

TOYOTA

2H ENGINE

REPAIR MANUAL

Aug., 1980



TOYOTA MOTOR CORPORATION

Pub. No. 36048E

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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INTRODUCTION

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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

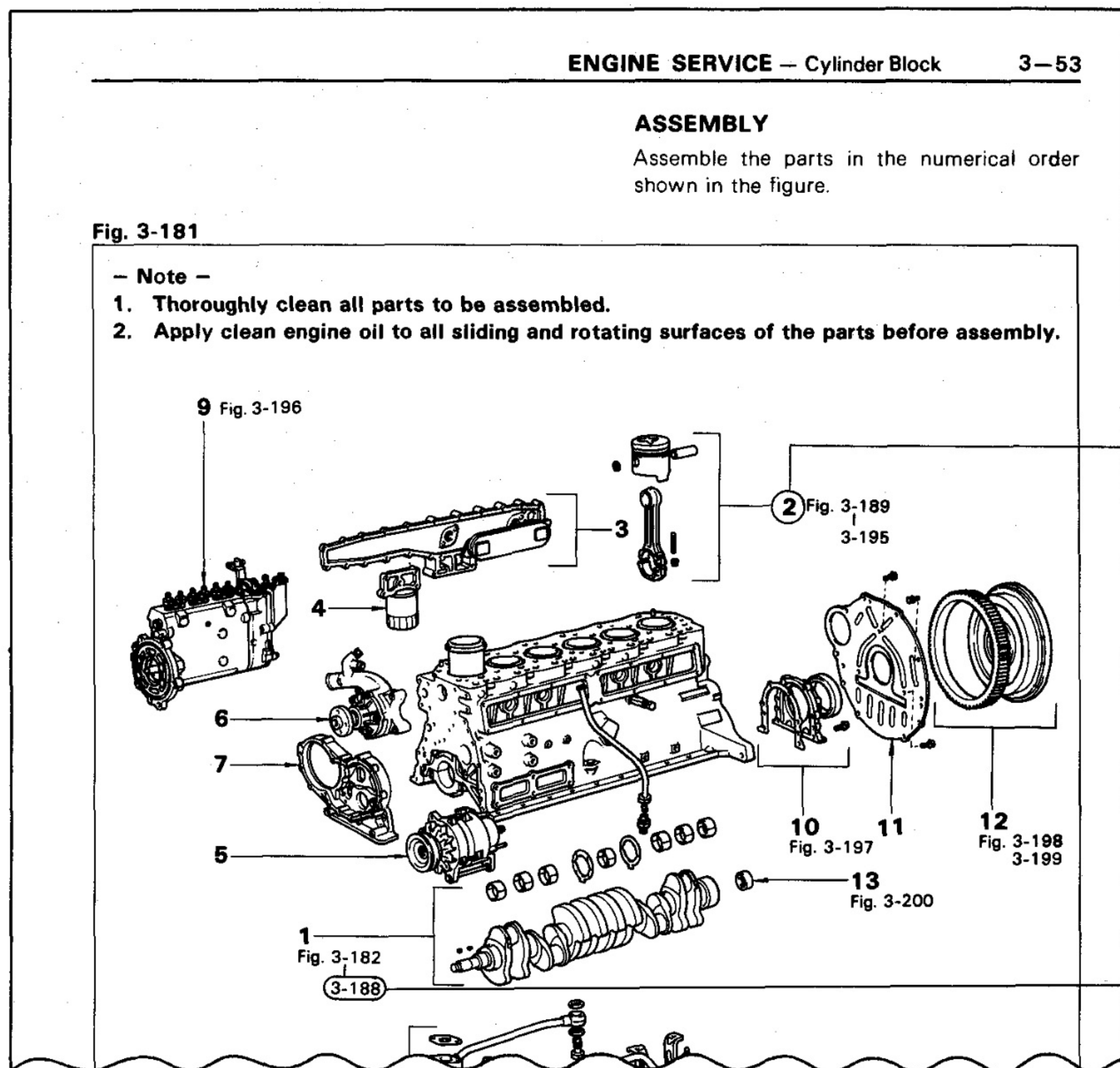
For convenience, the following abbreviations are used in Toyota repair manuals.

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.



- (A) : The bold numbers show the order in which the work is to be done.
- (B) : The figure numbers refer you to more detailed instructions and specifications.

2. ILLUSTRATED INSTRUCTIONS

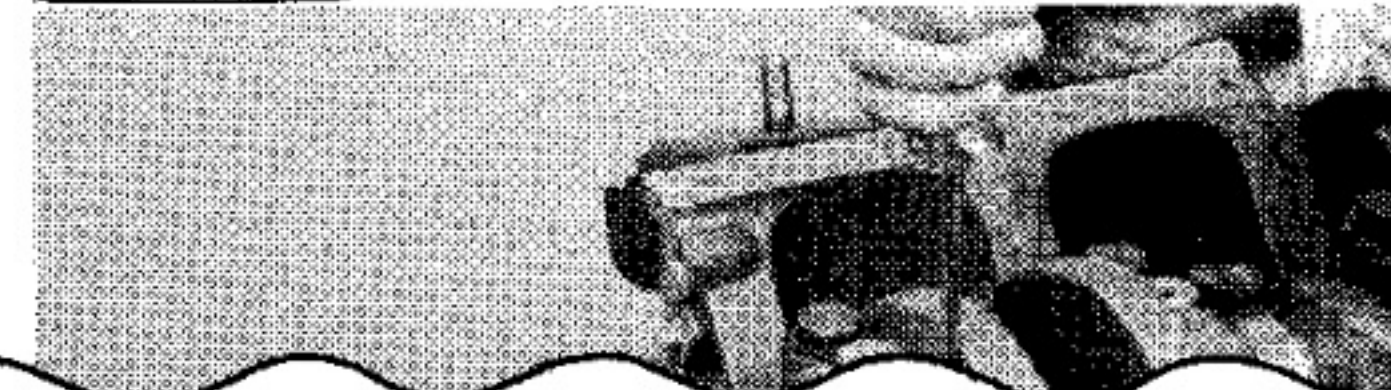
All important steps in every service job are illustrated. Obvious steps are omitted to save space. Experienced technicians may only need to glance at the overview illustration and/ or specifications.

ENGINE SERVICE — Cylinder Block 3—55




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

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



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

- (C)** : The pictures give basic information on what to do in each step.
- (D)** : A symbol is often used to explain the action required.
- (E)** : The text explains how to perform the step.
- (F)** : 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

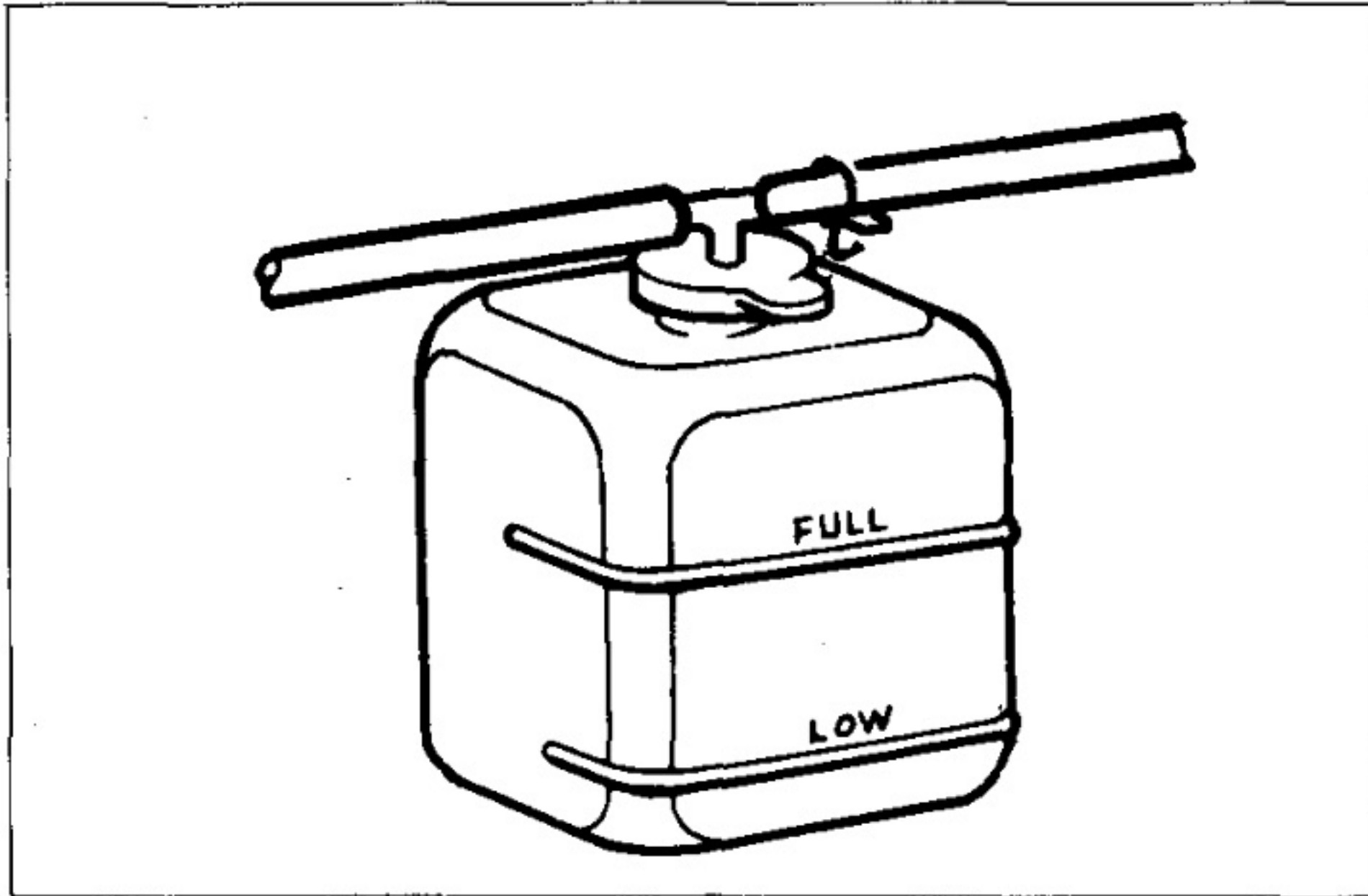
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ENGINE TUNE-UP ITEMS

	ITEM			REMARKS		
1	COOLING SYSTEM	Coolant level		Full line		
		Coolant quality				
		Leakage				
		Radiator cap				
		valve opening pressure				
			STD	0.75 – 1.05 kg/cm ²		
				10.7 – 14.9 psi		
2	DRIVE BELT		Limit	0.6 kg/cm ² 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		
		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				
4	BATTERY	Oil capacity (Oil bath type)		Indicated level		
		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/cm ² 398 psi		
			Limit	20.0 kg/cm ² 284 psi		
		Difference between each cylinder		Less than 2.0 kg/cm ² (28 psi)		
11	INJECTION NOZZLE	Opening pressure				
			New nozzle	115 – 125 kg/cm ²		
				1,636 – 1,778 psi		
			Reused nozzle	105 – 125 kg/cm ²		
				1,493 – 1,778 psi		

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

Fig. 2-1



COOLING SYSTEM

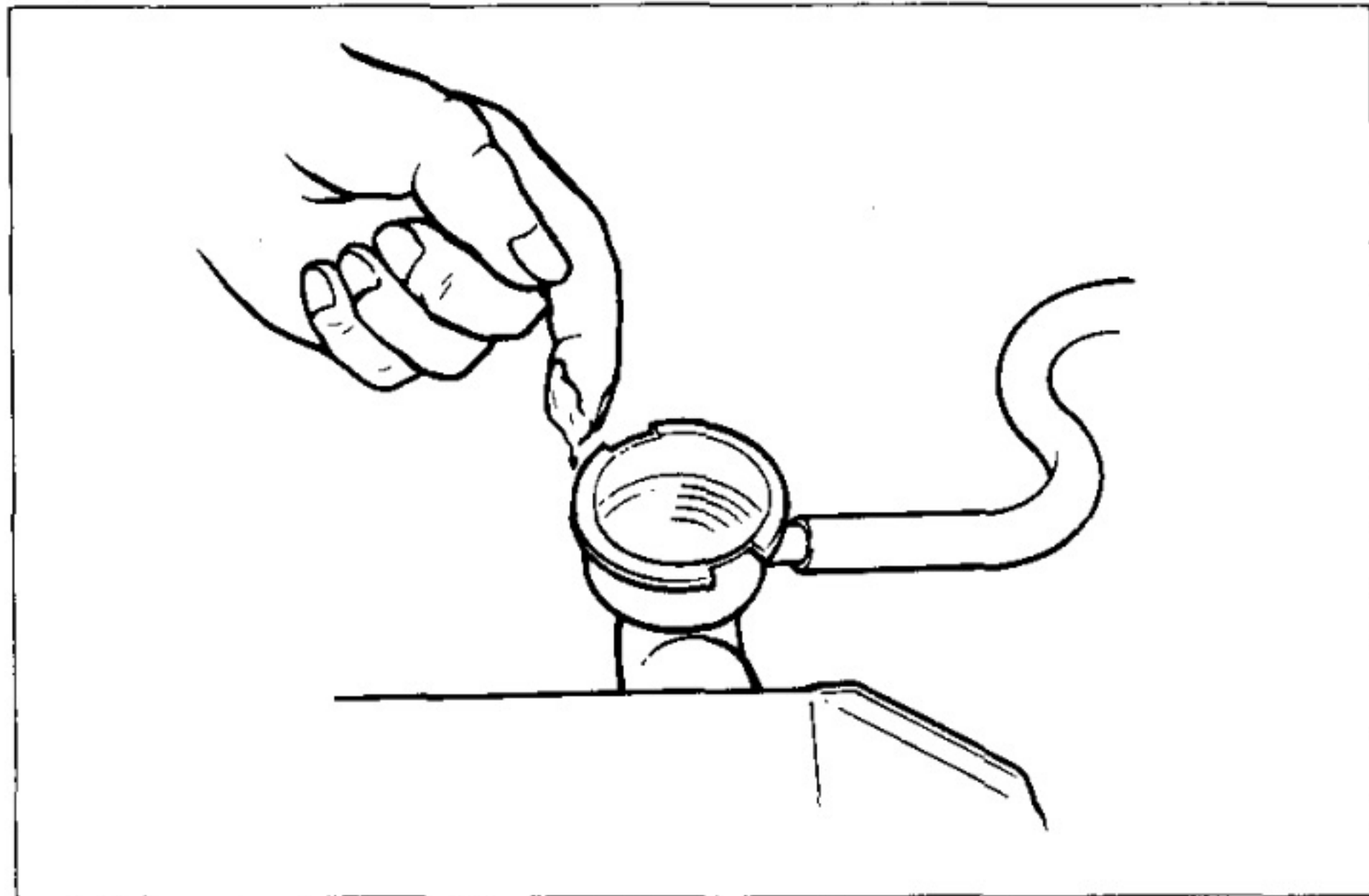
CHECK COOLANT LEVEL

If low, fill reservoir to FULL line.

—Note—

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

Fig. 2-2

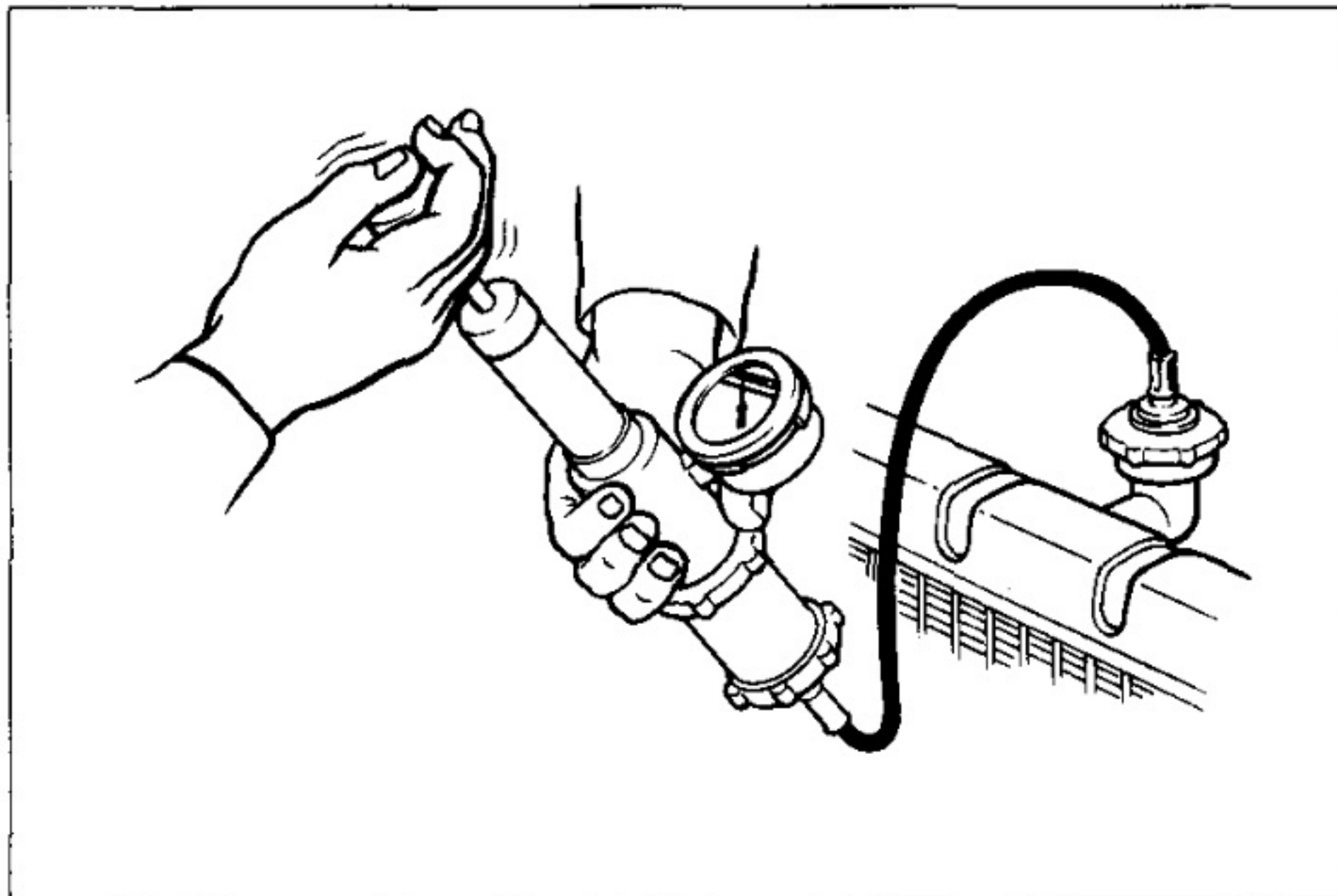


CHECK COOLANT QUALITY

Check for:

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

Fig. 2-3

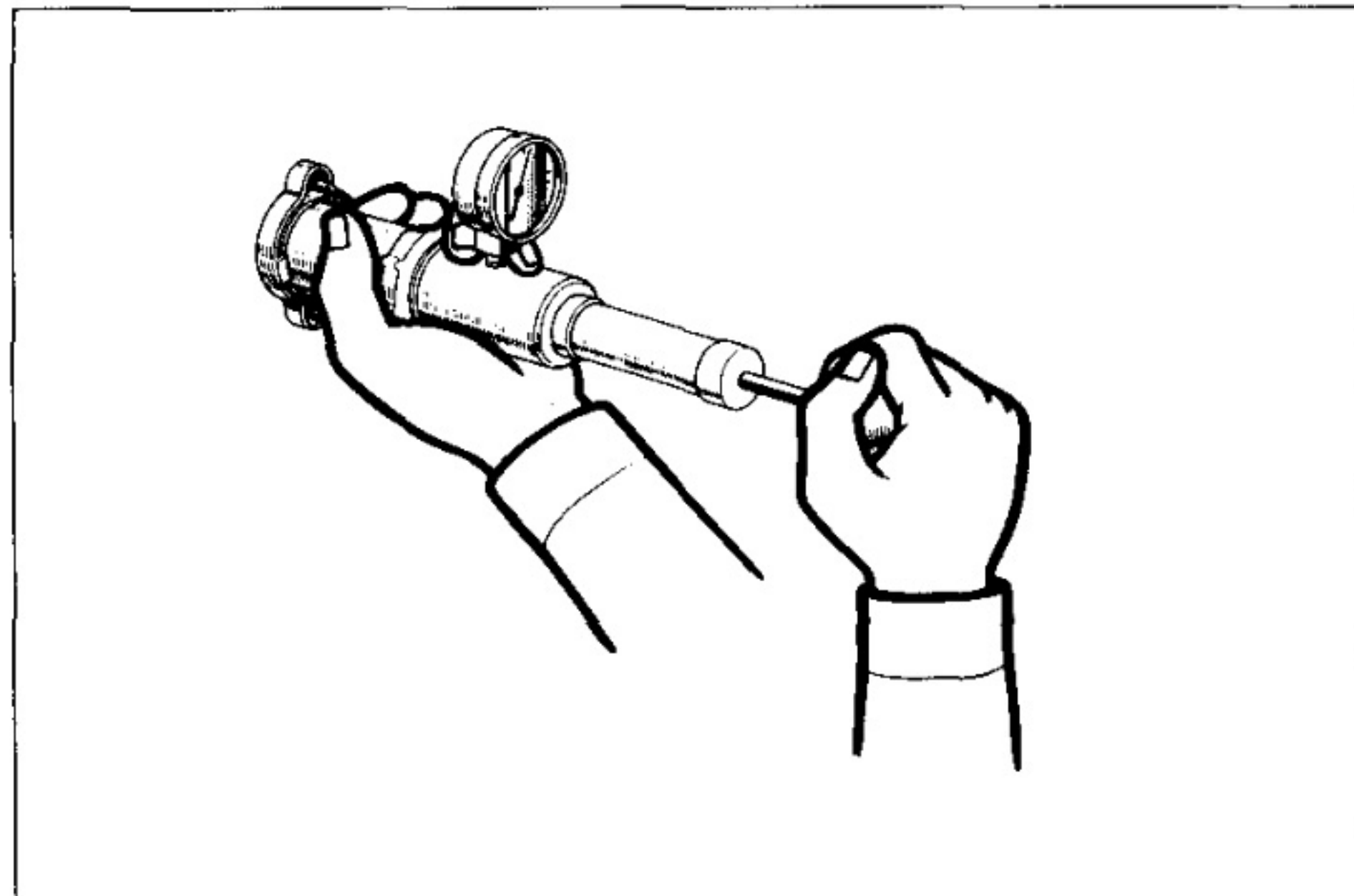


CHECK COOLING SYSTEM PARTS

Check for:

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

Fig. 2-4



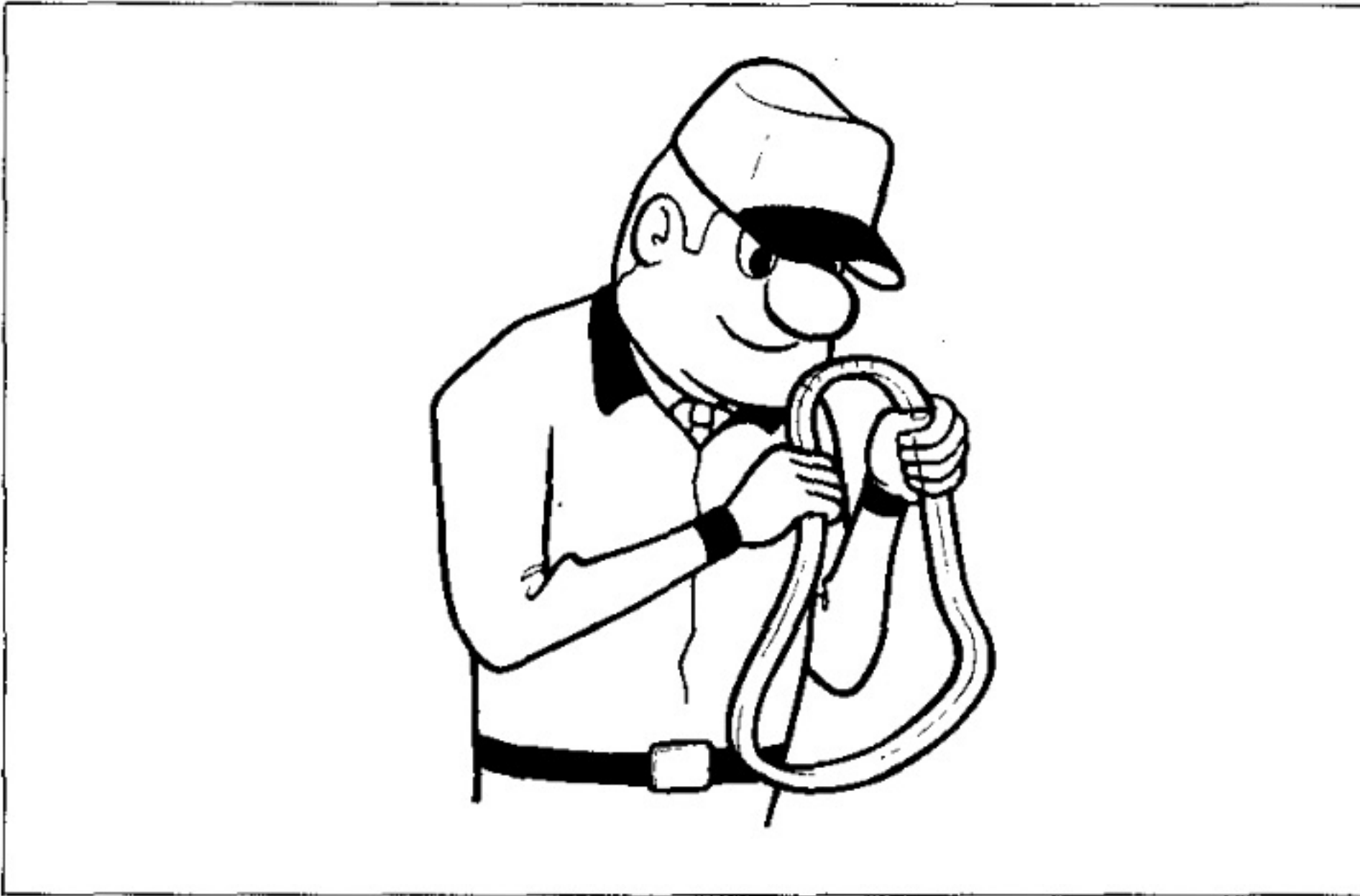
5. Faulty operation of radiator cap. Inspect the spring tension and seating condition of the radiator cap vacuum valves. If the valve opens at a pressure below specification or is otherwise defective, replace the radiator cap.

Valve opening pressure:

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

Limit 0.6 kg/cm²
(8.5 psi)

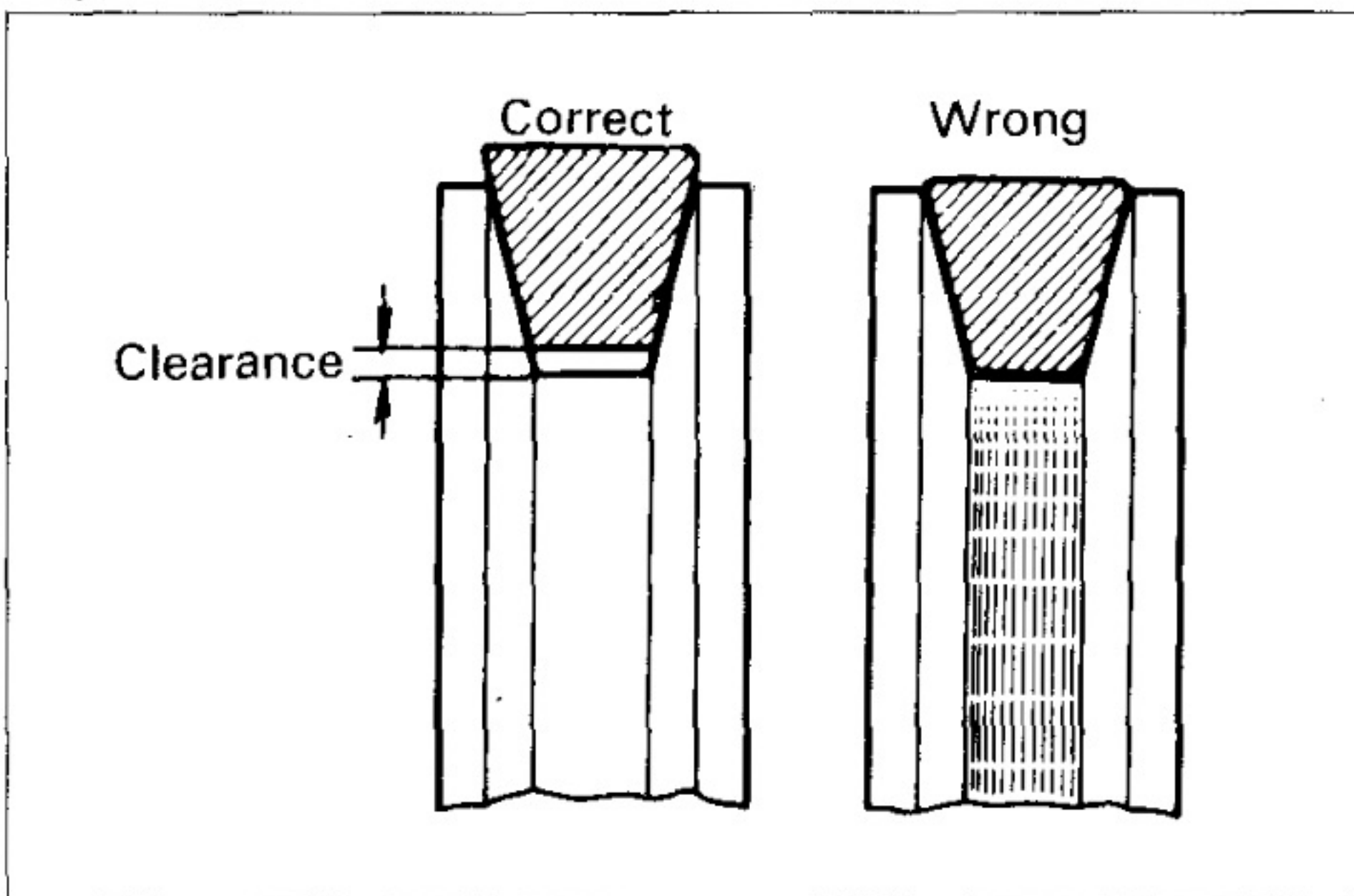
Fig. 2-5

**DRIVE BELT****VISUAL CHECK**

Check for:

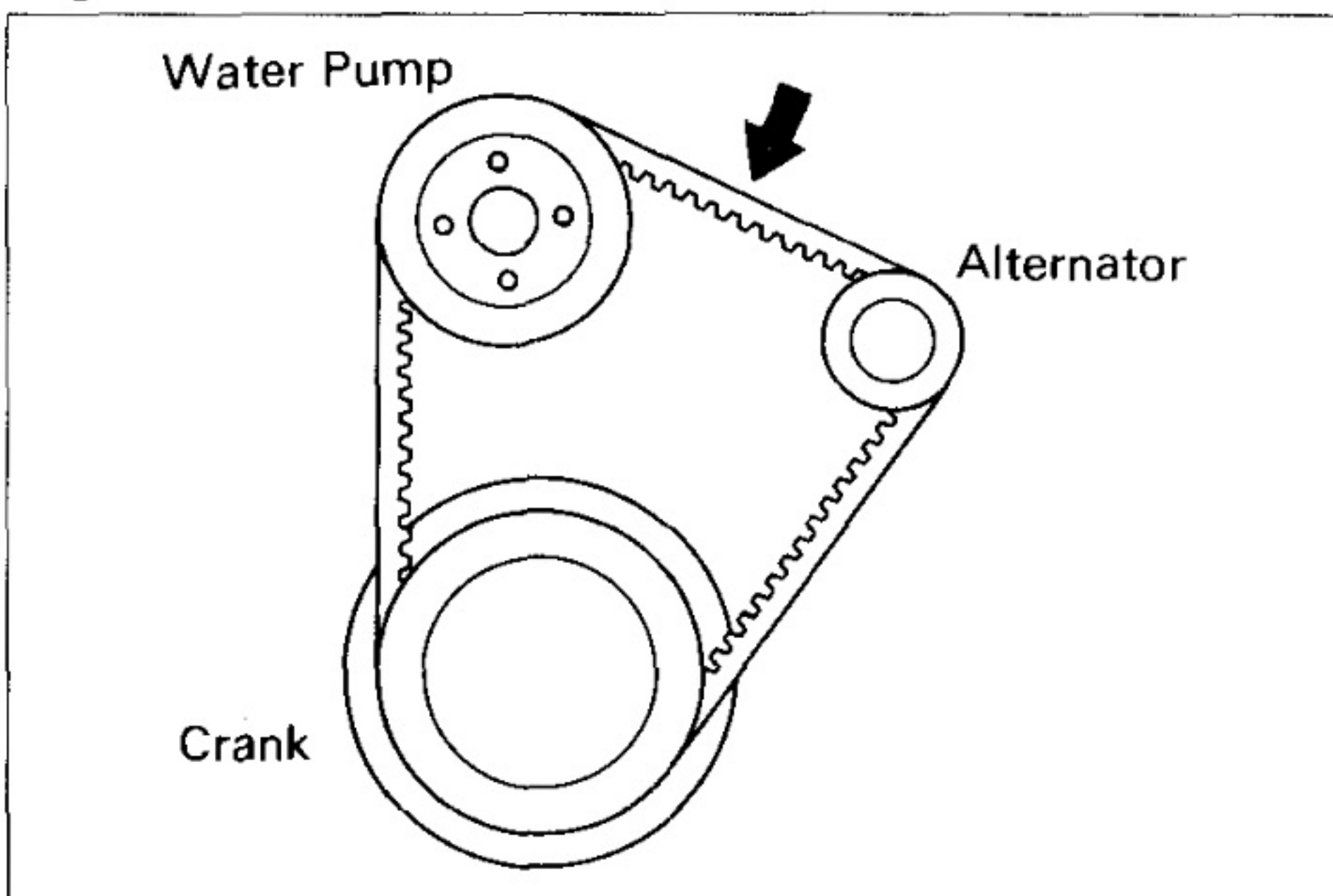
1. Cracks, deterioration, stretching or wear.
2. Adherence of oil or grease.

