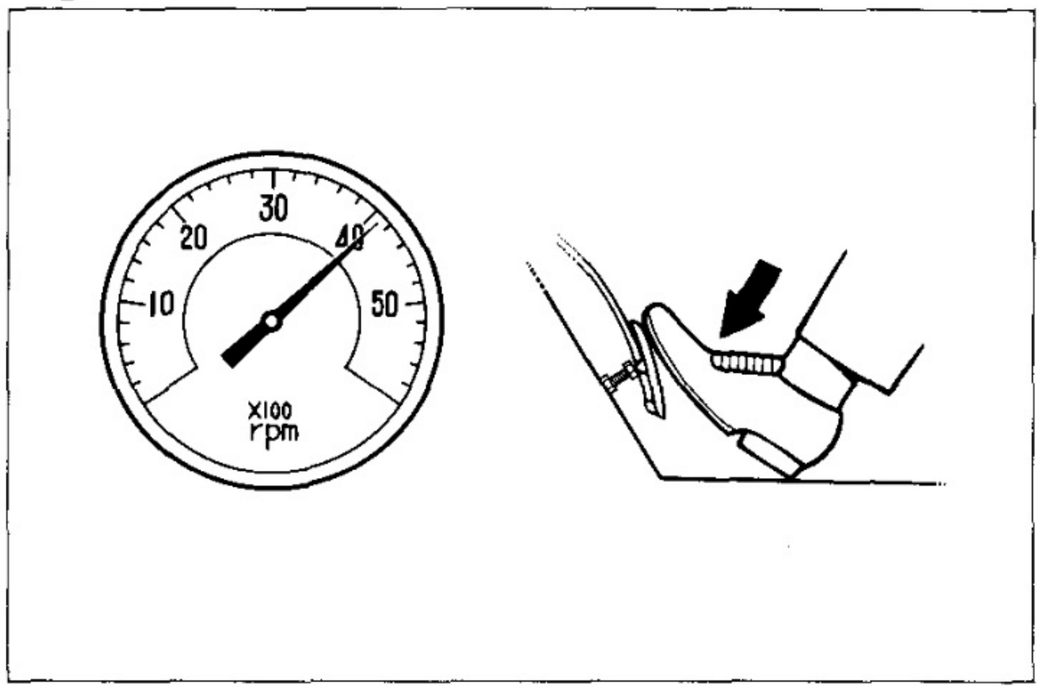
4. Make sure that the throttle valve is fully open when the accelerator pedal is depressed all the way.

Fig. 2-55



5. Make the full open adjustment with the accelerator pedal stop bolt.

Fig. 2-56



6. Check the engine maximum speed when the accelerator pedal is fully depressed.

Maximum speed:
Direct fan type
4,050 – 4,100 rpm
Fluid coupling type
4,120 – 4,170 rpm

Fig. 2-57



7. If necessary, adjust the maximum speed by turning the adjusting bolt.
   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, secure the cap nut with wire.

ENGINE SERVICE

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CUTAWAY VIEW	3-2
CYLINDER HEAD	3-4
TIMING GEAR	3-23
CYLINDER BLOCK	3-35

CUTAWAY VIEW

Fig. 3-1

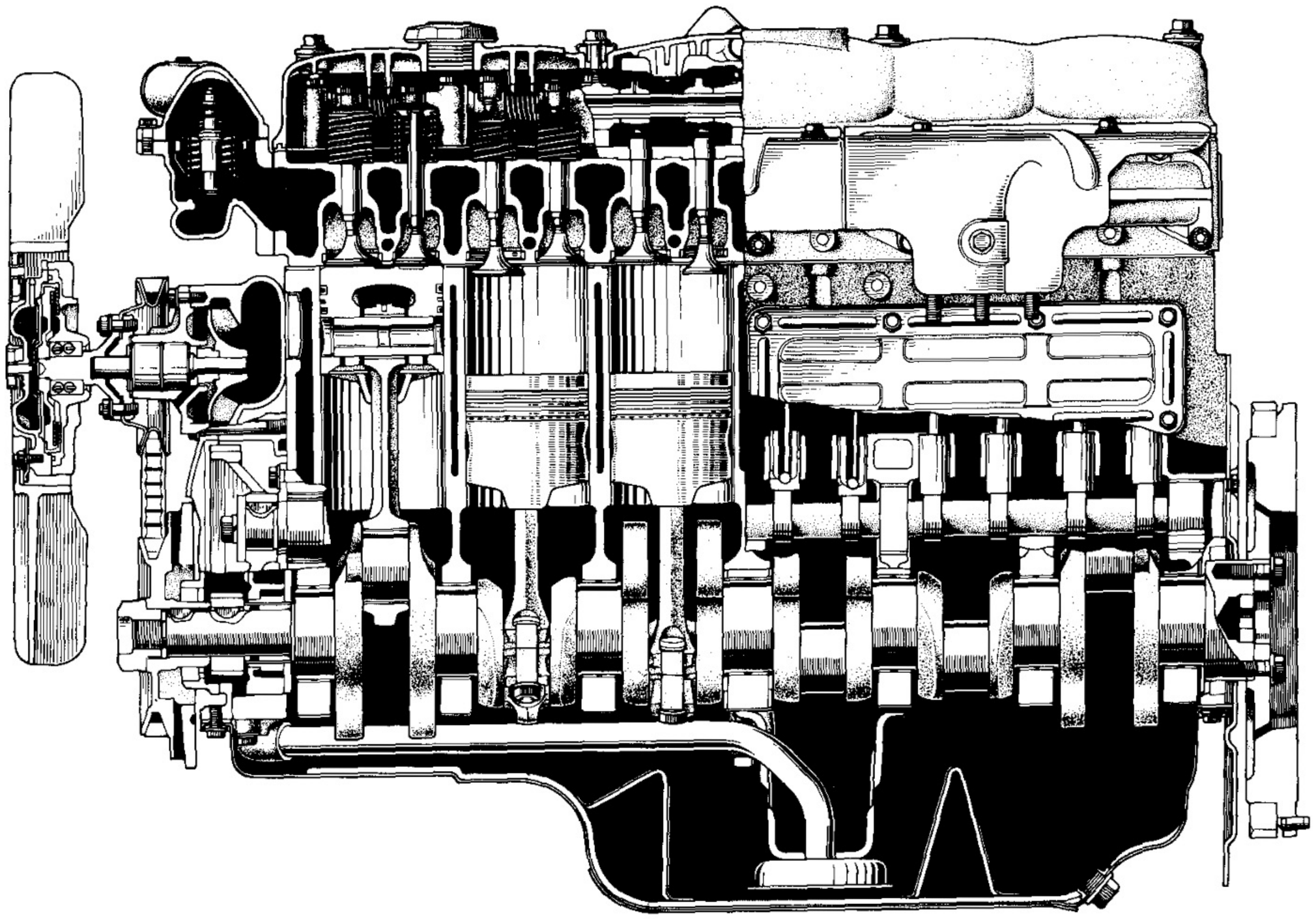
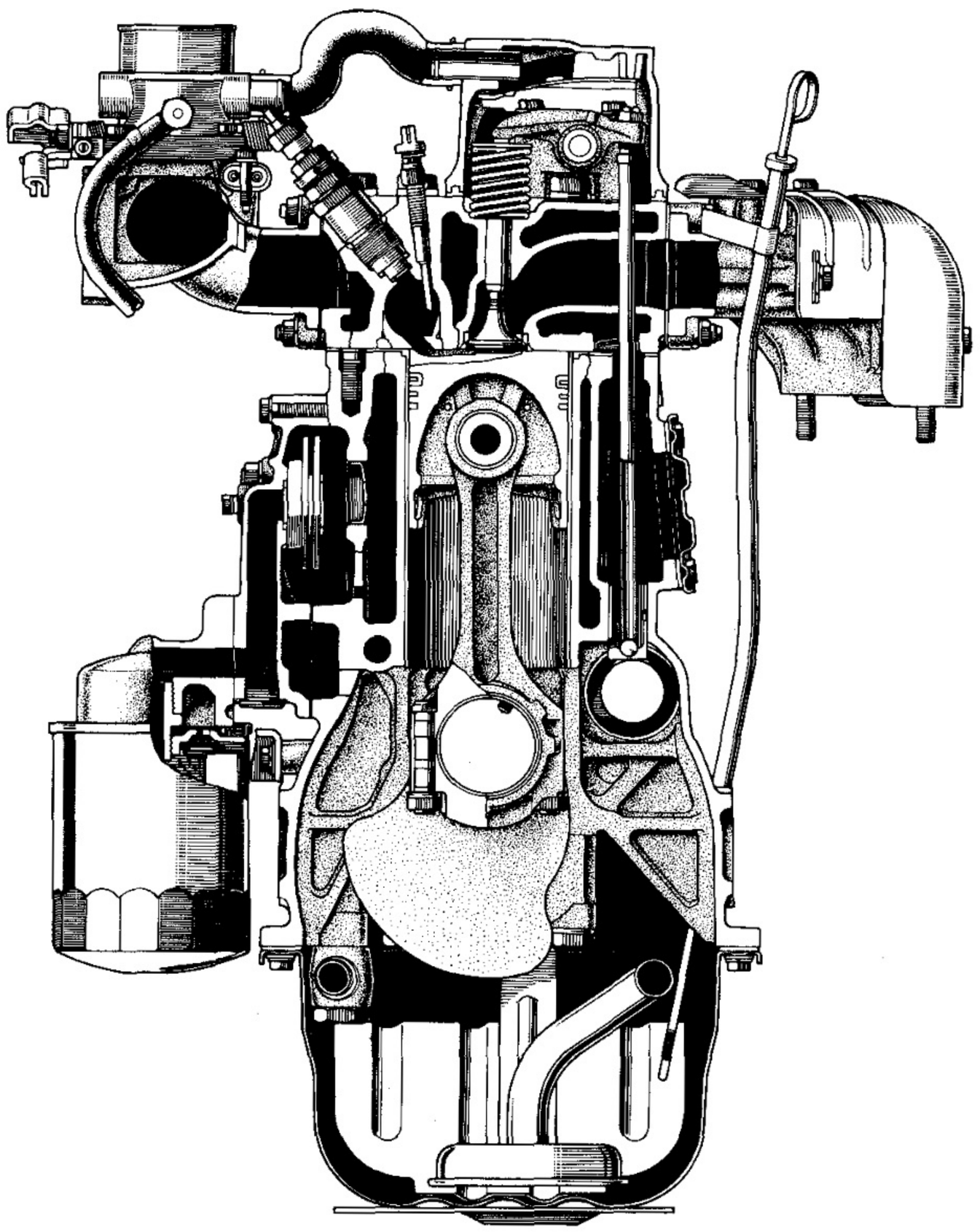


Fig. 3-2

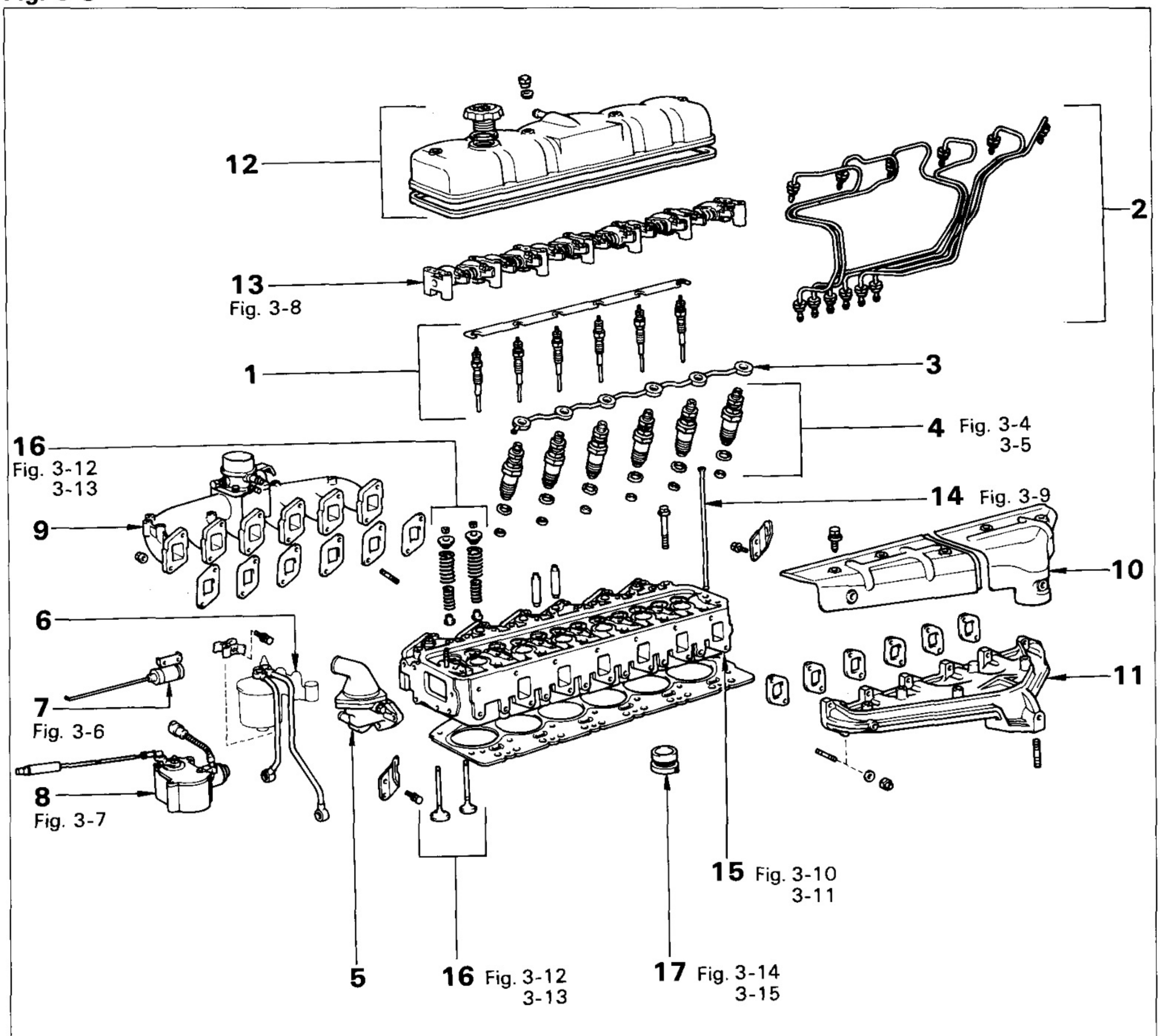


CYLINDER HEAD

DISASSEMBLY

Disassemble the parts in the numerical order shown in the figure.

Fig. 3-3



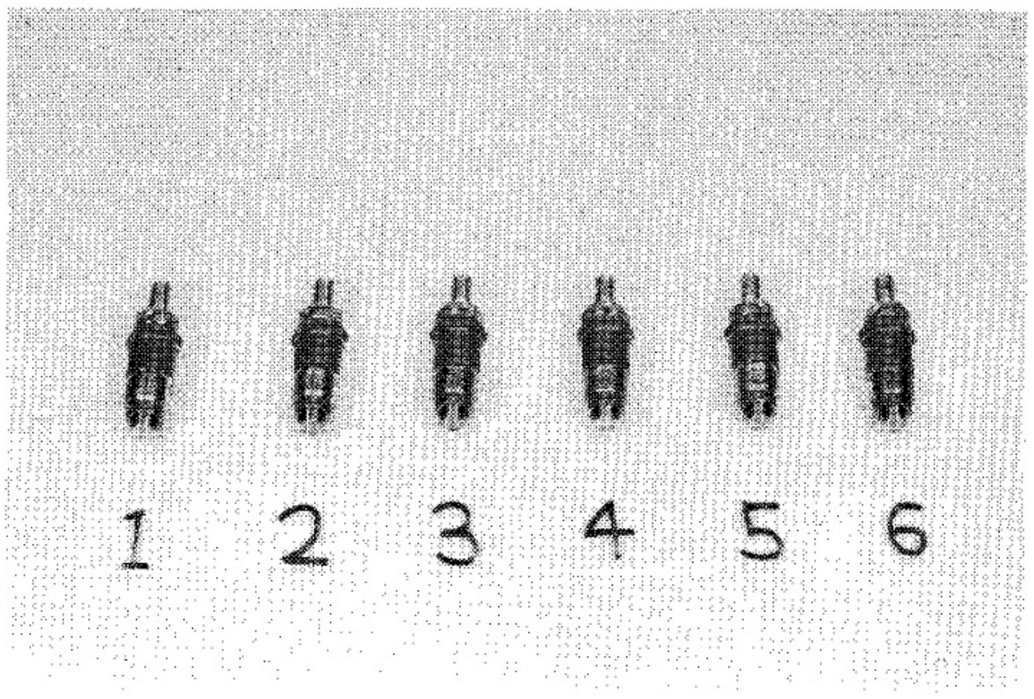
1. Glow Plug & Glow Plug Connector
2. Injection Pipe
3. Leakage Pipe
4. Injection Nozzle Holder
5. Water Outlet Housing
6. Fuel Filter
7. Overinjection Magnet (General countries only)
8. Fuel Control Motor
9. Intake Manifold
10. Heat Insulator
11. Exhaust Manifold
12. Cylinder Head Cover
13. Valve Rocker Shaft Assembly
14. Valve Push Rod
15. Cylinder Head
16. Valve & Compression Spring
17. Combustion Chamber

Fig. 3-4



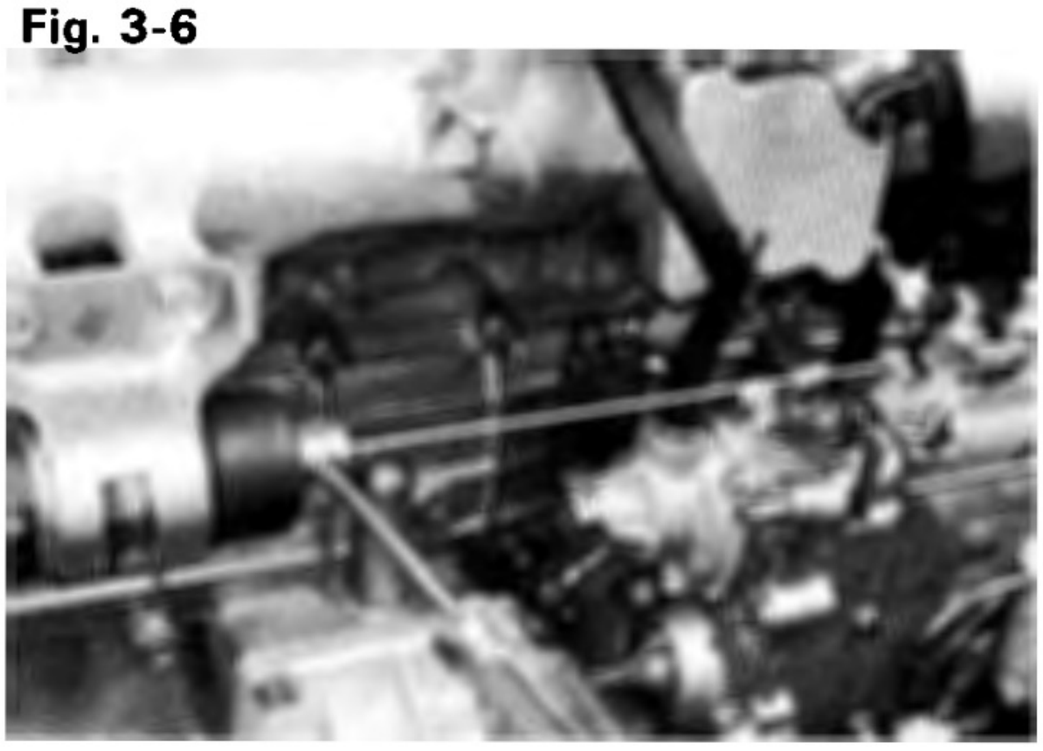
Remove the injection nozzle holder with SST.
SST (09268-46011) of set [09260-46011]

Fig. 3-5



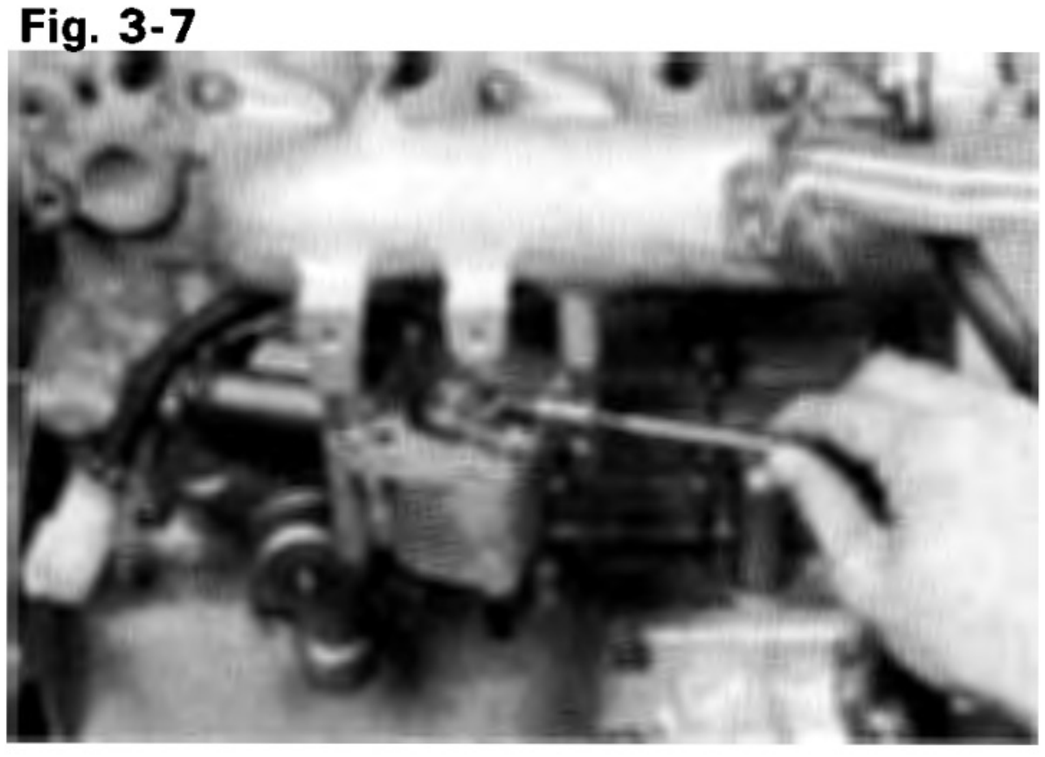
Keep the injection nozzle holders in correct order.

Fig. 3-6



Disconnect the overinjection magnet connecting wire and remove the overinjection magnet from the intake manifold. (General countries only)

Fig. 3-7

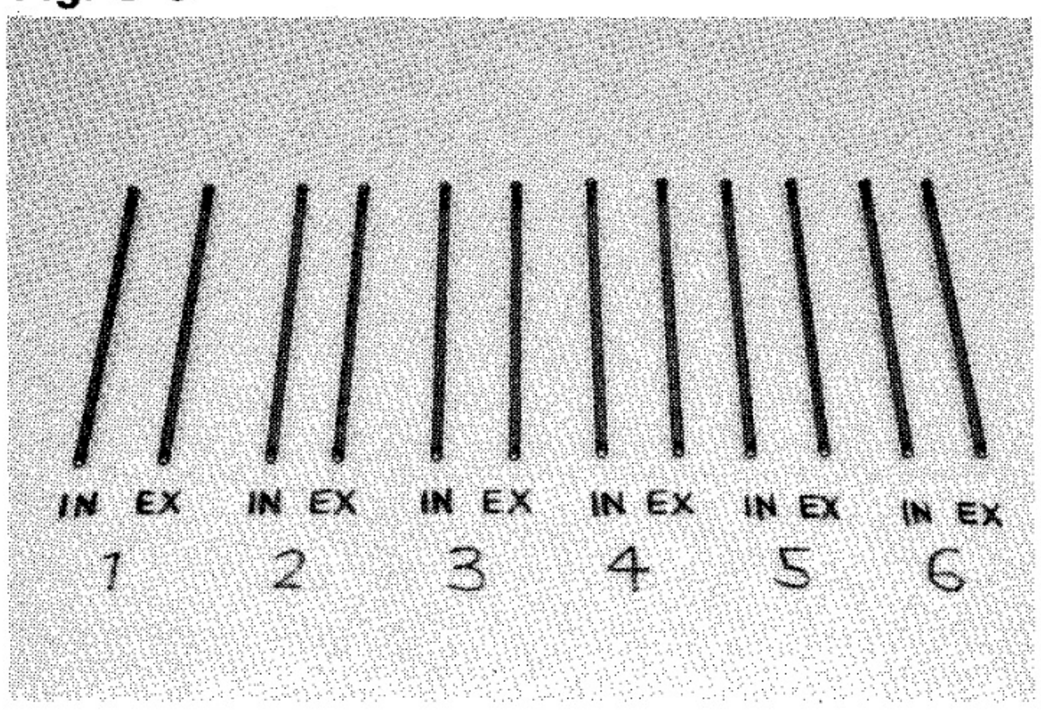


Disconnect the fuel control motor connecting rod and remove the fuel control motor from the intake manifold.



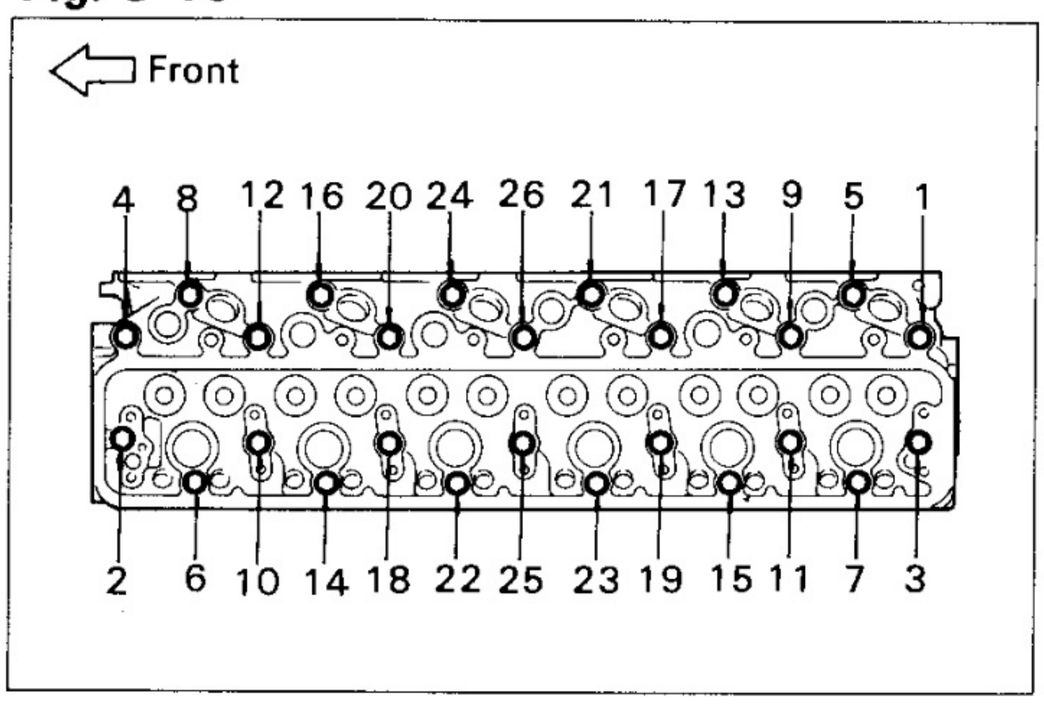
Loosen each rocker support bolt a little at a time in the sequence shown in the figure.

Fig. 3-9



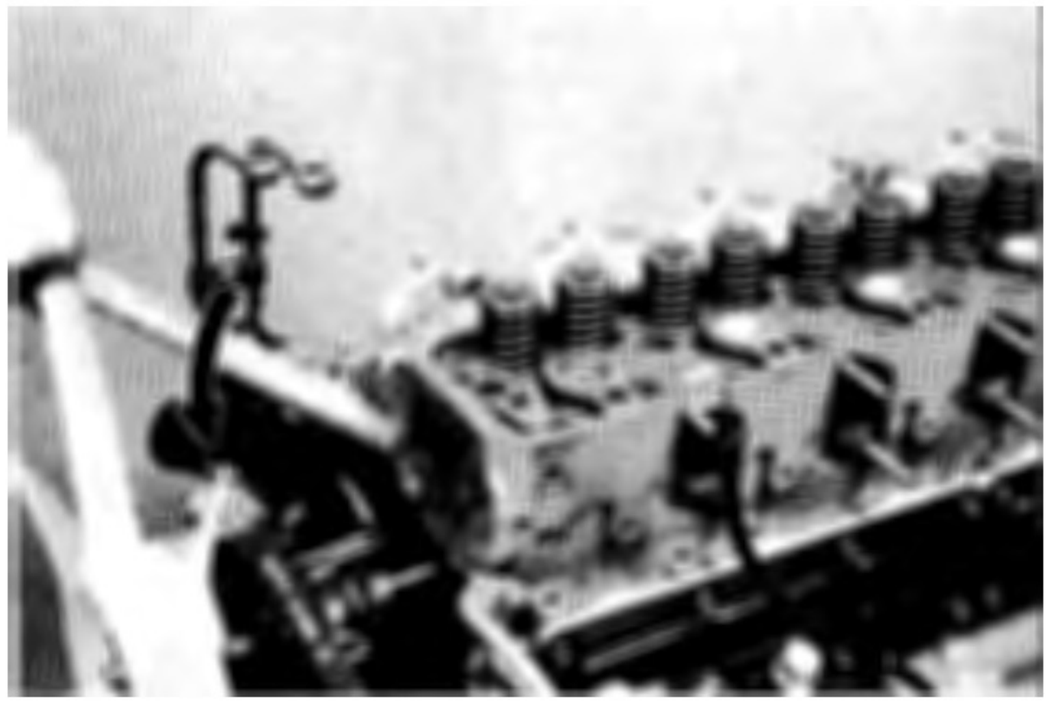
Keep the valve push rods in correct order.

Fig. 3-10



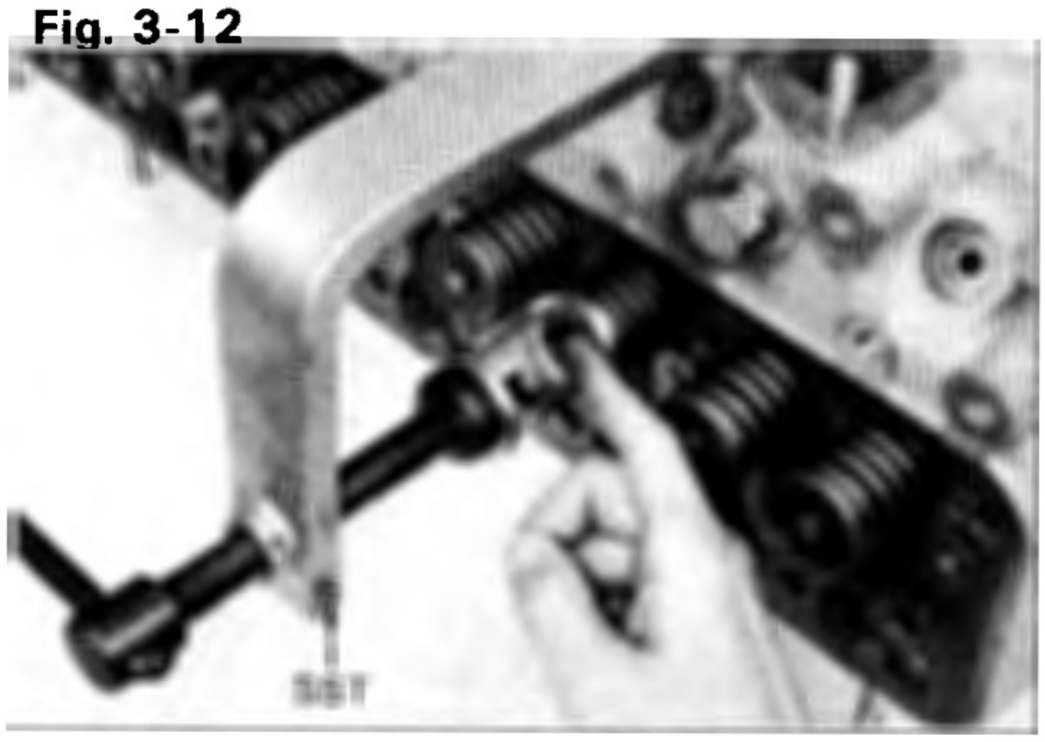
Loosen each cylinder head bolt a little at a time in the sequence shown in the figure.

Fig. 3-11



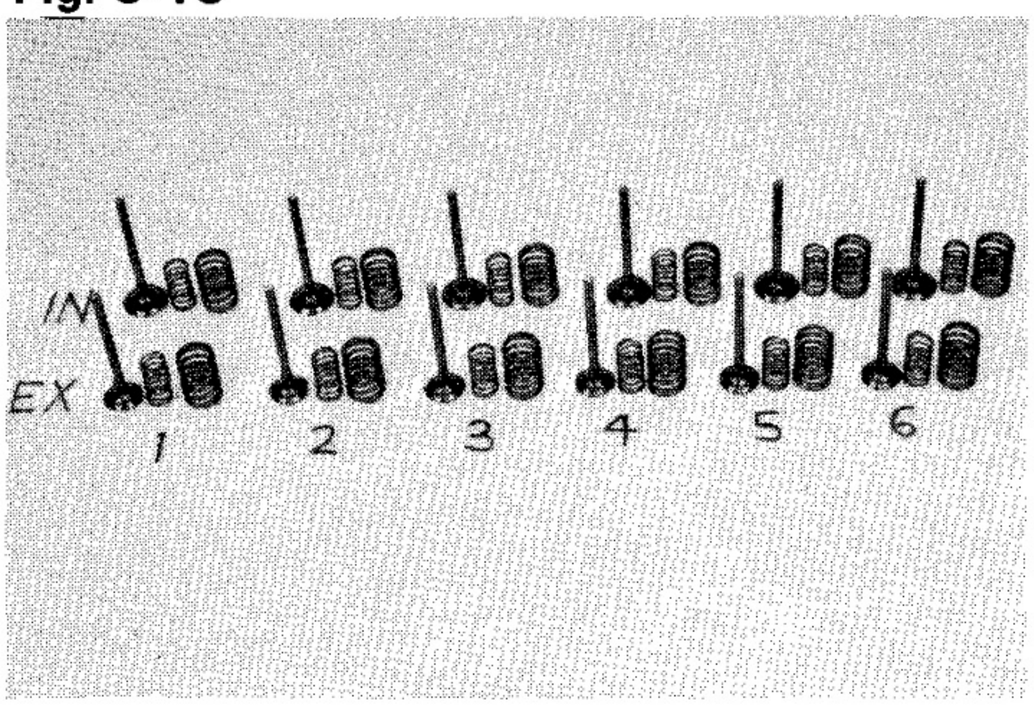
If the cylinder head is difficult to lift off, pry between the cylinder head and block with a wooden handle of a hammer or such.

Fig. 3-12



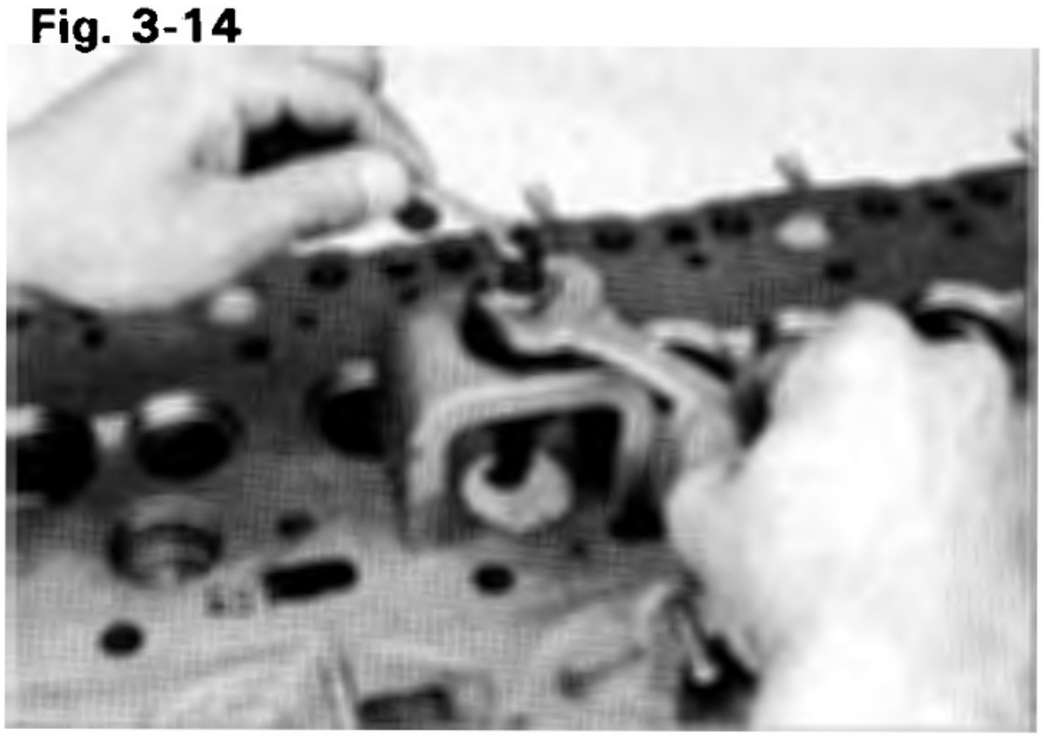
Compress the valve spring with SST and remove the spring retainer locks.
SST [09202-43012]

Fig. 3-13



Keep the valves and springs in correct order.

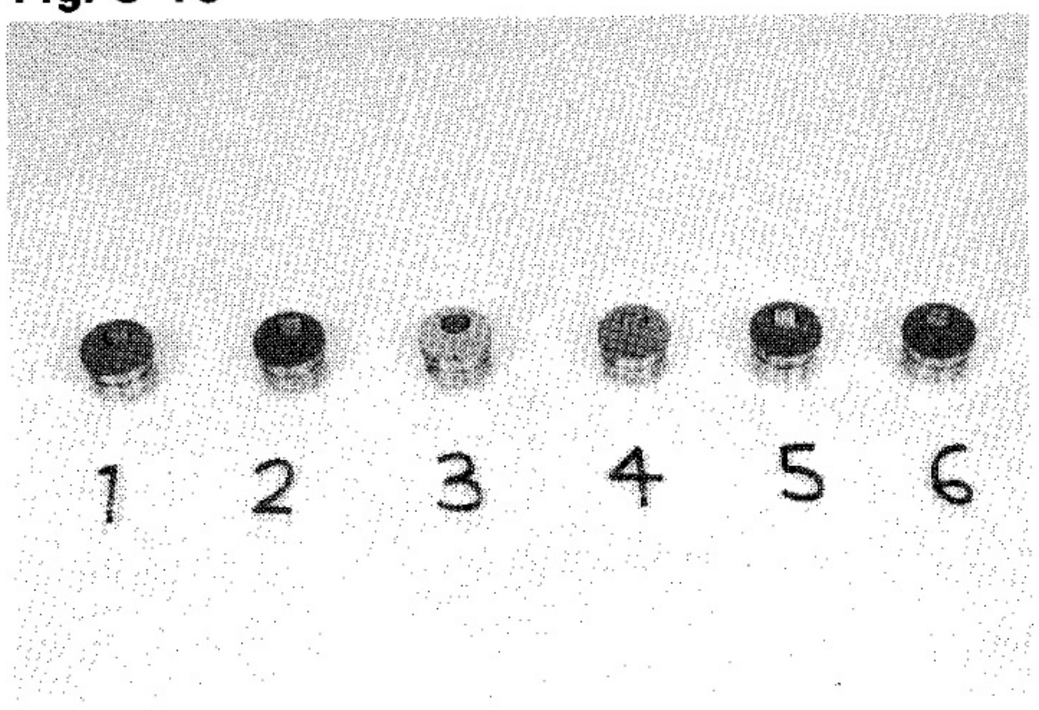
Fig. 3-14



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

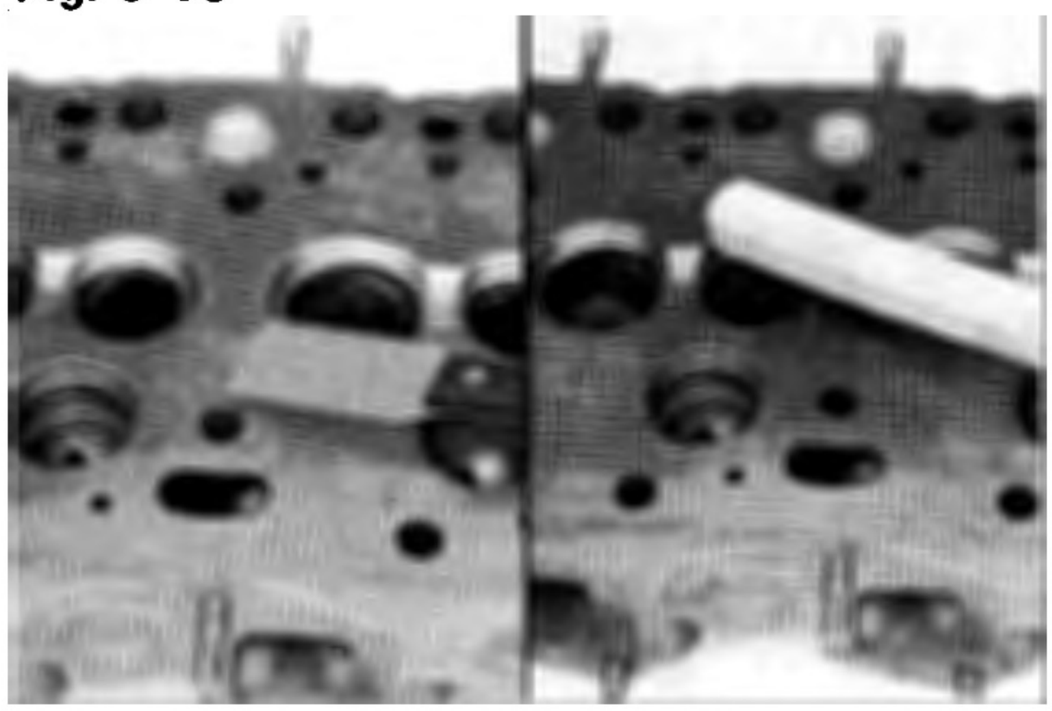
—Note—
Be careful not to damage the holes.

Fig. 3-15



Keep the combustion chambers in correct order.

Fig. 3-16

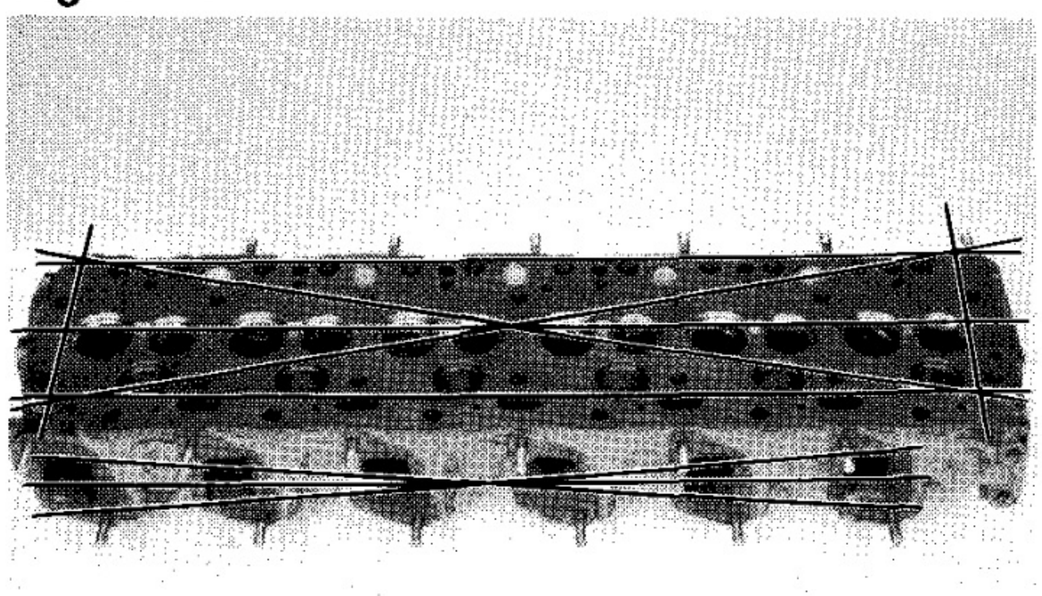


INSPECTION & REPAIR

Cylinder Head

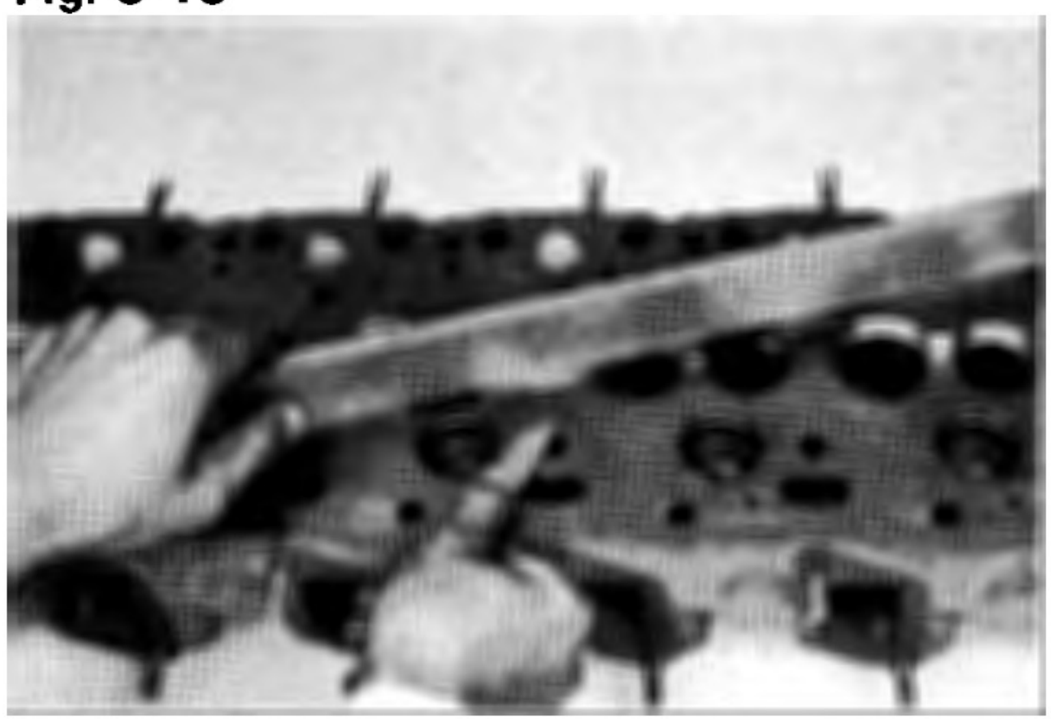
1. Clean the combustion chamber and remove any gasket material from the cylinder head and manifold mounting surfaces.
   Check the cylinder head for cracks or scoring.

Fig. 3-17



2. Check the surfaces along the indicated lines for warpage.

Fig. 3-18



(1) Check the cylinder head surface for warpage with a precision straight edge and thickness gauge.

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

Fig. 3-19

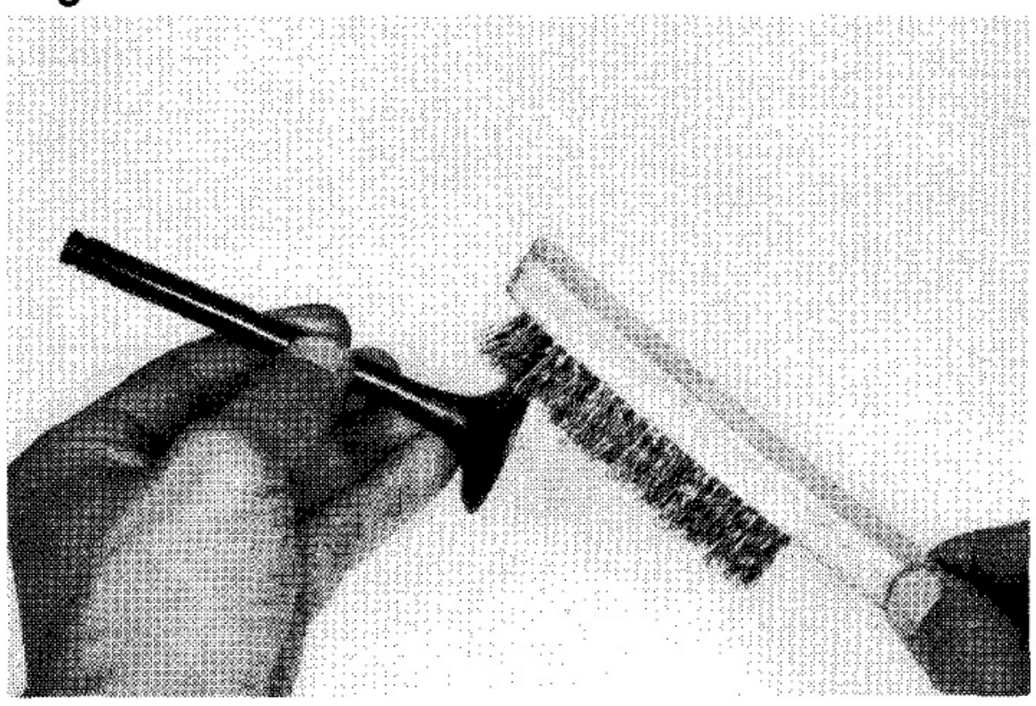


(2) Check the manifold-mounting surfaces for warpage.

Manifold mounting surface warpage:
Limit 0.2 mm (0.008 in.)

3. If the warpage exceeds the limit, replace the cylinder head.

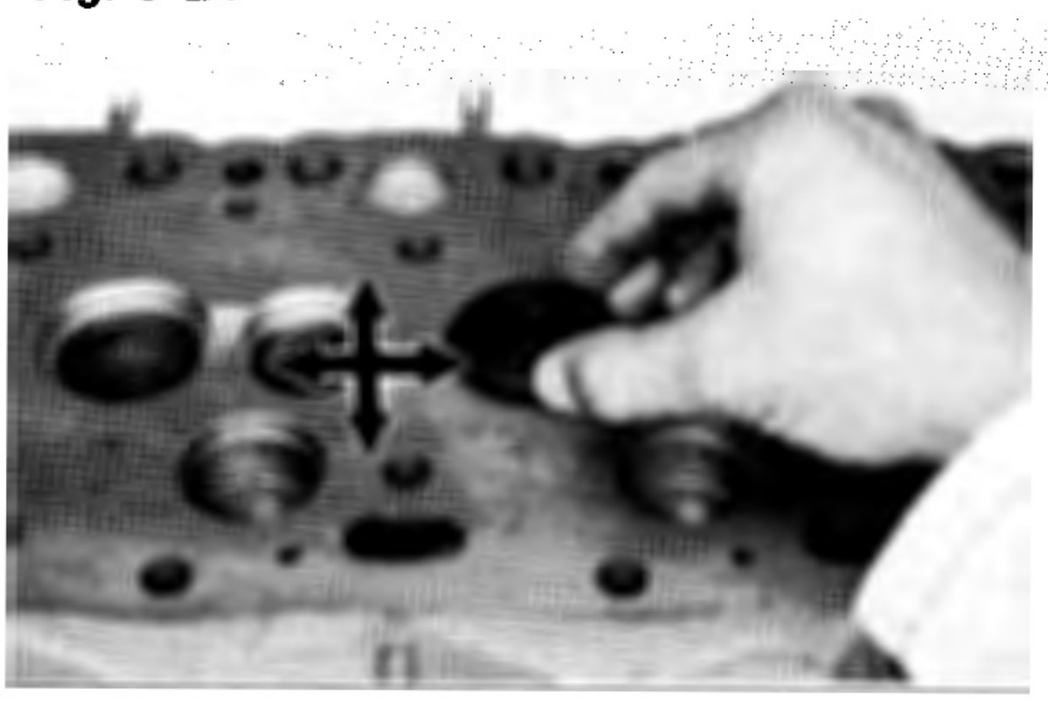
Fig. 3-20



Valve & Guide

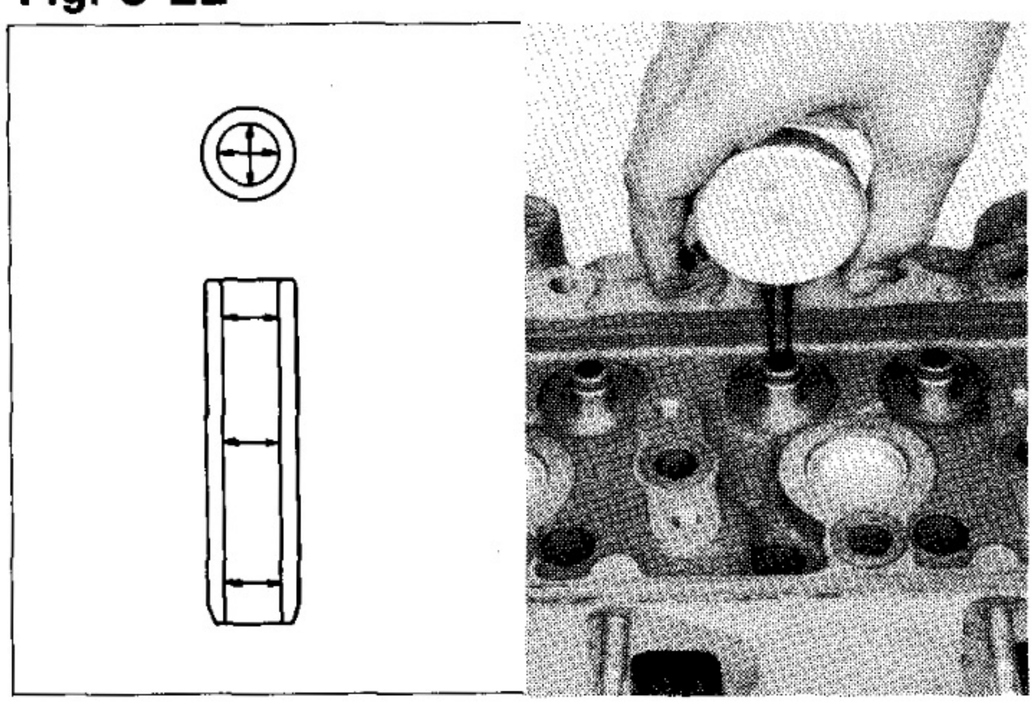
1. Clean the valves and check for wear, scoring or bending.

Fig. 3-21



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. 3-22



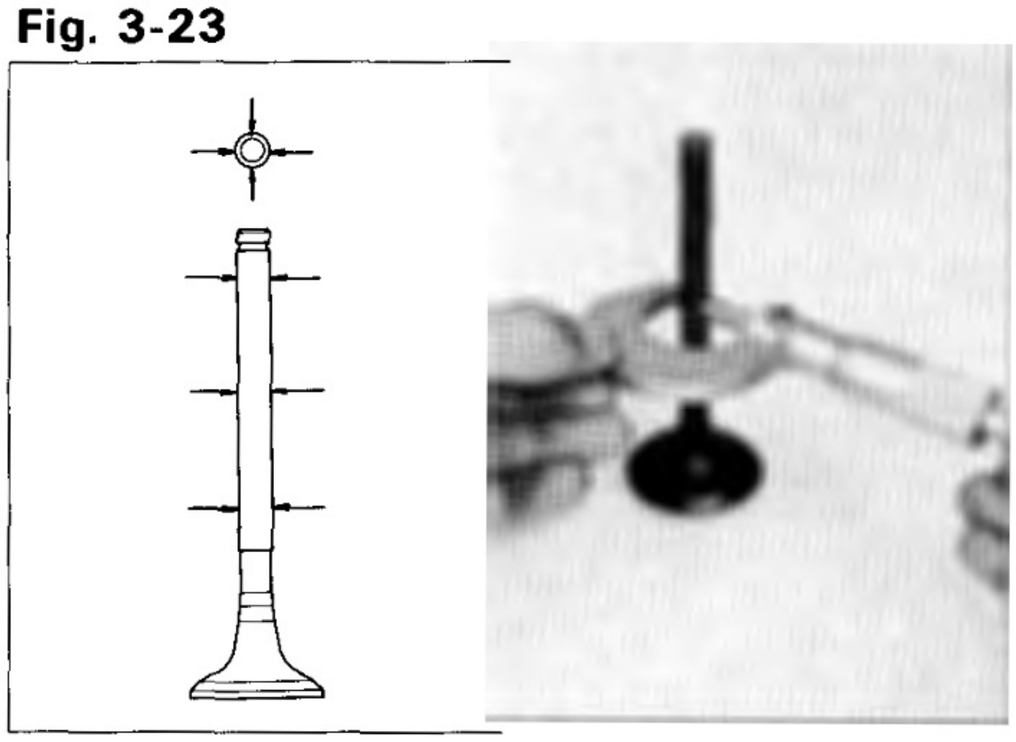
3. Measure the valve stem oil clearance.
   (1) Measure the inside diameter of the valve guide at several places.

Guide inside diameter:
9.010 – 9.030 mm
(0.3547 – 0.3555 in.)

   (2) Measure the valve stem diameter.

Stem diameter:
IN 8.973 – 8.989 mm
(0.3533 – 0.3539 in.)
EX 8.954 – 8.970 mm
(0.3525 – 0.3531 in.)

Fig. 3-23



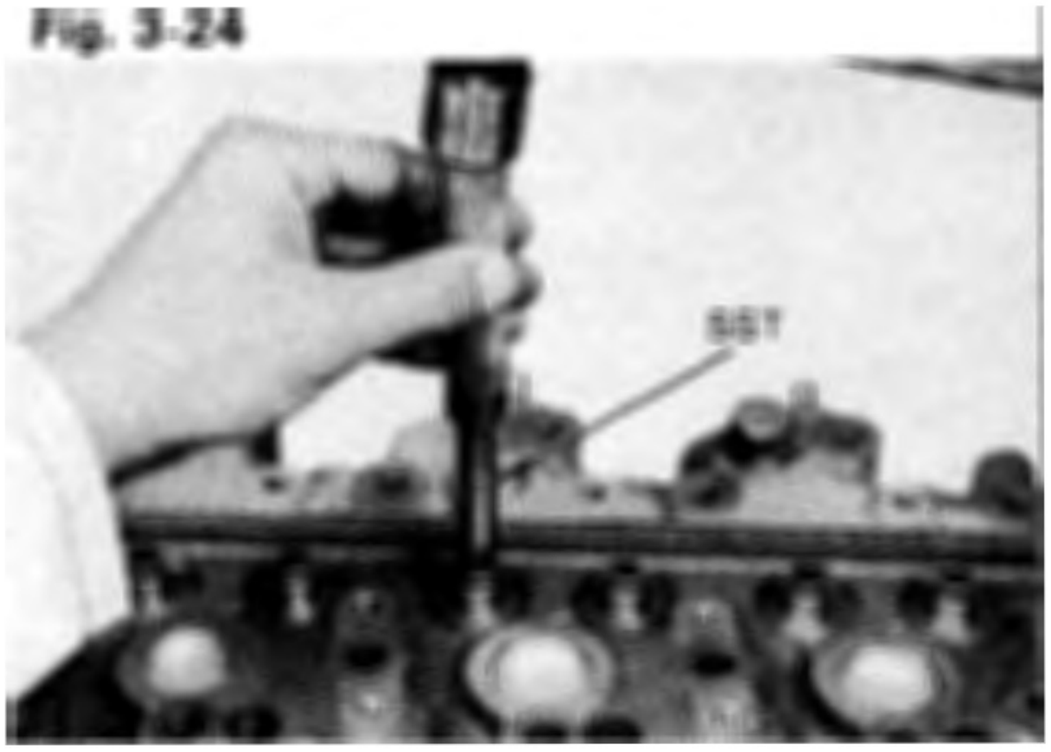
   (3) Calculate the valve stem oil clearance.

Stem oil clearance:

STD	**IN**	**0.021 – 0.057 mm (0.0008 – 0.0022 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.)**

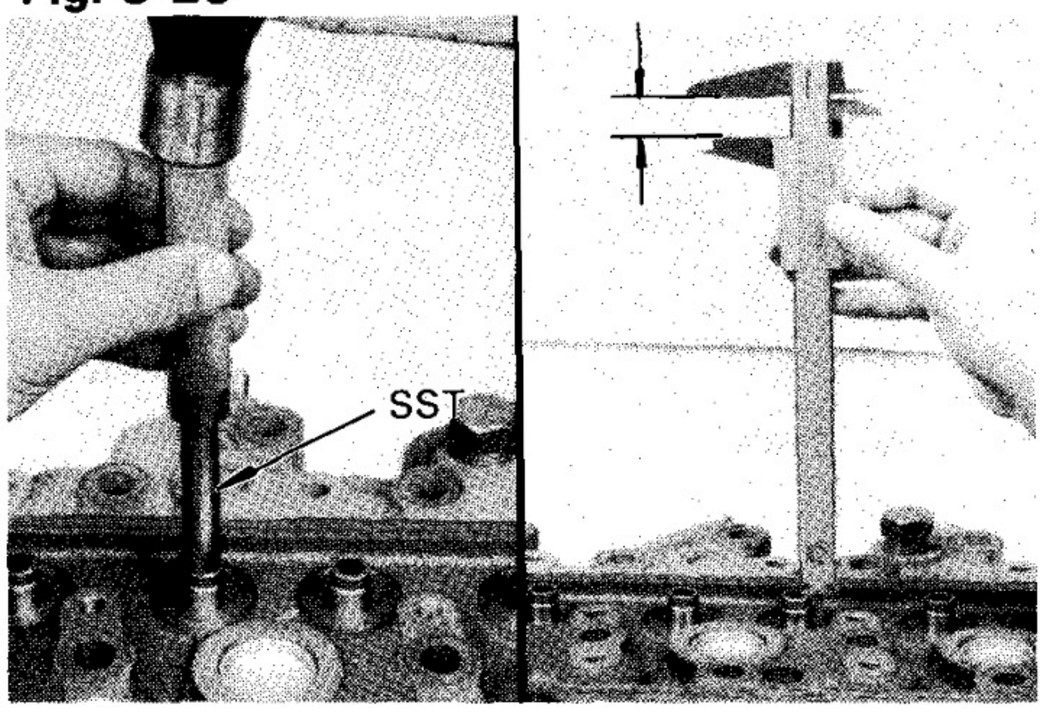
–Note–
Measure at several places and use the maximum wear for calculation.

Fig. 3-24



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

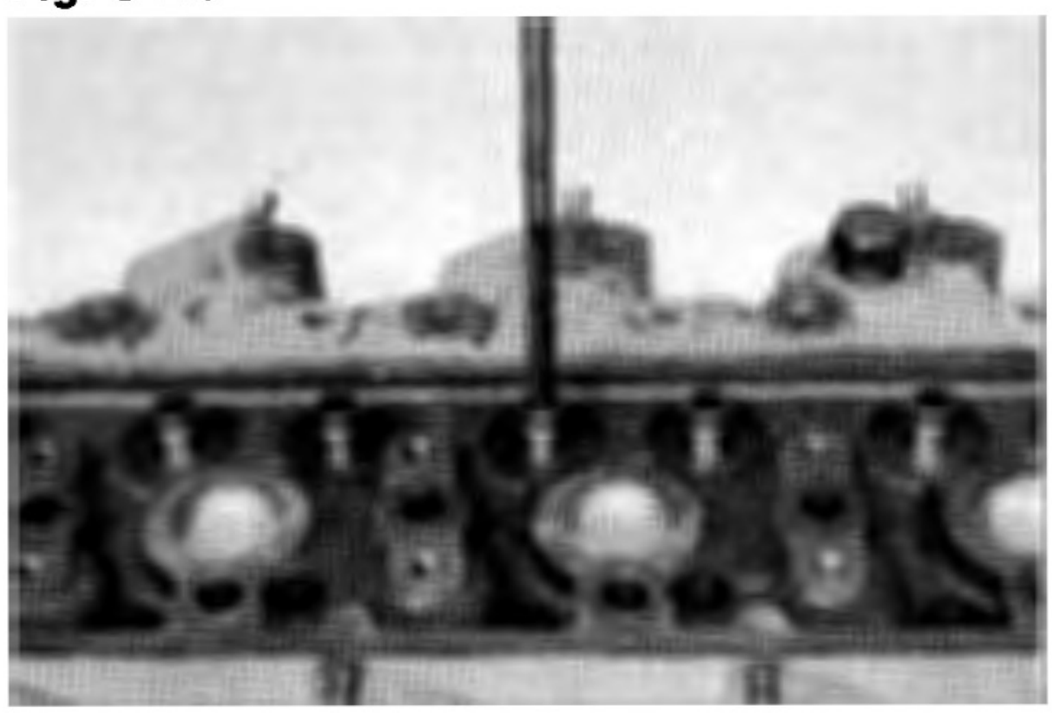
Fig. 3-25



(2) Drive in the new valve guide until its tip projects from the top of the cylinder head by the specified length.

Protrusion from cylinder head:
14.8 – 15.2 mm
(0.583 – 0.598 in.)

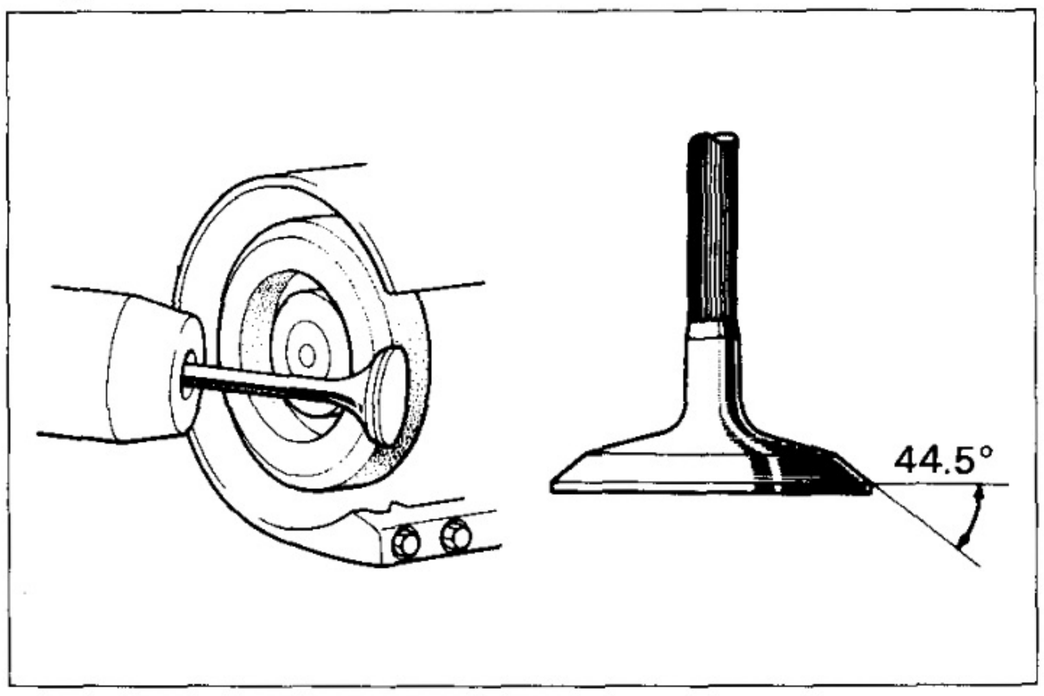
Fig. 3-26



(3) With a sharp reamer, ream the valve guide to obtain the specified clearance.

Oil clearance:
STD
IN 0.021 – 0.057 mm
(0.0008 – 0.0022 in.)
EX 0.040 – 0.076 mm
(0.0016 – 0.0030 in.)

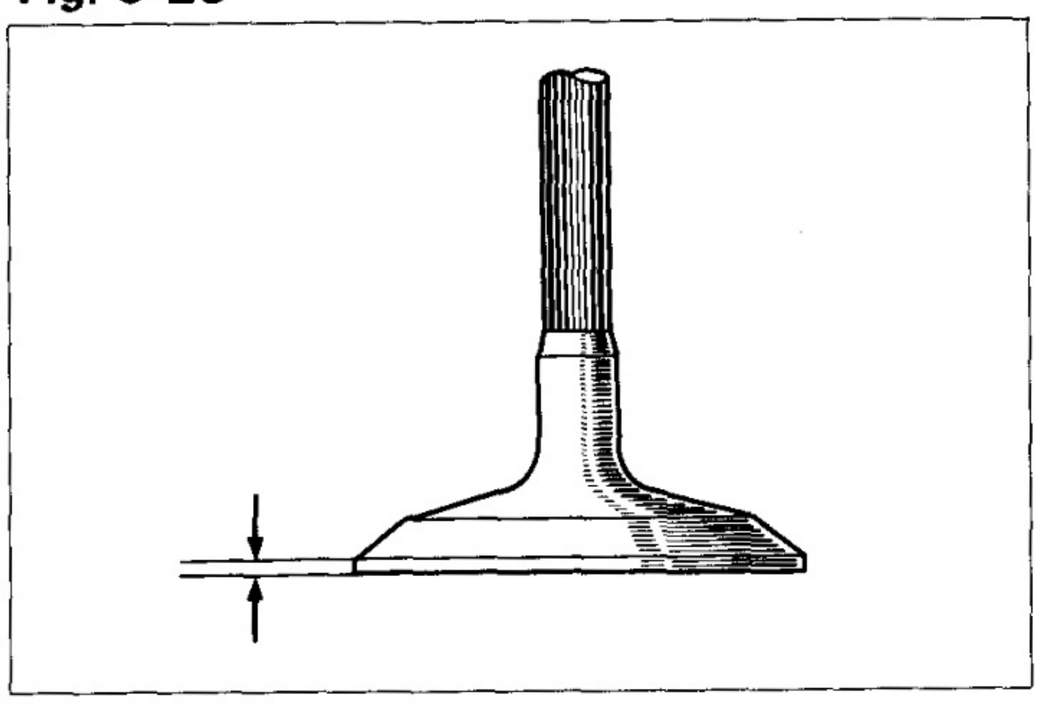
Fig. 3-27



5. Reface the valve seating face with a valve refacer.

Valve face angle: 44.5°

Fig. 3-28

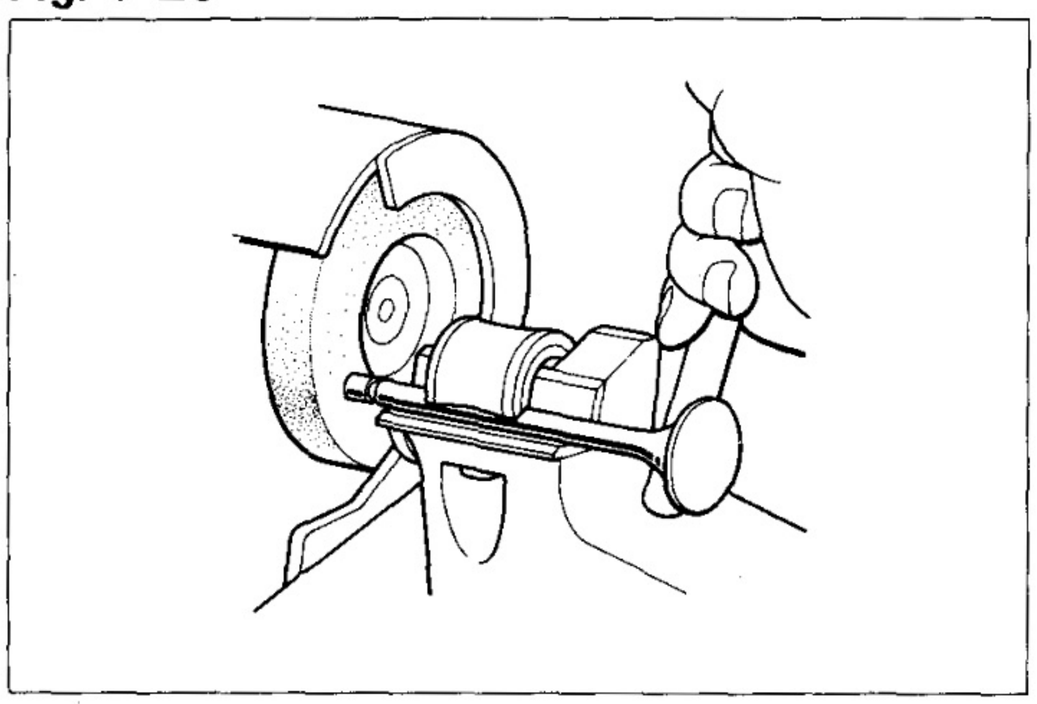


6. Check the valve head margin thickness.

Margin thickness:

STD	**IN**	**1.4 mm (0.055 in.)**
	EX	**1.8 mm (0.071 in.)**
Limit	**IN**	**0.9 mm (0.035 in.)**
	EX	**1.3 mm (0.051 in.)**

Fig. 3-29



7. Check the valve stem tip.
Resurface the valve stem tip with a valve glinder if necessary.

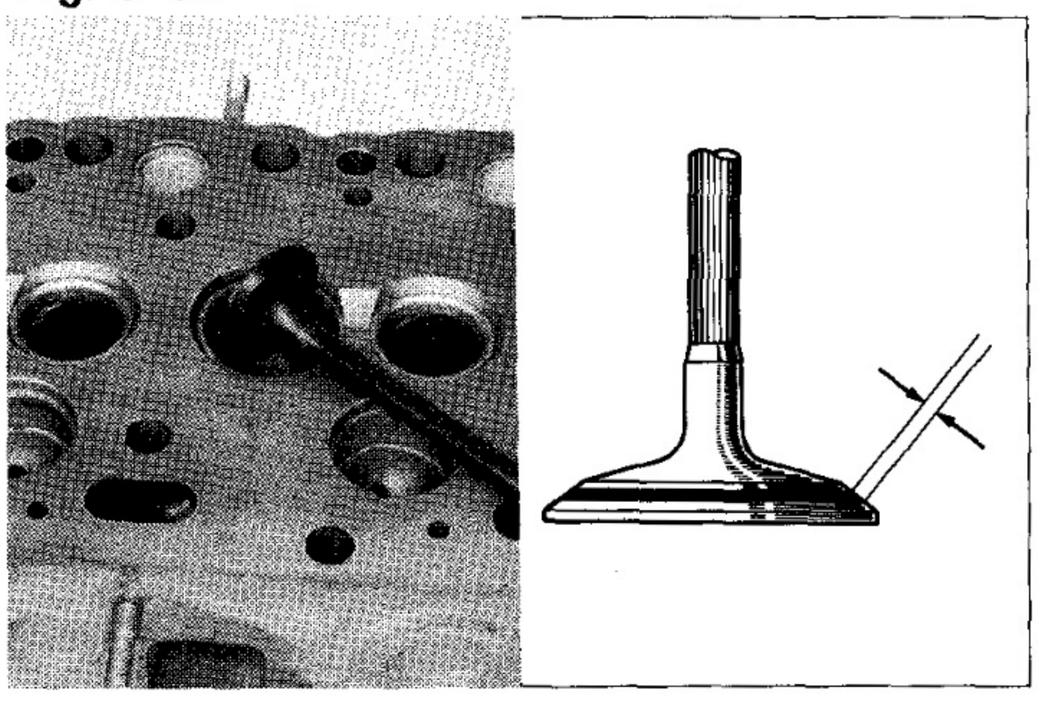
Stem tip resurfacing:

Limit	**0.5 mm (0.020 in.)**

Overall length:

IN	**120.7 mm (4.752 in.)**
EX	**120.6 mm (4.748 in.)**

Fig. 3-30

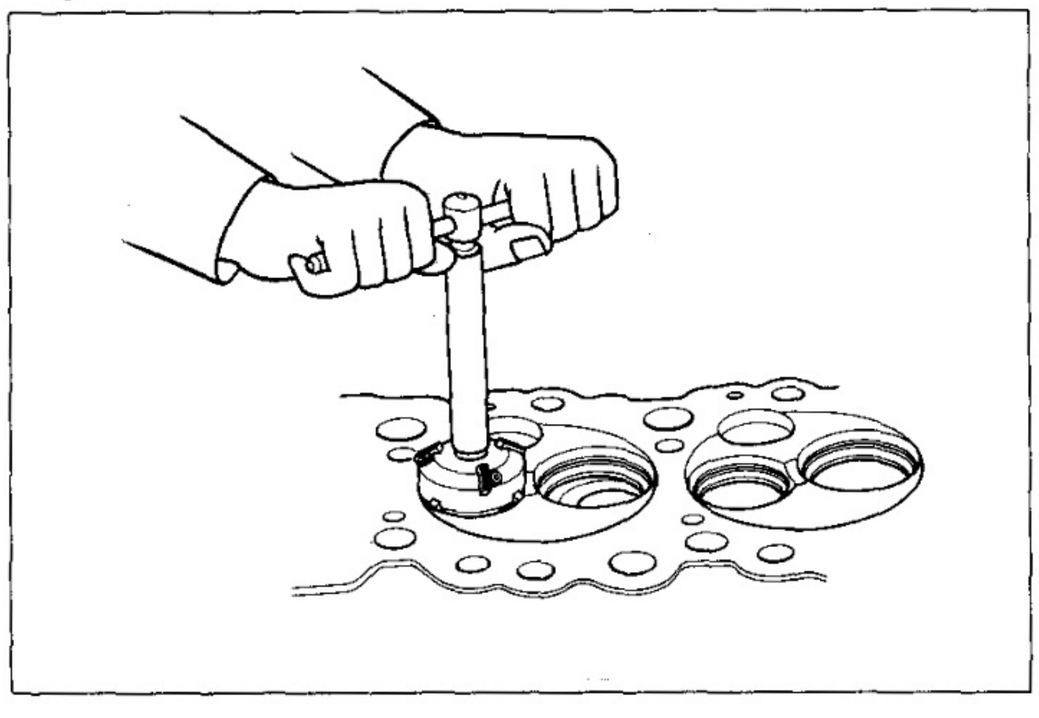


Valve Seat

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

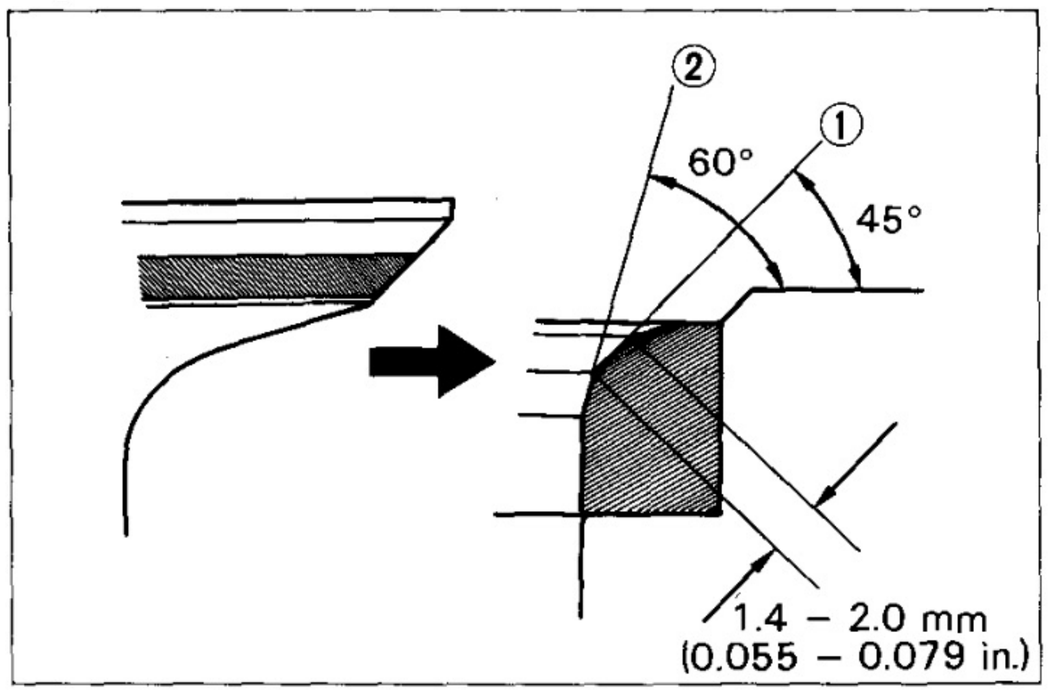
Contact width:
1.4 – 2.0 mm
(0.055 – 0.079 in.)
Contact position:
Middle of valve face

Fig. 3-31



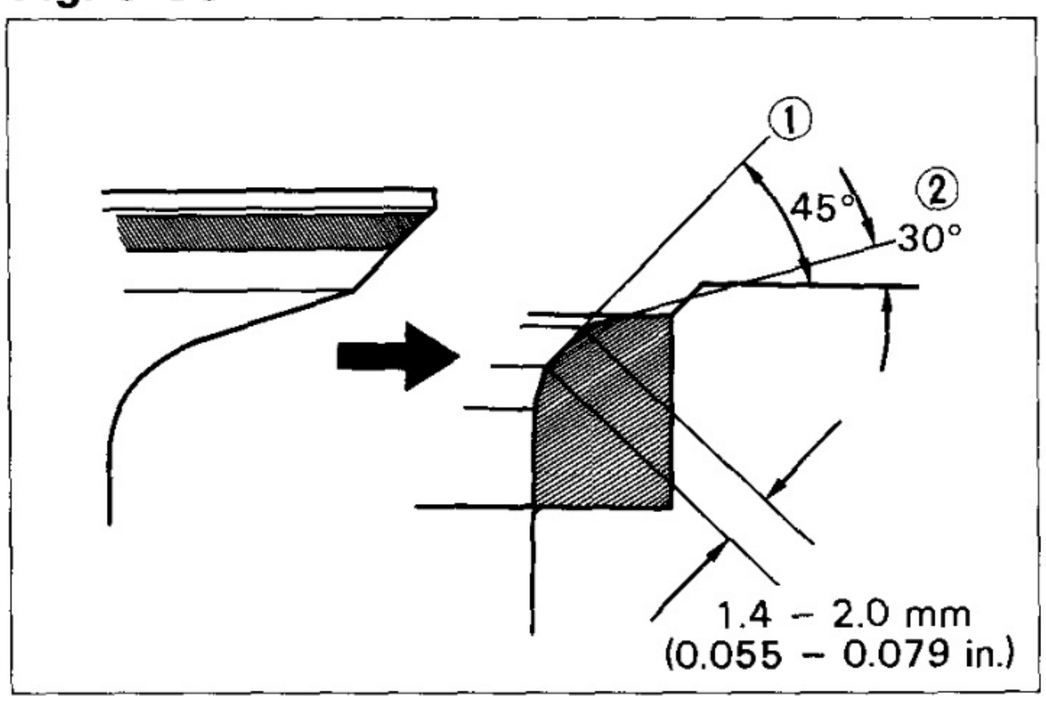
2. Resurface the valve seat with a 45° cutter.

Fig. 3-32



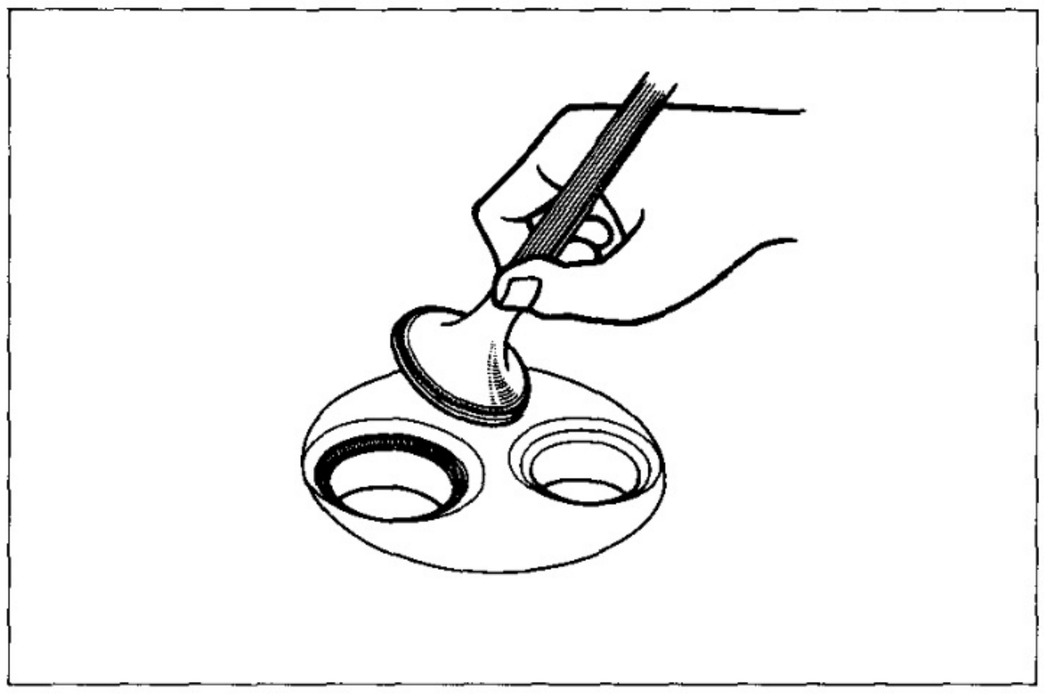
3. Correct the seat position.
   (1) If the seat position is too high, use a 45° and 60° cutters in the order indicated.

Fig. 3-33



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

Fig. 3-34



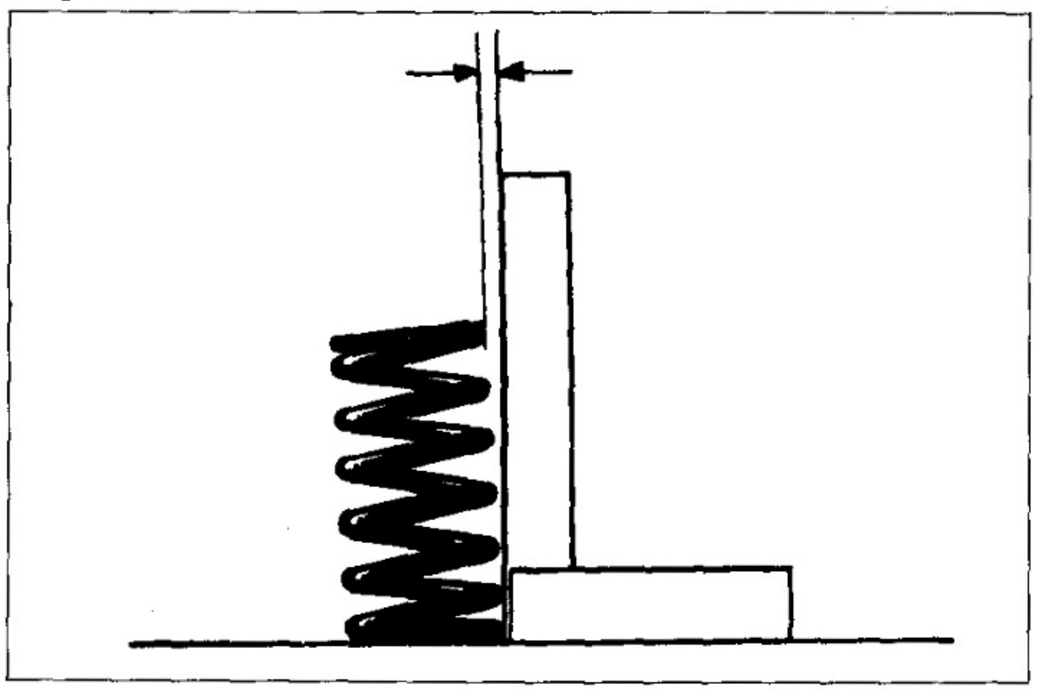
(3) Check the valve concentricity.
Lightly coat the seat with prussian blue.
Install the valve and rotate. If blue appears 360° around face, valve stem and face are concentric. If not, replace the valve.

Fig. 3-35



4. After correction, the valve and valve seat should be lapped lightly with a lapping compound.

Fig. 3-36



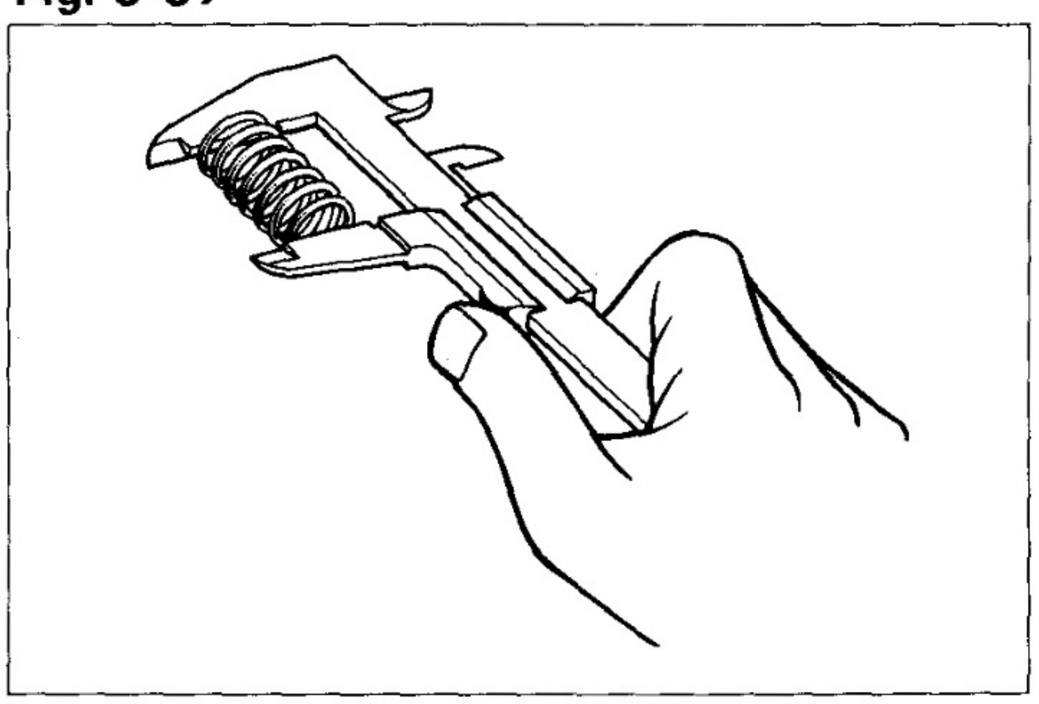
Valve Spring

1. Check the squareness of the valve spring with a square.

Tilt:

Limit 2.0 mm (0.079 in.)

Fig. 3-37



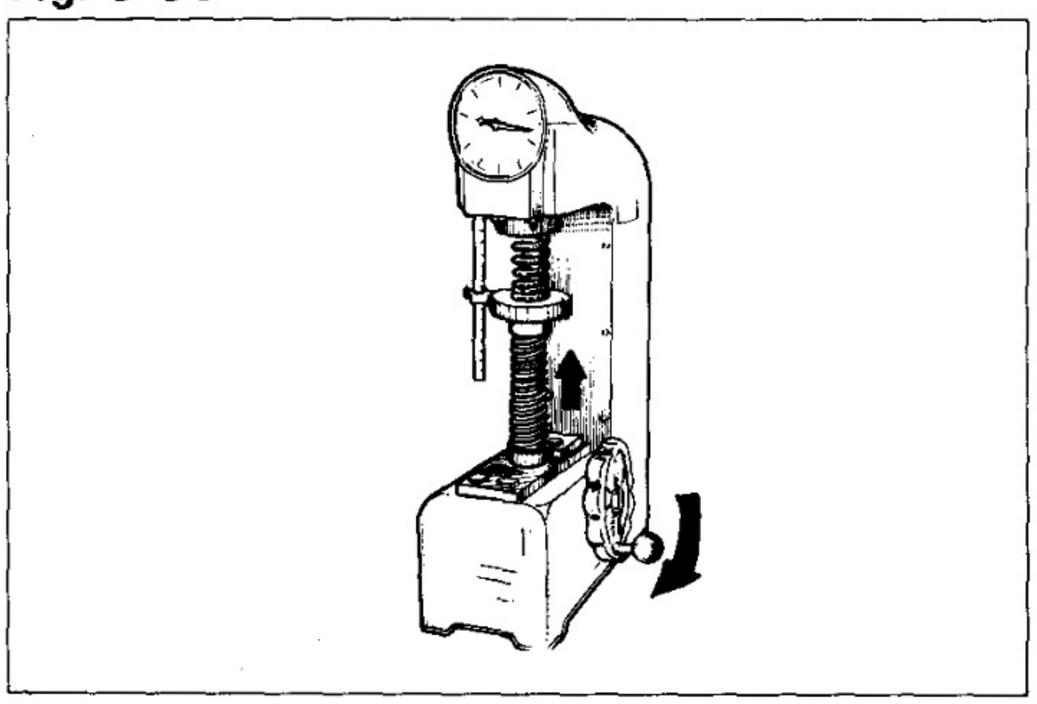
2. Measure the spring free length. Replace the springs that do not meet specification.

Free length:

Inner 44.3 mm (1.744 in.)

Outer 48.1 mm (1.894 in.)

Fig. 3-38



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:

Inner 36.0 mm (1.42 in.)

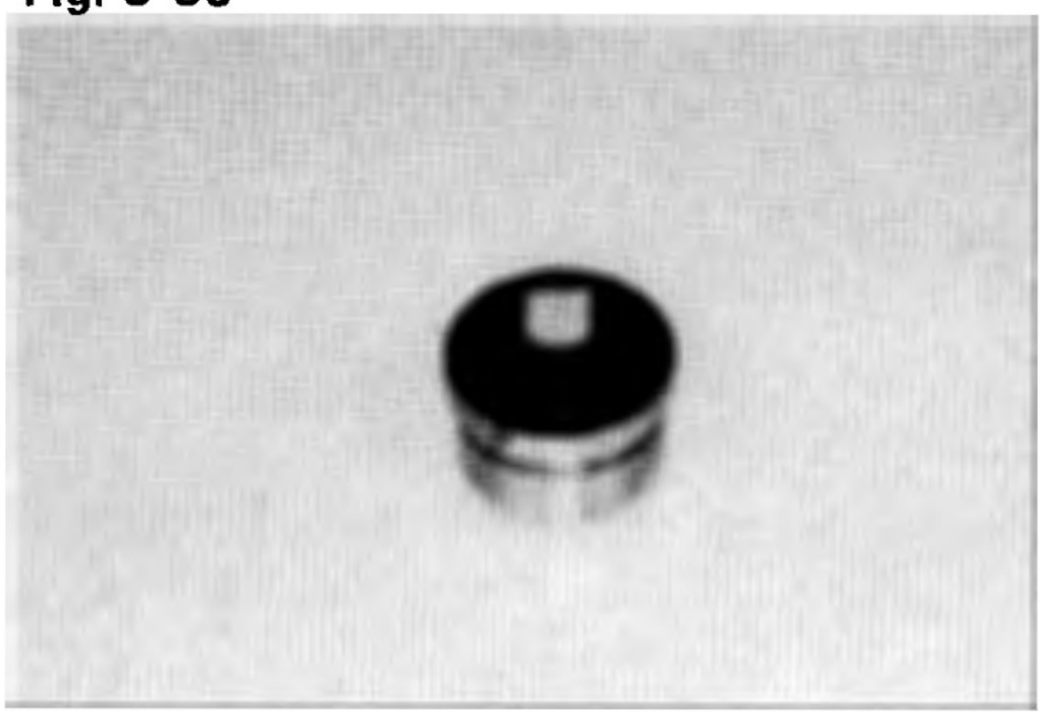
Outer 40.0 mm (1.57 in.)

Installed load:

Inner 7.6 kg (16.8 lb)

Outer 22.5 kg (49.6 lb)

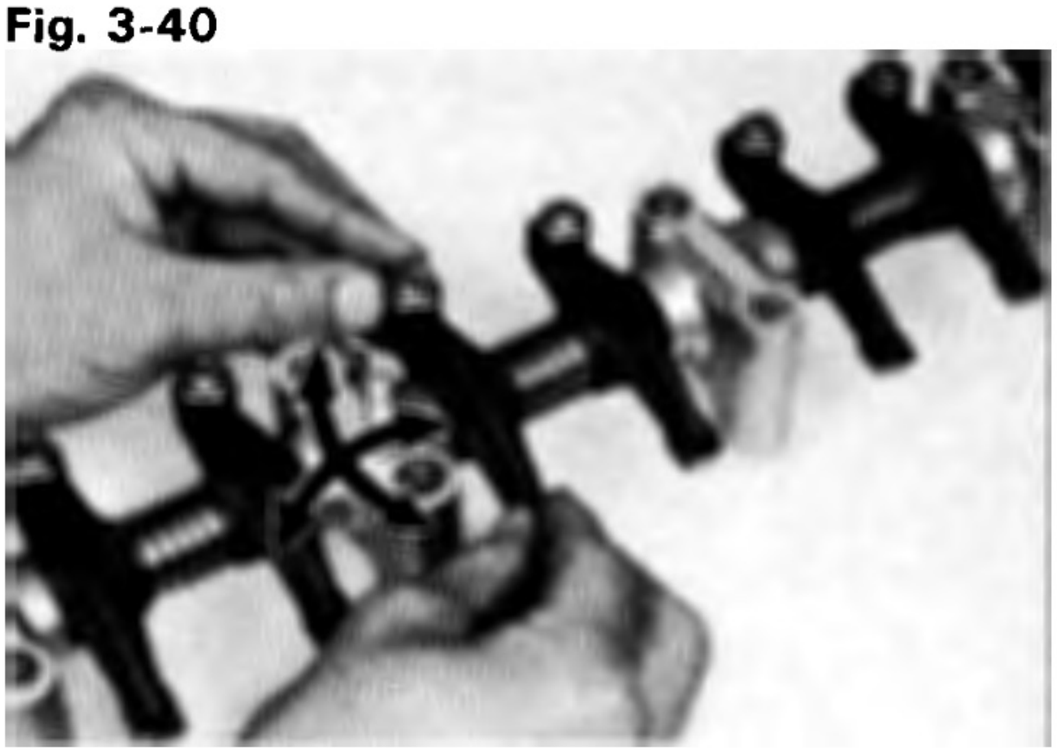
Fig. 3-39



Combustion Chamber

Clean the combustion chamber and check for cracks and extreme damage.

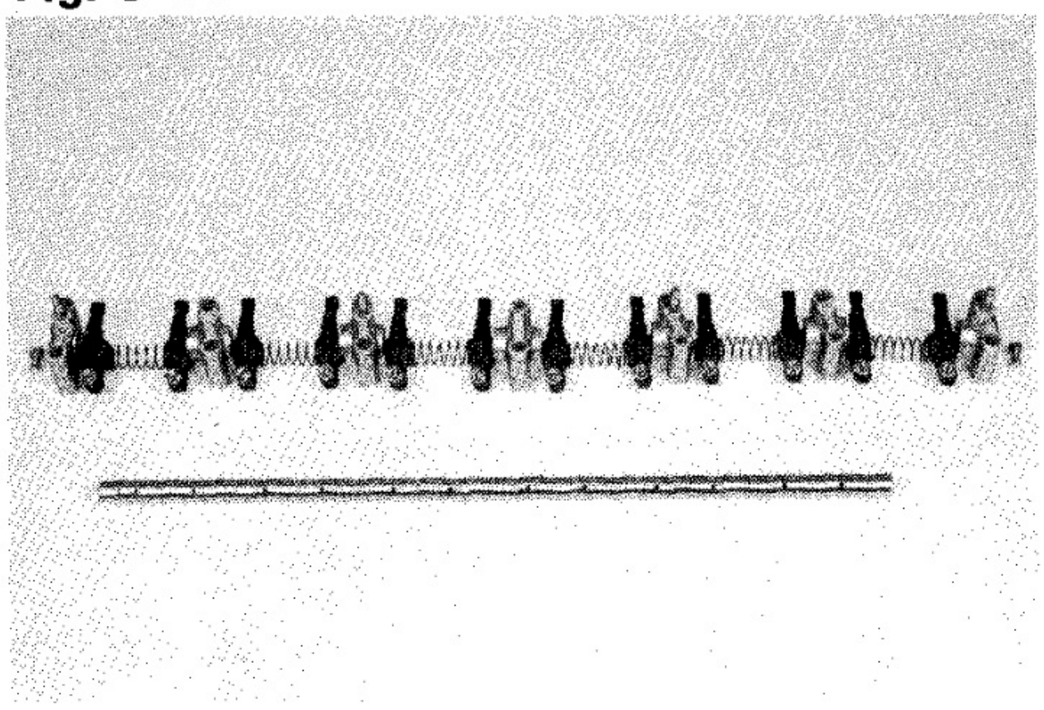
Fig. 3-40



Rocker Arm & Shaft

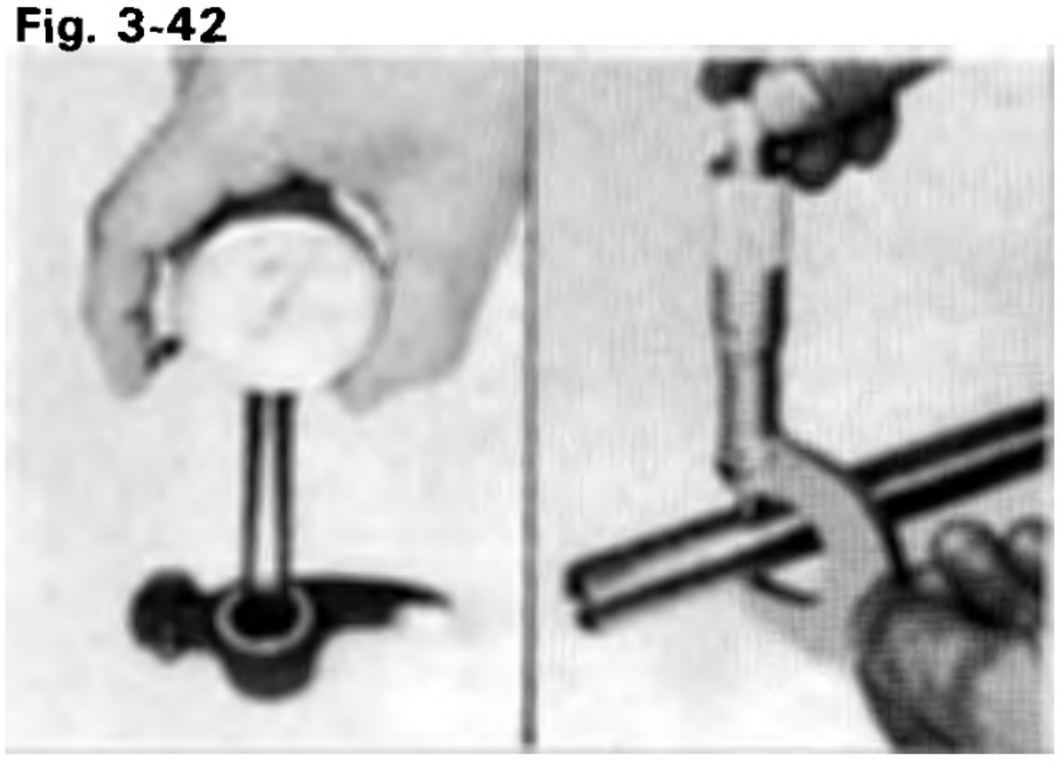
1. Check the rocker arm-to-shaft clearance. If worn excessively, disassemble and check.

Fig. 3-41



2. Arrange the rocker shaft and rocker support.

Fig. 3-42

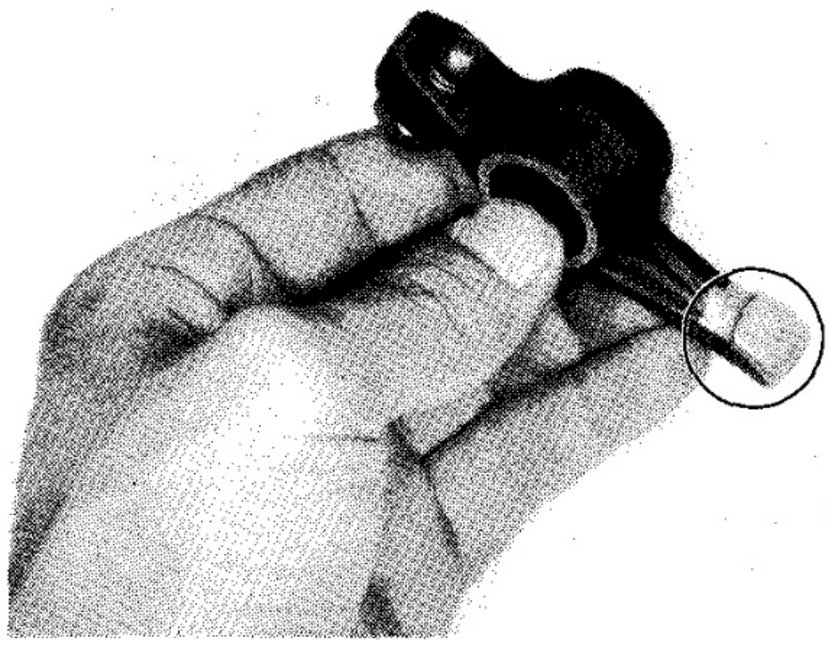


3. Measure the clearance with a dial indicator and outside micrometer. If the clearance exceeds the limit, replace the rocker arm and/or shaft.

Oil clearance:

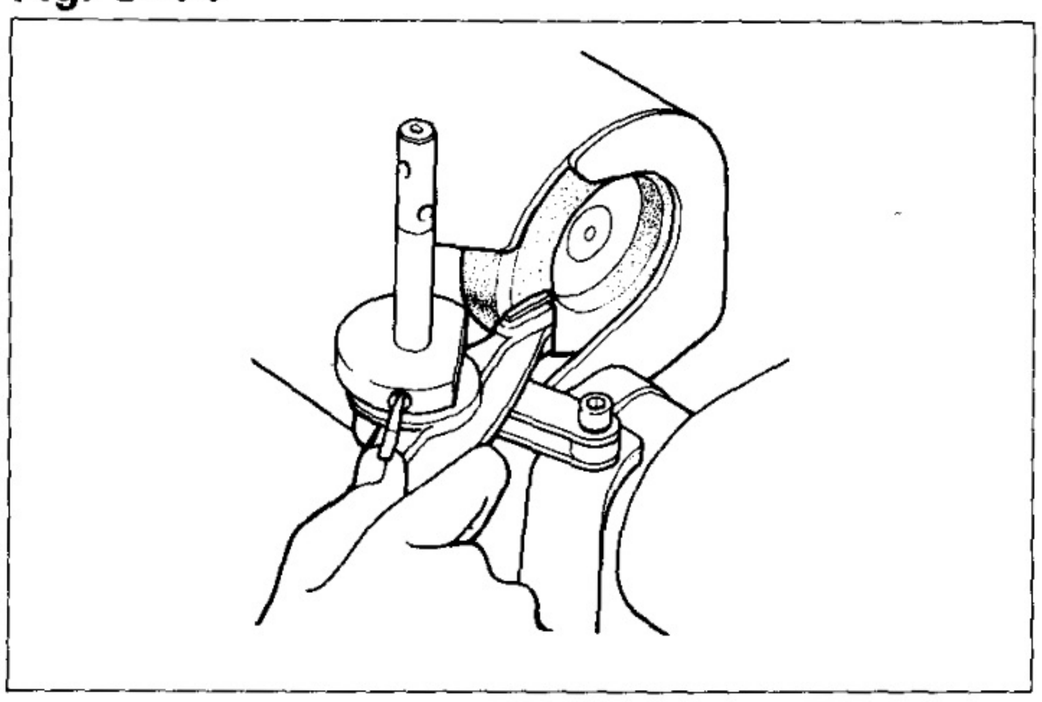
STD	**0.007 – 0.049 mm (0.0003 – 0.0019 in.)**
Limit	**0.1 mm (0.004 in.)**

Fig. 3-43



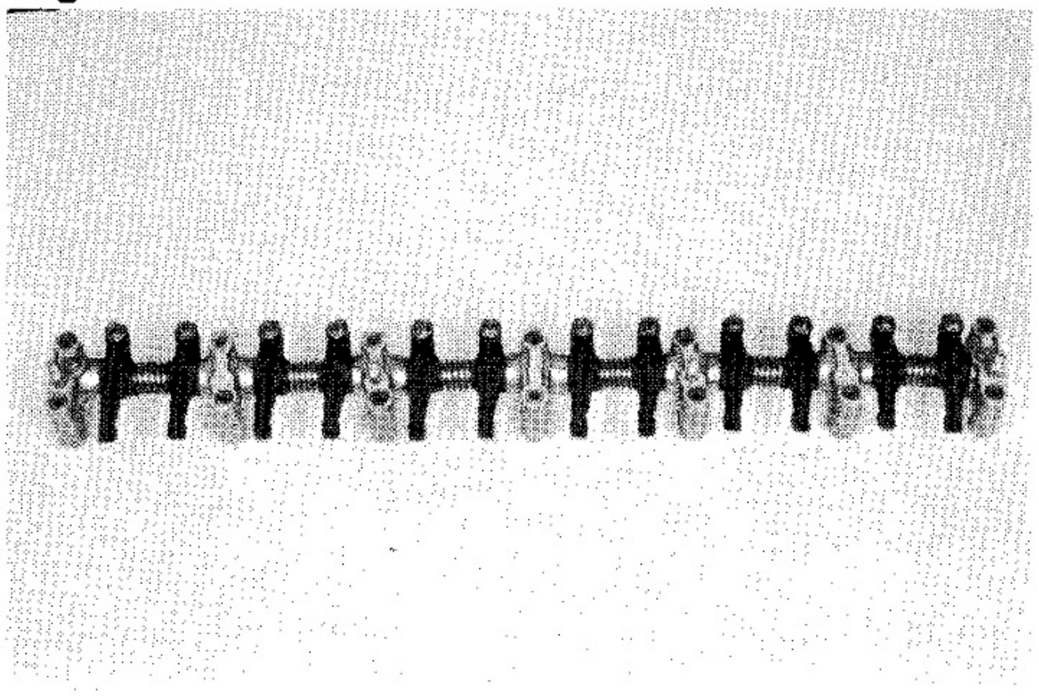
4. Check the contact surface.

Fig. 3-44



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

Fig. 3-45



6. Assemble the valve rocker shaft assembly.

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

Fig. 3-46

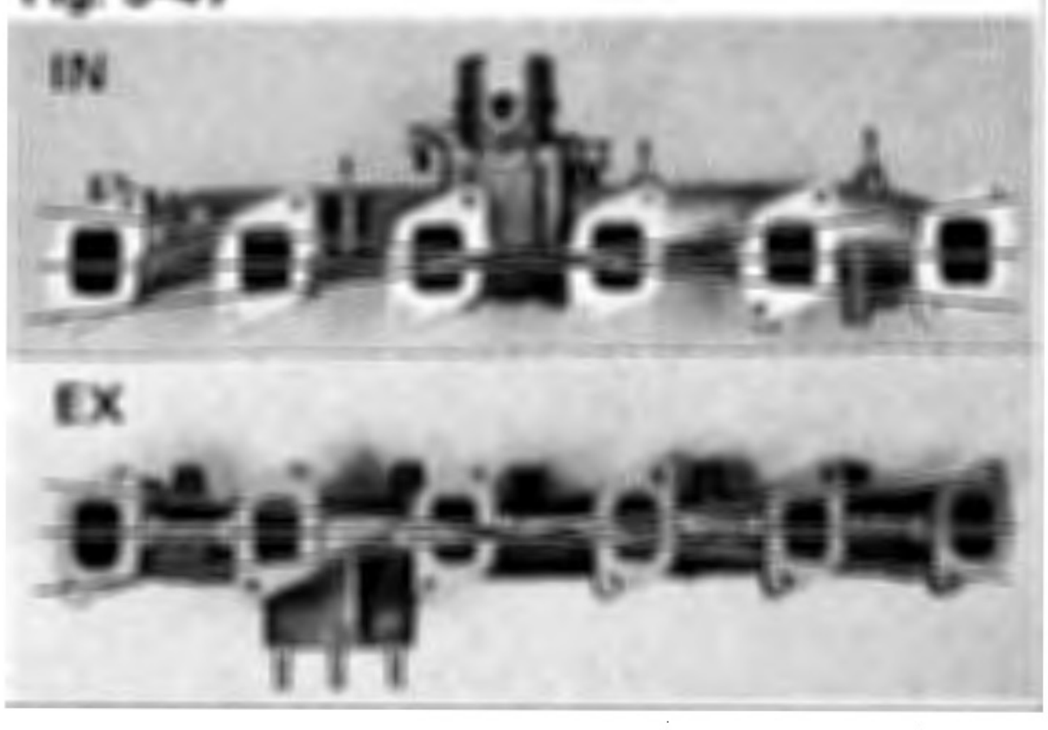


Manifold
Using a straight edge and thickness gauge, check the cylinder head contacting surfaces for warpage.
Replace the manifold if it exceeds the limit.

Installing surface warpage:

Limit	**IN**	**0.3 mm (0.012 in.)**
	EX	**0.5 mm (0.020 in.)**

Fig. 3-47



–Note–
Measure at three places as shown in the figure.

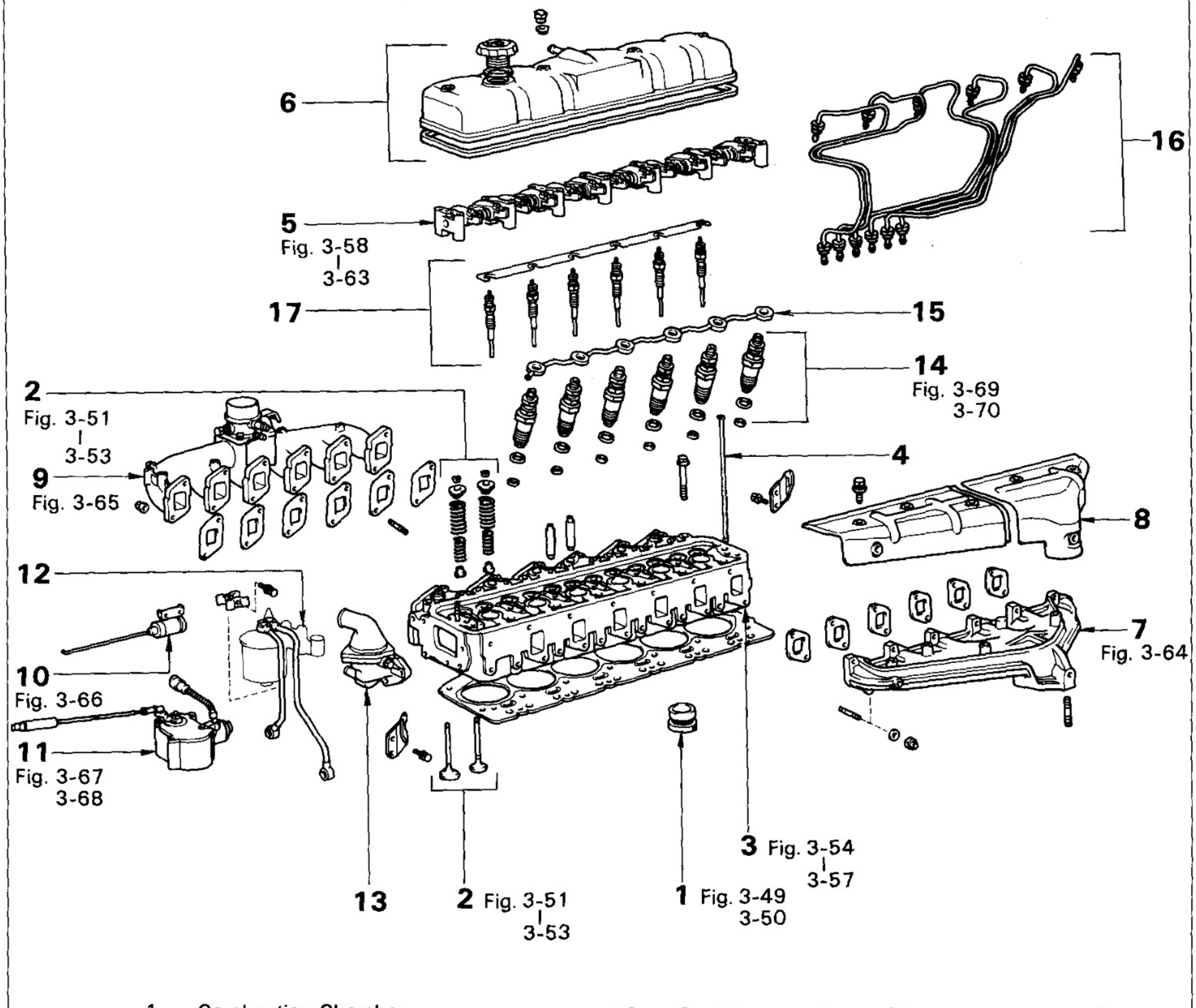
ASSEMBLY

Assemble the parts in the numerical order shown in the figure.

Fig. 3-48

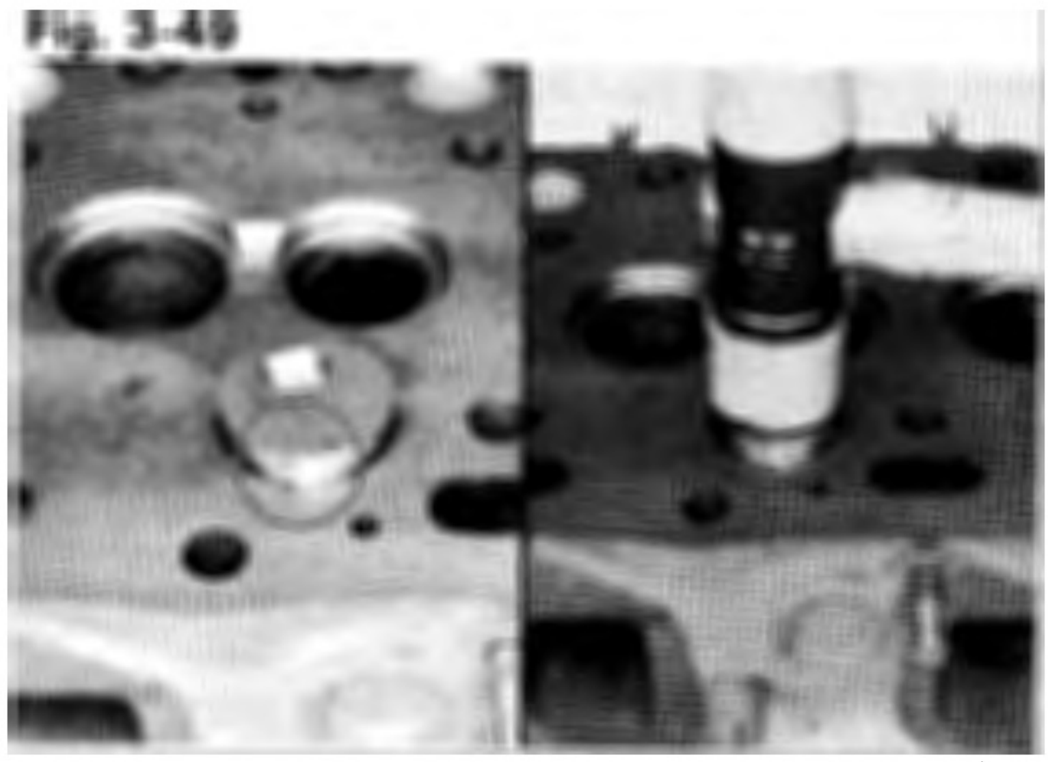
—Note—

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



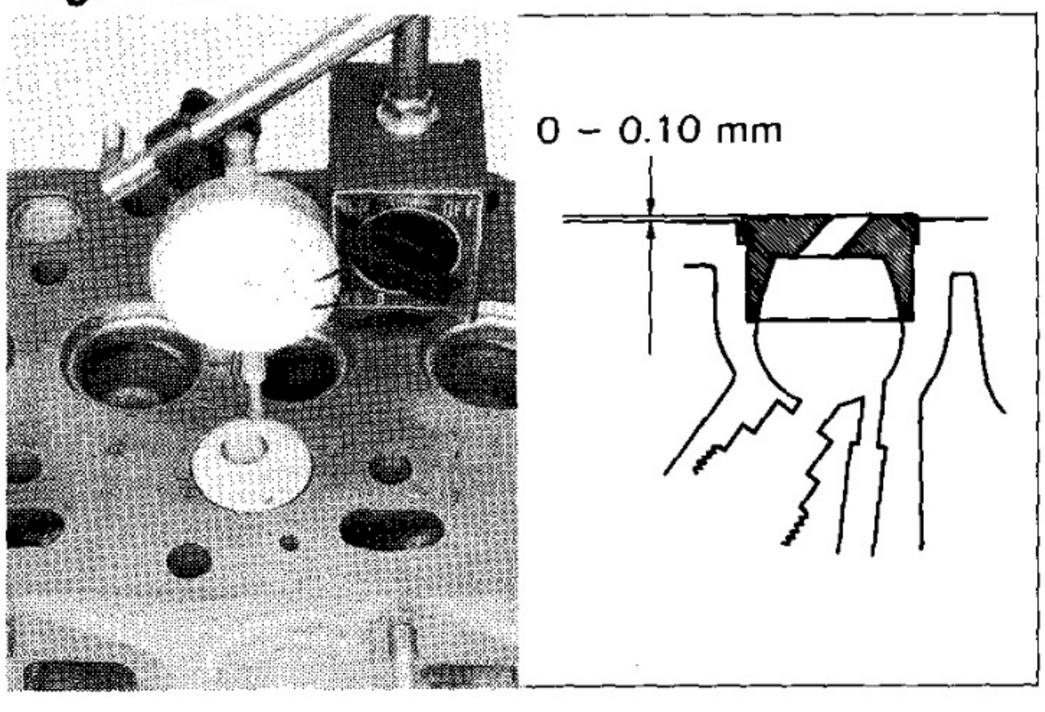
1. Combustion Chamber
2. Valve & Compression Spring
3. Cylinder Head
4. Valve Push Rod
5. Valve Rocker Shaft Assembly
6. Cylinder Head Cover
7. Exhaust Manifold
8. Heat Insulator
9. Intake Manifold
10. Overinjection Magnet (General countries only)
11. Fuel Control Motor
12. Fuel Filter
13. Water Outlet Housing
14. Injection Nozzle Holder
15. Leakage Pipe
16. Injection Pipe
17. Glow Plug & Glow Plug Connector

Fig. 3-49



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

Fig. 3-50



Check the combustion chamber protrusion.

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

Fig. 3-51

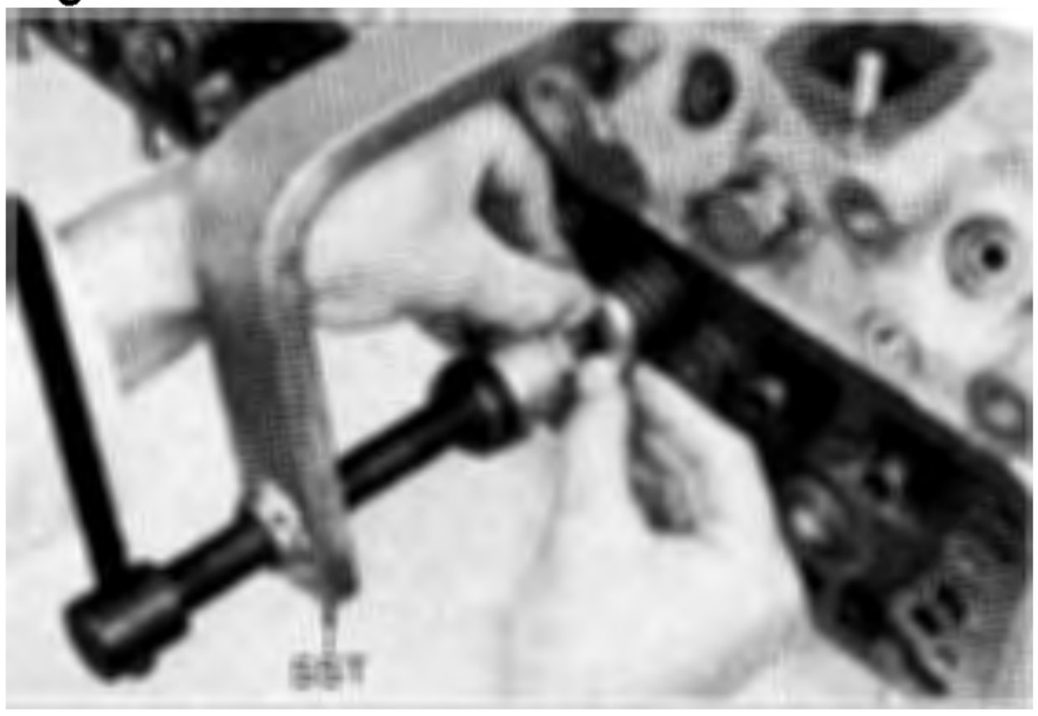


Press in the oil seal by hand.

–Note–

1. **A new oil seal should be used whenever the valve is disassembled.**
2. **Be careful not to press it in slantwise.**

Fig. 3-52



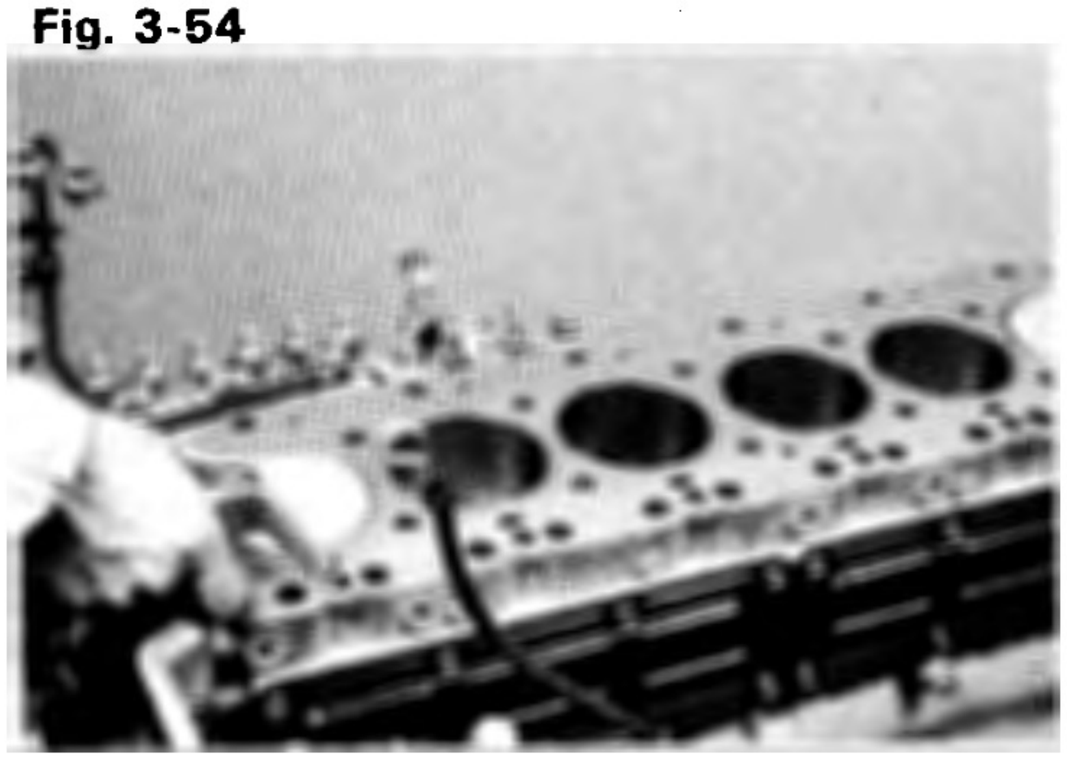
Compress the valve spring with SST and insert the spring retainer locks.
SST [09202-43012]

Fig. 3-53



⚠ After installing the springs, lightly tap the stem ends and allow the springs to settle down snugly.

Fig. 3-54

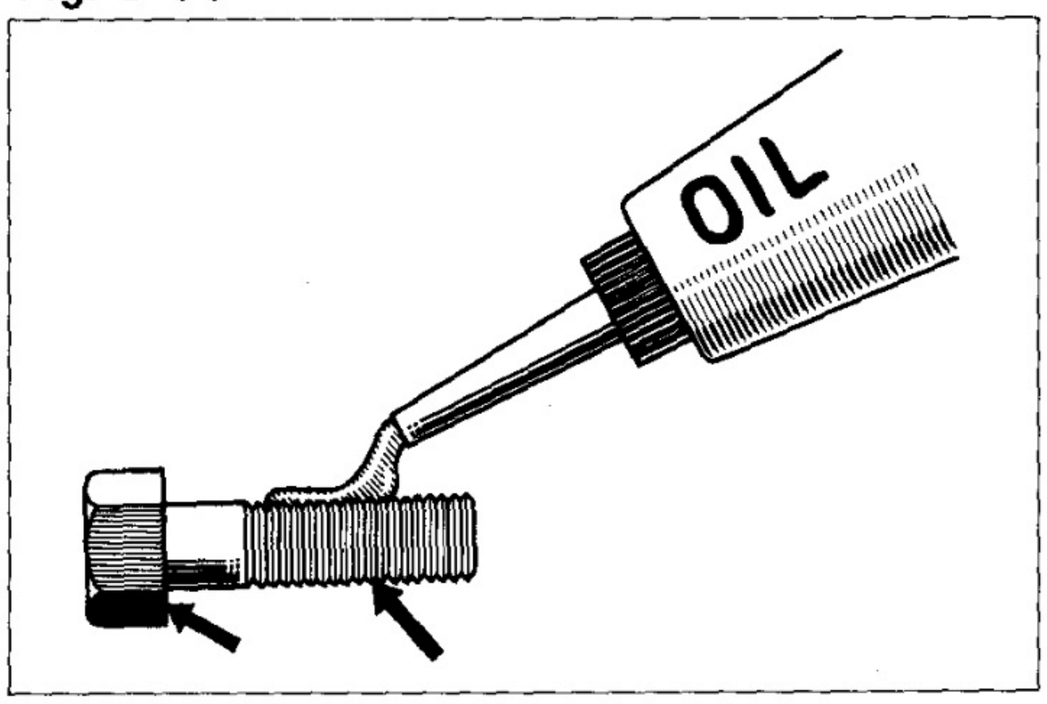


⚠ Put the cylinder head gasket on the cylinder block, aligning the bolt holes.

—Note—

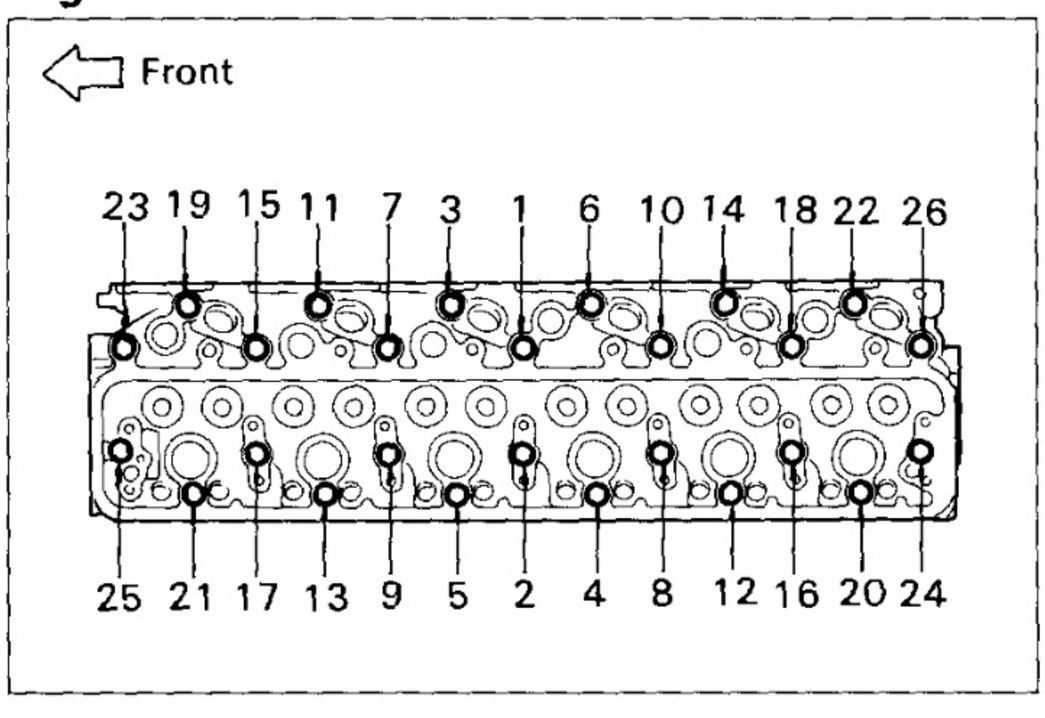
1. **Clean the cylinder block bolt holes with compressed air.**
2. **Clean the cylinder block upper surface with a scraper before installing the head gasket.**

Fig. 3-55



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

Fig. 3-56



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

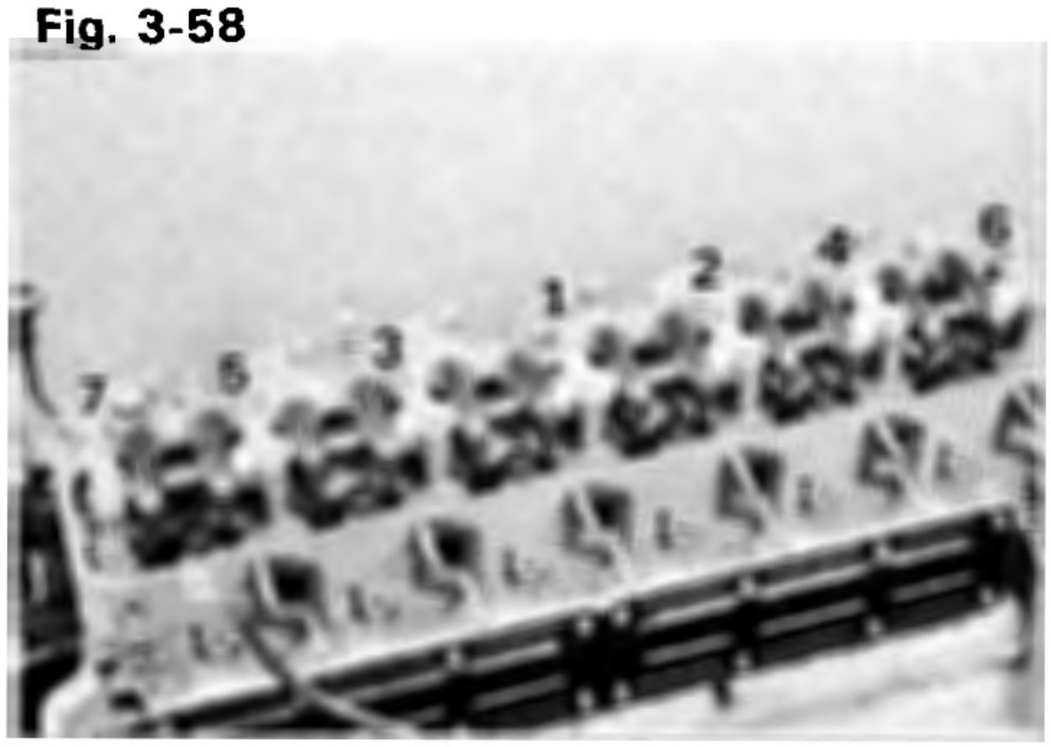
Fig. 3-57



Tighten the cylinder head bolts to specified torque.

Tightening torque:
11.0 – 12.0 kg-m
(80 – 86 ft-lb)

Fig. 3-58



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

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

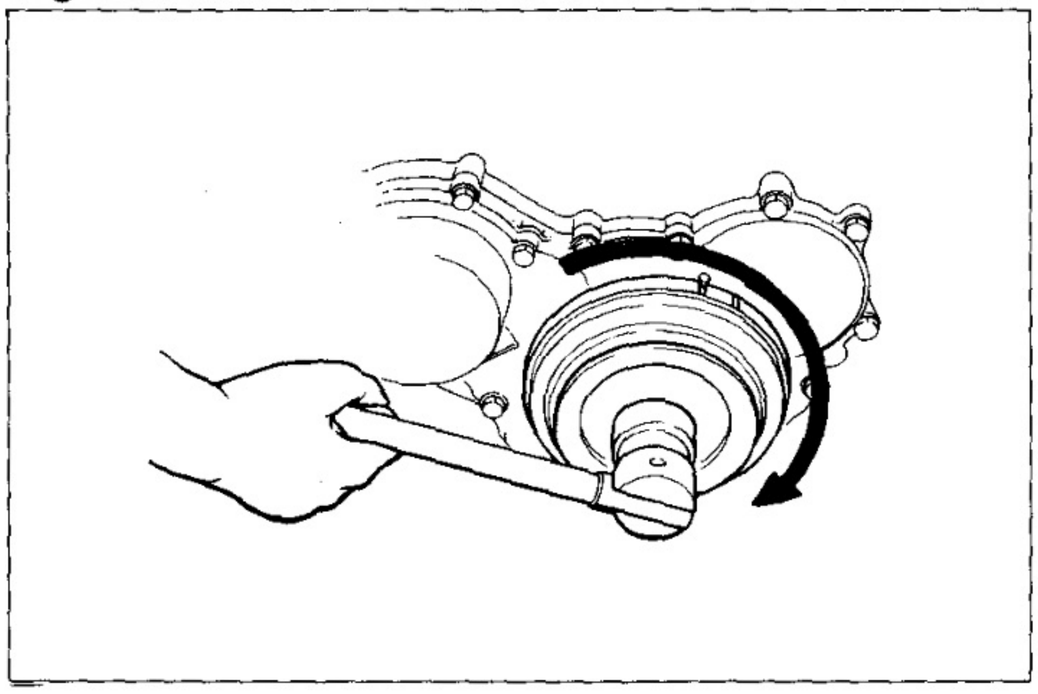
Fig. 3-59



Tighten the valve rocker support bolts to specified torque.

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

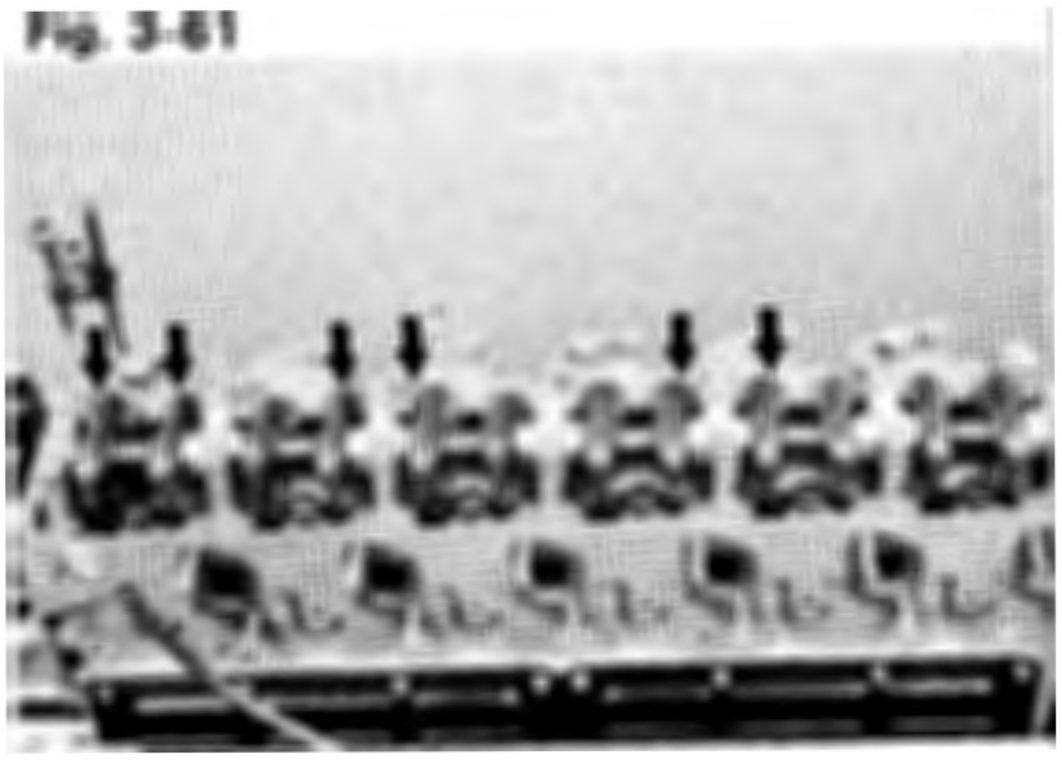
Fig. 3-60



Temporarily adjust the valve clearance.

1. Set the No.1 cylinder to TDC/compression.

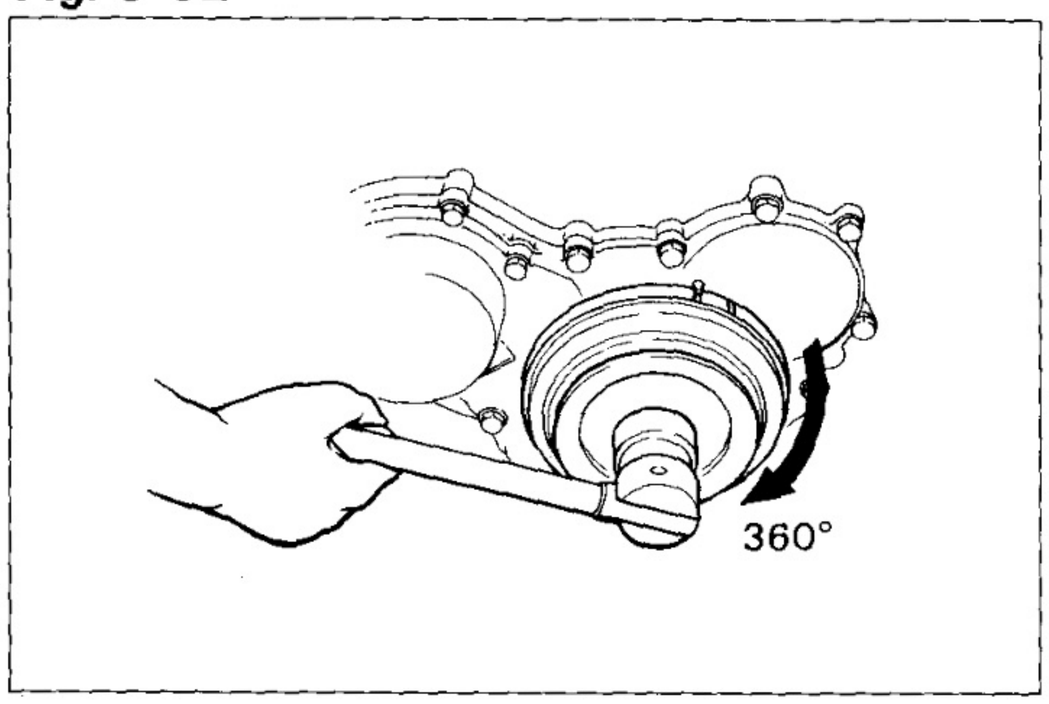
Fig. 3-61



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. 3-62



3. Rotate the crankshaft 360°.

Fig. 3-63



4. Adjust the remaining valves indicated by arrows.

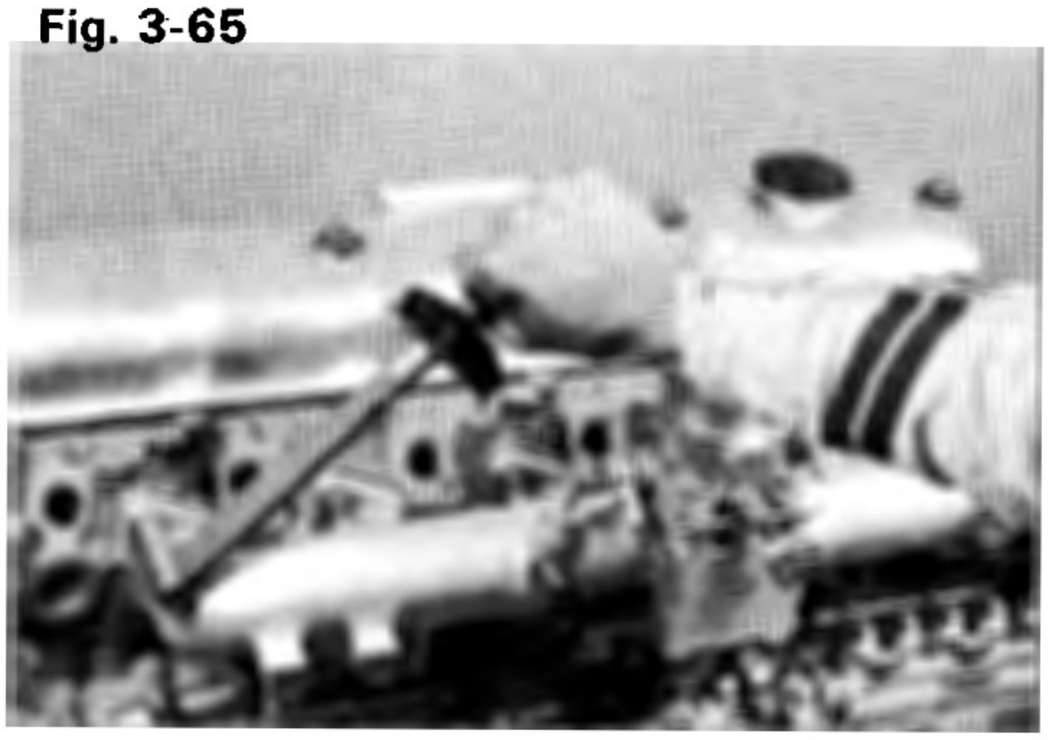
Fig. 3-64



Install the exhaust manifold.

Tightening torque: 1.8 – 2.4 kg-m (13 – 17 ft-lb)

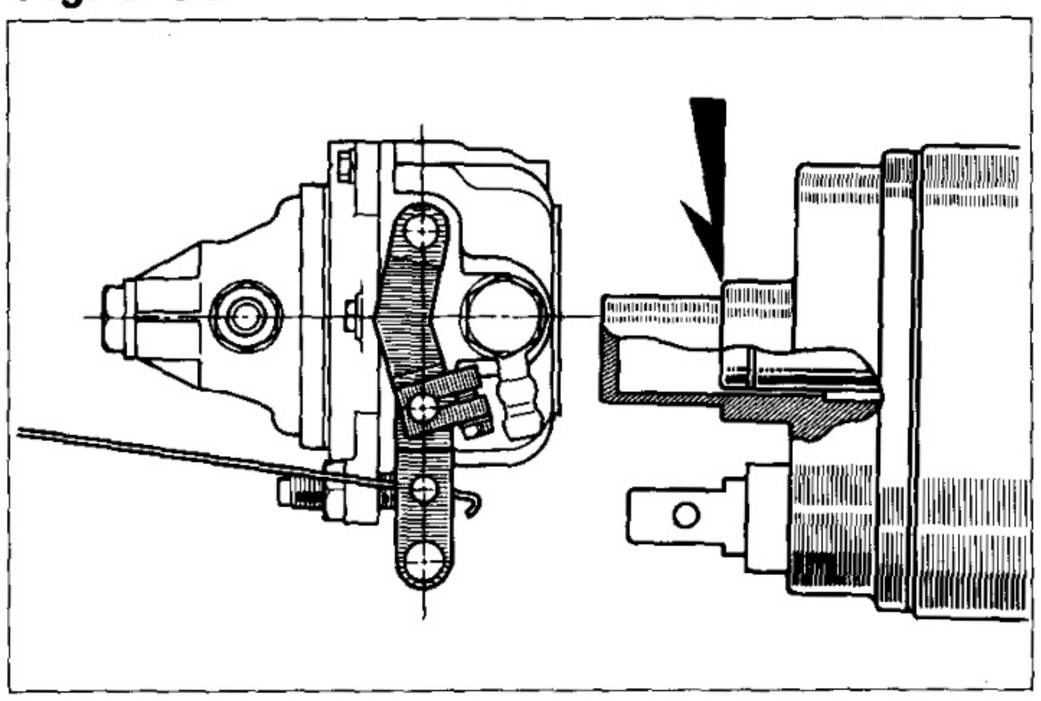
Fig. 3-65



Install the intake manifold.

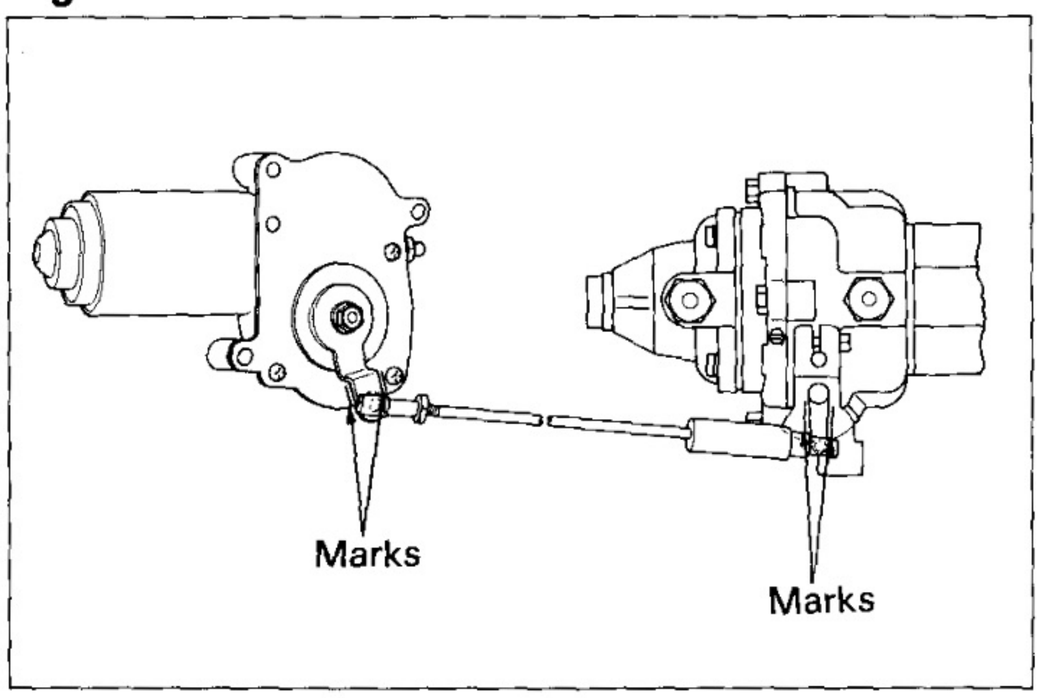
Tightening torque: 1.5 – 2.2 kg-m (11 – 15 ft-lb)

Fig. 3-66



Connect and adjust the overinjection magnet connecting wire with the magnet core end surface positioned as shown in the figure. (General countries only)

Fig. 3-67

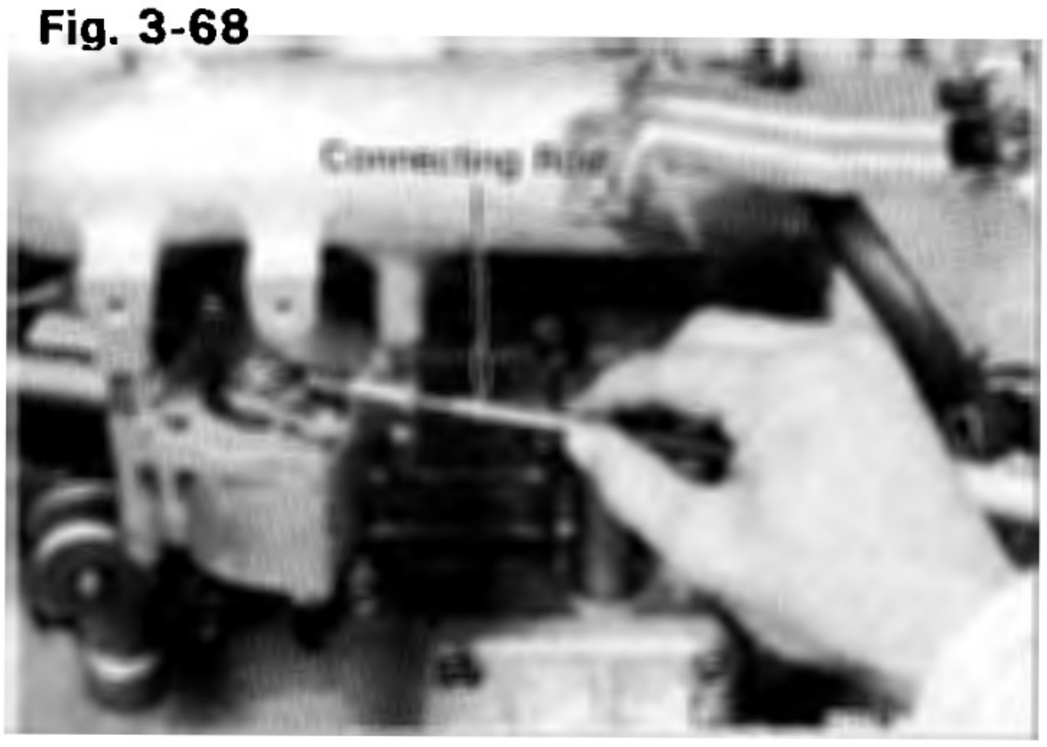


Install the fuel control motor and connecting rod.

–Note–

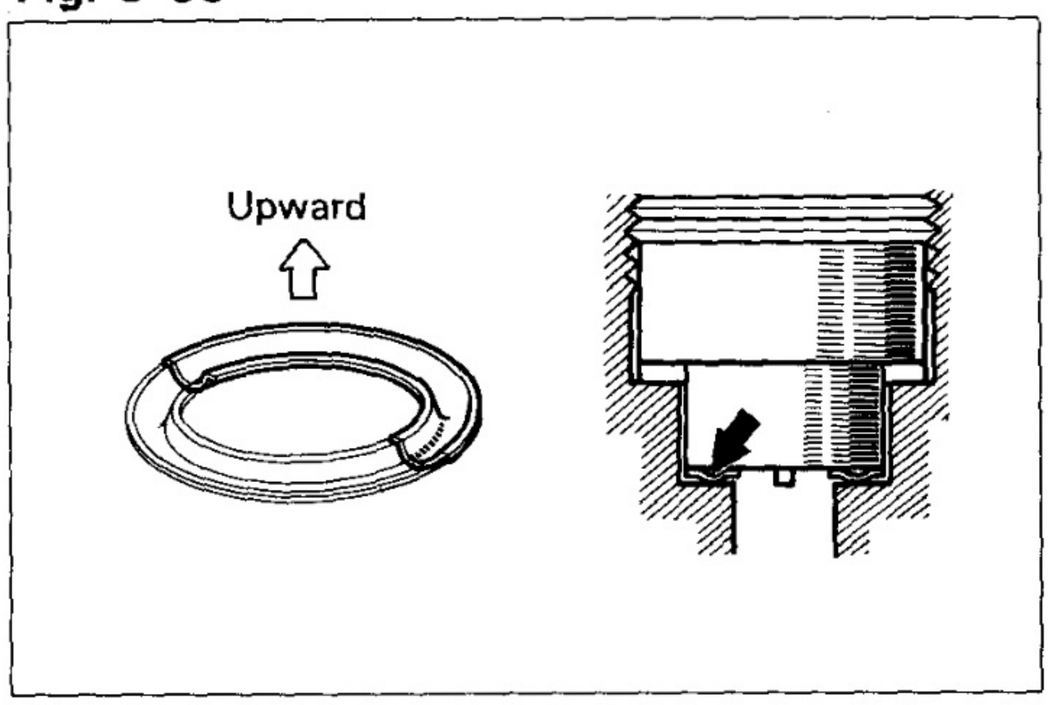
The fuel control motor lever should be positioned between the two marks while the engine is running.

Fig. 3-68



Adjust the connecting rod length so that the injection pump lever is positioned between the two marks.

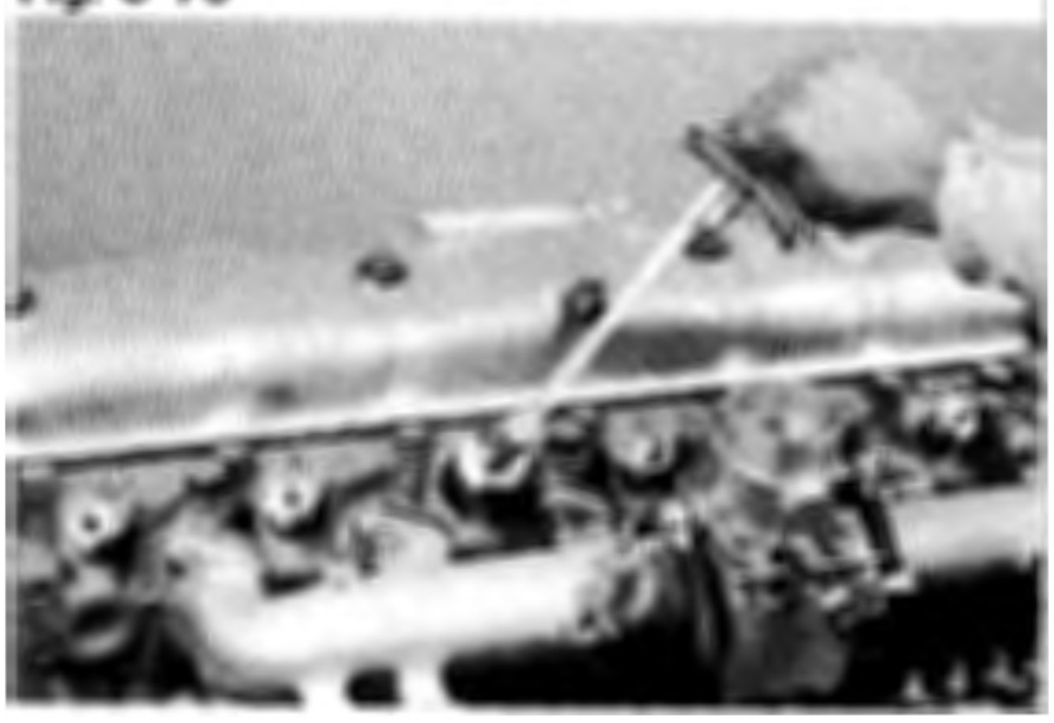
Fig. 3-69



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. 3-70



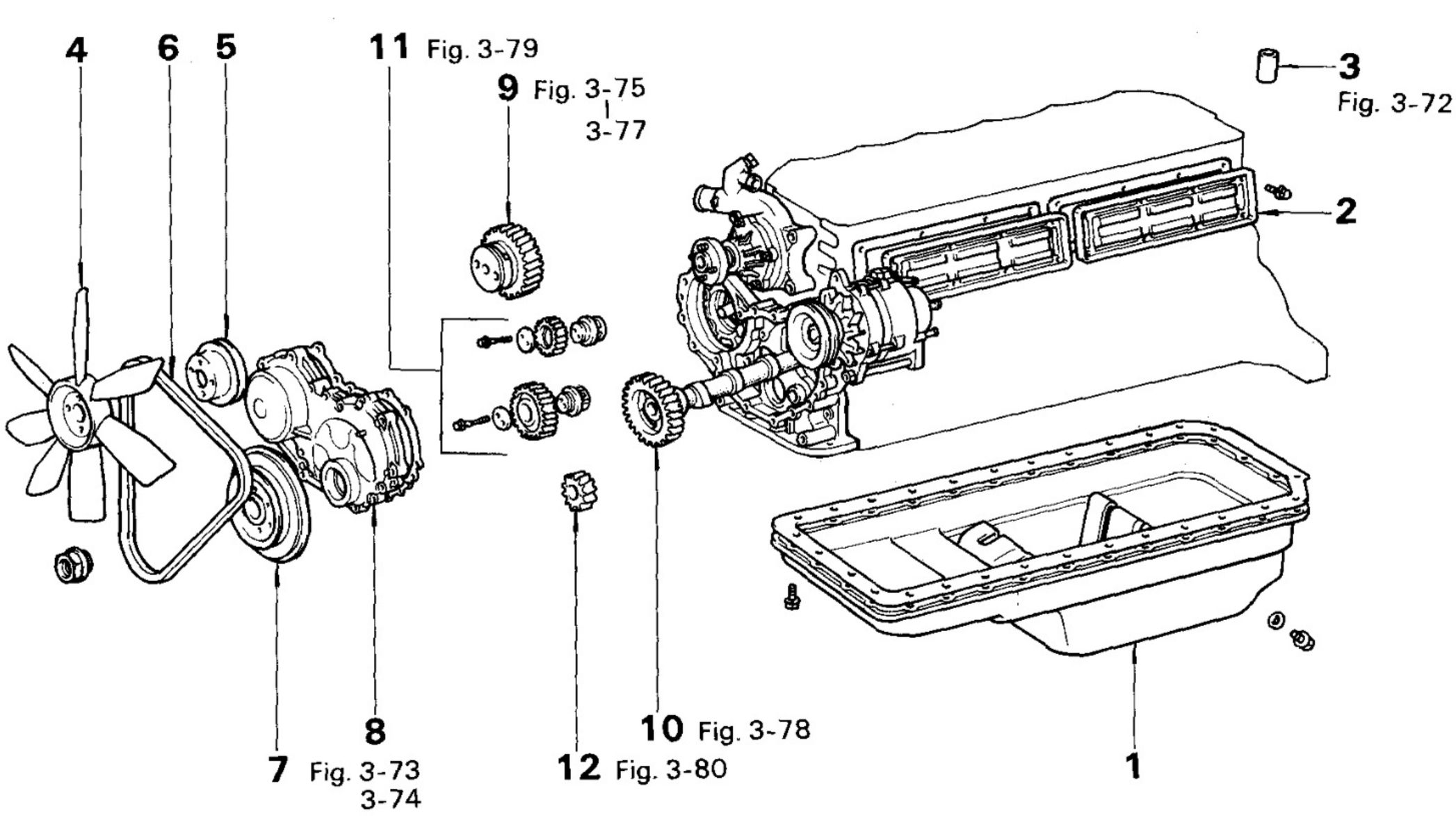
Tighten the nozzle holders with SST.
SST (09268-46011) of set [09260-46011]
Tightening torque: 6.0 – 8.0 kg-m (44 – 57 ft-lb)

TIMING GEAR

DISASSEMBLY

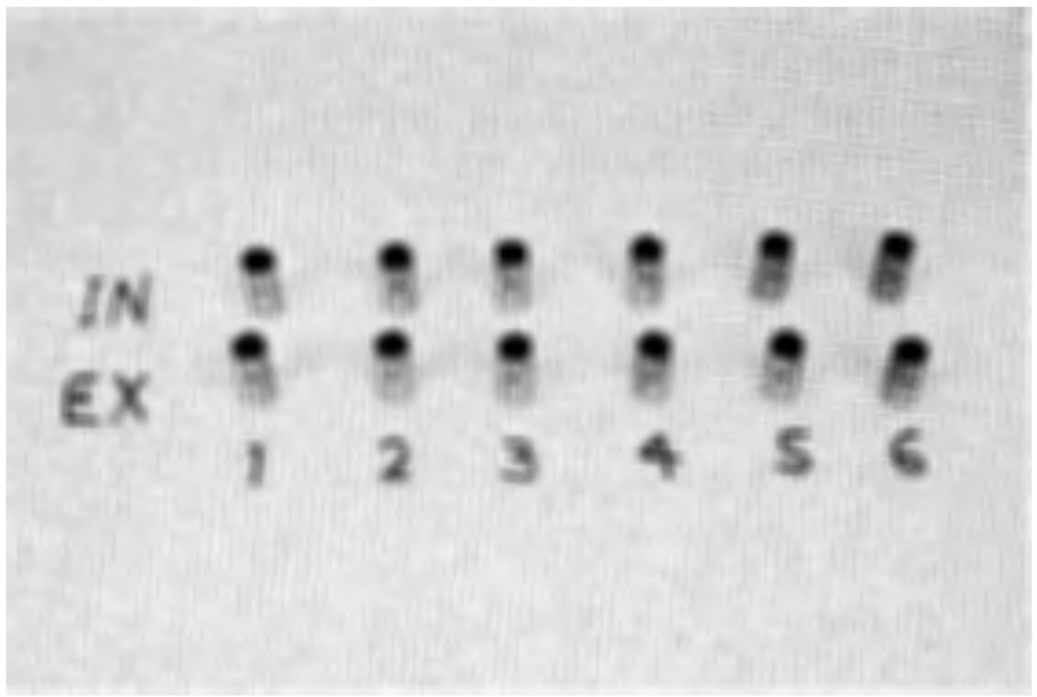
Disassemble the parts in the numerical order shown in the figure.

Fig. 3-71



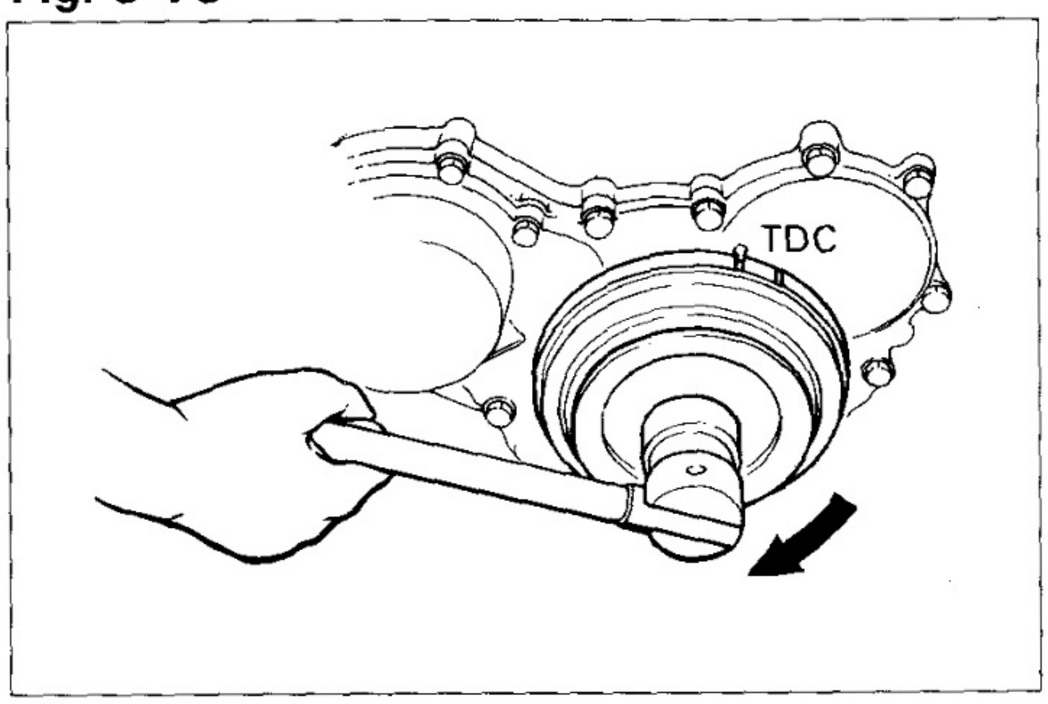
1. Oil Pan
2. Valve Push Rod Cover
3. Valve Lifter
4. Cooling Fan
5. Fan Pulley
6. Drive Belt
7. Crankshaft Pulley
8. Timing Gear Cover
9. Automatic Timer
10. Camshaft & Timing Gear
11. Idle Gear No. 1 & No. 2
12. Crankshaft Timing Gear

Fig. 3-72



Keep the valve lifters in correct order.

Fig. 3-73



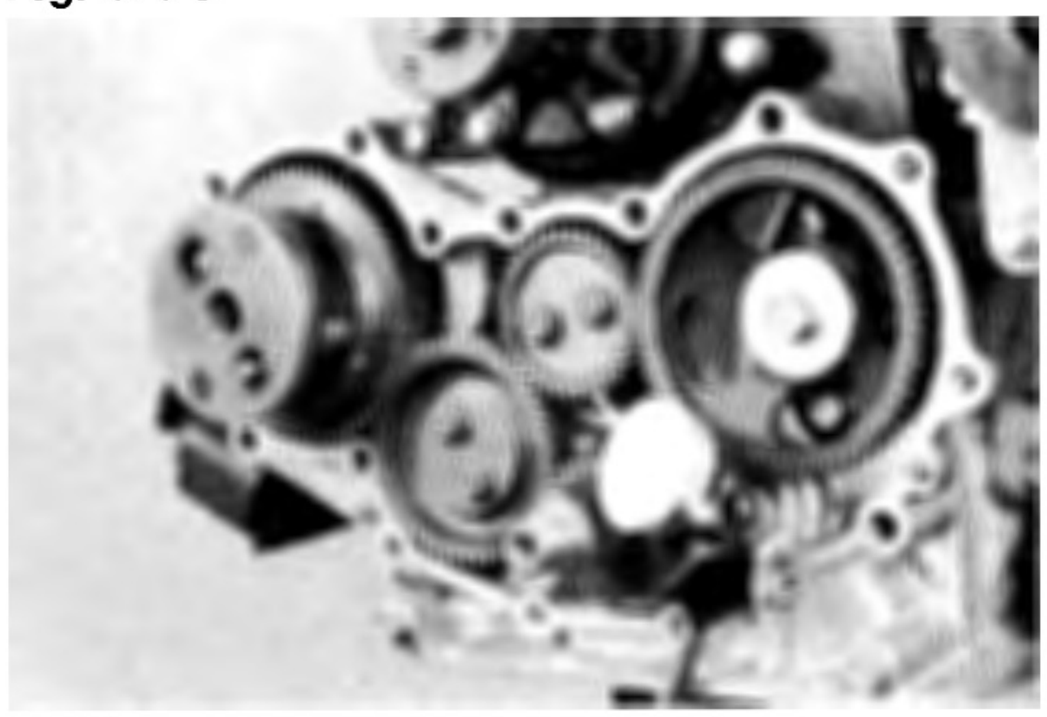
Before starting work, set No.1 cylinder piston to TDC/compression.

Fig. 3-74



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

Fig. 3-75



Measure the timing gear backlashes.

Backlash

Gears	mm (in.)
Crankshaft to idle gear No.1	0.050 – 0.116 (0.0019 – 0.0045)
Idle gear No.1 to timer	0.050 – 0.111 (0.0019 – 0.0043)
Idle gear No.1 to No.2	0.050 – 0.113 (0.0019 – 0.0044)
Idle gear No.2 to camshaft	0.050 – 0.113 (0.0019 – 0.0044)

Fig. 3-76



Remove the automatic timer from the injection pump.

1. Hold the timer with a screwdriver and remove the round nut.

—Note—

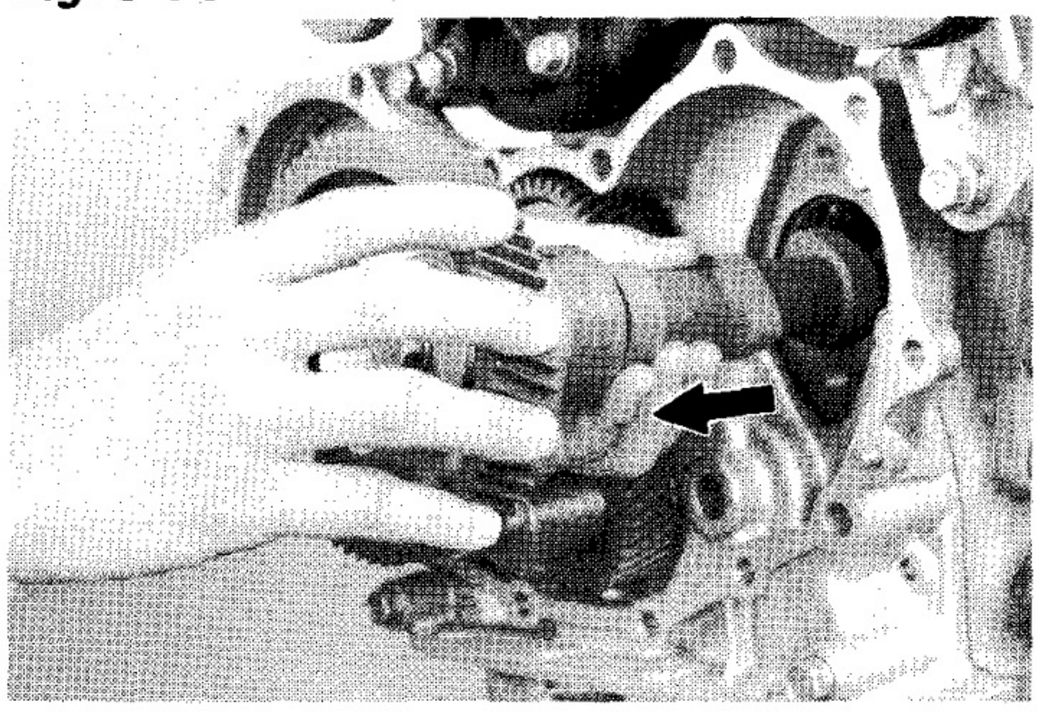
Be careful not to scratch the timer weight sliding surface.

Fig. 3-77



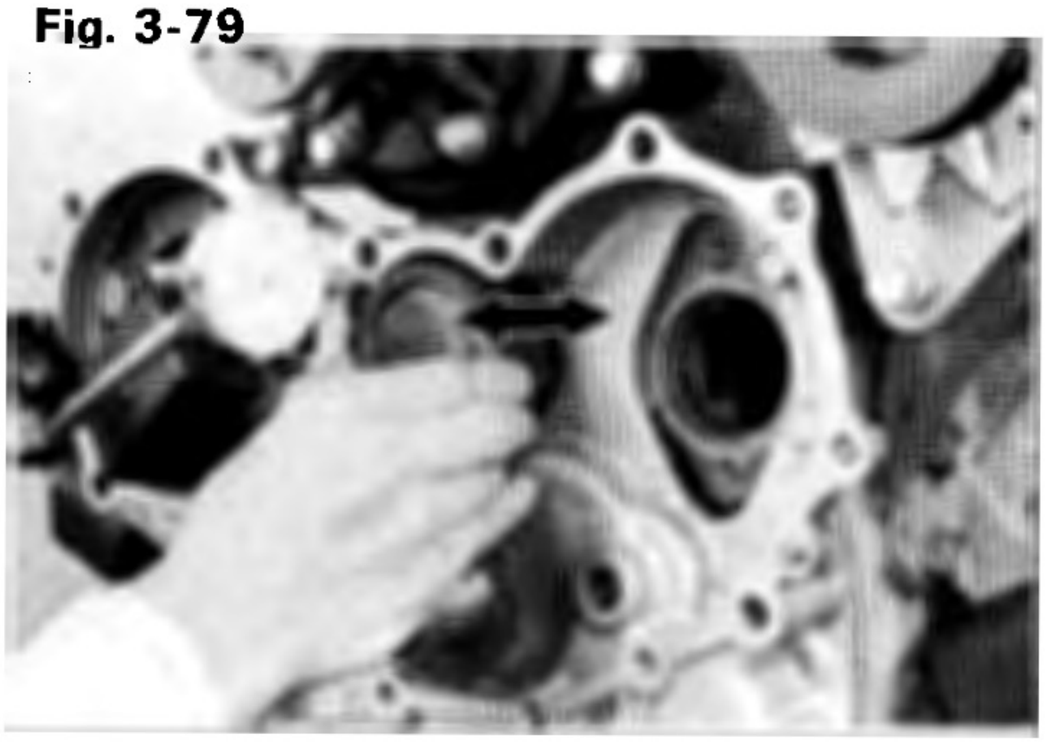
2. Using SST, drive out the timer from the injection pump camshaft.
SST [09267-76020]

Fig. 3-78



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

Fig. 3-79



Measure the idle gear thrust clearance.

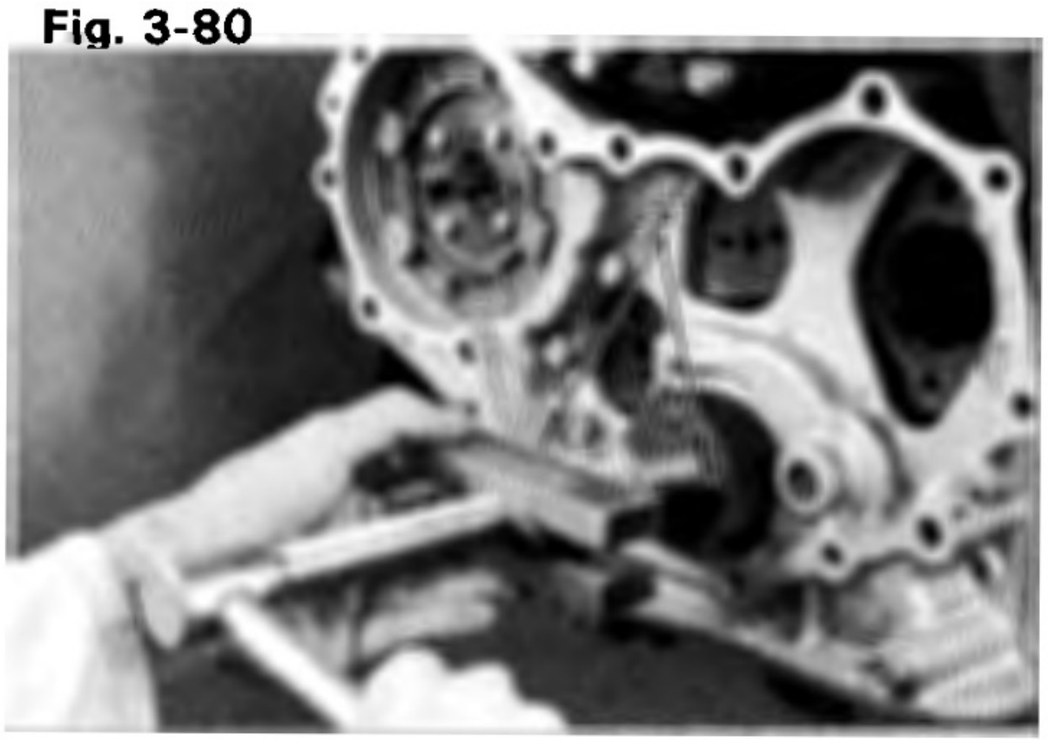
Thrust clearance:

No.1 & No.2

STD 0.05 – 0.15 mm (0.0019 – 0.0059 in.)

Limit 0.3 mm (0.012 in.)

Fig. 3-80



Pull out the crankshaft timing gear with SST.
SST [09213-60016]
[09219-60020]

Fig. 3-81

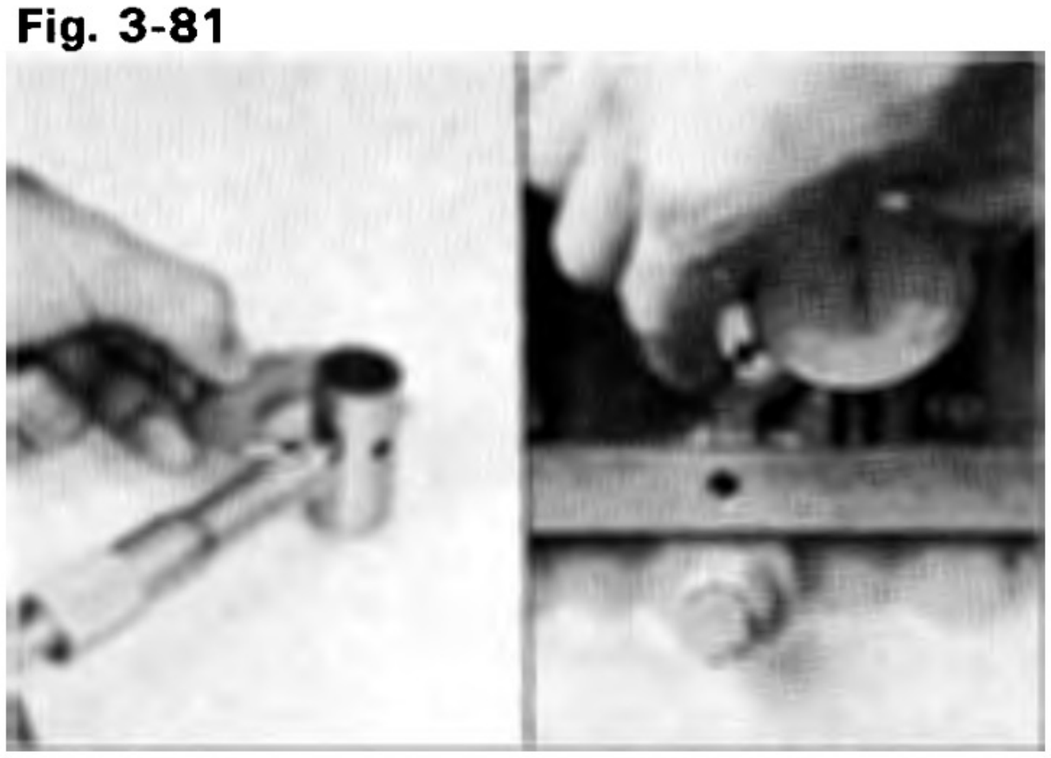


Fig. 3-82

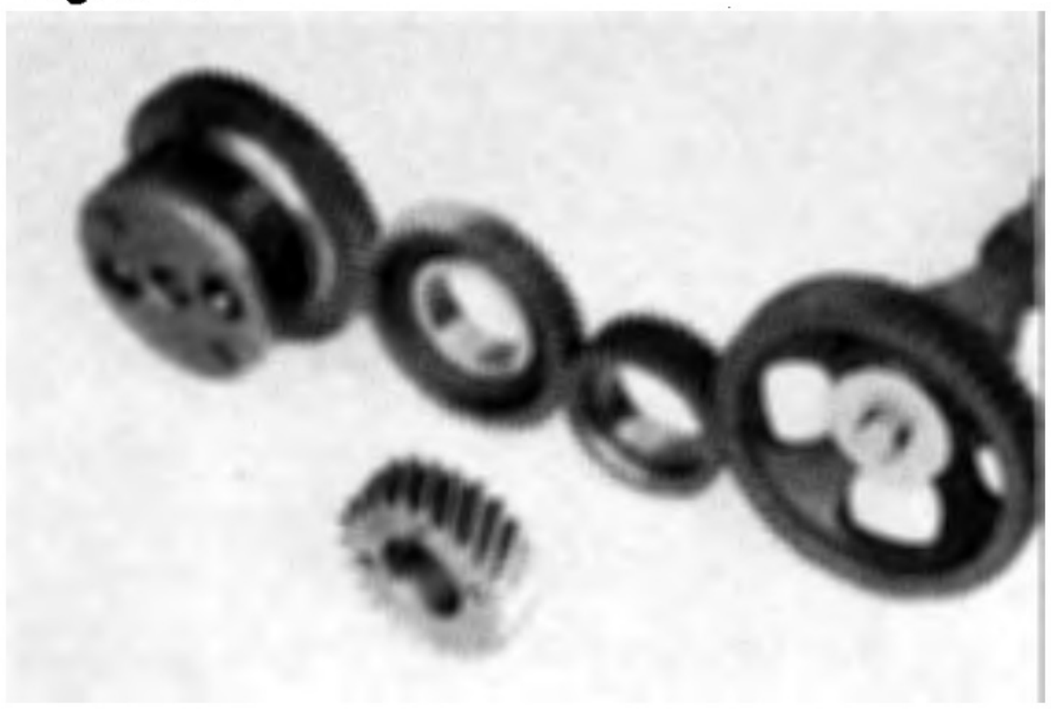


Fig. 3-83

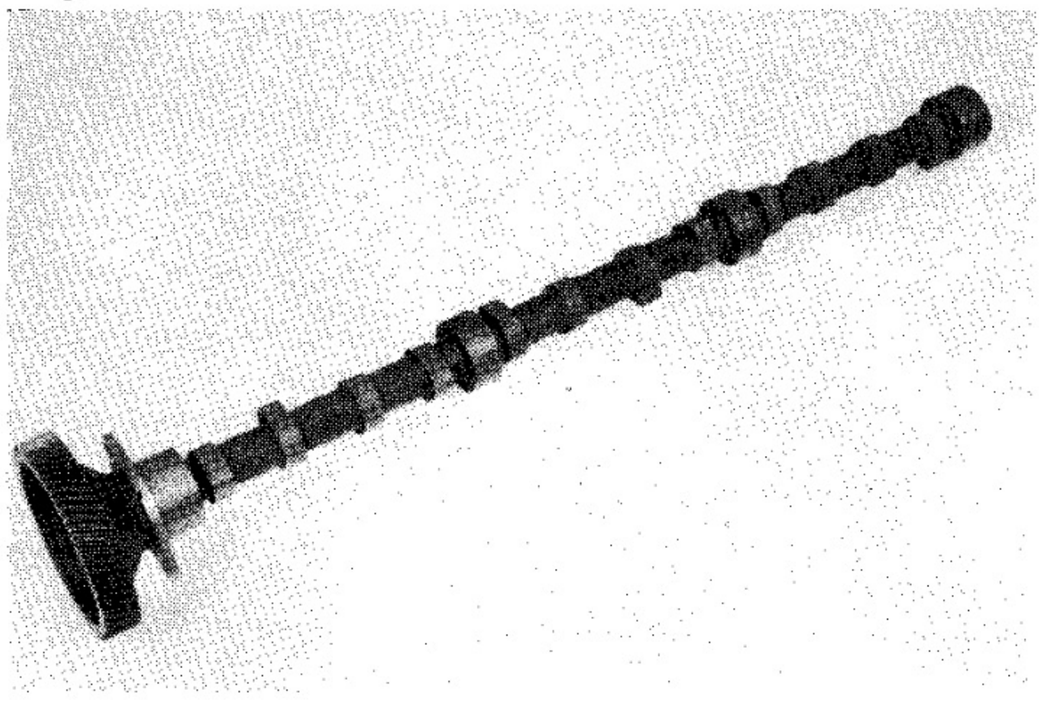
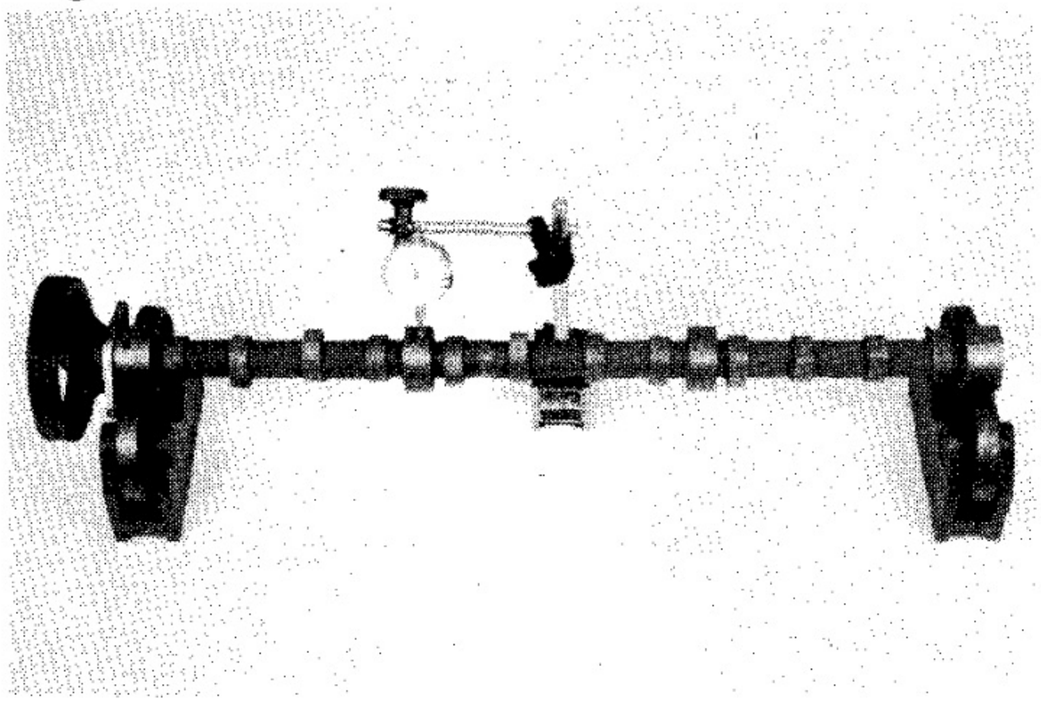


Fig. 3-84



INSPECTION & REPAIR

Valve Lifter

Check the lifters and lifter bores for wear or damage.

Measure the oil clearance.

Valve lifter outer diameter:
22.17 – 22.19 mm
(0.8728 – 0.8736 in.)

Valve lifter bore diameter:
22.20 – 22.22 mm
(0.8740 – 0.8748 in.)

Oil clearance:

STD	**0.010 – 0.051 mm (0.0004 – 0.0020 in.)**
Limit	**0.1 mm (0.004 in.)**

Timing Gear

Check for cracks, wear or chipped teeth.

If damaged, replace the gear along with its mate.

Camshaft

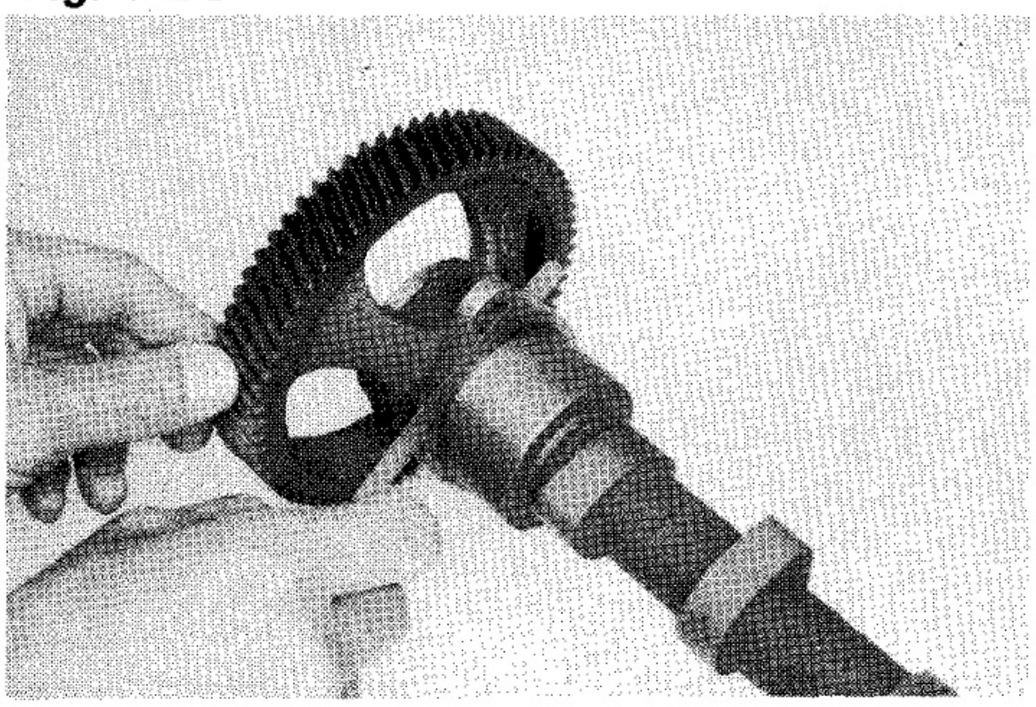
1. Check the cam and journal for cracks or wear.
   If damaged, replace the camshaft.

2. Check the camshaft for runout. Replace the camshaft if it exceeds the limit.

Runout:

Limit	**0.4 mm (0.016 in.)**

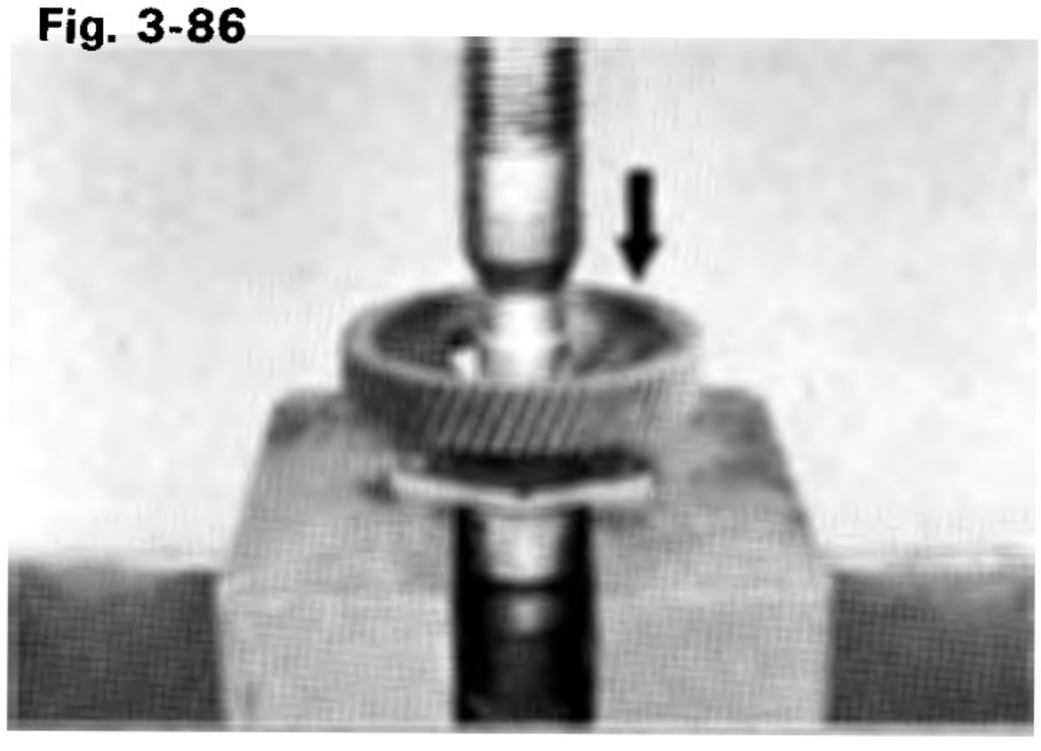
Fig. 3-85



3. Measure the camshaft thrust clearance. If it exceeds the limit, replace the thrust plate.

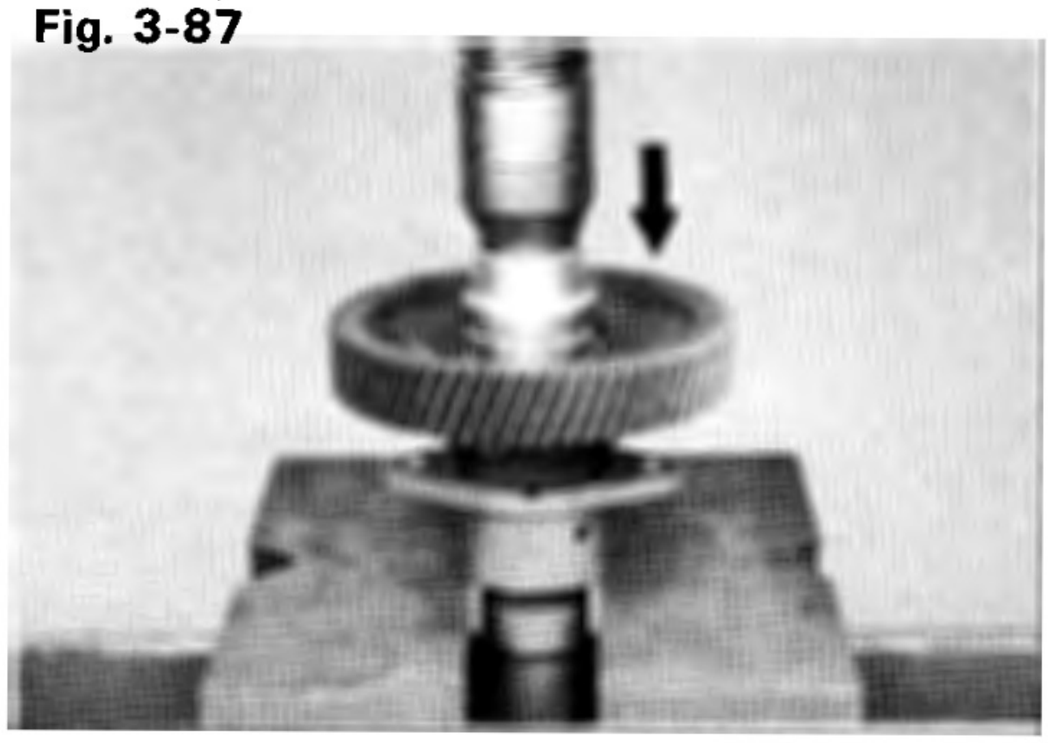
Thrust clearance:
STD 0.06 – 0.13 mm (0.0024 – 0.0051 in.)
Limit 0.3 mm (0.012 in.)

Fig. 3-86



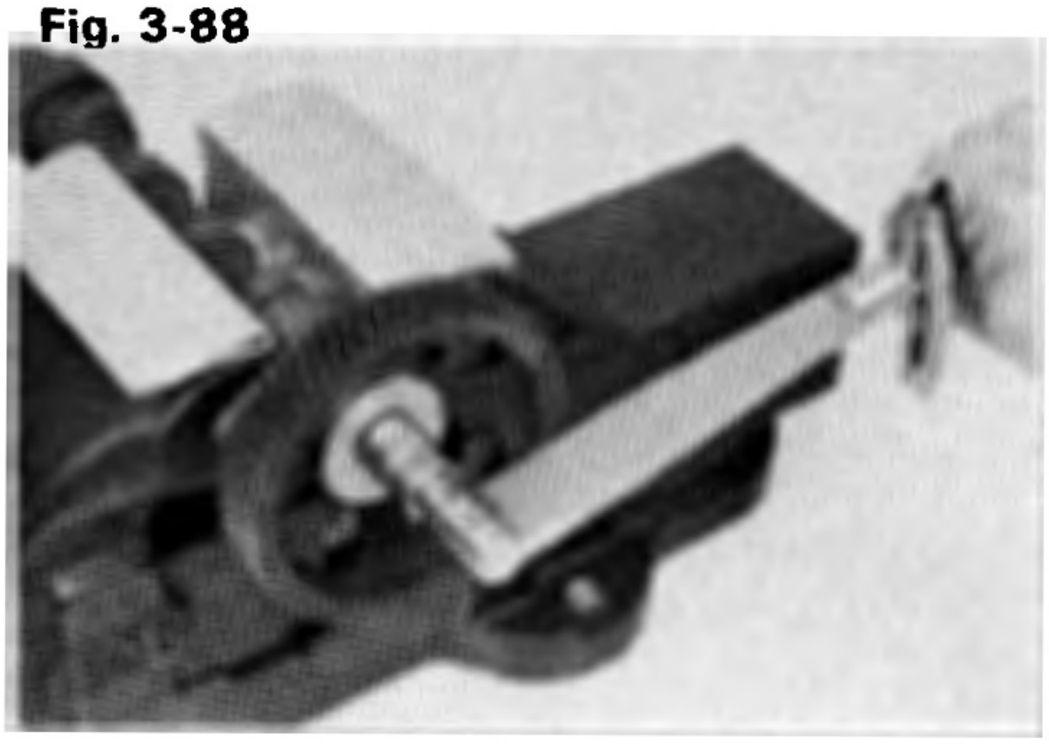
4. Replace the thrust plate if the thrust clearance exceeds the limit.
   (1) Using a press and 19 mm socket wrench, press out the timing gear from the camshaft.

Fig. 3-87



(2) Using a press and 29 mm socket wrench, press in the timing gear.

Fig. 3-88

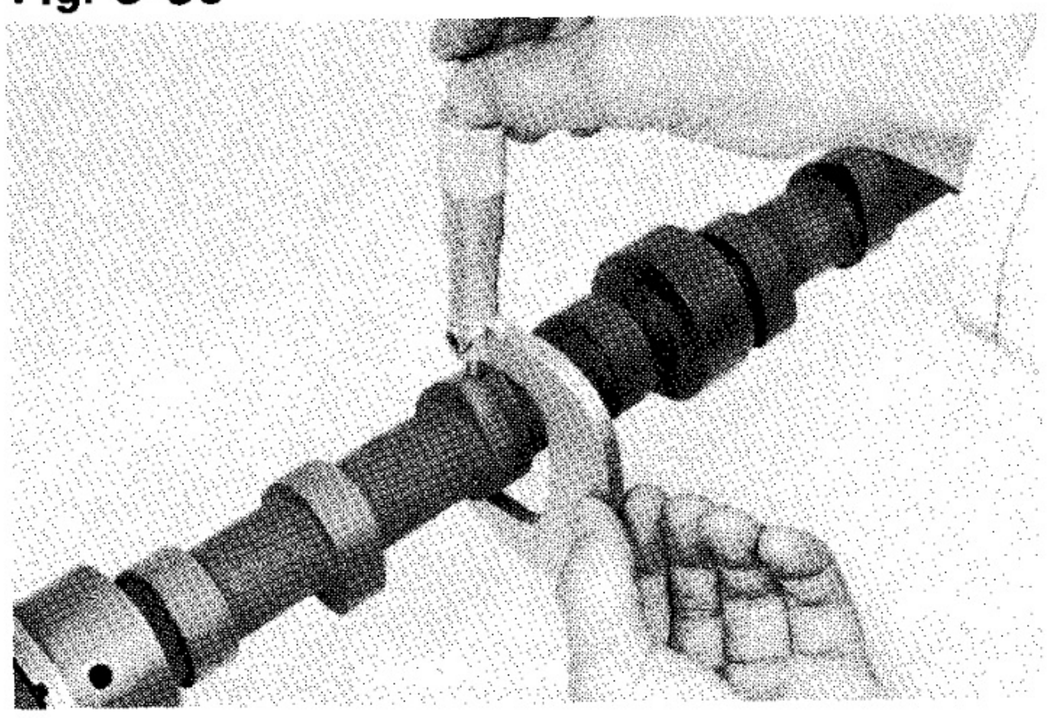


(3) Place the camshaft in a soft jaw vise and tighten the bolt to specified torque.

Tightening torque:
3.5 – 5.5 kg-m (26 – 39 ft-lb)

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

Fig. 3-89

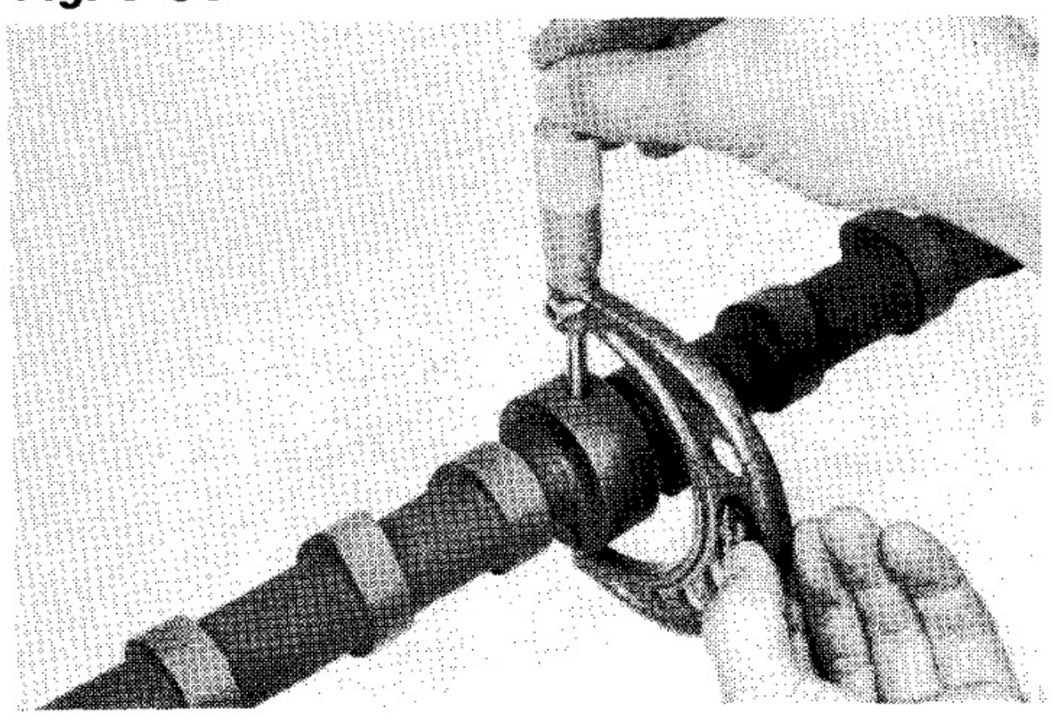


5. Measure the cam lobe height.

Cam height:

STD IN 41.90 mm (1.6496 in.)
EX 42.30 mm (1.6654 in.)

Fig. 3-90



6. Measure the journal oil clearance.
   (1) Measure the camshaft journal diameter.

Journal diameter:

No.1 51.15 – 51.17 mm (2.0138 – 2.0146 in.)
No.2 50.95 – 50.97 mm (2.0059 – 2.0067 in.)
No.3 50.75 – 50.77 mm (1.9980 – 1.9988 in.)
No.4 50.55 – 50.57 mm (1.9902 – 1.9909 in.)

Fig. 3-91

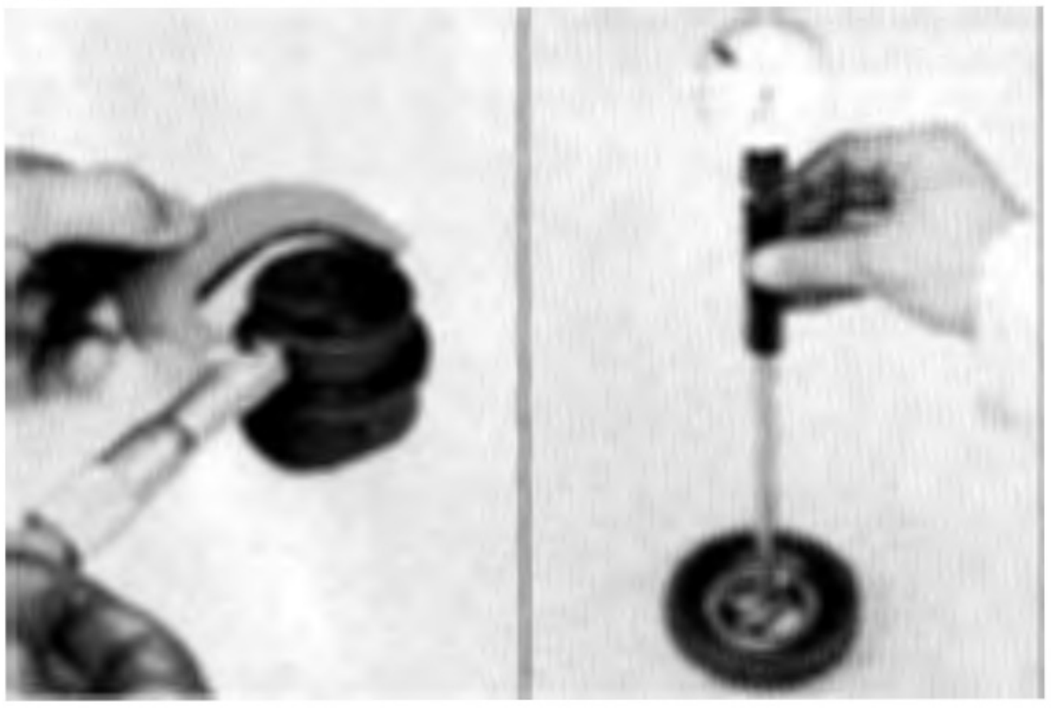


(2) Measure the bearing inner diameter, referring to CYLINDER BLOCK section.

Oil clearance:

STD 0.03 – 0.08 mm (0.0012 – 0.0031 in.)
Limit 0.1 mm (0.004 in.)

Fig. 3-92



Idle Gear

Measure the idle gear oil clearance.

Idle gear shaft diameter:

No.1 & No.2 44.95 – 44.98 mm (1.7697 – 1.7709 in.)

Idle gear bore:

No.1 & No.2 45.00 – 45.25 mm (1.7717 – 1.7815 in.)

Oil clearance:

No.1 & No.2
STD 0.025 – 0.075 mm (0.0010 – 0.0030 in.)
Limit 0.3 mm (0.012 in.)

Fig. 3-93



Crankshaft Front Oil Seal

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

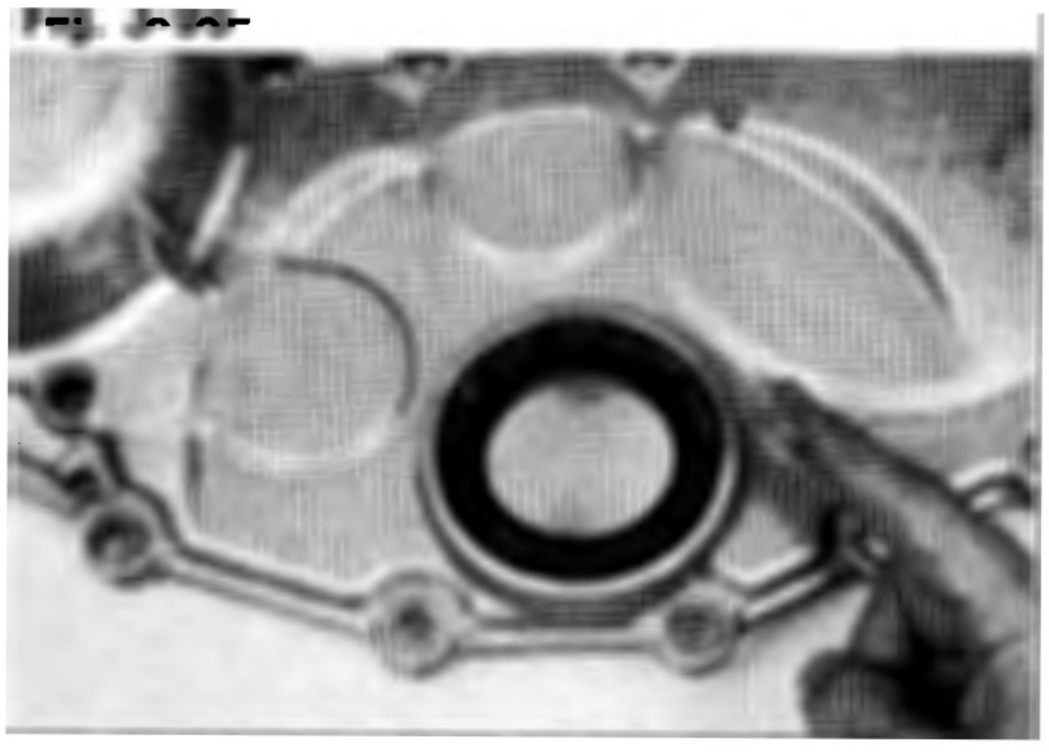
Fig. 3-94



(2) Install a new oil seal with SST.
SST [09223-46011]

—Note—

1. **Drive in the oil seal until it is about even with the timing gear cover.**
2. **Be careful not to drive it in slant wise.**



3. After driving in the seal, lightly coat the seal lip with MP grease.

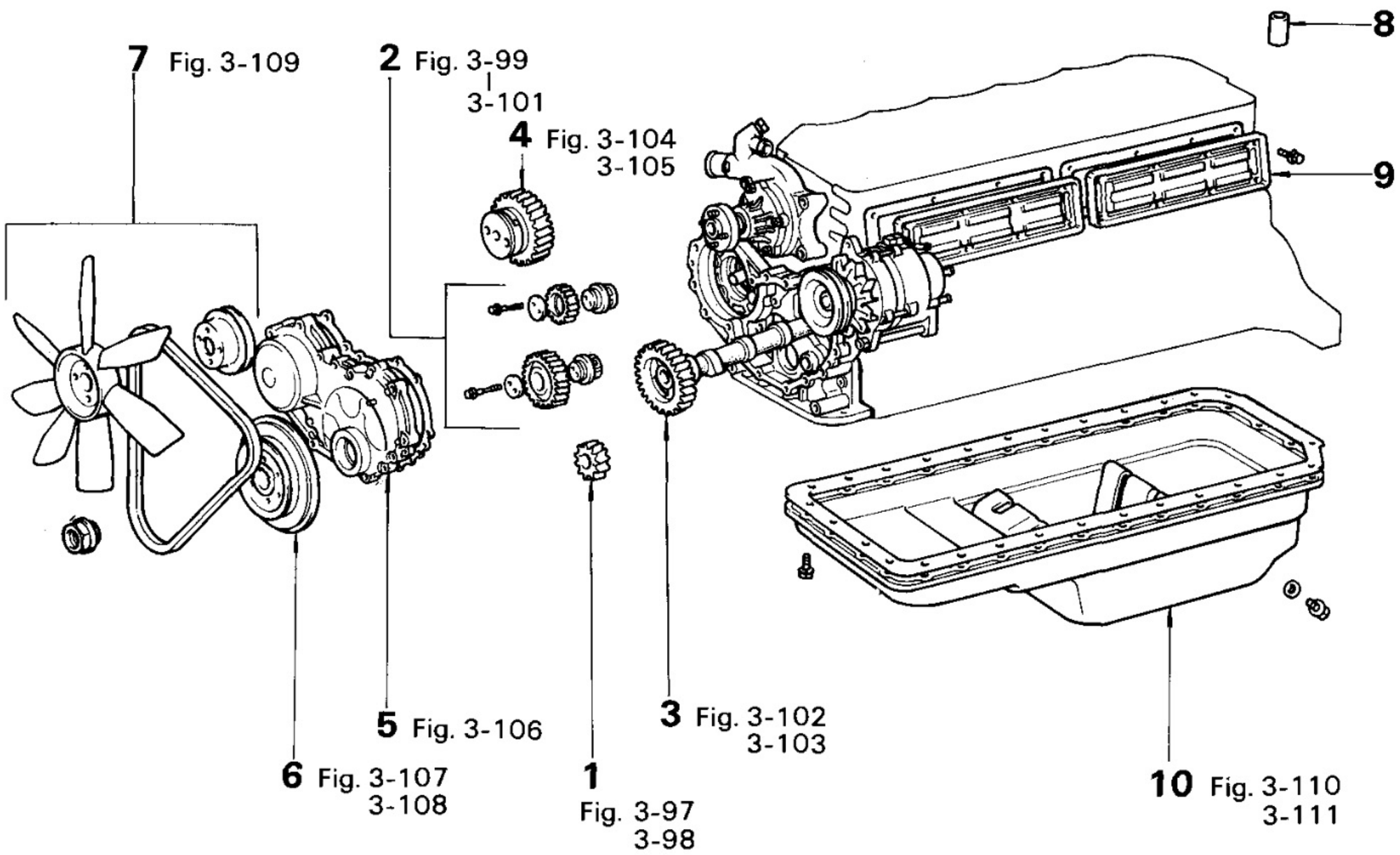
ASSEMBLY

Assemble the parts in the numerical order shown in the figure.

Fig. 3-96

—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
2. Idle Gear No. 1 & No. 2
3. Camshaft & Timing Gear
4. Automatic Timer
5. Timing Gear Cover
6. Crankshaft Pulley
7. Fan Pulley & Drive Belt
8. Valve Lifter
9. Valve Push Rod Cover
10. Oil Pan

Fig. 3-97



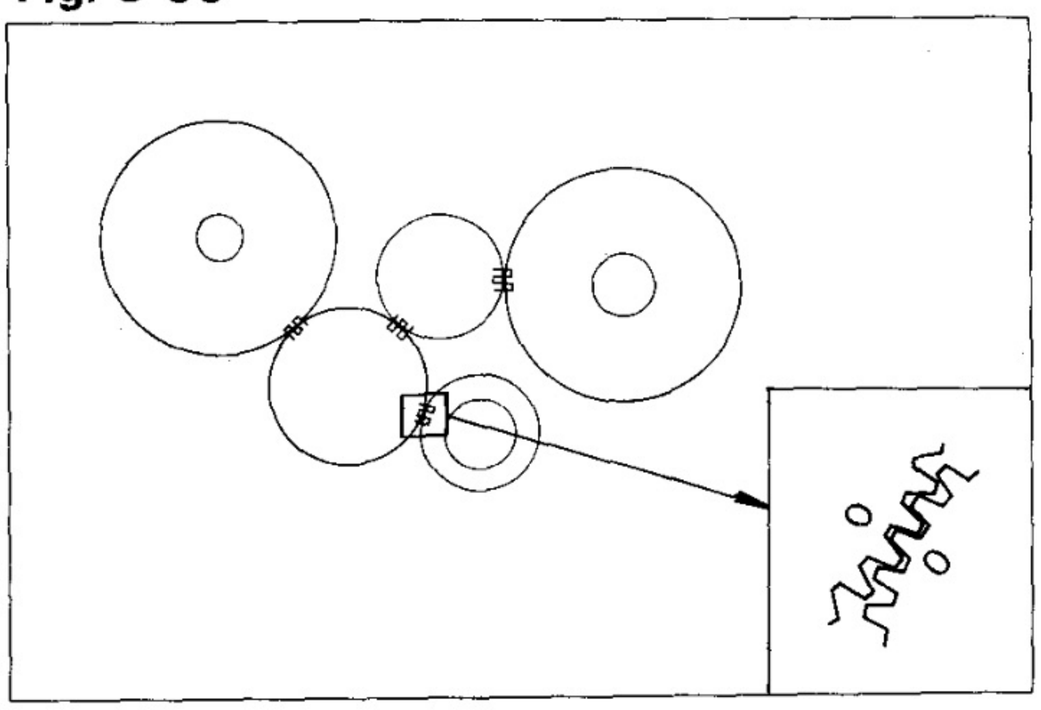
Drive in the crankshaft timing gear with SST.
SST [09608-35013]

Fig. 3-98



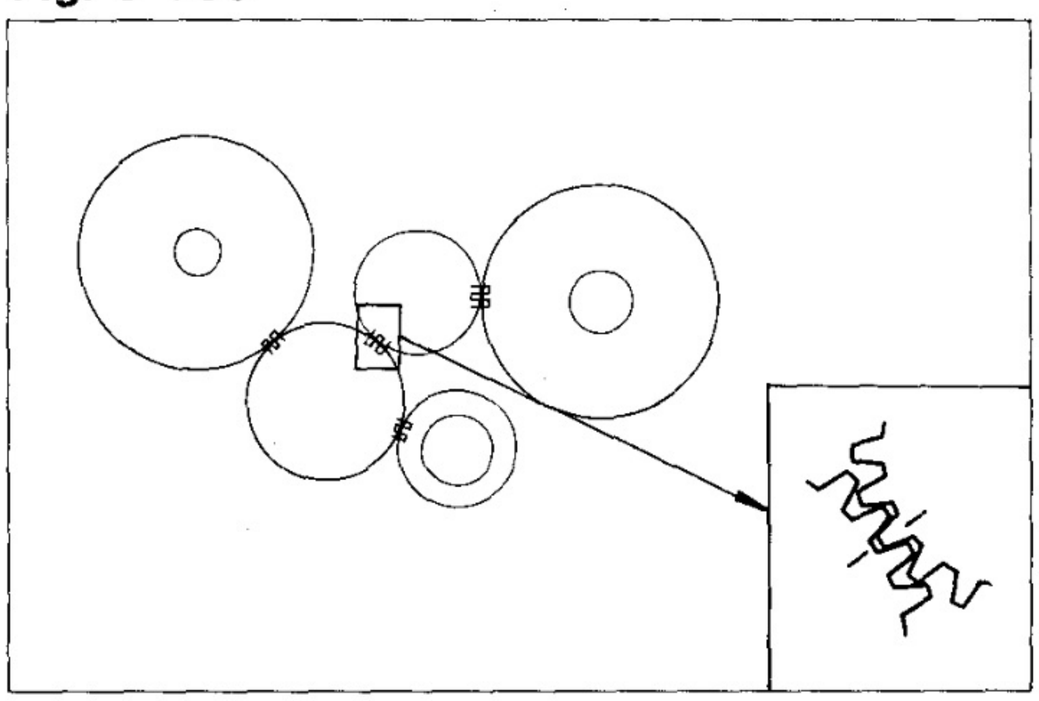
Set No.1 cylinder piston to TDC/compression.

Fig. 3-99



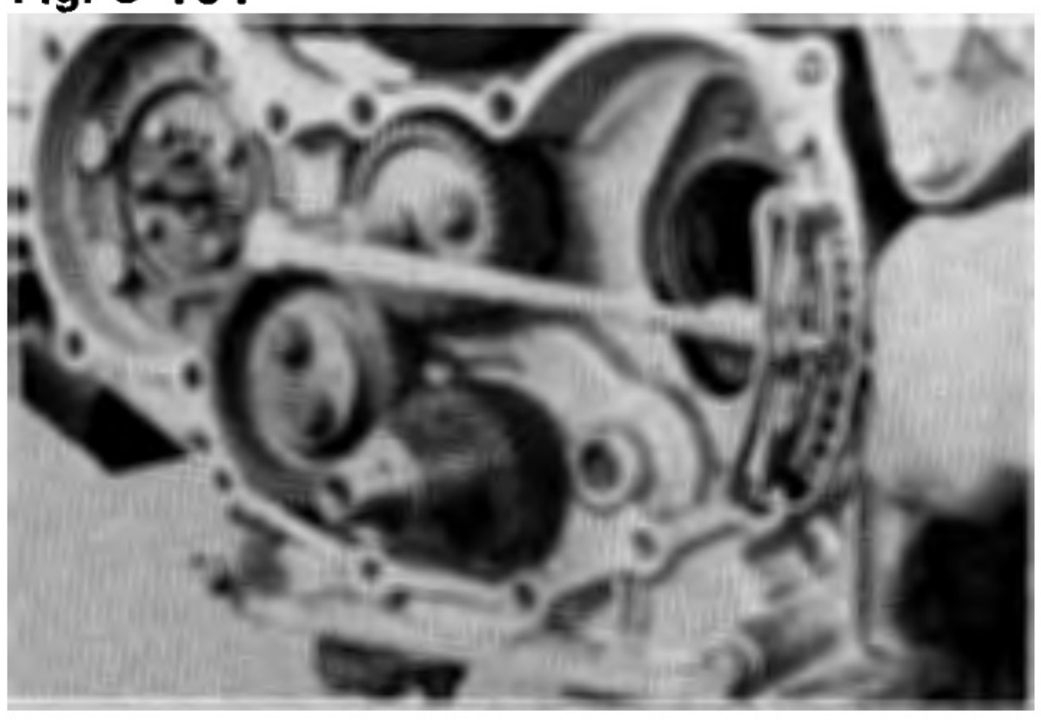
Align the matchmark of idle gear No.1 with that of the crankshaft timing gear.

Fig. 3-100



Align the matchmark of idle gear No.2 with that of idle gear No.1.

Fig. 3-101

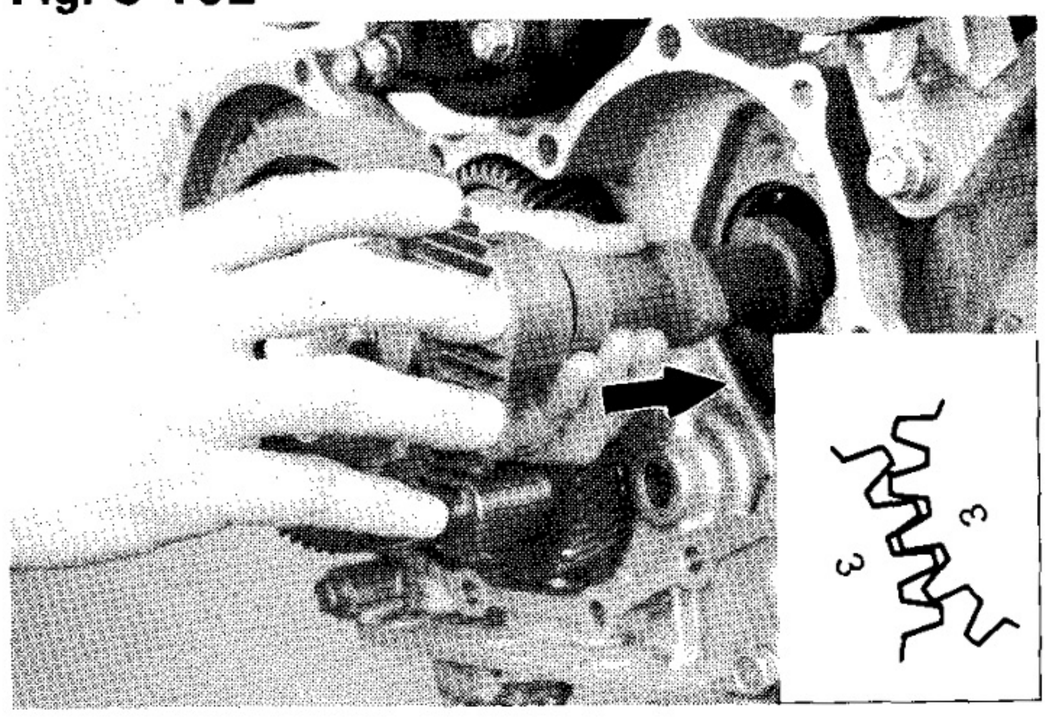


Tighten the idle gear and shaft.

Tightening torque:

No.1 & No.2 4.0 – 5.5 kg-m (29 – 39 ft-lb)

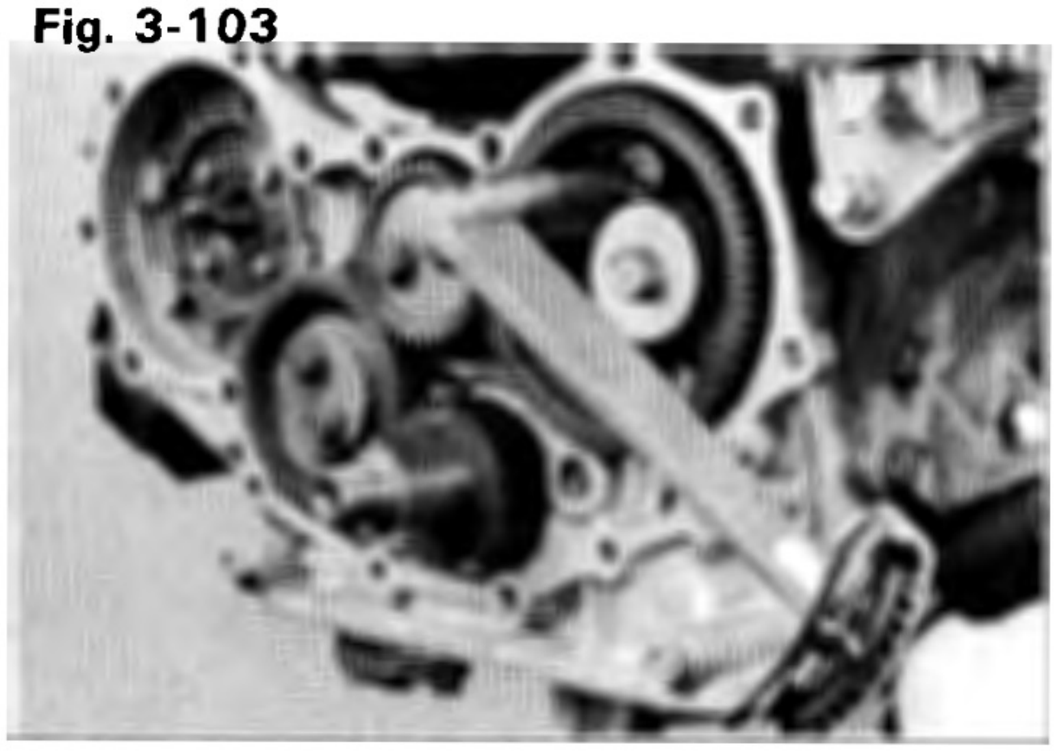
Fig. 3-102



Insert the camshaft, aligning the matchmark with that of idle gear No.2.

—Note—
Be careful not to damage the camshaft bearings.

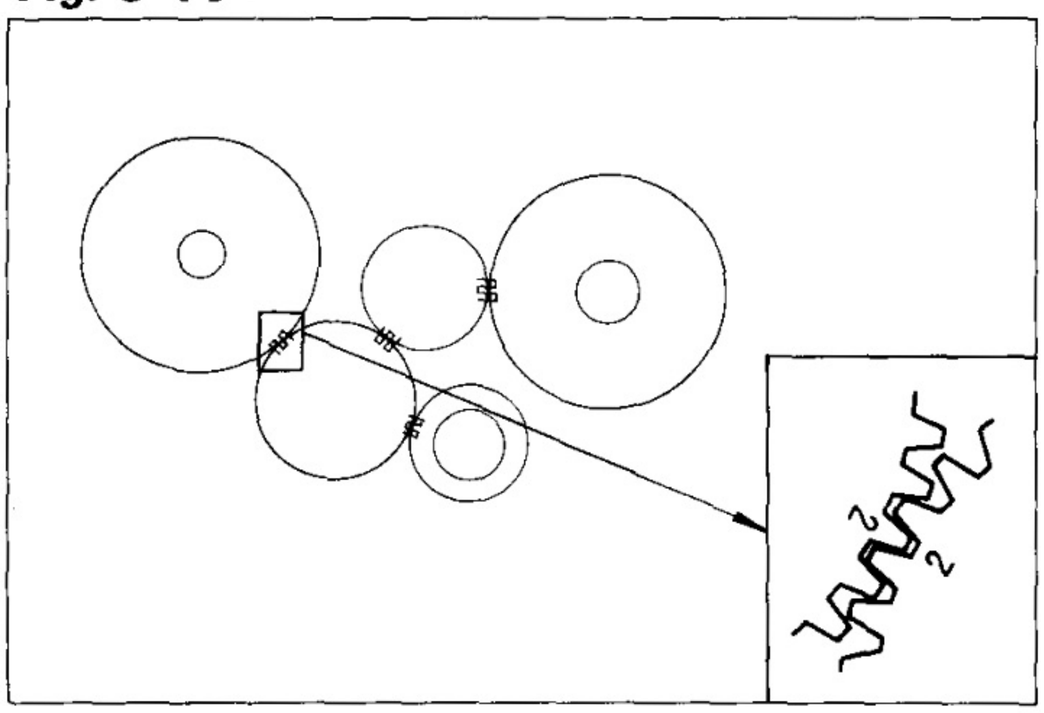
Fig. 3-103



Tighten the camshaft thrust plate.
Tightening torque: 3.0 – 4.5 kg-m (22 – 33 ft-lb)

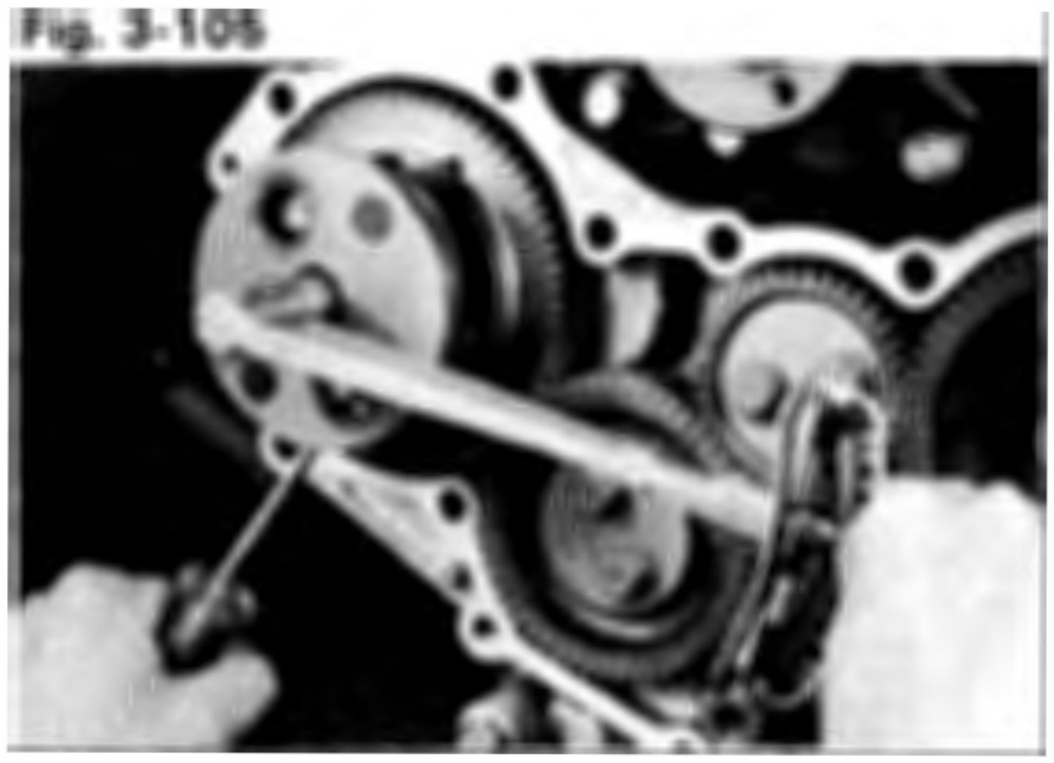
—Note—
Apply a light coat of engine oil on the bolt threads and under the bolt head before installing.

Fig. 3-104



Align the matchmark of the automatic timer with that of idle gear No.1.

Fig. 3-105



Hold the automatic timer with a screwdriver and tighten the round nut.
Tightening torque: 7.0 – 8.0 kg-m (51 – 58 ft-lb)

—Note—
Be careful not to scratch the timer weight sliding surface.

Fig. 3-106



Tighten the timing gear cover.
Tightening torque: 2.0 – 3.0 kg-m (15 – 21 ft-lb)

Fig. 3-107



Drive in the crankshaft pulley with SST.
SST [09608-35013]

Fig. 3-108



Tighten the retaining bolt.
Tightening torque: 18.0 – 22.0 kg-m (130 – 159 ft-lb)

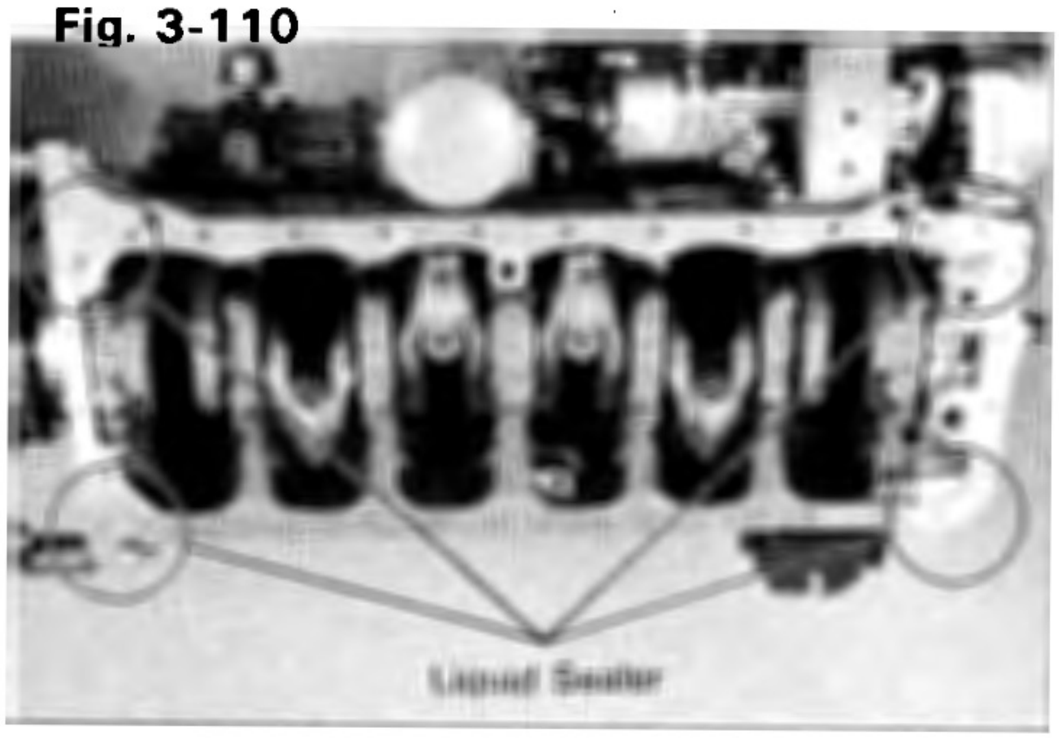
–Note–
Apply a light coat of engine oil on the bolt threads and under the bolt head before installing.

Fig. 3-109

SEE
ENGINE TUNE-UP
SECTION
Fig. 2-7

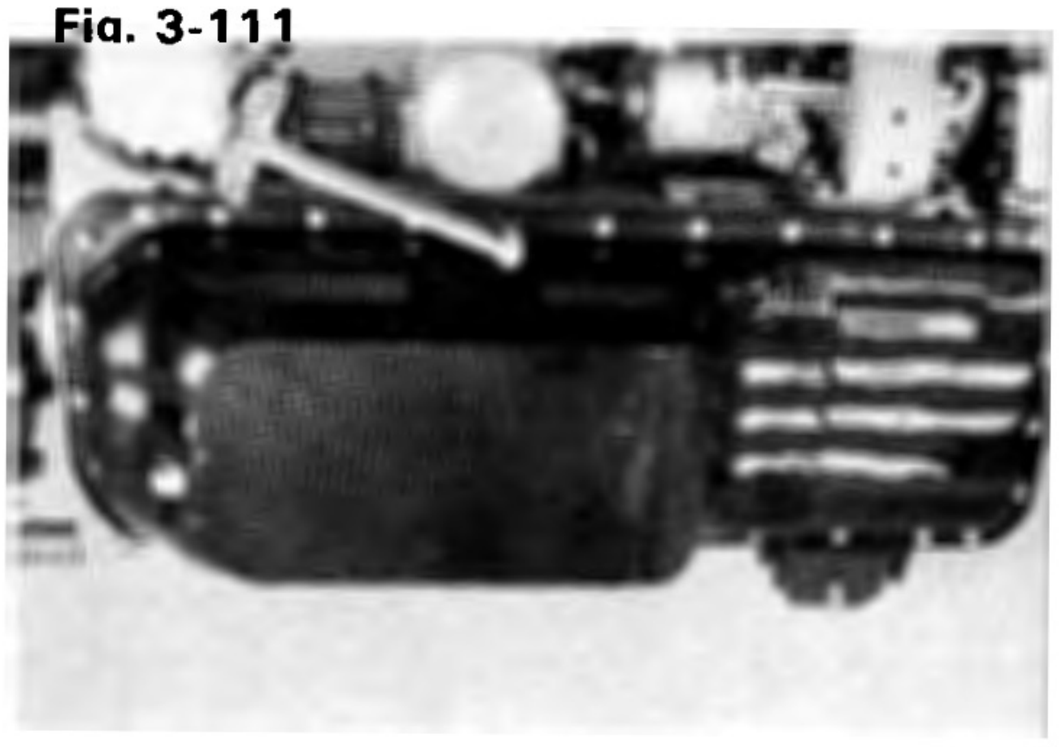
Adjust drive belt tension.

Fig. 3-110



⚠ Apply liquid sealer to the cylinder block and gear cover as shown in the figure.

Fig. 3-111



Install the oil pan.

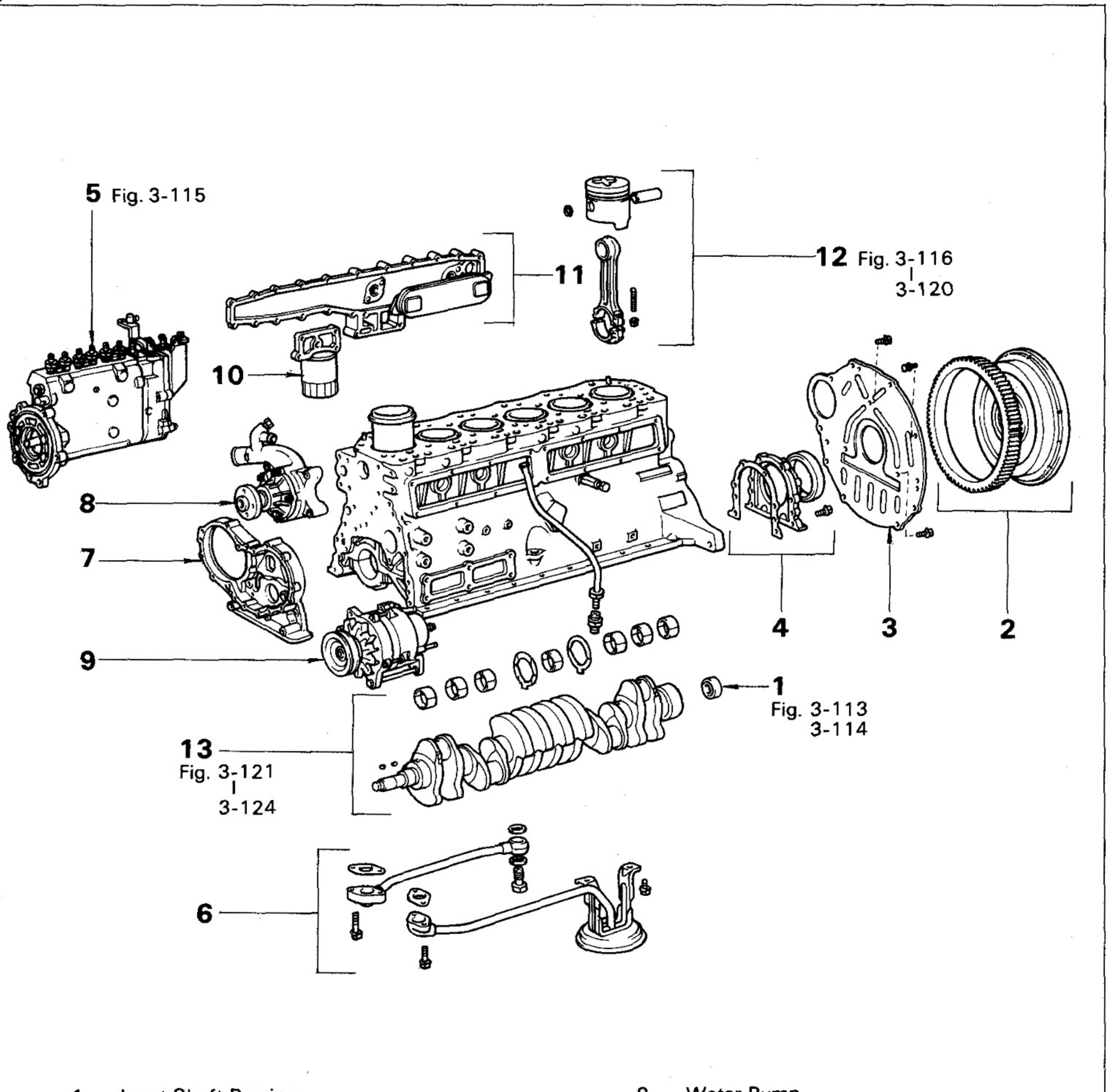
Tightening torque: 1.0 – 1.6 kg-m (7 – 12 ft-lb)

CYLINDER BLOCK

DISASSEMBLY

Disassemble the parts in the numerical order shown in the figure.

Fig. 3-112



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

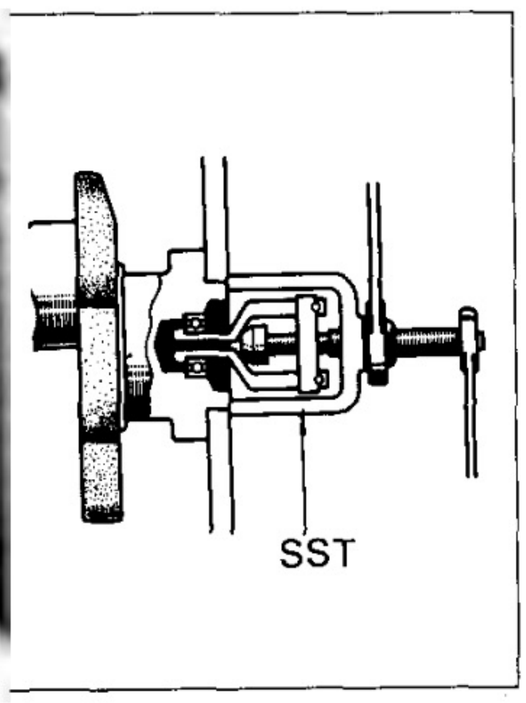
Fig. 3-113



Check the input shaft bearing for wear.
Check to see that there is no drag on the bearing when it is turned.

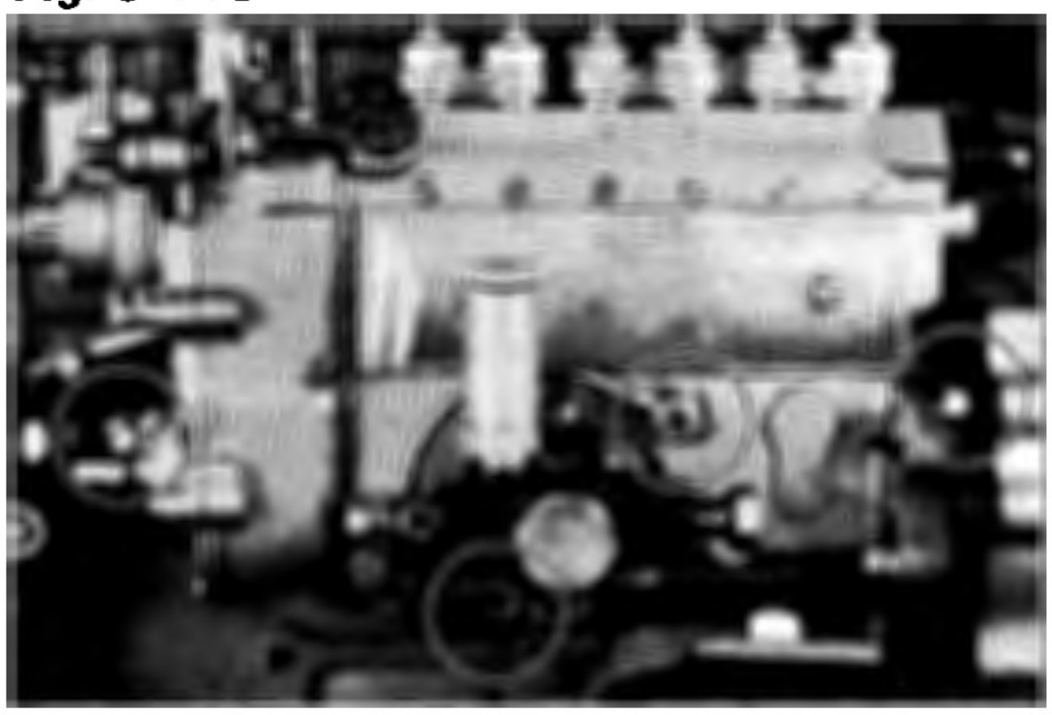
Fig. 3-114





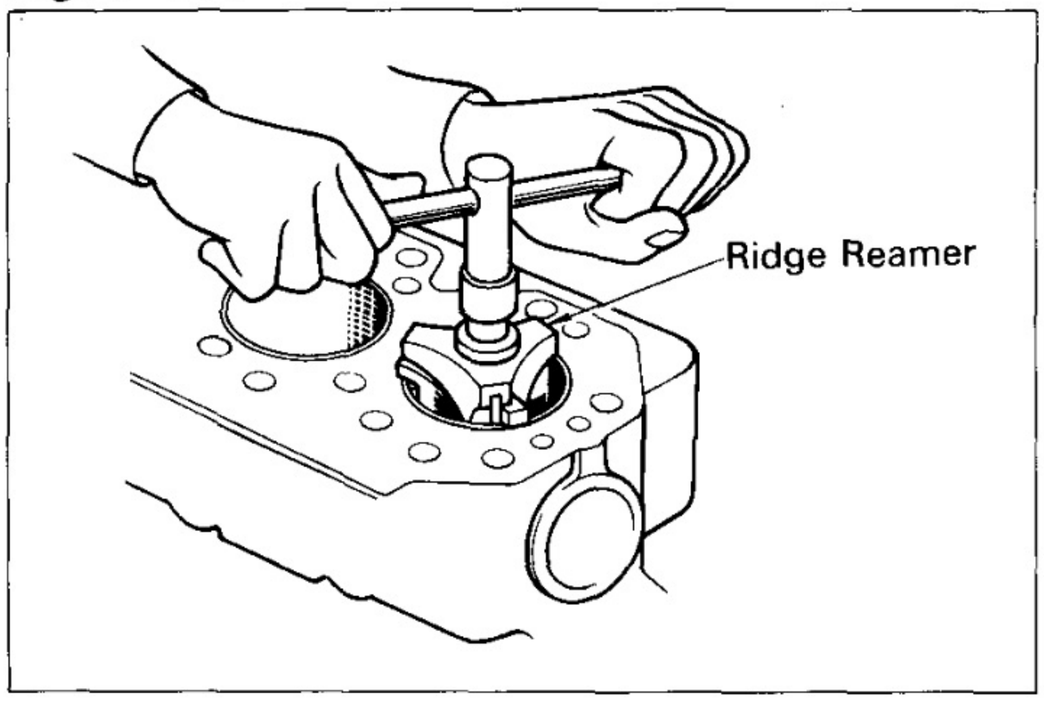
If necessary, remove the input shaft bearing with SST.
SST [09303-55010]

Fig. 3-115



Remove the injection pump together with the pump retainer by loosening the pump mounting bolt and oil pipe union bolt.

Fig. 3-116



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

Fig. 3-117

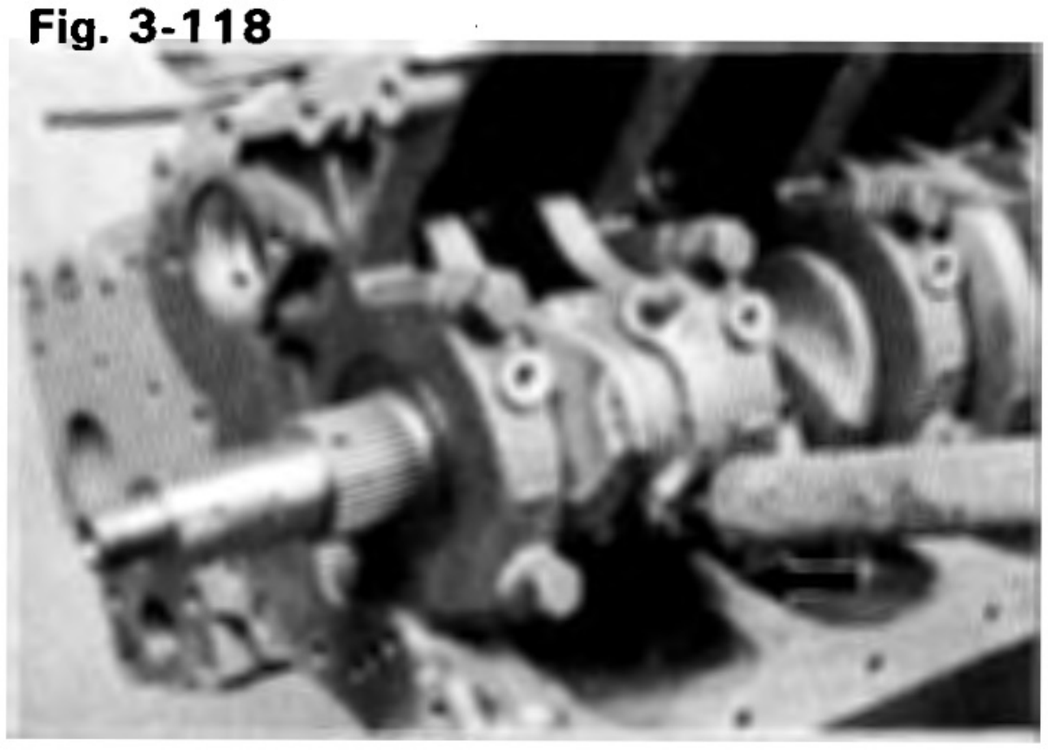


Measure the connecting rod thrust clearance. If it exceeds the limit, replace the connecting rod.

Thrust clearance:

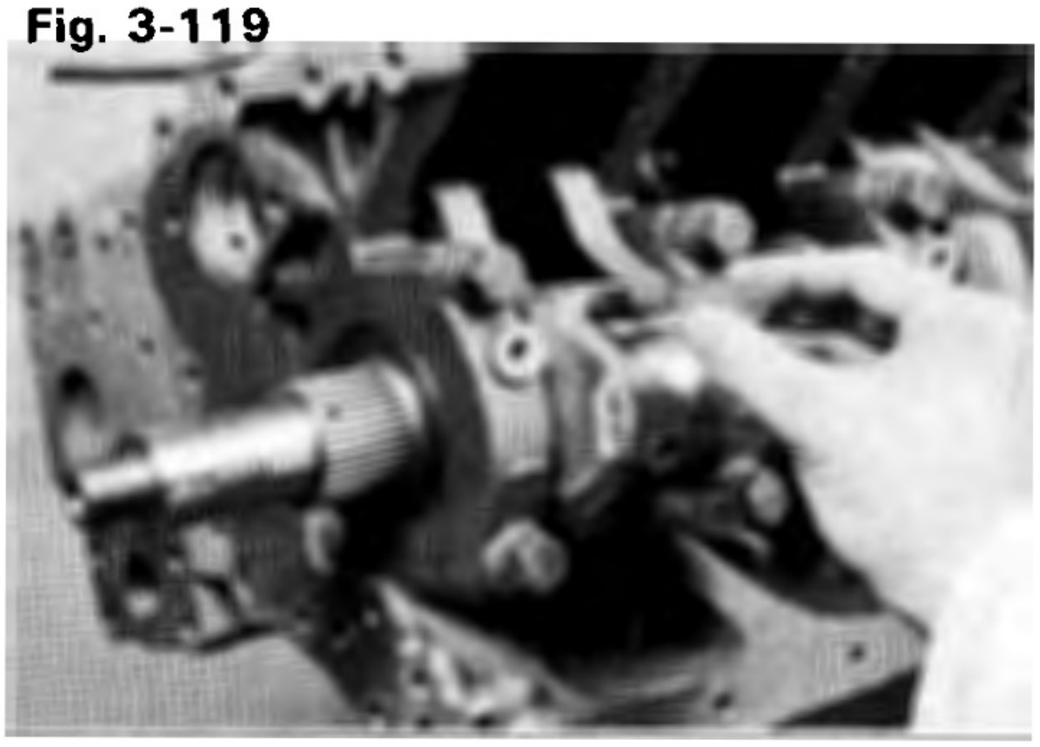
STD	**0.08 – 0.22 mm (0.003 – 0.009 in.)**
Limit	**0.3 mm (0.012 in.)**

Fig. 3-118



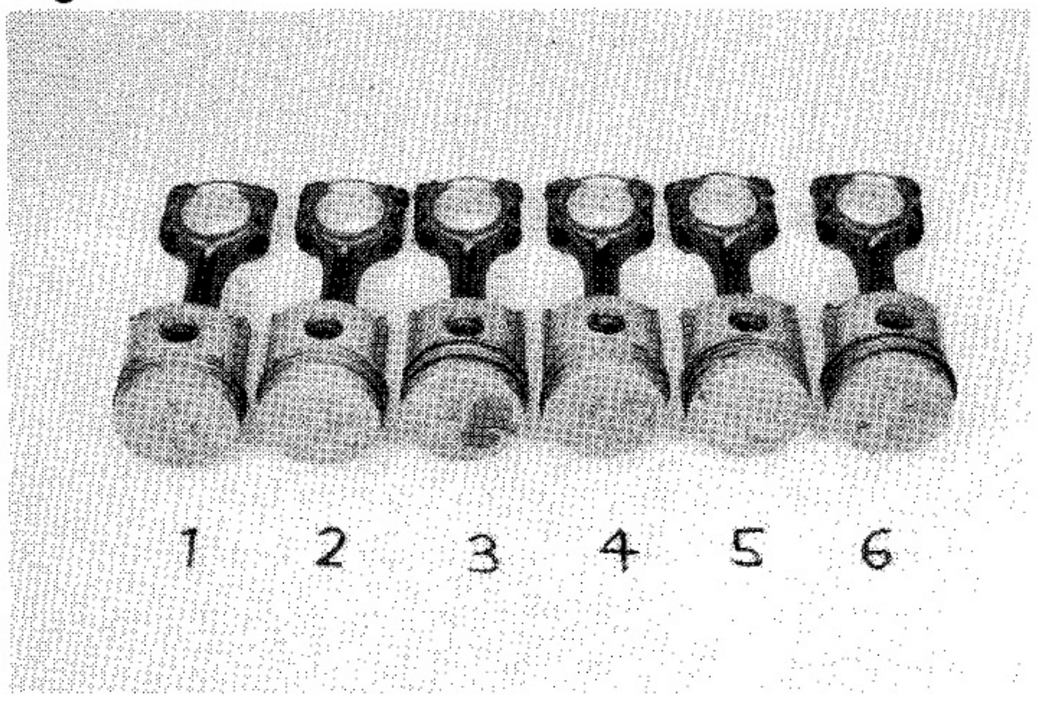
If the connecting rod cap is tight, lightly tap the stud bolt.

Fig. 3-119



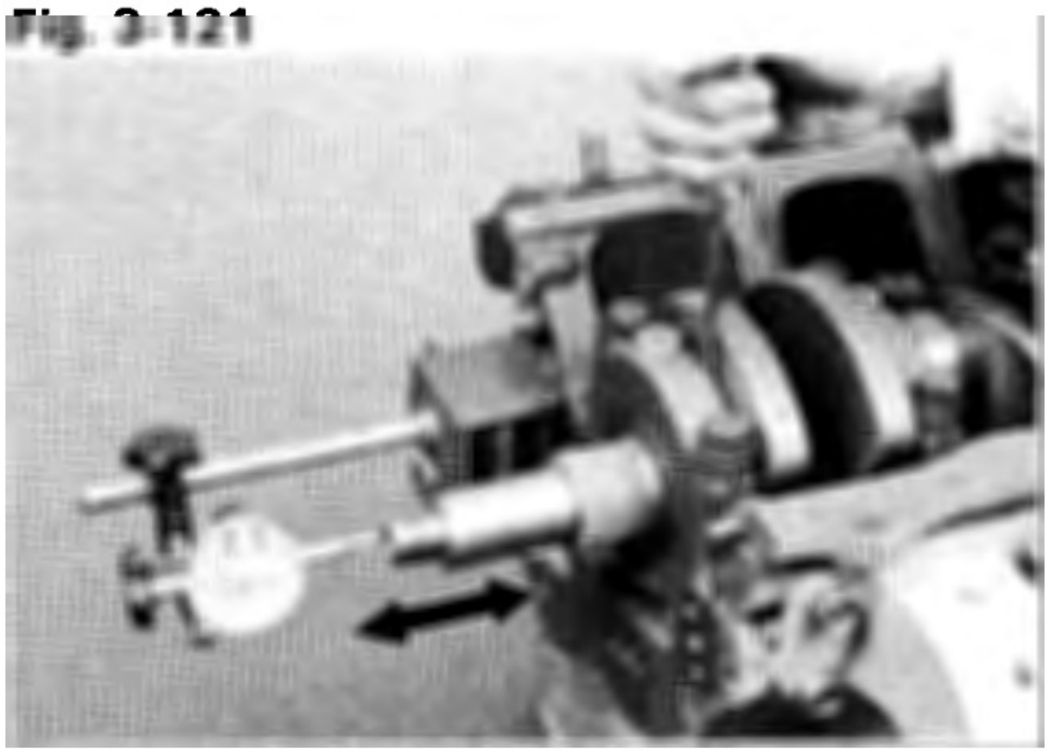
Cover the rod bolts with short pieces of hose to protect the crankshaft from damage.

Fig. 3-120



Keep the pistons and connecting rod caps in correct order.

Fig. 3-121



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

Thrust clearance:
STD 0.04 – 0.24 mm (0.0016 – 0.0094 in.)
Limit 0.3 mm (0.012 in.)
O/S bearing sizes:
O/S 0.125, 0.250

Fig. 3-122



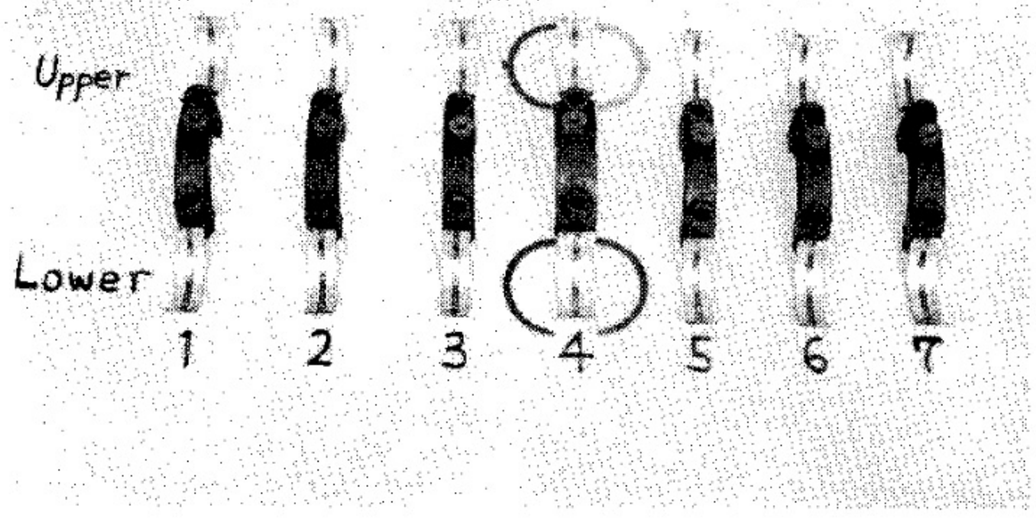
Loosen each crankshaft bearing bolts a little at a time in the sequence shown in the figure.

Fig. 3-123



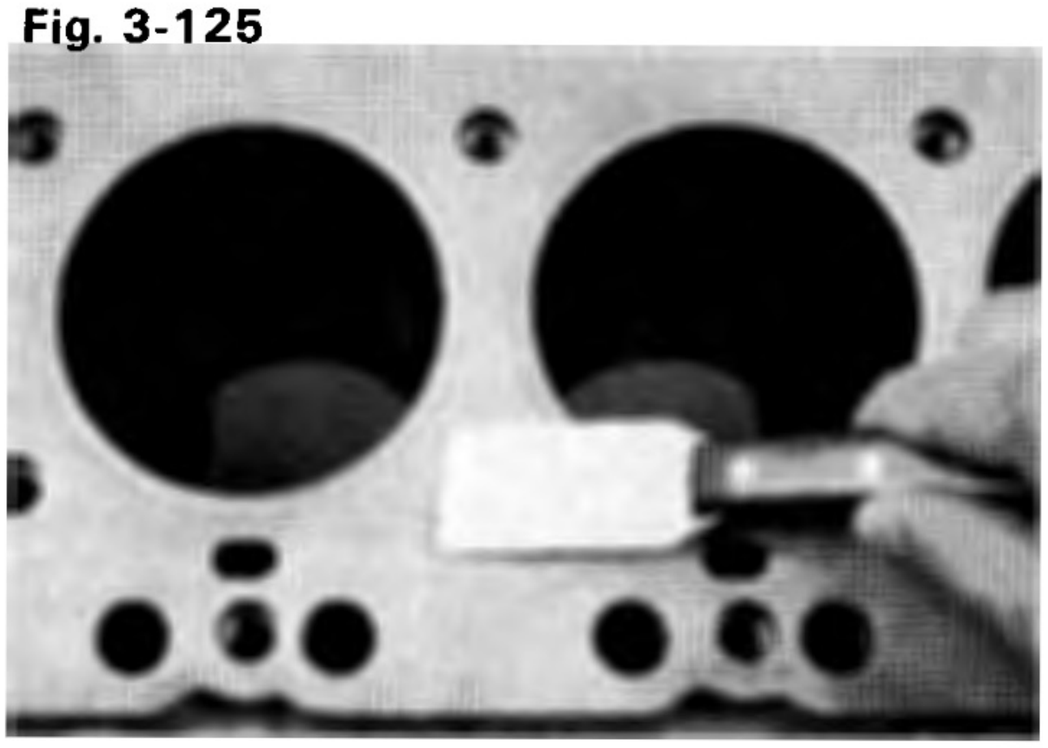
If the crankshaft bearing cap will not come off, remove by raising the bolts and prying fore and aft.

Fig. 3-124



Keep the crankshaft bearings and caps in correct order.

Fig. 3-125

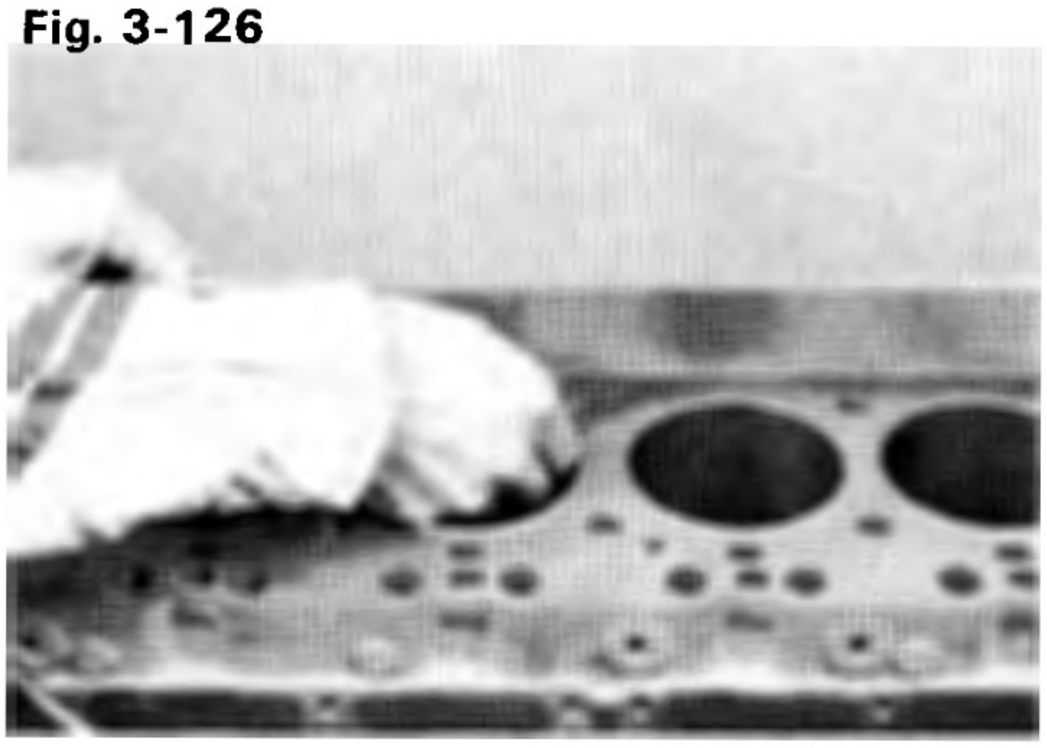


INSPECTION & REPAIR

Cylinder Block & Liner

1. Clean the cylinder block and check for cracks or scores.

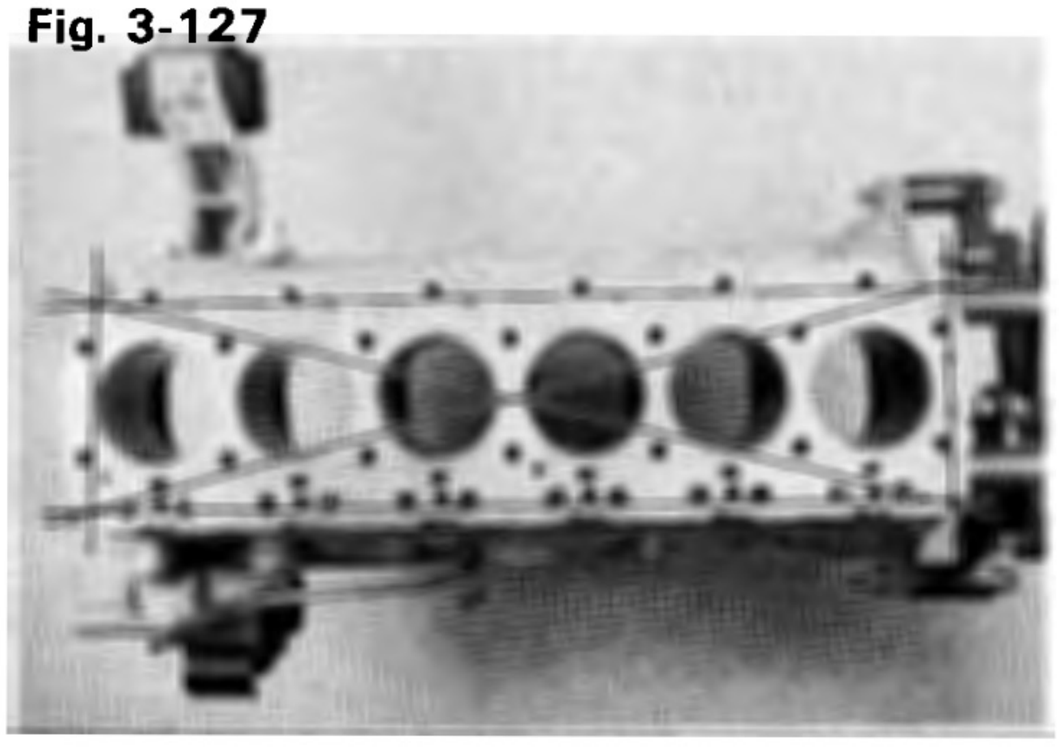
Fig. 3-126



2. Check the cylinder block topside surface for warpage with a precision straight edge and thickness gauge.

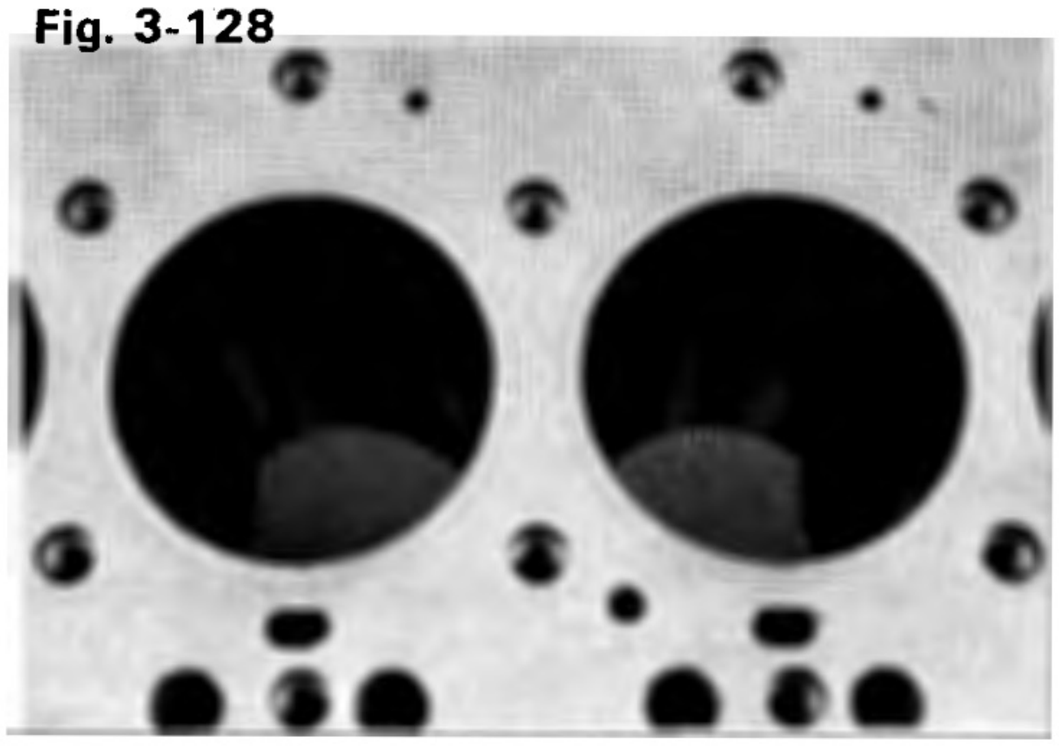
Topside surface warpage:
Limit 0.2 mm (0.008 in.)

Fig. 3-127



3. Check for warpage along the indicated lines.

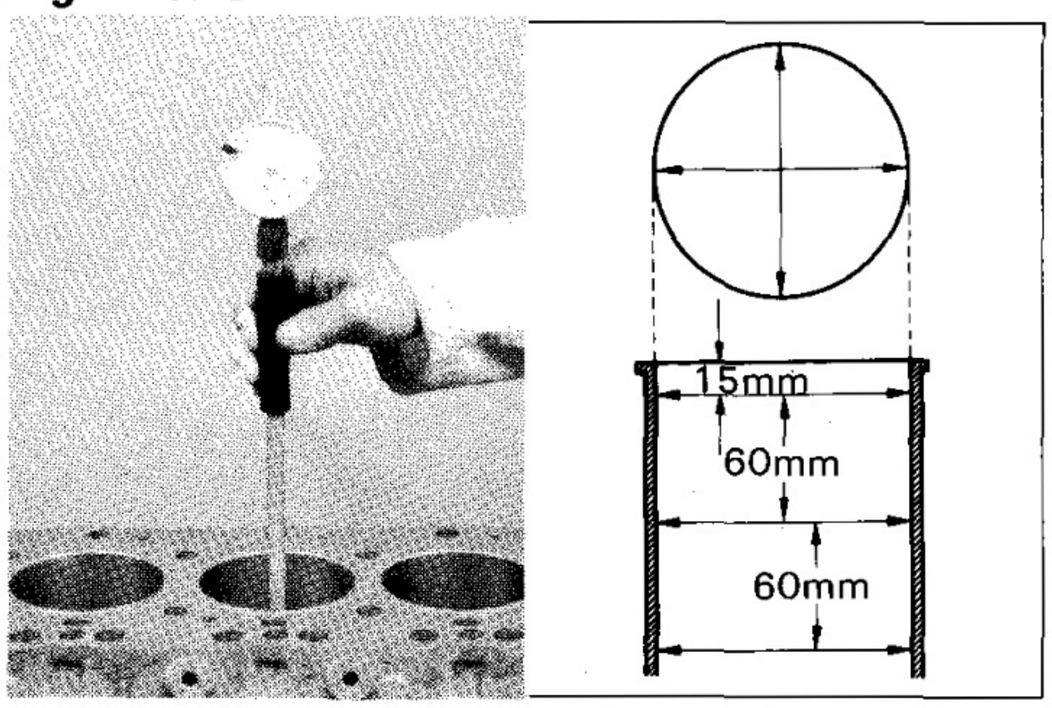
Fig. 3-128



4. Visually check the cylinder for vertical scratches. If there are deep scratches, the cylinder liner must be rebored or replaced referring to Fig. 3-131 to 3-137.

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

Fig. 3-129



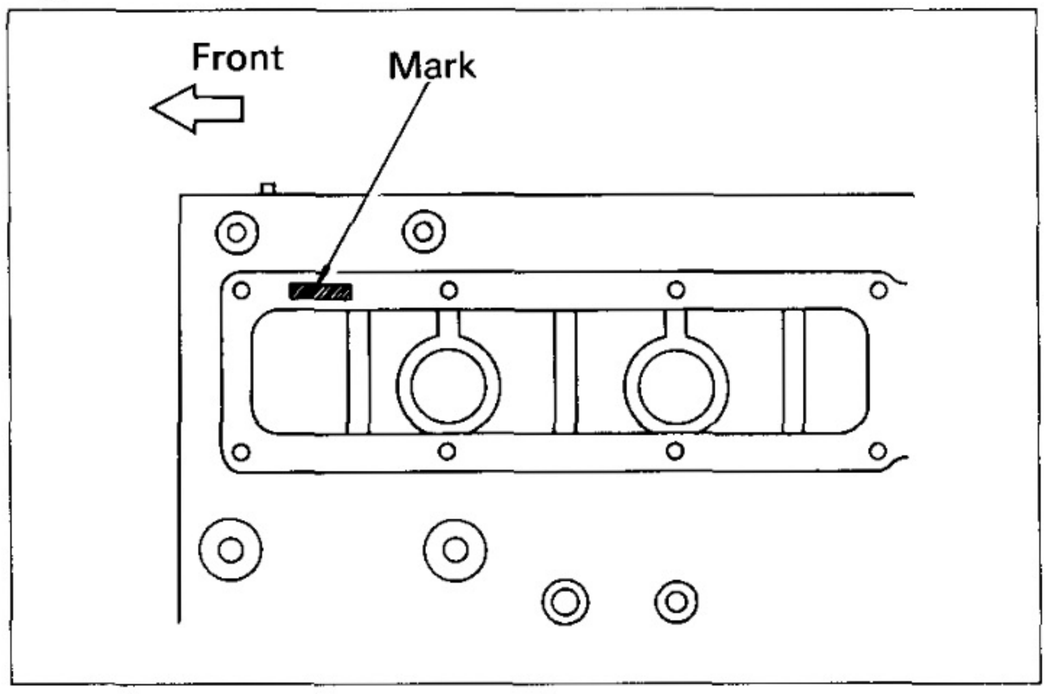
5. Measure the cylinder bore at top, middle and bottom as shown in the figure. If wear exceeds the limit, the liner must be rebored or replaced referring to Fig. 3-131 to 3-137.

Wear limit: 0.2 mm (0.008 in.)

Cylinder bore size

Mark	1	2	3
Size mm (in.)	91.000—91.010 (3.5827—3.5831)	91.010—91.020 (3.5831—3.5835)	91.020—91.030 (3.5835—3.5839)

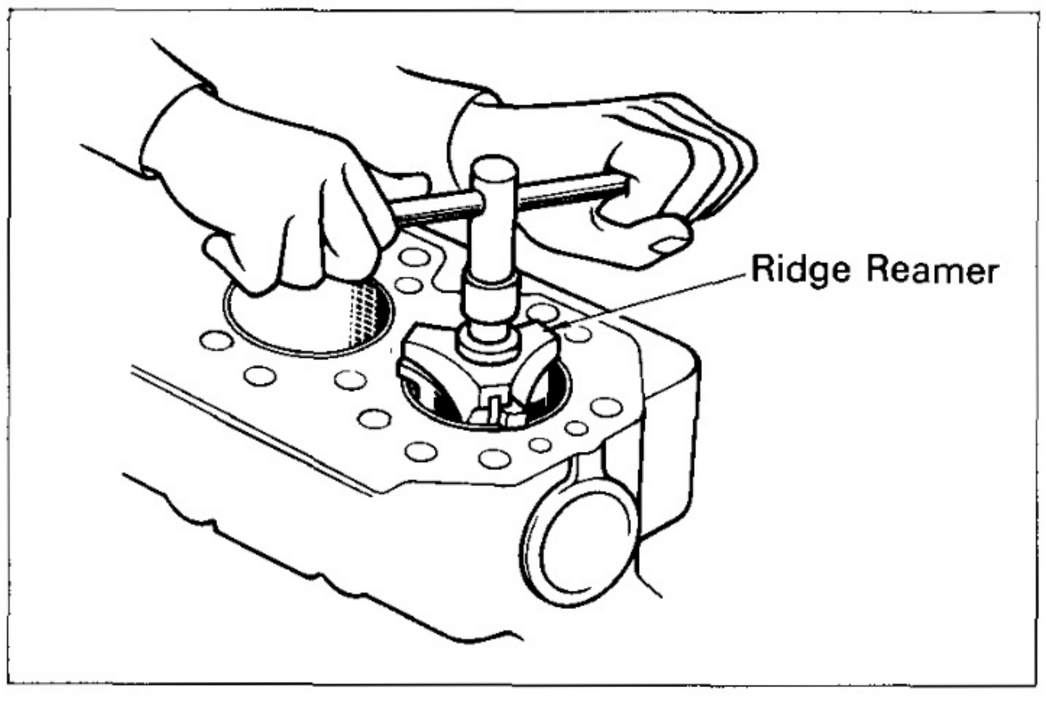
Fig. 3-130



— Note —

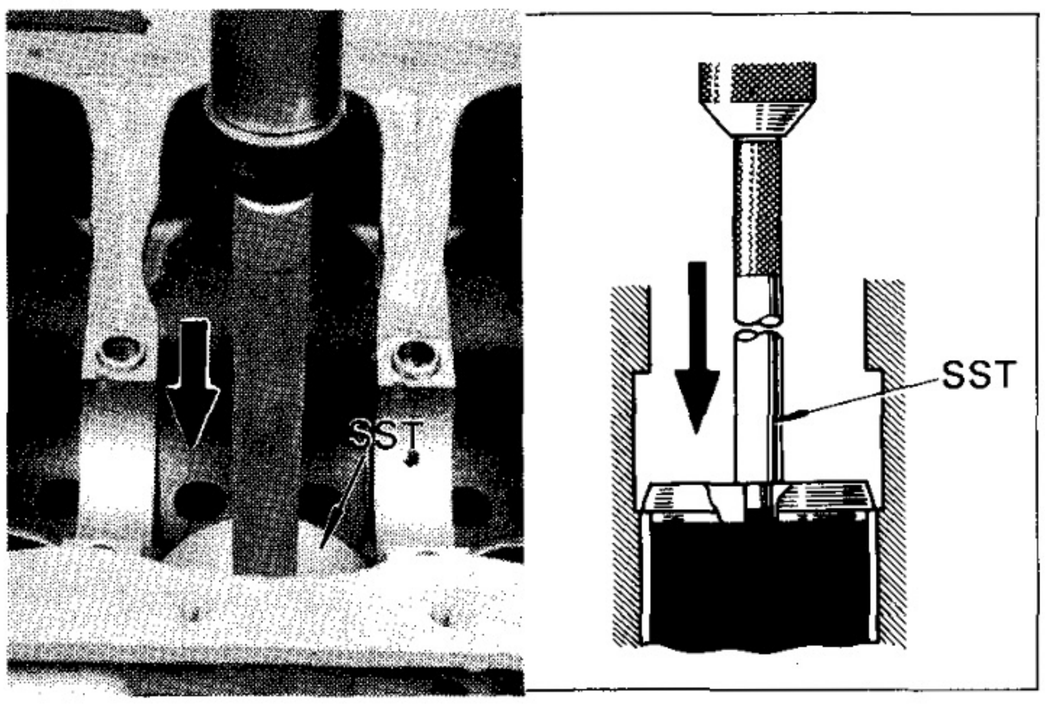
The bore marks are stamped on the cylinder block valve lifter side as shown in the figure.

Fig. 3-131



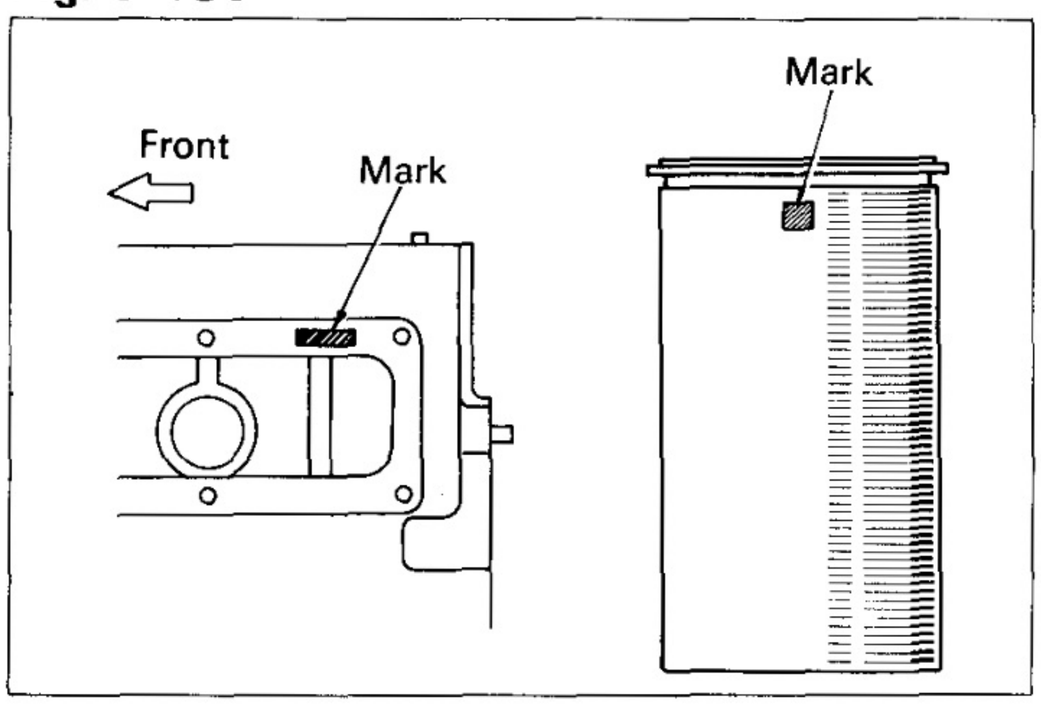
6. If wear is less than 0.2 mm (0.008 in.), machine the piston ring ridge at the top of the bore with a ridge reamer.

Fig. 3-132



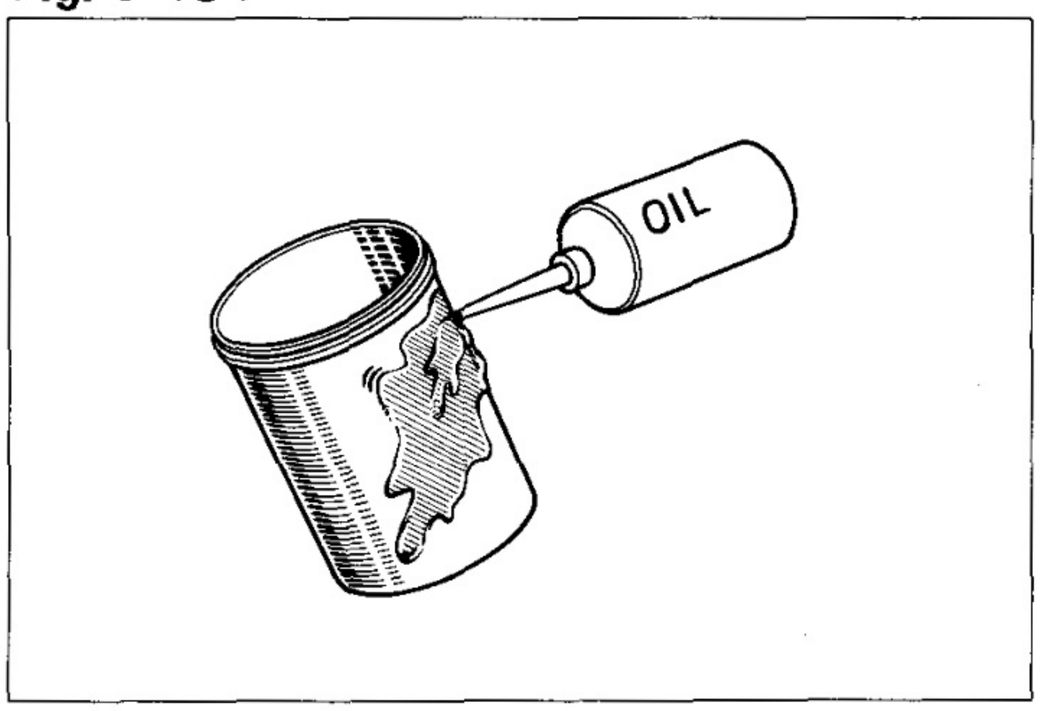
7. If wear exceeds the limit, replace the cylinder liner with SST.
   (1) Press out the cylinder liner with SST. SST [09218-54011]

Fig. 3-133



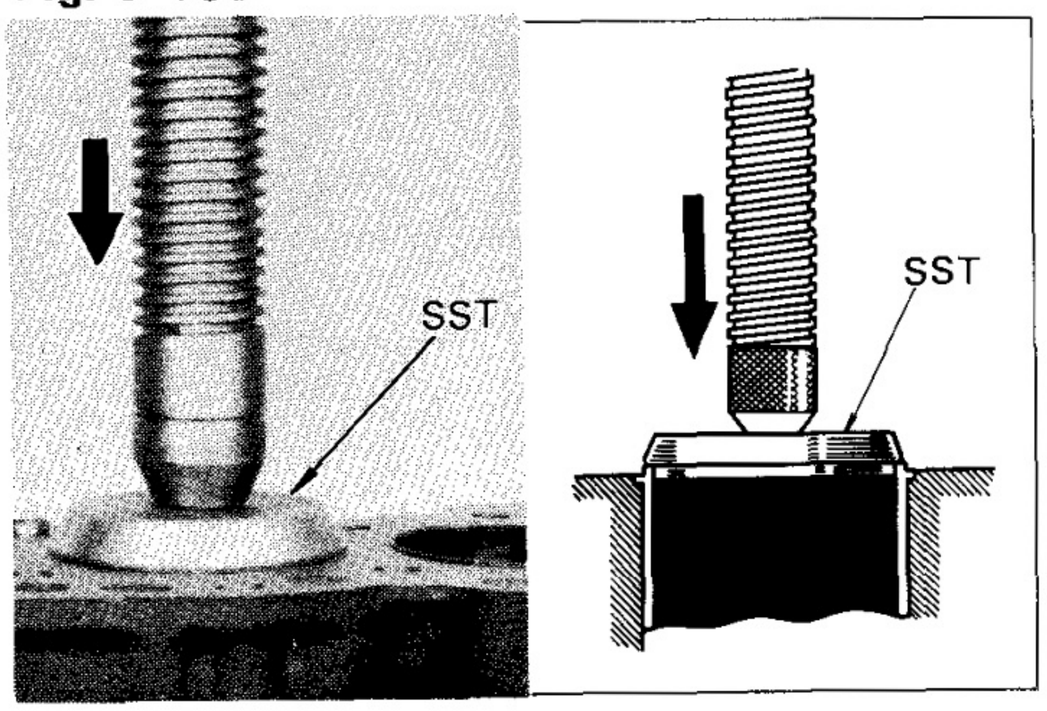
(2) Select a liner having the same mark as the cylinder block, A or B.

Fig. 3-134



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

Fig. 3-135

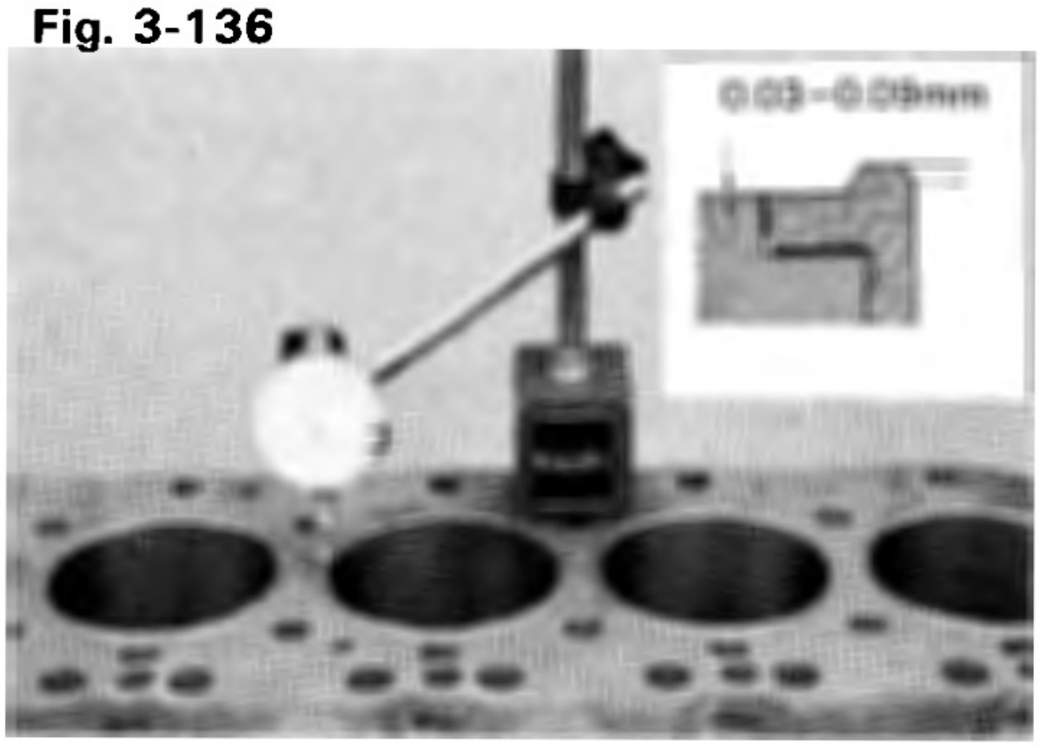


(4) Press in the cylinder liner with SST.
SST [09218-54011]

Pressing force:
3,000 – 5,000 kg
(6,613.8 – 11,023.0 lb)

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

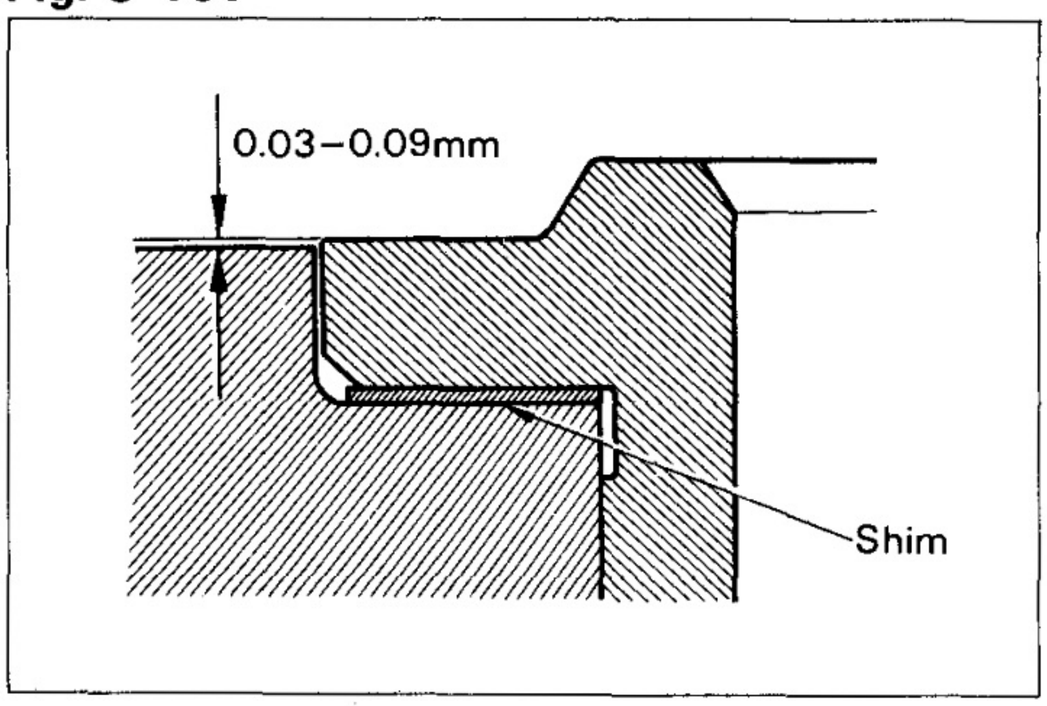
Fig. 3-136



8. After replacing the cylinder liner, measure the protrusion of liner above the cylinder block topside surface at four positions.

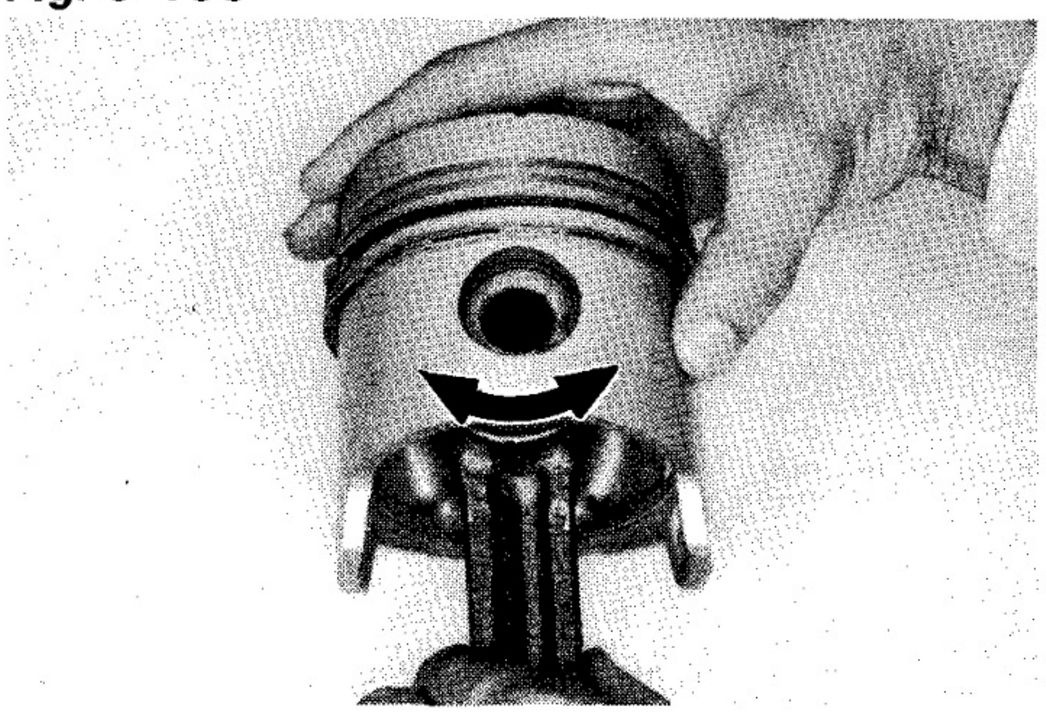
Protrusion: 0.03 – 0.09 mm
(0.0012 – 0.0035 in.)

Fig. 3-137



9. Adjust protrusion of the cylinder liner with cylinder liner shims.
   Cylinder liner shim thickness:
   0.05 mm, 0.10 mm
   (0.0020 in., 0.0039 in.)

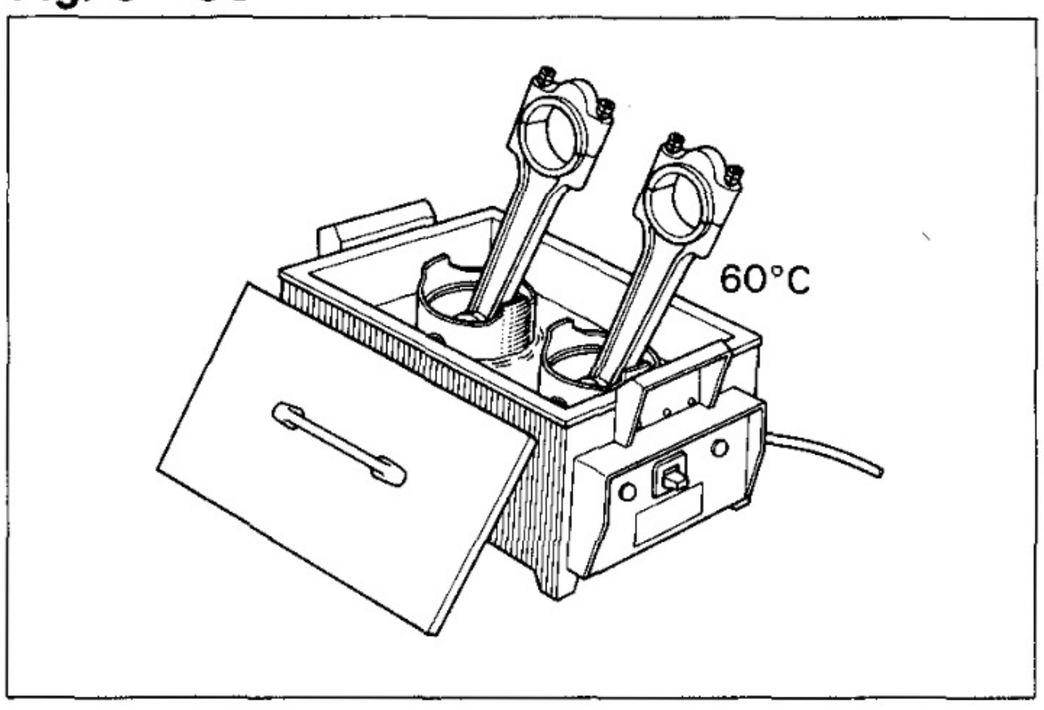
Fig. 3-138



Piston Pin & Connecting Rod

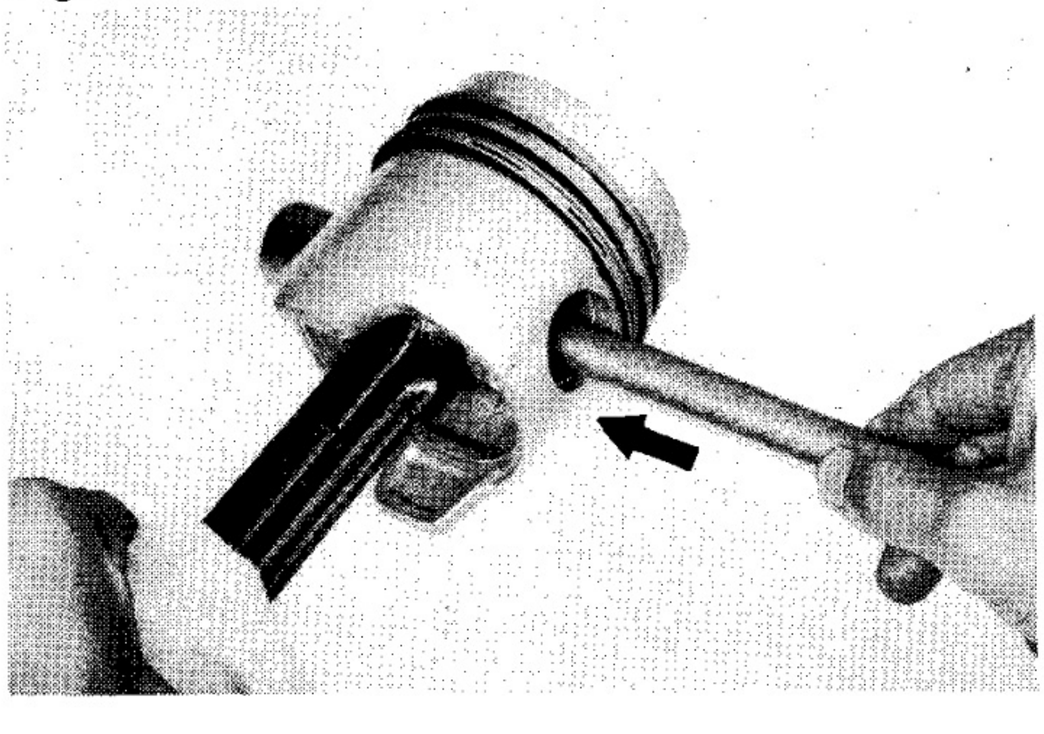
1. Check pin fit by rocking the piston at right angle to the pin.
   If any movement is felt, replace the piston and pin.

Fig. 3-139



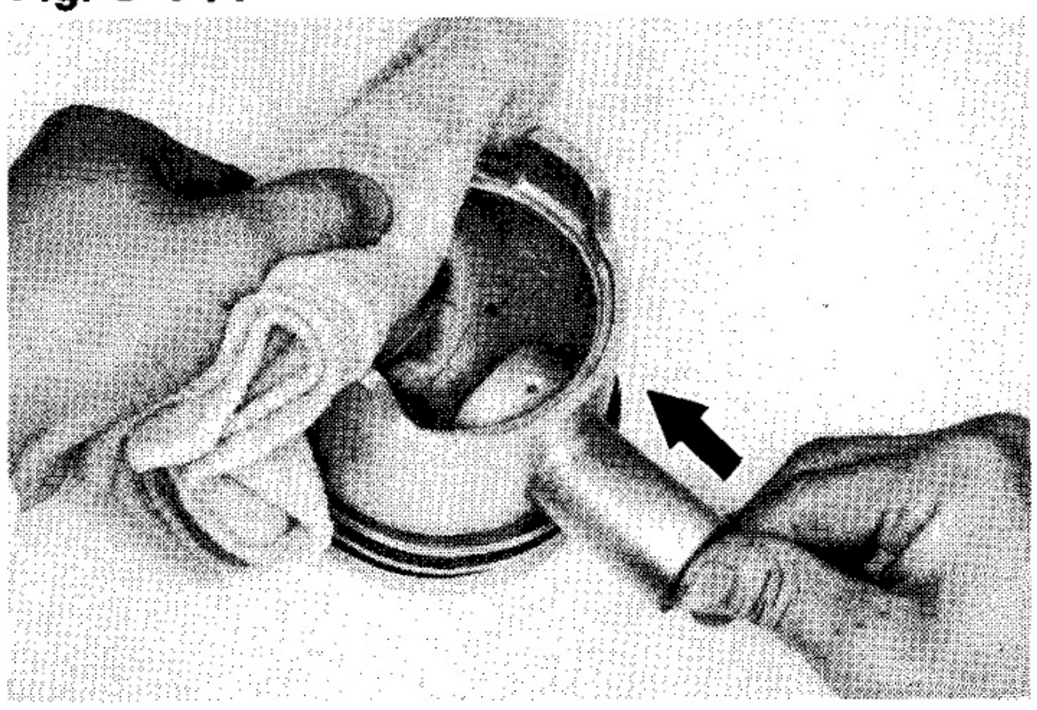
2. Heat the piston in a piston heater to about 60°C (140°F) before removing the piston pin.

Fig. 3-140



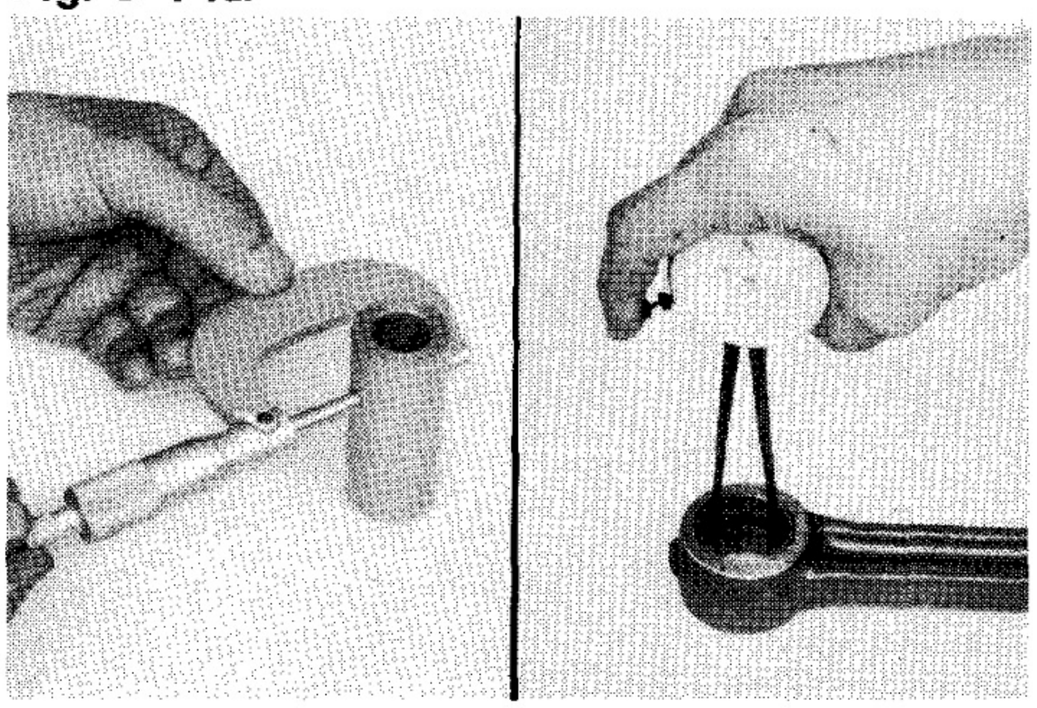
3. Push out the piston pin by hand.
   If it does not come out easily, drive it out with a brass bar or such.

Fig. 3-141



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

Fig. 3-142



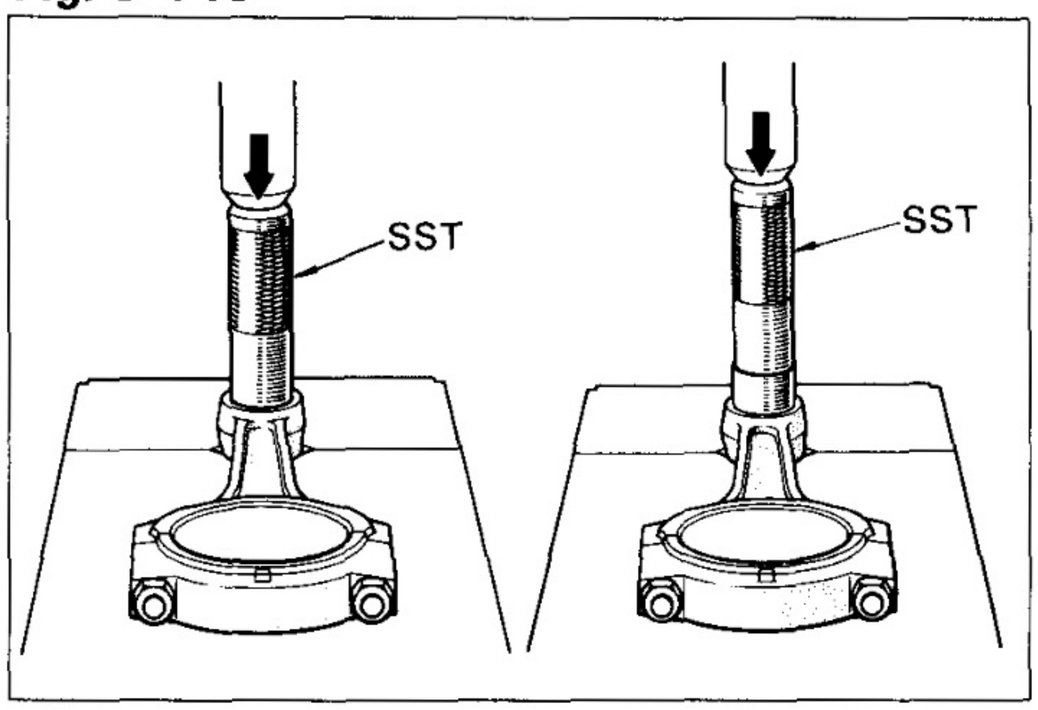
5. Measure the oil clearance between the bushing and piston pin.

Oil clearance:

STD 0.004 – 0.012 mm (0.0002 – 0.0005 in.)

Limit 0.05 mm (0.0020 in.)

Fig. 3-143

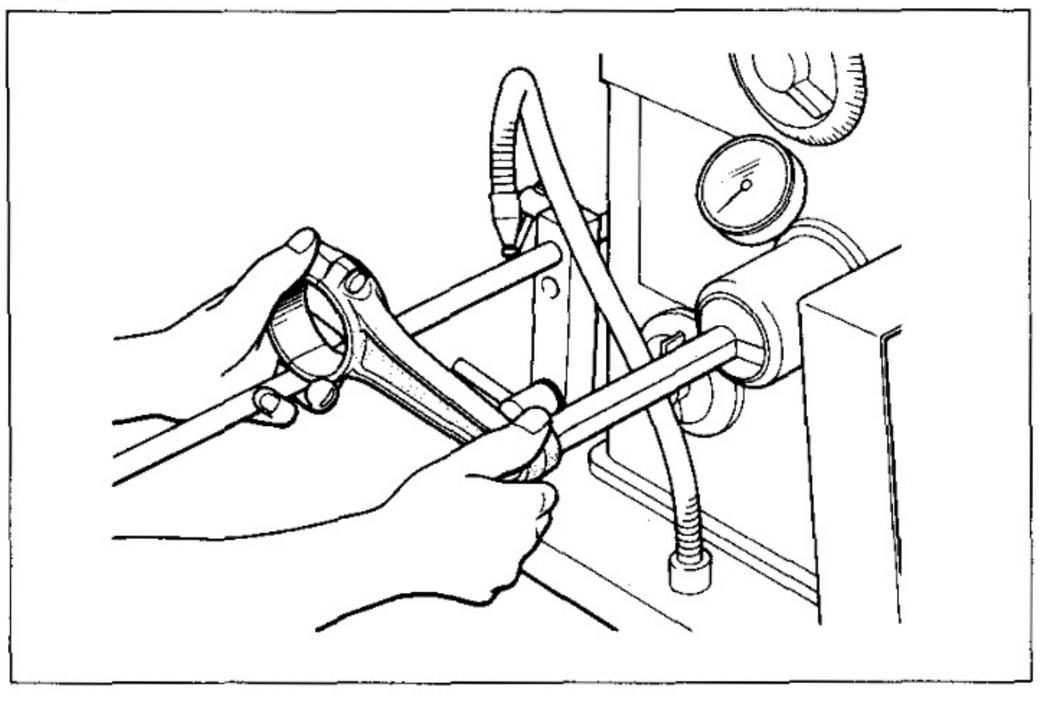


6. Replace the bushing with SST.
SST [09222-66010]

– Note –

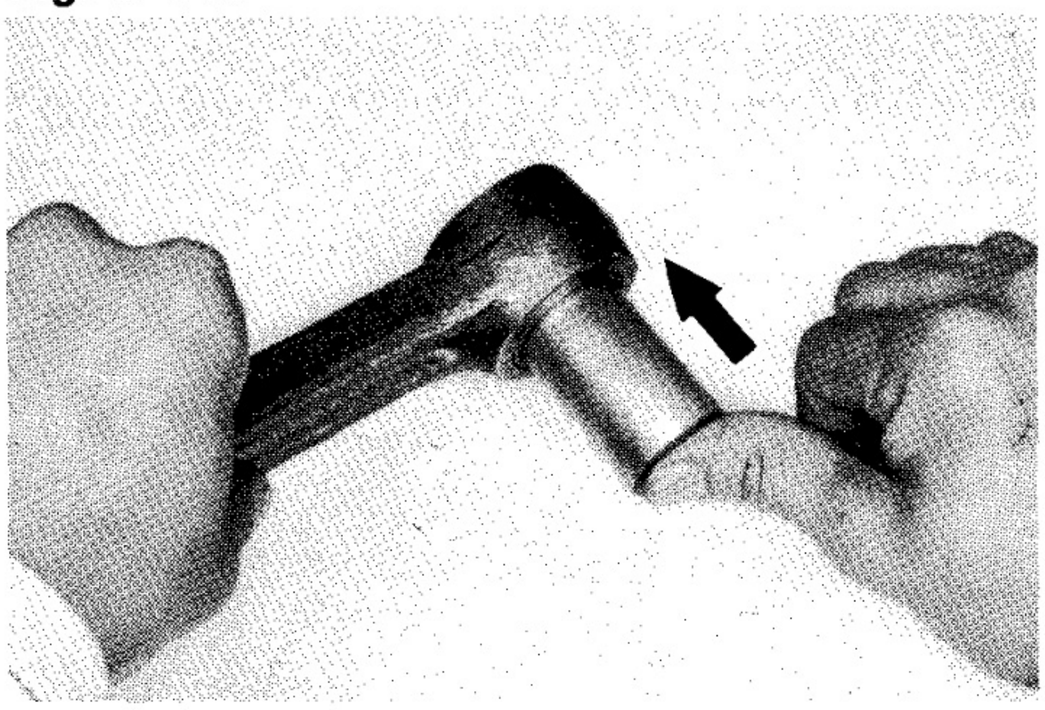
Align the bushing oil hole with the connecting rod oil hole.

Fig. 3-144



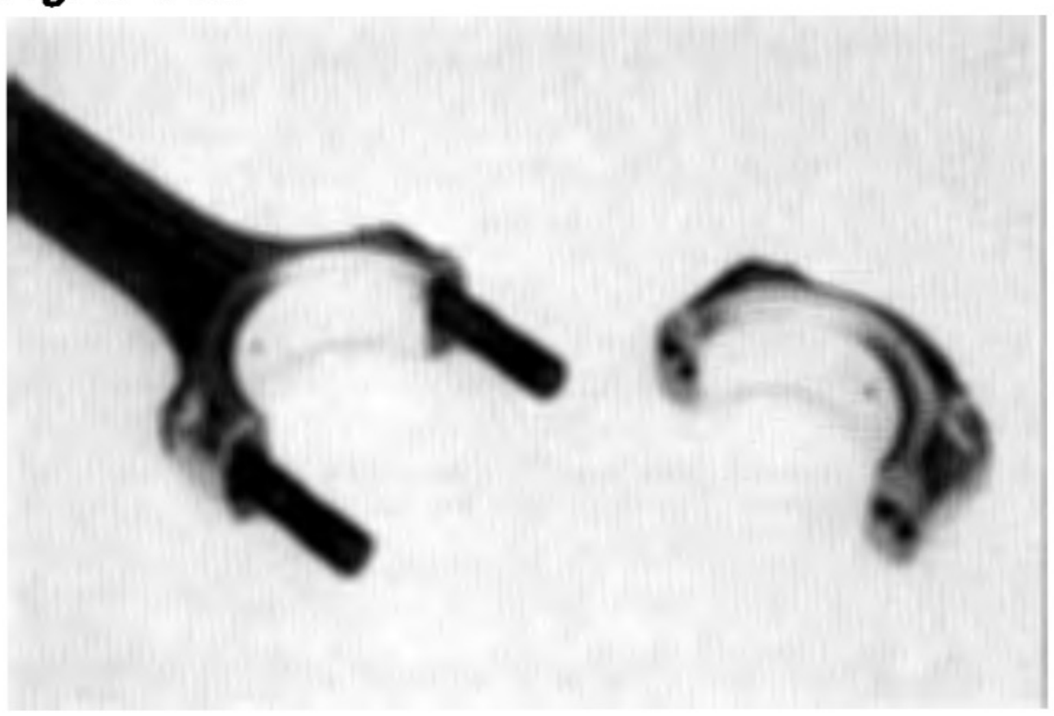
7. After installing the bushing, grind the bushing bore with a pin hole grinder.

Fig. 3-145



8. Check the fitting of the bushing and pin.
   Coat the piston pin with engine oil.
   At normal temperature, the pin can be pushed in with thumb pressure.

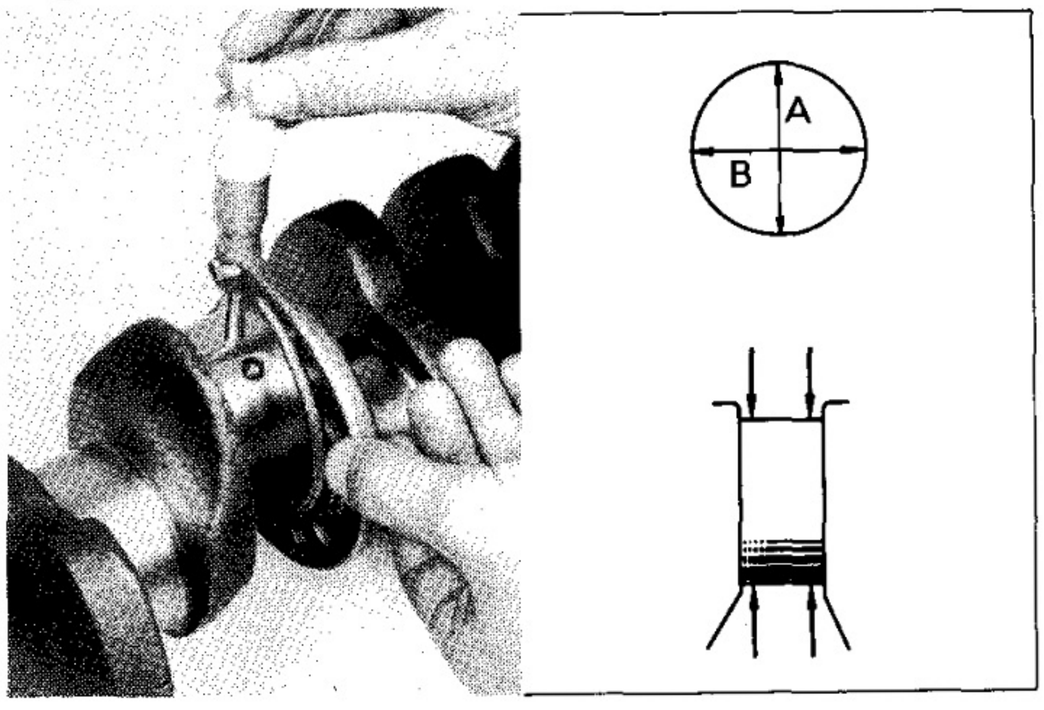
Fig. 3-146



Crank Pin Bearing

1. Check for flaking or scoring.
   If damaged, replace.

Fig. 3-147

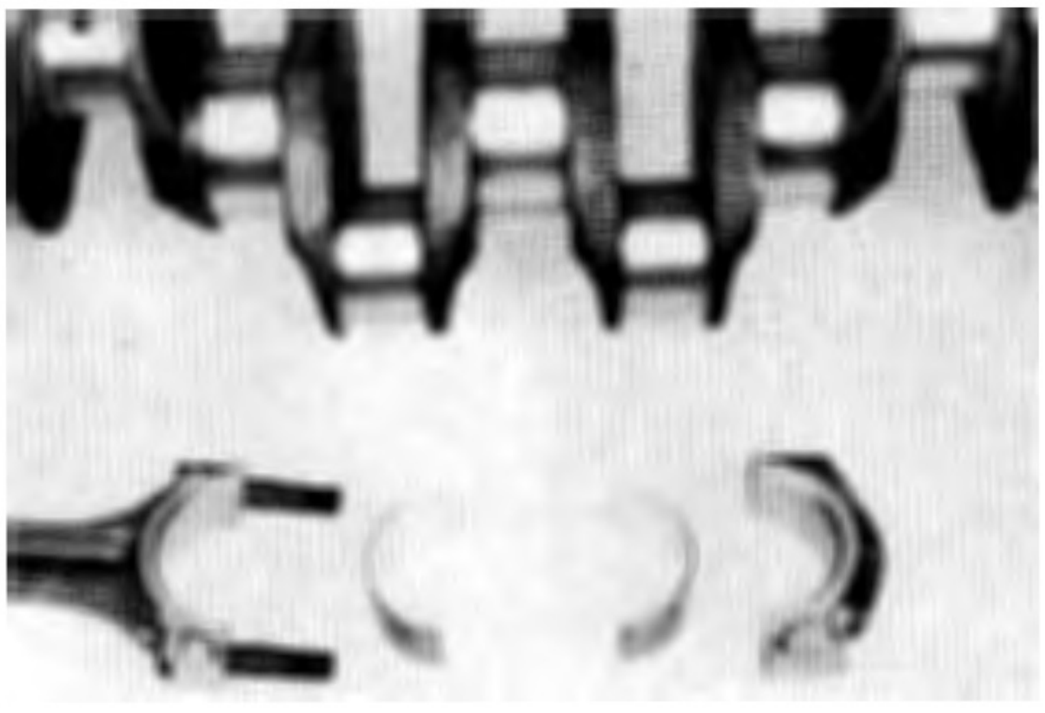


2. Measure the crank pin diameter.
   If wear is excessive, the crankshaft must be reground or replaced.

   Crank pin diameter:
   STD 54.98 – 55.00 mm
   (2.1646 – 2.1654 in.)
   Taper and out-of-round:
   Limit 0.02 mm
   (0.0008 in.)

– Note –
Measure A and B diameters in two places.

Fig. 3-148



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

Fig. 3-149



(2) Lay a strip of plastigage across the pin.

Fig. 3-150

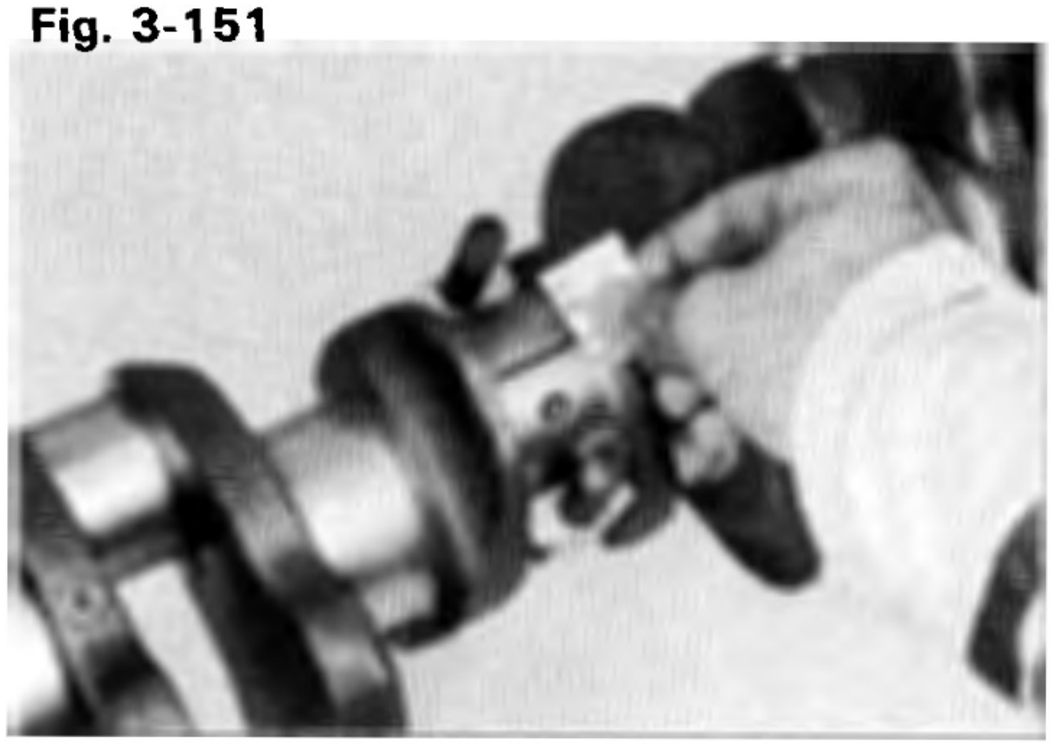


(3) Tighten the cap nuts to specified torque.

Tightening torque:
8.5 – 9.5 kg-m
(62 – 69 ft-lb)

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

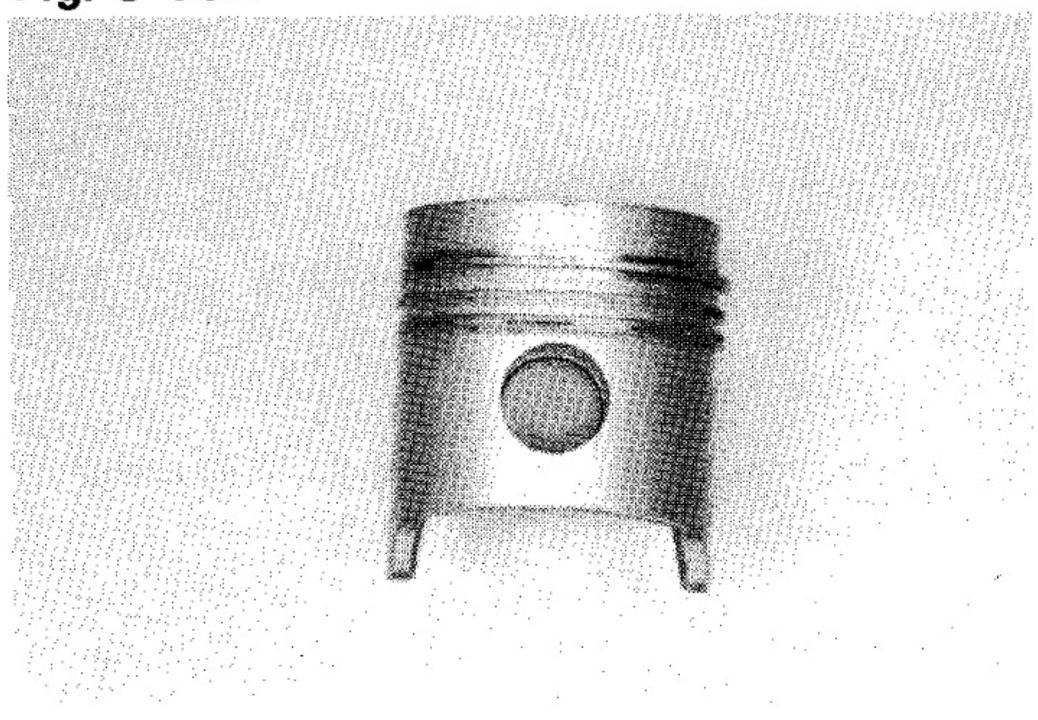
Fig. 3-151



(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:
0.05, 0.25, 0.50, 0.75, 1.00

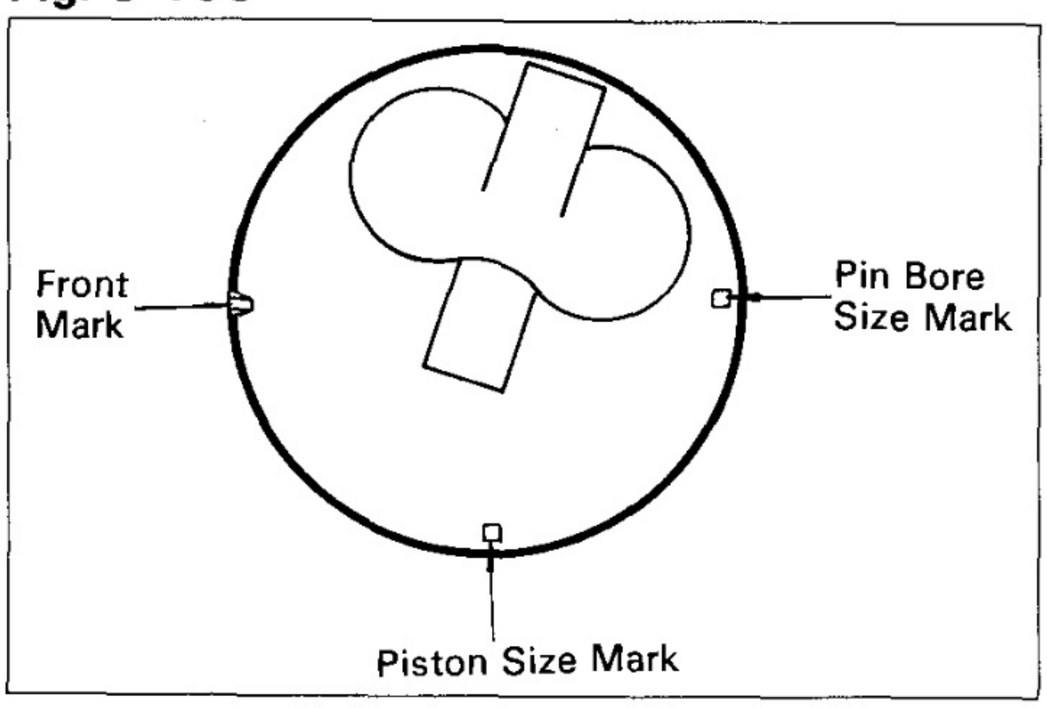
Fig. 3-152



Piston

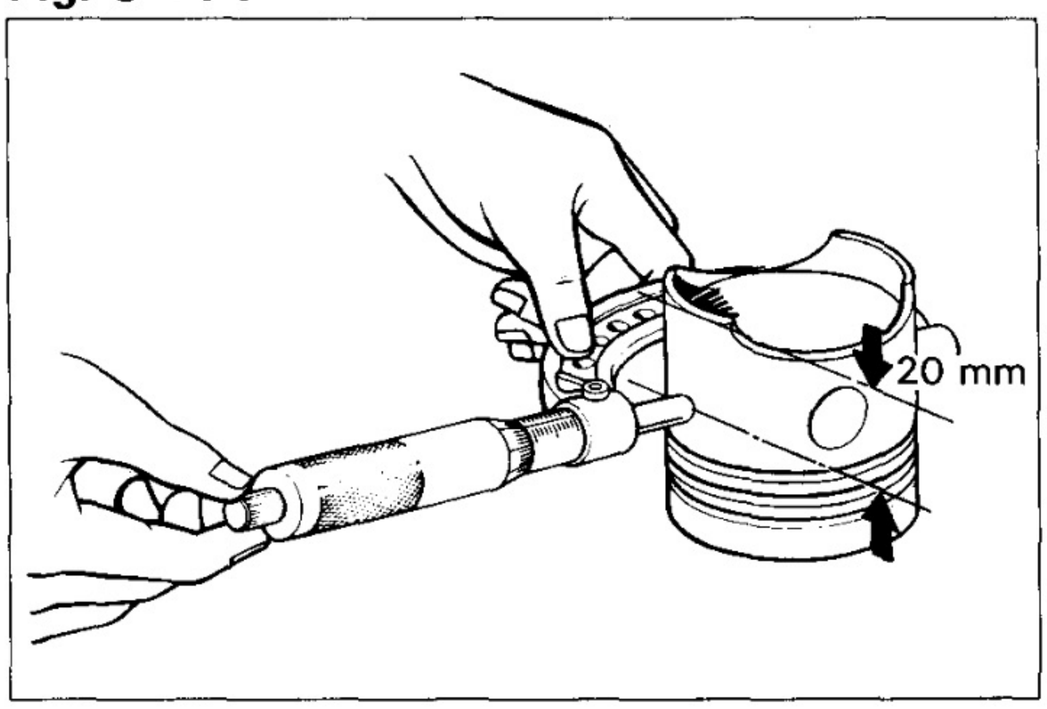
1. Check for wear or damage, especially in the piston ring grooves and ring lands.

Fig. 3-153



– 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. 3-154

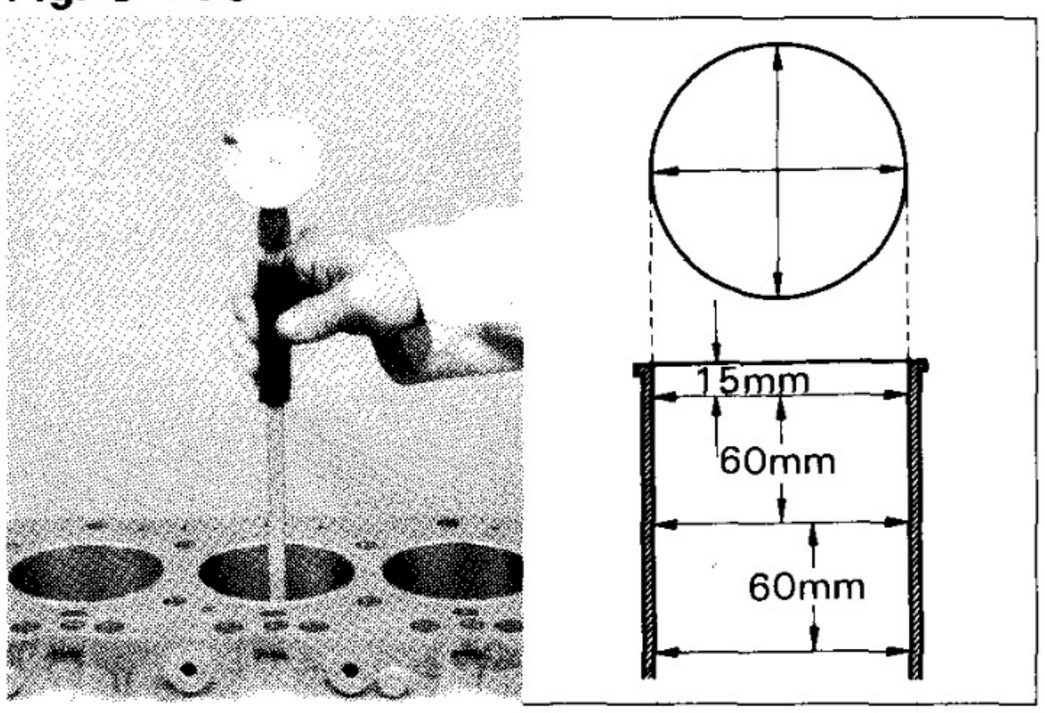


2. Check piston clearance.
   (1) Measure piston diameter in the thrust direction about 20 mm (0.79 in.) down from the skirt bottom edge.
   Measurement must be made at normal temperature 20°C (68°F).

Piston diameter size

Mark	1	2	3
Size mm (in.)	90.920—90.930 (3.5795—3.5799)	90.930—90.940 (3.5799—3.5803)	90.940—90.950 (3.5803—3.5807)

Fig. 3-155



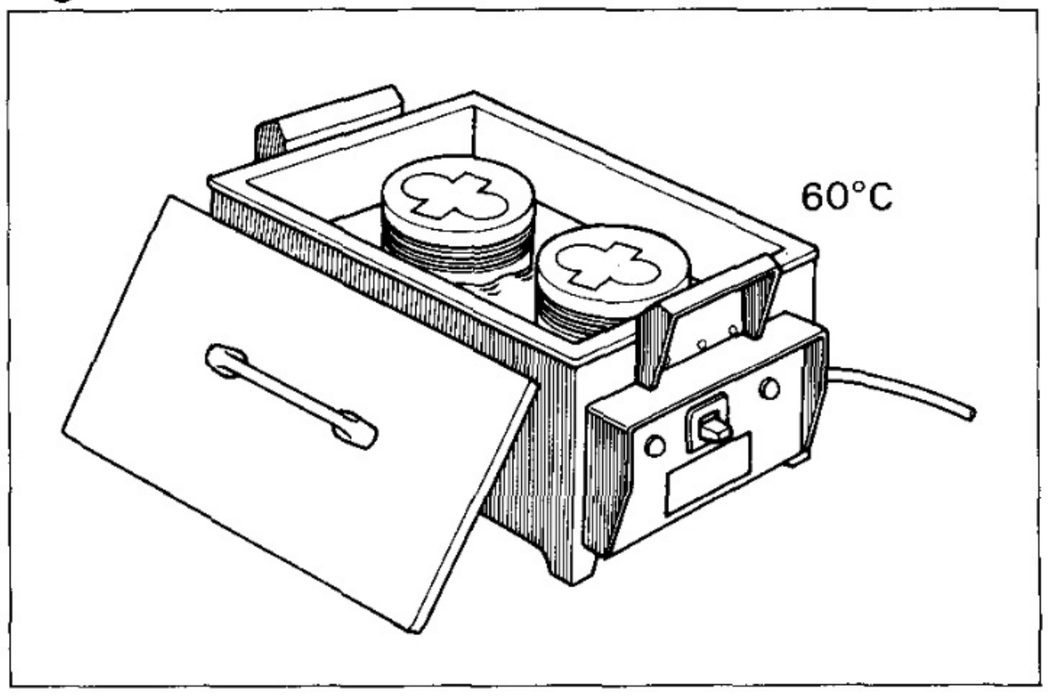
(2) Measure the cylinder bore and subtract the piston size.

Cylinder bore size

Mark	1	2	3
Size mm (in.)	91.000—91.010 (3.5827—3.5831)	91.010—91.020 (3.5831—3.5835)	91.020—91.030 (3.5835—3.5839)

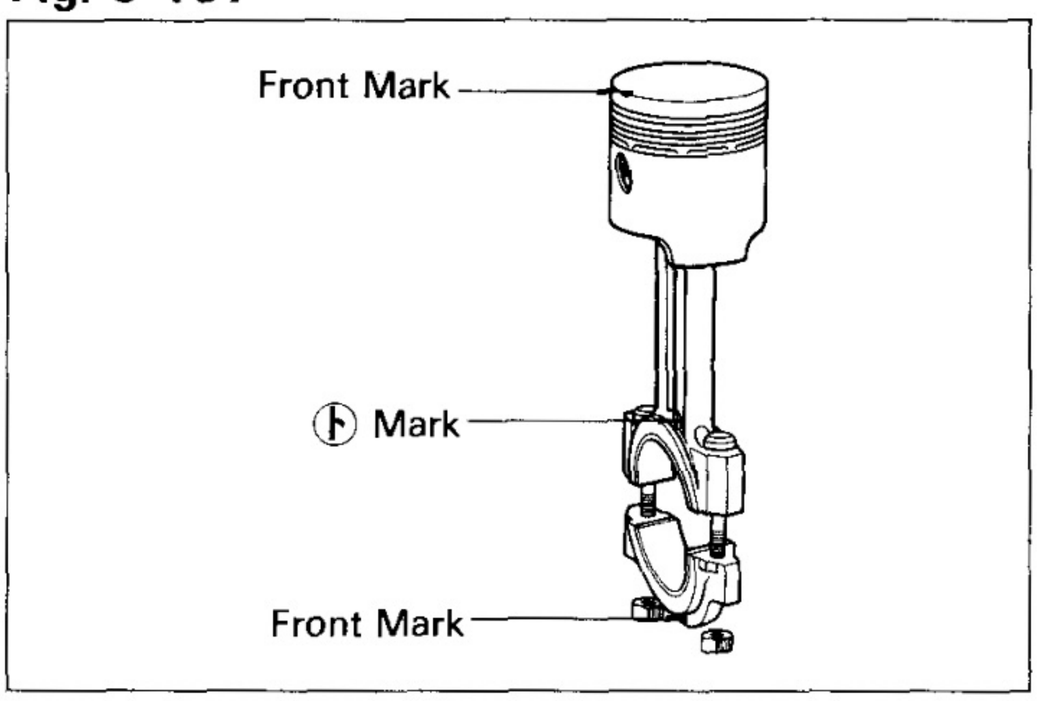
Piston clearance:
0.07 – 0.09 mm
(0.0028 – 0.0035 in.)

Fig. 3-156



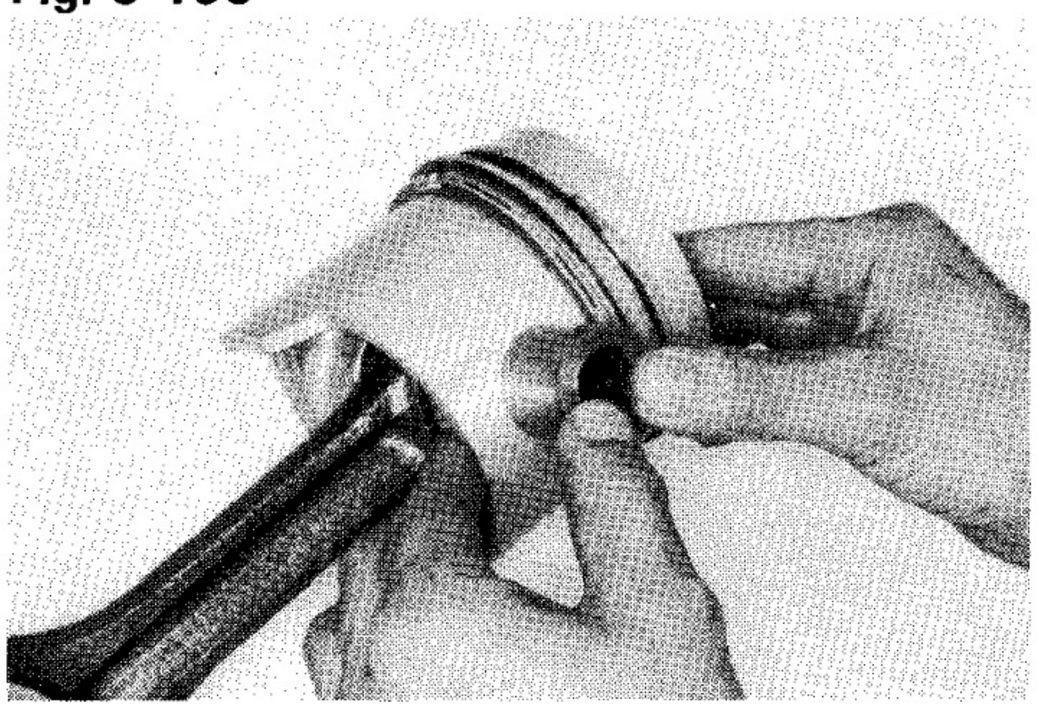
3. Assemble the piston and connecting rod as follows.
   (1) Heat the piston to about 60°C (140°F) before installing the piston pin.

Fig. 3-157



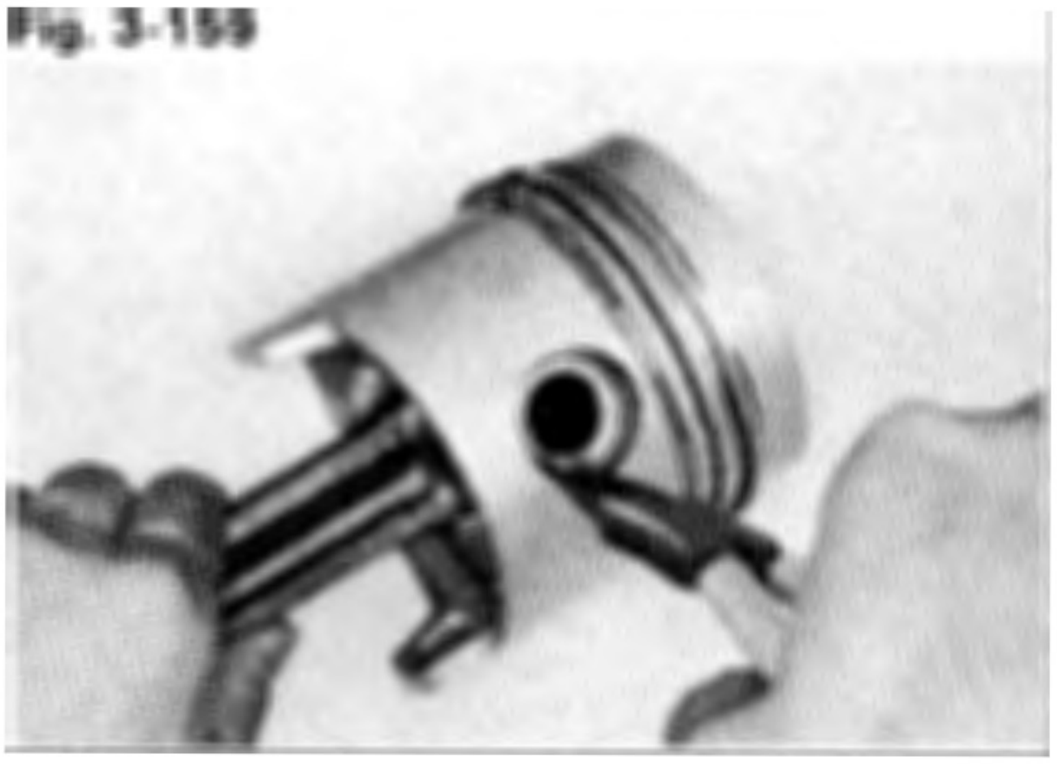
(2) Align the front mark of the piston and Ⓕ mark of the connecting rod as shown in the figure.

Fig. 3-158



(3) Push in the piston pin by hand.
If difficult to press in, drive it in with a brass bar or such.

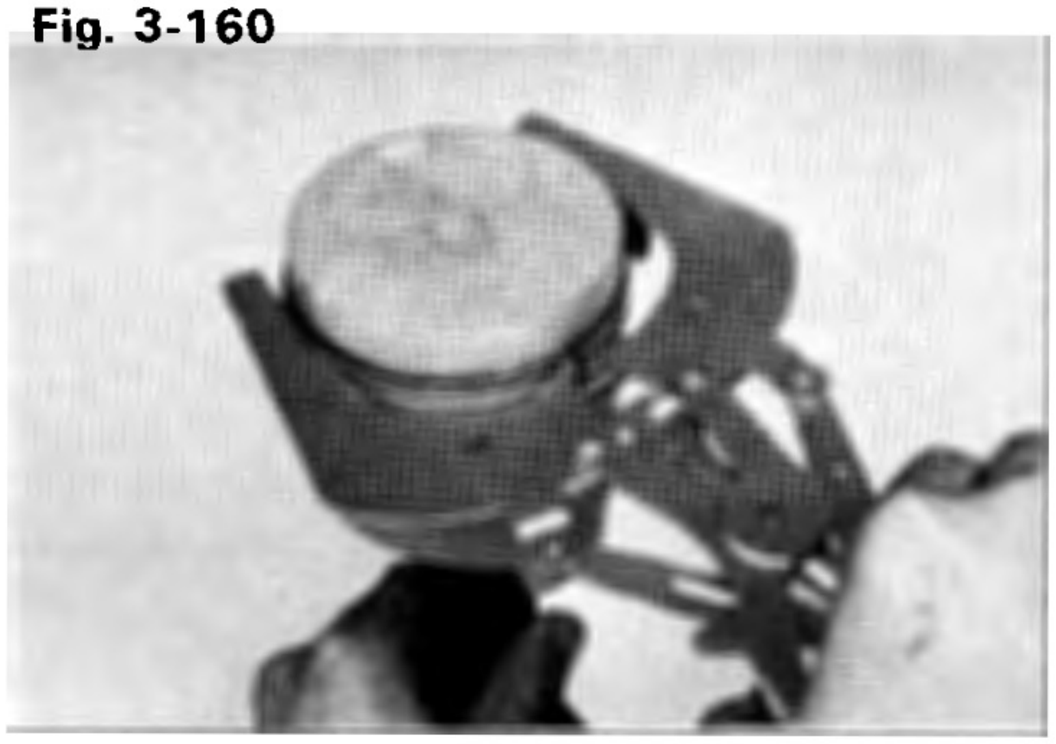
Fig. 3-159



(4) Install a snap ring on both sides.

– Note –
Make sure that each snap ring is securely in place.

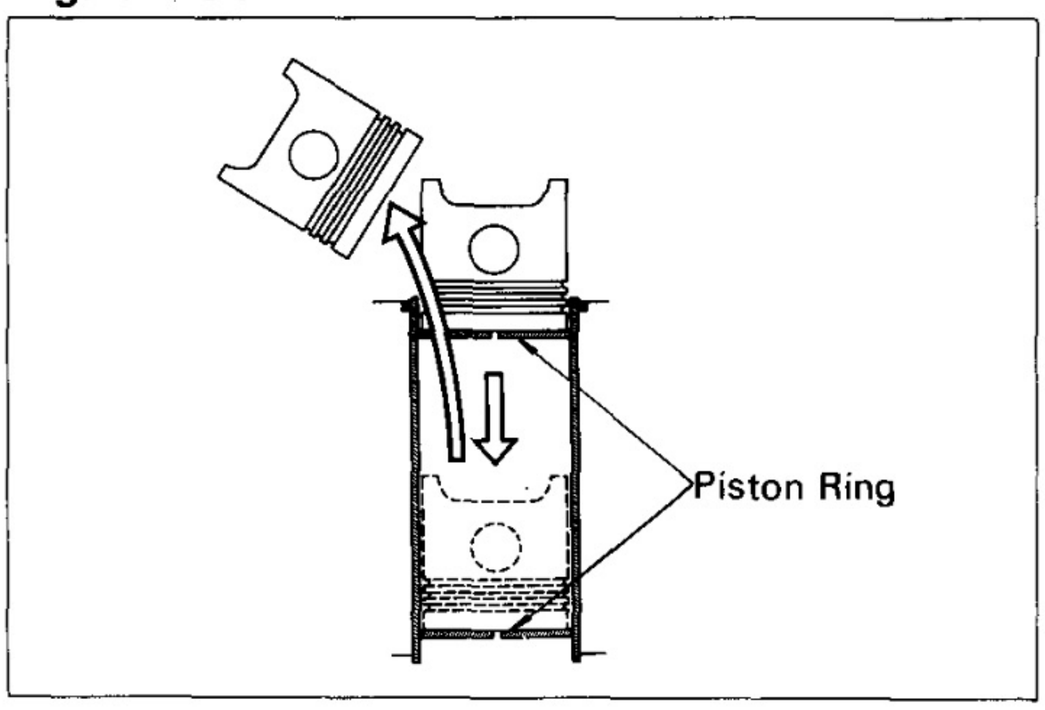
Fig. 3-160



Piston Ring

1. Remove the piston ring with a piston ring expander.

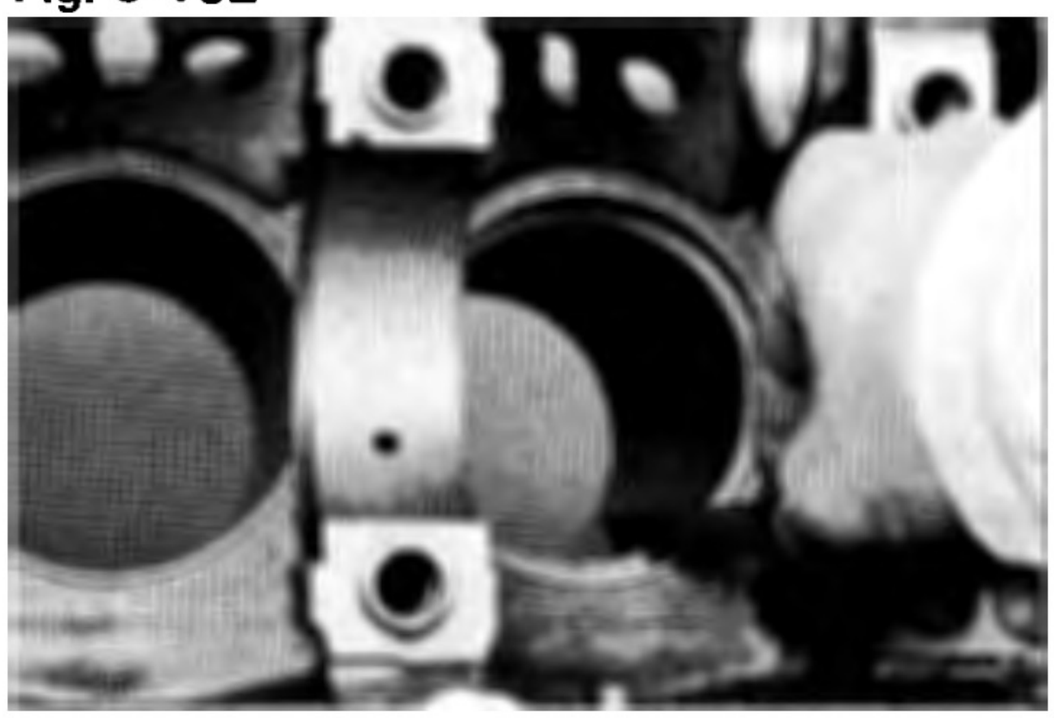
Fig. 3-161



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 correct size rings to match the piston size.

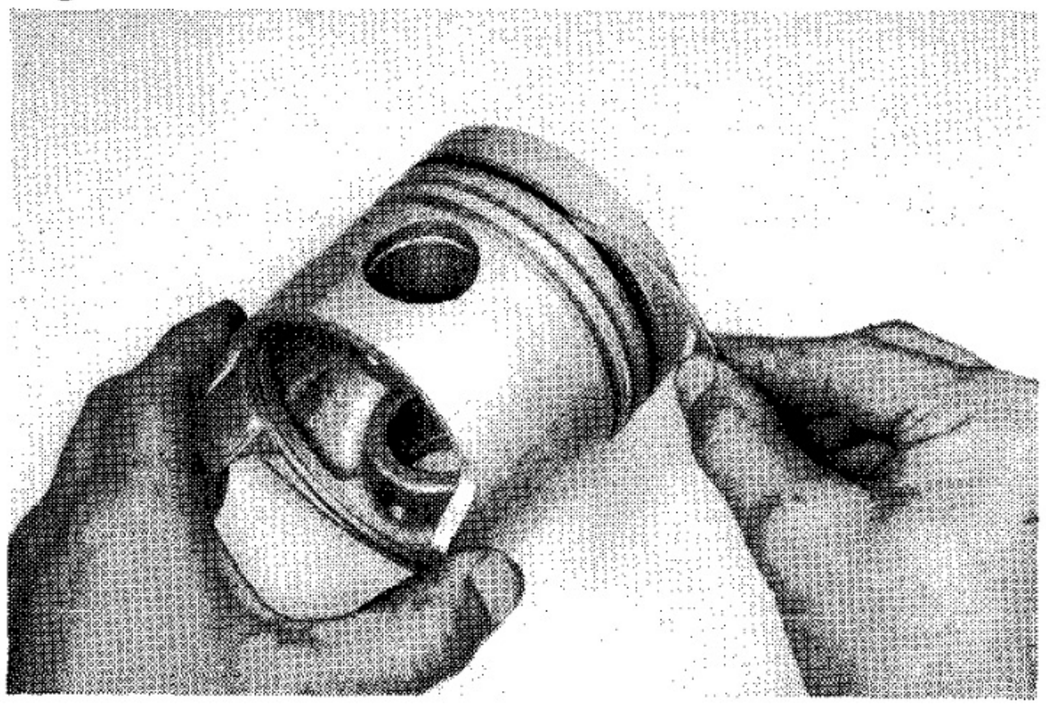
Fig. 3-162



3. Measure the piston ring end gap.

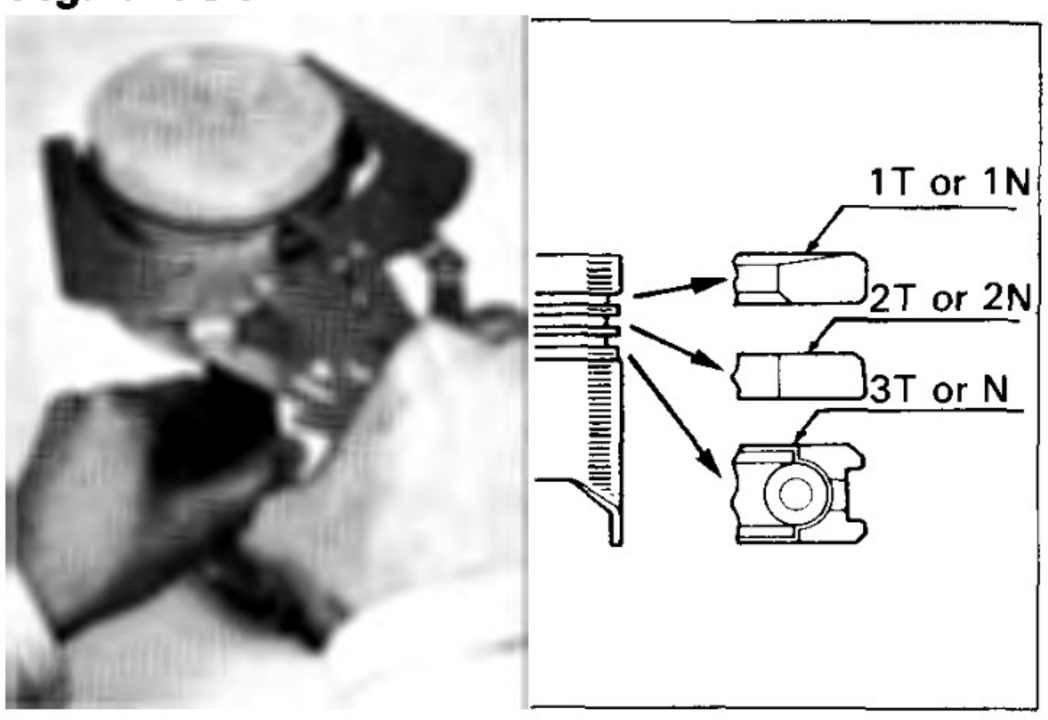
End gap:
No.1 & No.2
0.20 – 0.47 mm
(0.0079 – 0.0185 in.)
Oil
0.20 – 0.52 mm
(0.0079 – 0.0204 in.)

Fig. 3-163



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

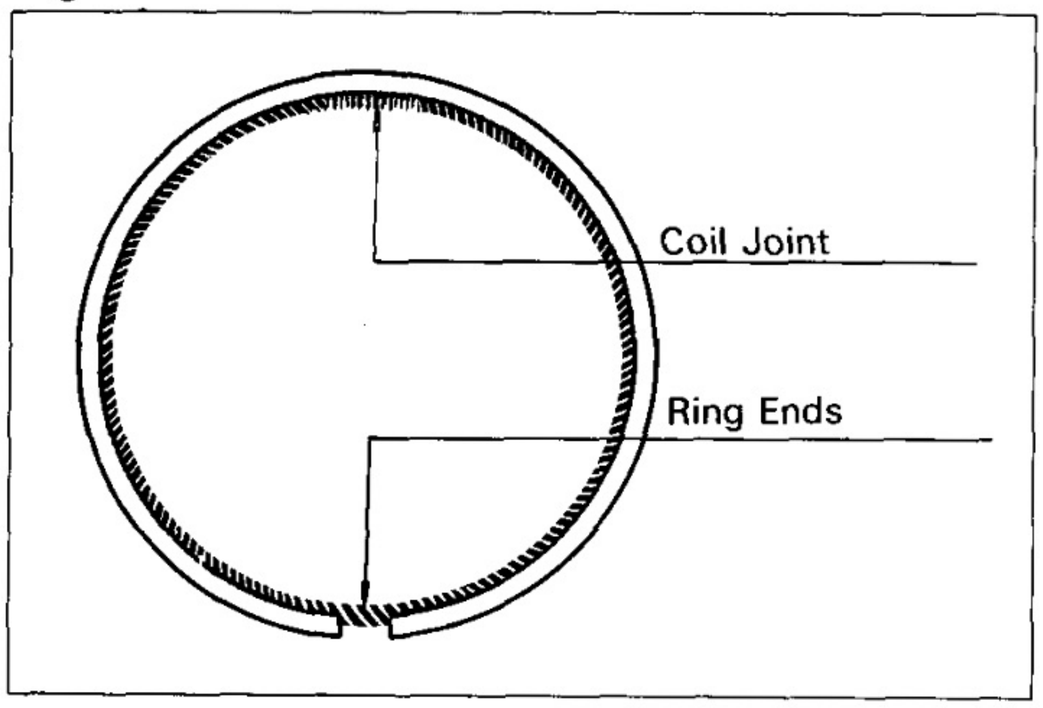
Fig. 3-164



5. Install the piston ring with the piston ring expander.

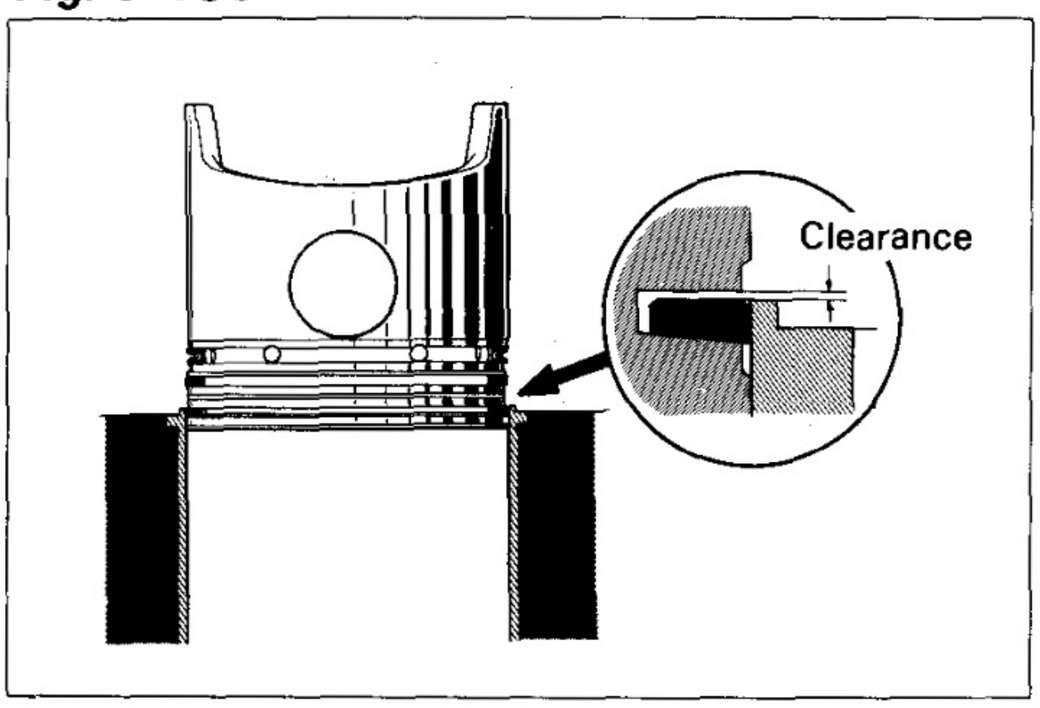
– Note –
1. **Always install the rings with the code marks facing upward.**

Fig. 3-165



2. When assembling the oil ring and expander coil, insure that the expander coil joint is at the opposite side of the ring ends.

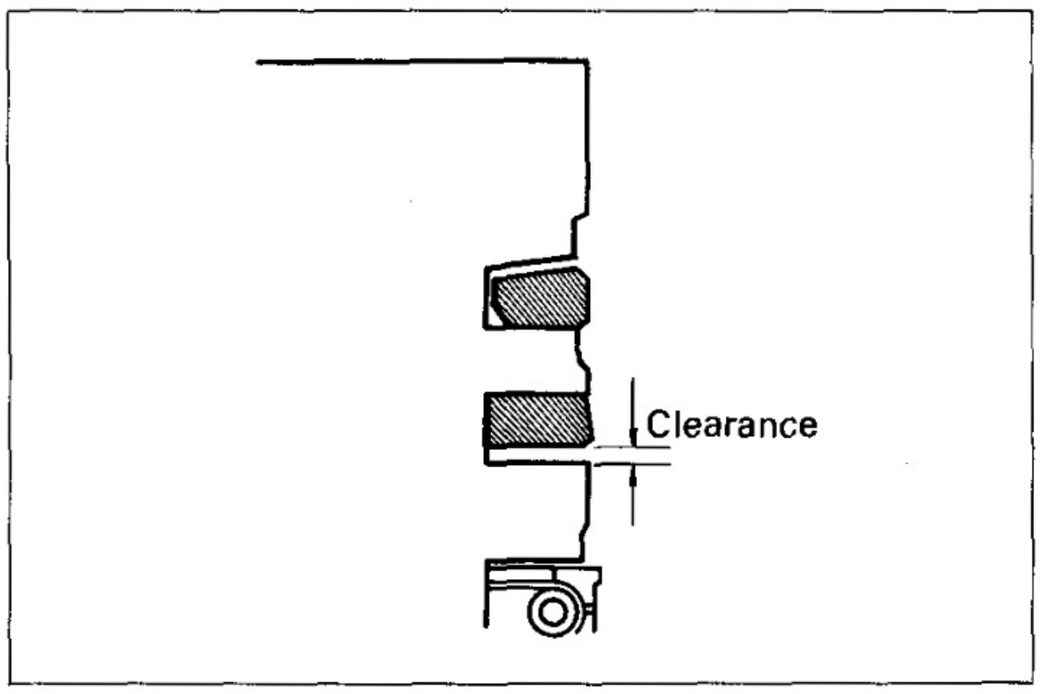
Fig. 3-166



6. Measure the No.1 ring groove clearance with a thickness gauge as shown in the figure. If it exceeds specification, replace the ring and/or piston.

Ring to groove clearance:
0.046 – 0.085 mm
(0.0018 – 0.0033 in.)

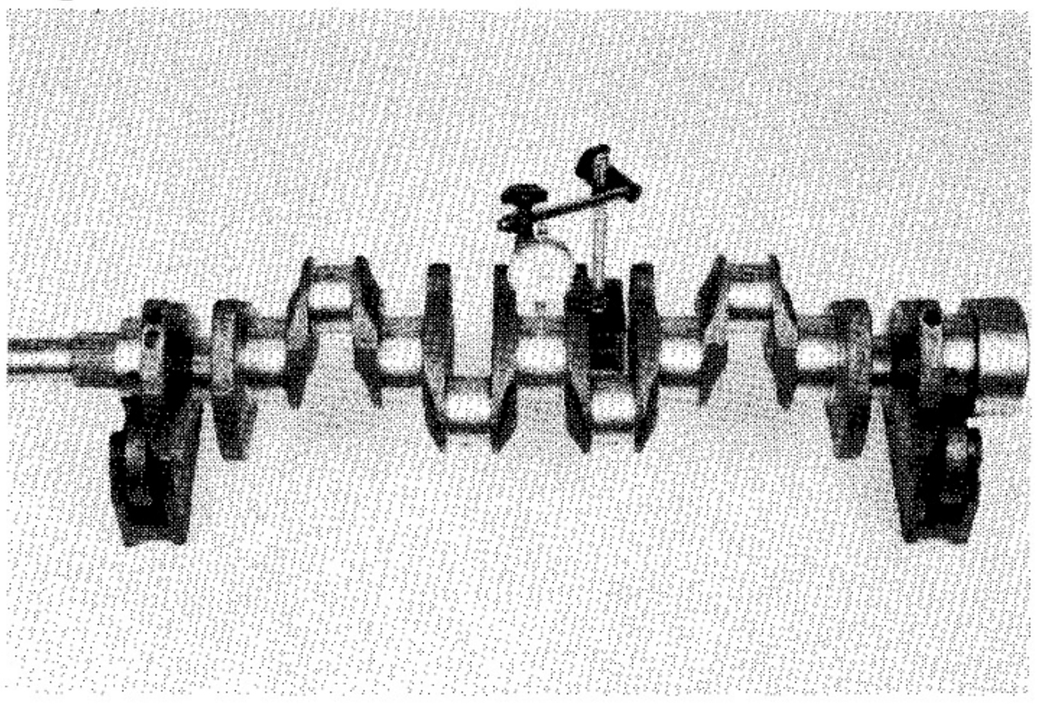
Fig. 3-167



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

Ring to groove clearance:
No.2 0.05 – 0.09 mm
(0.0020 – 0.0035 in.)
Oil ring 0.03 – 0.07 mm
(0.0012 – 0.0028 in.)

Fig. 3-168

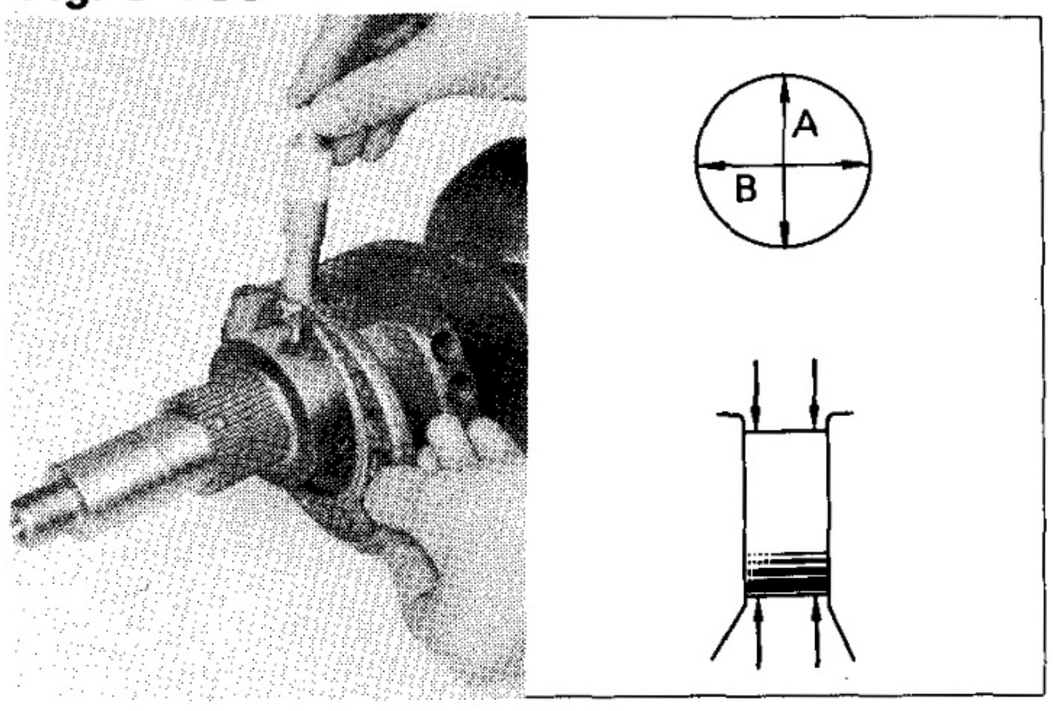


Crankshaft & Bearing

1. Check the crankshaft for runout. If it exceeds the limit, replace.

Circle runout:
Limit 0.06 mm
(0.0024 in.)

Fig. 3-169

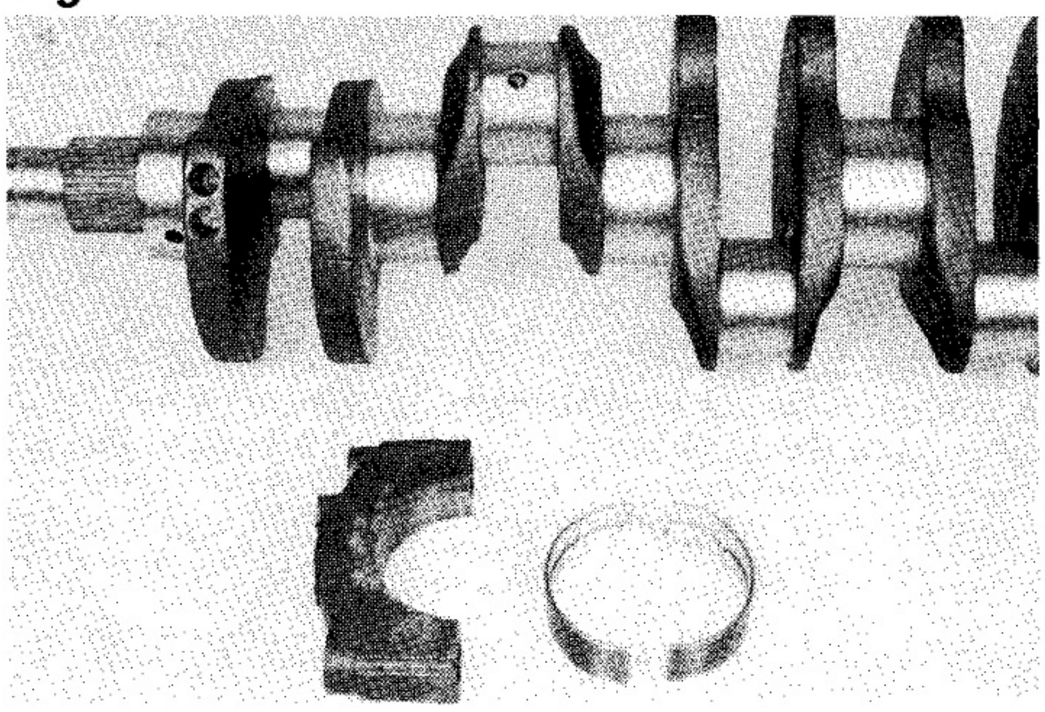


2. Measure the crankshaft main journal.
If wear is excessive, the crankshaft must be reground or replaced.

Main journal diameter:
STD 69.98 – 70.00 mm
(2.7551 – 2.7559 in.)
Taper and out-of-round:
Limit 0.02 mm
(0.0008 in.)

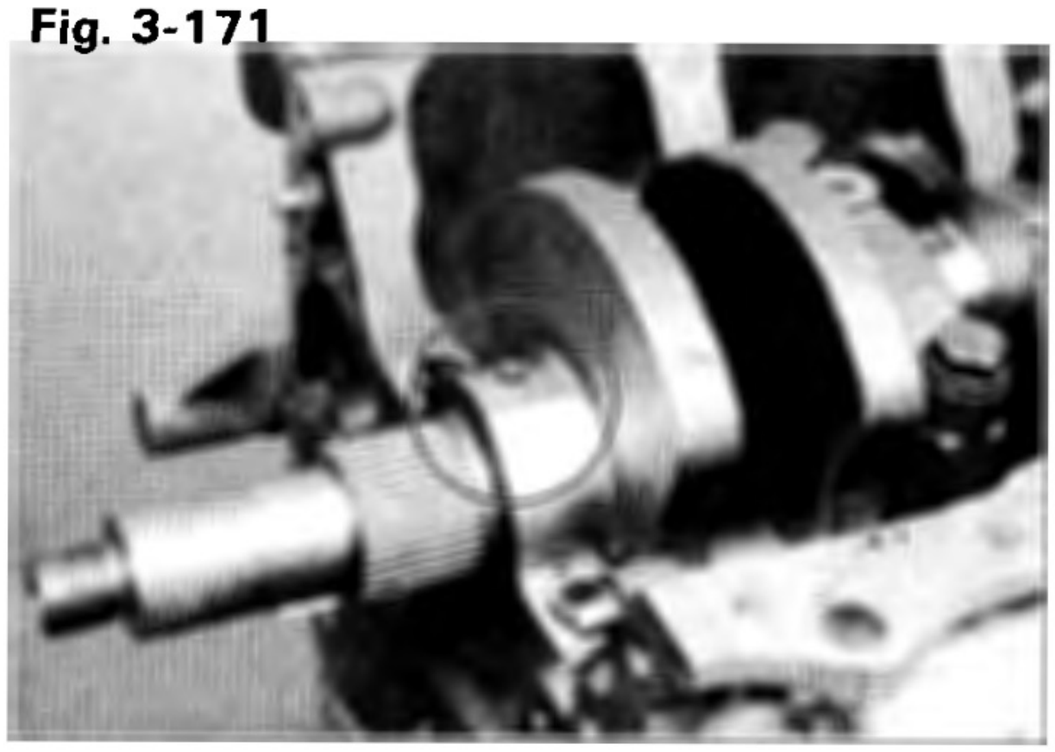
– Note –
Measure A and B diameters in two places.