Fig. 2-6



3. Improper belt-to-pulley contact.

Fig. 2-7

**CHECK BELT TENSION**

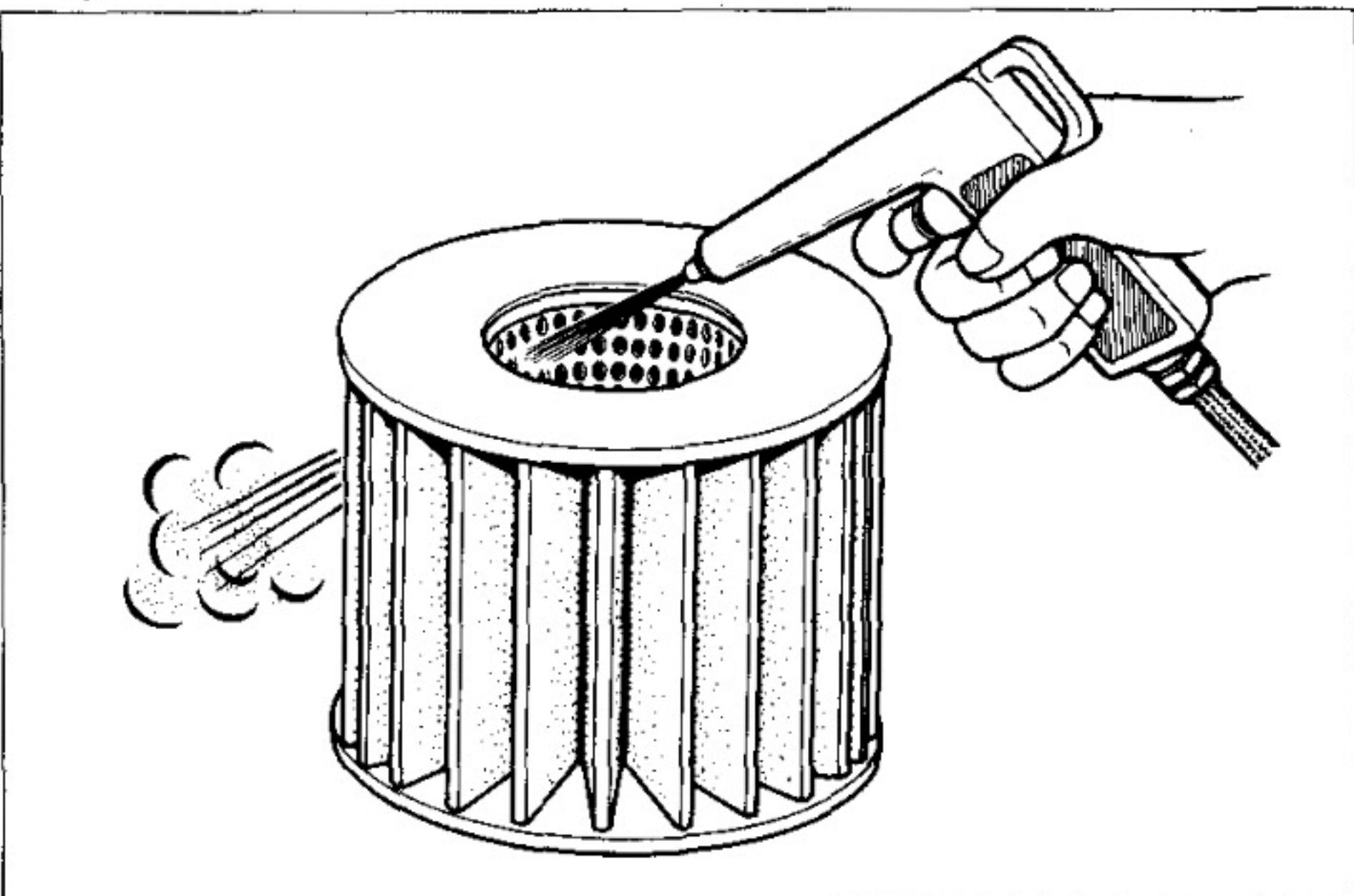
With 10 kg (22 lb) of force, press on the belts at the points indicated in the figure. The belts should deflect as specified.

Drive belt tension:

New belt 8 – 9 mm
(0.31 – 0.35 in.)

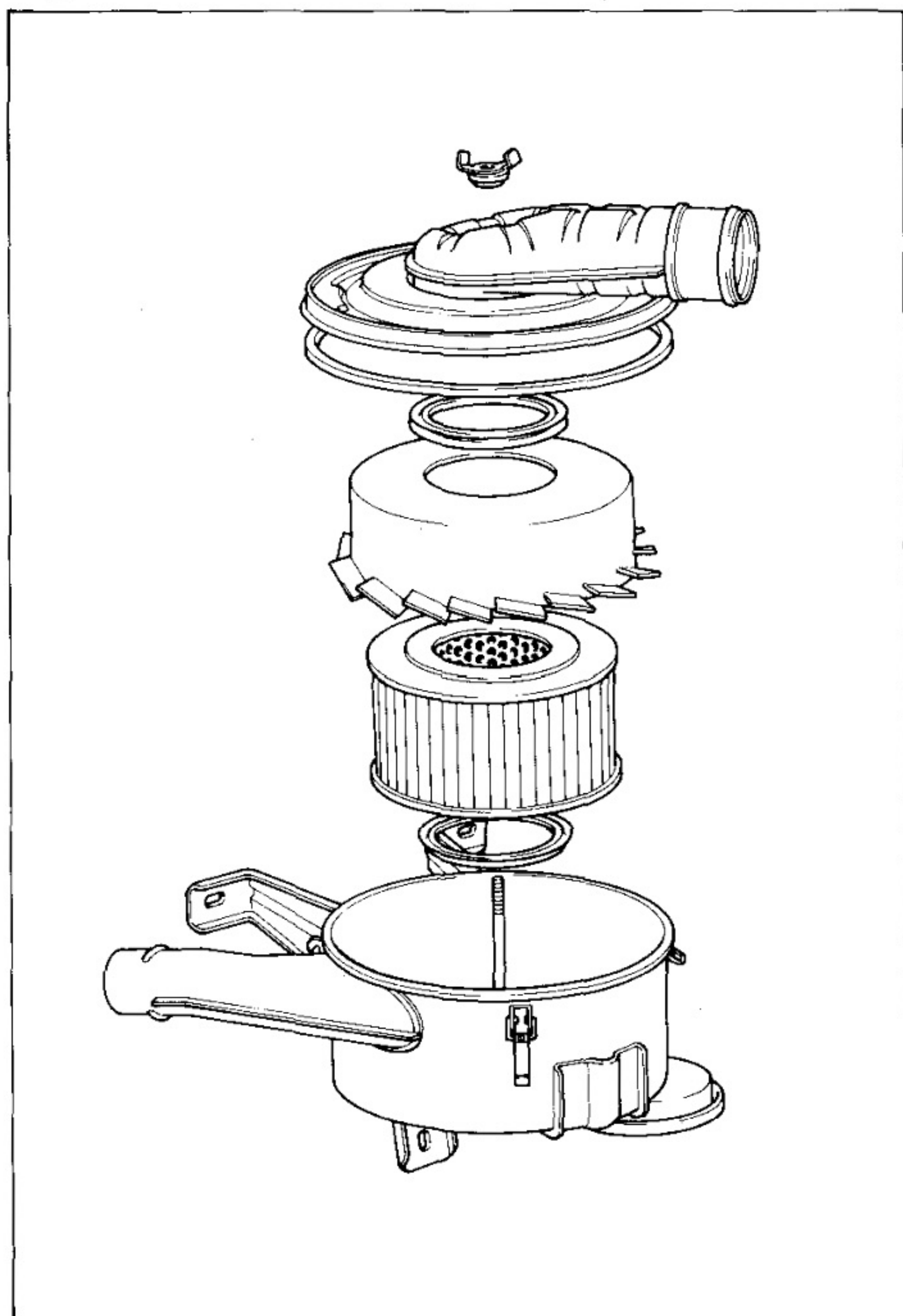
Used belt 10 – 11 mm
(0.39 – 0.43 in.)

Fig. 2-8

**AIR CLEANER****[Paper Element & Cyclone Type]****CLEAN ELEMENT**

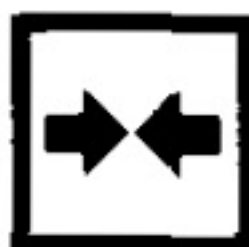
1. Remove the air cleaner.
2. Remove the element and blow compressed air from inside.
3. Replace the element with a new one if torn or excessively dirty.

Fig. 2-9

**VISUAL CHECK**

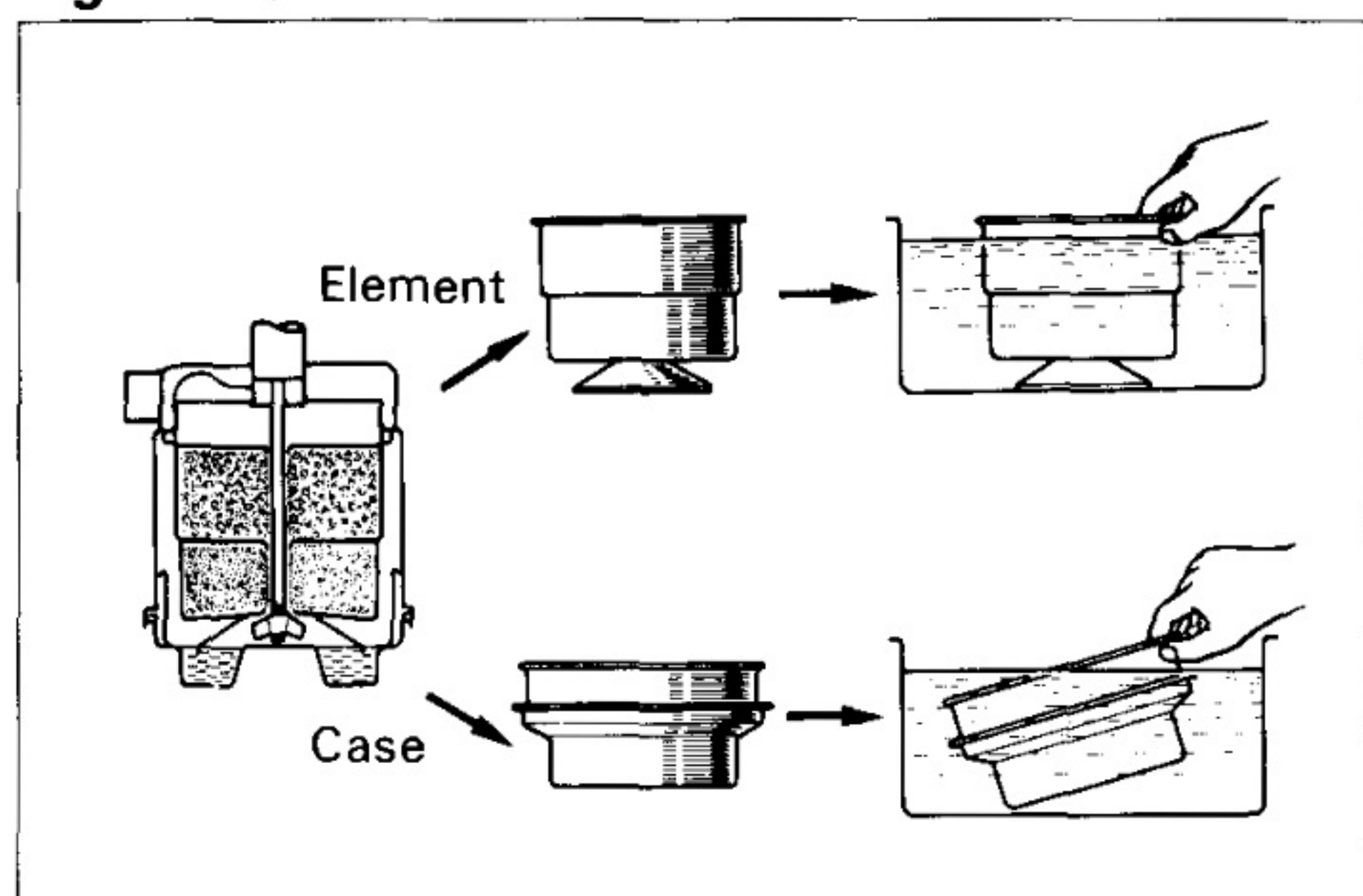
Check for:

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

**INSTALL AIR CLEANER**

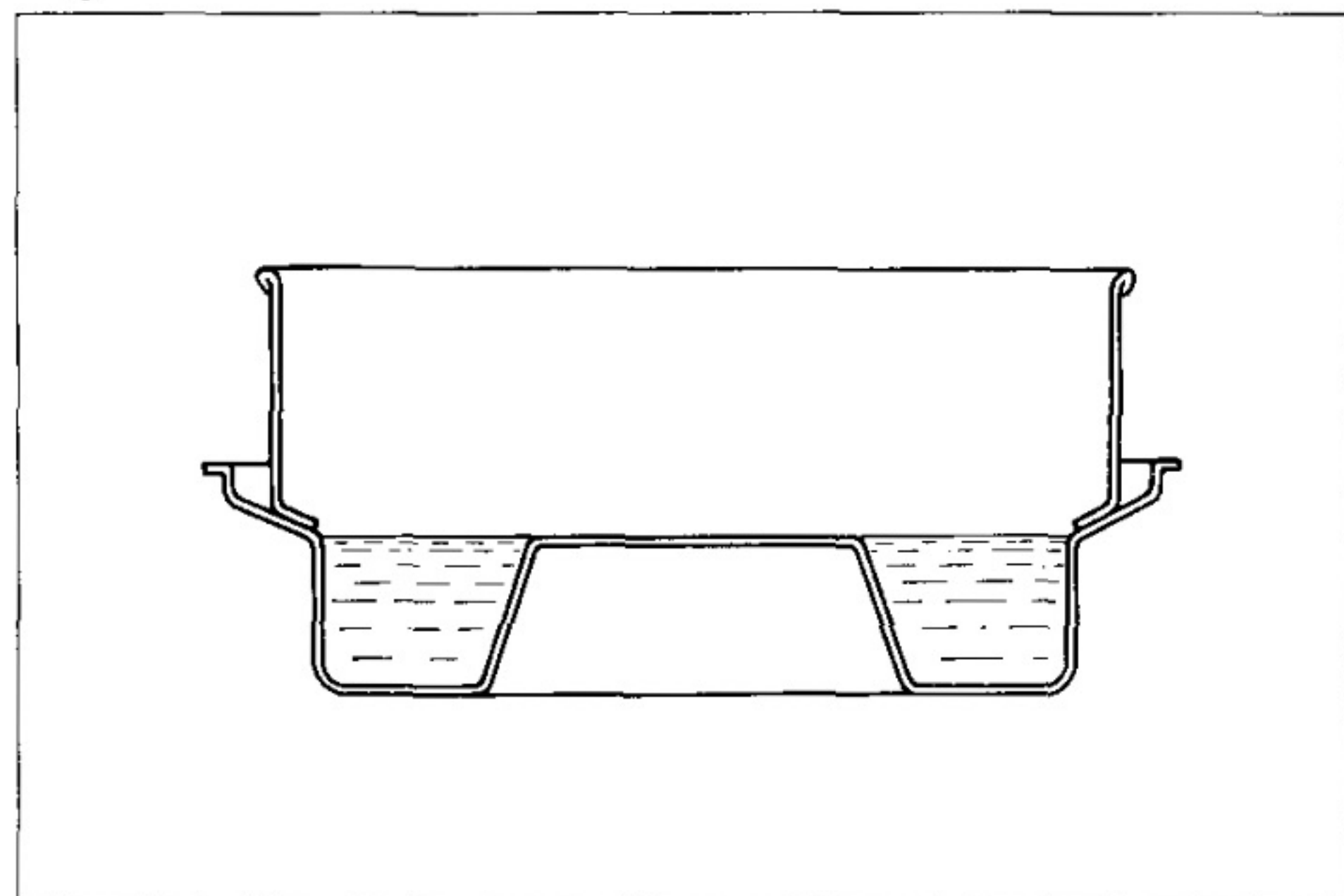
1. Install the gasket
2. Finger tighten the stay.
3. After installing the element, position the air cleaner cap.
4. Tighten the wing nut and stay.
5. Connect the hoses to air cleaner.

Fig. 2-10

**[Oil Bath Type]****CLEAN ELEMENT**

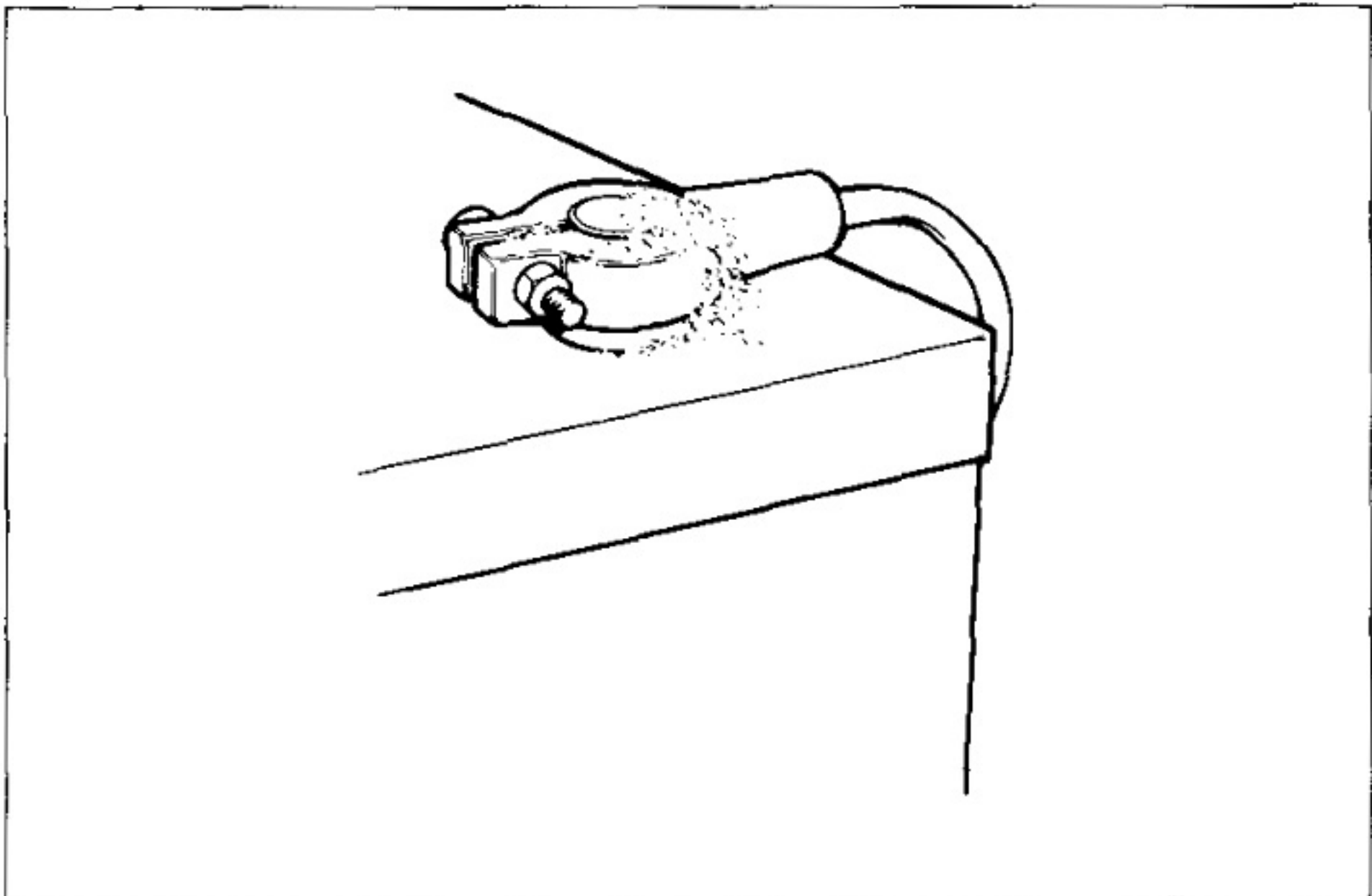
1. Remove the air cleaner and element.
2. Wash the element and case with kerosene and dry them thoroughly.