Fig. 3-170



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

Fig. 3-171



(2) Lay a strip of plastigage across the journal.

Fig. 3-172

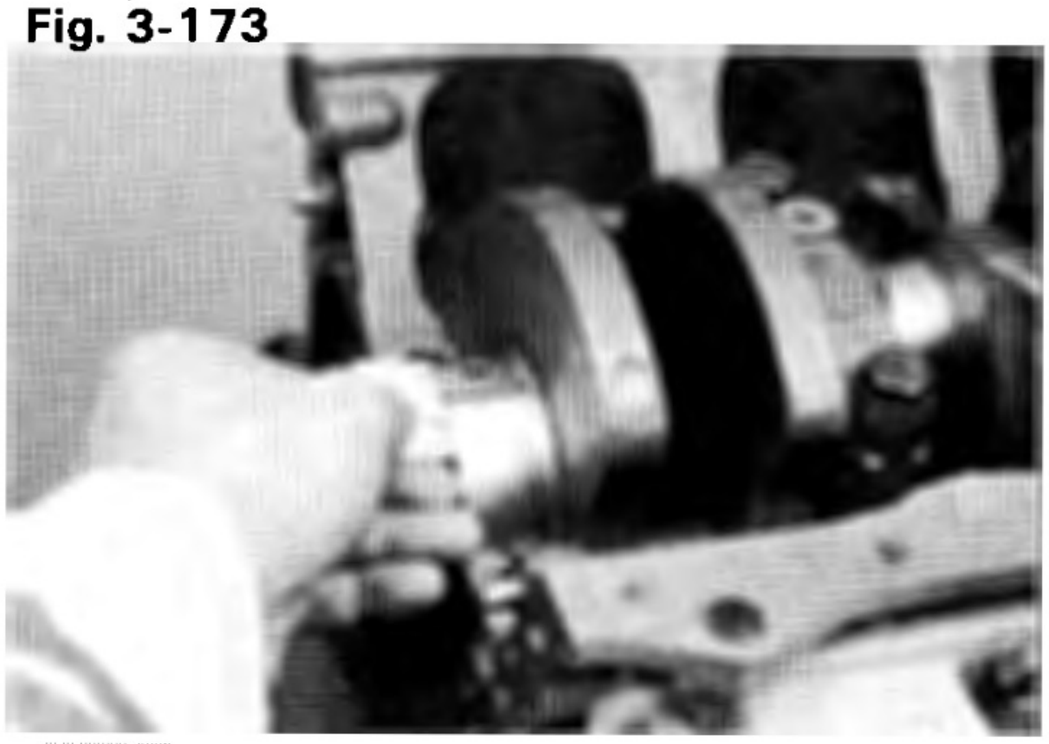


(3) Tighten the cap bolts to specified torque.

Tightening torque:
12.8 – 14.2 kg-m
(92 – 103 ft-lb)

– Note –
Do not turn the crankshaft.

Fig. 3-173



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

Oil clearance:

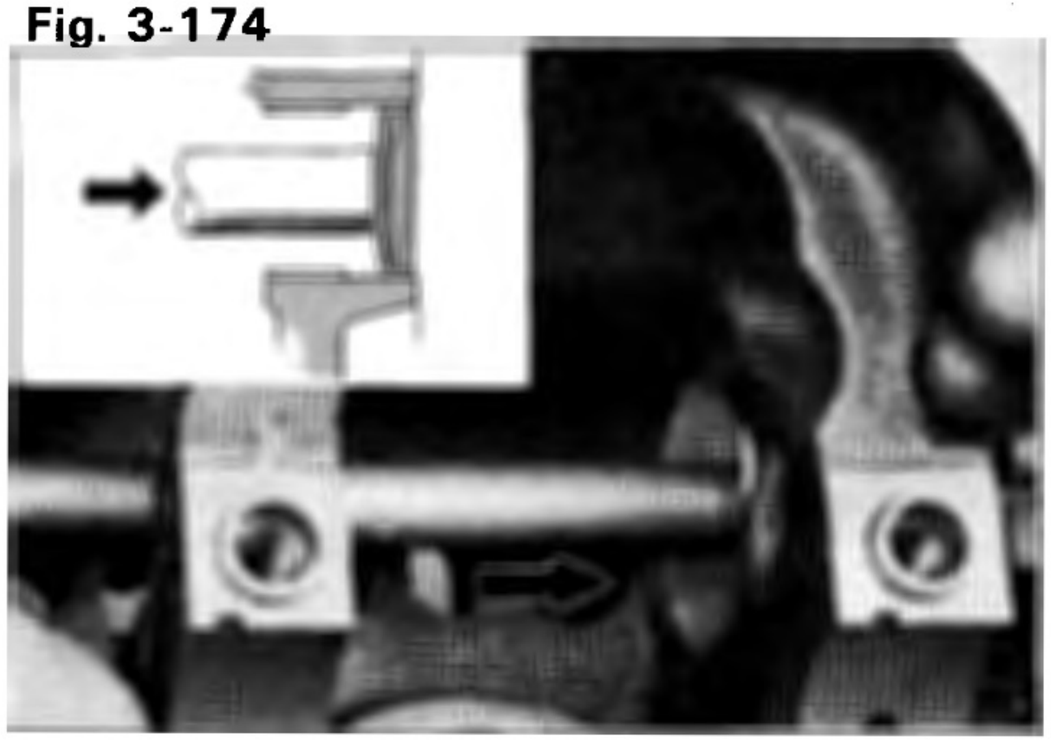
STD 0.03—0.07 mm (0.0012—0.0028 in.)

Limit 0.1 mm (0.004 in.)

U/S bearing:

0.05, 0.25, 0.50, 0.75, 1.00

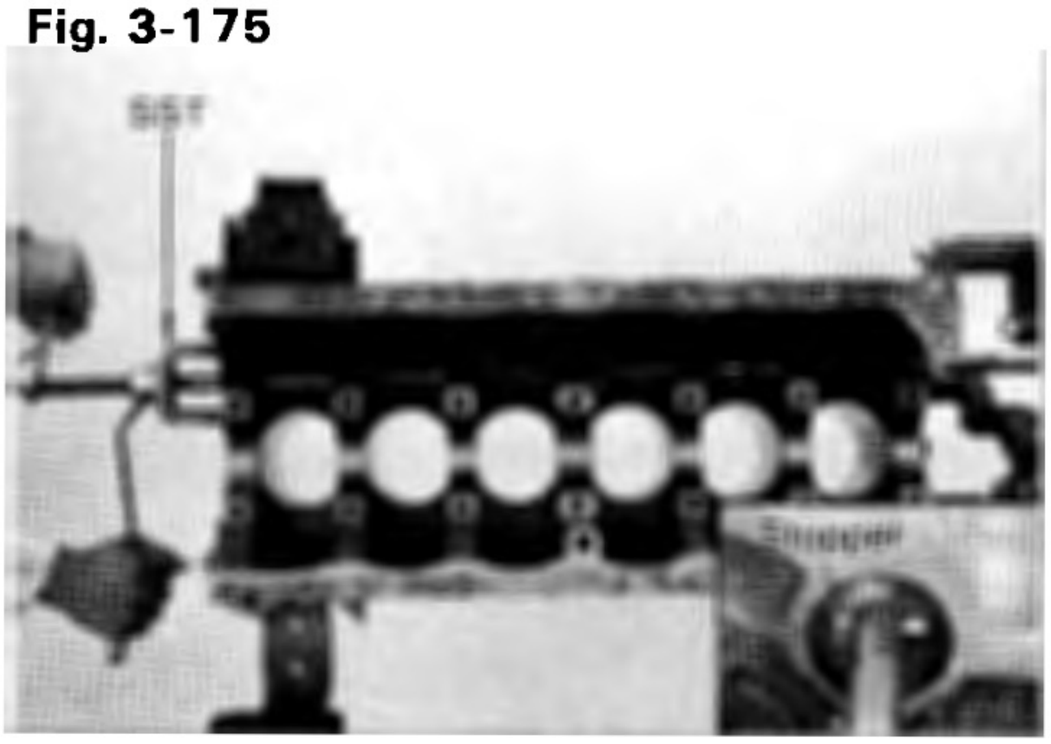
Fig. 3-174



Camshaft Bearing

1. Remove the camshaft rear expansion plug.

Fig. 3-175

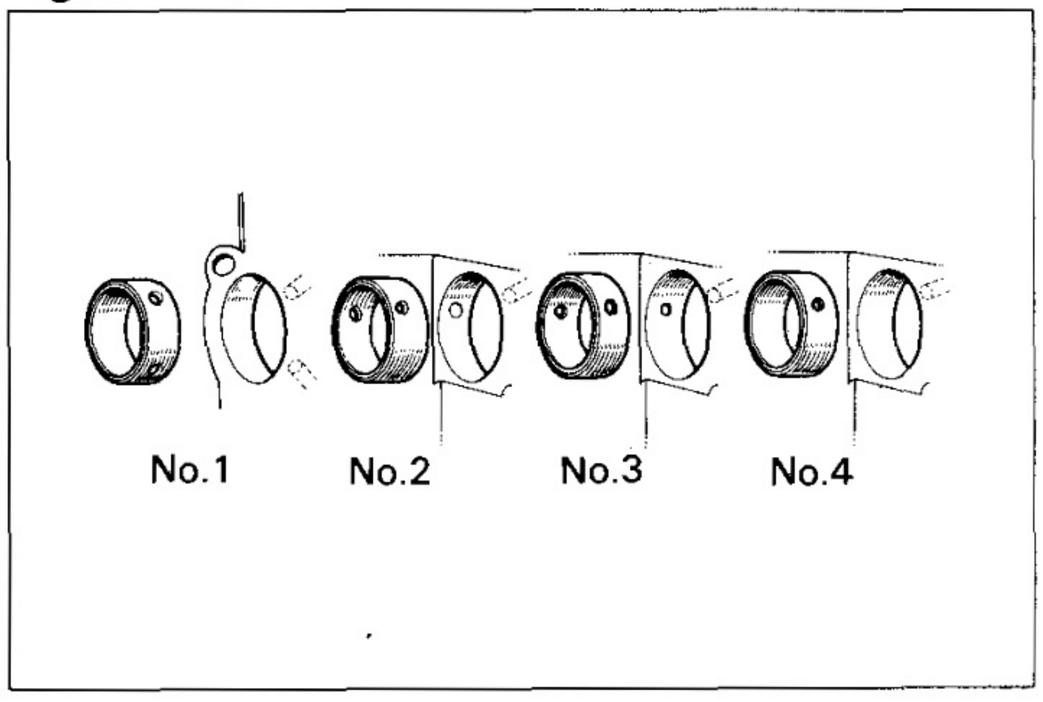


2. Remove the camshaft bearings with SST. SST [09215-00100]

— Note —

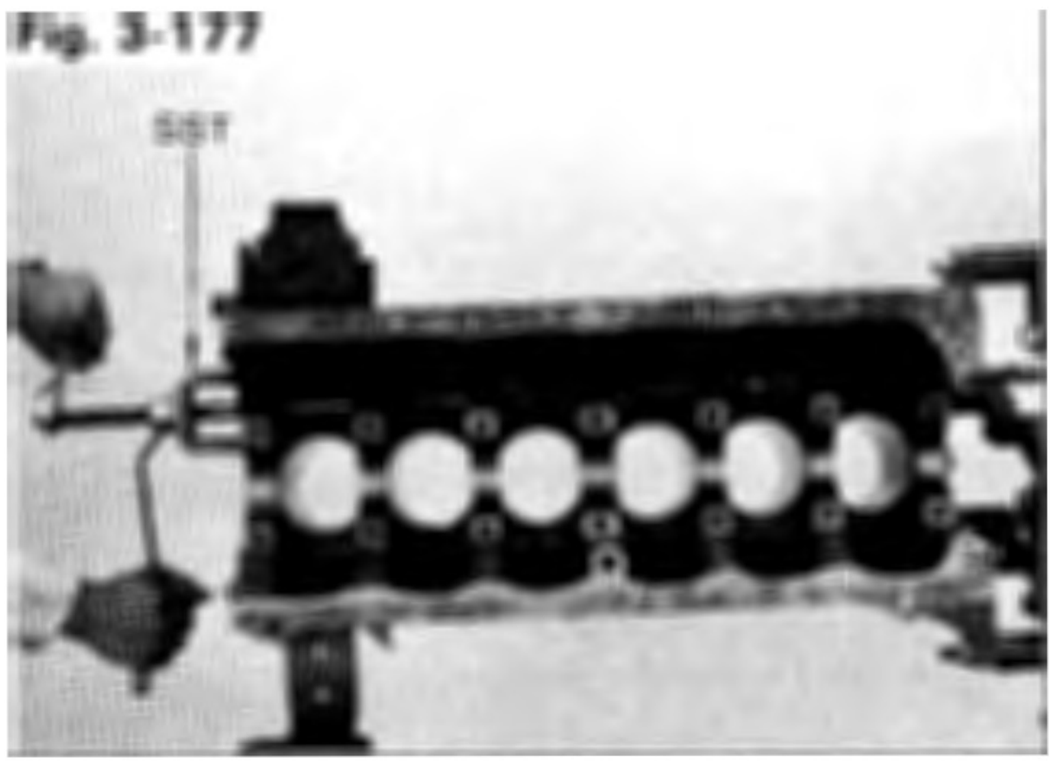
1. **Shorten the shaft of SST to proper length by inserting the stopper into the shaft hole as shown in the figure.**
2. **Remove each bearing one at a time.**

Fig. 3-176



3. When installing the bearings, align the bearing oil holes with the cylinder block oil holes.

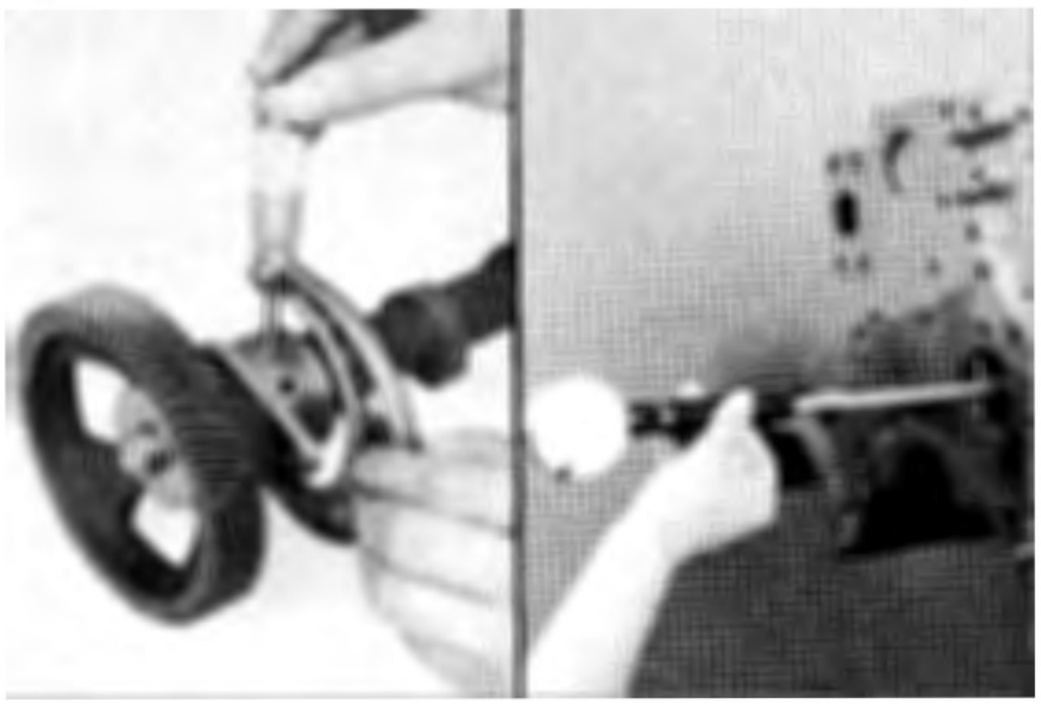
Fig. 3-177



4. Install new bearings with SST.
   SST [09215-00100]

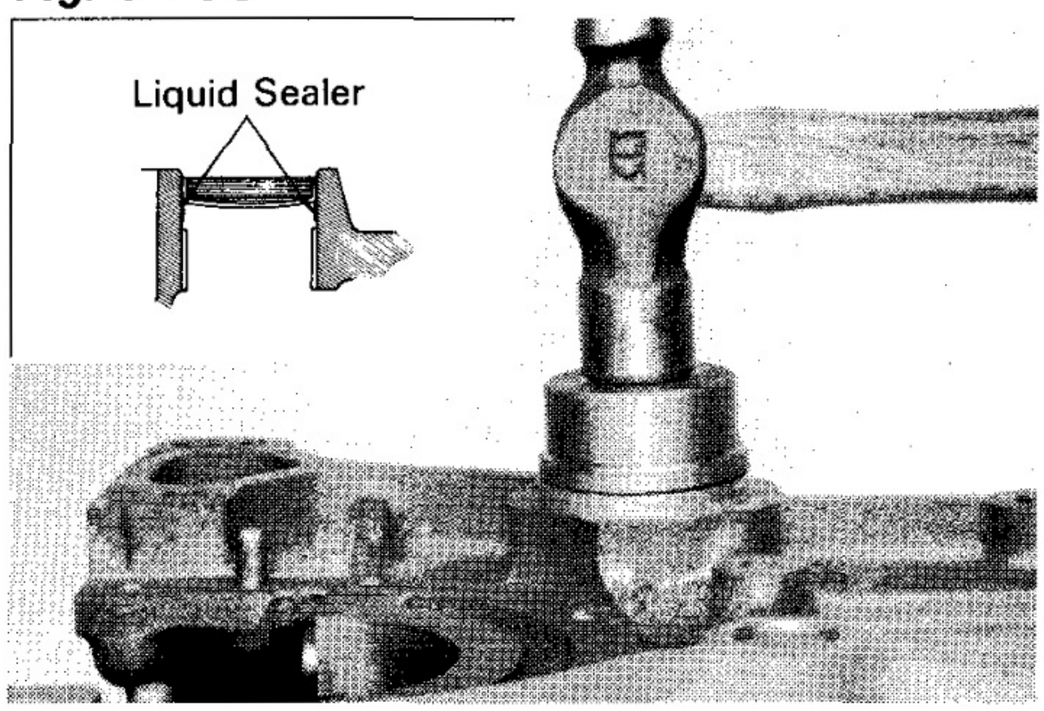
– Note –
Install each bearing one at a time.

Fig. 3-178



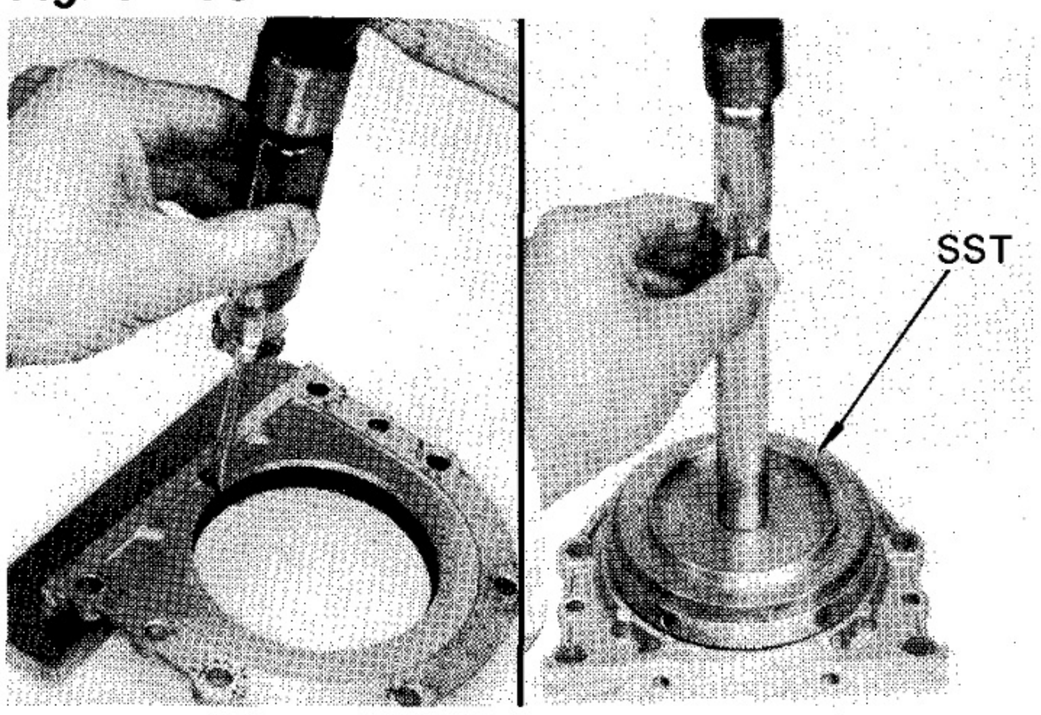
5. Check the bearing oil clearance.
   Oil clearance:
   STD 0.03 – 0.08 mm (0.0012 – 0.0031 in.)
   Limit 0.1 mm (0.004 in.)

Fig. 3-179



6. Install a new expansion plug with liquid sealer.

Fig. 3-180



Crankshaft Rear Oil Seal

1. Remove the oil seal.
2. Install a new oil seal with SST.
   SST [09550-55010]

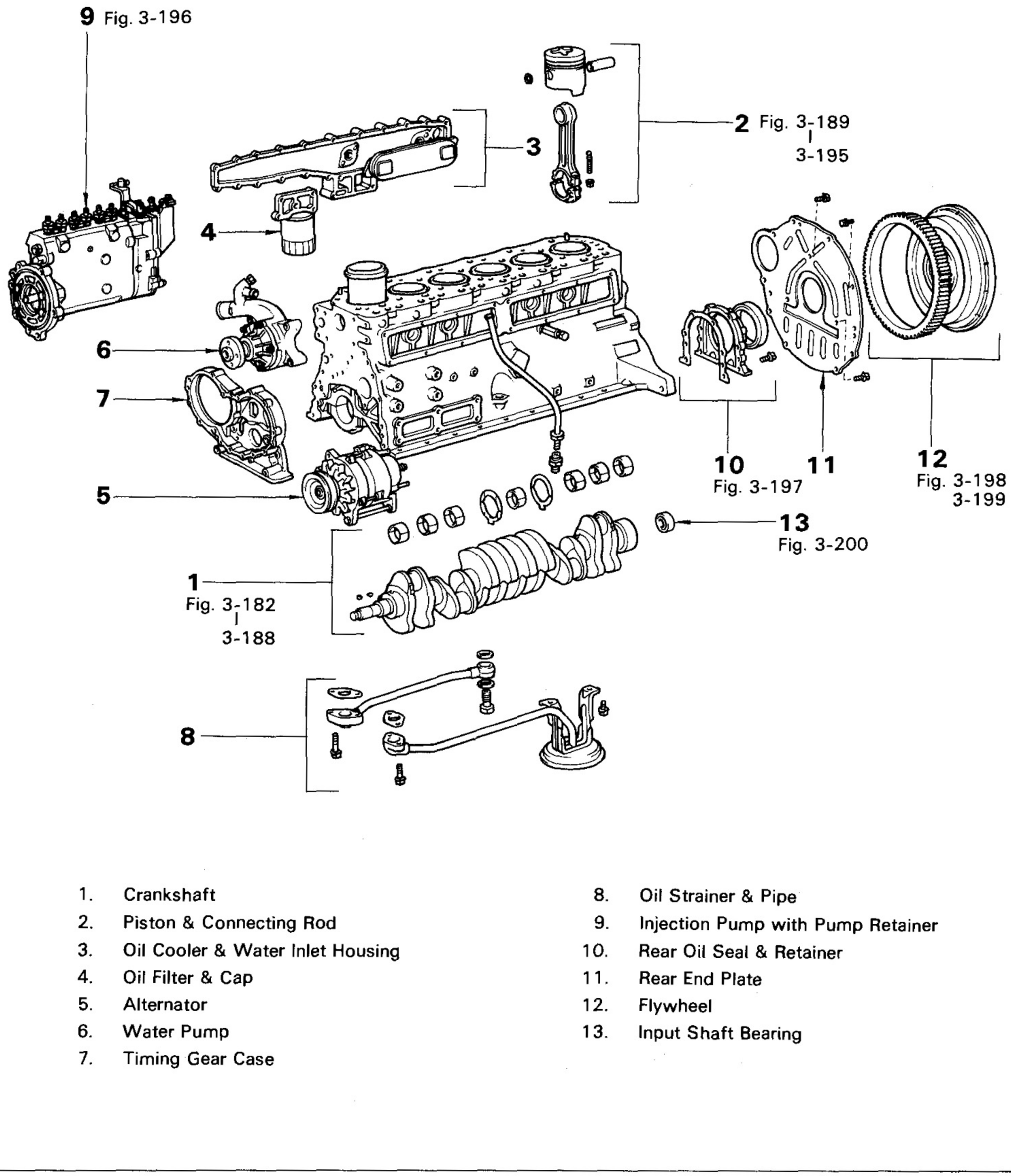
ASSEMBLY

Assemble the parts in the numerical order shown in the figure.

Fig. 3-181

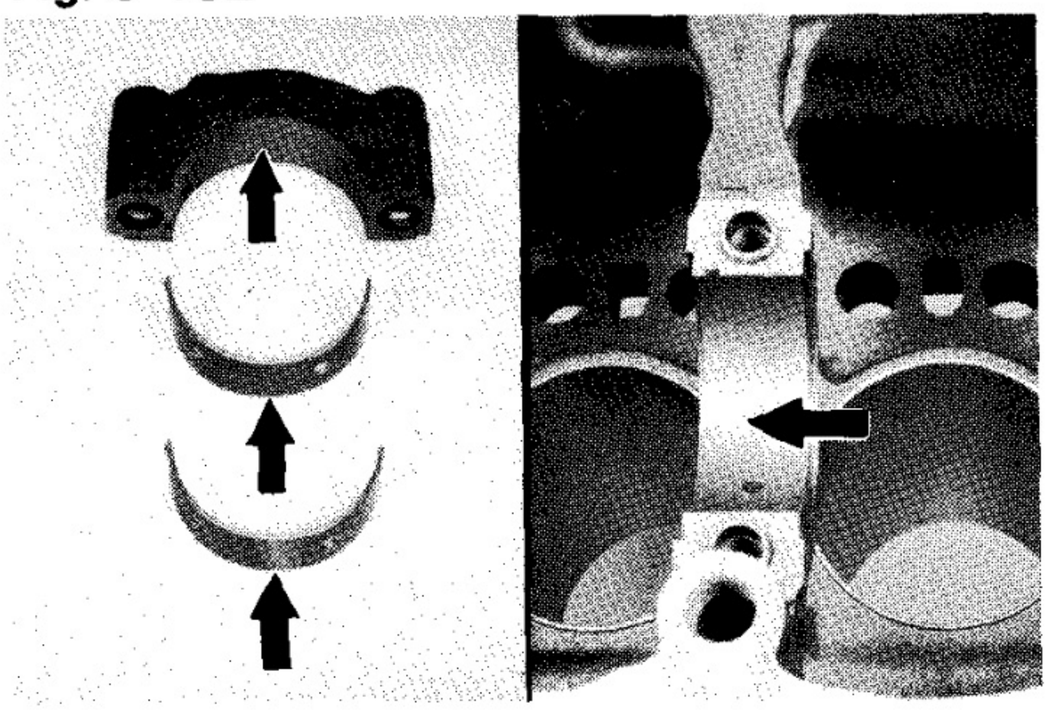
– Note –

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
2. Piston & Connecting Rod
3. Oil Cooler & Water Inlet Housing
4. Oil Filter & Cap
5. Alternator
6. Water Pump
7. Timing Gear Case
8. Oil Strainer & Pipe
9. Injection Pump with Pump Retainer
10. Rear Oil Seal & Retainer
11. Rear End Plate
12. Flywheel
13. Input Shaft Bearing

Fig. 3-182



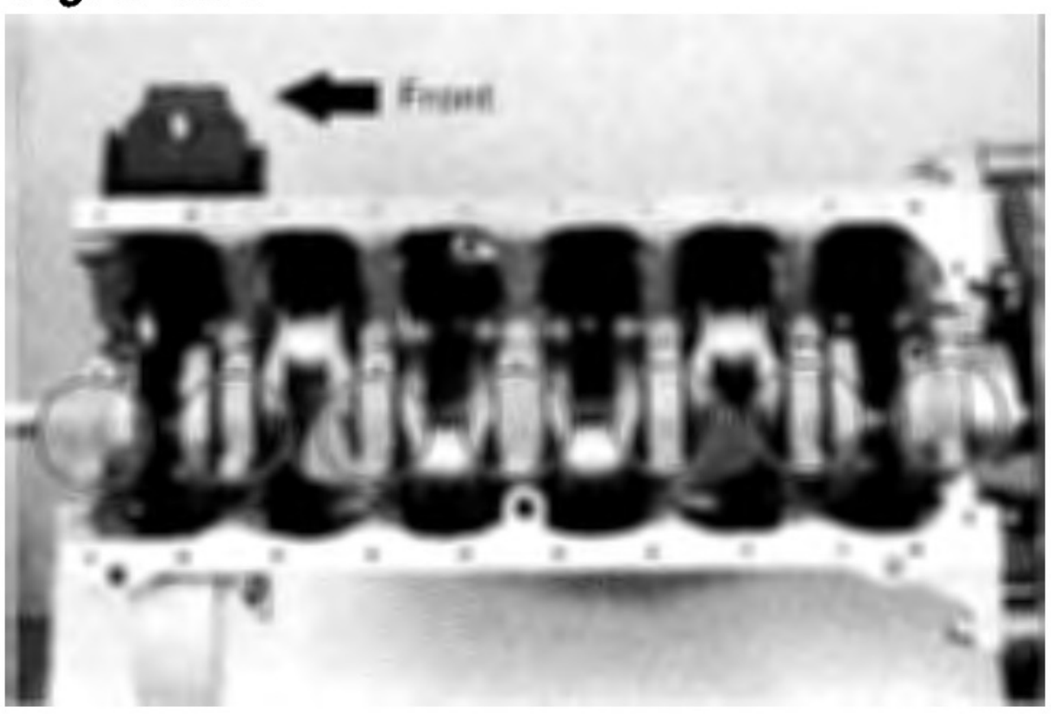
Do not allow oil to get on the back side of the bearing.

Fig. 3-183



Face the oil groove of the thrust washer toward the outside.

Fig. 3-184



Face the mark toward the front.

Fig. 3-185

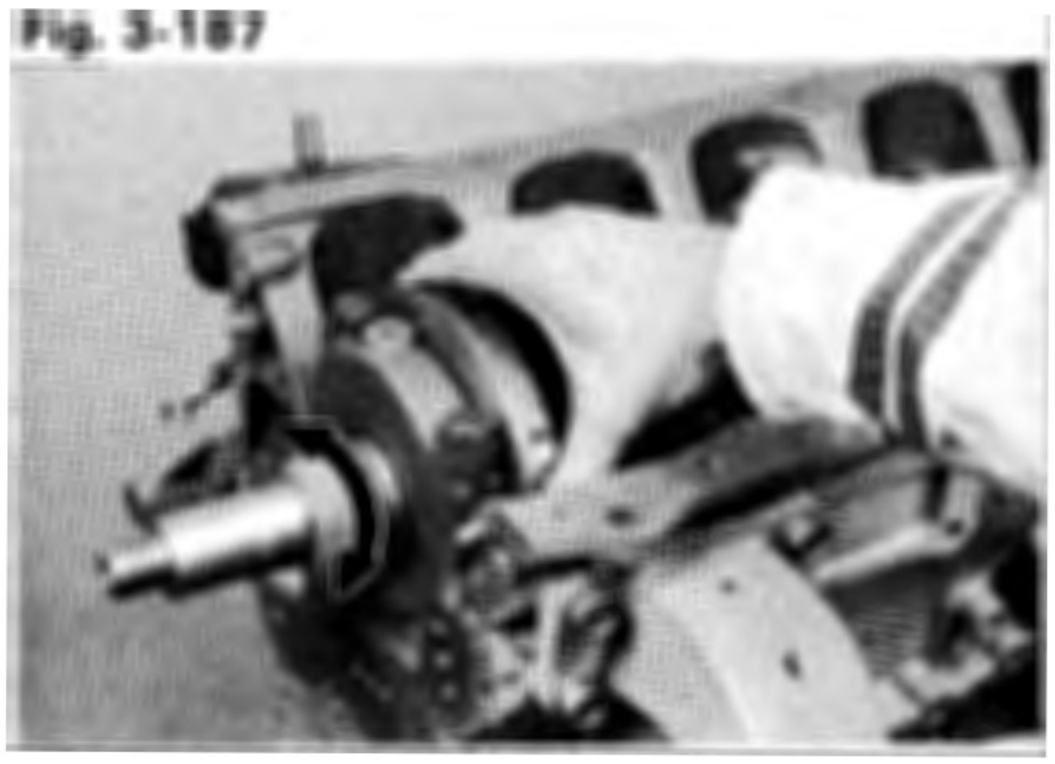


Tighten each bearing cap bolt a little at a time in the sequence shown in the figure.



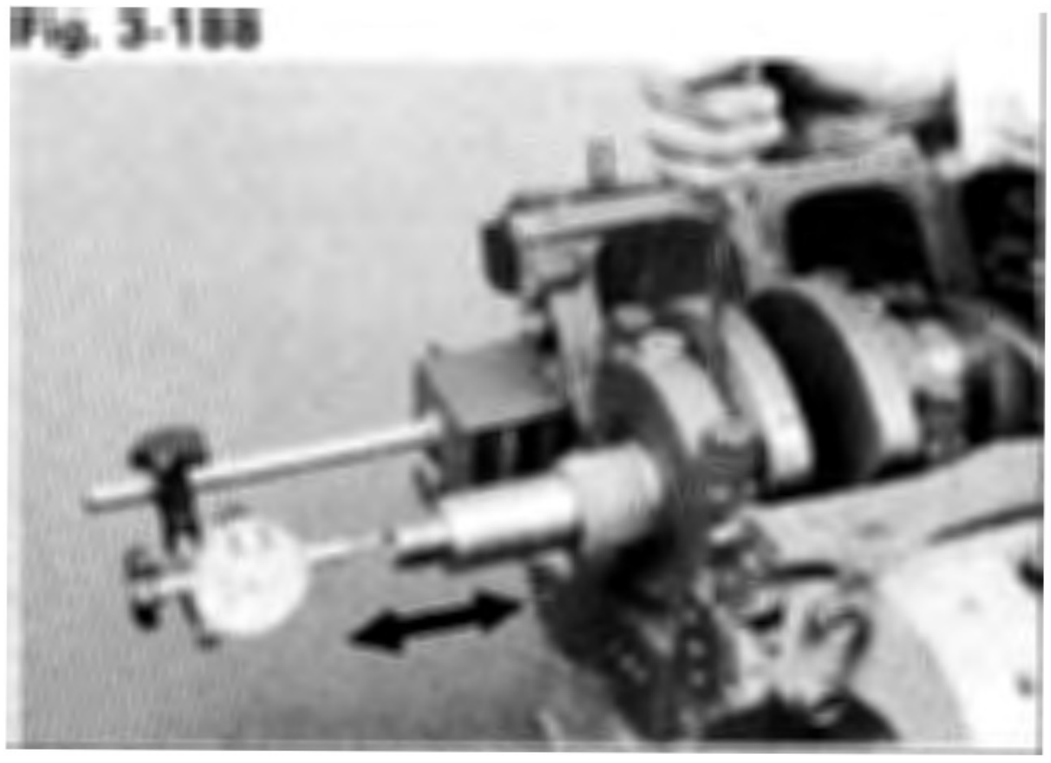
Tighten the bearing caps to specified torque.
Tightening torque: 12.8 – 14.2 kg-m (93 – 102 ft-lb)

Fig. 3-187



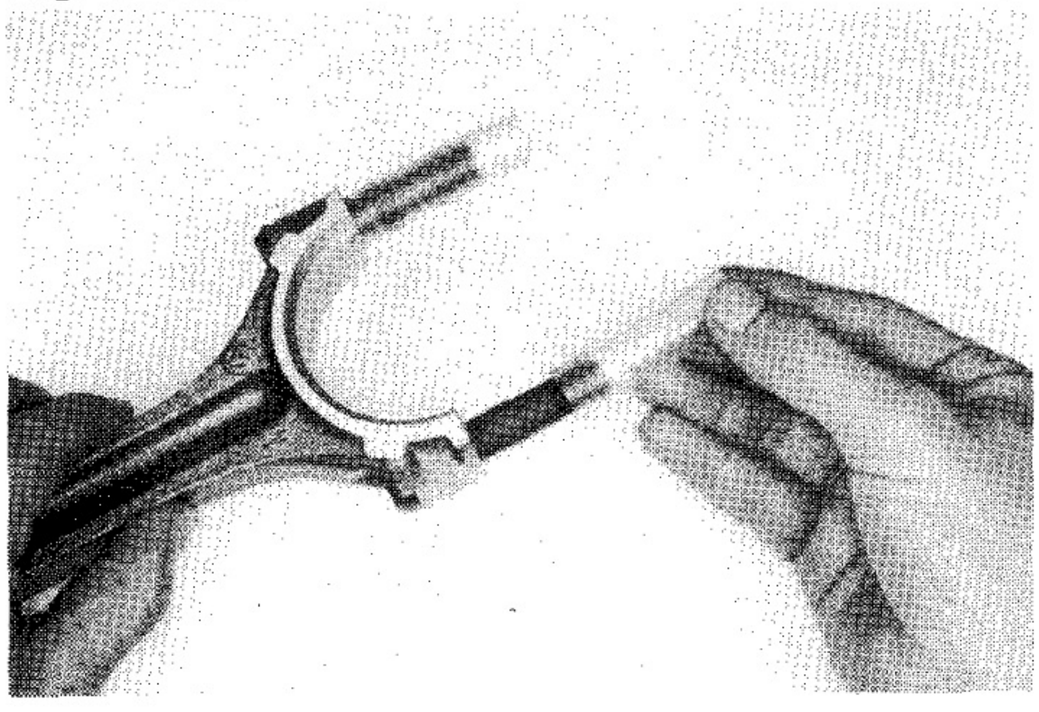
– Note –
Check for tightness of crankshaft rotation after each time a bearing cap is tightened.

Fig. 3-188



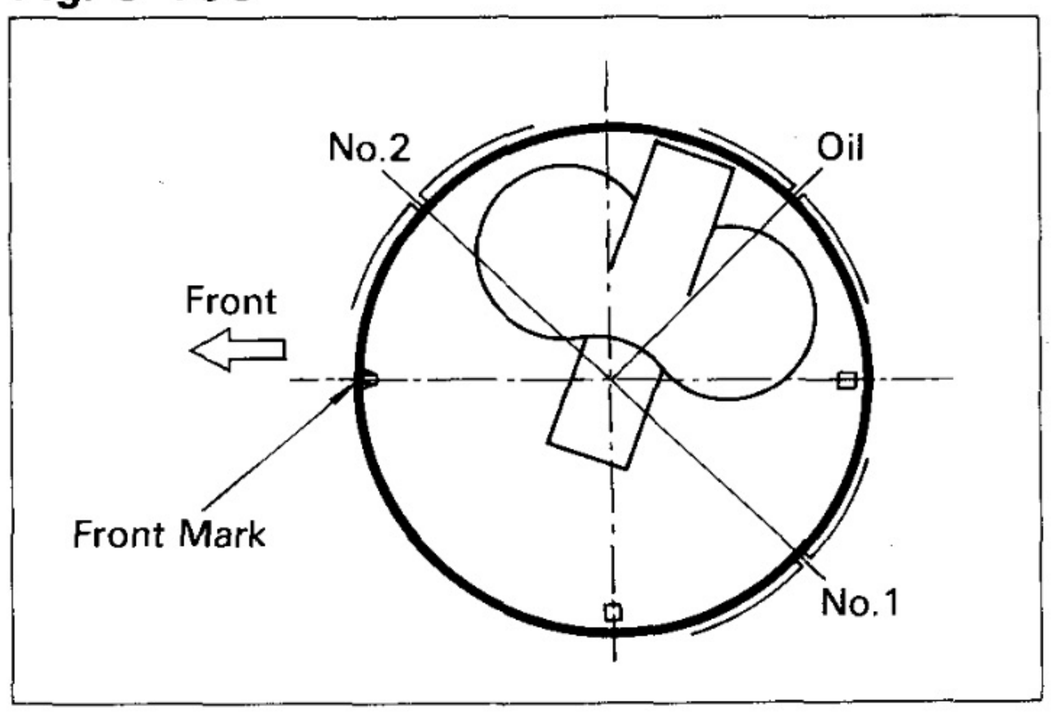
Measure the crankshaft thrust clearance.
Thrust clearance:
STD 0.04 – 0.24 mm (0.0016 – 0.0094 in.)
Limit 0.3 mm (0.012 in.)

Fig. 3-189



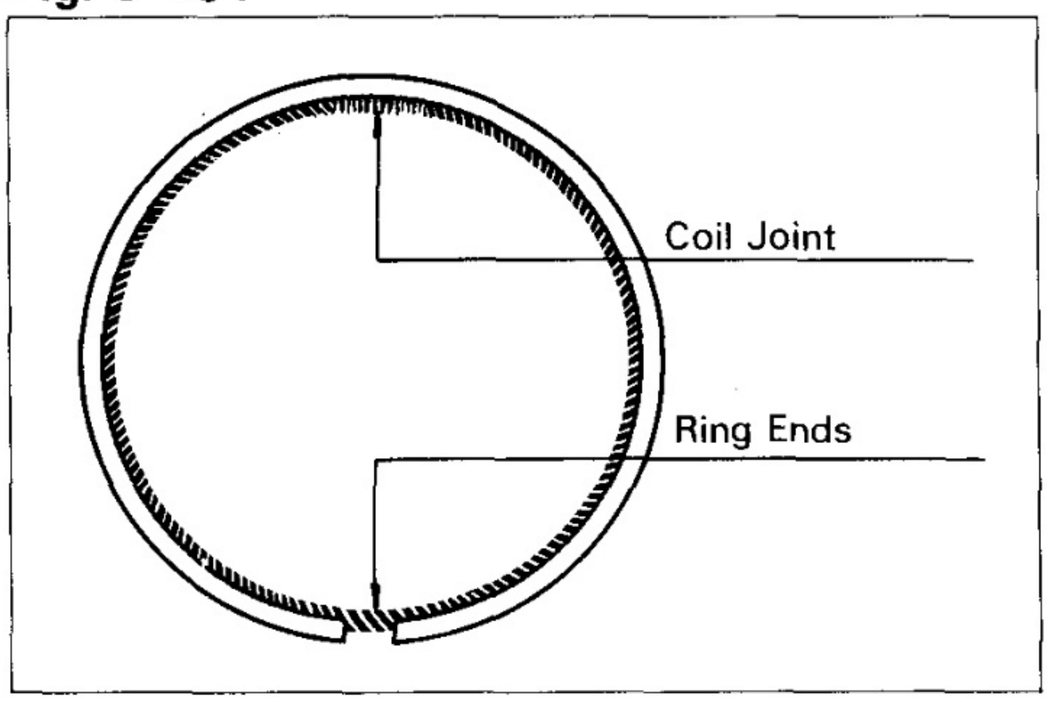
Cover the rod bolts with a piece of hose to protect the crank pins from damage.

Fig. 3-190



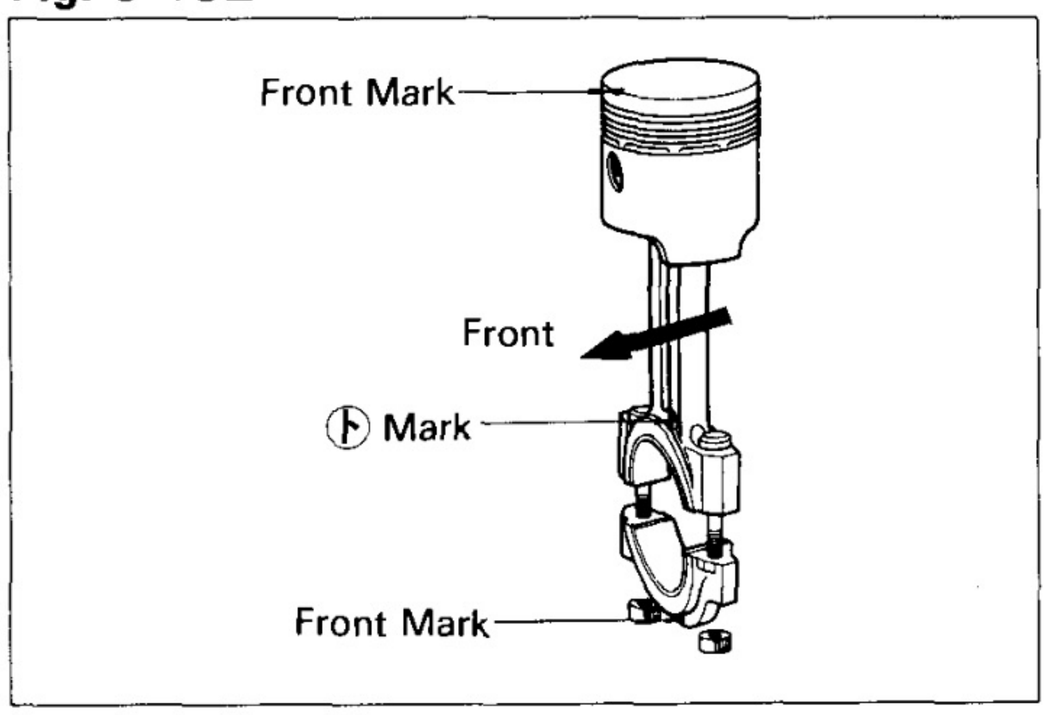
Position the ring gap in the direction shown in the figure.

Fig. 3-191



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

Fig. 3-192



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

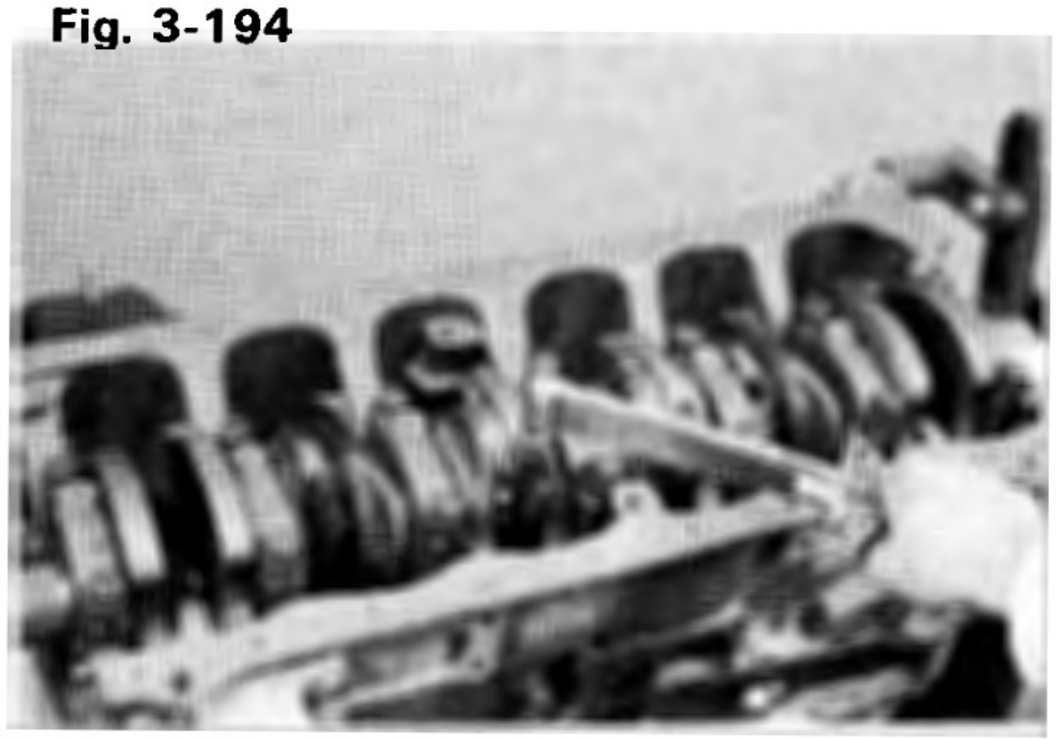
Fig. 3-193



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

— Note —
Be careful not to break the piston ring.

Fig. 3-194

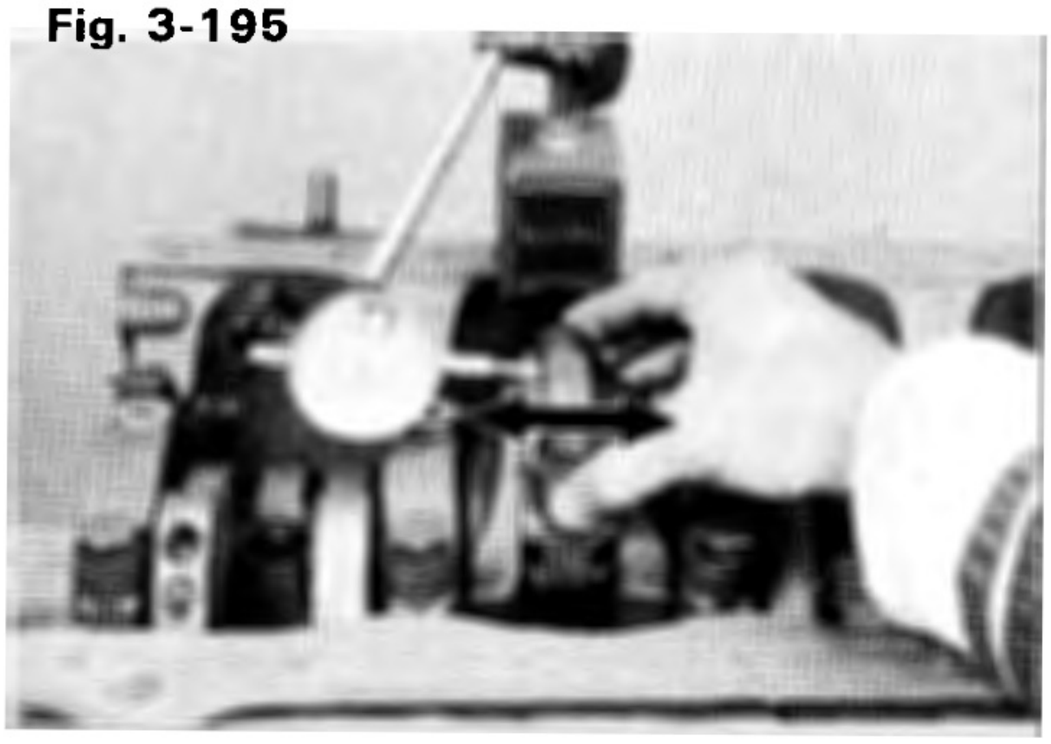


Tighten the connecting rod cap to specified torque.

Tightening torque: 8.5 – 9.5 kg-m (62 – 68 ft-lb)

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

Fig. 3-195

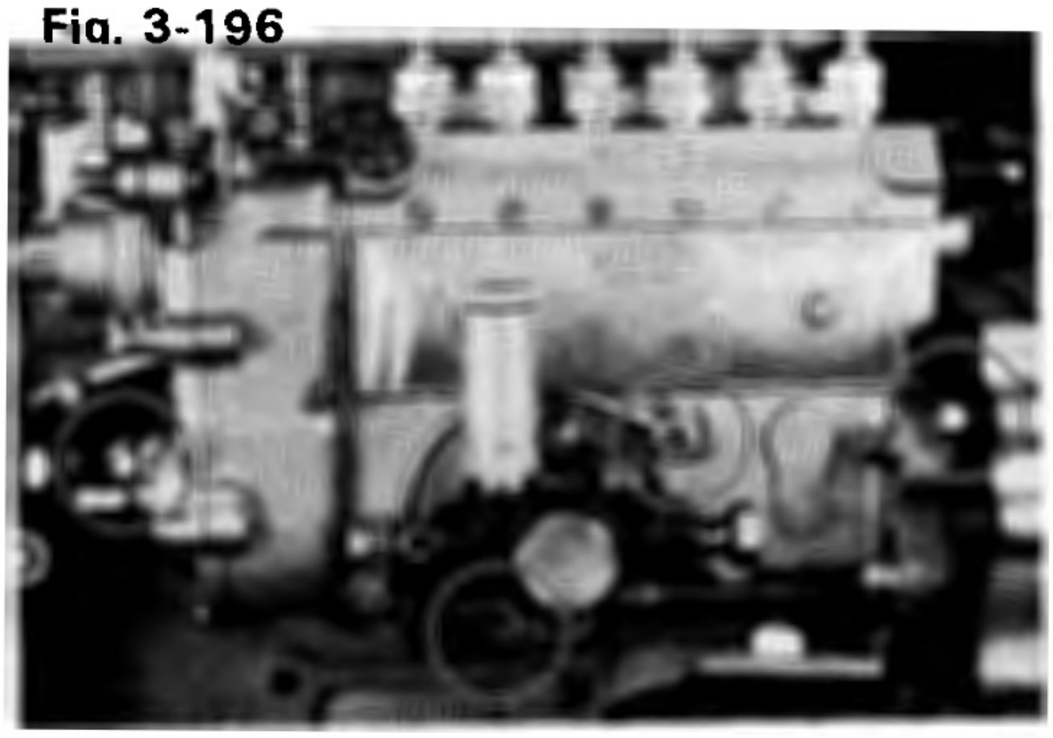


Check the connecting rod thrust clearance.

Thrust clearance:

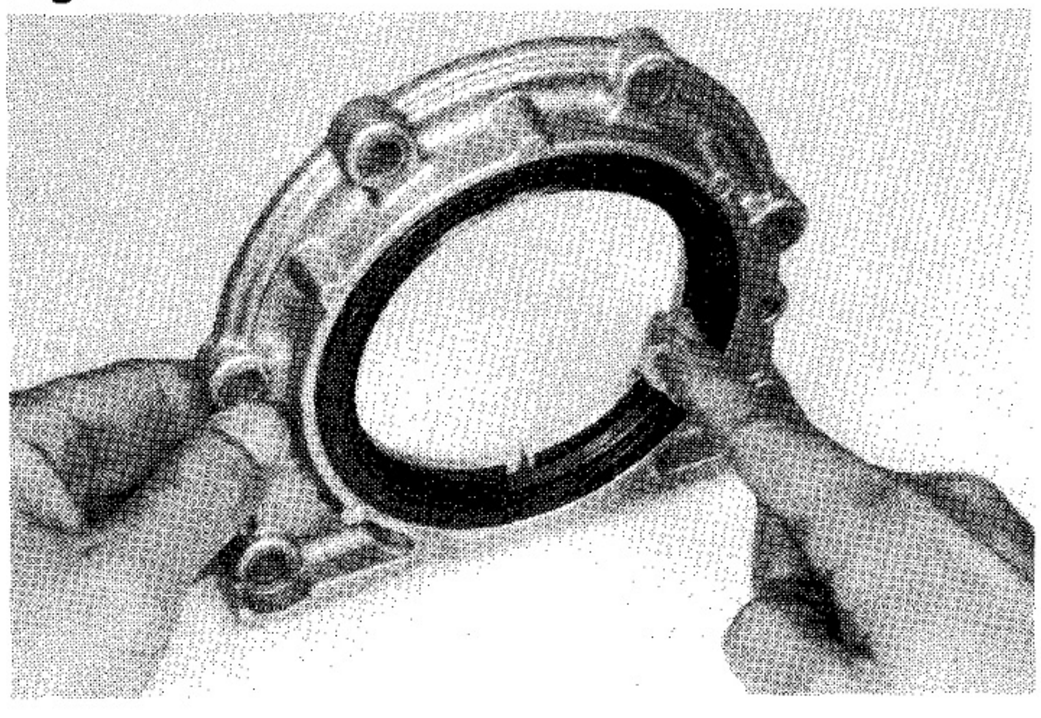
STD	**0.08 – 0.22 mm (0.0031 – 0.0087 in.)**
Limit	**0.3 mm (0.012 in.)**

Fig. 3-196



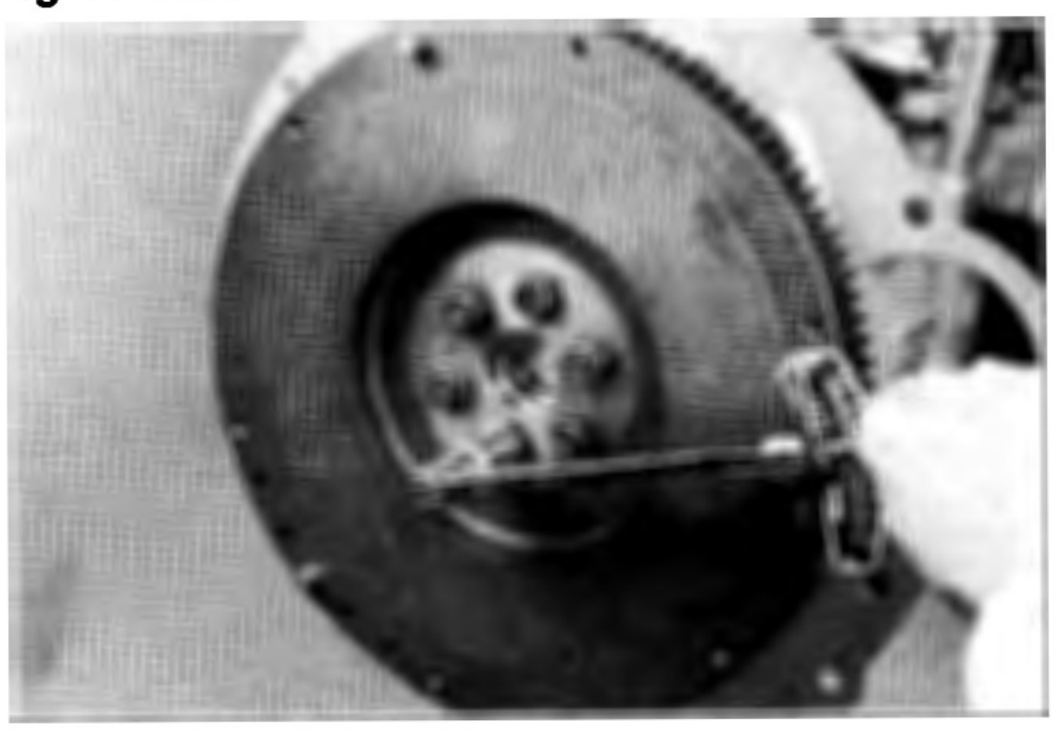
Install the injection pump with the pump retainer by tightening the pump mounting bolts and oil pipe union bolt.

Fig. 3-197



Coat the oil seal lip with MP grease before assembling.

Fig. 3-198



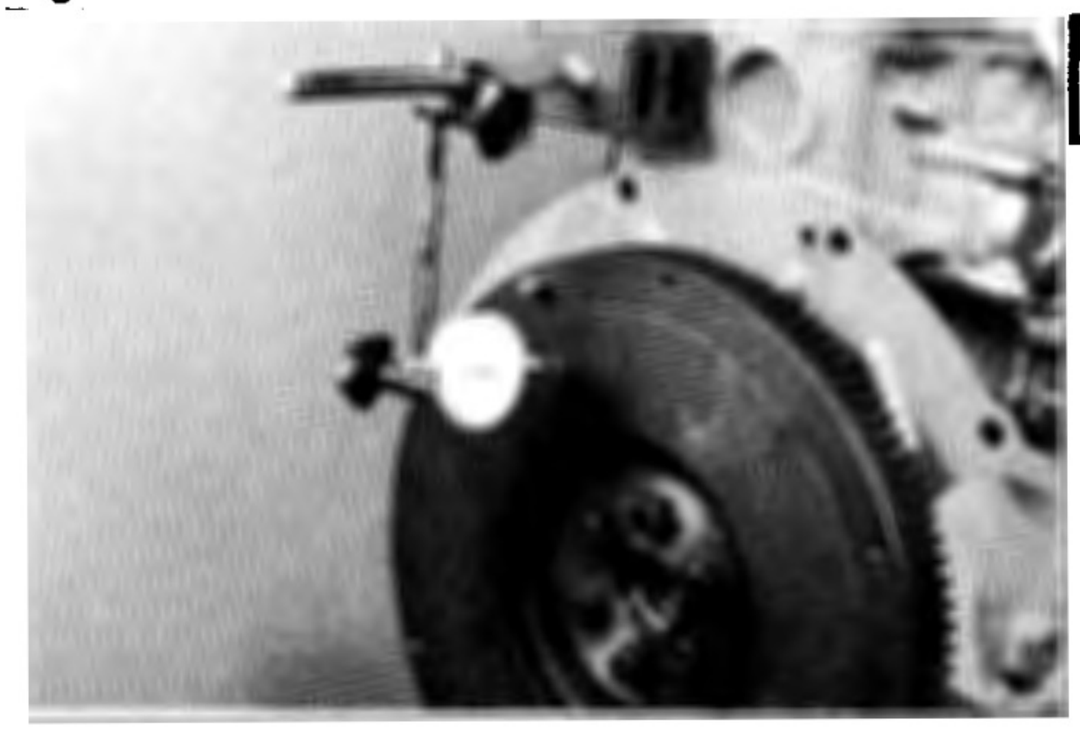
Tighten the bolts to specified torque.

Tightening torque: 11.5 – 12.5 kg-m (84 – 90 ft-lb)

– Note –

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

Fig. 3-199

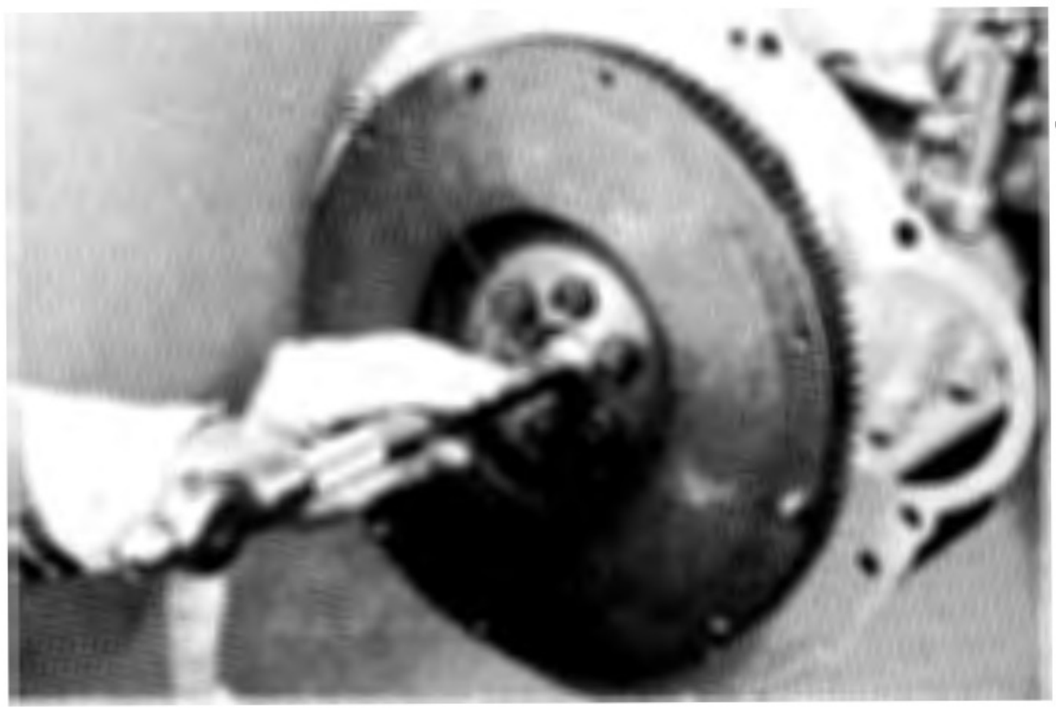


Check the flywheel for runout.

Runout:

Limit 0.2 mm (0.008 in.)

Fig. 3-200



Drive in the input shaft bearing with SST.

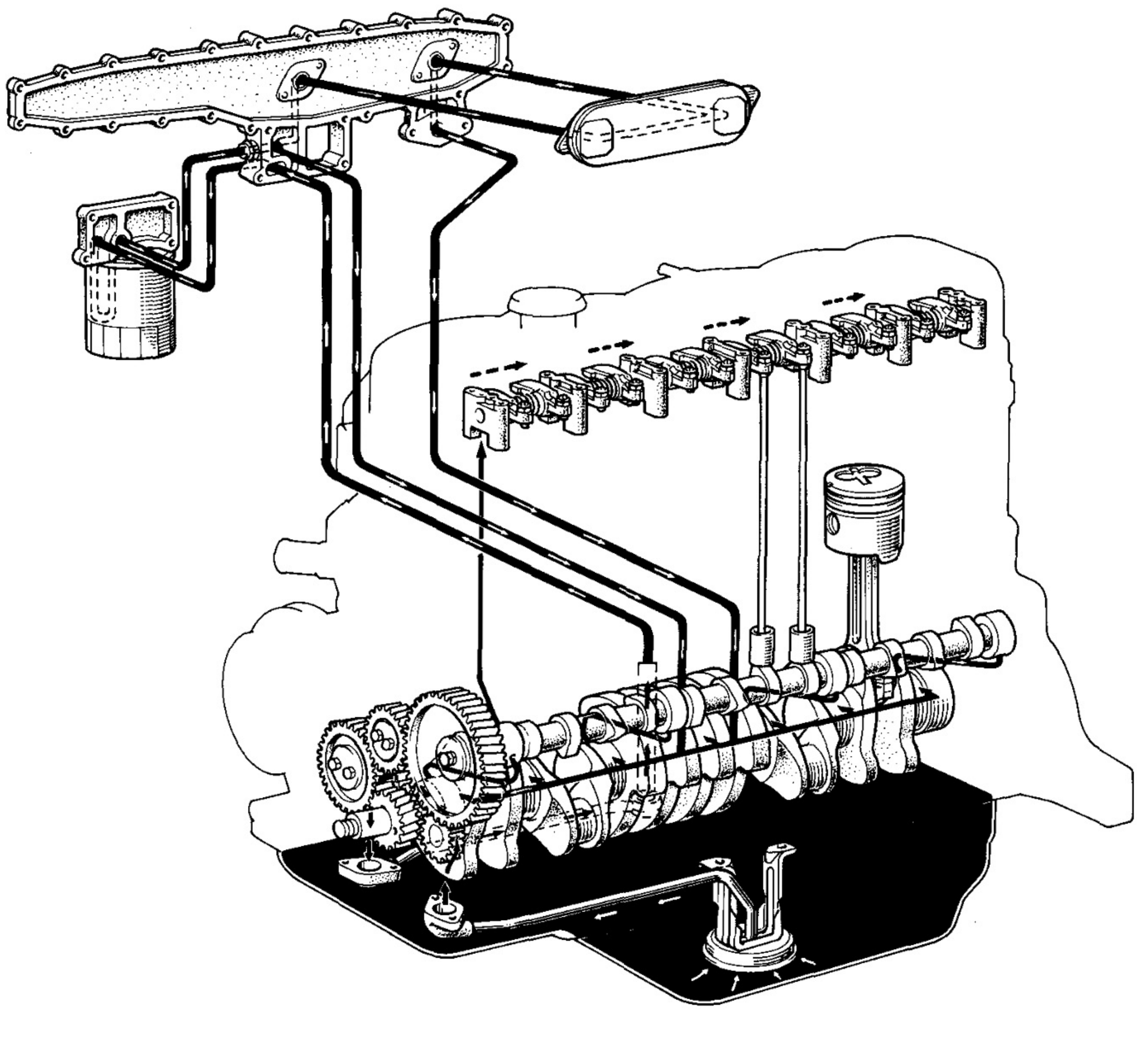
SST [09620-30010]

LUBRICATION SYSTEM

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OIL FILTER	4-3
CENTRIFUGAL OIL FILTER	4-5
OIL PUMP	4-9

LUBRICATION SYSTEM CIRCUIT

Fig. 4-1

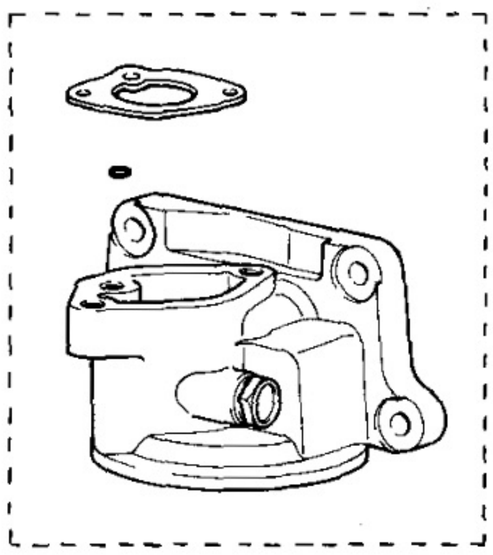


OIL FILTER

DISASSEMBLY

Disassemble the parts in the numerical order shown in the figure.

Fig. 4-2



w/ Centrifugal Oil Filter Type

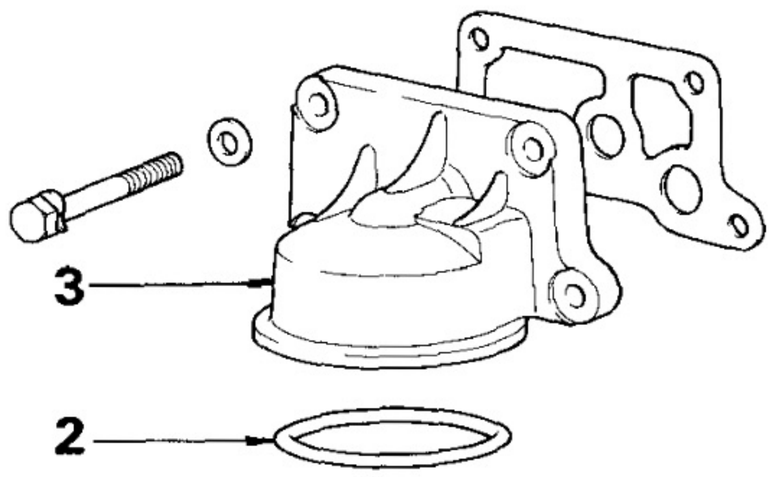
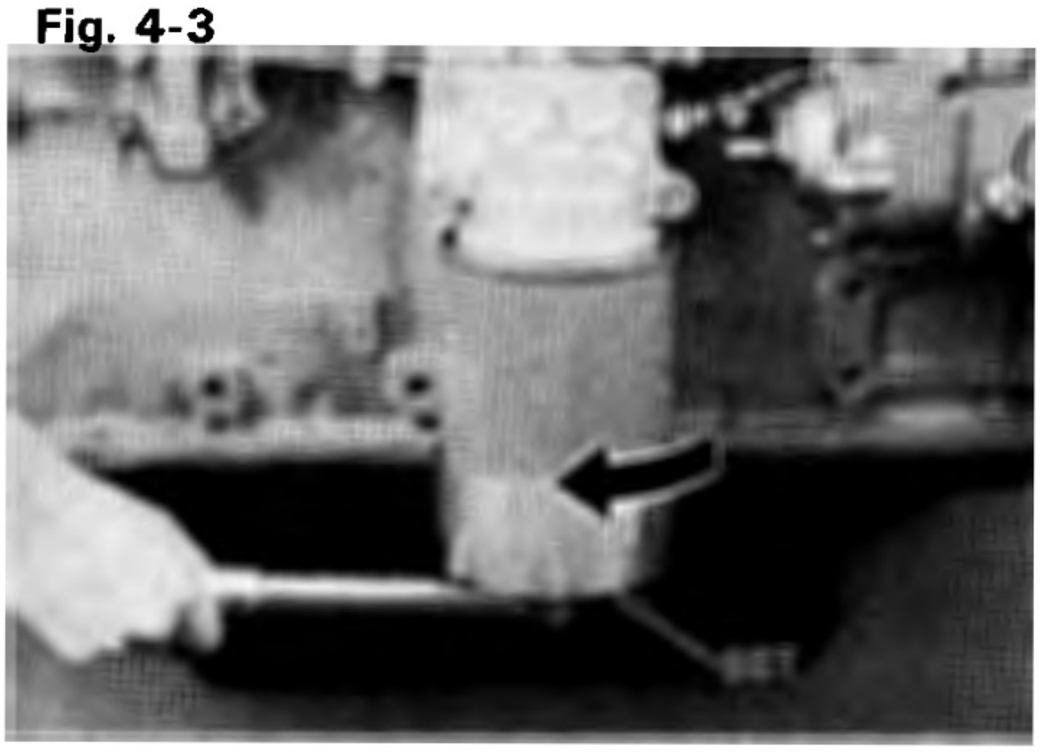


Fig. 4-3

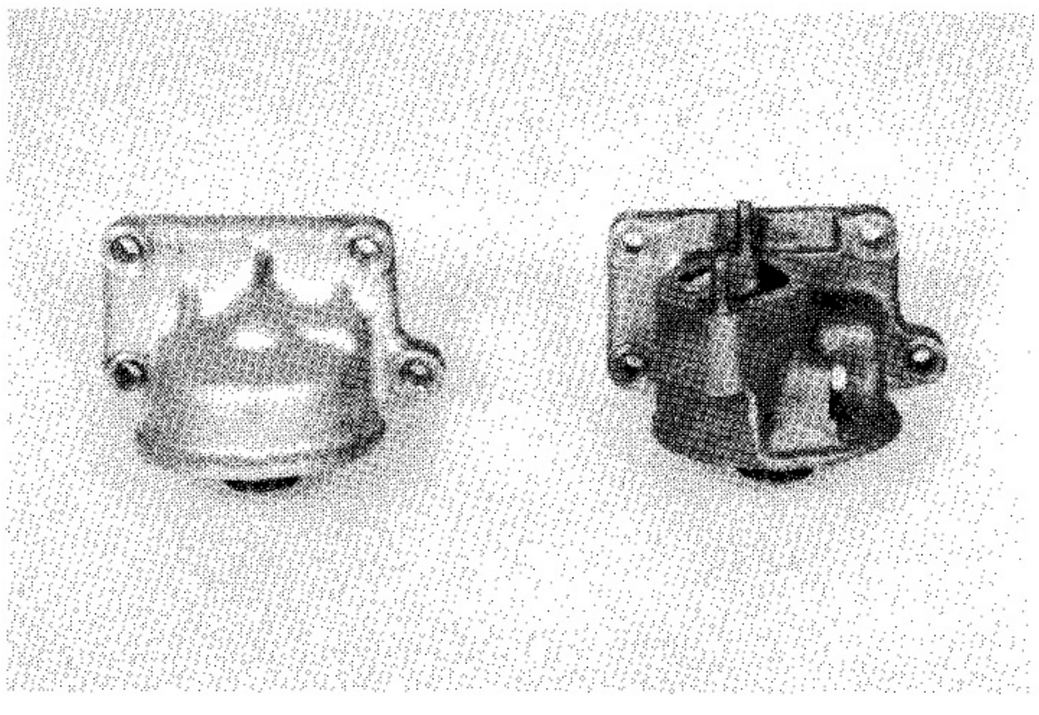
1. Filter Element
2. Oil Filter Body Gasket
3. Oil Filter Cap

Fig. 4-3



Remove the oil filter with SST.
SST [09228-60010]

Fig. 4-4



INSPECTION

Check the contacting surface of the oil filter cap for scoring or cracks.

ASSEMBLY

Assemble the parts in the numerical order shown in the figure.

Fig. 4-5

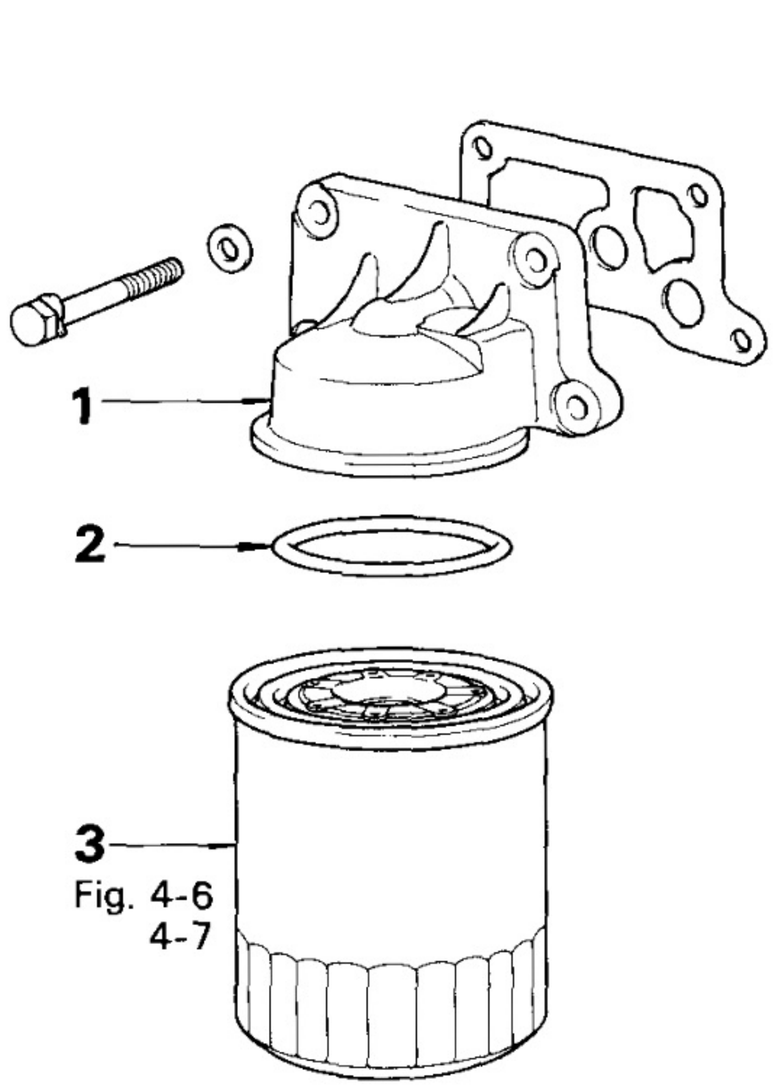
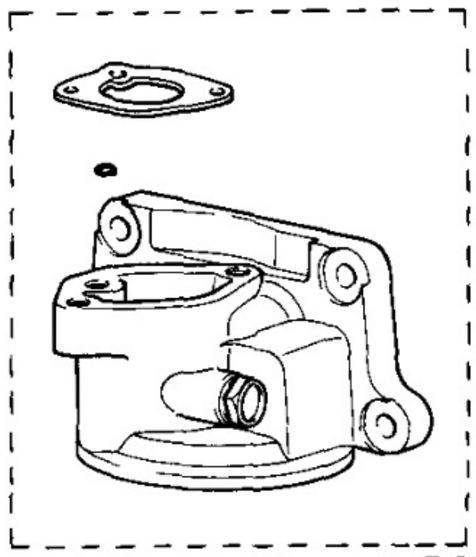


Fig. 4-6
4-7



w/ Centrifugal Oil Filter Type

1. Oil Filter Cap
2. Oil Filter Body Gasket
3. Filter Element

Fig. 4-6



Install the oil filter and tighten it firmly by hand.

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

Fig. 4-7



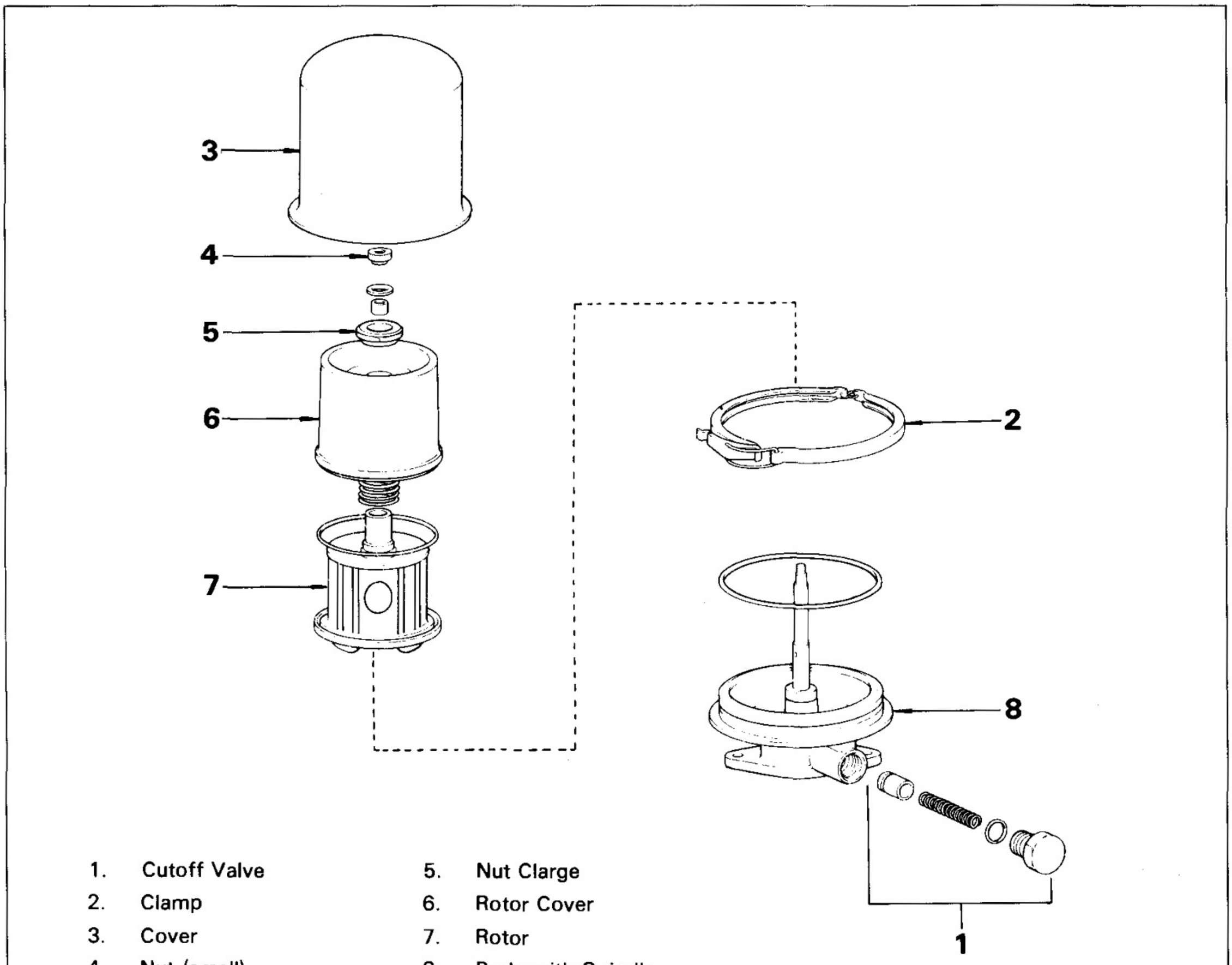
After installing, start the engine and check for oil leakage.
Then, stop the engine and recheck the oil level.

CENTRIFUGAL OIL FILTER

DISASSEMBLY

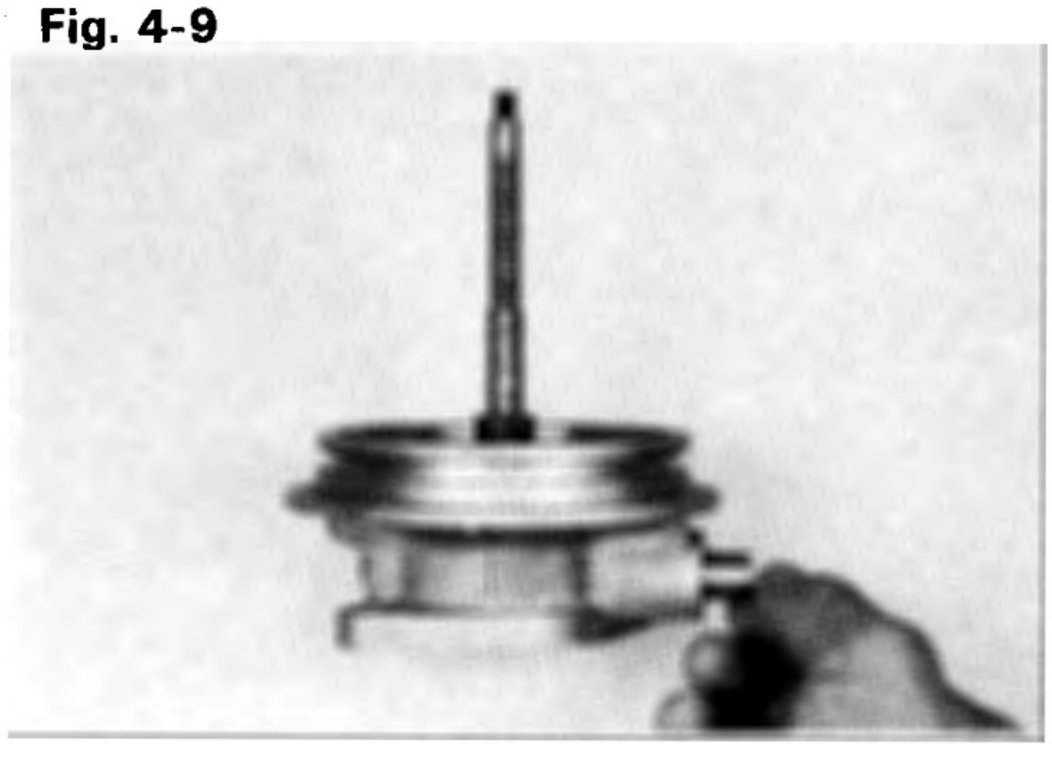
Disassemble the parts in the numerical order shown in the figure.

Fig. 4-8



1. Cutoff Valve
2. Clamp
3. Cover
4. Nut (small)
5. Nut Clarge
6. Rotor Cover
7. Rotor
8. Body with Spindle

Fig. 4-9

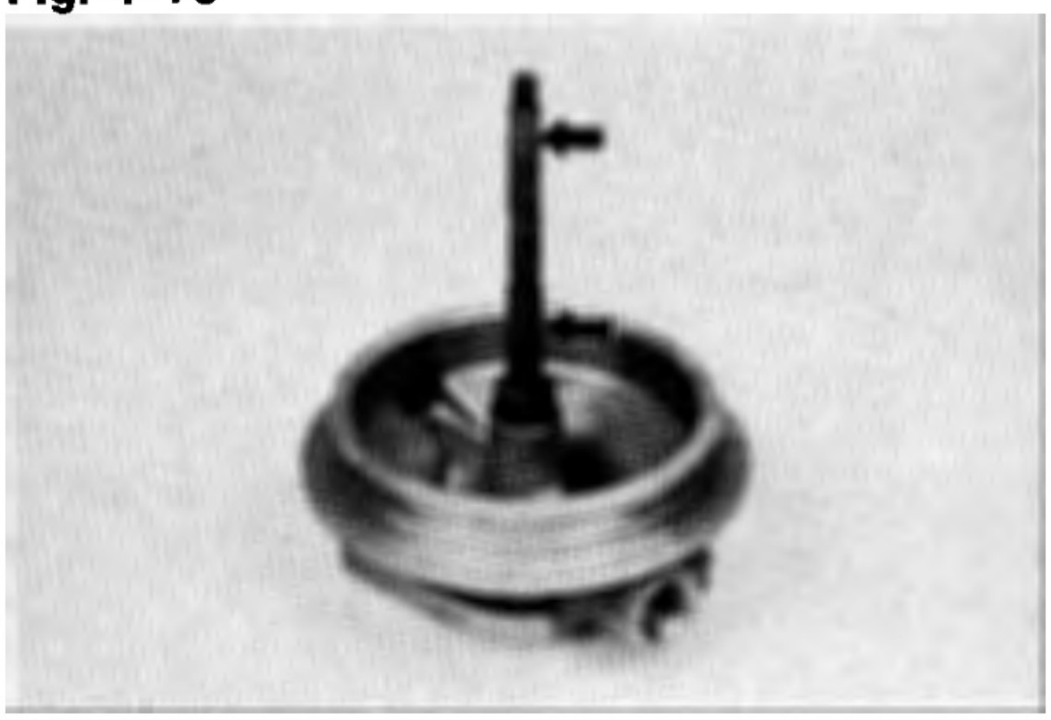


INSPECTION

Cutoff Valve

Check for wear and confirm the sliding condition.

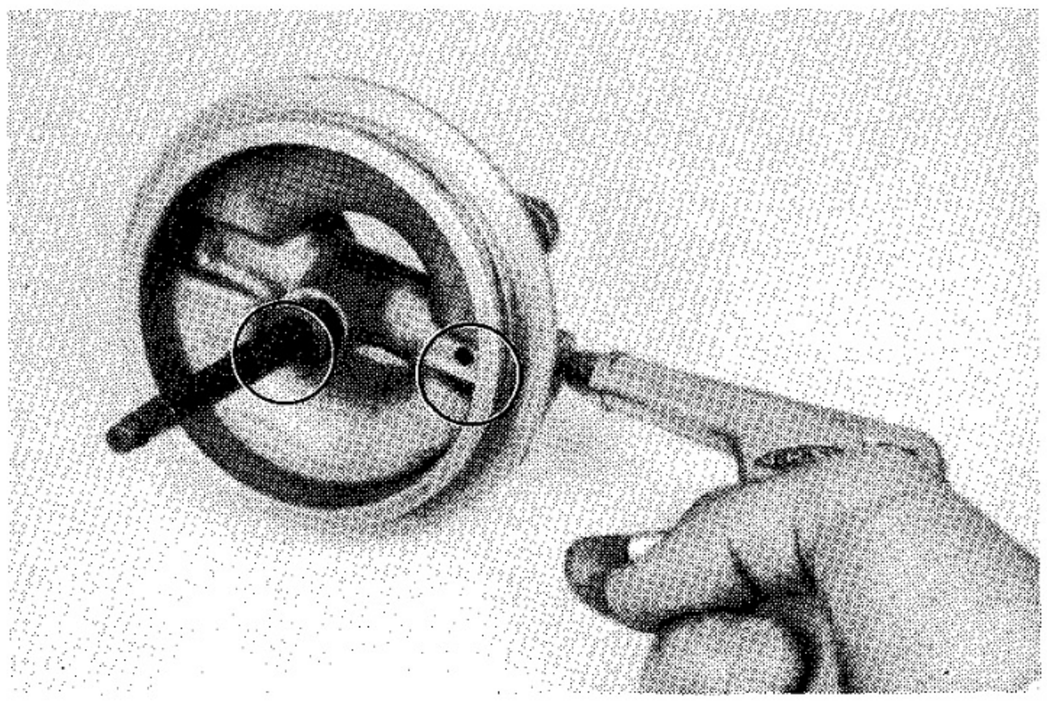
Fig. 4-10



Body & Spindle

1. Check for wear or damage, especially the points indicated by arrows in the figure.

Fig. 4-11



2. Check the oil holes for clogging.
   If necessary, clean the holes with compressed air.

Fig. 4-12



Rotor

1. Check the bushings for wear or damage.

Fig. 4-13

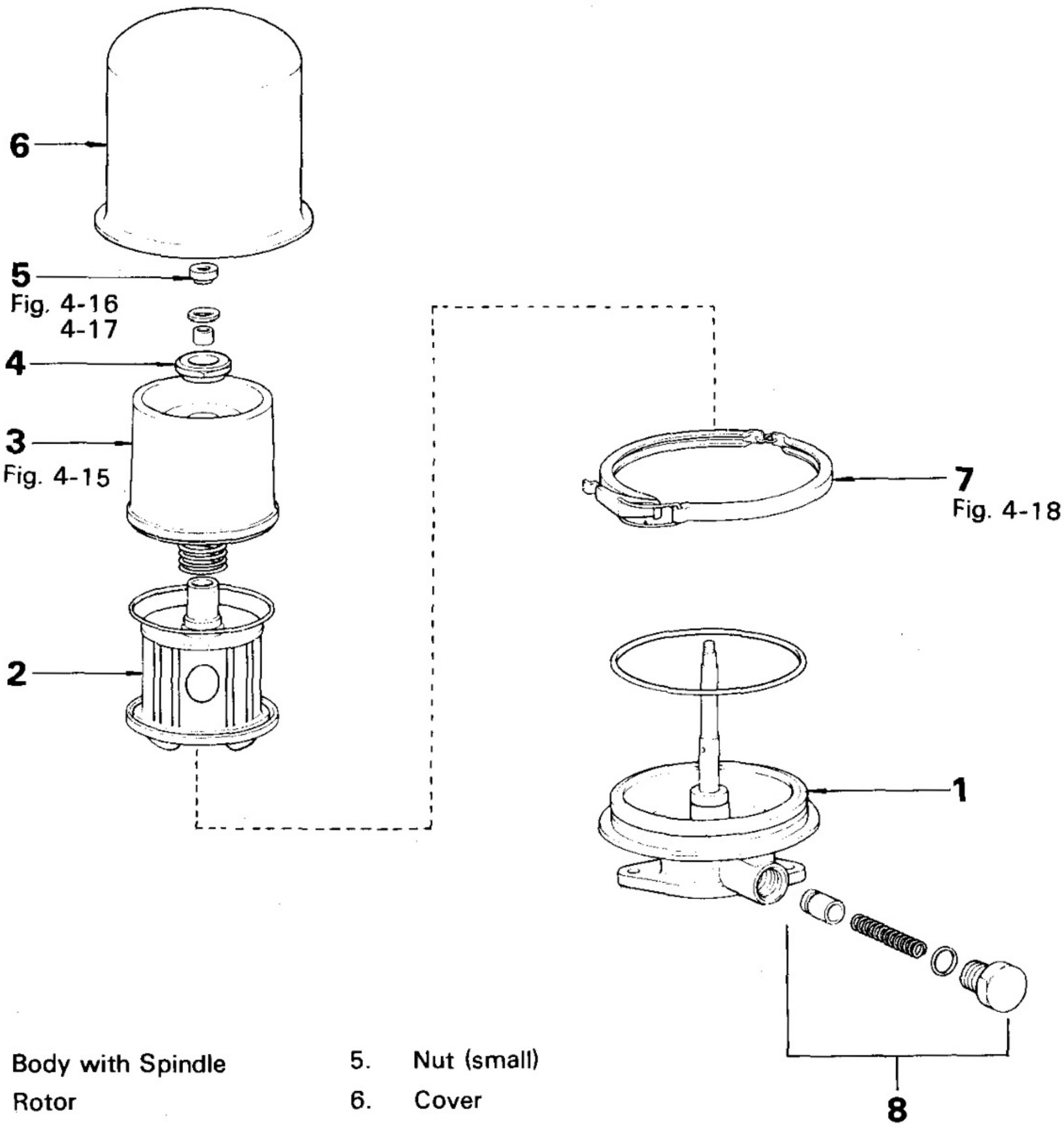


2. Check the oil discharge holes for clogging.
   If necessary, clean the holes with compressed air.

ASSEMBLY

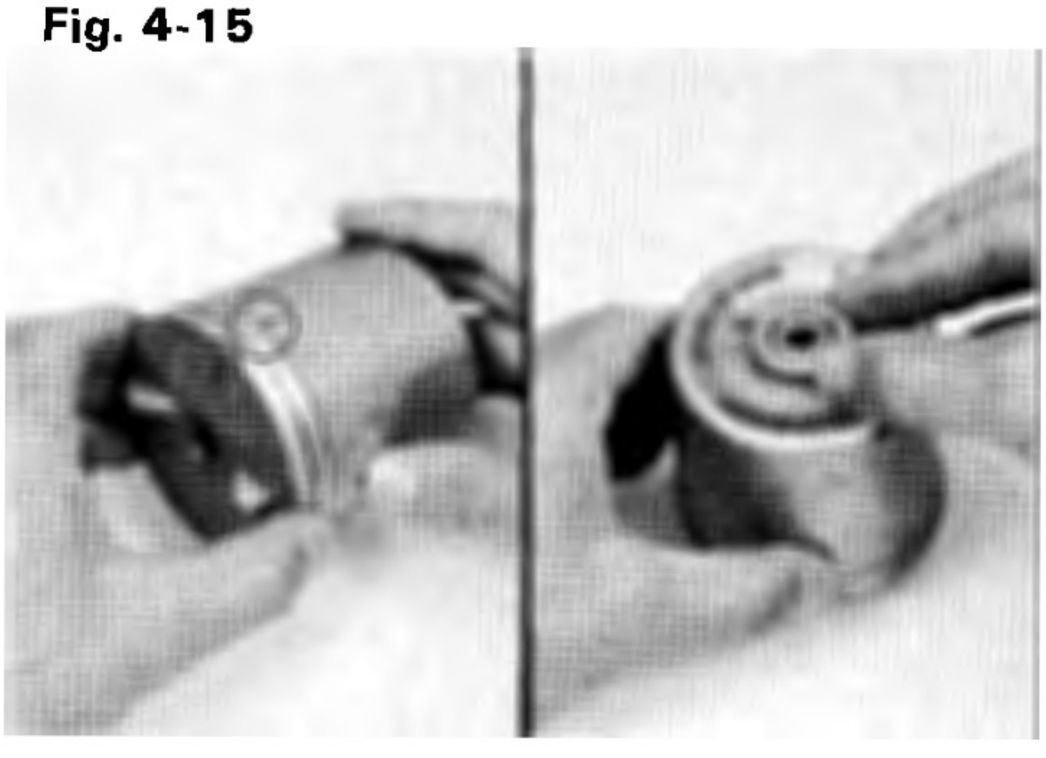
Assemble the parts in the numerical order shown in the figure.

Fig. 4-14



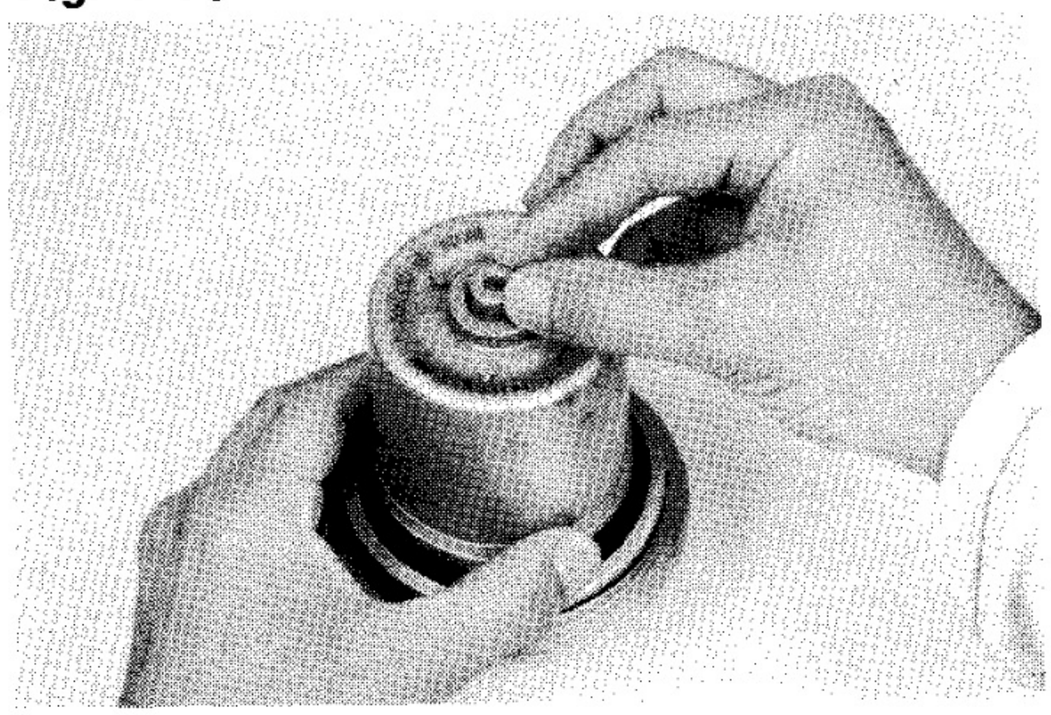
1. Body with Spindle
2. Rotor
3. Rotor Cover
4. Nut (large)
5. Nut (small)
6. Cover
7. Clamp
8. Cutoff Valve

Fig. 4-15



⚠ Align the matchmark of the rotor with that of the rotor cover.
Tighten the rotor cover set nut by hand.

Fig. 4-16



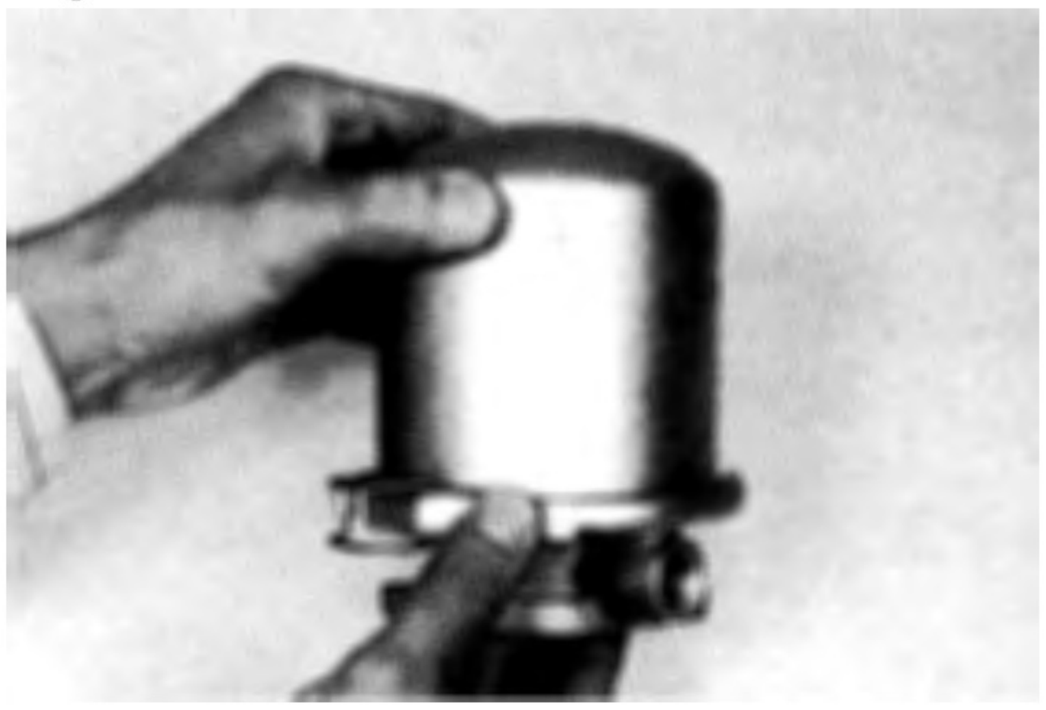
Set the rotor on the body and tighten the nut by hand.

Fig. 4-17



Make sure that the rotor rotates smoothly and lightly.

Fig. 4-18



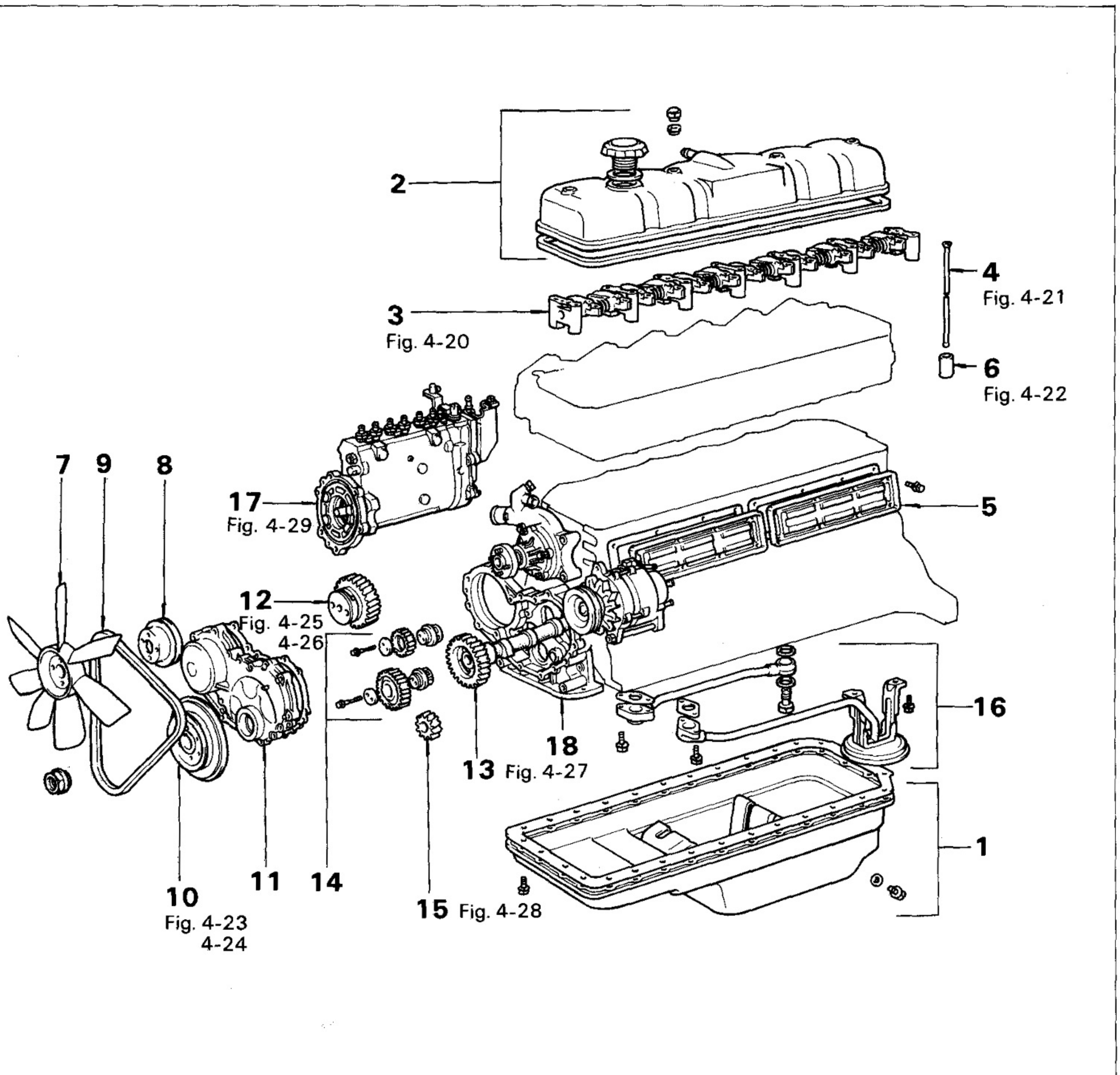
Clamp the filter cover, being careful not to clamp over the hole for the cutoff valve.

OIL PUMP

REMOVAL

Remove the parts in the numerical order shown in the figure.

Fig. 4-19



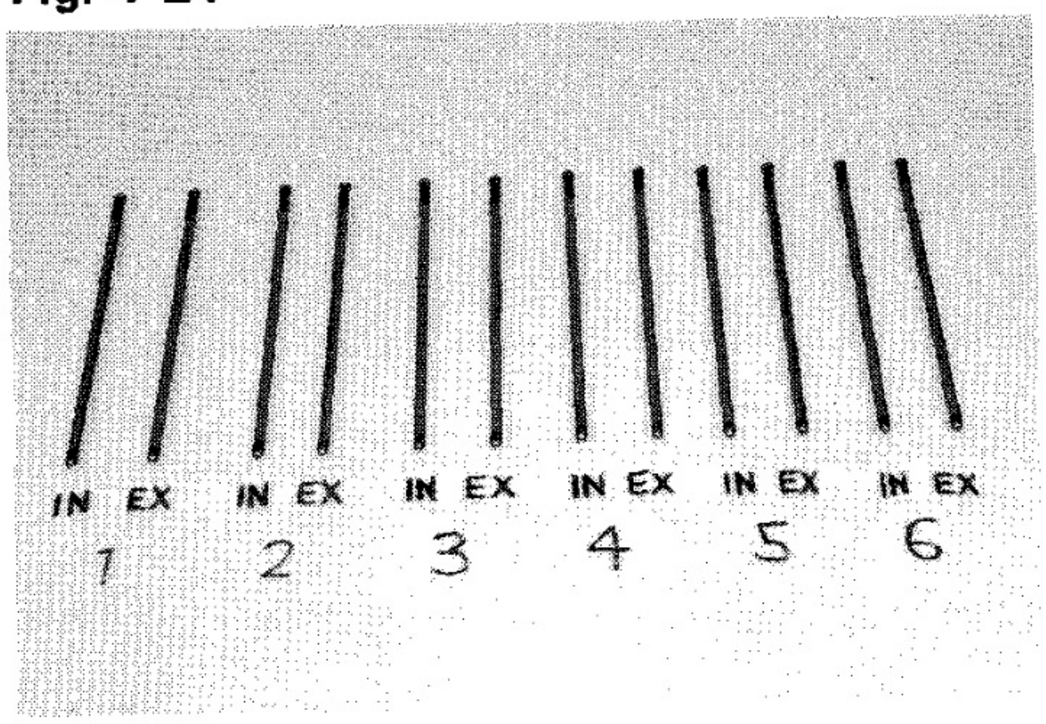
1. Oil Pan
2. Cylinder Head Cover
3. Valve Rocker Shaft Assembly
4. Valve Push Rod
5. Valve Push Rod Cover
6. Valve Lifter
7. Cooling Fan
8. Fan Pulley
9. Drive Belt
10. Crankshaft Pulley
11. Timing Gear Cover
12. Automatic Timer
13. Camshaft & Timing Gear
14. Idle Gear No. 1 & No. 2
15. Crankshaft Timing Gear
16. Oil Strainer & Pipe
17. Injection Pump & Oil Pipe
18. Timing Gear Case & Oil Pump

Fig. 4-20



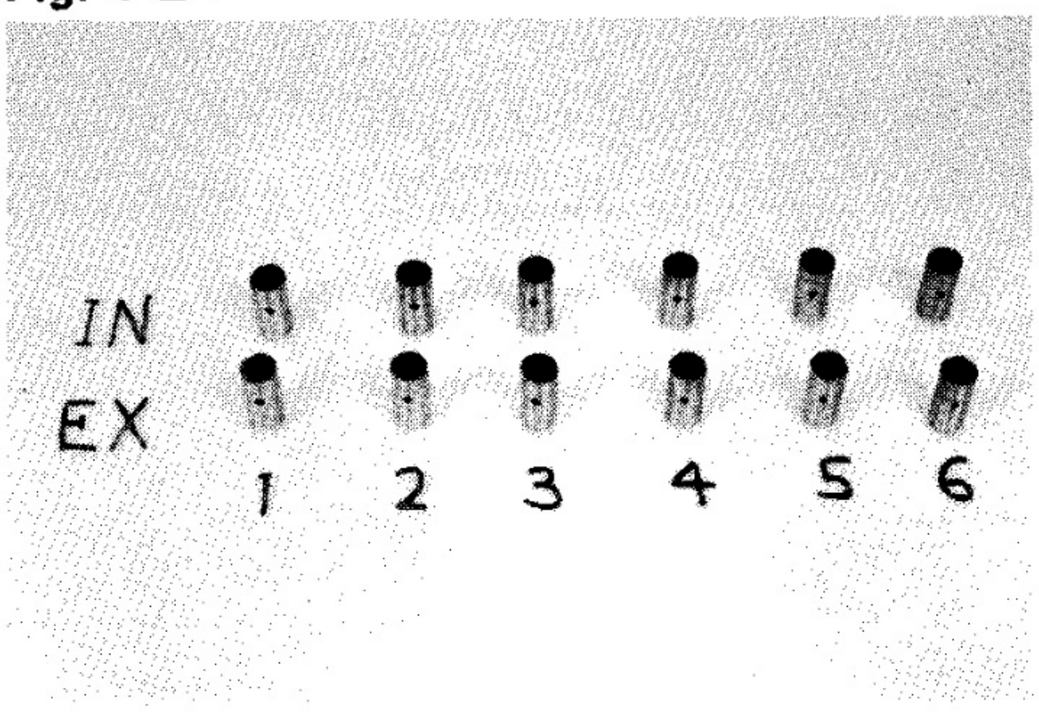
Loosen each rocker support bolt a little at a time in the sequence shown in the figure.

Fig. 4-21



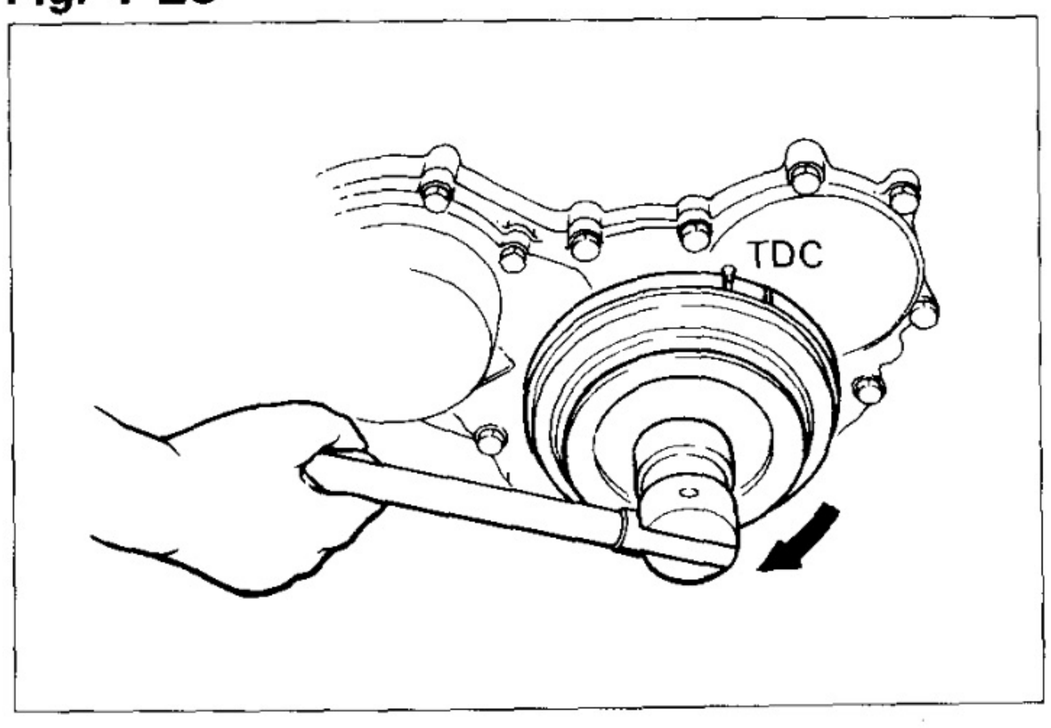
Keep the push rods in correct order.

Fig. 4-22



Keep the valve lifters in correct order.

Fig. 4-23



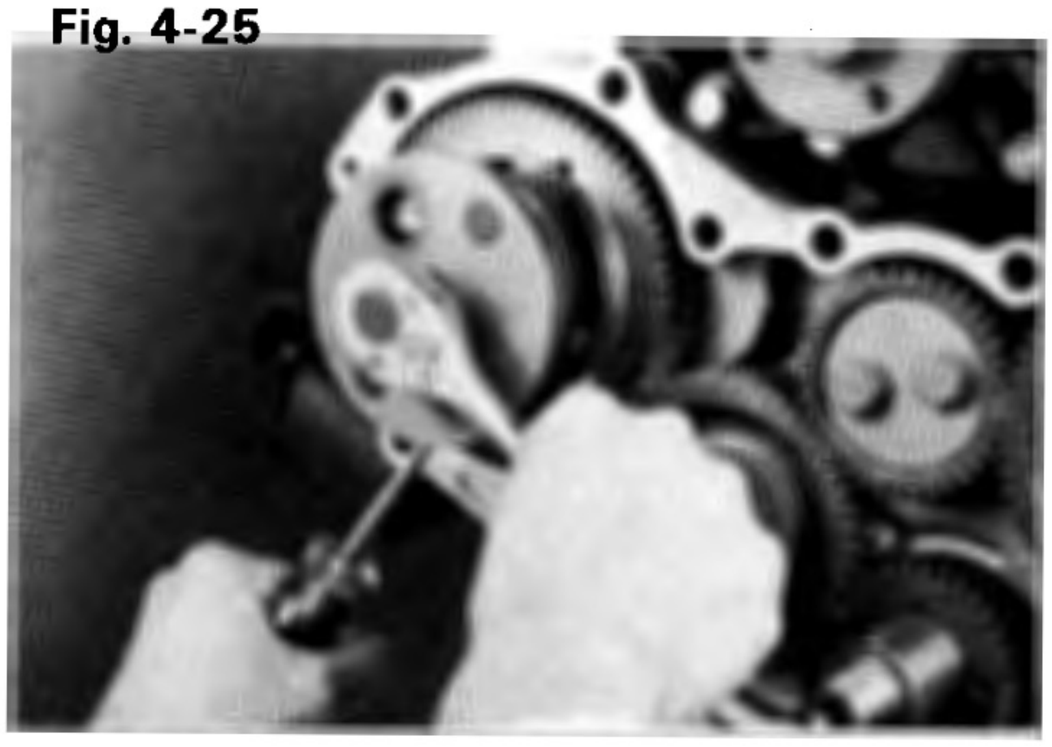
Before starting work, set No.1 cylinder piston to TDC/compression.

Fig. 4-24



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

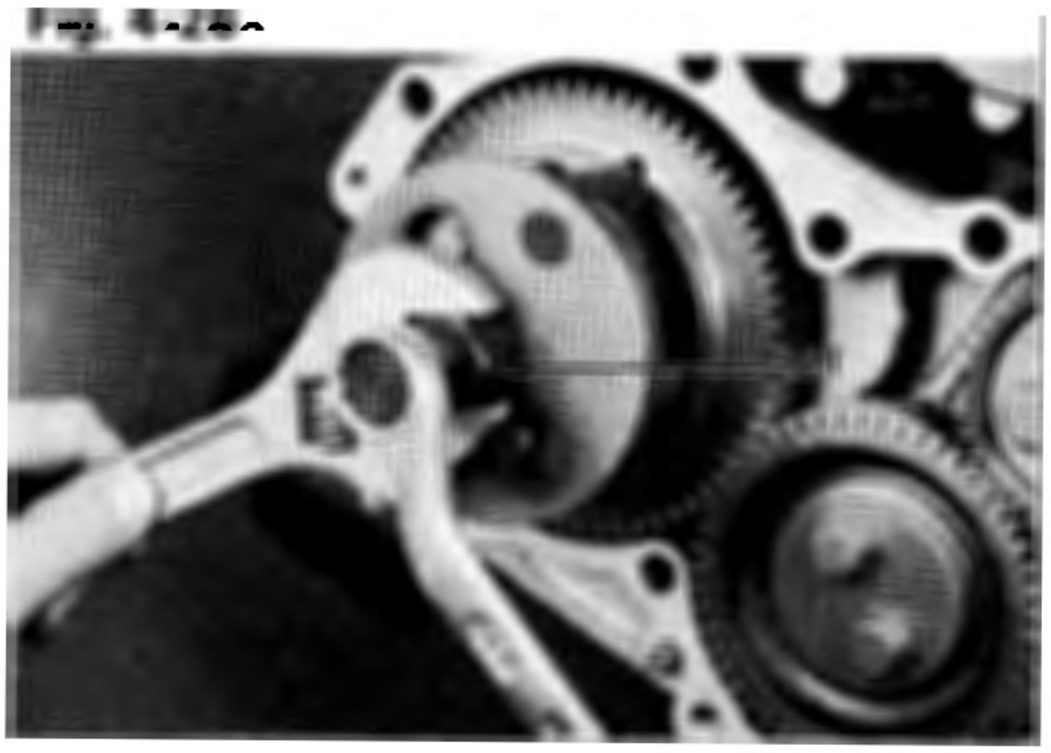
Fig. 4-25



Remove the automatic timer from the injection pump.

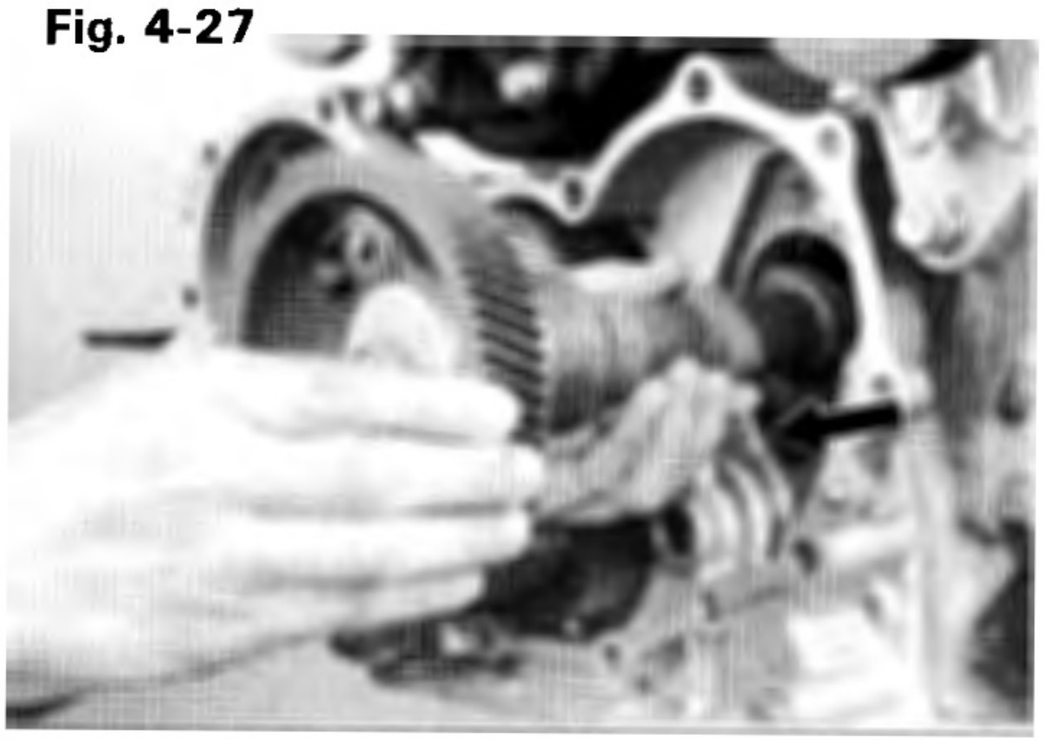
1. Hold the timer with a screwdriver and remove the round nut.

—Note—
Be careful not to scratch the timer weight sliding surface.



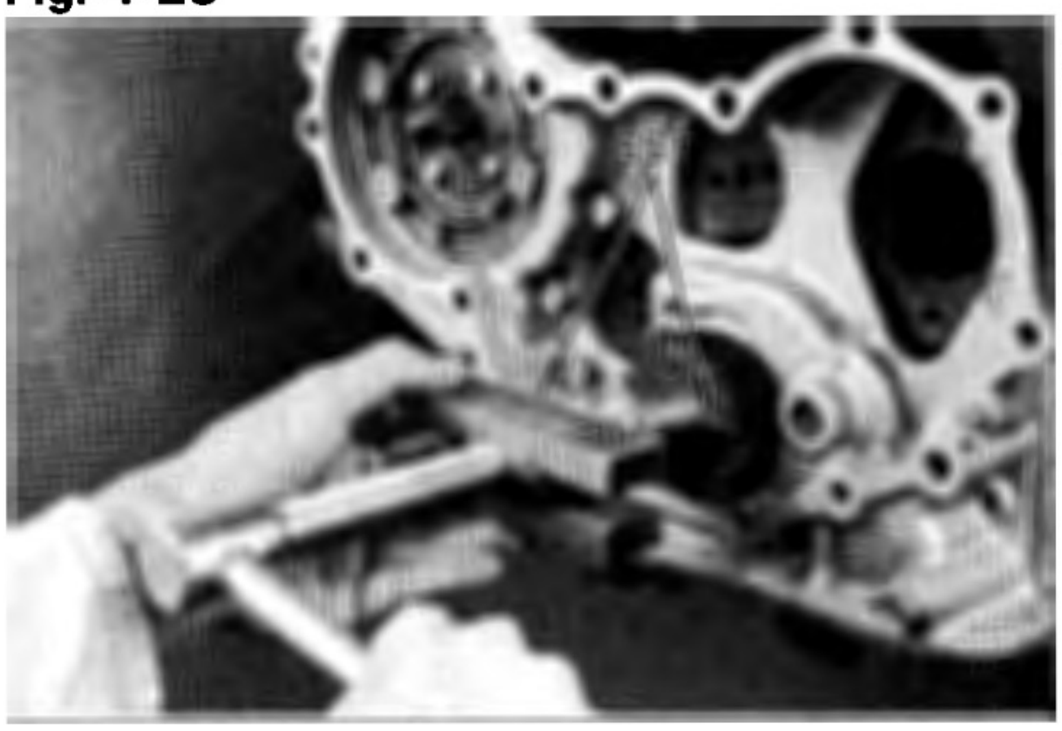
2. Using SST, drive out the timer from the injection pump camshaft.
SST [09267-76020]

Fig. 4-27



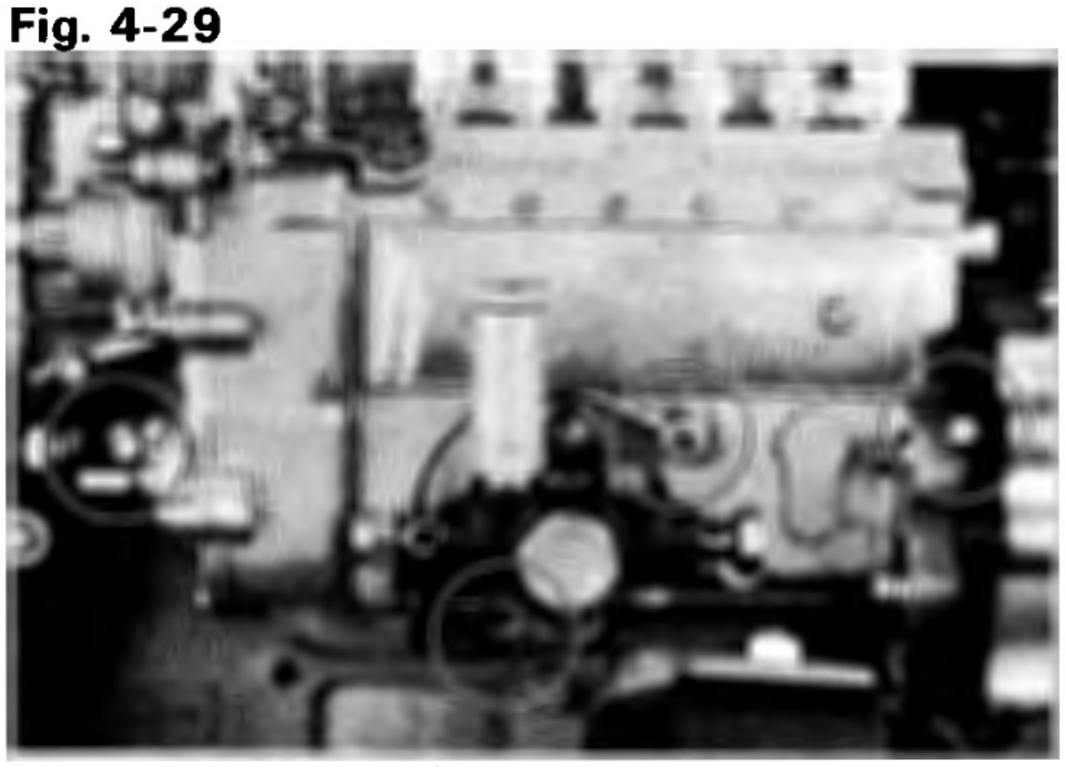
Pull out the camshaft, using care not to damage the camshaft bearings.

Fig. 4-28



Pull out the crankshaft timing gear with SST.
SST [09213-60016]
[09219-60020]

Fig. 4-29

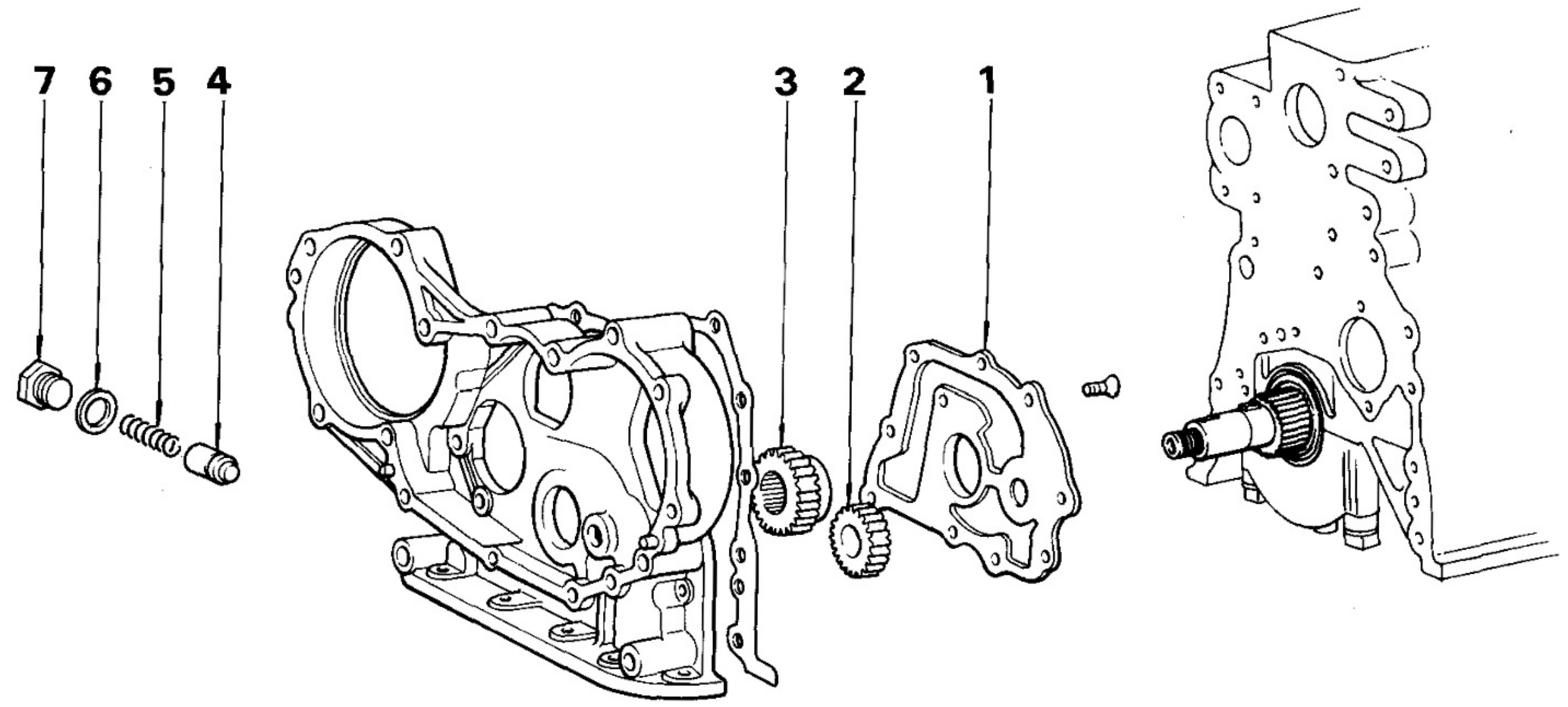


Remove the injection pump with pump retainer by loosening the pump mounting bolts and oil pipe union bolt.

DISASSEMBLY

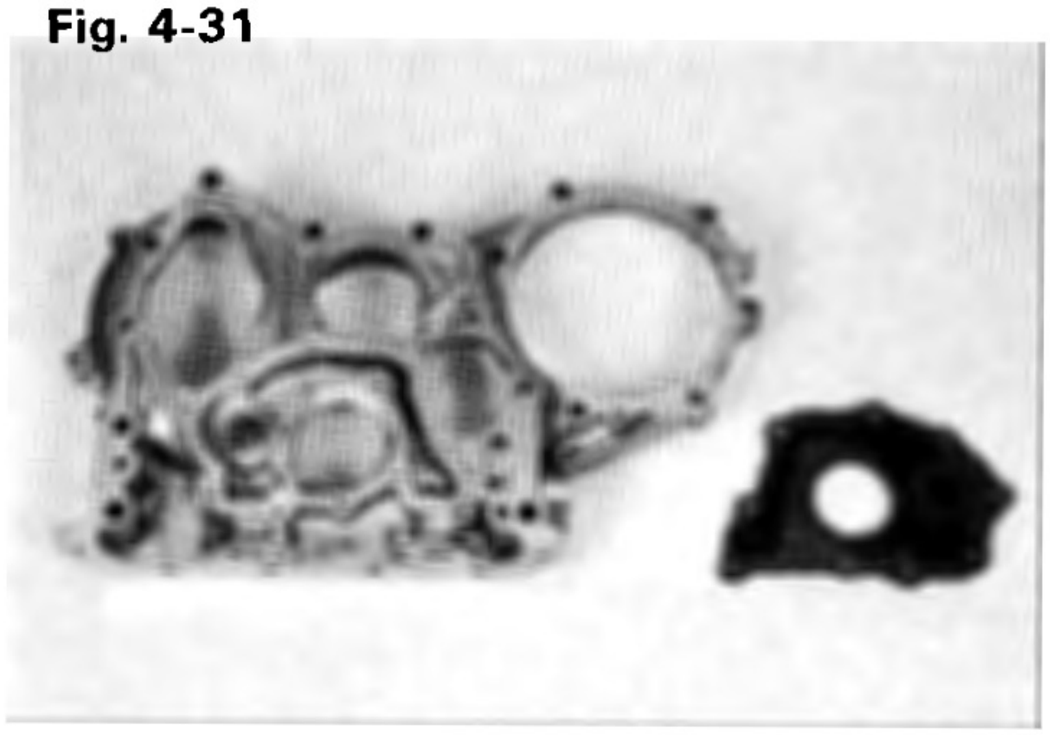
Disassemble the parts in the numerical order shown in the figure.

Fig. 4-30



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

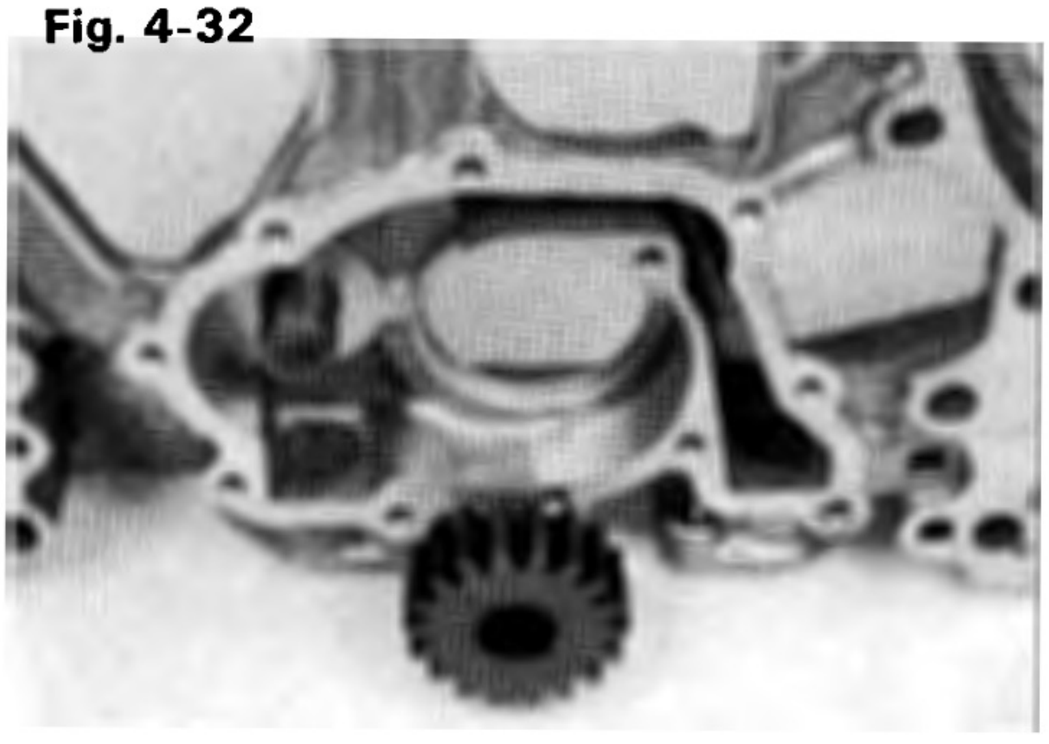
Fig. 4-31



INSPECTION

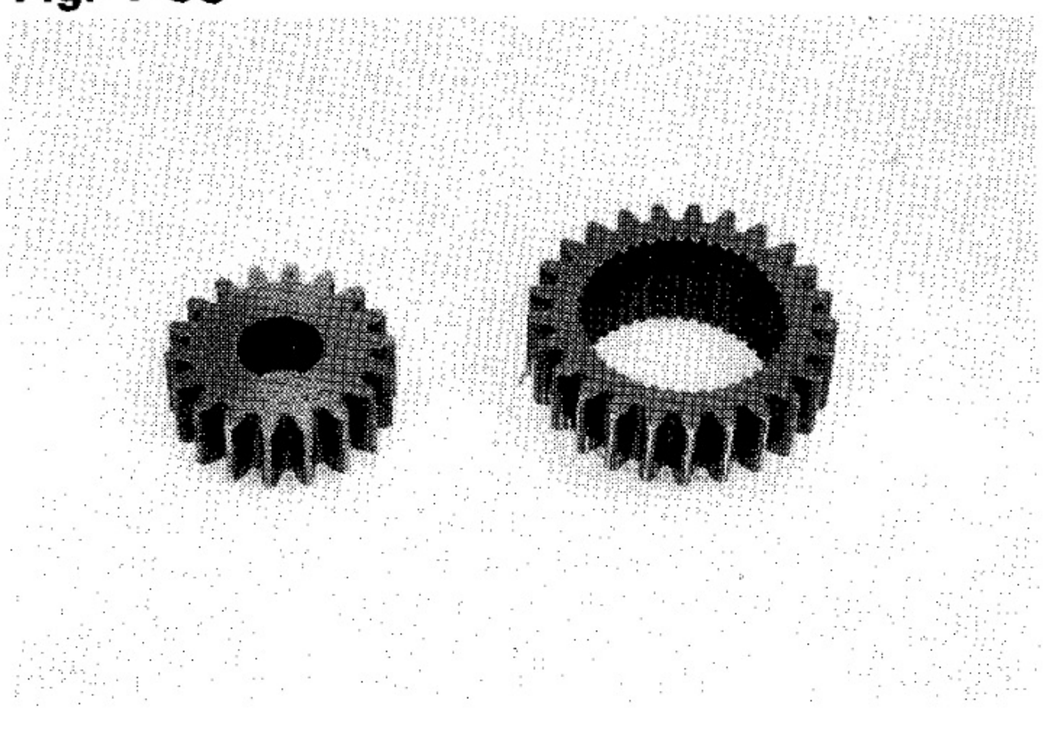
1. Check the timing gear case and oil pump plate for wear or damage.

Fig. 4-32



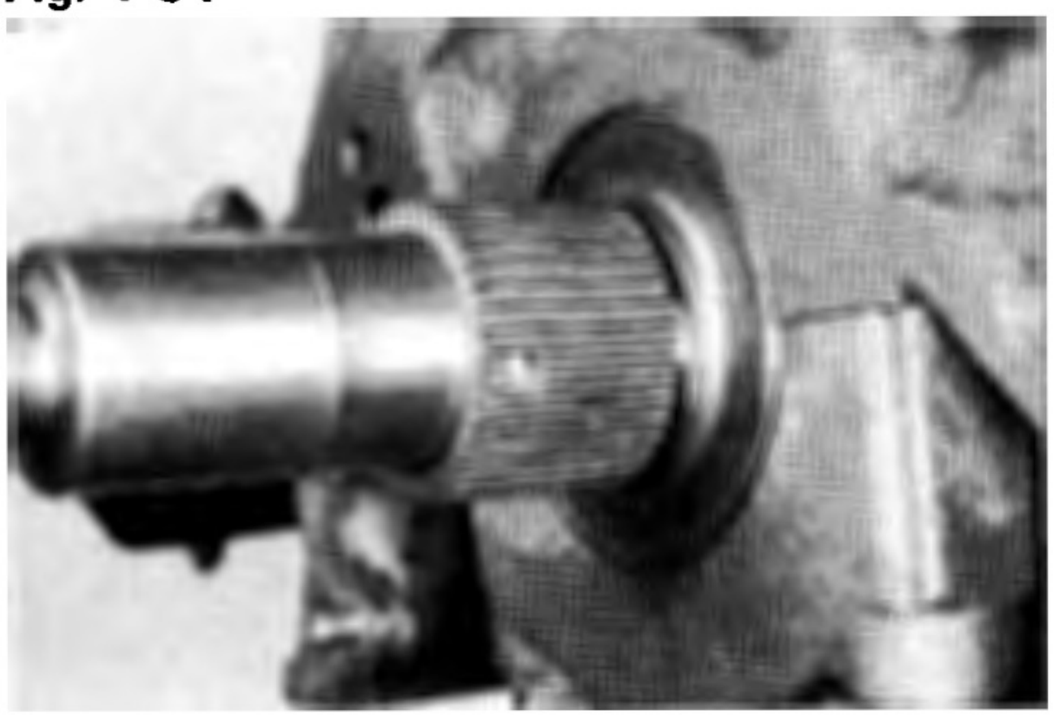
2. Check the driven gear shaft and driven gear for wear or damage.

Fig. 4-33



3. Check the gear teeth for wear or damage.

Fig. 4-34



4. Check the oil pump drive spline for wear or damage and replace if necessary.

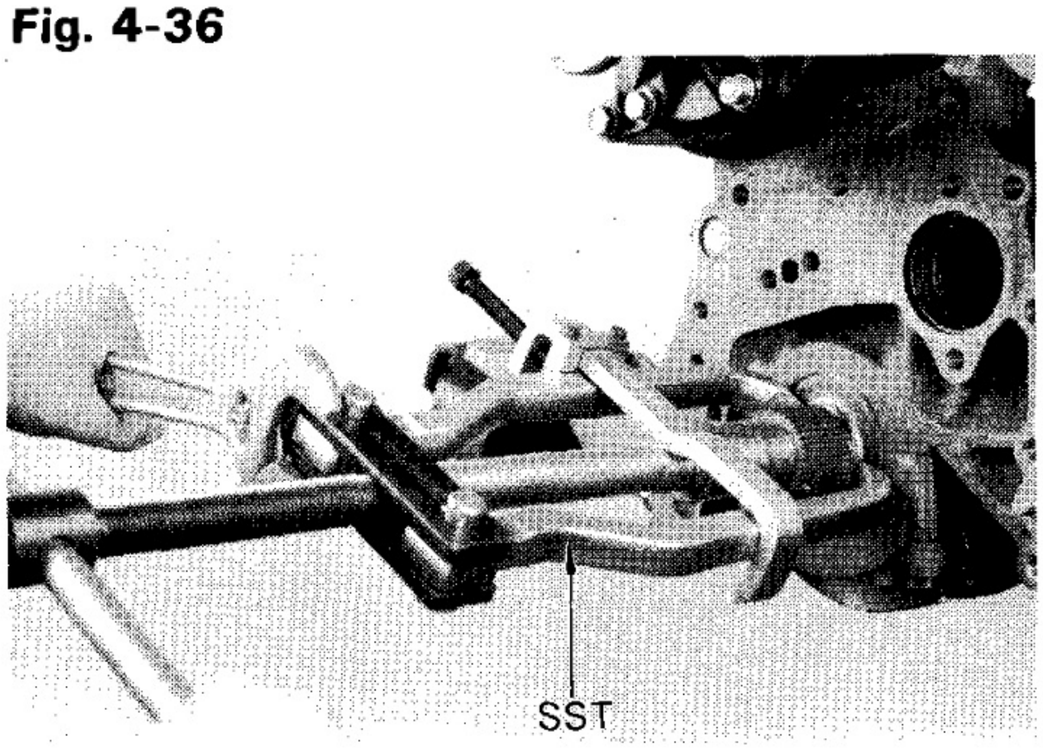
Fig. 4-35



5. Replace the oil pump drive spline.
   (1) Drive out the spline with a chisel until SST can be hooked on the spline end.
   SST [09950-20014]

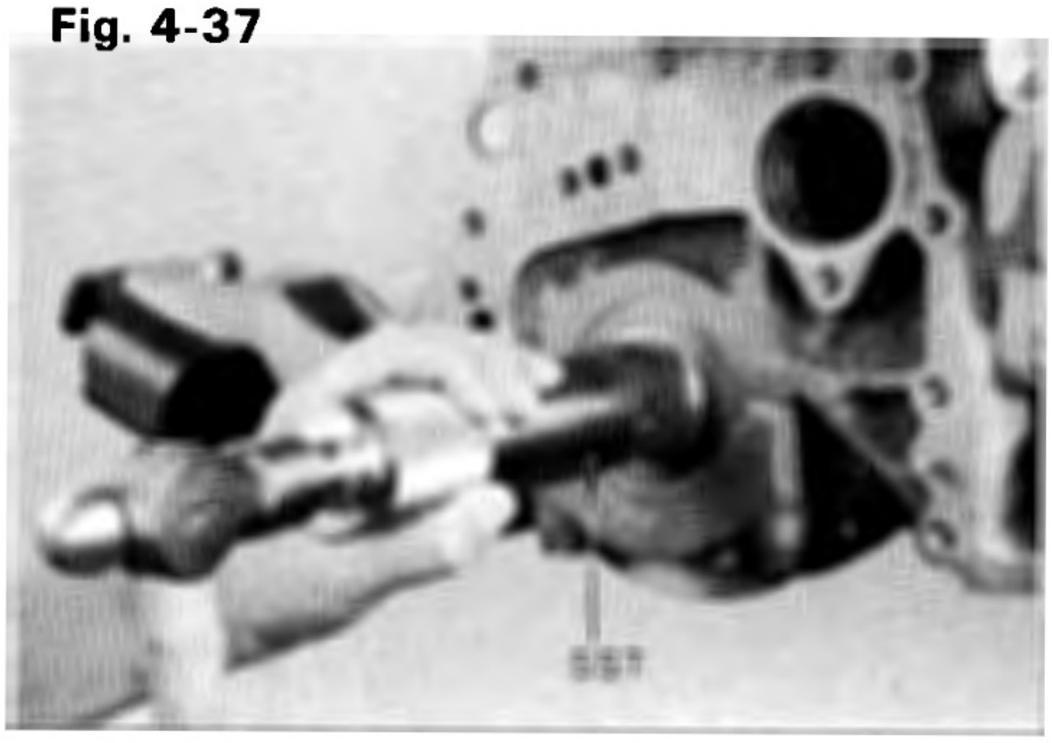
— Note —
Place the chisel point in the oil pump drive spline hole indicated in the figure.

Fig. 4-36



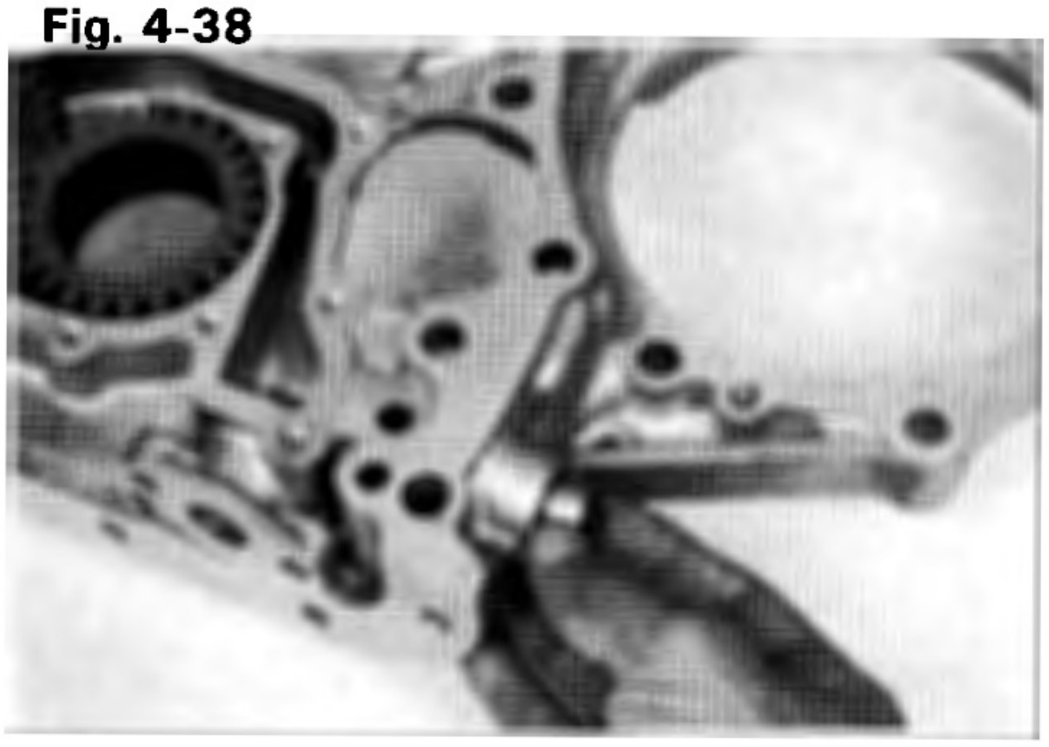
   (2) Pull out the spline with SST.
   SST [09950-20014]

Fig. 4-37



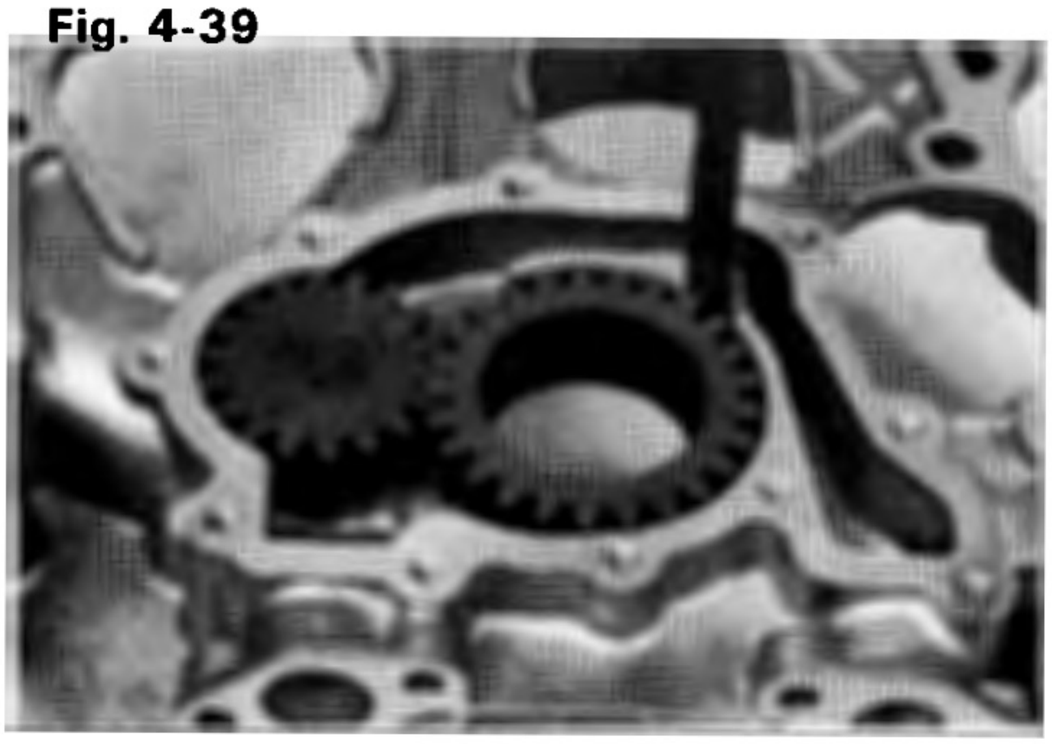
(3) Drive in a new spline with SST.
SST [09316-60010]

Fig. 4-38



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

Fig. 4-39

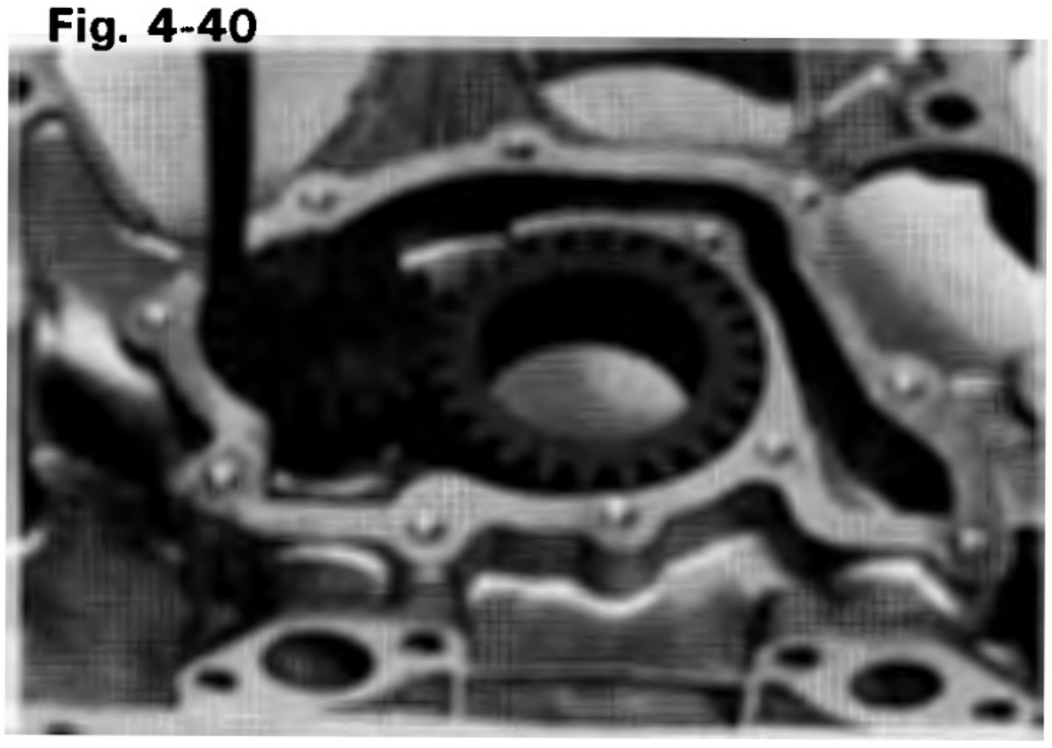


7. Measure the drive gear tip clearance.

Tip clearance:

STD	**0.20 — 0.38 mm (0.0080 — 0.0150 in.)**
Limit	**0.6 mm (0.024 in.)**

Fig. 4-40

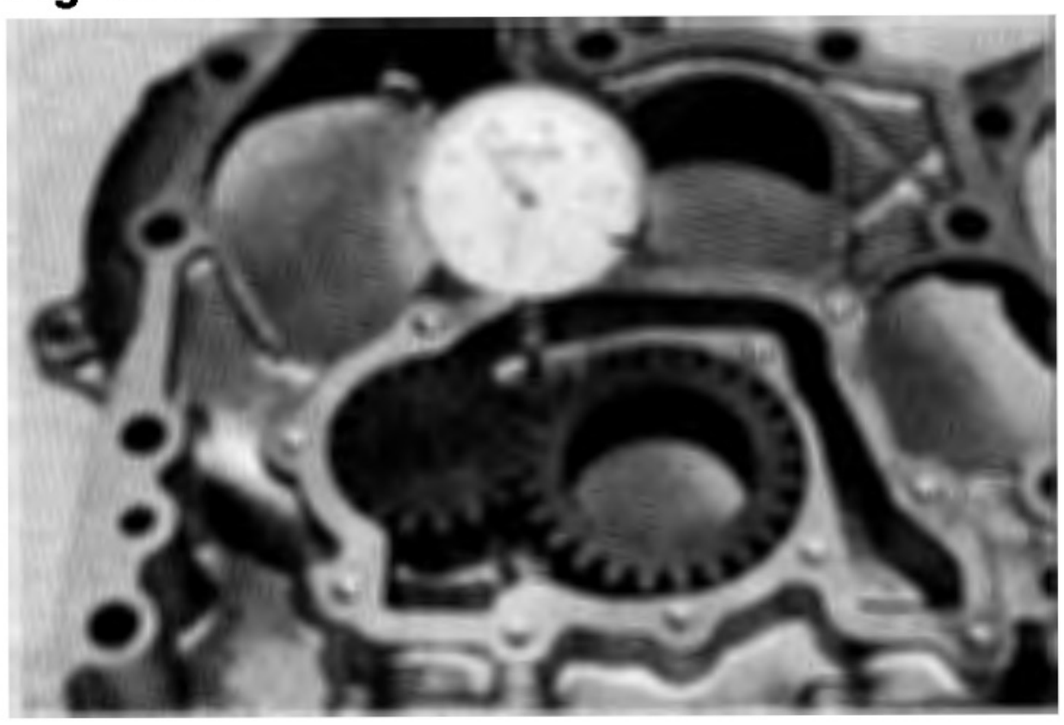


8. Measure the driven gear tip clearance.

Tip clearance:

STD	**0.07 — 0.16 mm (0.0028 — 0.0063 in.)**
Limit	**0.25 mm (0.0098 in.)**

Fig. 4-41



9. Measure the gear backlash.

Gear backlash:

STD	**0.2 – 0.4 mm (0.008 – 0.016 in.)**
Limit	**0.6 mm (0.024 in.)**

Fig. 4-42



10. Measure the side clearance.

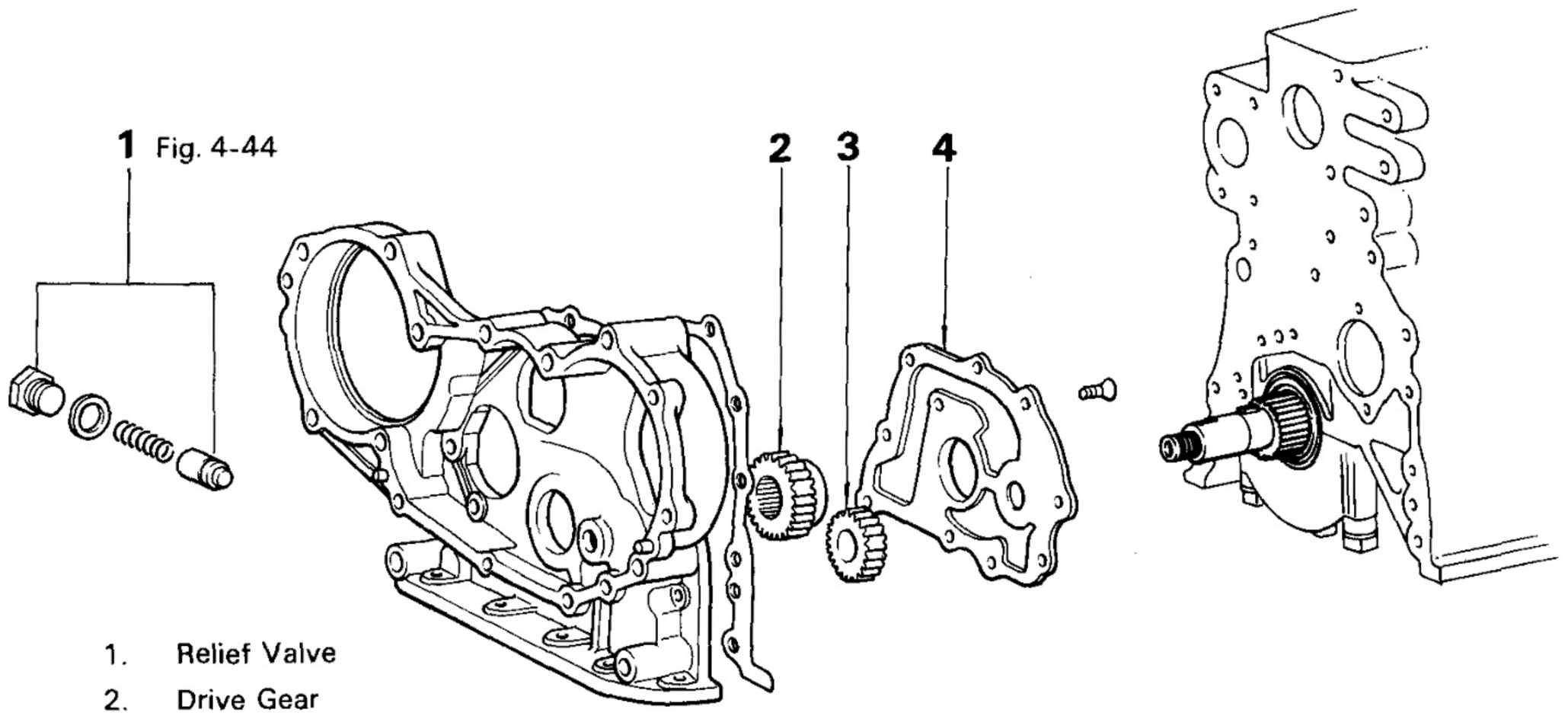
Side clearance:

STD	**0.03 – 0.10 mm (0.0012 – 0.0039 in.)**
Limit	**0.15 mm (0.0059 in.)**

ASSEMBLY

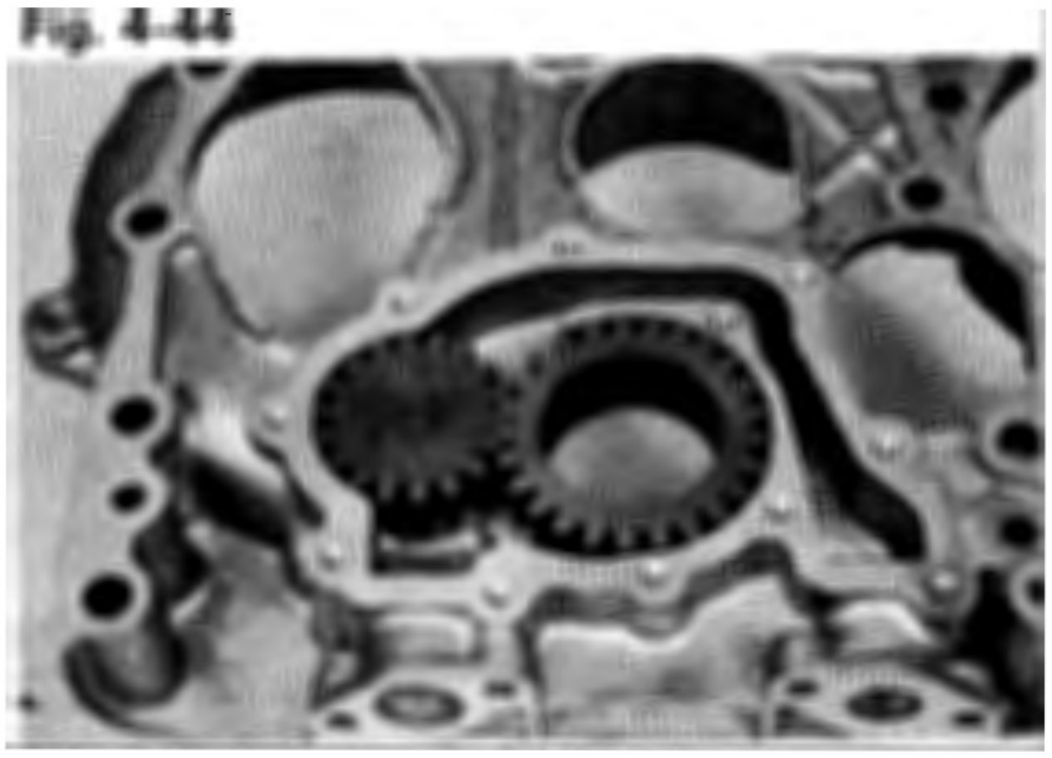
Assemble the parts in the numerical order shown in the figure.

Fig. 4-43



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

Fig. 4-44

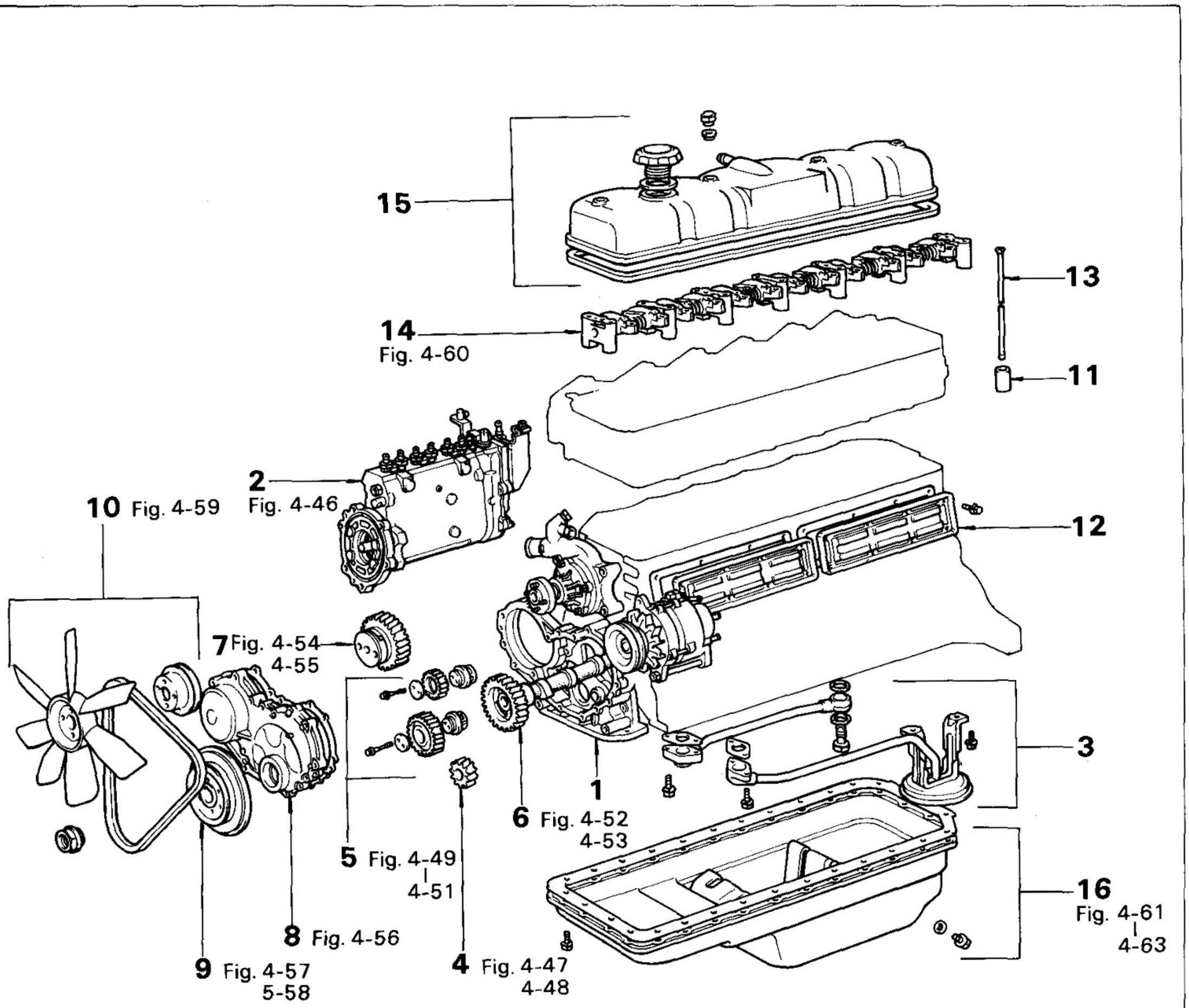


⚠ When assembling the oil pump, coat the relief valve, drive gear and driven gear with a small amount of engine oil.

INSTALLATION

Install the parts in the numerical order shown in the figure.

Fig. 4-45



1. Timing Gear Case & Oil Pump
2. Injection Pump & Oil Pipe
3. Oil Strainer & Pipe
4. Crankshaft Timing Gear
5. Idle Gear No. 1 & No. 2
6. Camshaft & Timing Gear
7. Automatic Timer
8. Timing Gear Cover
9. Crankshaft Pulley
10. Fan Pulley & Drive Belt
11. Valve Lifter
12. Valve Push Rod Cover
13. Valve Push Rod
14. Valve Rocker Shaft Assembly
15. Cylinder Head Cover
16. Oil Pan

Fig. 4-46



Install the injection pump with pump retainer by tightening the pump mounting bolts and oil pipe union bolt.

Fig. 4-47



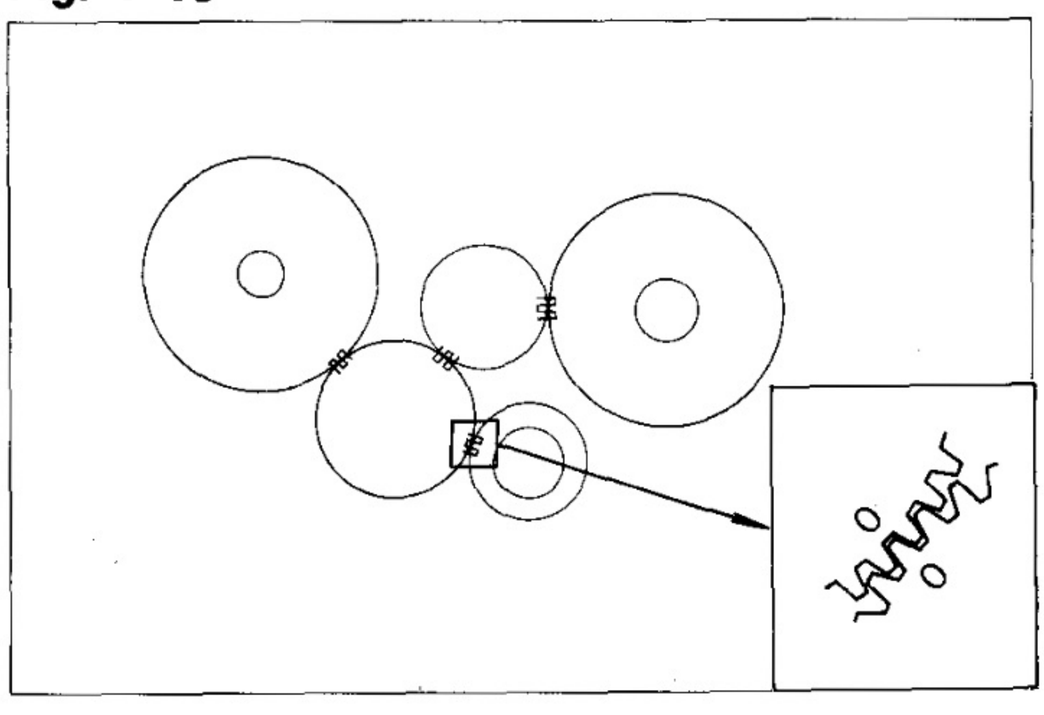
Drive in the crankshaft timing gear with SST.
SST [09608-35013]

Fig. 4-48



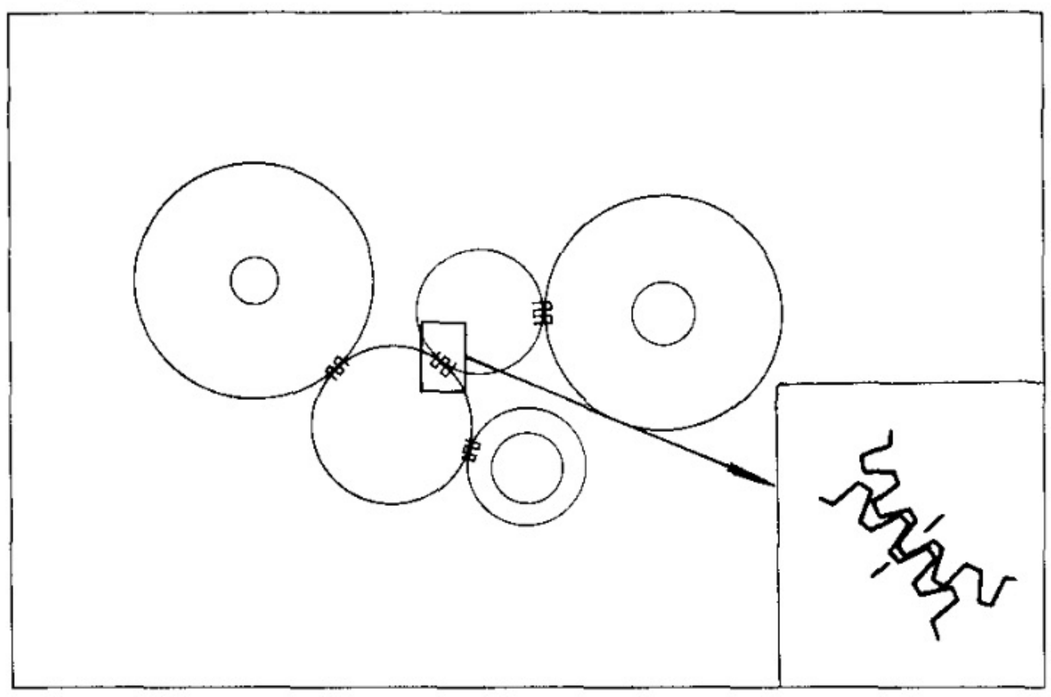
Set No.1 cylinder piston to TDC/compression.

Fig. 4-49



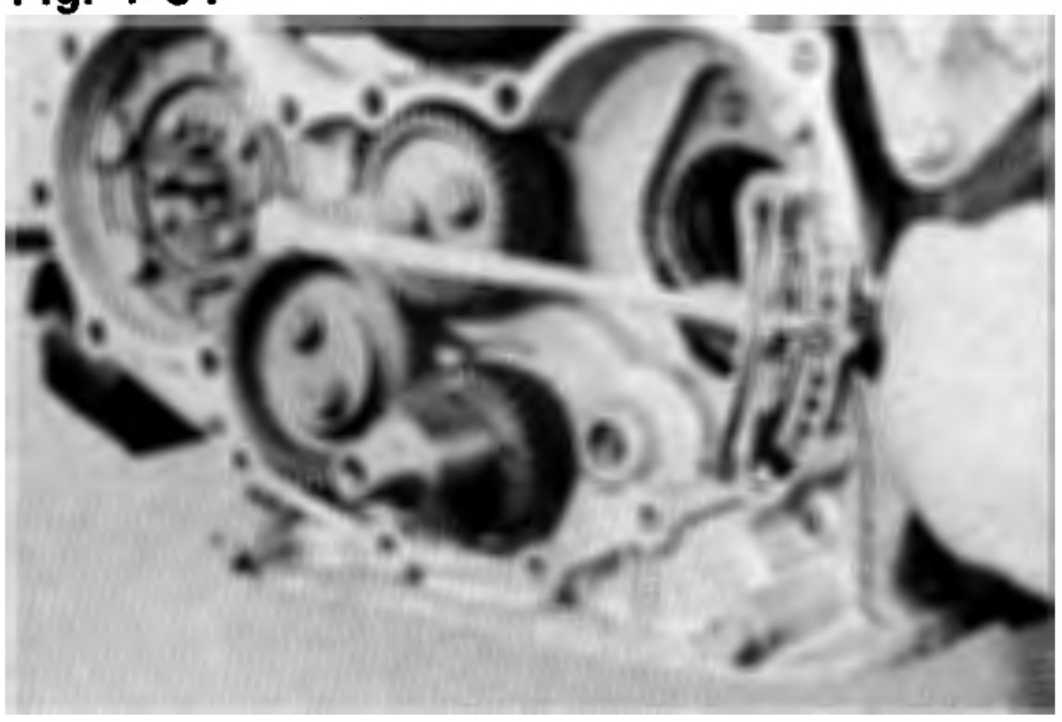
Align the matchmark of idle gear No.1 with that of the crankshaft timing gear.

Fig. 4-50



Align the matchmark of idle gear No.2 with that of idle gear No.1.

Fig. 4-51



Tighten the idle gear and shaft.

Tightening torque:

No.1 & No.2 4.0 – 5.5 kg-m (29 – 40 ft-lb)

Fig. 4-52

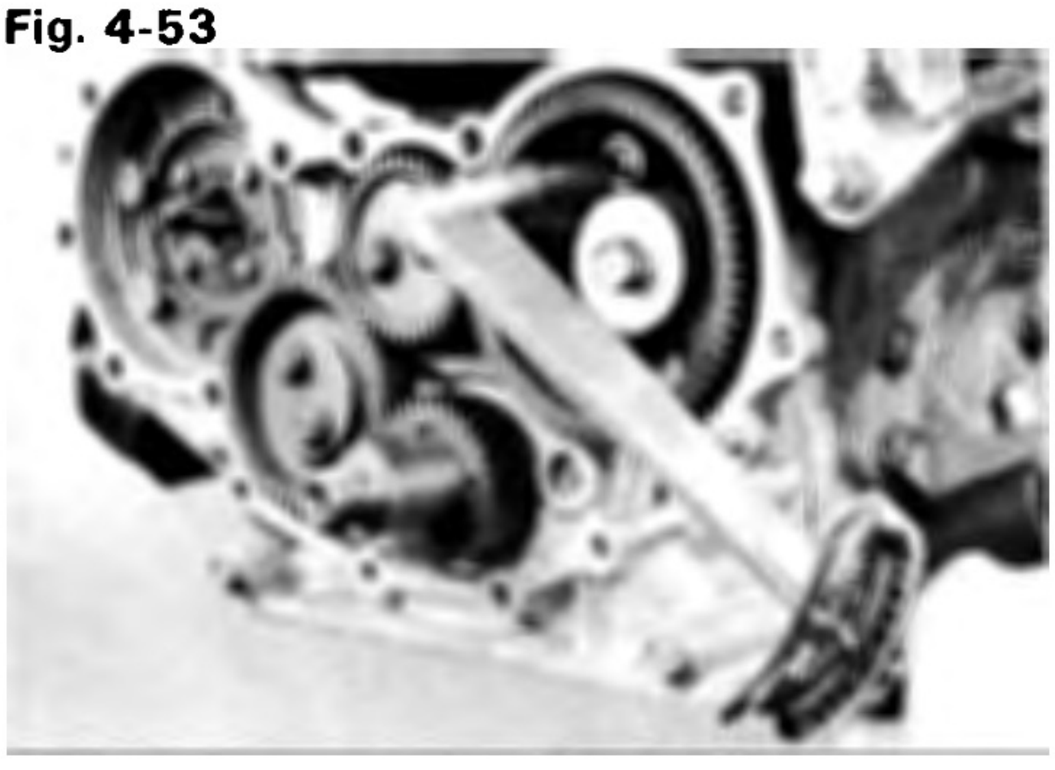


Insert the camshaft, aligning the matchmark with that of idle gear No.2.

—Note—

Be careful not to damage the camshaft bearings.

Fig. 4-53



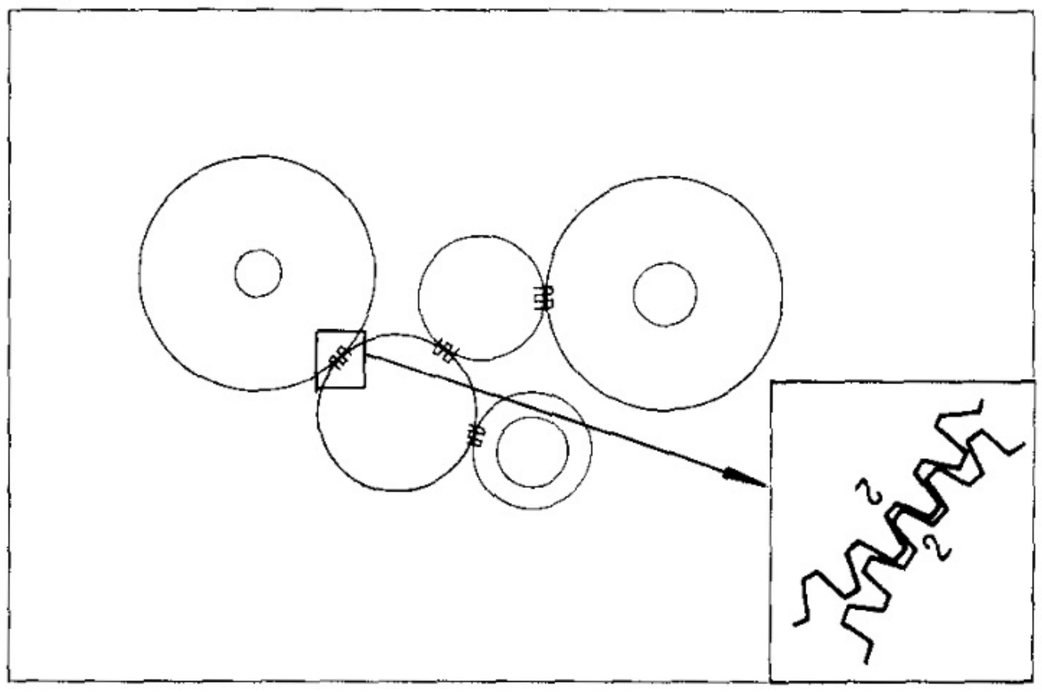
Tighten the camshaft thrust plate.

Tightening torque: 3.0 – 4.5 kg-m (22 – 33 ft-lb)

—Note—

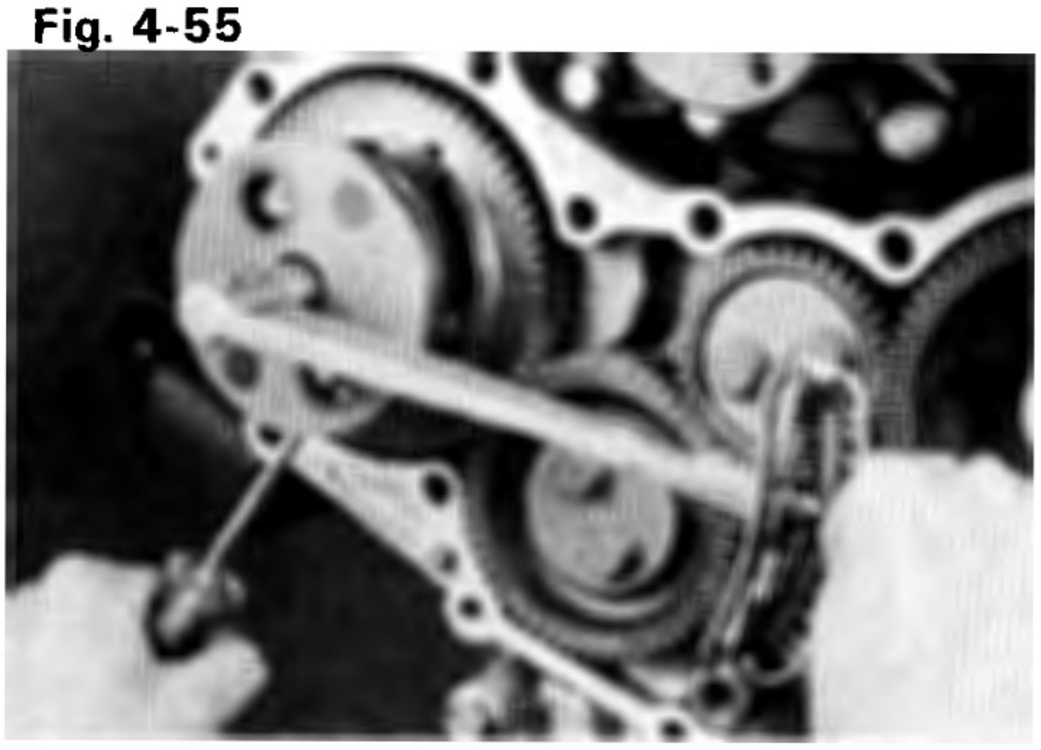
Apply a light coat of engine oil on the bolt threads and under the bolt head before installing.

Fig. 4-54



Align the matchmark of automatic timer with that of idle gear No.1.

Fig. 4-55

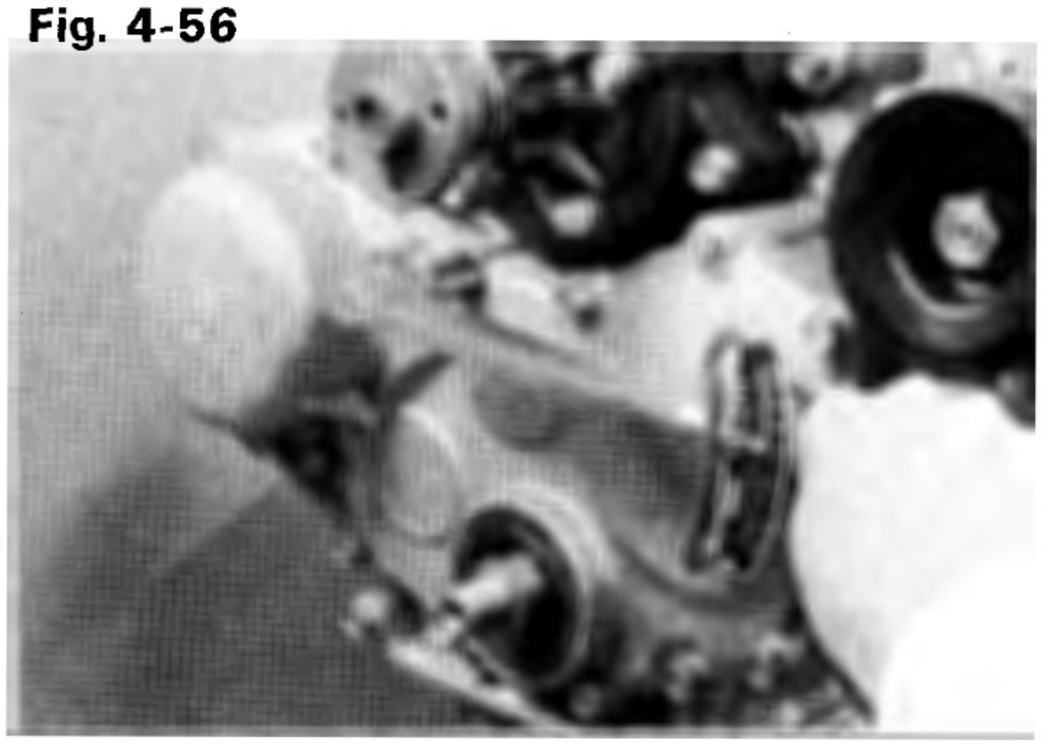


Hold the automatic timer with a screwdriver and tighten the round nut.

Tightening torque: 7.0 – 8.0 kg-m (51 – 58 ft-lb)

–Note–
Be careful not to scratch the timer weight sliding surface.

Fig. 4-56



Tighten the timing gear cover.

Tightening torque: 2.0 – 3.0 kg-m (14 – 22 ft-lb)

Fig. 4-57



Drive in the crankshaft pulley with SST.
SST [09608-35013]

Fig. 4-58



Tighten the retaining bolt.

Tightening torque:
18.0 – 22.0 kg-m
(130 – 159 ft-lb)

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

Fig. 4-59

SEE
ENGINE TUNE-UP
SECTION
Fig. 2-7

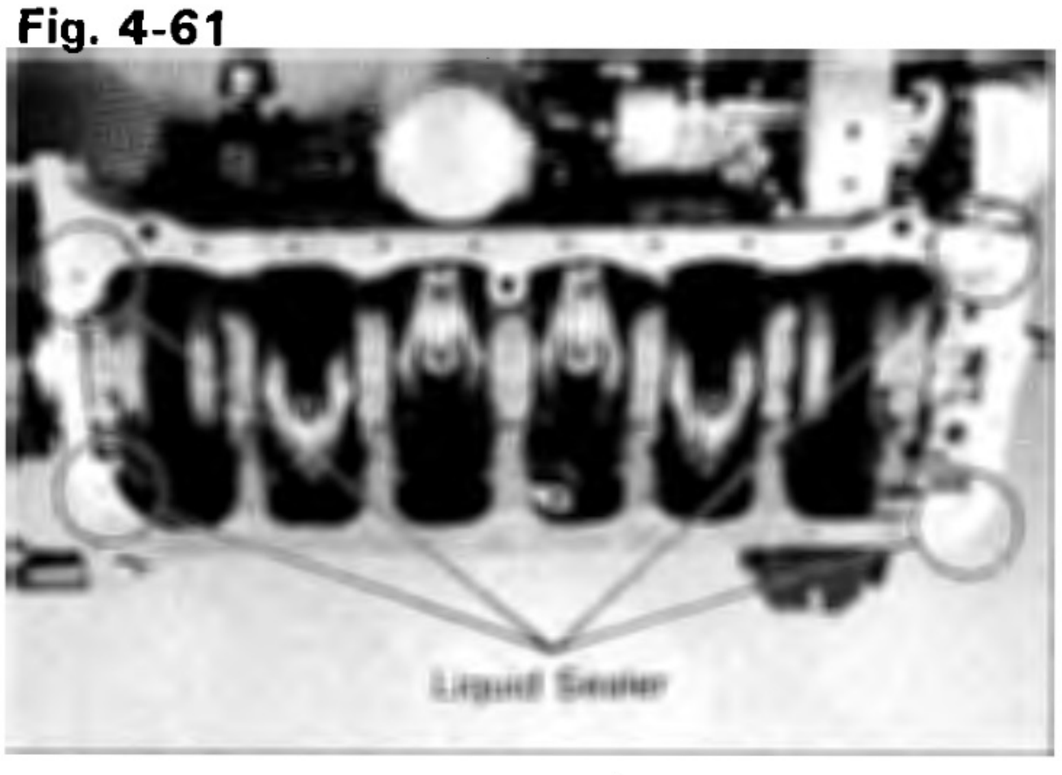
Adjust drive belt tension.

Fig. 4-60

SEE
ENGINE TUNE-UP
SECTION
Fig. 2-48 to 2-51

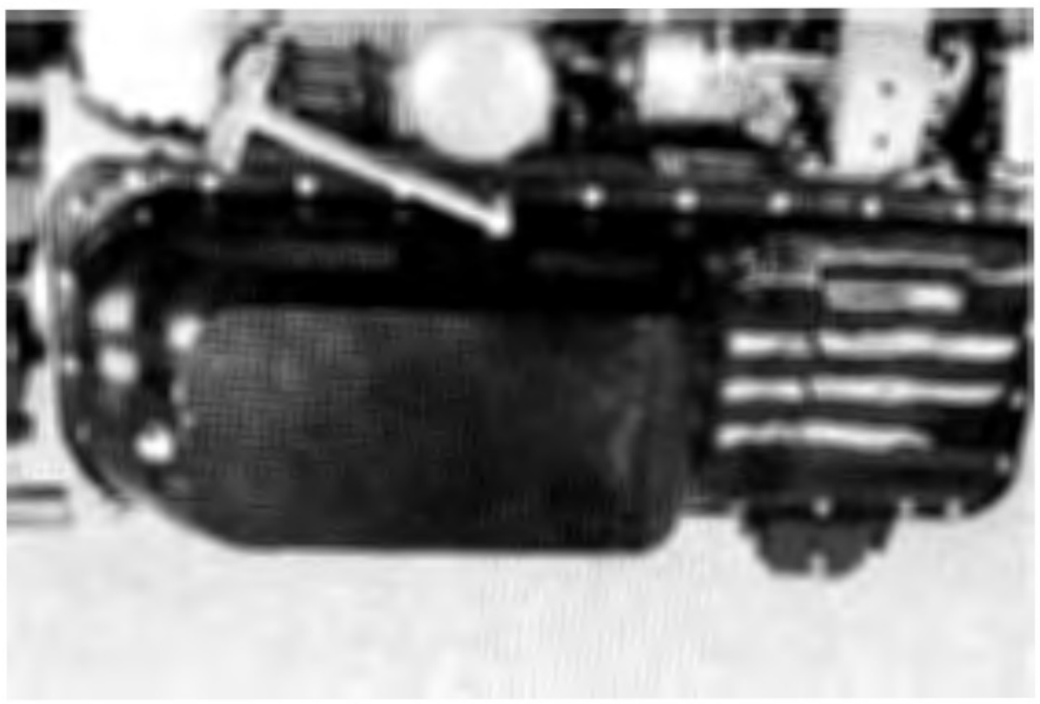
Adjust the valve clearance.

Fig. 4-61



Apply liquid sealer to the cylinder block and gear cover as shown in the figure.

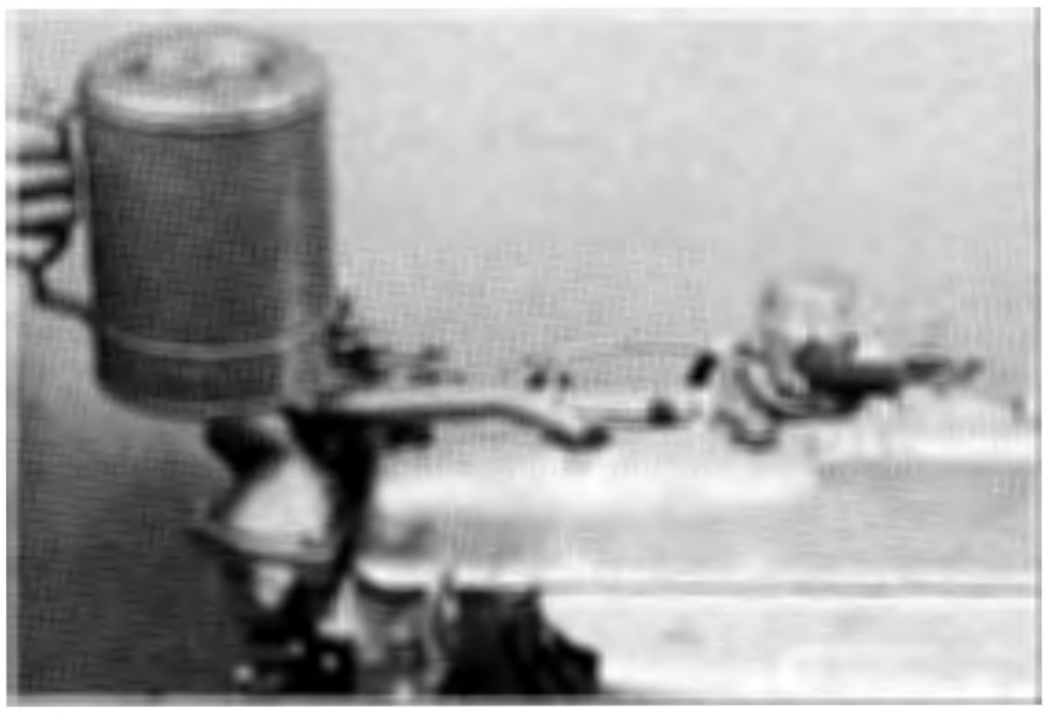
Fig. 4-62



Install the oil pan.

Tightening torque: 1.0 – 1.6 kg-m (7 – 12 ft-lb)

Fig. 4-63



Fill the engine with engine oil.

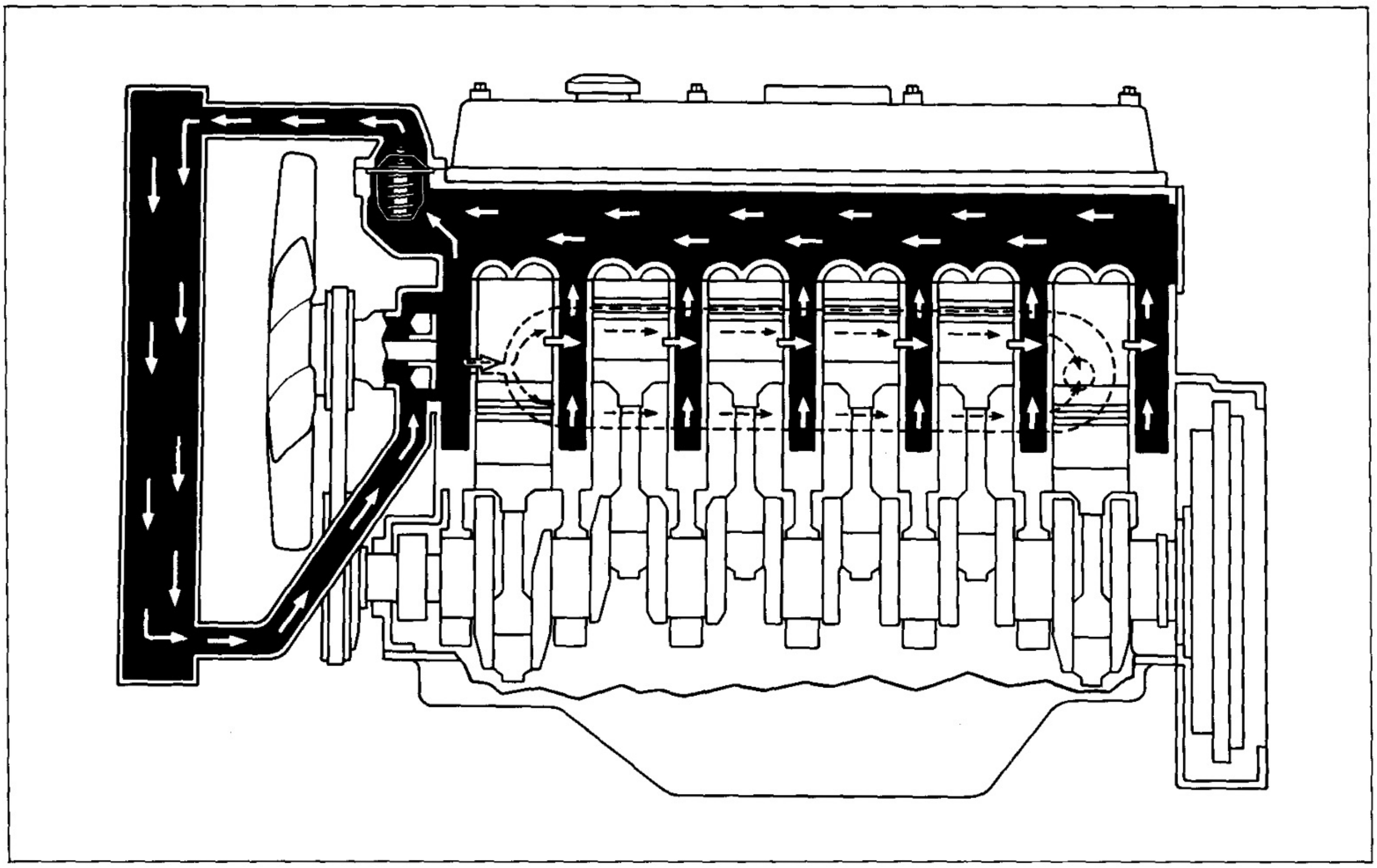
Oil grade:
API service CC-CD
Oil capacity:
(Dry fill, w/ oil filter)
10.3 liters (10.9 US qt, 9.1 Imp.qt)

COOLING SYSTEM

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COOLING SYSTEM CIRCUIT	5-2
WATER PUMP CUTAWAY VIEW	5-2
WATER PUMP	5-3
RADIATOR	5-9
THERMOSTAT	5-9

COOLING SYSTEM CIRCUIT

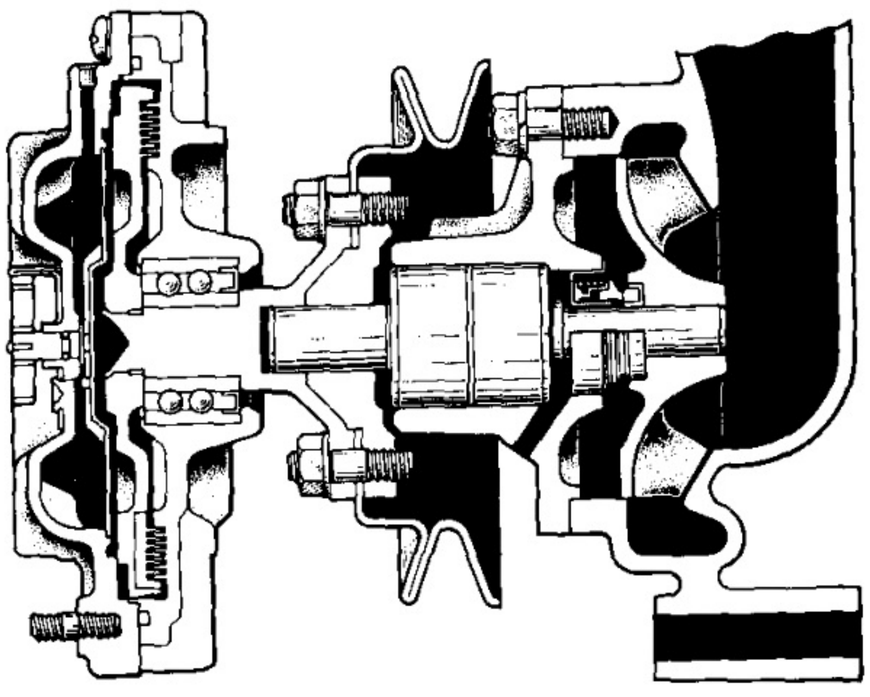
Fig. 5-1



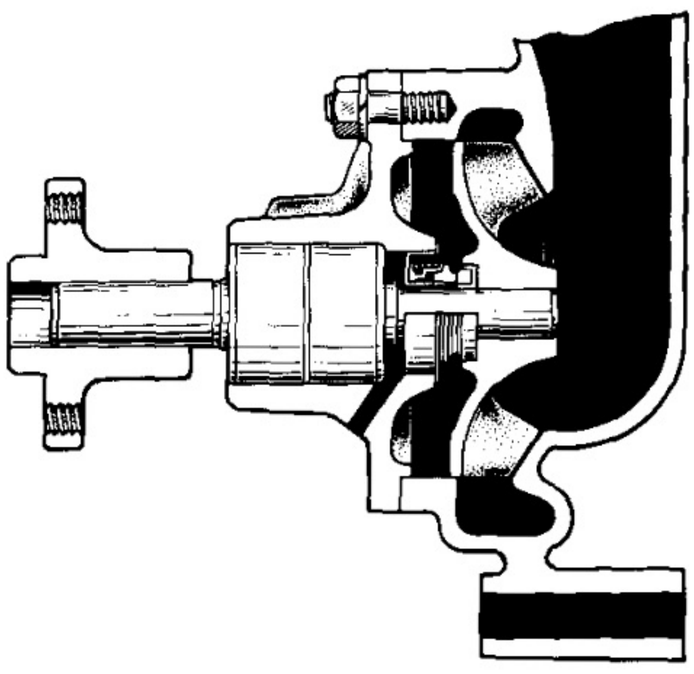
WATER PUMP CUTAWAY VIEW

Fig. 5-2

w/ Fluid Coupling Type



w/o Fluid Coupling Type

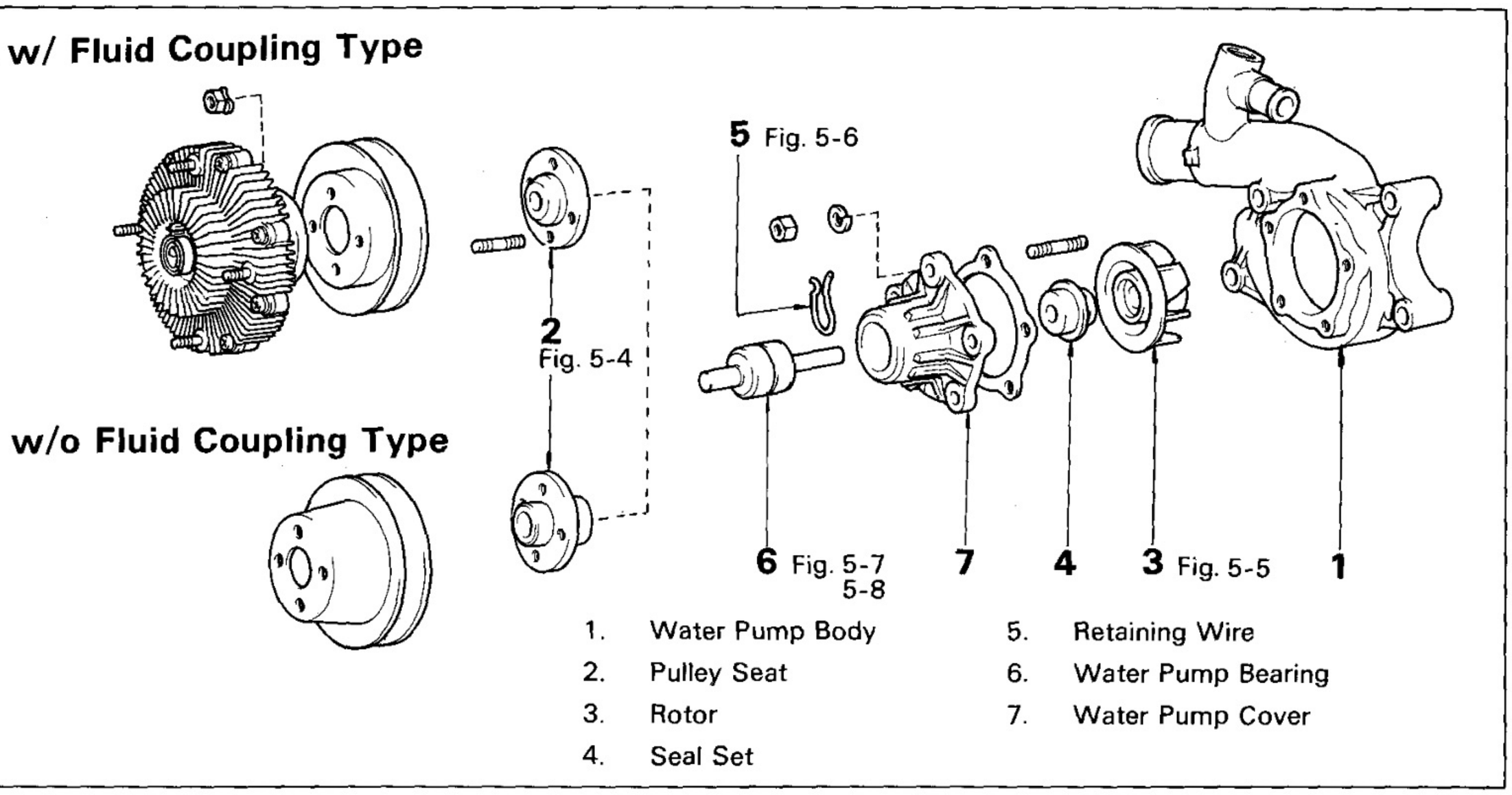


WATER PUMP

DISASSEMBLY

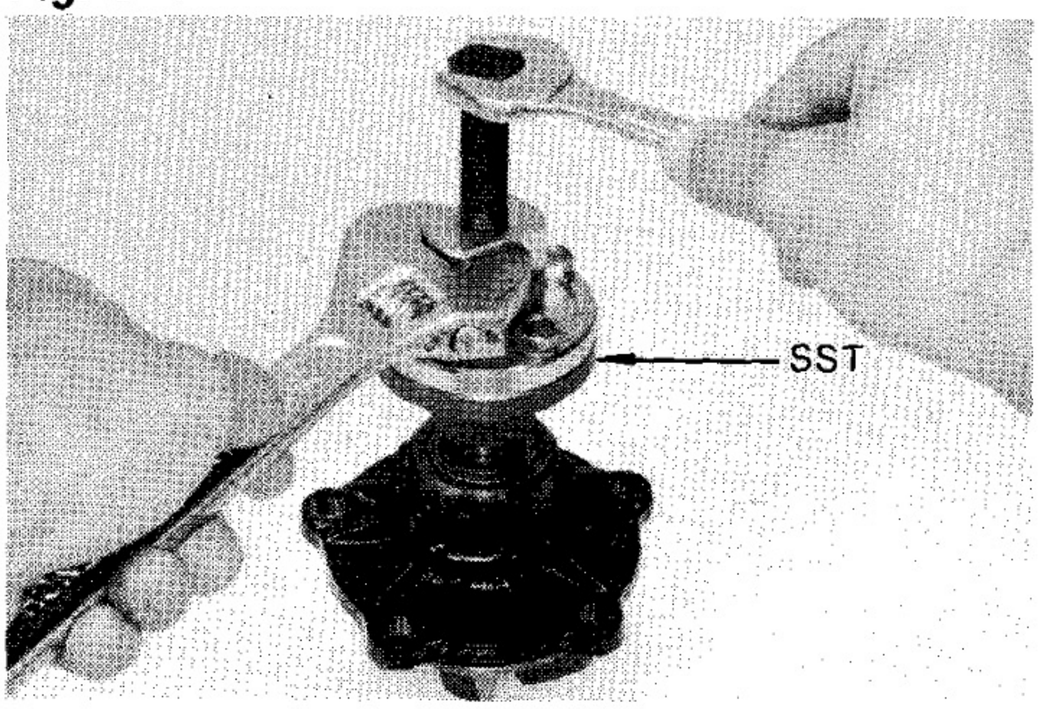
Disassemble the parts in the numerical order shown in the figure.

Fig. 5-3



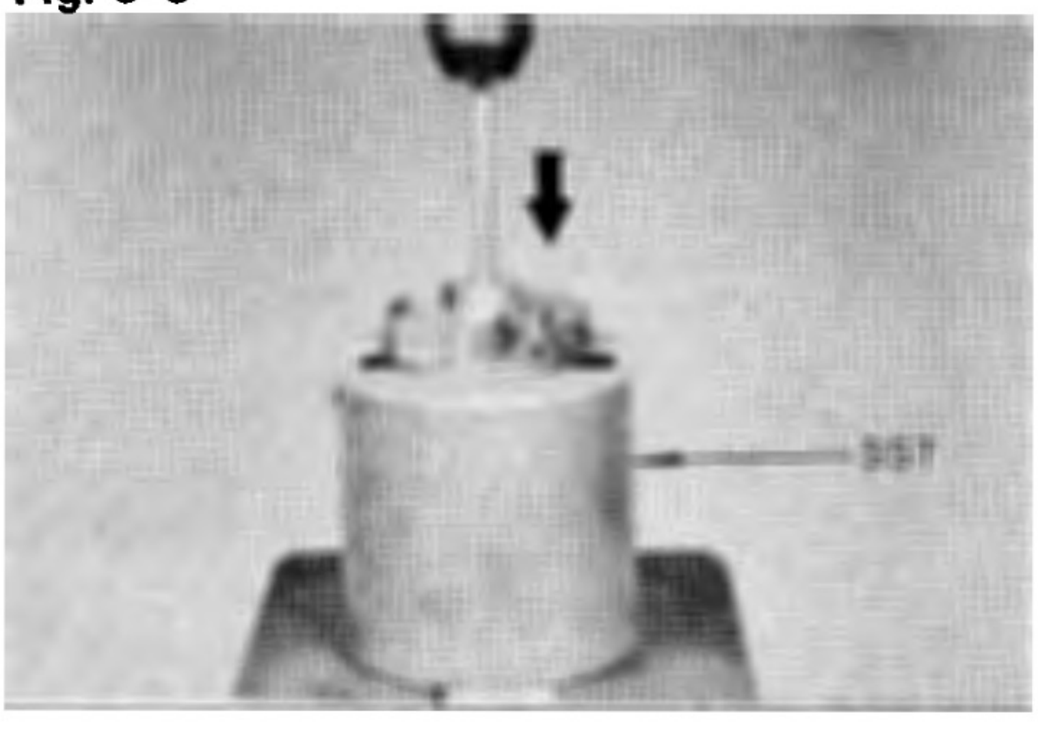
1. Water Pump Body
2. Pulley Seat
3. Rotor
4. Seal Set
5. Retaining Wire
6. Water Pump Bearing
7. Water Pump Cover

Fig. 5-4



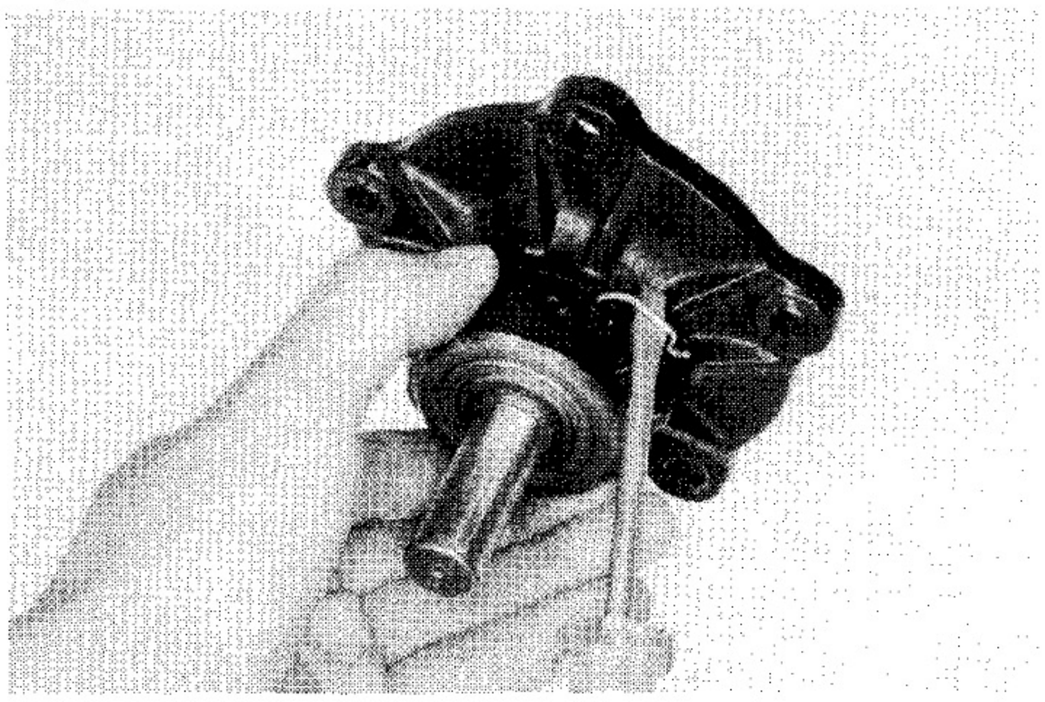
Remove the pulley seat with SST.
SST [09235-60010]

Fig. 5-5



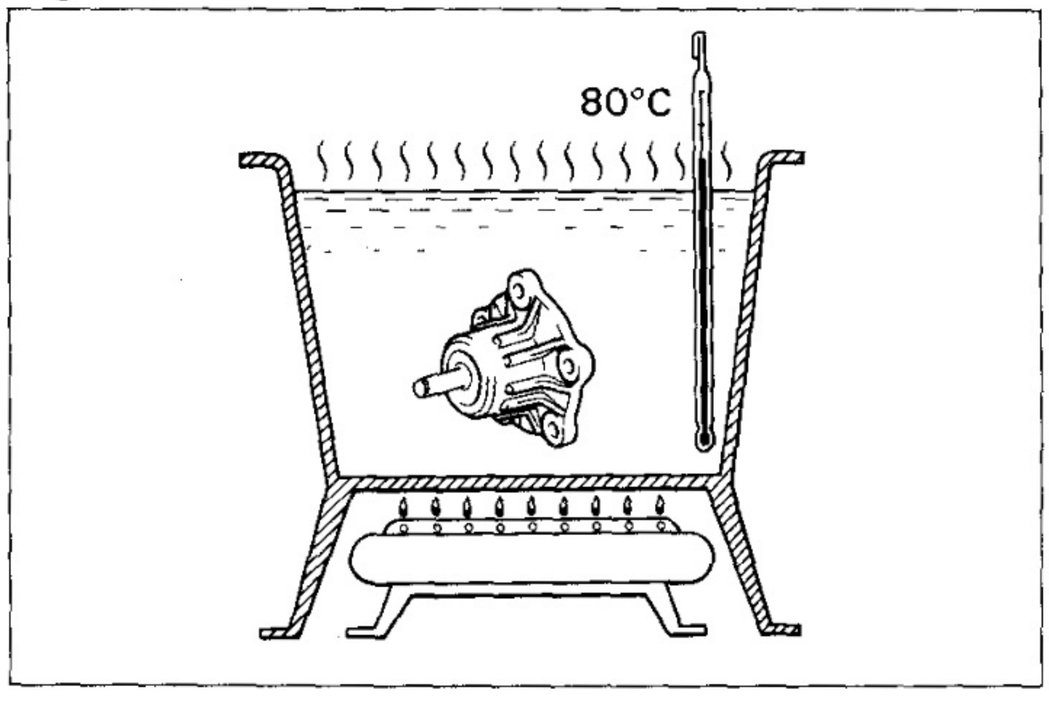
Remove the rotor with SST and a press.
SST [09239-40010]

Fig. 5-6



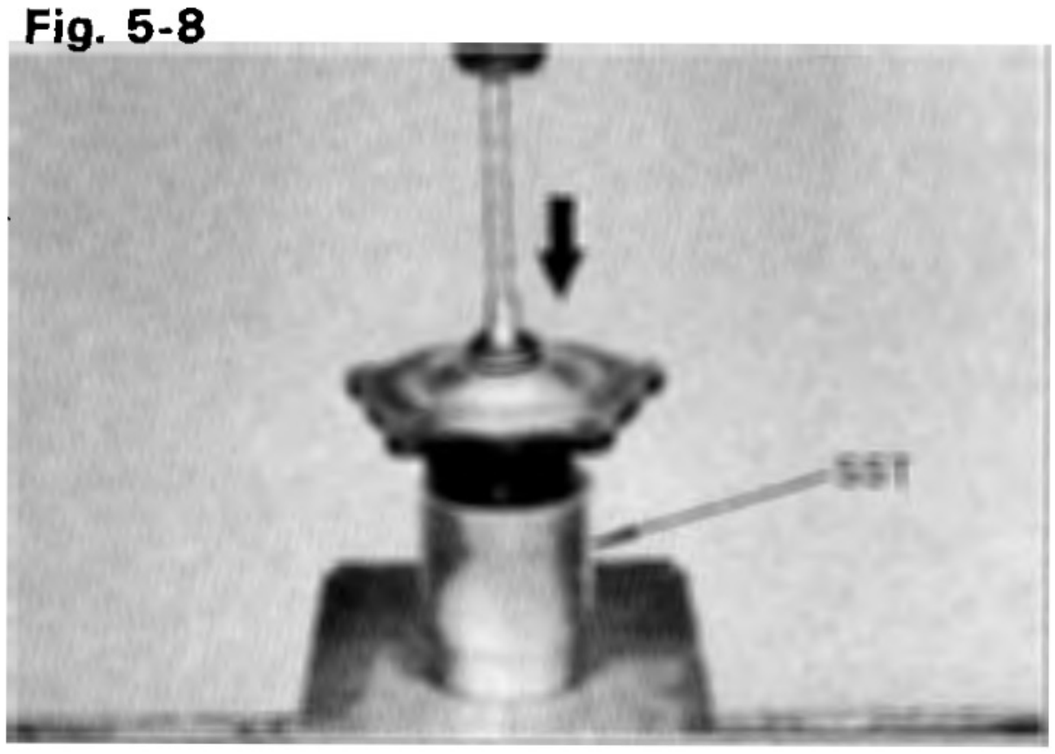
Remove the retaining wire from the water pump cover.

Fig. 5-7



Heat the water pump cover to about 80°C (176°F).

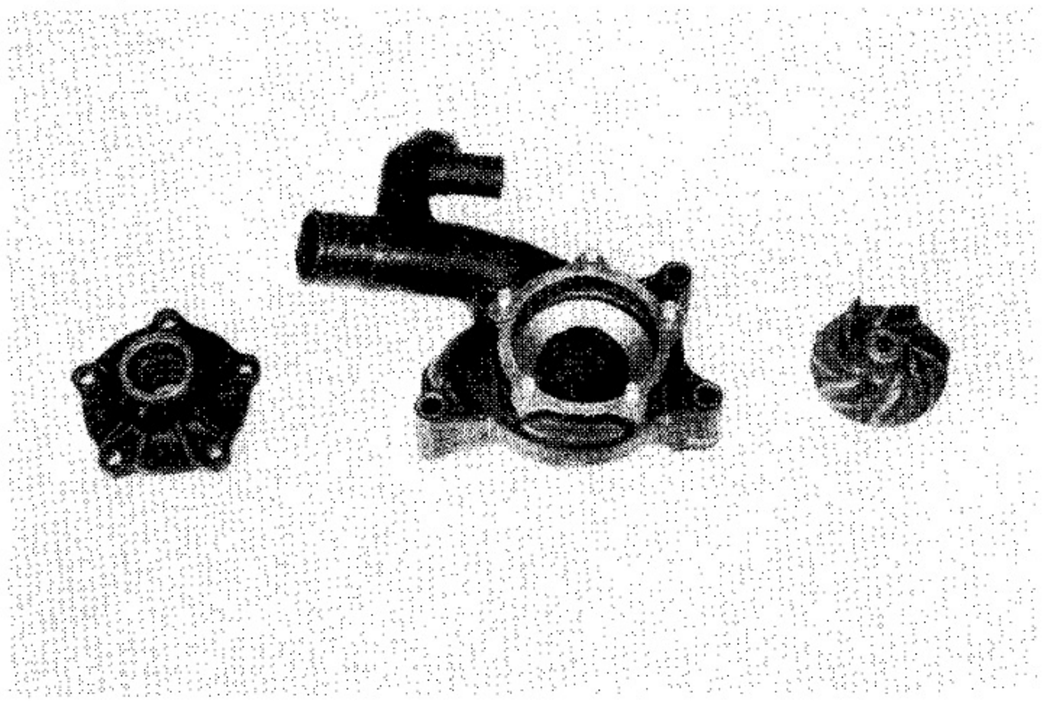
Fig. 5-8



Press out the water pump bearing with SST and press.
SST [09238-47010]

—Note—
Press the bearing toward the pulley seat side.

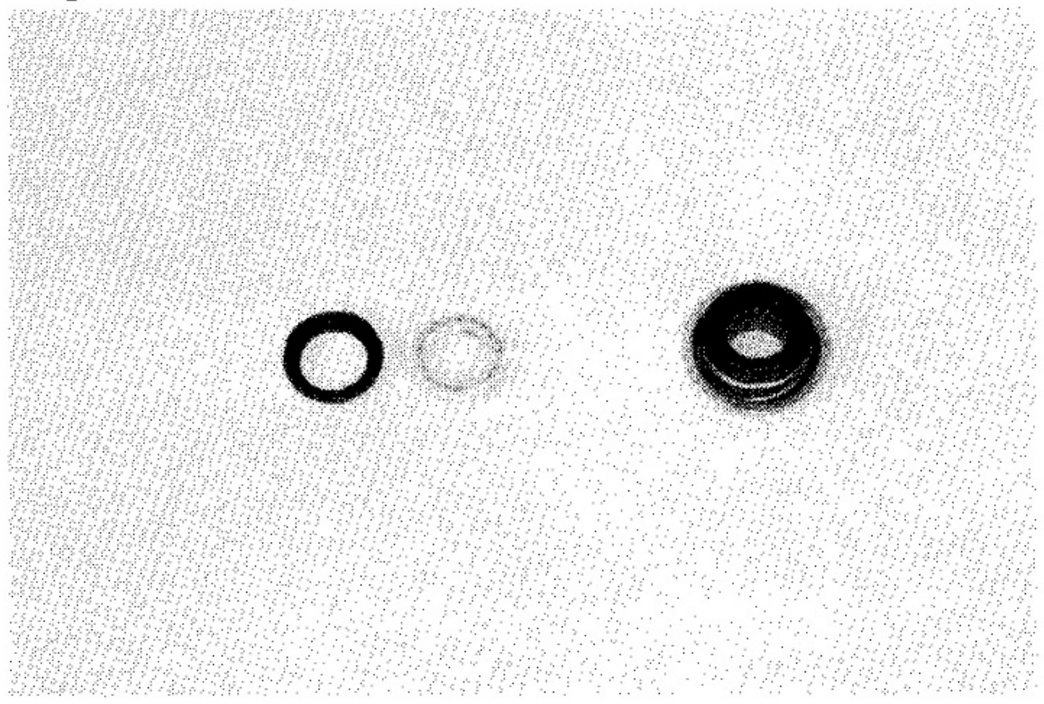
Fig. 5-9



INSPECTION

1. Check the water pump cover, body and rotor for cracks, wear or damage.

Fig. 5-10



2. Check the seat, packing and seal set for wear, damage, deformation or poor contact.

—Note—
If necessary, replace the shaft seal as a set.

Fig. 5-11



3. Check the bearing for operating condition. If damaged, produces noise or does not turn properly, replace.

Fig. 5-12



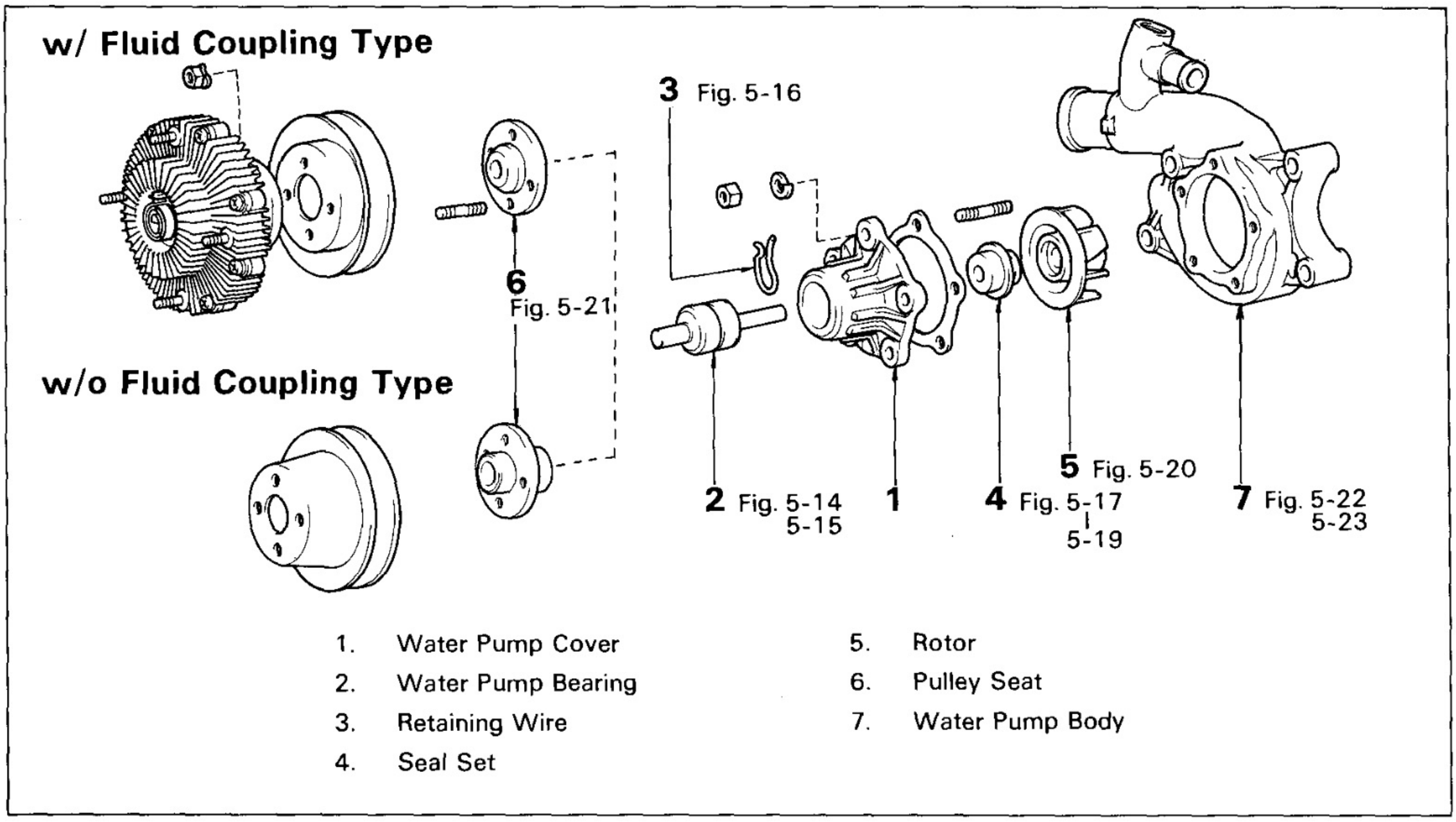
4. Check the fluid coupling for damage or silicone oil leak.
   If necessary, replace the coupling assembly.

— Note —
Do not press the bimetal.

ASSEMBLY

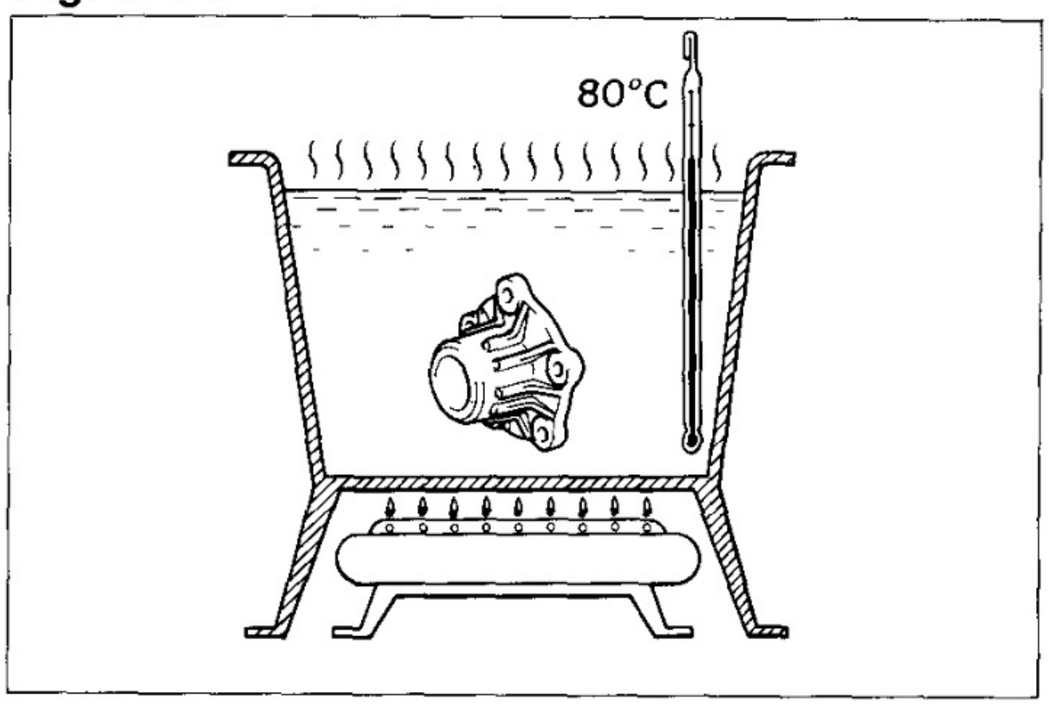
Assemble the parts in the numerical order shown in the figure.

Fig. 5-13



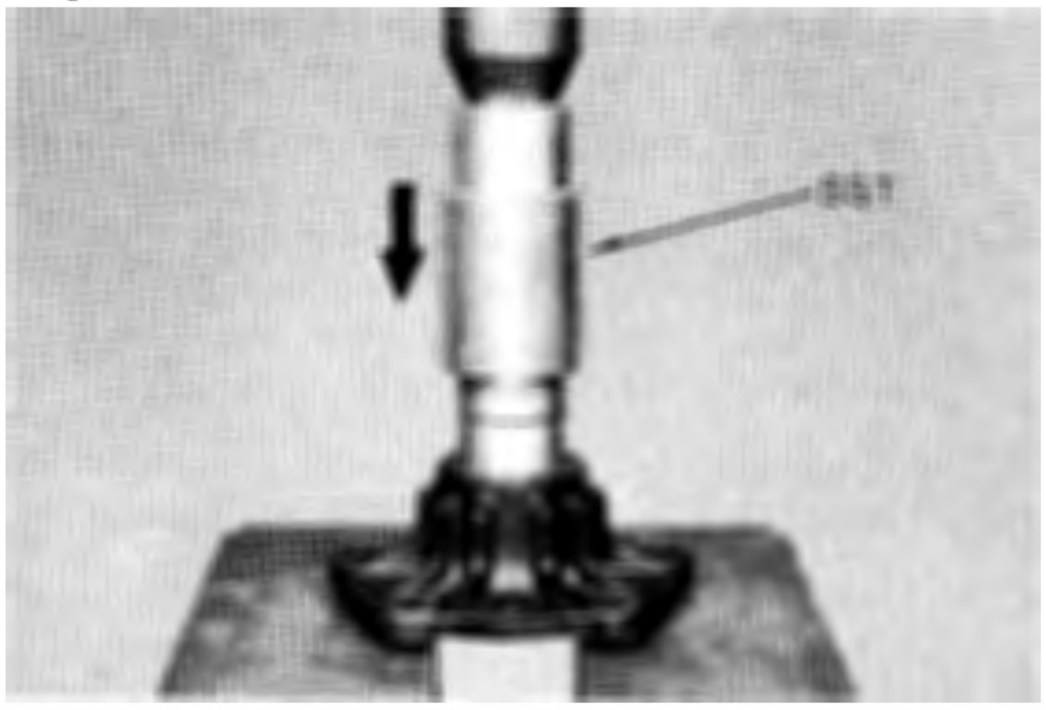
1. Water Pump Cover
2. Water Pump Bearing
3. Retaining Wire
4. Seal Set
5. Rotor
6. Pulley Seat
7. Water Pump Body

Fig. 5-14



⚠ Heat the water pump cover to about 80°C (176°F).

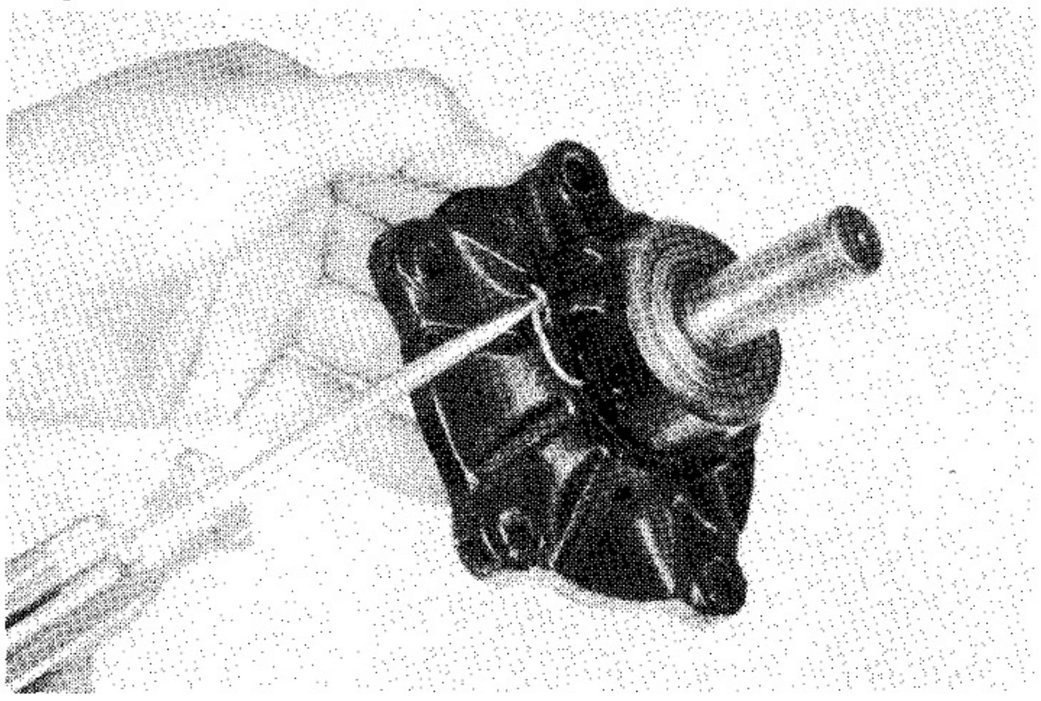
Fig. 5-15



Using SST and a press, press in the water pump bearing until its end surface is flush with the water pump cover.
SST [09238-47010]

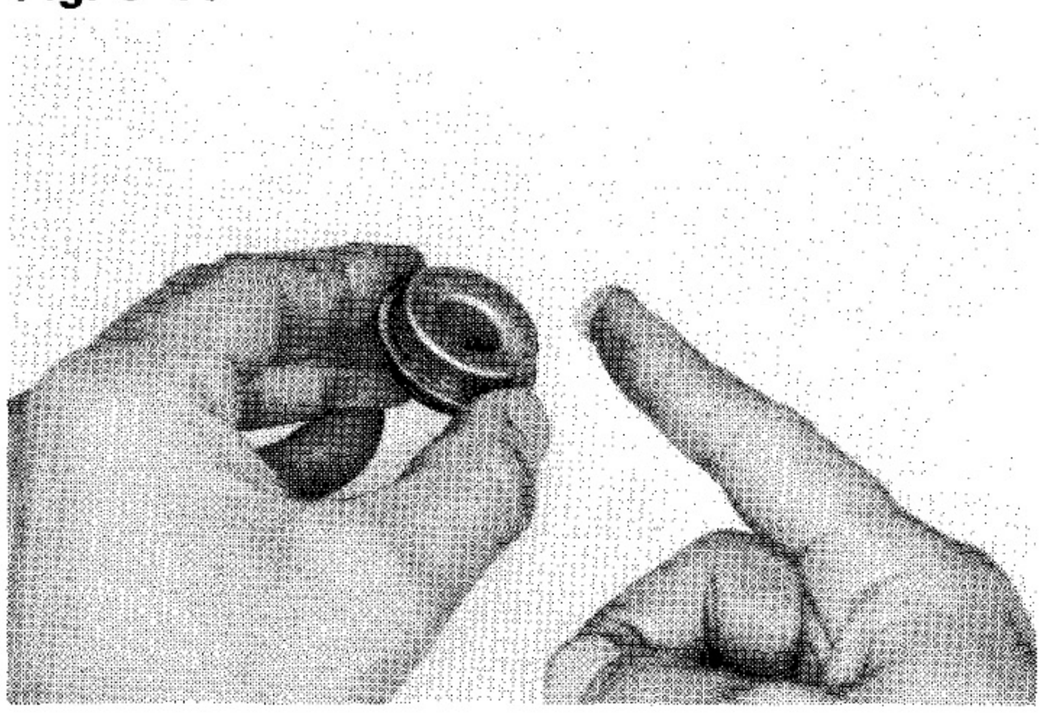
—Note—
Press in the bearing from the pulley seat side.

Fig. 5-16



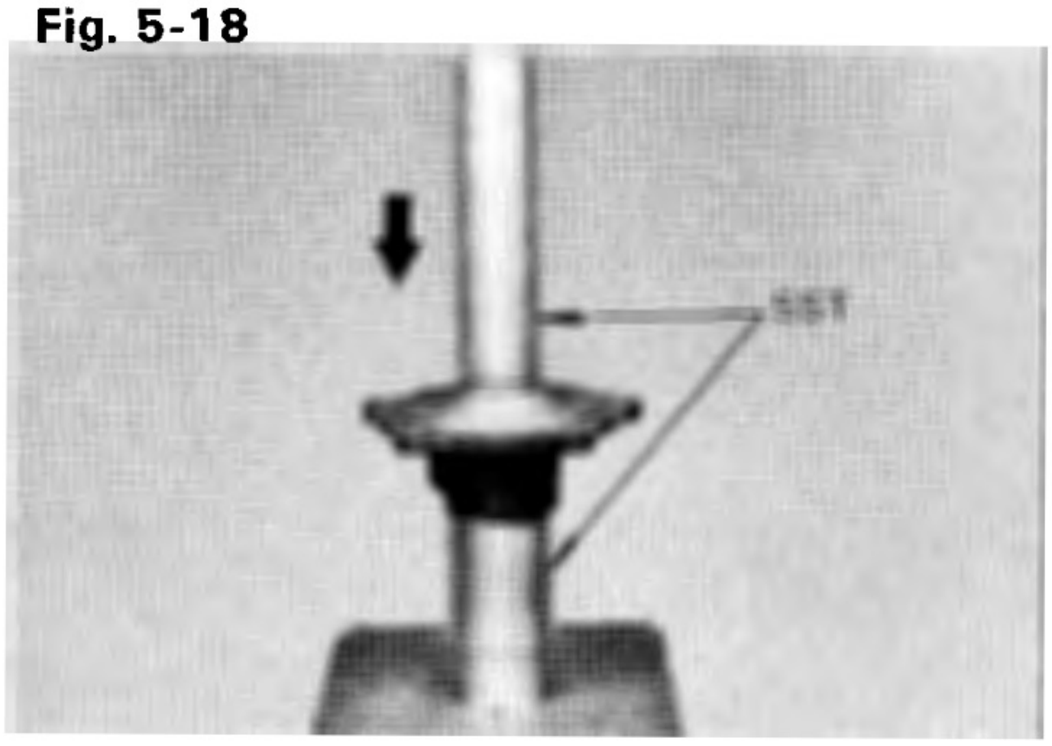
Install the retaining wire to the water pump cover.

Fig. 5-17



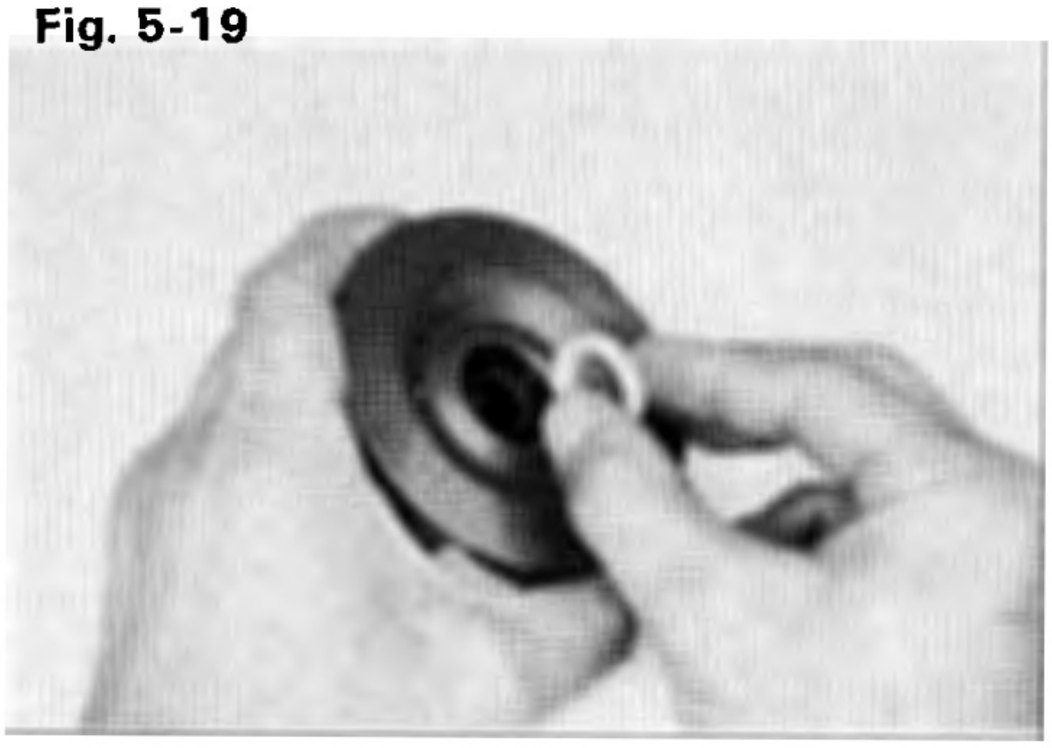
Apply liquid sealer to the seal set surface contacting the water pump cover.

Fig. 5-18



Press the seal set into the water pump cover with SST and a press.
SST [09236-36010]
[09238-47010]

Fig. 5-19



Install the seat and packing into the rotor.

—Note—
Lightly coat the seat with engine oil.

Fig. 5-20



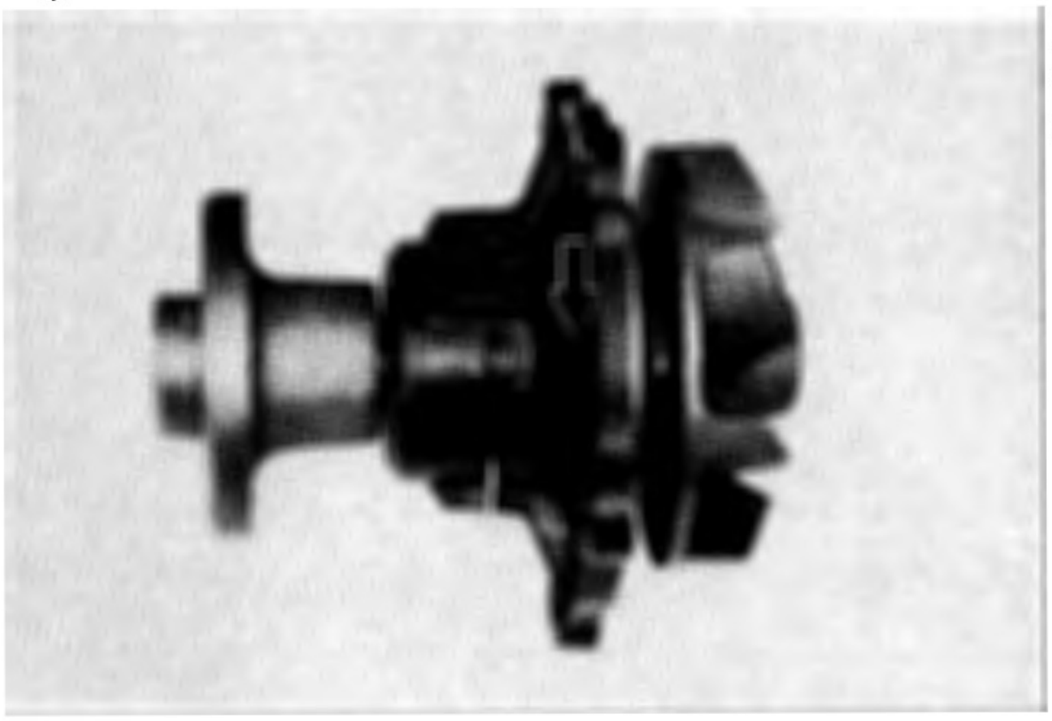
Press in the rotor from the rear side of pump cover until its end surface is flush with the water pump shaft.

Fig. 5-21



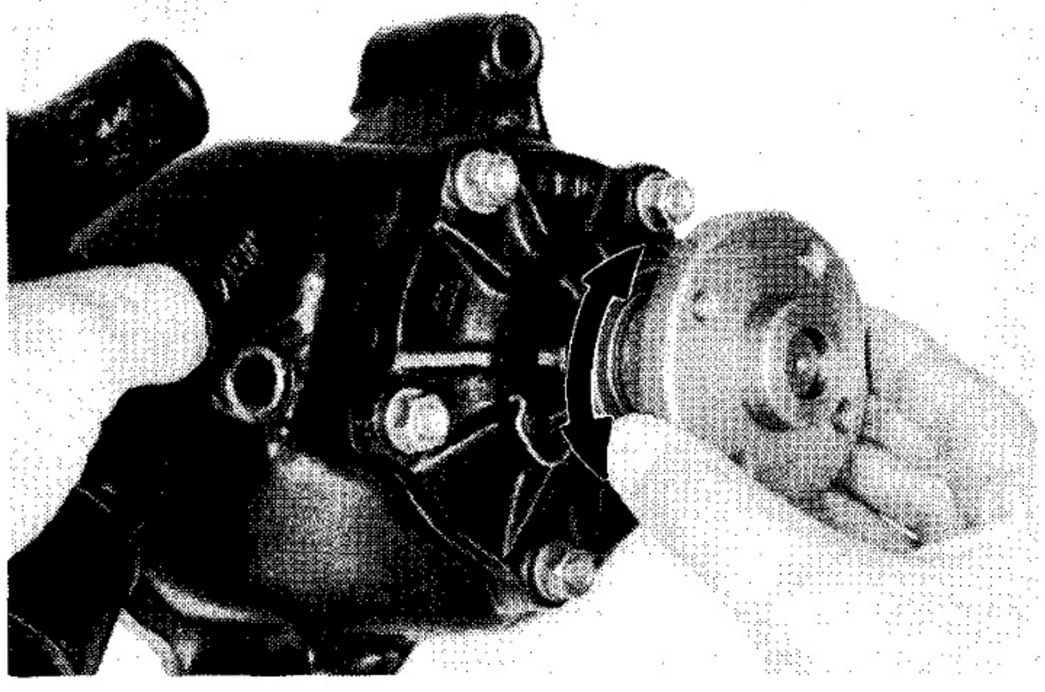
Press in the pulley seat until it touches the bearing inner race.

Fig. 5-22



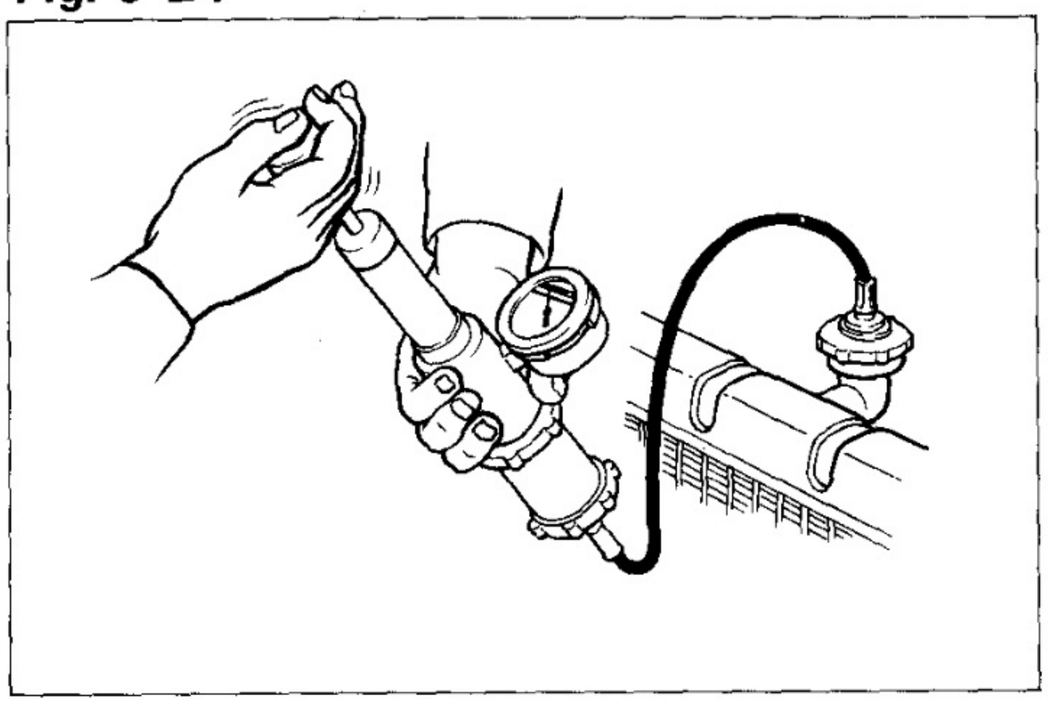
Assemble the water pump cover and body facing the cover drain hole downward.

Fig. 5-23



After assembling, make sure that the rotor rotates smoothly.

Fig. 5-24



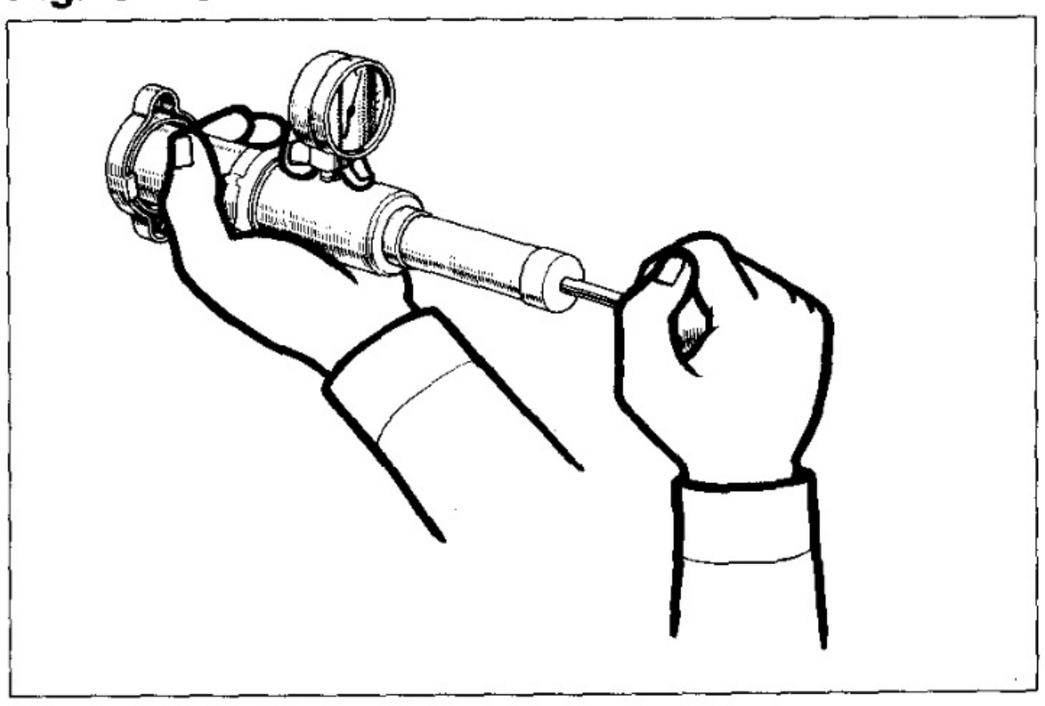
RADIATOR

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 (21.3 psi)

Fig. 5-25

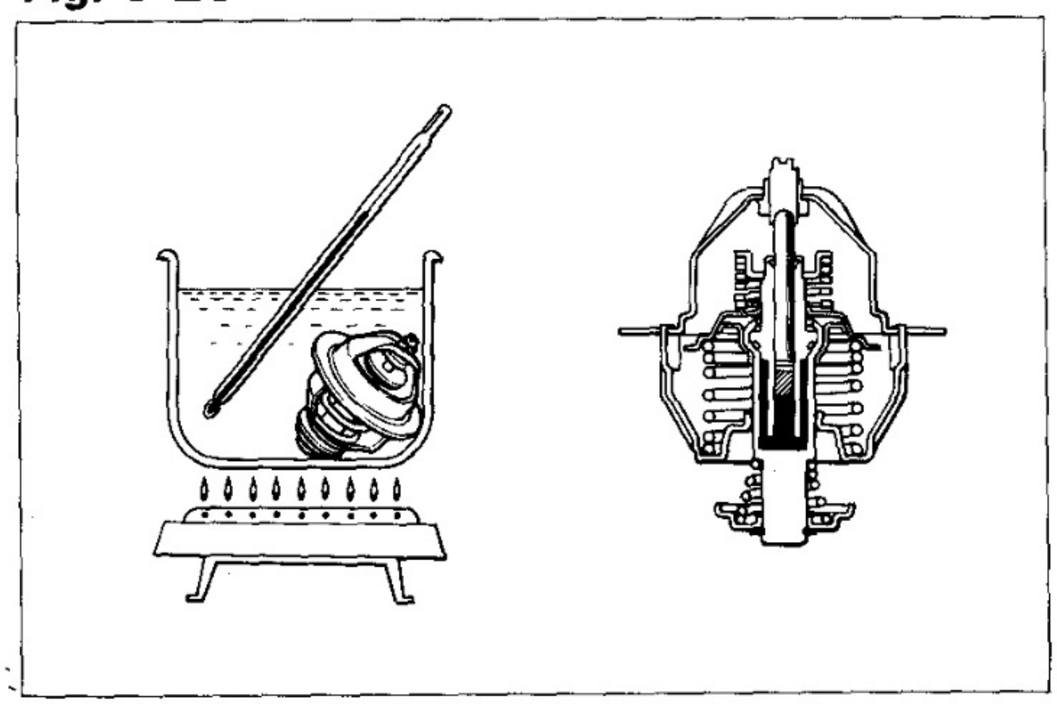


2. Check the pressure sealing and vacuum relief valve operation.

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 specification, replace the radiator cap.

Fig. 5-26

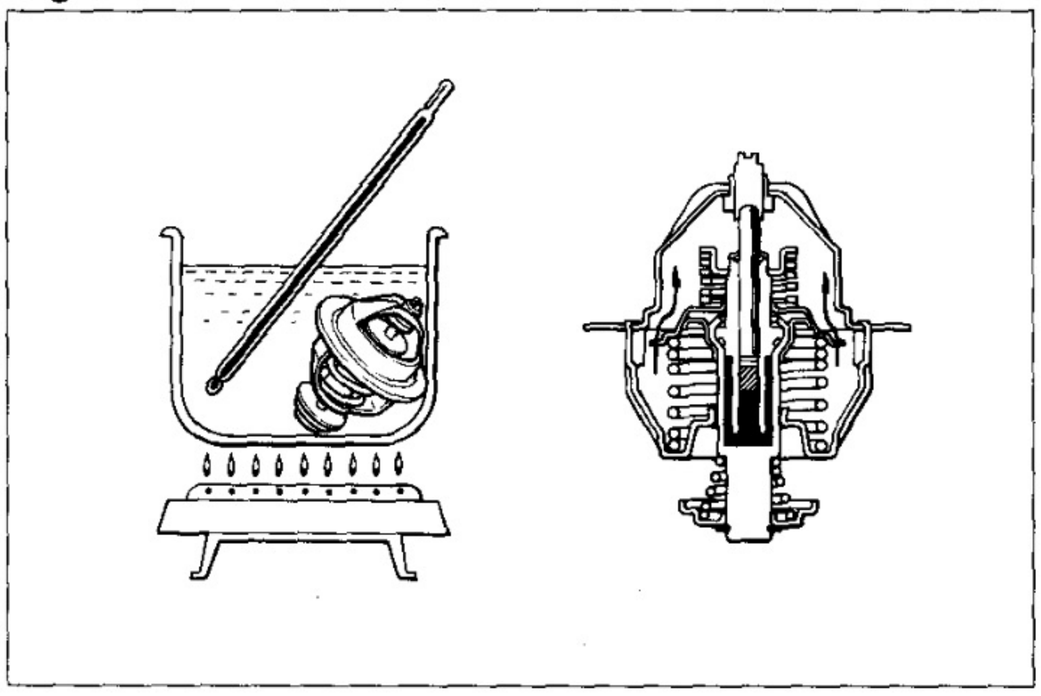


THERMOSTAT

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 does not close tightly.

Fig. 5-27



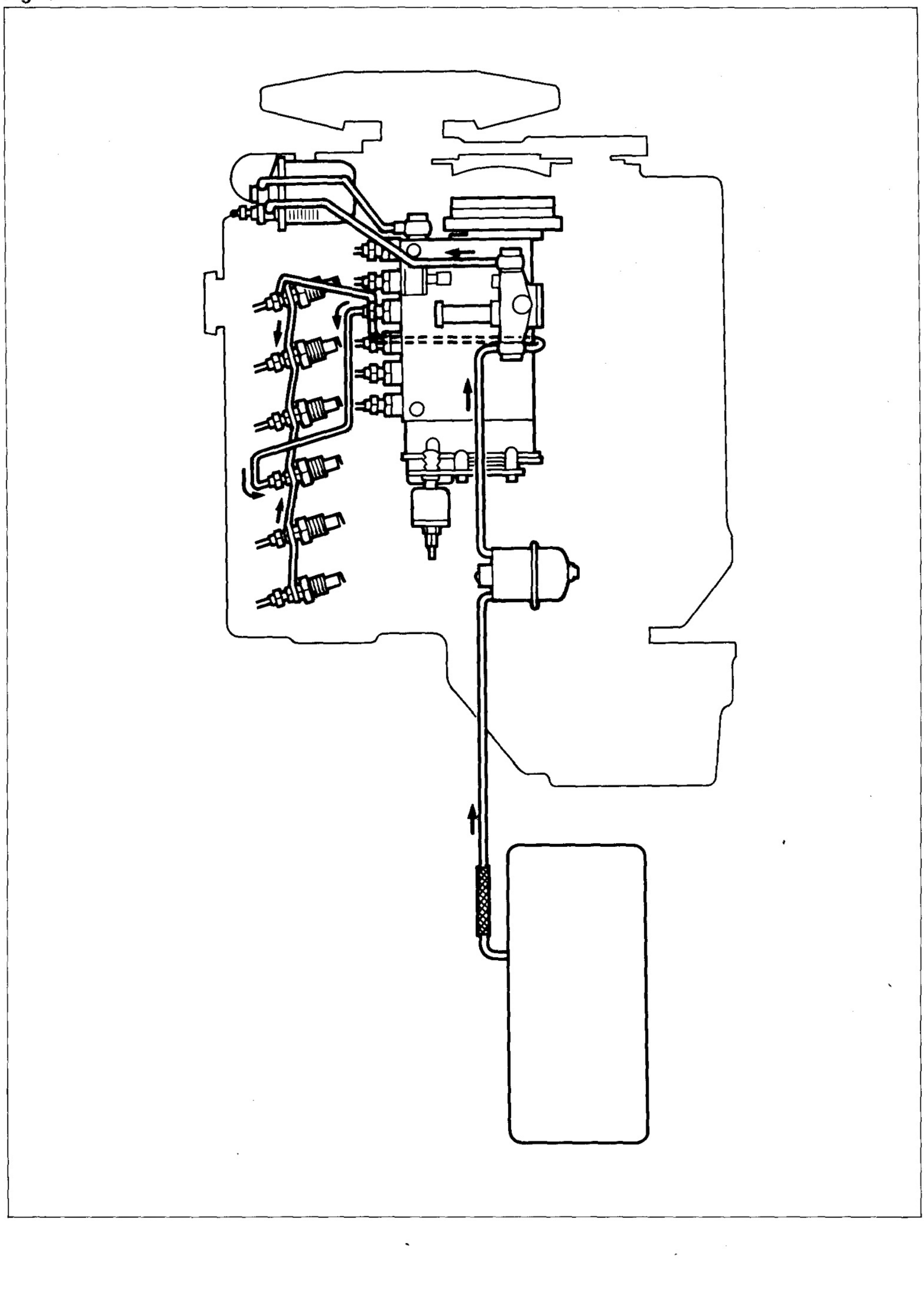
Low temperature type:
Valve starts to open at 80 – 84°C (176 – 183°F)
Valve opens by more than 10 mm (0.39 in.) at 95°C (203°F)
High temperature type:
Valve starts to open at 86 – 90°C (186 – 194°F)
Valve opens by more than 10 mm (0.39 in.) at 100°C (212°F)

FUEL SYSTEM

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FUEL SYSTEM CIRCUIT	6-2
FUEL FILTER	6-3
SEDIMENTER	6-6
INJECTION NOZZLE	6-7
FUEL FEED PUMP	6-15
AUTOMATIC TIMER	6-20
INJECTION PUMP	6-29

FUEL SYSTEM CIRCUIT

Fig. 6-1



FUEL FILTER

DISASSEMBLY

Disassemble the parts in the numerical order shown in the figure.

Fig. 6-2

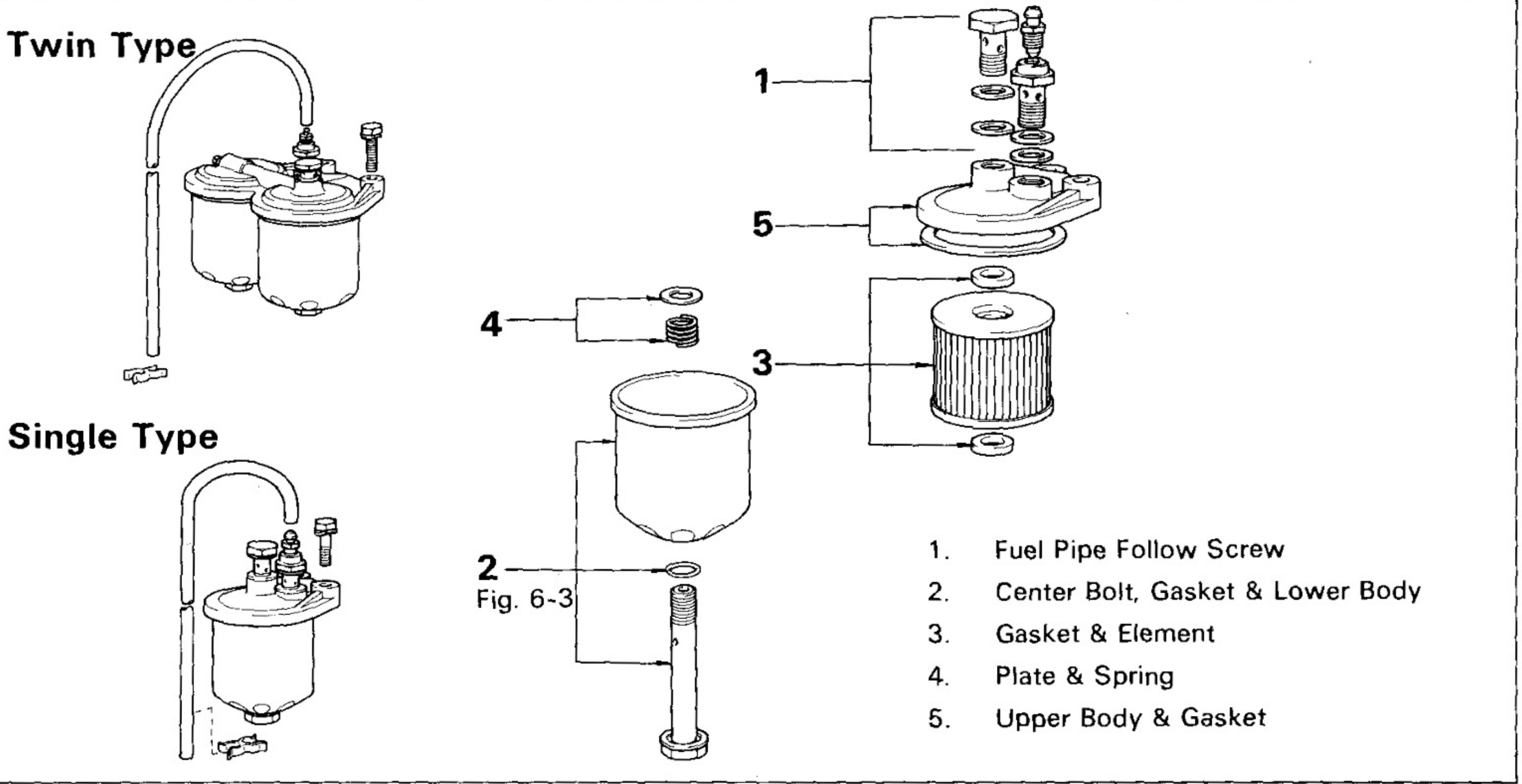
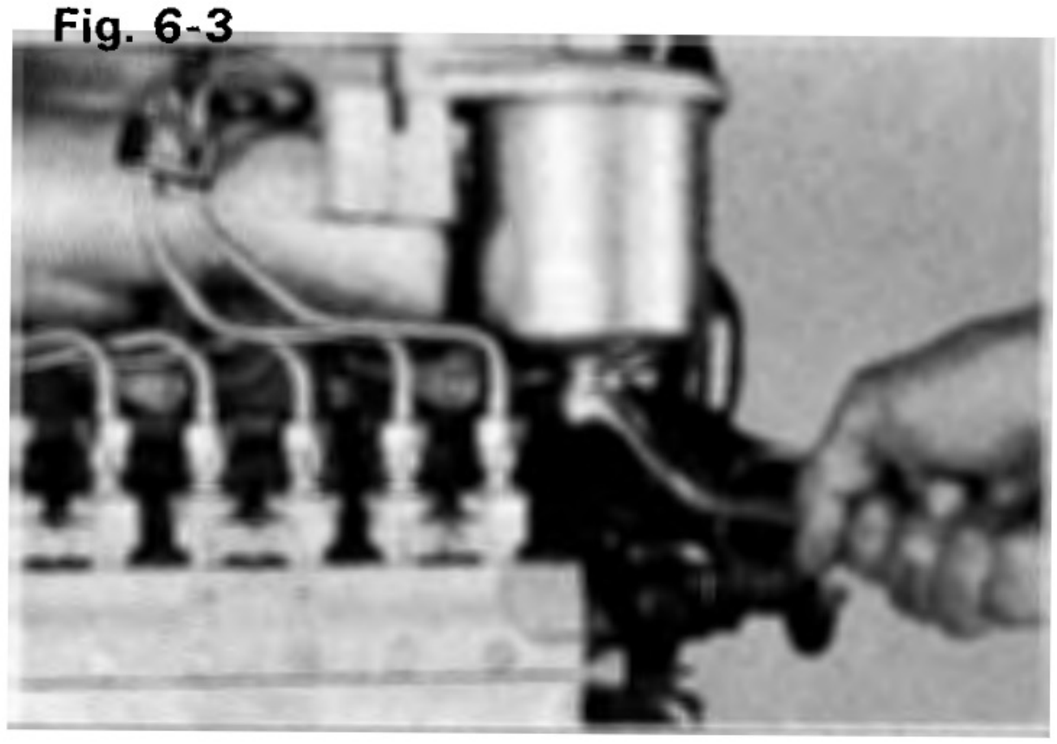


Fig. 6-3

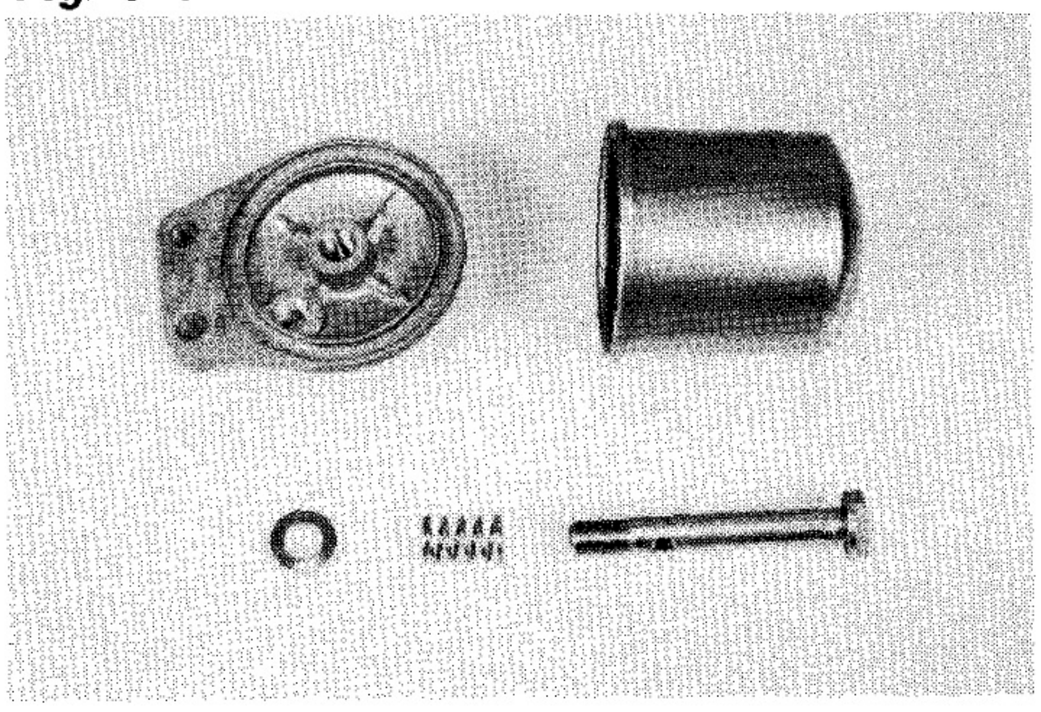
1. Fuel Pipe Follow Screw
2. Center Bolt, Gasket & Lower Body
3. Gasket & Element
4. Plate & Spring
5. Upper Body & Gasket

Fig. 6-3



Loosen the bolt and take off the lower body.

Fig. 6-4



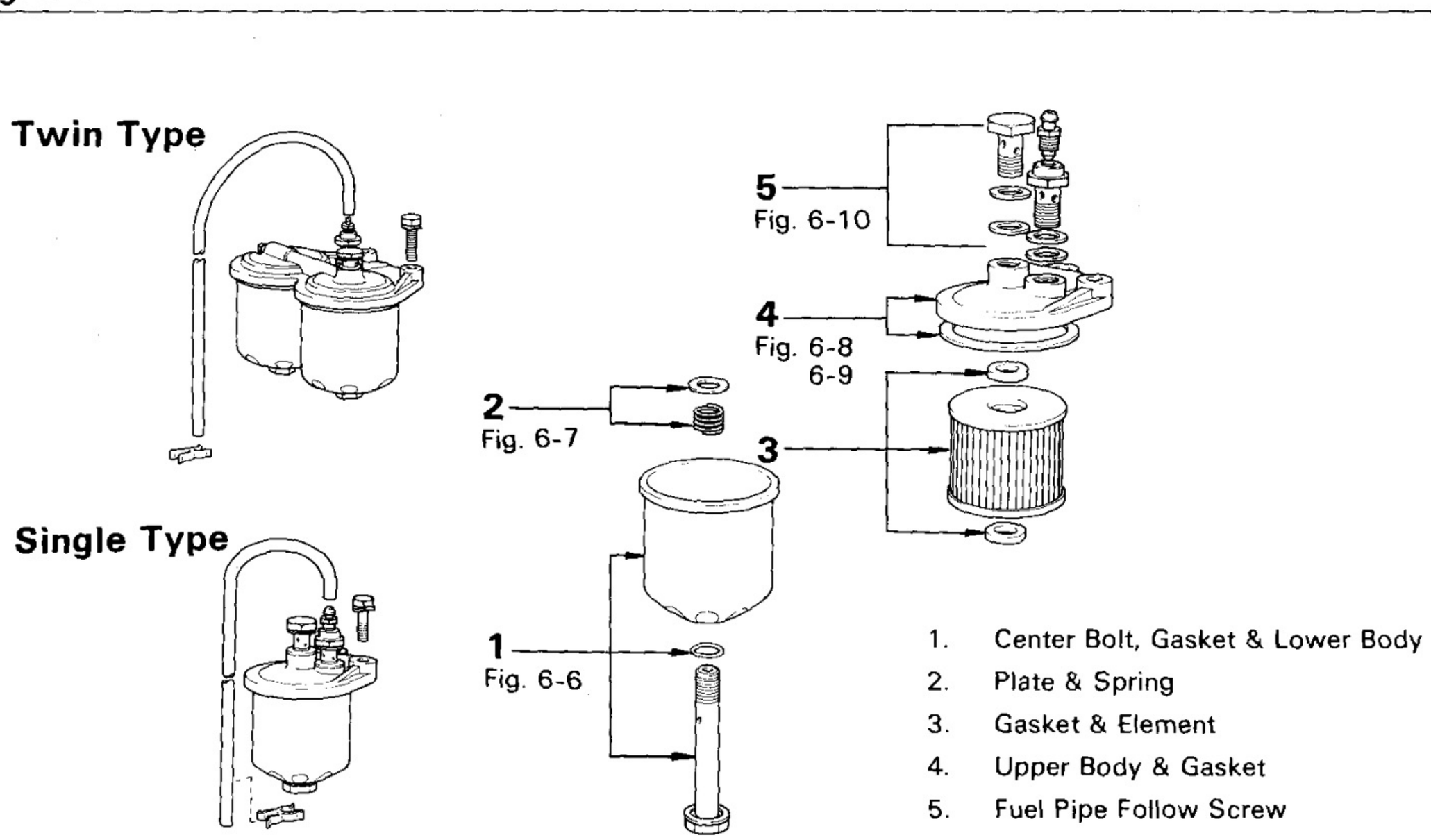
INSPECTION

Clean all disassembled parts.
Check the disassembled parts for wear or damage.

ASSEMBLY

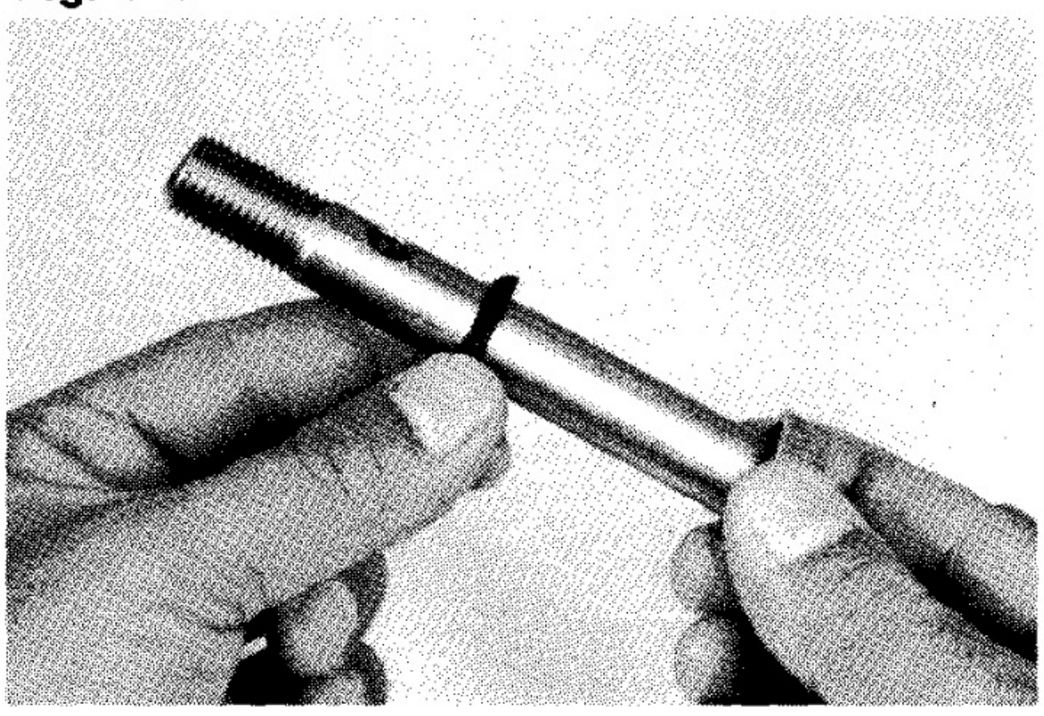
Assemble the parts in the numerical order shown in the figure.

Fig. 6-5



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

Fig. 6-6



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

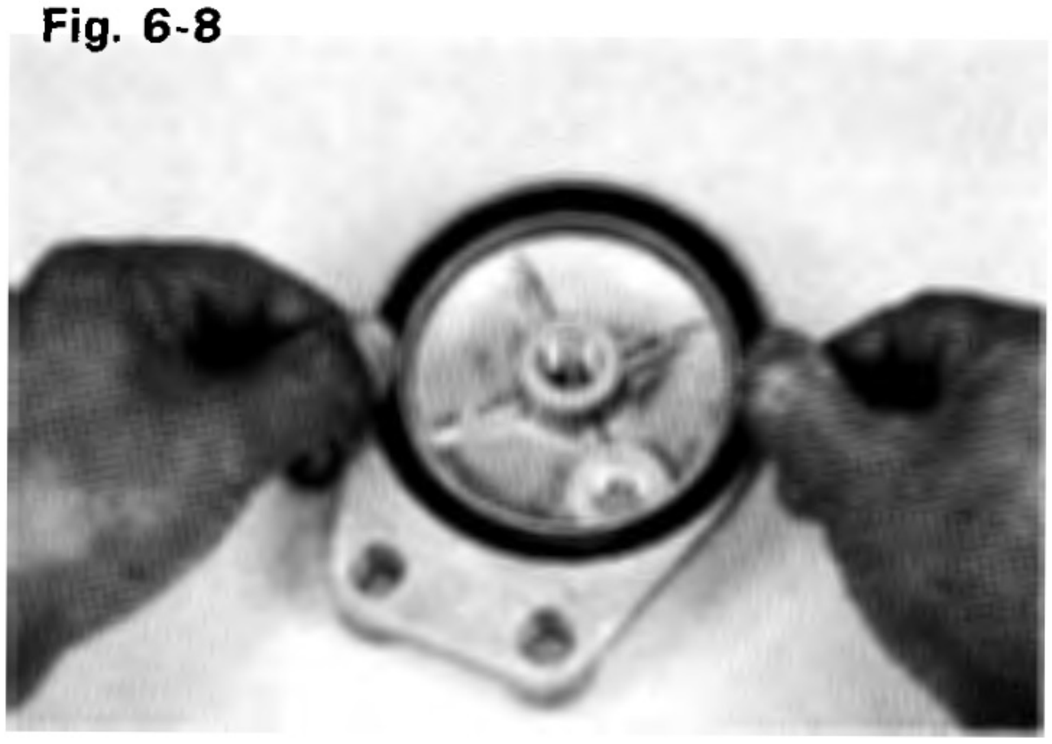
— Note —
Use a new gasket.

Fig. 6-7



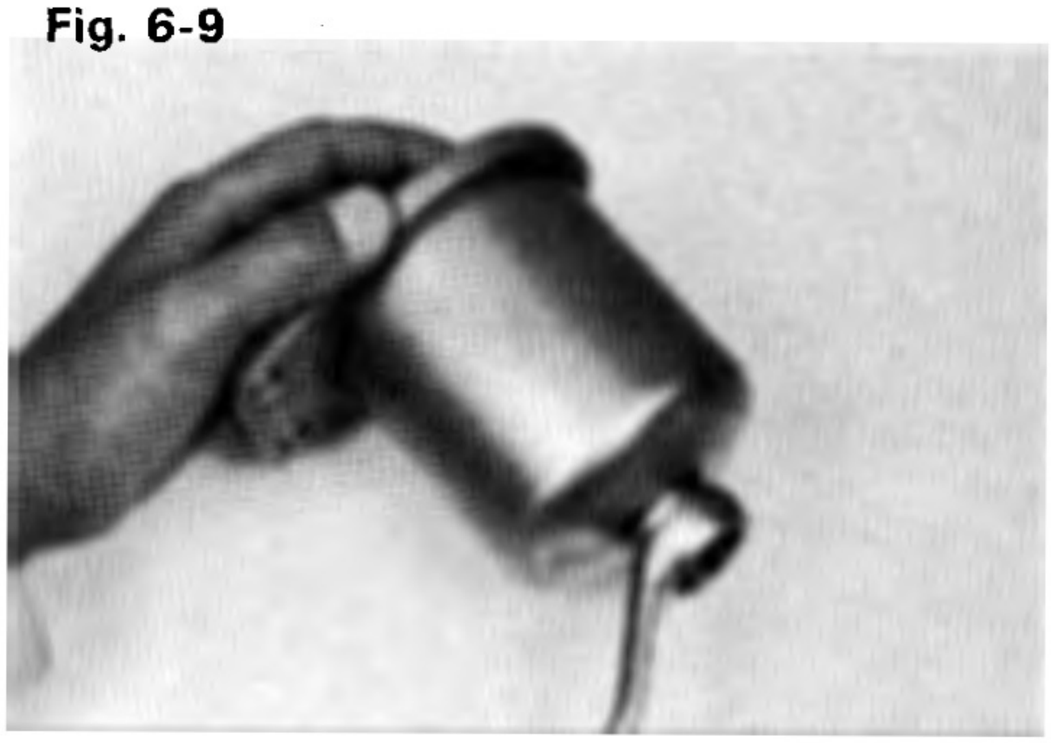
Install the spring and plate to the lower body.

Fig. 6-8



Install the gasket.

Fig. 6-9



Assemble the lower body and tighten the bolt.

Fig. 6-10

SEE

INJECTION PUMP

AIR BLEEDING

SECTION

Fig. 6-210 to 6-215

After installing, bleed air from fuel filter.

SEDIMENTER

FILTER WARNING SYSTEM

Fig. 6-11

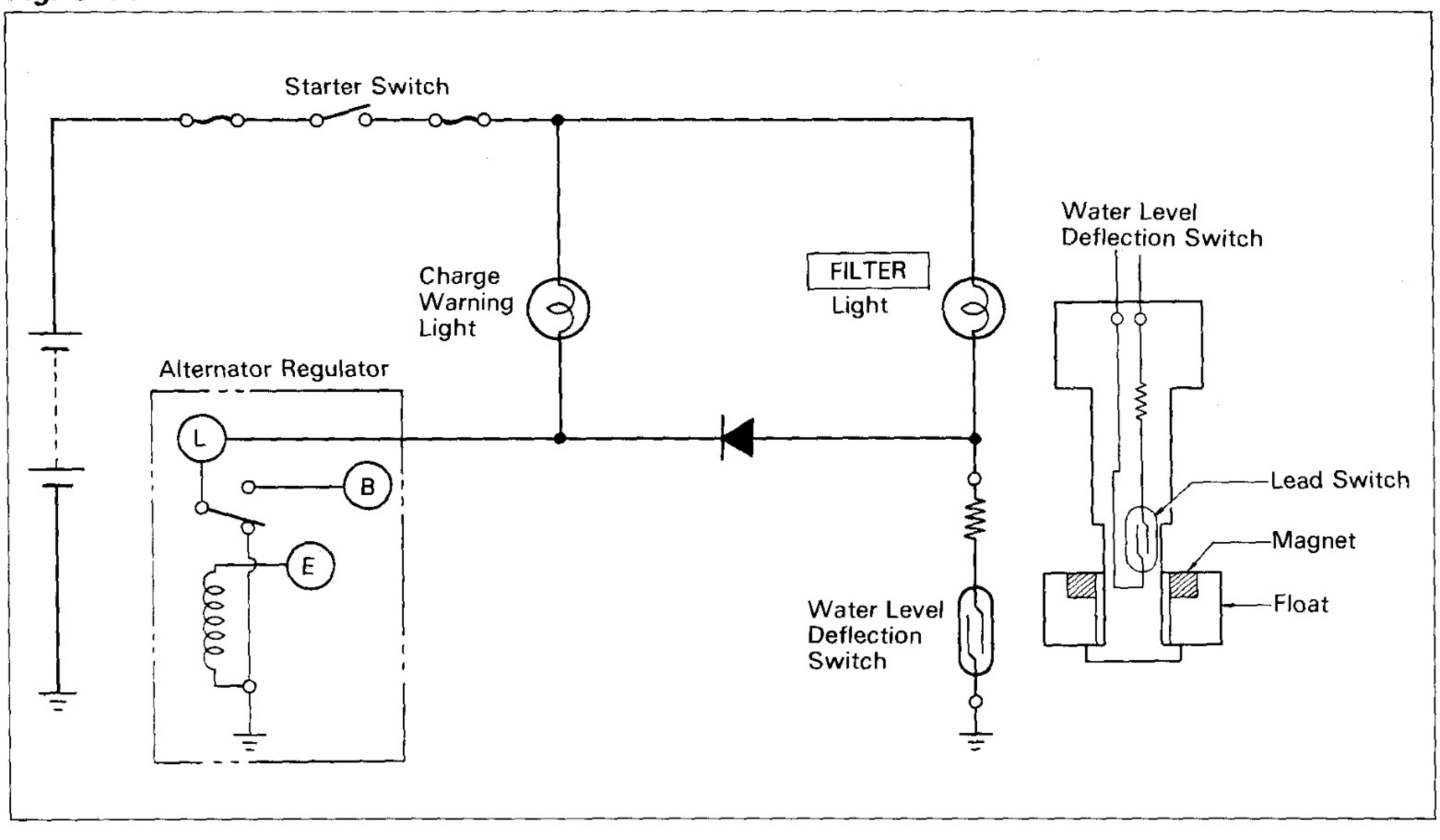
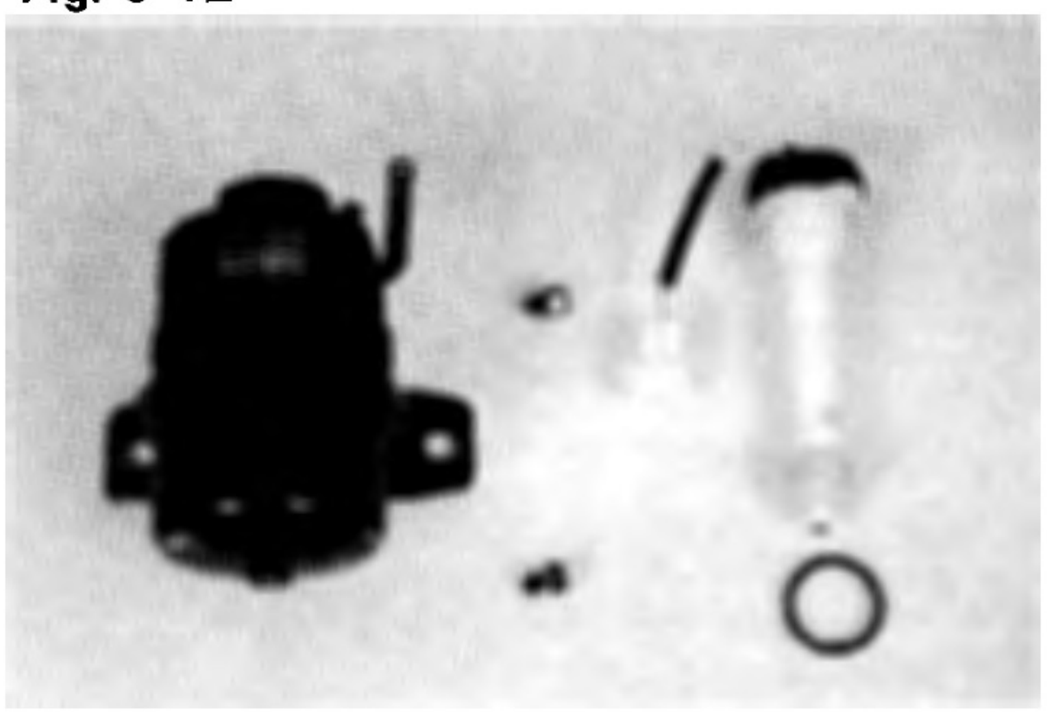


Fig. 6-12

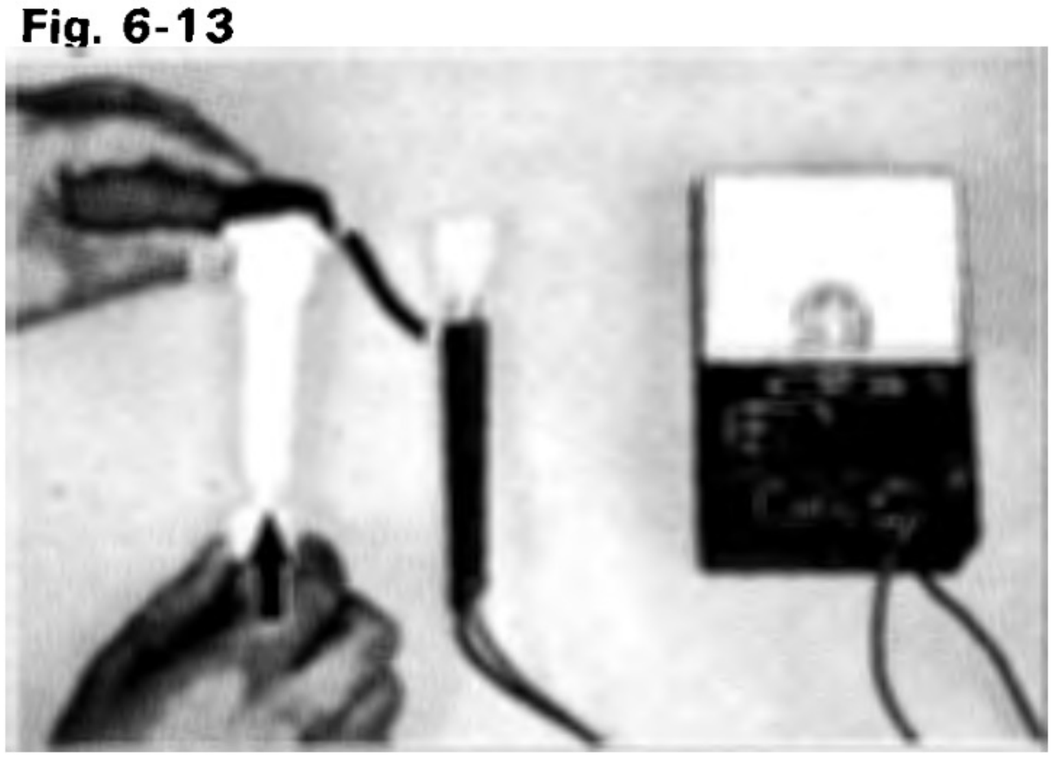


INSPECTION

Check each part for damage, cracks or deformation.

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

Fig. 6-13



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. 6-14

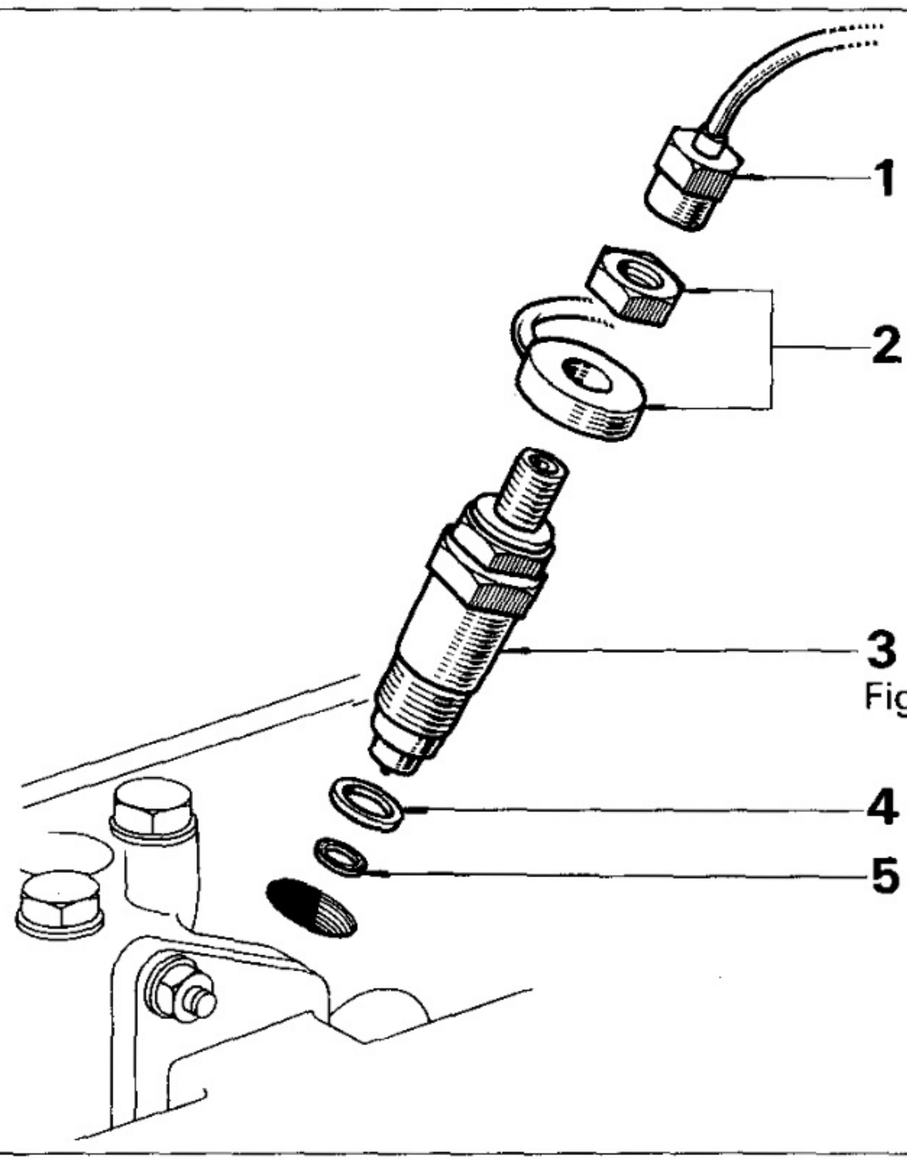
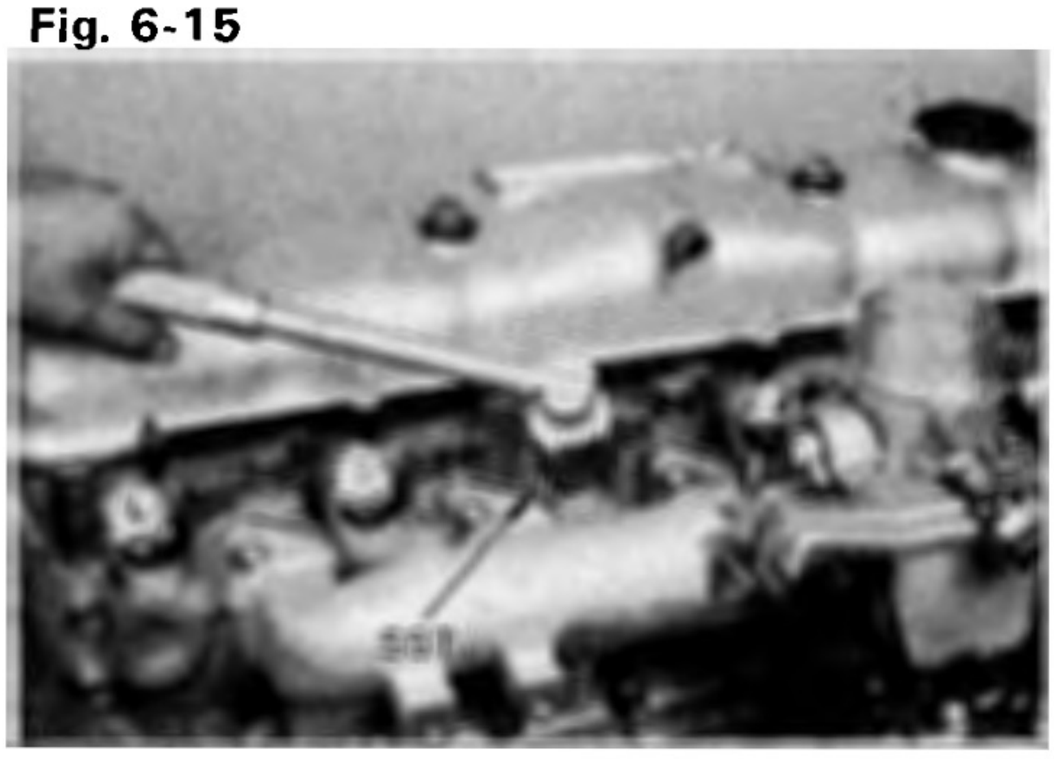


Fig. 6-15
6-16

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

Fig. 6-15



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

Fig. 6-16



Arrange the injection nozzle holders in correct order to facilitate reassembly.

Fig. 6-17

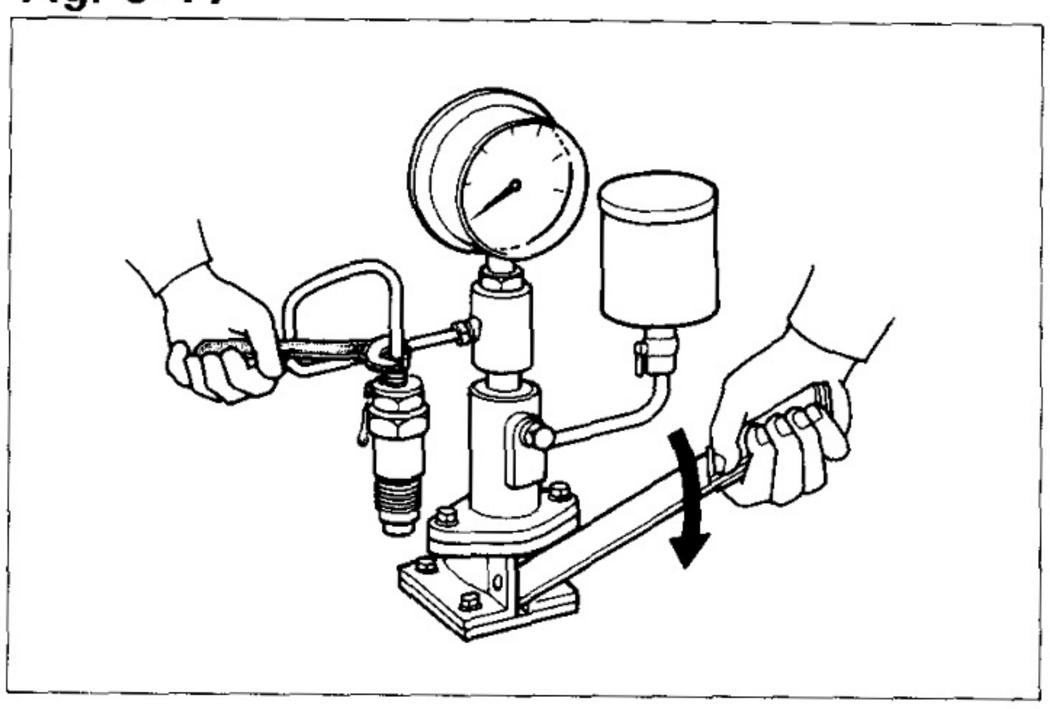


Fig. 6-18

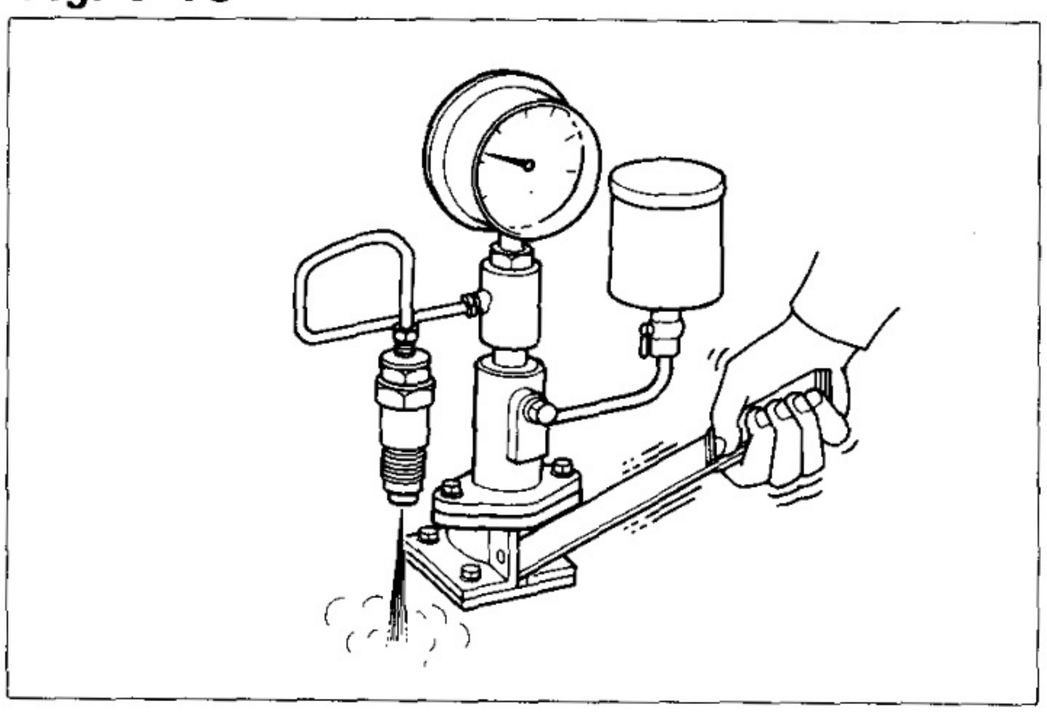


Fig. 6-19

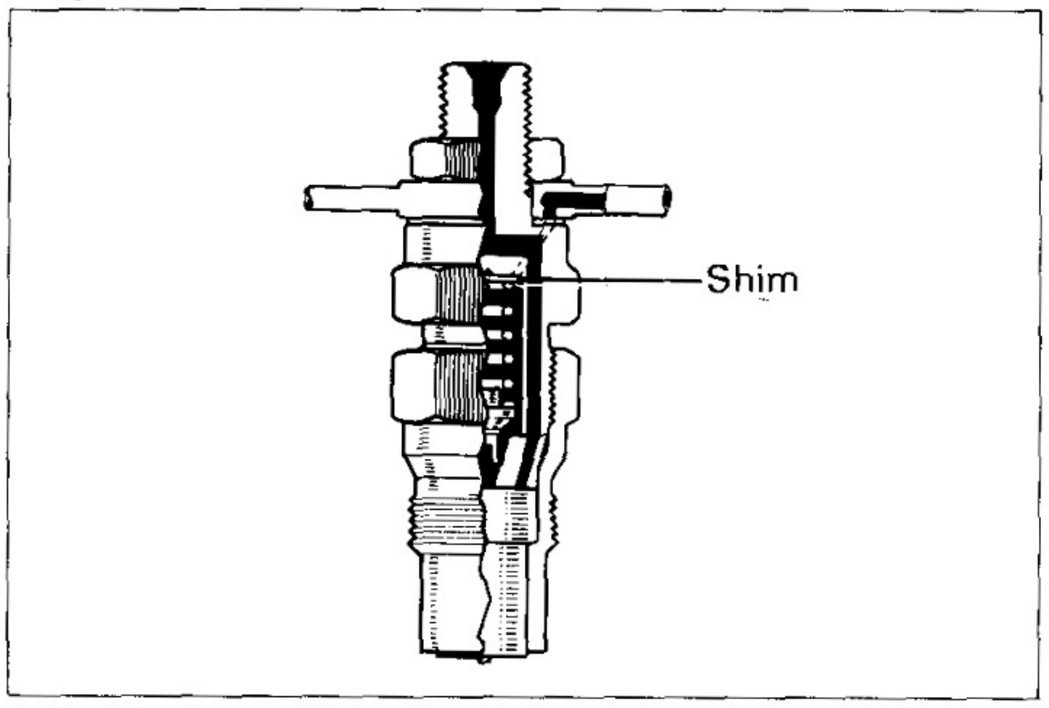
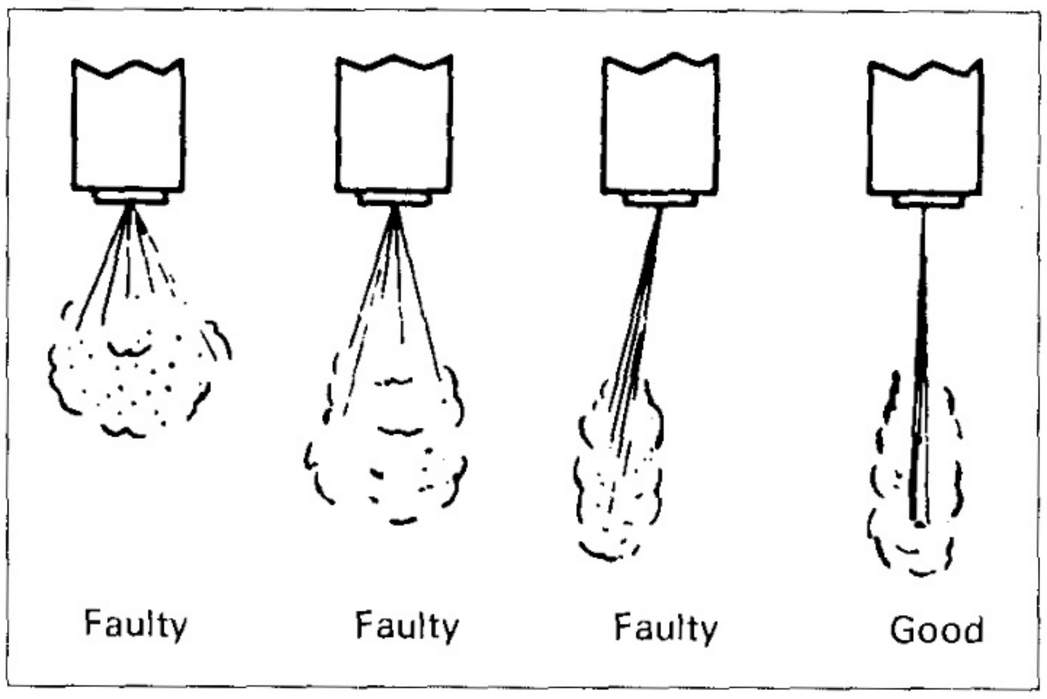


Fig. 6-20



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)

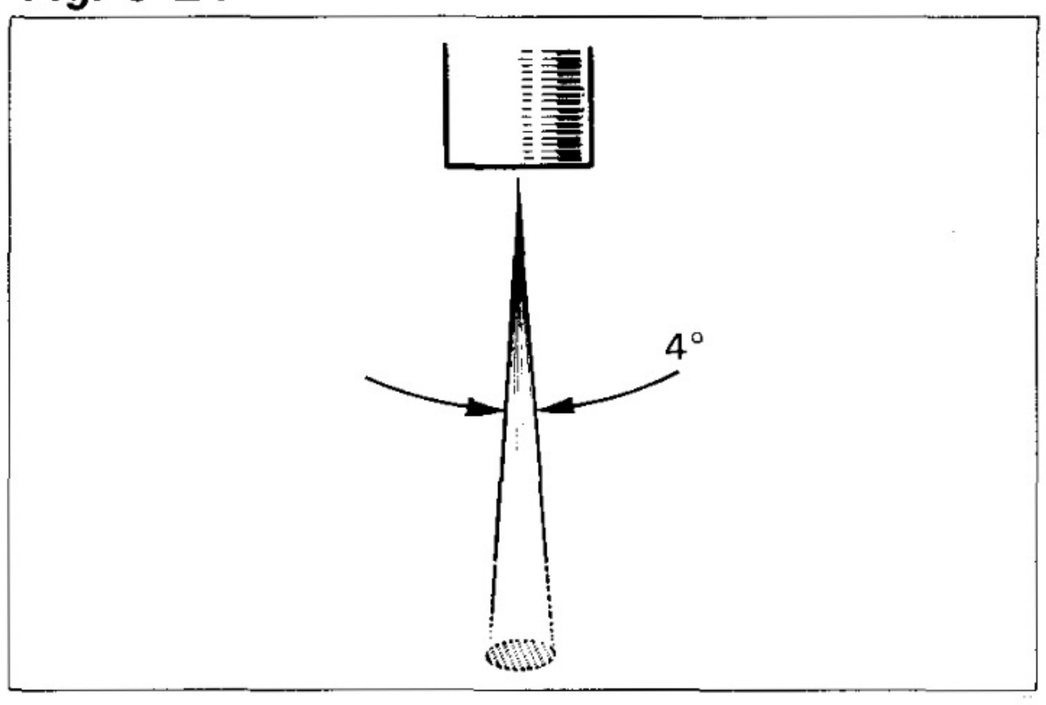
— Note —
1. **Proper nozzle operation can be determined by a hissing sound.**
2. **Adjust the injection starting pressure to 110—125 kg/cm² (1,565—1,778 psi), if the reused nozzle has been overhauled.**

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 (71psi).**

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

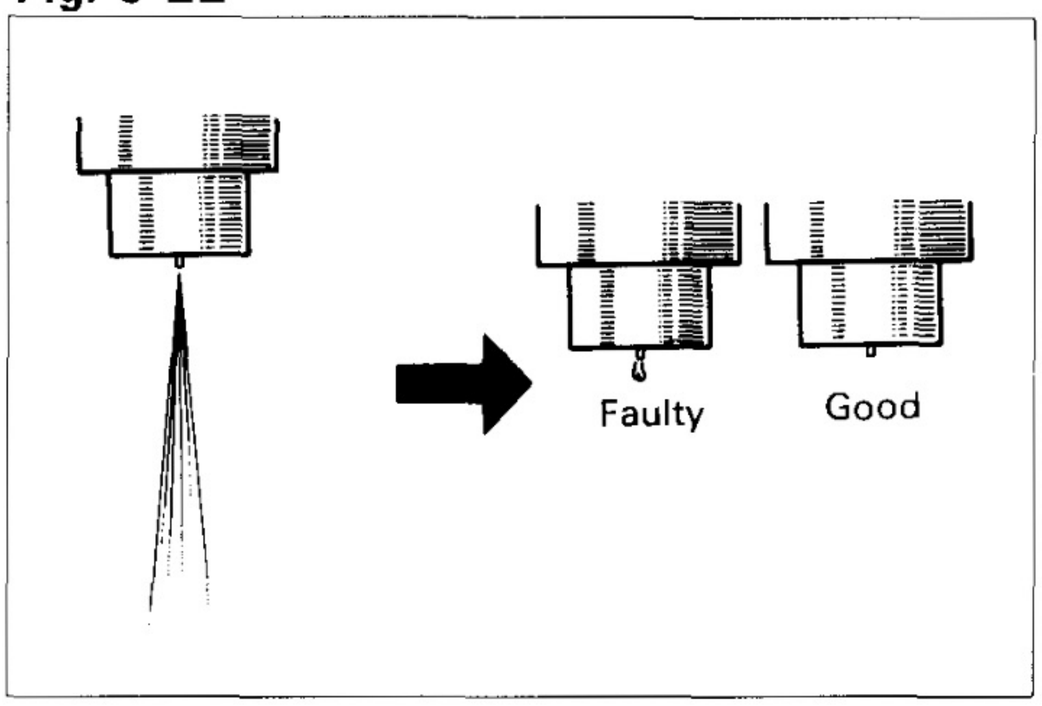
Fig. 6-21



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

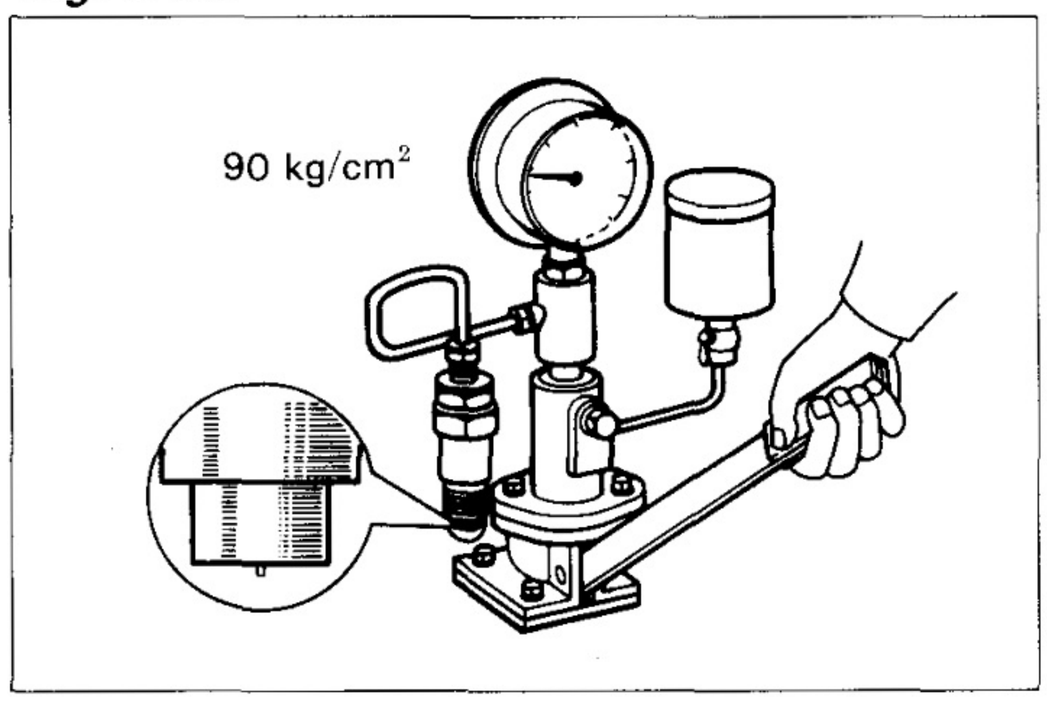
(3) Place a white sheet of paper about 30 cm (11.8 in.) away from the nozzle to check if spray pattern is in circular form.

Fig. 6-22



5. There should be no dripping after injection.

Fig. 6-23



6. Leakage test
Apply 90 kg/cm^2 (1,280 psi) of fuel pressure, and check for leaks at the nozzle valve seat and retaining nut.

DISASSEMBLY

Disassemble the parts in the numerical order shown in the figure.

Fig. 6-24

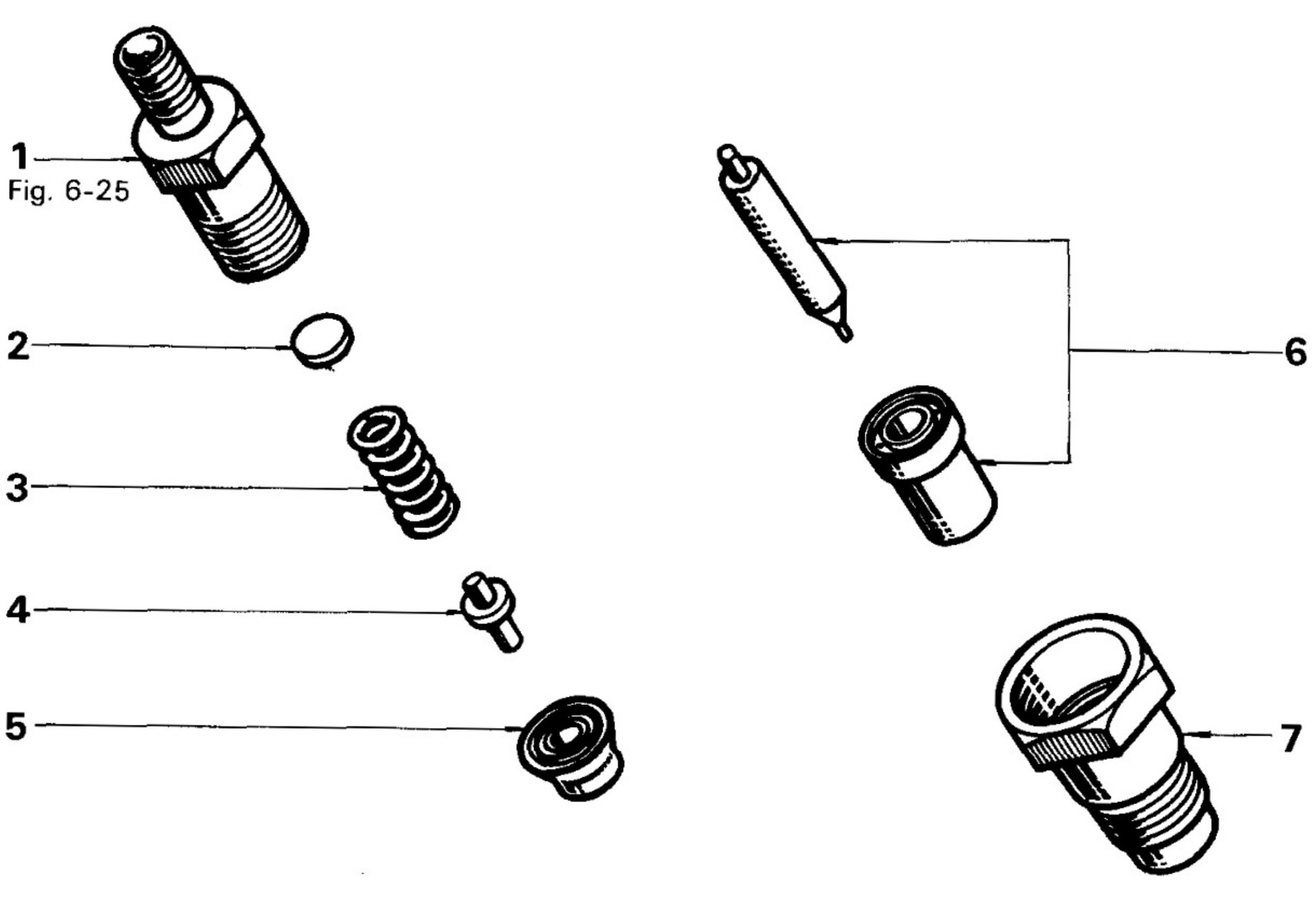
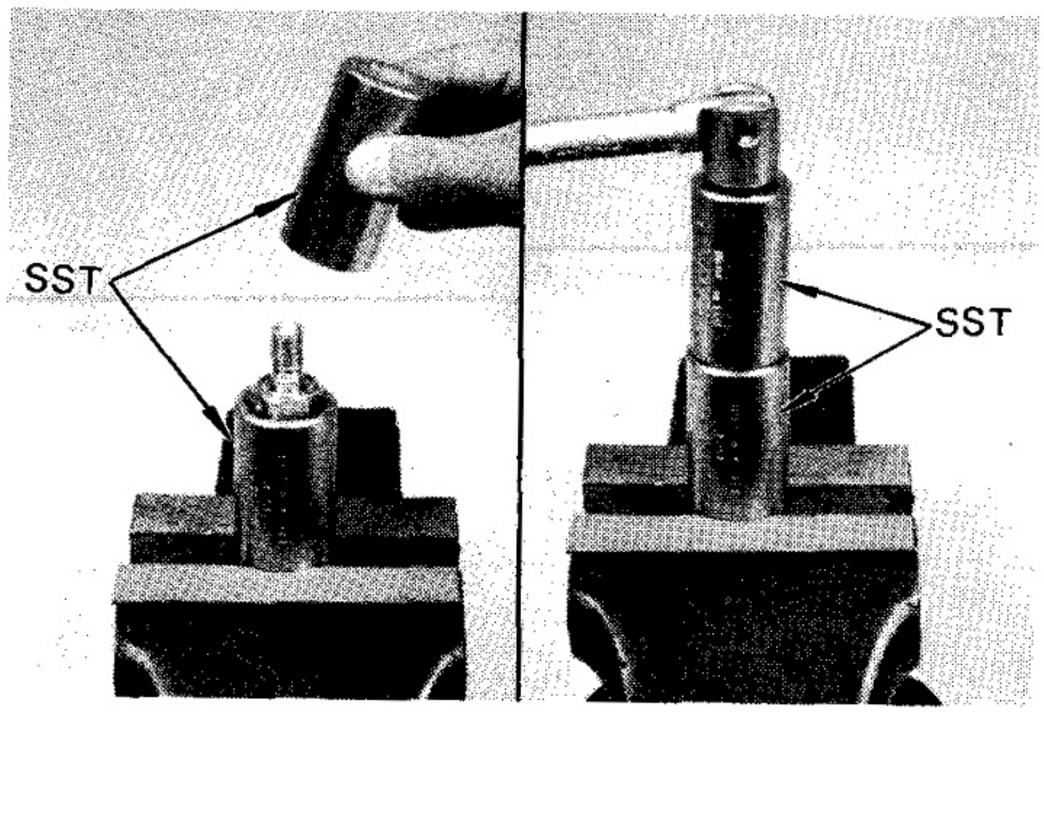


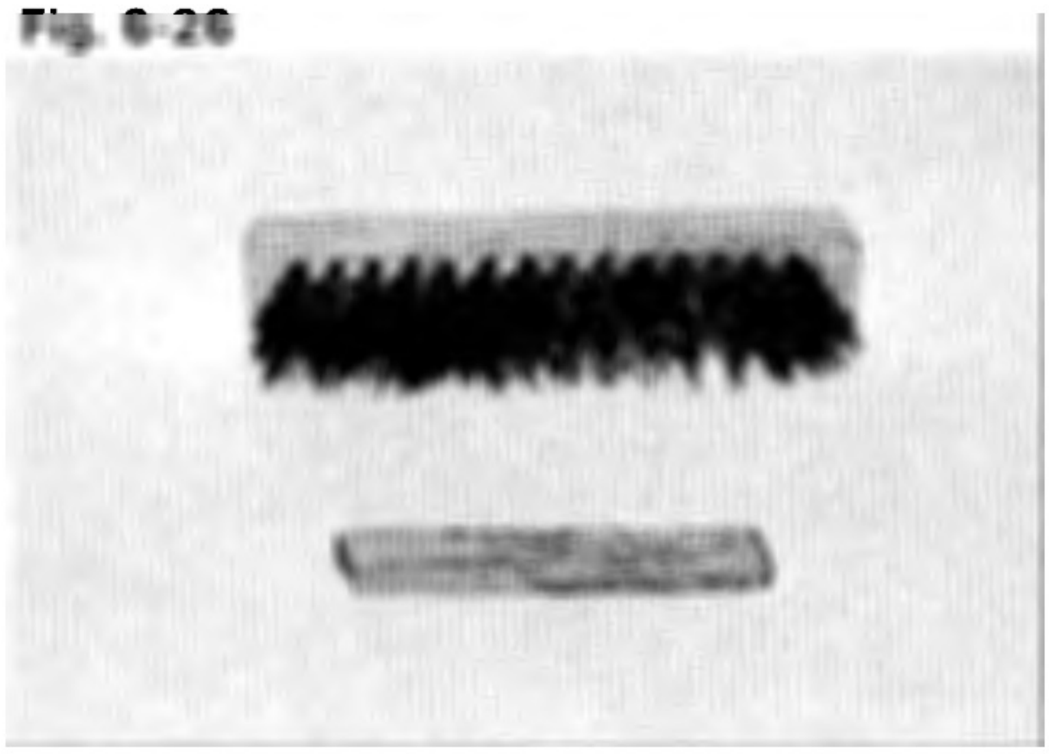
Fig. 6-25

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



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

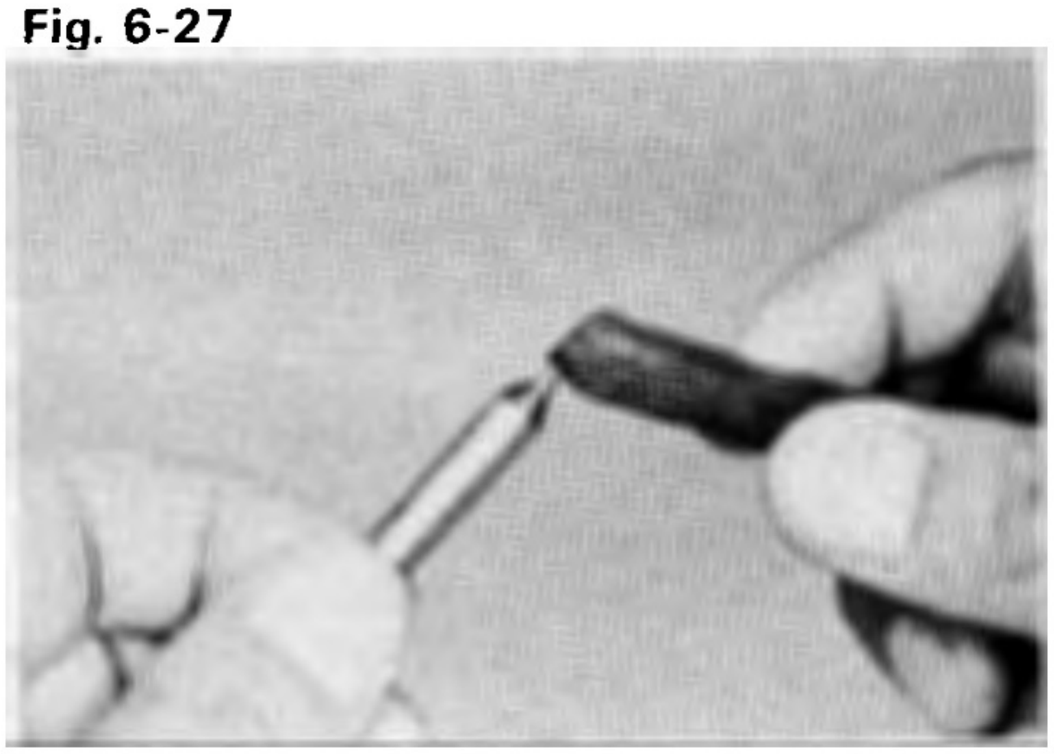
Fig. 6-26



NOZZLE CLEANING

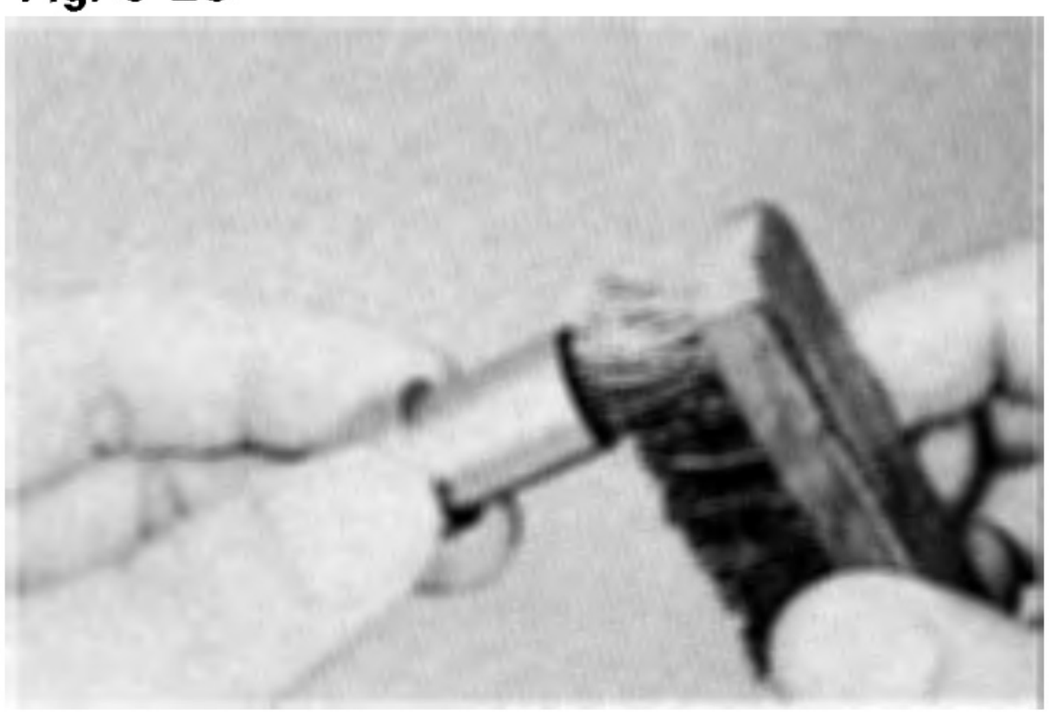
1. To wash the nozzles, use a wooden stick and brass brush. Wash in clean diesel fuel or light oil.

Fig. 6-27



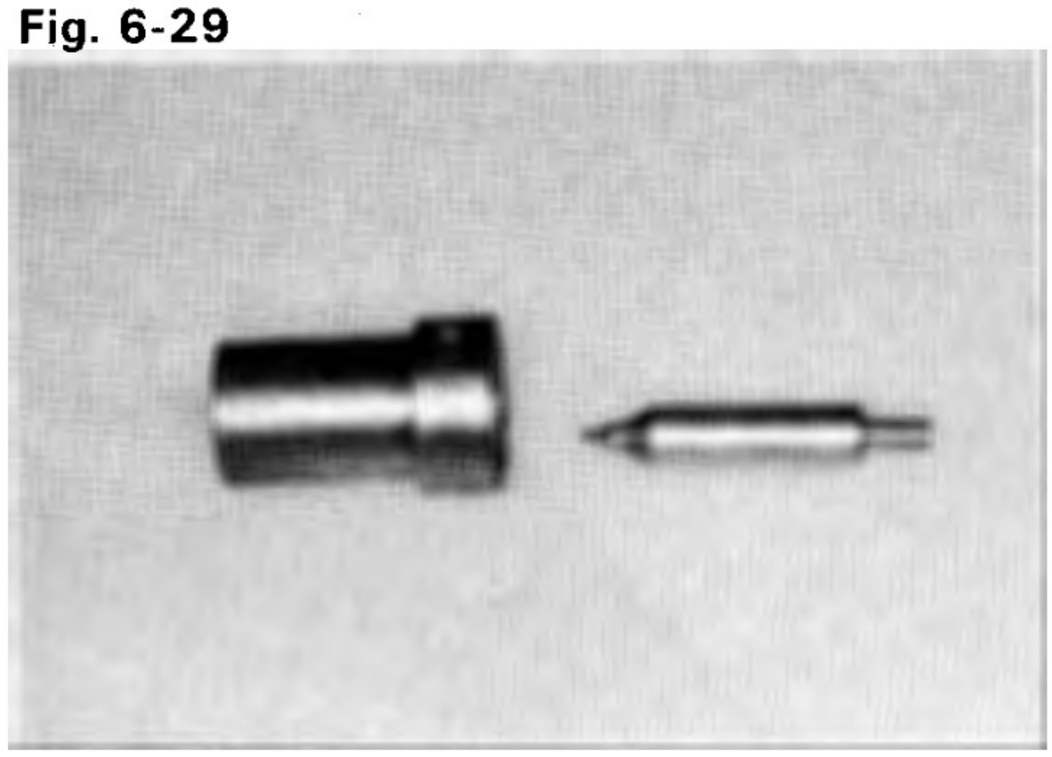
2. Remove the carbon adhering to the nozzle needle tip with a wooden stick.

Fig. 6-28



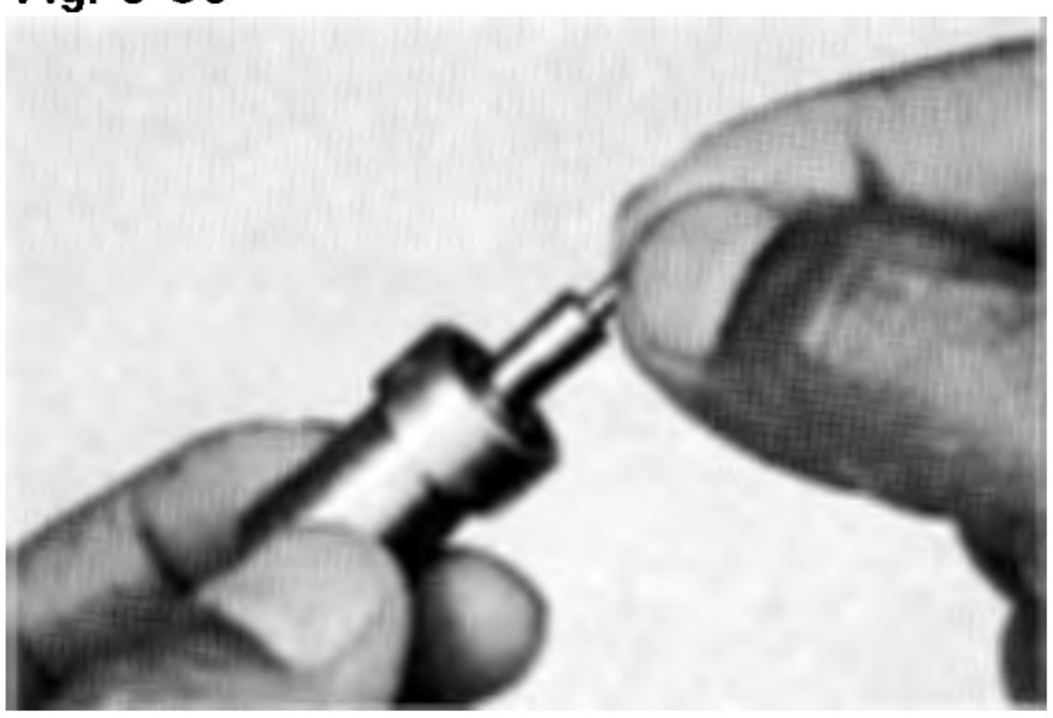
3. Remove the carbon from the exterior of the nozzle body (except wrapping angle) with a brass brush.

Fig. 6-29



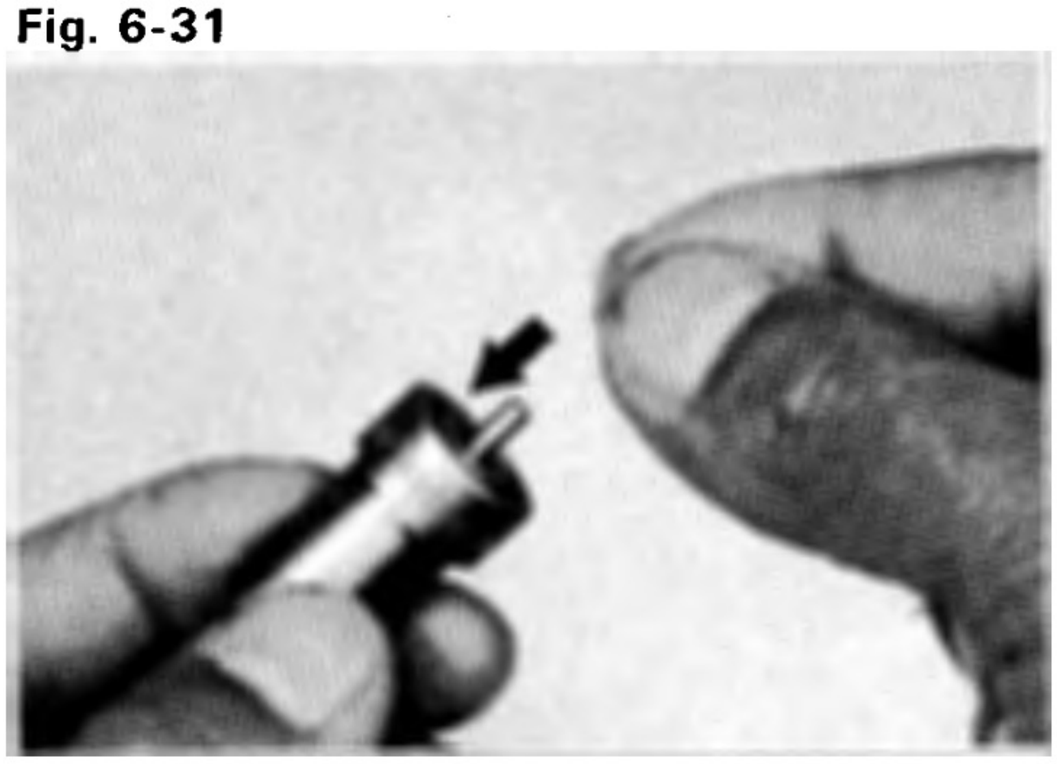
4. Wash the nozzle in clean diesel fuel or light oil.

Fig. 6-30



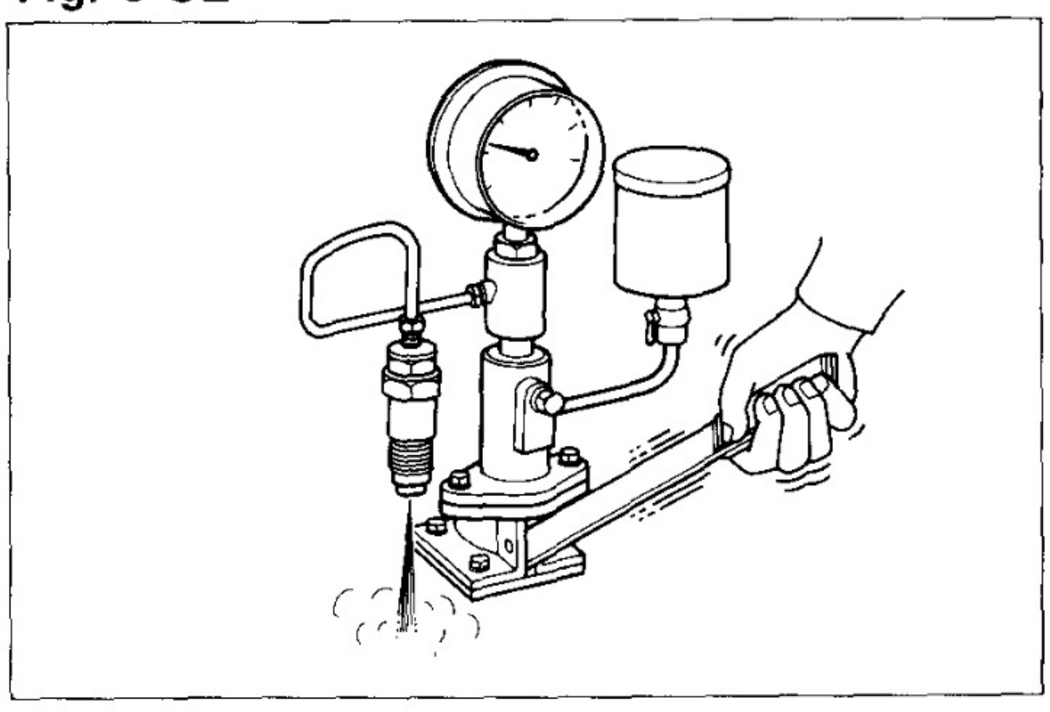
5. Perform a sinking test.
   (1) Pull the needle out about half way from the body and release it.

Fig. 6-31



   (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. 6-32



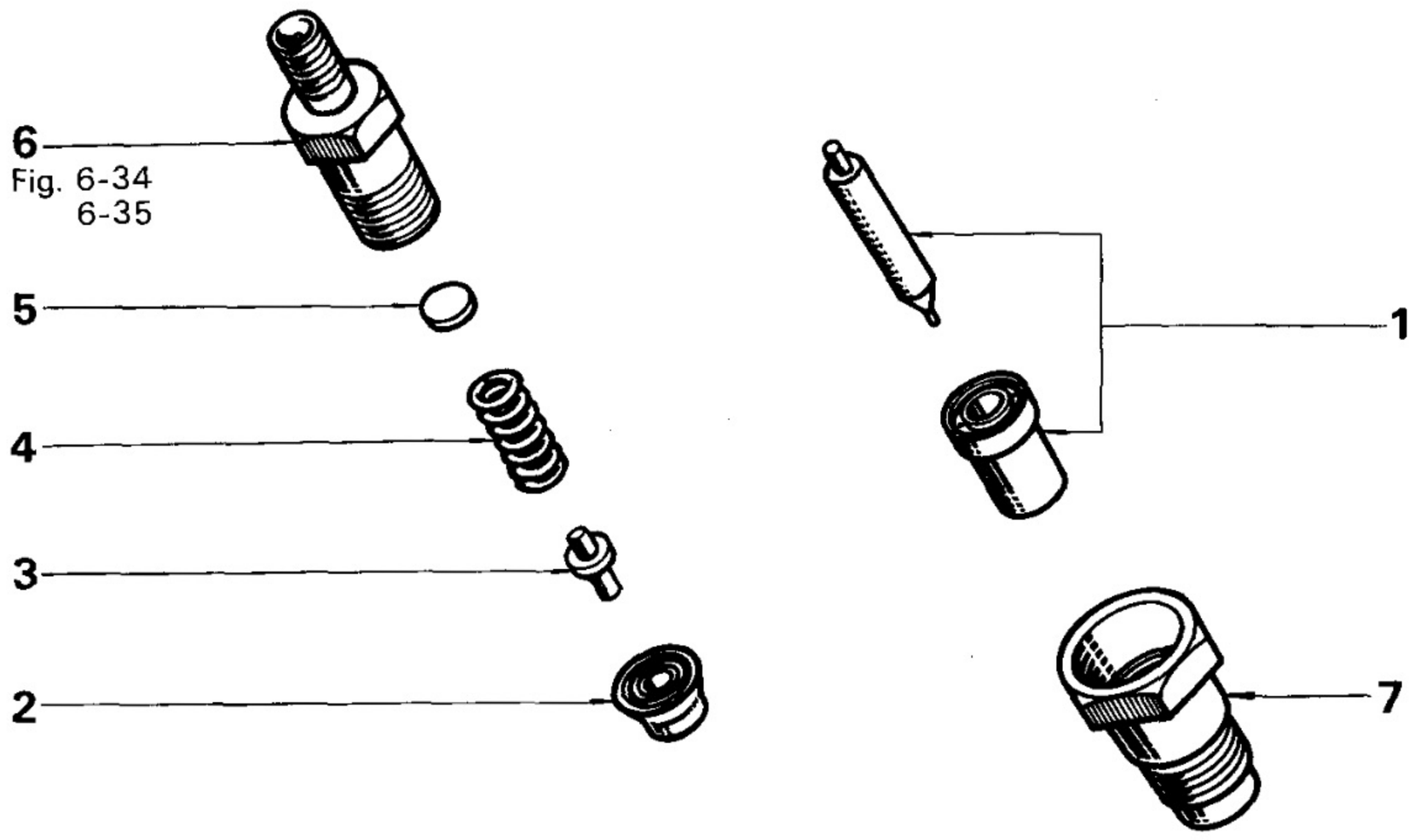
6. Perform a spray test.

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

ASSEMBLY

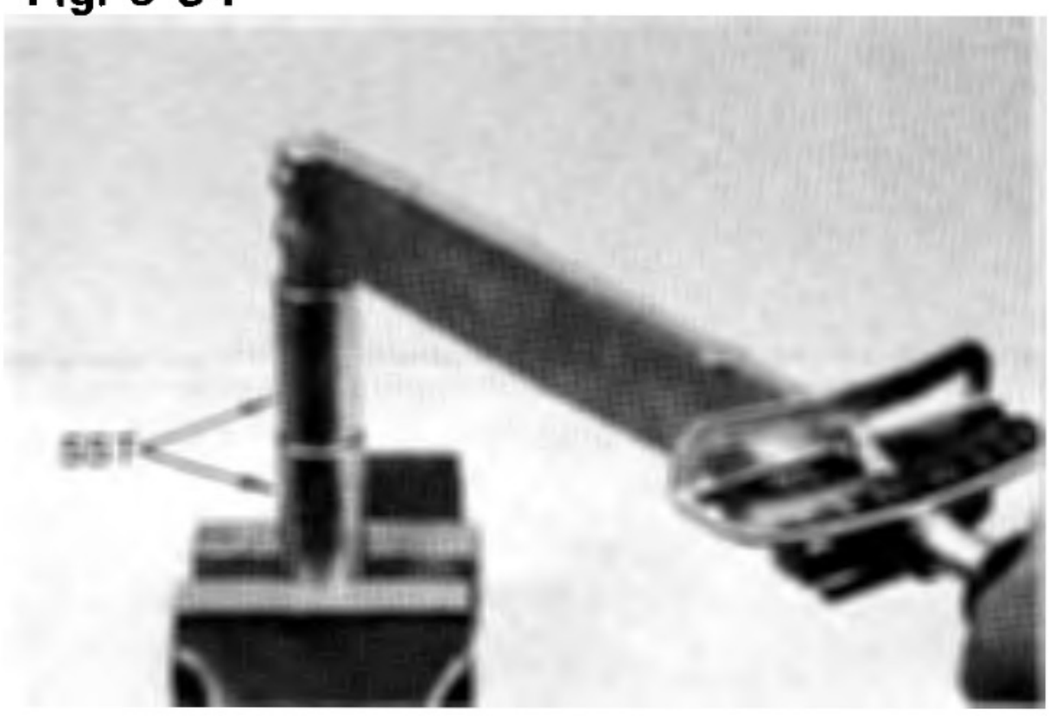
Assemble the parts in the numerical order shown in the figure.

Fig. 6-33



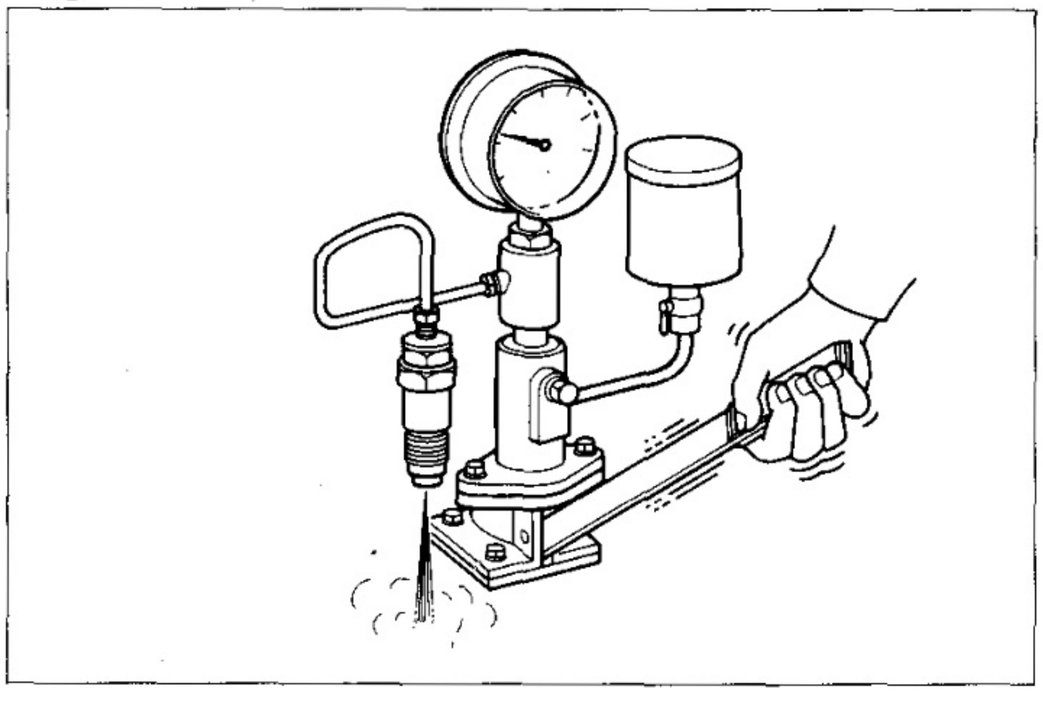
1. Injection Nozzle
2. Distance Piece
3. Pressure Pin
4. Pressure Spring
5. Adjusting Shim
6. Nozzle Holder Body
7. Retaining Nut

Fig. 6-34



Tighten the retaining nut with SST.
SST (09268-46011) &
(09268-46021) of set [09260-46011]
Tightening torque: 6.0 — 8.0 kg-m (44 — 57 ft-lb)

Fig. 6-35



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. 6-36

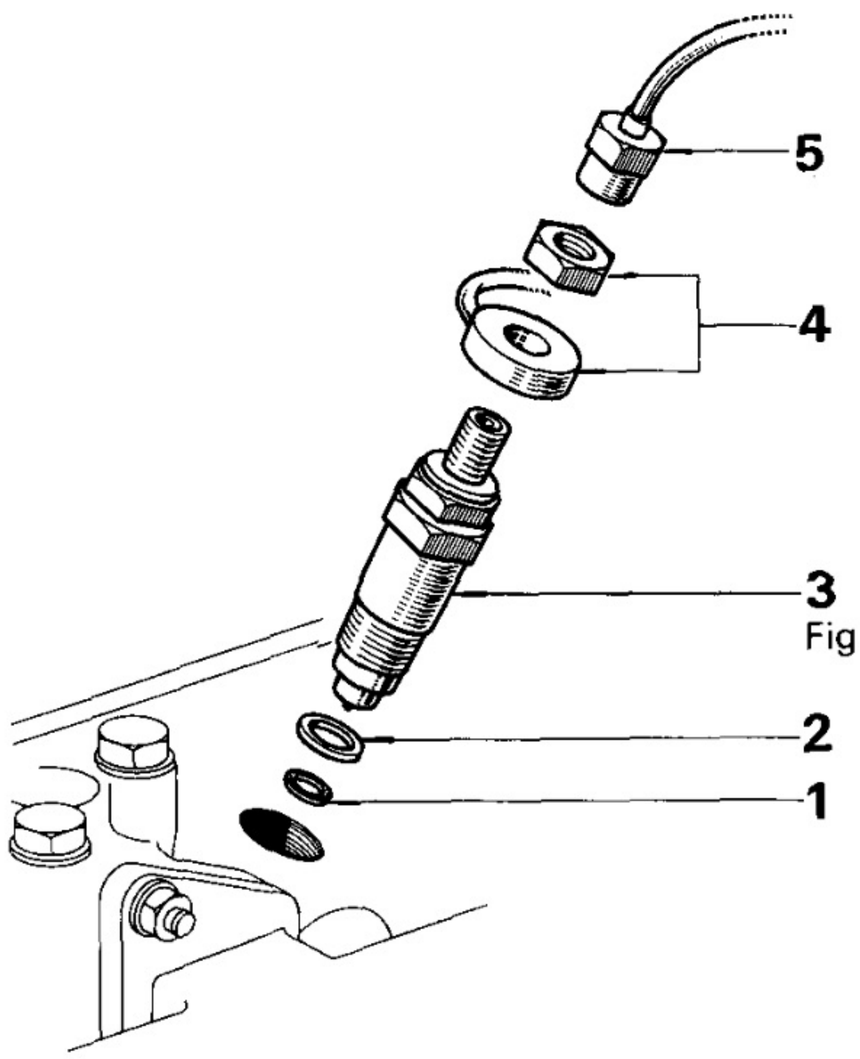
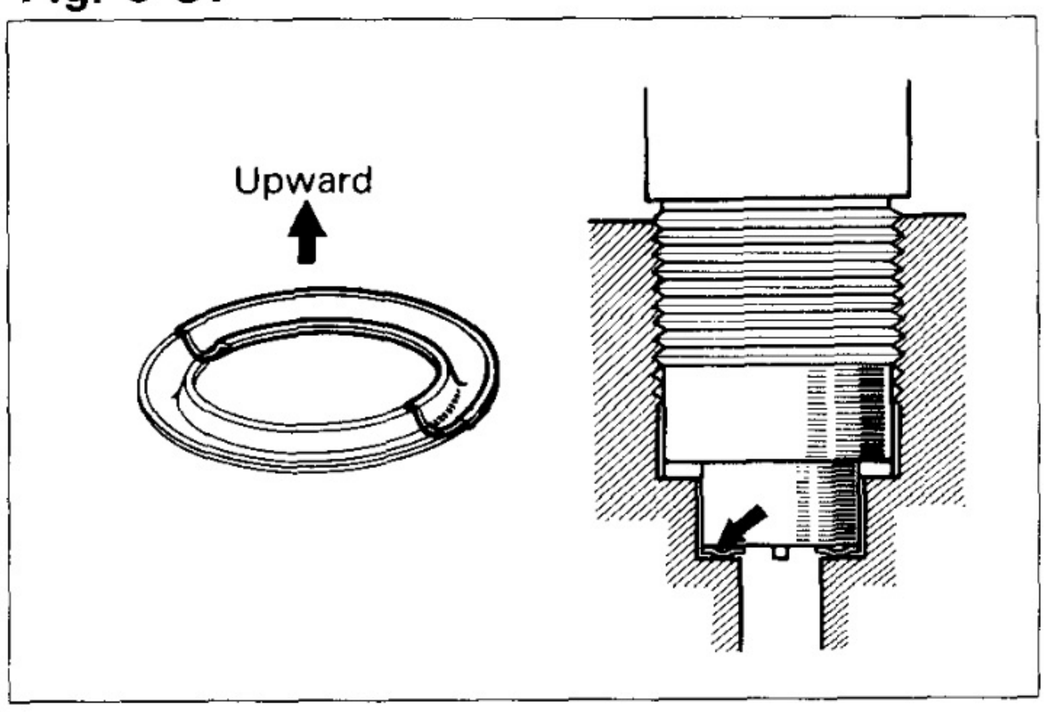


Fig. 6-37
6-38

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

Fig. 6-37



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

Fig. 6-38



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)

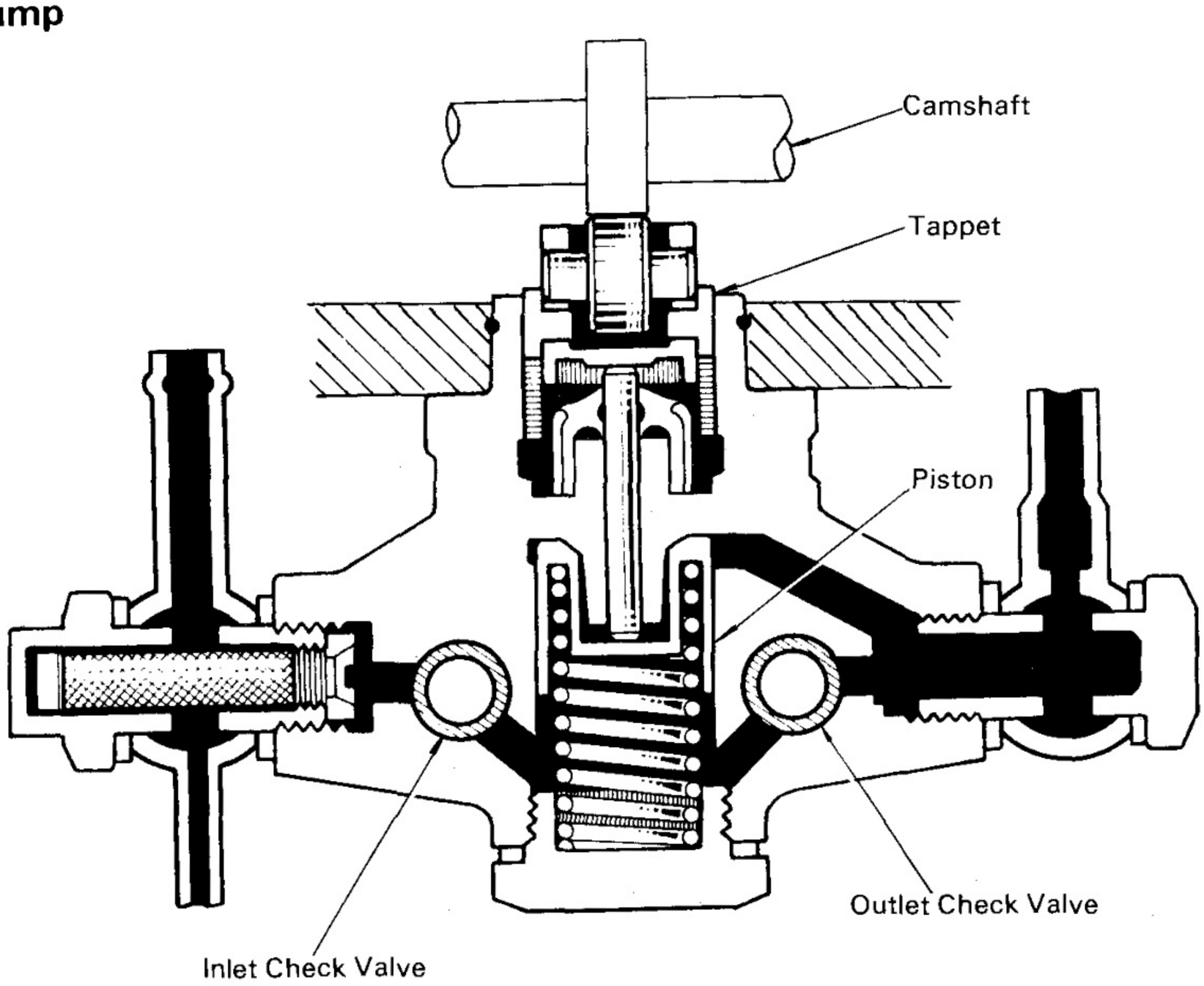
– Note –
After installing, bleed the air.

FUEL FEED PUMP

CUTAWAY VIEW

Fig. 6-39

Feed Pump



Priming Pump

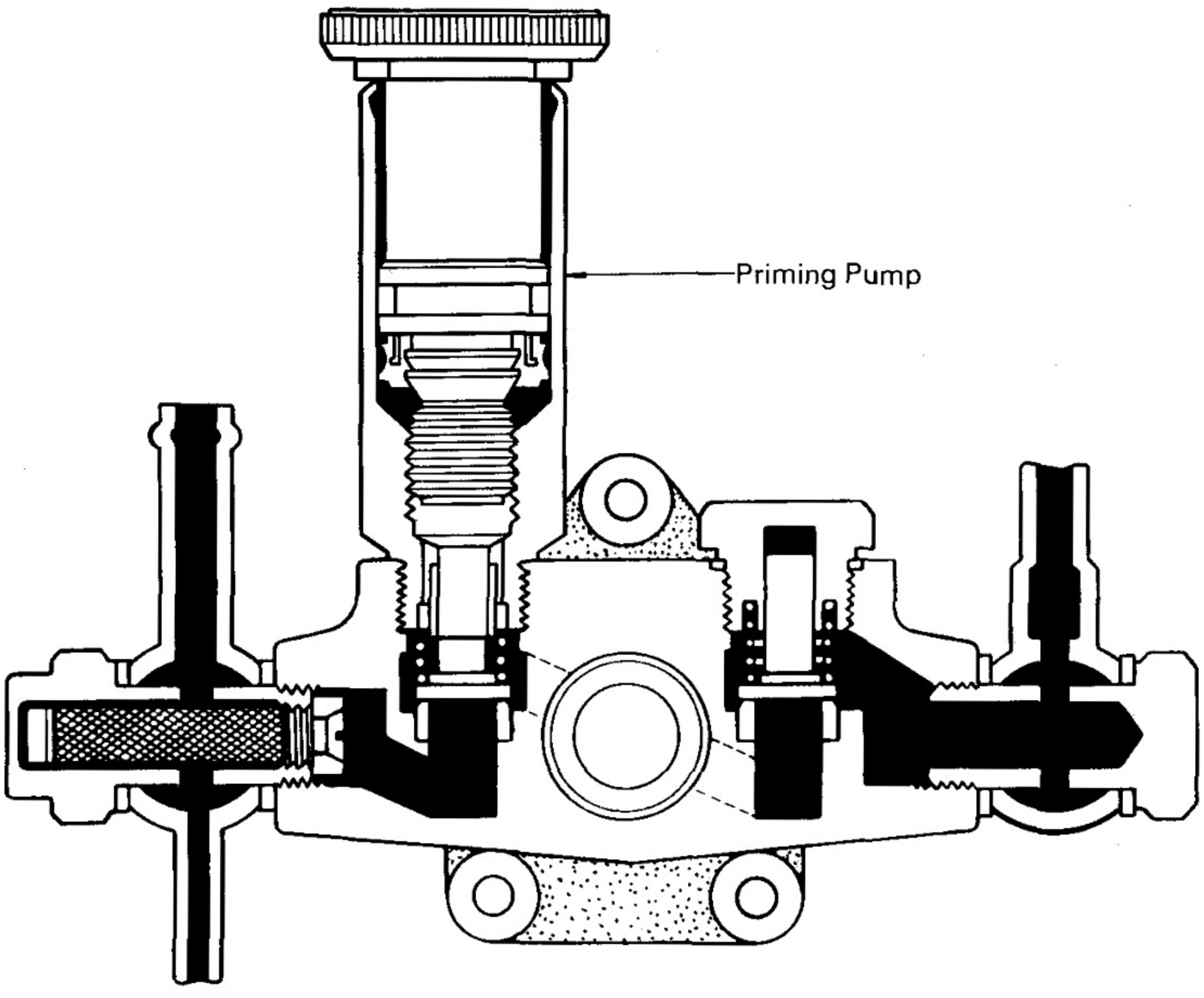
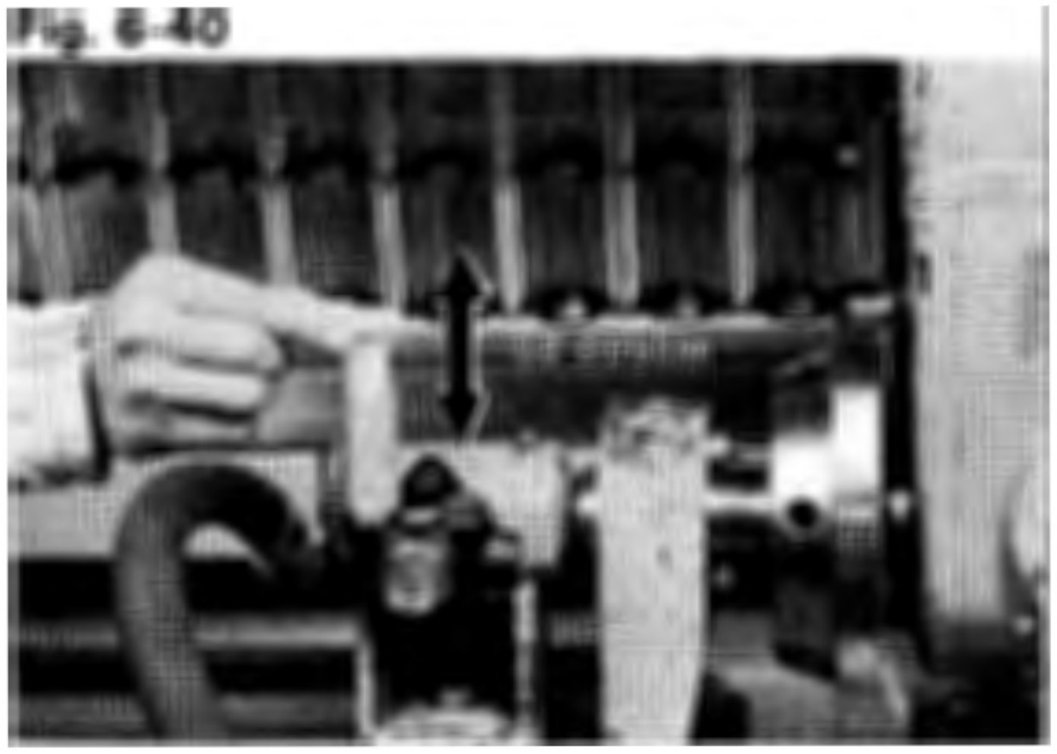


Fig. 6-40



FEED PUMP TEST

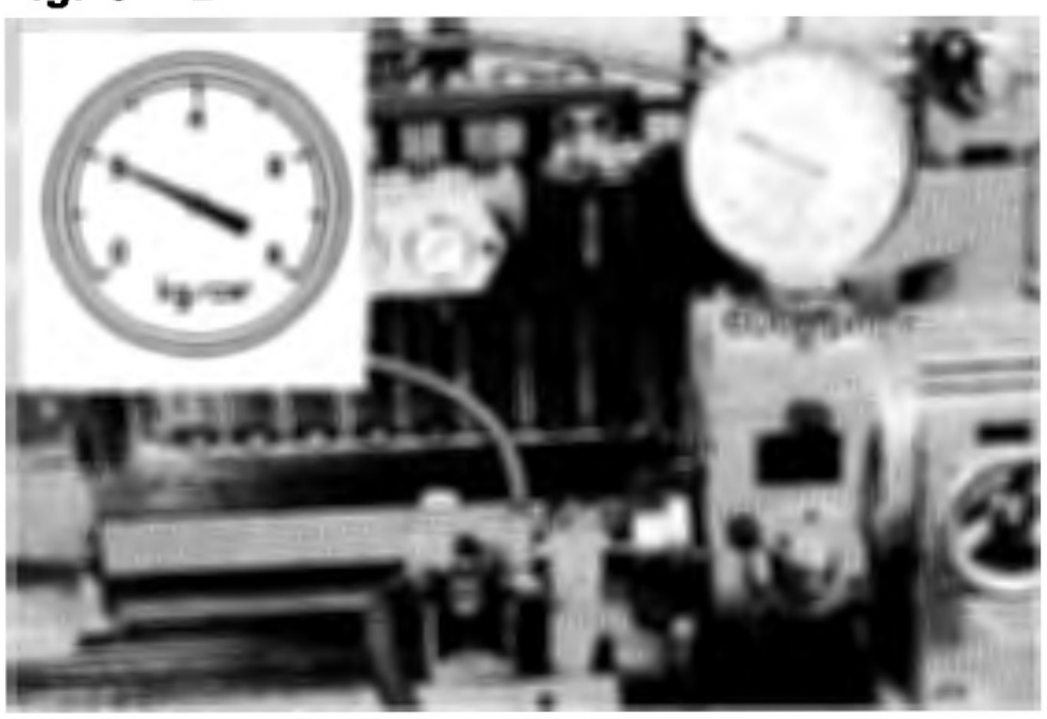
1. Suction capacity test
   The size of the suction pipes should be:
   Pipe inner diameter:
   8 mm (0.31 in.)
   Pipe length: 2 m (78.7 in.)
   Suction height: 1 m (39.4 in.)
   (1) Operate the priming pump for one minute at 60 strokes per minute.
   Suction capacity:
   Fuel must discharge within 25 strokes

Fig. 6-41



(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. 6-42



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. 6-43



(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./min.)

DISASSEMBLY

Disassemble the parts in the numerical order shown in the figure.

Fig. 6-44

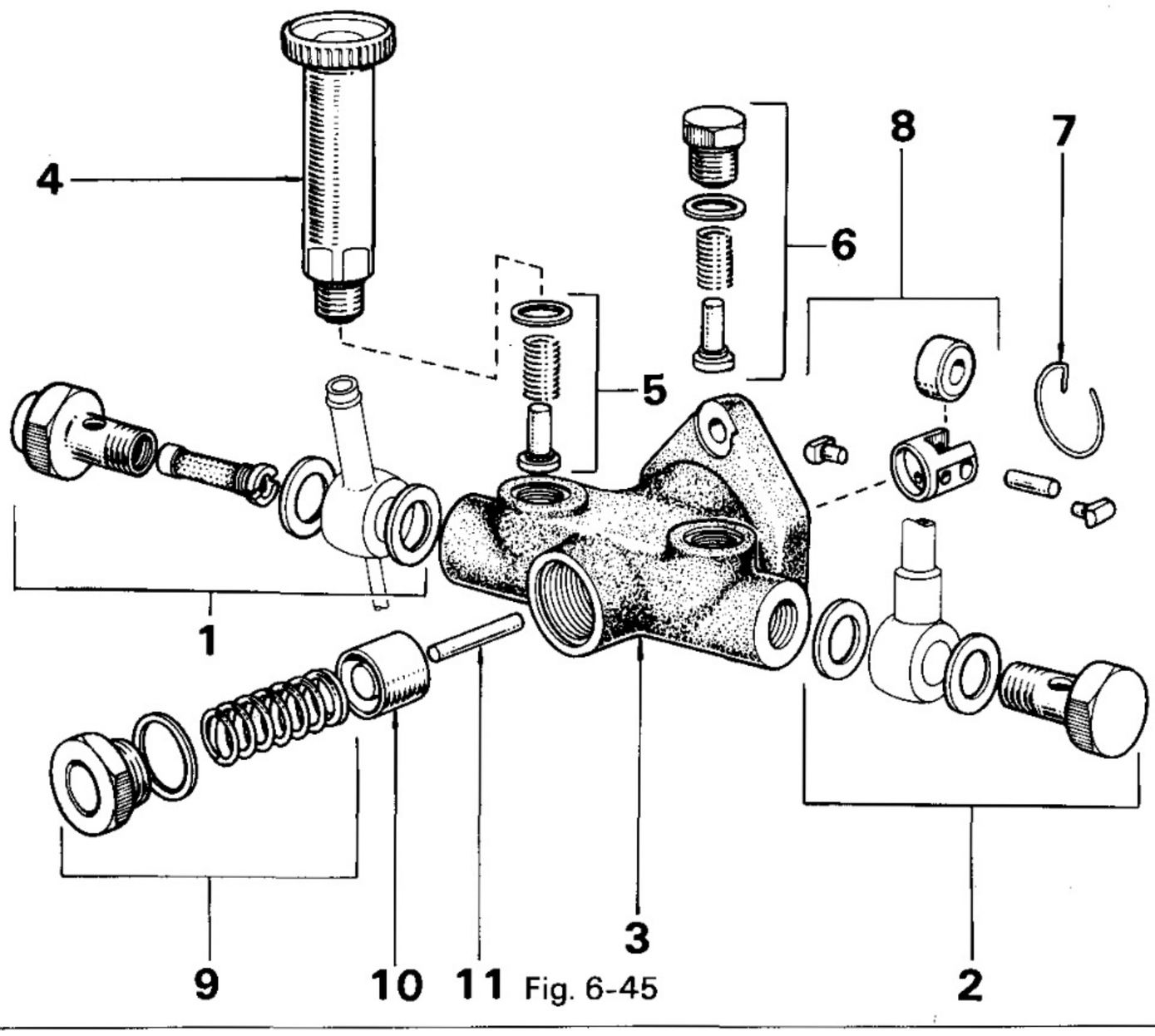


Fig. 6-45

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. 6-45



Since the push rod is precisionly fitted into the feed pump housing, do not remove the rod unless necessary. If removed, be sure to confirm assembly direction.

Fig. 6-46



INSPECTION

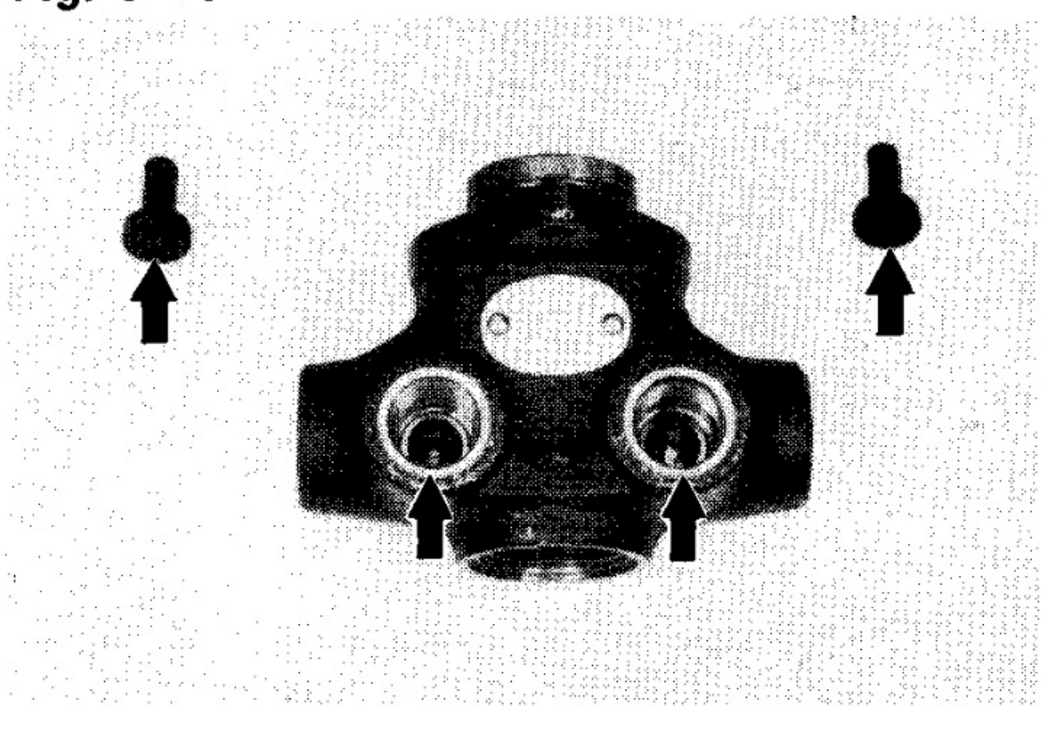
Inspect the piston, push rod and feed pump housing for wear or damage.