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

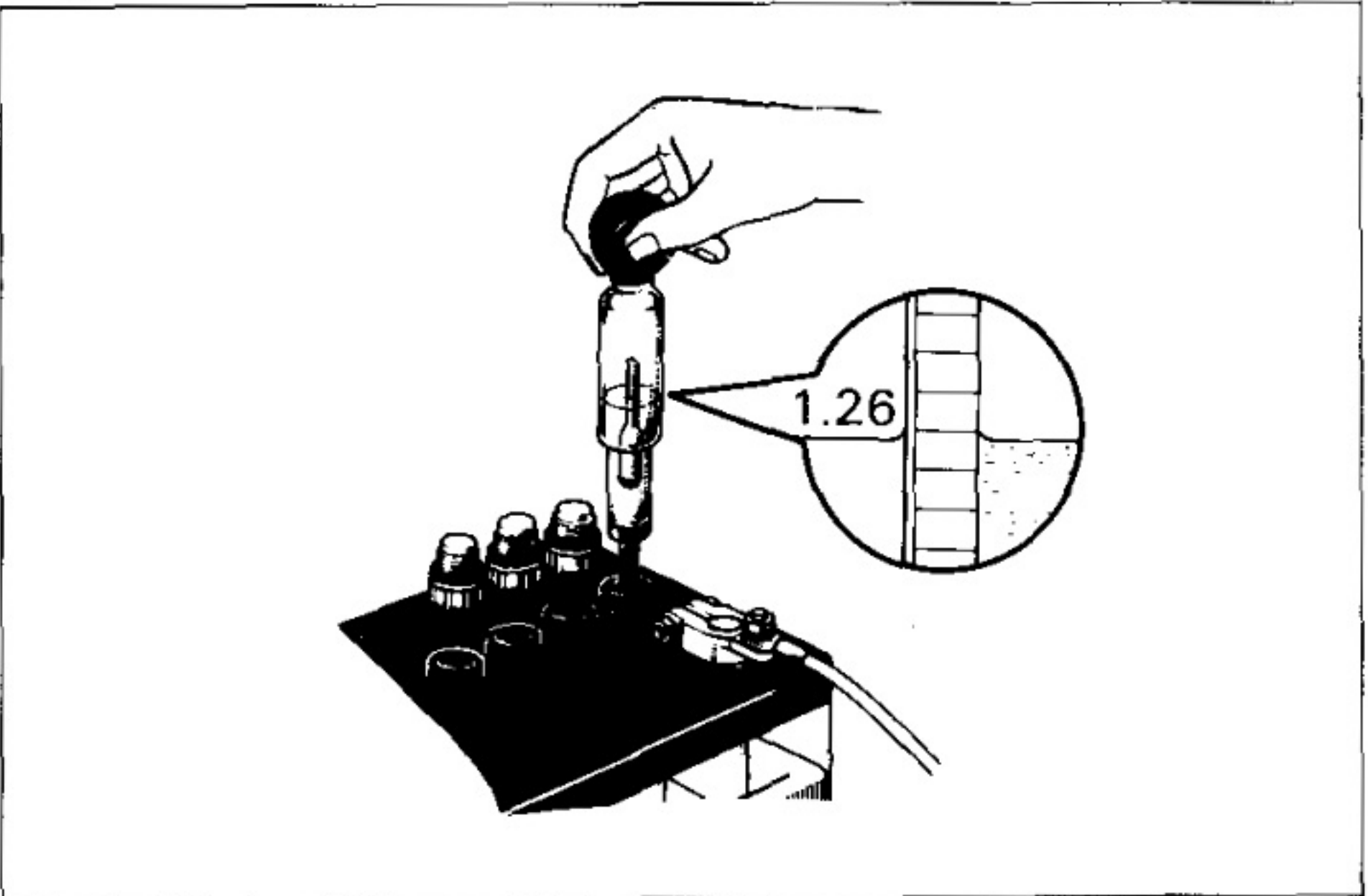


BATTERY

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

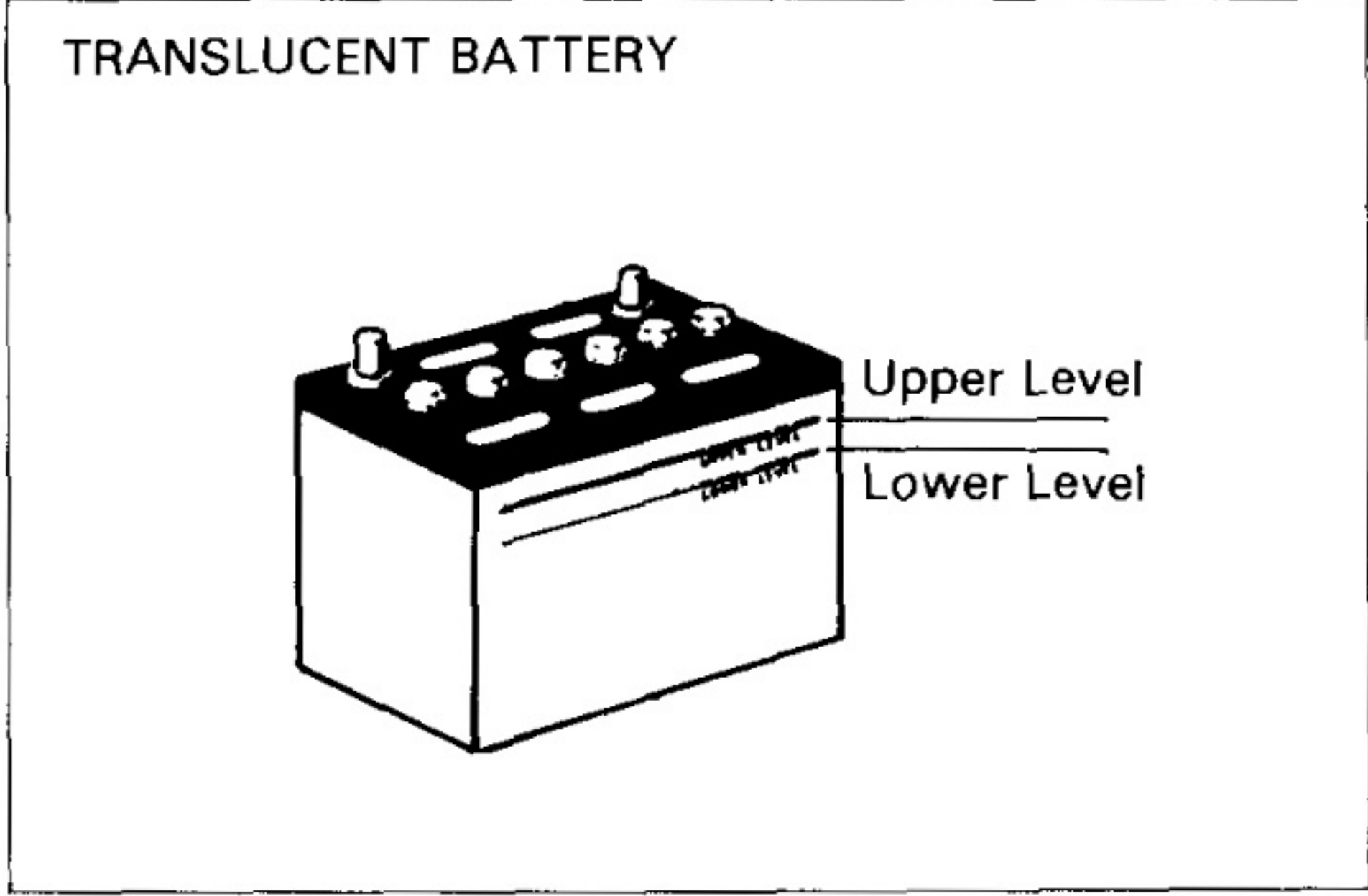


MEASURE SPECIFIC GRAVITY

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

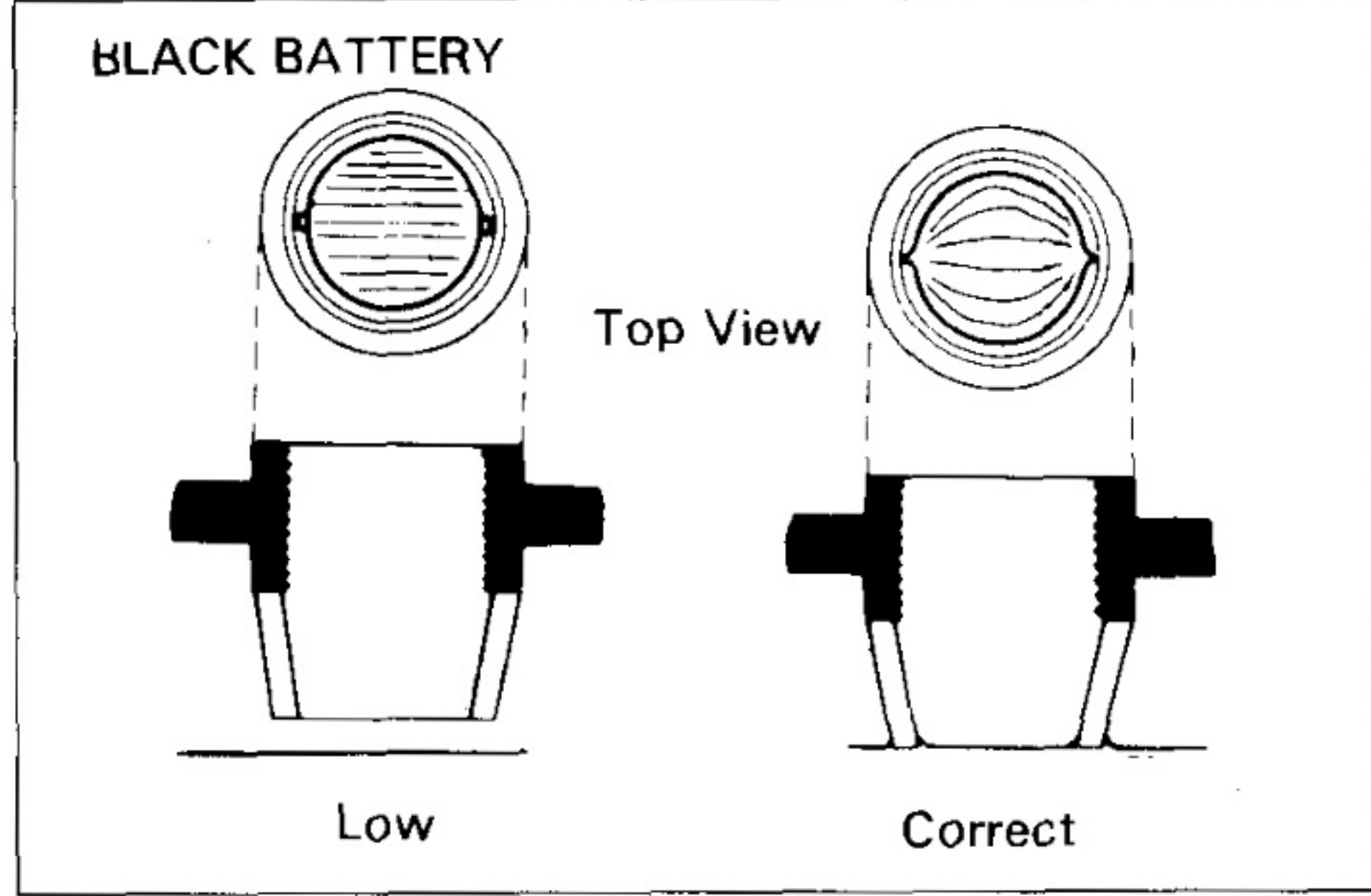


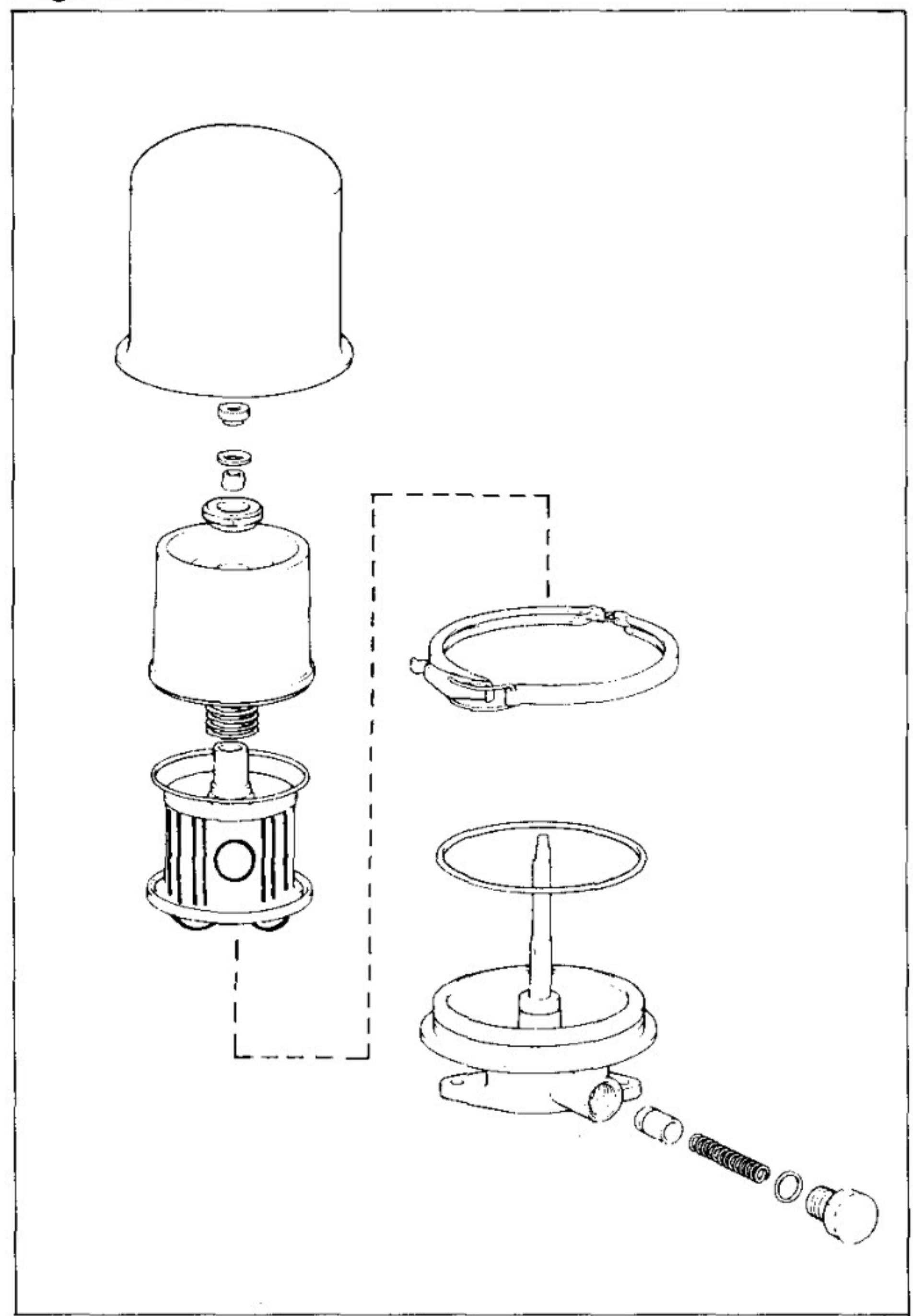
Fig. 2-16



Fig. 2-17



Fig. 2-18

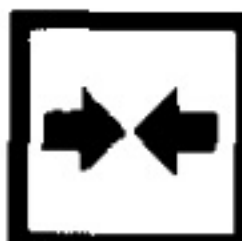


OIL FILTER REPLACEMENT



1. Remove the oil filter with SST.
2. Install a new filter and tighten it firmly by hand.

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

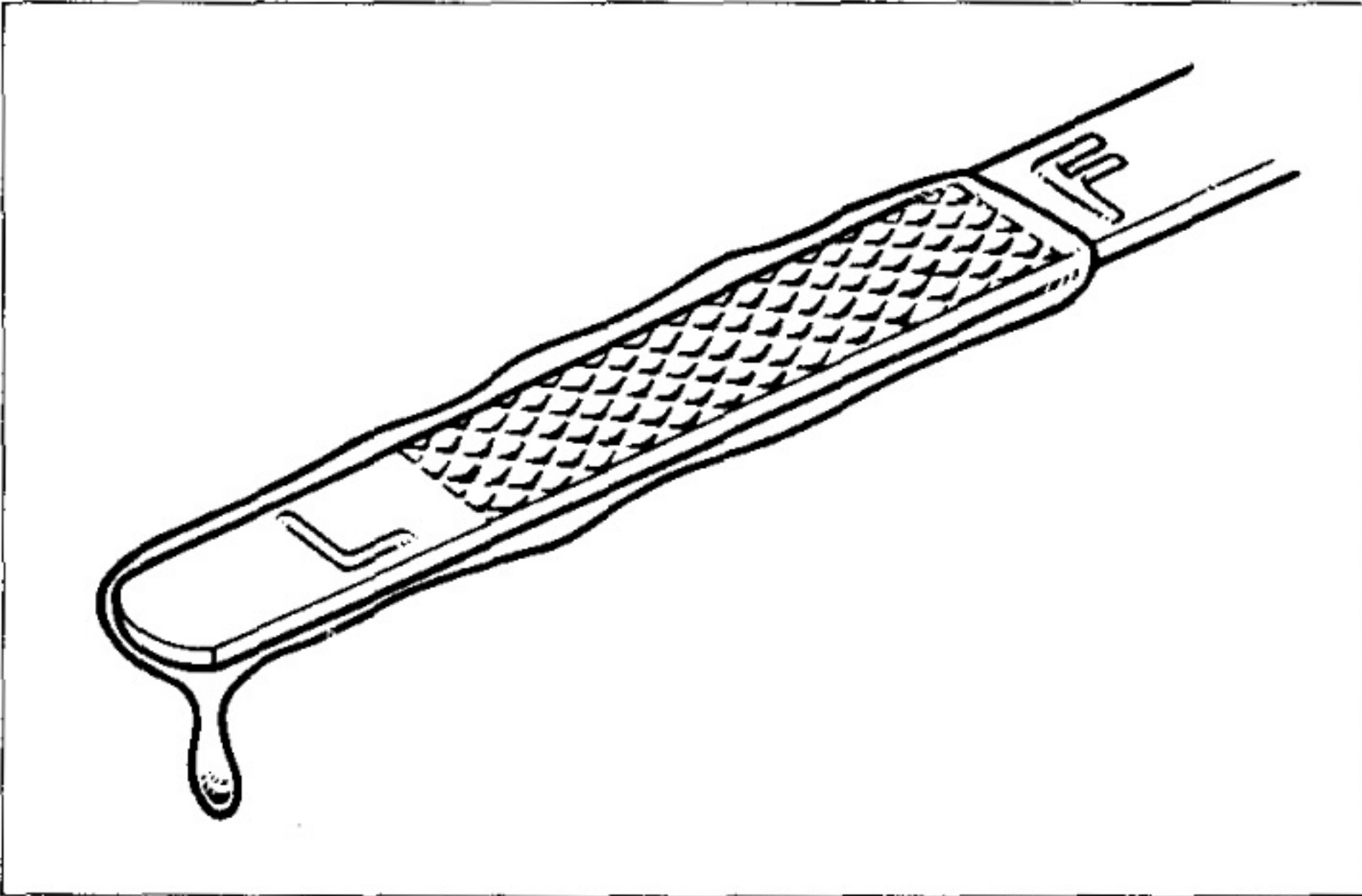


3. Start the engine and check for oil leakage.
4. Stop the engine and recheck the oil level.

CENTRIFUGAL OIL FILTER CLEANING

Refer to LUBRICATION SYSTEM section.

Fig. 2-19



ENGINE OIL

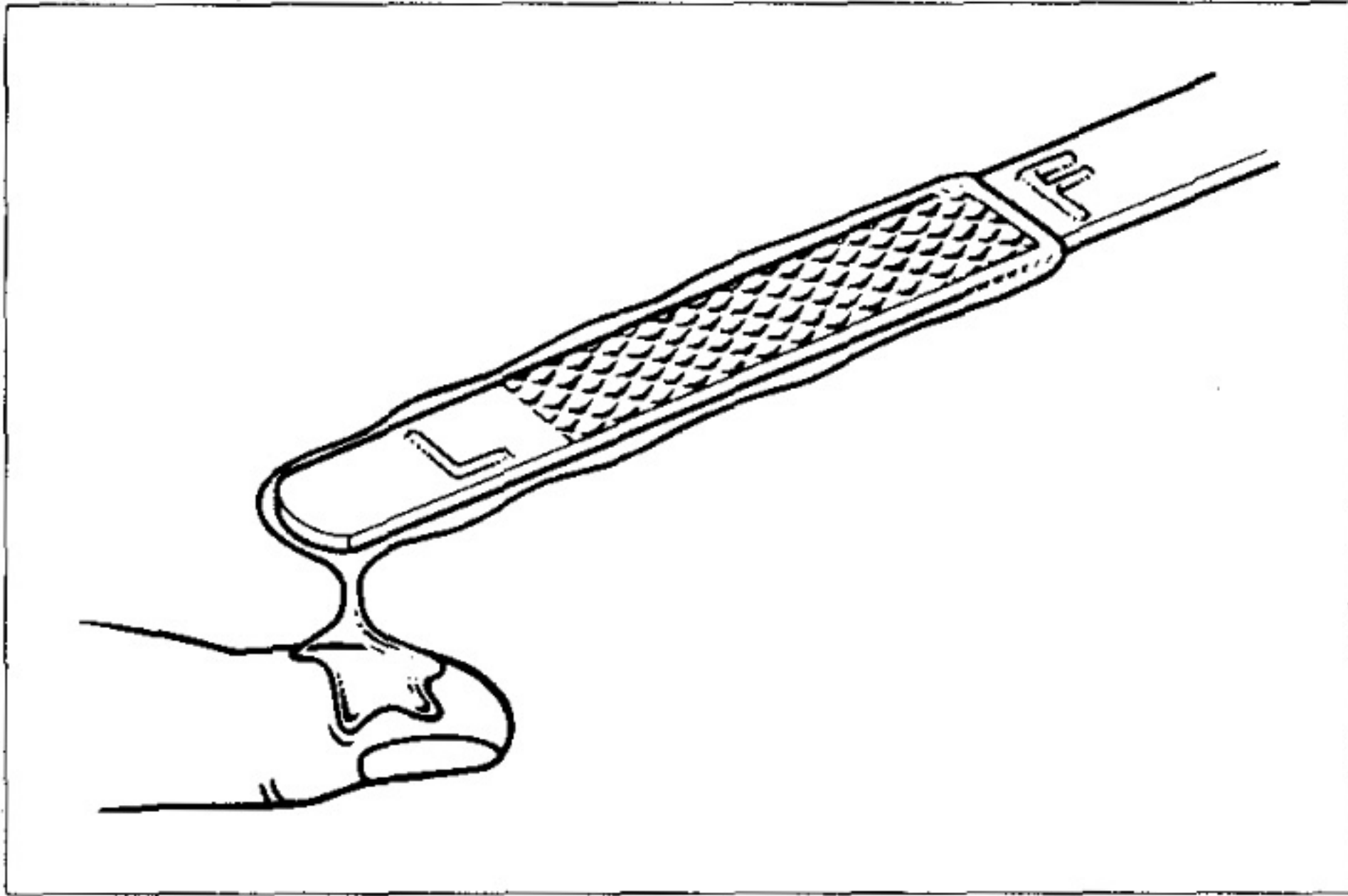
CHECK OIL LEVEL

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

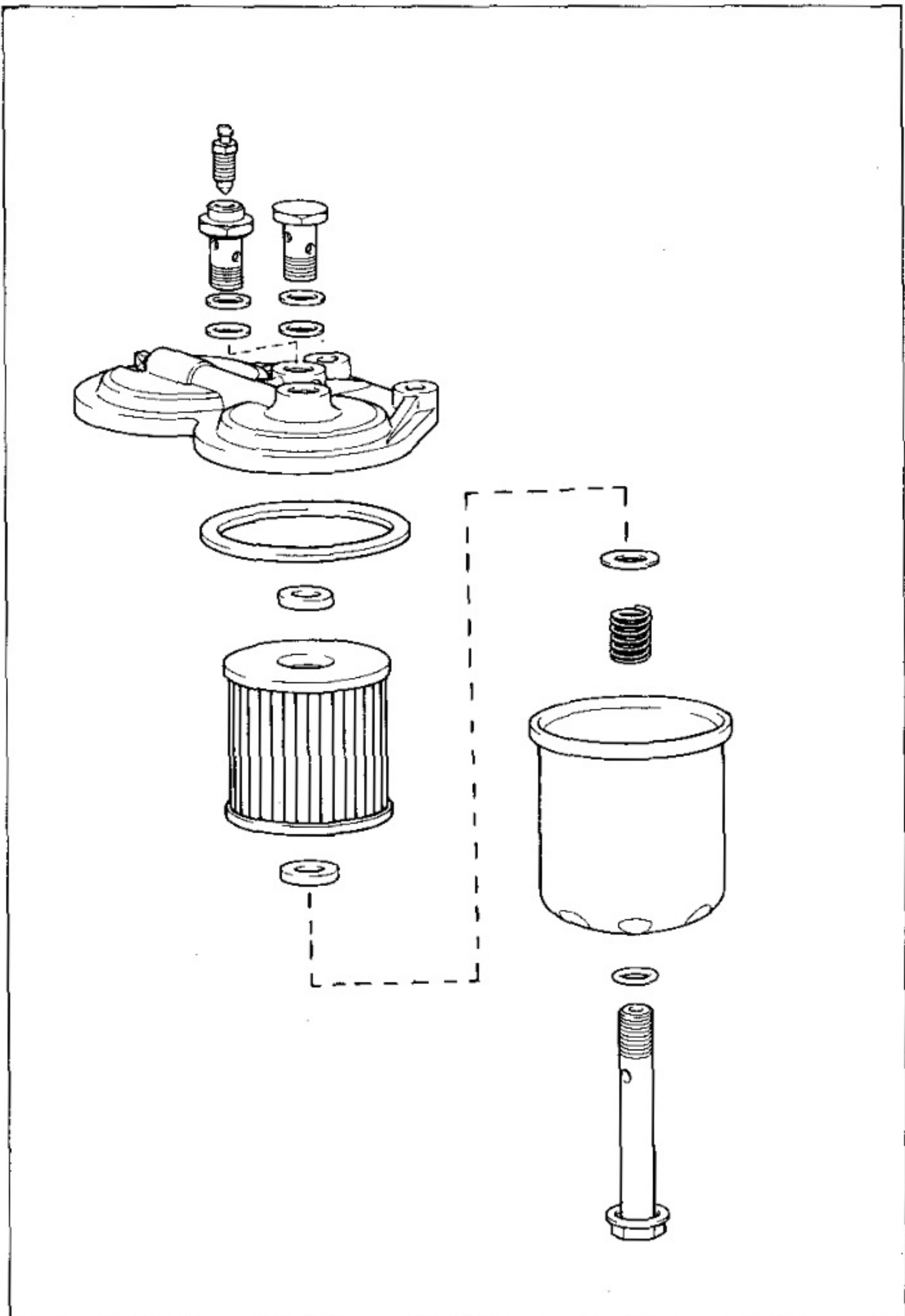


CHECK OIL QUALITY

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

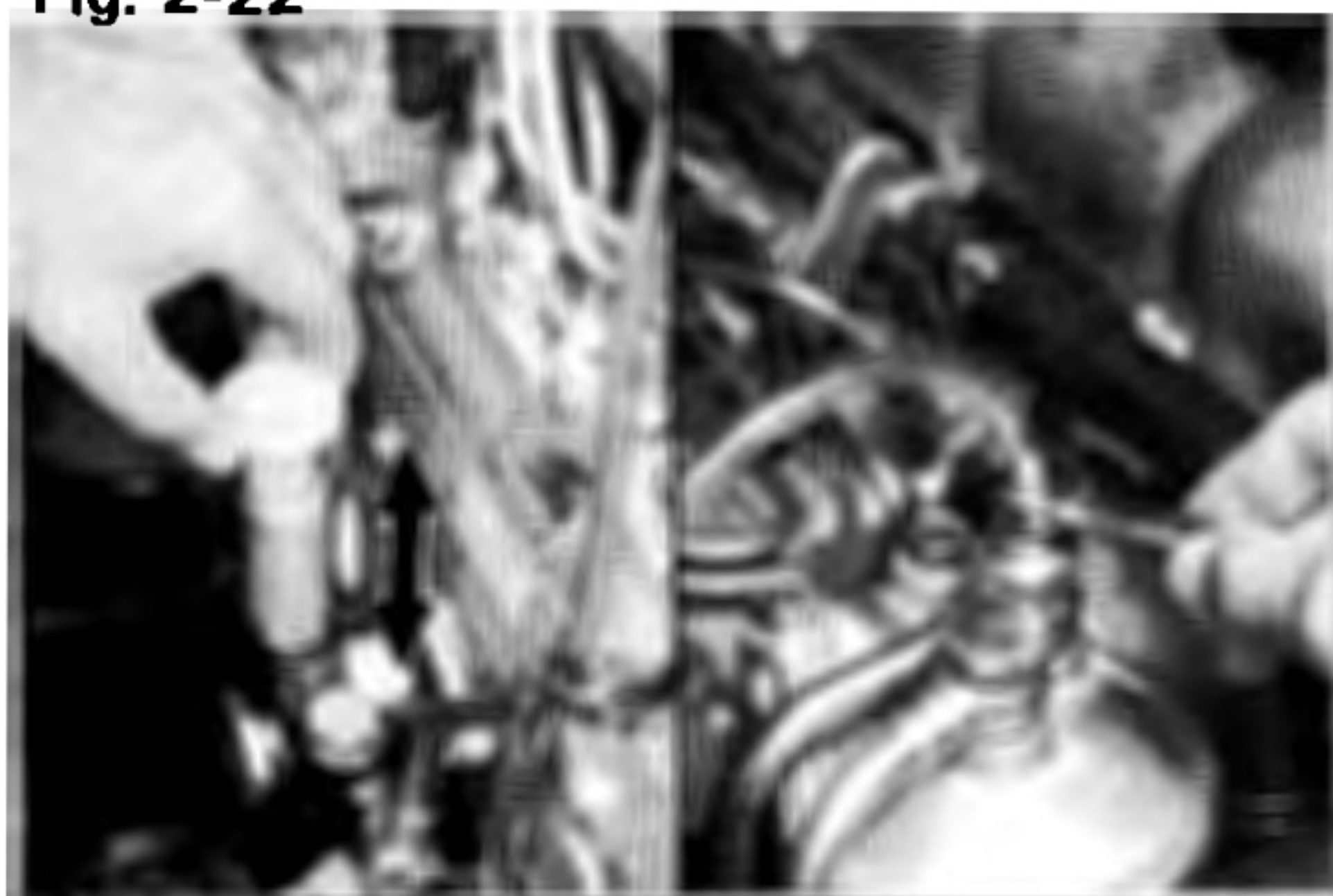
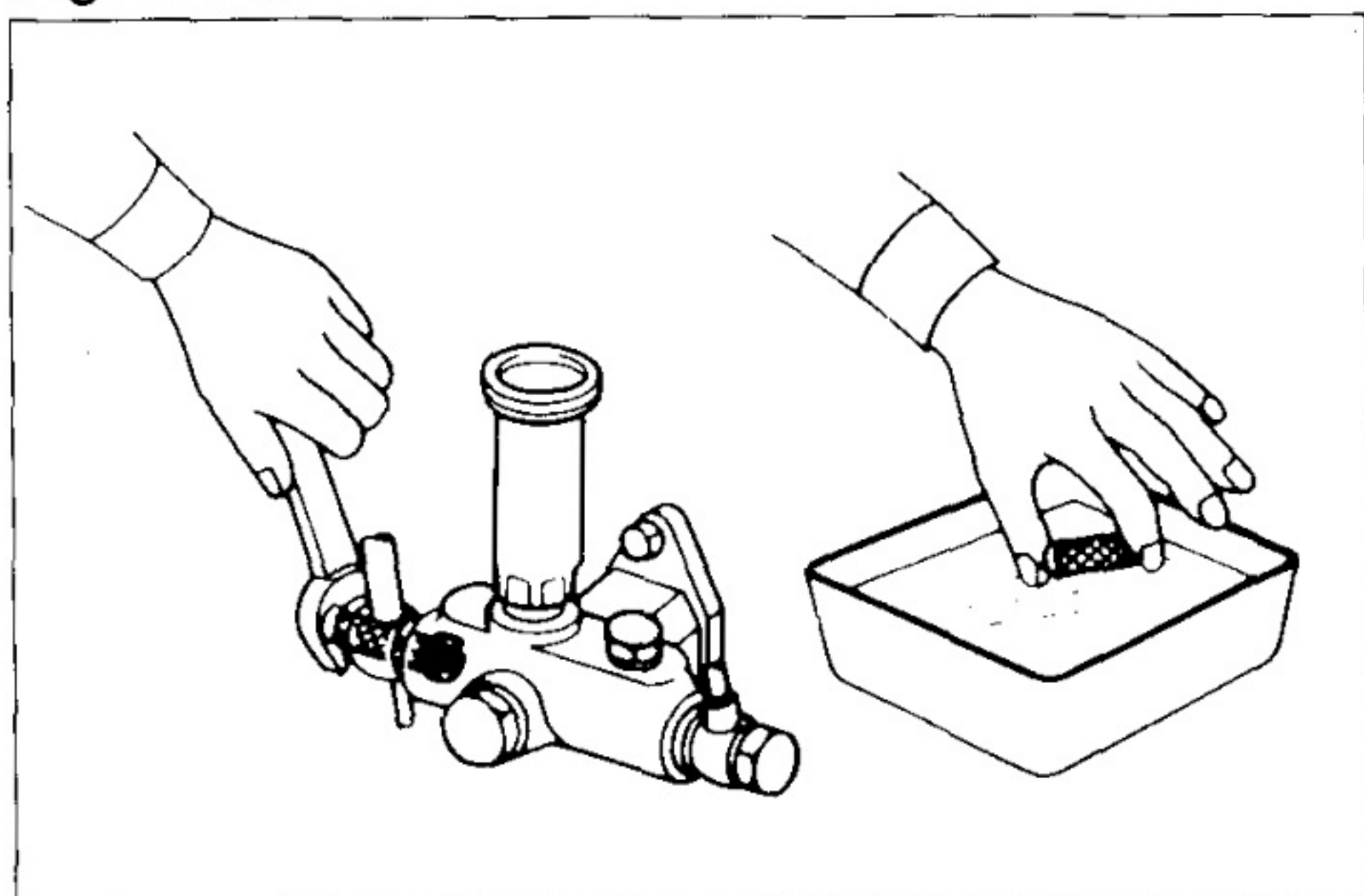


Fig. 2-23

**BLEED AIR**

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

**[Feed Pump Filter]**

Remove the inlet union and clean the filter.

Fig. 2-24

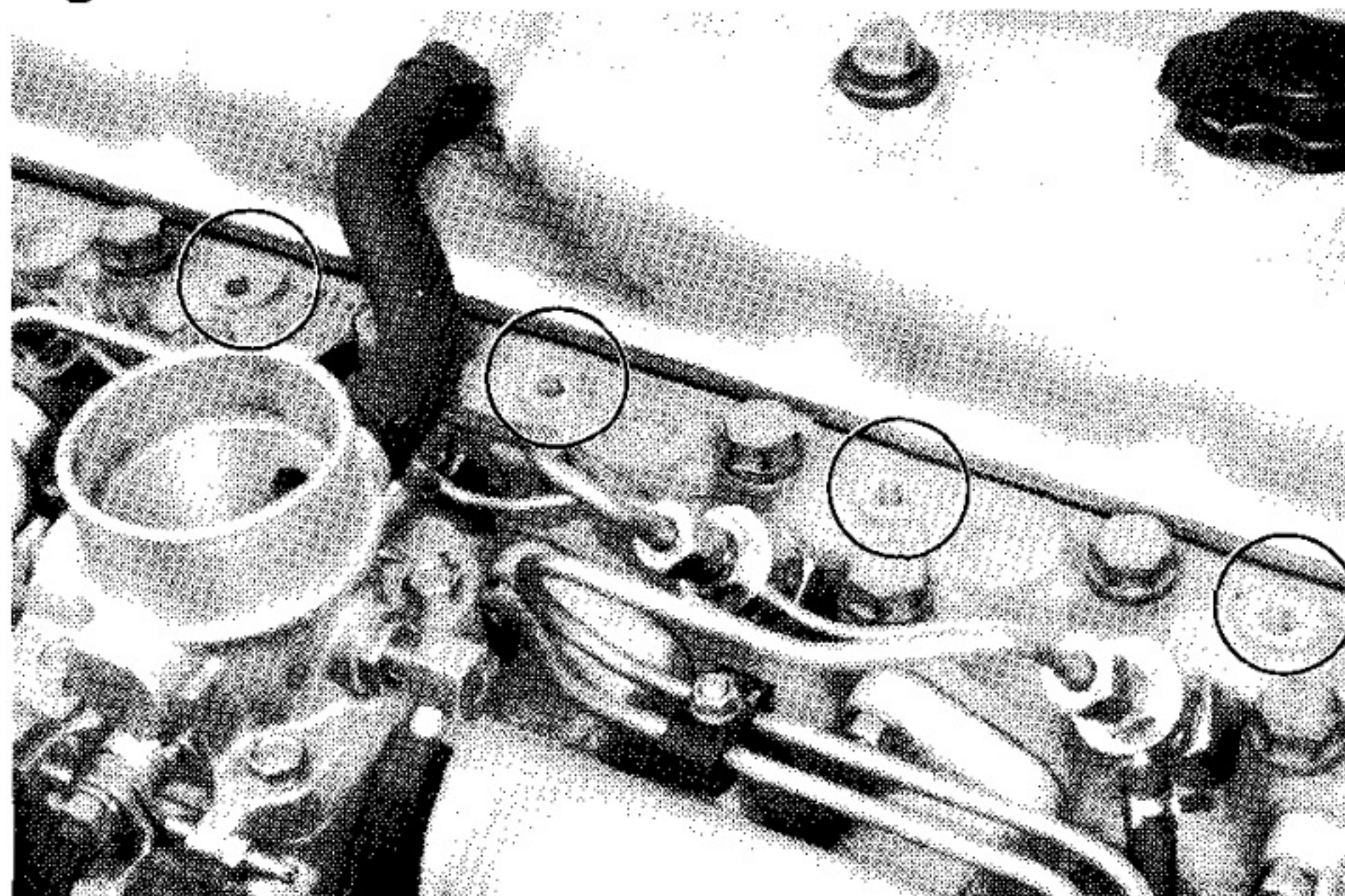
**INJECTION PUMP****LUBRICATE DIAPHRAGM HOUSING**

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

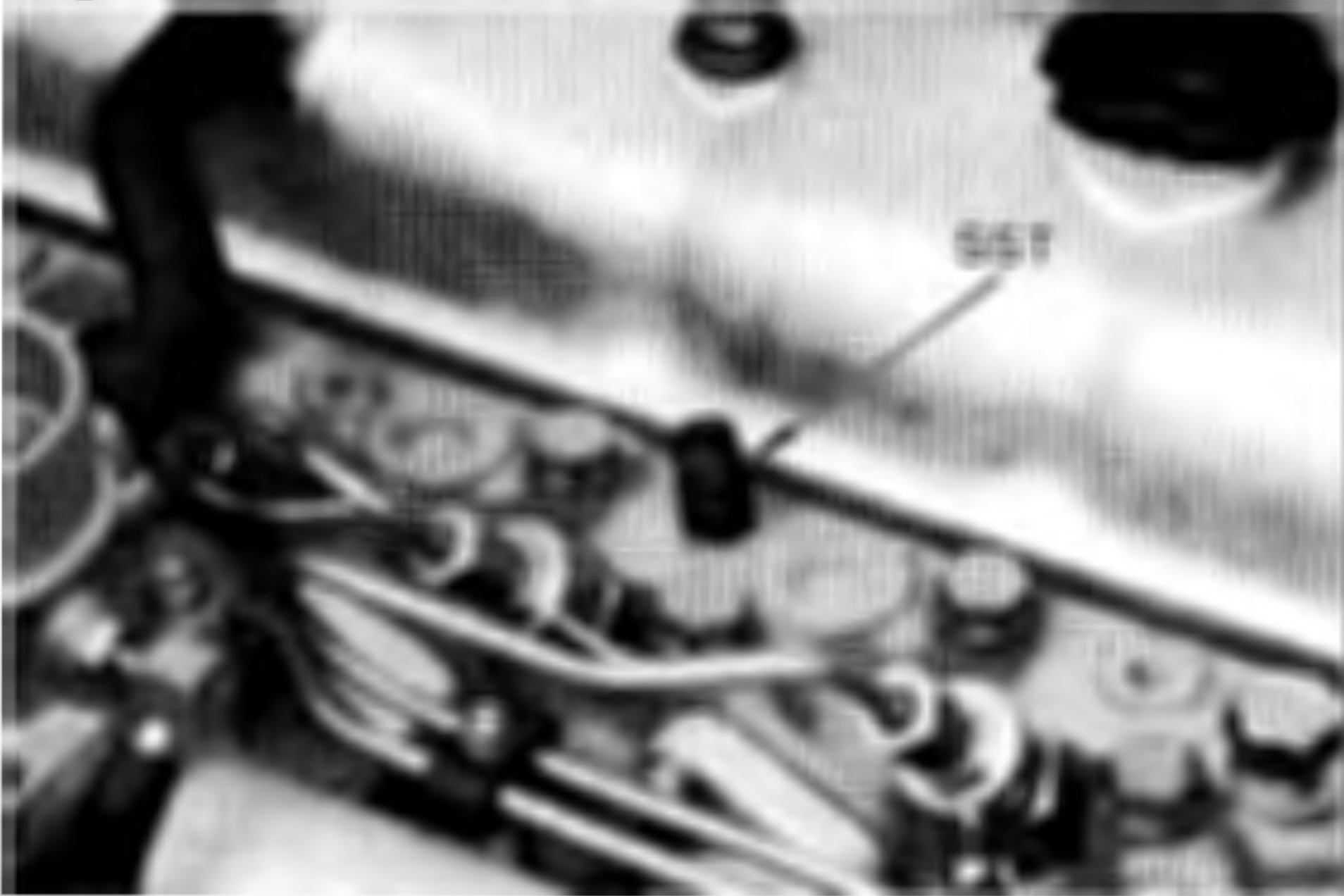


Fig. 2-27

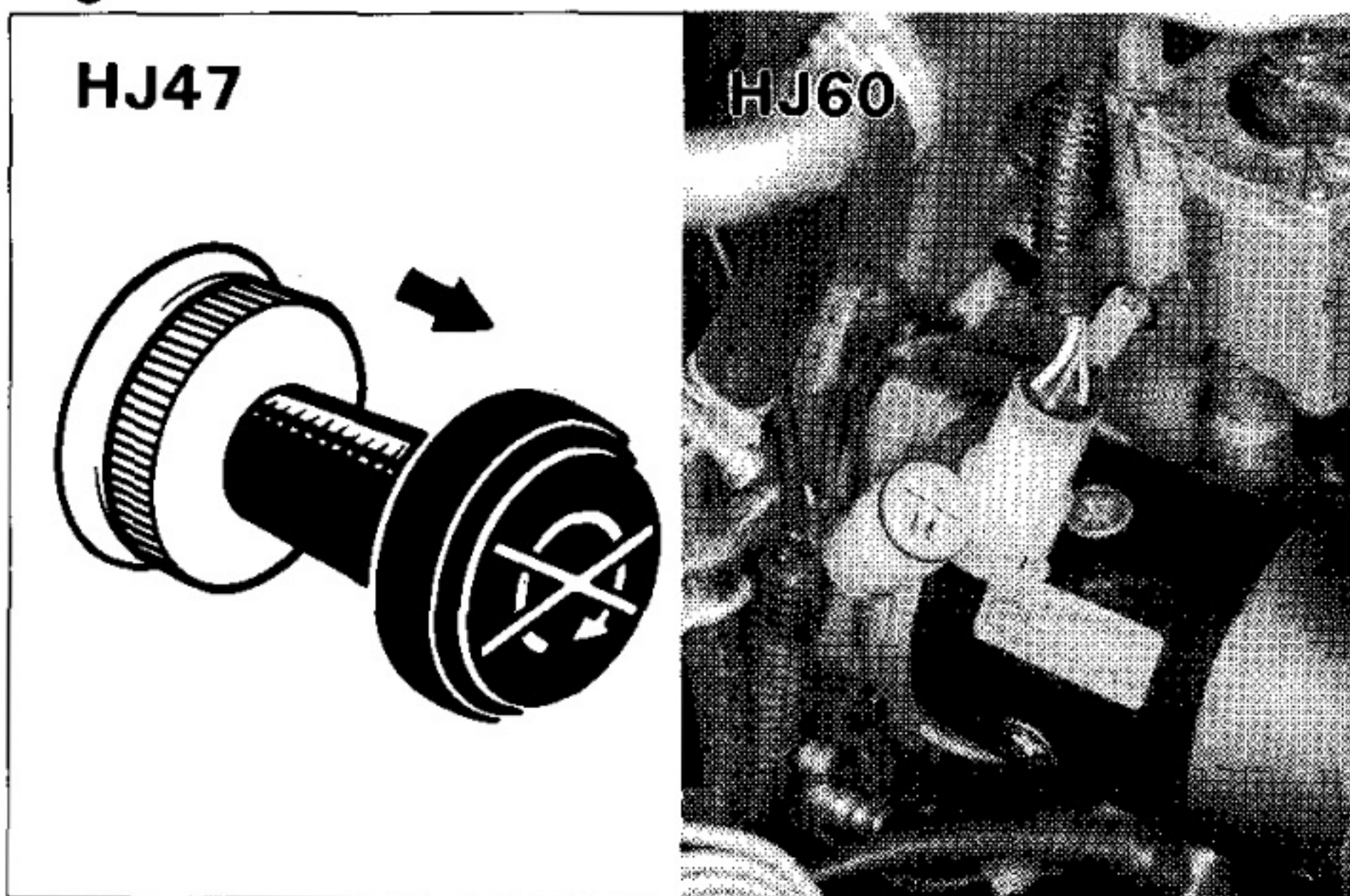


Fig. 2-28

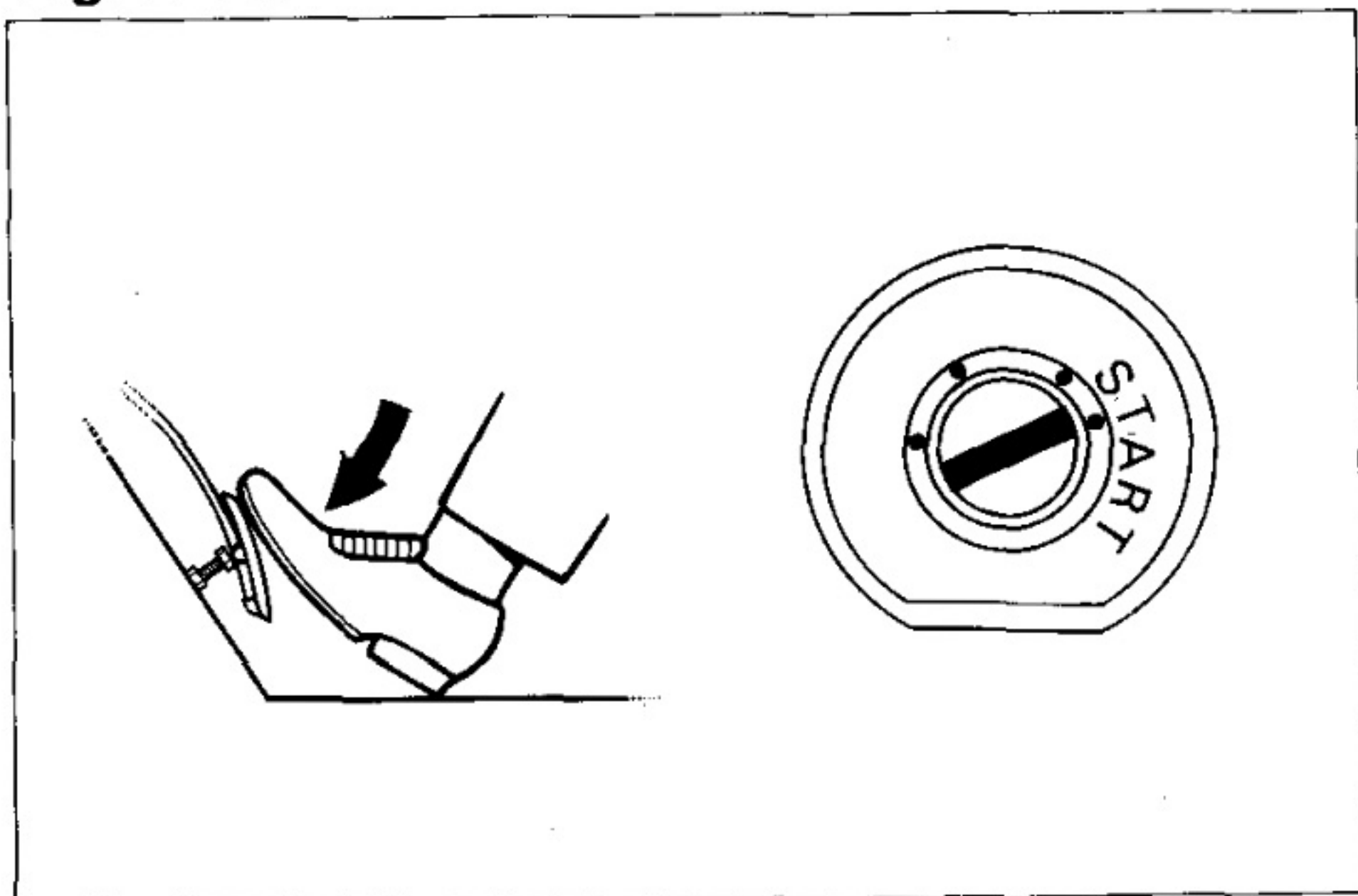


Fig. 2-29



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

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.



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.



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

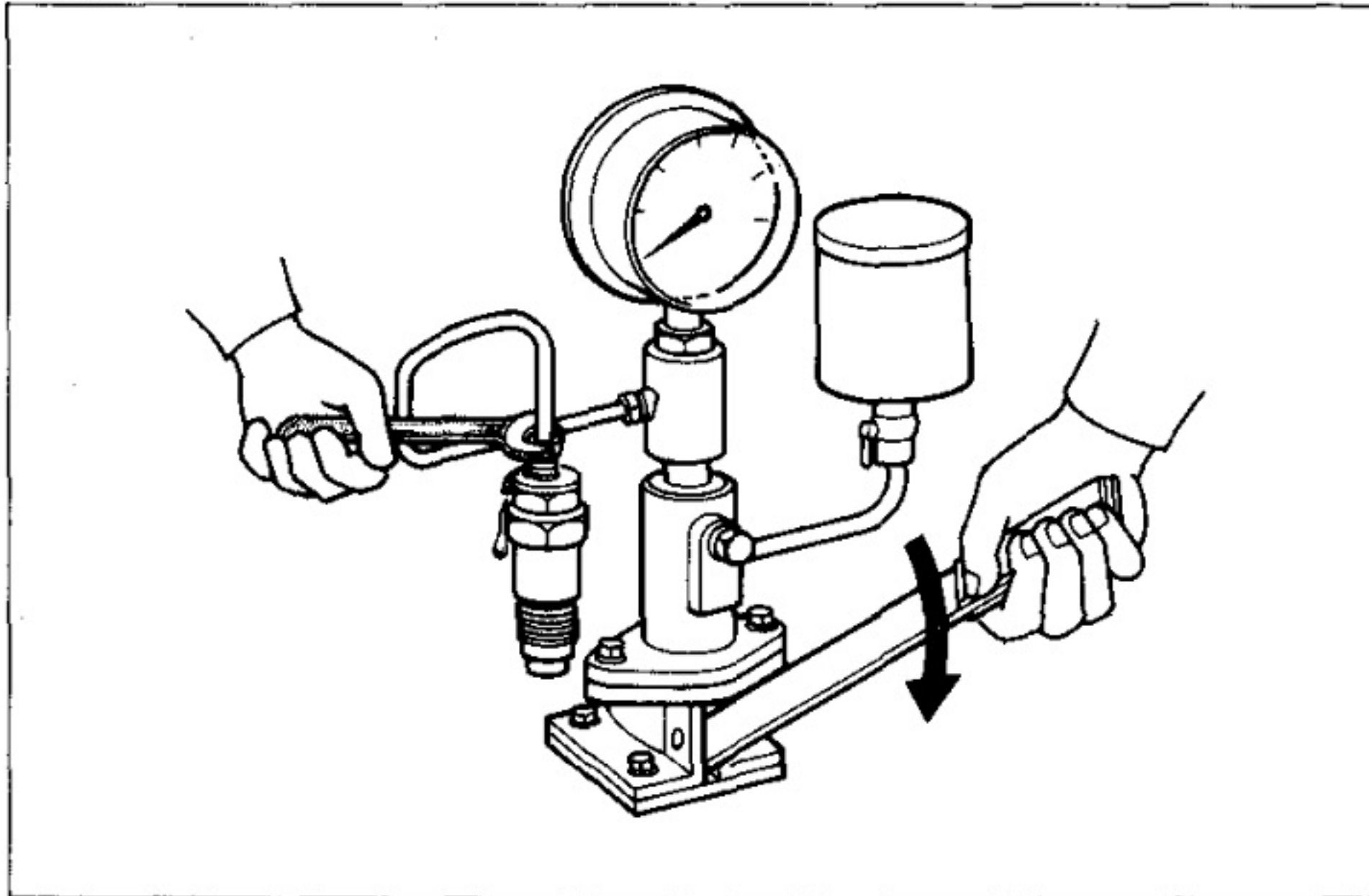


Fig. 2-31

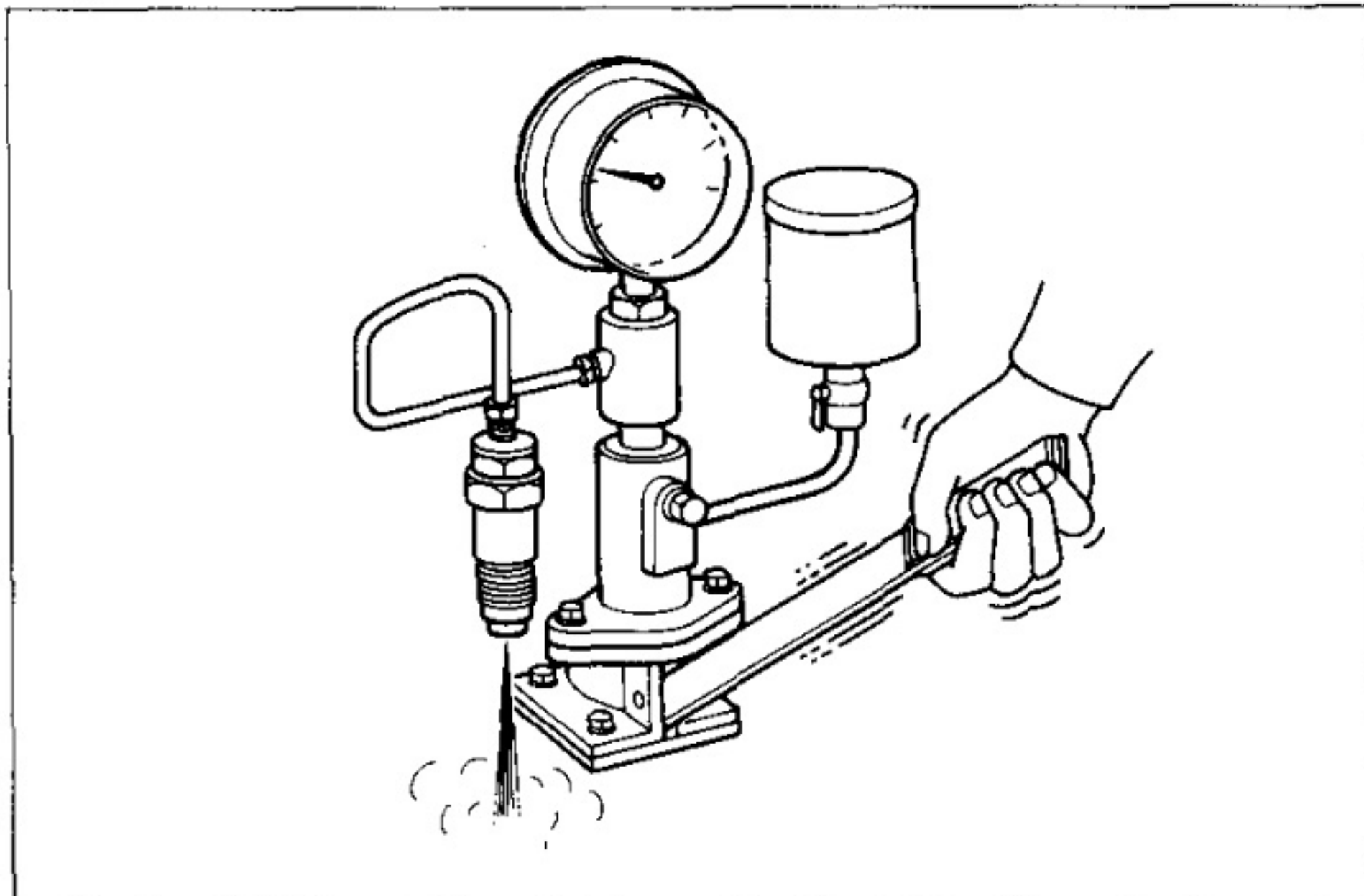


Fig. 2-32

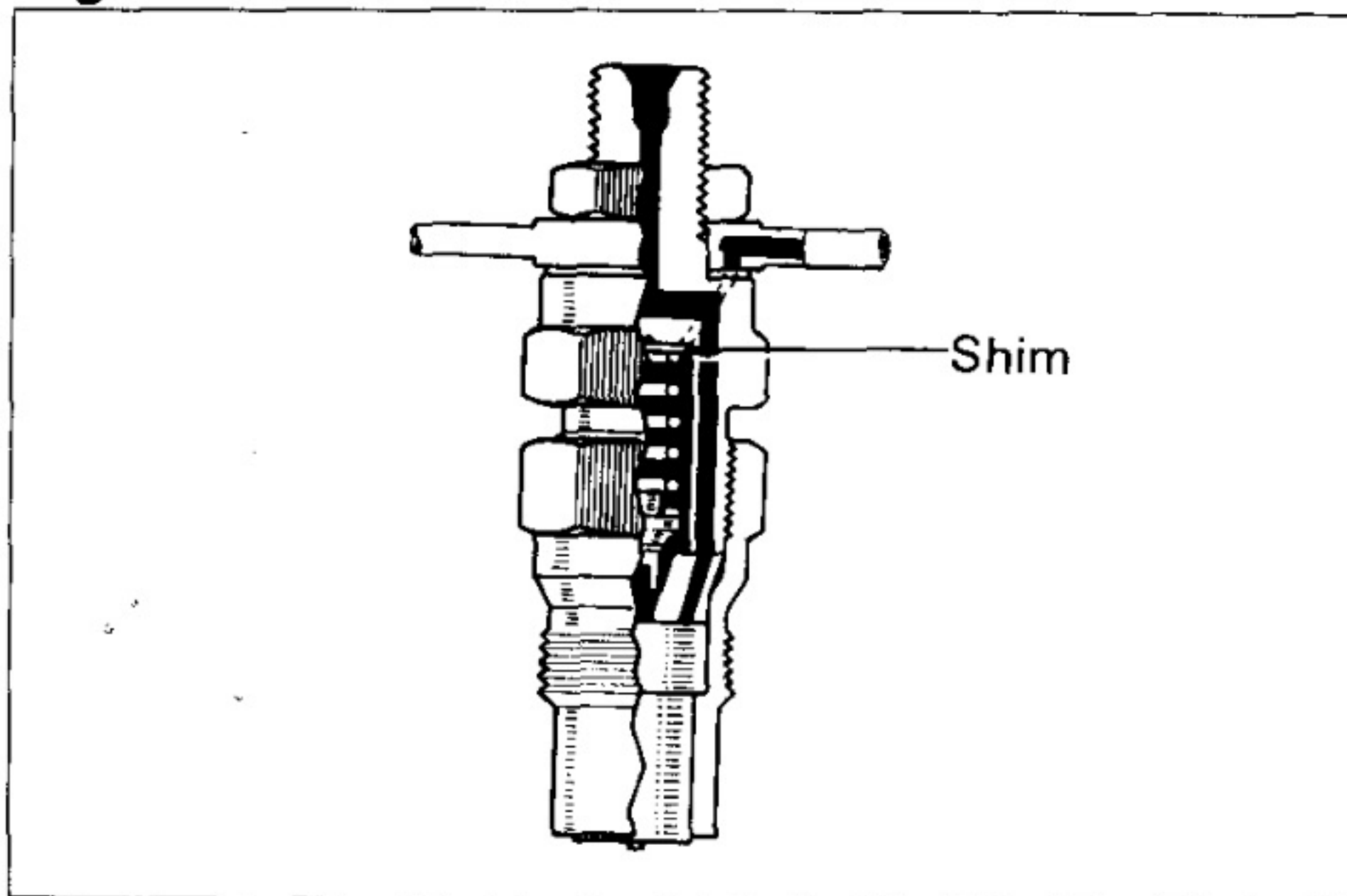
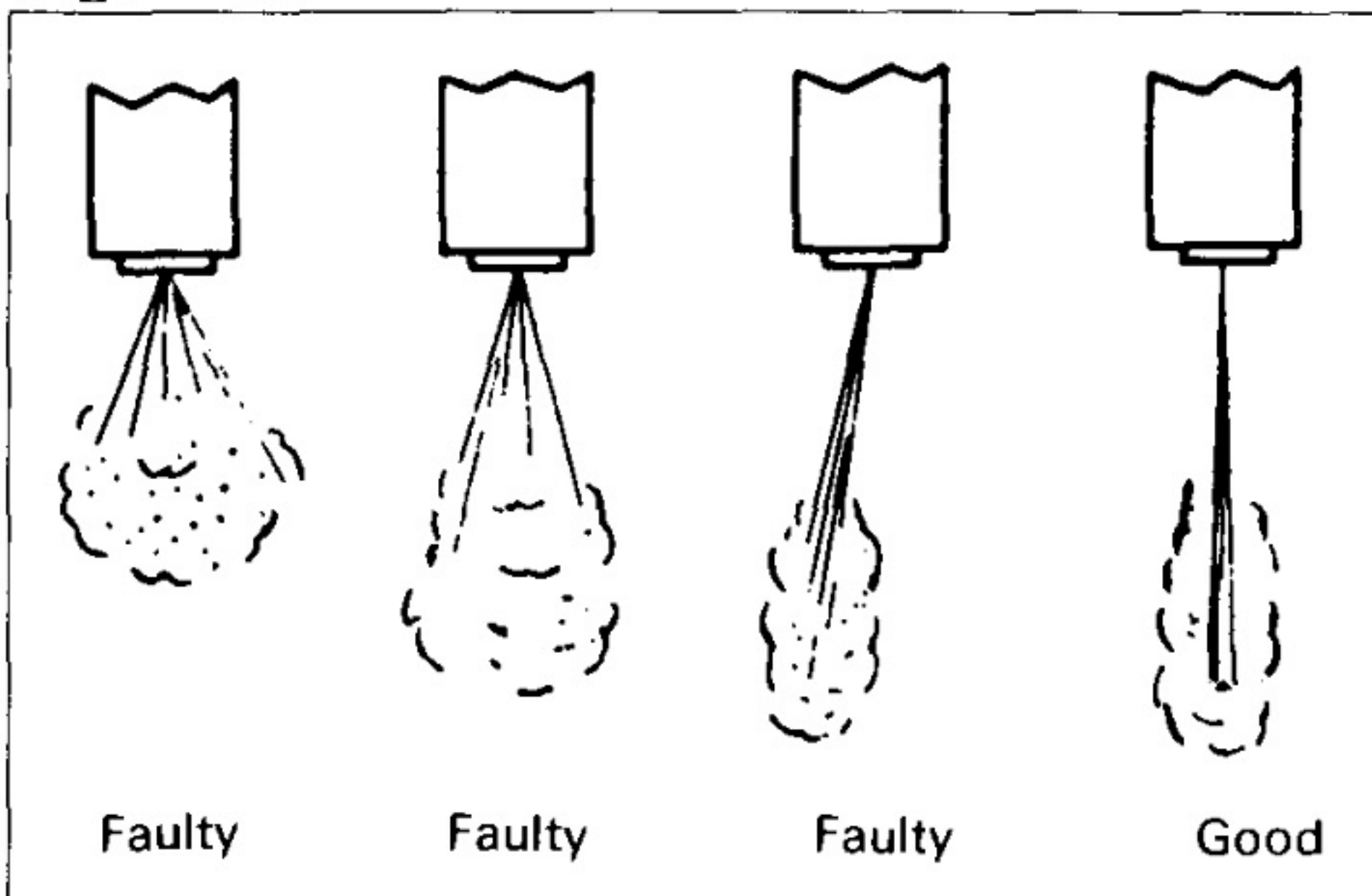


Fig. 2-33



INJECTION NOZZLE

SPRAY TEST

1. Install the nozzle to an injection nozzle hand tester and bleed air from the union nut.
2. Check injection pressure.
 - (1) Pump the tester handle 50 – 60 times per minute by hand.
 - (2) Read the injection starting pressure.

Opening pressure:

New nozzle

115 – 125 kg/cm²
(1,636 – 1,778 psi)

Reused nozzle

105 – 125 kg/cm²
(1,493 – 1,778 psi)

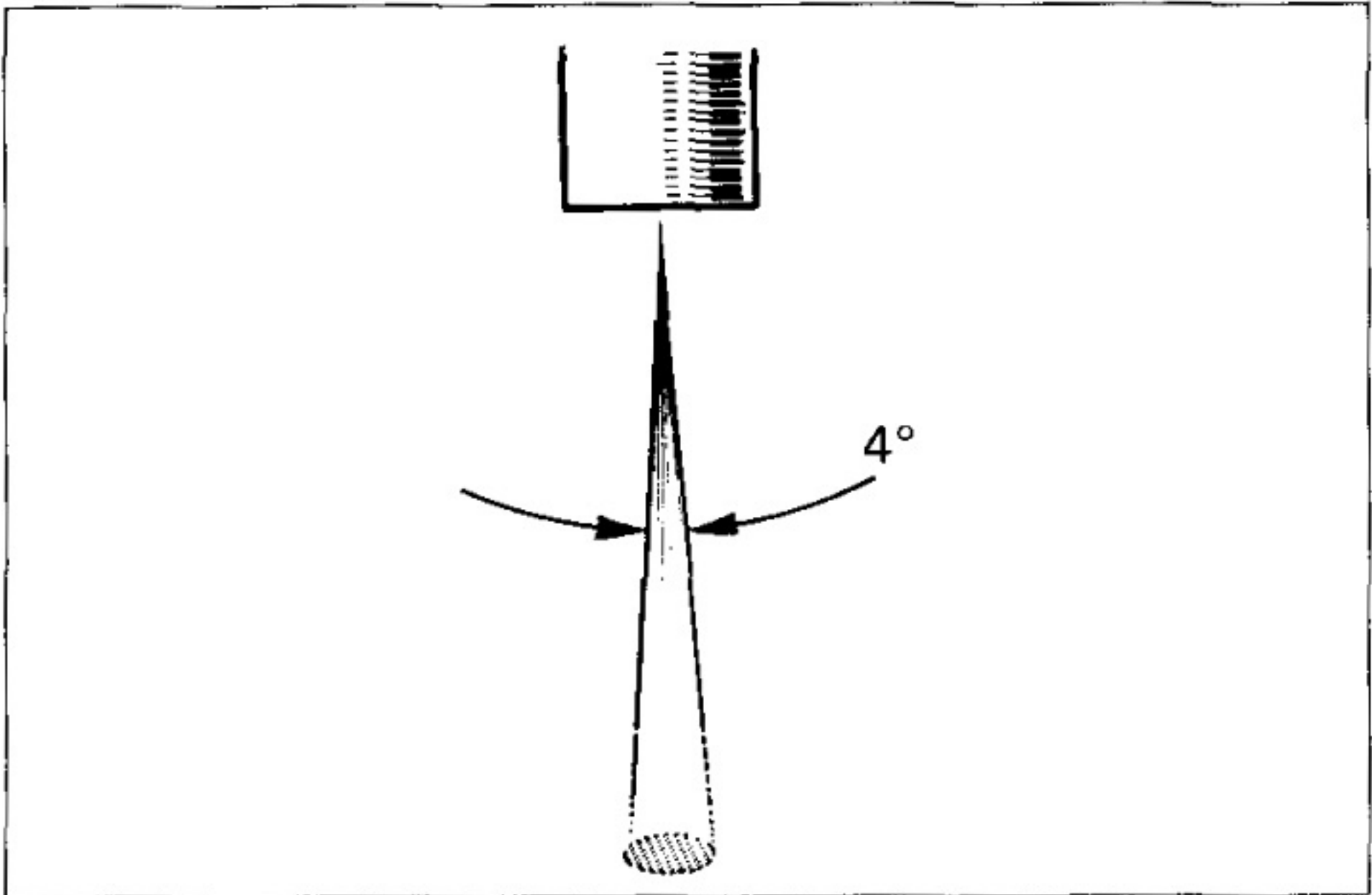
—Note—

1. Proper nozzle operation can be determined by a swishing sound.
2. If an overhauled nozzle is being used, adjust the injection starting pressure to 110 – 125 kg/cm² (1,565 – 1,778 psi).
3. To adjust the injection pressure, change the shim on the top of pressure spring.

—Note—

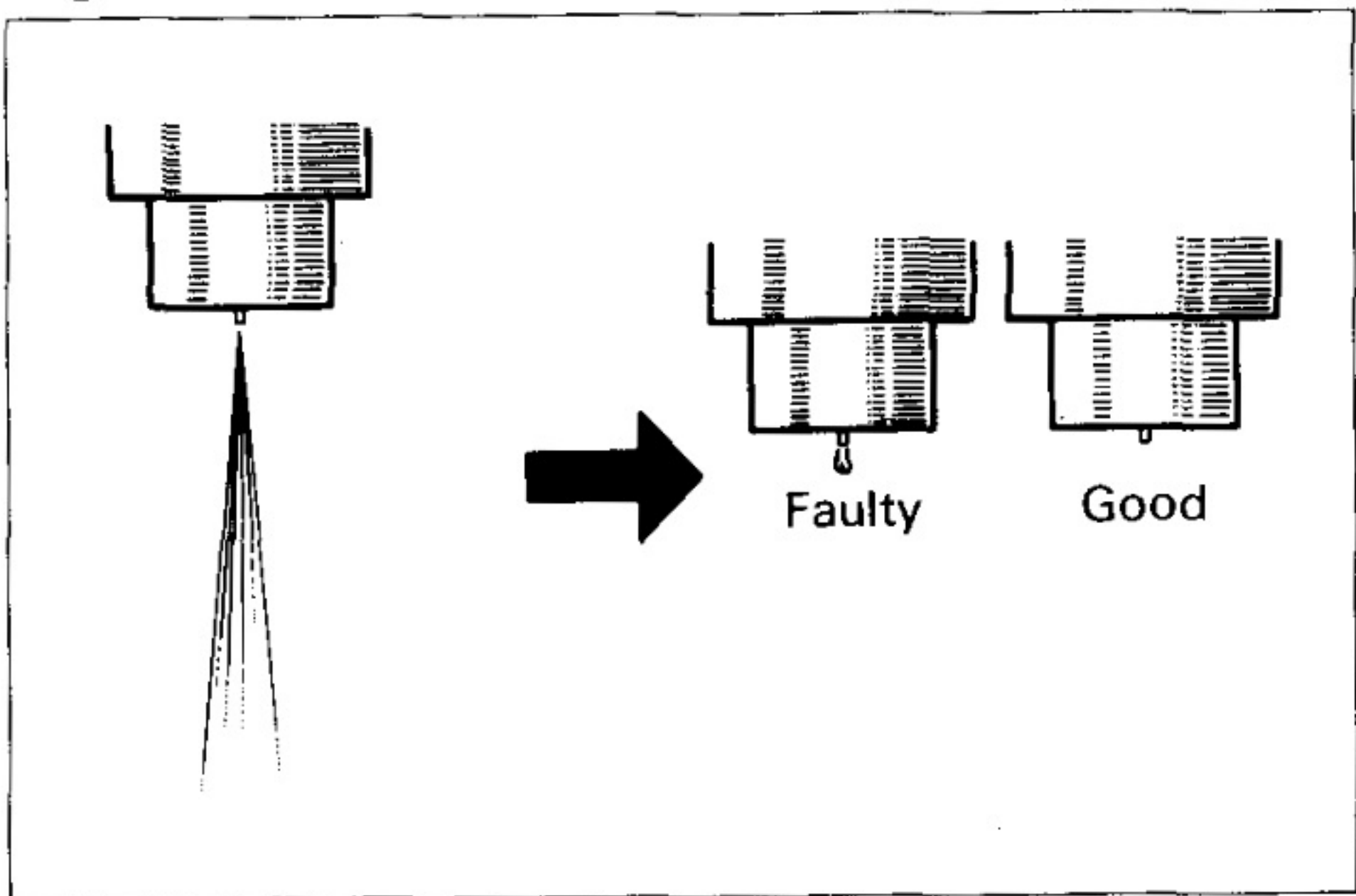
1. Shims are available in 20 sizes, in increments of 0.05 mm (0.0020 in.), from 1.00 – 1.95 mm (0.0394 – 0.0768 in.).
2. Varying the adjusting shim thickness by 0.05 mm (0.0020 in.) changes the injection pressure by about 5 kg/cm² (71 psi).
4. Check spray patterns.
 - (1) Check the spray patterns when pumping the tester handle 50 – 60 times per minute by hand.