Clearance (Reference):

STD

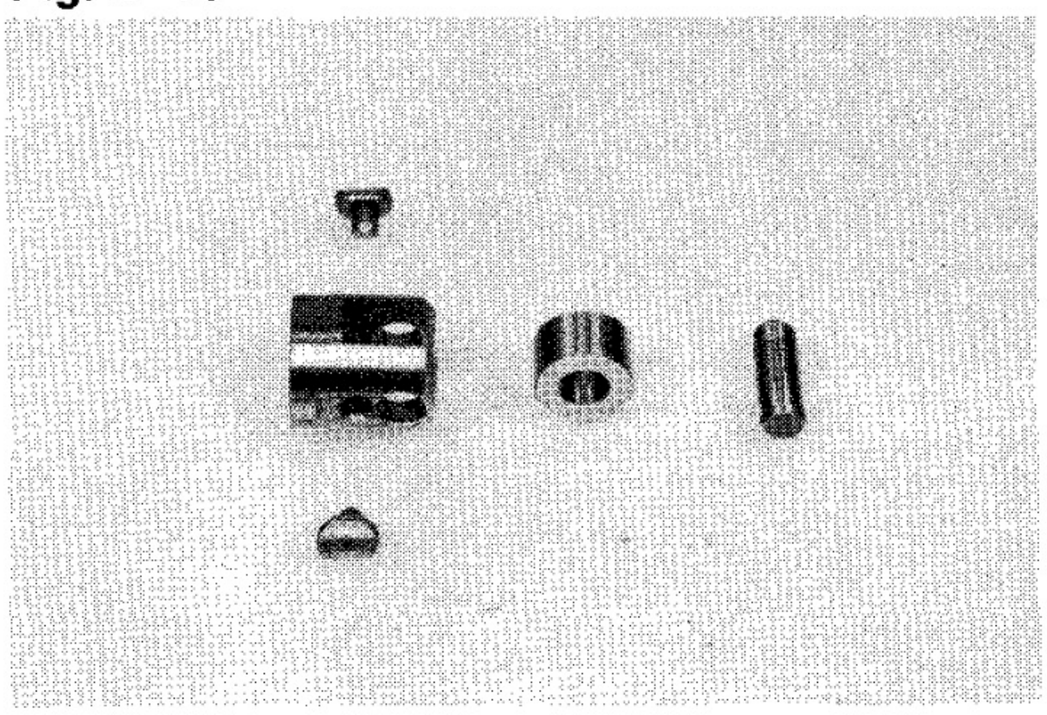
Piston	**0.009 – 0.013 mm (0.0004 – 0.0005 in.)**
Push Rod	**0.003 – 0.006 mm (0.0001 – 0.0002 in.)**

Fig. 6-47



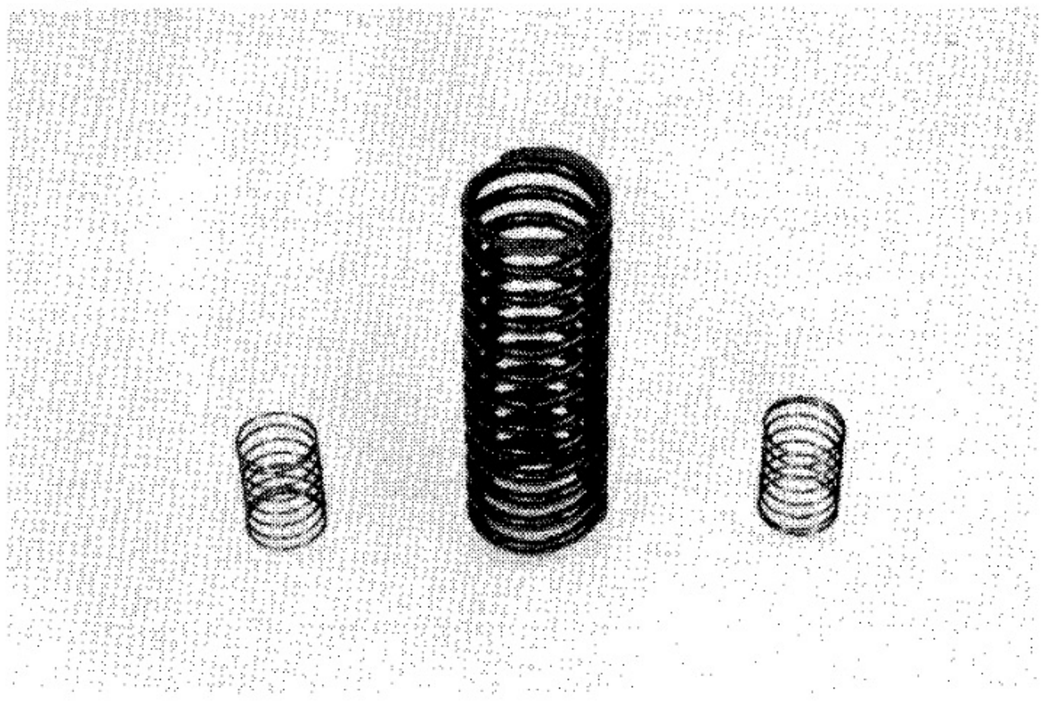
Inspect the check valve and valve seat for wear or damage.

Fig. 6-48



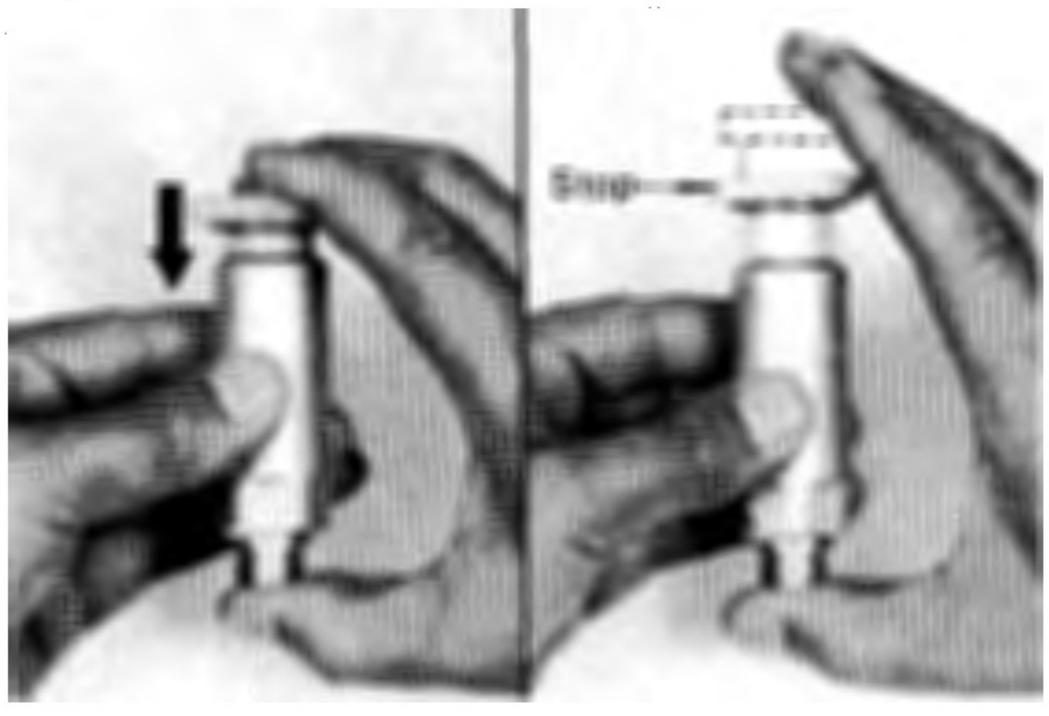
Inspect the tappet and roller for wear or damage.

Fig. 6-49



Inspect the check valve and piston springs for wear or damage.

Fig. 6-50

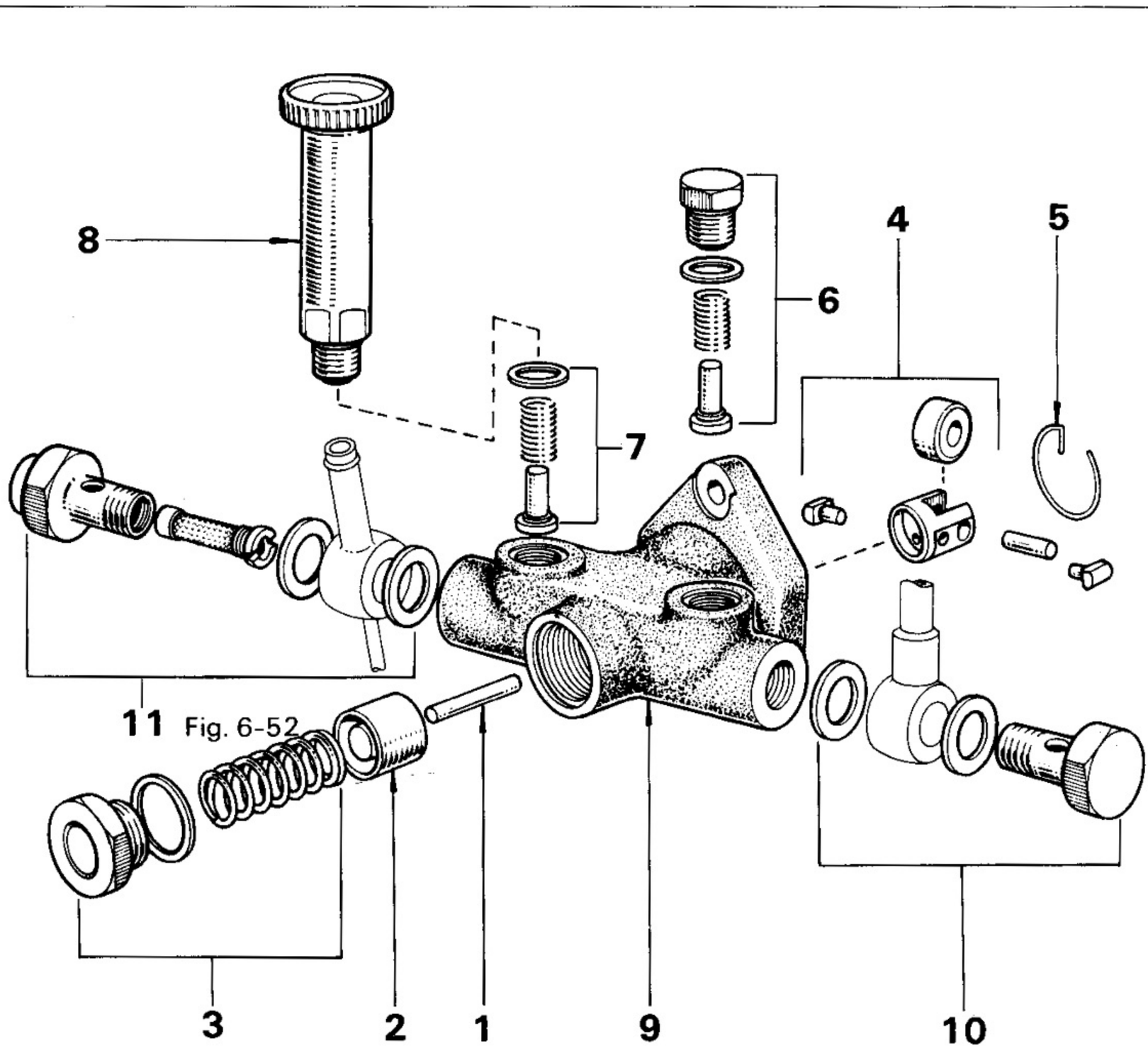


Strongly plug the priming pump inlet port with your finger and check that pressure and vacuum are created when the pump is operated.

ASSEMBLY

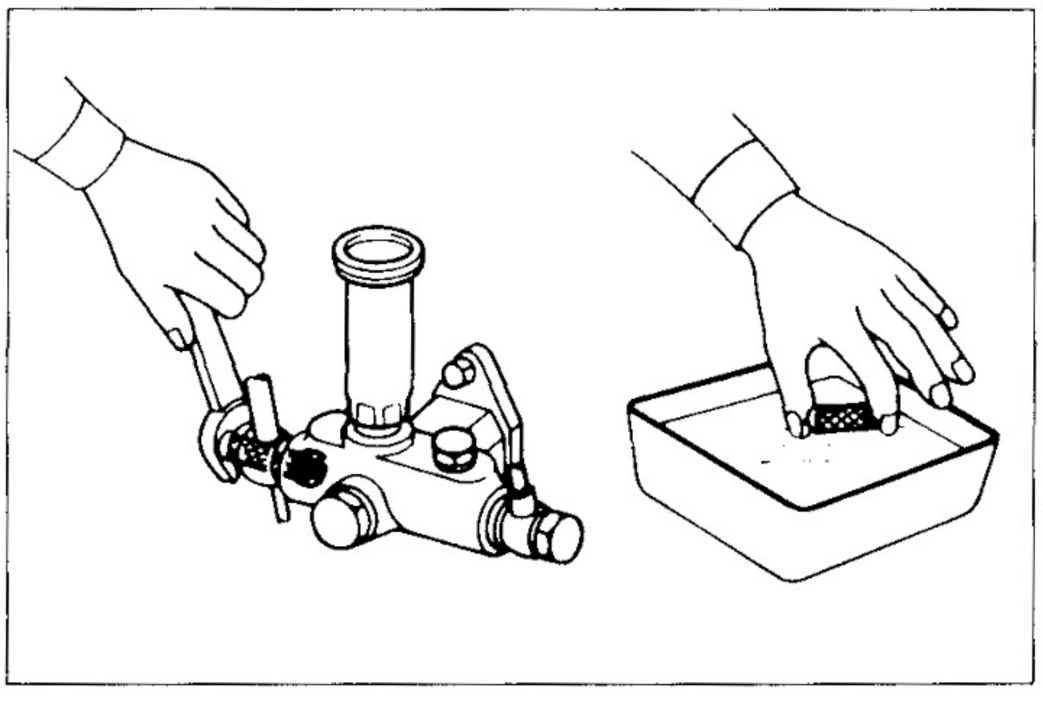
Assemble the parts in the numerical order shown in the figure.

Fig. 6-51



1. Push Rod
2. Piston
3. Piston Chamber & 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. 6-52



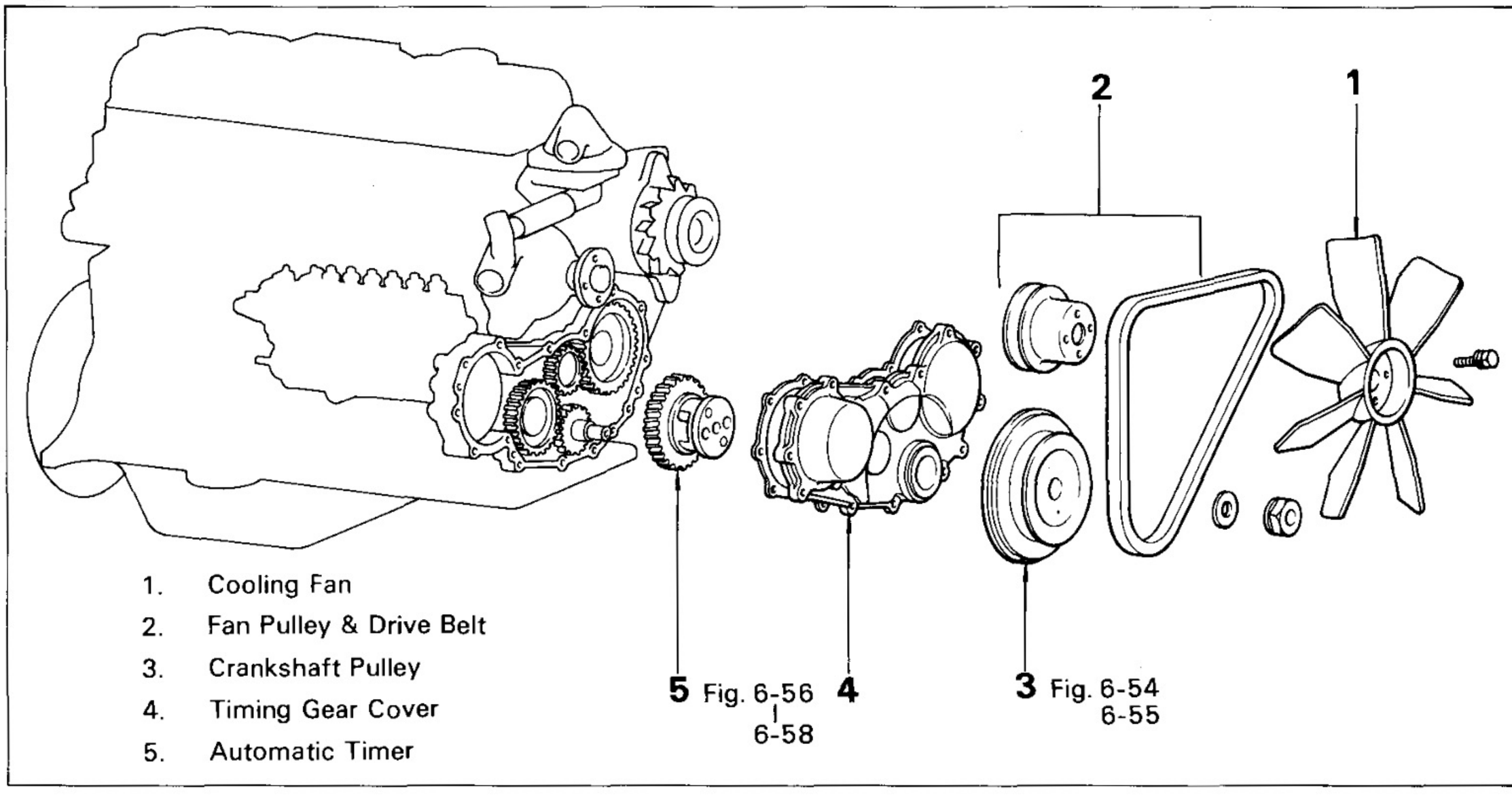
Before assembling, clean the filter inside the union bolt.

AUTOMATIC TIMER

REMOVAL

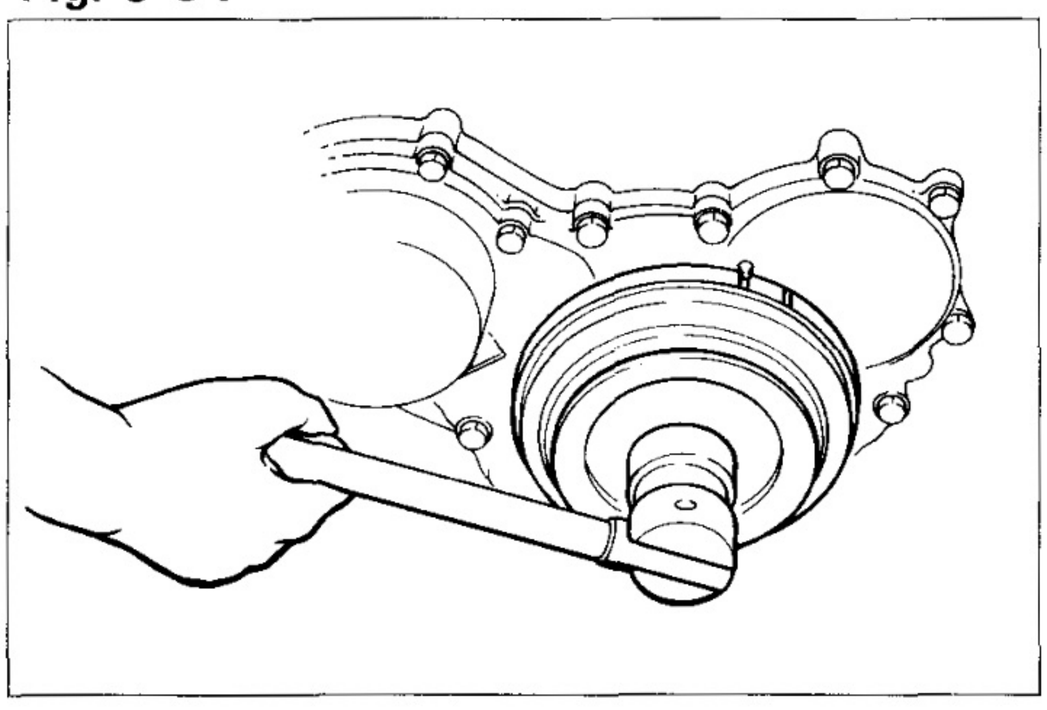
Remove the parts in the numerical order shown in the figure.

Fig. 6-53



1. Cooling Fan
2. Fan Pulley & Drive Belt
3. Crankshaft Pulley
4. Timing Gear Cover
5. Automatic Timer

Fig. 6-54



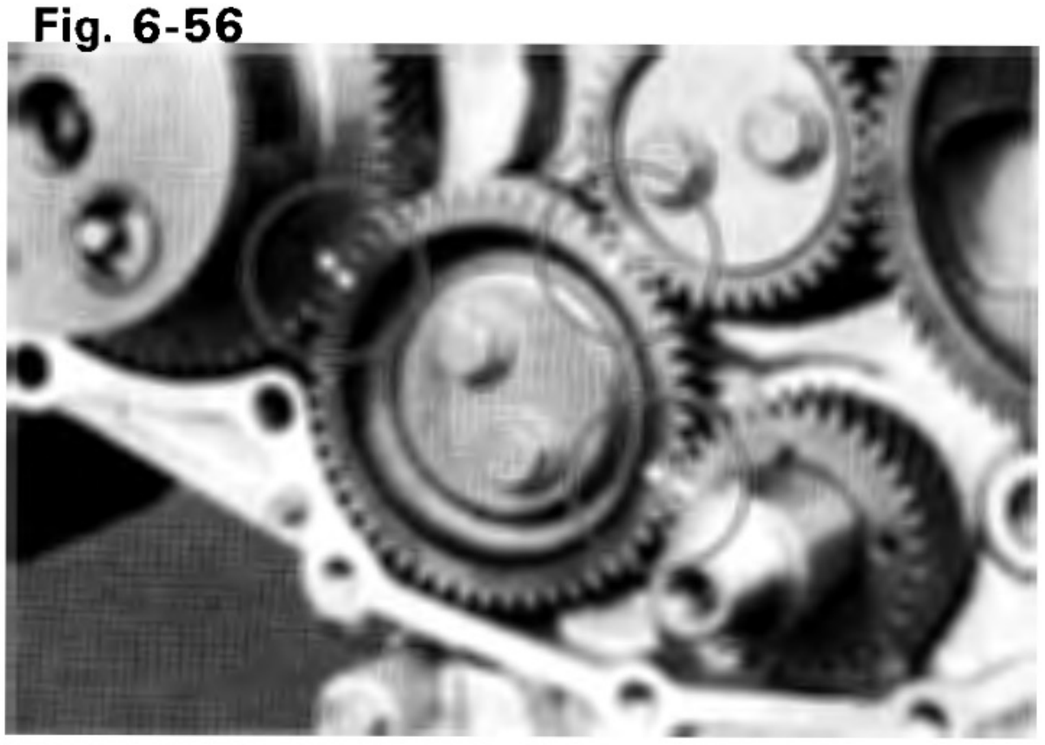
⚠ Before starting work, set No.1 cylinder piston to TDC/compression.

Fig. 6-55



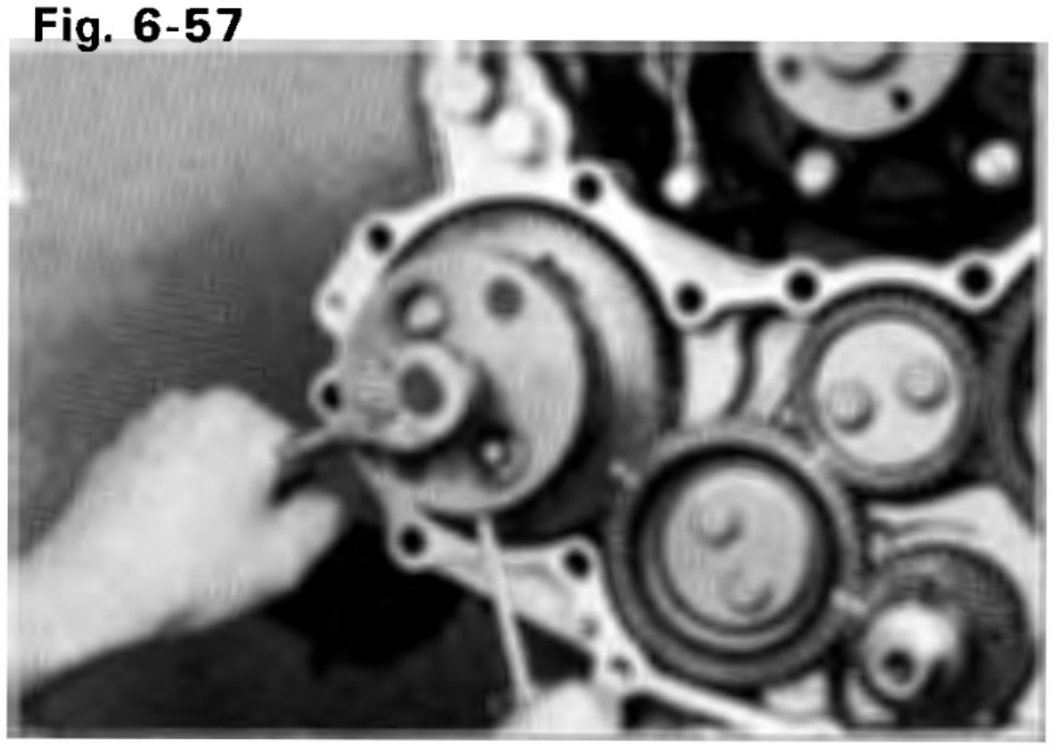
Pull out the crankshaft pulley with SST.
SST [09213-60016]

Fig. 6-56



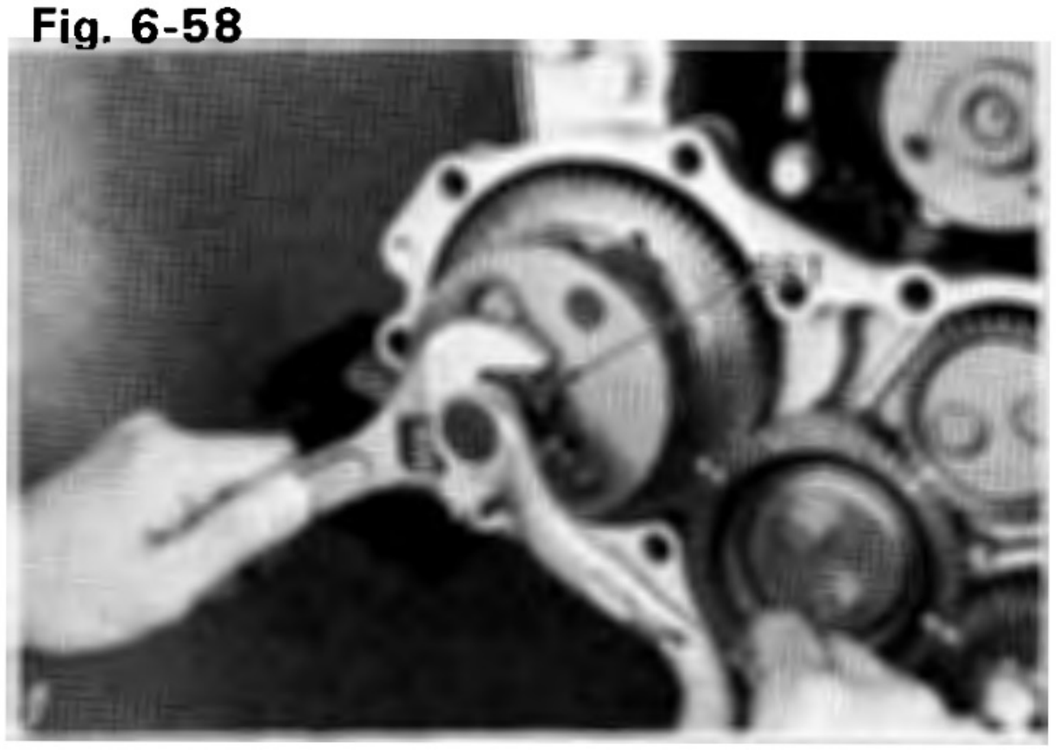
⚠ Put matchmarks on each gear to facilitate reassembly.

Fig. 6-57



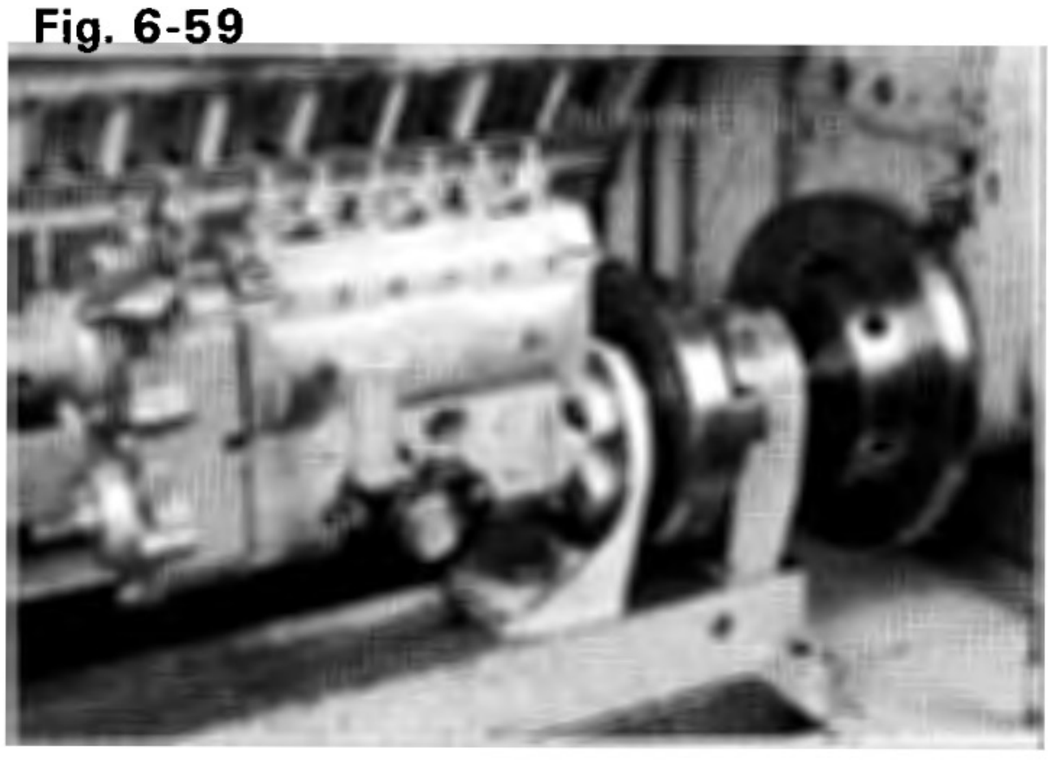
Hold the automatic timer with a screwdriver and remove the round nut.

Fig. 6-58



Pull out the automatic timer with SST.
SST [09267-76020]

Fig. 6-59

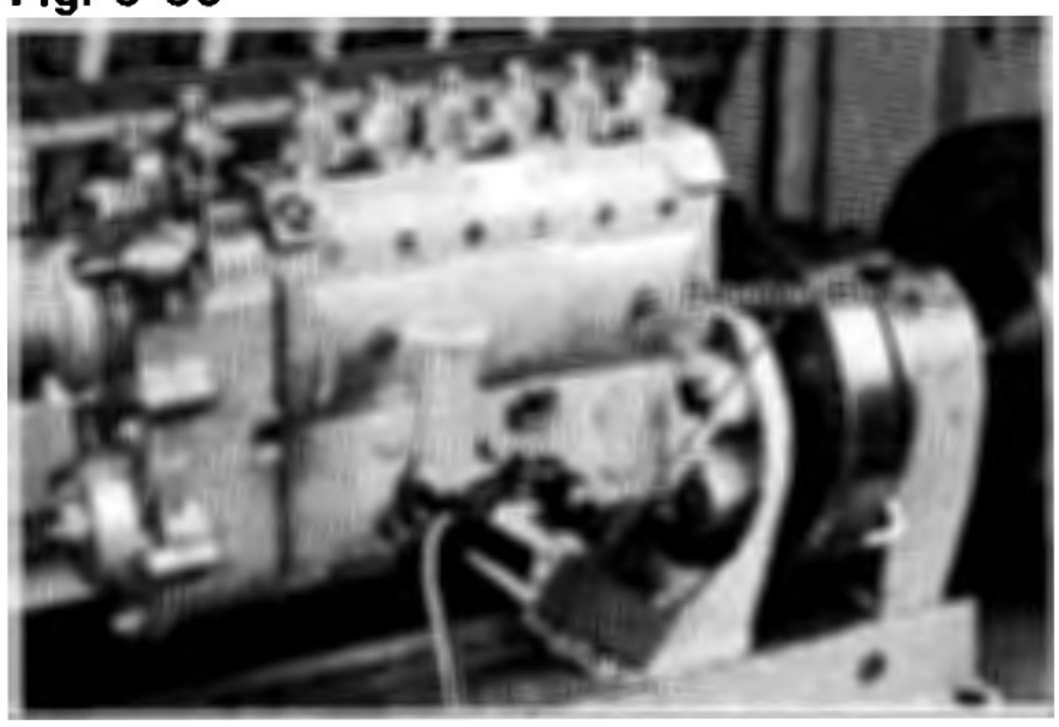


INSPECT ADVANCE ANGLE

⚠

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

Fig. 6-60



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

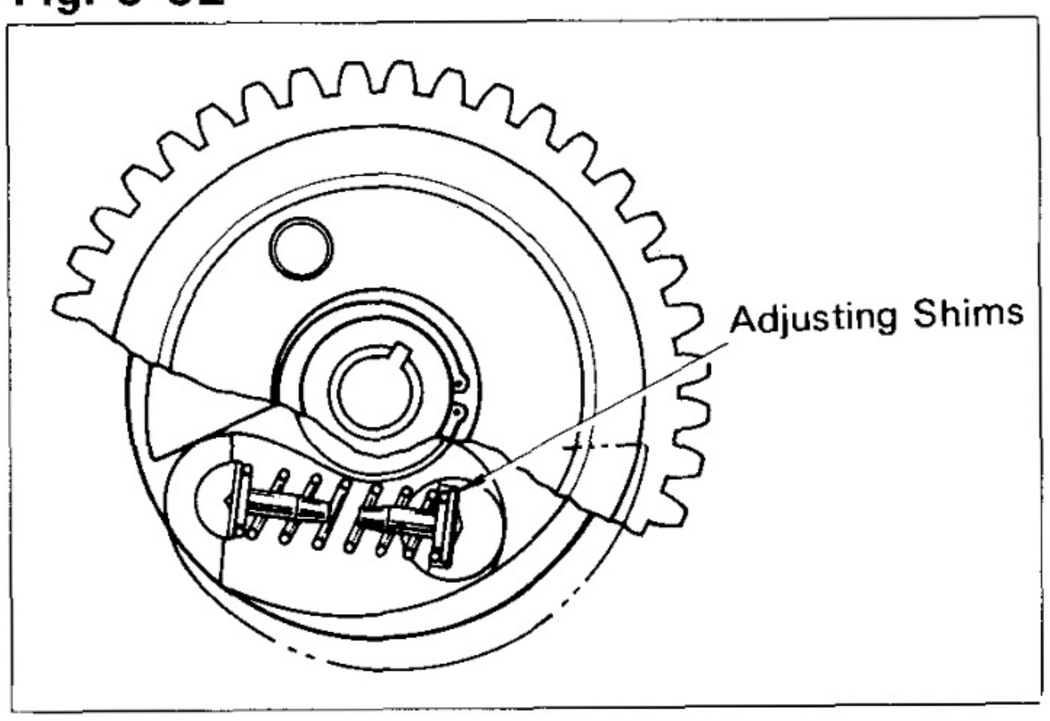
Fig. 6-61



4. Use a timing light to check advance angle.

Pump (rpm)	Timer advance angle
400	Advance begins (≦0.5°)
1,050	2.3 – 3.3°
1,450	4.0 – 5.0°
1,800	5.5 – 6.5°
1,900	5.5 – 6.5°

Fig. 6-62

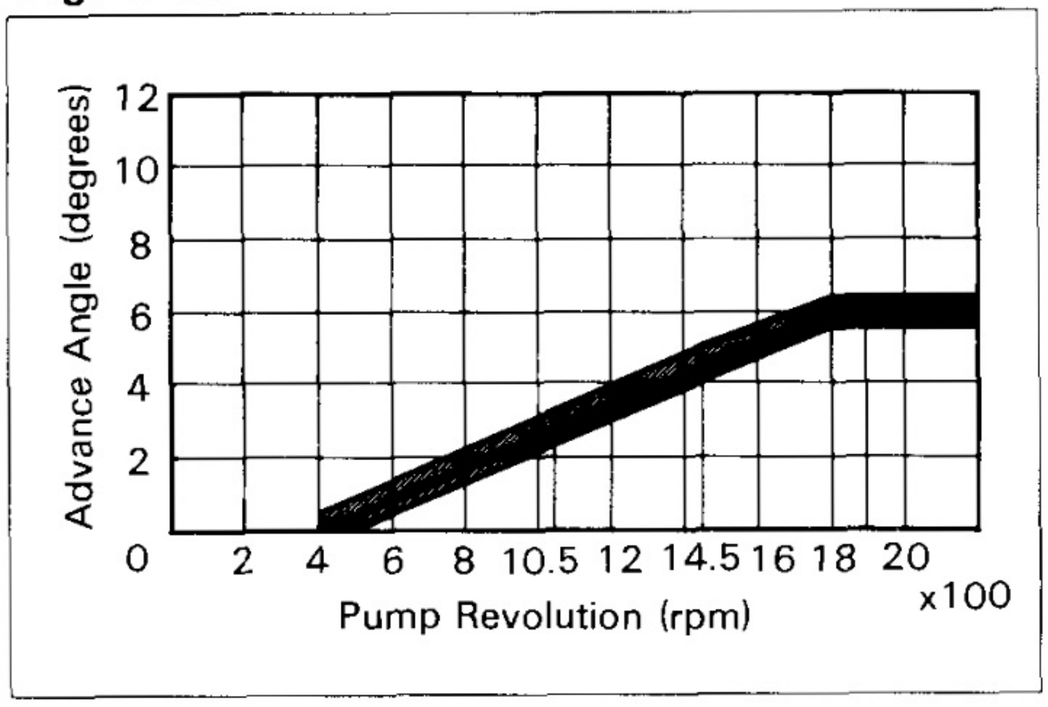


5. If the advance angle is not within specified range, adjust by changing timer spring shims.

Adjusting shim thickness:
0.1, 0.2, 0.3, 0.5, 1.0 mm
(0.004, 0.008, 0.011, 0.020, 0.039 in.)

– Note –
Be caveful that the springs and shims do not fly out.
When injection timing is advanced, increase shim thickness.

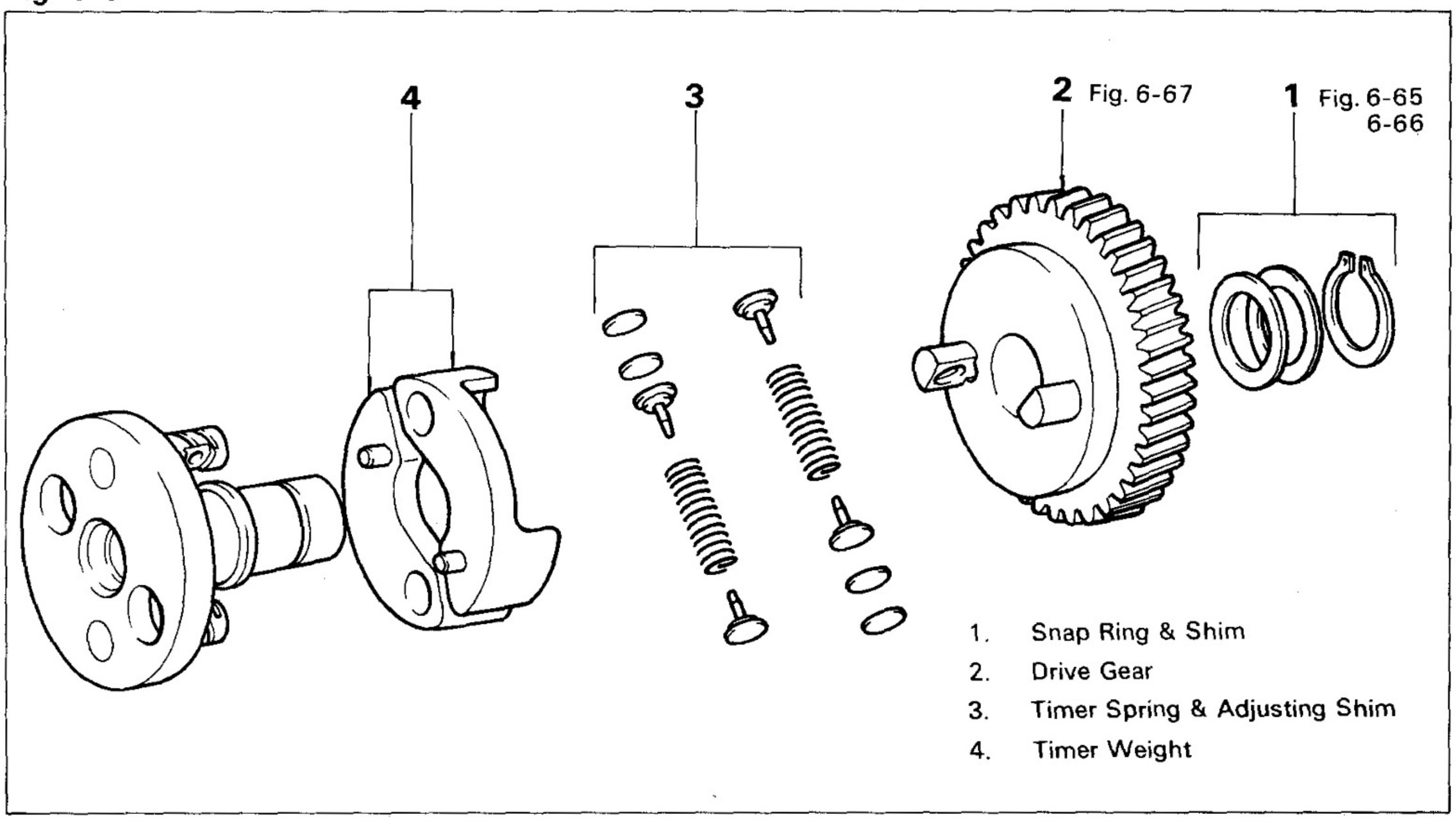
Fig. 6-63



DISASSEMBLY

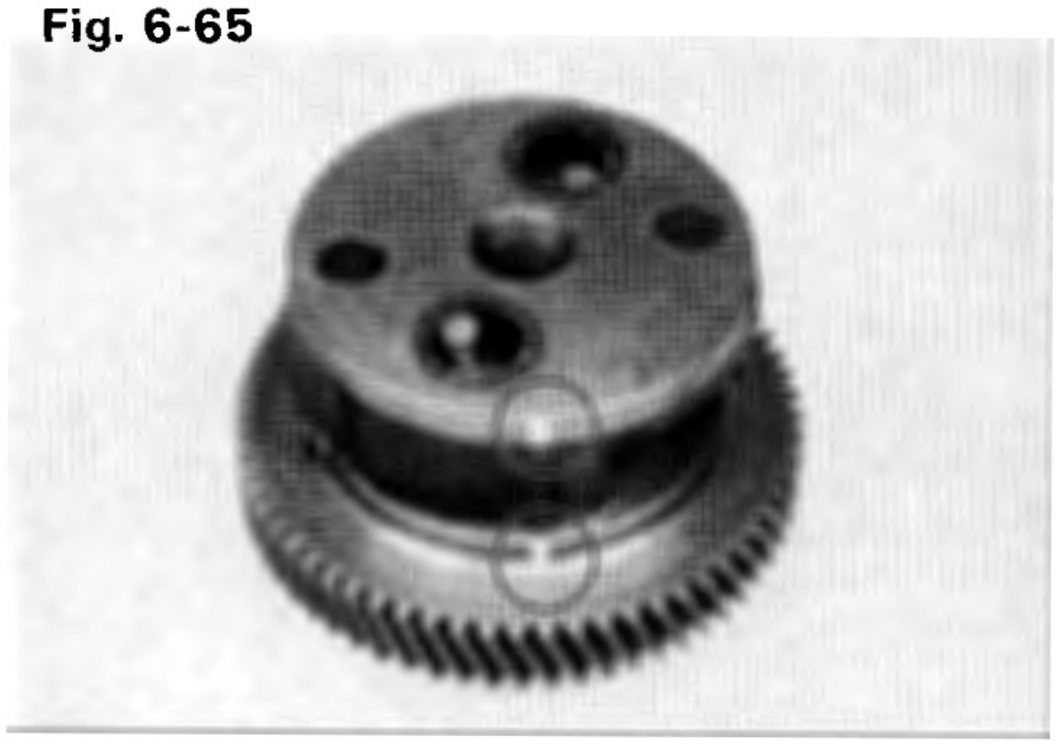
Disassemble the parts in the numerical order shown in the figure.

Fig. 6-64



1. Snap Ring & Shim
2. Drive Gear
3. Timer Spring & Adjusting Shim
4. Timer Weight

Fig. 6-65



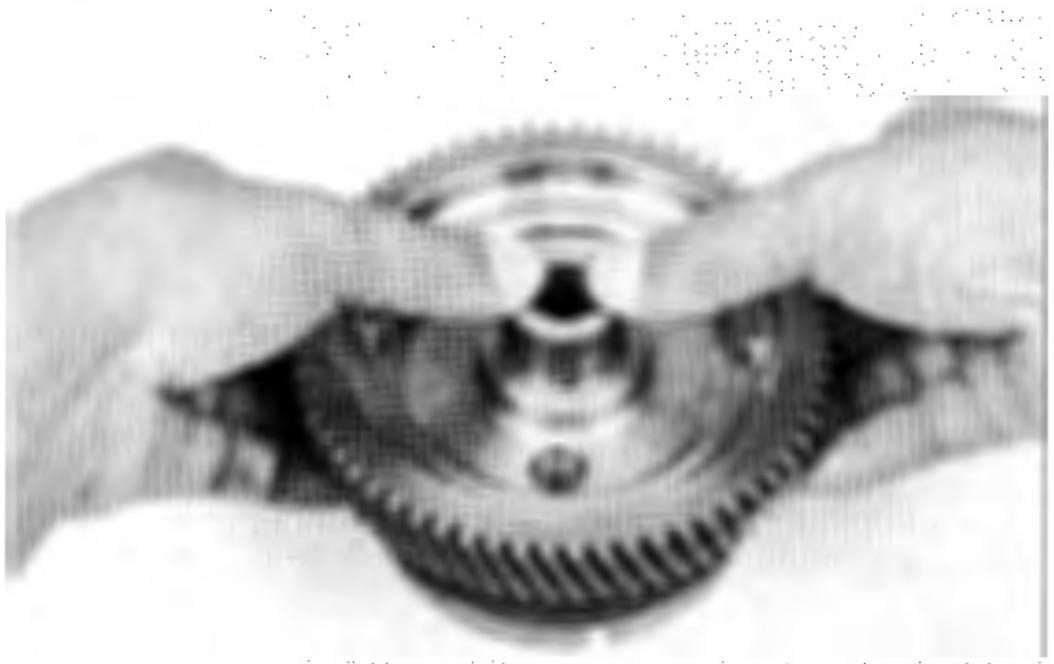
⚠ Place matchmarks on the timer hub and drive gear.

Fig. 6-66



Remove the snap ring with a snap ring expander.

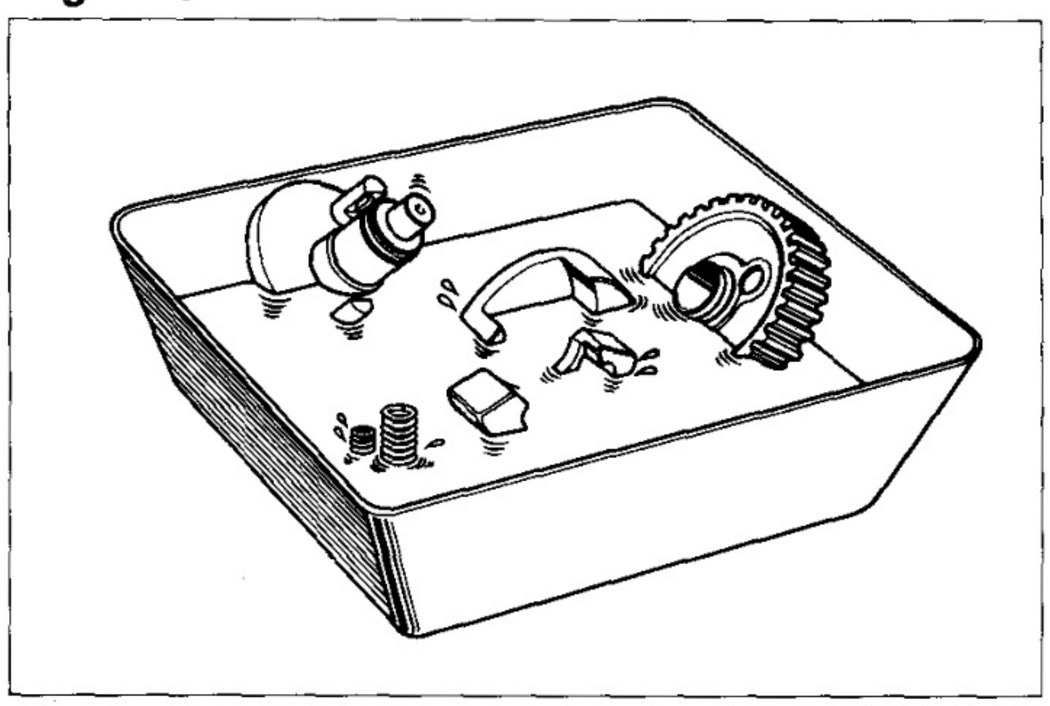
Fig. 6-67



Pull up the drive gear.

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

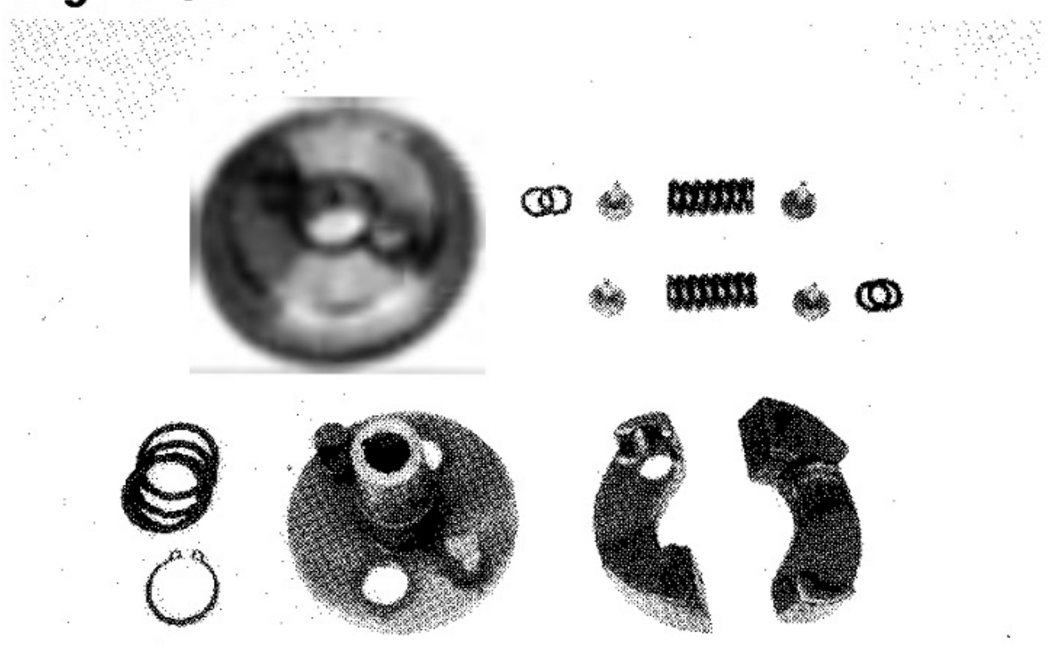
Fig. 6-68



INSPECTION

Clean the all parts.

Fig. 6-69

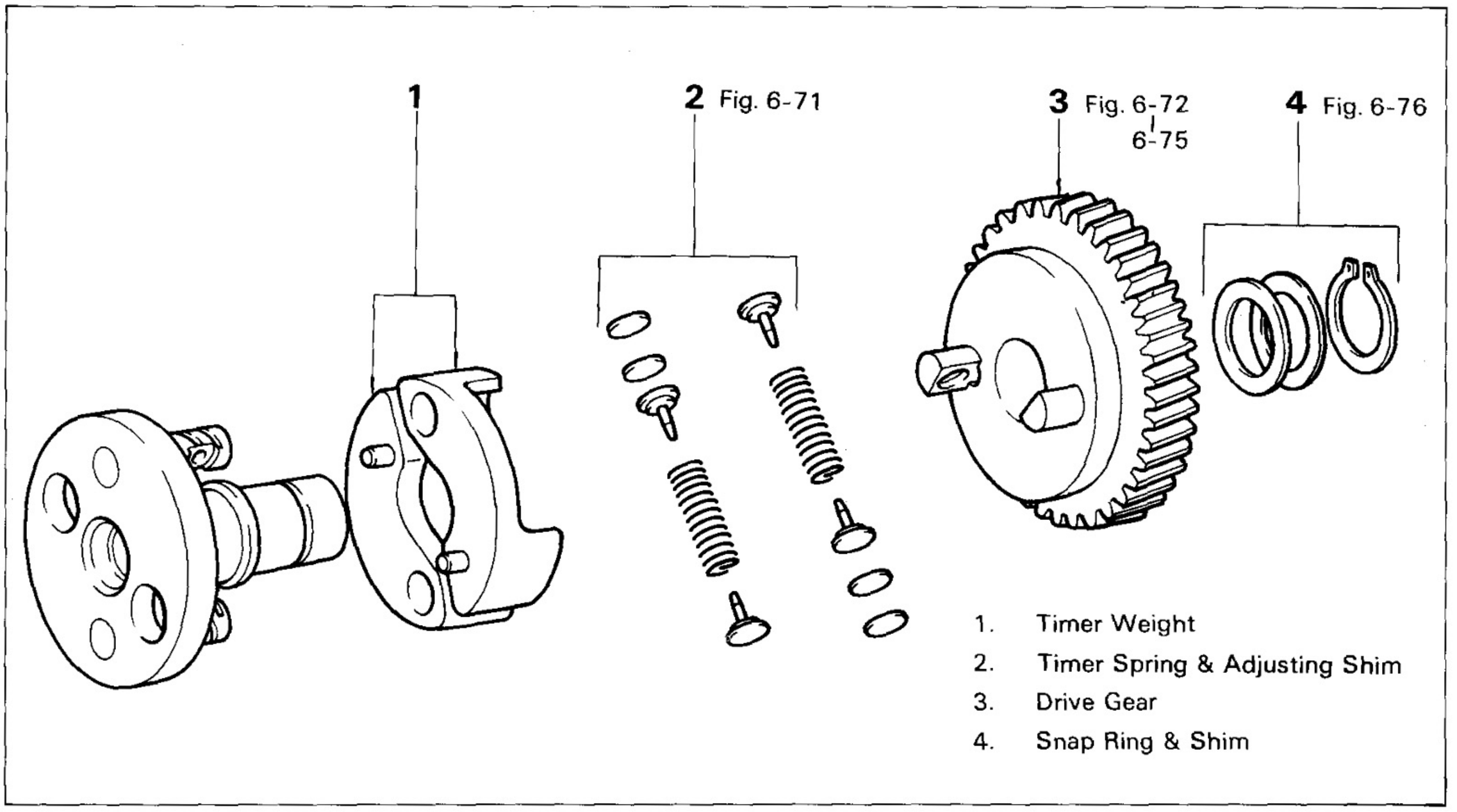


Check all parts for wear or damage.

ASSEMBLY

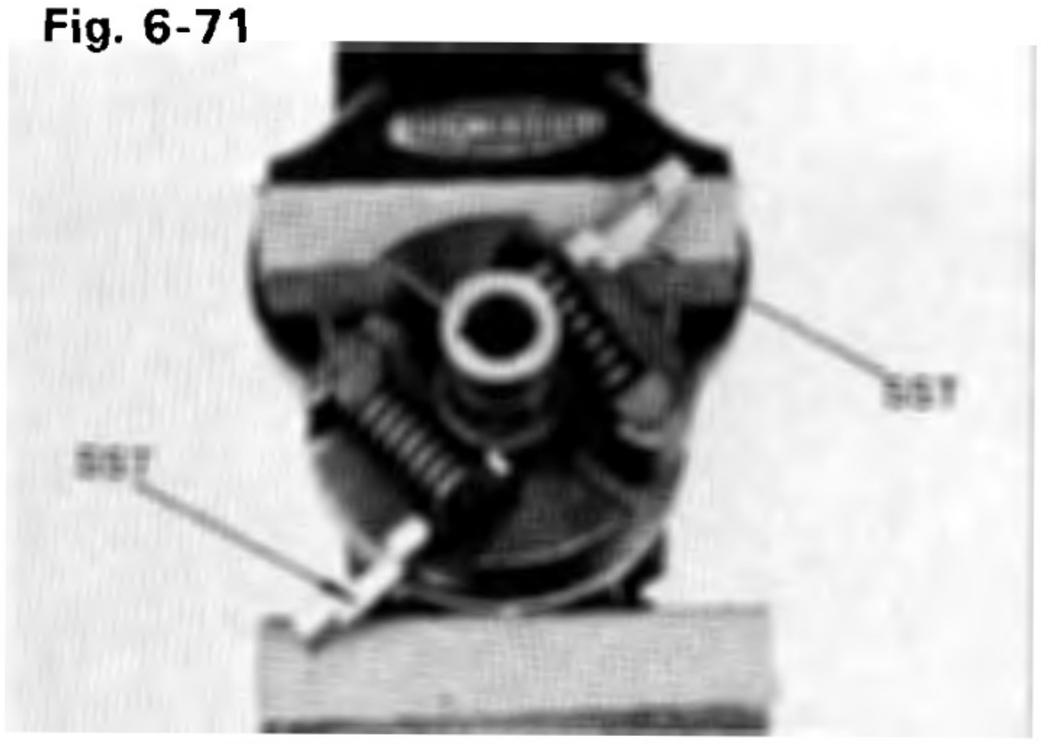
Assemble the parts in the numerical order shown in the figure.

Fig. 6-70



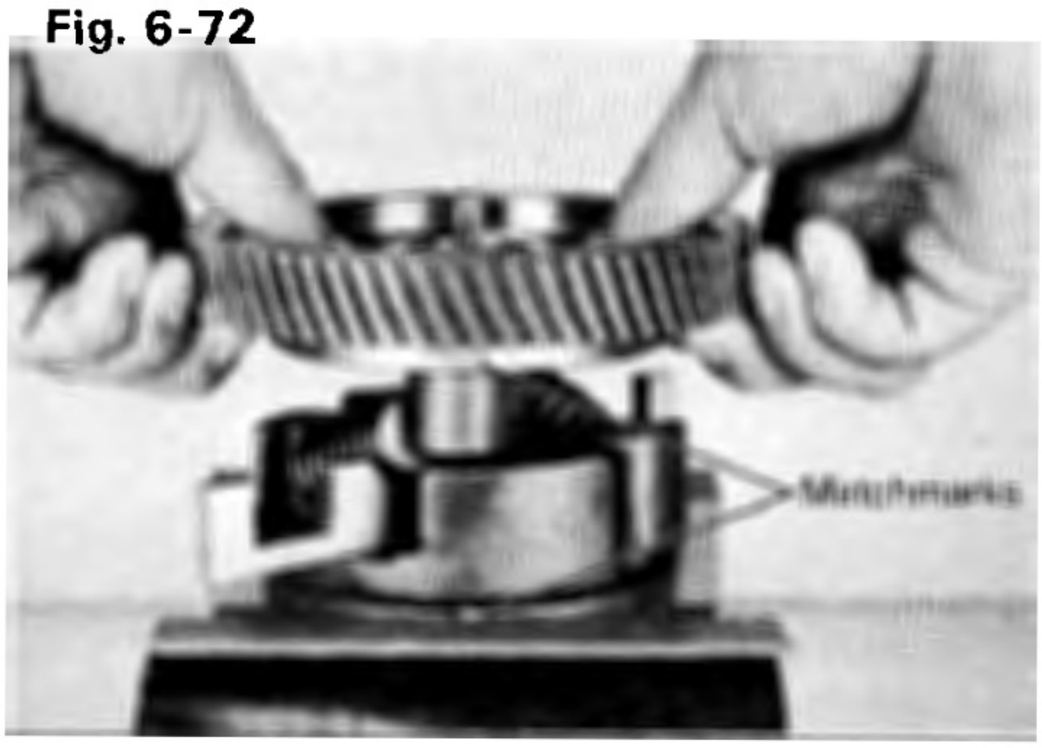
1. Timer Weight
2. Timer Spring & Adjusting Shim
3. Drive Gear
4. Snap Ring & Shim

Fig. 6-71



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

Fig. 6-72



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

Fig. 6-73



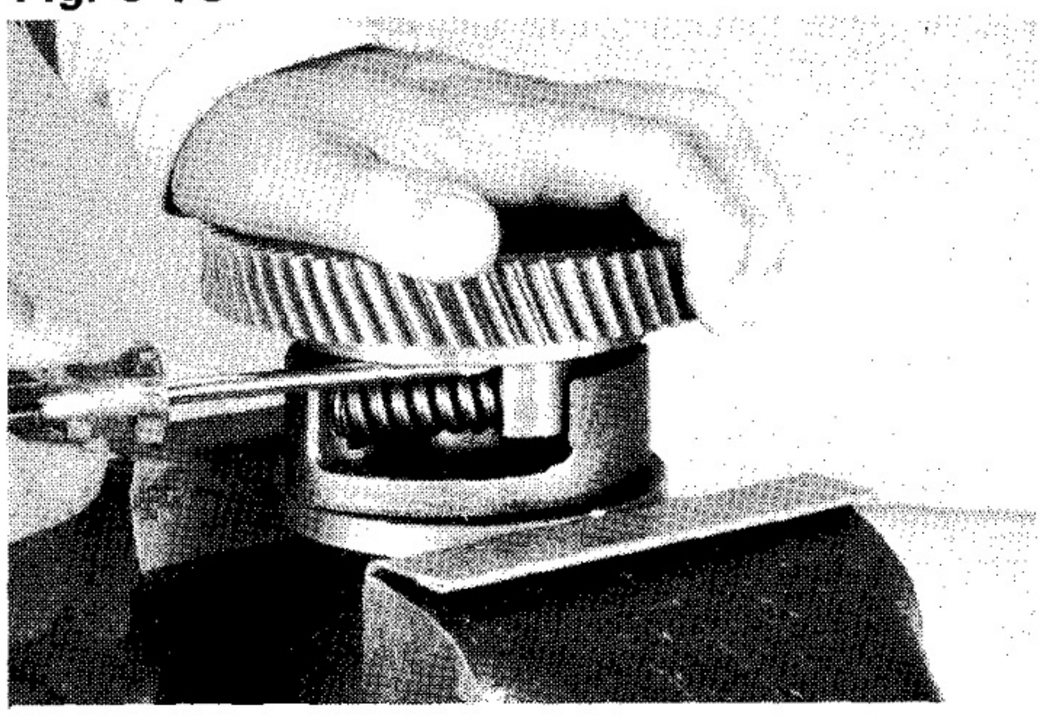
Hold the drive gear so that the springs will not fall out and remove SST.

Fig. 6-74



Press down and turn the drive gear onto the hub.

Fig. 6-75



Seat the timer spring snugly with a screwdriver.

Fig. 6-76



Measure the timer hub thrust clearance.
If it exceeds the limit, adjust the clearance with shims.

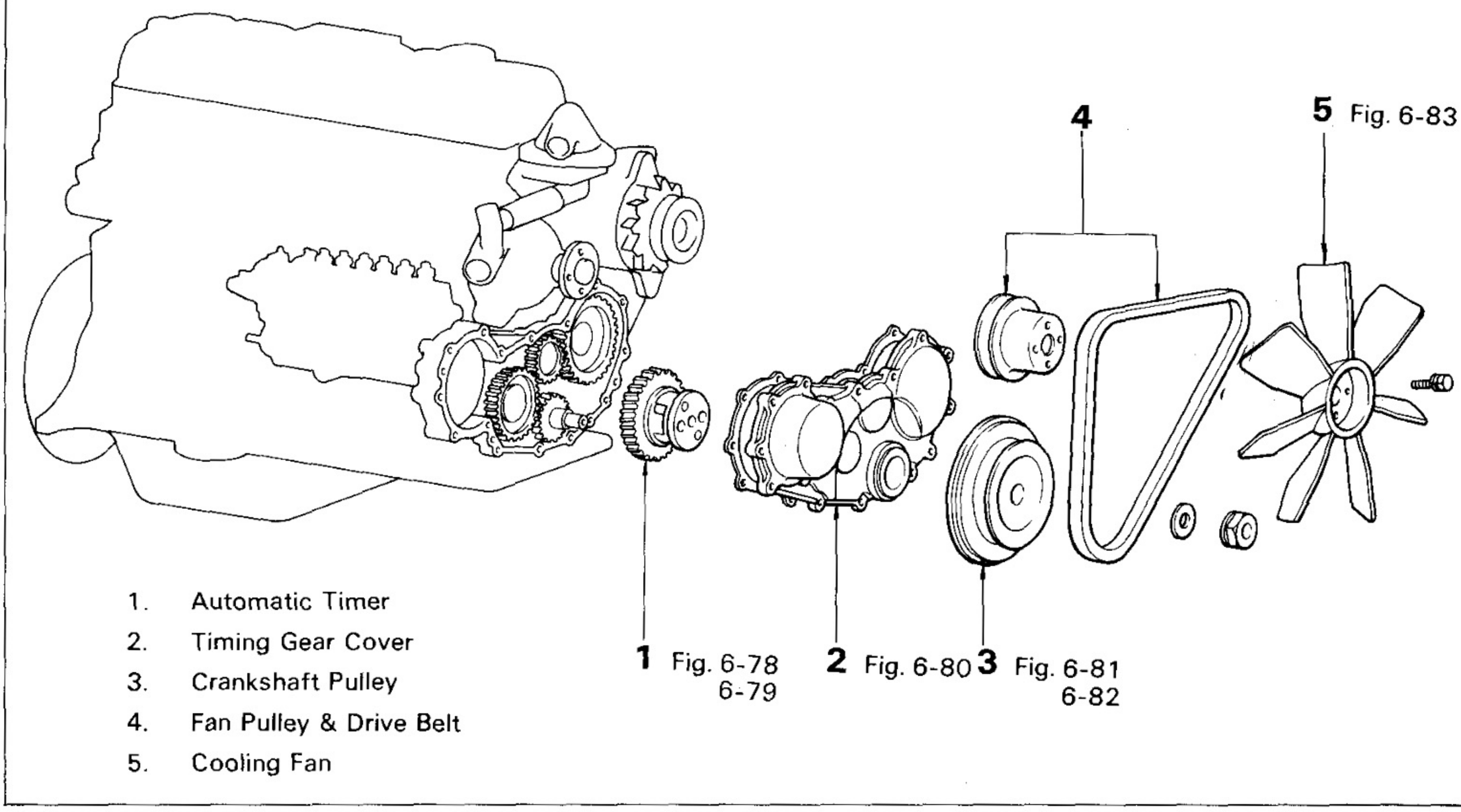
Thrust clearance:
Less than 0.3 mm (0.011 in.)

Shim thickness:
0.1, 0.2 mm (0.004, 0.008 in.)

INSTALLATION

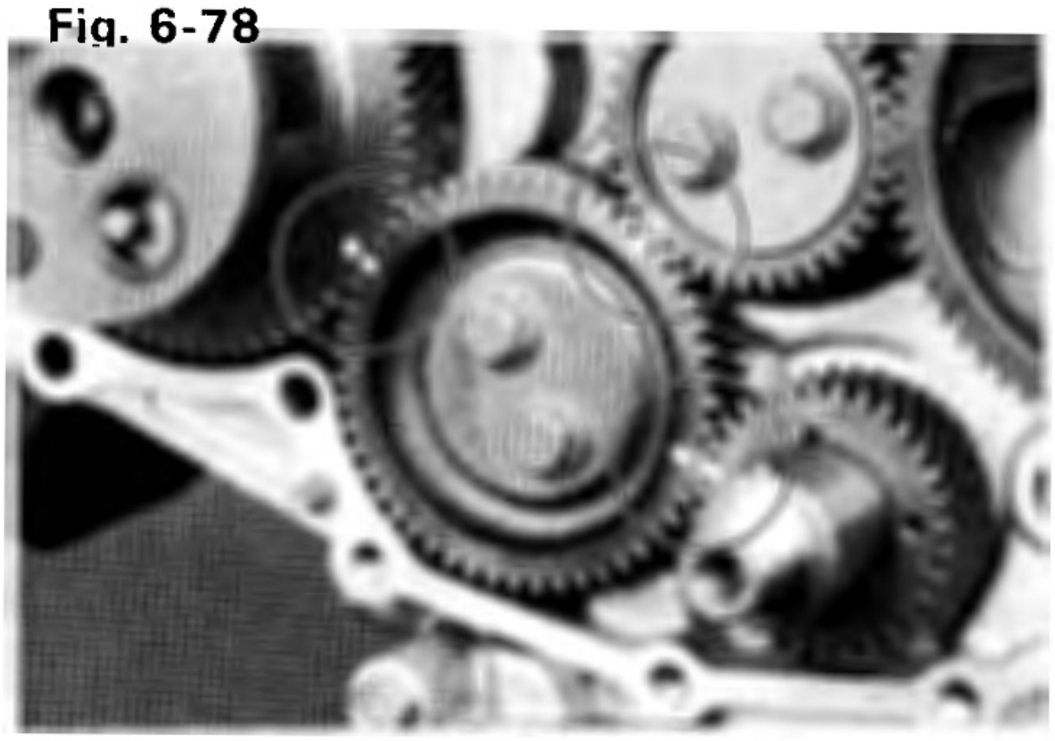
Install the parts in the numerical order shown in the figure.

Fig. 6-77



1. Automatic Timer
2. Timing Gear Cover
3. Crankshaft Pulley
4. Fan Pulley & Drive Belt
5. Cooling Fan

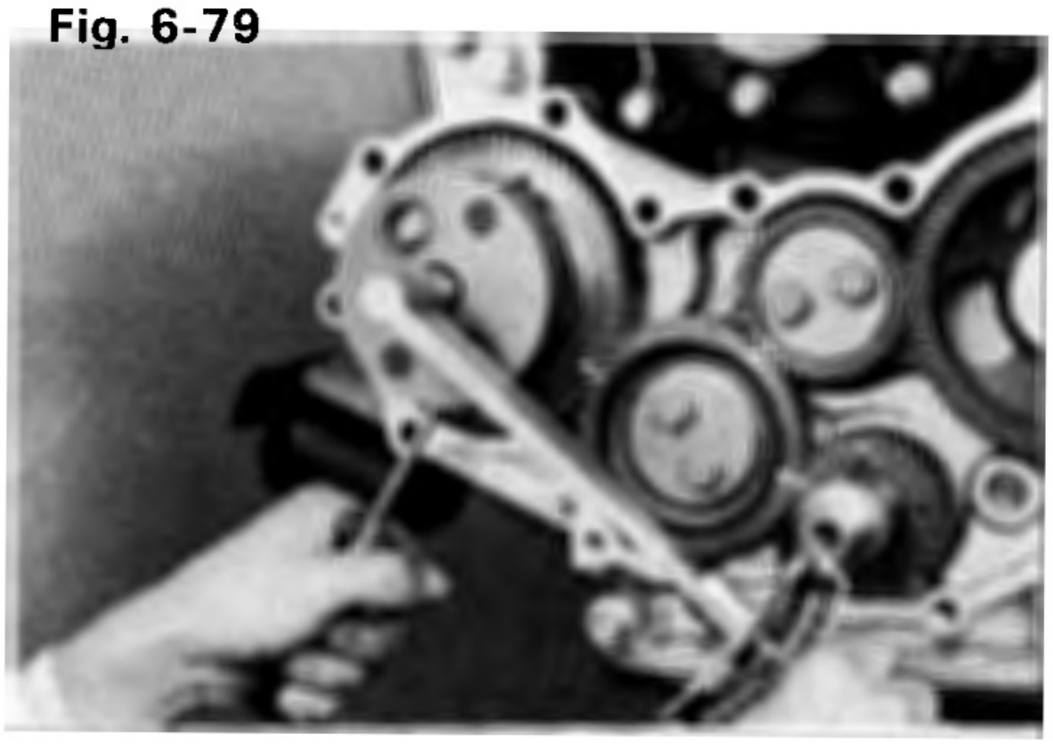
Fig. 6-78



⚠ Install the automatic timer while aligning the matchmark with that of idle gear No.1.

— Note —
Before installing the automatic timer, be sure to confirm that each matchmark is aligned with that of engaged one.

Fig. 6-79



Hold the automatic timer with screwdriver and tighten the round nut.

Tightening torque: 7.0 — 8.0 kg-m (51 — 57 ft-lb)

— Note —
Apply a light coating of engine oil on the contacting surface of the round nut before tightening.

Fig. 6-80



Tighten the timing gear cover.
Tightening torque: 2.0 – 3.0 kg-m (15 – 20 ft-lb)

Fig. 6-81



Drive in the crankshaft pulley with SST.
SST [09608-35013]

Fig. 6-82



Tighten the retaining bolt.
Tightening torque: 18.0 – 22.0 kg-m (131 – 159 ft-lb)

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

Fig. 6-83

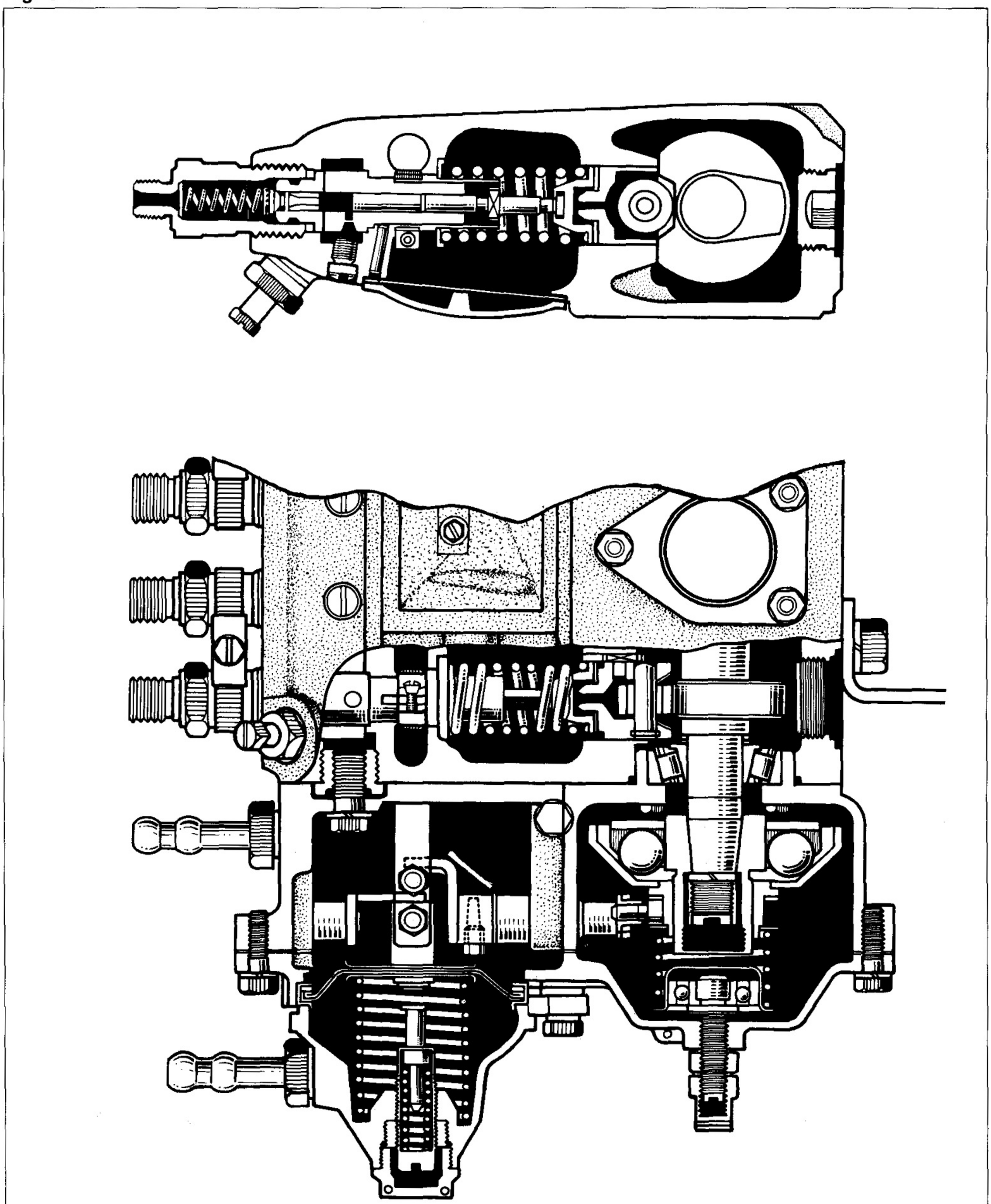
SEE
ENGINE TUNE-UP
SECTION
Fig. 2-7

Adjust drive belt tension.

INJECTION PUMP

CUTAWAY VIEW

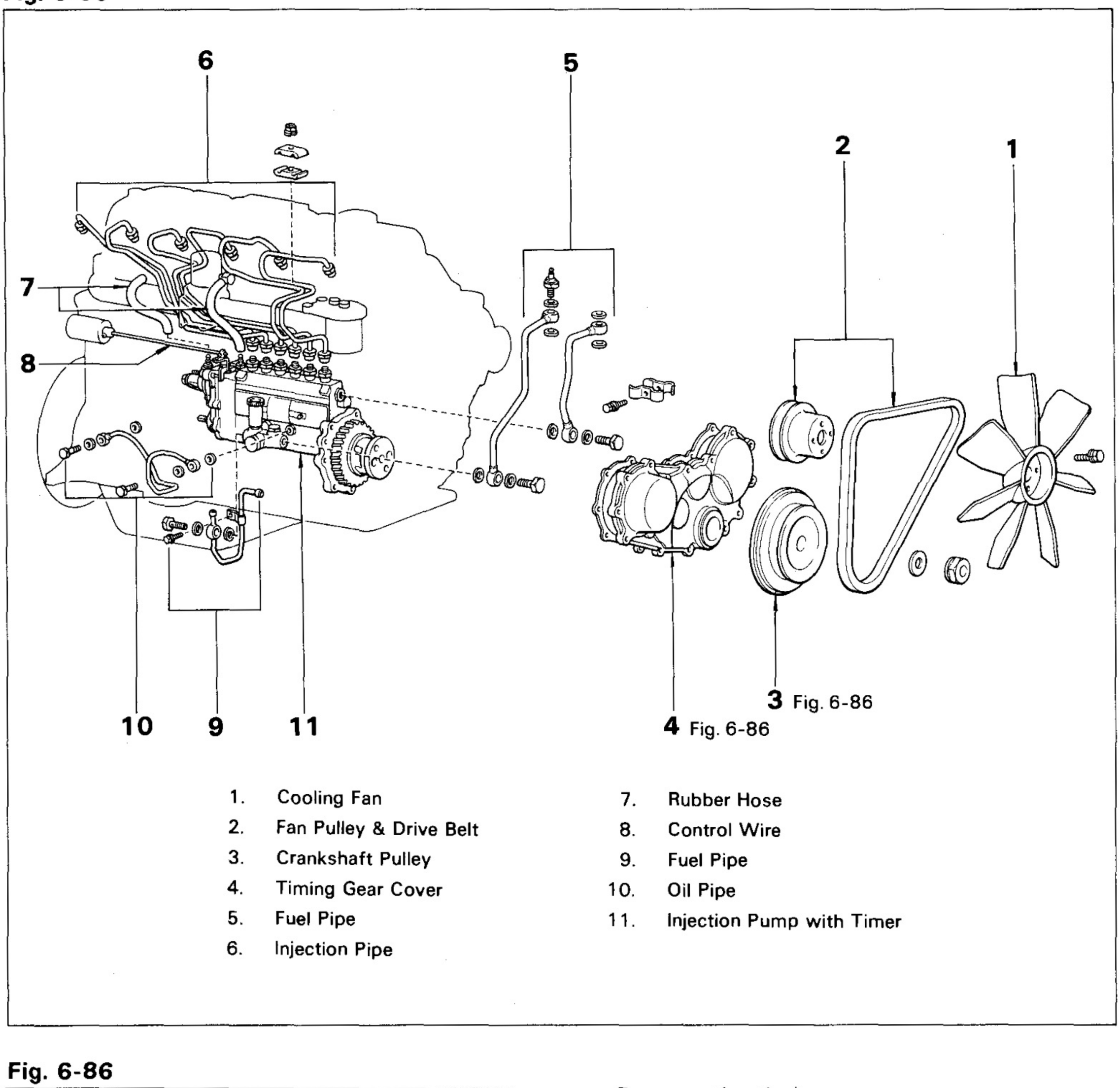
Fig. 6-84



REMOVAL

Remove the parts in the numerical order shown in the figure.

Fig. 6-85



1. Cooling Fan
2. Fan Pulley & Drive Belt
3. Crankshaft Pulley
4. Timing Gear Cover
5. Fuel Pipe
6. Injection Pipe
7. Rubber Hose
8. Control Wire
9. Fuel Pipe
10. Oil Pipe
11. Injection Pump with Timer

Fig. 6-86

AUTOMATIC TIMER

REMOVAL

SECTION

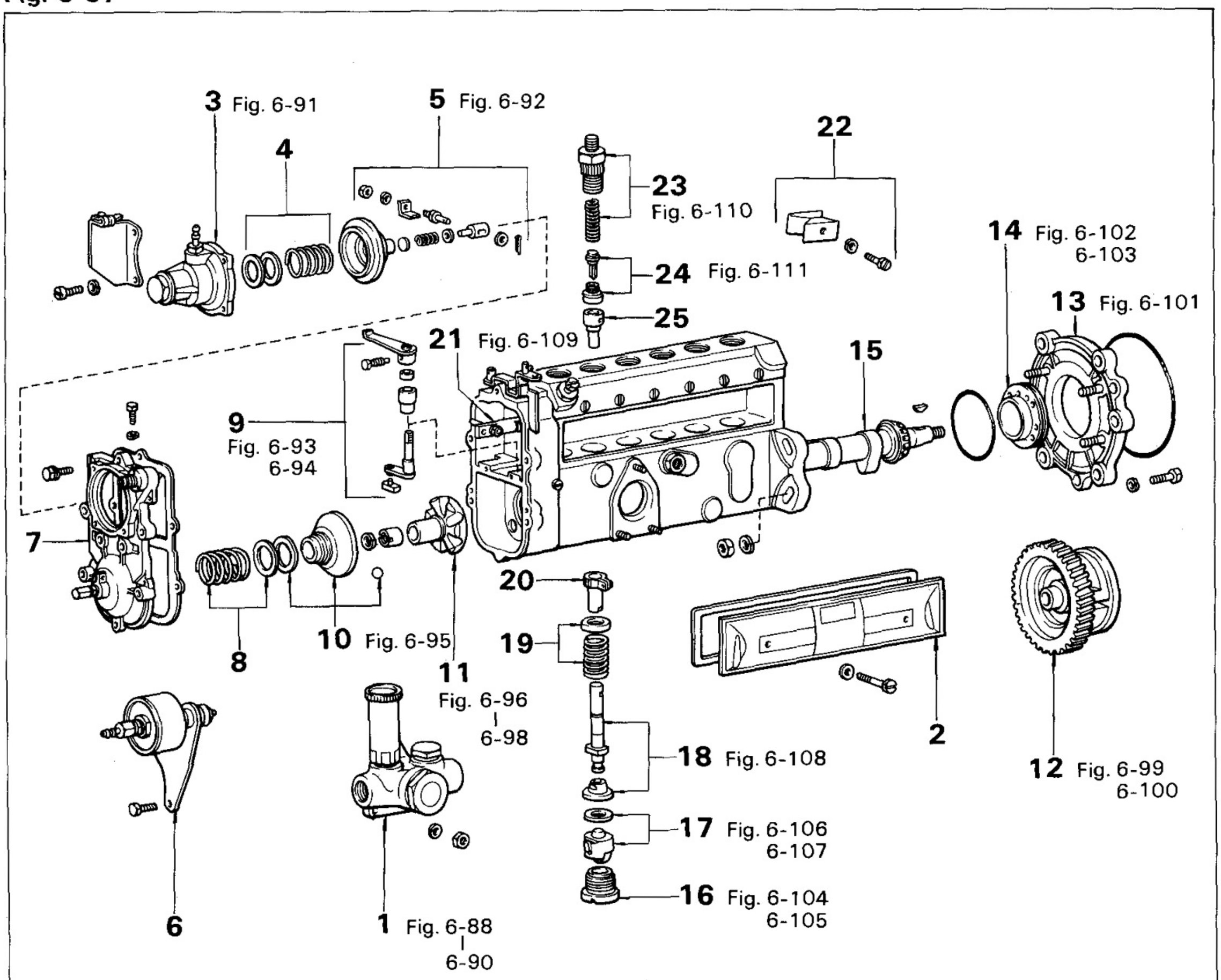
Fig. 6-53 to 6-56

Remove the timing gear cover.

DISASSEMBLY

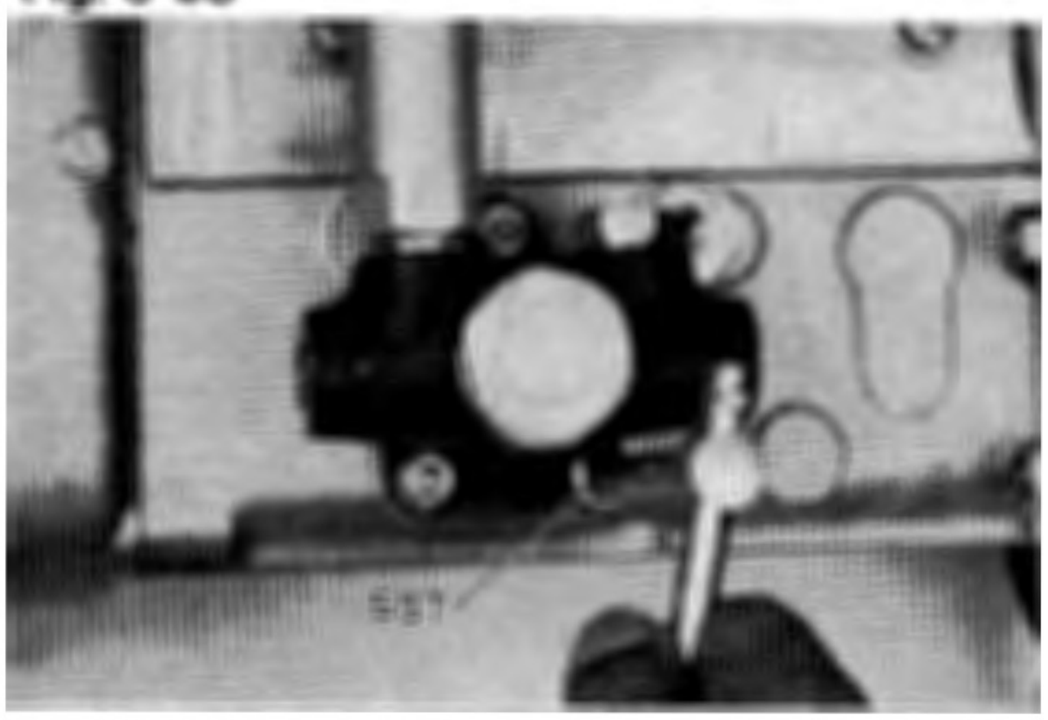
Disassemble the parts in the numerical order shown in the figure.

Fig. 6-87



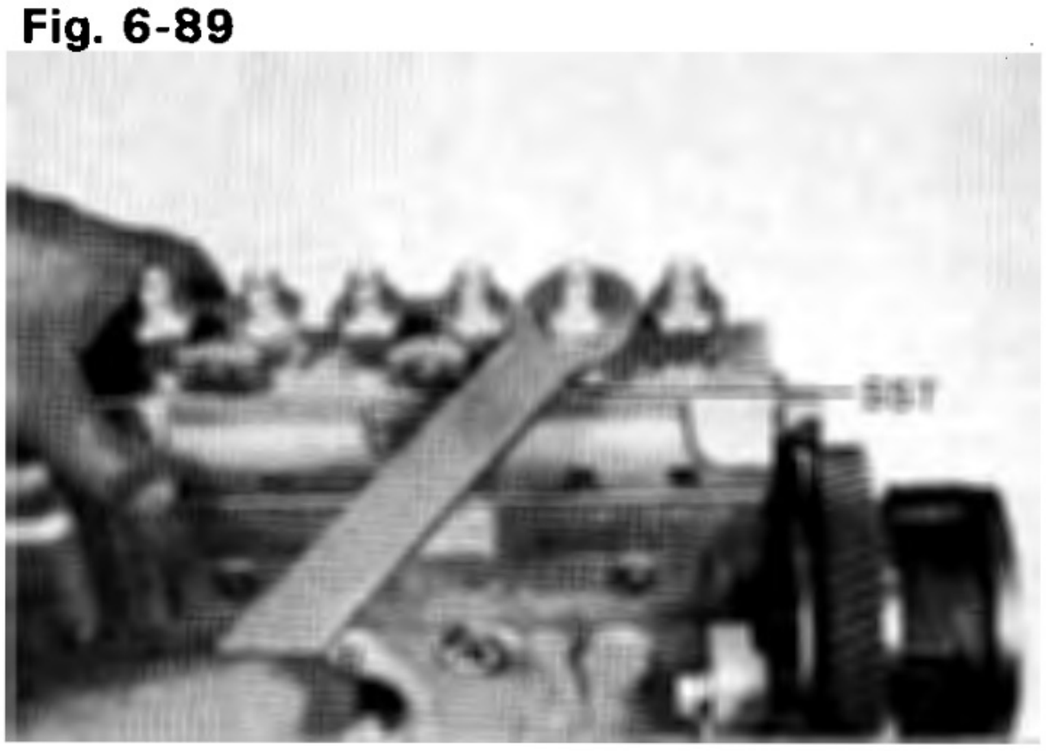
1. Fuel Feed Pump
2. Injection Pump Cover
3. Diaphragm Housing
4. Main Spring & Adjusting Shim
5. Diaphragm & Connecting Rod
6. DHAC & Bracket
7. Governor Cover
8. Speed control Spring
9. Control Rack Lever
10. Slider & Steel Ball
11. Ball Guide
12. Automatic Timer
13. Injection Pump Retainer
14. Bearing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

Fig. 6-88



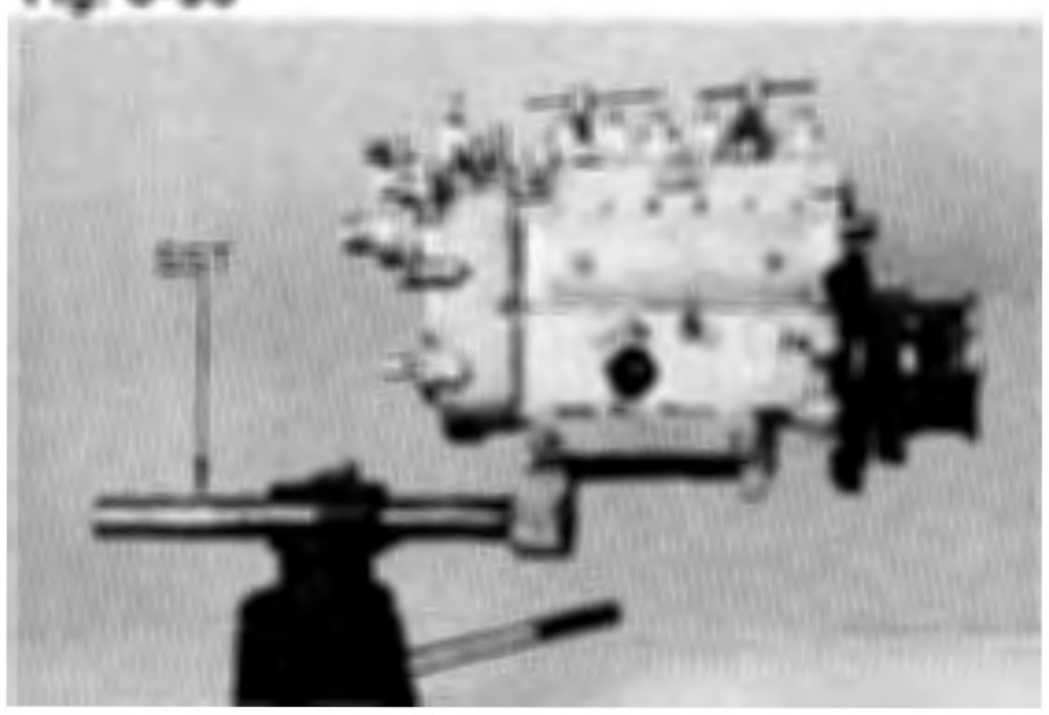
Remove the fuel feed pump with SST.
SST (09276-76010) of set [09260-76016]

Fig. 6-89



Remove the No.2 delivery valve holder with SST.
SST (09270-76010) of set [09260-76016]

Fig. 6-90



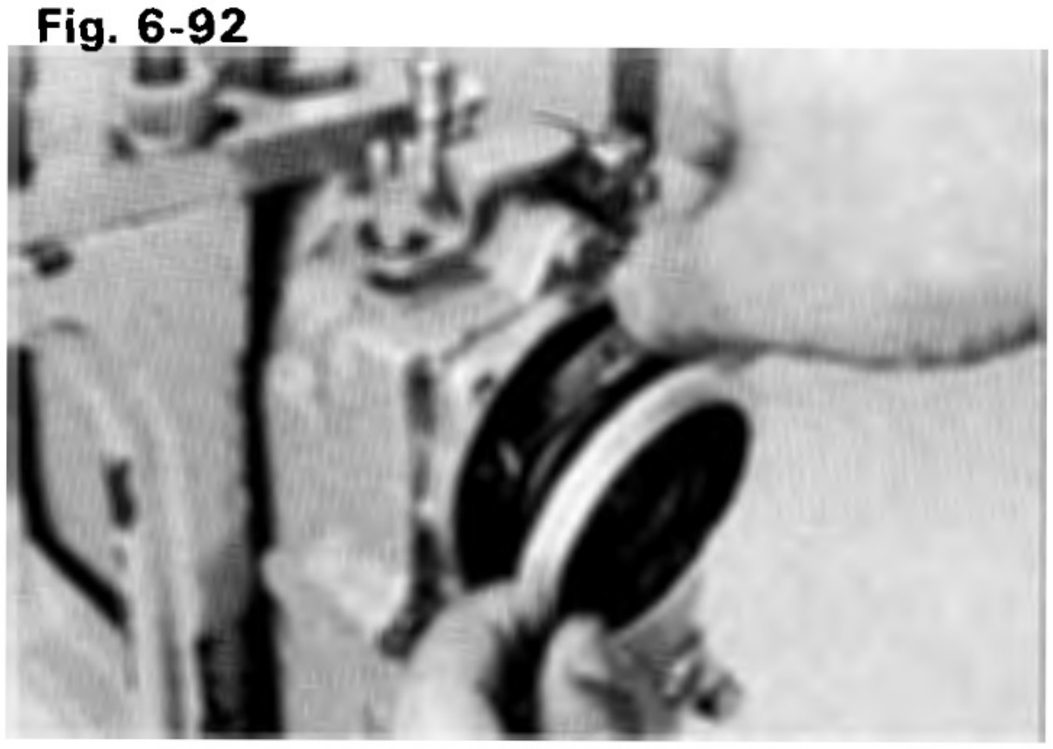
Install the injection pump to the SST.
SST [09241-76021]

Fig. 6-91



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

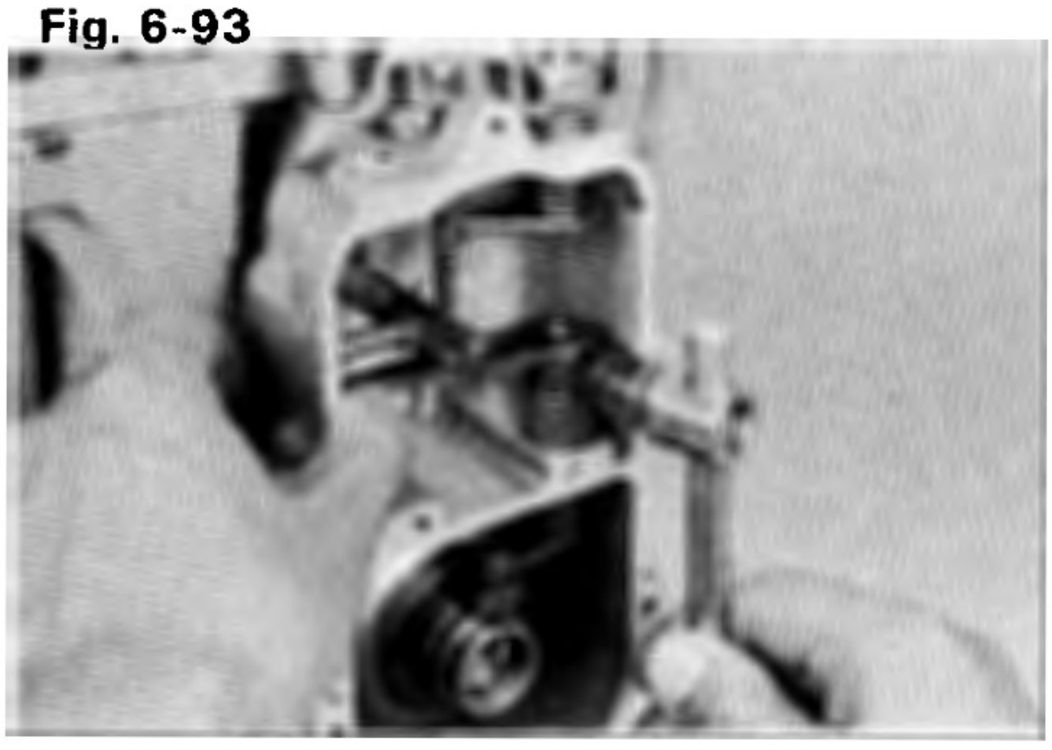
Fig. 6-92



Disconnect the diaphragm from the control rack.

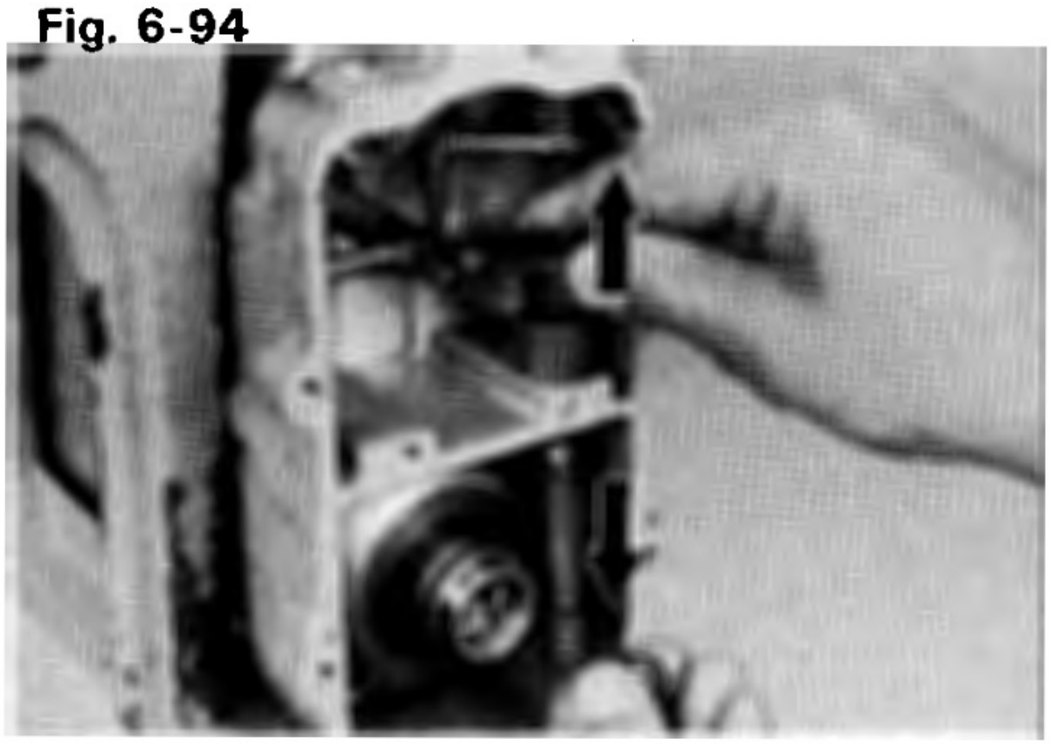
– Note –
Do not allow any engine oil, fuel or grease to get on the diaphragm.

Fig. 6-93



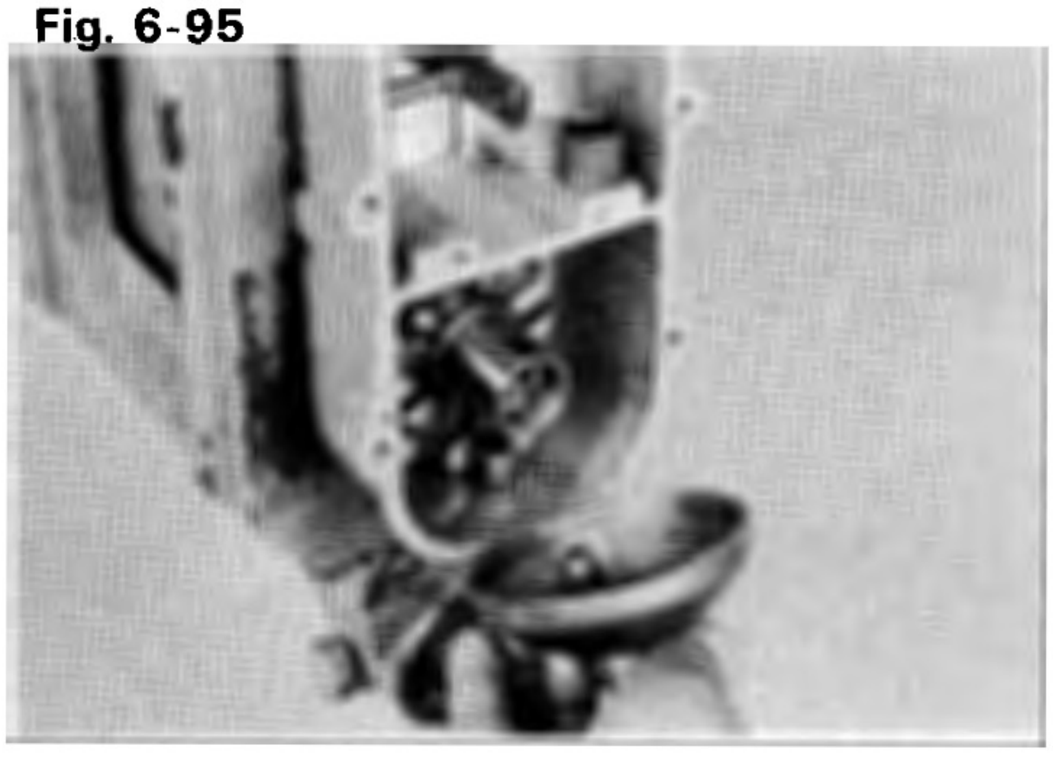
Remove the stop lever bolt with a 6 mm socket wrench.

Fig. 6-94



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

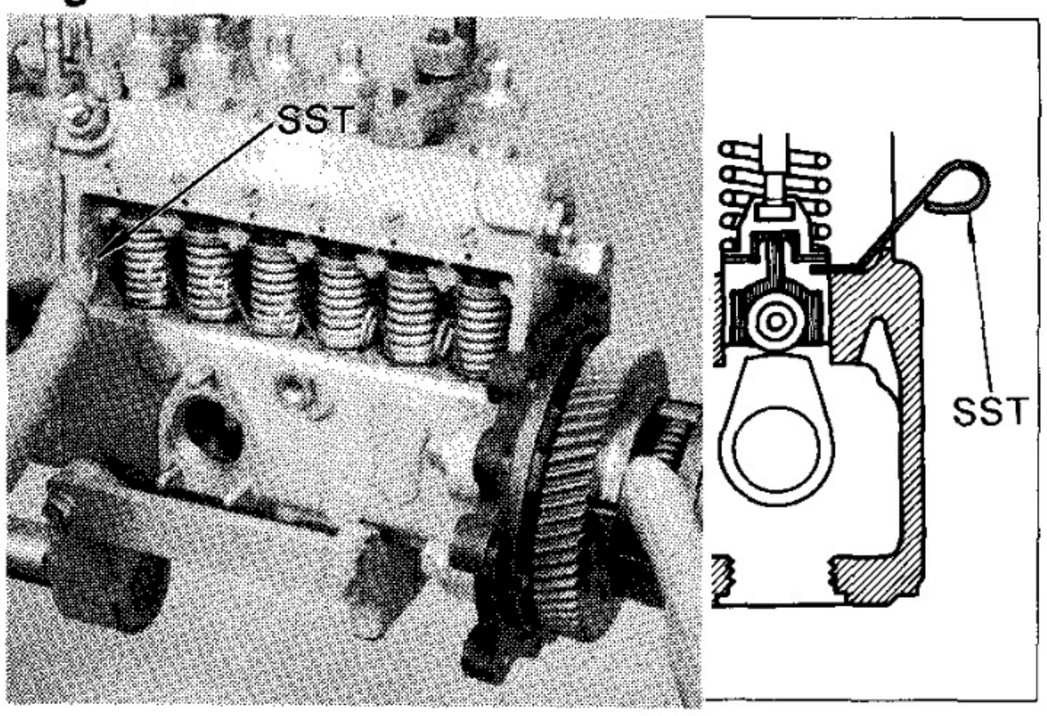
Fig. 6-95



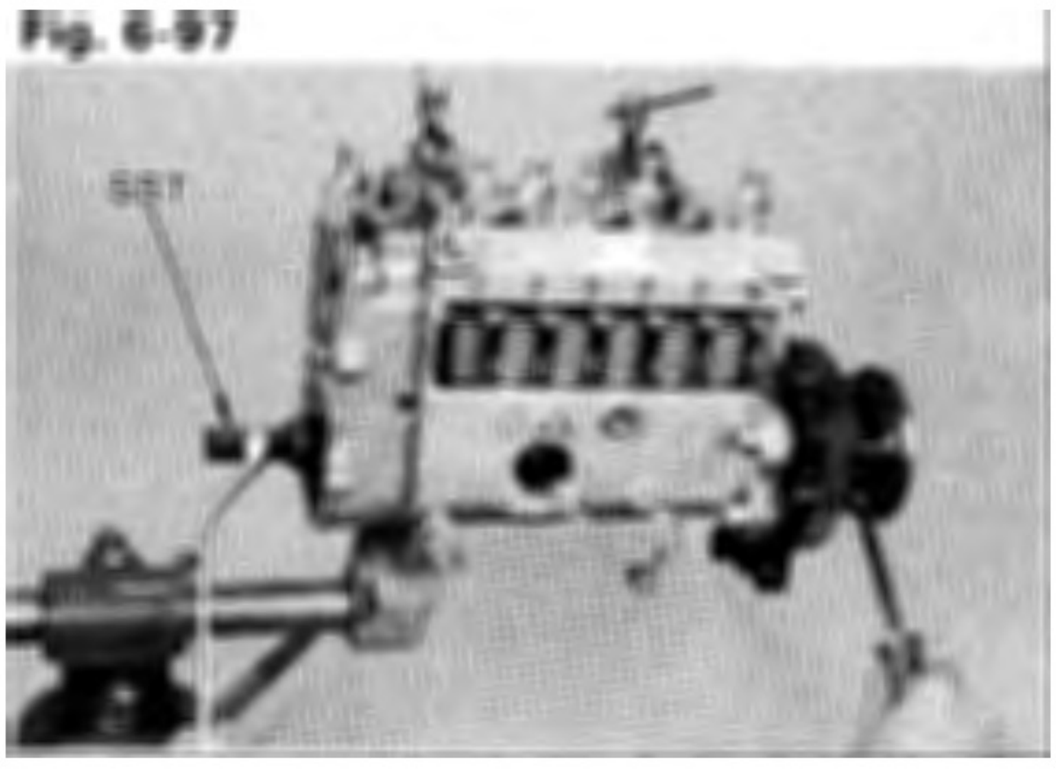
Remove the spring seat and slider, and then take out the six steel balls.

– Note –
Do not drop the steel balls.

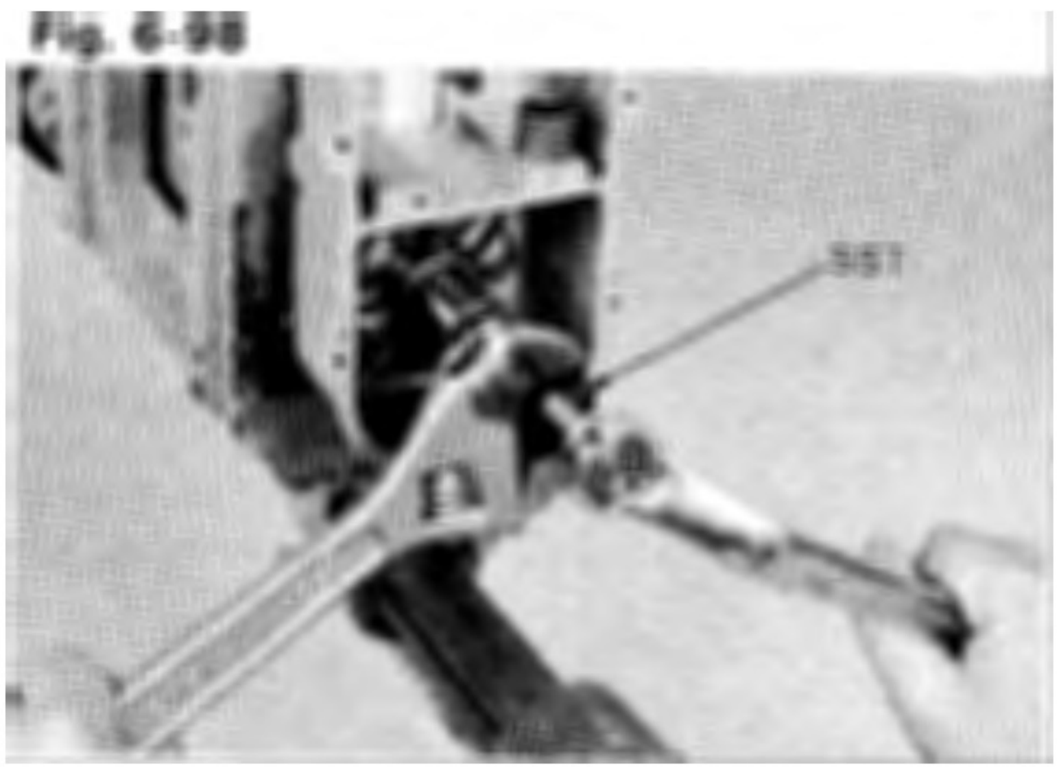
Fig. 6-96



Turn the automatic timer and insert SST into each tappet service opening when the tappets are at their highest positions.
SST (09274-46010) of set [09260-46011]

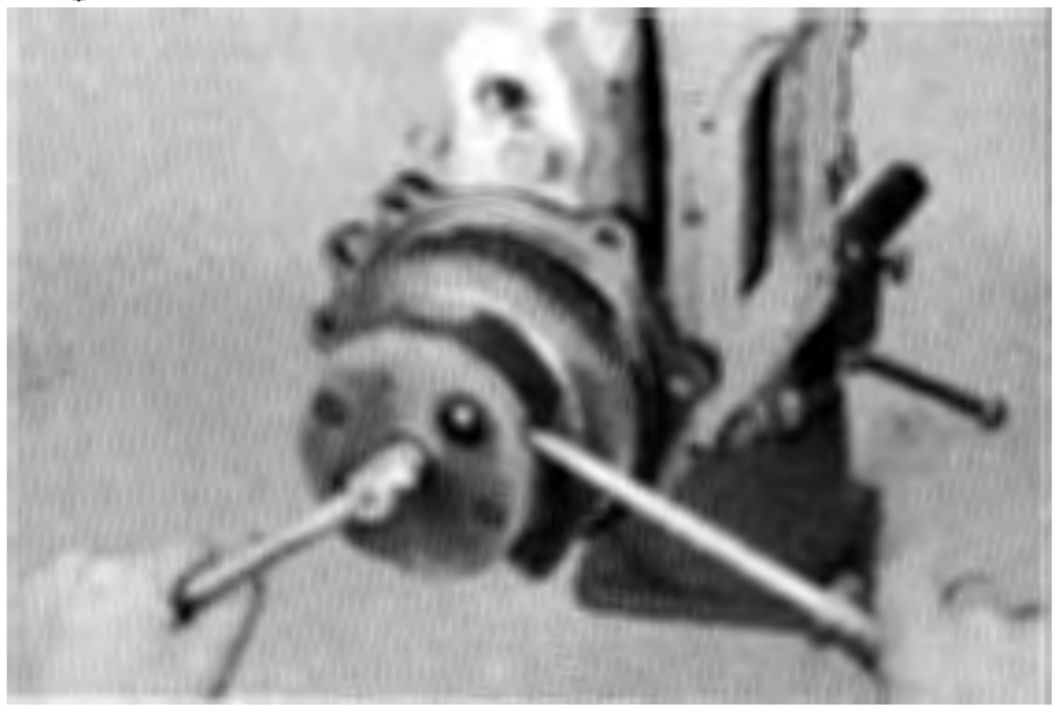


Hold the automatic timer with a screwdriver and remove the round nut with SST.
SST (09266-67011) of set [09260-76016]



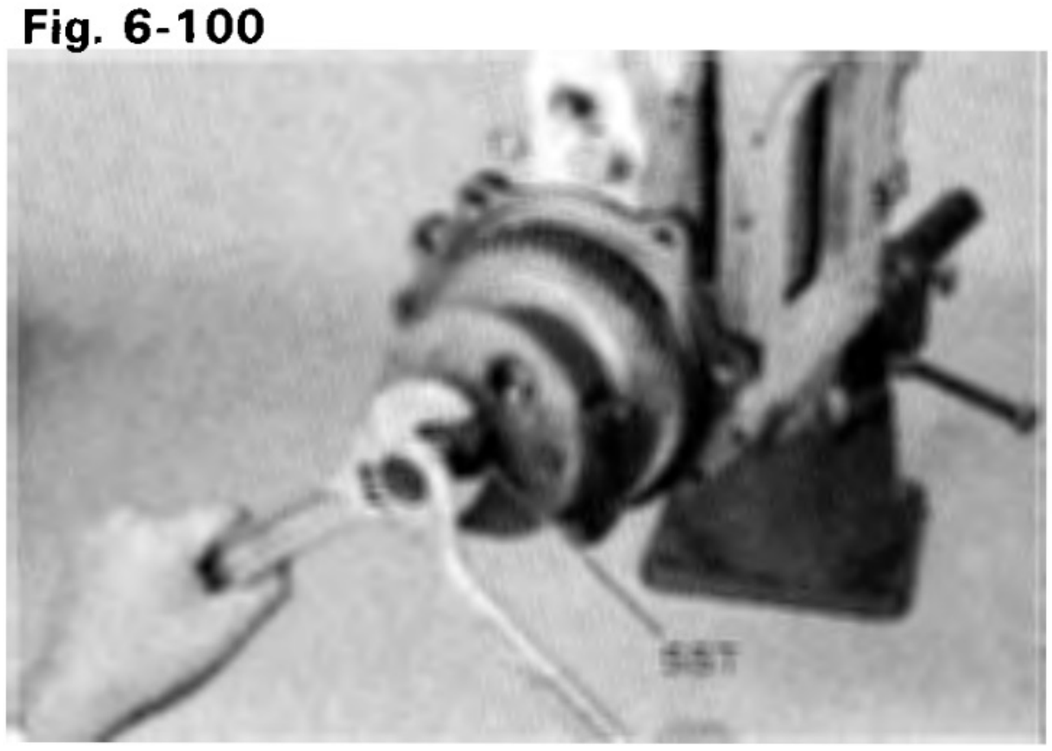
Pull out the ball guide with SST.
SST (09267-76011) of set [09260-76016]

Fig. 6-99



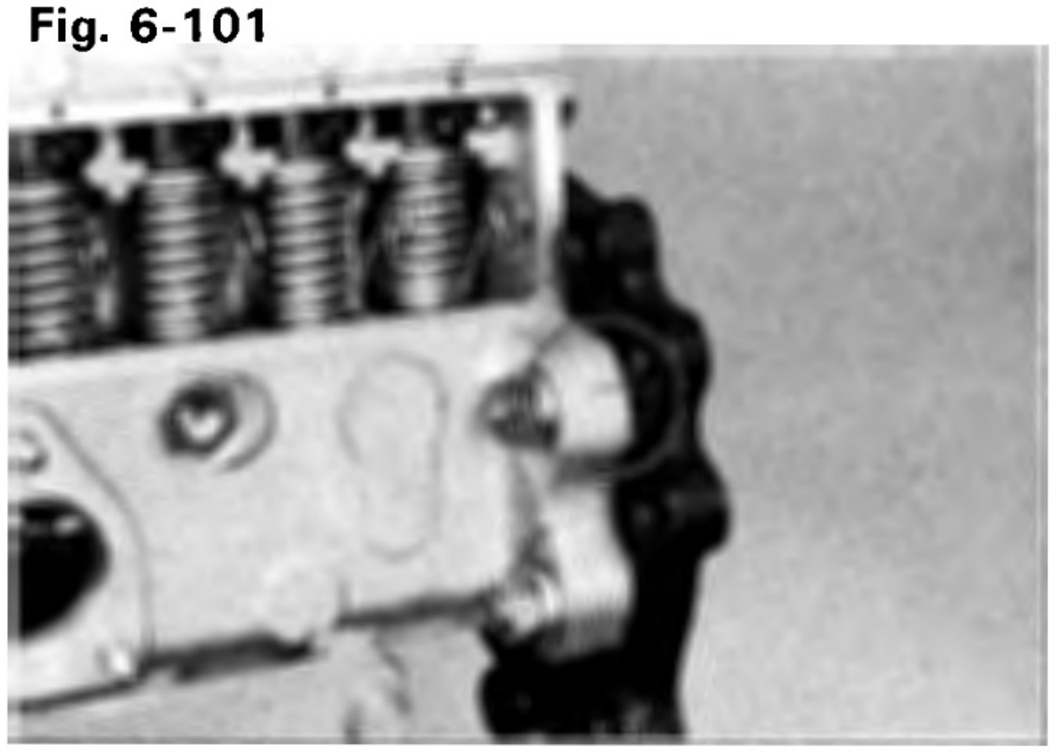
Hold the automatic timer with a screwdriver and remove the round nut.

Fig. 6-100



Pull out the automatic timer with SST.
SST[09267-76020]

Fig. 6-101



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

Fig. 6-102

SEE

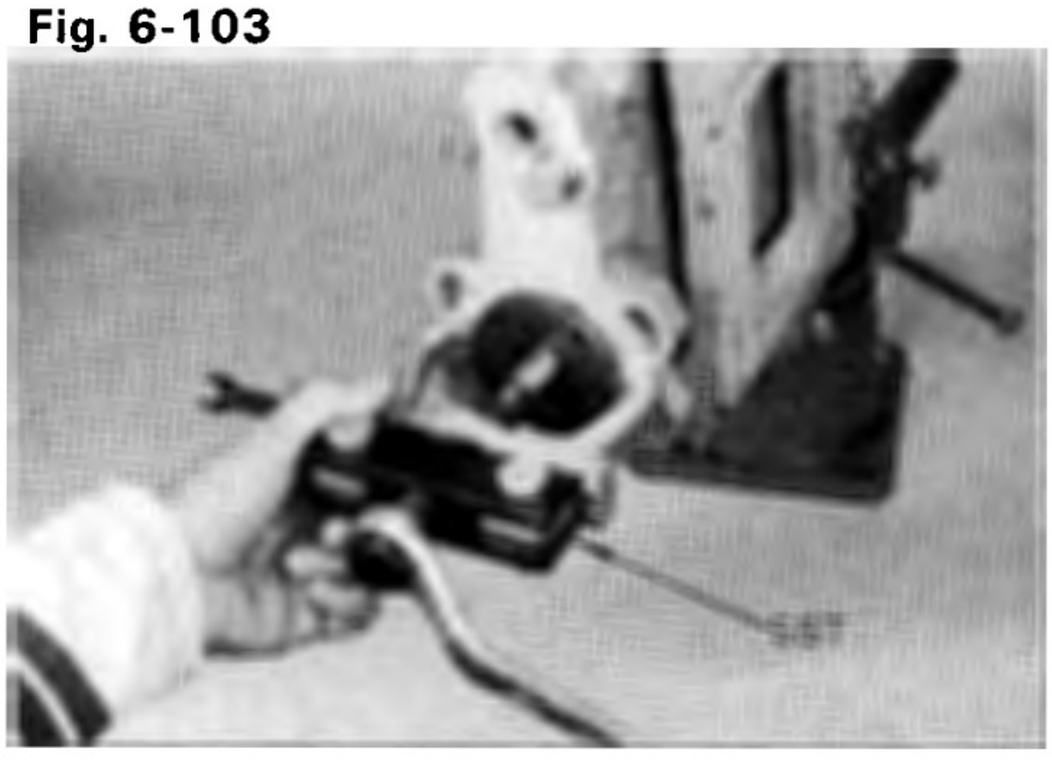
FUEL PUMP

ASSEMBLY

Fig. 6-152 to 6-156

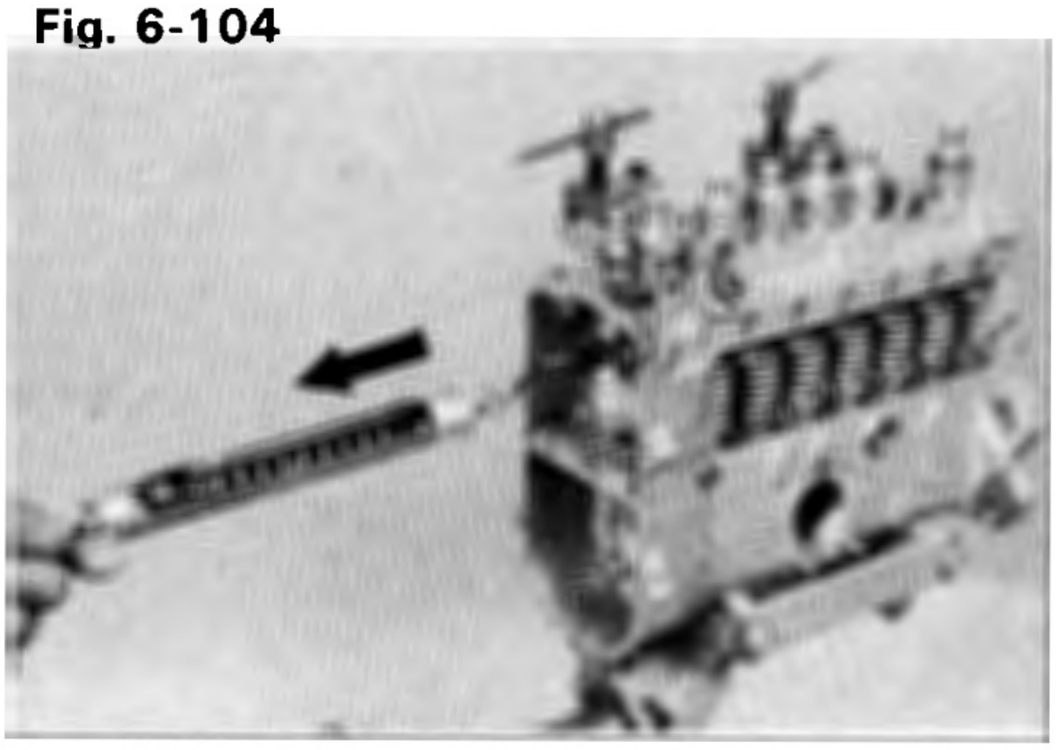
Before removing the bearing cover, measure the thrust clearance and refer to this value when inspecting or reassembling.

Fig. 6-103



Remove the bearing cover with SST.
SST [09950-20014]

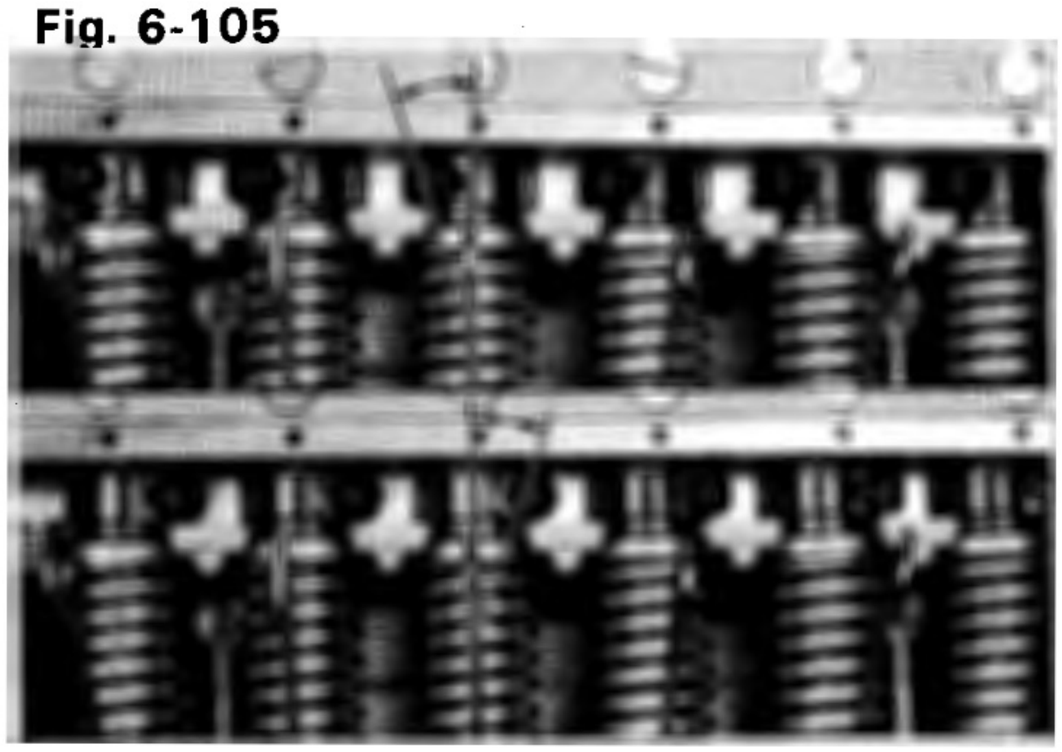
Fig. 6-104



Check the sliding resistance of the control rack.

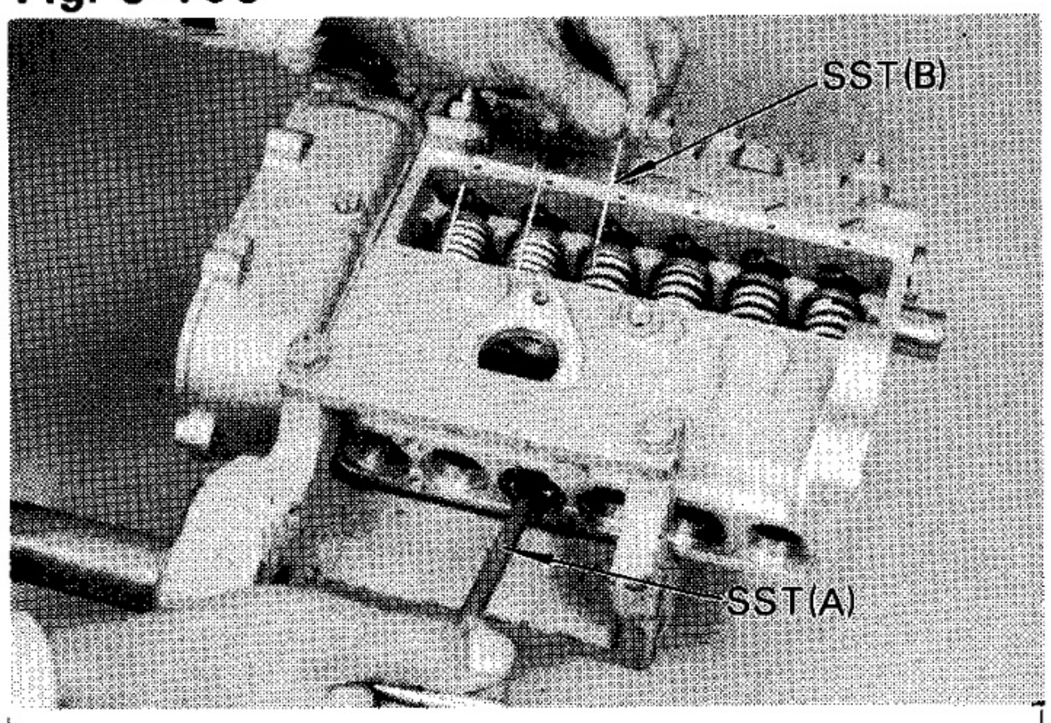
Sliding resistance: Less than 120 g (4.2 oz)

Fig. 6-105



To prevent error when re-assembling, confirm the control pinion stop position by moving the control rack fully to left and right.

Fig. 6-106



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.

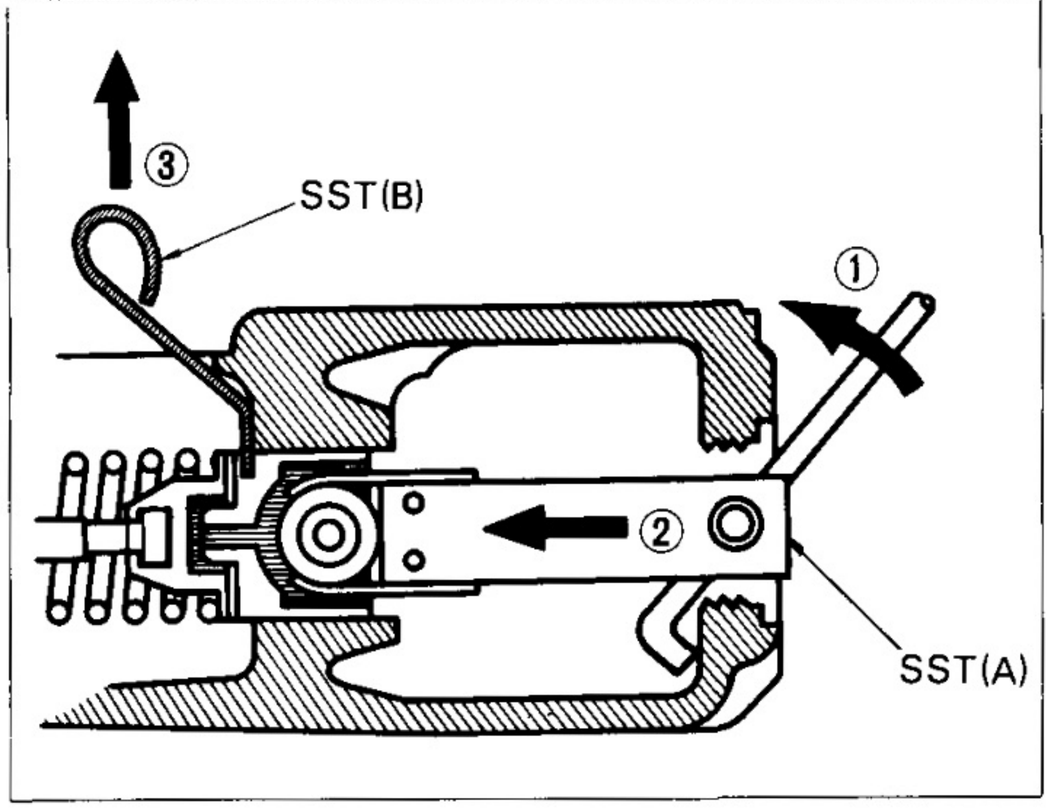
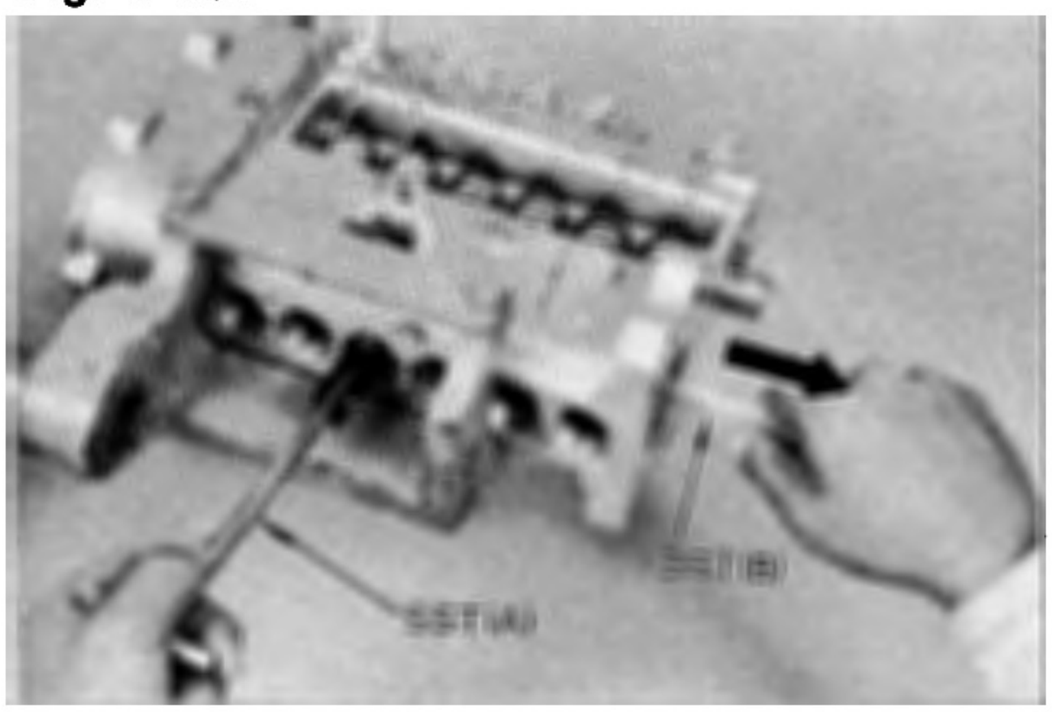
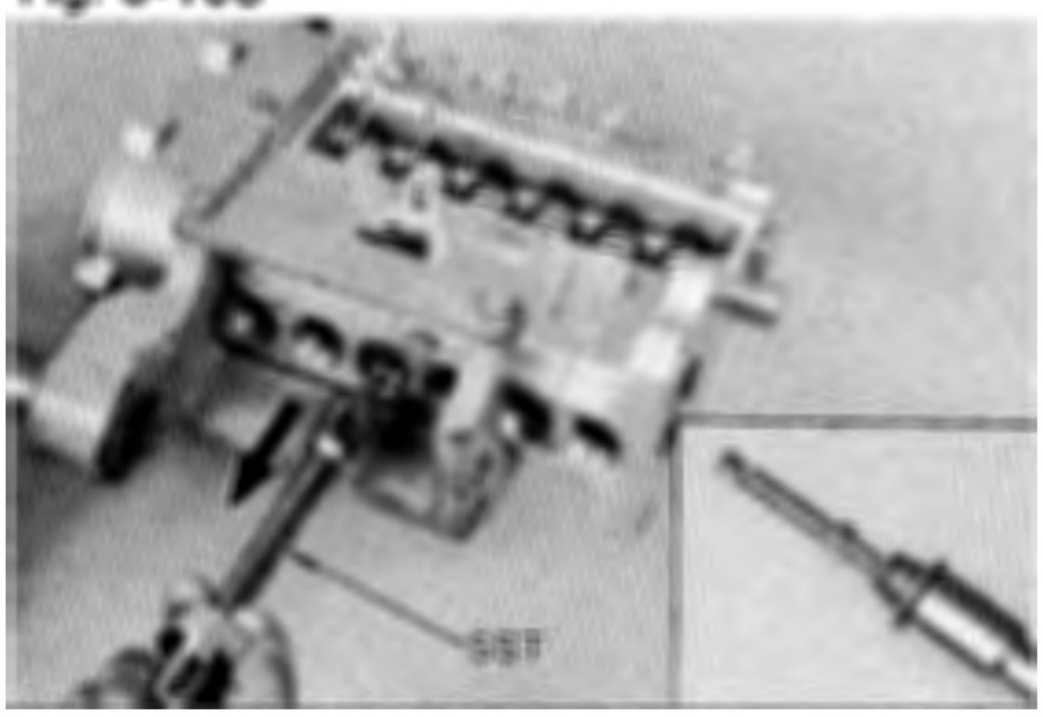


Fig. 6-107



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]

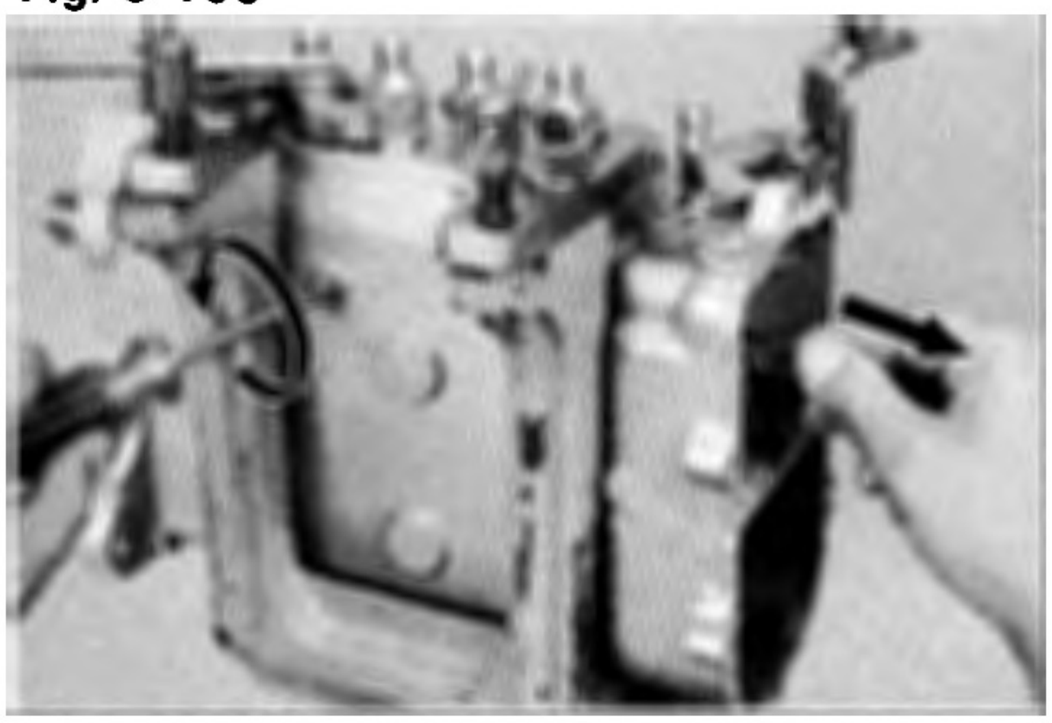
Fig. 6-108



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

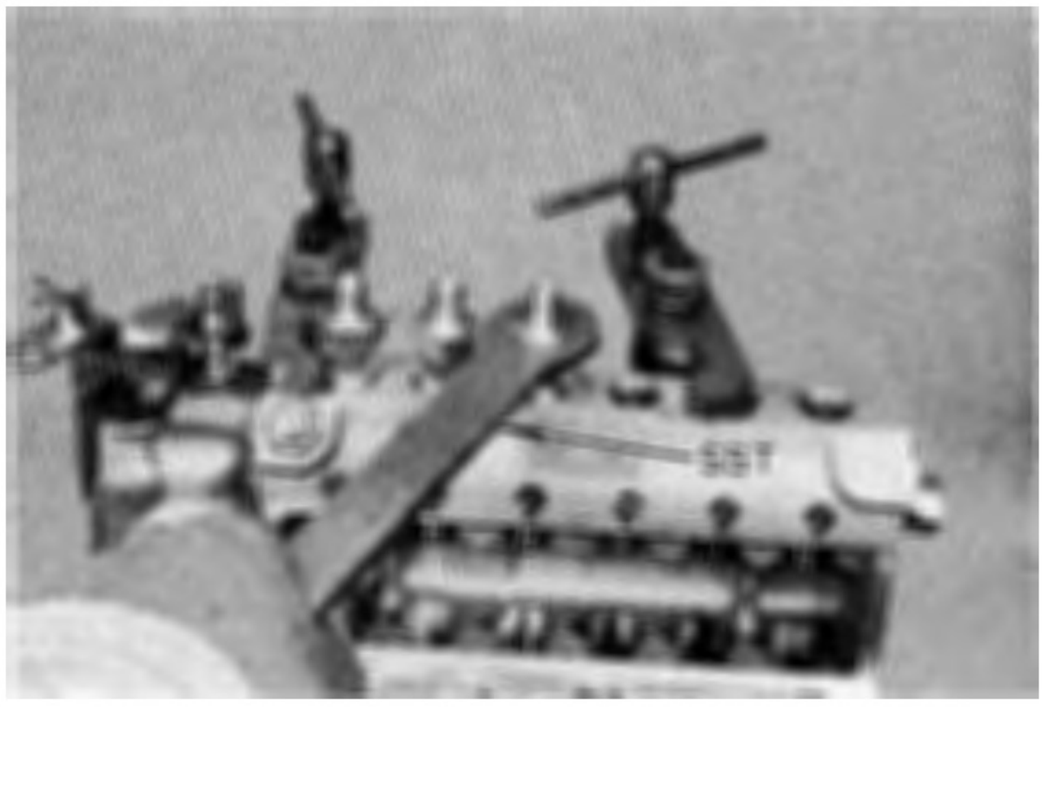
– Note –
Do not touch the sliding surfaces of the delivery valve.

Fig. 6-109



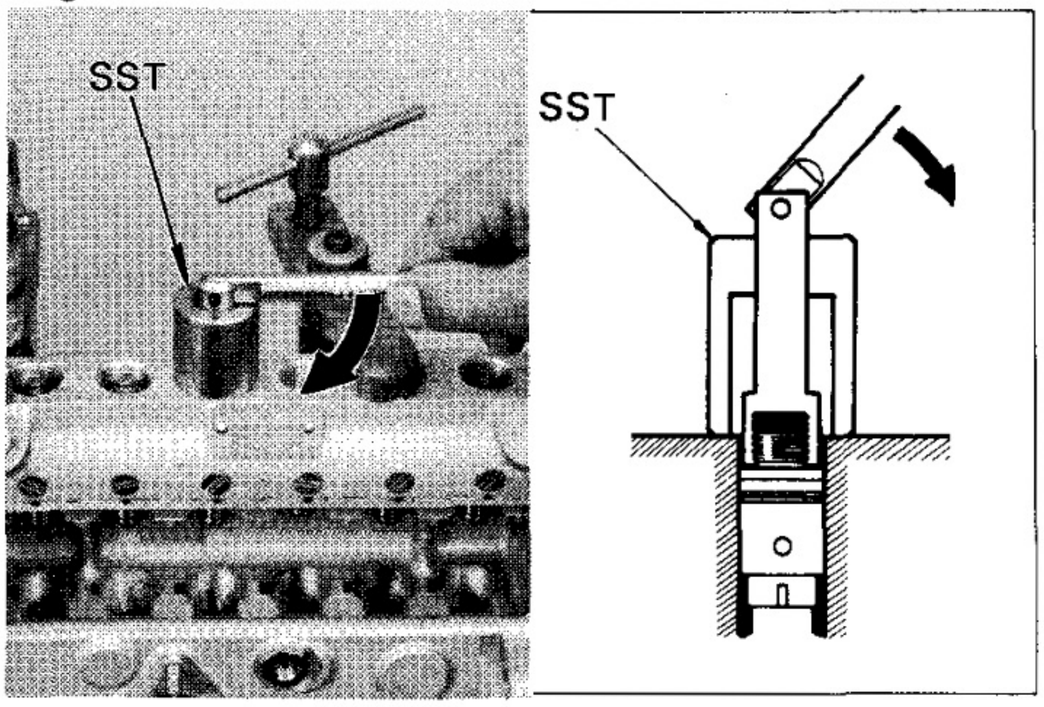
Loosen the rack guide screw and pull out the control rack.

Fig. 6-110



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

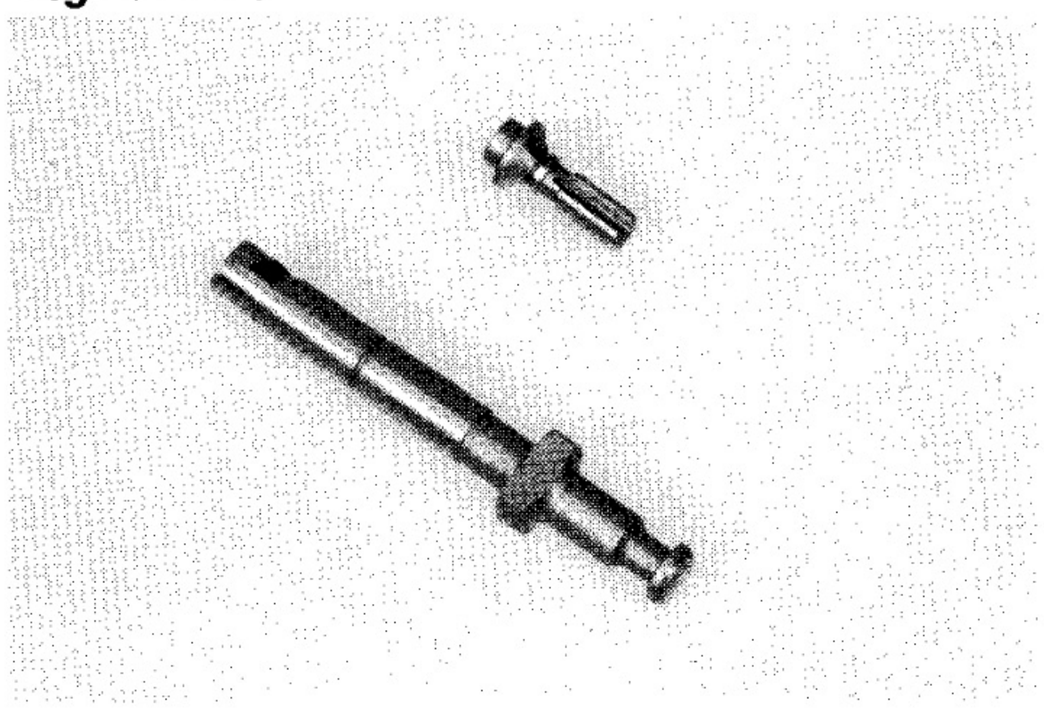
Fig. 6-111



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.

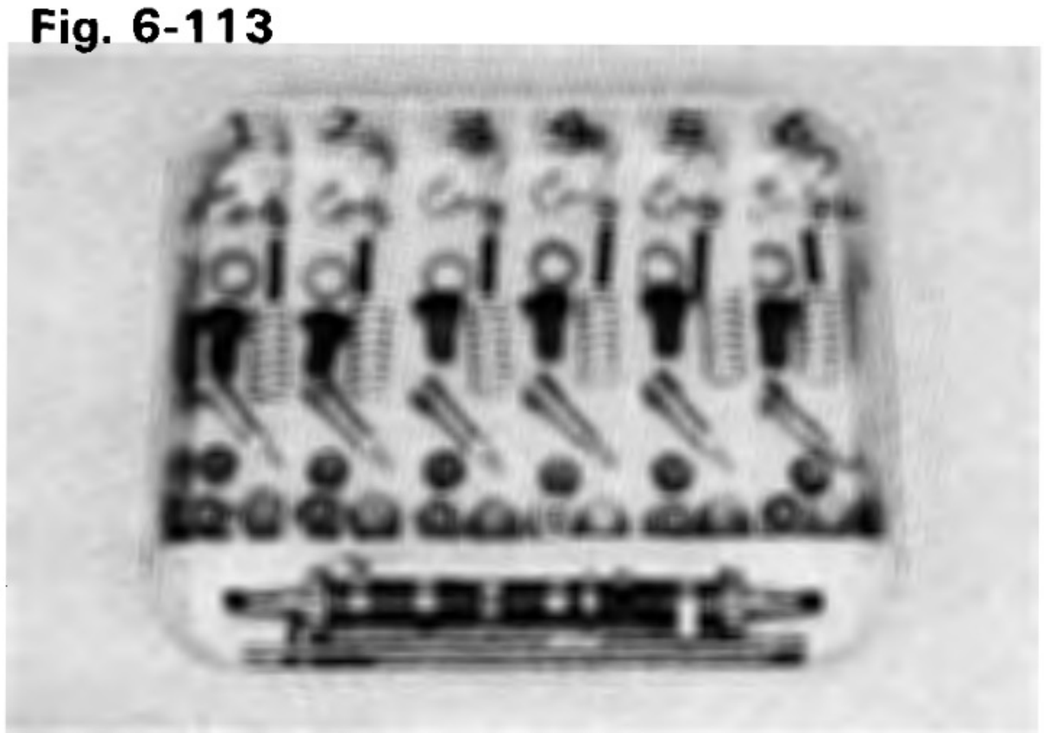
Fig. 6-112



INSPECTION & REPAIR

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

Fig. 6-113



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.

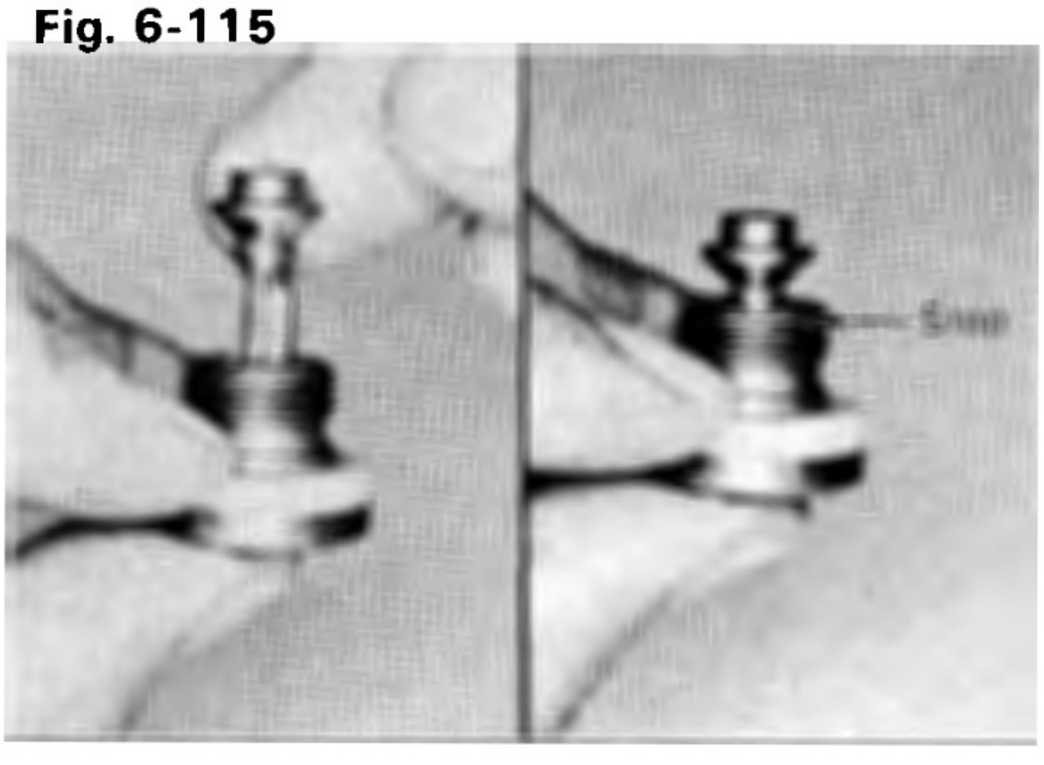
Fig. 6-114



Diaphragm

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

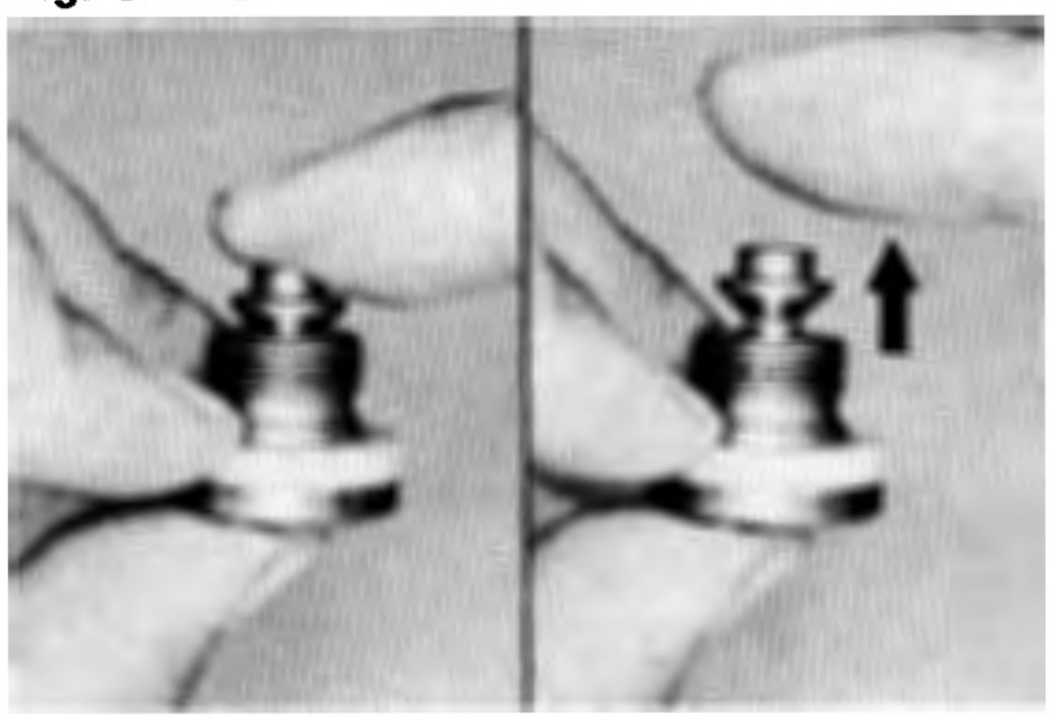
Fig. 6-115



Delivery Valve

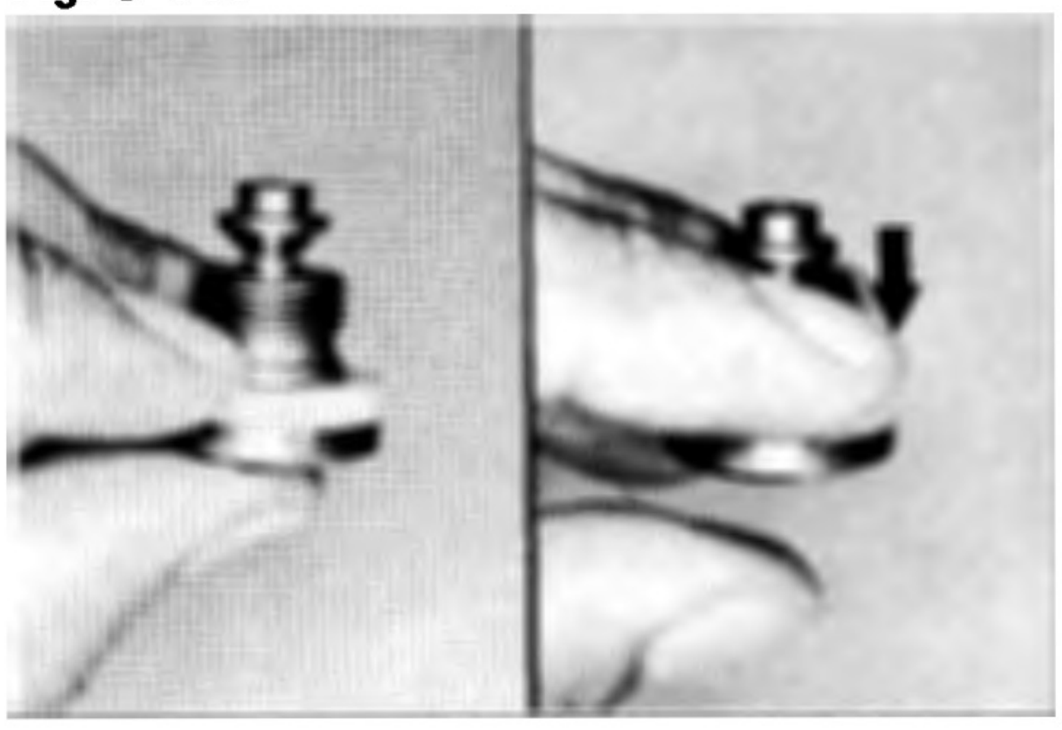
1. Pull up the valve and close the hole at the valve seat bottom end with your thumb. When the valve is released, it should sink down quickly and stop at the position where the relief ring closes the valve seat hole.
   If defective, replace the valve as a set.

Fig. 6-116



2. Place your thumb over the hole at the 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.

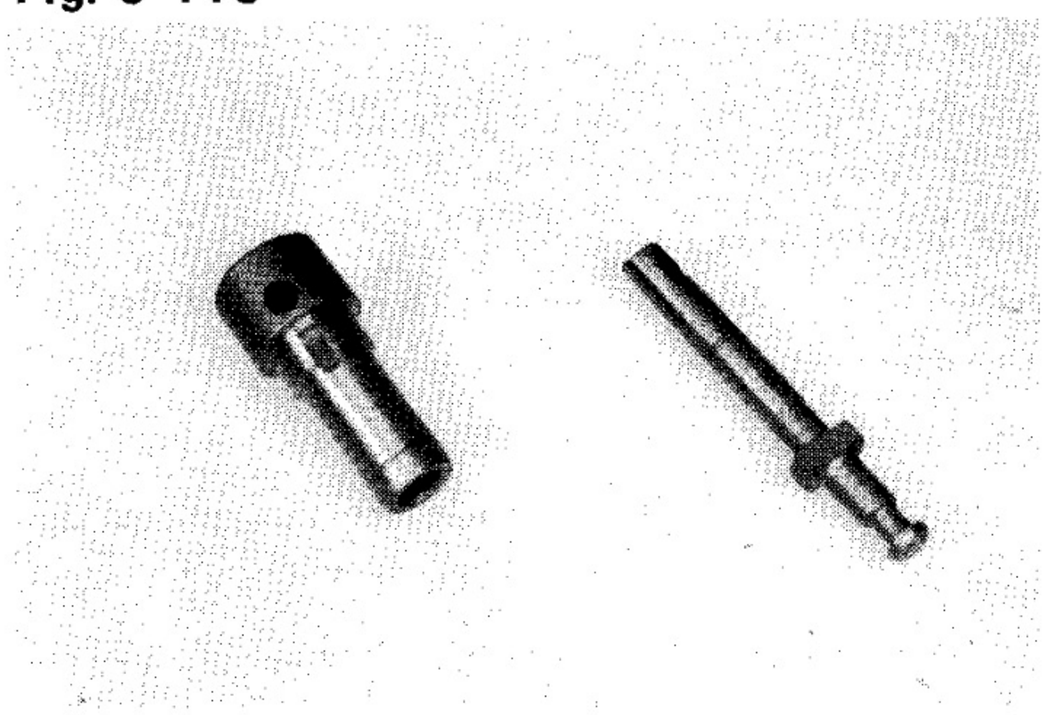
Fig. 6-117



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

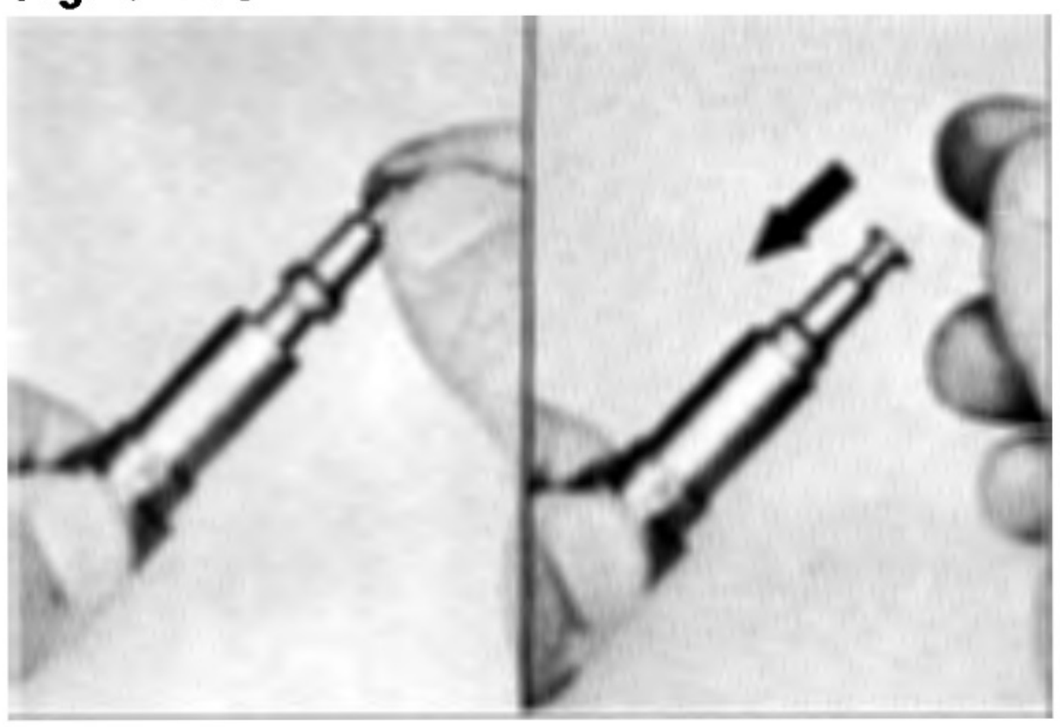
— Note —
Before using a new valve set, wash it with light oil and perform the above tests.

Fig. 6-118



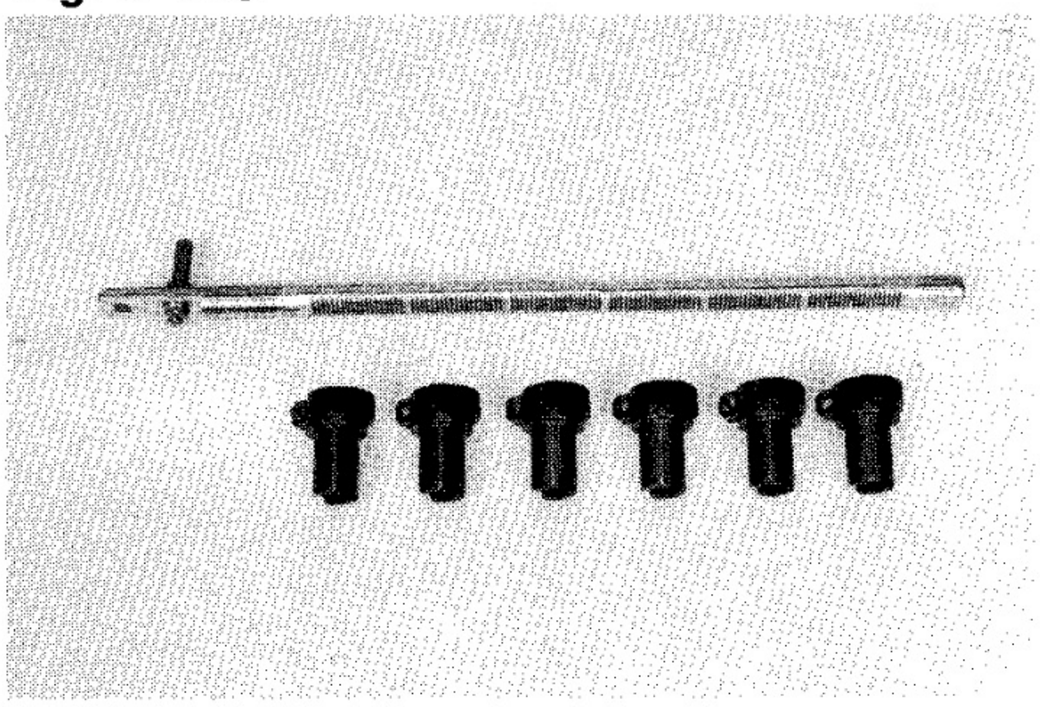
Plunger & Cylinder
Check the sliding parts, and if damaged, replace the element as a set.

Fig. 6-119



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.

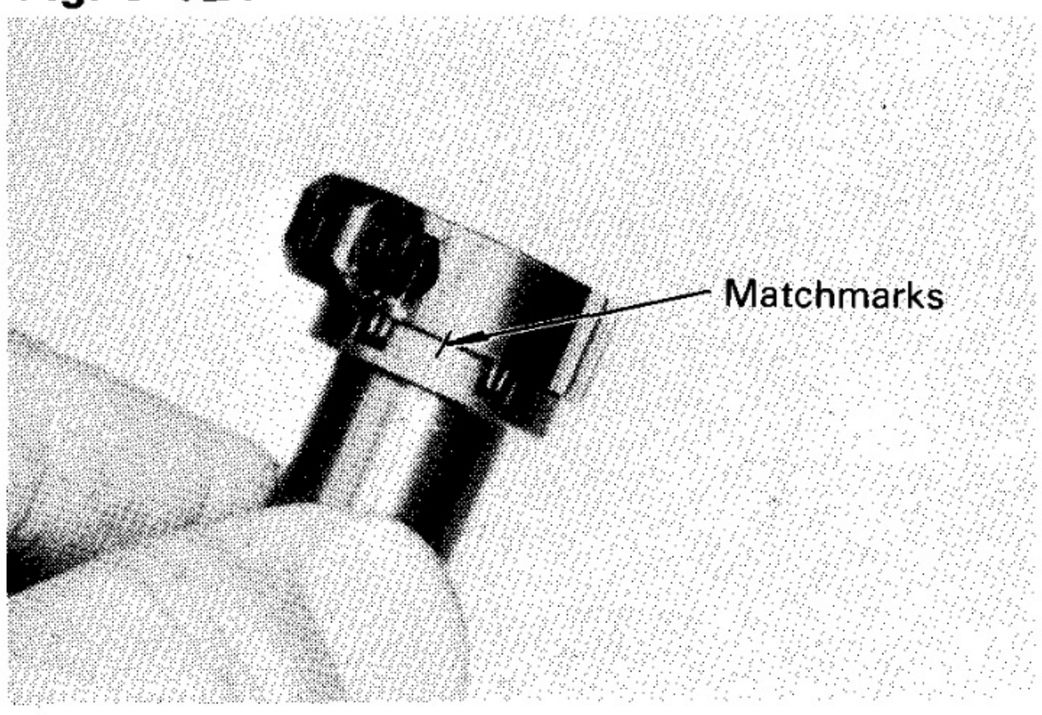
Fig. 6-120



Control Rack & Pinion

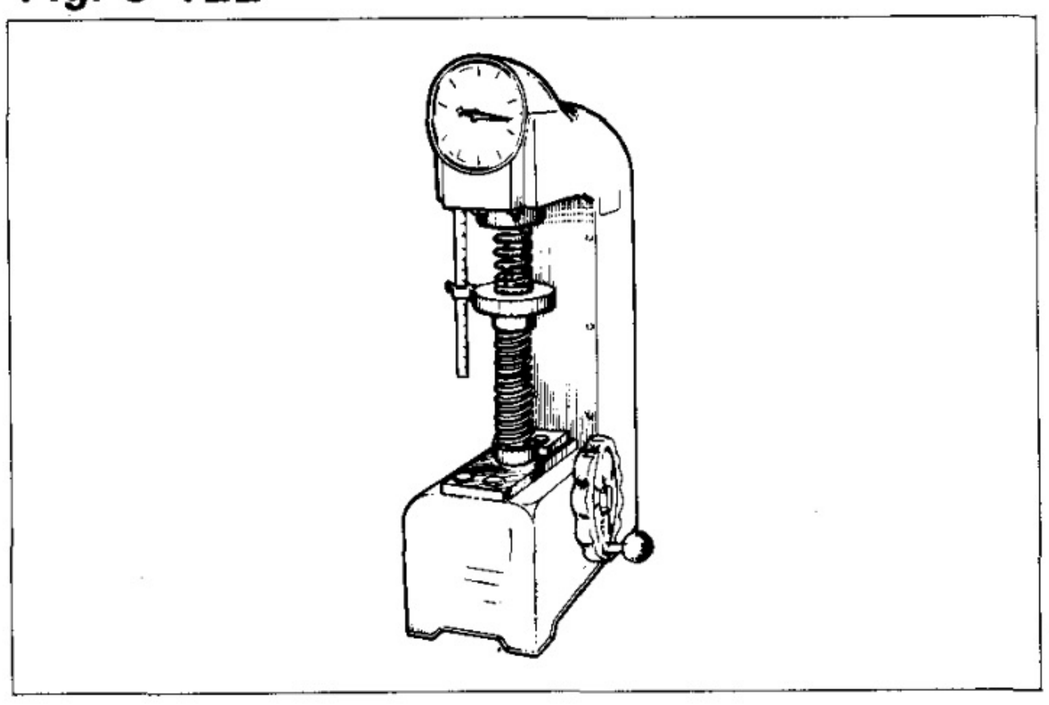
Inspect the tooth surfaces of the control rack and pinion for wear or damage and replace if defective.

Fig. 6-121



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

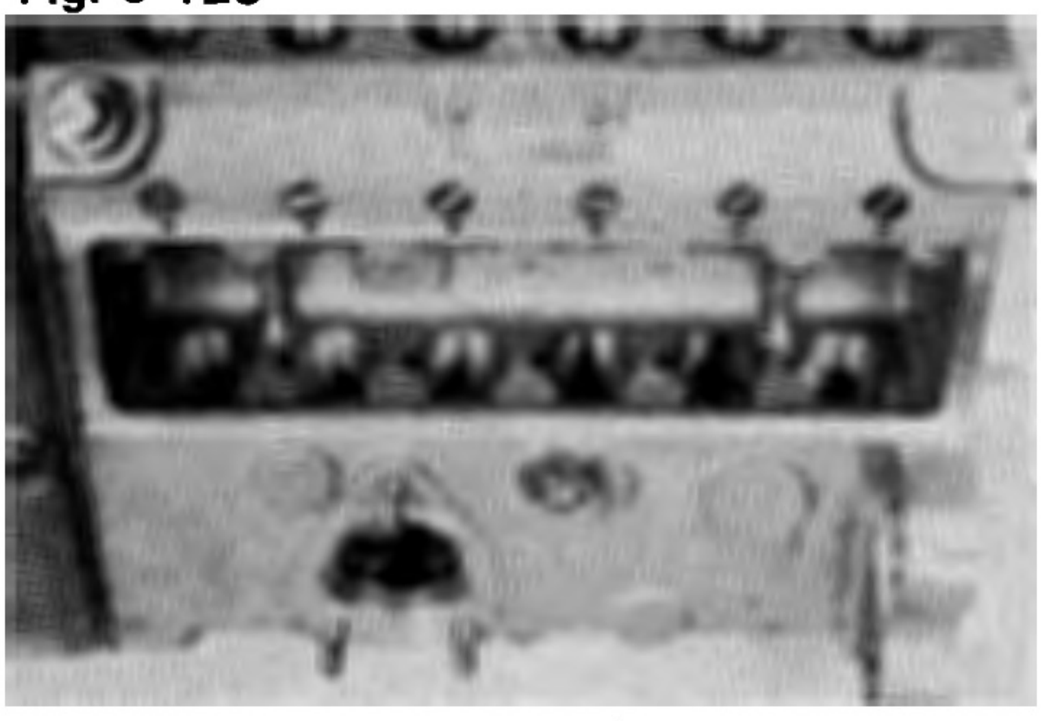
Fig. 6-122



Spring

Item \ Spring	Plunger spring	Delivery valve spring	Governor main spring	Speed control spring
Free length	49.4 mm (1.945 in.)	36.8 mm (1.449 in.)	43.5 mm (1.713 in.)	38.0 mm (1.496 in.)
Installed length	44.0 mm (1.732 in.)	27.0 mm (1.063 in.)	33.0 mm (1.299 in.)	24.0 mm (0.945 in.)
Installed load	15.1 kg (33 lb)	3.9 kg (8.6 lb)	0.95 kg (2 lb)	4.2 kg (9.3 lb)

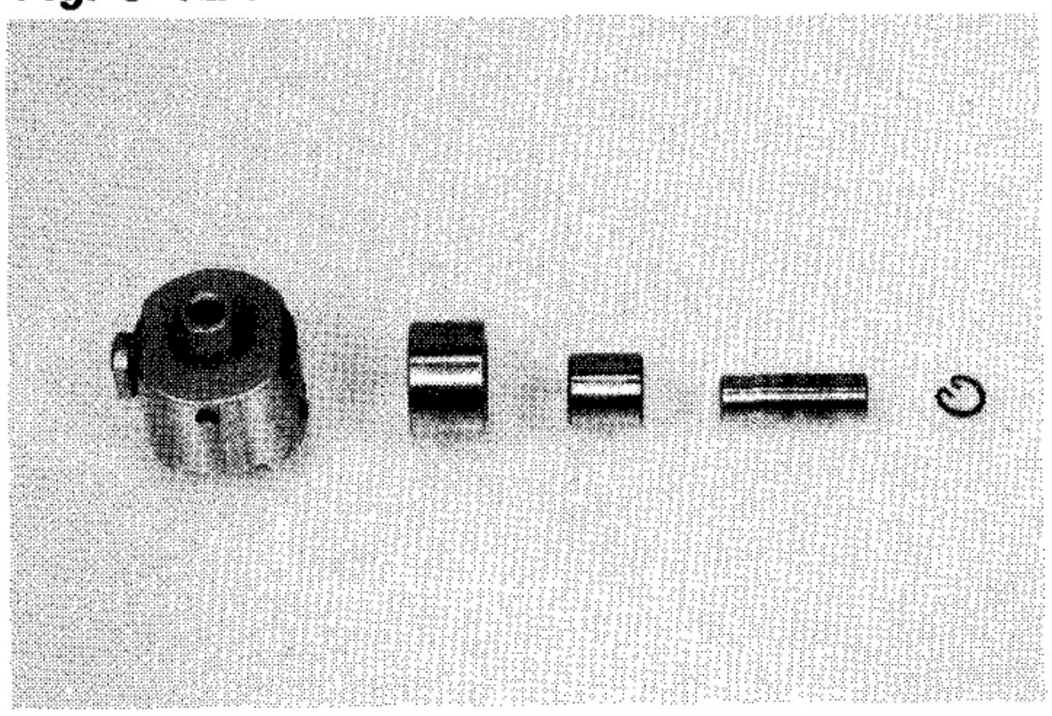
Fig. 6-123



Tappet

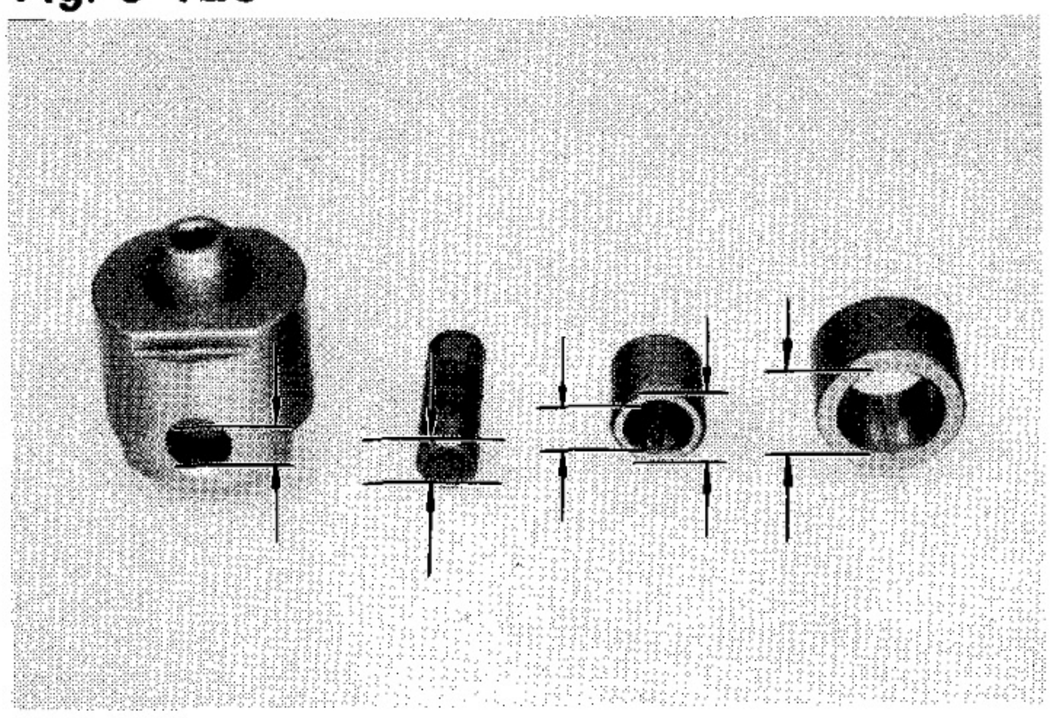
Check the tappet holes of the pump housing for wear or damage.

Fig. 6-124



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

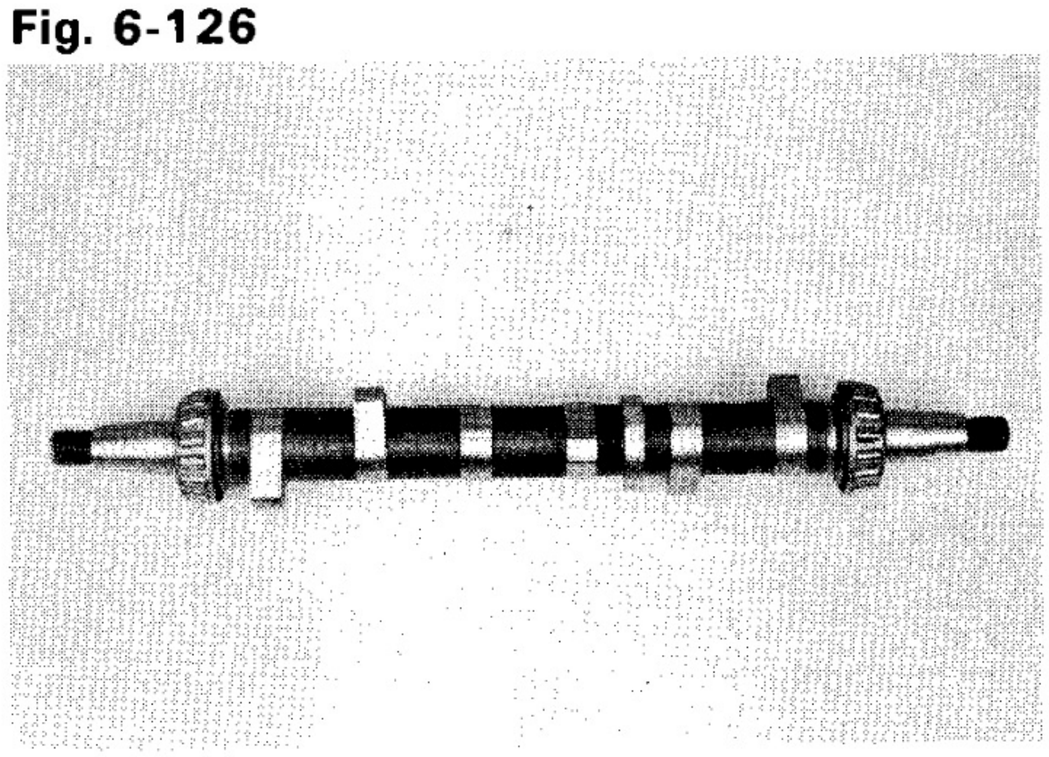
Fig. 6-125



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.)

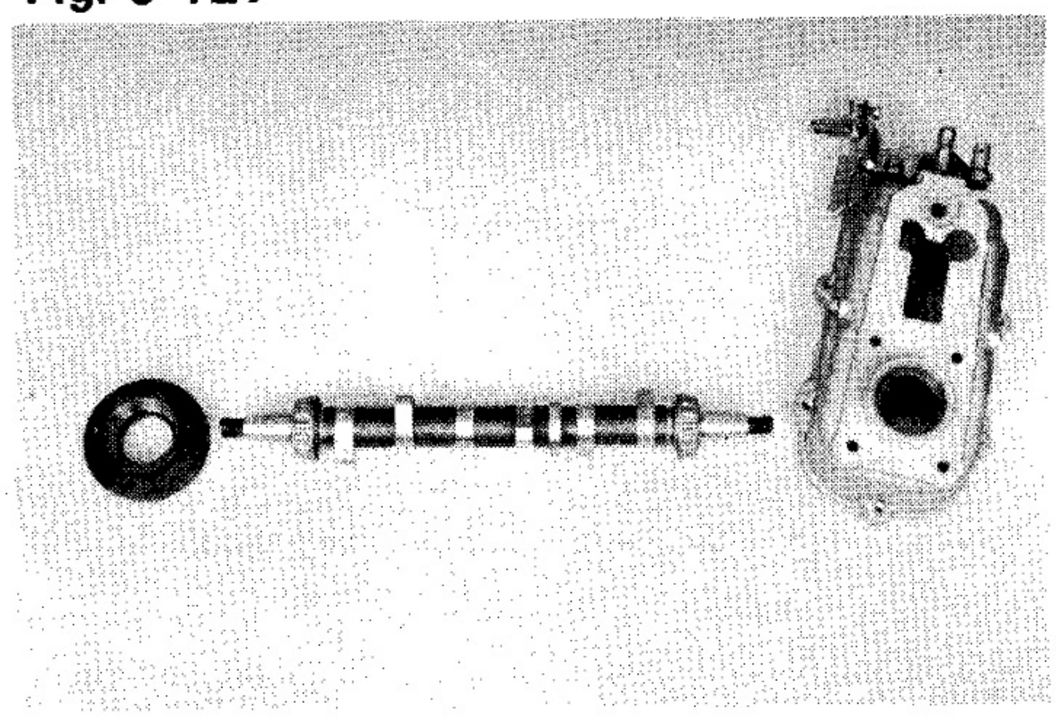
Fig. 6-126



Camshaft

Check the cam surfaces for wear or damage.

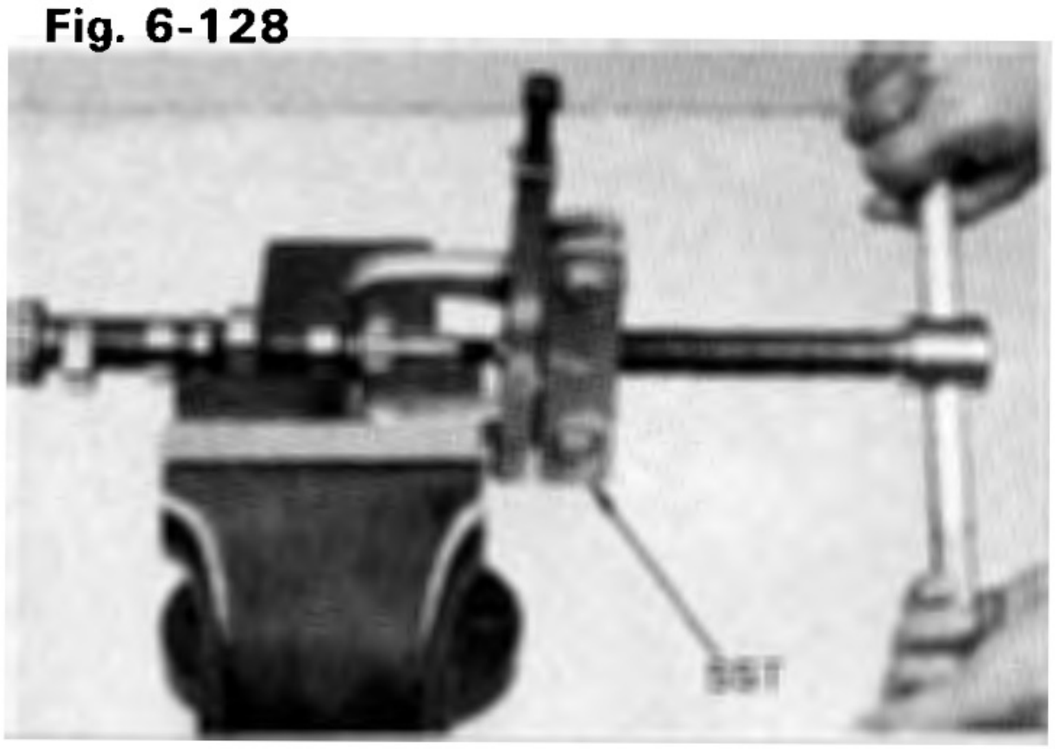
Fig. 6-127



Camshaft Bearing

Check the roller and race for wear or damage.

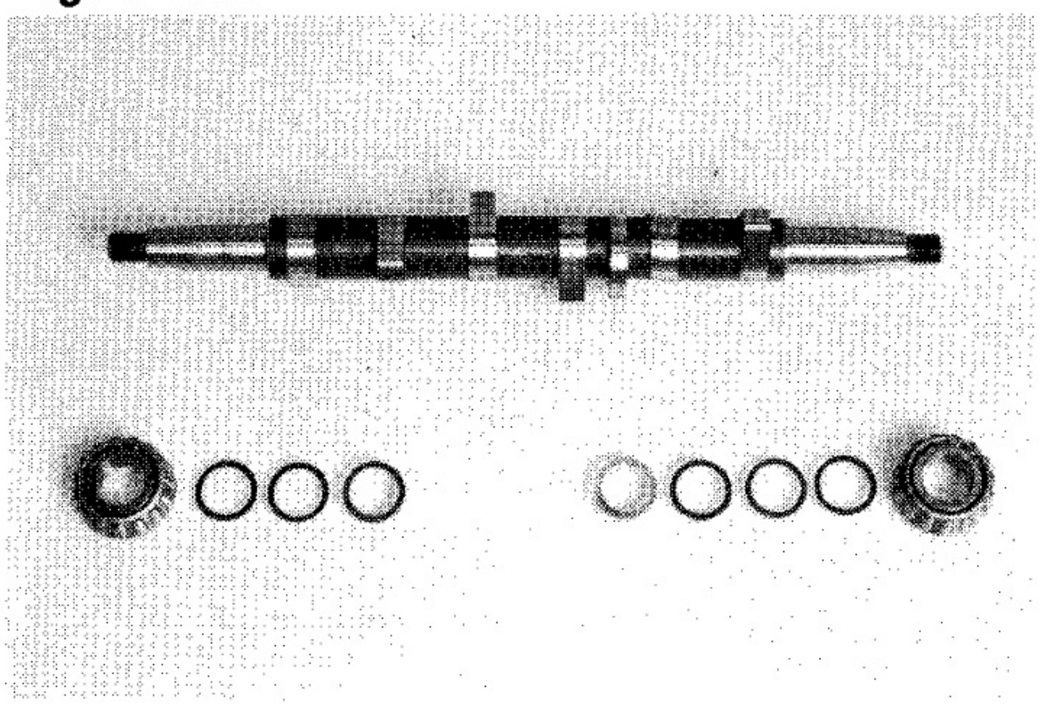
Fig. 6-128



Replace Camshaft Bearing

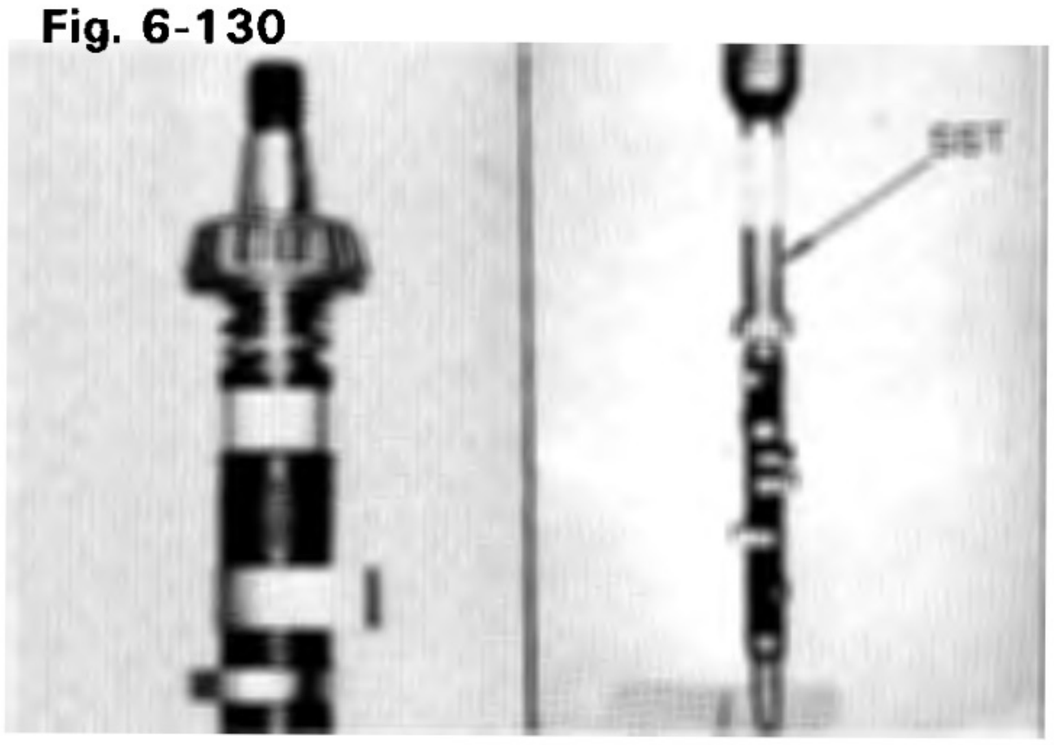
1. Pull out the front bearing with SST.
   SST [09950-20014]

Fig. 6-129



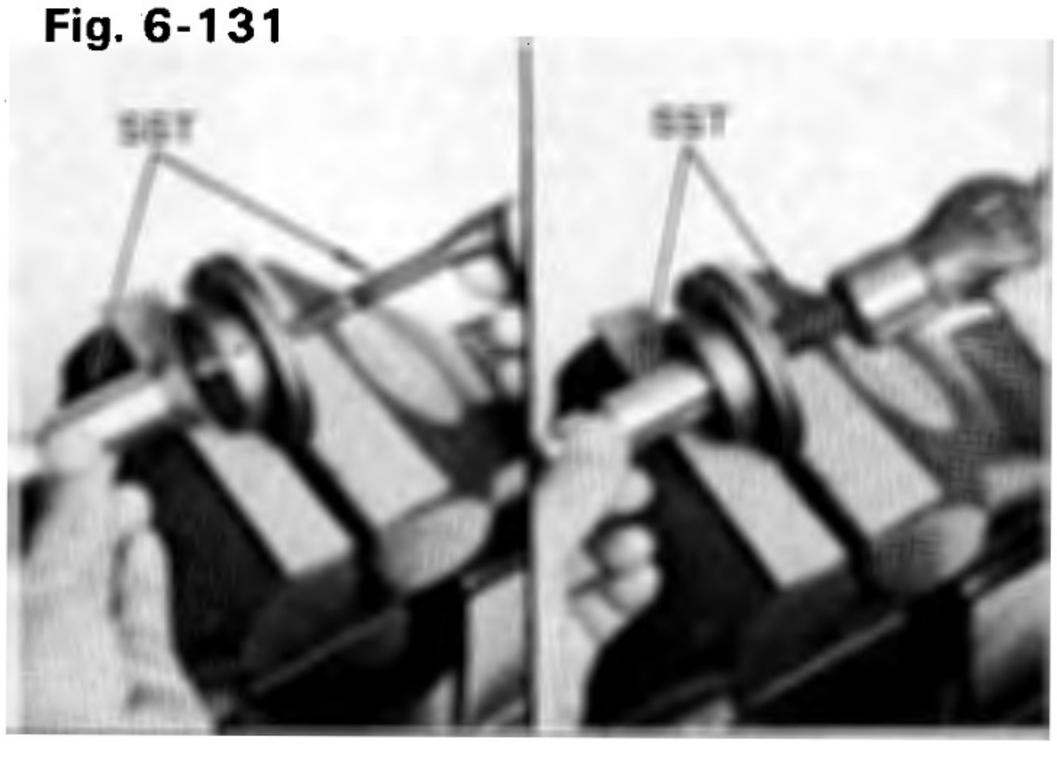
2. Keep the removed shims separately to prevent loss or getting them mixed up with other shims.