Fig. 2-34



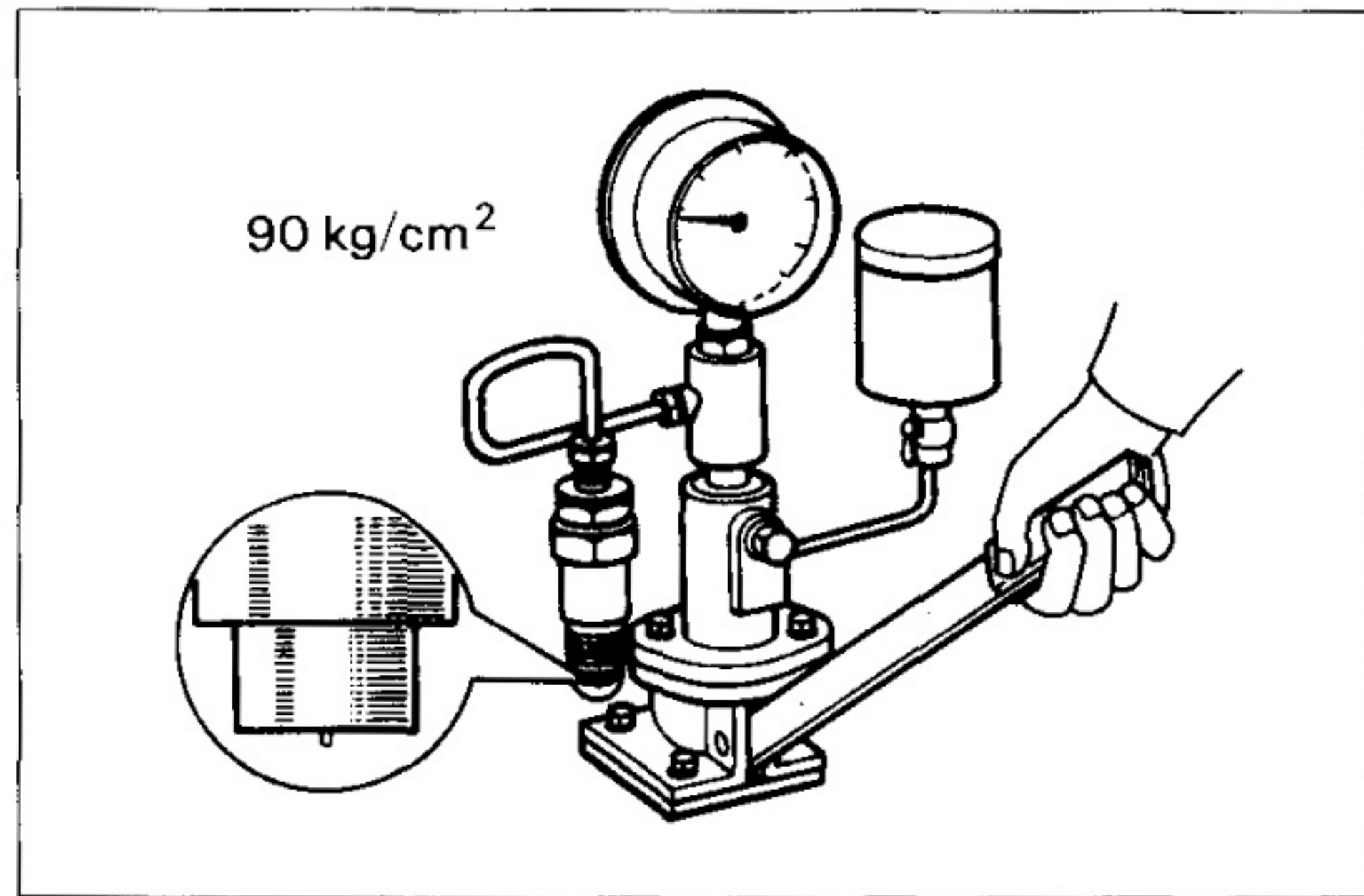
- (2) Spray should spread evenly down the nozzle center line in a 4° conical form.
- (3) Place a white sheet of paper about 30 cm (12 in.) away from the nozzle to check if spray pattern is in circular form.

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.

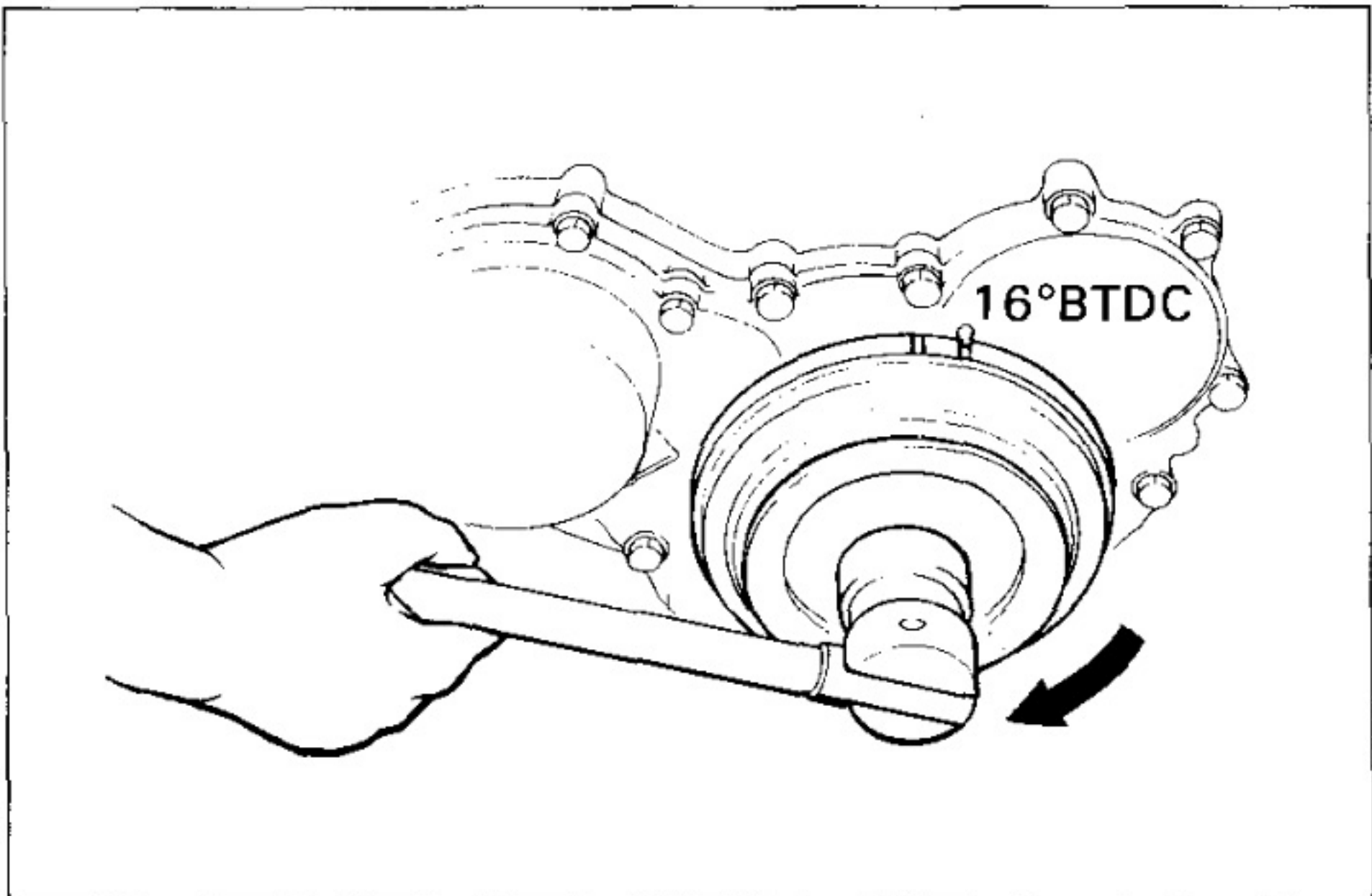
Fig. 2-37

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



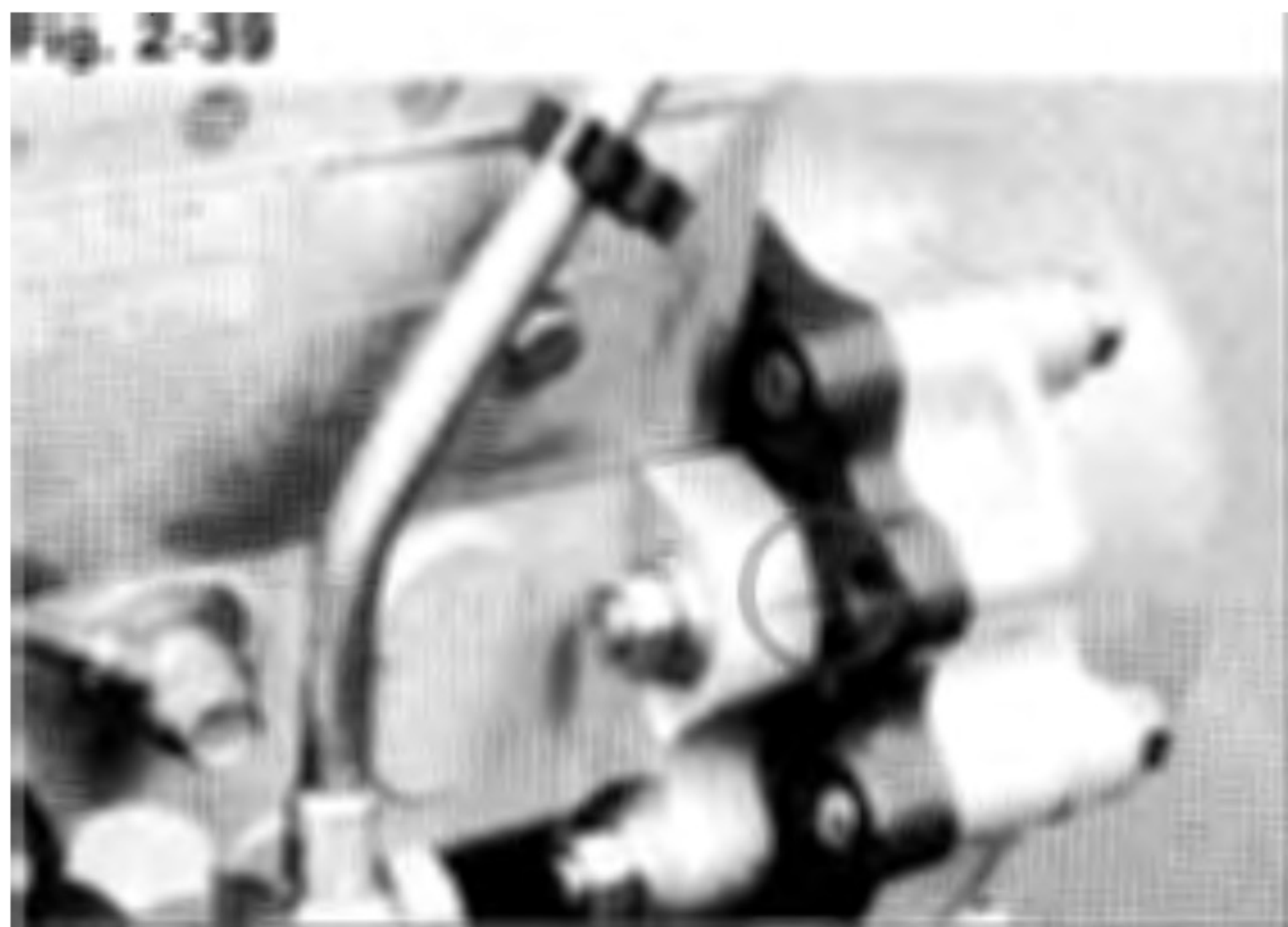
INJECTION TIMING

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



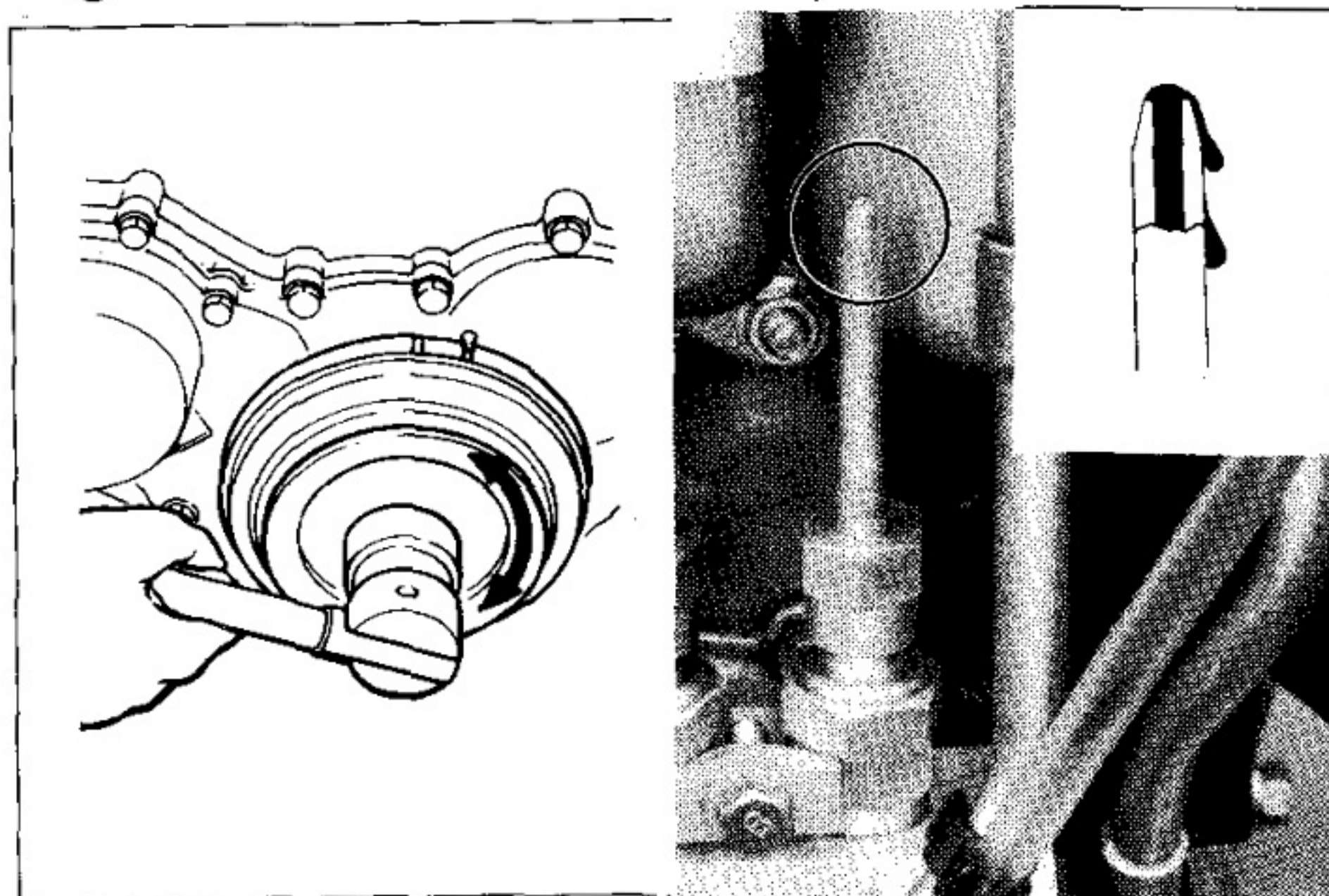
- (2) Bleed air from the fuel filter by operating the priming pump.

Fig. 2-42



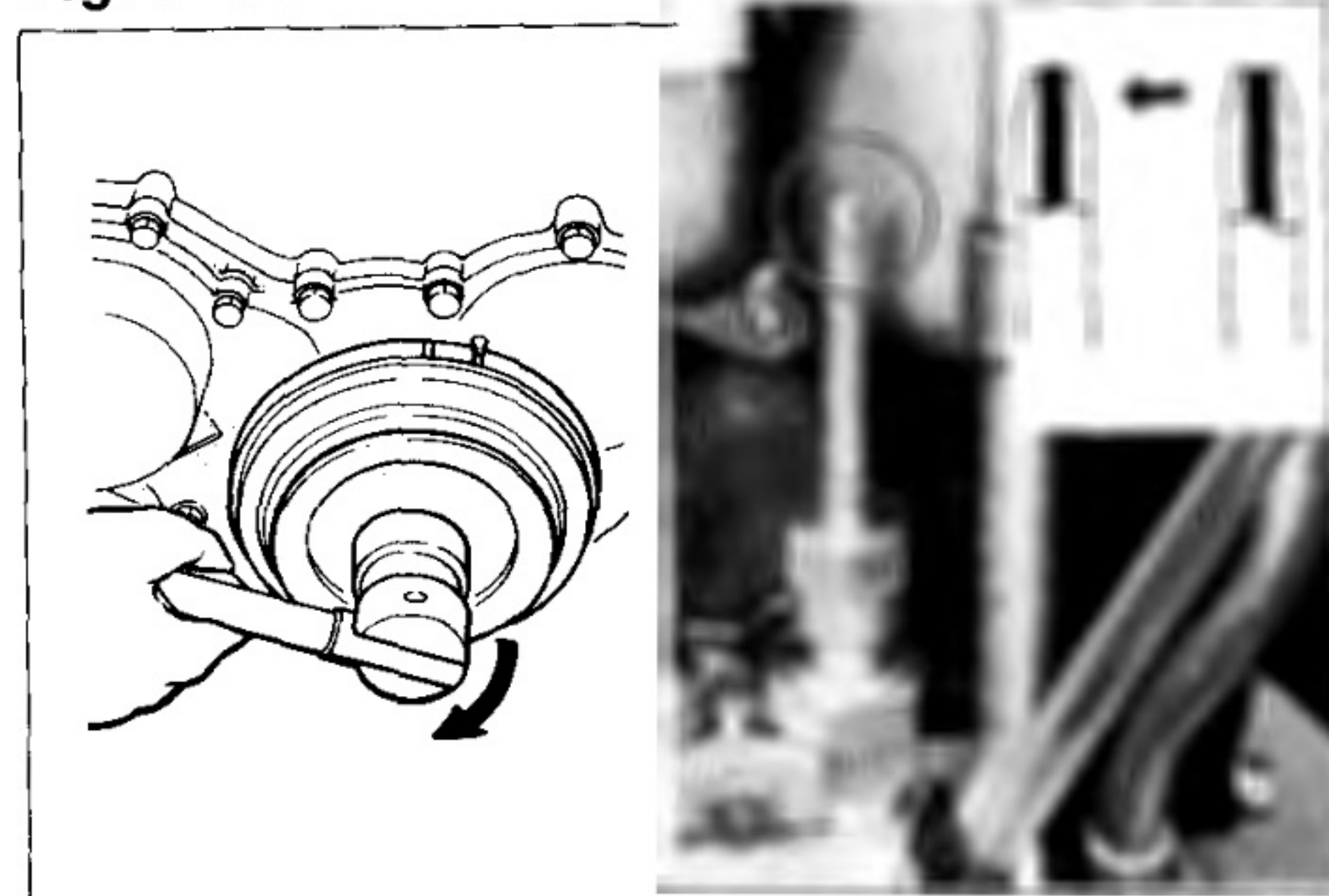
- (3) Bleed air from the injection pump by operating the priming pump.

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. 2-47

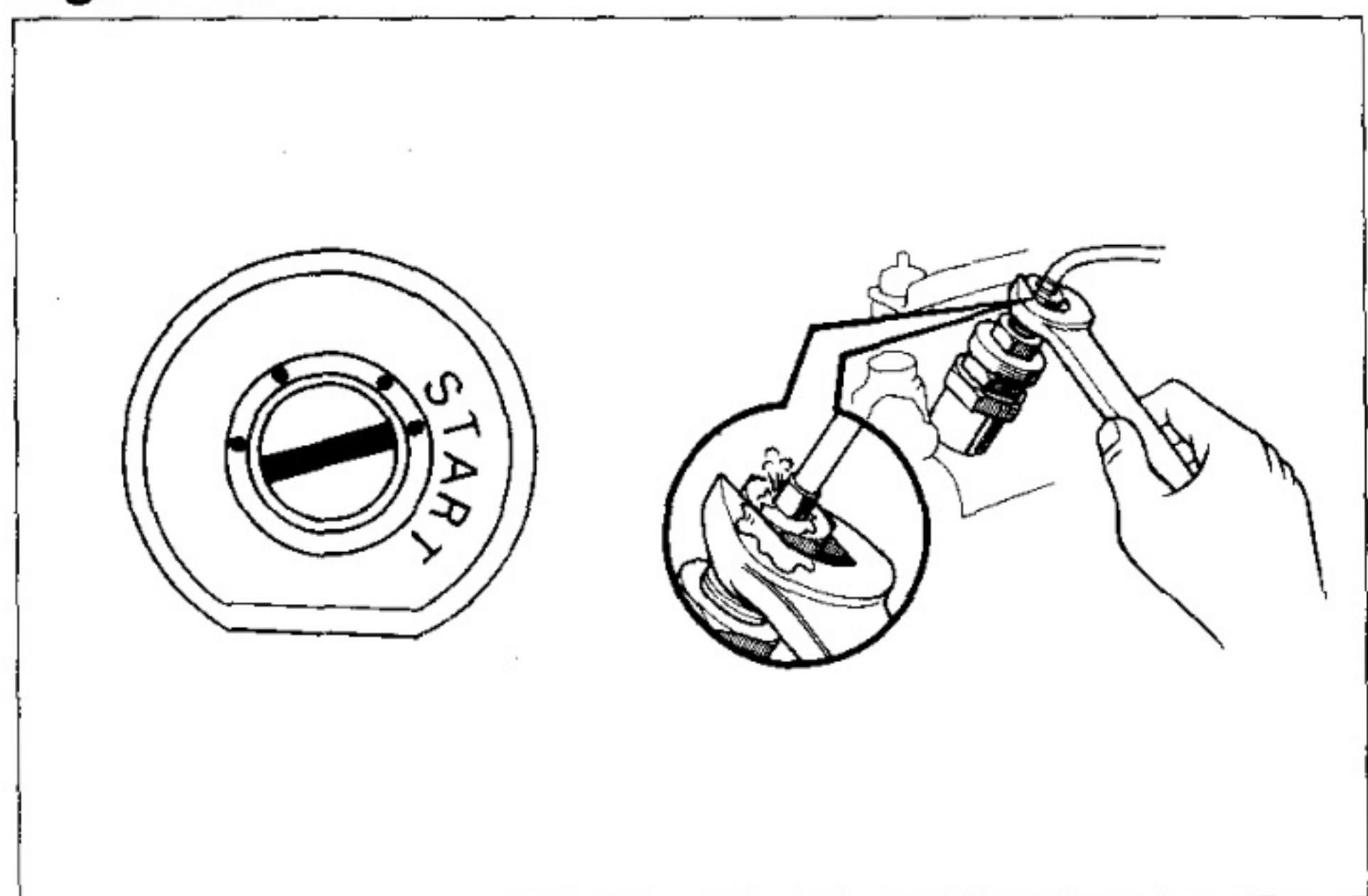


Fig. 2-48

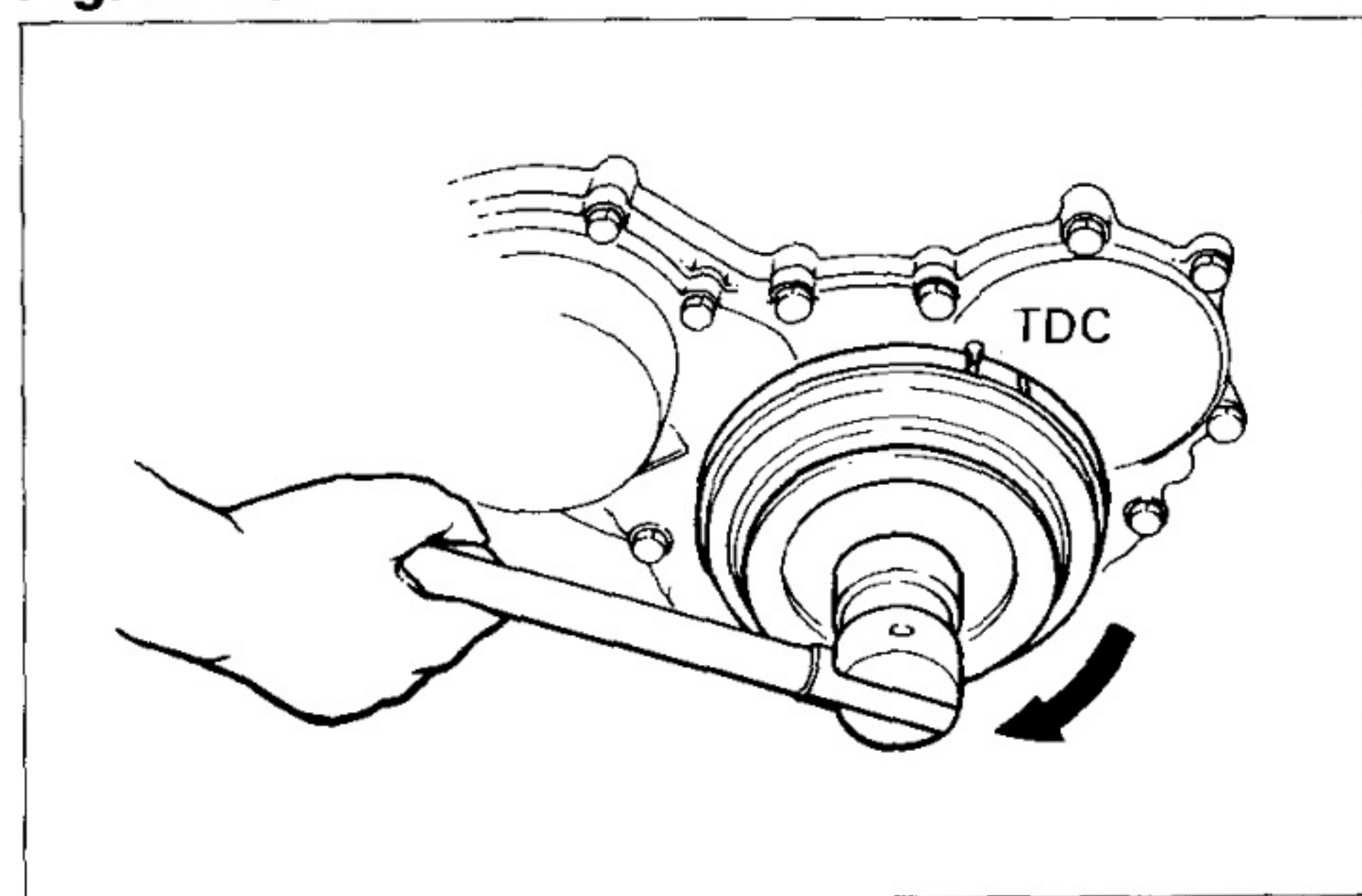


Fig. 2-49



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



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



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)

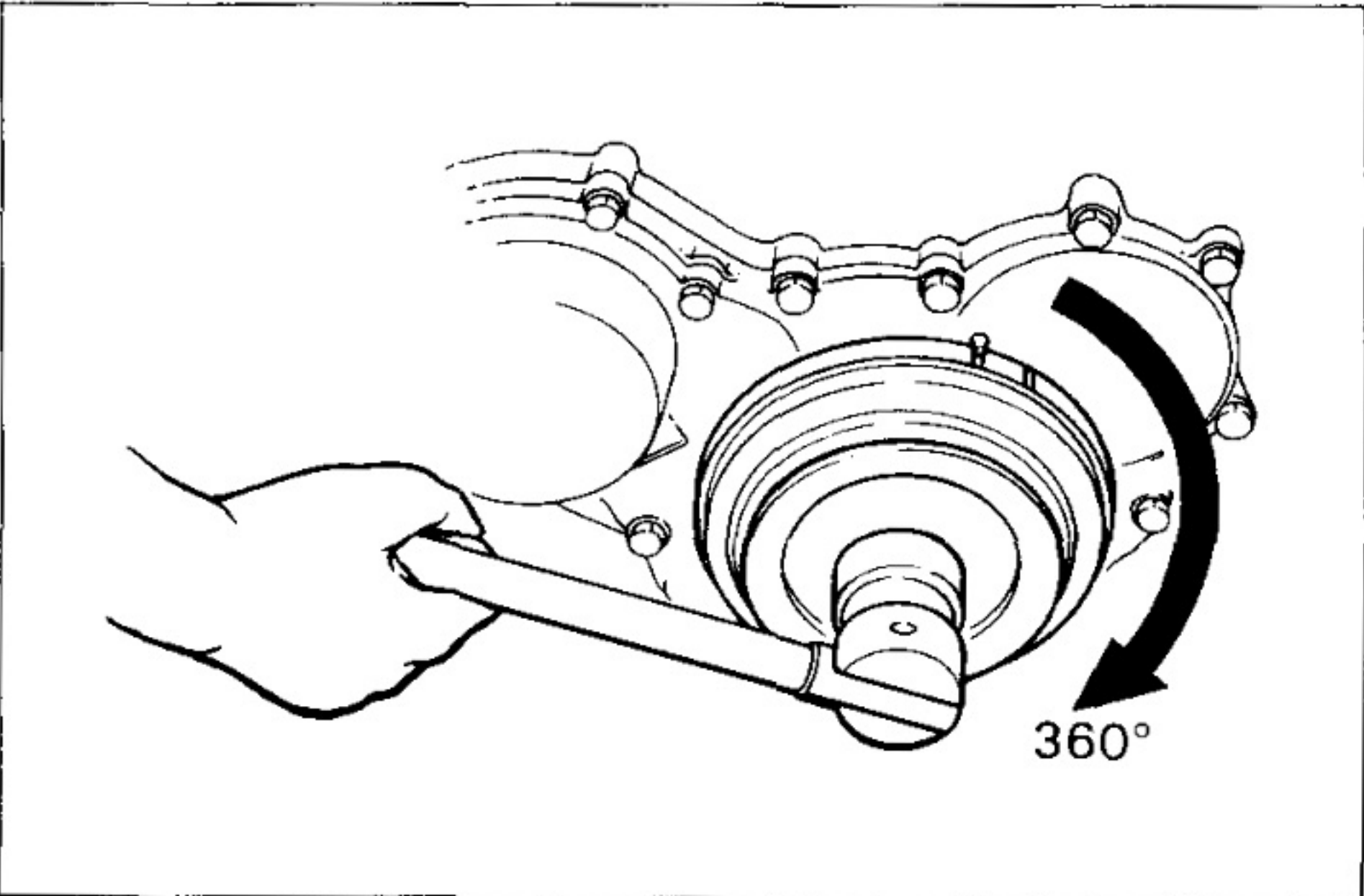


4. Adjust the valve clearance.
The valve clearance is measured between the valve stem and rocker arm adjusting screw.
Adjust only the valves indicated by arrows.

Valve clearance:

IN 0.20 mm
(0.008 in.)
EX 0.36 mm
(0.014 in.)

Fig. 2-50



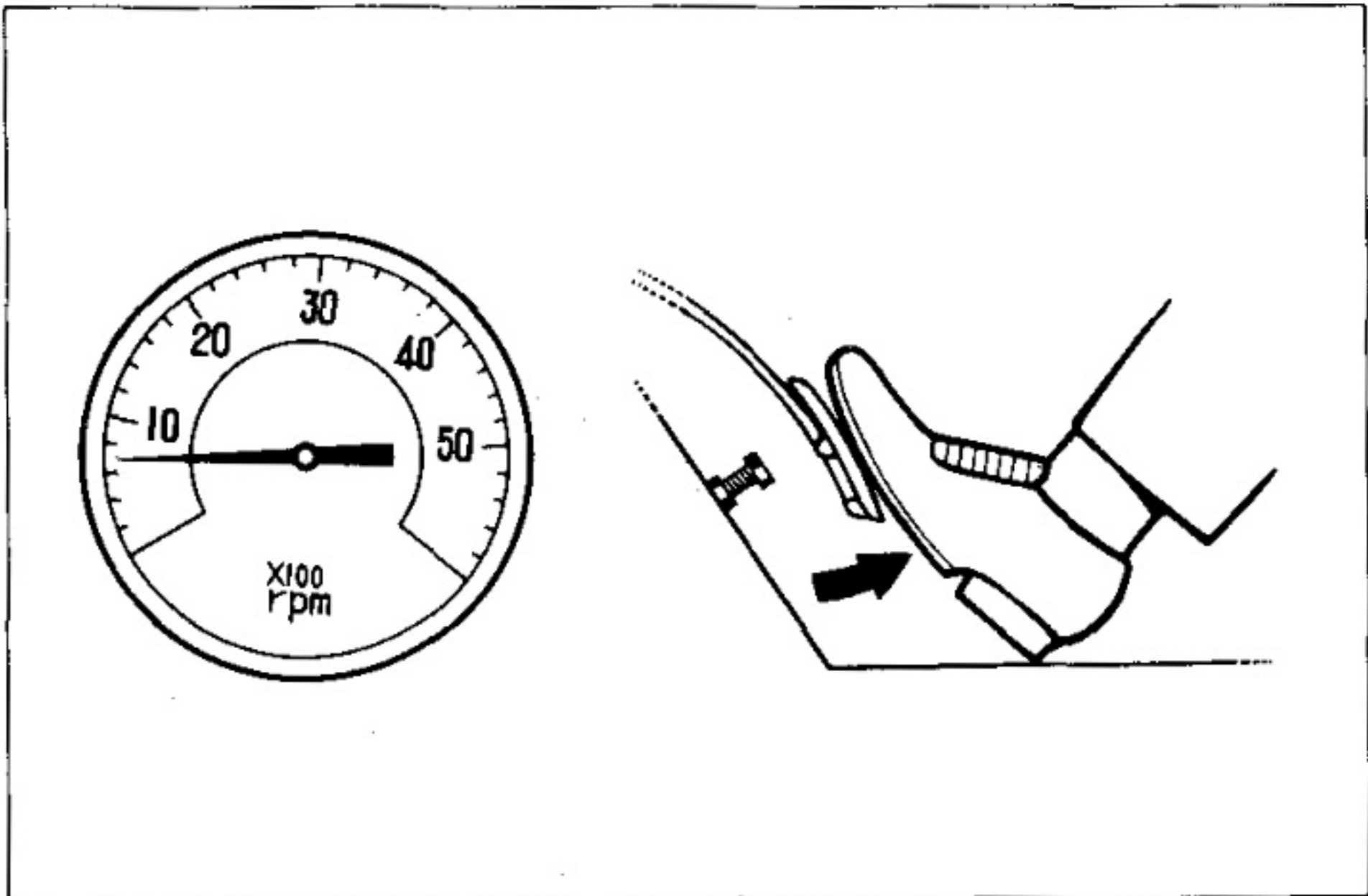
5. Rotate the crankshaft 360°.

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

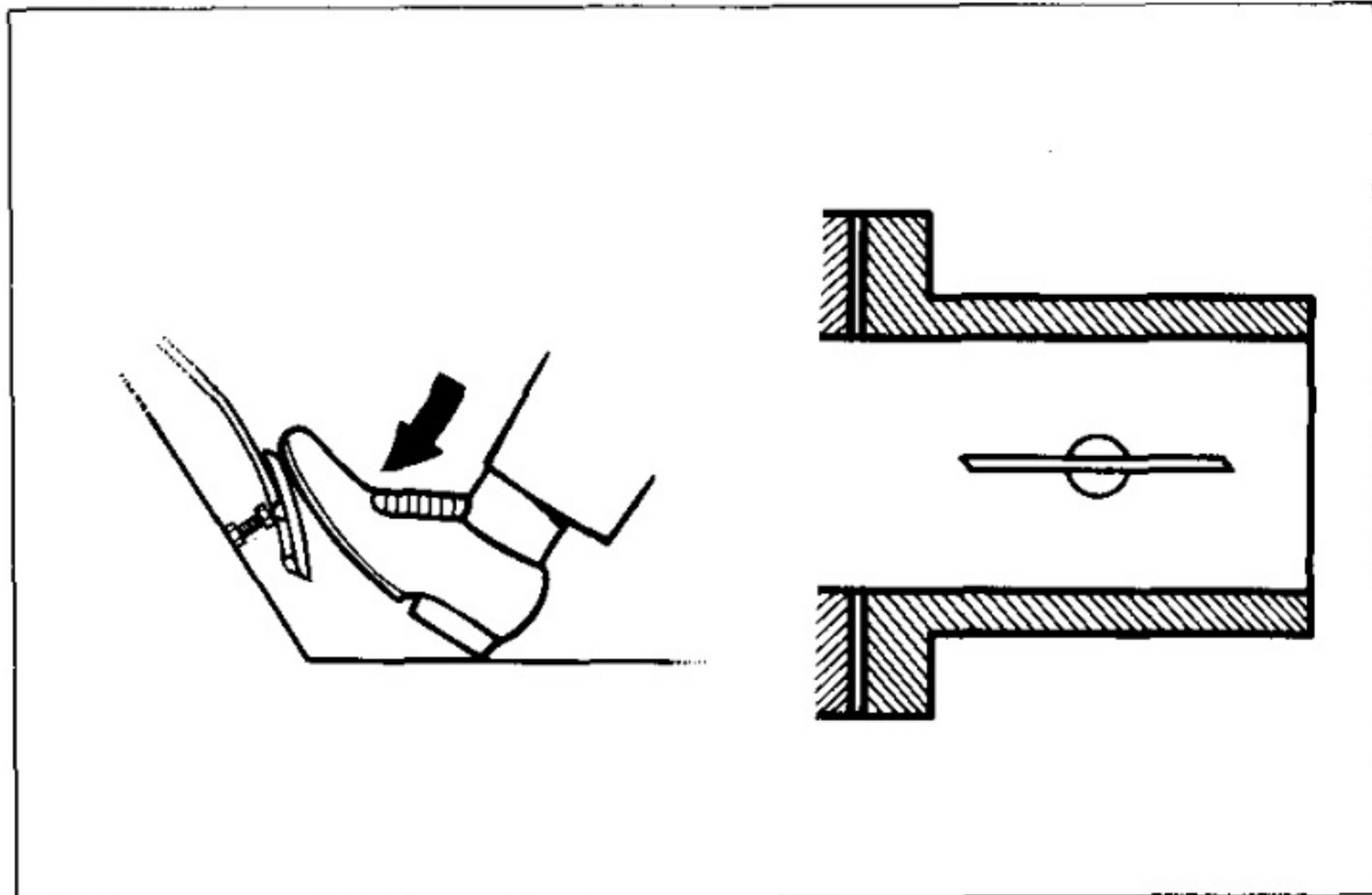


3. If necessary, adjust the idle speed by turning the stop plate adjusting screw.
To increase rpm — Screw in
To decrease rpm — Screw out

—Note—

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

Fig. 2-54



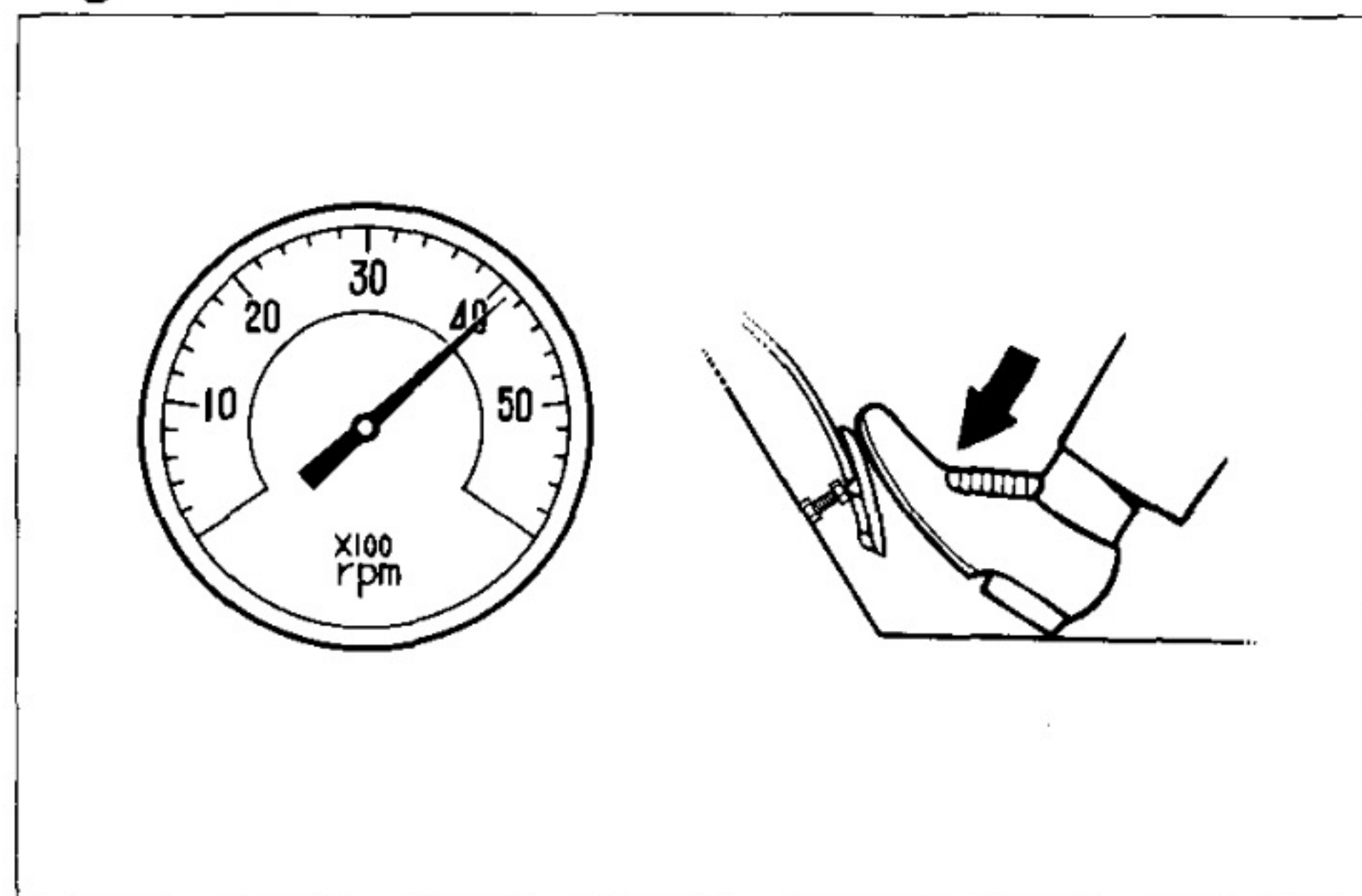
4. Make sure that the throttle valve is fully open when the accelerator pedal is depressed all the way.

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

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

CUTAWAY VIEW

Fig. 3-1

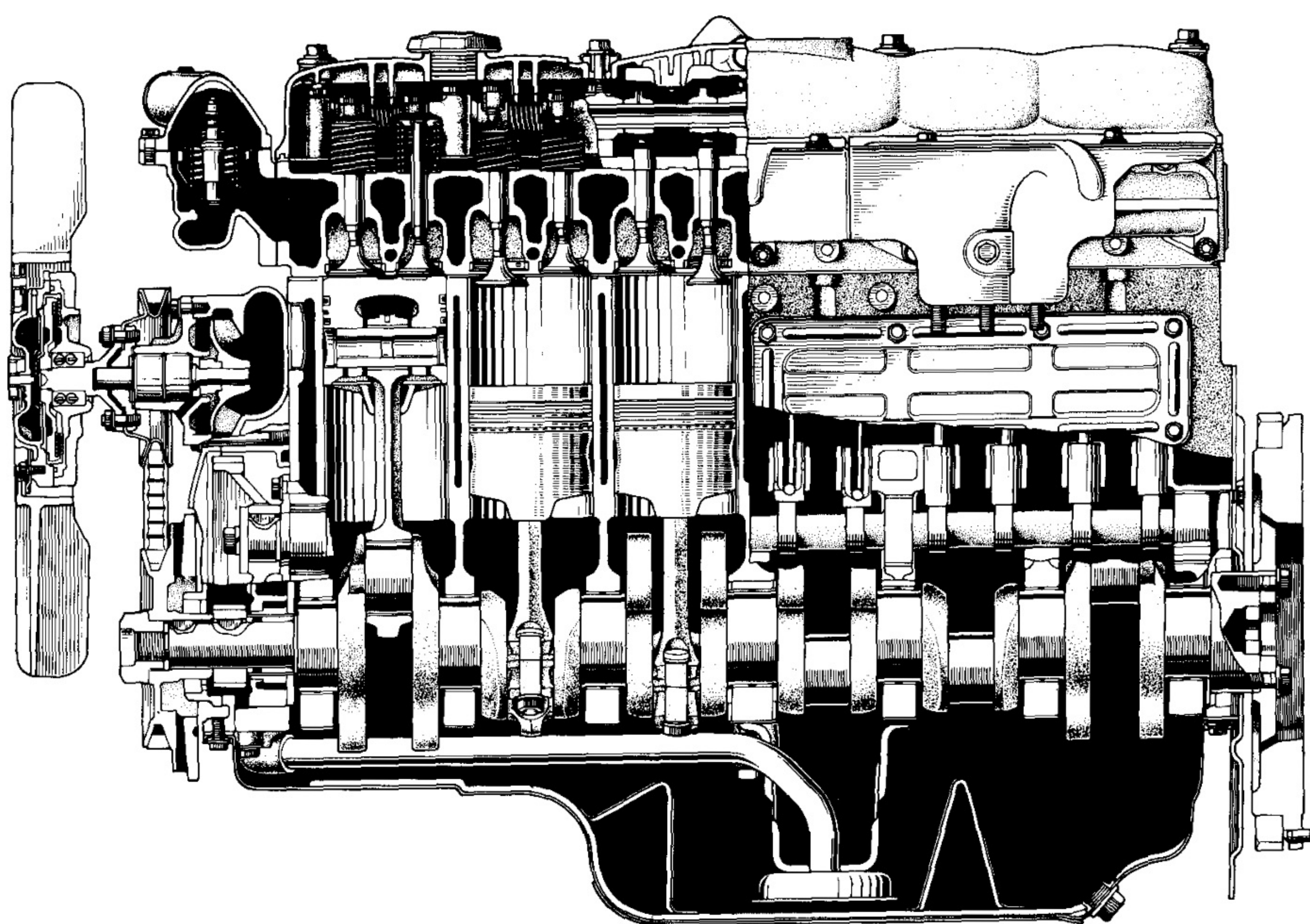
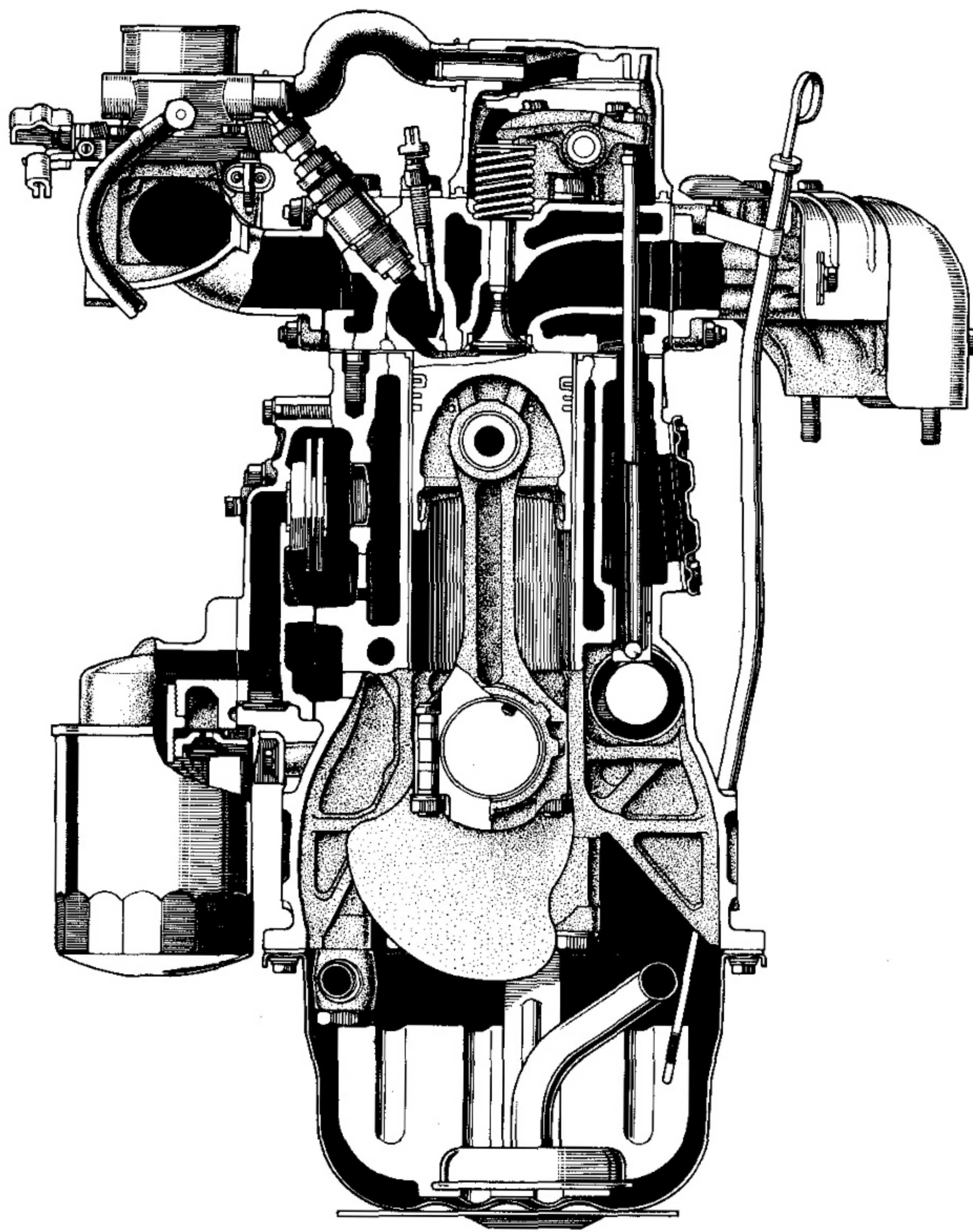


Fig. 3-2

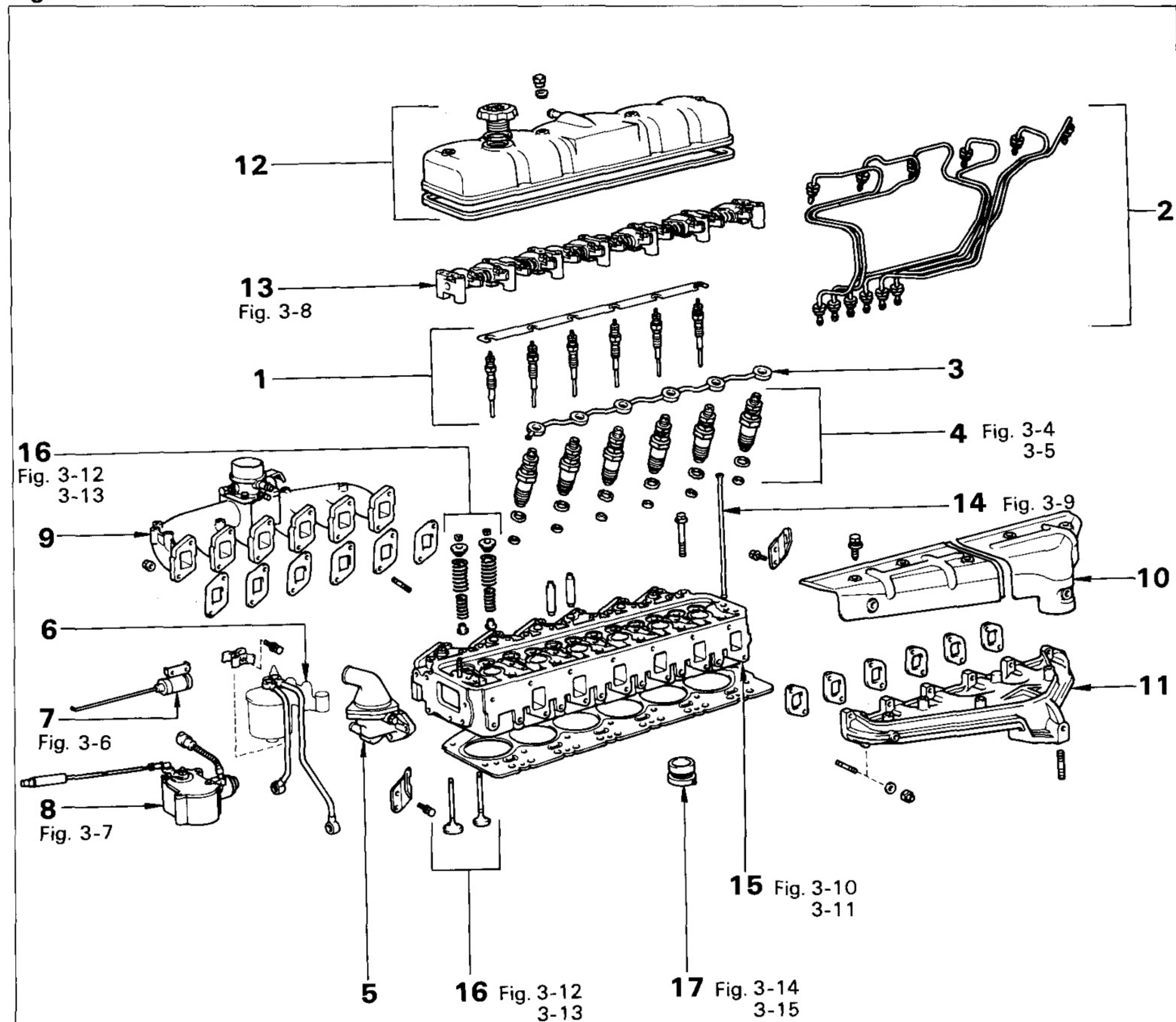


CYLINDER HEAD

DISASSEMBLY

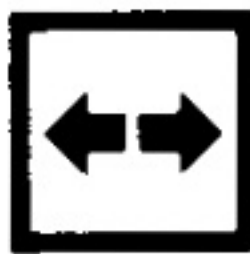
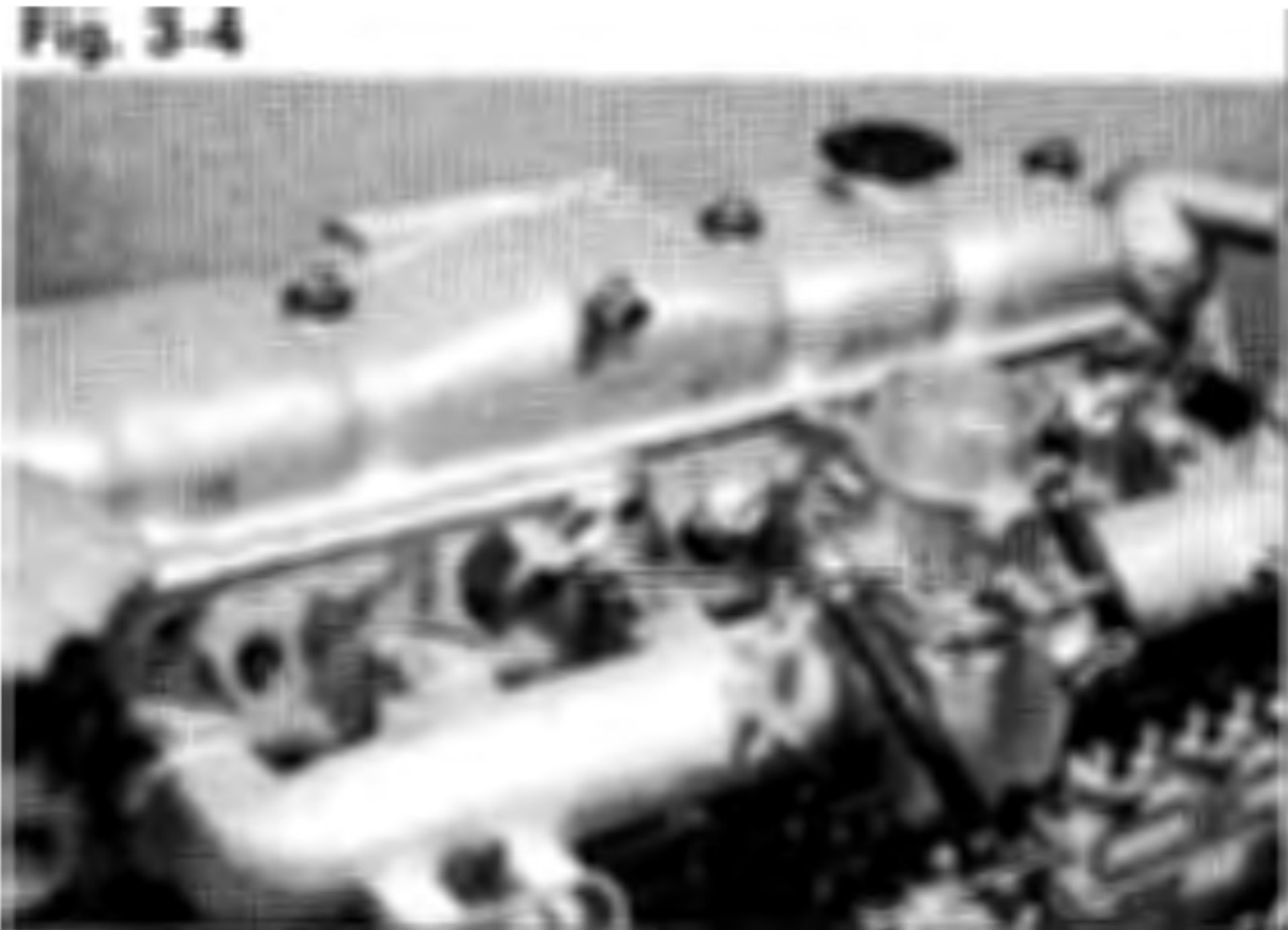
Disassemble the parts in the numerical order shown in the figure.

Fig. 3-3



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

Fig. 3-4



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



Keep the injection nozzle holders in correct order.

Fig. 3-5

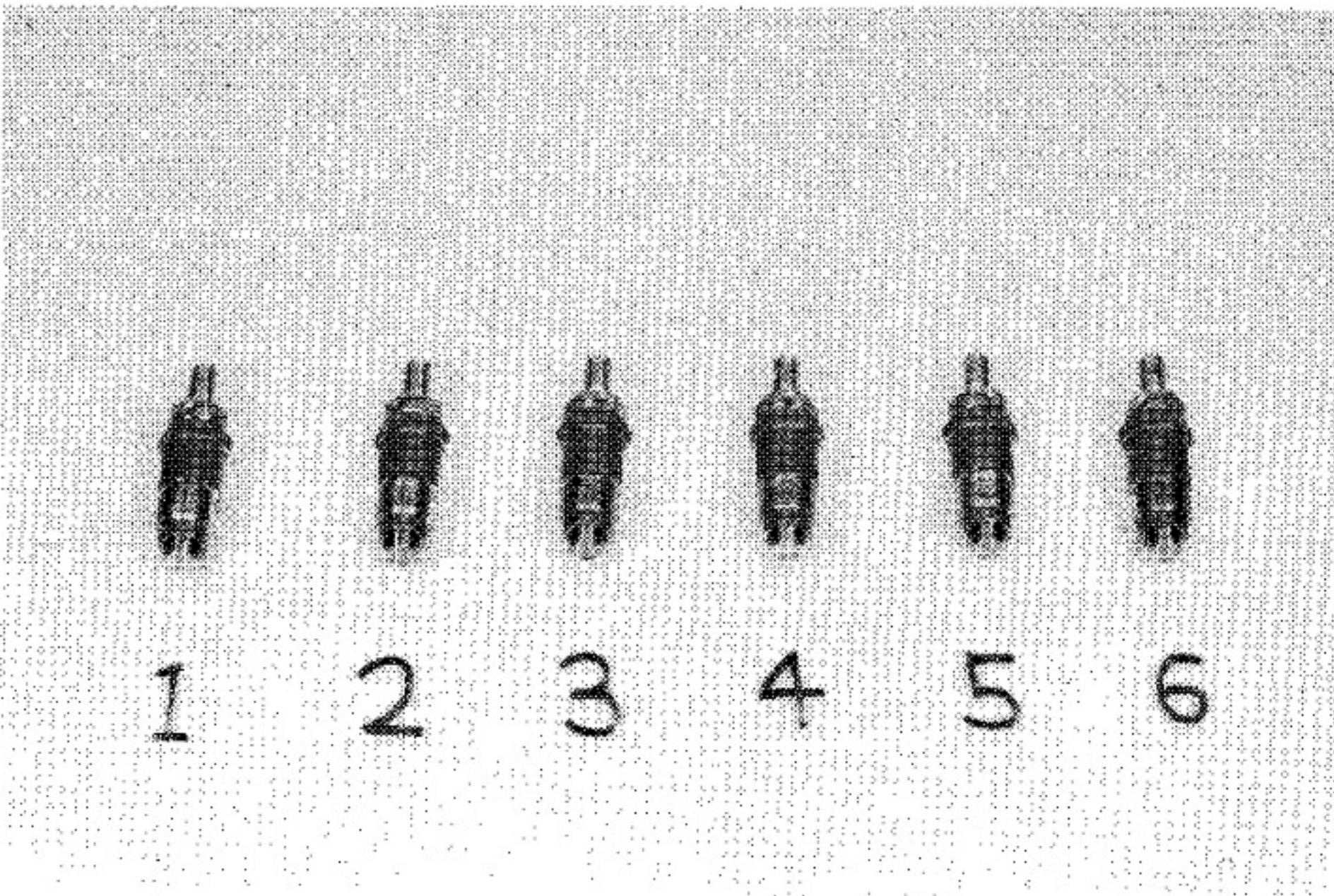


Fig. 3-6



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

Fig. 3-7

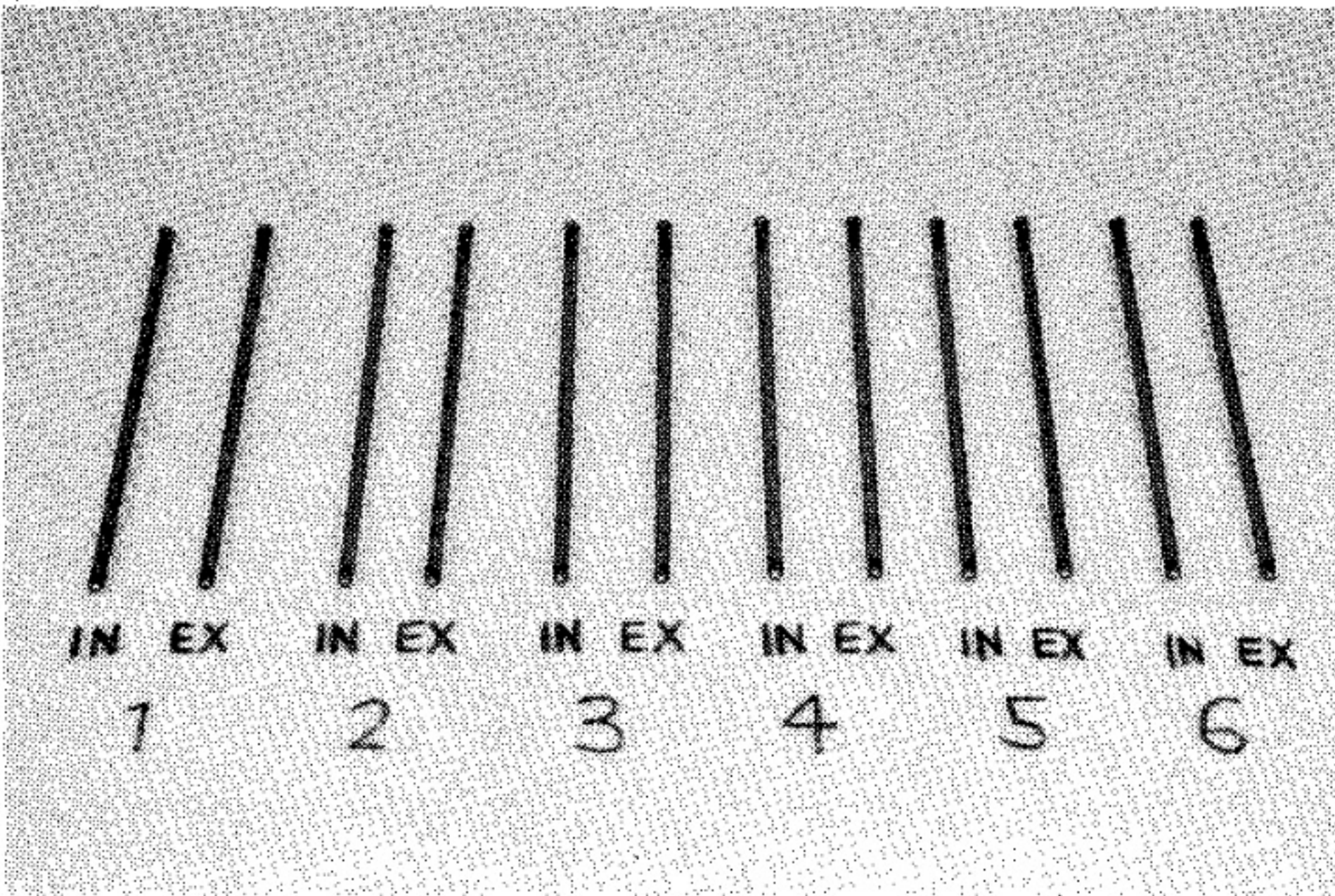


Disconnect the fuel control motor connecting rod and remove the fuel control motor from the intake manifold.