Fig. 6-130



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

Fig. 6-131



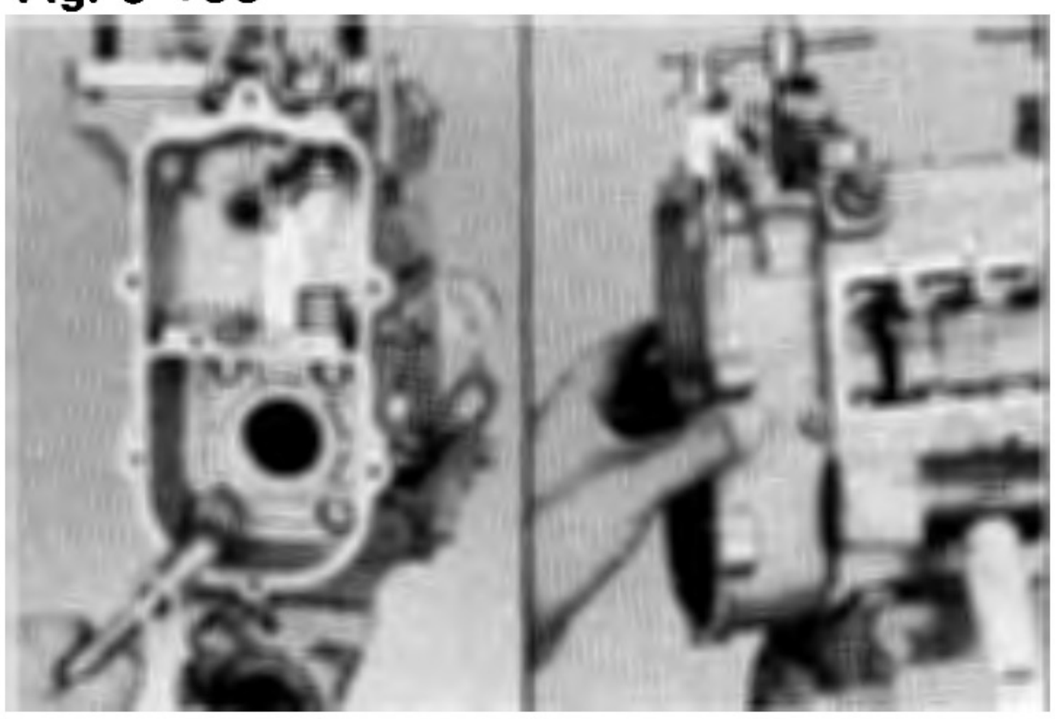
4. Install SST to the bearing cover and drive out the outer race.
   SST [09286-76011]

Fig. 6-132



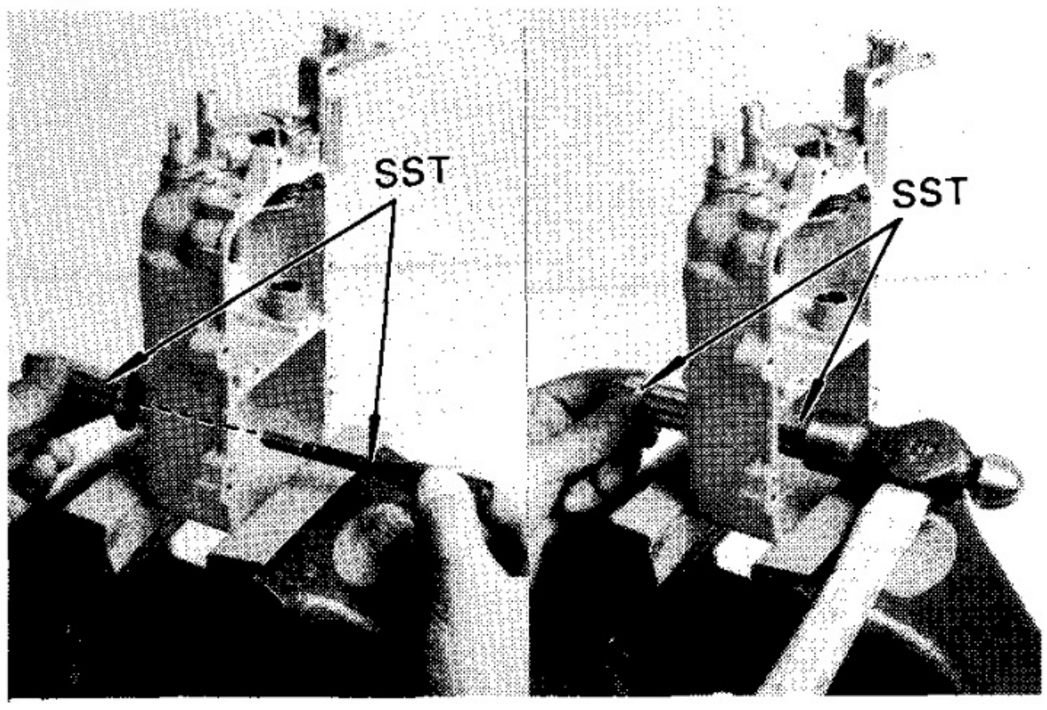
5. Drive a new bearing outer race into the cover with SST.
SST [09608-12010]

Fig. 6-133



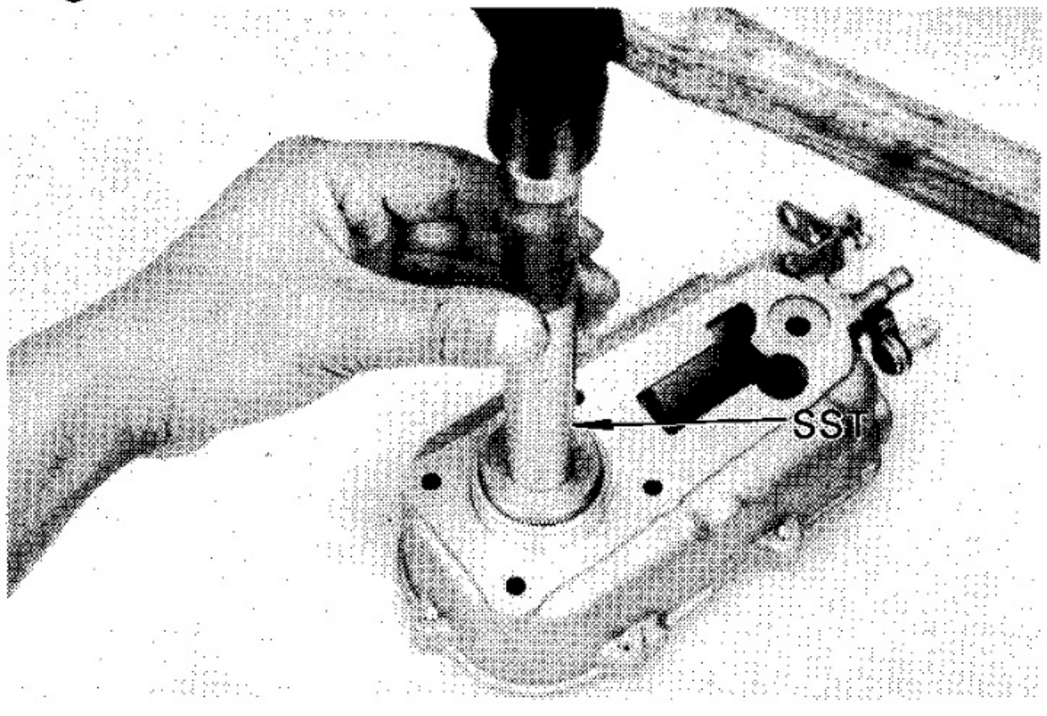
6. Remove the governor housing from the pump body.

Fig. 6-134



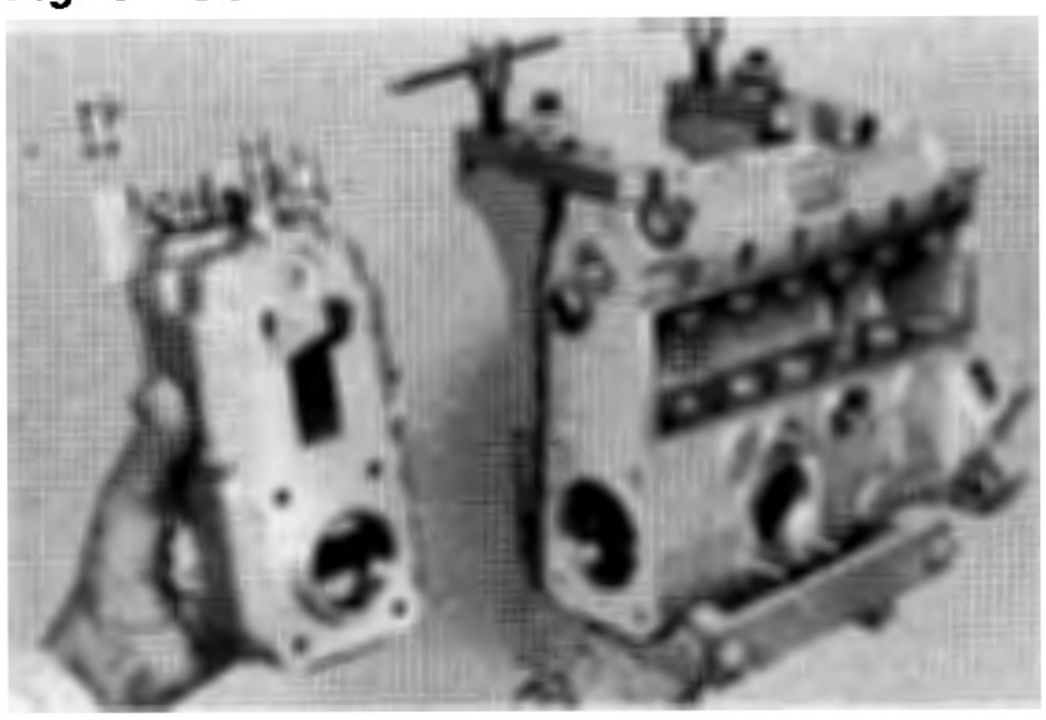
7. Install SST to the governor housing and drive out the outer race.
SST [09286-76011]

Fig. 6-135



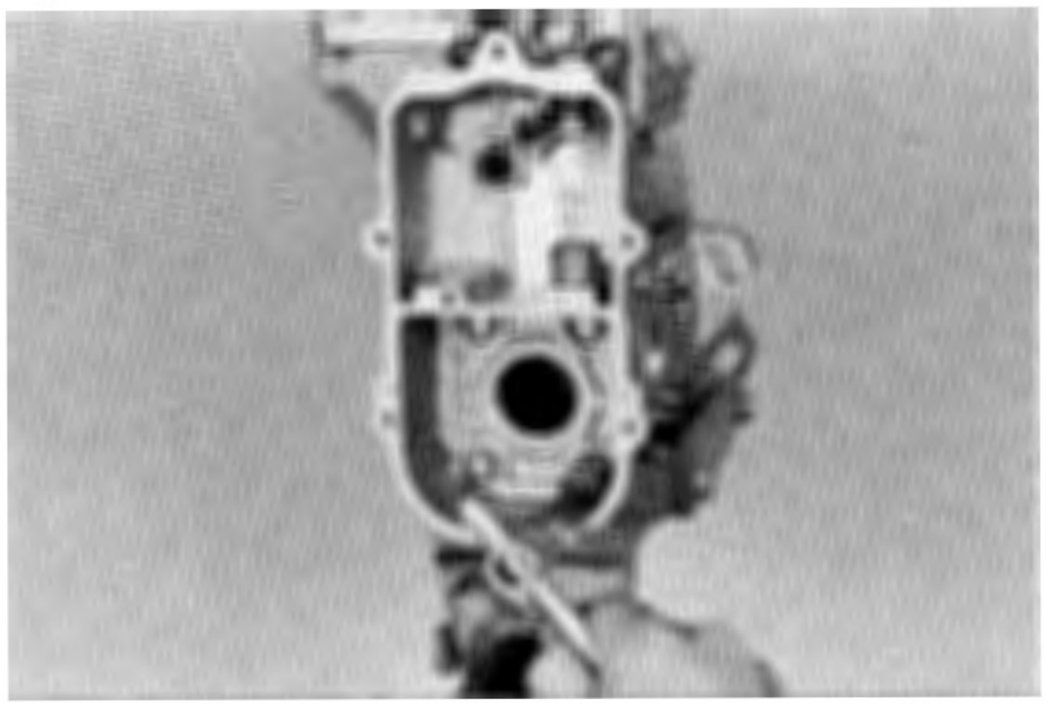
8. Drive a new bearing outer race into the governor housing with SST.
SST [09608-12010]

Fig. 6-136



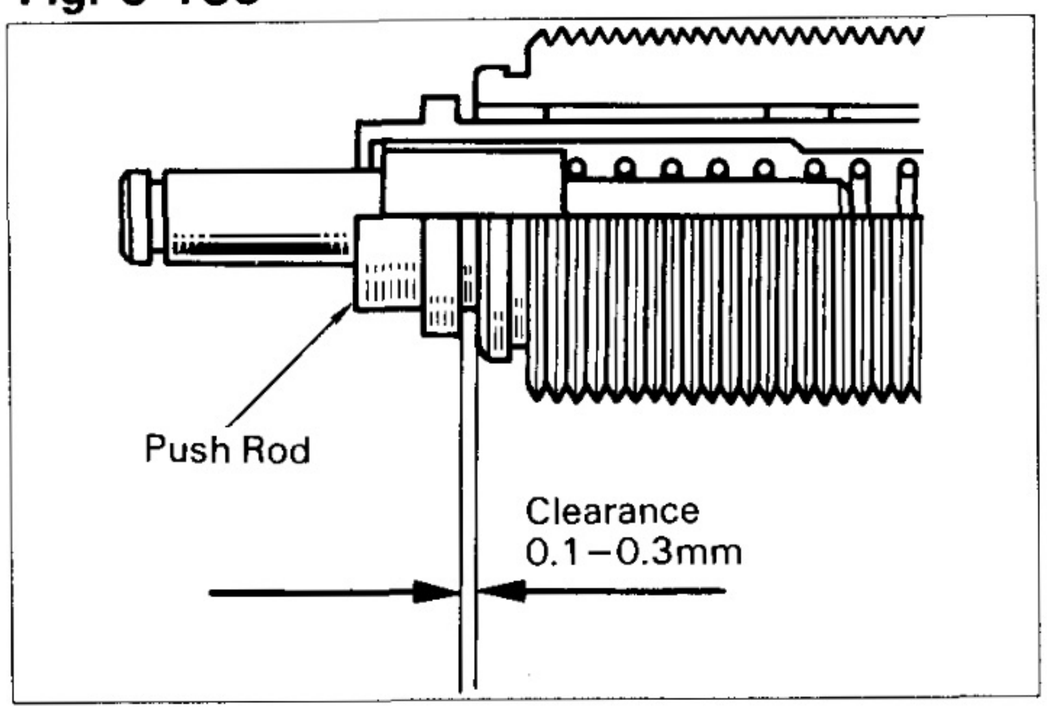
9. Clean the installing surfaces.

Fig. 6-137



10. Install a new gasket and the governor housing.

Fig. 6-138

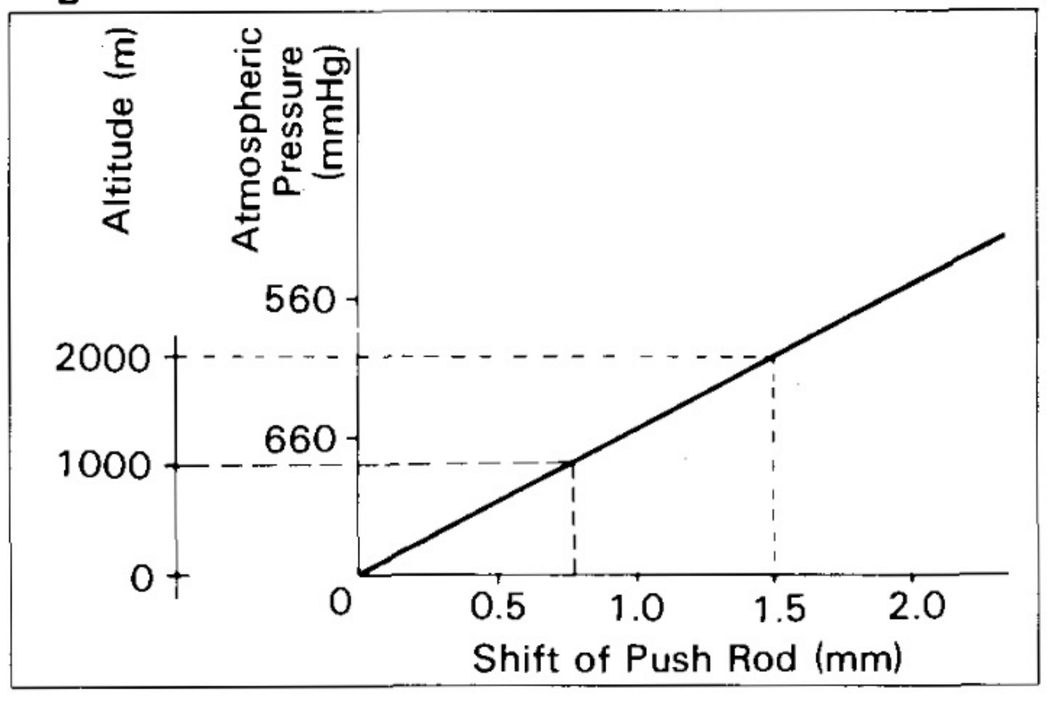


Diesel High Altitude Compensator (DHAC)

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. 6-139

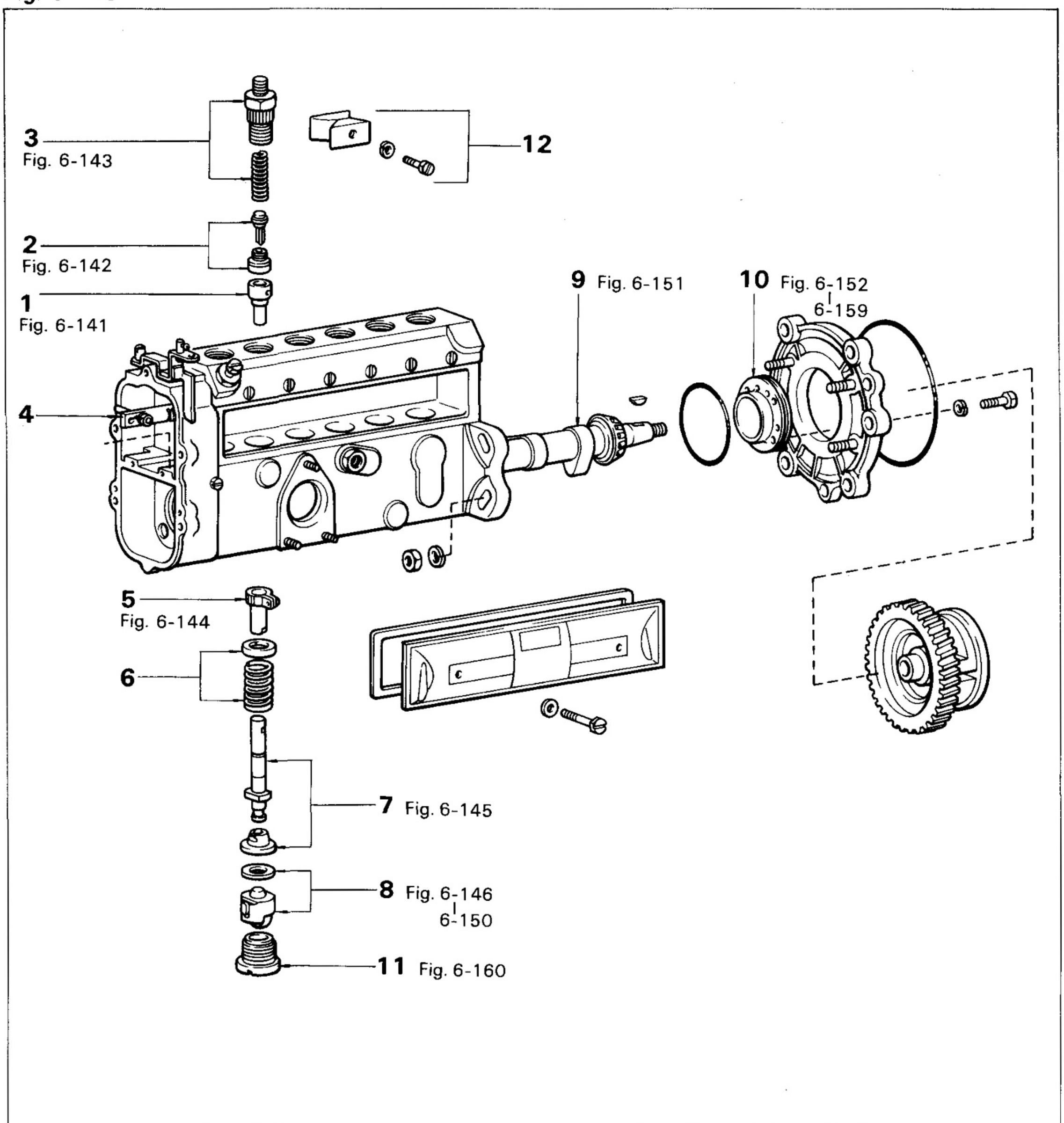


2. Since the position of the push rod depends on altitude, the clearance mentioned above must be 0.1—0.3 mm (0.004—0.012 in.) plus the amount of push rod shift as shown in the figure.

ASSEMBLY (PUMP BODY)

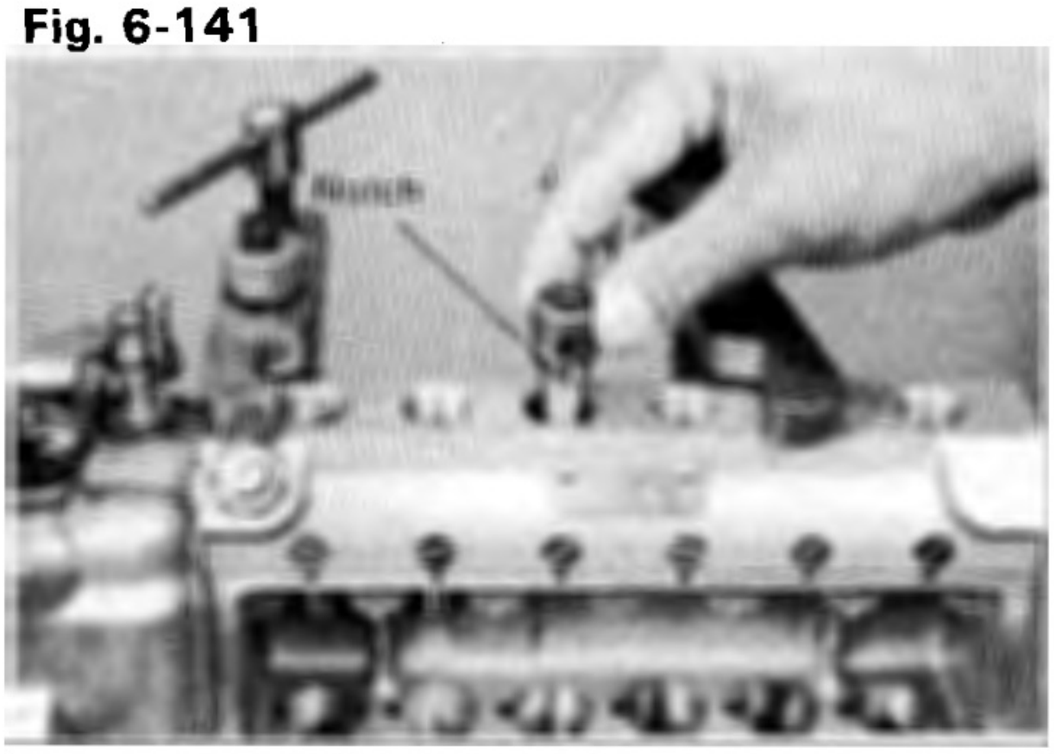
Assemble the parts in the numerical order shown in the figure.

Fig. 6-140



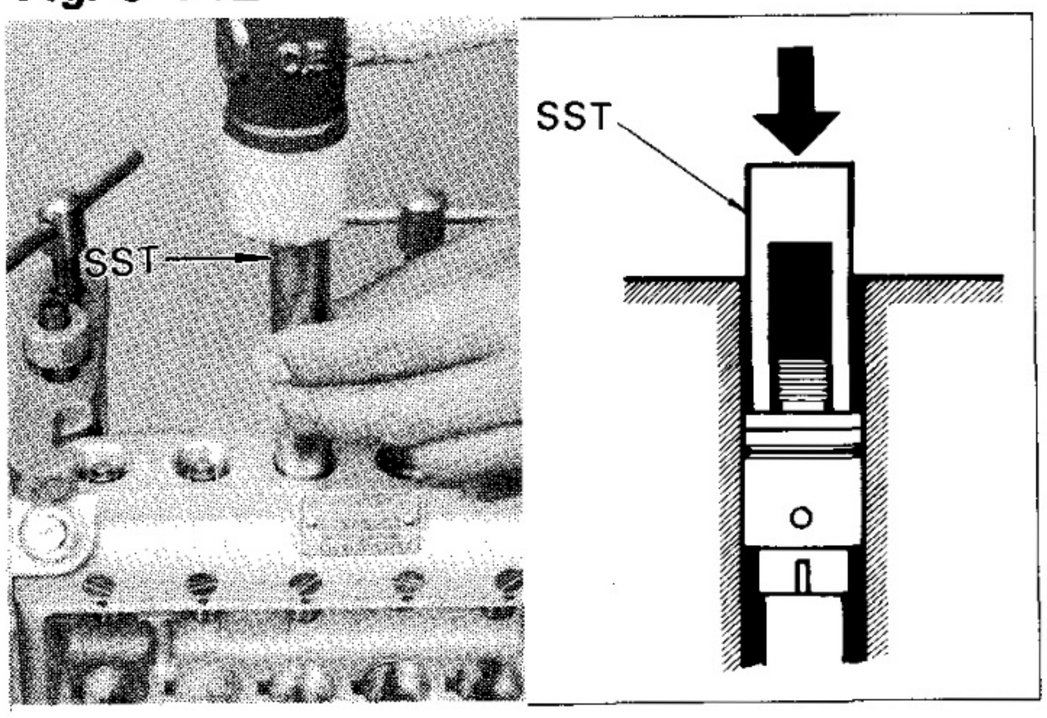
1. Cylinder
2. Delivery Valve & Seat
3. Delivery Valve Holder & Spring
4. Control Rack
5. Control Pinion & Sleeve
6. Spring & Upper Seat
7. Plunger & Lower Seat
8. Tappet
9. Camshaft
10. Bearing Cover
11. Plug
12. Lock Plate

Fig. 6-141



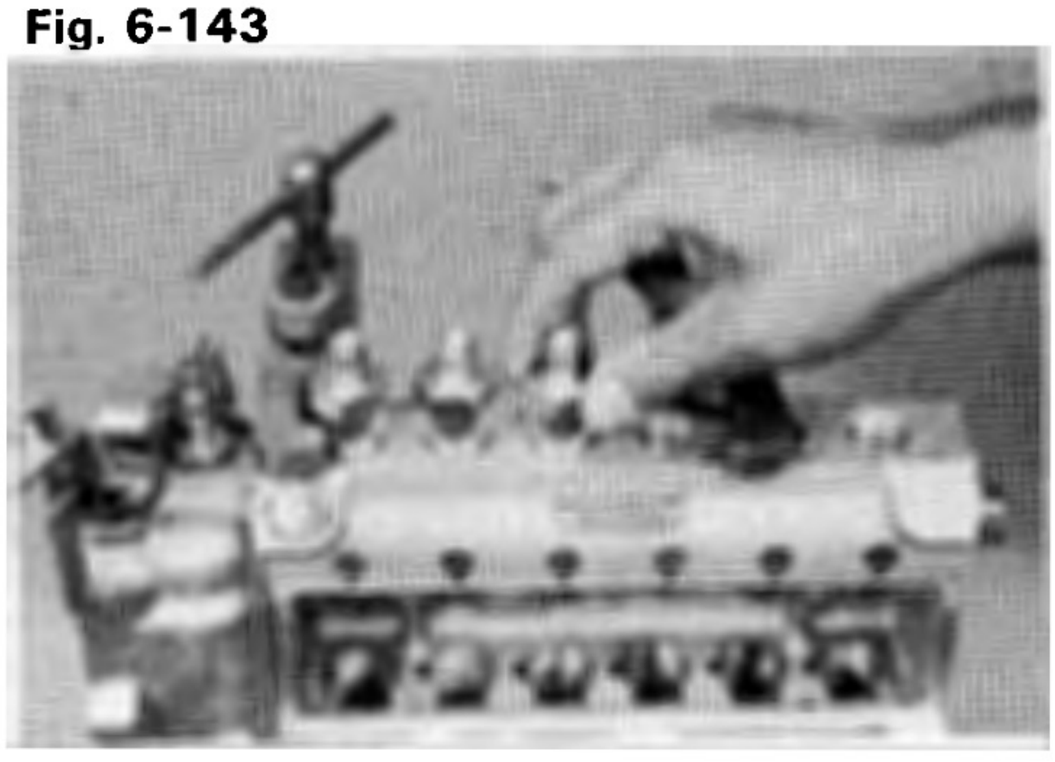
To assemble the cylinder, match the pump cylinder notch with the pump housing knock pin.

Fig. 6-142



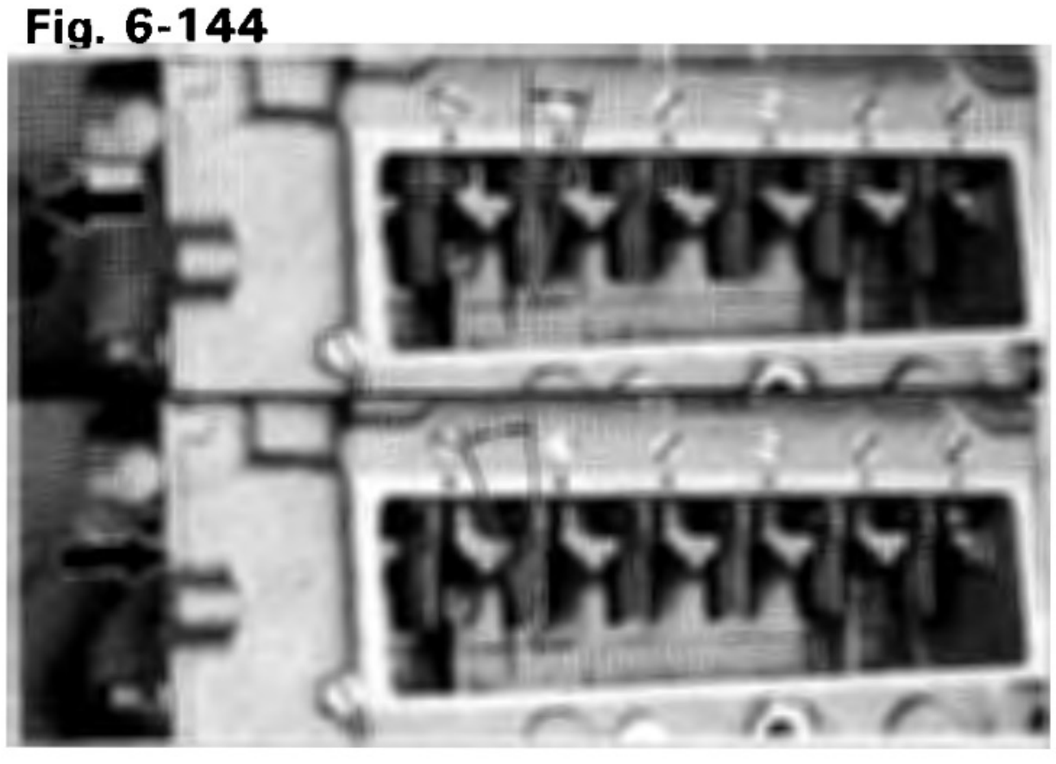
Drive in the pump cylinder lightly with SST.
SST (09262-76010) of set [09260-76016]

Fig. 6-143



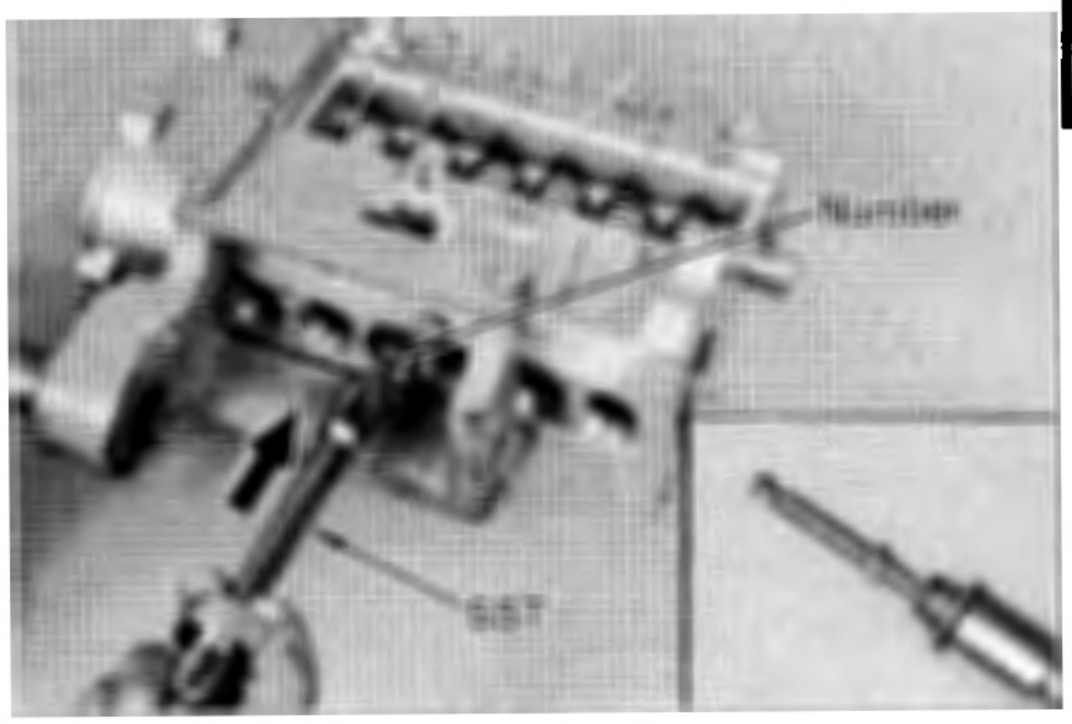
Lightly tighten the delivery valve holder by hand.

Fig. 6-144



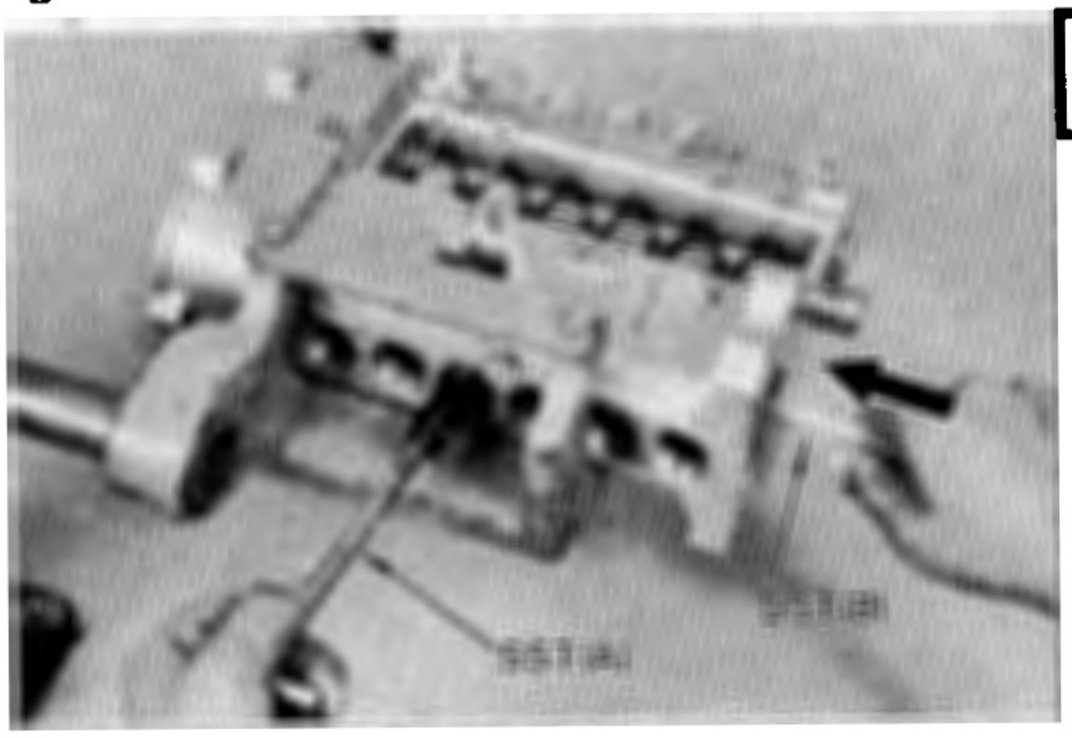
Assemble so that the pinion swings evenly left and right when the rack is moved to the right and left.
When assembling the sleeves, inspect the fitting by moving the rack.

Fig. 6-145



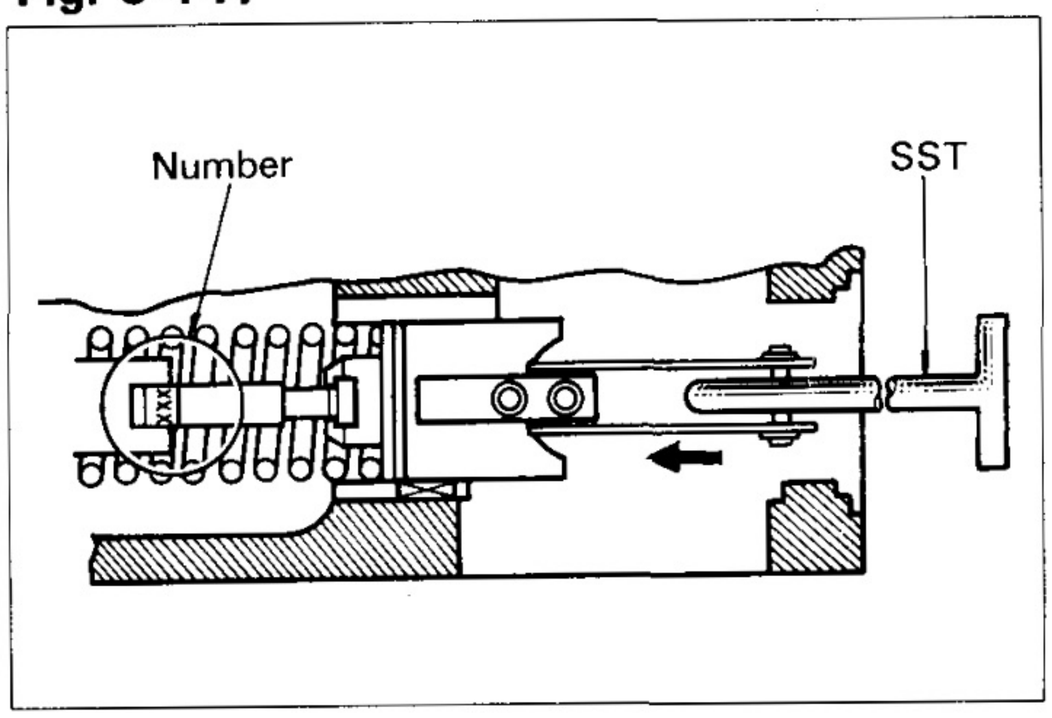
Using SST, assemble the plunger and spring lower seat, inserting the driving face marked with a number and the lower seat notch part upward (cover plate side).
SST (09275-46010) of set [09260-46011]

Fig. 6-146



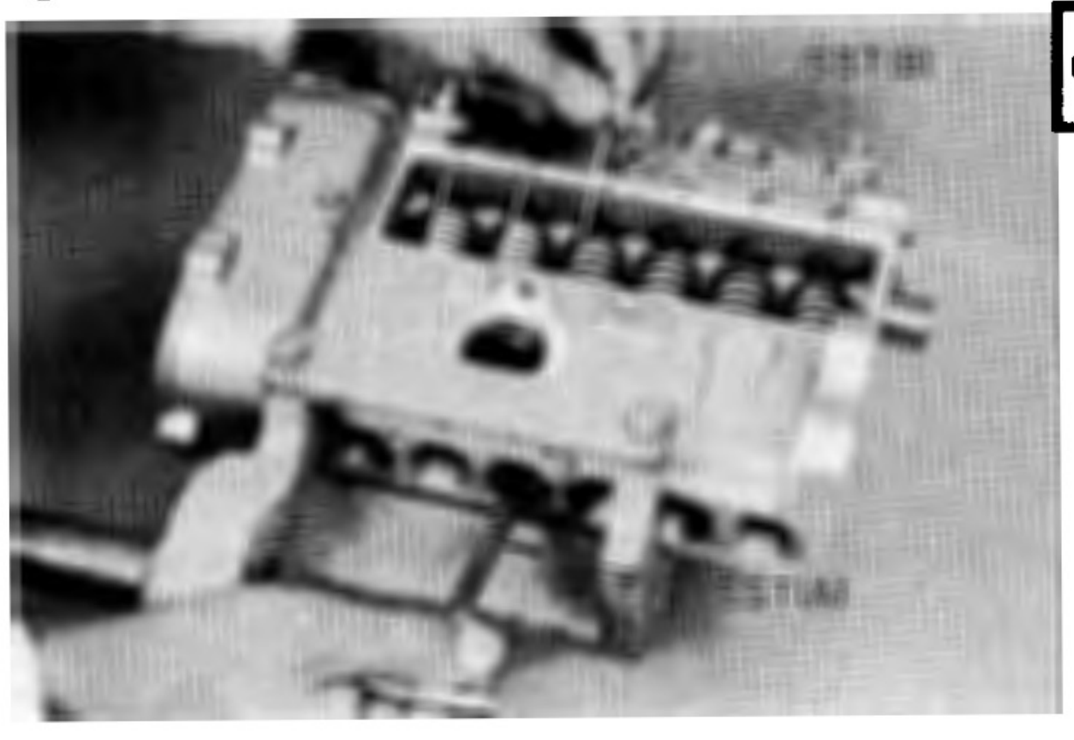
Insert the tappet into the housing with SST (A) and (B).
SST (A) (09273-76011) &
(B) (09272-76011) of set [09260-76016]

Fig. 6-147



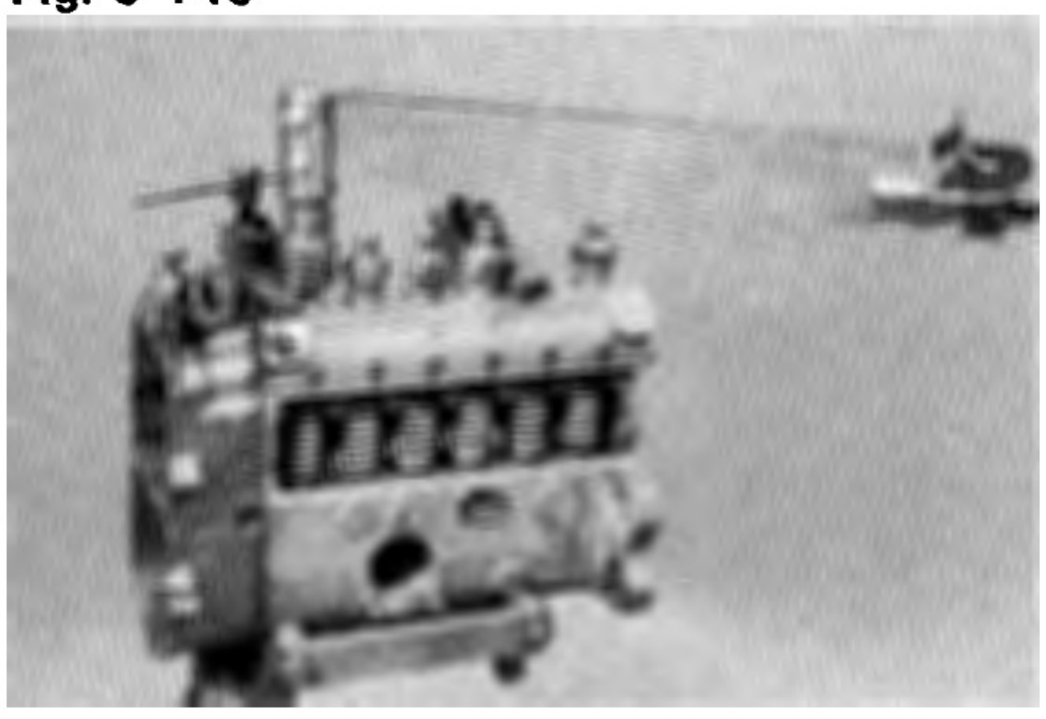
Fit the driving face into the cylinder groove, facing its number toward pump cover side.

Fig. 6-148



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]

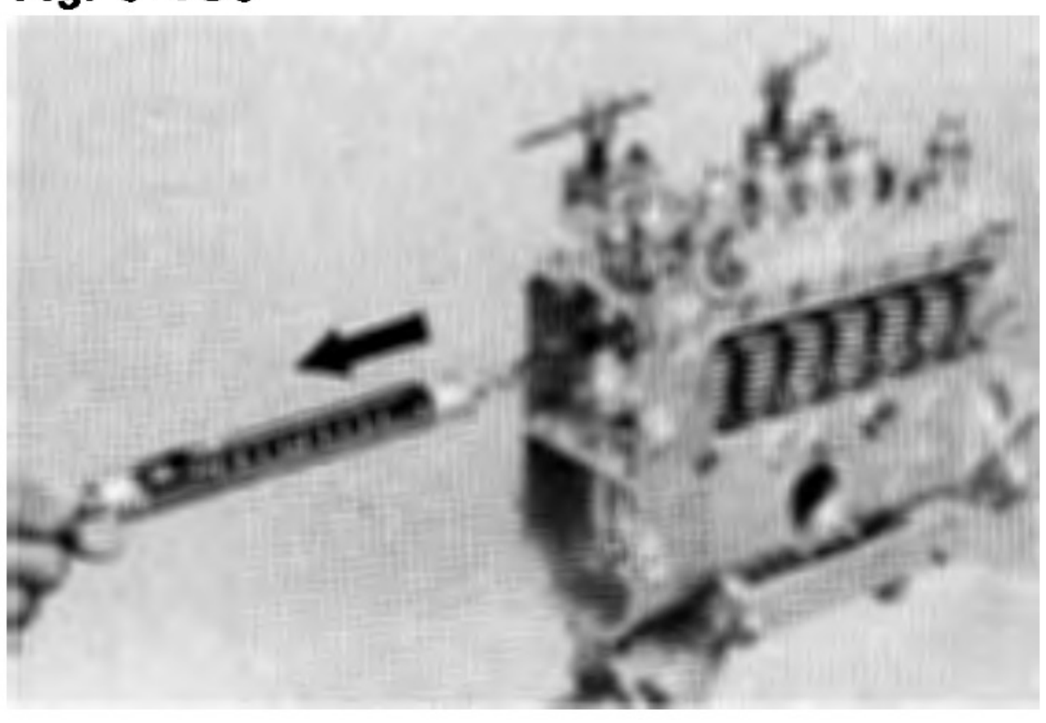
Fig. 6-149



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)

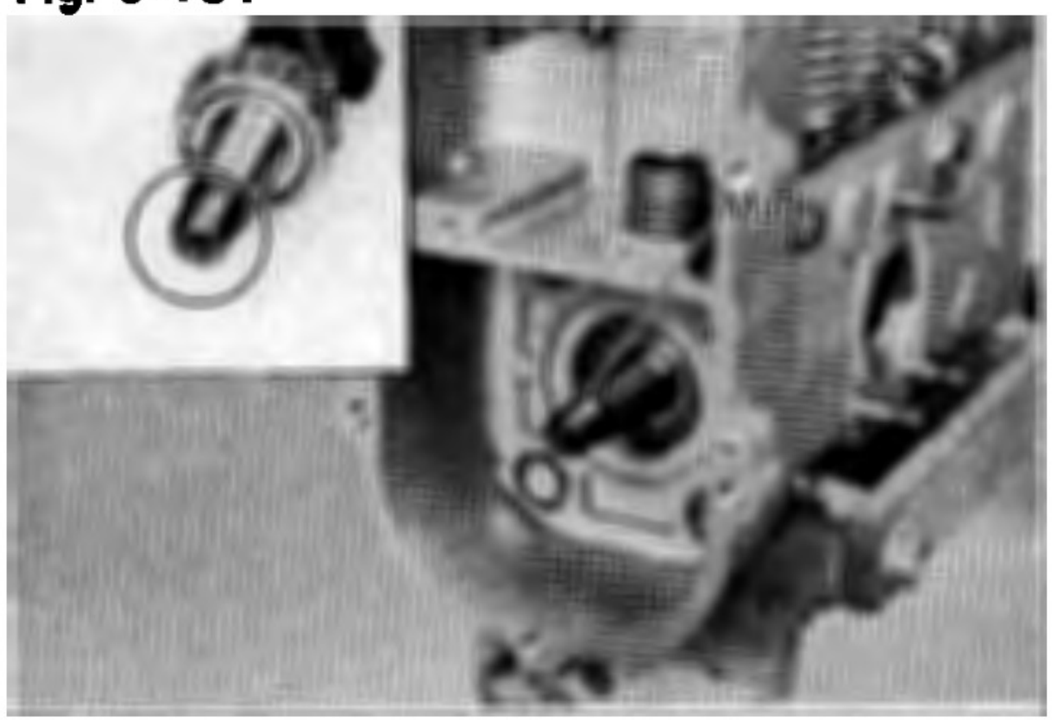
Fig. 6-150



Measure the control rack sliding resistance with a spring scale. The rack should move smoothly.

Sliding resistance:
Less than 120g (4.2 oz)

Fig. 6-151



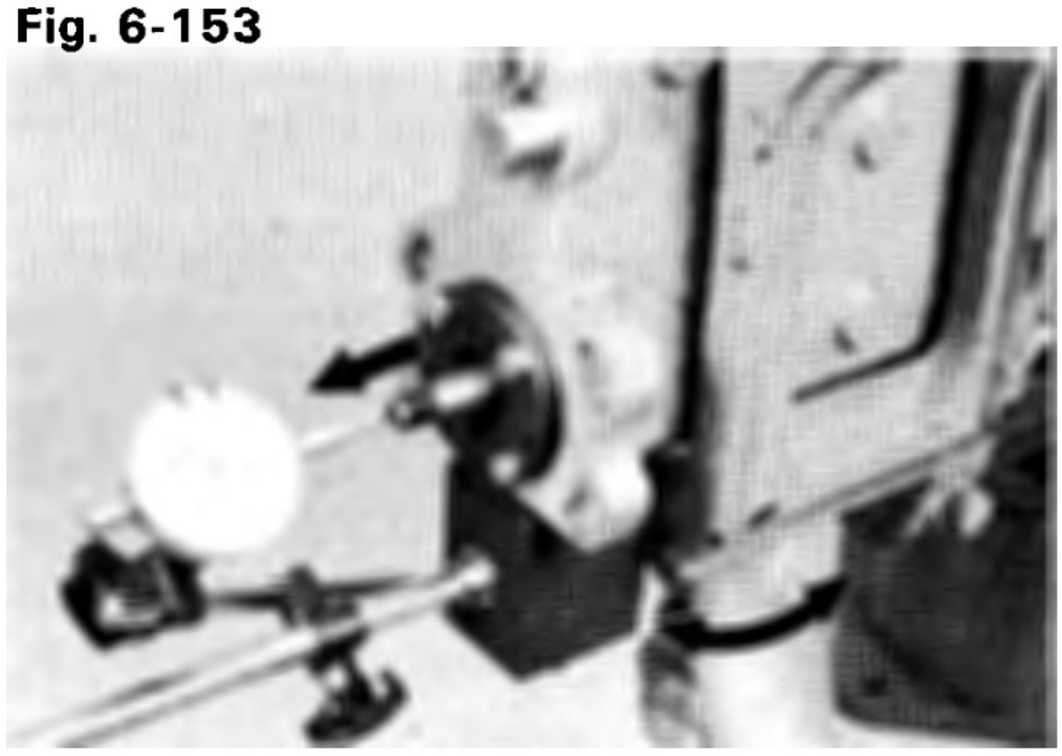
Assemble the camshaft, facing the mark toward the rear.

Fig. 6-152



Drive the bearing cover into the pump body by tapping lightly with plastic hammer.

Fig. 6-153



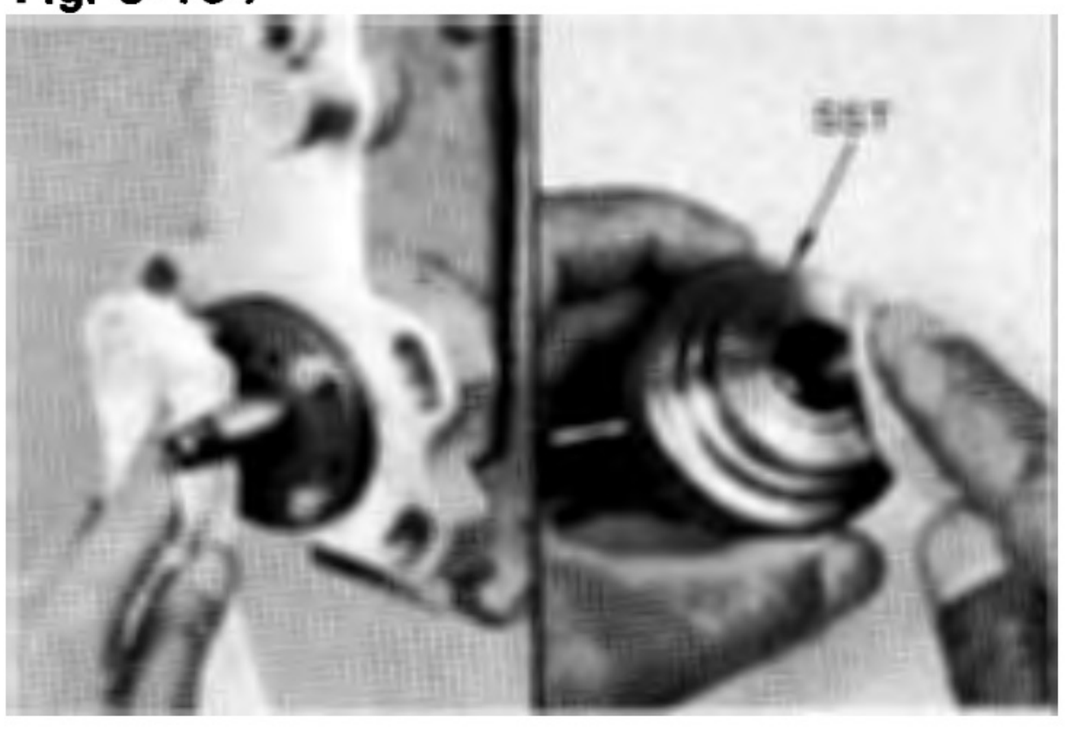
Measure Camshaft Thrust Clearance. [When dial gauge is used]

1. Set the magnetic base on the injection pump flange and contact the dial gauge to the end of the 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.)**

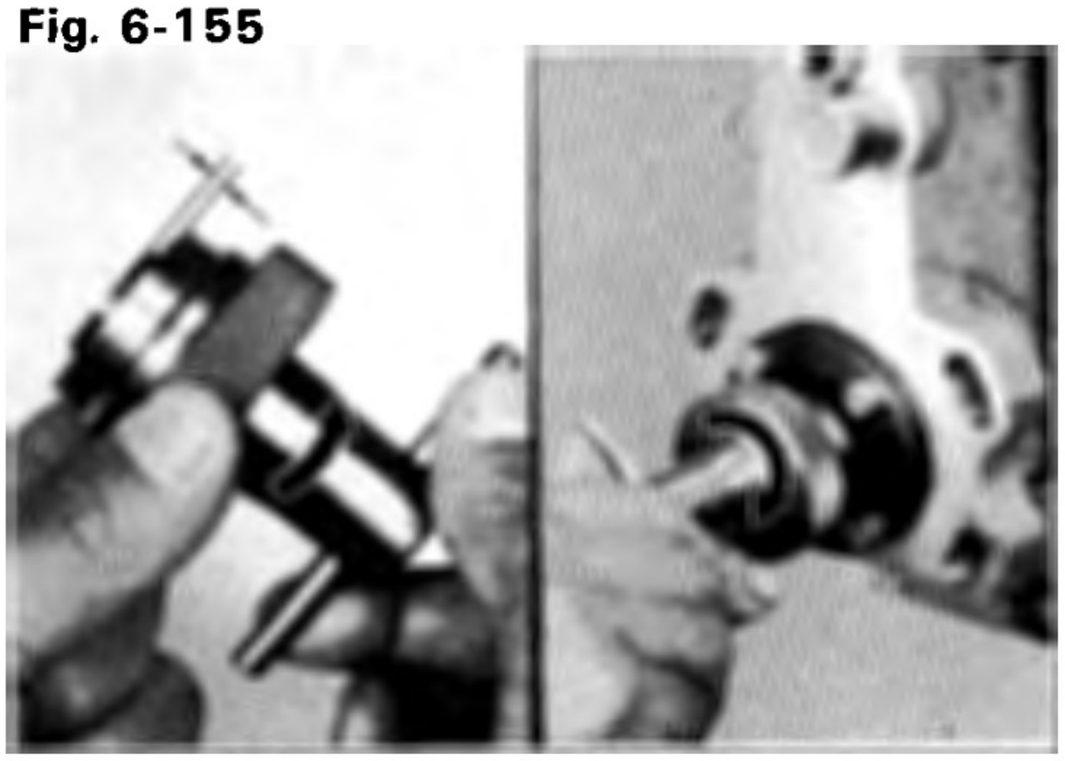
Fig. 6-154



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

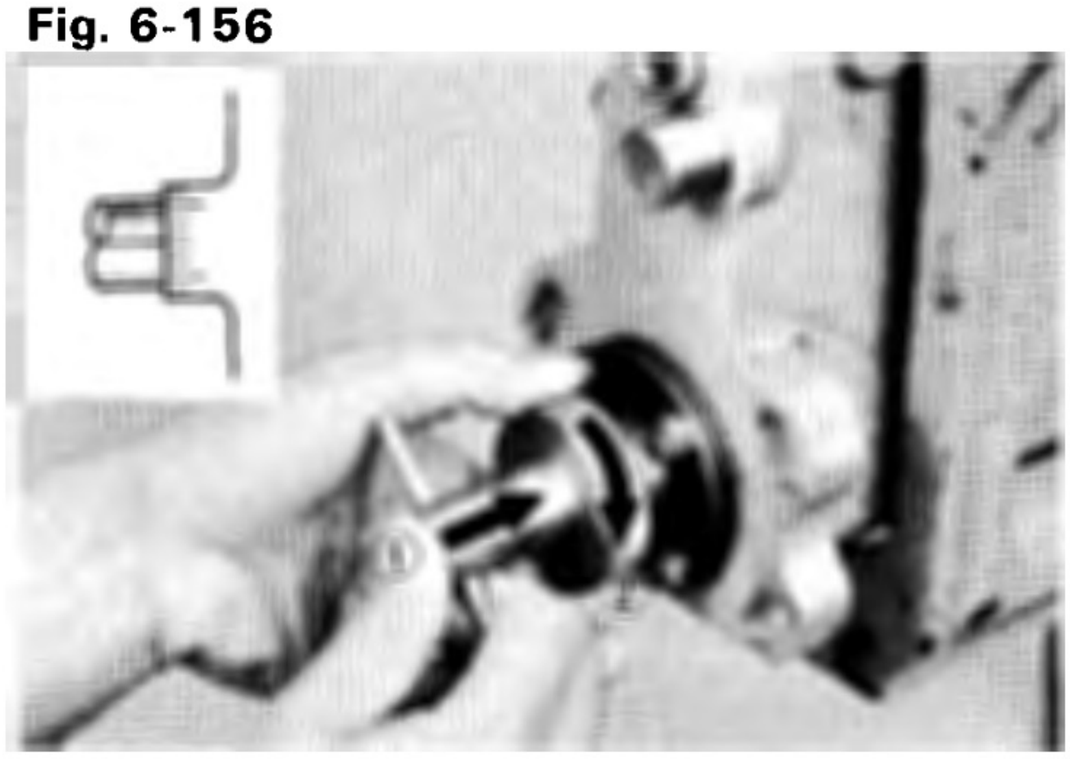
1. Clean the bearing cover and SST.

Fig. 6-155



2. Firmly install SST to the camshaft.

Fig. 6-156

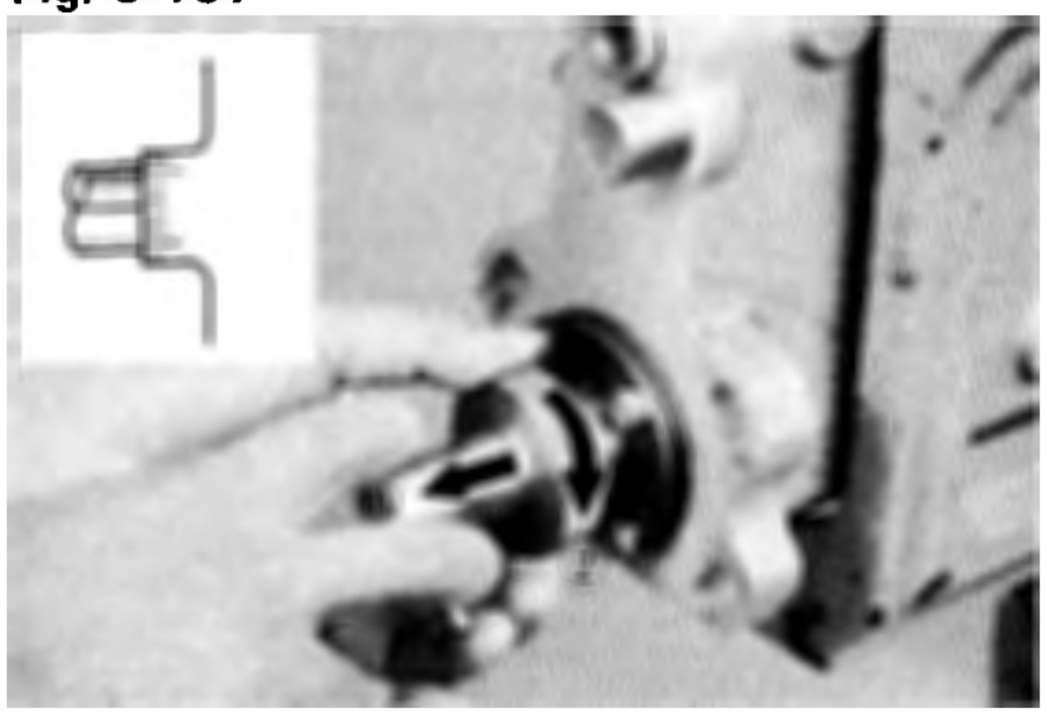


3. Push SST toward the pump side, and contact the outer dial with the bearing cover by screwing in the outer dial.
4. Read the scale on the outer dial.

– Note –

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

Fig. 6-157

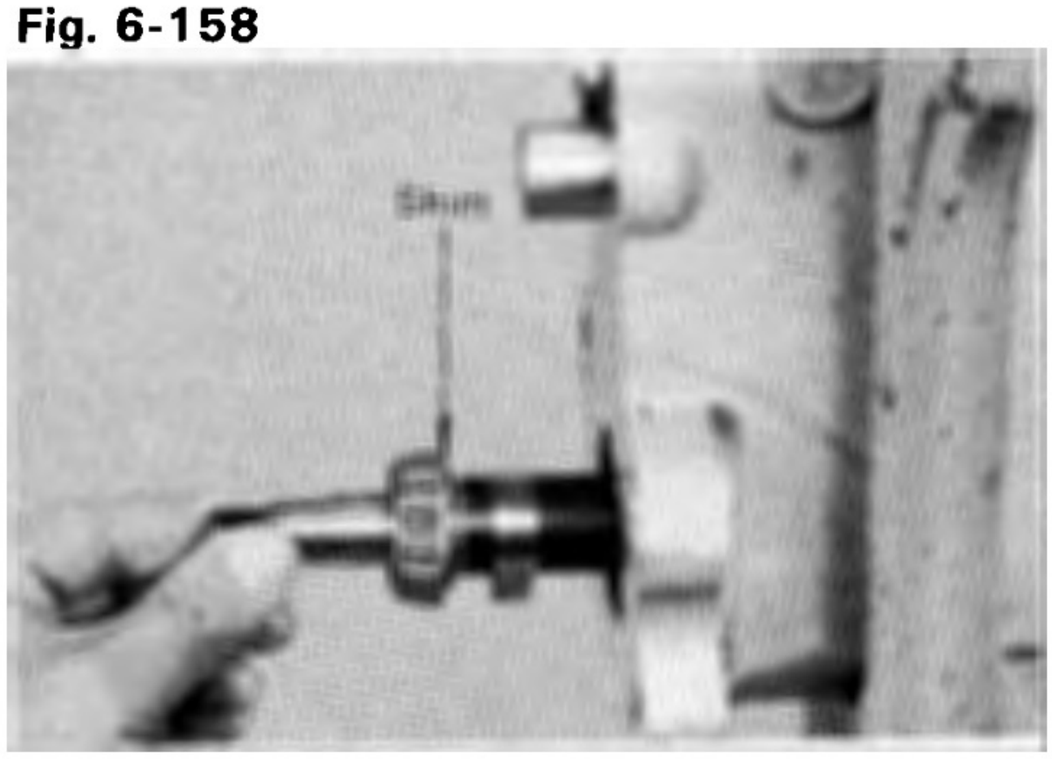


5. Pull SST toward the front, and contact the outer dial with the bearing cover by screwing in the outer dial.
6. The screwing distance is the camshaft thrust clearance.

Thrust clearance:

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

Fig. 6-158



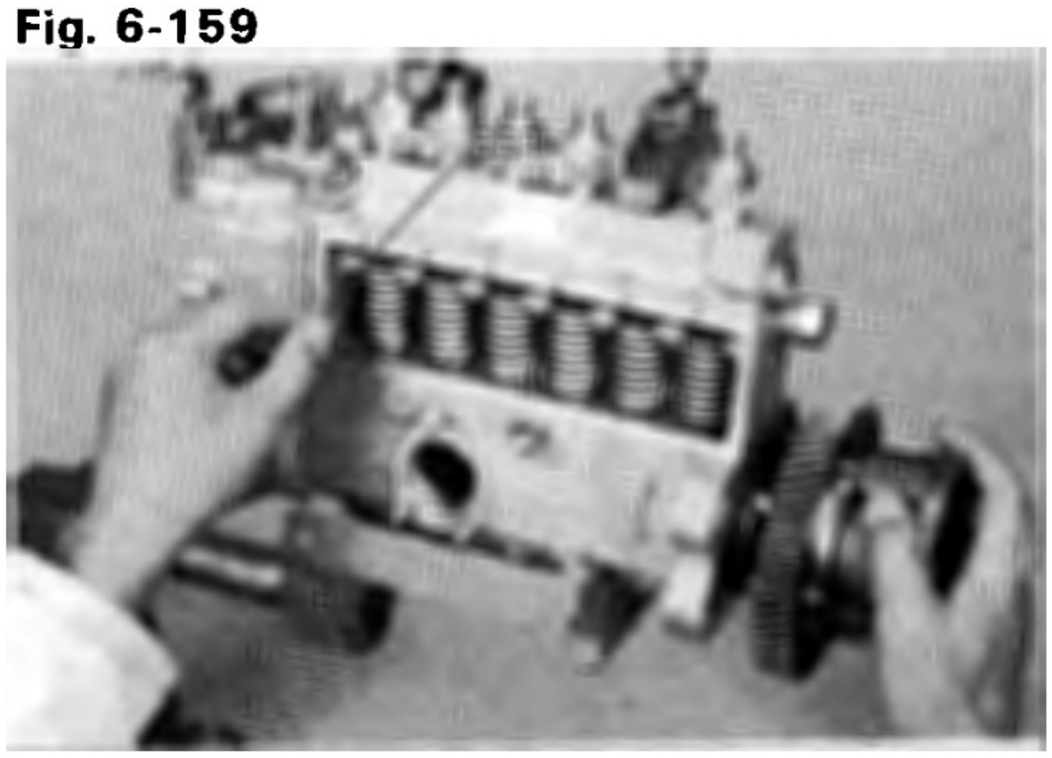
To adjust the thrust clearance, increase or decrease the number of camshaft adjusting shims.

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

— Note —

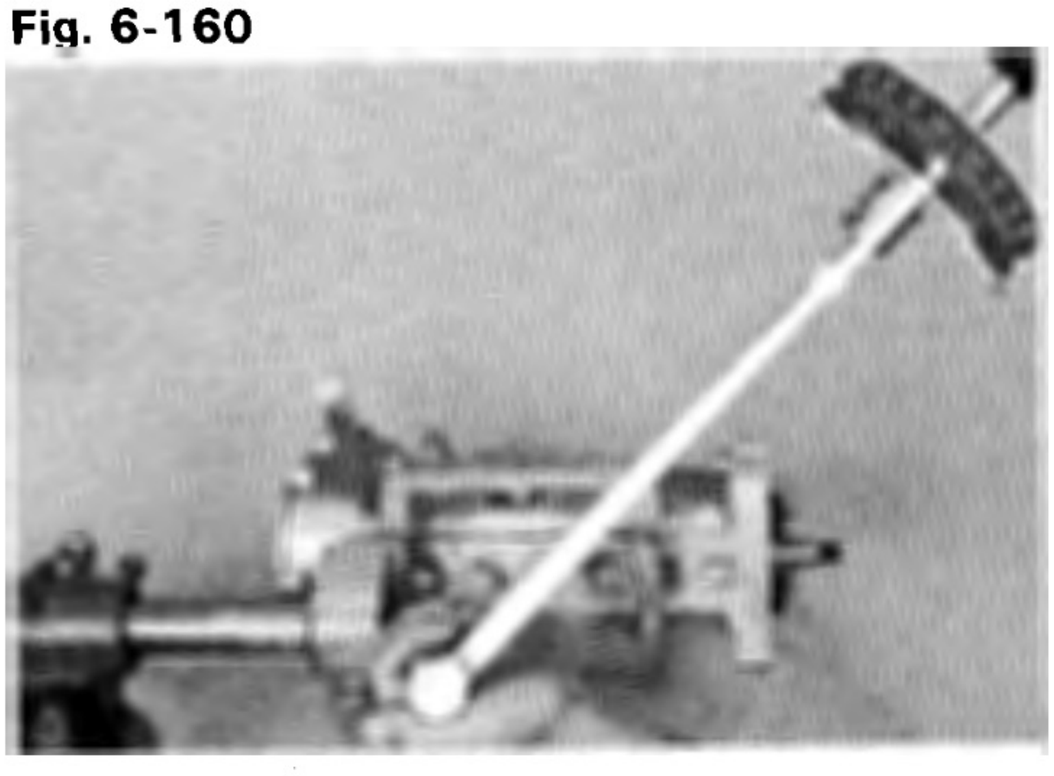
Refer to "Replace Camshaft Bearing" on Fig. 6-128 to 6-130 for replacement of adjusting shim.

Fig. 6-159



After setting the automatic timer on the camshaft, rotate the camshaft and remove SST.

Fig. 6-160



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 4SD24	
Nozzle	Opening pressure	115 – 125 kg/cm^2	(1,636 – 1,778 psi)
Injection pipe	Outer diameter	6.0 mm	(0.24 in.)
	Inner diameter	2.0 mm	(0.08 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/cm^2	(7.1 psi)

Control Rack Sliding Resistance

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

Injection Timing

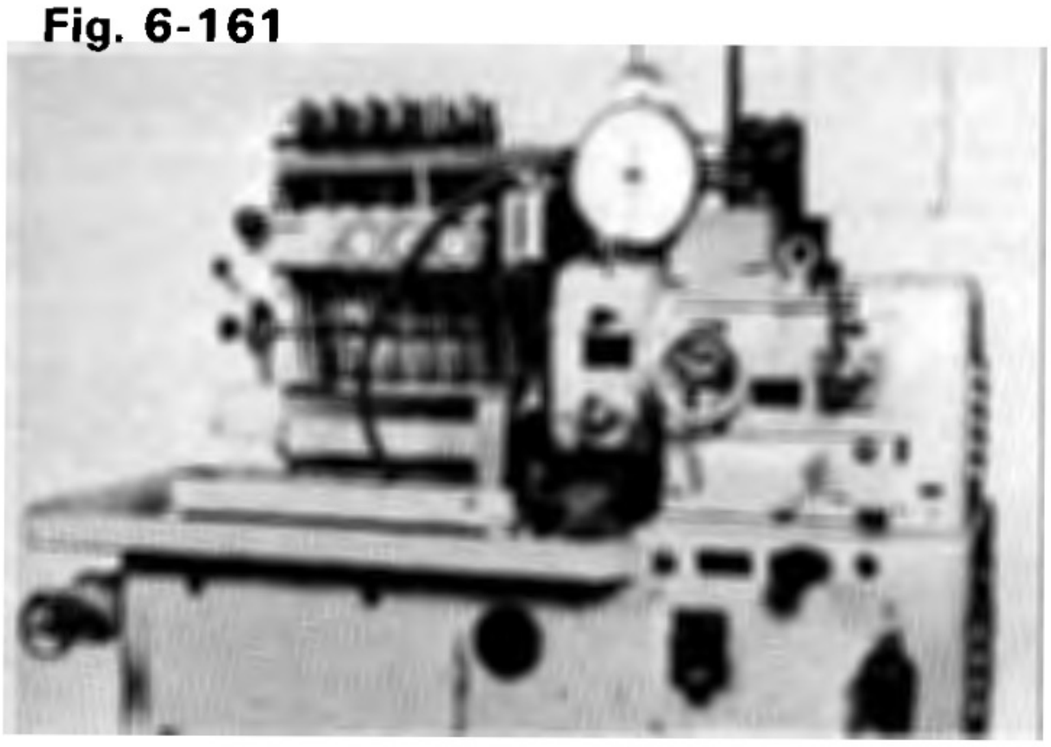
Pre-stroke	1.9—2.0 mm (0.075—0.079 in.) [Control rack position at 11.0 mm (0.433 in.)]
Injection interval	60° ± 30′
Tappet clearance	More than 0.2 mm (0.008 in.)

Injection Volume Adjustment

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	9.0—10.4 (0.55—0.63) * 9.6—11.6 (0.59—0.71)	1.2 (0.07)
10.8 (0.425)	1,100	200	8.7—9.3 (0.53—0.57)	0.4 (0.02)
10.8 (0.425)	1,700	200	9.1—10.1 (0.56—0.62)	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)

* For Arctic Regions

Fig. 6-161

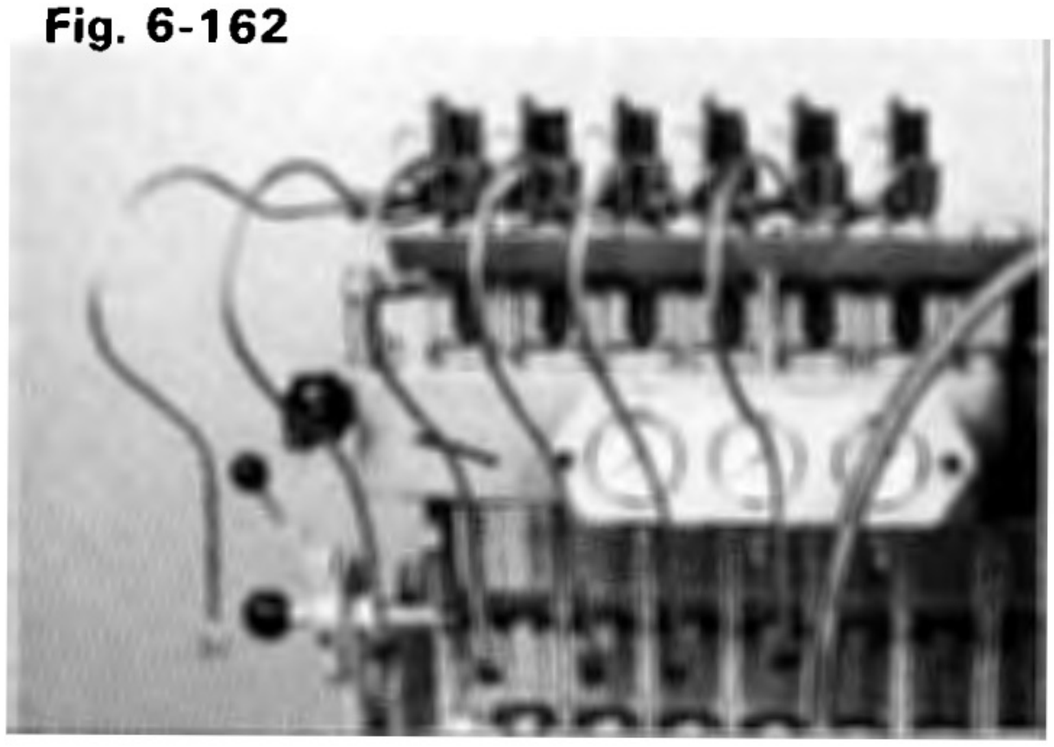


Pre-test Check & Preparations

1. Specifications for test nozzle and nozzle holder are as follows:

   Nozzle type: ND-DN4 SD24
   Nozzle holder valve opening pressure:
   115 – 125 kg/cm² (1,636 – 1,778 psi)

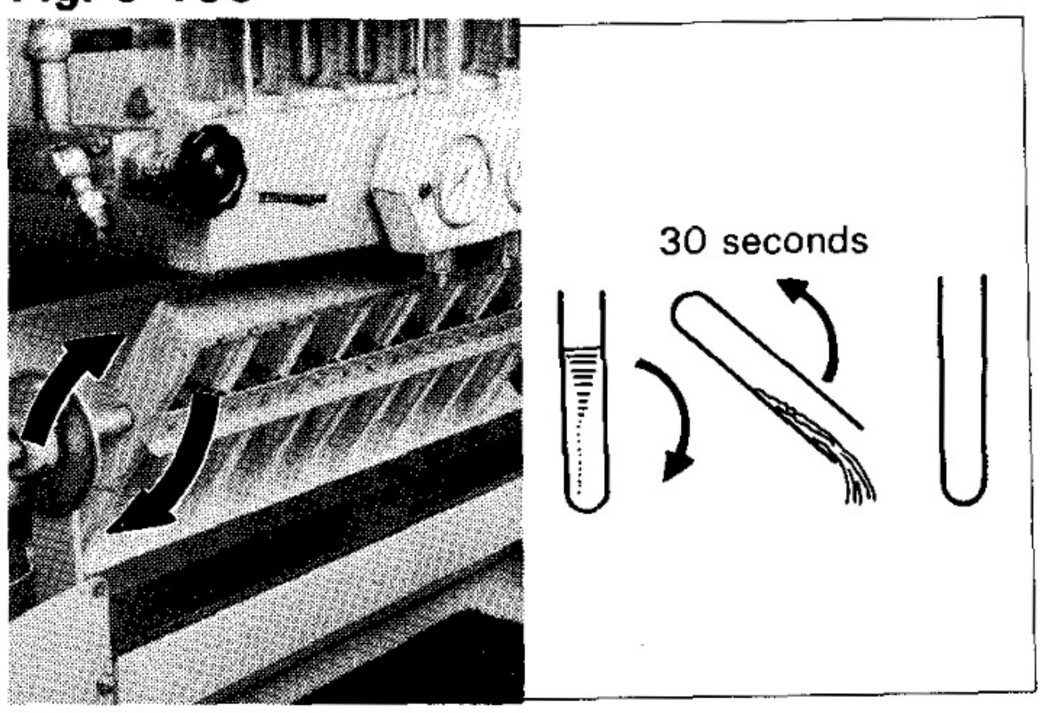
Fig. 6-162



2. Use injection pipes with the following specifications.

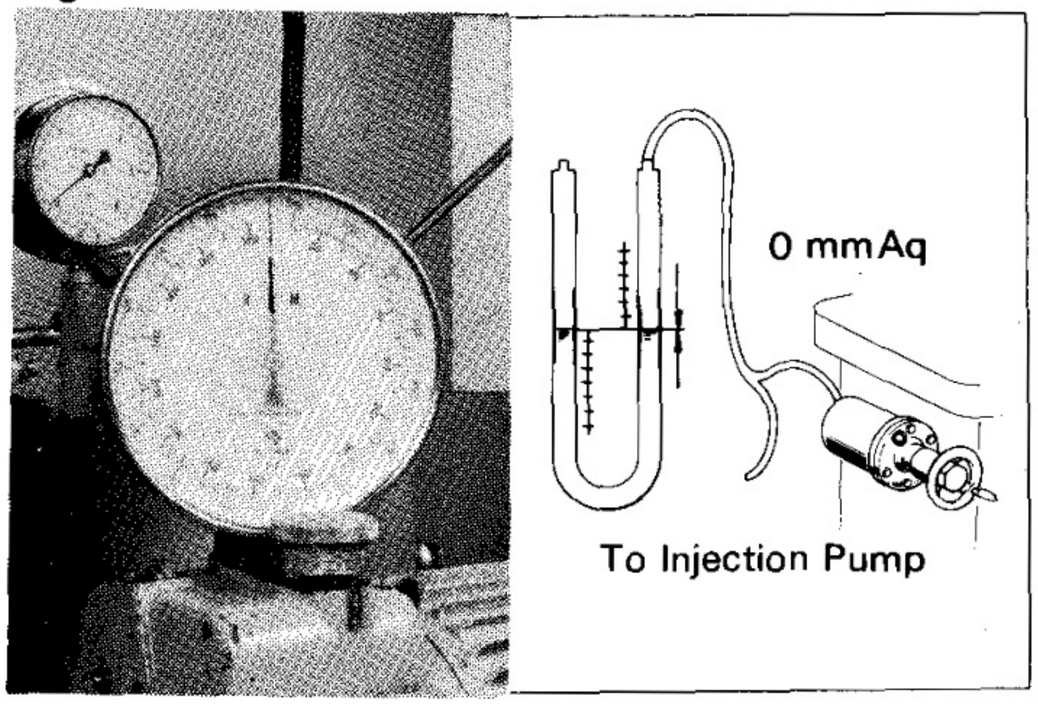
   Outer diameter: 6.0 mm (0.236 in.)
   Inner diameter: 2.0 mm (0.079 in.)
   Length: 600 mm (23.62 in.)
   Minimum bending radius: More than 25 mm (0.98 in.)

Fig. 6-163



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. 6-164

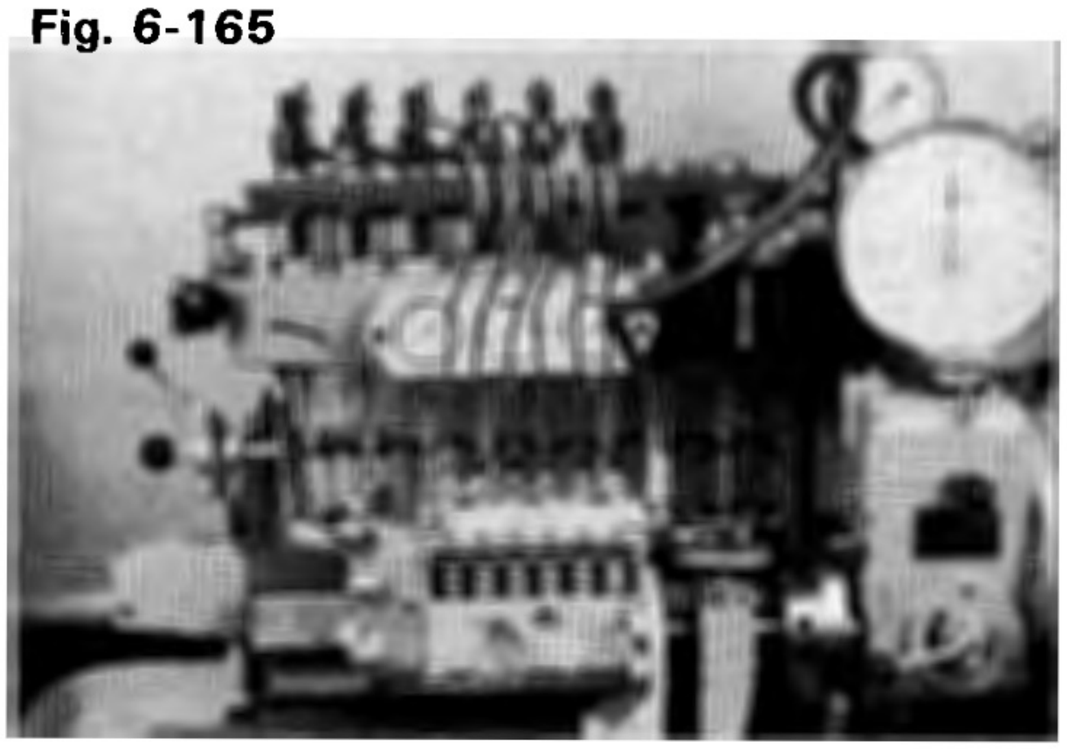


5. Check tachometer accuracy.

   Allowable error: ± 40 rpm

6. Confirm that both water columus of U tube are of the same height, and align the zero point on the scale at that height.

Fig. 6-165



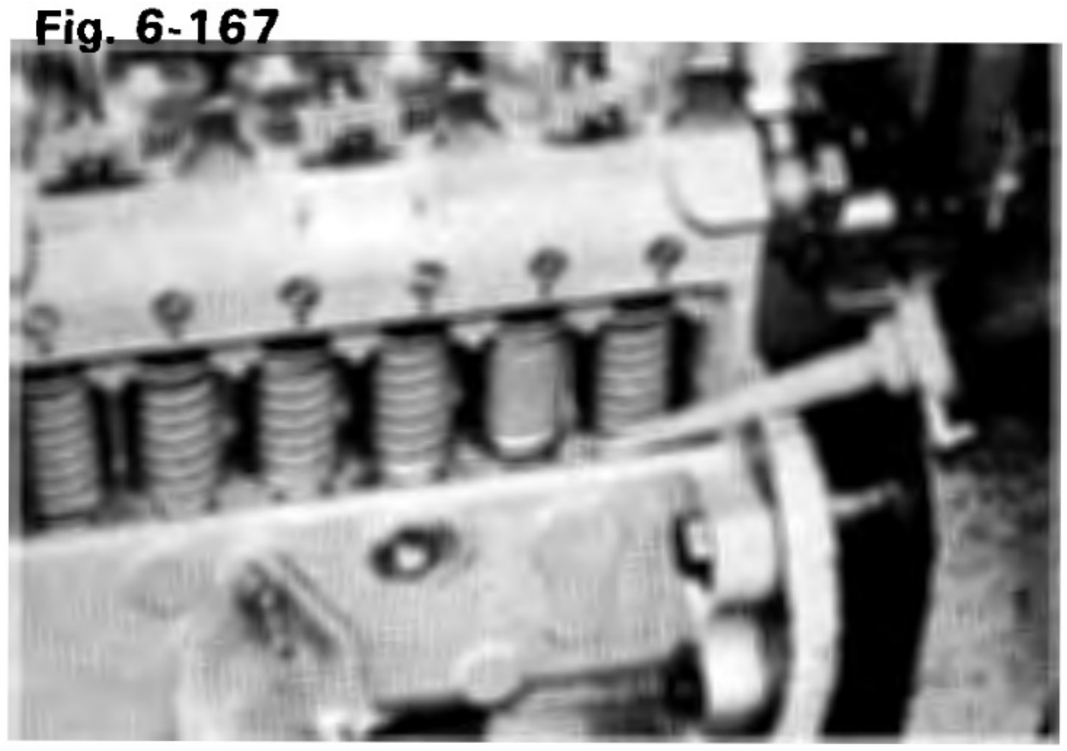
7. Mount the injection pump body on the pump tester.

Fig. 6-166



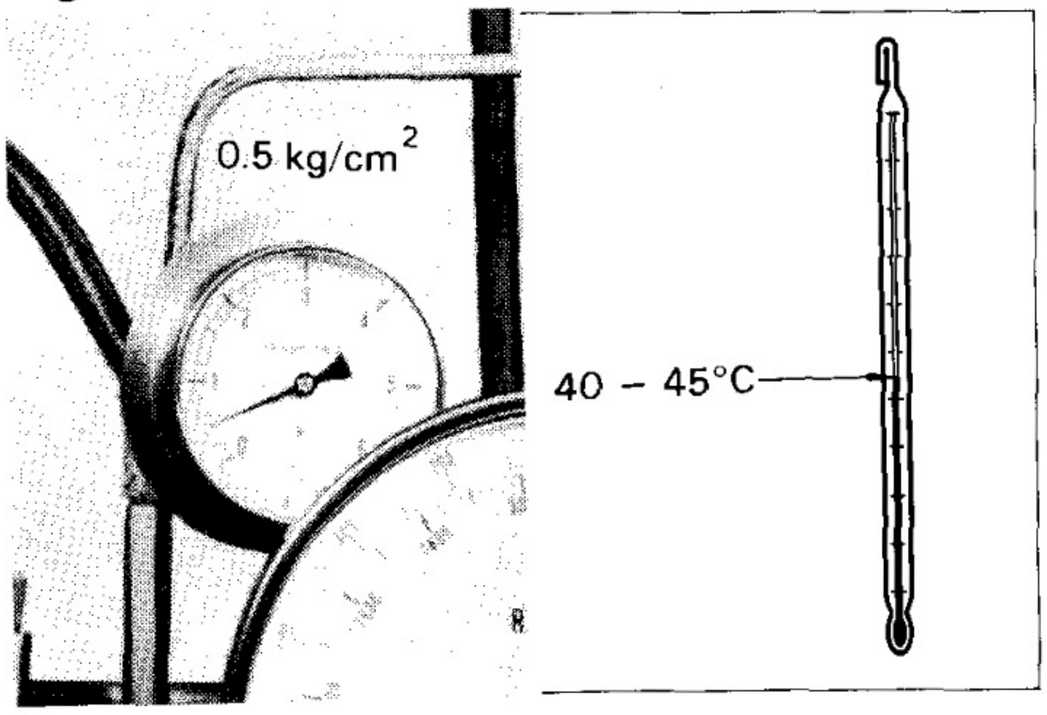
⚠ 8. Install the rack scale so that its zero point will be at the position where the control rack is pushed fully toward the governor side, and set to allow easy reading of the scale graduations.

Fig. 6-167



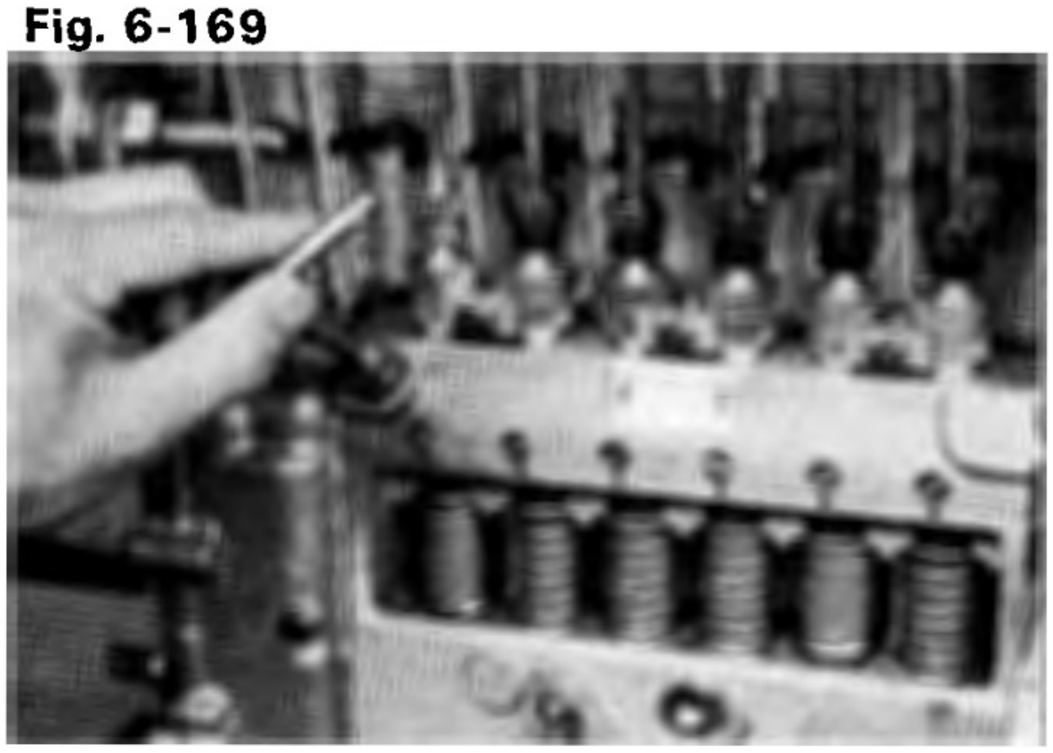
⚠ 9. Install the cover to the feed pump mounting surface, and fill the pump camshaft chamber with engine oil.

Fig. 6-168



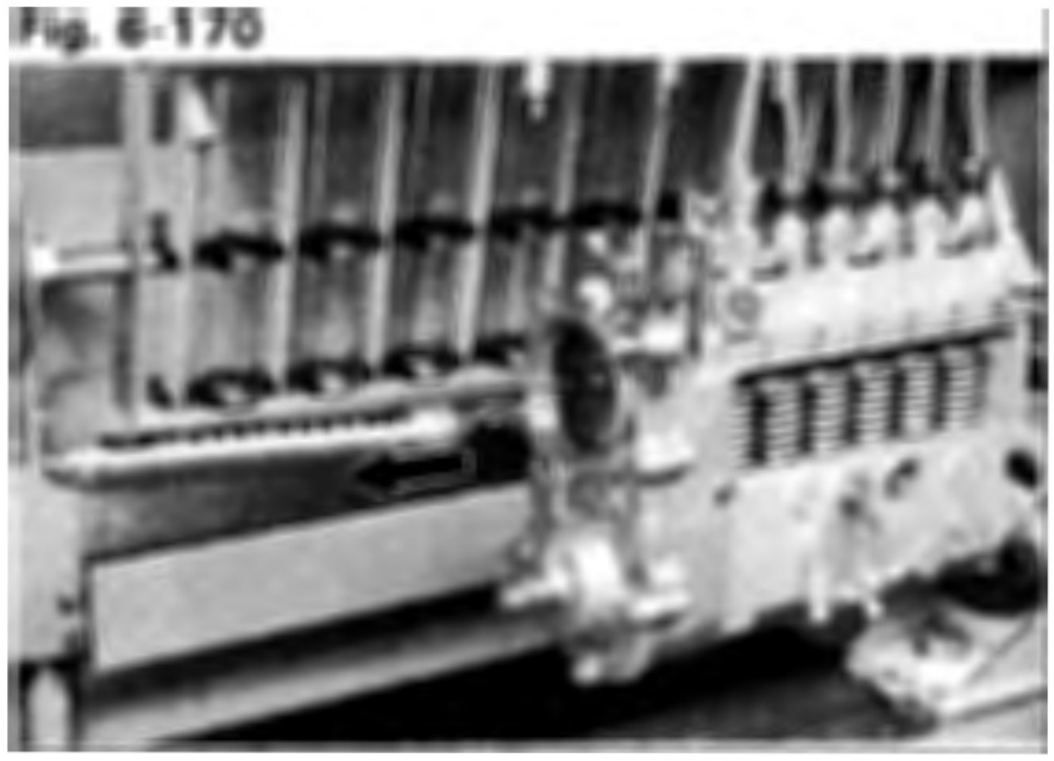
10. Fuel feeding pressure to the injection pump should be 0.5 kg/cm^2 (7.1 psi).
11. Fuel temperature for pump testing should be 40—45°C (104—113°F).

Fig. 6-169



12. Bleed air from pump housing.

Fig. 6-170

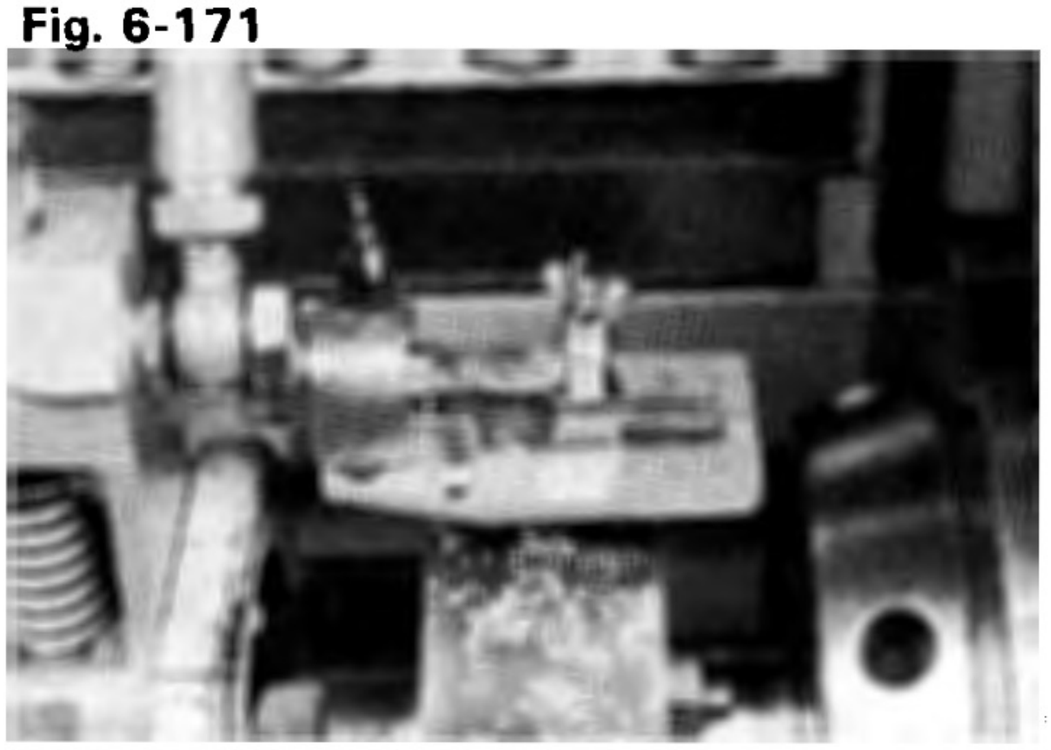


Control Rack Sliding Resistance

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

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

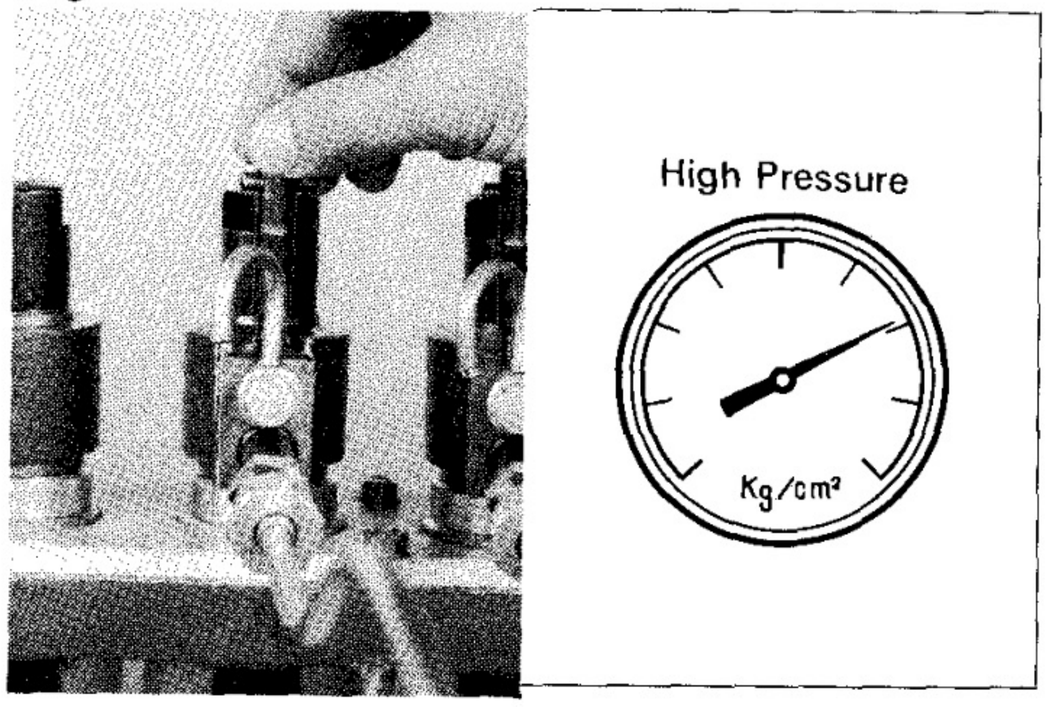
Fig. 6-171



Adjust Injection Timing

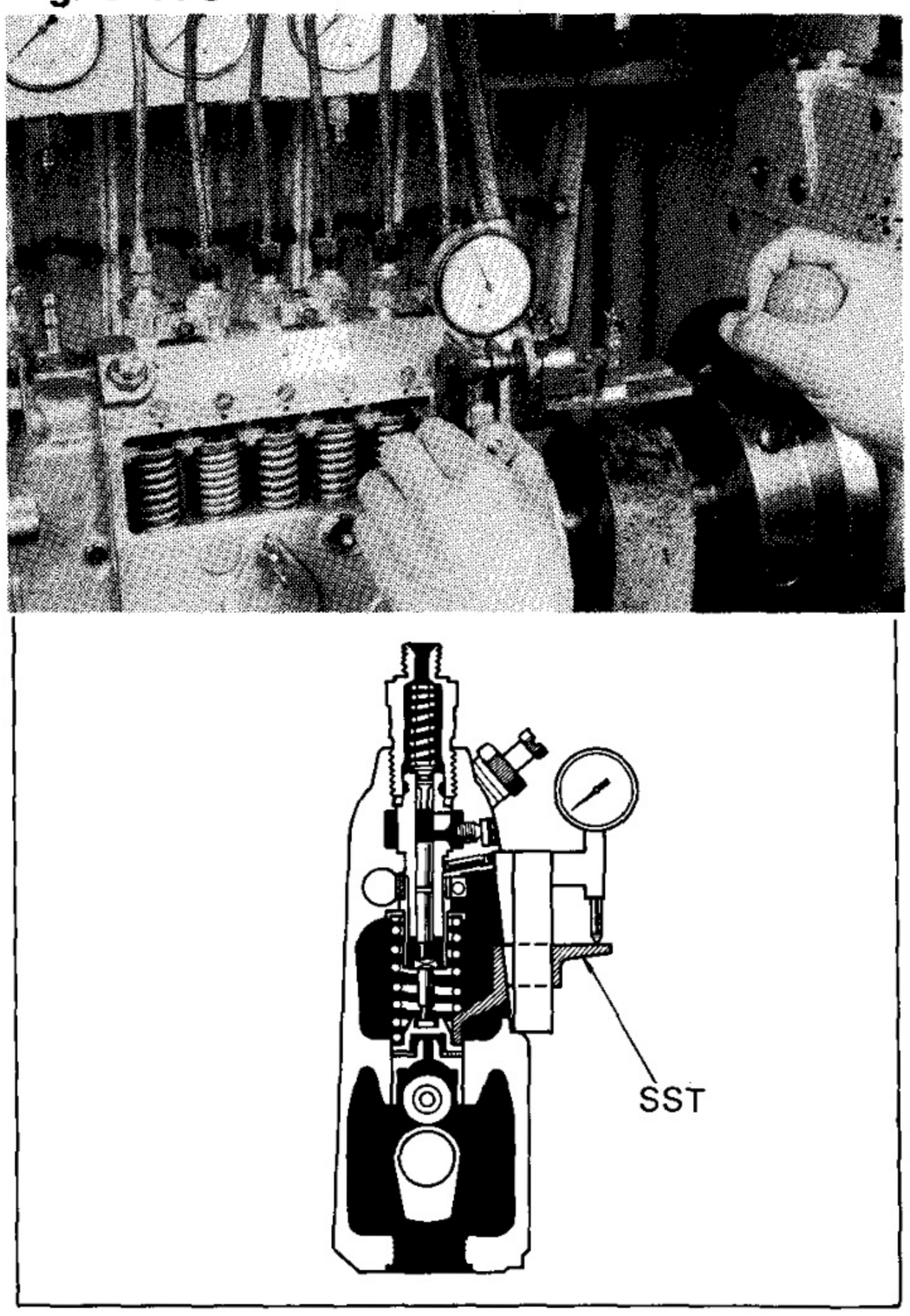
1. Pre-stroke (for No.1 plunger)
   (1) Set the control rack position at 8.0 mm (0.315 in.).

Fig. 6-172



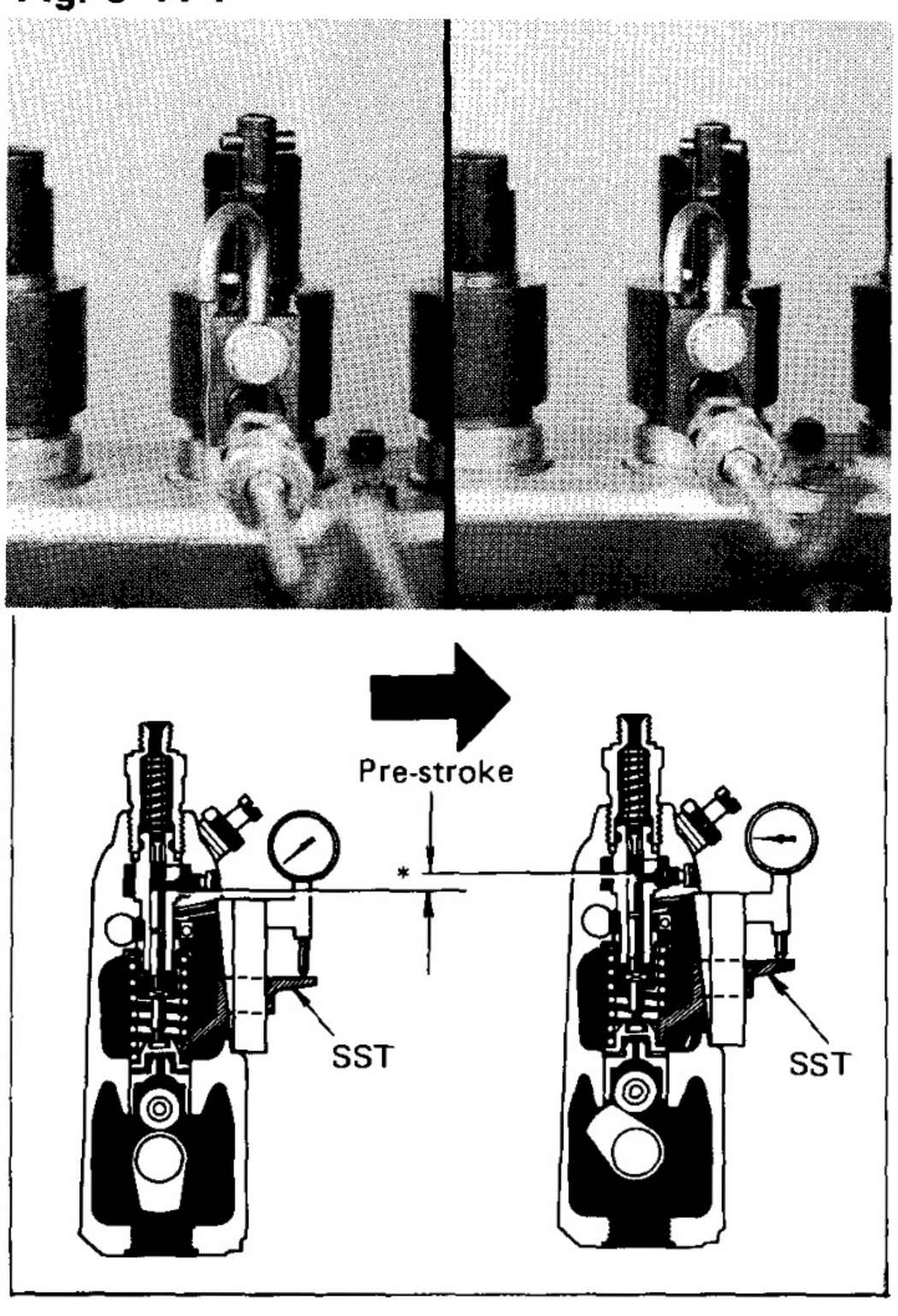
   (2) Loosen the overflow cock of the pump tester bench nozzle holder.
   (3) Fuel feeding pressure to the injection pump should be on the high side.

Fig. 6-173



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

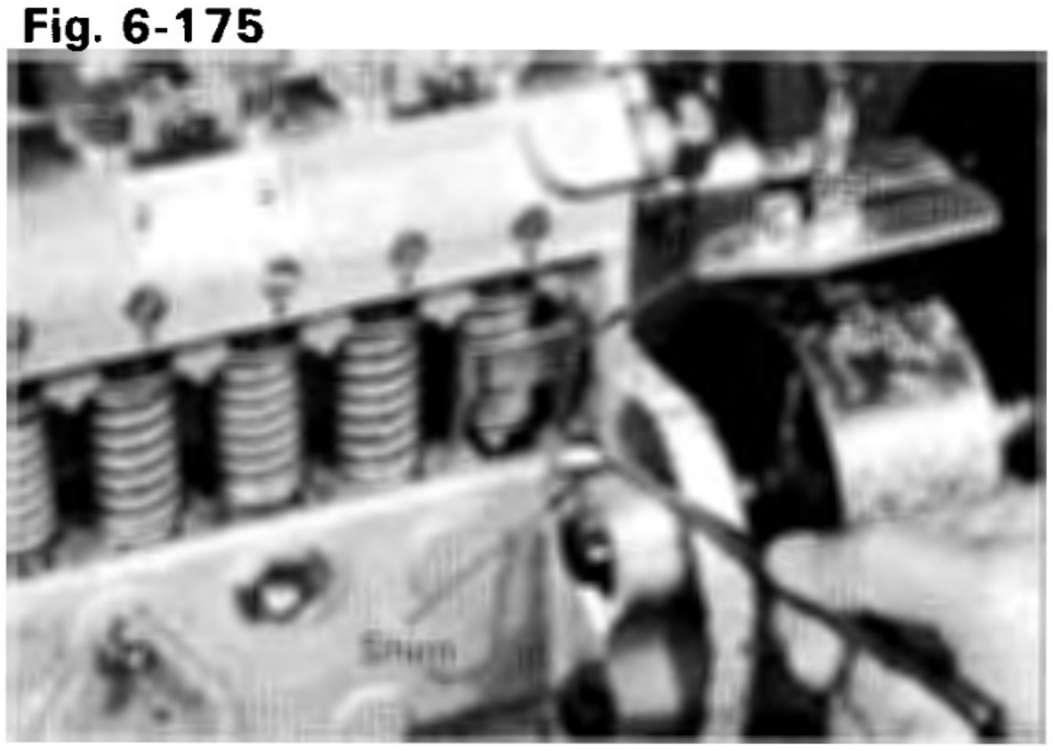
Fig. 6-174



(5) Rotate the camshaft clockwise, and measure the lift of the No.1 plunger when it 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.)

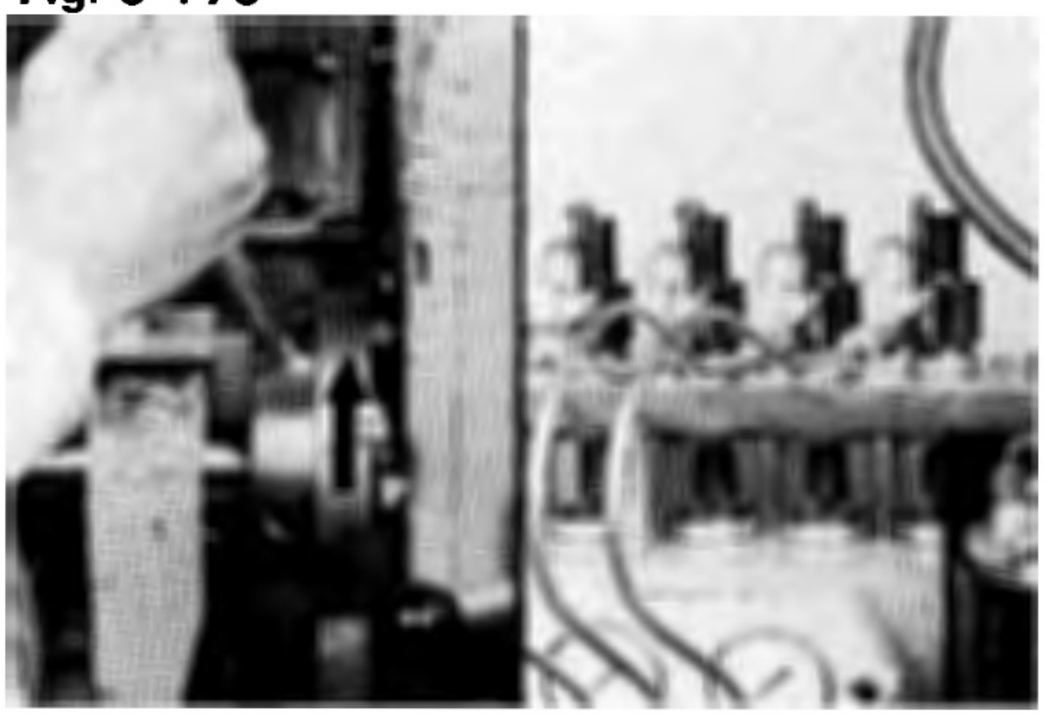
Fig. 6-175



(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 (0.0059 in.).

Fig. 6-176

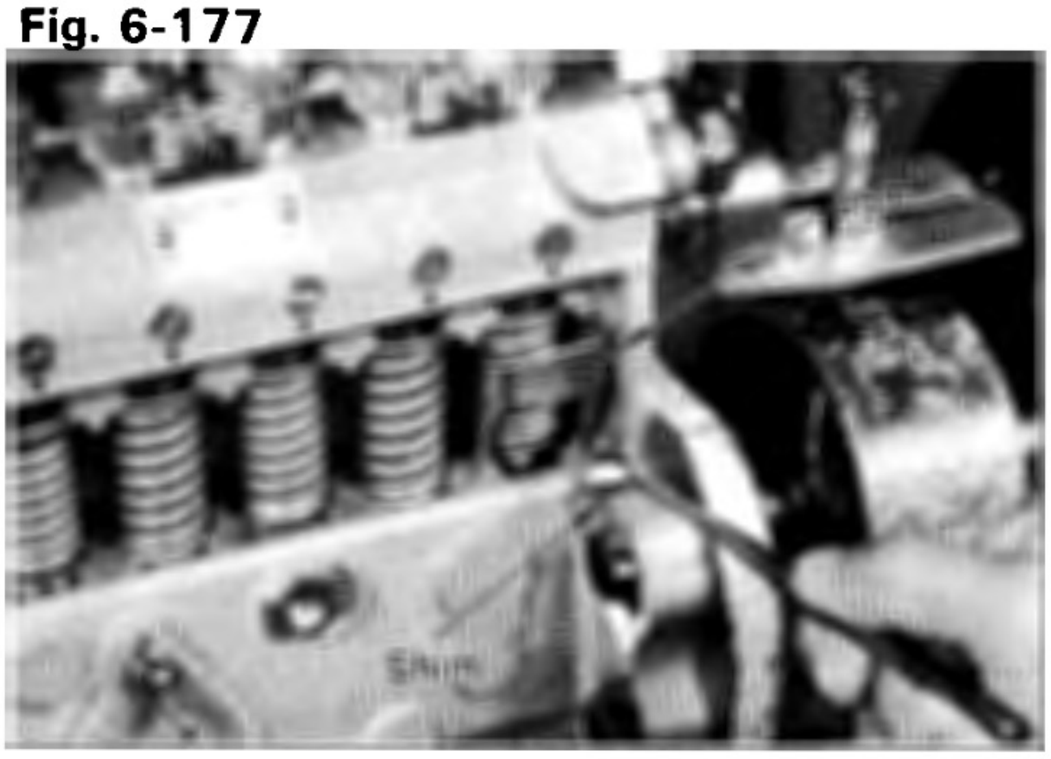


2. Injection Interval
(1) Using the No.1 cylinder injection starting time position as a base, inspect and adjust the injection starting angles in the order of injection.

Injection starting angle

Cylinder No.	Injection starting angle
1	0
4	59°30′— 60°30′
2	119°30′—120°30′
6	179°30′—180°30′
3	239°30′—240°30′
5	299°30′—300°30′

Fig. 6-177



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

Fig. 6-178



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) (09280-46010) of set
[09260-46011]
(B) [09288-46011]
(2) The camshaft should turn easily.

Tappet clearance:
More than 0.2 mm (0.008 in.)

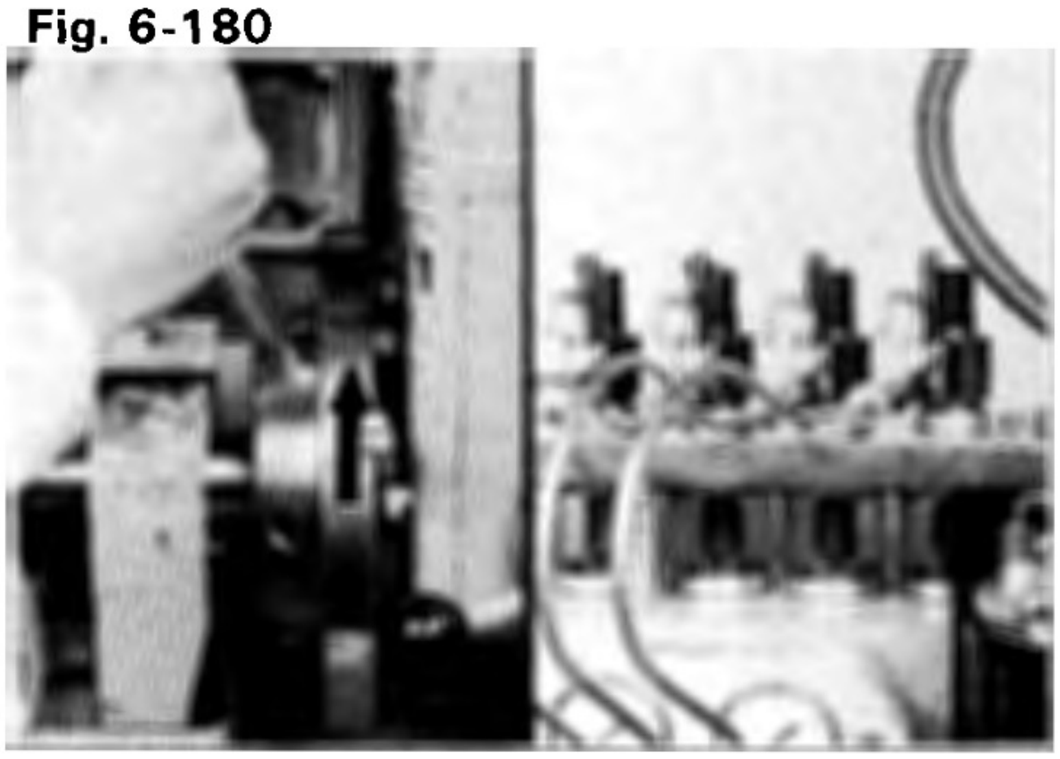
Fig. 6-179



(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.)

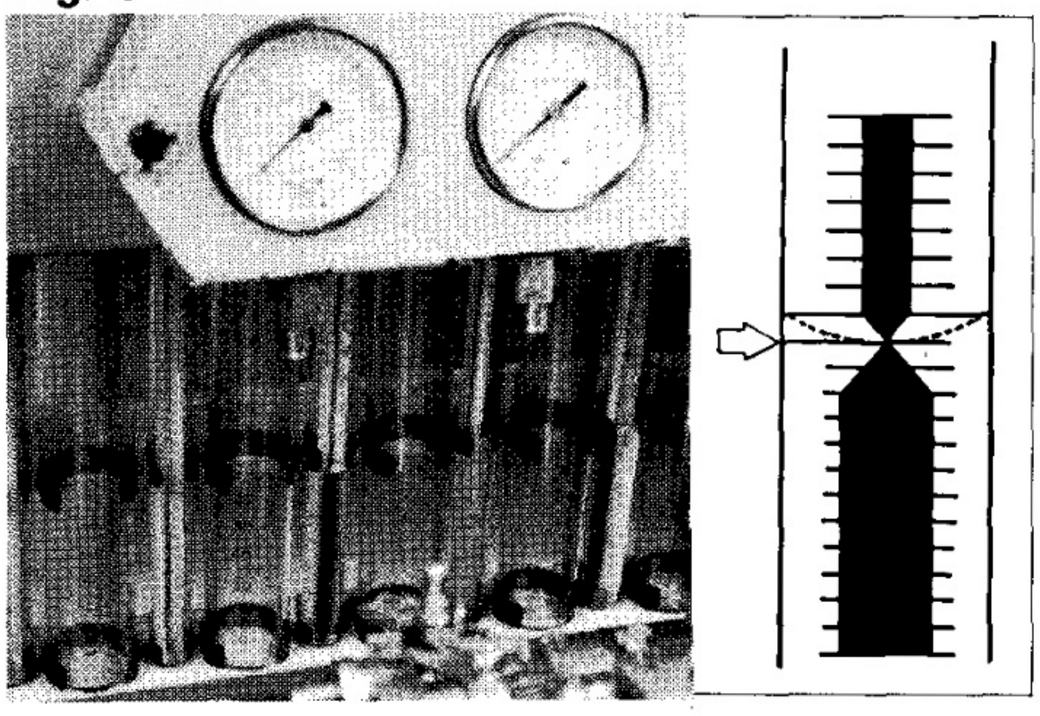
Fig. 6-180



(4) Recheck and adjust the injection starting angle.

Cylinder No.	Injection starting angle
1	0
4	59°30′– 60°30′
2	119°30′–120°30′
6	179°30′–180°30′
3	239°30′–240°30′
5	299°30′–300°30′

Fig. 6-181



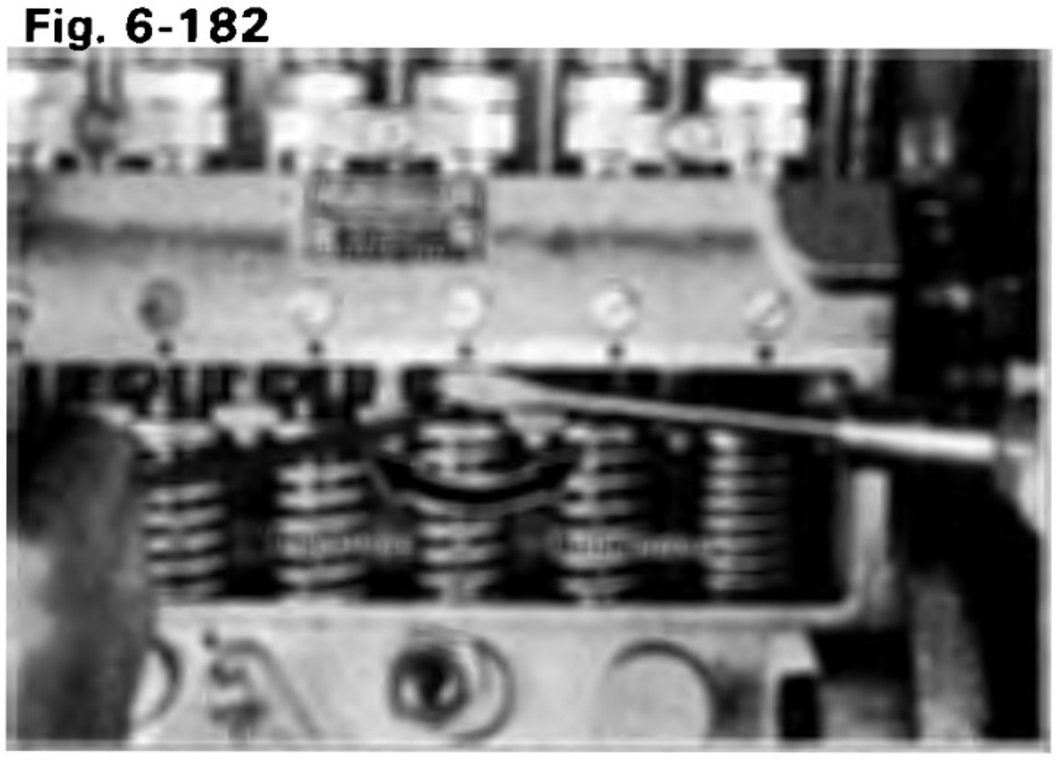
Adjust Injection Volume

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 rpm.

Rack position mm (in.)	Pump revolution (rpm)	Measuring stroke	Injection volume cc (cu in.)	Variation limit cc (cu in.)
16.0 (0.630)	100	200	9.0–10.4 (0.55–0.63) * 9.6–11.6 (0.59–0.71)	1.2 (0.07)
10.8 (0.425)	1,100	200	8.7–9.3 (0.53–0.57)	0.4 (0.02)
10.8 (0.425)	1,700	200	9.1–10.1 (0.56–0.62)	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)

* For Arctic Regions

Fig. 6-182

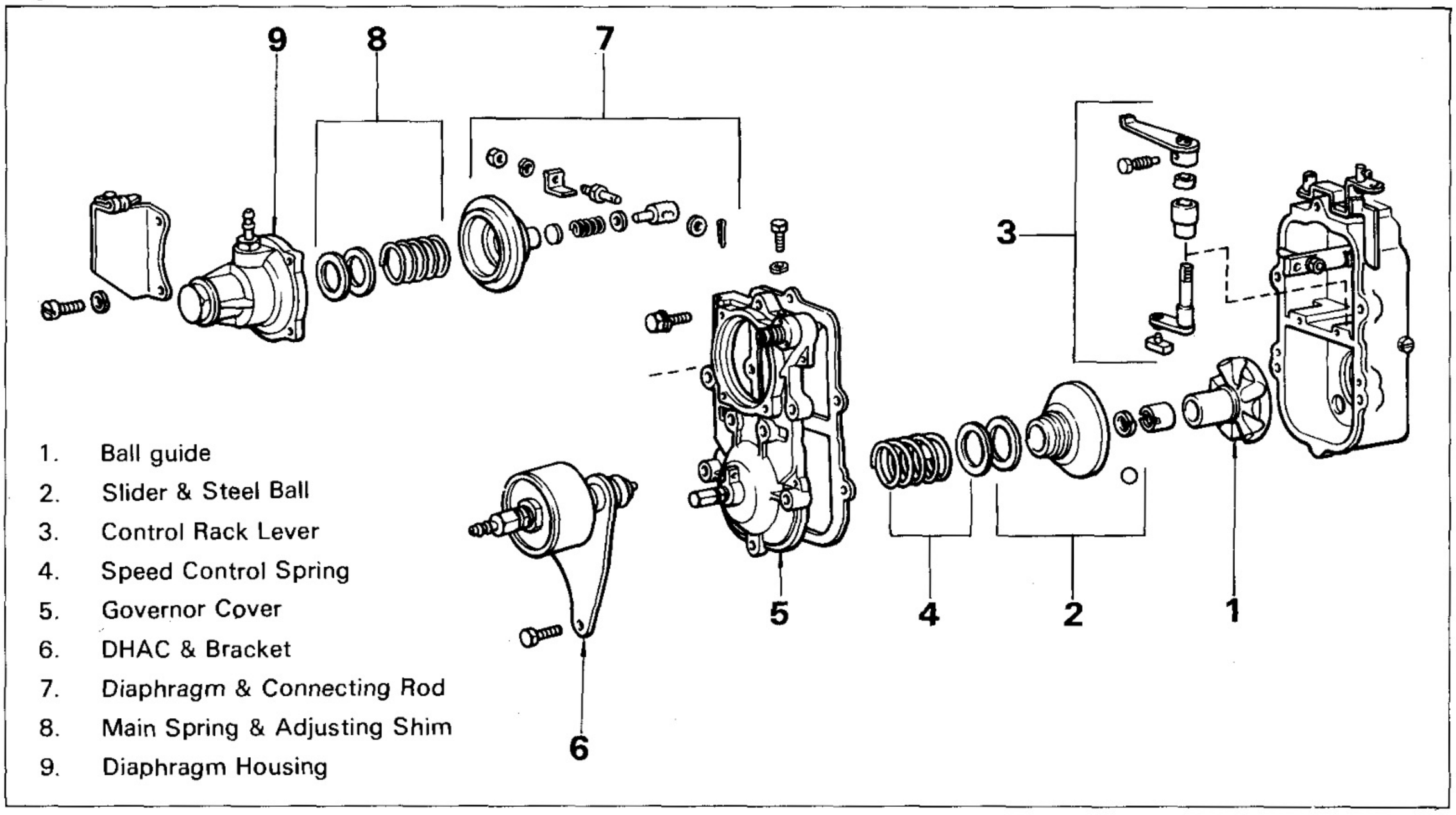


3. To adjust the injection volume, loosen the pinion clamp screw and rotate the control sleeve.

ASSEMBLY (COMBINED GOVERNOR)

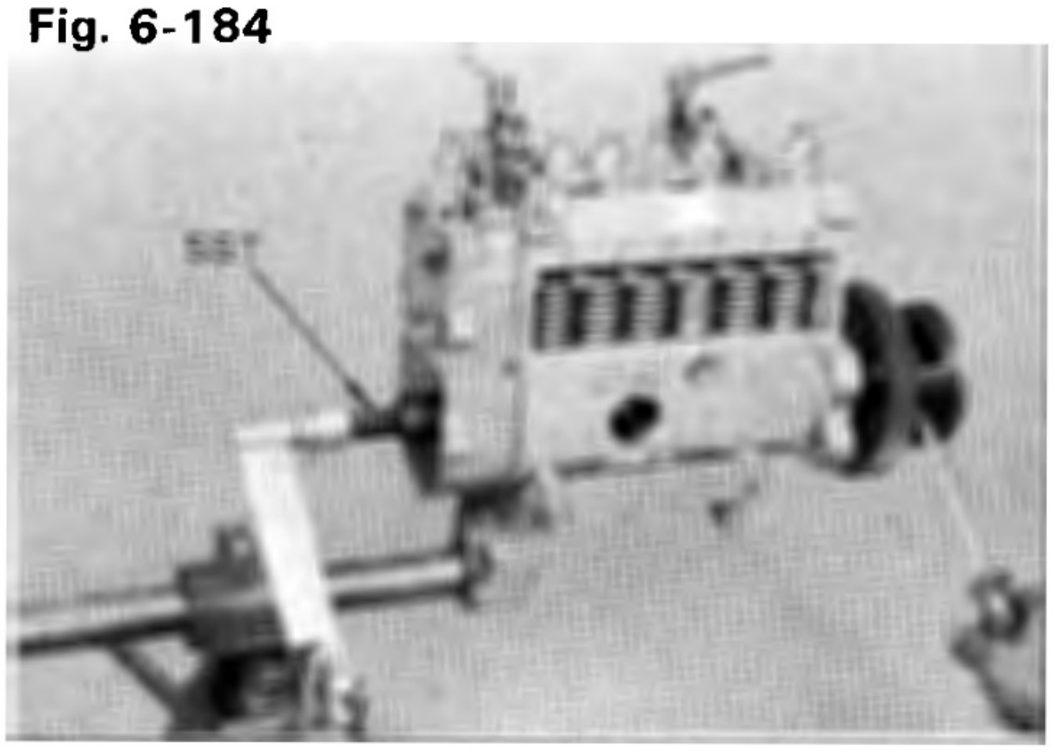
Assemble the parts in the numerical order shown in the figure.

Fig. 6-183



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

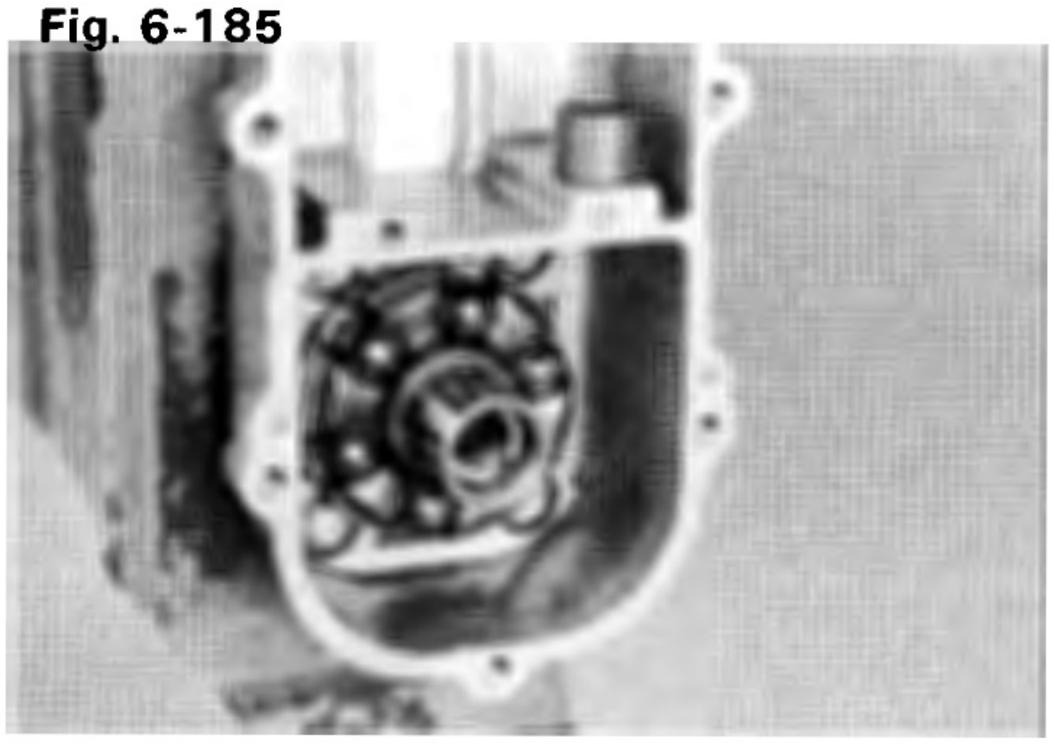
Fig. 6-184



Temporarily install the automatic timer and hold it with a screwdriver. Then tighten the round nut with SST.
SST (09266-67011) of set [09260-76016]

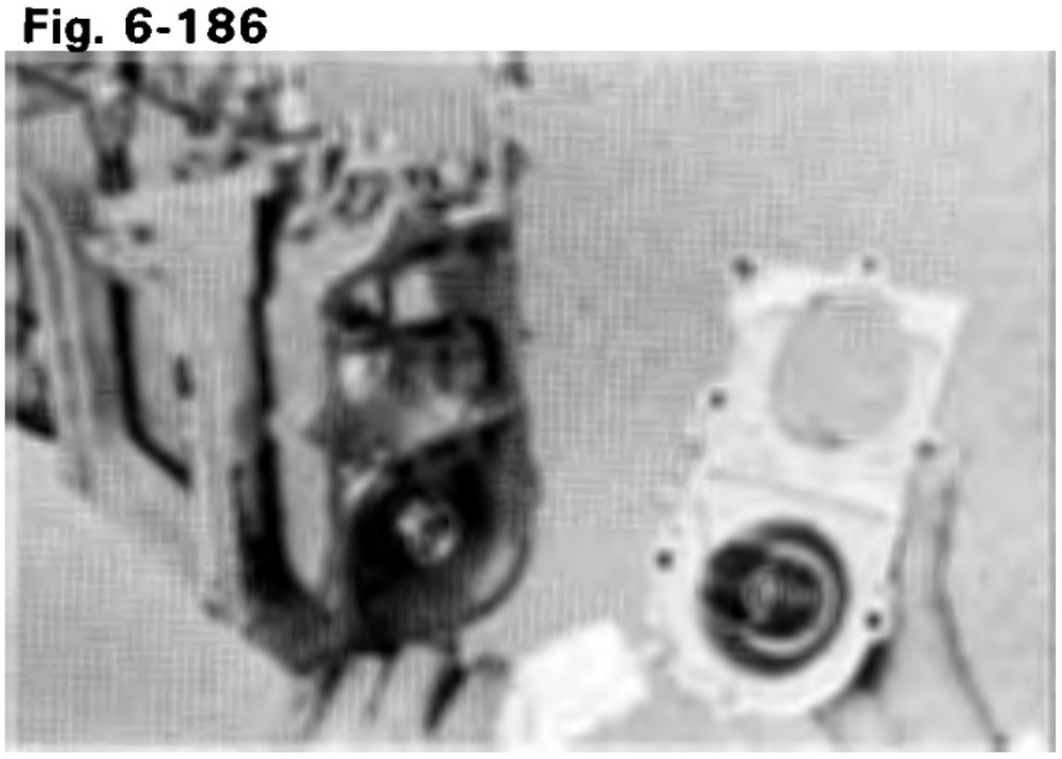
Tightening torque: 5.0 – 6.0 kg-m (37 – 43 ft-lb)

Fig. 6-185



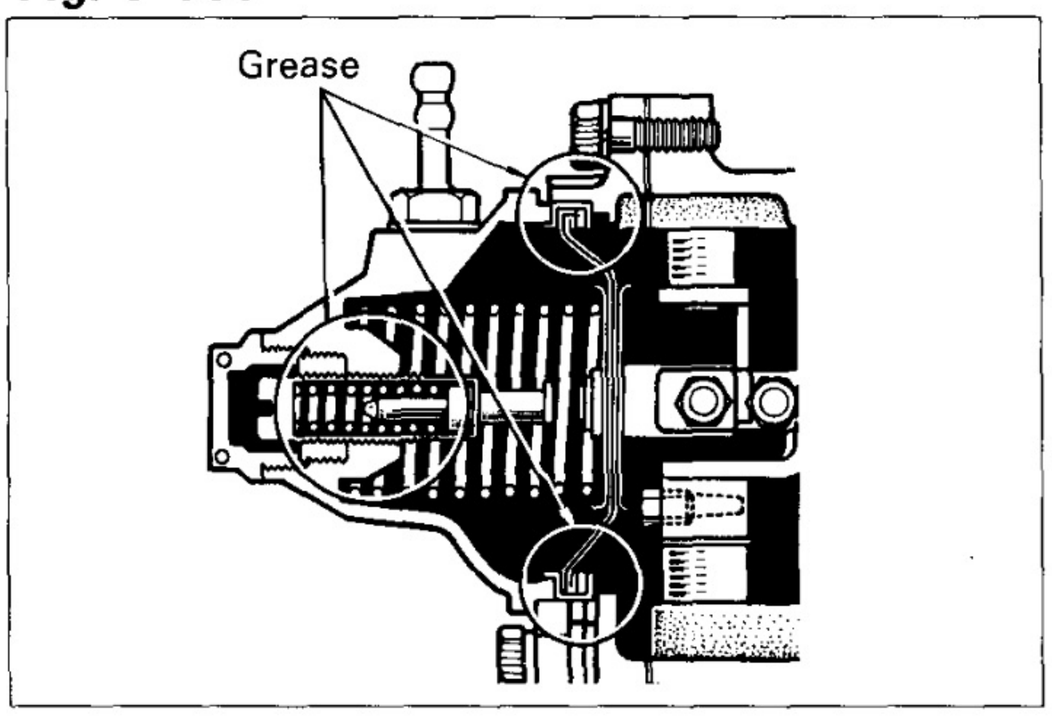
Apply grease to the ball guide groove and put six steel balls in the groove.
Place the slider onto the ball guide.

Fig. 6-186



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

Fig. 6-187

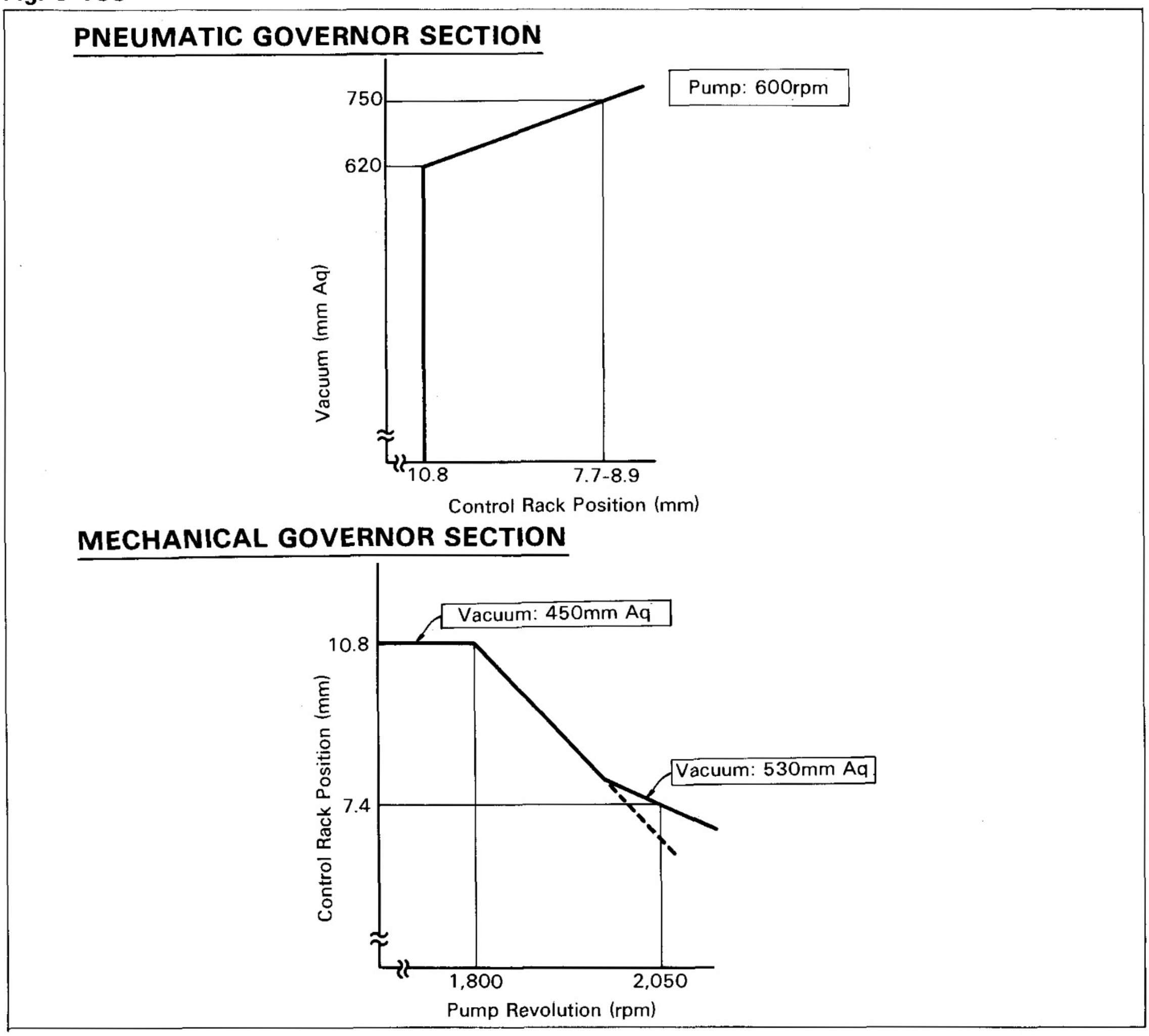


⚠ Coat the diaphragm housing and idling capsule with grease to keep the vacuum chamber airtight.

ADJUSTMENT (COMBINED GOVERNOR)

Combined Governor Characteristic Diagram

Fig. 6-188

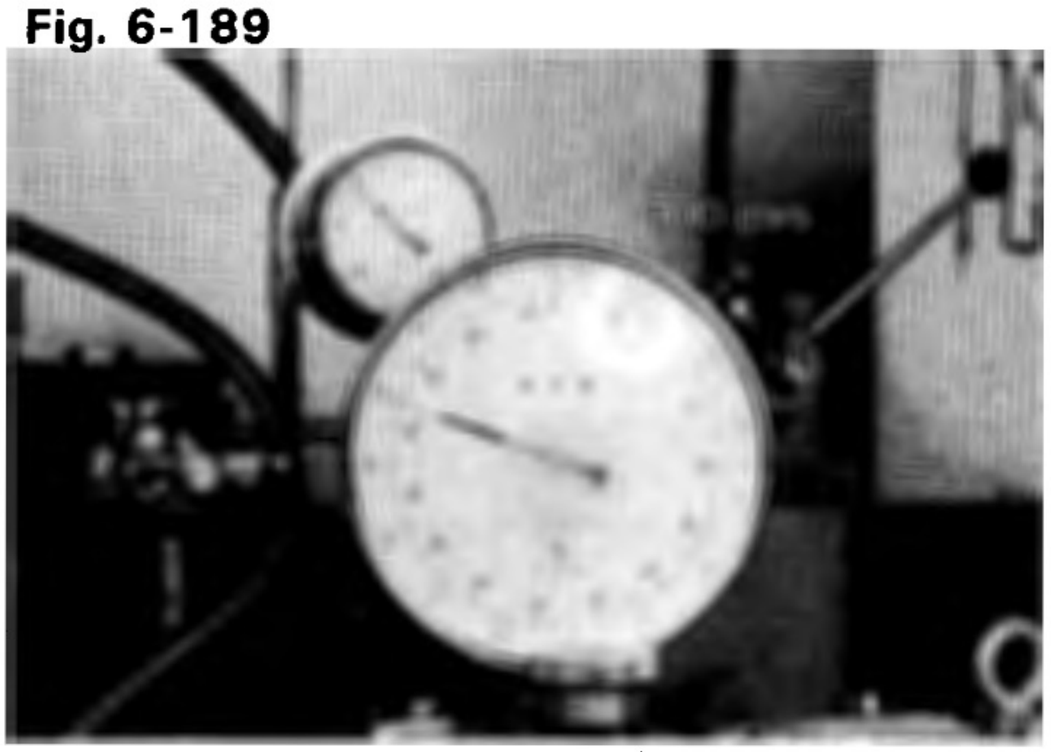


Total Injection Volume

Measuring strokes	Pump revolution (rpm)	Vacuum mm Aq (in.Aq)	Total injection volume cc (cu in.)
500	700	60 (2.36)	117.0—129.0 (7.14—7.87)
	1,100	150 (5.91)	132.0—138.0 (8.06—8.42)
	1,700	400 (15.75)	138.0—150.0 (8.42—9.15) *133.5—145.5 (8.15—8.88)

*w/ DHAC

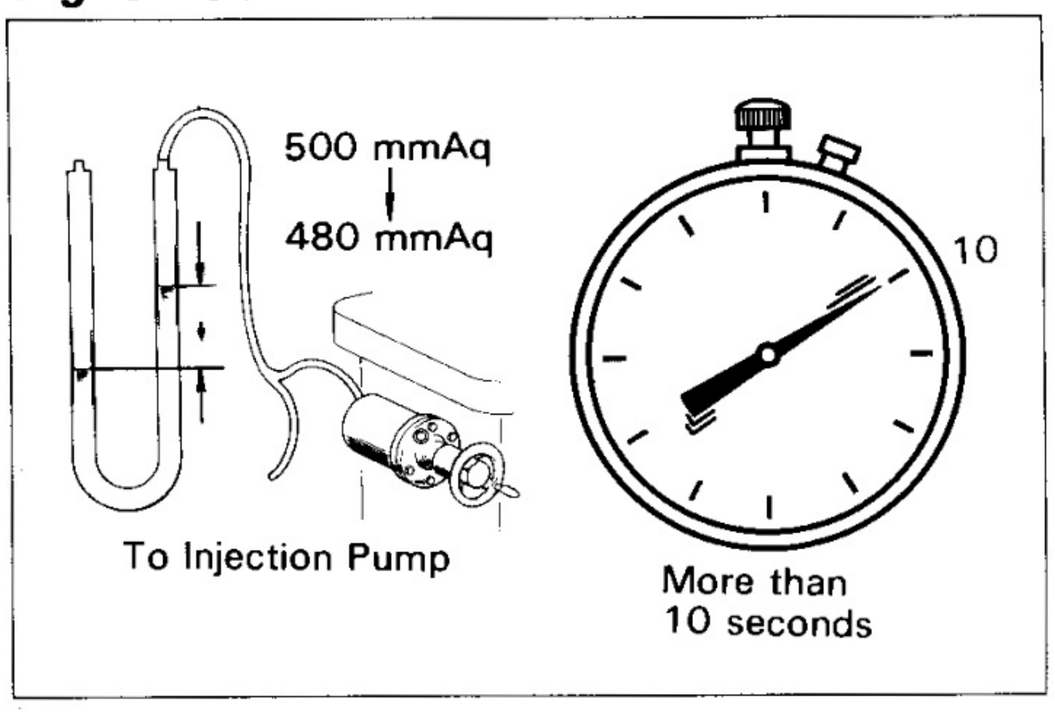
Fig. 6-189



Test Airtightness

1. Set the injection pump revolution at 600 rpm.

Fig. 6-190

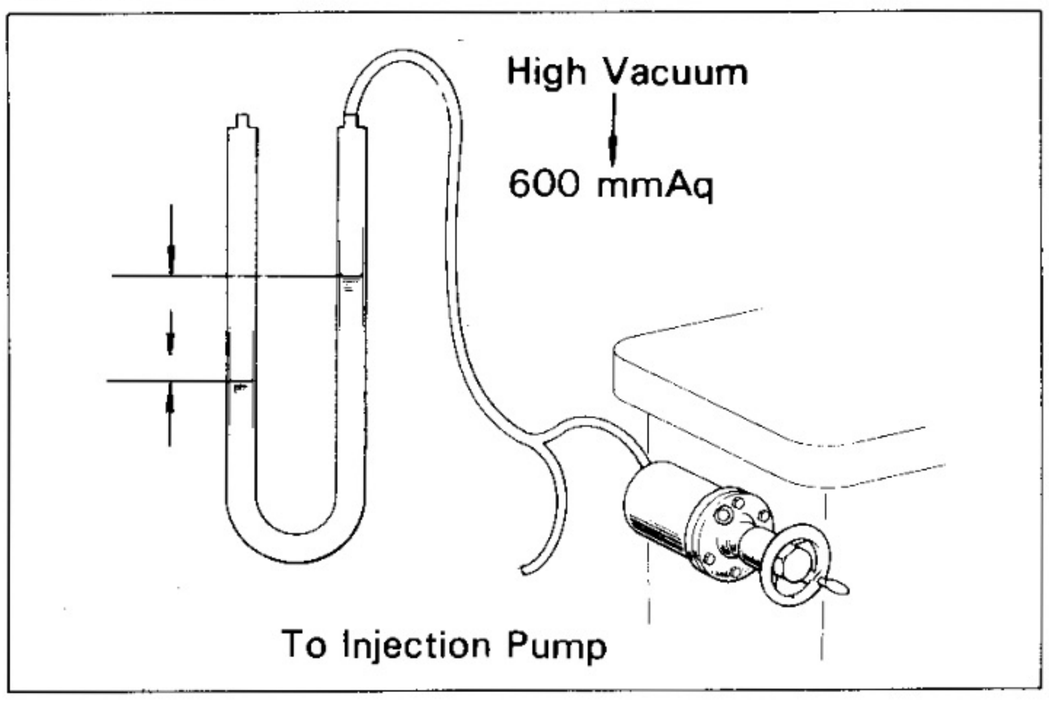


2. Check the time it takes for the vacuum in the vacuum chamber to decrease to 480 mm Aq (18.9 in.Aq).

Vacuum loss	Time
From 500 mm Aq to 480 mm Aq (19.68 in.Aq) (18.90 in.Aq)	More than 10 seconds

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

Fig. 6-191



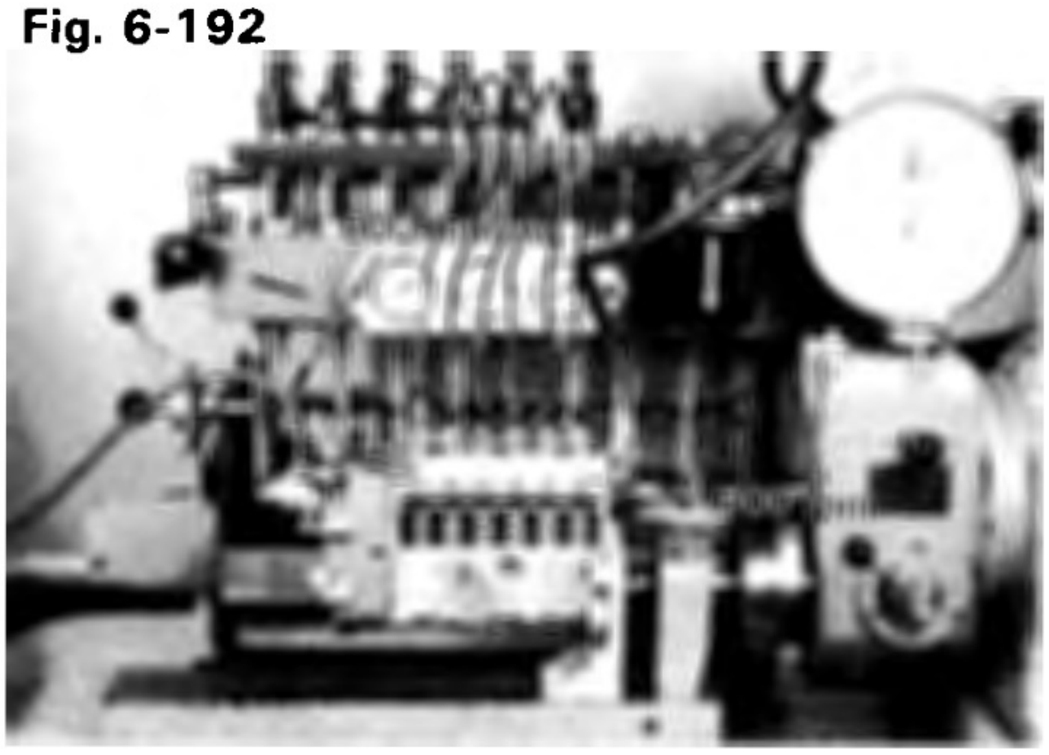
Adjust Initial Set of Control Rack

1. Set the vacuum to specified value.

— Note —

Adjust to specification after alterating it to some extent. Read the graduation after it becomes steady.

Fig. 6-192



2. Check the initial set point of control rack.

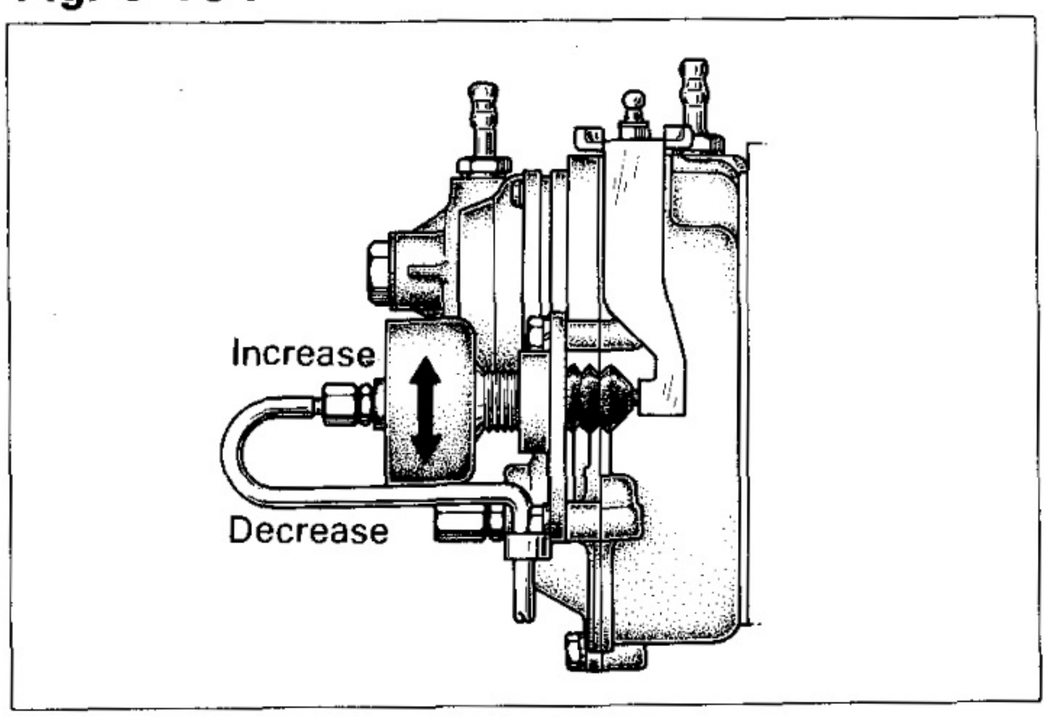
Pump revolution (rpm)	Vacuum mm Aq (in.Aq)	Control rack position mm (in.)
600	600 (23.62)	10.8±0.1 (0.425±0.004)

Fig. 6-193



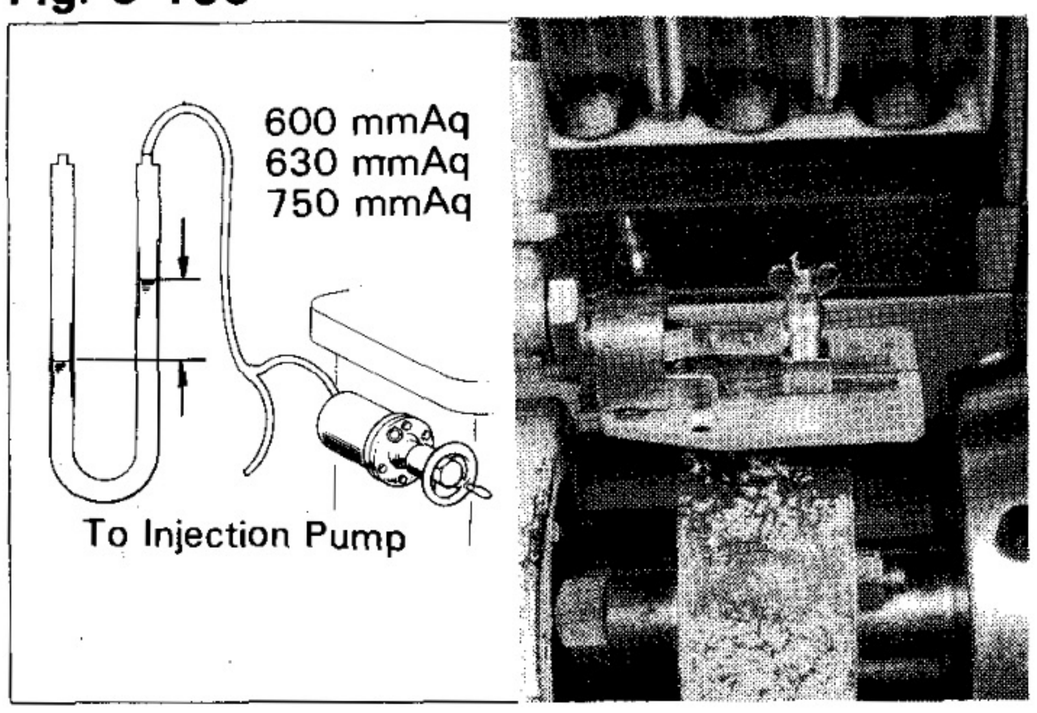
3. Adjust the initial set of the control rack by turning the full stop capsule with SST.
SST [09283-76010]

Fig. 6-194



4. If the governor is equipped with a Diesel High Altitude Compensator (DHAC) instead of full stop capsule, adjust it with SST.
SST [09283-76020]

Fig. 6-195

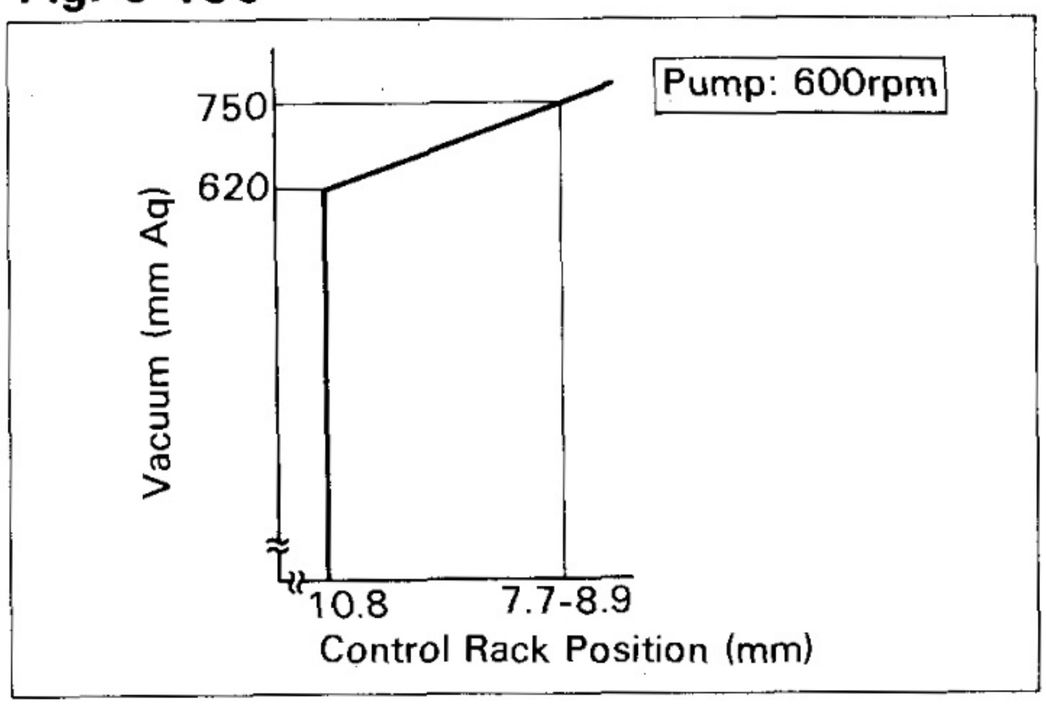


Adjust Main Spring

1. Check the control rack position.

Pump revolution (rpm)	Vacuum mm Aq (in.Aq)	Control rack position mm (in.)
600	600 (23.62)	10.8±1 (0.425±0.004)
	630 (24.80)	10.5—10.7 (0.413—0.421)
	750 (29.53)	7.7—8.9 (0.303—0.350)

Fig. 6-196

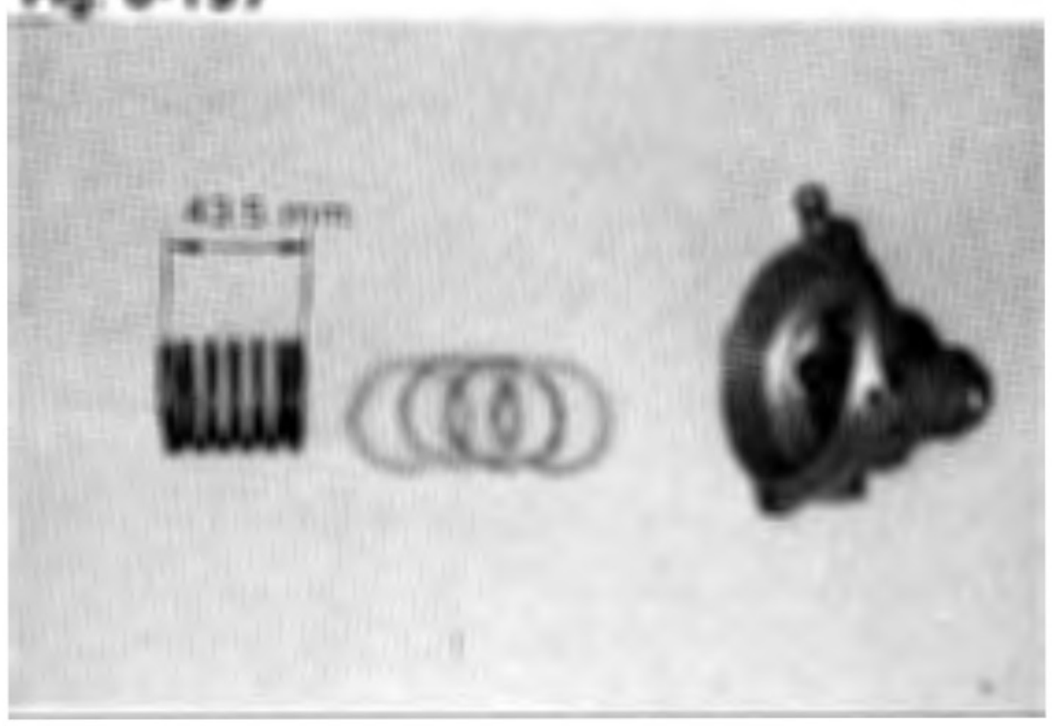


2. Adjust the control rack position by increasing the number of main spring shims.

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

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

Fig. 6-197



3. If the control rack position is not within specification, check the main spring.
   Free length: 43.5 mm (1.713 in.)

Fig. 6-198



4. When adjustment is completed, reconfirm the initial setting.

Initial set of control rack

Pump revolution (rpm)	Vacuum mm Aq (in.Aq)	Control rack position mm (in.)
600	600 (23.62)	10.8±1 (0.425±0.004)

Fig. 6-199



Adjust Idling Spring Capsule

1. Check the control rack position.

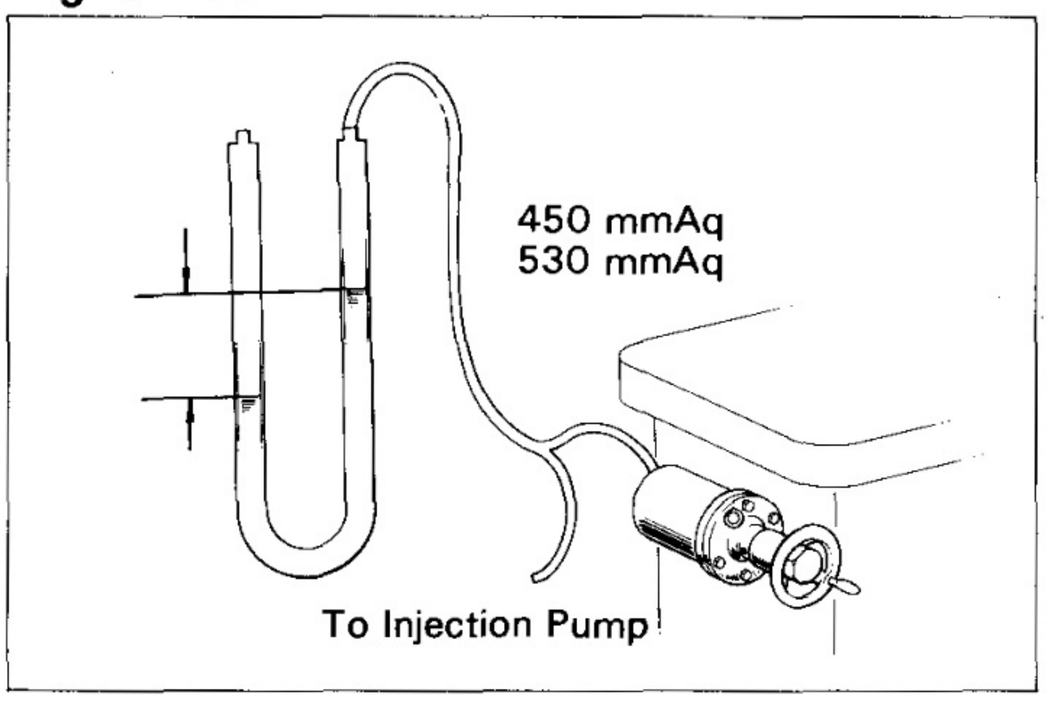
Pump revolution (rpm)	Vacuum mm Aq (in.Aq)	Control rack position mm (in.)
2,050	530 (20.87)	7.4±0.1 (0.291±0.004)
2,050	450 (17.72)	7.5—8.3 (0.295—0.327)
1,950	450 (17.72)	8.3—9.1 (0.327—0.358)

Fig. 6-200



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

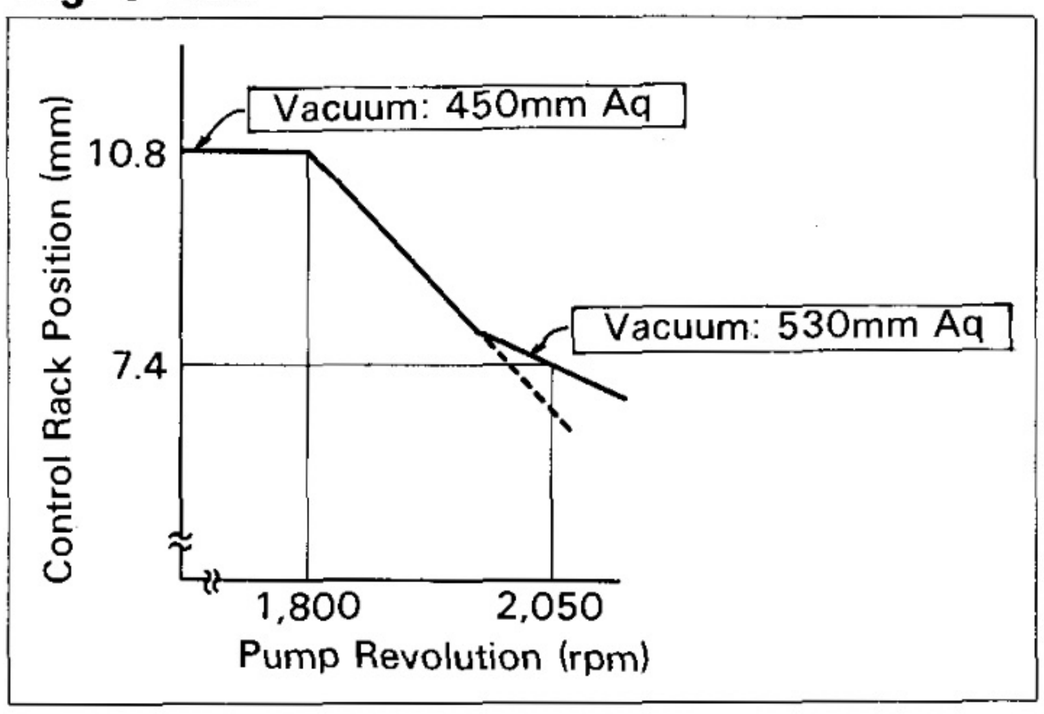
Fig. 6-201



Adjust Mechanical Governor Section

1. Set the vacuum to specified value.

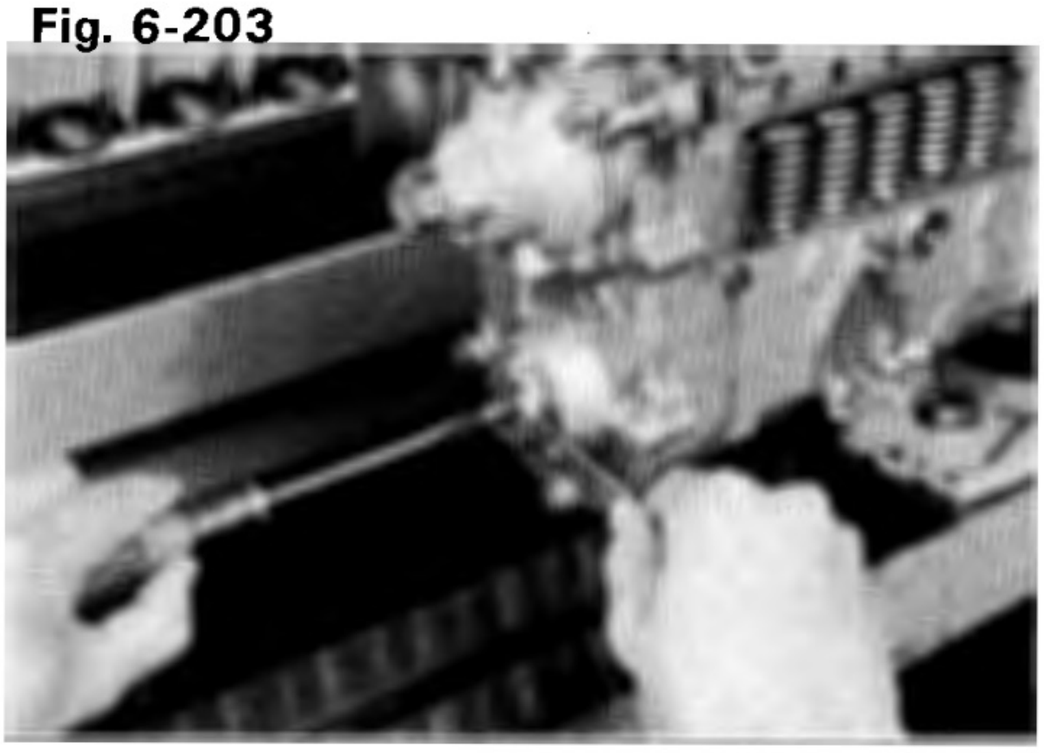
Fig. 6-202



2. Check the control rack position.

Pump revolution (rpm)	Vacuum mm Aq (in.Aq)	Control rack position mm (in.)
1,800	450 (17.72)	10.8 (0.425)
1,825		10.3—10.7 (0.406—0.421)
1,900		8.8—9.9 (0.346—0.390)
2,050	530 (20.87)	7.4±0.1 (0.291±0.004)

Fig. 6-203



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

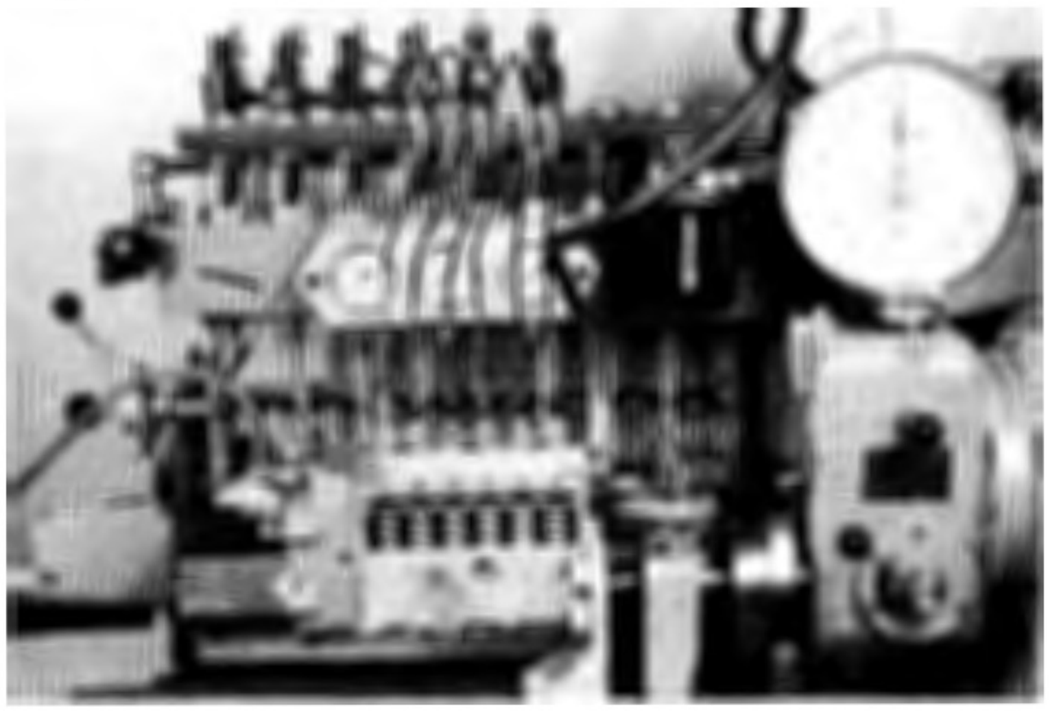
Fig. 6-204



Total Injection Volume

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

Fig. 6-205

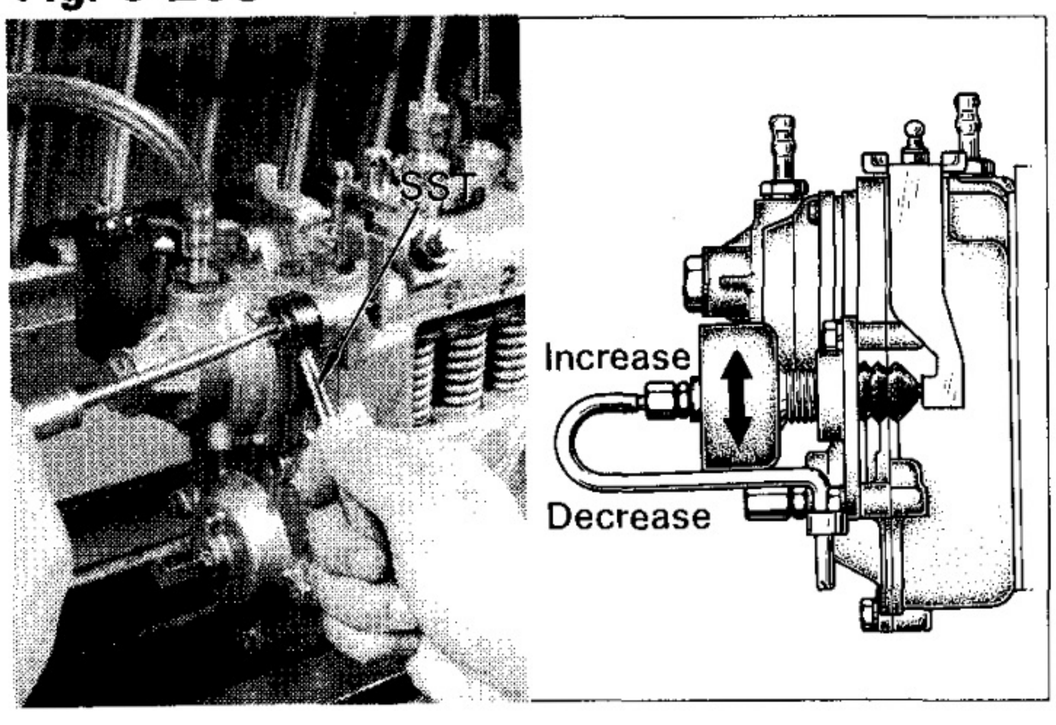


2. Measure the total injection volume at 500 strokes.

Pump revolution (rpm)	Vacuum mm Aq (in.Aq)	Total injection volume cc (cu in.)
700	60 (2.36)	117.0—129.0 (7.14—7.87)
1,100	150 (5.91)	132.0—138.0 (8.06—8.42)
1,700	400 (15.75)	138—150 (8.42—9.15) *133.5—145.5 (8.15—8.88)

*w/ DHAC

Fig. 6-206

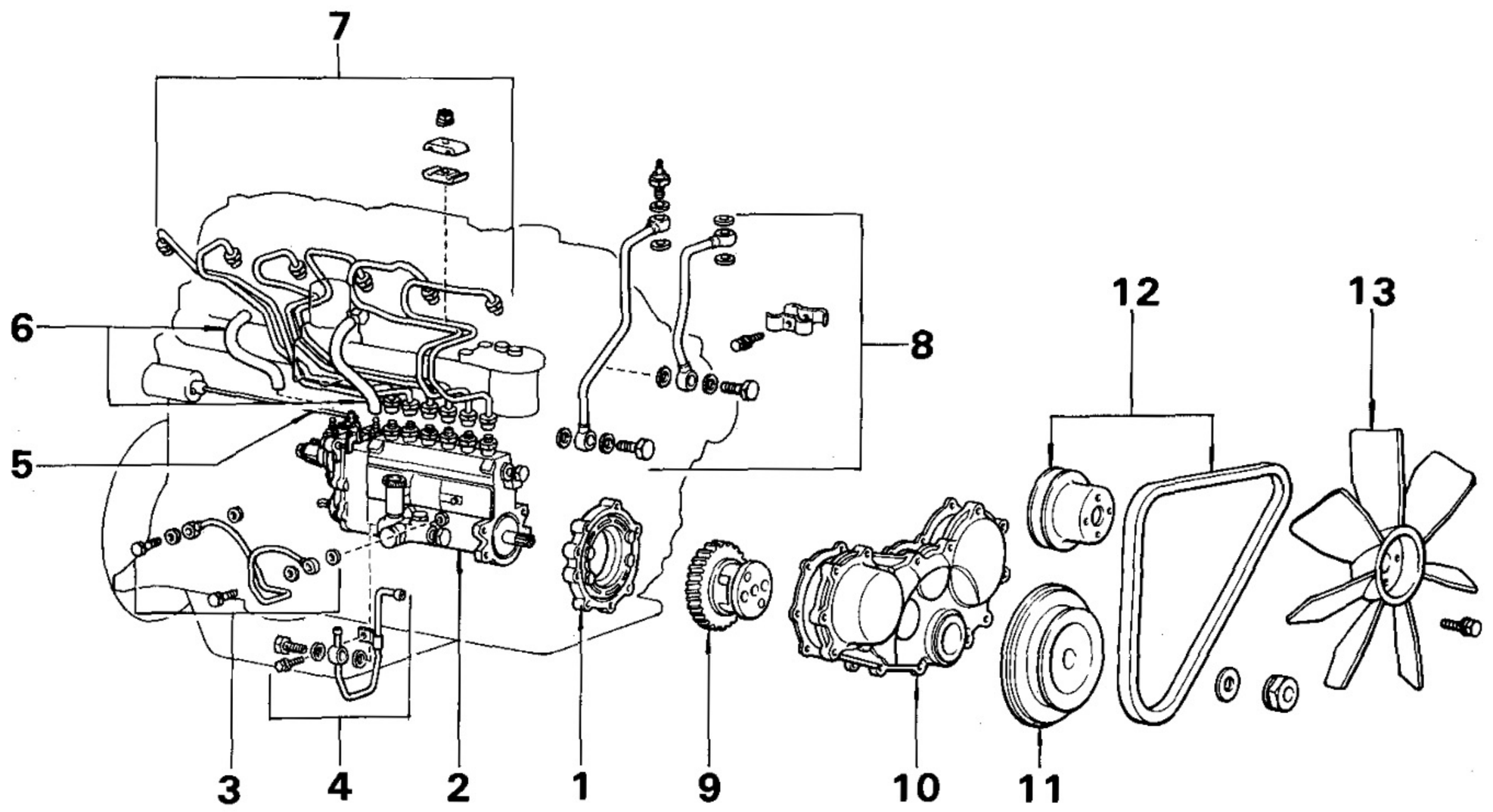


3. If the total injection volume is not within specification adjust it by turning the full stop capsule or Diesel High Altitude Compensator with SST.
   SST [09260-76010] w/o DHAC type
   [09260-76020] w/ DHAC type

INSTALLATION

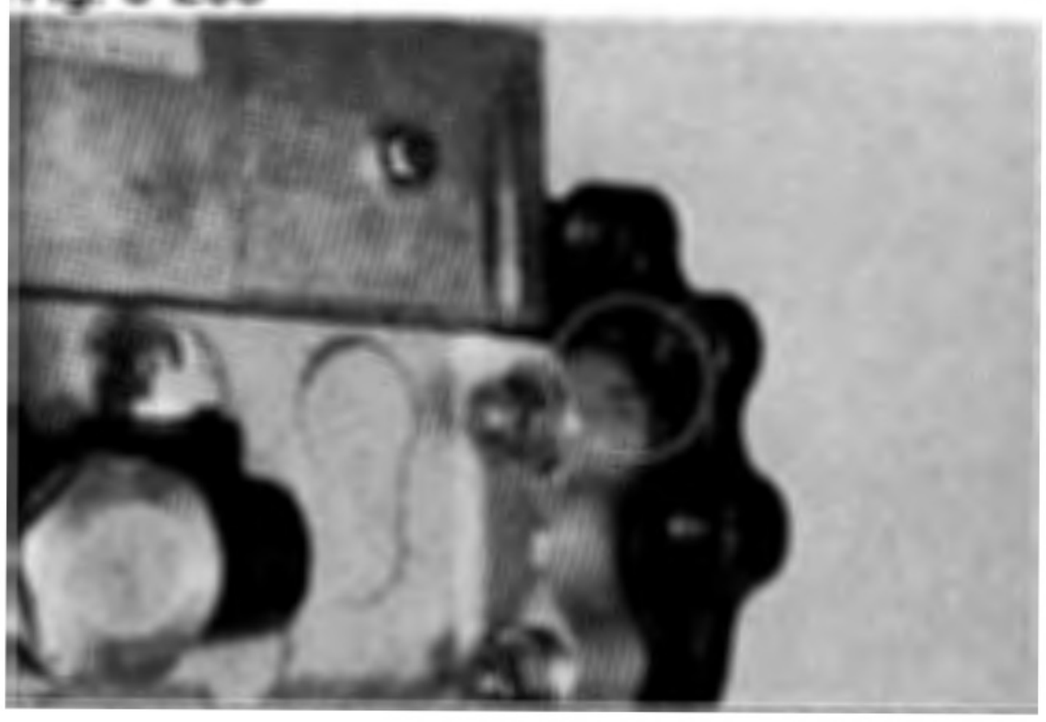
Install the parts in the numerical order shown in the figure.

Fig. 6-207



1. Injection Pump Retainer
2. Injection Pump
3. Oil Pipe
4. Fuel Pipe
5. Control Wire
6. Rubber Hose
7. Injection Pipe
8. Fuel Pipe
9. Automatic Timer
10. Timing Gear Cover
11. Crankshaft Pulley
12. Fan Pulley & Drive Belt
13. Cooling Fan

Fig. 6-208



⚠ Set the injection period line back to the former position.

Fig. 6-209

AUTOMATIC TIMER

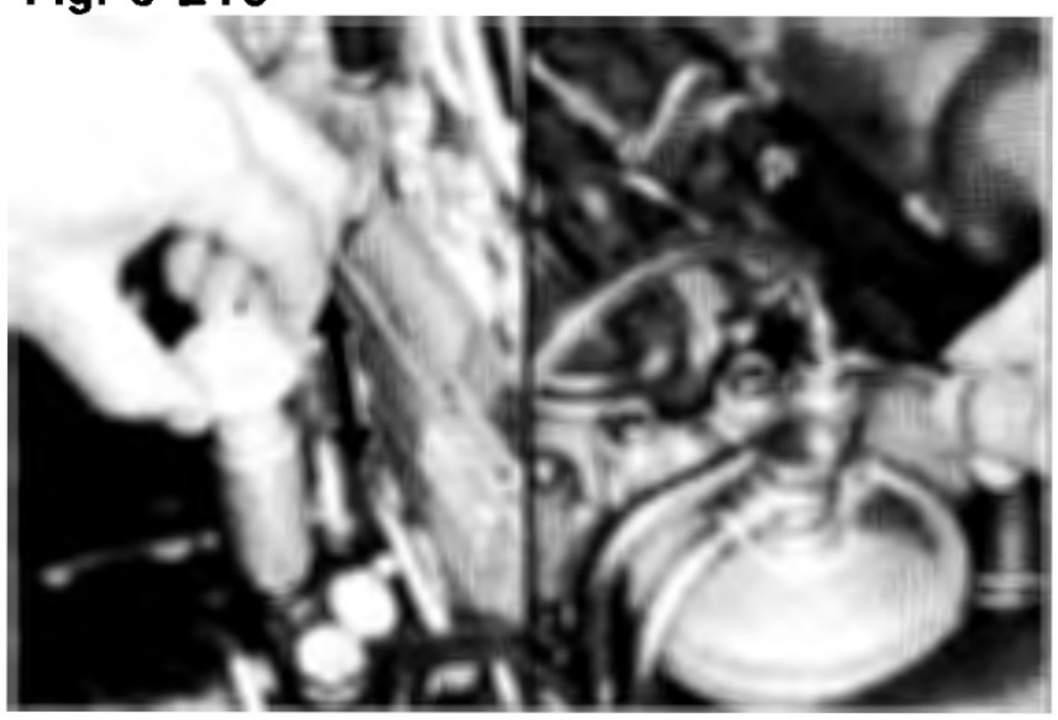
INSTALLATION

SECTION

Fig. 6-77 to 6-83

Install the automatic timer.

Fig. 6-210



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. 6-211

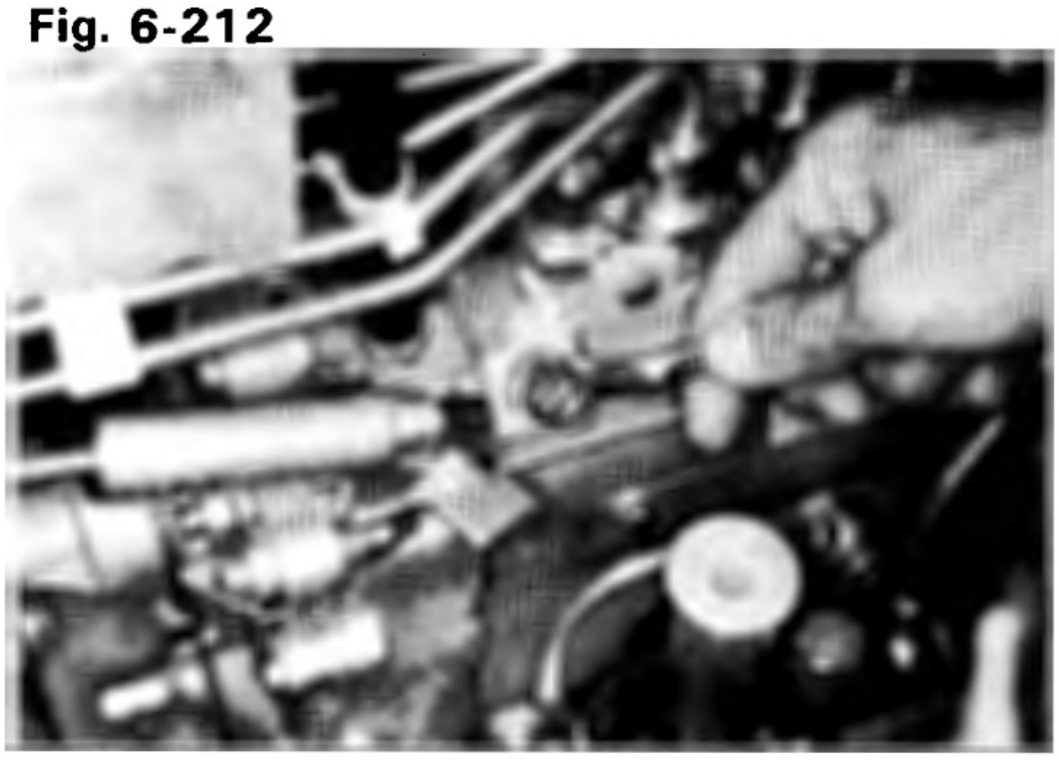


3. Loosen the injection pump bleeder plug and operate the priming pump until there is no air emission from the injection pump.
4. Screw in the priming pump handle and lock it.

— Note —

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

Fig. 6-212



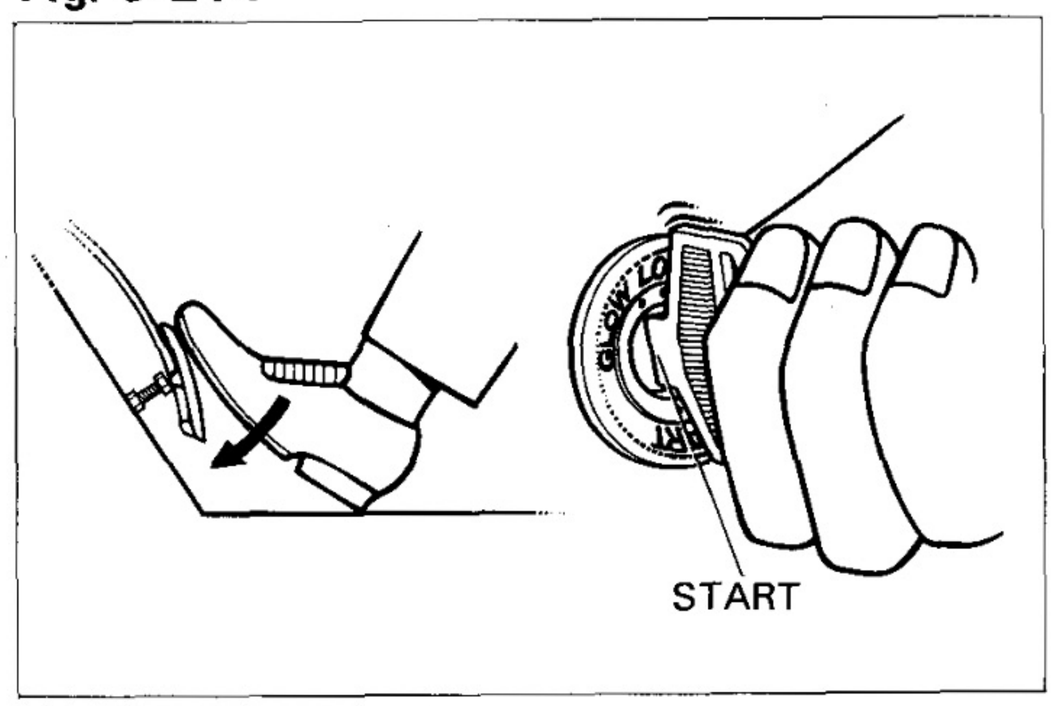
5. Tighten the injection pump bleeder plug.

Fig. 6-213



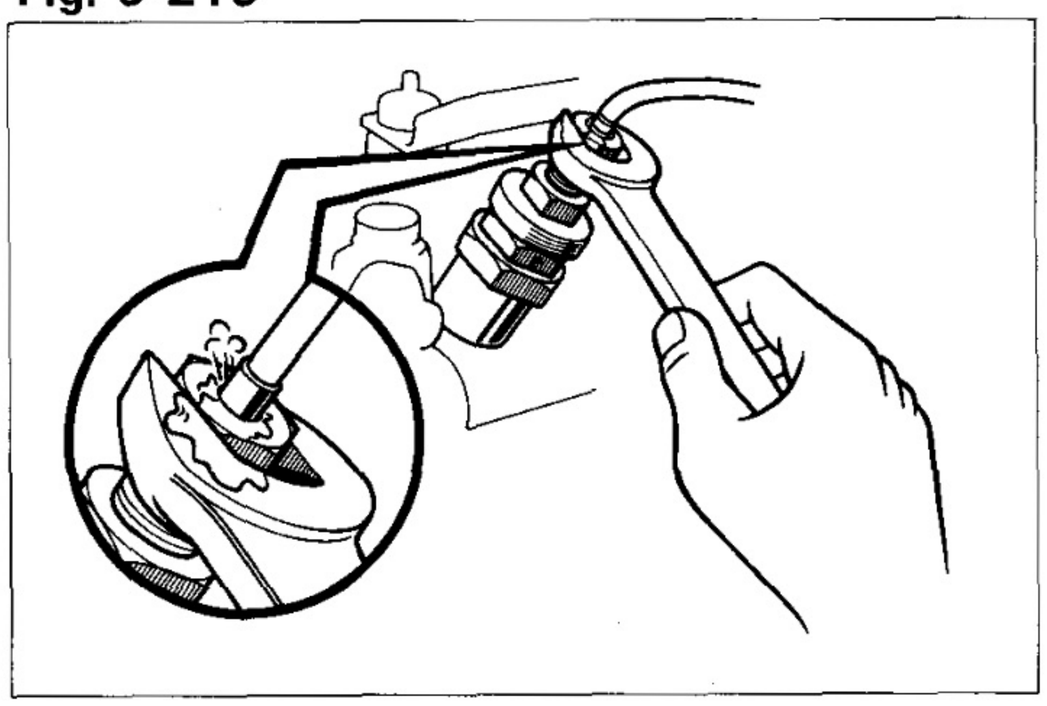
⚠ 6. Loosen all union nuts of the injection pipe on the nozzle holder side.

Fig. 6-214



⚠ 7. Turn the engine with the accelerator pedal fully depressed.

Fig. 6-215



⚠ 8. Crank the engine to bleed the air and force out the fuel from the injection pipe.
9. Tighten the all union nuts.

Tightening torque:
2.3 – 3.7 kg-m
(17 – 26 ft-lb)

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

Fig. 6-216

SEE

ENGINE TUNE-UP

SECTION

Fig. 2-52 to 2-57

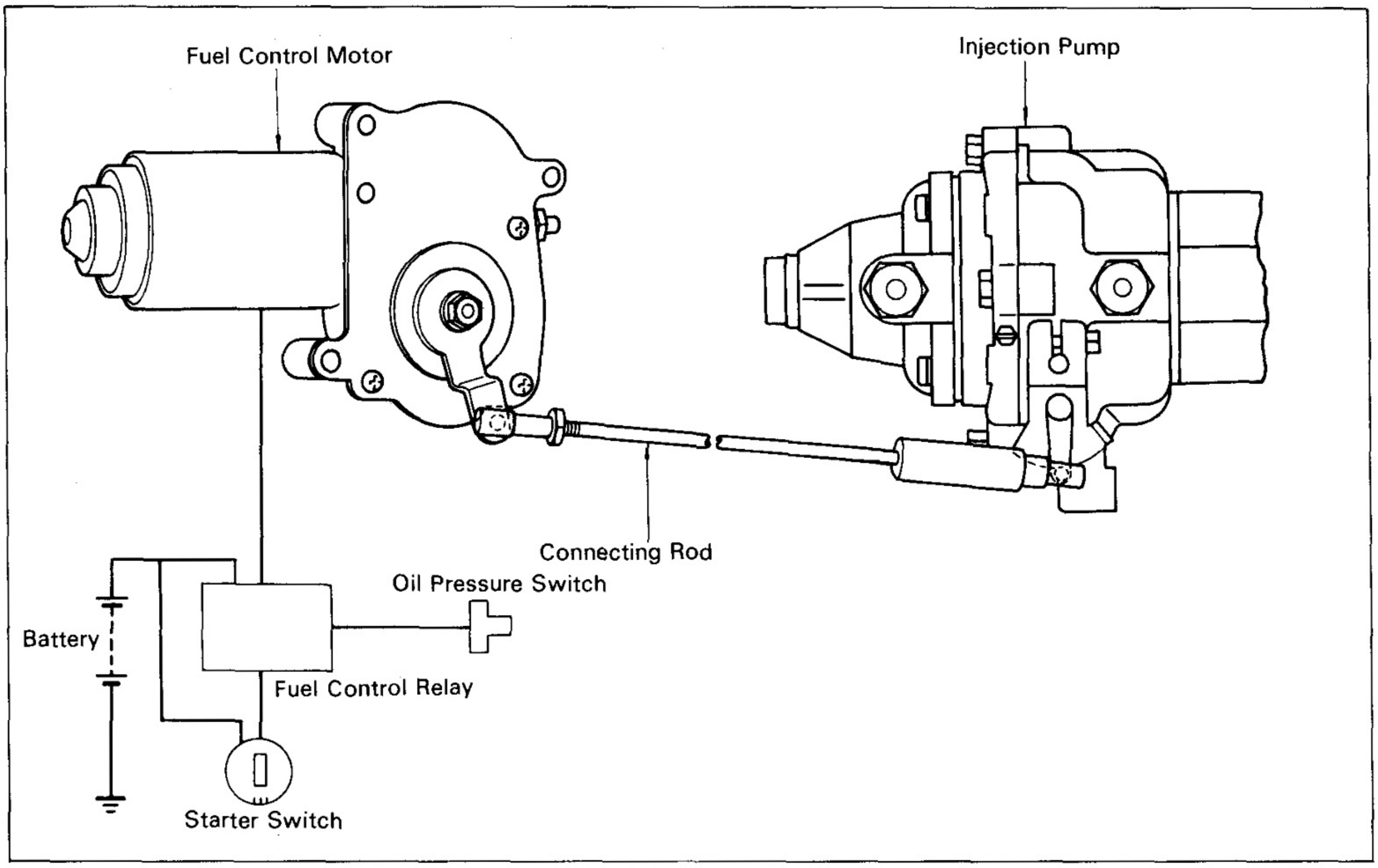
Check the engine idle speed and maximum speed.

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

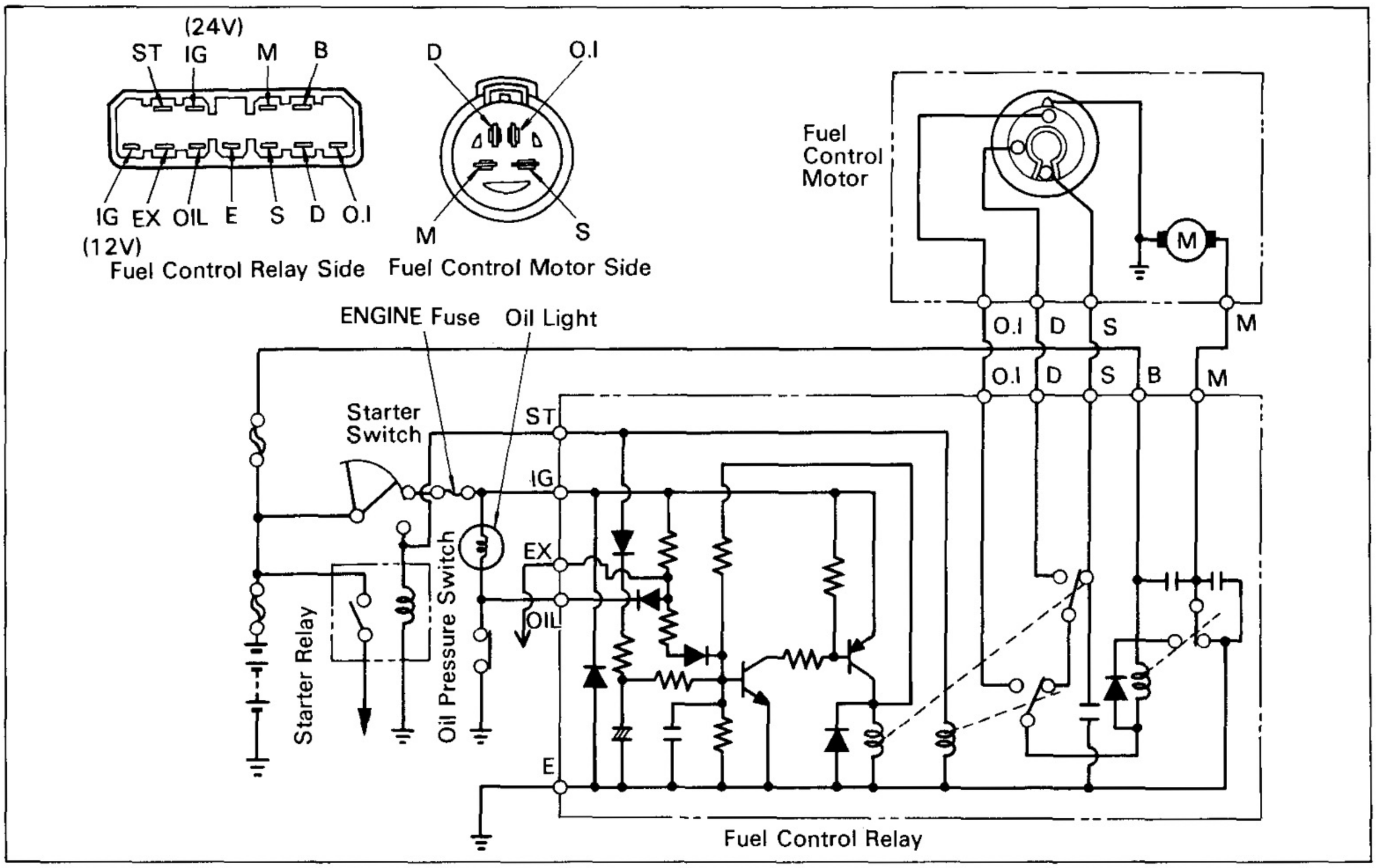
OPERATING DIAGRAM

Fig. 7-1



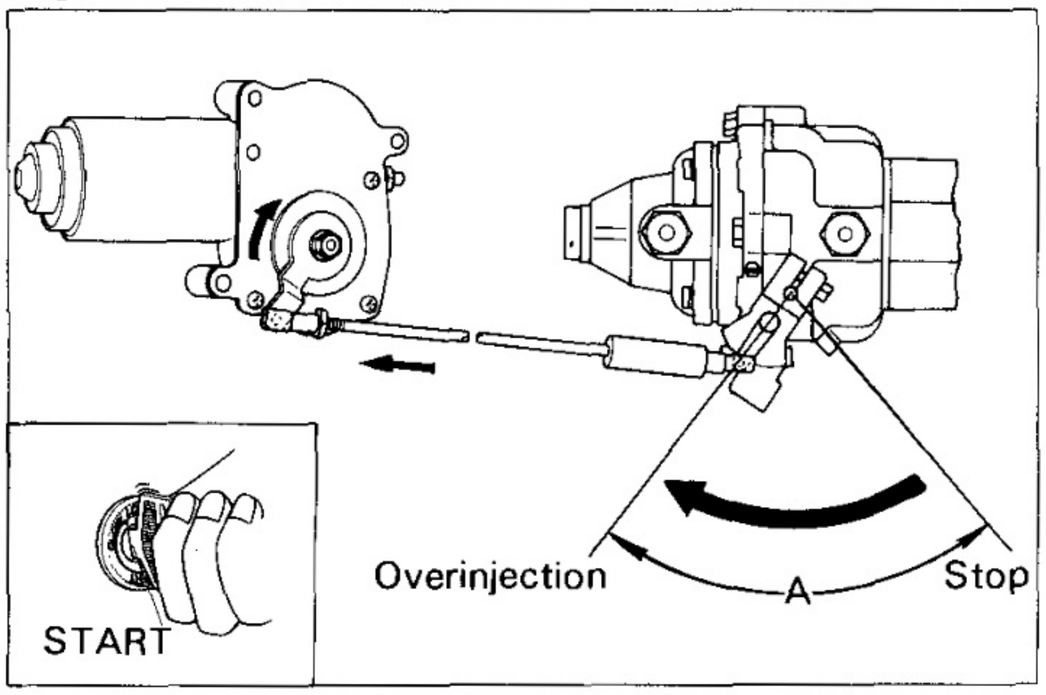
EDIC SYSTEM CIRCUIT

Fig. 7-2



OPERATIONAL CHECK

Fig. 7-3

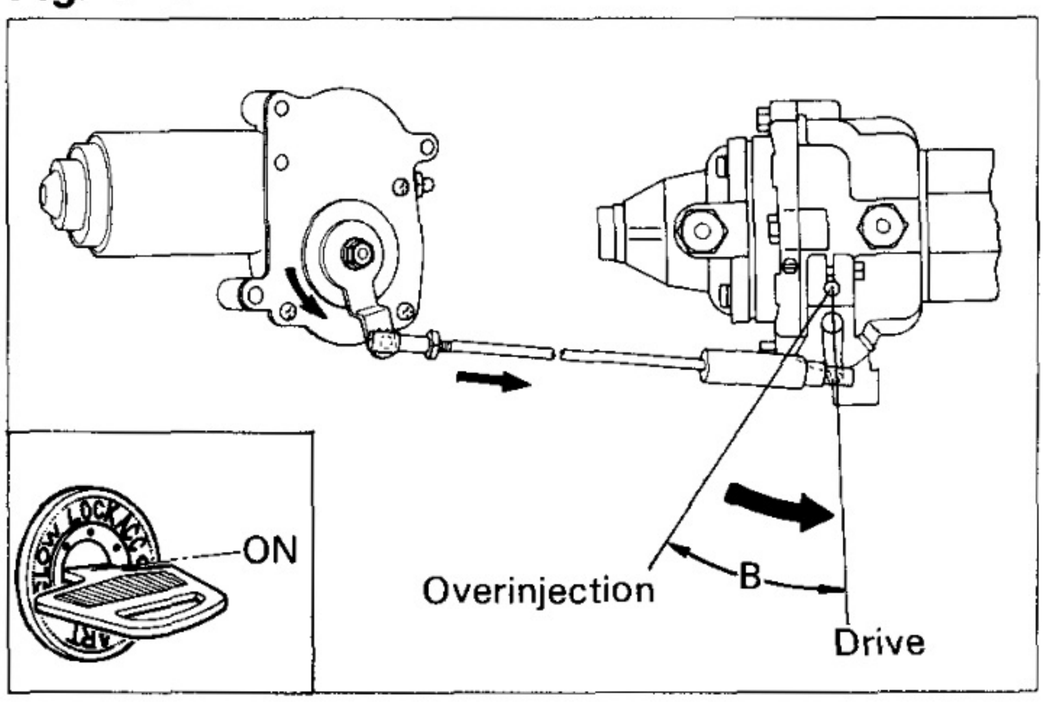


STARTING OVERINJECTION

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

A: 78.5°

Fig. 7-4

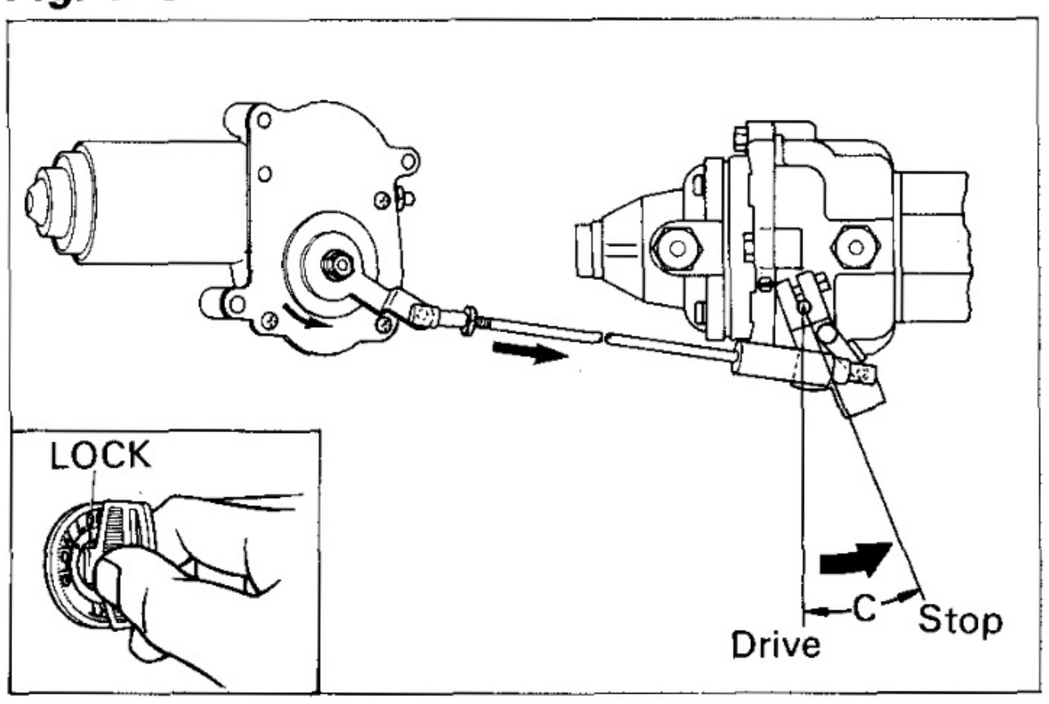


AFTER STARTING (DRIVE POSITION)

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

B: 37.5°

Fig. 7-5

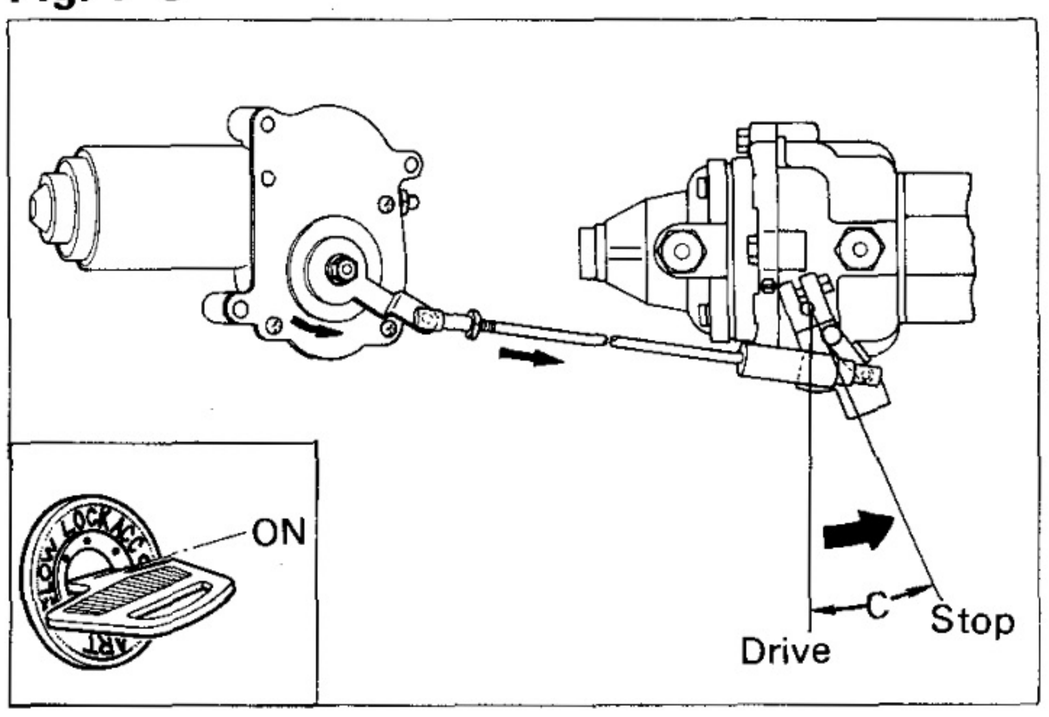


ENGINE STOPPING ACTION

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

C: 41°

Fig. 7-6

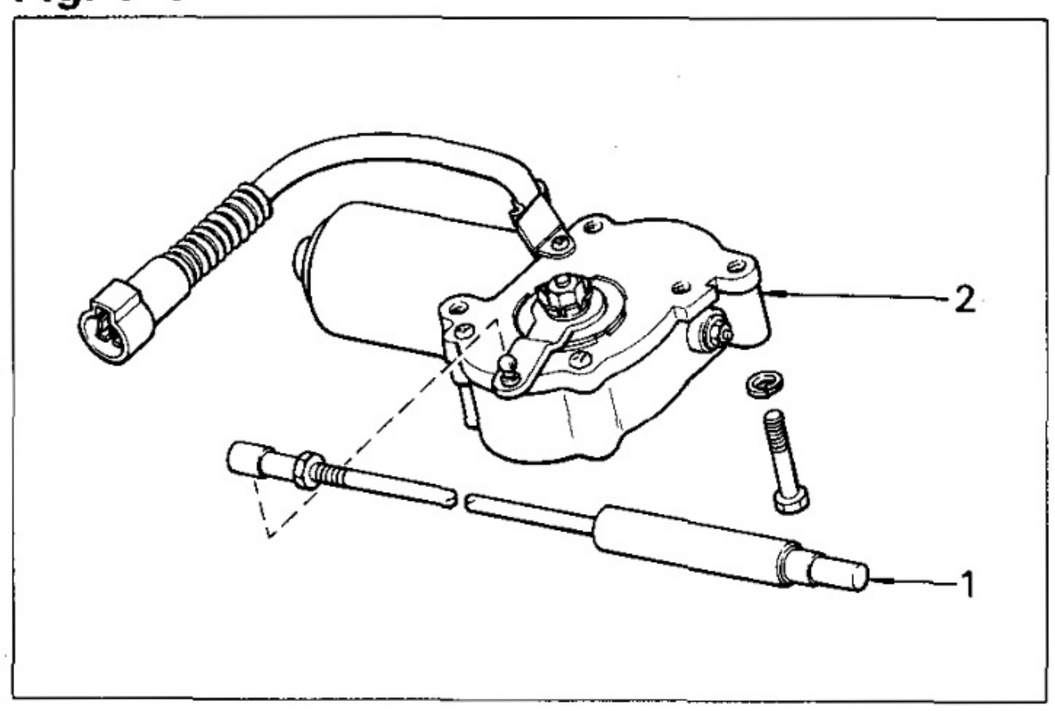


REVERSE ROTATION PREVENTION

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.

Fig. 7-7

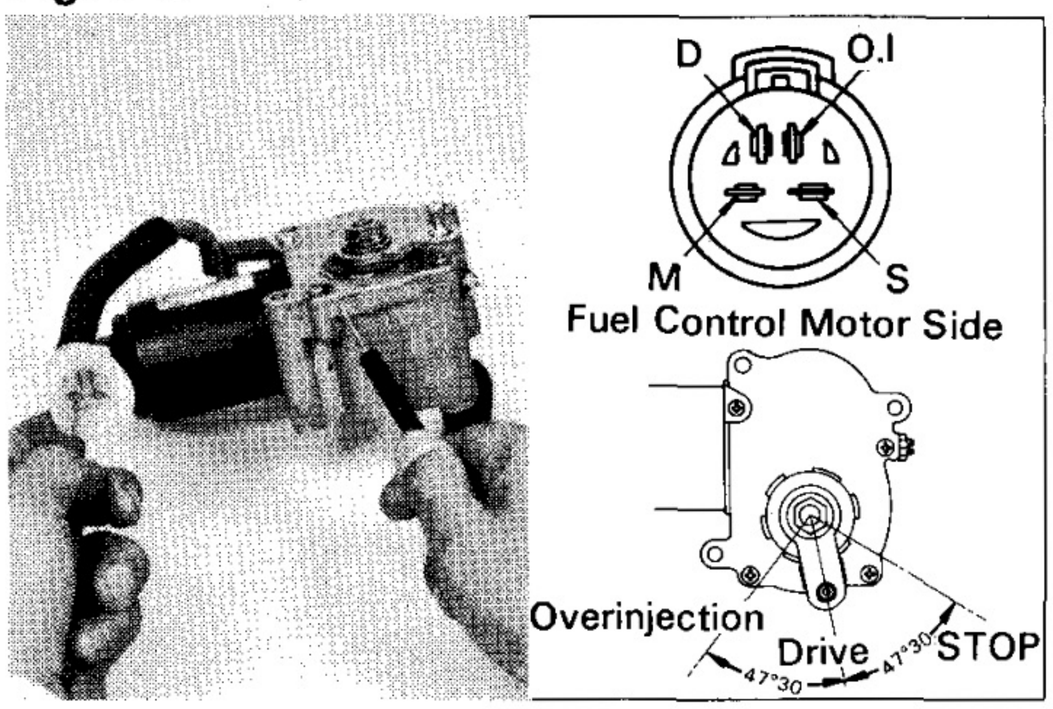


FUEL CONTROL MOTOR

REMOVAL

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

Fig. 7-8



INSPECTION

1. Measure resistance between terminal M and body.

   Resistance:

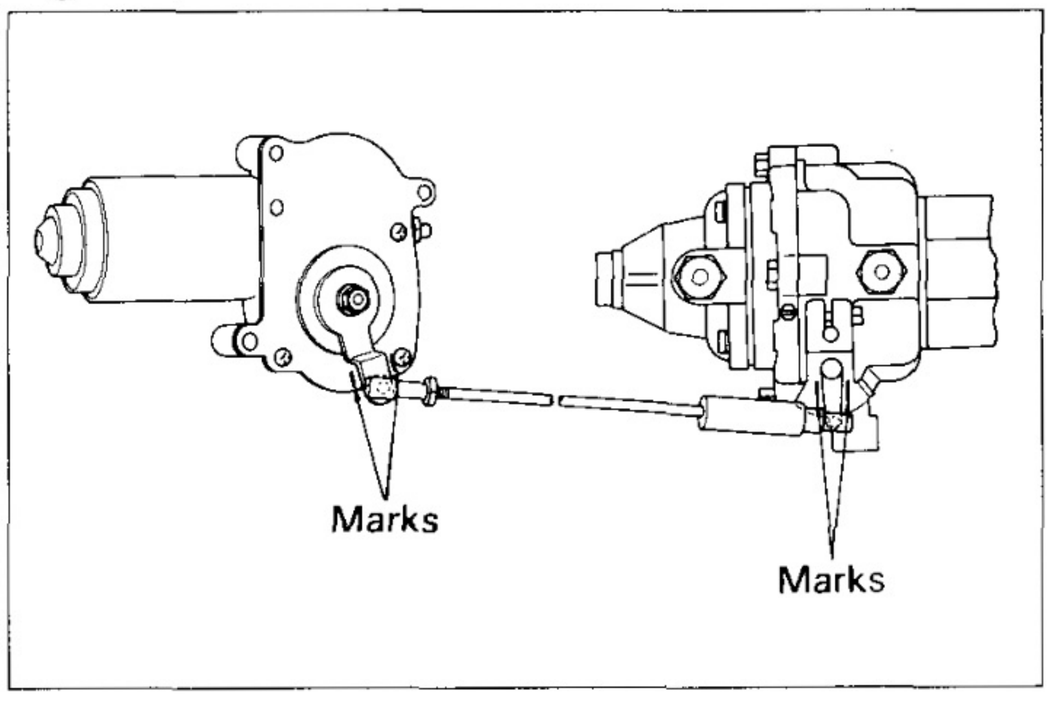
   12V type About 0.8Ω

   24V type About 3.3Ω

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

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

Fig. 7-9



INSTALLATION

1. Install the fuel control motor and connecting rod to the intake manifold.

—Note—

The fuel control motor lever should be positioned between the two marks while the engine is running.

Fig. 7-10



2. If necessary, adjust the connecting rod length.

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 HJ60

Fig. 8-1

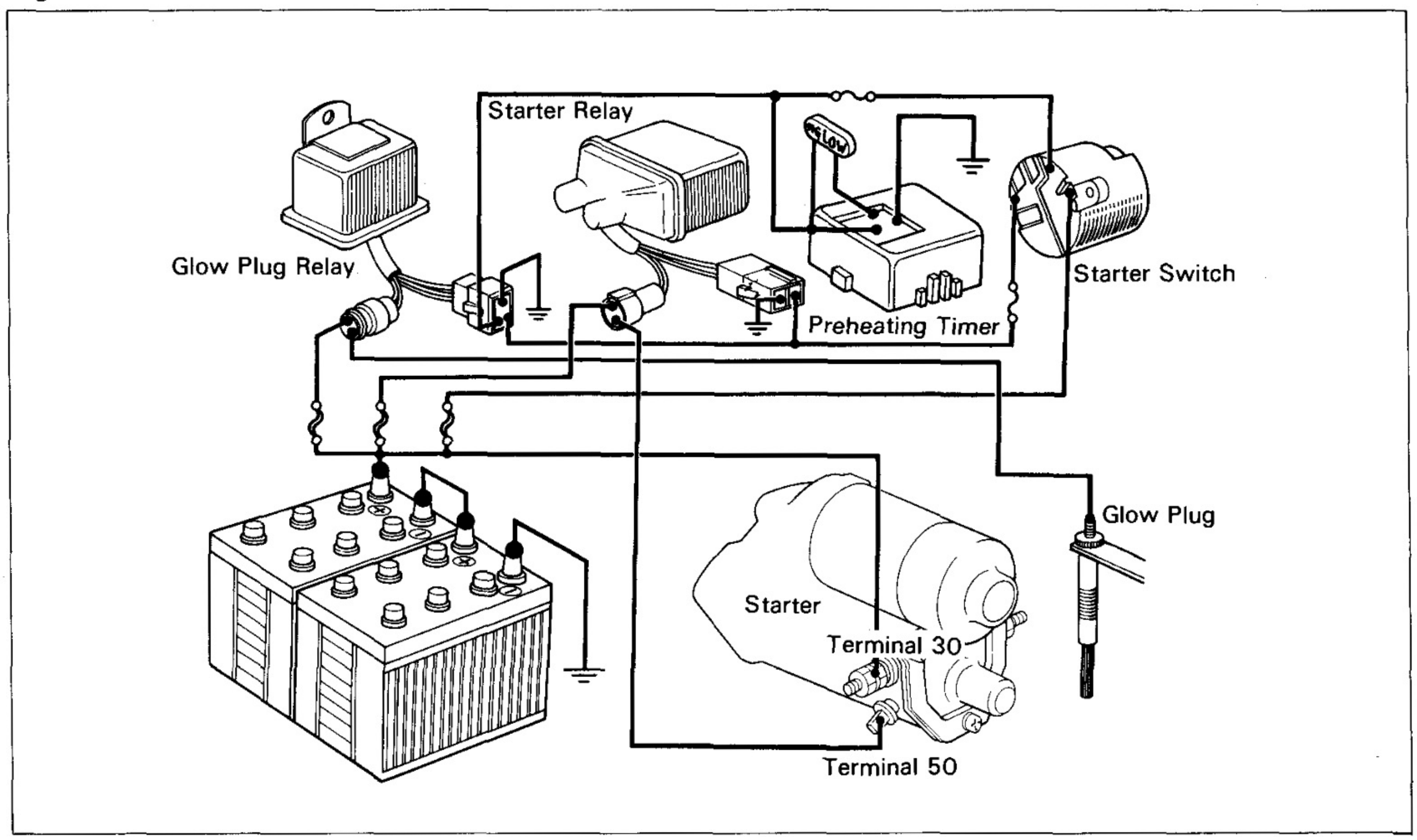
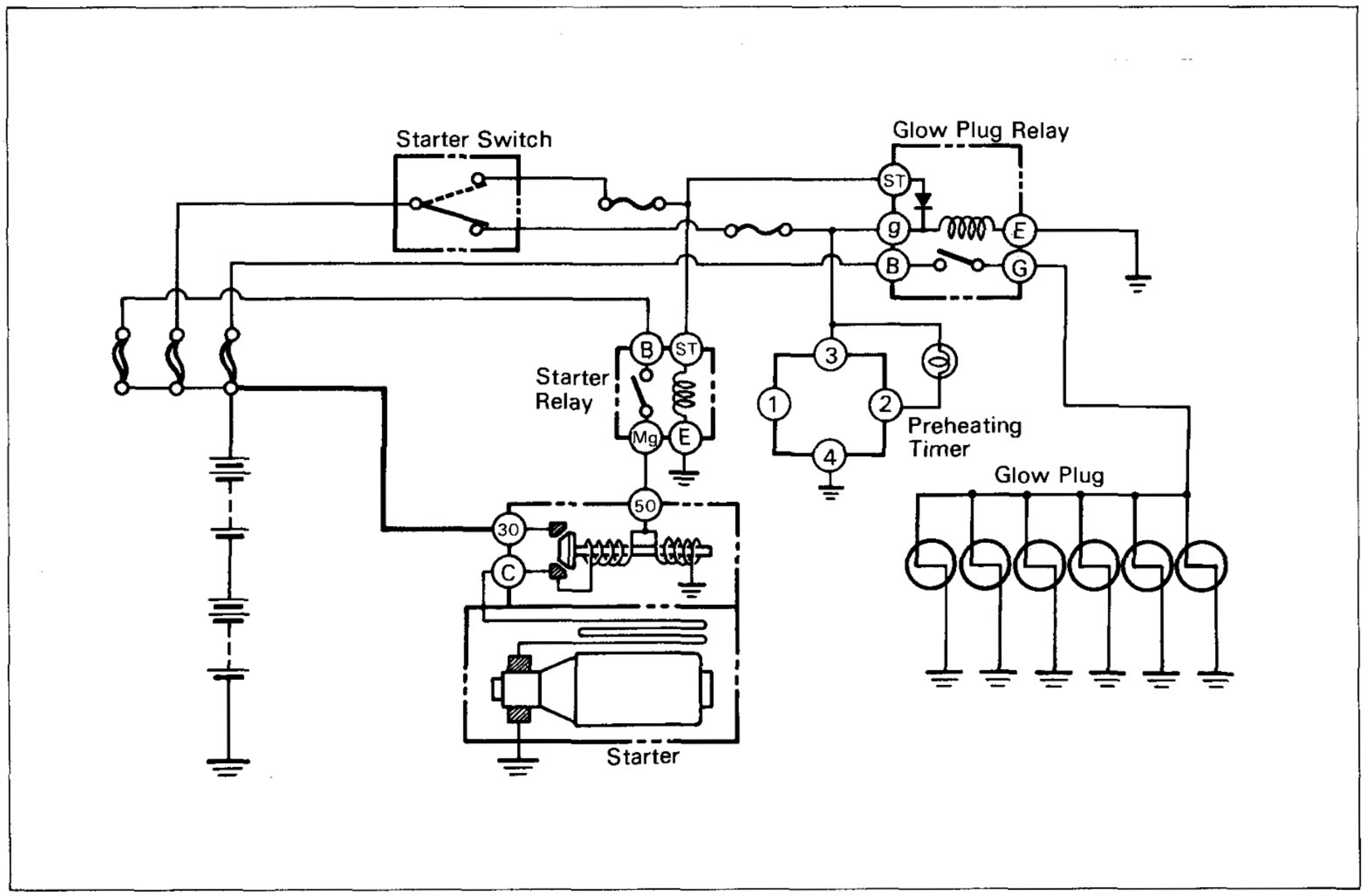


Fig. 8-2



For HJ47

Fig. 8-3

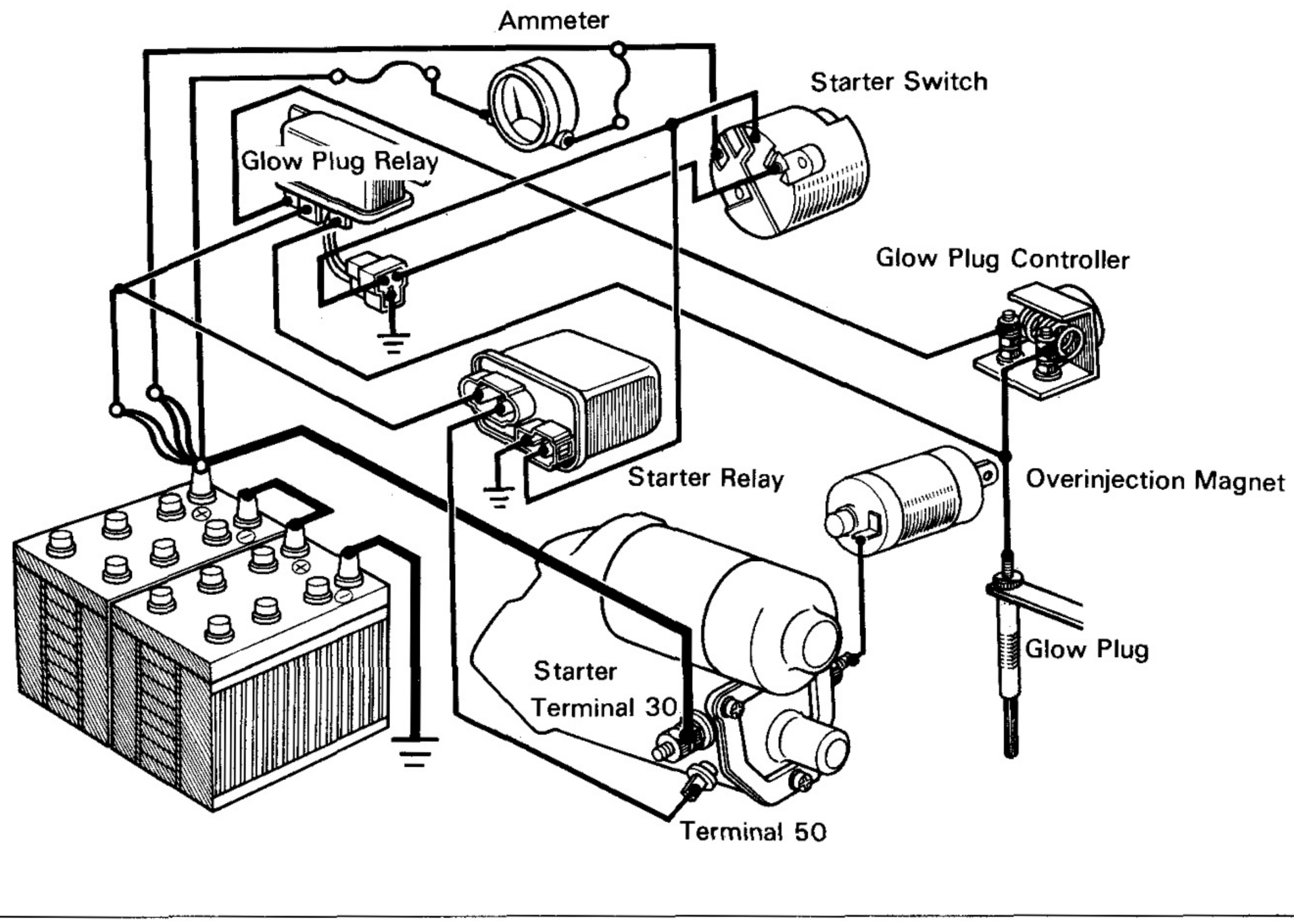


Fig. 8-4

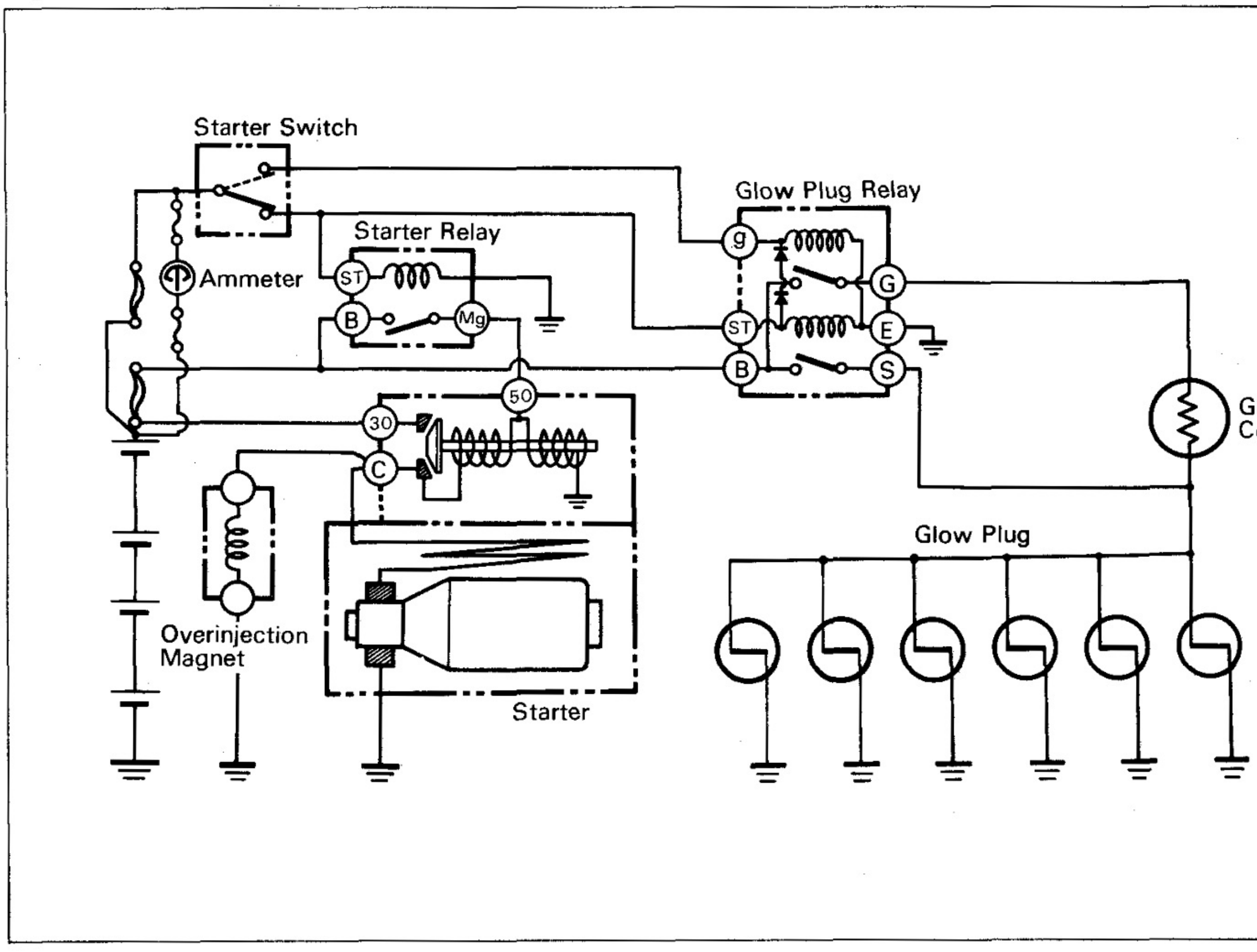
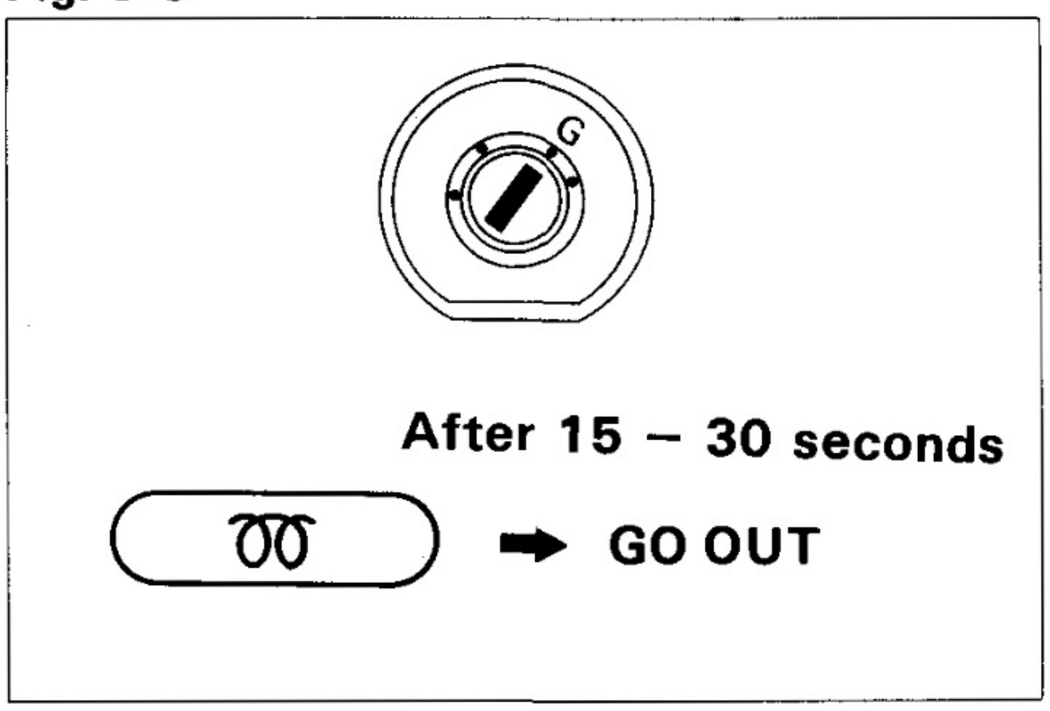


Fig. 8-5



PREHEATING SYSTEM

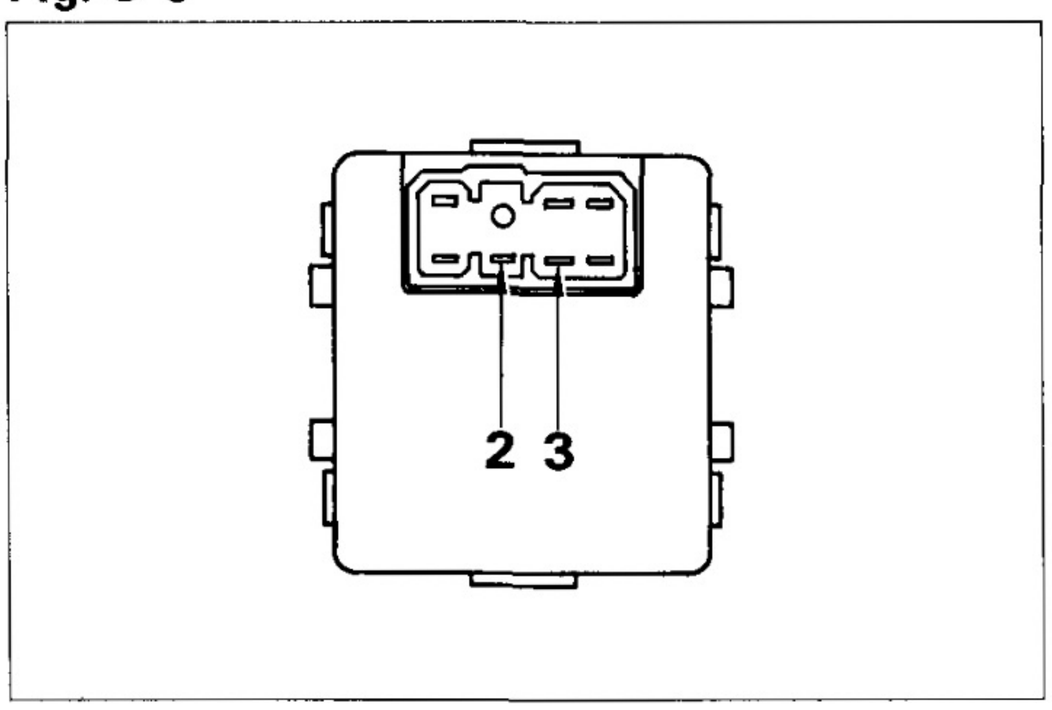
INSPECTION

Preheating Timer (for HJ60)

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

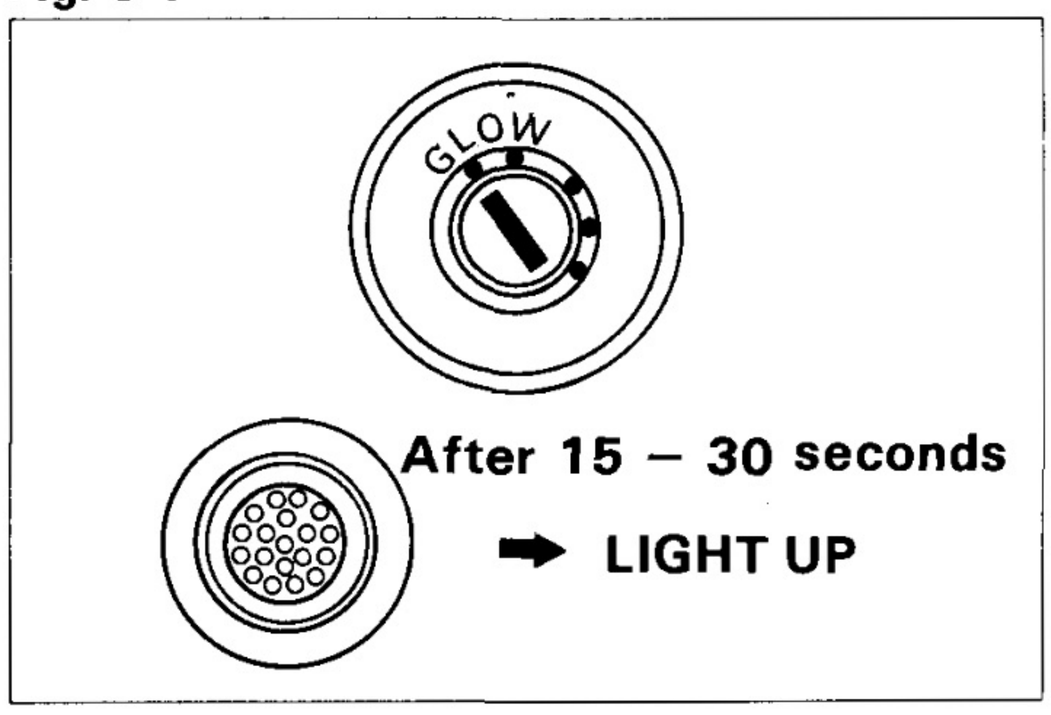
   Glow time: 15 – 30 seconds

Fig. 8-6



2. When the engine is started with the timer in operation, check that there is no continuity to the 2nd and 3rd terminals of the preheating timer.

Fig. 8-7

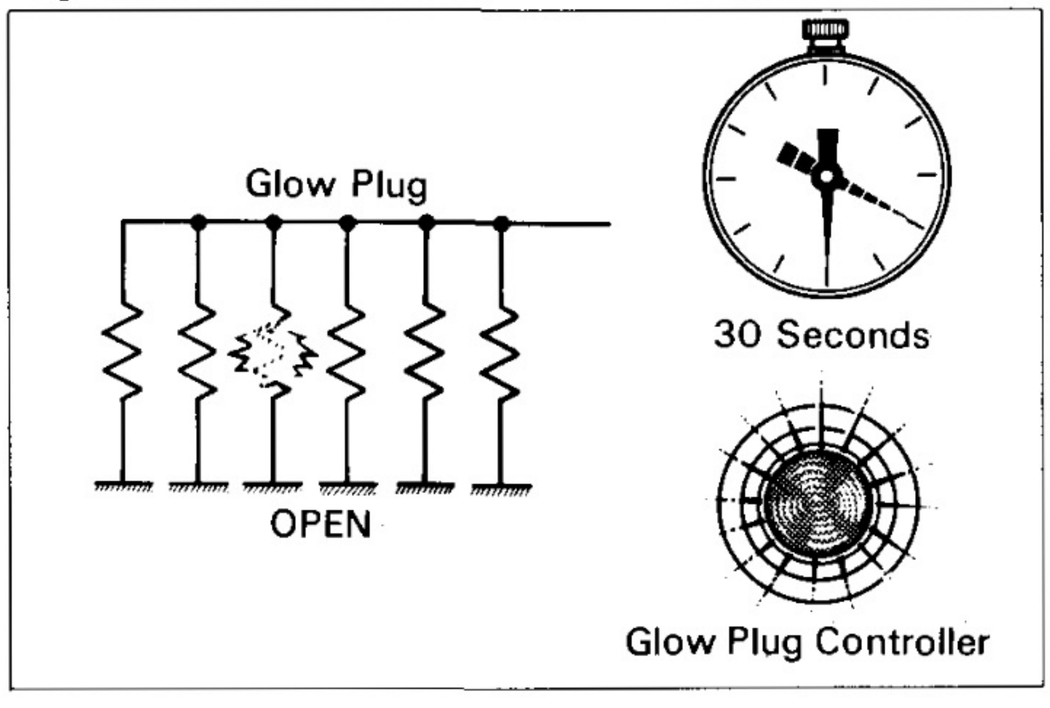


Glow Plug Controller (for HJ47)

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

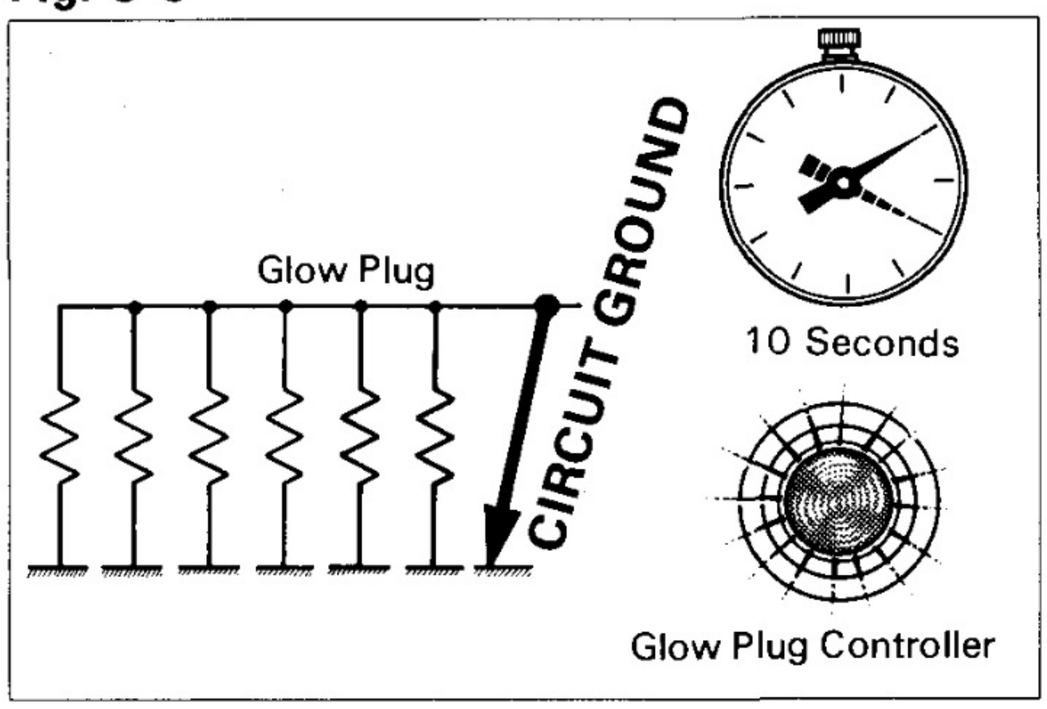
   Glow time: 15 – 30 seconds

Fig. 8-8



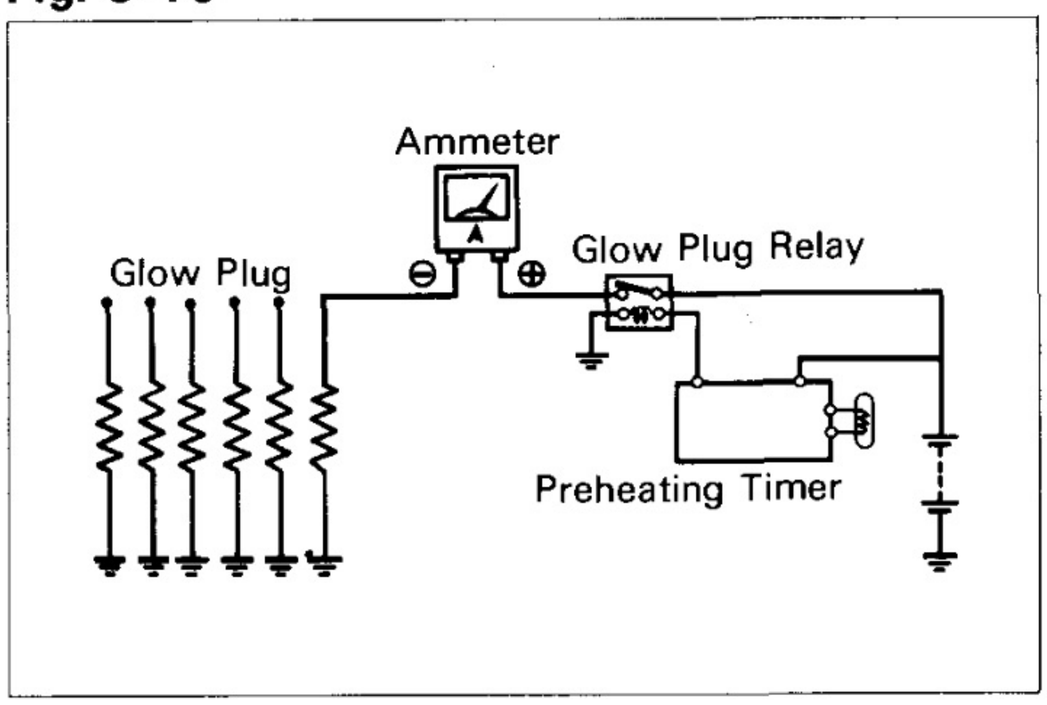
2. If glow time is more than 30 seconds, check the following conditions.
   (1) Open circuit in wiring
   (2) Loose terminal connection
   (3) Burnt switch or relay points
   (4) Open glow plug or controller

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



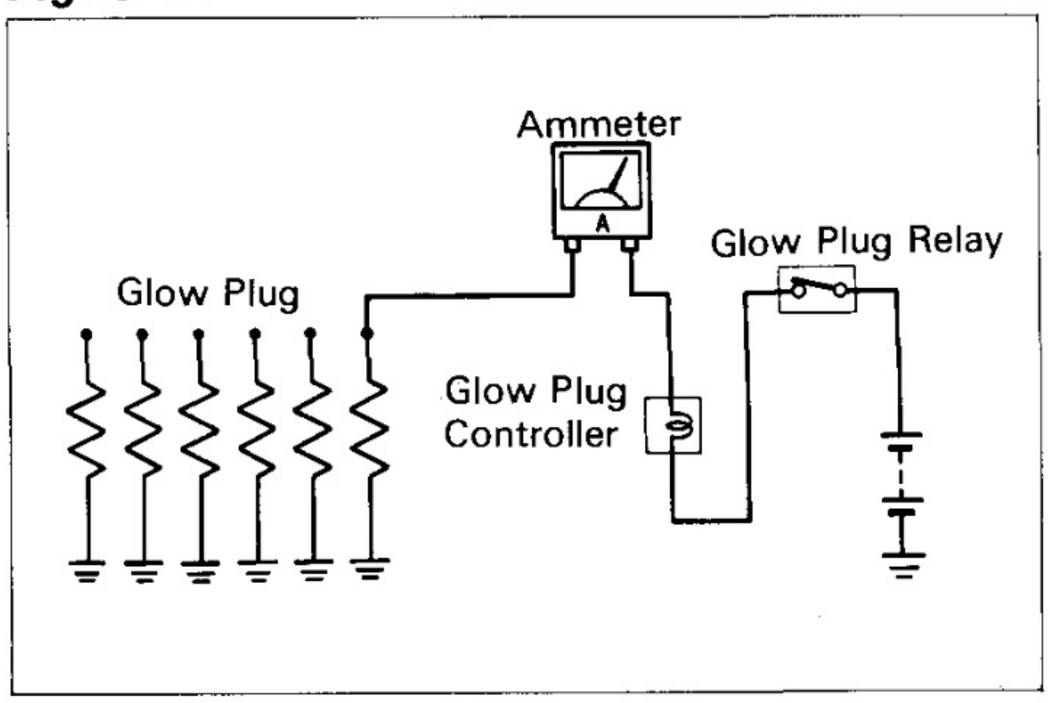
Load Current

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:

HJ60
12V type 7.2 — 9.8A
24V type 3.8 — 5.2A
HJ47
12V type 7.6 — 10.4A

Fig. 8-11



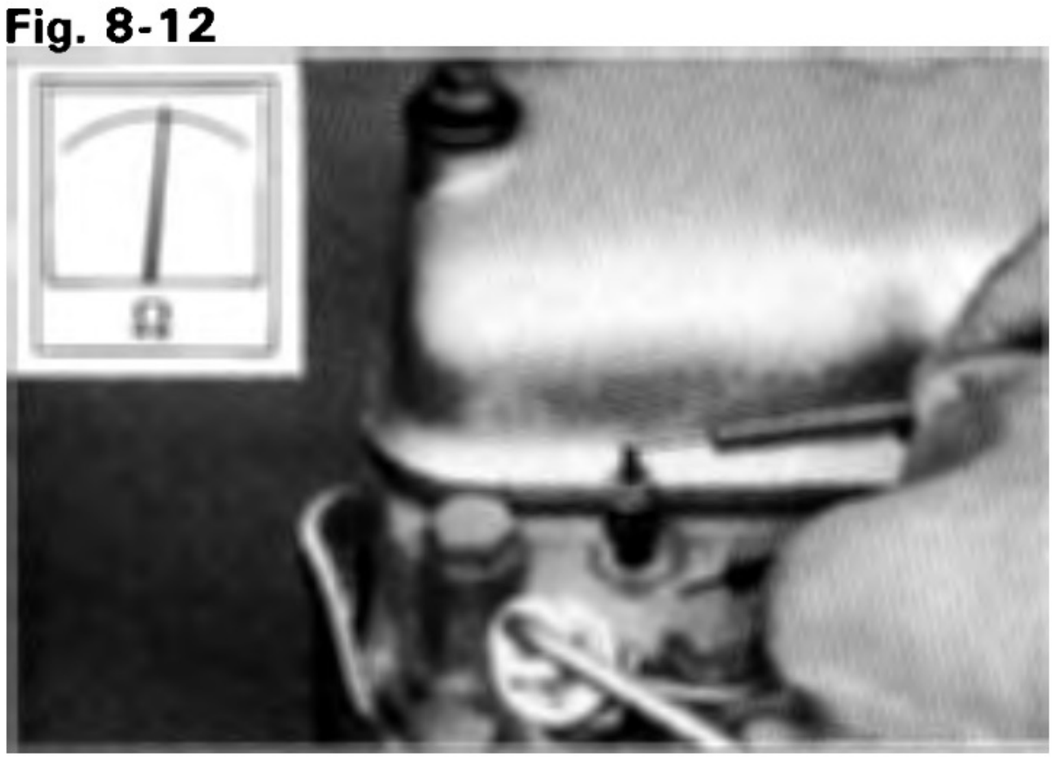
Glow Plug Resistance

Measure the glow plug resistance.

Resistance at 20°C (68°F):

HJ60
12V type 0.2Ω
24V type 1.0Ω
HJ47
12V type 0.2Ω

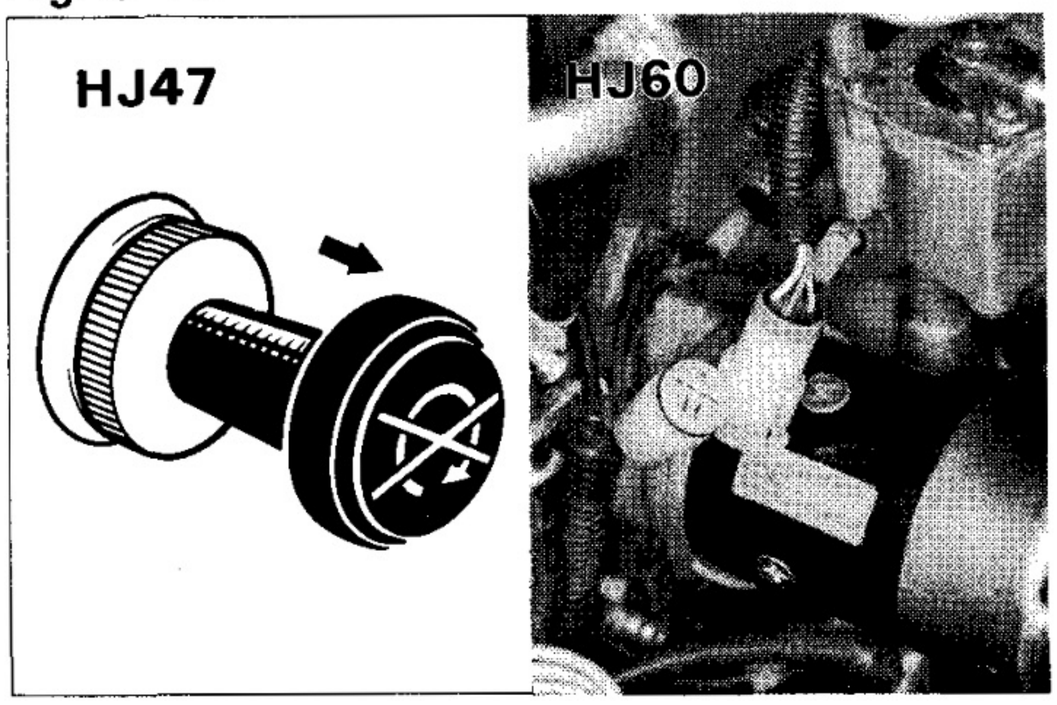
Fig. 8-12



—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 glow plug when cleaning.**
3. **At the time of inspection, be sure to 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 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 that there is a contact click noise when the starter switch is turned to the START position.

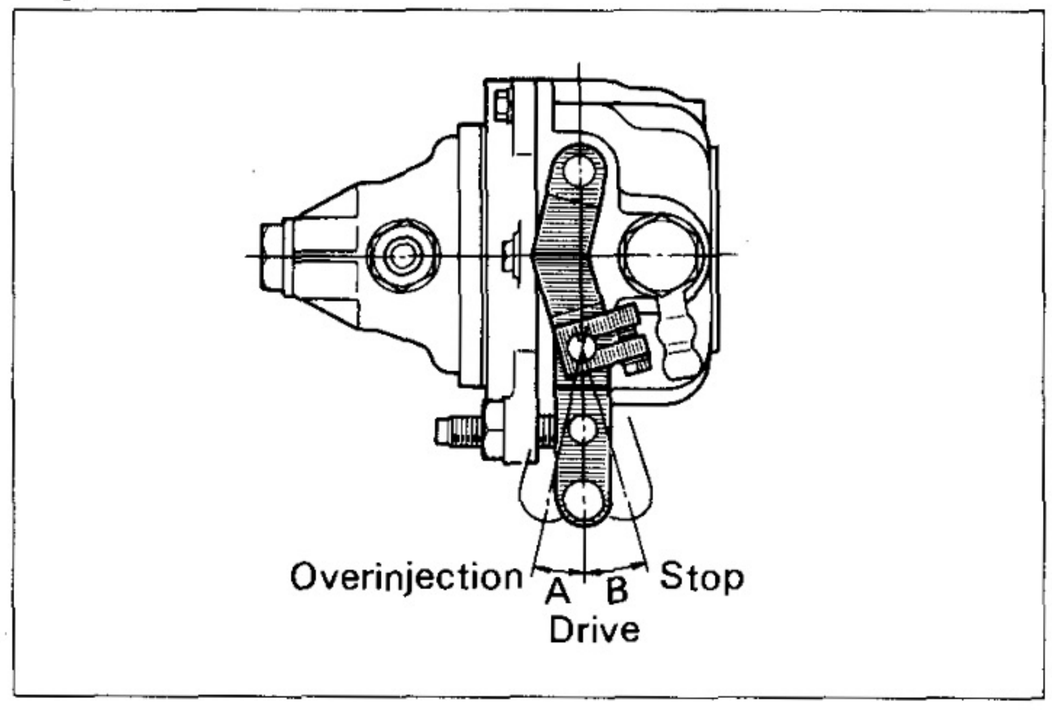
Fig. 8-16



Overinjection Magnet

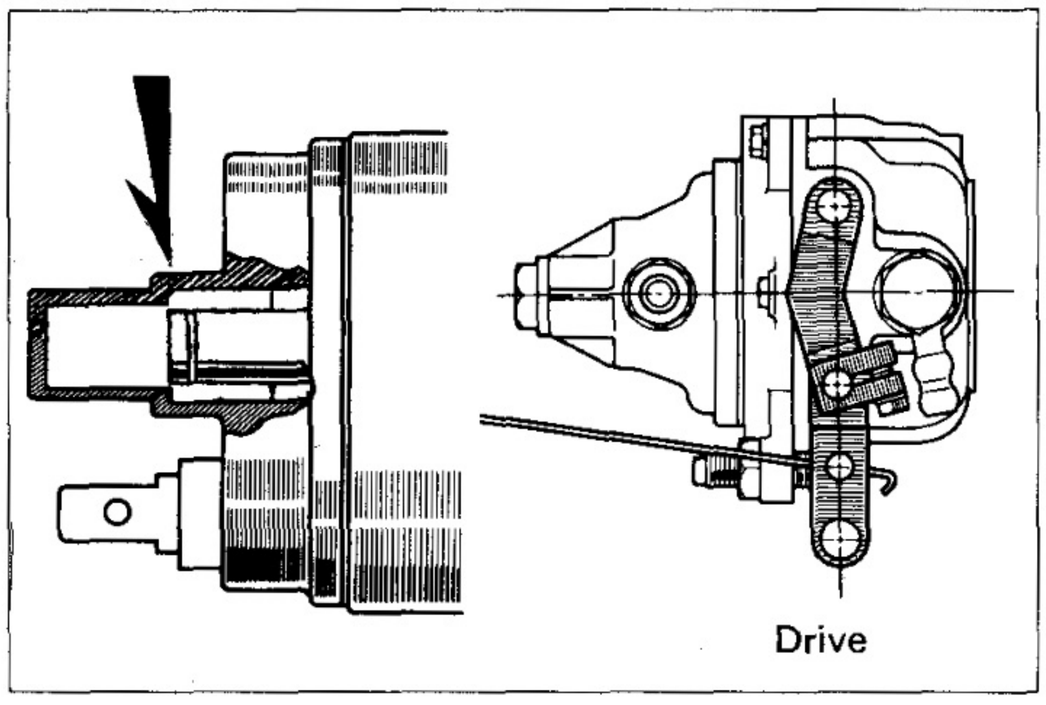
Check to see if the injection pump lever moves to the overinjection position when the starter switch is turned to START position.

Fig. 8-17



A: 12.5°
B: 16.0°

Fig. 8-18



When connecting the overinjection magnet connecting wire, position the magnet core end and pump lever as shown..

STARTER

CUTAWAY VIEW

Fig. 8-19

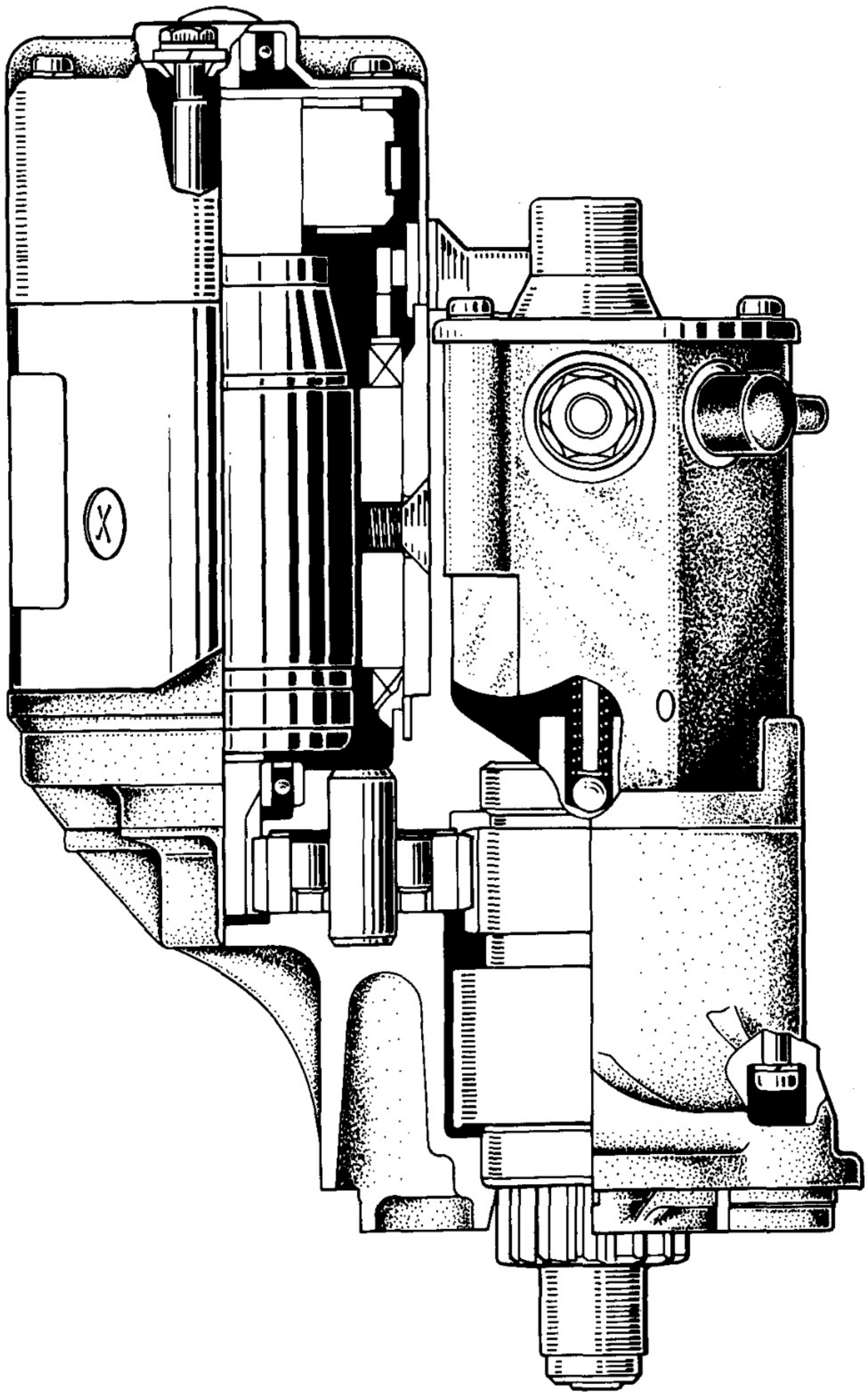
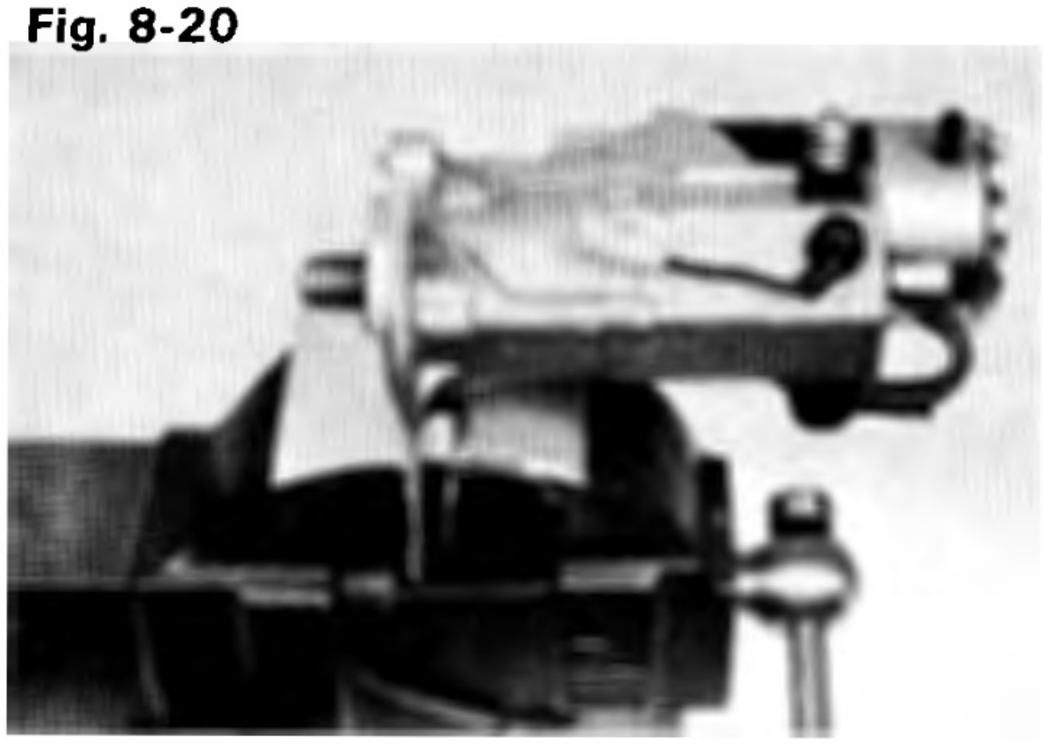


Fig. 8-20

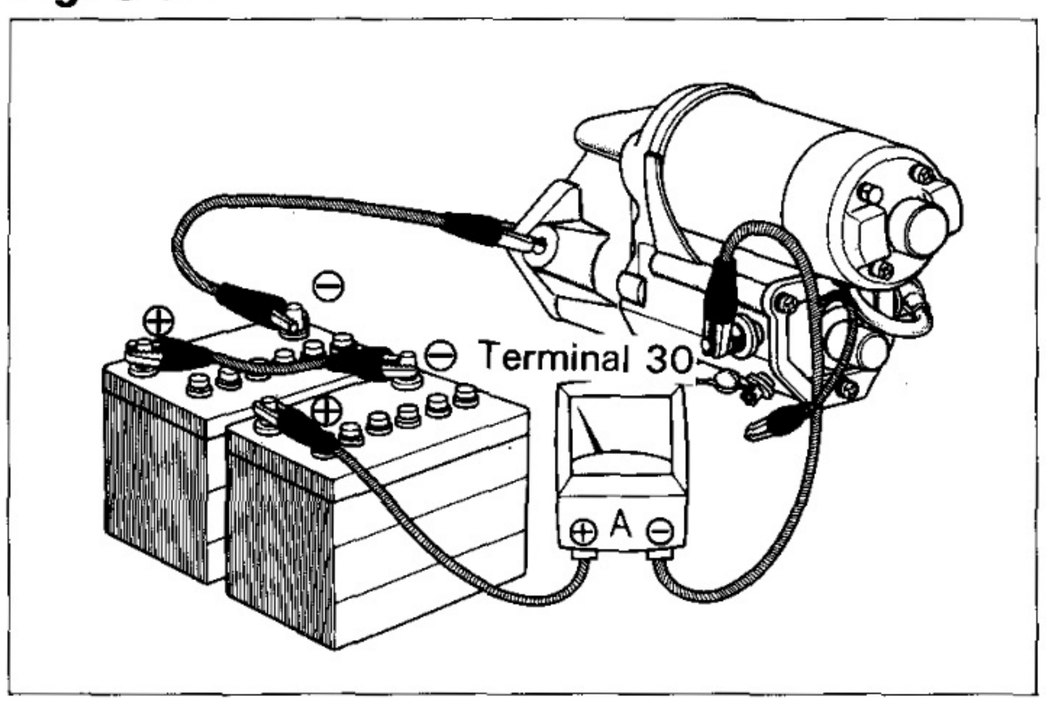


PERFORMANCE TEST

No-Load Performance Test

1. Secure the starter in a vise to prevent an accident.

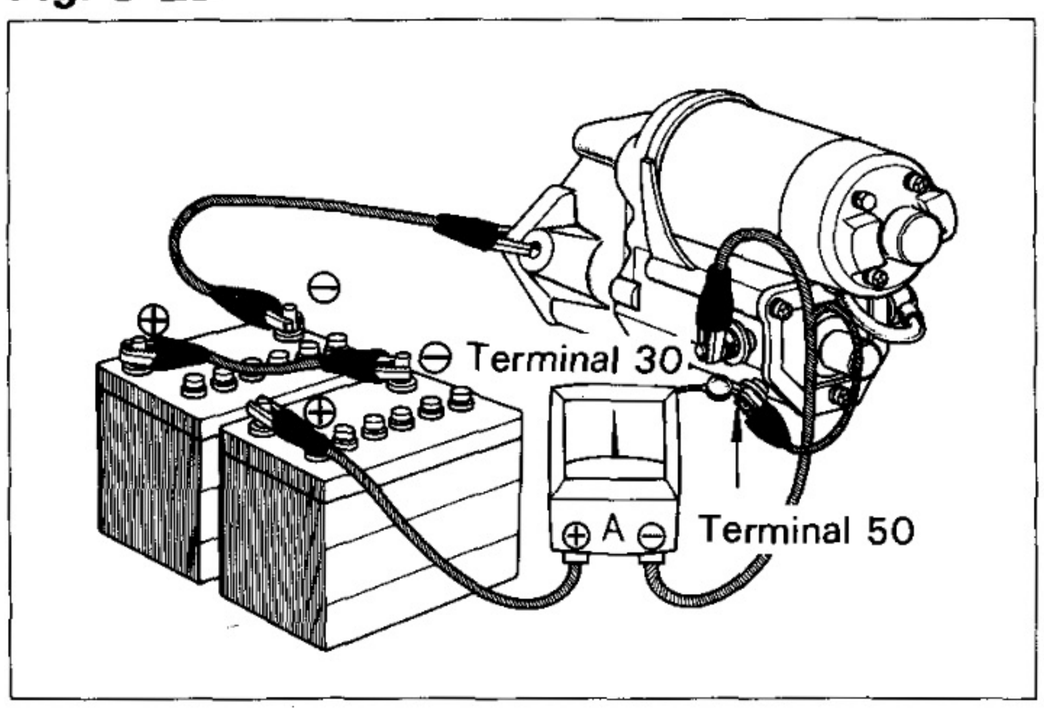
Fig. 8-21



2. Connect the starter to the battery as shown in the figure.

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

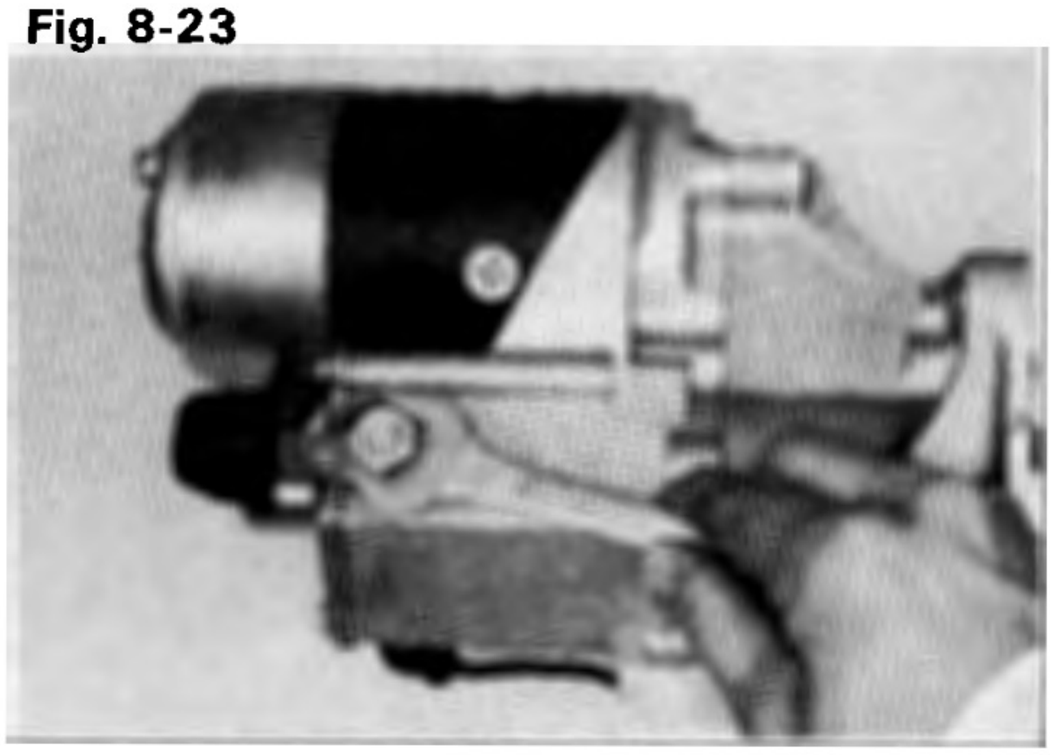
Fig. 8-22



3. Connect the positive wire to the terminal 50.
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

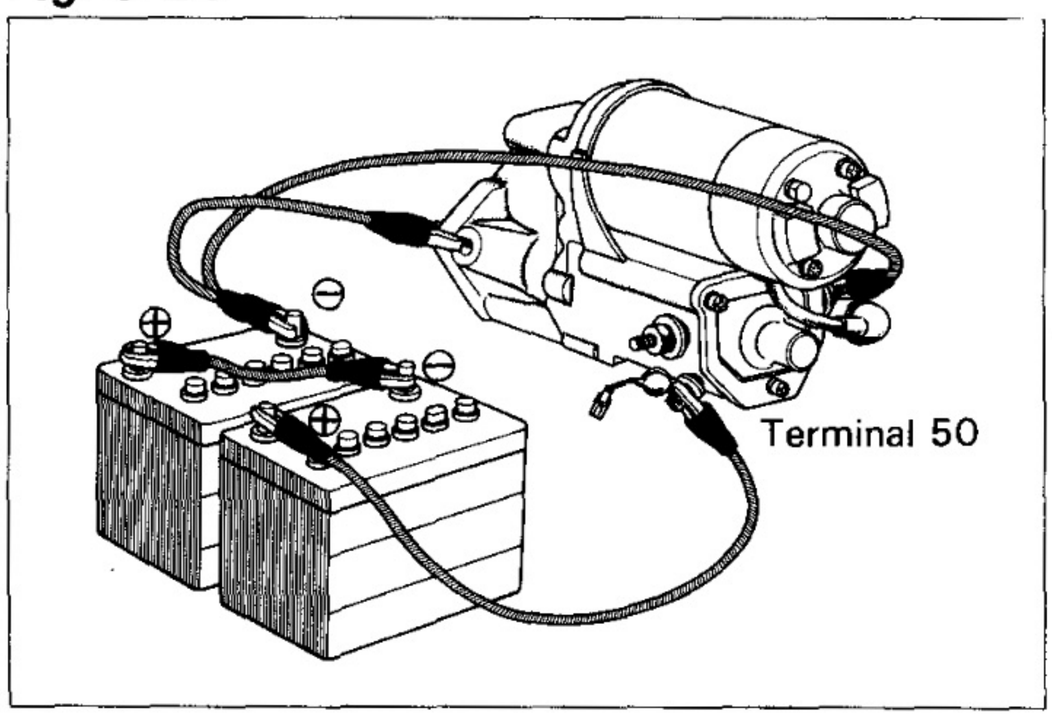


Magnetic Switch Test

—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

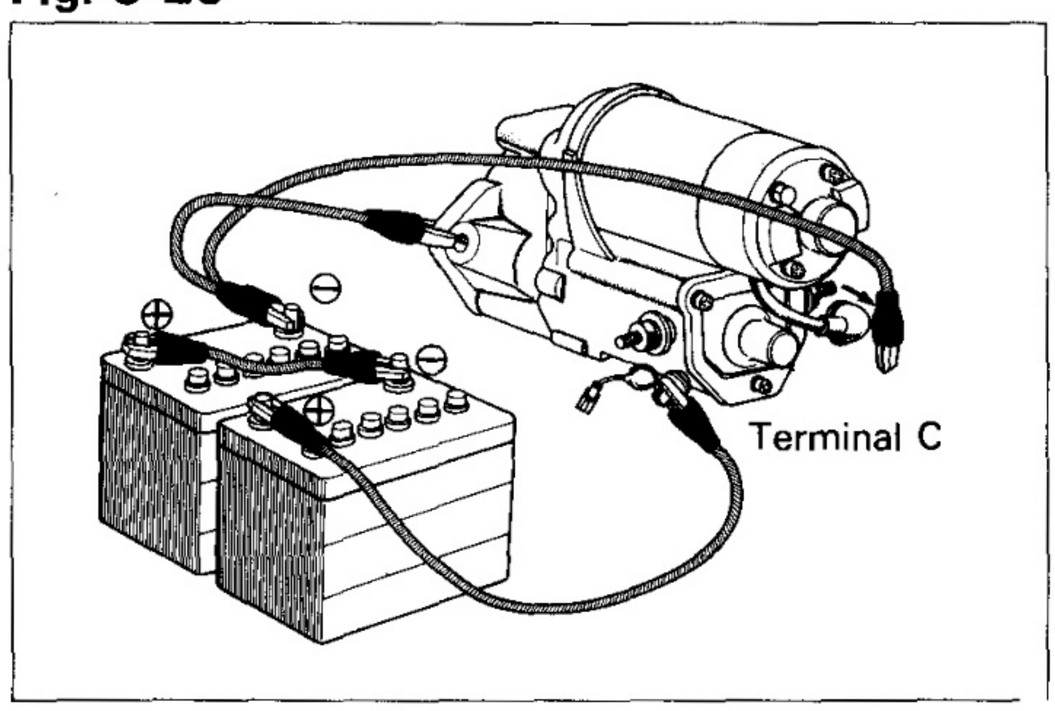


2. Test pull-in coil.
Connect the magnetic switch to the battery as shown in the figure. The pinion should jump out.

Negative side
Battery (—) ——→ Starter housing and terminal

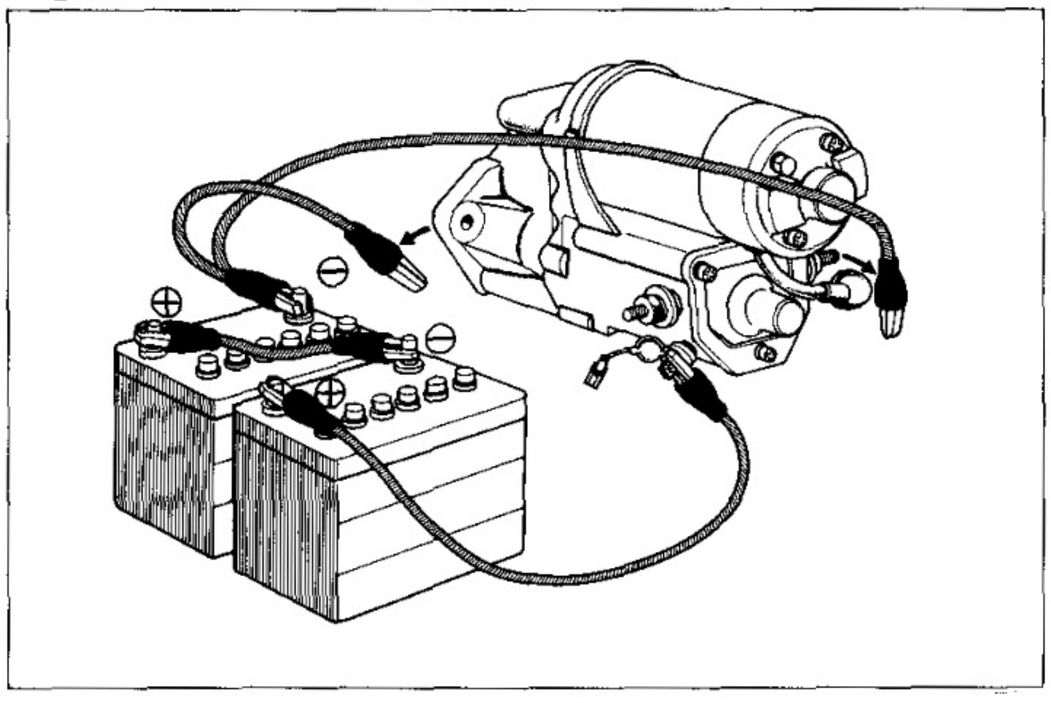
Positive side
Battery (+) ——→ Terminal 50

Fig. 8-25



3. Test hold-in coil.
With the same connections as in the "Pull-in coil test", disconnect terminal C. At this time, the pinion should remain in protruding condition.

Fig. 8-26

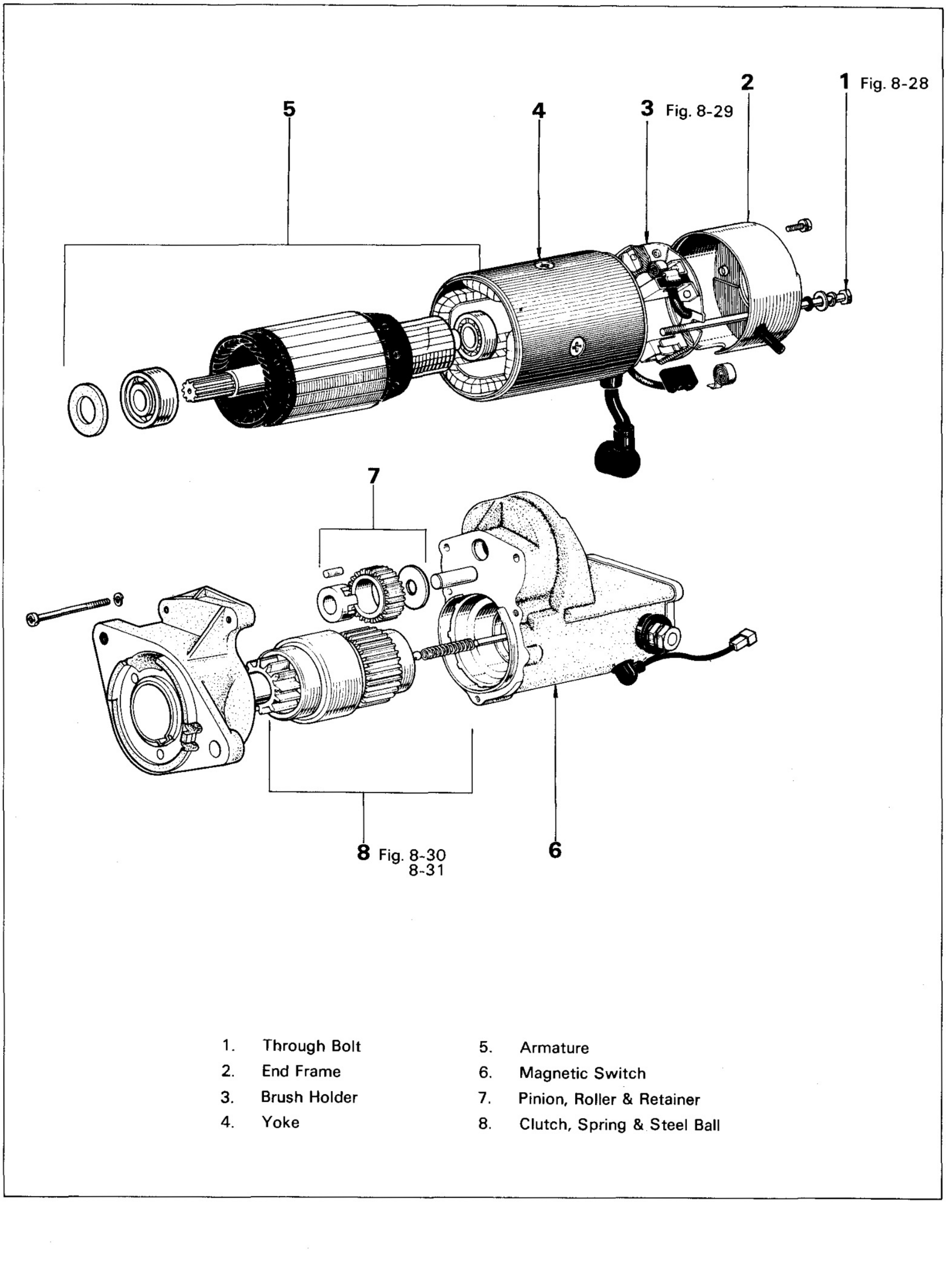


4. Check pinion return.
When disconnecting the cable from the starter housing, the protruded pinion should return quickly.

DISASSEMBLY

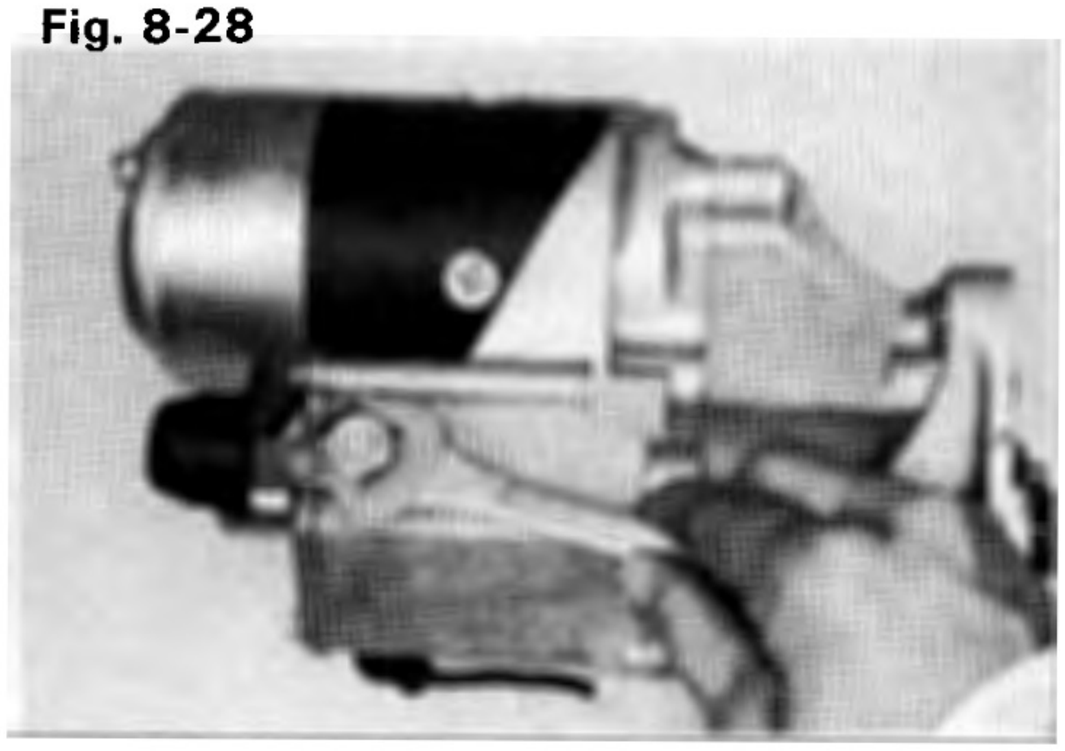
Disassemble the parts in the numerical order shown in the figure.

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.

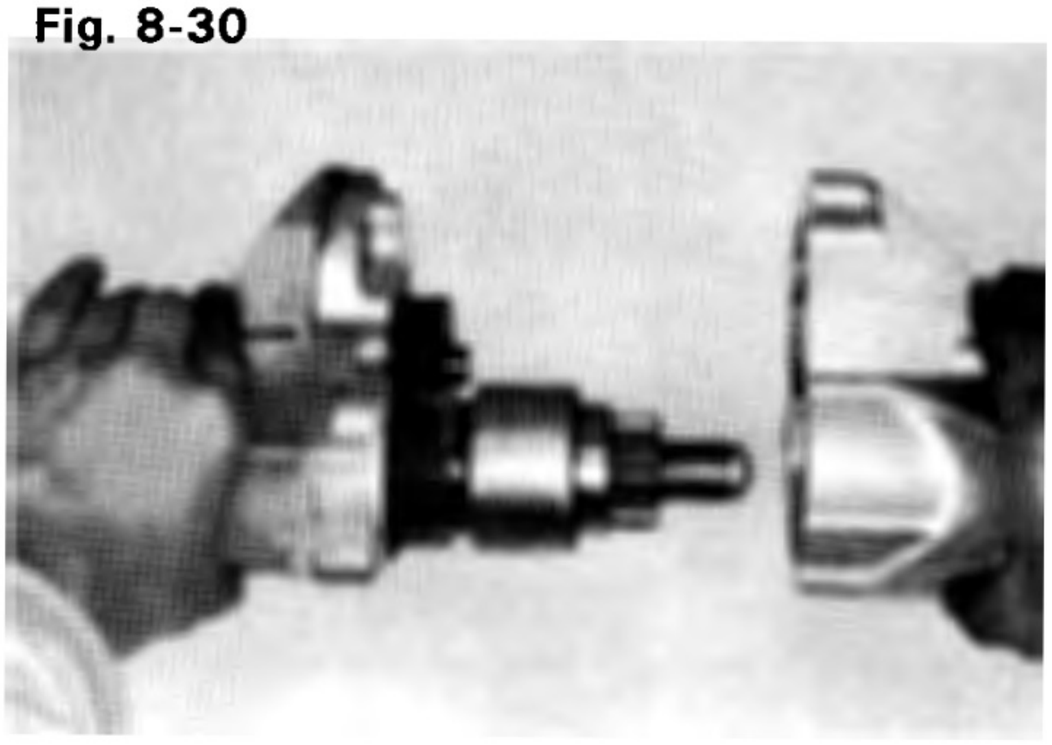
Fig. 8-29



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

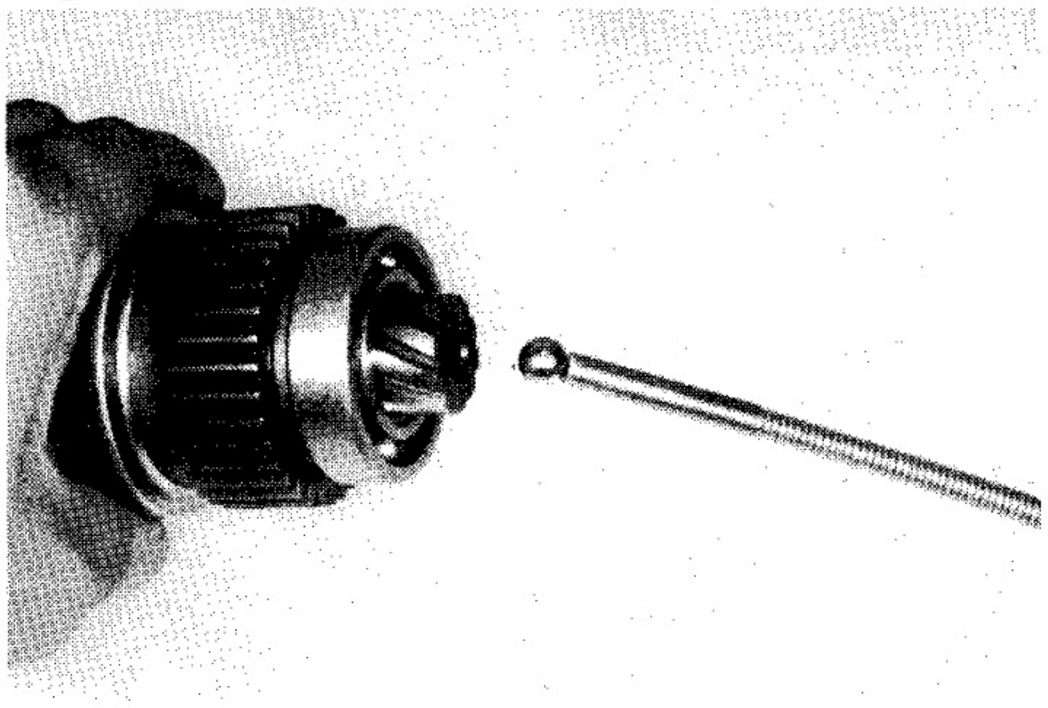
—Note—
Use care not to damage the brush and commutator and do not allow oil or grease to get on them.

Fig. 8-30



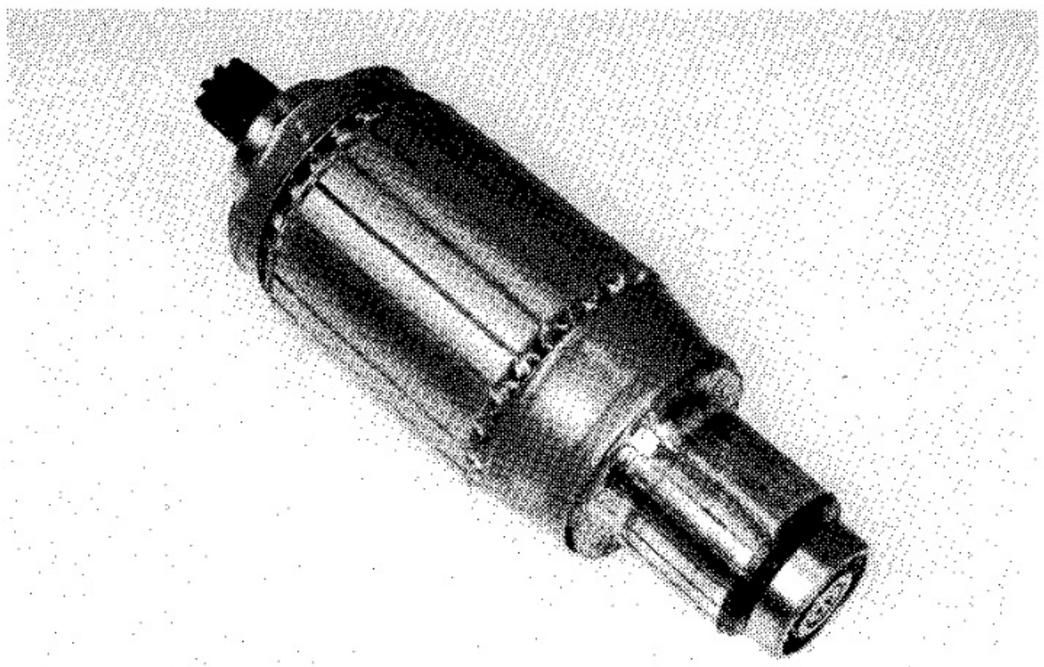
Remove the starter housing together with the idler gear and clutch.

Fig. 8-31



Take the steel ball out from the clutch shaft hole.

Fig. 8-32



INSPECTION & REPAIR

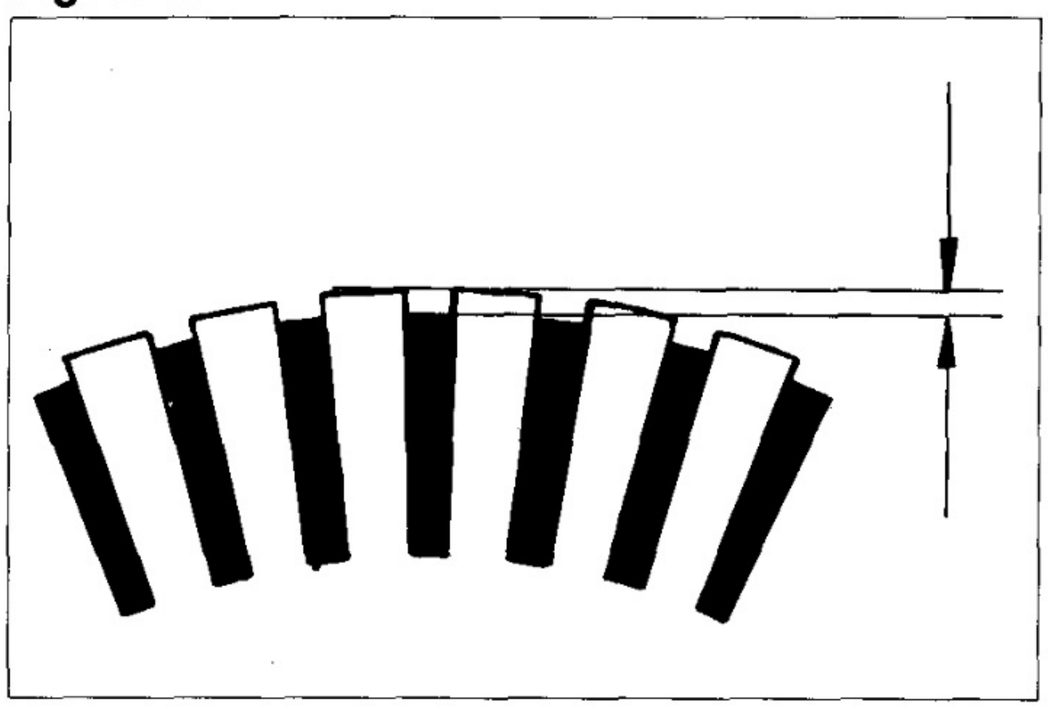
Wipe off dirt and grease from the disassembled parts.

Commutator

Check for the following items and repair or replace as necessary.

1. Dirty or burnt surface:
   Correct with sandpaper or a lathe if necessary.

Fig. 8-33

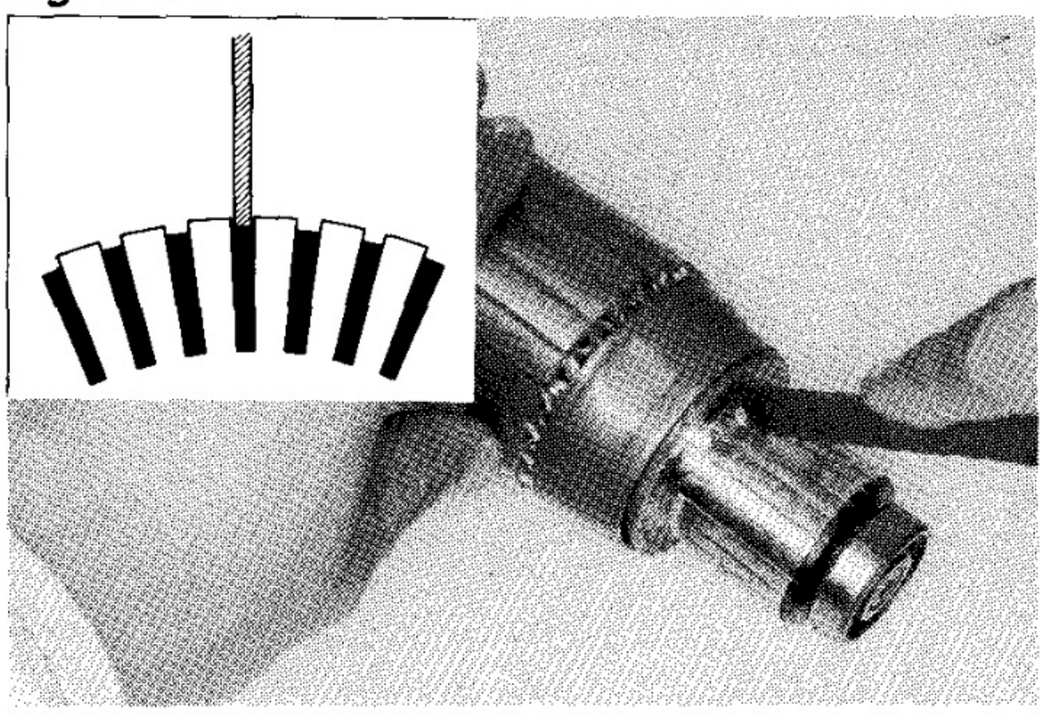


2. Depth of segment mica:

Mica depth:

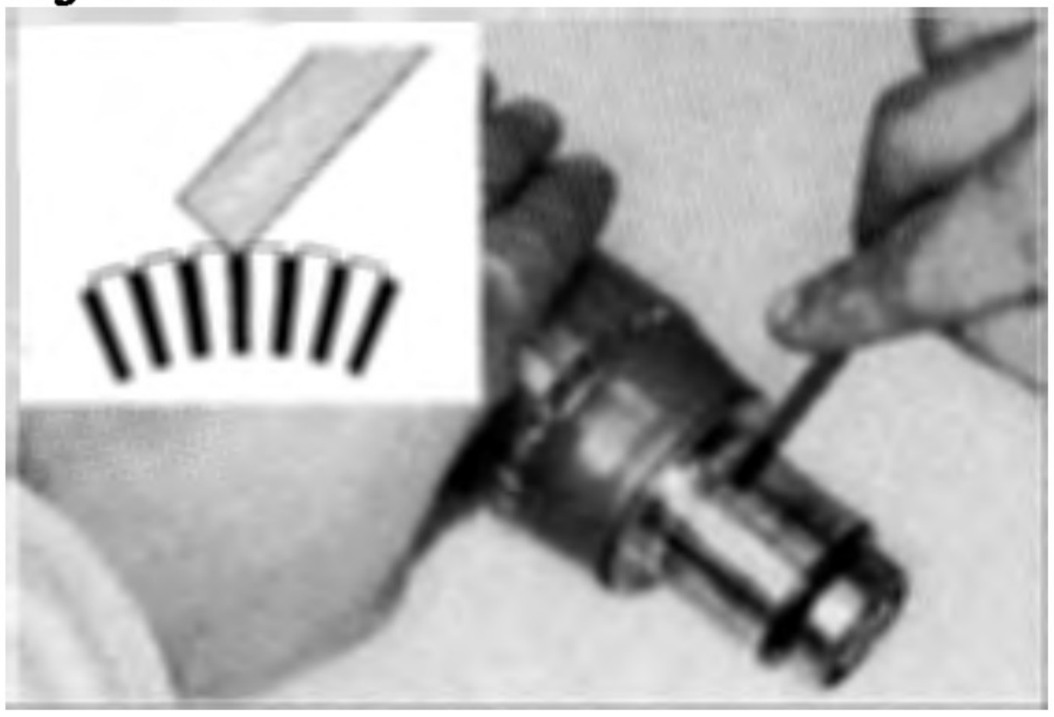
STD	**0.7 – 0.9 mm (0.028 – 0.035 in.)**
Limit	**0.2 mm (0.008 in.)**

Fig. 8-34



3. If the mica depth is below the limit, repair the segment mica.
   (1) Correct with a hacksaw blade.

Fig. 8-35



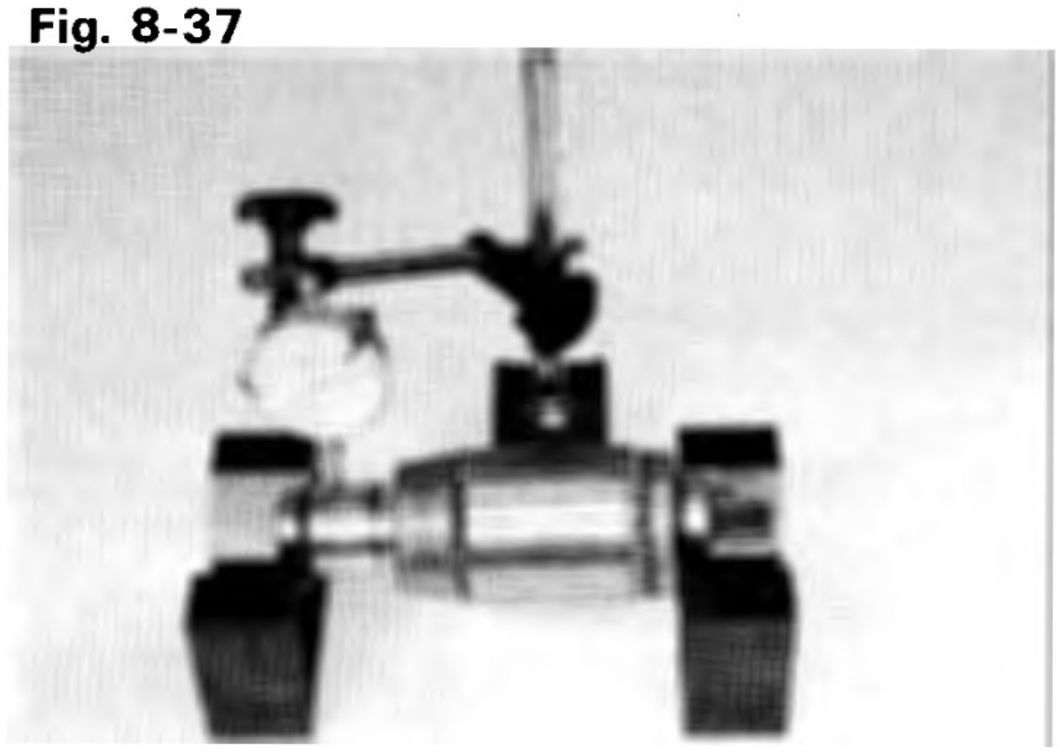
   (2) Smooth out the edge with a hacksaw blade.

Fig. 8-36



(3) After correcting, eliminate chips with #400 sandpaper.

Fig. 8-37



4. Runout:
Correct on a lathe if it exceeds the limit.

Runout:

STD	**Less than 0.05 mm (0.0020 in.)**
Limit	**0.05 mm (0.0020 in.)**

Fig. 8-38

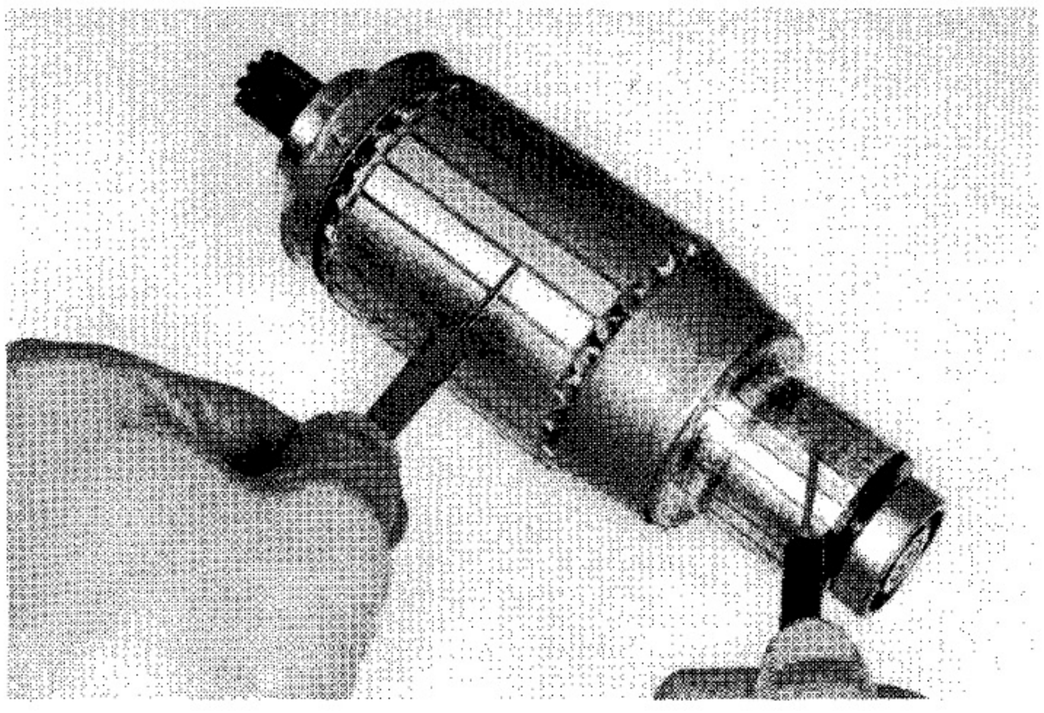


5. Diameter wear:
If the diameter is less than the limit, replace the armature.

Outer diameter:

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

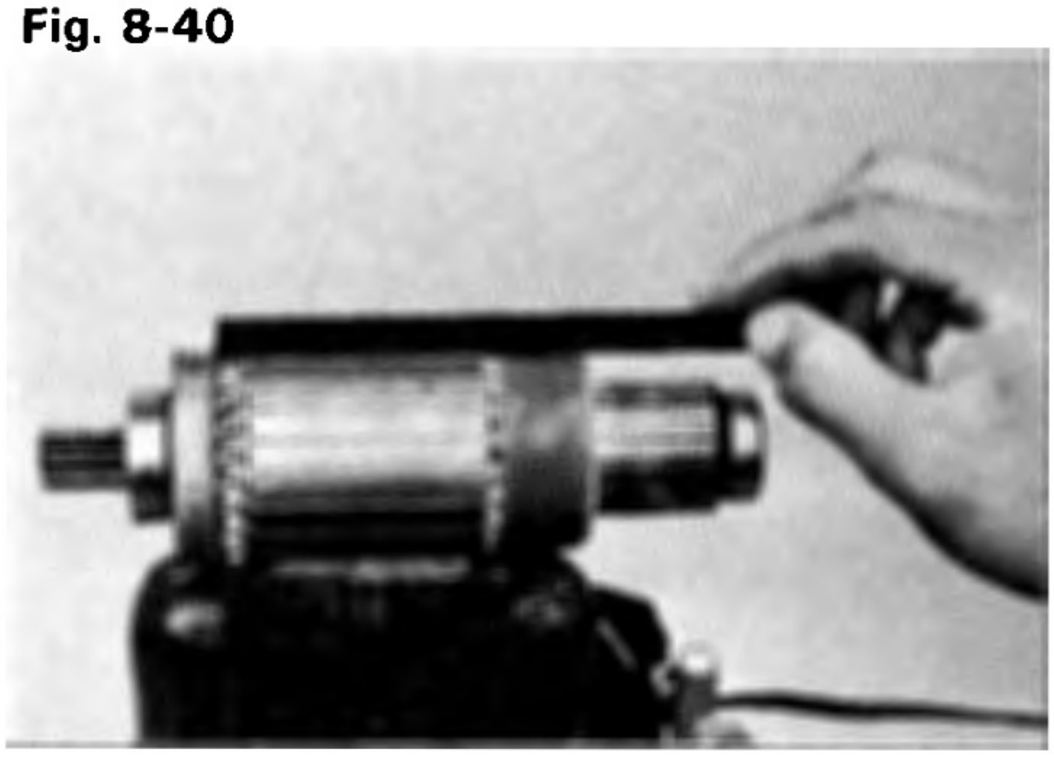
Fig. 8-39



Armature Coil

1. Ground test:
Using an armature tester or a circuit tester, 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



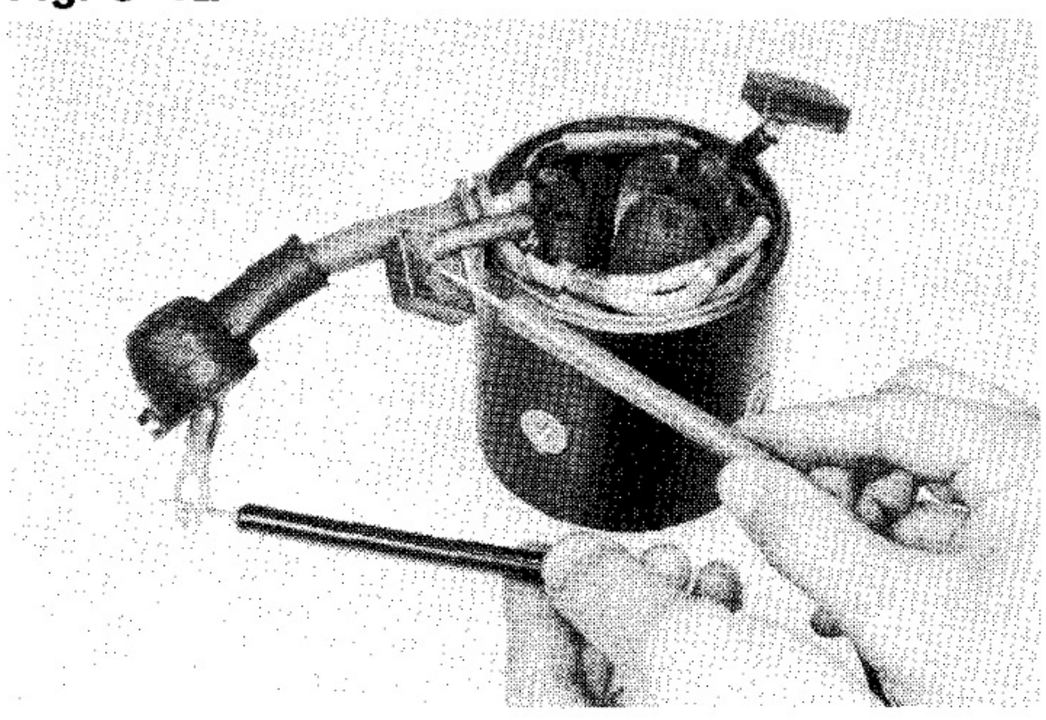
2. Short circuit test:
Place the armature on the armature tester and hold a hacksaw blade against the armature core while turning the armature. If the hacksaw blade is attracted or vibrates, the armature is shorted and must be replaced.

Fig. 8-41



3. Open circuit test:
Using the 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.

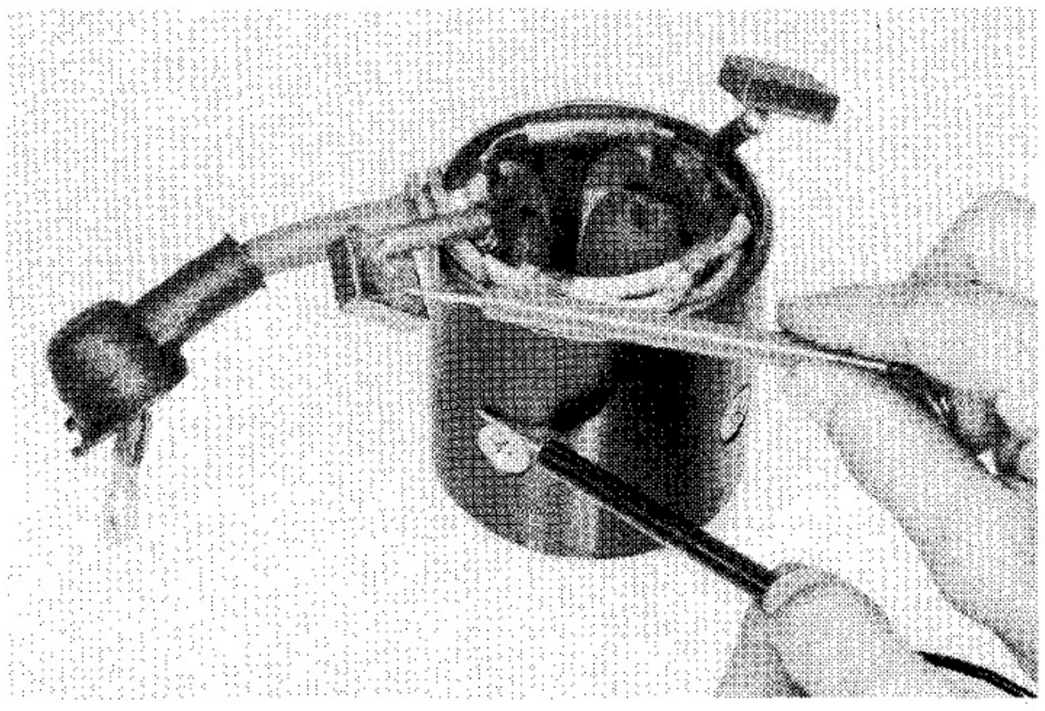
Fig. 8-42



Field Coil

1. Open circuit test:
Check for continuity between 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



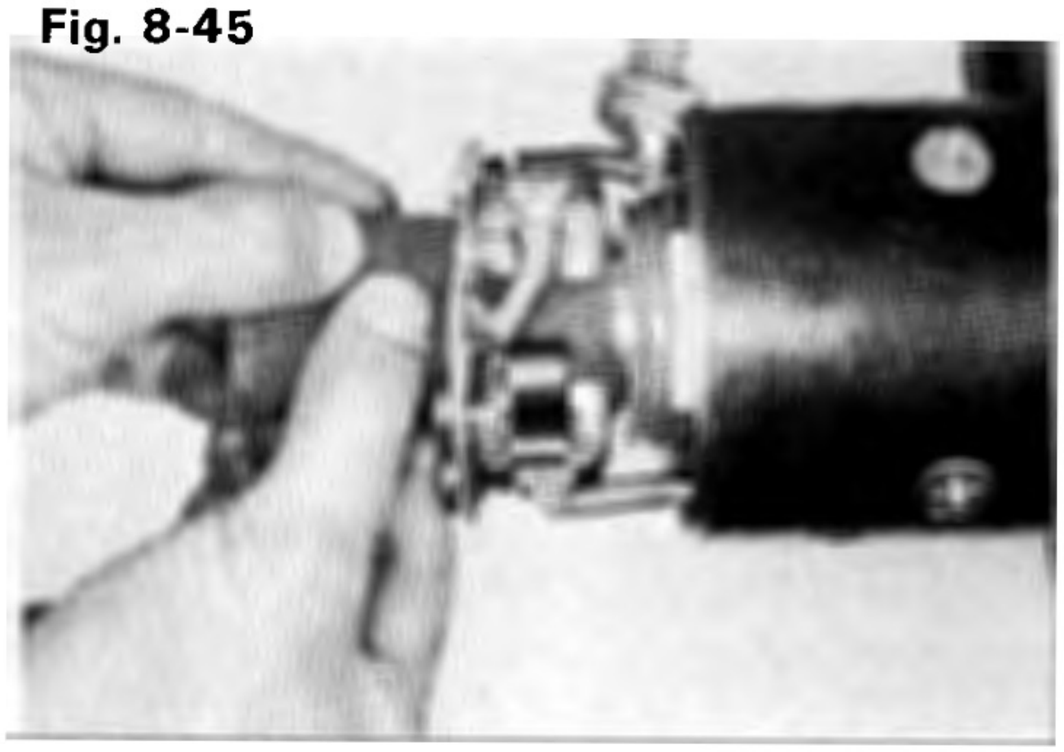
Brush

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.)**

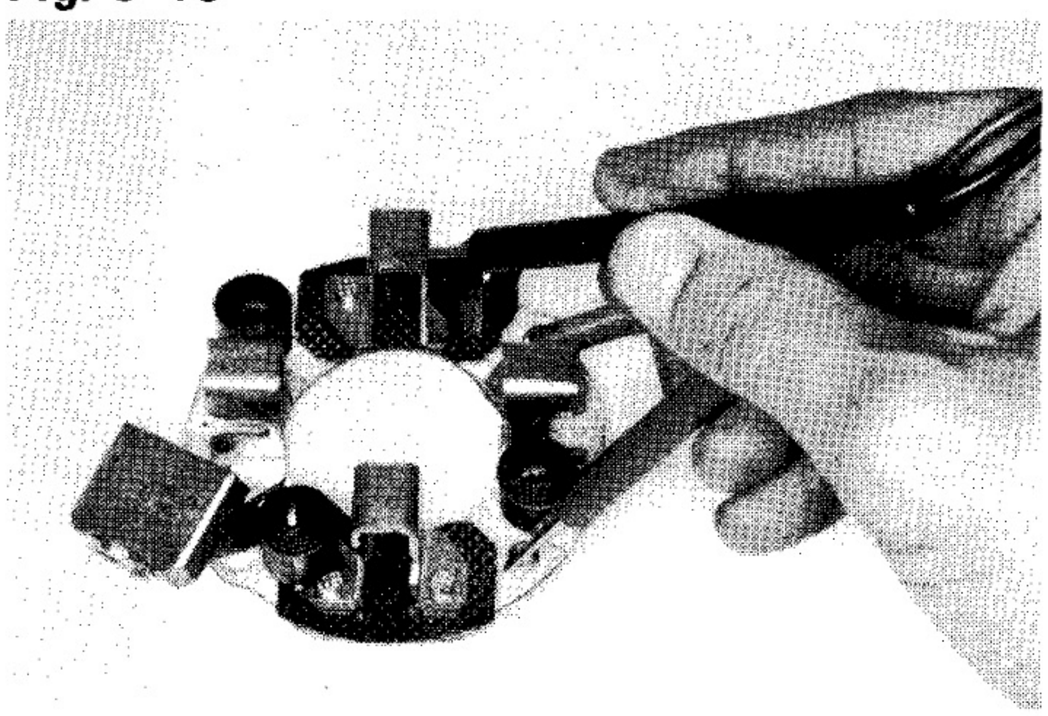
Fig. 8-45



2. Using #400 sandpaper, clean and fit the brushes so they make proper contact with the commutator.

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

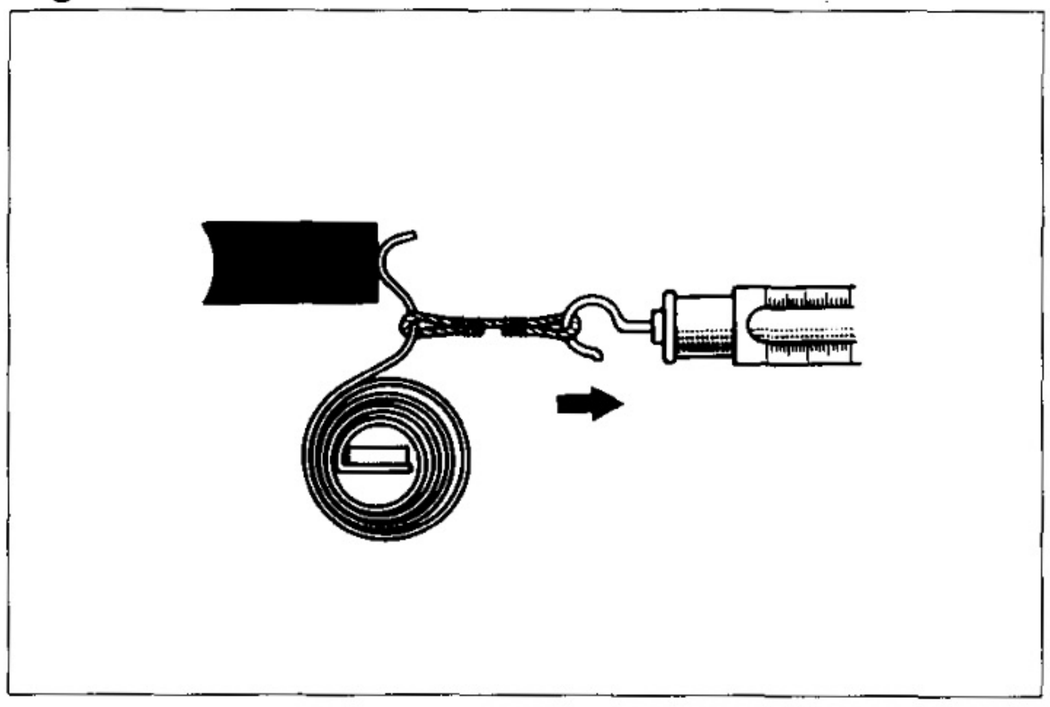
Fig. 8-46



Brush Holder

Check insulation between the (+) side brush holder and holder plate.
If there is continuity, repair or replace the brush holder.

Fig. 8-47



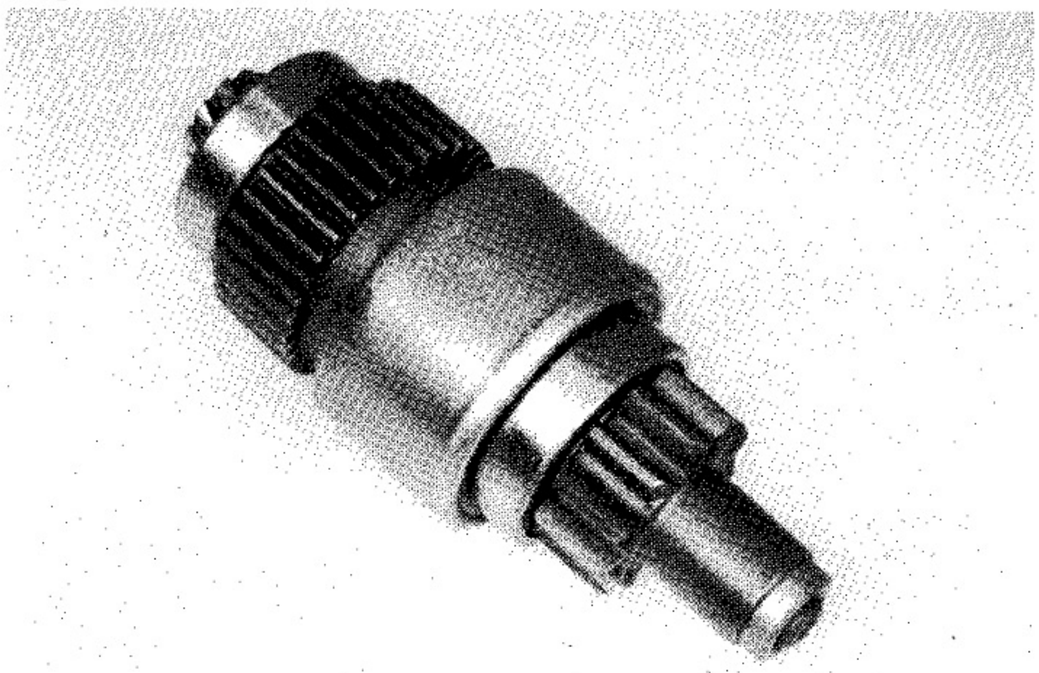
Brush Spring

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 (7.1 — 8.8 lb)

Fig. 8-48



Clutch & Gear

1. Check the gear teeth for wear or damage. Replace if damaged. If damaged, also inspect flywheel ring gear for same.

Fig. 8-49



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

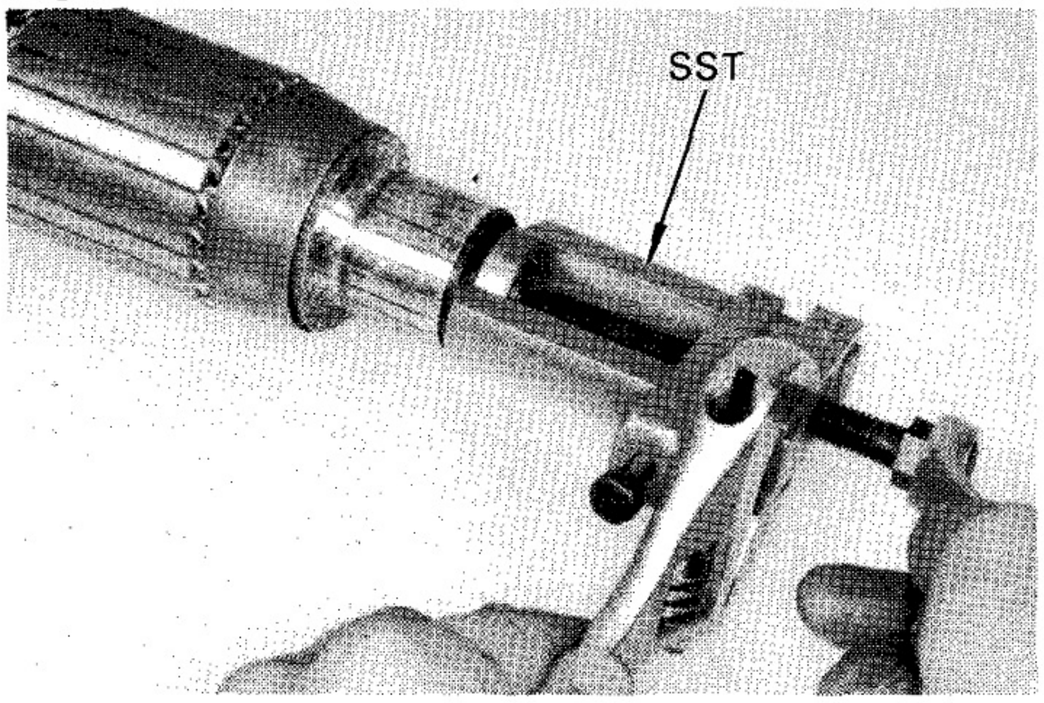
Fig. 8-50



Bearing

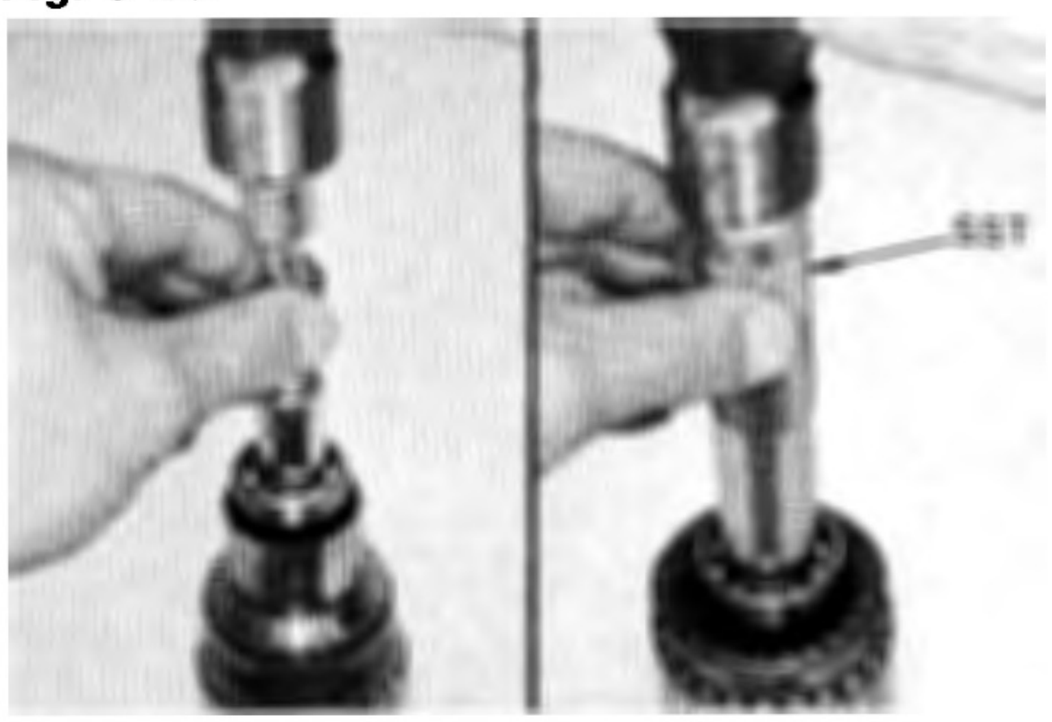
1. Check for sticking and abnormal noise while turning rapidly.

Fig. 8-51



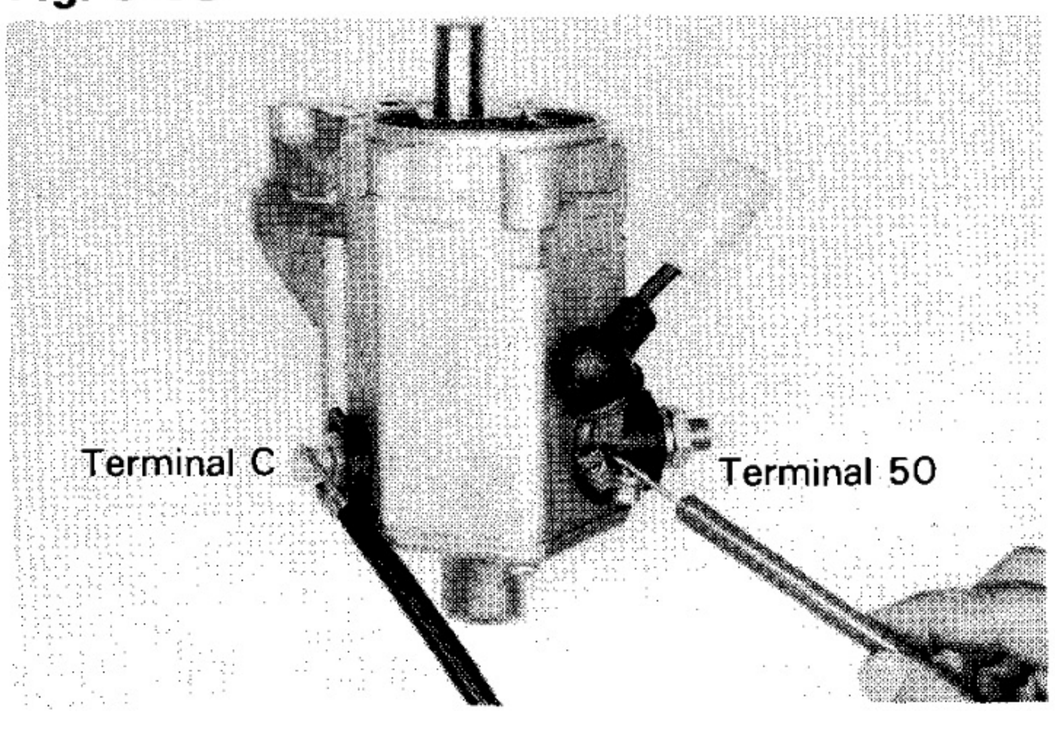
2. Replace the armature bearing if defective.
   (1) Remove the bearing with SST.
   SST [09286-46011]

Fig. 8-52



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

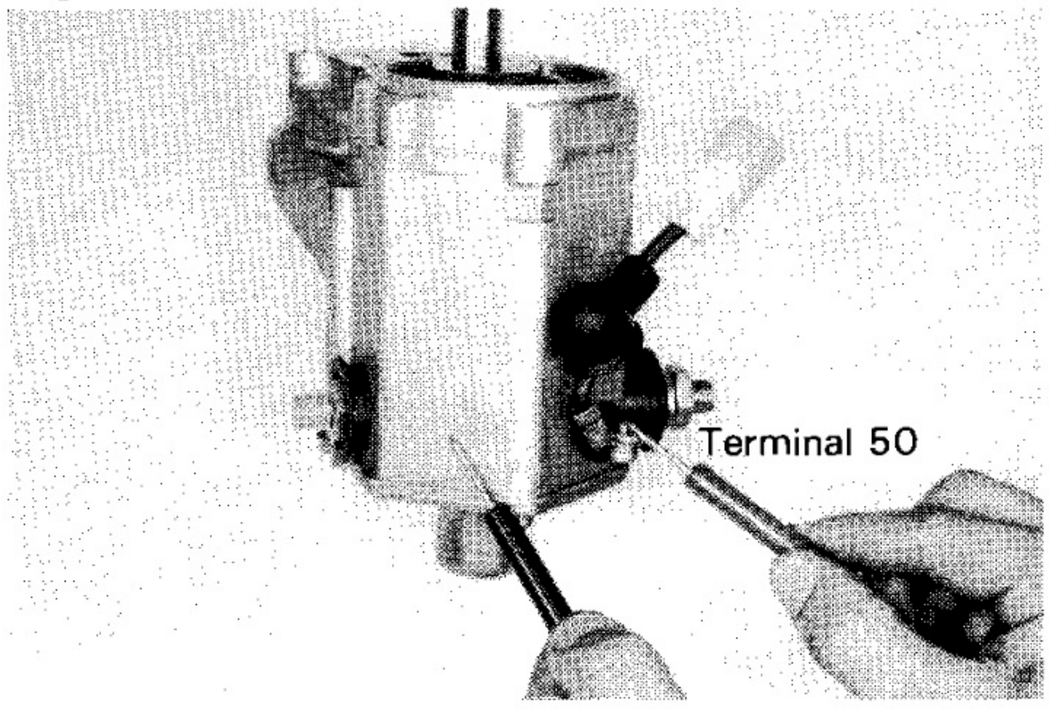
Fig. 8-53



Magnetic Switch

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

Fig. 8-54



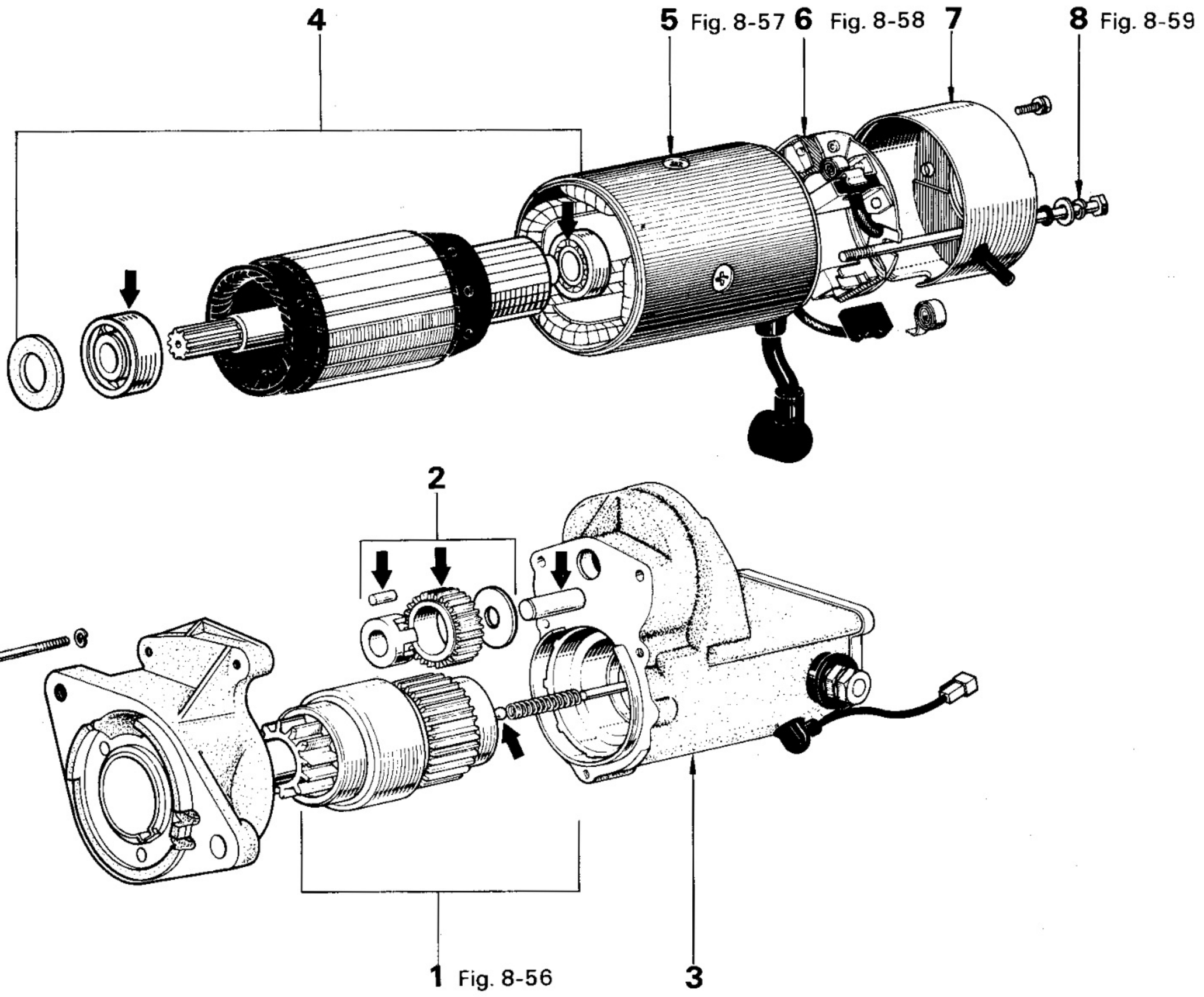
2. Hold-in coil open circuit test:
Check for continuity between the terminal 50 and magnetic switch body.

ASSEMBLY

Assemble the parts in the numerical order shown in the figure.

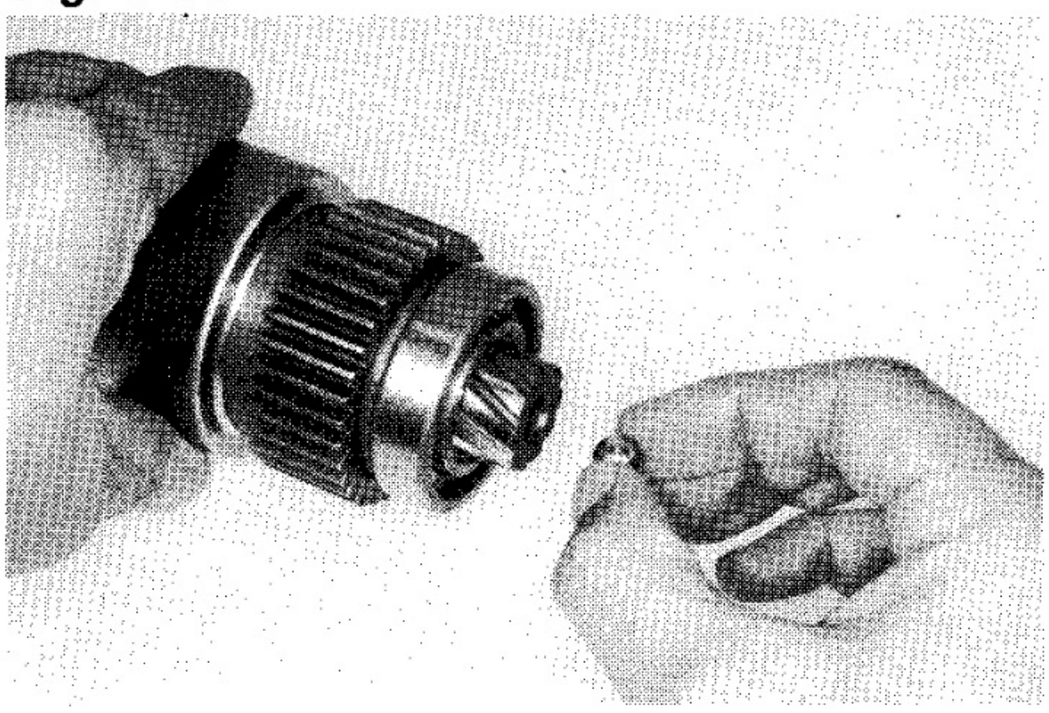
Fig. 8-55

—Note—
Use high temperature grease to lubricate the bearings and gears indicated by arrows.



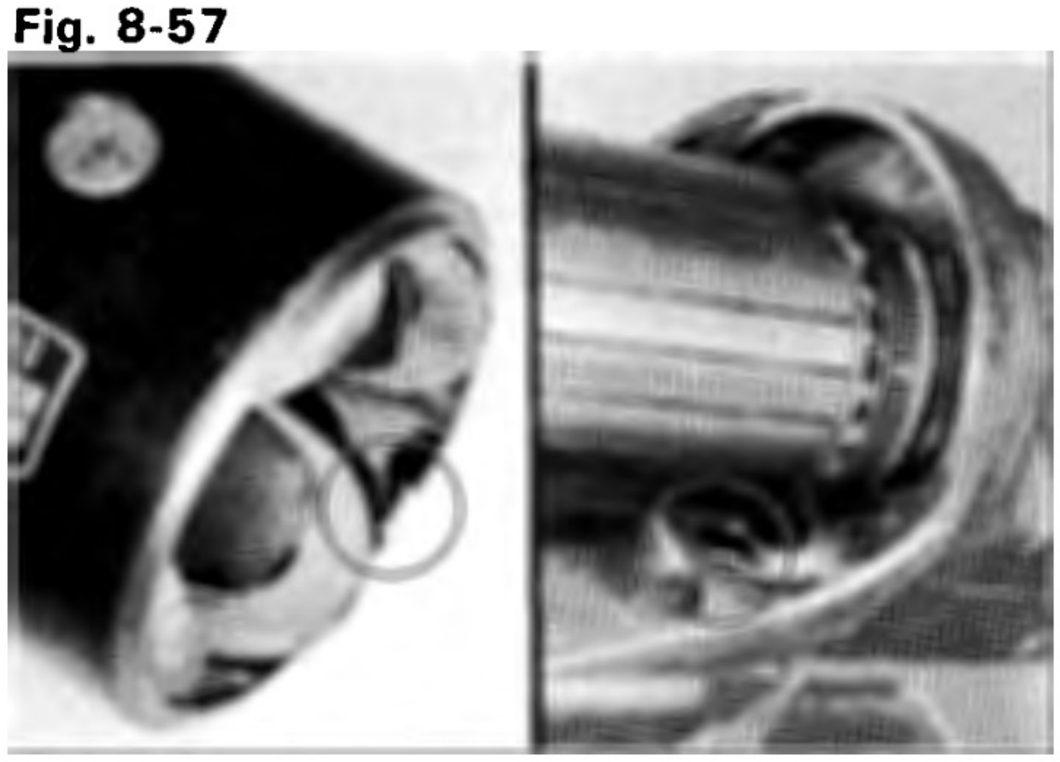
1. Clutch, Spring & Steel Ball
2. Pinion, Roller & Retainer
3. Magnetic Switch
4. Armature
5. Yoke
6. Brush Holder
7. End Frame
8. Through Bolt

Fig. 8-56



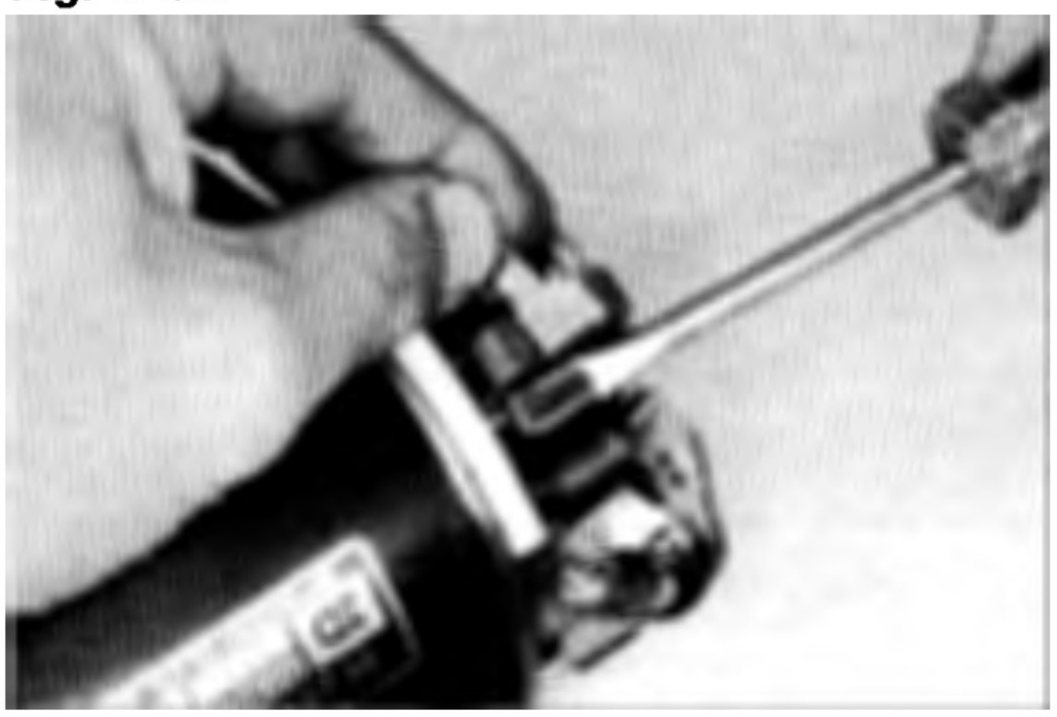
Apply grease and insert the ball into the clutch shaft hole.

Fig. 8-57



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

Fig. 8-58

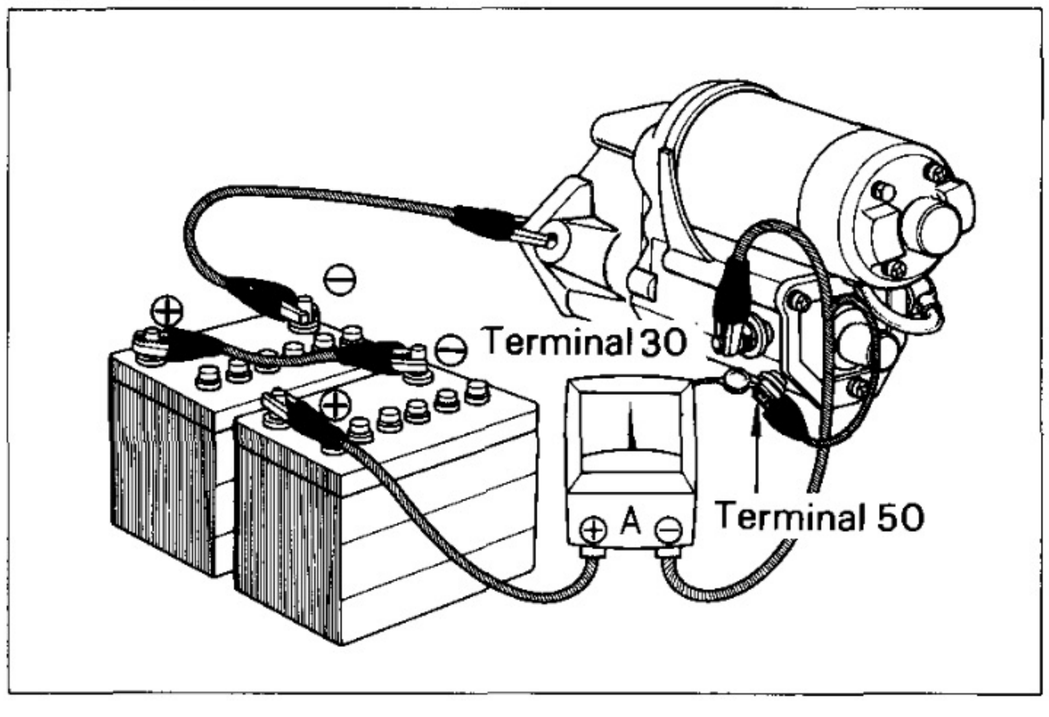


Assemble the brush holder.

—Note—

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

Fig. 8-59



Check performance of the starter after assembly.

Specified current:

12V type Less than 180A

24V type Less than 90A

CHARGING SYSTEM

	Page
CHARGING SYSTEM CIRCUITS	9-2
ON-VEHICLE INSPECTION	9-4
ALTERNATOR	9-8
ALTERNATOR REGULATOR	9-18

CHARGING SYSTEM CIRCUITS

Fig. 9-1

HJ47 Series

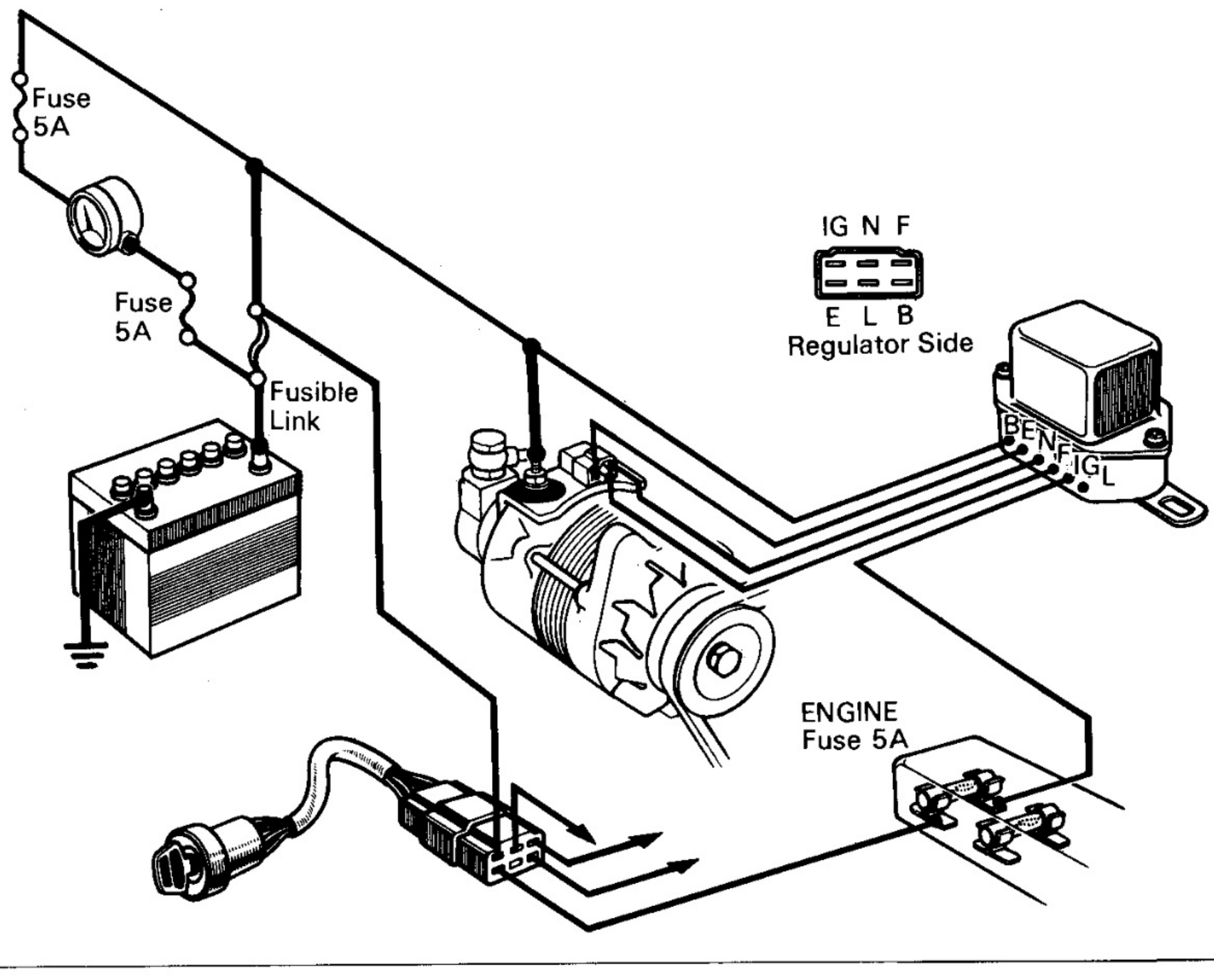


Fig. 9-2

HJ47 Series (12V)

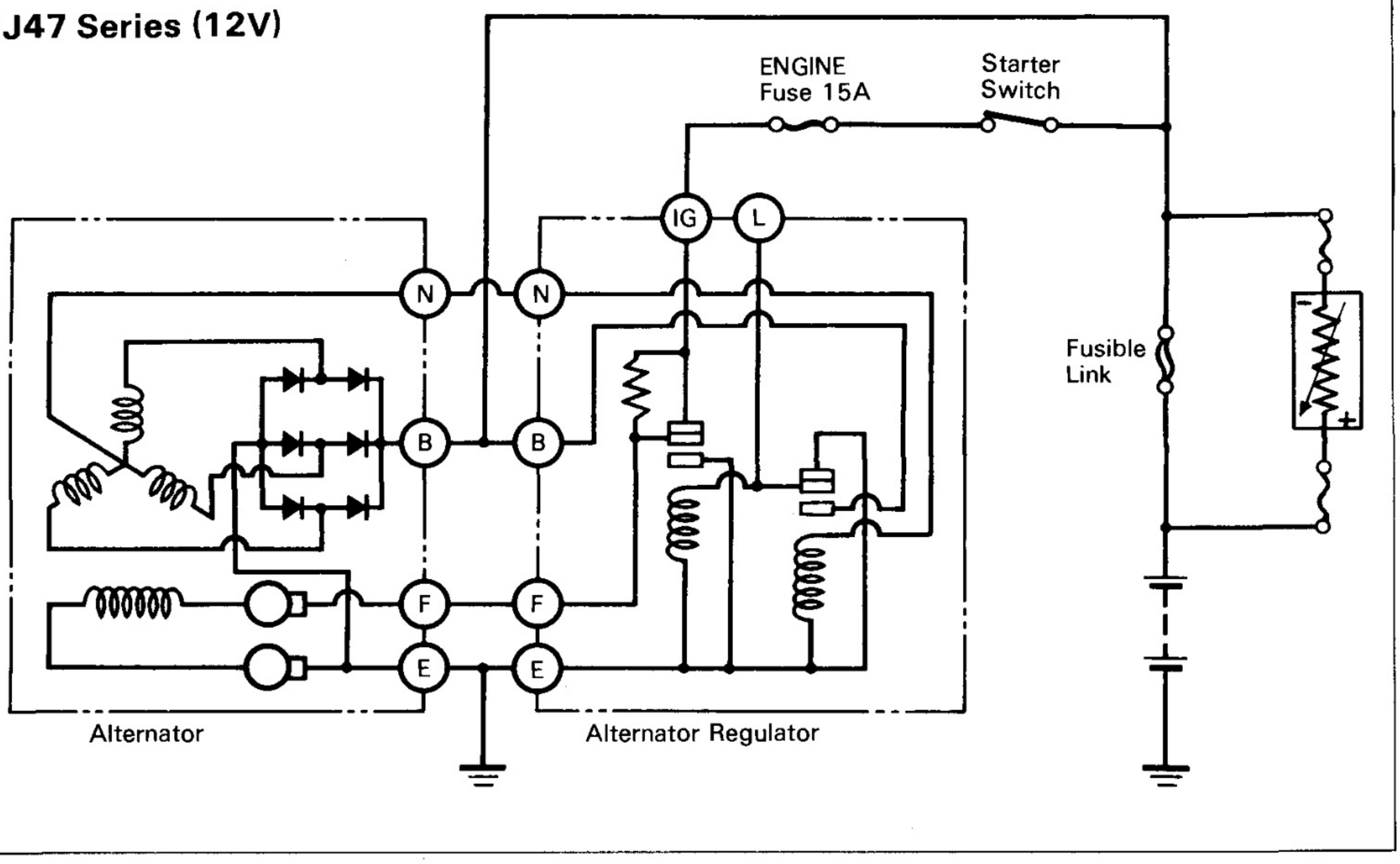


Fig. 9-3

HJ60 Series

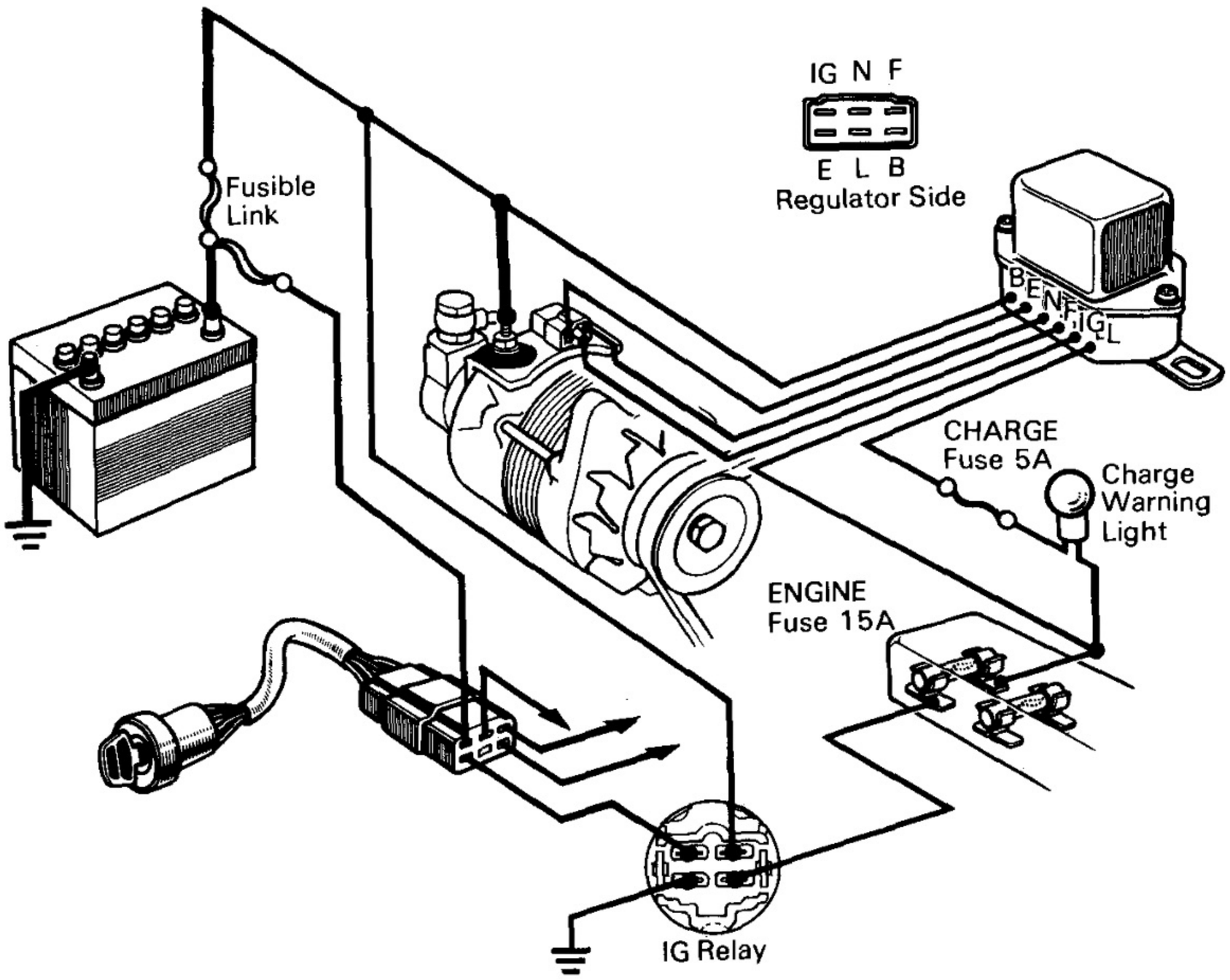


Fig. 9-4

HJ60 Series (24V)

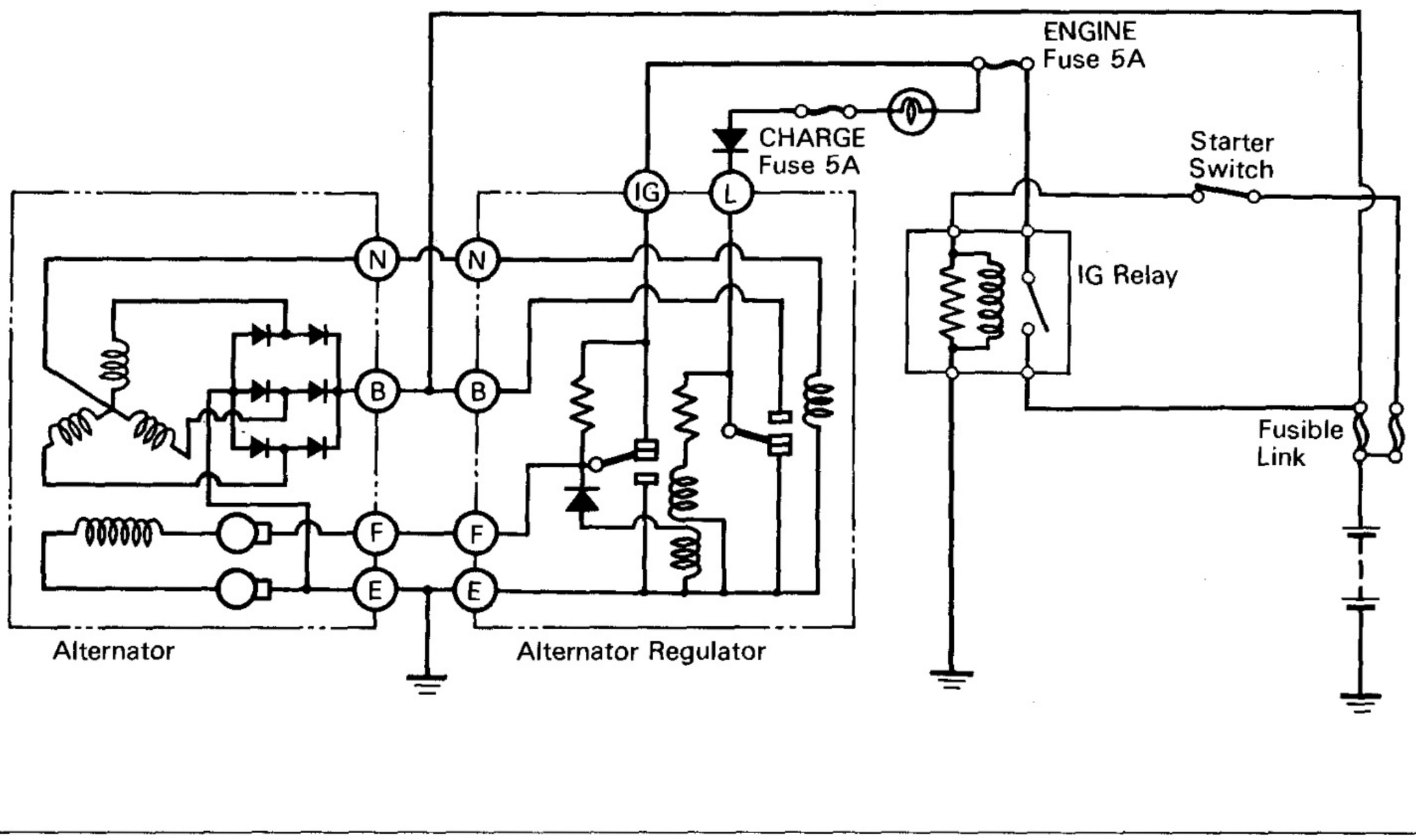
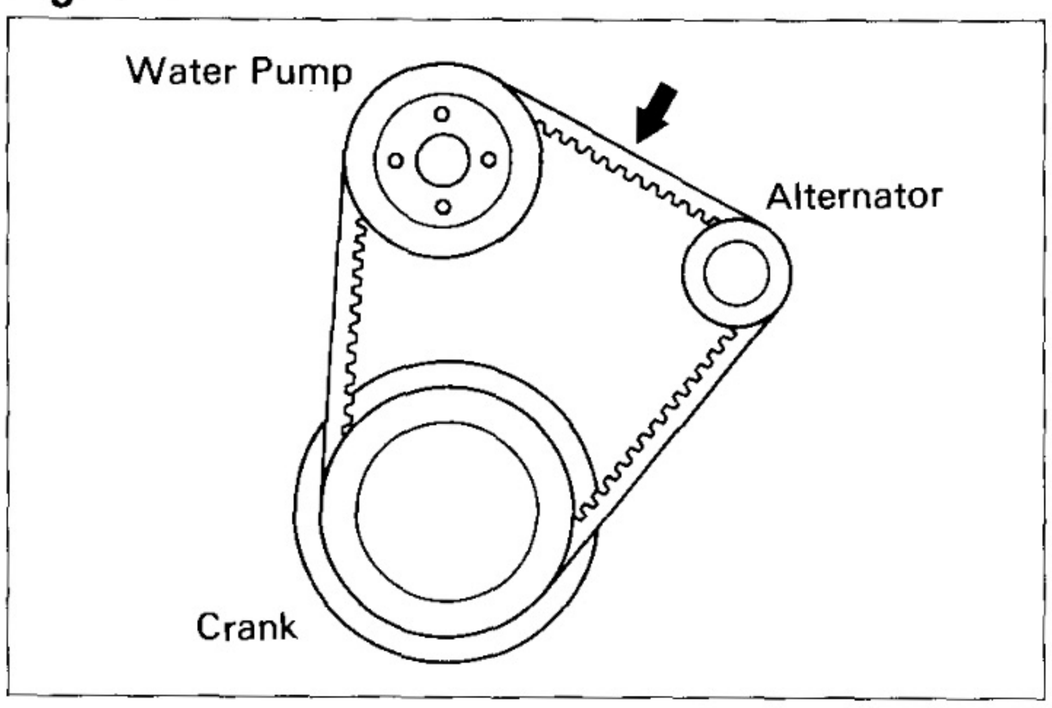


Fig. 9-5



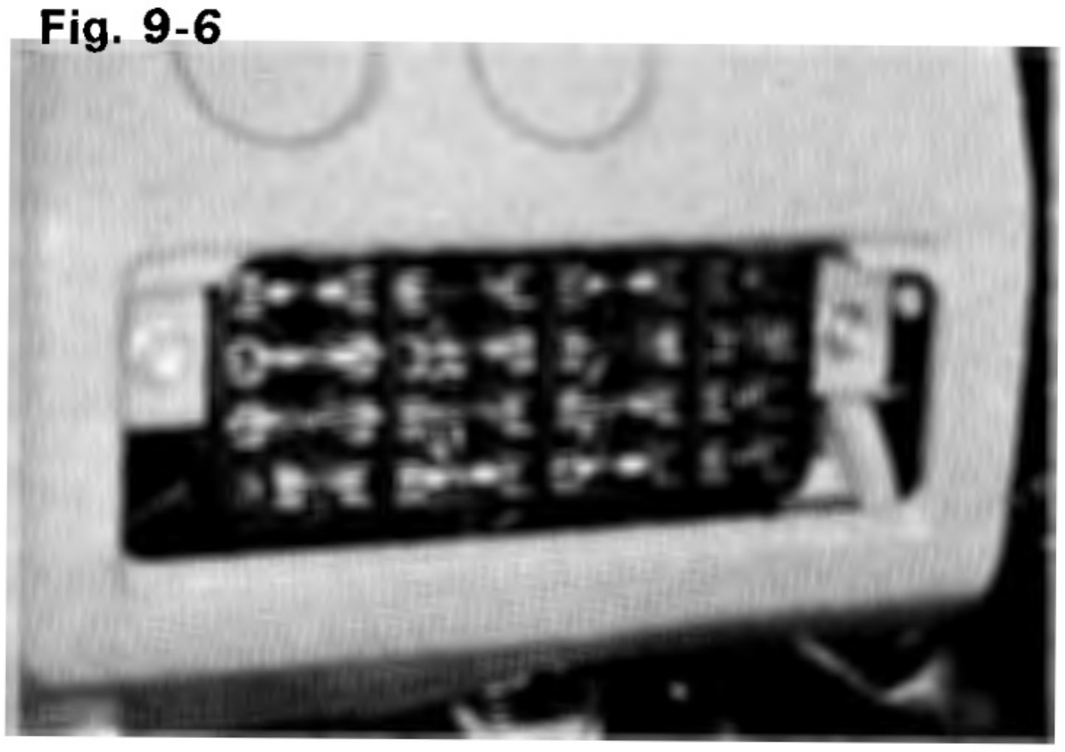
ON-VEHICLE INSPECTION

CHECK FOLLOWING ITEMS

1. Drive belt tension.

Drive belt tension:
New belt
8 – 9 mm at 10 kg
(0.31 – 0.35 in.) (22lb)
Used belt
10 – 11 mm at 10 kg
(0.39 – 0.43 in.) (22lb)

Fig. 9-6



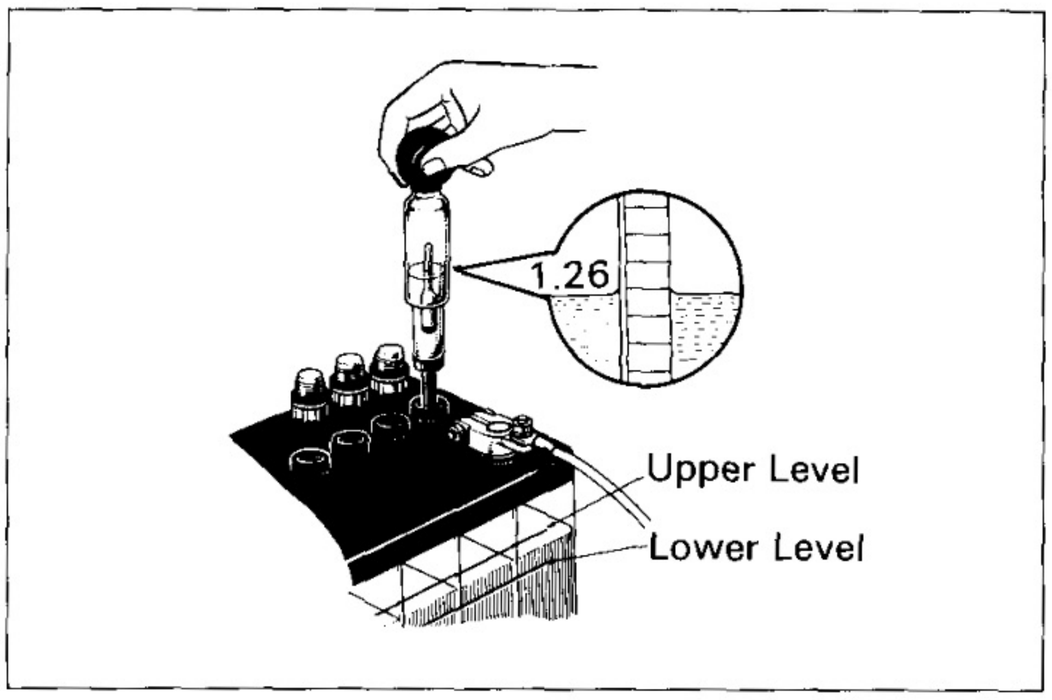
2. Fuses

Fig. 9-7



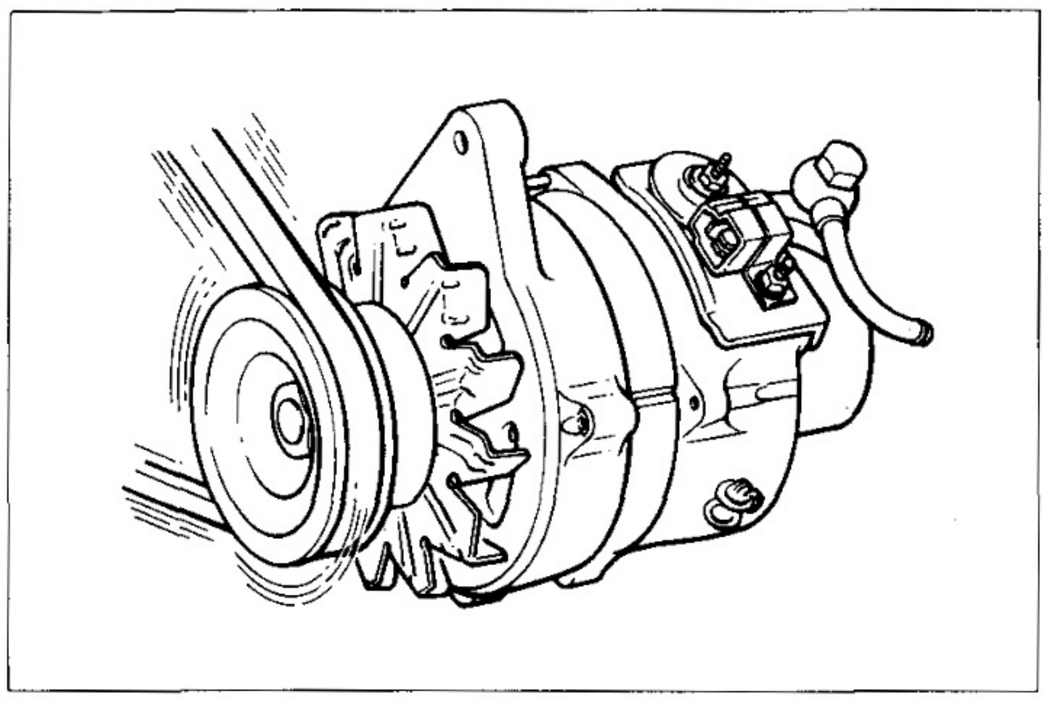
3. Installed condition of wiring for alternator and regulator.