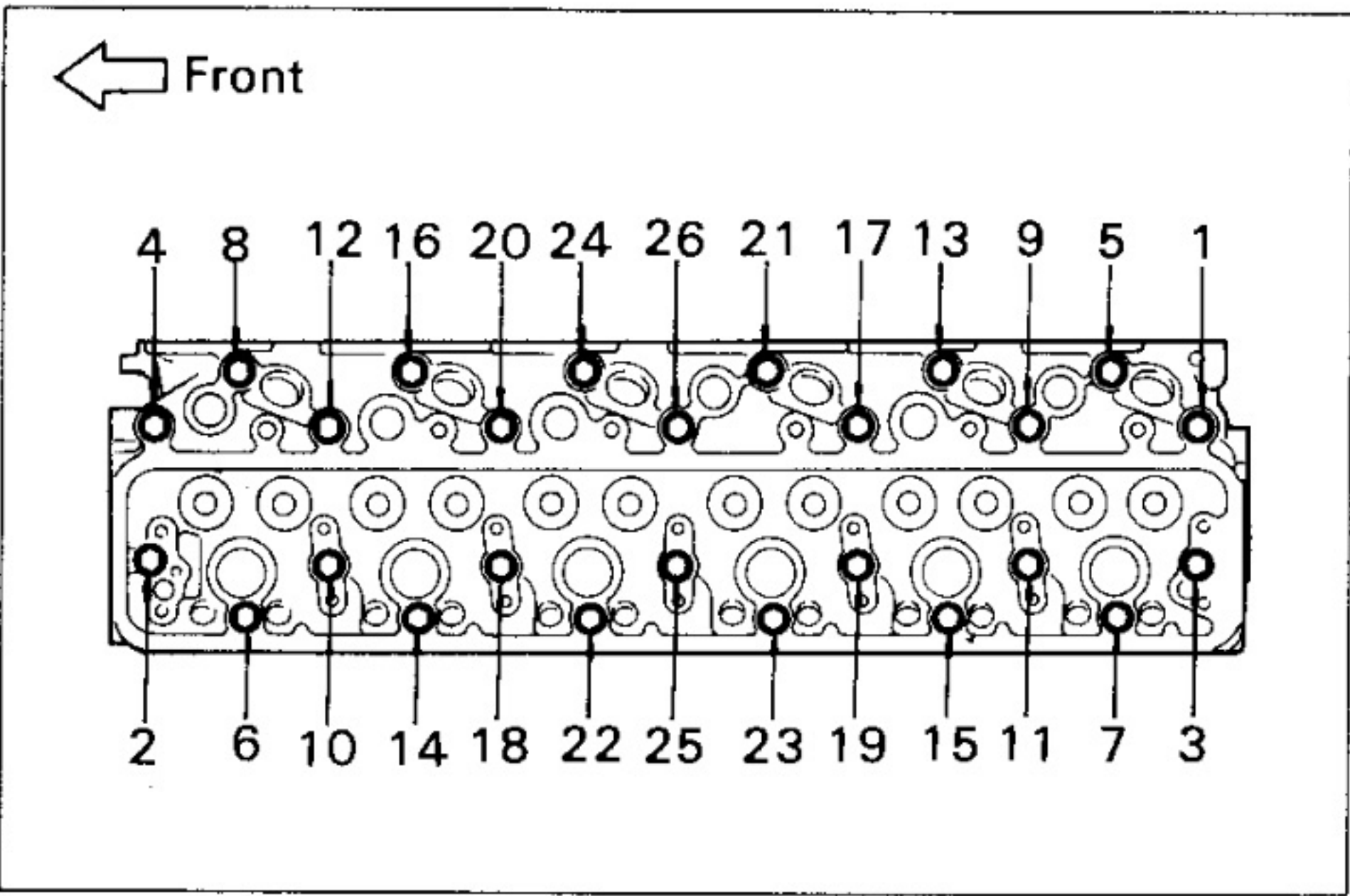
Loosen each rocker support bolt a little at a time in the sequence shown in the figure.

Fig. 3-9



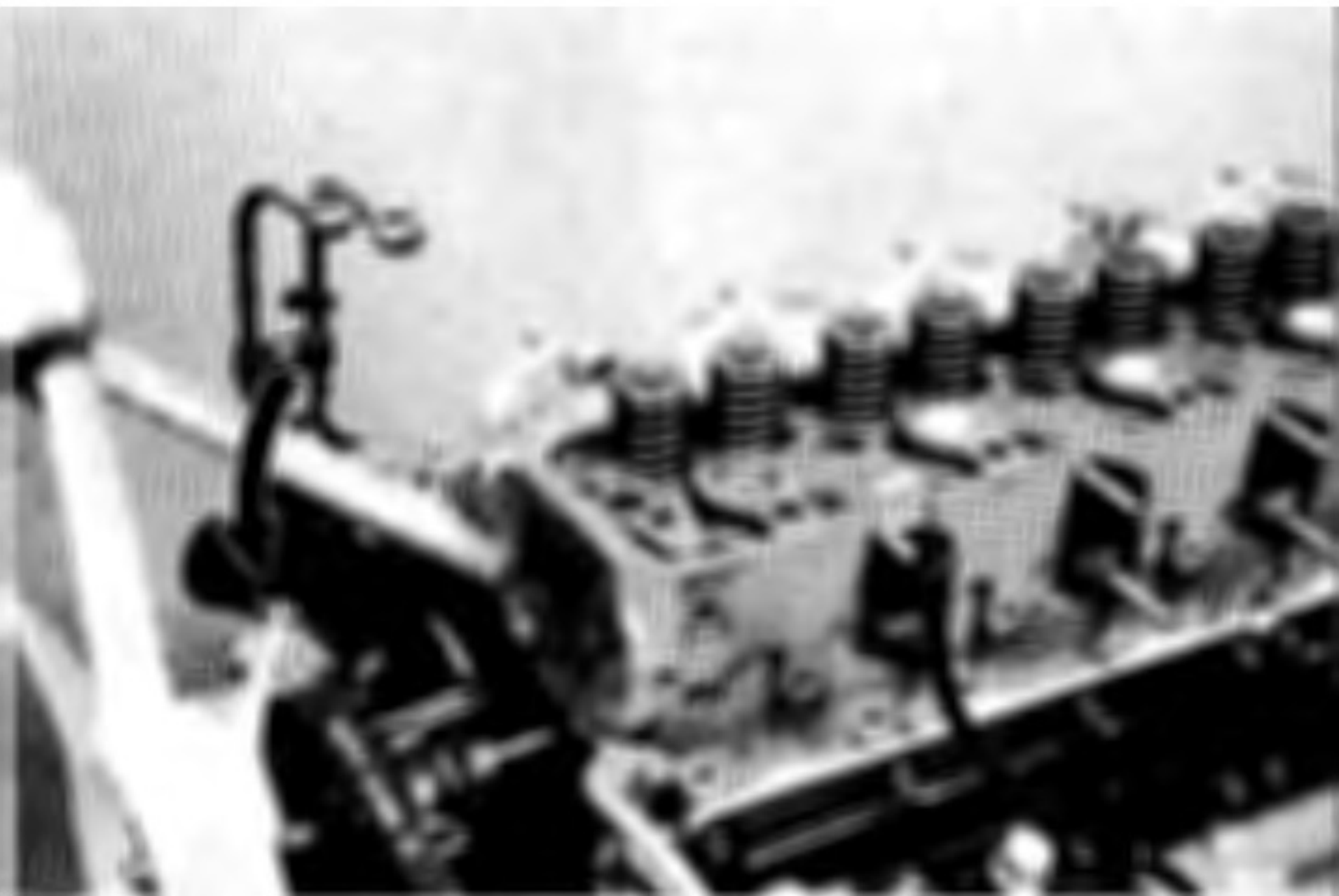
Keep the valve push rods in correct order.

Fig. 3-10



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

Fig. 3-11



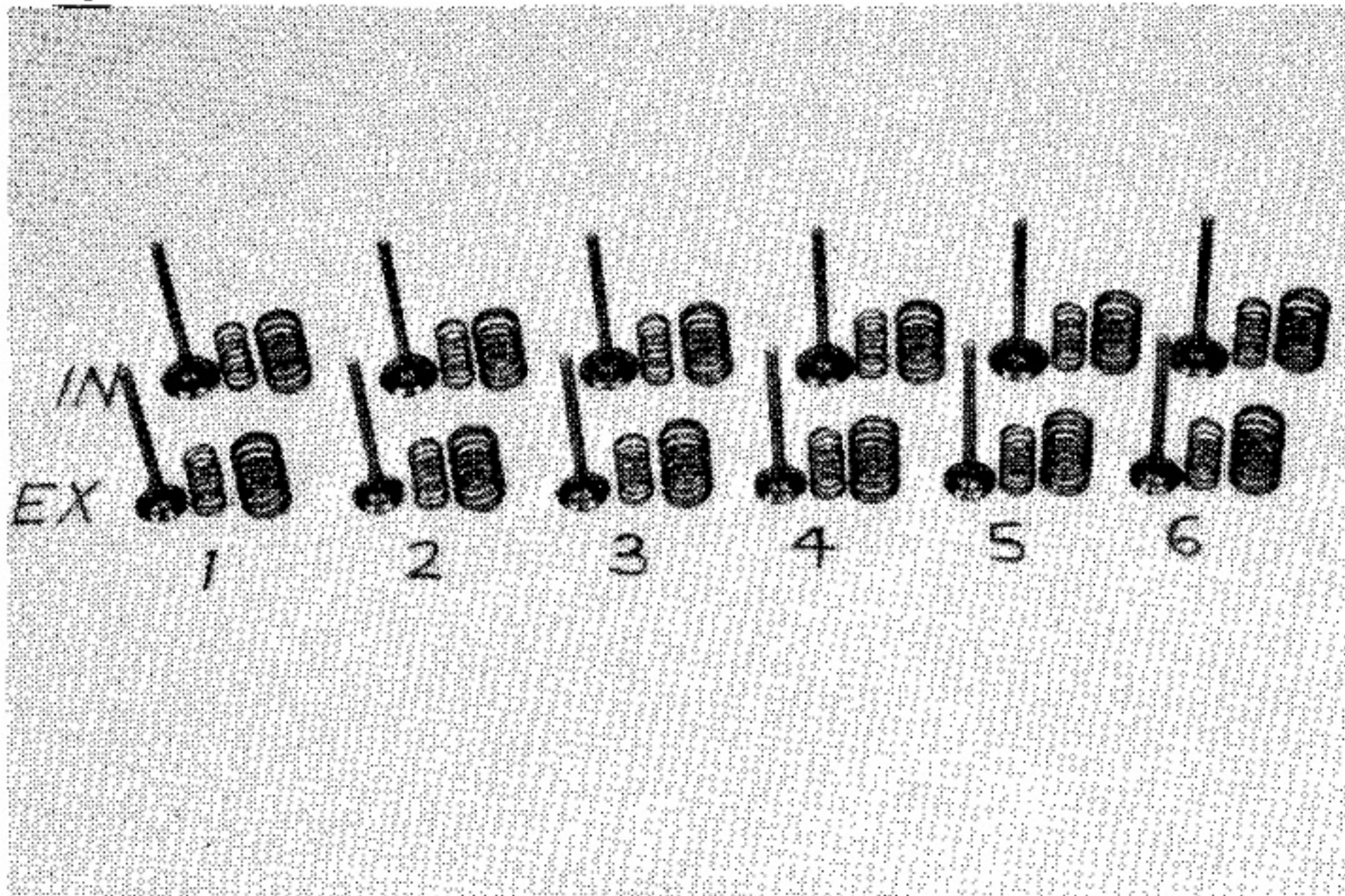
If the cylinder head is difficult to lift off, pry between the cylinder head and block with a wooden handle of a hammer or such.

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.

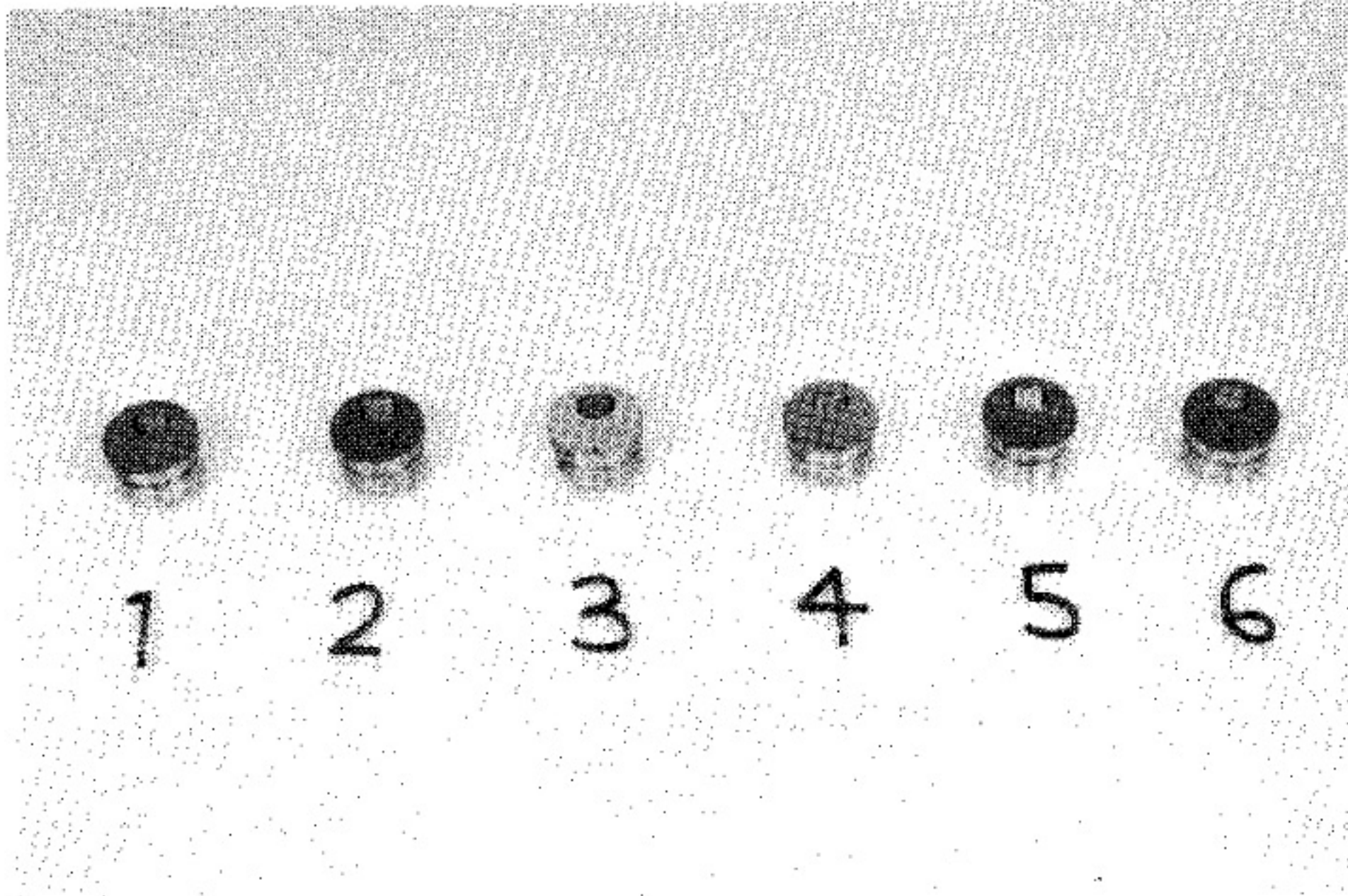
Fig. 3-14



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

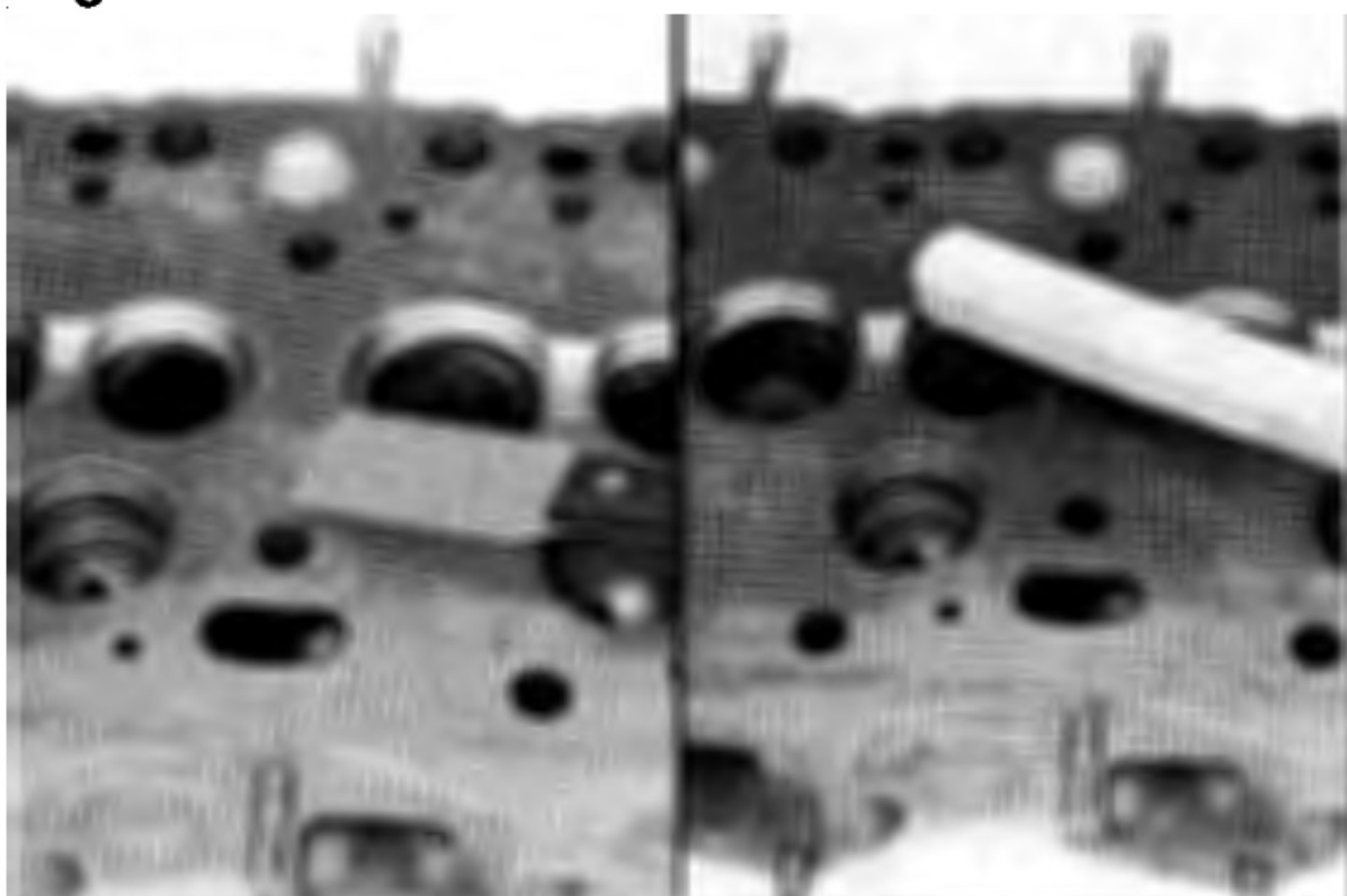


Fig. 3-17

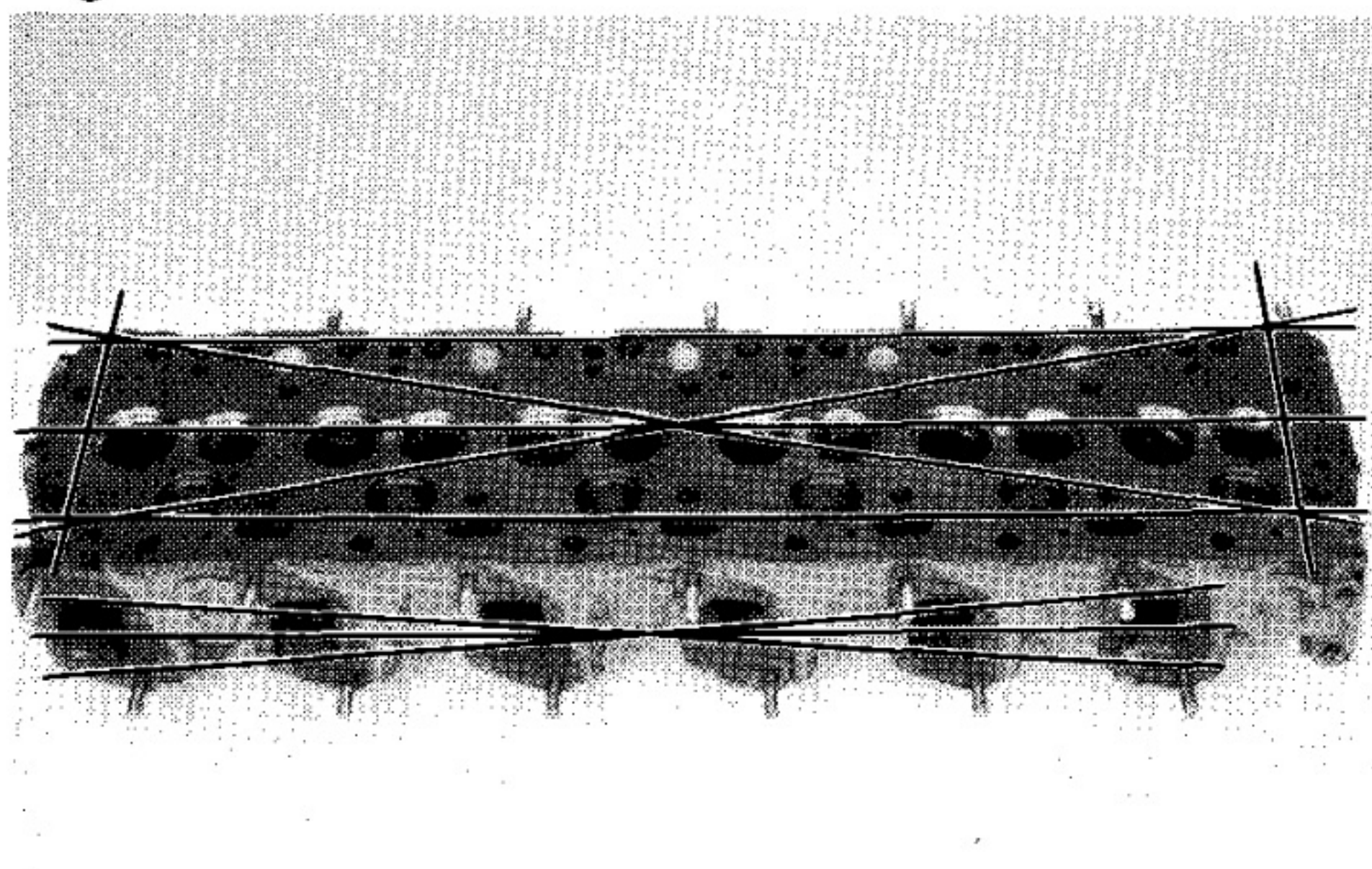


Fig. 3-18

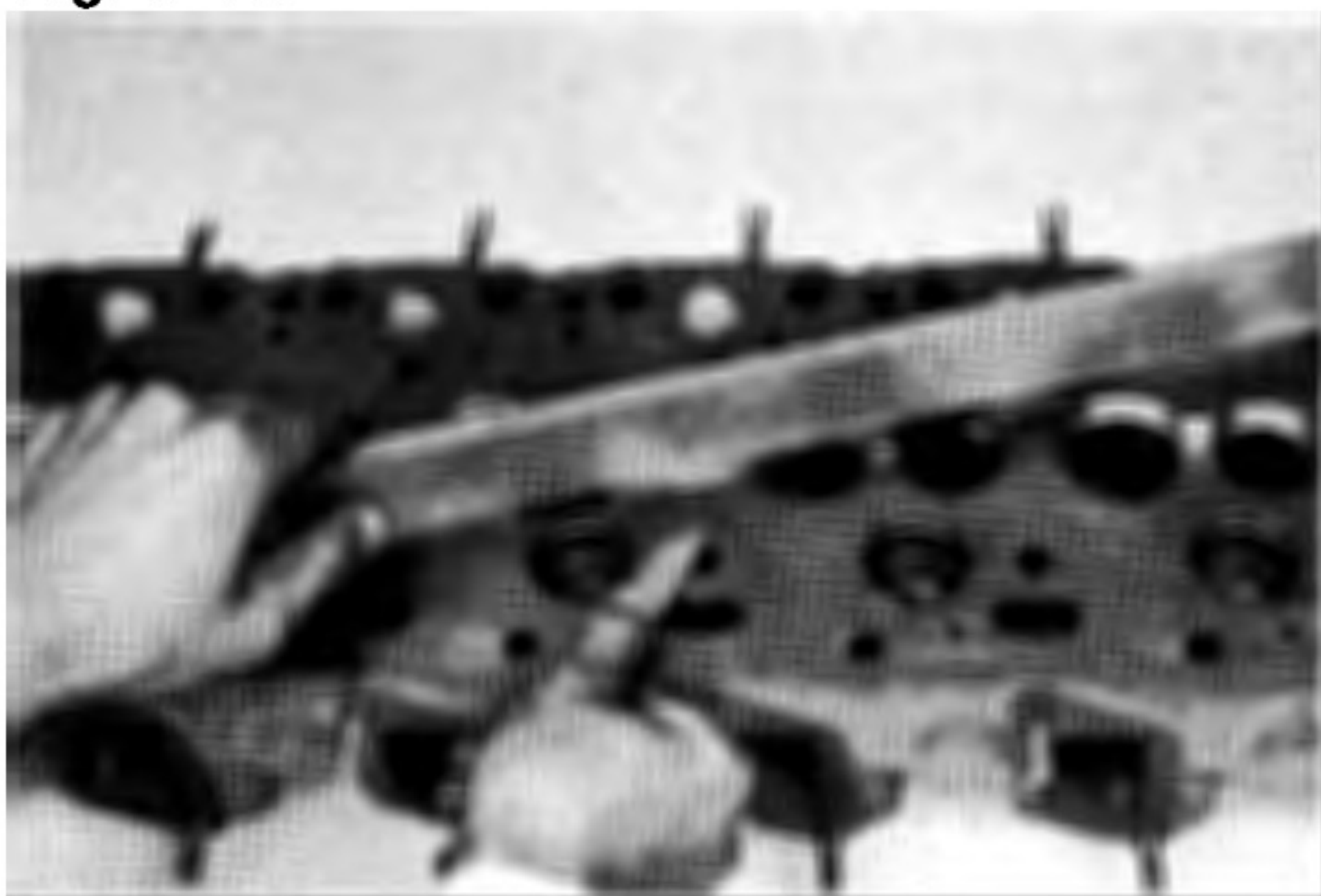


Fig. 3-19



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.



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



- (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.)**



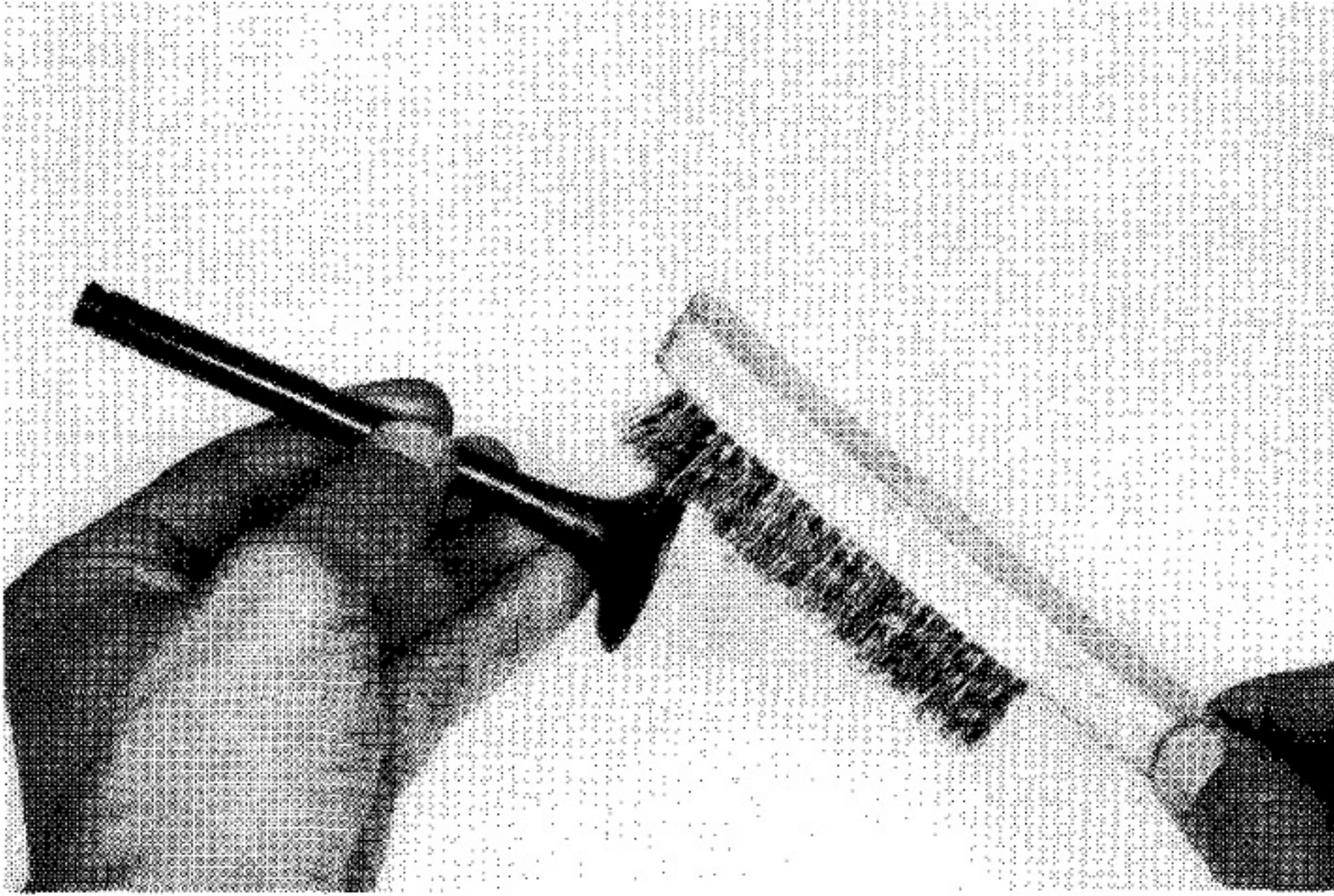
- (2) Check the manifold mounting surfaces for warpage.

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.

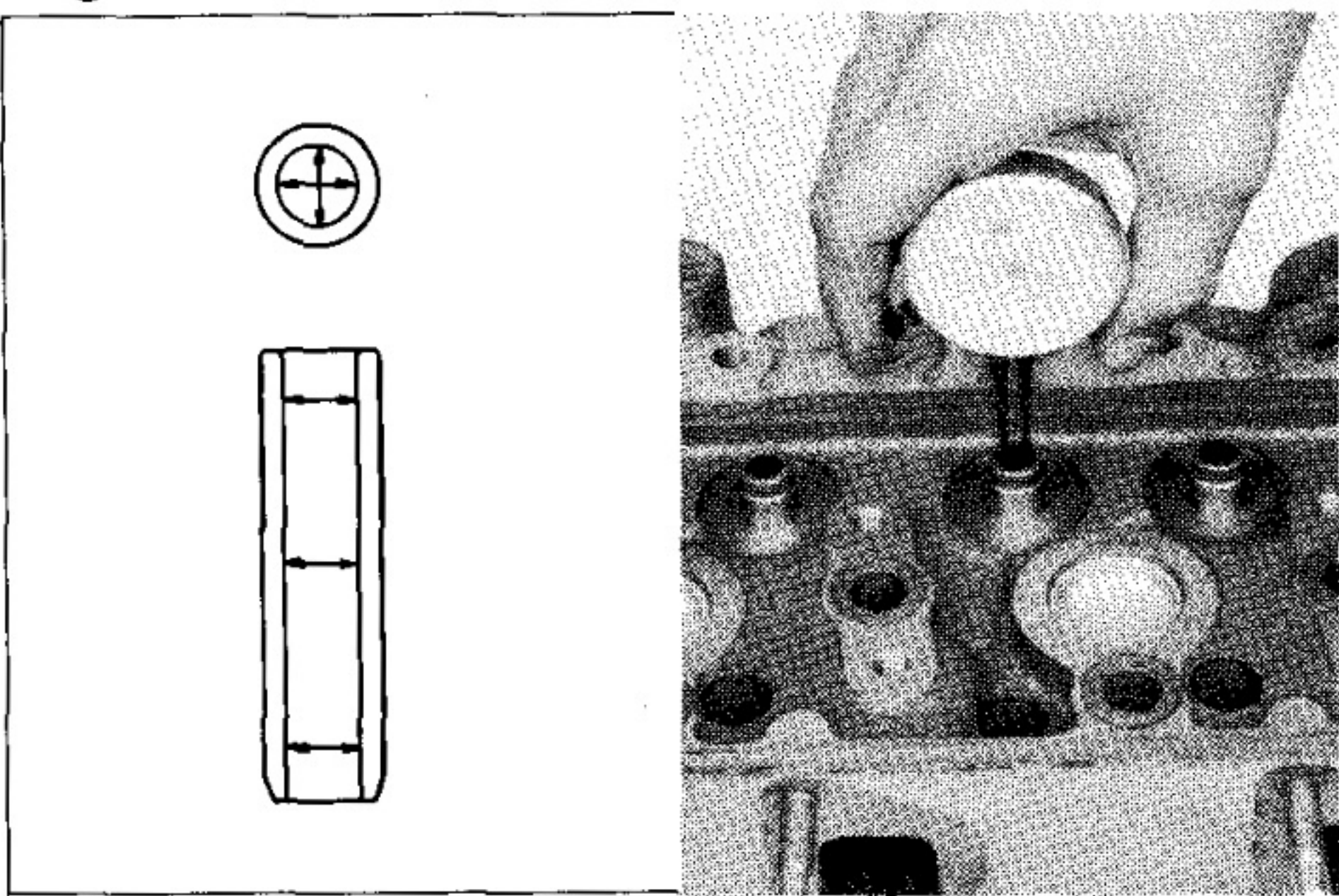
Fig. 3-21



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.)