Fig. 9-8



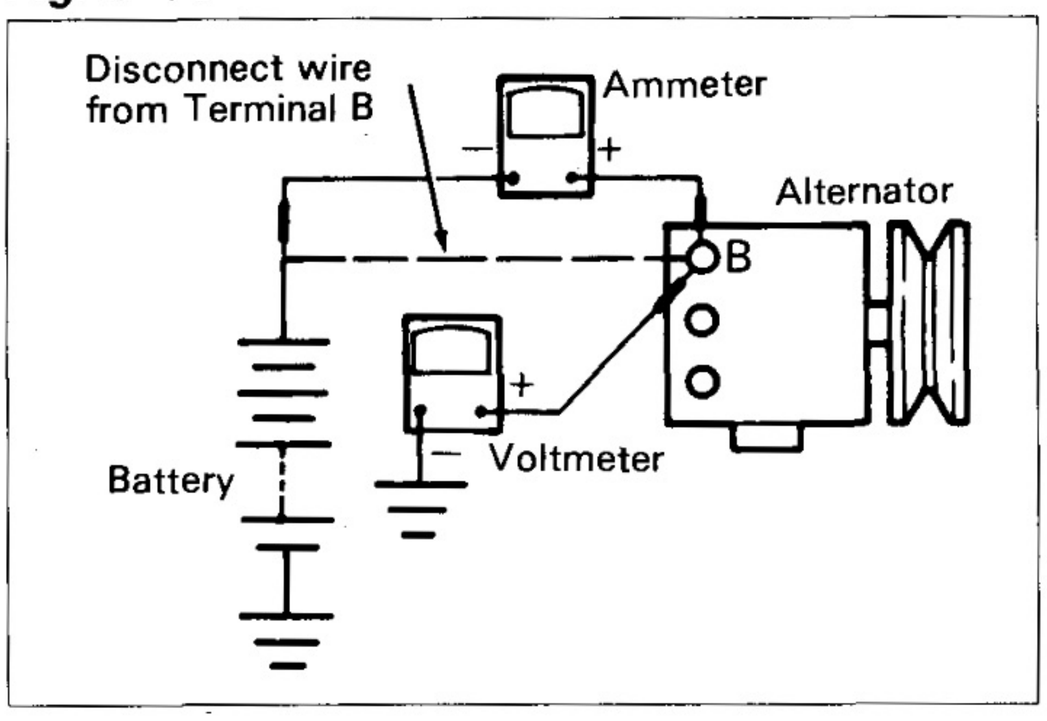
4. Battery terminal and fusible link.
Loose
Corroded
Burnt
Specific gravity: 1.25 – 1.27 at 20°C (68°F)

Fig. 9-9



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

Fig. 9-10



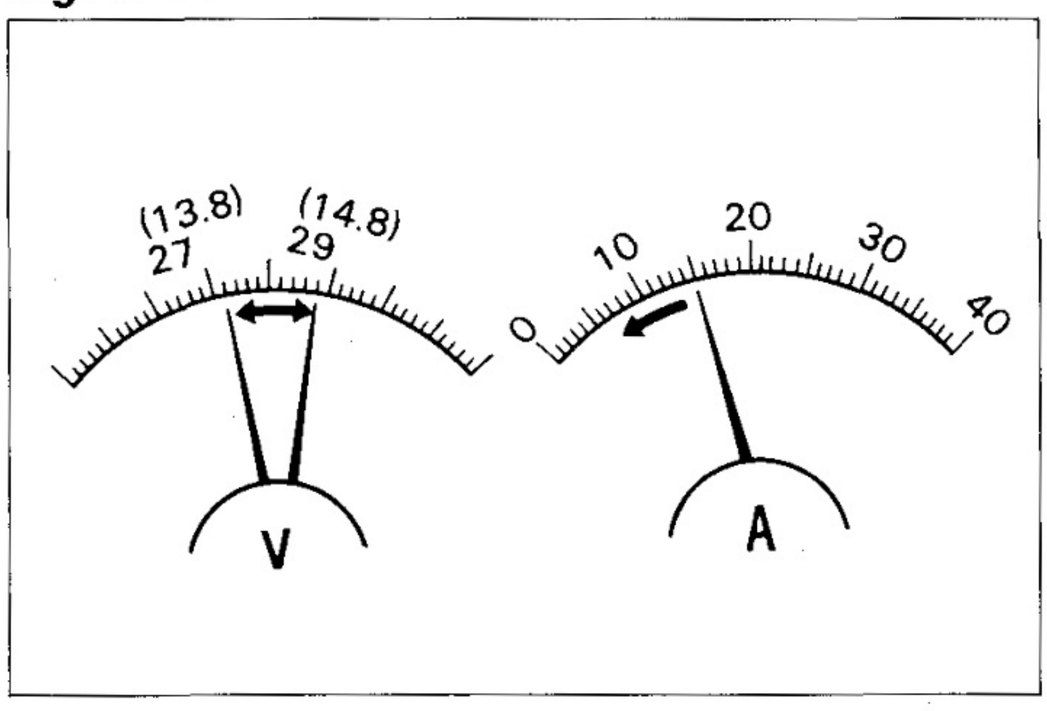
PERFORMANCE TEST BY VOLTMETER & AMMETER

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. 9-11

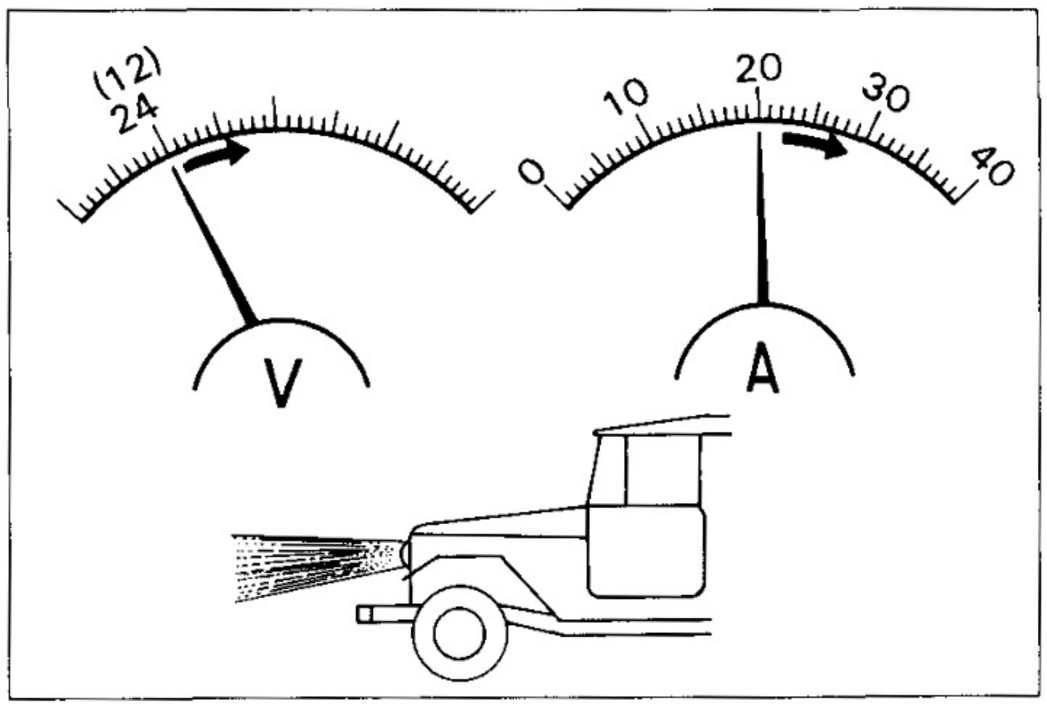


No-load Performance Test

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. 9-12

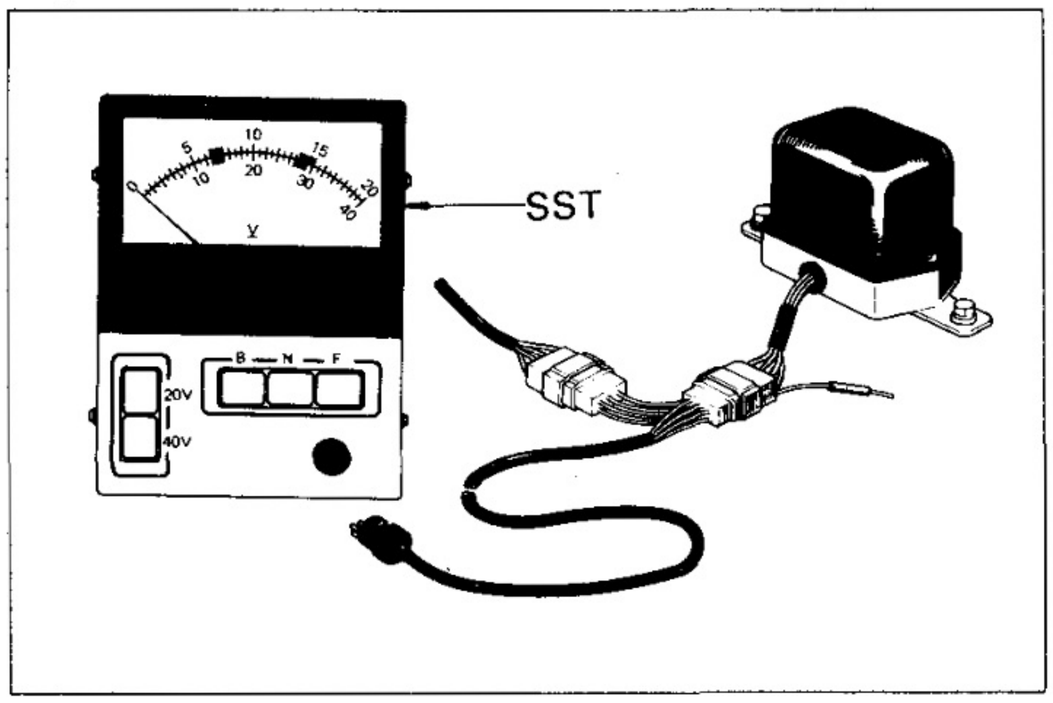


Load Performance Test

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: More than 20A

Fig. 9-13



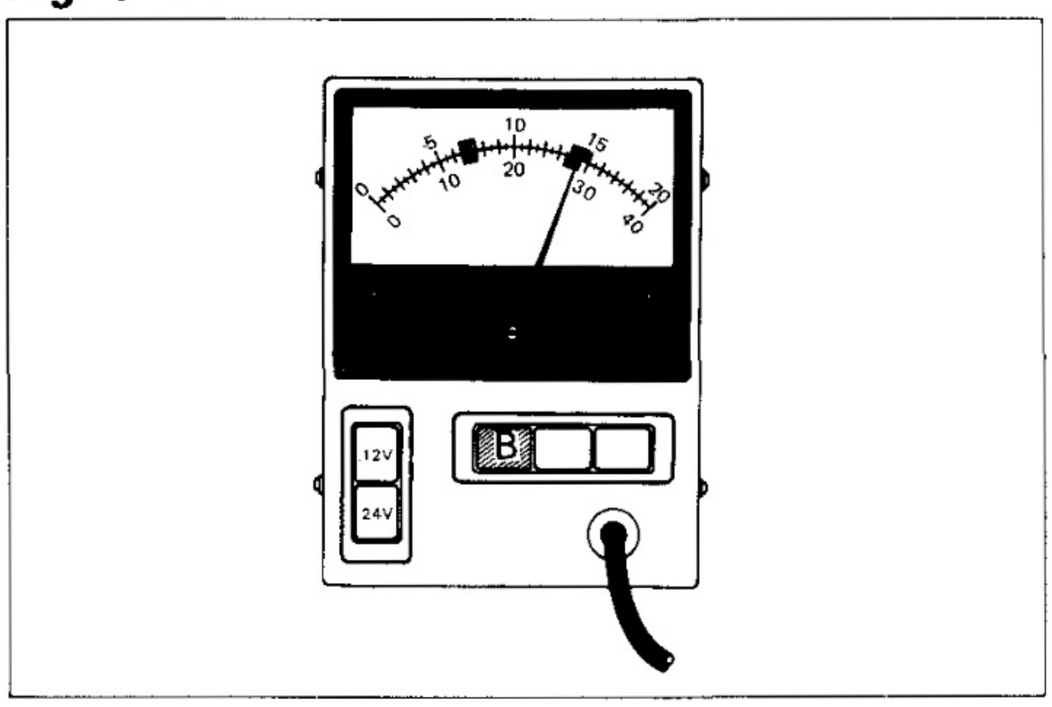
PERFORMANCE TEST WITH SST (ALTERNATOR CHECKER)

Disconnect the alternator regulator connector and connect SST.

SST [09081-00011]

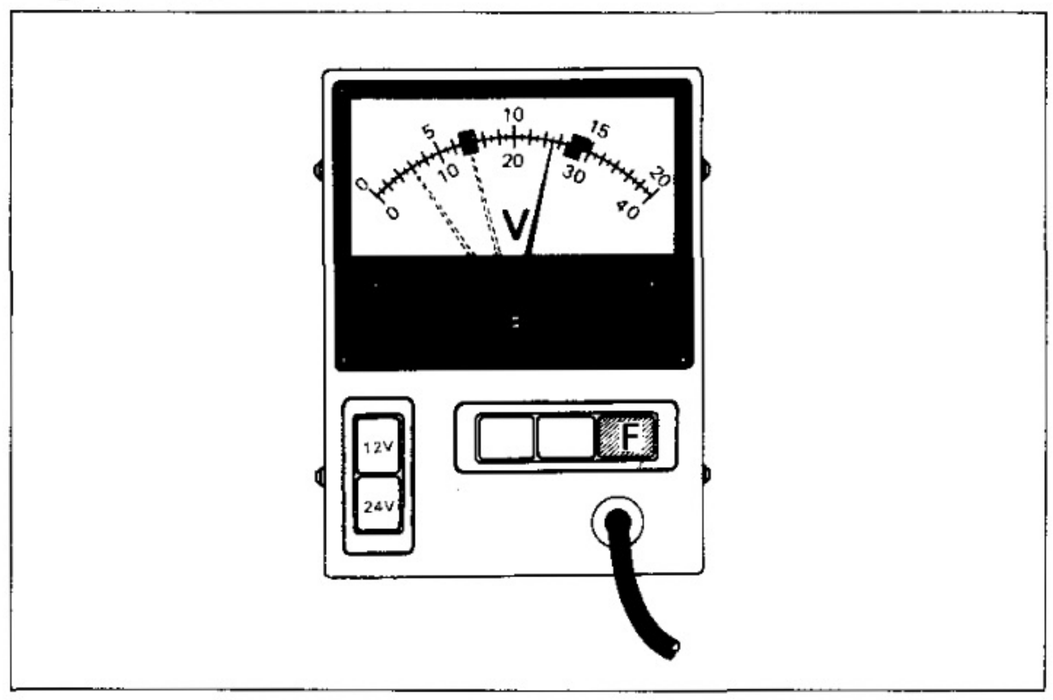
12V type alternator
Push 20V switch
24V type alternator
Push 40V switch

Fig. 9-14



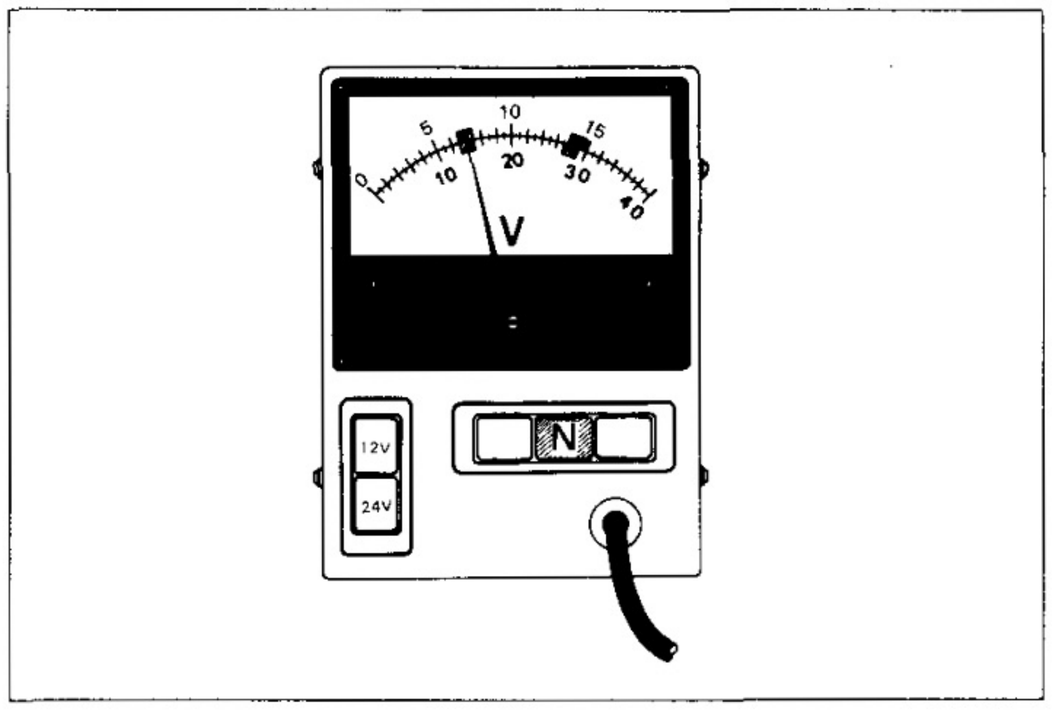
1. Check terminal B voltage.
   Push B switch.
   Raise engine speed from idling to 2,300 rpm.
   Voltage:
   STD 12V type 13.8 – 14.8V
   24V type 27 – 29V
   If not within standard, probable cause is the alternator regulator.

Fig. 9-15



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 not, probable cause is alternator regulator.

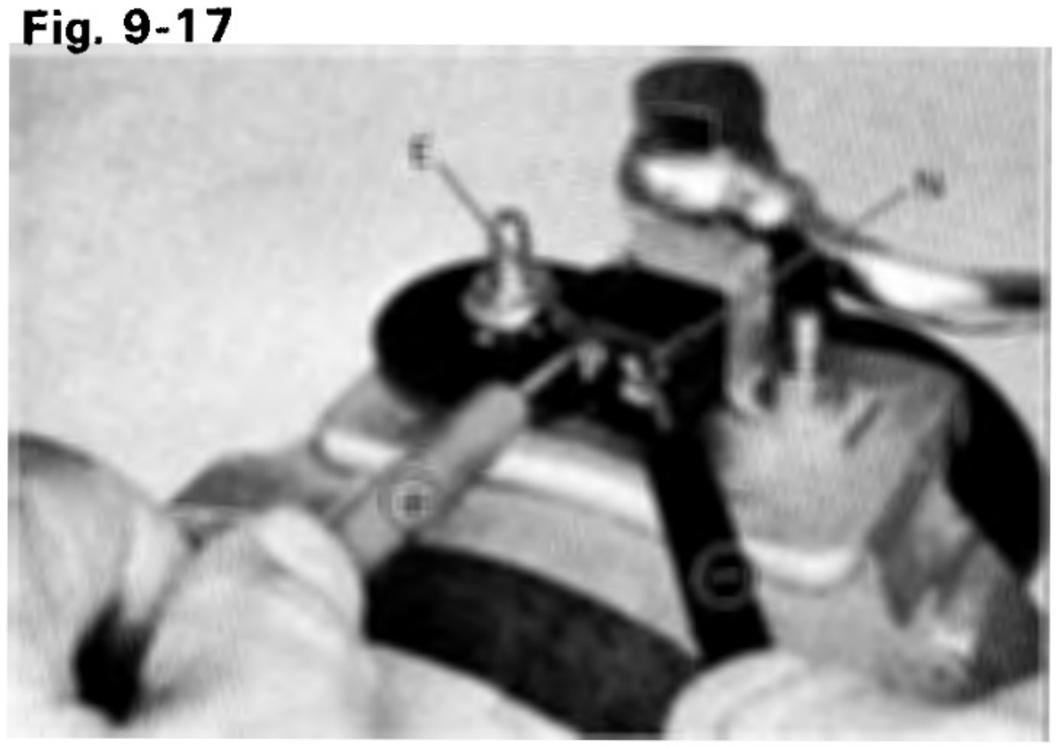
Fig. 9-16



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 – 7.4V
   24V type 13.5 – 14.5V
   If the voltage is higher, the cause is the (+) rectifier.
   If the voltage is lower, the cause is the (–) rectifier.

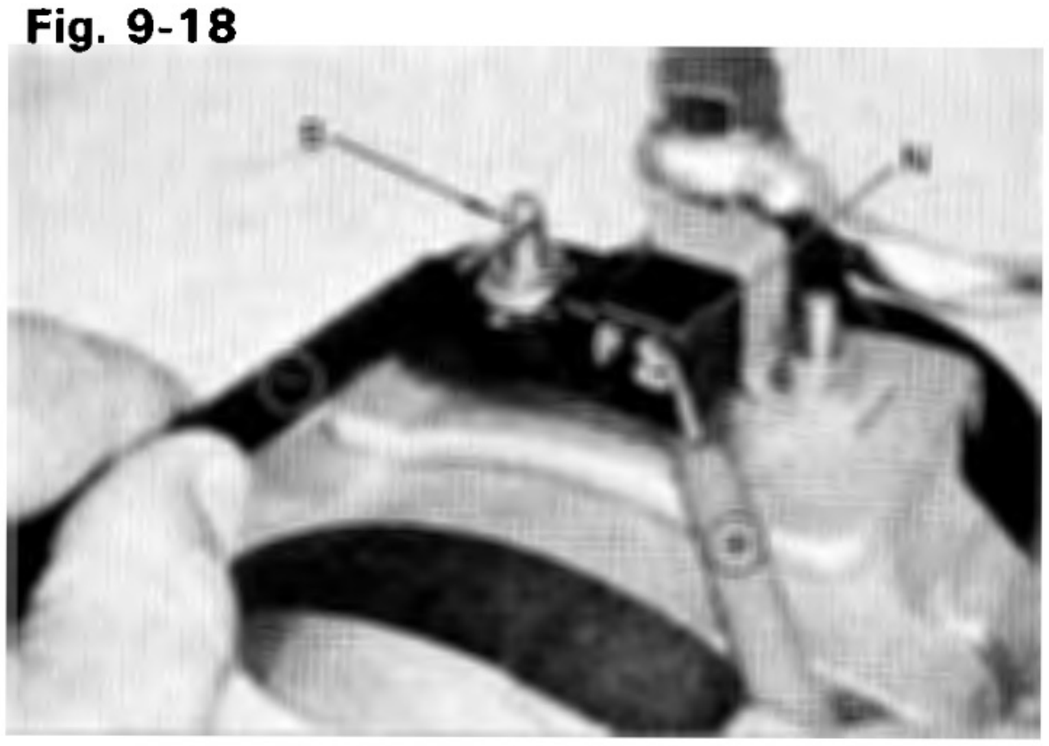
ALTERNATOR INSPECTION

Fig. 9-17



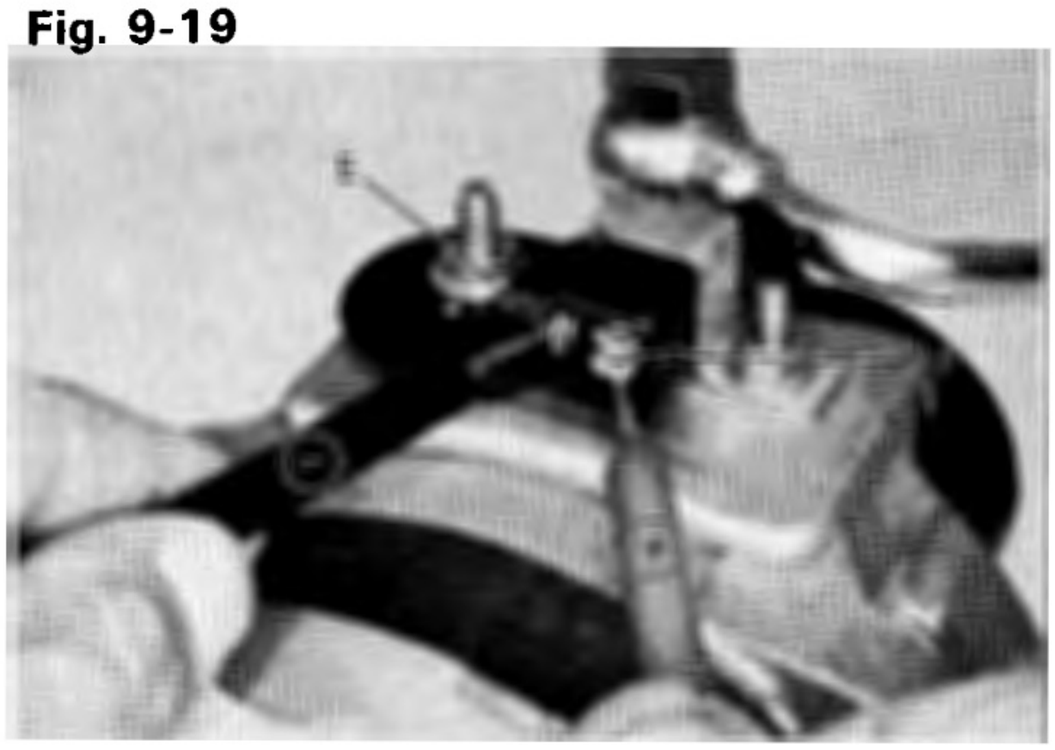
1. Negative side rectifier short test
   Connect an ohmmeter ⊖ lead to terminal N and the ⊕ lead to terminal E.
   The meter should indicate infinity.

Fig. 9-18



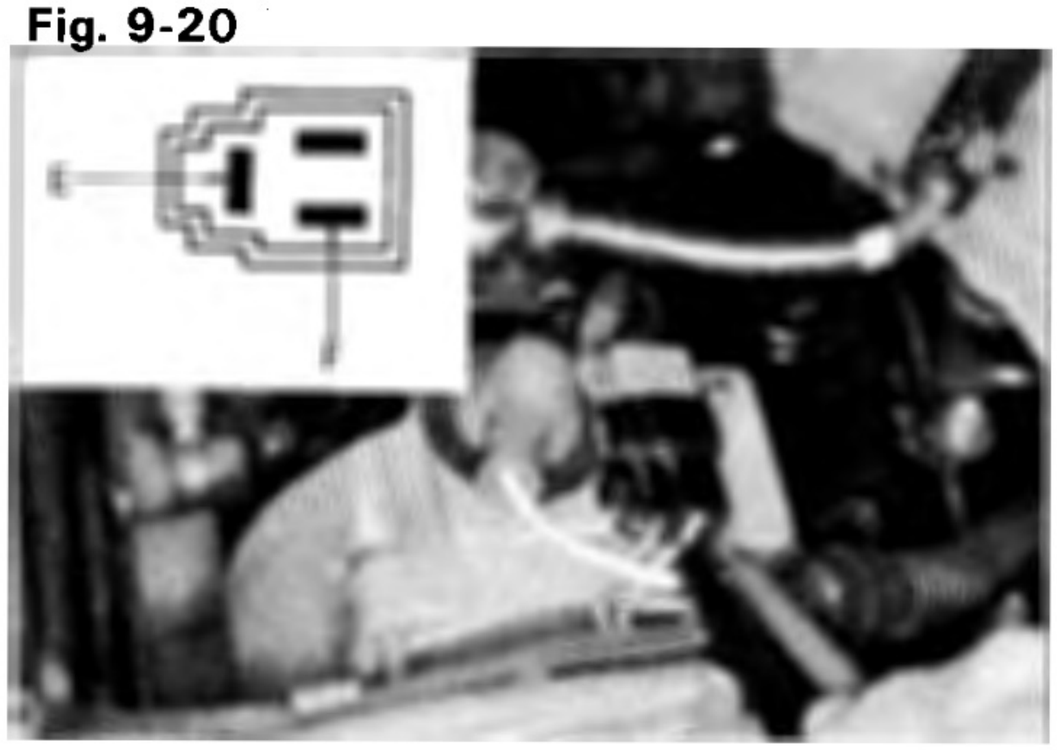
2. Positive side rectifier short test
   Connect an ohmmeter ⊖ lead to terminal B and the ⊕ lead to terminal N.
   The meter should indicate infinity.

Fig. 9-19



3. Check the rotor coil resistance.
   Resistance:
   12V type 2.8 – 3.0Ω
   24V type 19.0Ω

Fig. 9-20

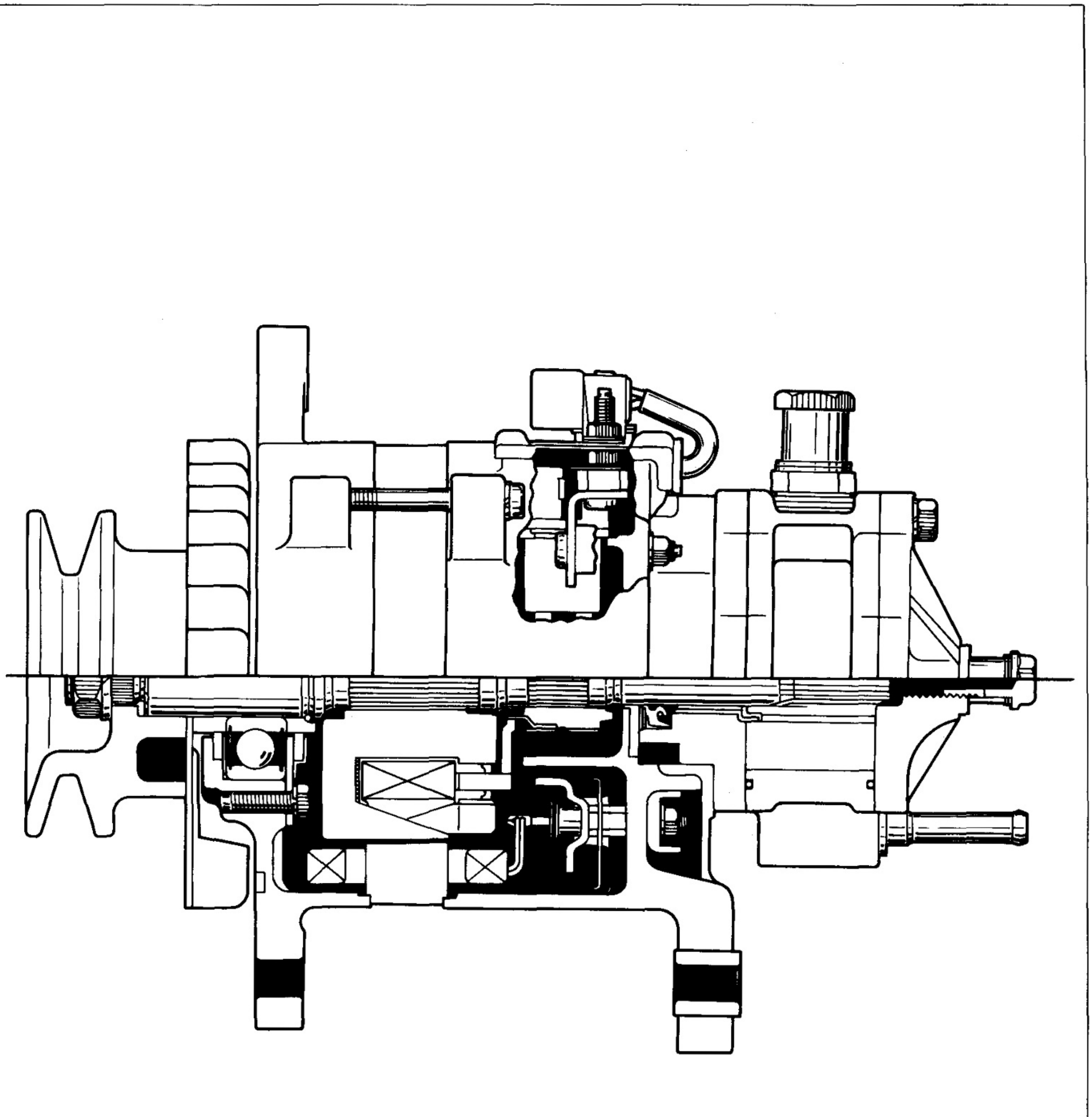


4. Turn the starter switch to the ON position, and check to see if there is battery voltage at terminal F.
   If not, check the ENGINE fuse.

ALTERNATOR

CUTAWAY VIEW

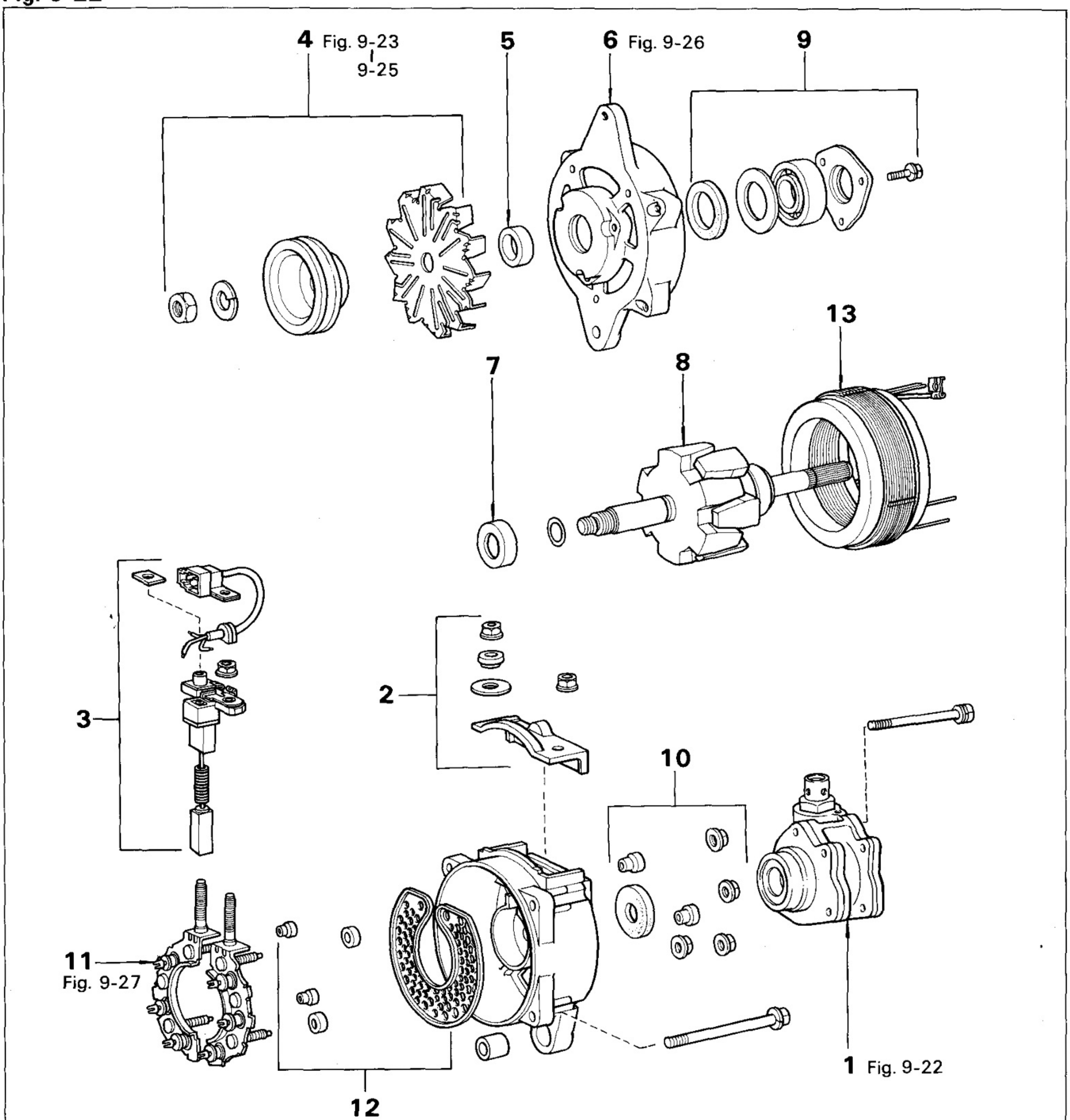
Fig. 9-21



DISASSEMBLY

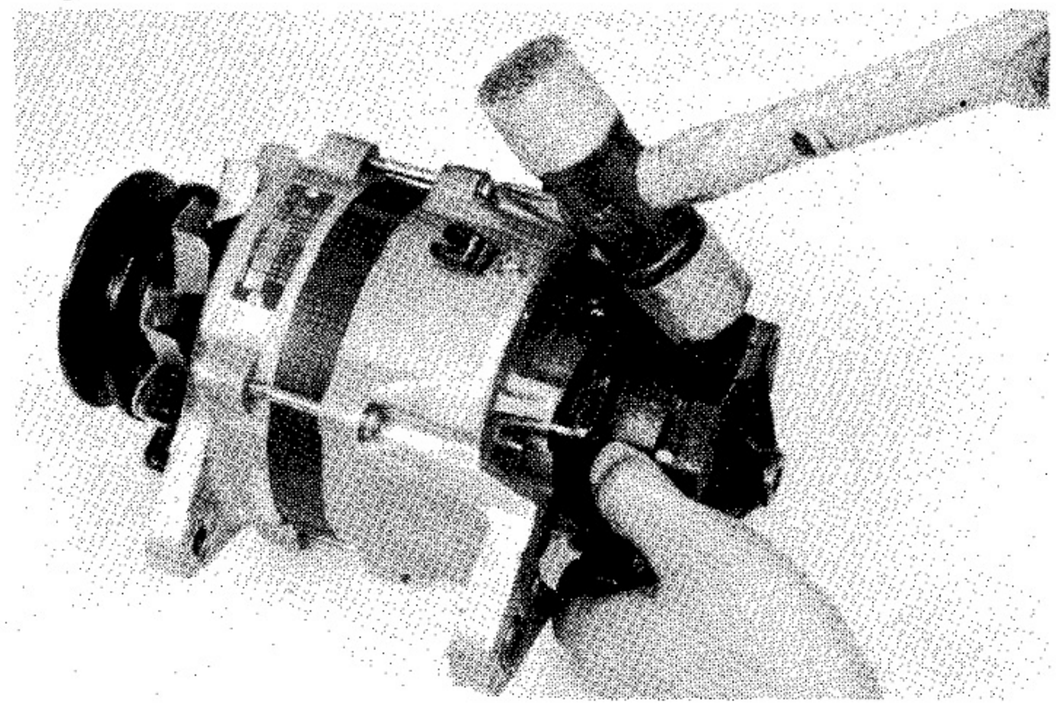
Disassemble the parts in the numerical order shown in the figure.

Fig. 9-22



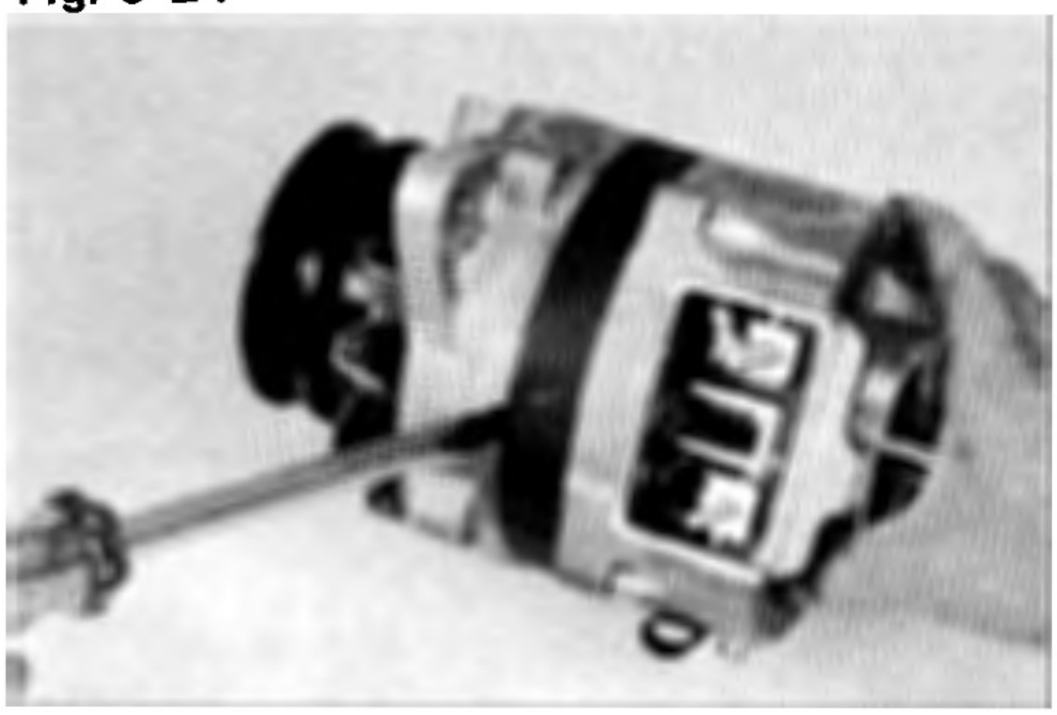
1. Vacuum Pump
2. Brush Cover
3. Brush Holder
4. Pulley & Fan
5. Collar
6. Drive End Frame
7. Collar
8. Rotor
9. Front Bearing
10. Insulator & Nut
11. Rectifier Holder
12. Rear End Cover & Insulator
13. Stator Coil

Fig. 9-23



Lightly tap the vacuum pump with a plastic hammer to remove the pump.

Fig. 9-24



Pry off the drive end frame from the stator.

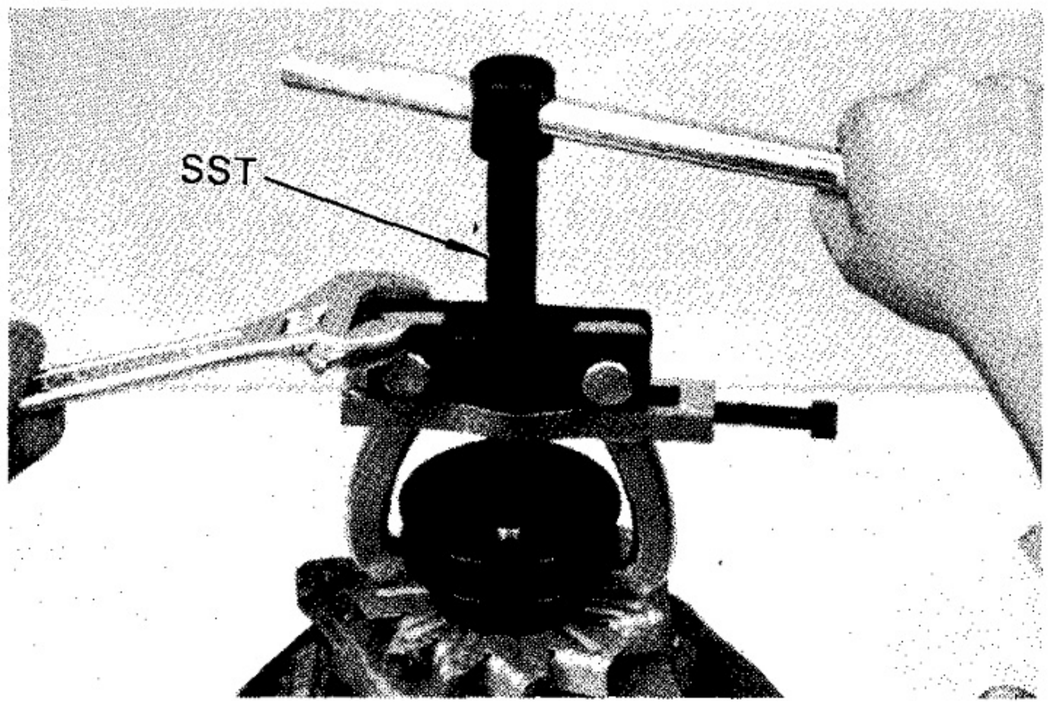
–Note–
Do not damage the coil wires.

Fig. 9-25



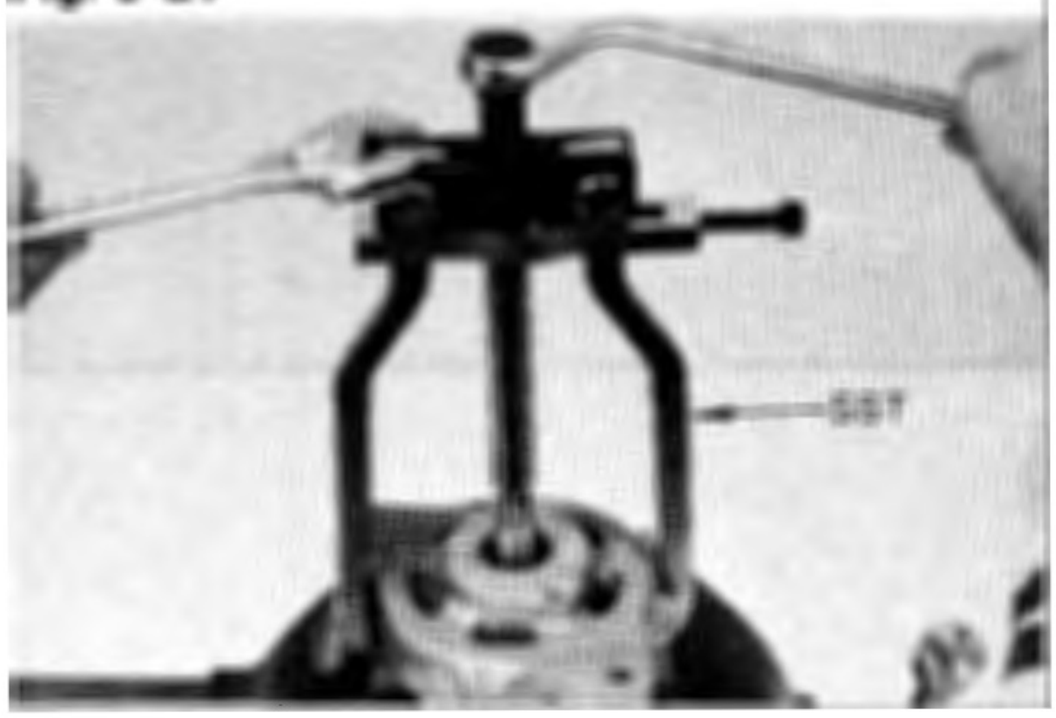
Using a soft jaw vise, loosen the pulley nut.

Fig. 9-26



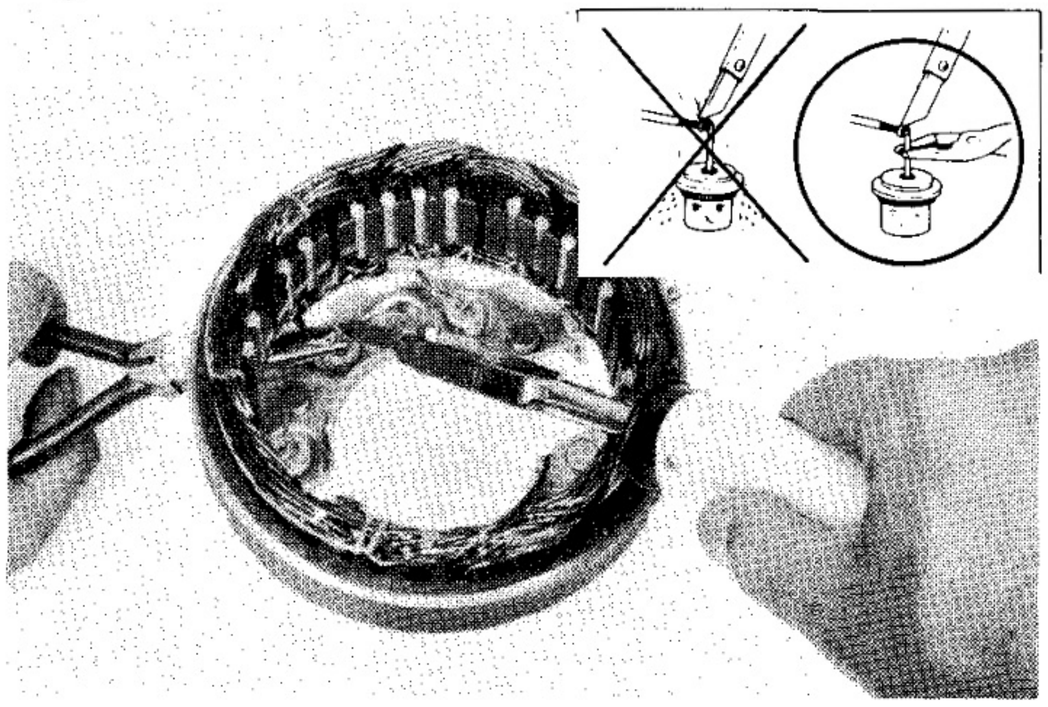
Remove the pulley with SST.
SST [09950-20014]

Fig. 9-27



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

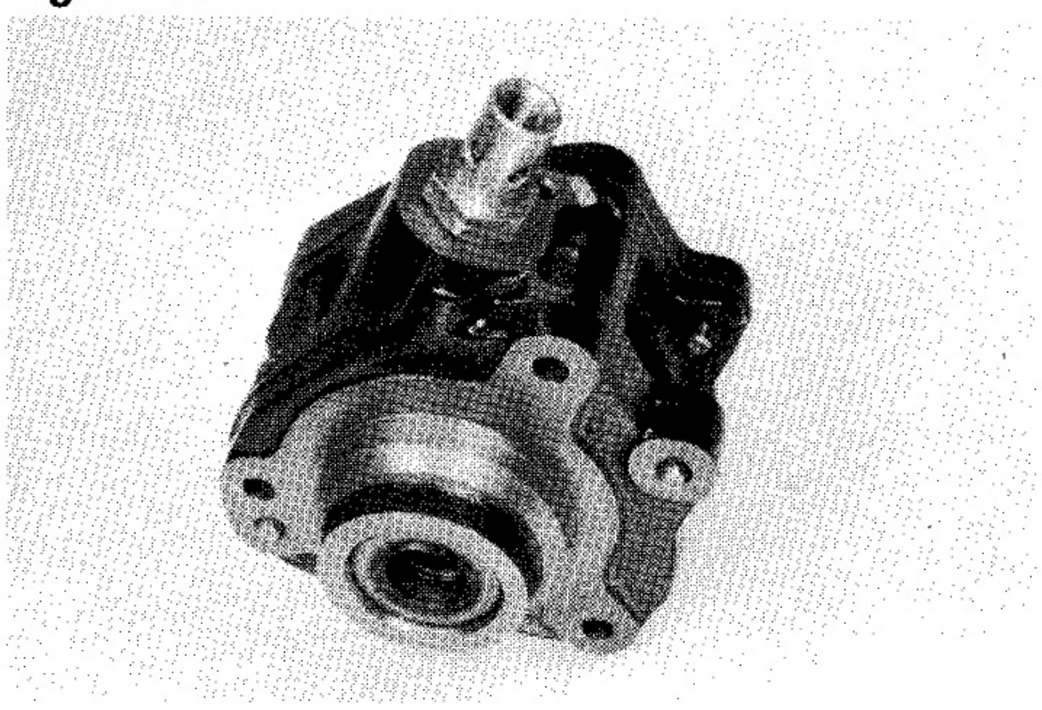
Fig. 9-28



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. 9-29

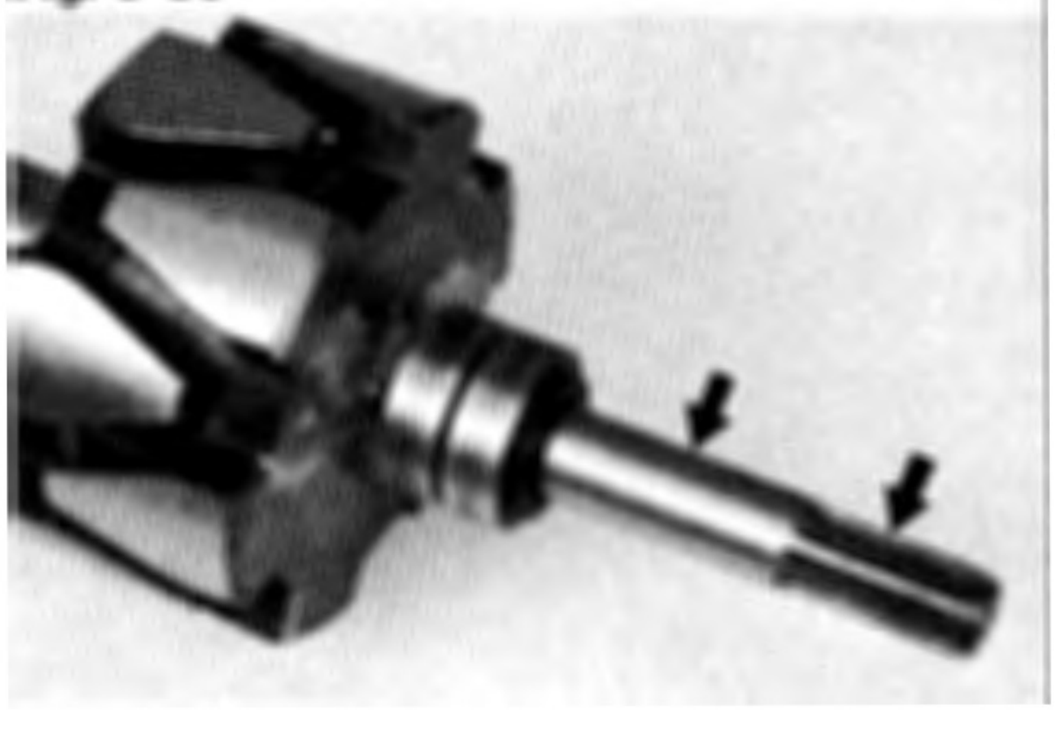


INSPECTION & REPAIR

Vacuum Pump

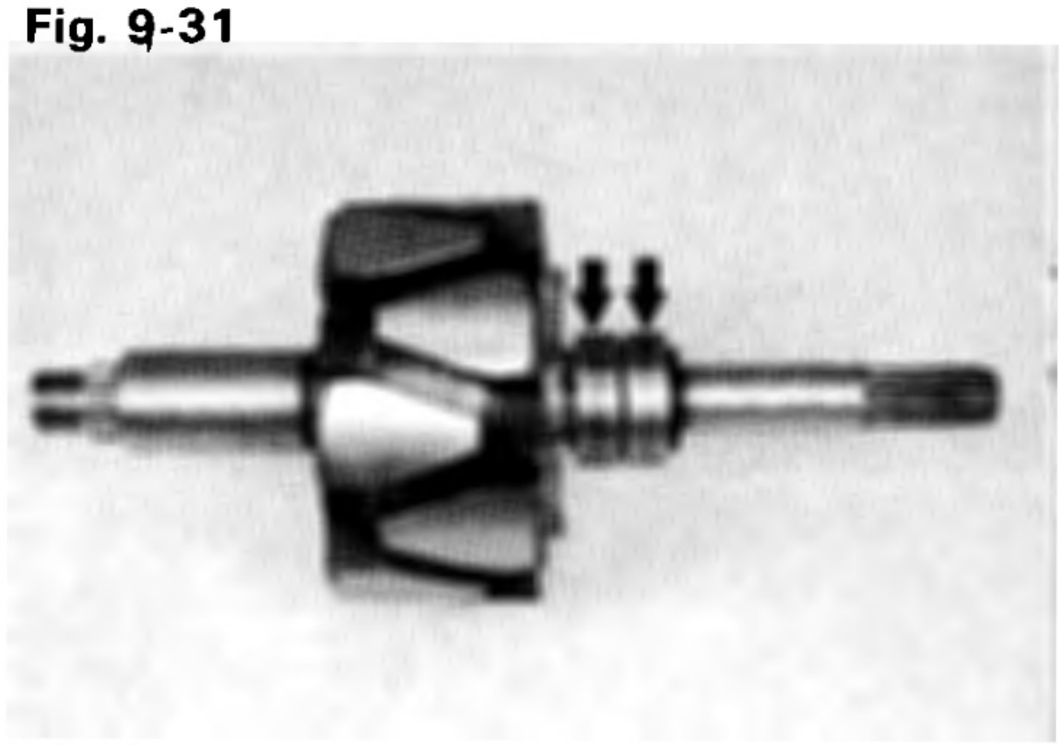
1. Check the oil seal and bearing for wear or damage.

Fig. 9-30



2. Check the journal and spline teeth for wear.

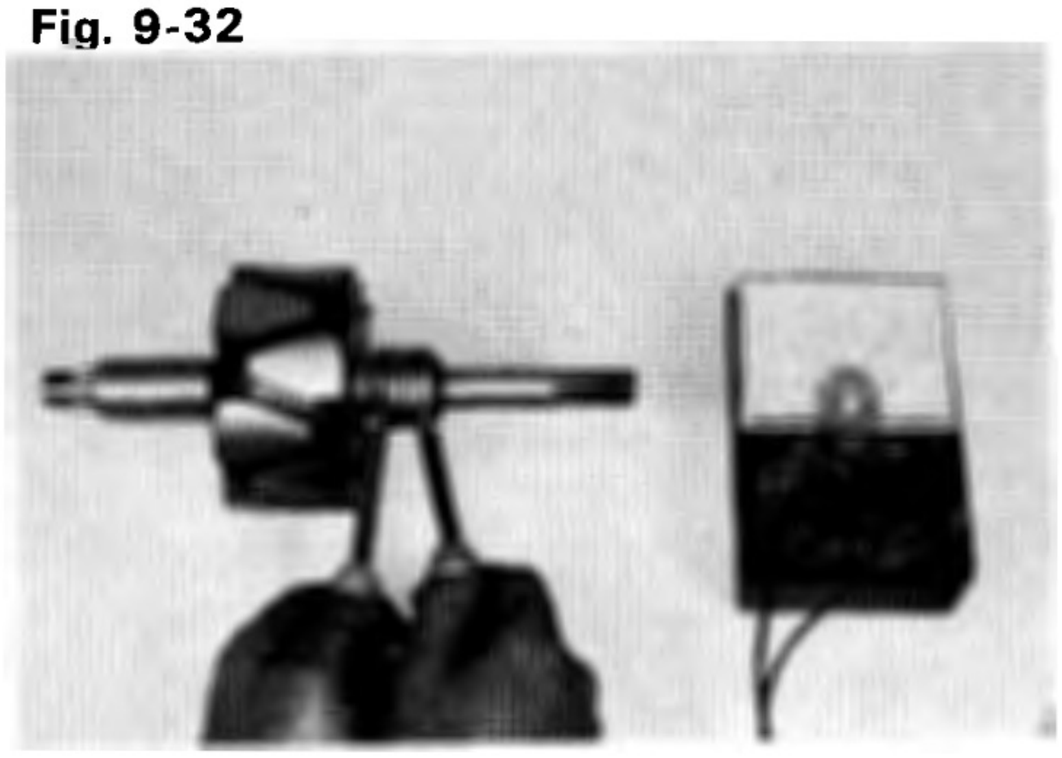
Fig. 9-31



Rotor

1. Check the slip ring for dirt or burns.

Fig. 9-32



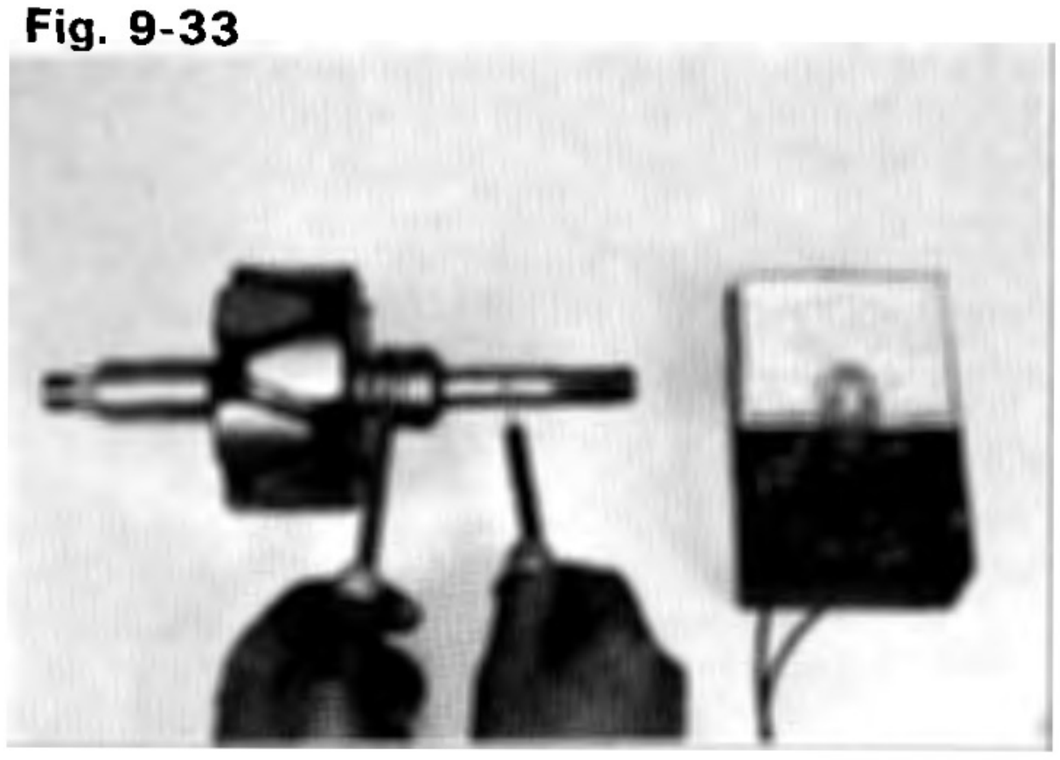
2. Open circuit test
   Measure the resistance between both slip rings.

   Resistance:

   12V type 2.8 – 3.0 Ω

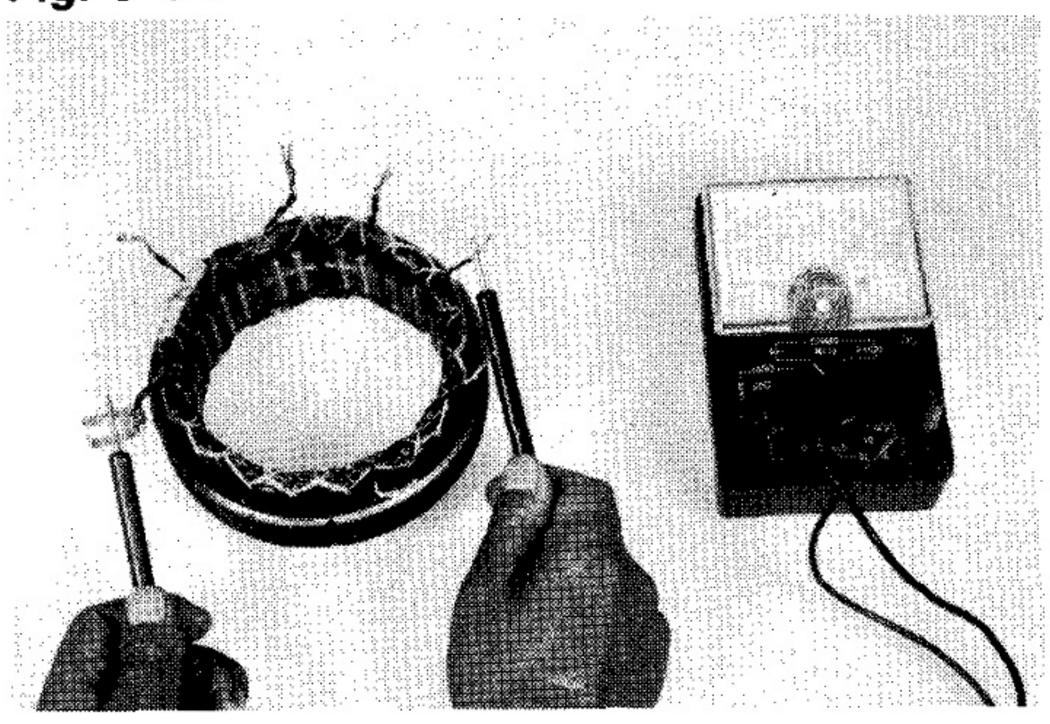
   24V type 19.0Ω

Fig. 9-33



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

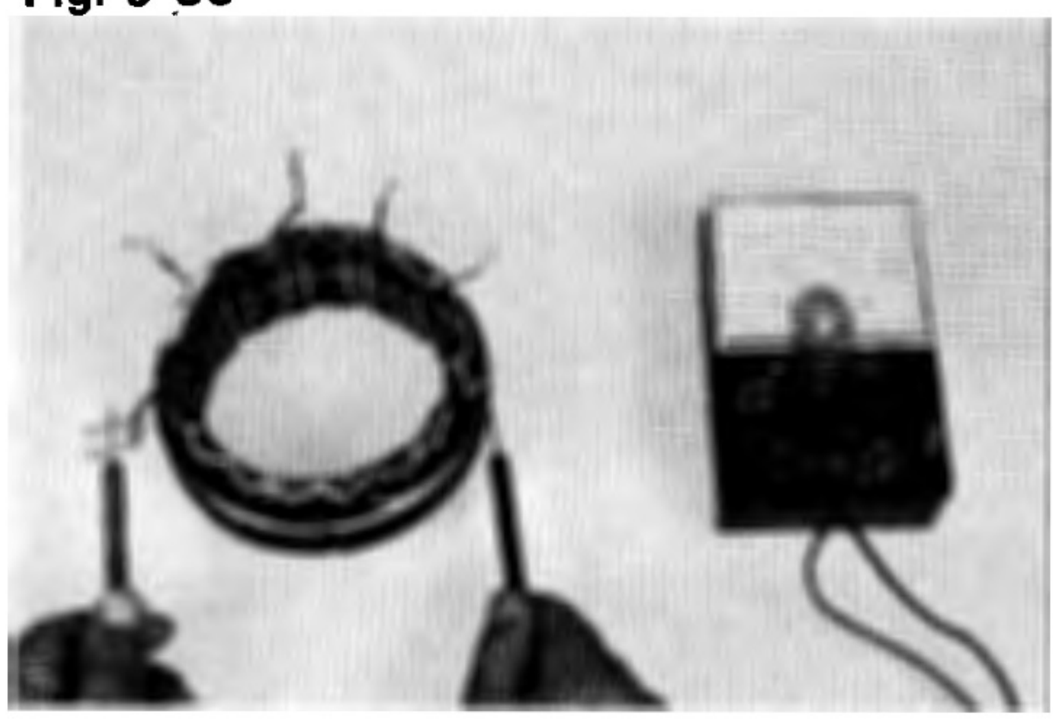
Fig. 9-34



Stator

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

Fig. 9-35



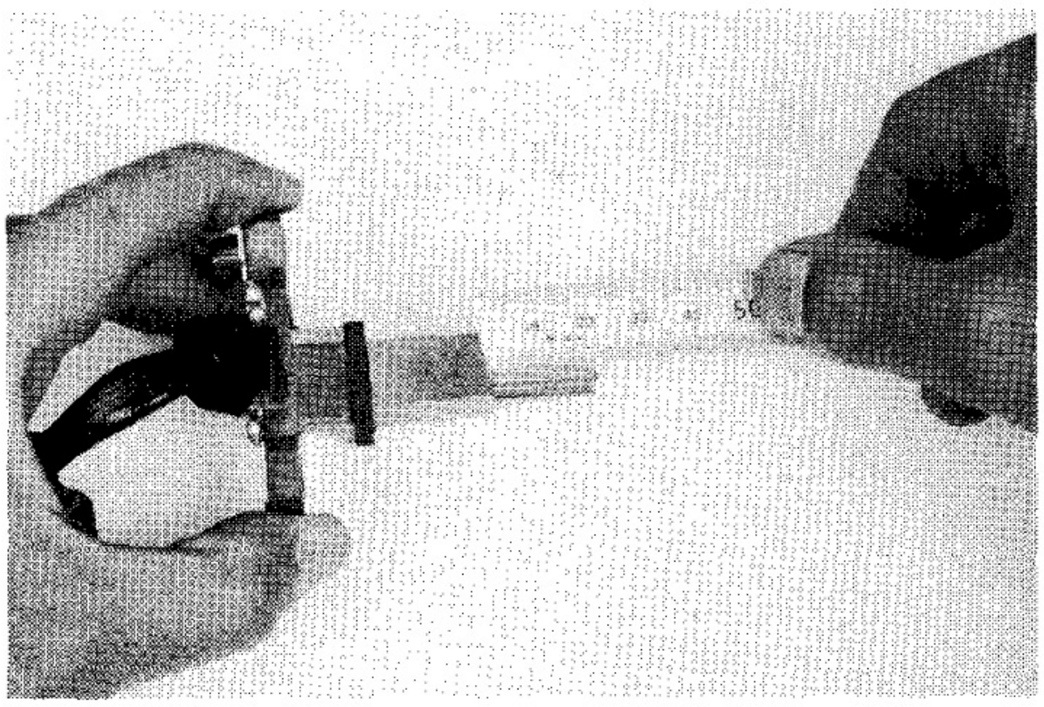
2. Ground test
Check that there is no continuity between each coil lead stator core.

Fig. 9-36



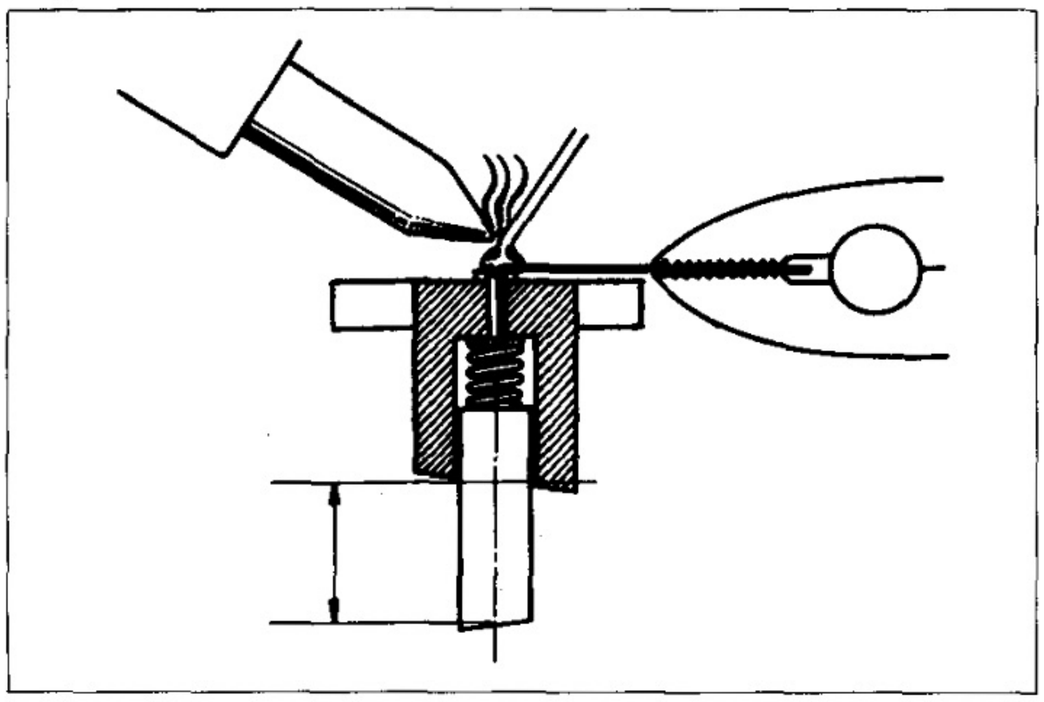
Bearing
Check the bearing for wear or roughness.

Fig. 9-37



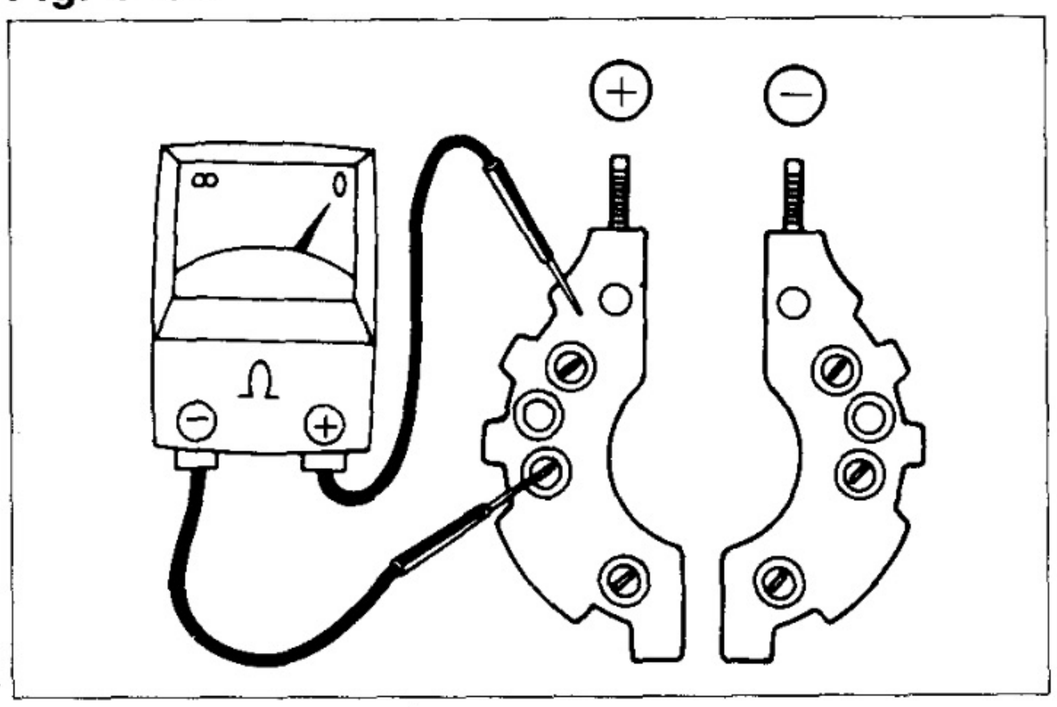
Brush & Brush Holder
1. Measure the exposed brush length.
Exposed length:
Minimum 5.5 mm
(0.217 in.)

Fig. 9-38



2. When replacing the brushes, assemble them as shown in figure.
Exposed length: 20.0 mm
(0.787 in.)

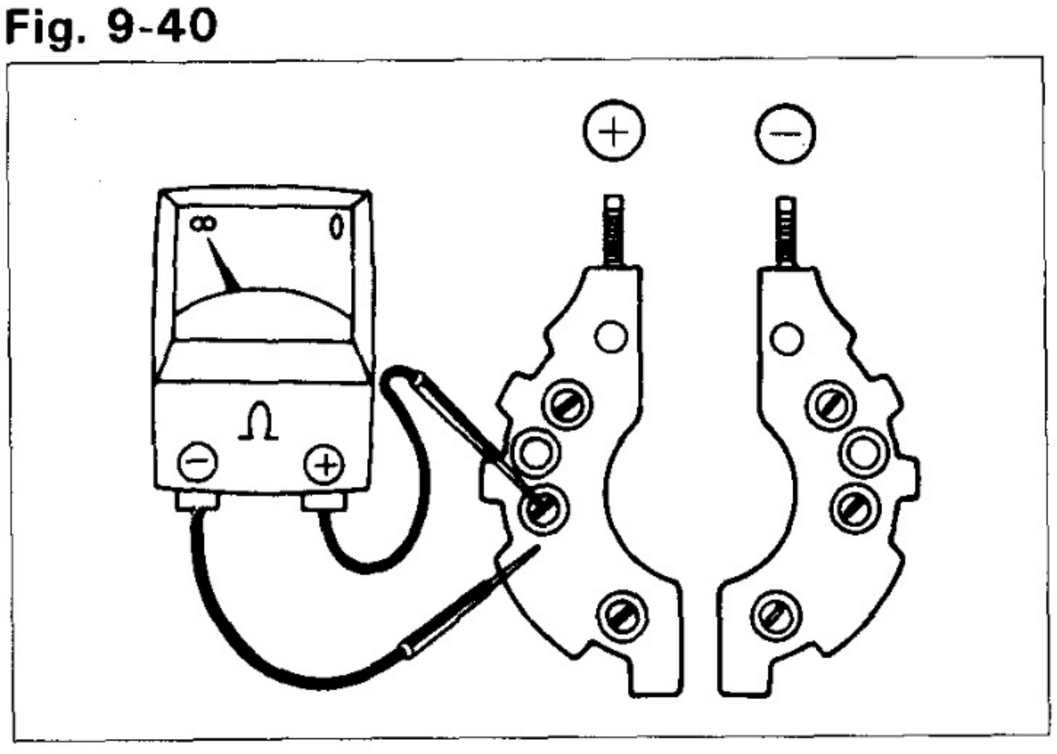
Fig. 9-39



Rectifier

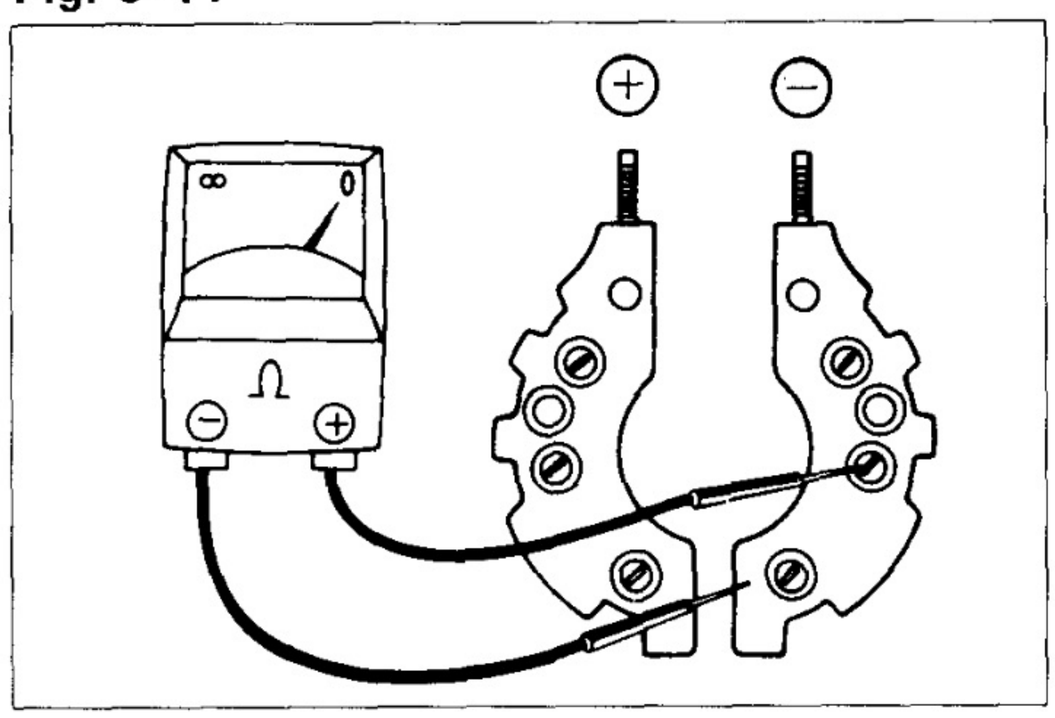
1. Rectifier holder positive side
   Connect an ohmmeter ⊕ lead to the rectifier holder, and the ⊖ lead to the rectifier terminal.
   If there is no continuity, the rectifier assembly must be replaced.

Fig. 9-40



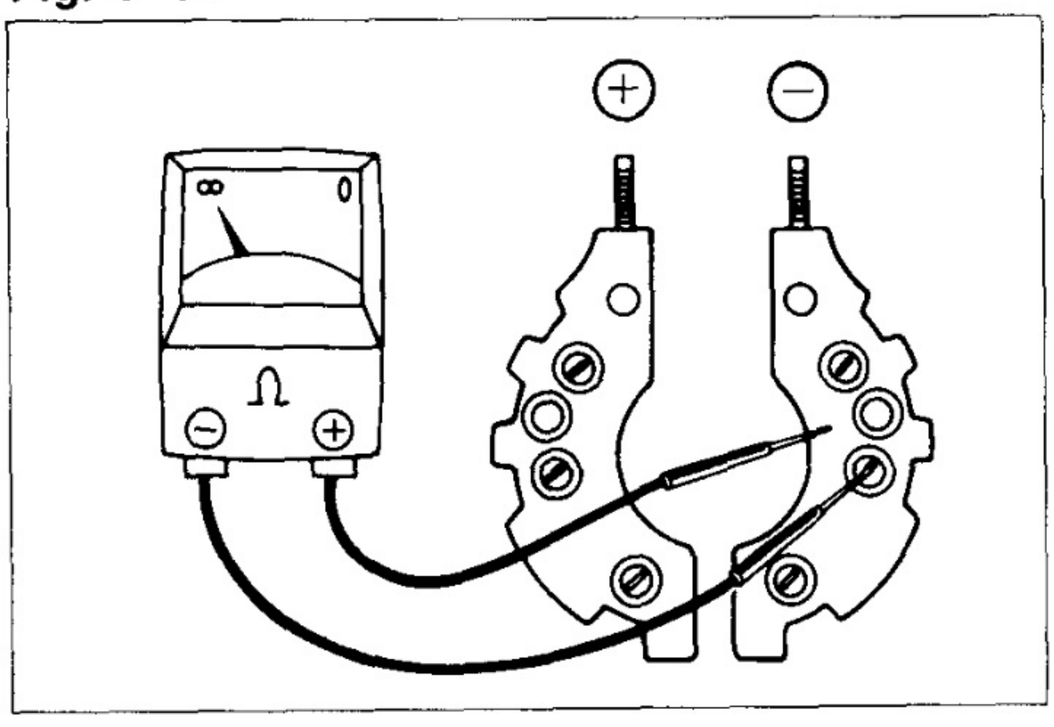
2. Reverse the polarity of the test leads and check again.
   If there is continuity, the rectifier assembly must be replaced.

Fig. 9-41



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. 9-42

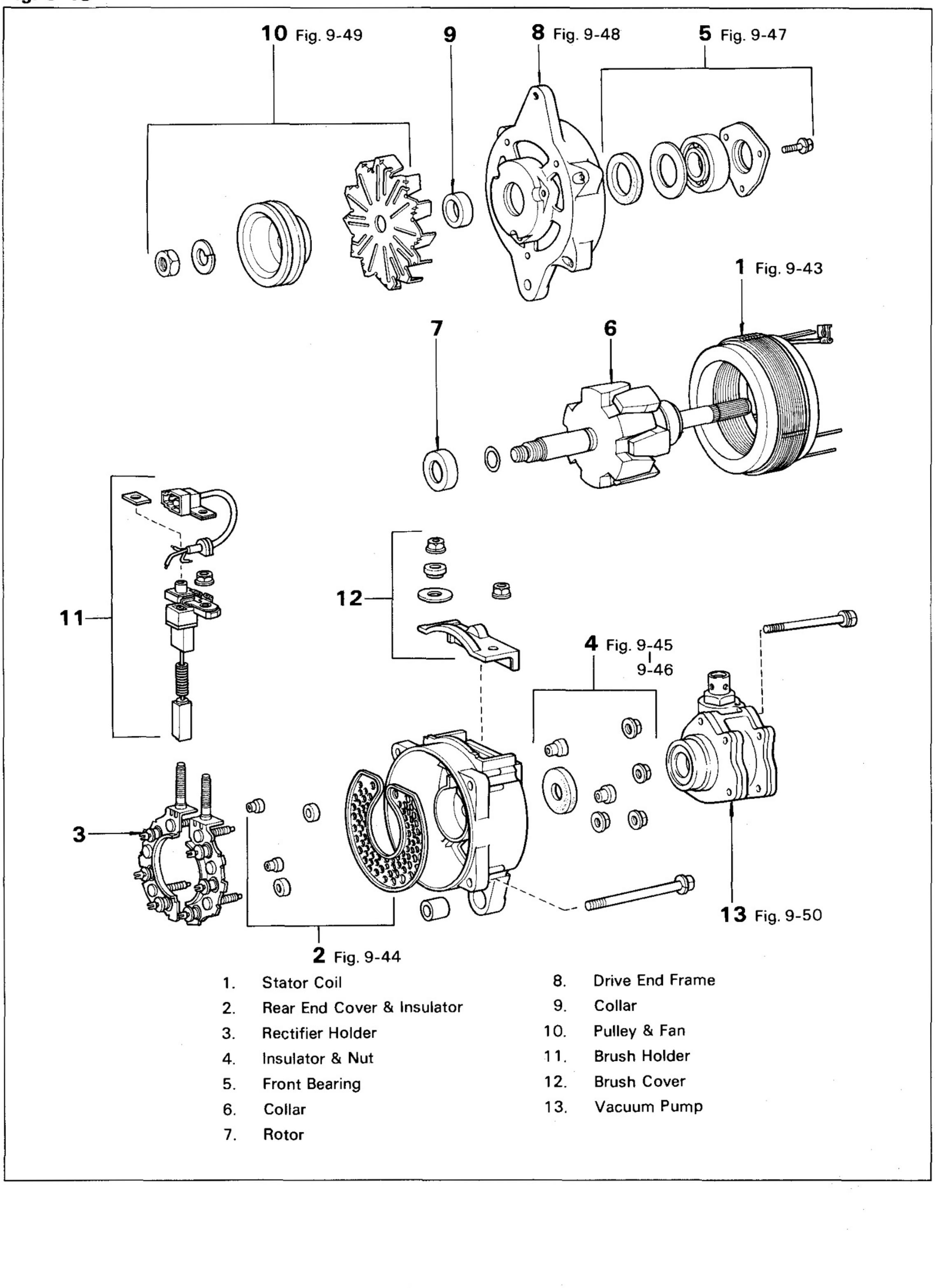


4. Reverse polarity of the test leads and check again.
   If there is continuity, the rectifier assembly must be replaced.

ASSEMBLY

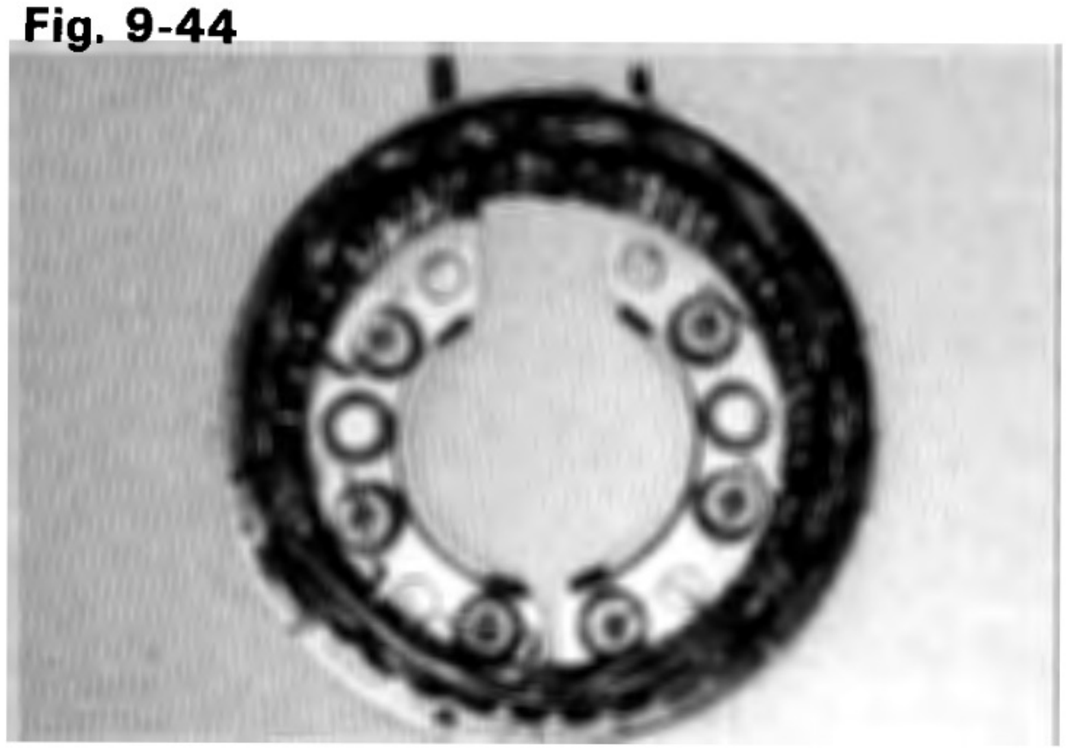
Assemble the parts in the numerical order shown in the figure.

Fig. 9-43



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

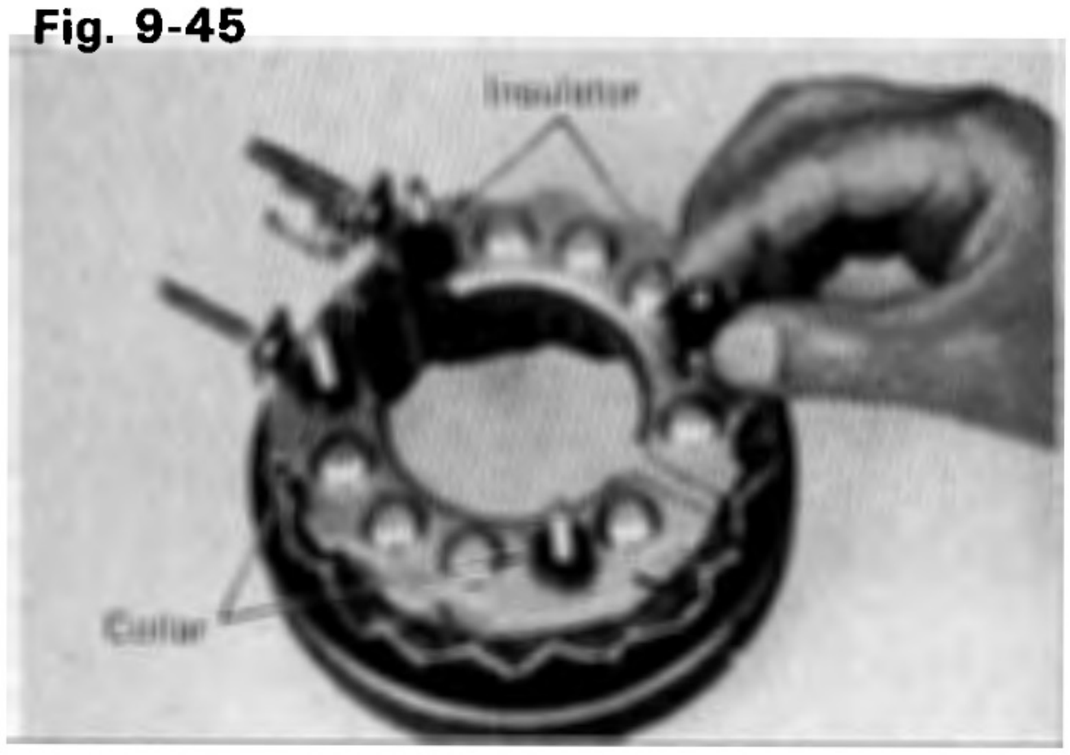
Fig. 9-44



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

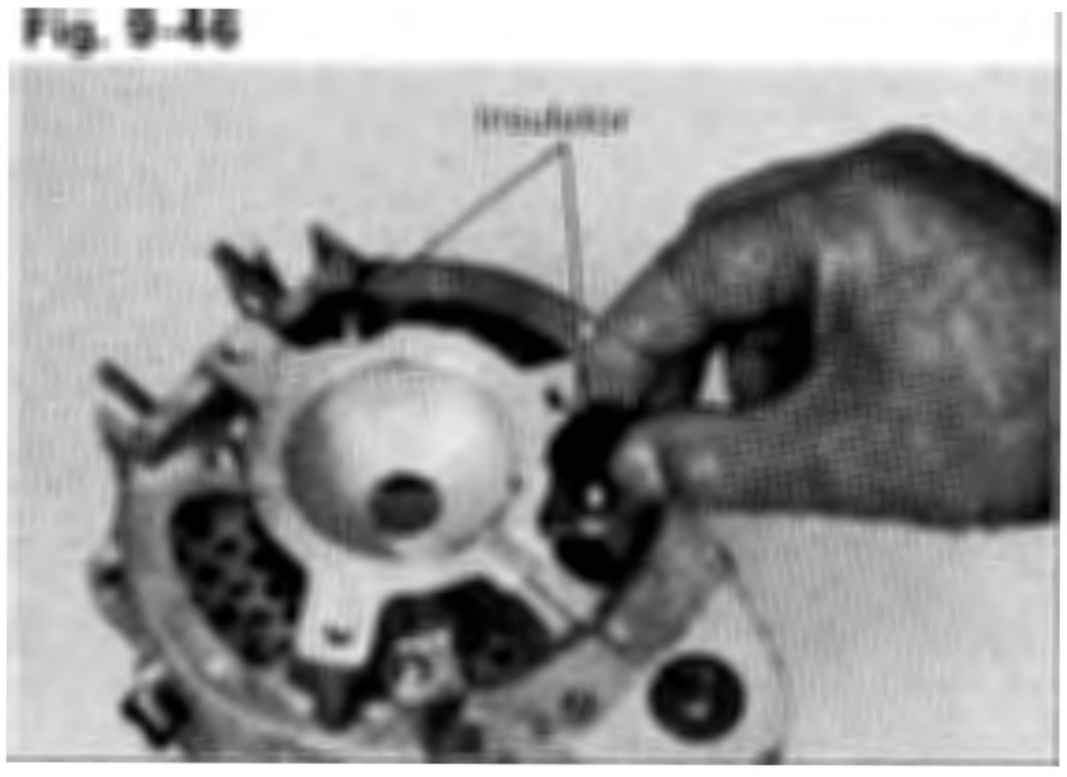
—Note—
When soldering the leads, hold the rectifier terminal with a long nose pliers to protect the rectifier from heat.

Fig. 9-45



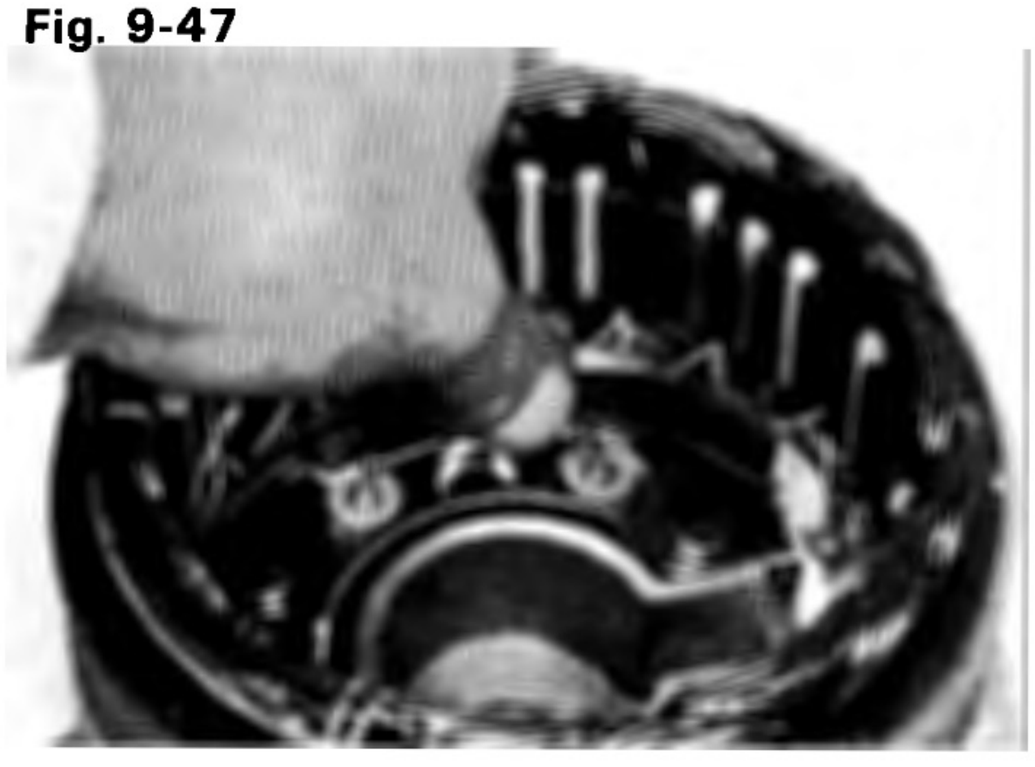
Install the insulator to the rectifier (+) holder and the collar to (—) holder.

Fig. 9-46



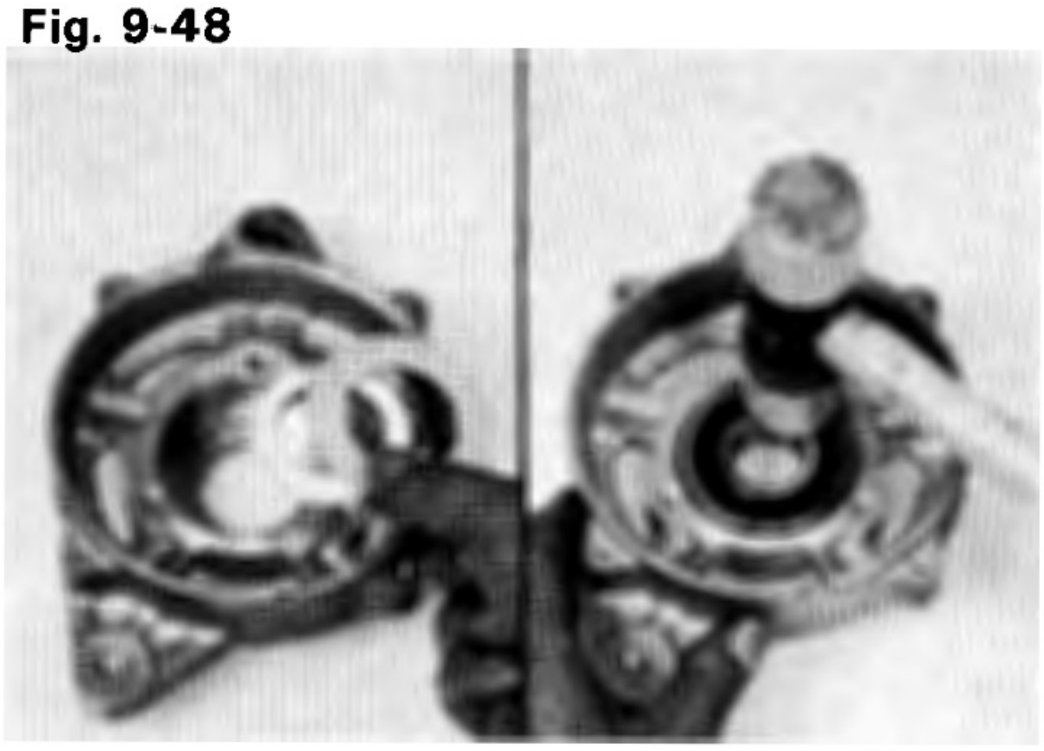
Assemble the rectifier end frame with the insulators.

Fig. 9-47



If there is danger of the stator coil terminal wiring contacting the frame or rotor, correct by bending the wire.

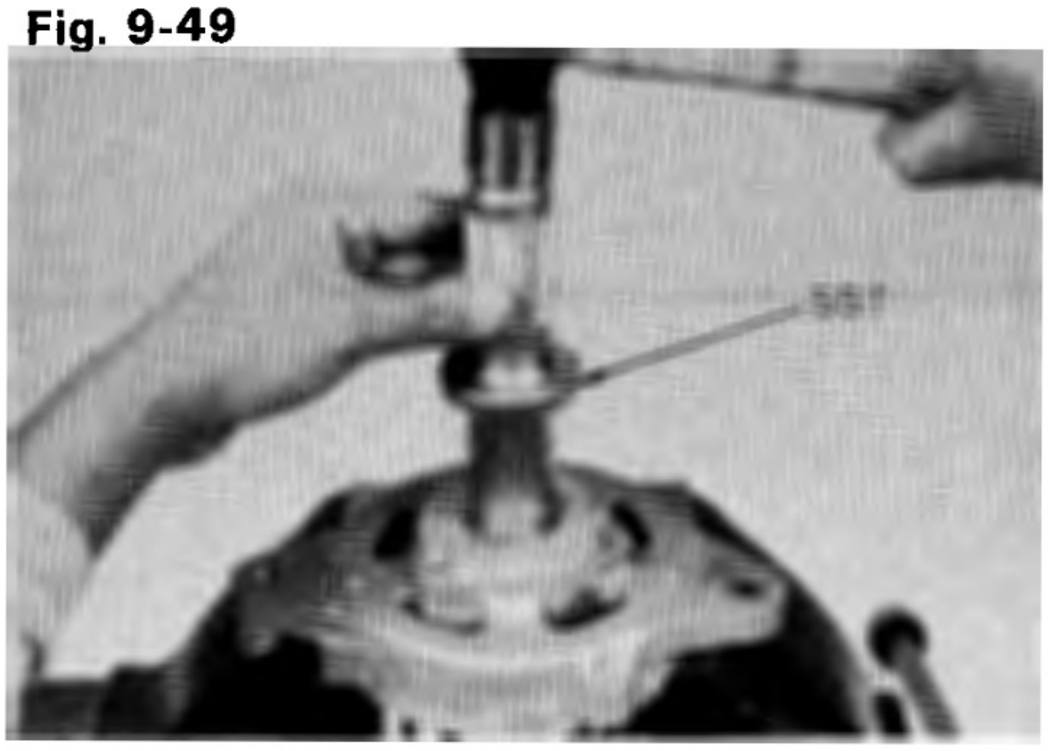
Fig. 9-48



Install the bearing and retainers.

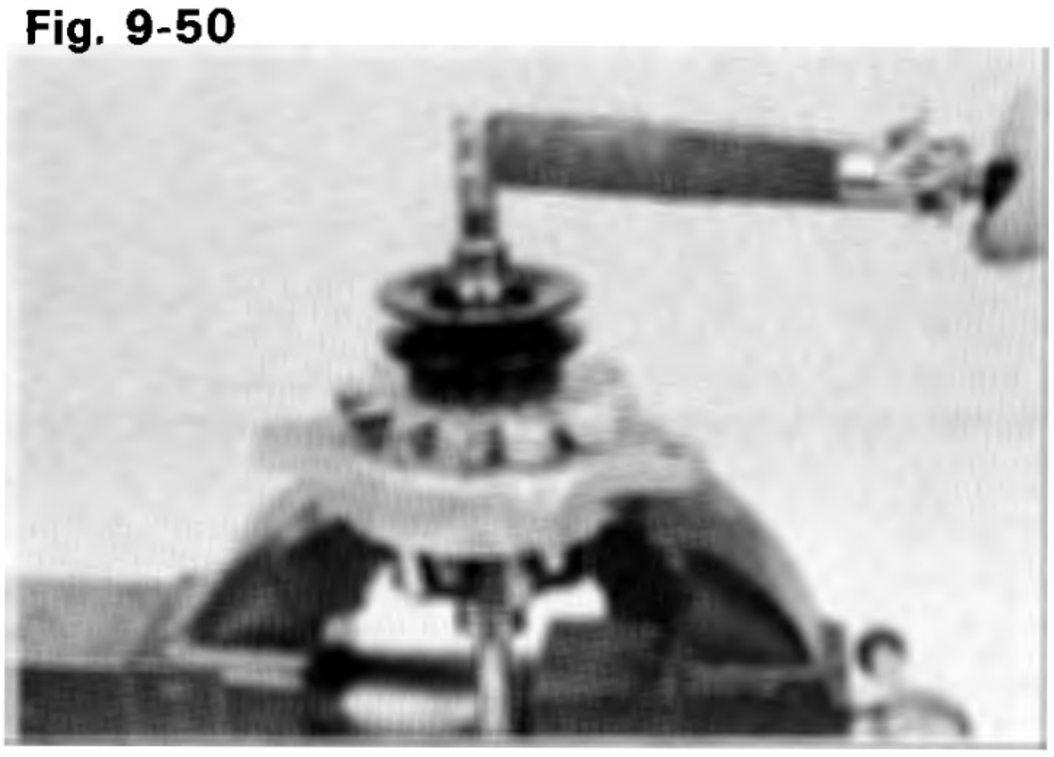
–Note–
Tap the bearing lightly with a plastic hammer if necessary.

Fig. 9-49



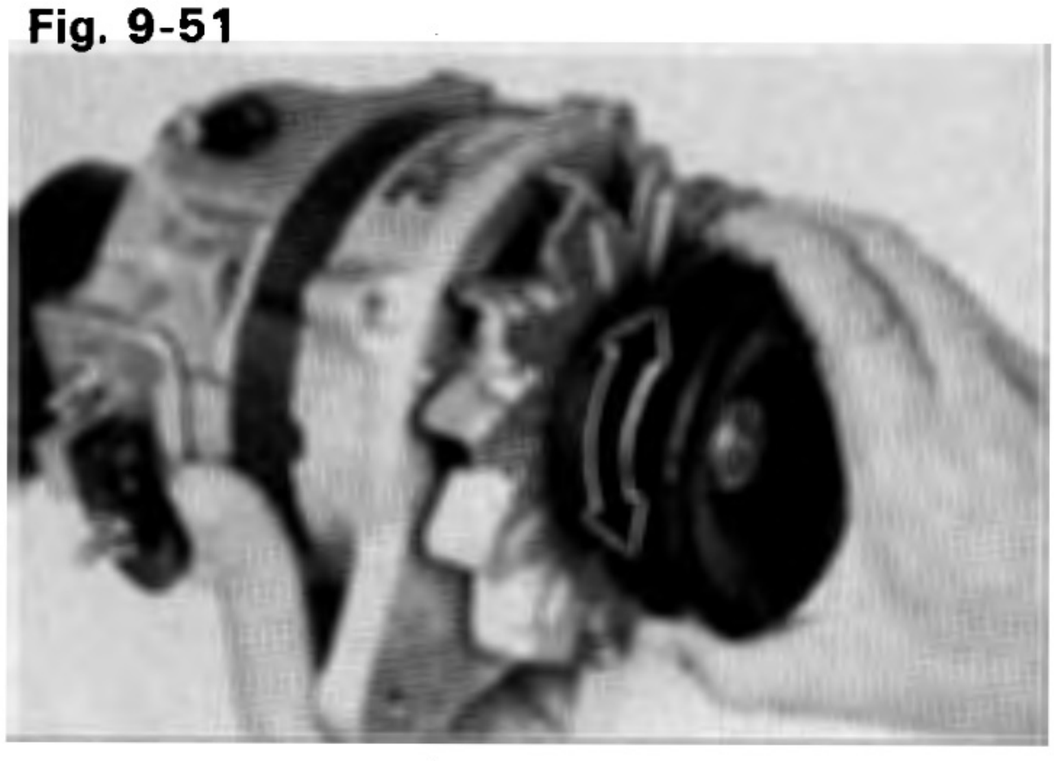
Insert the drive end frame together with a collar into the rotor with SST.
SST [09325-12010]

Fig. 9-50



Using a soft jaw vise, tighten the pulley nut.
Tightening torque: 8.0 – 10.5 kg-m (58 – 75 ft-lb)

Fig. 9-51



Check the rotor for smooth rotation after assembly is completed.

ALTERNATOR REGULATOR

Fig. 9-52

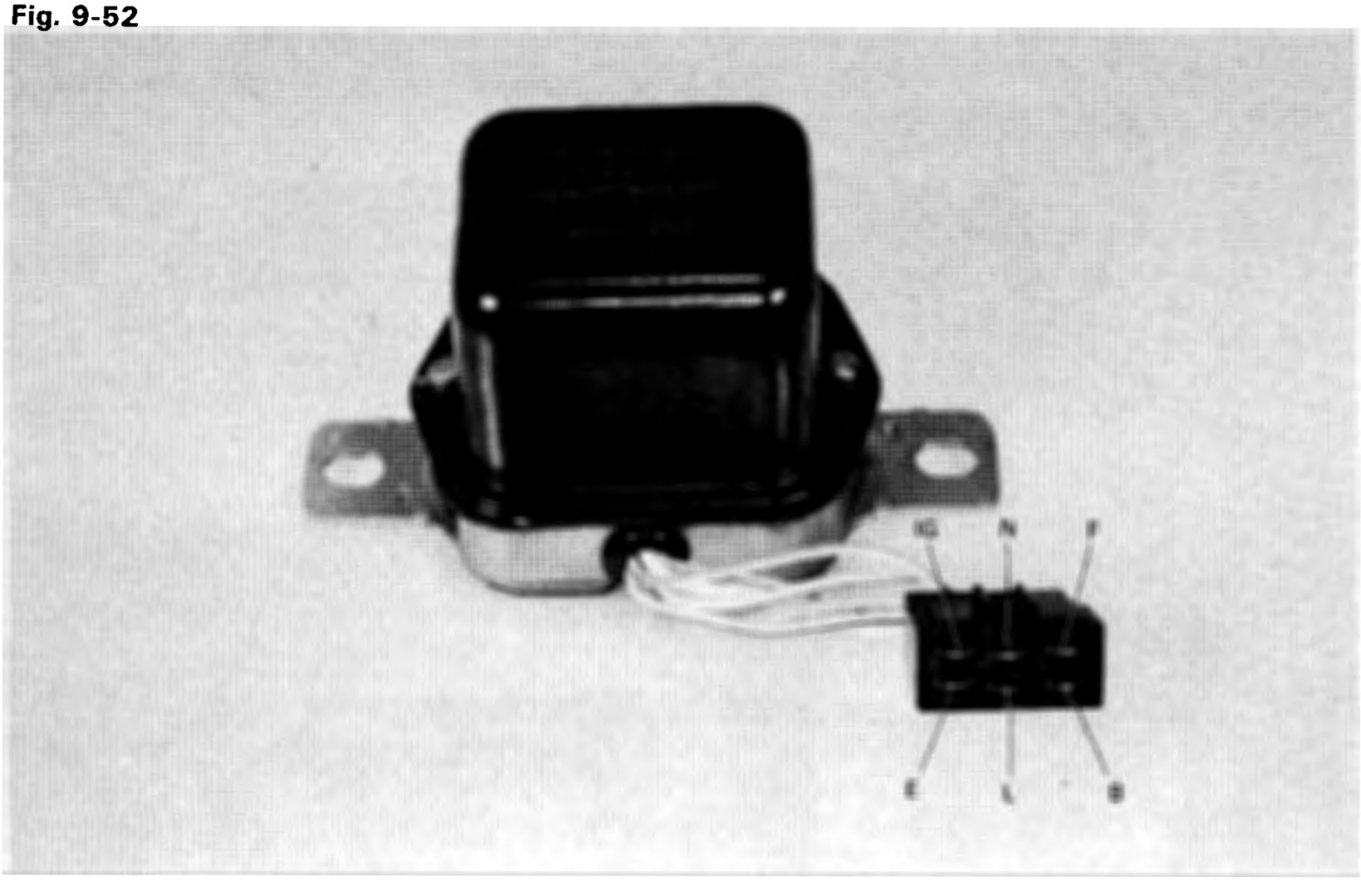


Fig. 9-53



INSPECTION & ADJUSTMENT

Check the connector fitting condition before inspecting the regulator.

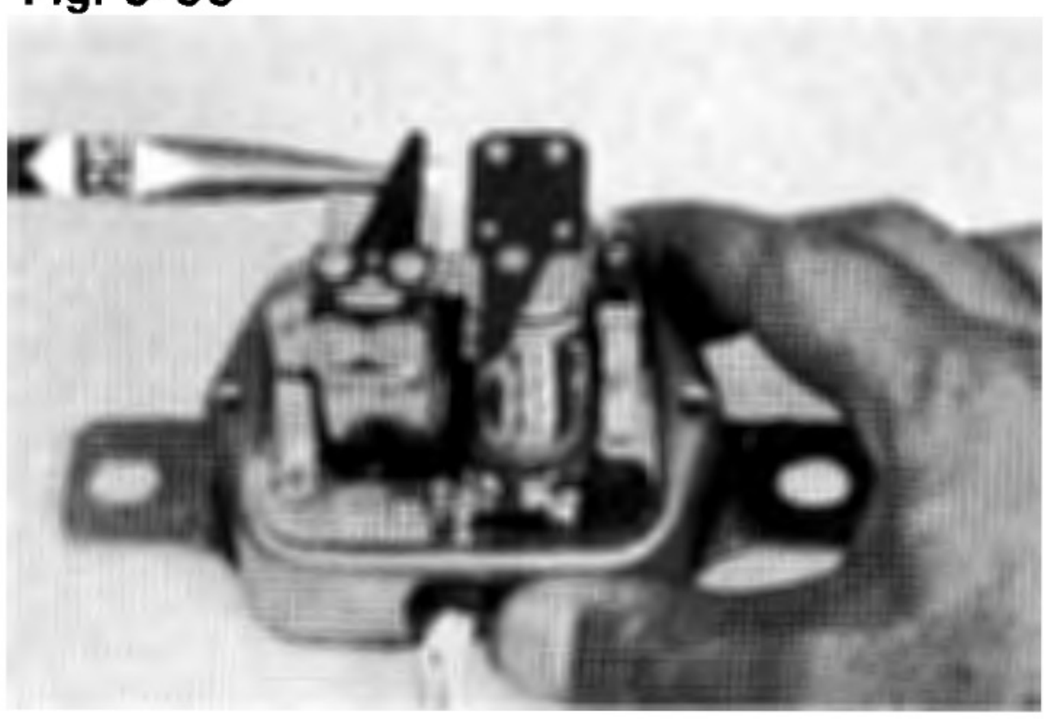
—Note—
Make sure that the regulator connector is pulled out when inspecting and adjusting.

Fig. 9-54



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

Fig. 9-55



Voltage adjustment
To adjust, bend the voltage regulator adjusting arm.

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

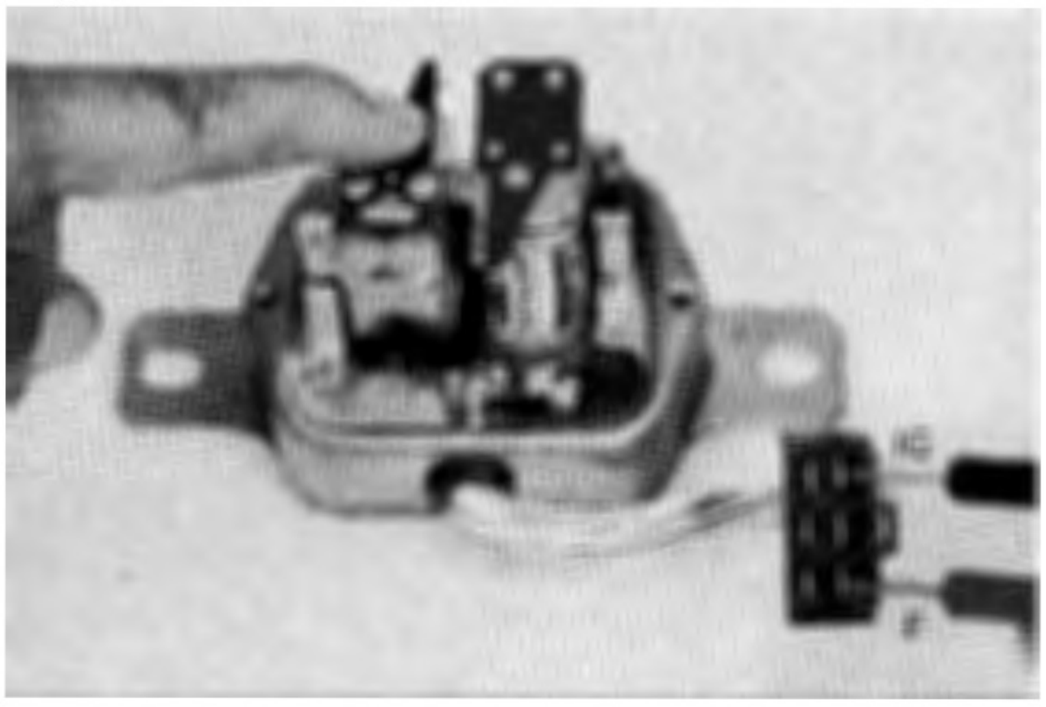
Fig. 9-56



To adjust the voltage relay, bend the relay adjusting arm.

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

Fig. 9-57

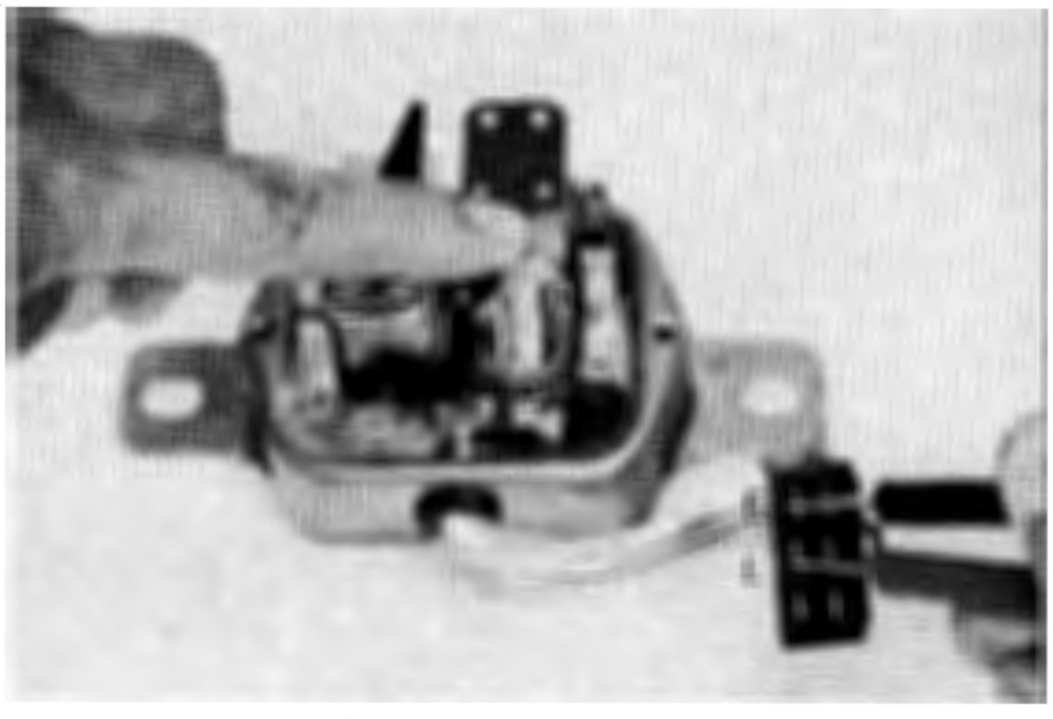


Resistance measurement between the terminals.

IG – F

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

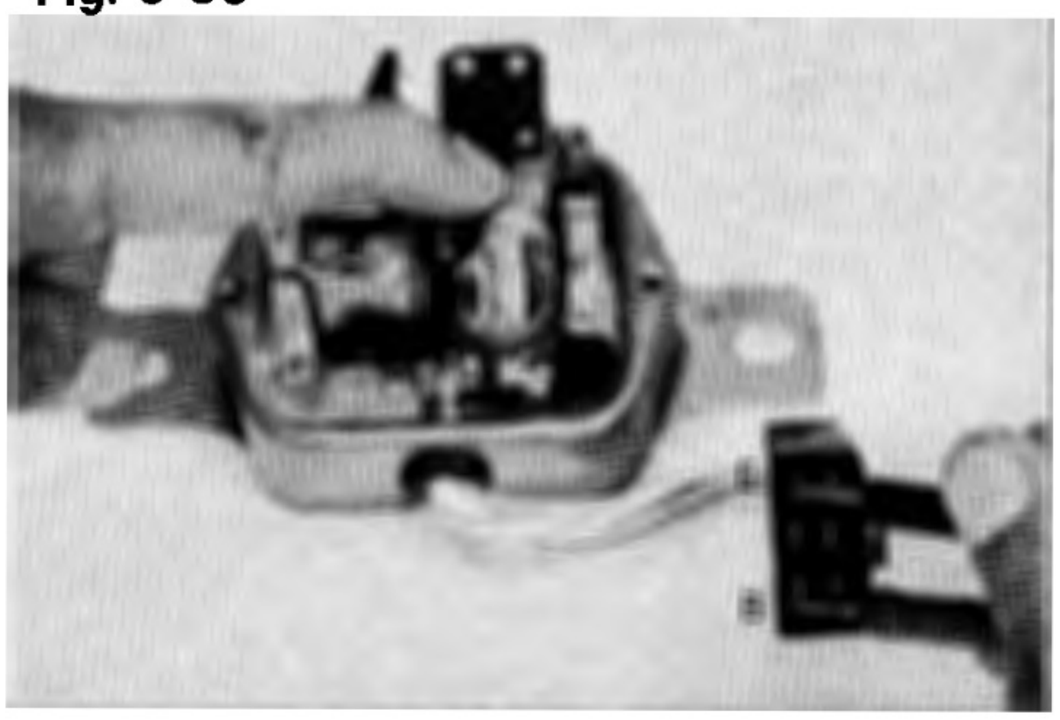
Fig. 9-58



L – E

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

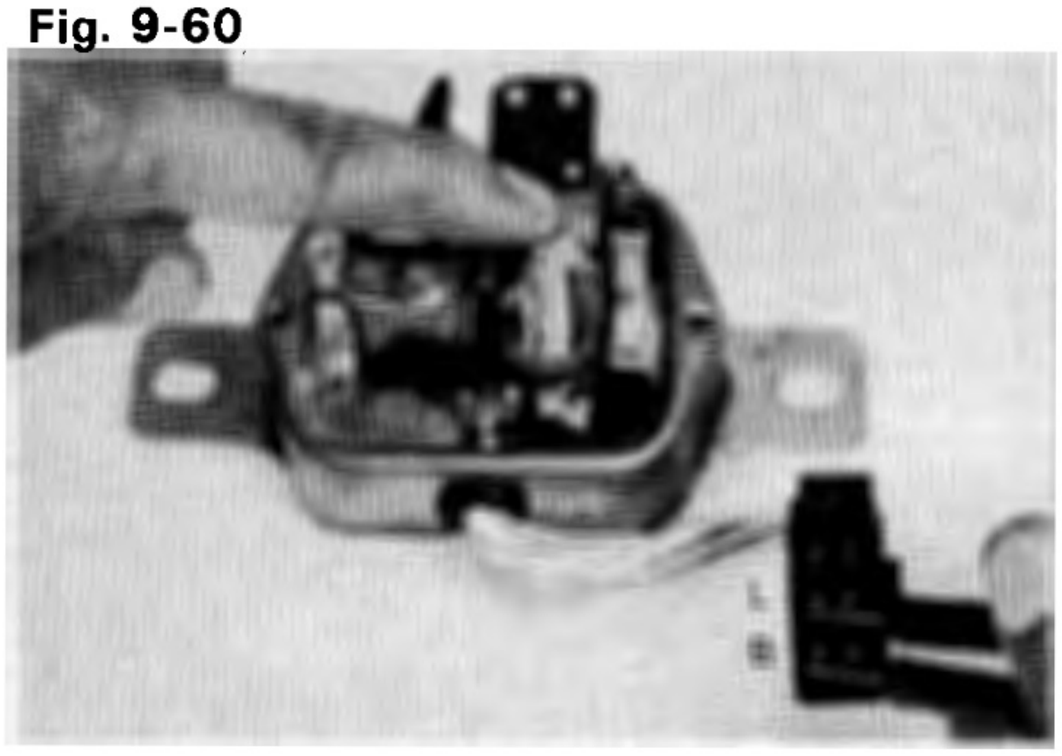
Fig. 9-59



B — E

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

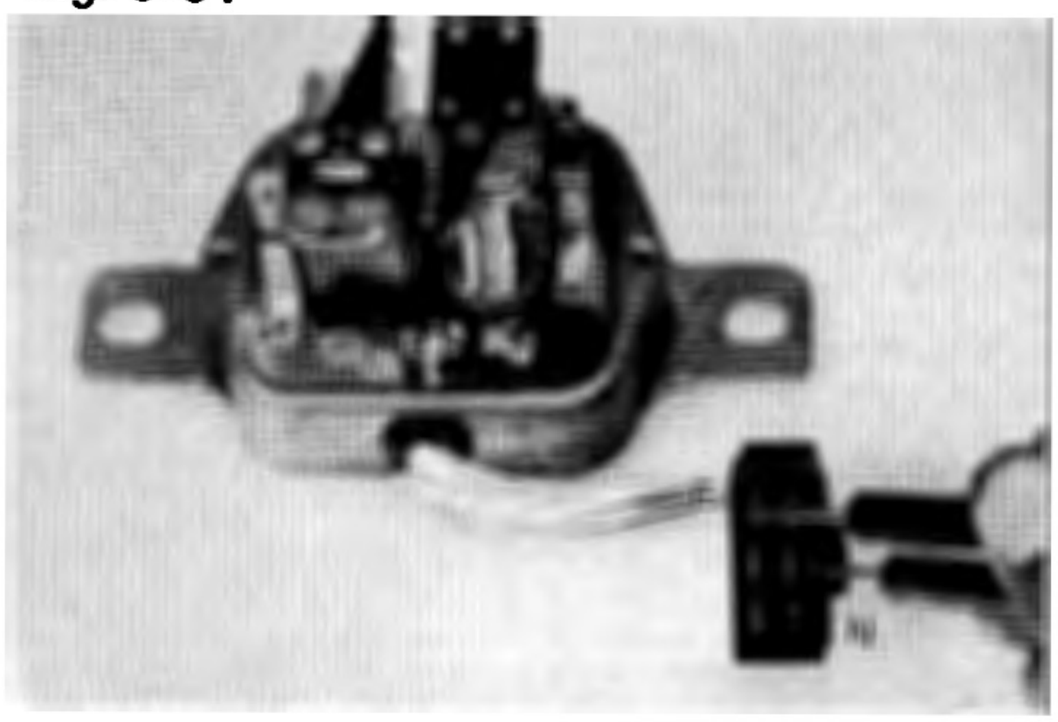
Fig. 9-60



B — L

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

Fig. 9-61



N — E
12V type Approx. 24Ω
24V type Approx. 100Ω

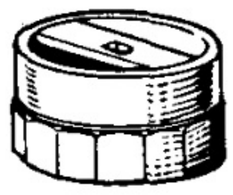
SST & SERVICE SPECIFICATIONS

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TIGHTENING TORQUE FOR MAIN PARTS	10-14
SERVICE SPECIFICATIONS	10-15

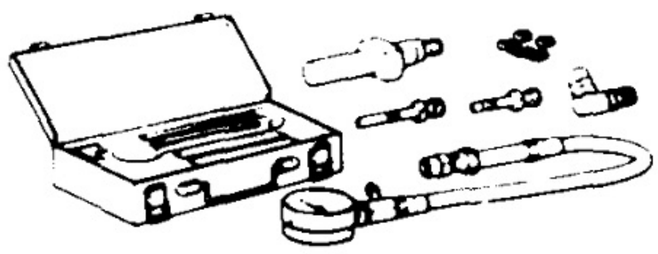
SST (SPECIAL SERVICE TOOLS)

ENGINE TUNE-UP

Oil Filter

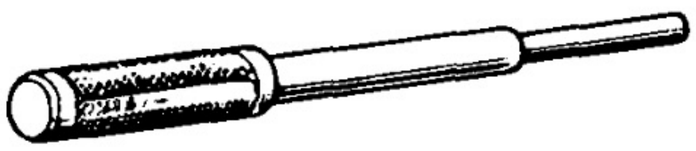
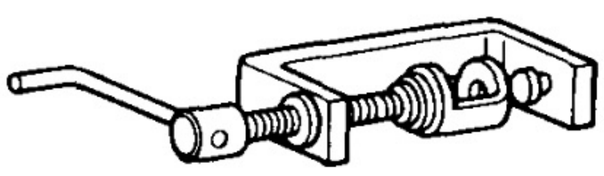
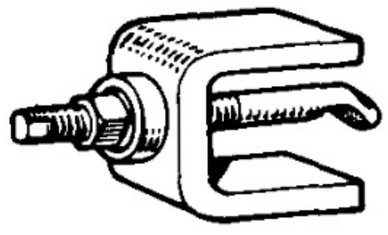
Illustration	Tool No.	Tool Name
	09228-60010	Oil Filter Wrench

Compression Pressure

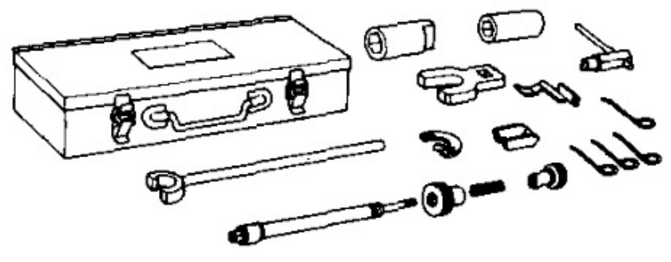
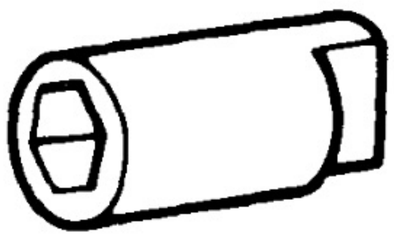
Illustration	Tool No.	Tool Name
	09992-00022	Cylinder Compression Check Gauge Set

ENGINE SERVICE

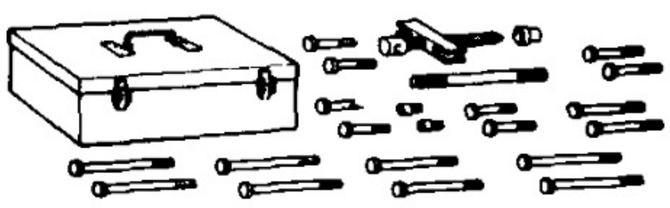
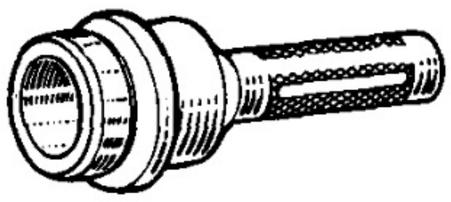
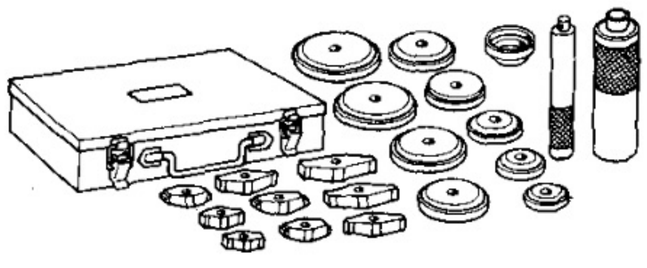
Cylinder Head

Illustration	Tool No.	Tool Name
	09201-60011	Valve Stem Guide Remover & Replacer
	09202-43013	Valve Spring Compressor
	09208-48010	Combustion Chamber Remover

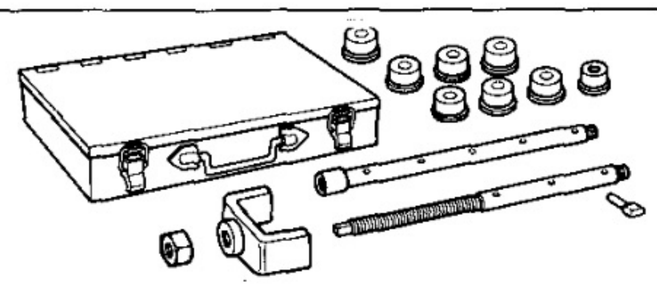
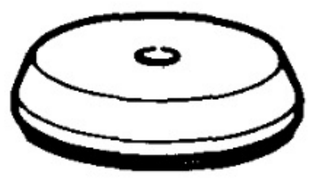
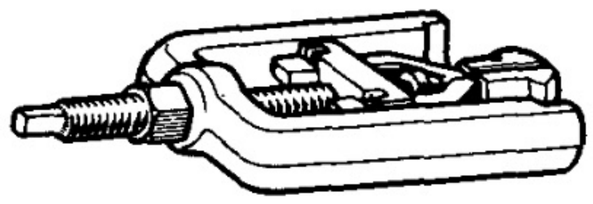
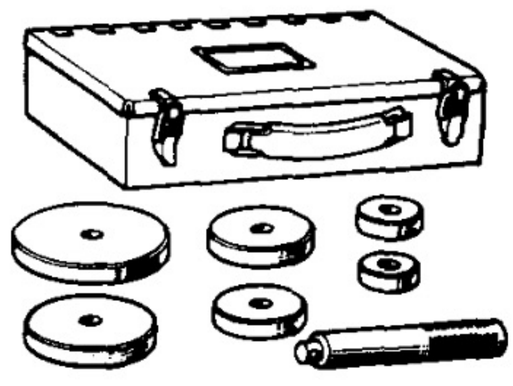
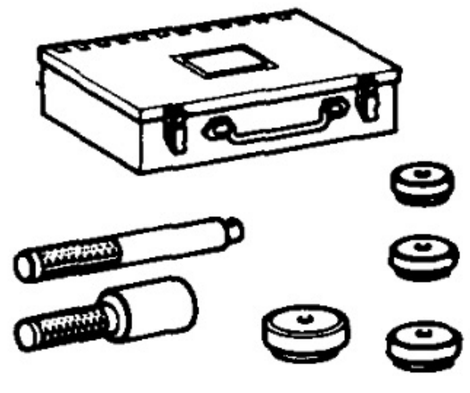
Cylinder Head (Cont'd)

Illustration	Tool No.	Tool Name
	09260-46012	Injection Pump Tool Set
	(09268-46011)	(Nozzle Holder Body Wrench)

Timing Gear

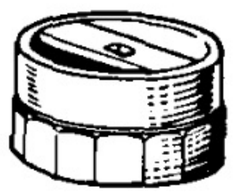
Illustration	Tool No.	Tool Name
	09213-60017	Crankshaft Pulley & Gear Puller
	09219-60020	Set Bolt
	09223-46011	Crankshaft Front Oil Seal Replacer
	09260-76017	Injection Pump Tool Set
	09608-35013	Transmission & Transfer Bearing Replacer

Cylinder Block

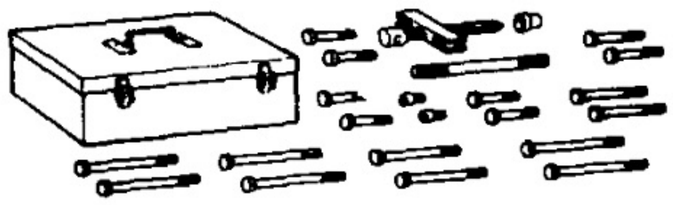
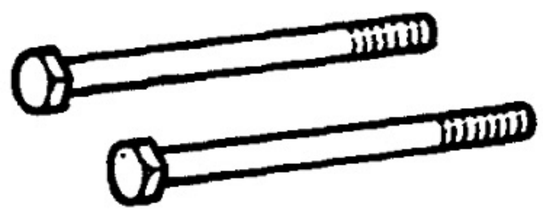
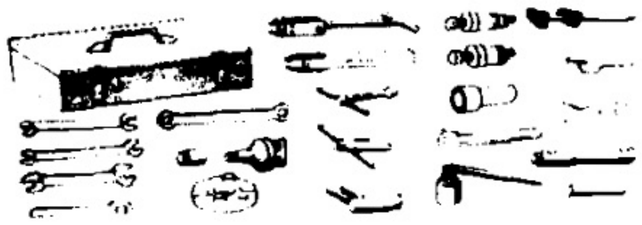
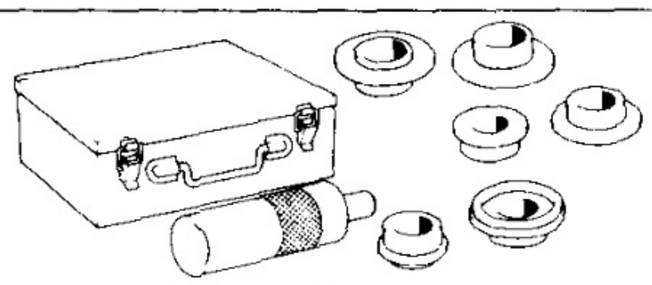
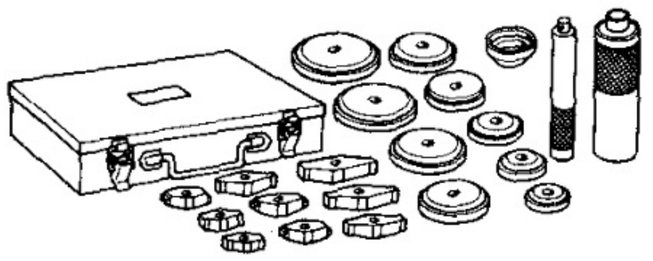
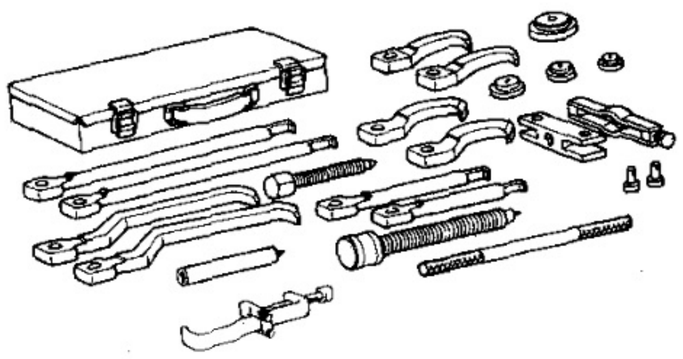
Illustration	Tool No.	Tool Name
	09215-00100	Camshaft Bearing Remover & Replacer
	09218-54011	Cylinder Liner Remover & Replacer
	09222-66010	Connecting Rod Bushing Remover & Replacer
	09303-55010	Input Shaft Front Bearing Puller
	09550-55010	Differential Replacer Set
	09620-30010	Steering Gear Box Replacer Set

LUBRICATION SYSTEM

Oil Filter

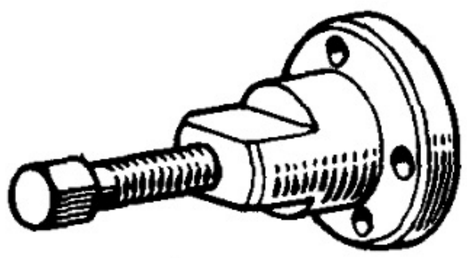
Illustration	Tool No.	Tool Name
	09228-60010	Oil Filter Wrench

Oil Pump

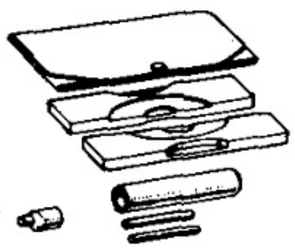
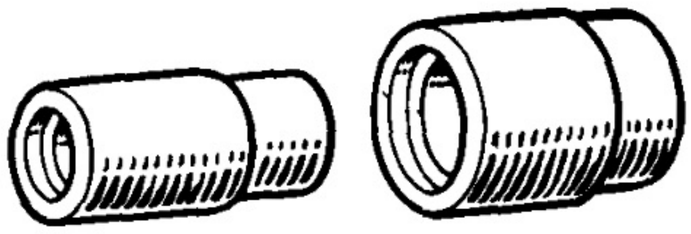
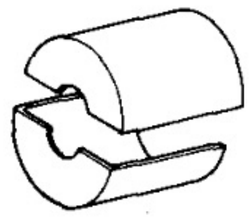
Illustration	Tool No.	Tool Name
	09213-60017	Crankshaft Pulley & Gear Puller
	09219-60020	Set Bolt
	09260-76017	Injection Pump Tool Set
	09316-60010	Transmission & Transfer Bearing Replacer Set
	09608-35013	Axle Hub & Drive Pinion Bearing Tool Set
	09950-20014	Universal Puller

COOLING SYSTEM

Water Pump

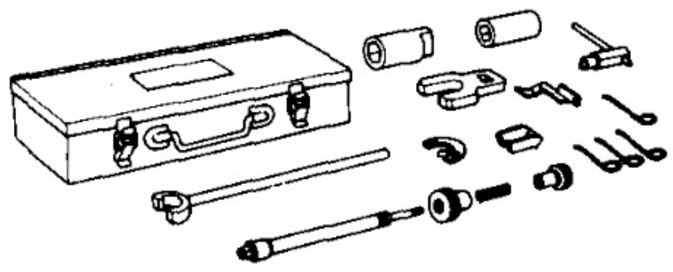
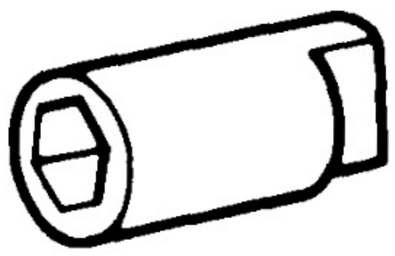
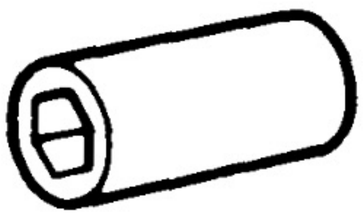
Illustration	Tool No.	Tool Name
	09236-00100	Water Pump Overhaul Tool Set

Water Pump (Cont'd)

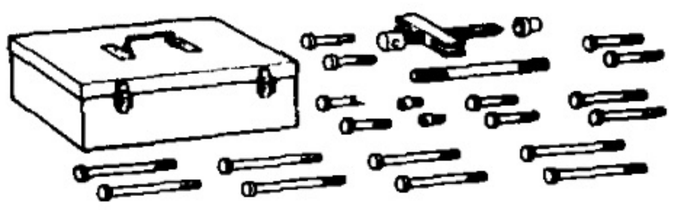
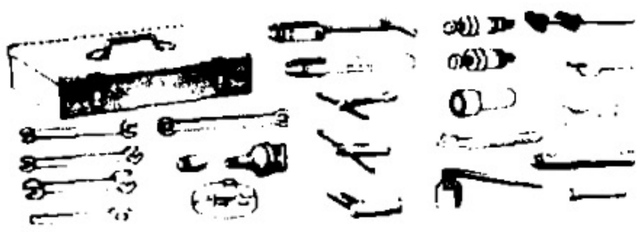
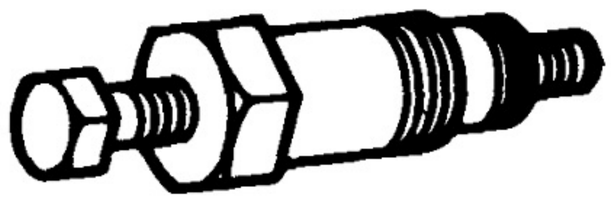
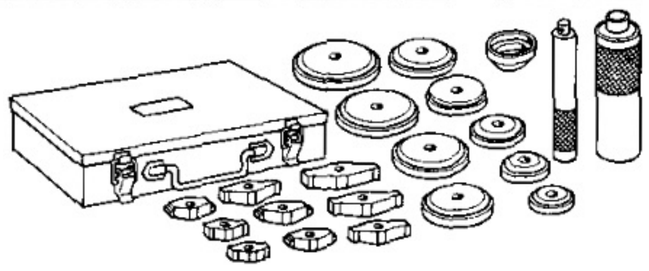
Illustration	Tool No.	Tool Name
	09236-00100	Water Pump Overhaul Tool Set
	09238-47012	Water Pump Bearing Remover & Replacer
	09236-00100	Water Pump Overhaul Tool Set

FUEL SYSTEM

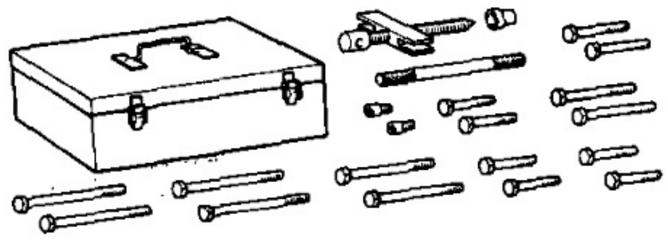
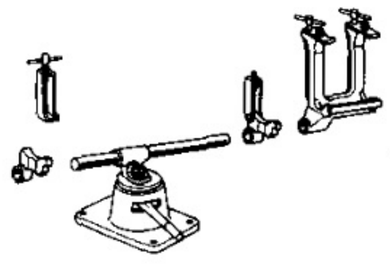
Injection Nozzle

Illustration	Tool No.	Tool Name
	09260-46012	Injection Pump Tool Set
	(09268-46011)	(Nozzle Holder Body Wrench)
	(09268-46021)	(Nozzle Holder Retaining Nut Wrench)

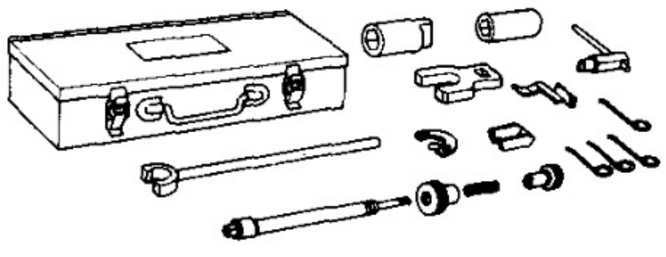
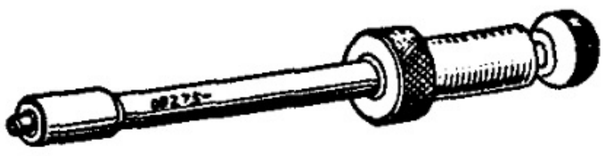
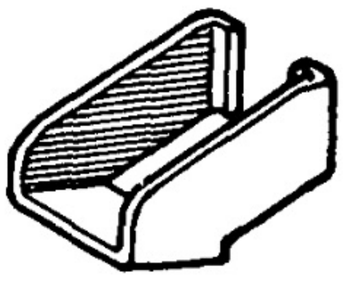
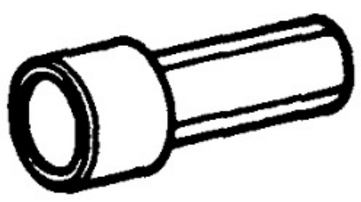
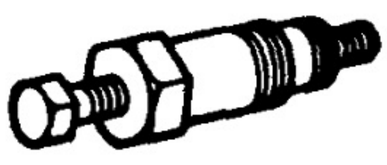
Automatic Timer

Illustration	Tool No.	Tool Name
	09213-60017	Crankshaft Pulley & Gear Puller
	09260-76017	Injection Pump Tool Set
	(09280-76010)	(Automatic Timer Spring Holder)
	09267-76020	Automatic Timer Remover
	09608-35013	Axle Hub & Drive Pinion Bearing Tool Set

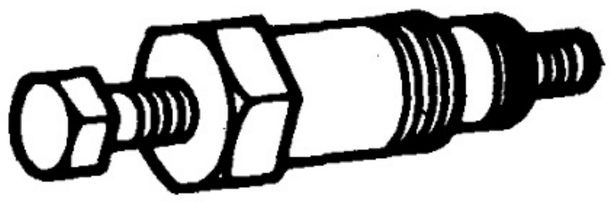
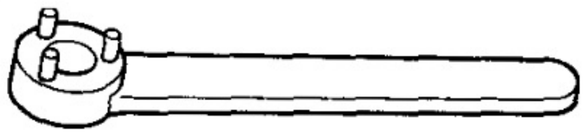
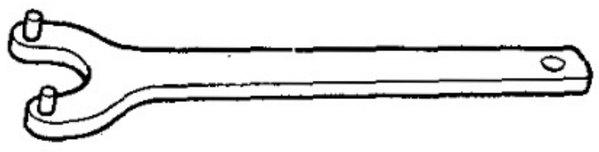
Injection Pump

Illustration	Tool No.	Tool Name
	09213-60016	Crankshaft Pulley & Gear Puller
	09241-76021	Injection Pump Stand Set

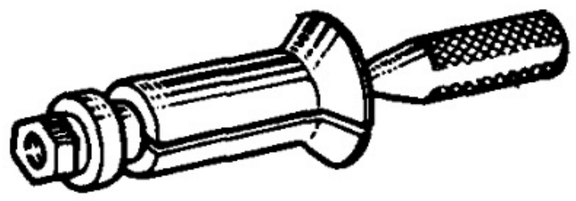
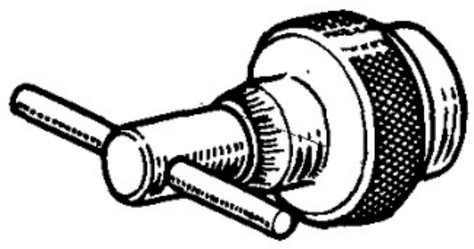
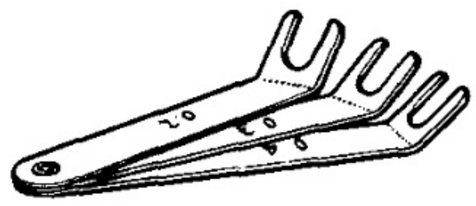
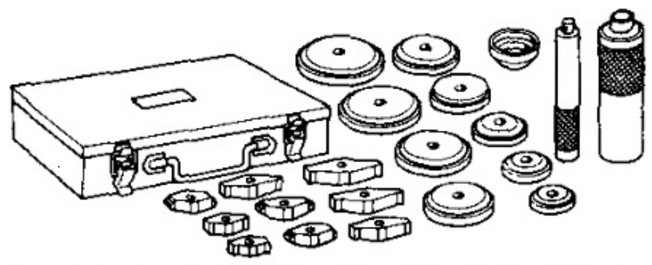
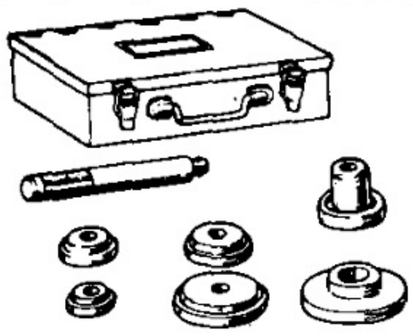
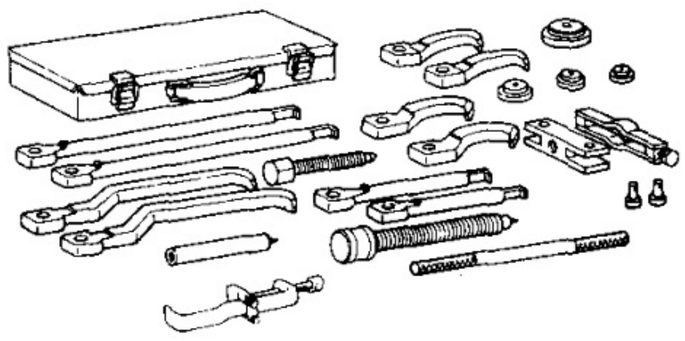
Injection Pump (Cont'd)

Illustration	Tool No.	Tool Name
	09260-46012	Injection Pump Tool Set
	(09274-46010)	(Tappet Insert)
	(09275-46010)	(Plunger Clamp)
	(09280-46010)	(Plunger Spring Holder)
	(09283-46010)	(Tappet Holder Attachment Gauge)
	09260-76017	Injection Pump Tool Set
	(09262-76010)	(Delivery Valve Gasket Replacer)
	(09266-67011)	(Fly Weight Round Nut Wrench)
	(09267-76011)	(Automatic Timer Extractor)

Injection Pump (Cont'd)

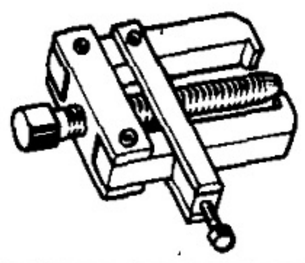
Illustration	Tool No.	Tool Name
	(09270-76010)	(Delivery Valve Holder)
	(09271-76011)	(Delivery Valve Extractor)
	(09272-76011)	(Tappet Roller Clamp)
	(09273-76011)	(Tappet Clamp)
	(09276-76010)	(T Type Box Wrench)
	(09282-76010)	(Idling Adjust Wrench)
	09267-76020	Automatic Timer Remover
	09283-76010	Fuel Stop Capsule Lock Nut Wrench
	09283-76020	DHAC Bellows Lock Nut Wrench
	09285-76010	Injection Camshaft Bearing Cone Replacer

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
	09608-35013	Axle Hub & Drive Pinion Bearing Tool Set
	09608-12010	Front Hub & Drive Pinion Bearing Replacer Set
	09950-20014	Universal Puller

STARTING SYSTEM

Starter

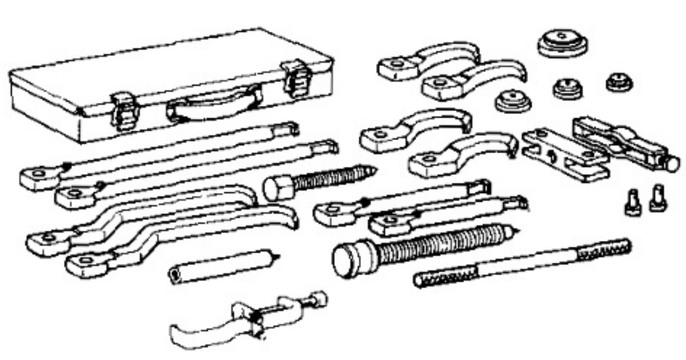
Illustration	Tool No.	Tool Name
	09285-76010	Injection Camshaft Bearing Cone Replacer
	09286-46011	Injection Pump Spline Shaft Puller

CHARGING SYSTEM

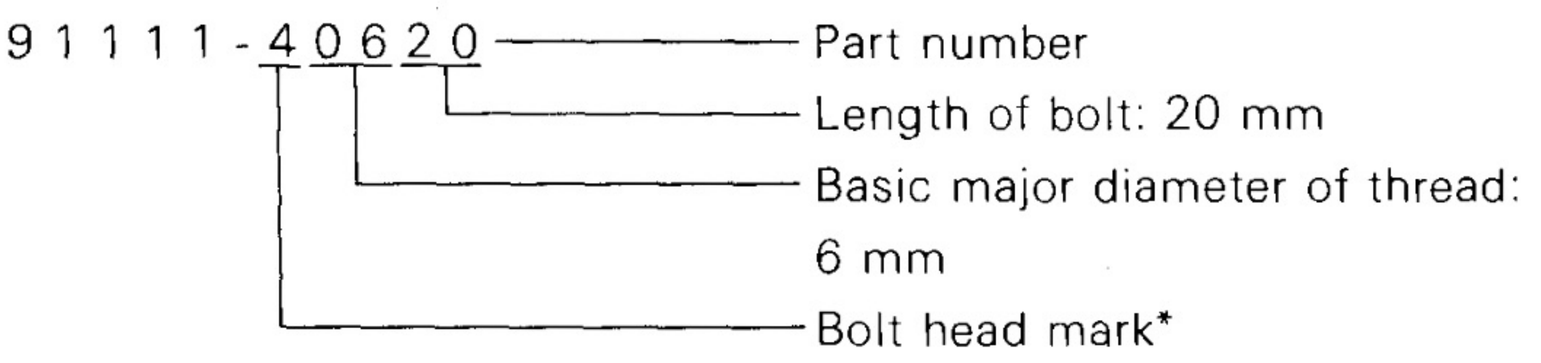
On-Vehicle Inspection

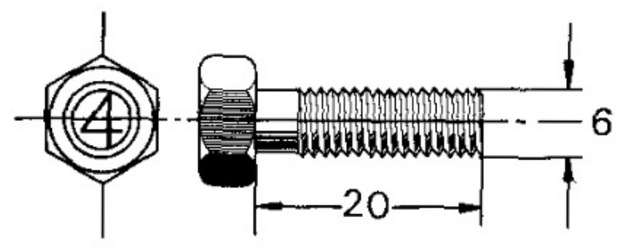
Illustration	Tool No.	Tool Name
	09081-00011	Alternator Checker

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	11.0 — 12.0	80 — 86
Rocker arm support x Cylinder head	1.5 — 2.2	11 — 15
Exhaust manifold x Cylinder head	1.8 — 2.4	13 — 17
Intake manifold x Cylinder head	1.5 — 2.2	11 — 15
Camshaft timing gear x Camshaft	3.5 — 5.5	26 — 39
Camshaft thrust plate x Cylinder block	3.0 — 4.5	22 — 32
Idle gear x Idle gear shaft	4.0 — 5.5	29 — 39
Timing gear cover bolt	2.0 — 3.0	15 — 21
Crankshaft pulley x Crankshaft	18.0 — 22.0	131 — 159
Crankshaft bearing cap x Cylinder block	12.8 — 14.2	93 — 102
Connecting rod cap x Connecting rod	8.5 — 9.5	62 — 68
Oil pan x Cylinder block	1.0 — 1.6	8 — 11
Flywheel x Crankshaft	11.5 — 12.5	84 — 90
Injection pump x Automatic timer	7.0 — 8.0	51 — 57
Nozzle holder x Cylinder head	6.0 — 8.0	44 — 57
Nozzle retaining nut	6.0 — 8.0	44 — 57
Injection pipe union nut	1.0 — 1.6	8 — 11
Delivery valve holder	2.5 — 3.5	19 — 25

SERVICE SPECIFICATIONS

ENGINE TUNE-UP

Drive belt tension	at 10 kg (22 lb)			
Fan — Alternator		New belt	8 — 9 mm	0.31 — 0.35 in.
		Used belt	10 — 11 mm	0.39 — 0.43 in.
Battery electrolyte specific gravity				
When fully charged	at 20°C (68°F)		1.25 — 1.27	
Engine oil capacity				
Dry fill			10.3 liters	10.9 US qt 9.1 Imp.qt
Drain & refill	w/ Oil filter change		9.7 liters	10.3 US qt 8.5 Imp.qt
	w/o Oil filter change		8.1 liters	8.6 US qt 7.1 Imp.qt
Coolant capacity	w/ Heater	HJ60	15.4 liters	16.3 US qt 13.6 Imp.qt
		HJ47	14.1 liters	14.9 US qt 12.4 Imp.qt
Injection timing	Stationary		16°BTDC	
Injection order			1 — 4 — 2 — 6 — 3 — 5	
Valve clearance	Hot	Intake	0.20 mm	0.008 in.
		Exhaust	0.36 mm	0.014 in.
Idle speed			625 — 675 rpm	
Maximum speed				
No-load	Direct fan type		4,050 — 4,100 rpm	
	w/ Fluid coupling type		4,120 — 4,170 rpm	
Compression pressure	at 250 rpm			
		STD	28.0 kg/cm²	398 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

ENGINE

Cylinder head

Surface warpage	Limit	0.2 mm	0.008 in.
Manifiold mounting surface warpage	Limit	0.2 mm	0.008 in.
Valve seat			
Contacting surface angle		45°	
Contacting width		1.4 — 2.0 mm	0.055 — 0.079 in.
Refacing angle		30°, 45°, 60°	

Combustion Chamber

Extent of protrusion	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	120.7 mm	4.752 in.
		Exhaust	120.6 mm	4.748 in.
Stem end refacing	Limit	IN & EX	0.5 mm	0.020 in.
Stem diameter		Intake	8.973 – 8.989 mm	0.3533 – 0.3539 in.
		Exhaust	8.954 – 8.970 mm	0.3525 – 0.3531 in.
Stem oil clearance	STD	Intake	0.021 – 0.057 mm	0.0008 – 0.0022 in.
		Exhaust	0.040 – 0.076 mm	0.0016 – 0.0032 in.
	Limit	Intake	0.10 mm	0.0039 in.
		Exhaust	0.12 mm	0.0047 in.
Guide bushing				
Inner diameter			9.010 – 9.030 mm	0.3547 – 0.3555 in.
Protrusion from cylinder head			14.8 – 15.2 mm	0.583 – 0.598 in.

Valve Spring

Free length	Inner	44.3 mm	1.744 in.
	Outer	48.1 mm	1.894 in.
Installed length	Inner	36.0 mm	1.417 in.
	Outer	40.0 mm	1.575 in.
Installed load	Inner	7.6 kg	16.8 lb
	Outer	22.5 kg	49.6 lb
Squareness	Limit	2.0 mm	0.079 in.

Valve Rocker Arm & Shaft

Oil clearance	STD	0.007 – 0.049 mm	0.0003 – 0.0019 in.
	Limit	0.1 mm	0.004 in.

Valve Lifter

Outer diameter	STD	22.17 – 22.19 mm	0.8728 – 0.8736 in.
Bore diameter	STD	22.20 – 22.22 mm	0.8740 – 0.8748 in.
Oil clearance	STD	0.01 – 0.05 mm	0.0004 – 0.0020 in.
	Limit	0.1 mm	0.004 in.

Camshaft

Circle runout		Limit	0.4 mm	0.016 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 – 0.08 mm	0.0012 – 0.0031 in.
		Limit	0.1 mm	0.004 in.
Journal diameter		No.1	51.15 – 51.17 mm	2.0138 – 2.0146 in.
		No.2	50.95 – 50.97 mm	2.0059 – 2.0067 in.
		No.3	50.75 – 50.77 mm	1.9980 – 1.9988 in.
		No.4	50.55 – 50.57 mm	1.9902 – 1.9909 in.
Cam height	STD	Intake	41.90mm	1.6496 in.
		Exhaust	42.30 mm	1.6654 in.

Timing & Idle Gear

Gear backlash				
Crankshaft to idle gear No.1			0.050 – 0.116 mm	0.0019 – 0.0045 in.
Idle gear No.1 to timer			0.050 – 0.111 mm	0.0019 – 0.0043 in.
Idle gear No.1 to No.2			0.050 – 0.113 mm	0.0019 – 0.0044 in.
Idle gear No.2 to camshaft			0.050 – 0.113 mm	0.0019 – 0.0044 in.
Idle gear thrust clearance		STD	0.05 – 0.15 mm	0.0019 – 0.0059 in.
		Limit	0.3 mm	0.012 in.
Idle gear shaft diameter	STD	No.1 & No.2	44.95 – 44.98 mm	1.7697 – 1.7709 in.
Idle gear bore	STD	No.1 & No.2	45.00 – 45.25 mm	1.7717 – 1.7815 in.
Idle gear oil clearance	STD	No.1 & No.2	0.025 – 0.075 mm	0.0010 – 0.0030 in.
	Limit		0.3 mm	0.012 in.

Manifold

Installing surface warpage	Limit	Intake	0.3 mm	0.012 in.
		Exhaust	0.5 mm	0.020 in.

Cylinder Block

Warpage		Limit	0.2 mm	0.008 in.
Cylinder bore diameter	STD	Mark 1	91.000 – 91.010 mm	3.5827 – 3.5831 in.
		Mark 2	91.010 – 91.020 mm	3.5831 – 3.5835 in.
		Mark 3	91.020 – 91.030 mm	3.5835 – 3.5839 in.
Liner				
Max. wear		Limit	0.2 mm	0.008 in.
Pressing force			3,000 – 5,000 kg	6613.8 – 11023.0 lb
Protrusion			0.03 – 0.09 mm	0.0012 – 0.0035 in.
Shim thickness			0.05, 0.10 mm	0.0020, 0.0039 in.

Piston & Piston Ring

Piston diameter	STD	Mark 1	90.920 – 90.930 mm	3.5795 – 3.5799 in.
		Mark 2	90.930 – 90.940 mm	3.5799 – 3.5803 in.
		Mark 3	90.940 – 90.950 mm	3.5803 – 3.5807 in.
Piston oil clearance			0.07 – 0.09 mm	0.0028 – 0.0035 in.
Piston ring end gap	No.1 & No.2		0.20 – 0.47 mm	0.0079 – 0.0185 in.
	Oil		0.20 – 0.52 mm	0.0079 – 0.0204 in.
Piston ring to ring groove clearance				
	No.1		0.046 – 0.085 mm	0.0018 – 0.0033 in.
	No.2		0.05 – 0.09 mm	0.0020 – 0.0035 in.
	Oil		0.03 – 0.07 mm	0.0012 – 0.0028 in.
Piston pin installing temperature			60°C	140°F

Connecting Rod

Thrust clearance	STD	0.08 – 0.22 mm	0.0031 – 0.0087 in.
	Limit	0.3 mm	0.012 in.
Bushing oil clearance	STD	0.004 – 0.012 mm	0.0002 – 0.0005 in.
	Limit	0.05 mm	0.0020 in.

Crankshaft

Circle runout	Limit	0.06 mm	0.0024 in.
Thrust clearance	STD	0.04 – 0.24 mm	0.0016 – 0.0094 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 0.05	69.89 – 69.90 mm	2.7516 – 2.7520 in.
	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 0.75	69.24 – 69.25 mm	2.7260 – 2,7264 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 (0.05, 0.25, 0.50, 0.75, 1.00)	
Crank pin journal			
Diameter	STD	54.98 – 55.00 mm	2.1646 – 2.1654 in.
U/S finished diameter	U/S 0.05	54.94 – 54.95 mm	2.1630 – 2.1634 in.
	U/S 0.25	54.74 – 54.75 mm	2.1551 – 2.1555 in.
	U/S 0.50	54.49 – 54.50 mm	2.1453 – 2.1457 in.
	U/S 0.75	54.24 – 54.25 mm	2.1354 – 2.1358 in.
	U/S 1.00	53.99 – 54.00 mm	2.1256 – 2.1260 in.

Crankshaft (Cont'd)

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 (0.05, 0.25, 0.50, 0.75, 1.00)	

Flywheel

Runout	Limit	0.2 mm	0.008 in.

LUBRICATION SYSTEM

Oil Pump

Tip clearance			
Driven gear to crescent	STD	0.07 – 0.16 mm	0.0028 – 0.0063 in.
	Limit	0.25 mm	0.098 in.
Drive gear to crescent	STD	0.20 – 0.38 mm	0.0079 – 0.0150 in.
	Limit	0.6 mm	0.024 in.
Side clearance	STD	0.03 – 0.10 mm	0.0012 – 0.0394 in.
	Limit	0.15 mm	0.0059 in.
Gear backlash	STD	0.2 – 0.4 mm	0.008 – 0.016 in.
	Limit	0.6 mm	0.024 in.

COOLING SYSTEM

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

Water Pump

Bearing installing temperature	80°C	176°F

Thermostat

Valve opening temperature	Low temp. type		High temp. type	
Starts to open at	80 – 84°C	176 – 183°F	86 – 90°C	186 – 194°F
Fully opens at	95°C	203°F	100°C	212°F
Valve opening travel	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	78.7 in.
Suction height		1 m	39.4 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.) increment]	

Automatic Timer

Timer advance angle	400 rpm	Advance begins (≦0.5°)
	1,050 rpm	2.3 – 3.3°
	1,450 rpm	4.0 – 5.0°
	1,800 rpm	5.5 – 6.5°
	1,900 rpm	5.5 – 6.5°
Adjusting shim thickness		0.1, 0.2, 0.3, 0.5, 1.0 mm
		0.004, 0.008, 0.011, 0.020 0.039 in.

Injection Pump

Direction of rotation	Clockwise as seen from drive side	
Cam lift	8.0 mm	0.315 in.
Injection order	1 – 4 – 2 – 6 – 3 – 5	

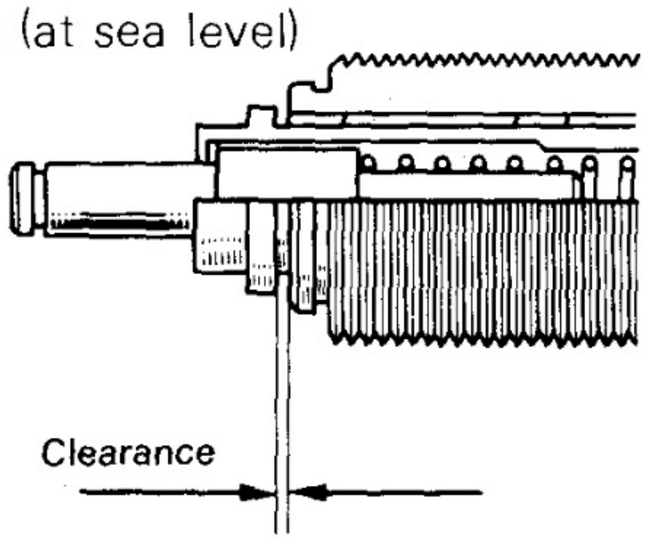
Injection Pump (Cont'd)

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		60° ± 30′	
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	33.3 lb
Delivery valve spring			
Free length		36.8 mm	1.449 in.
Installed length		27.0 mm	1.063 in.
Installed load		3.9 kg	8.6 lb

Combined Governor

Main spring		
Free length	43.5 mm	1.713 in.
Installed length	33.0 mm	1.299 in.
Installed load	3.9 kg	8.6 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	24.0 mm	0.945 in.
Installed load	4.2 kg	9.3 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 SD24	
Nozzle opening pressure	115 – 125 kg/cm²	1,636 – 1,778 psi
Outer diameter	6.0 mm	0.24 in.
Inner diameter	2.0 mm	0.08 in.
Length	600 mm	23.6 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	7.1 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 11.0 mm (0.433 in.)	1.9 – 2.0 mm	0.075 – 0.079 in.
Injection interval	60° ± 30′	
Tappet clearance	More than 0.2 mm (0.008 in.)	

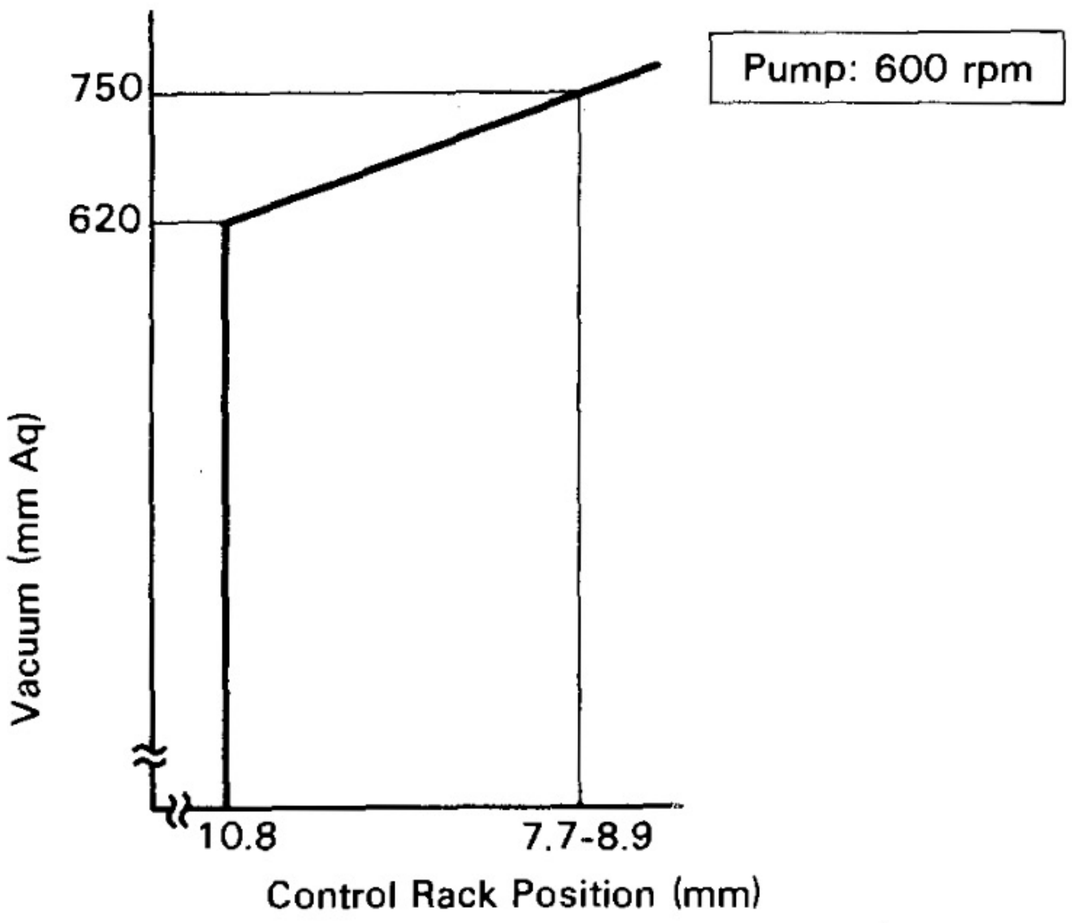
Injection Volume Adjustment

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	9.0 – 10.4 (0.55 – 0.63) * 9.6 – 11.6 (0.59 – 0.71)	1.2 (0.07)
10.8 (0.425)	1,100	200	8.7 – 9.3 (0.53 – 0.57)	0.4 (0.02)
10.8 (0.425)	1,700	200	9.1 – 10.1 (0.56 – 0.62)	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)

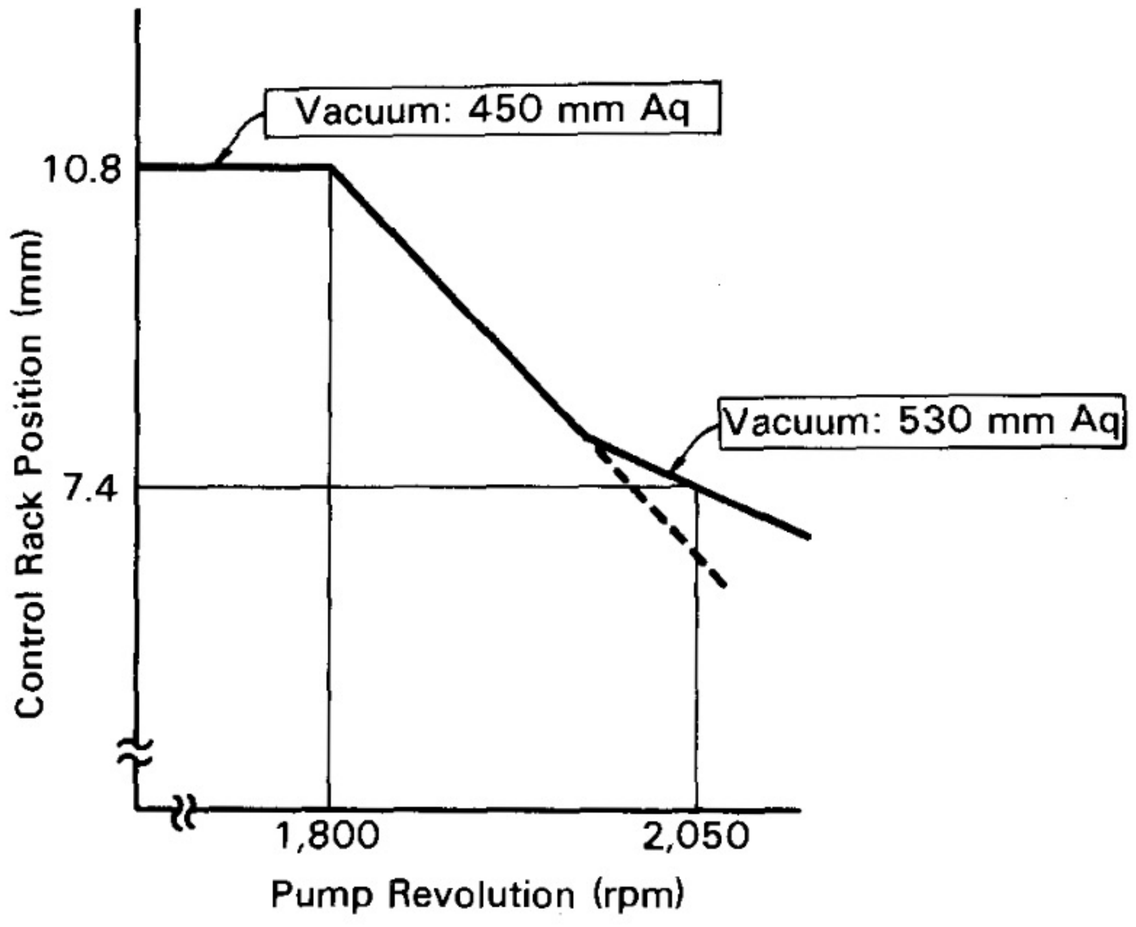
* For Arctic Regions

GOVERNOR ADJUSTMENT & TEST
Characteristic Diagram

PNEUMATIC GOVERNOR SECTION



MECHANICAL GOVERNOR SECTION



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	600	600 (23.62)	10.8 ± 0.1 (0.425 ± 0.004)	———
Main spring	600	600 (23.62)	10.8 ± 0.1 (0.425 ± 0.004)	———
		630 (24.80)	10.5 – 10.7 (0.413 – 0.421)	
		750 (29.53)	7.7 – 8.9 (0.303 – 0.350)	
Idling spring capsule	2,050	530 (20.87)	7.4 ± 0.1 (0.291 ± 0.004)	———
	2,050	450 (17.72)	7.5 – 8.3 (0.295 – 0.327)	
	1,950	450 (17.72)	8.3 – 9.1 (0.327 – 0.358)	
Speed control spring	1,800	450 (17.72)	10.8 (0.425)	———
	1,825		10.3 – 10.7 (0.406 – 0.421)	
	1,900		8.8 – 9.9 (0.346 – 0.390)	
	2,050	530 (20.87)	7.4 ± 0.1 (0.291 ± 0.004)	

Total Injection Volume

Measuring strokes	Pump revolution (rpm)	Vacuum mm Aq (in. Aq)	Total injection volume cc (cu in.)
500	700	60 (2.36)	117.0 — 129.0 (7.14 — 7.87)
	1,100	150 (5.91)	132.0 — 138.0 (8.06 — 8.42)
	1,700	400 (15.75)	138.0 — 150.0 (8.42 — 9.15) * 133.5 — 145.5 (8.15 — 8.88)

* w/ DHAC

EDIC (ELECTRICAL DIESEL INJECTION CONTROL) SYSTEM

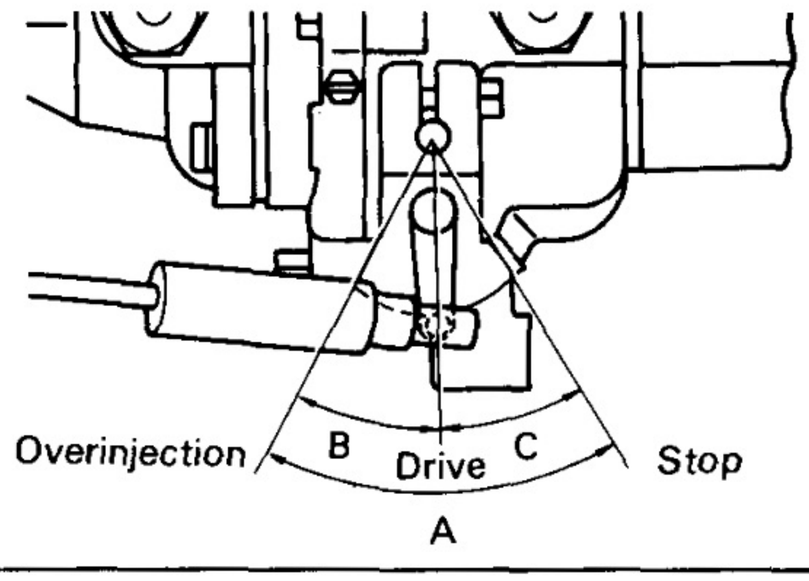
Operational Check

Injection pump lever position

A: 78.5°

B: 37.5°

C: 41°



STARTING SYSTEM

Preheating System

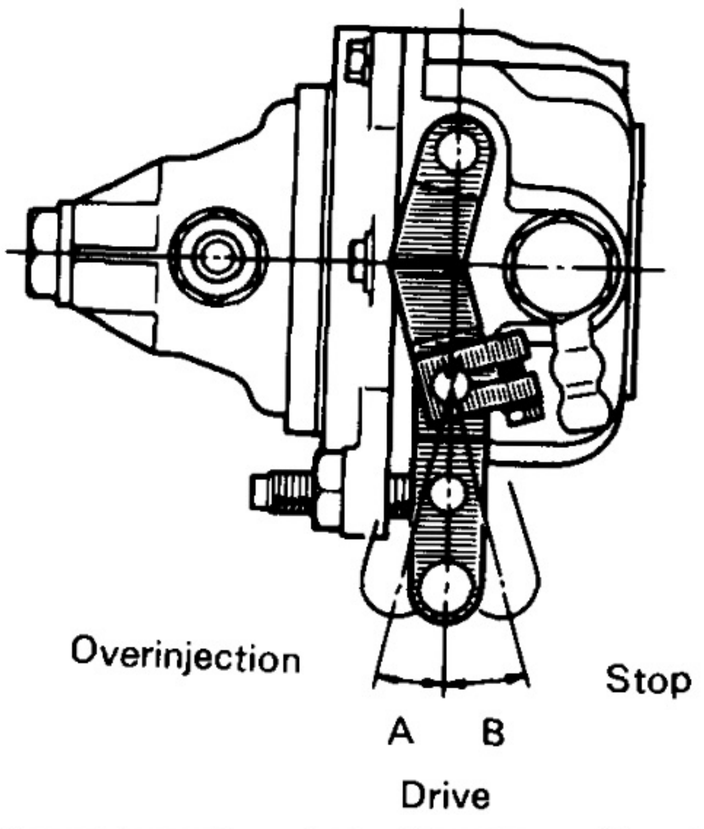
Type		12V type	24V type
Glow time		15 — 30 seconds	←
Load current per one glow plug	HJ60	7.2 — 9.8A	3.8 — 5.2A
	HJ47	7.6 — 10.4A	—
Glow plug resistance at 20°C (68°F)	HJ60	0.2Ω	1.0Ω
	HJ47	0.2Ω	—

Overinjection Magnet (Operational Check)

Injection pump lever position

A: 12.5°

B: 16.0°



Starter

Type		12V type	24V type
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	7.1 — 8.8 lb

CHARGING SYSTEM

Alternator

Type		12V type	24V type
Rating output		12V — 40A	24V — 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 type	24V type
Regulating voltage	13.8 — 14.8V	27 — 29V
Voltage relay actuating voltage	4.0 — 5.8V	8.0 — 11.6V