- (3) Calculate the valve stem oil clearance.

Stem oil clearance:

STD IN 0.021 – 0.057 mm

(0.0008 – 0.0022 in.)

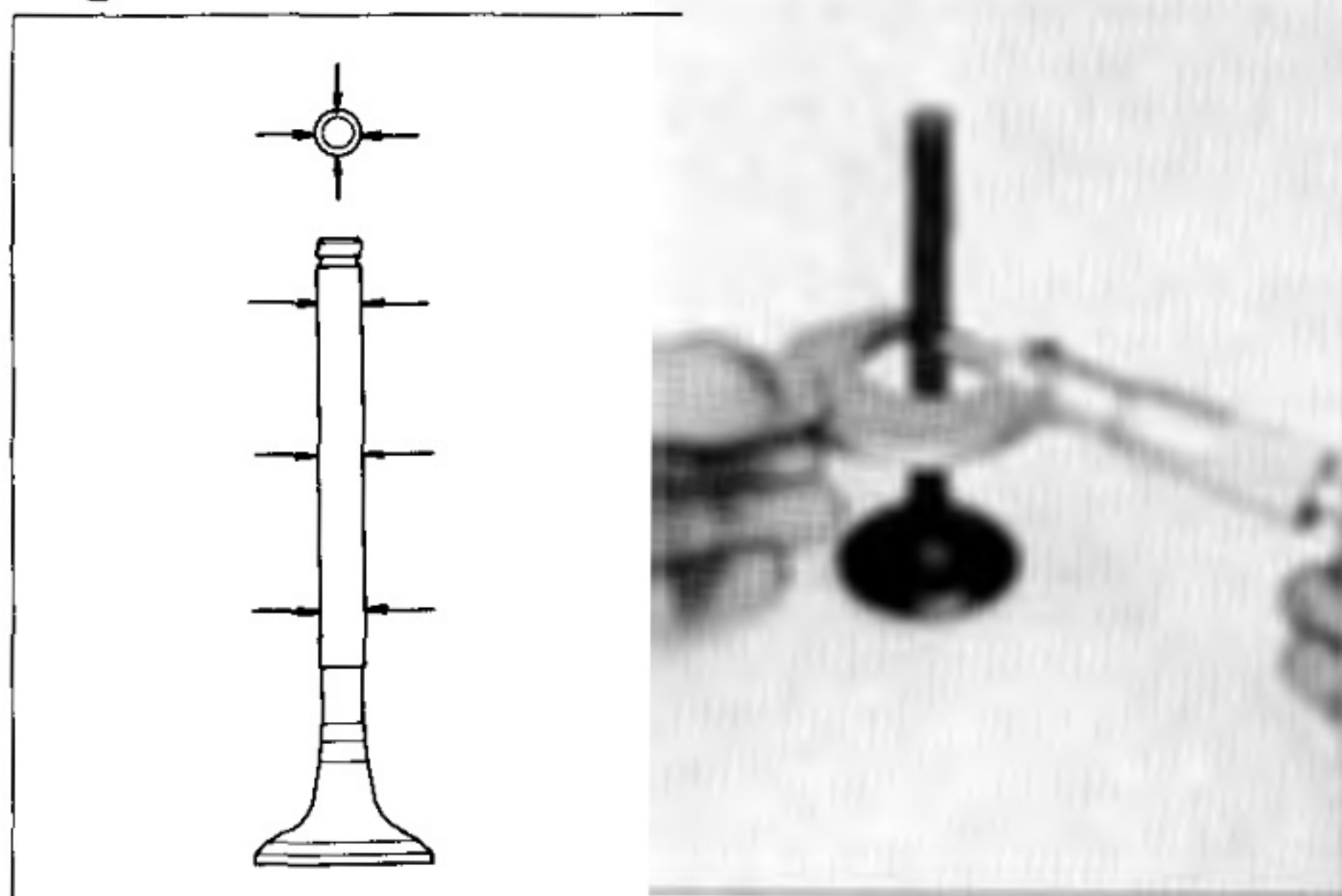
EX 0.040 – 0.076 mm

(0.0016 – 0.0030 in.)

Limit IN 0.10 mm (0.0039 in.)

EX 0.12 mm (0.0047 in.)

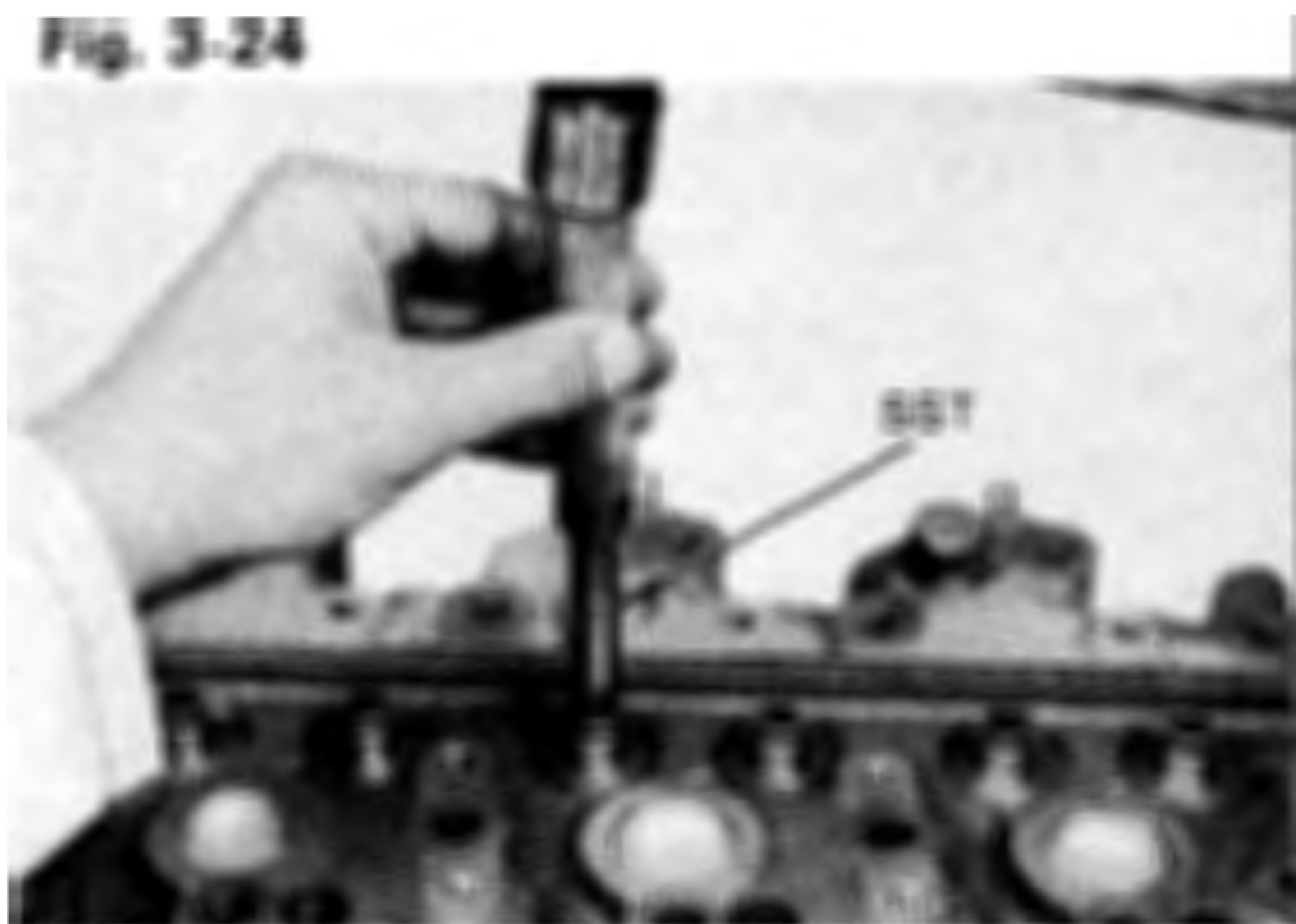
Fig. 3-23



—Note—

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

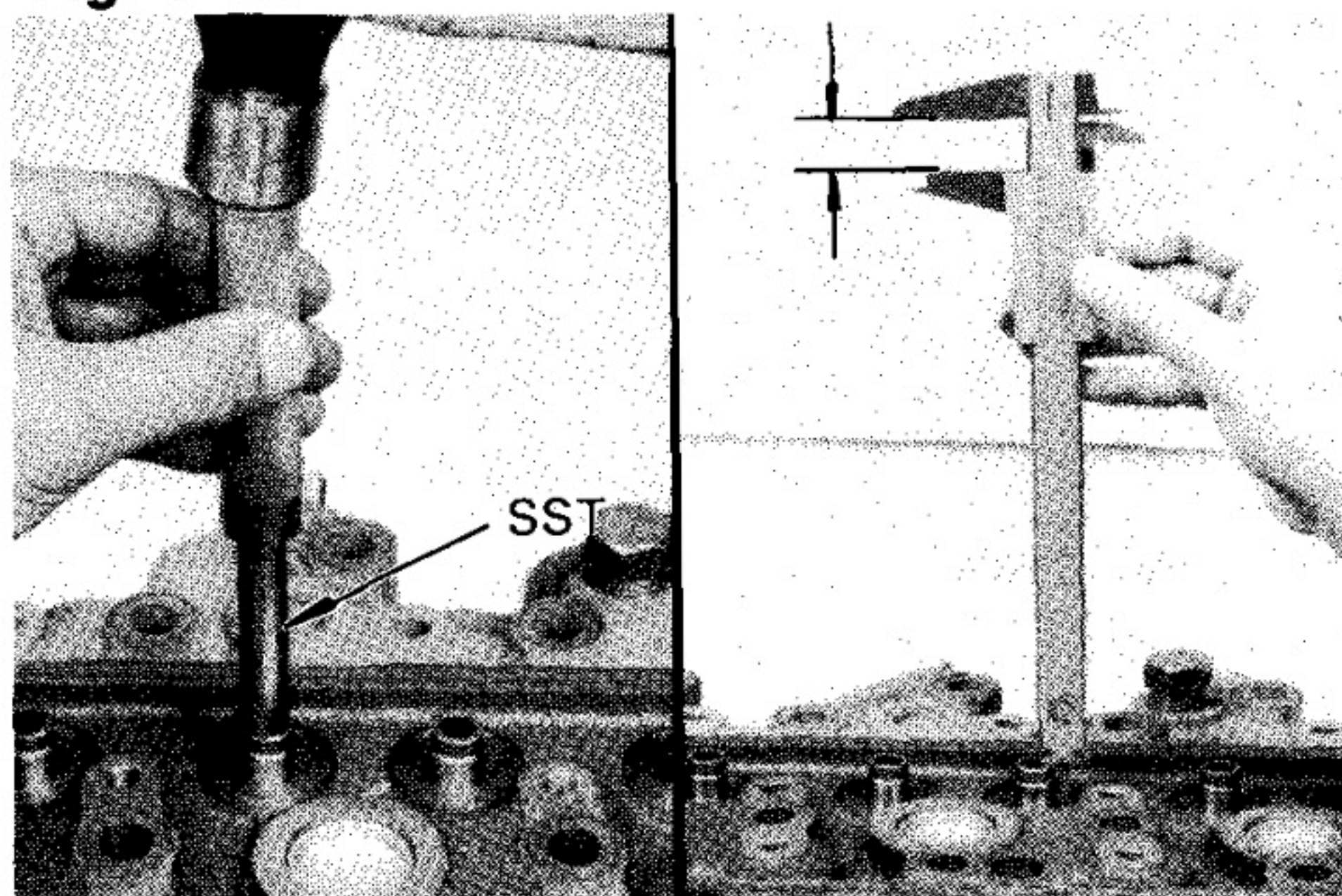
Fig. 3-24



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

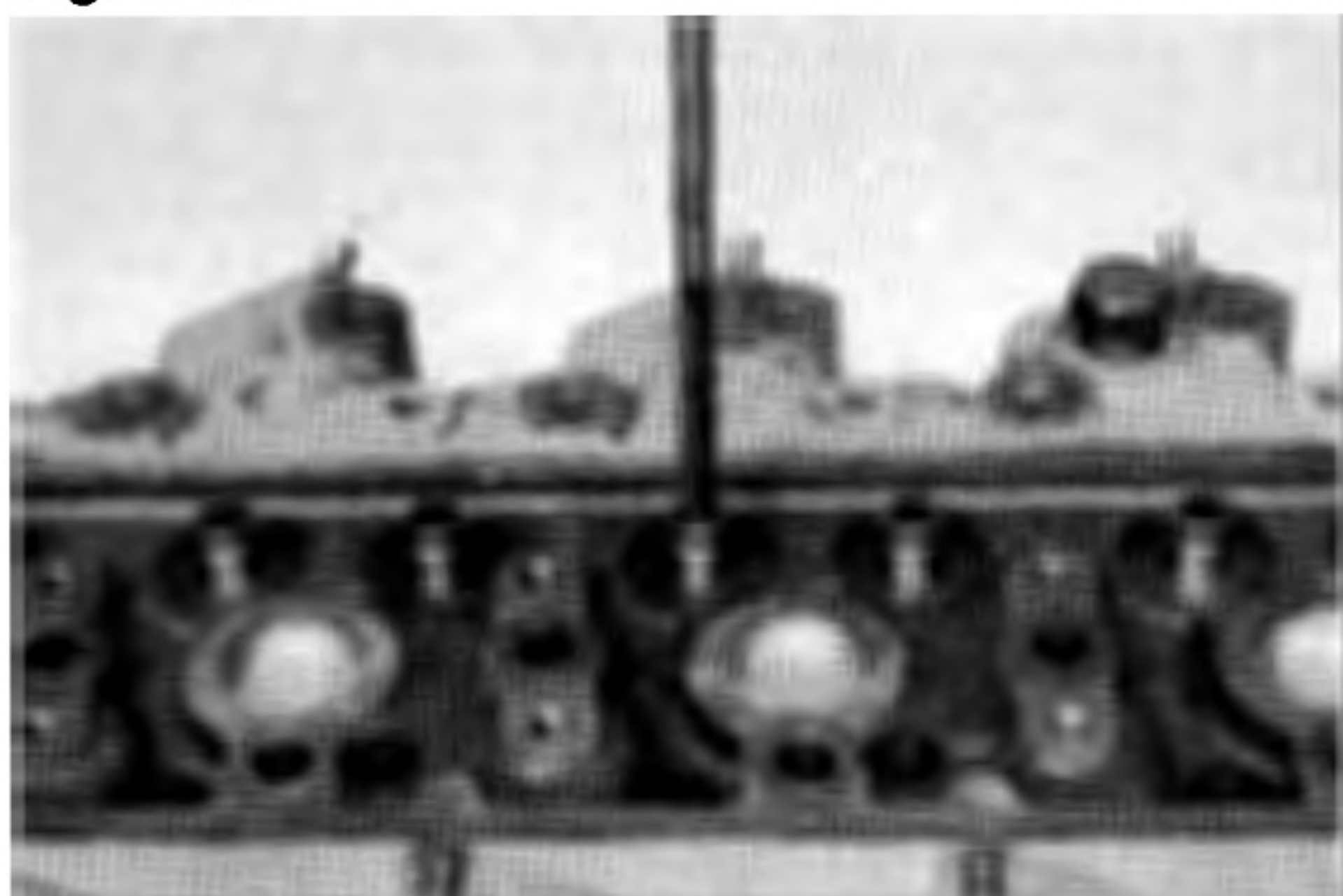


- (2) Drive in the new valve guide until its tip projects from the top of the cylinder head by the specified length.

**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.

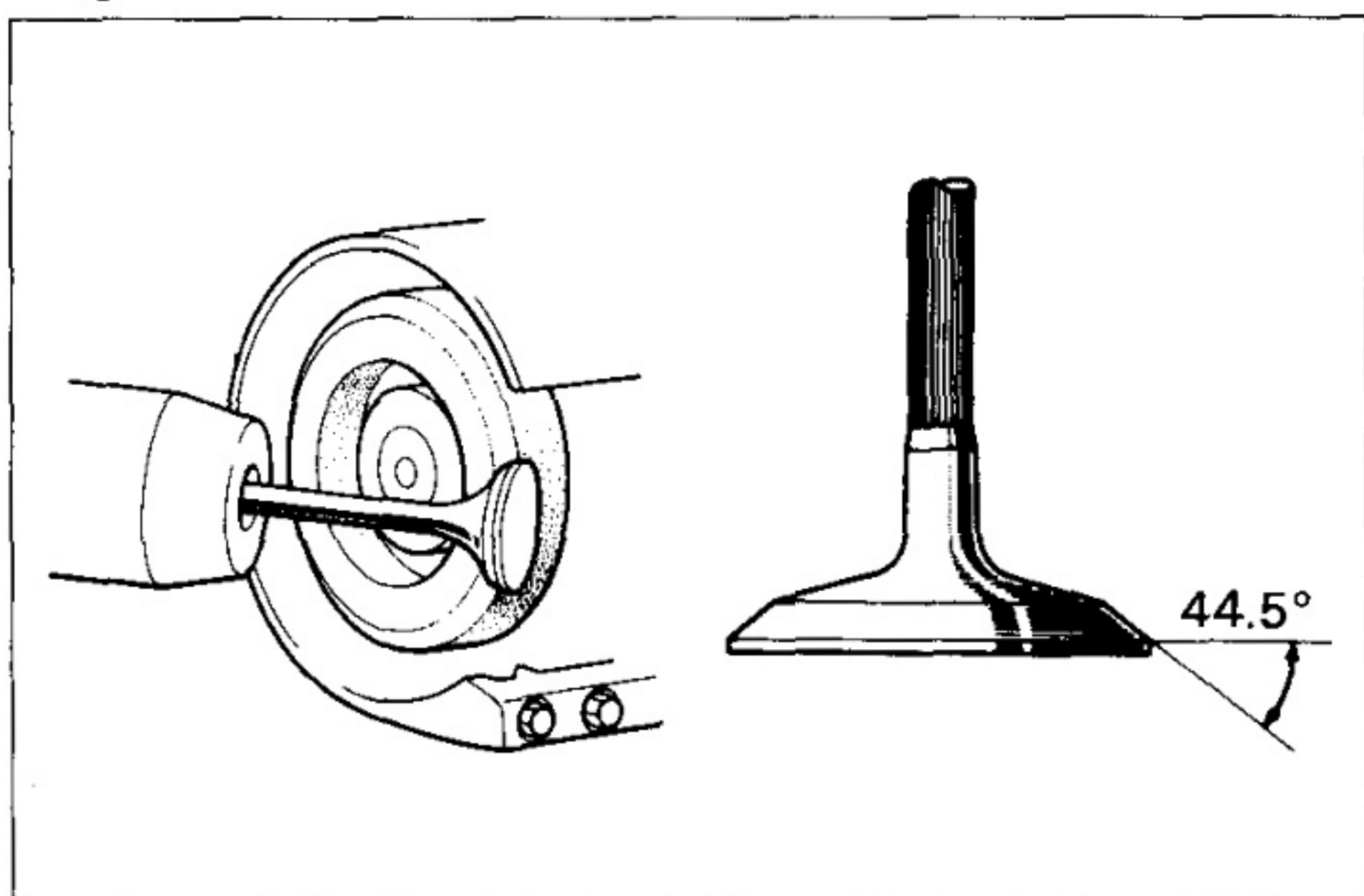
Oil clearance:

STD

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

**EX 0.040 – 0.076 mm
(0.0016 – 0.0030 in.)**

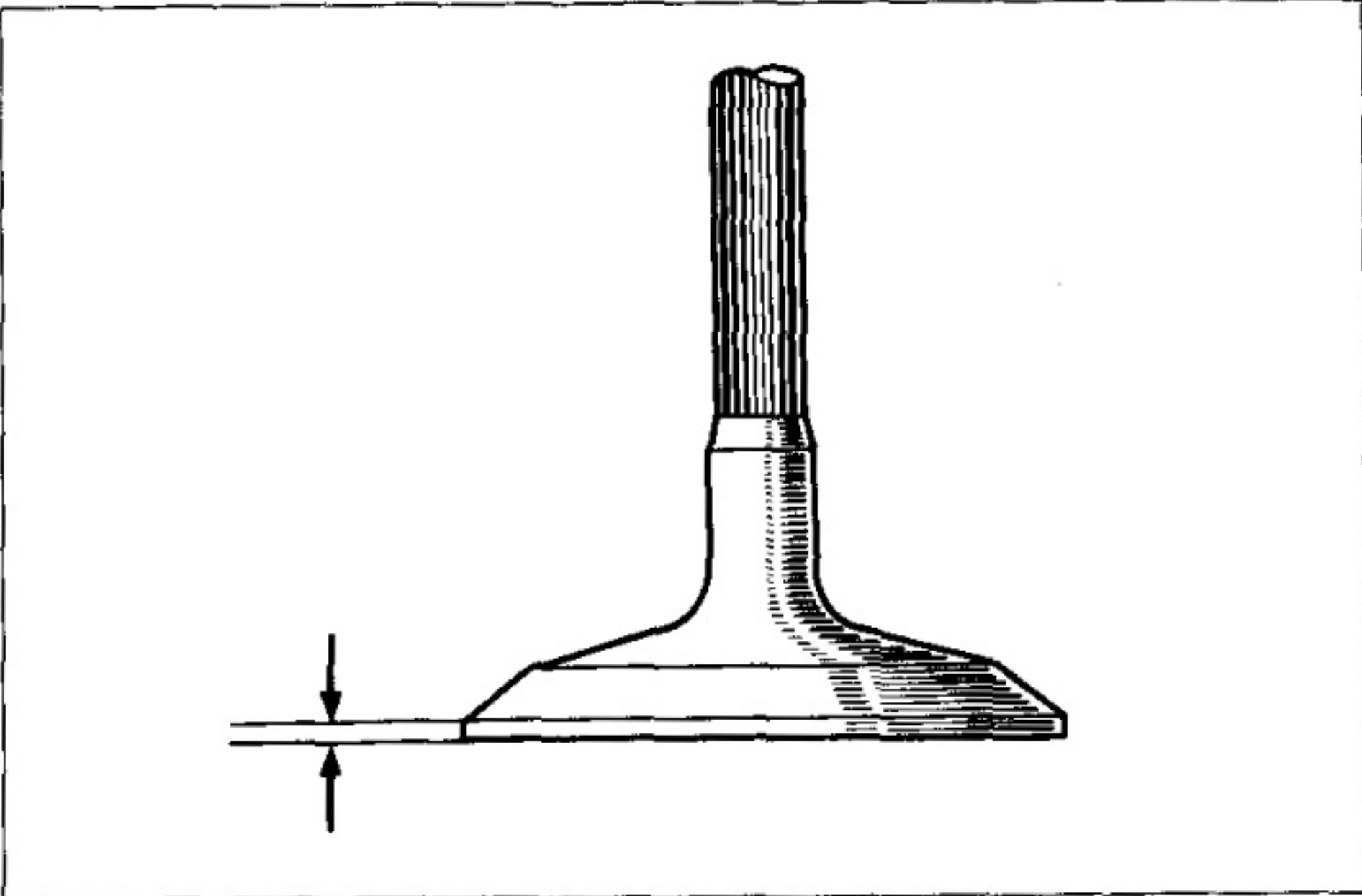
Fig. 3-27



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

Valve face angle: 44.5°

Fig. 3-28

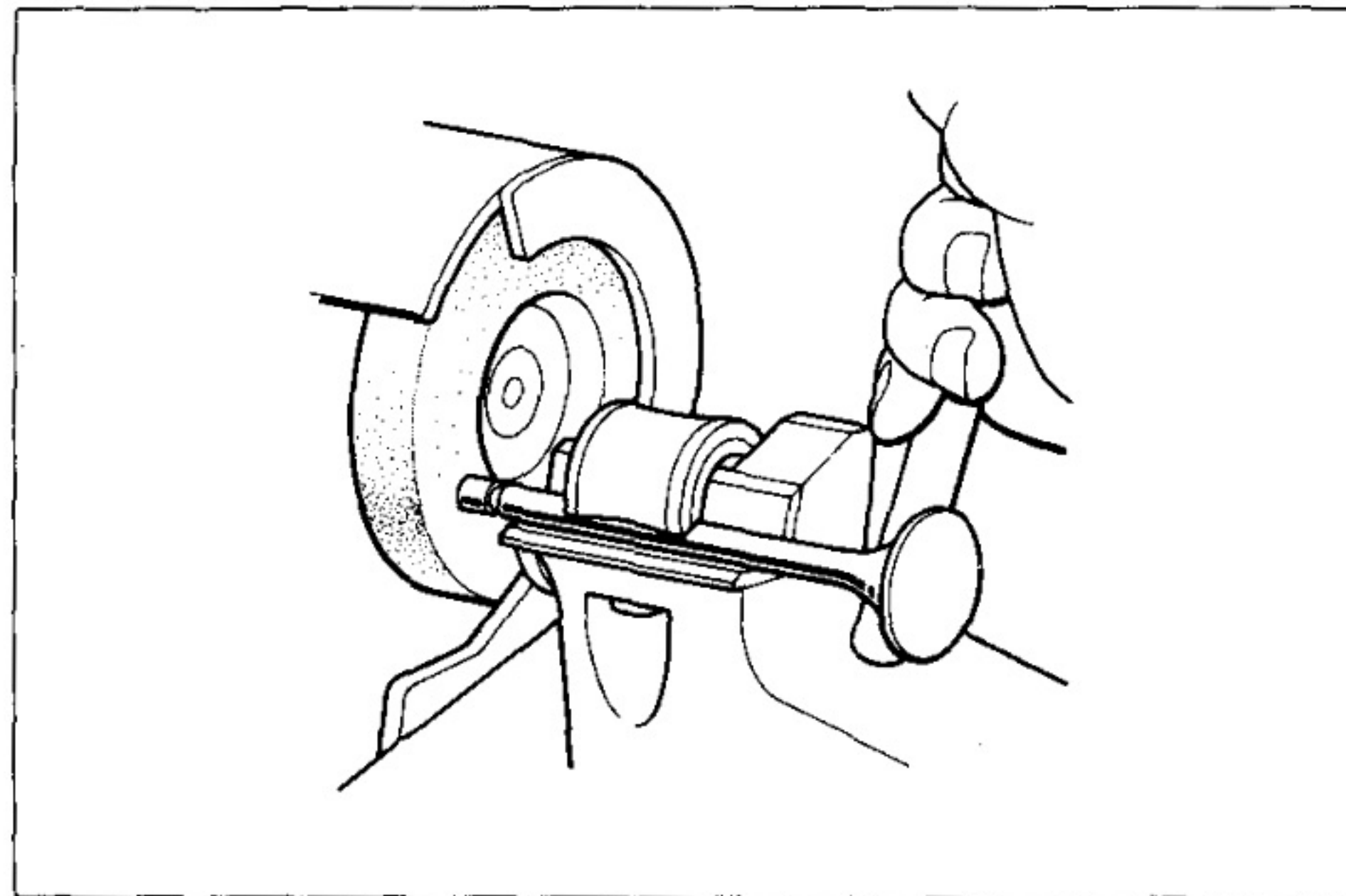


6. Check the valve head margin thickness.

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.

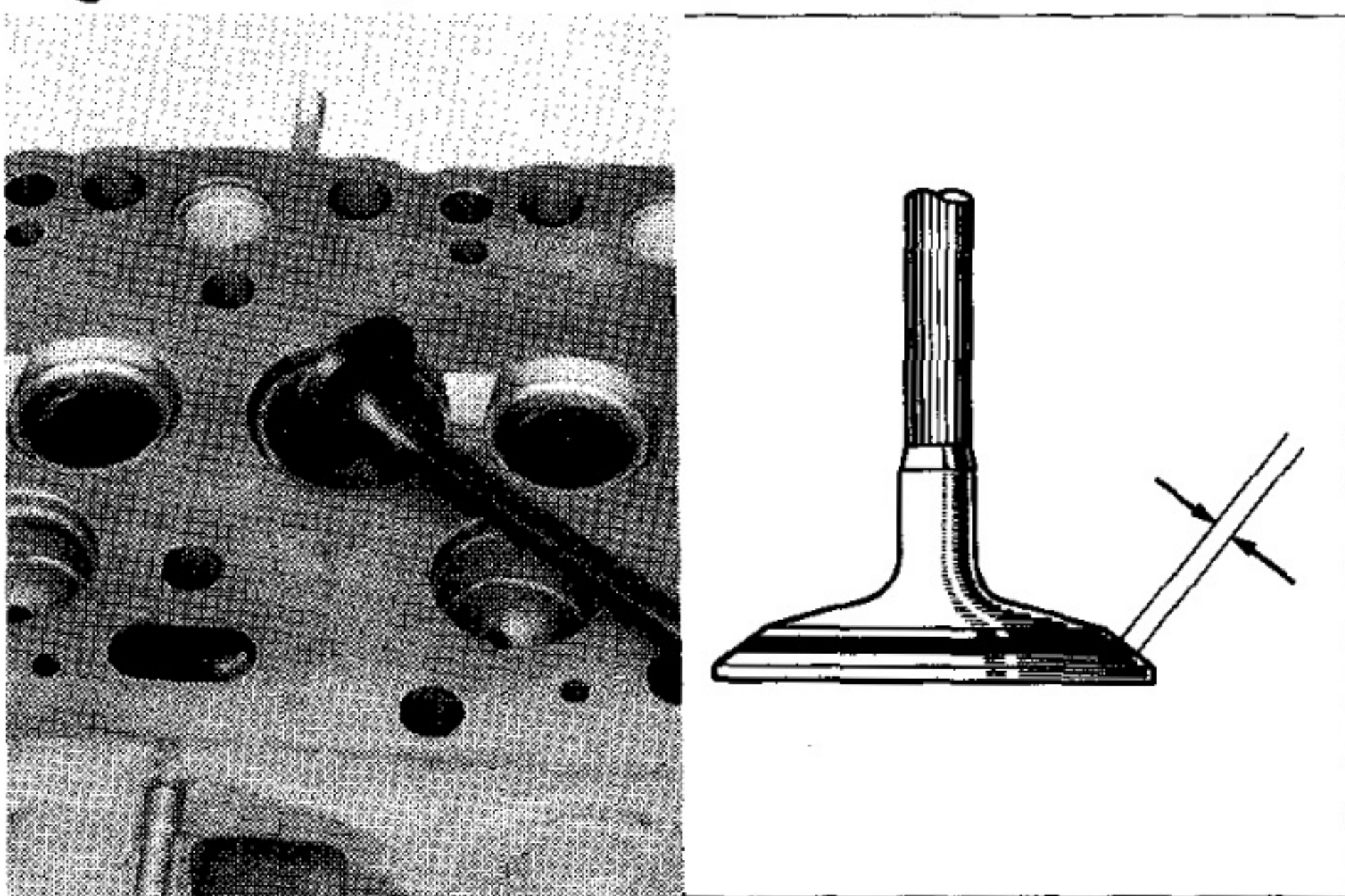
Stem tip resurfacing:

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.

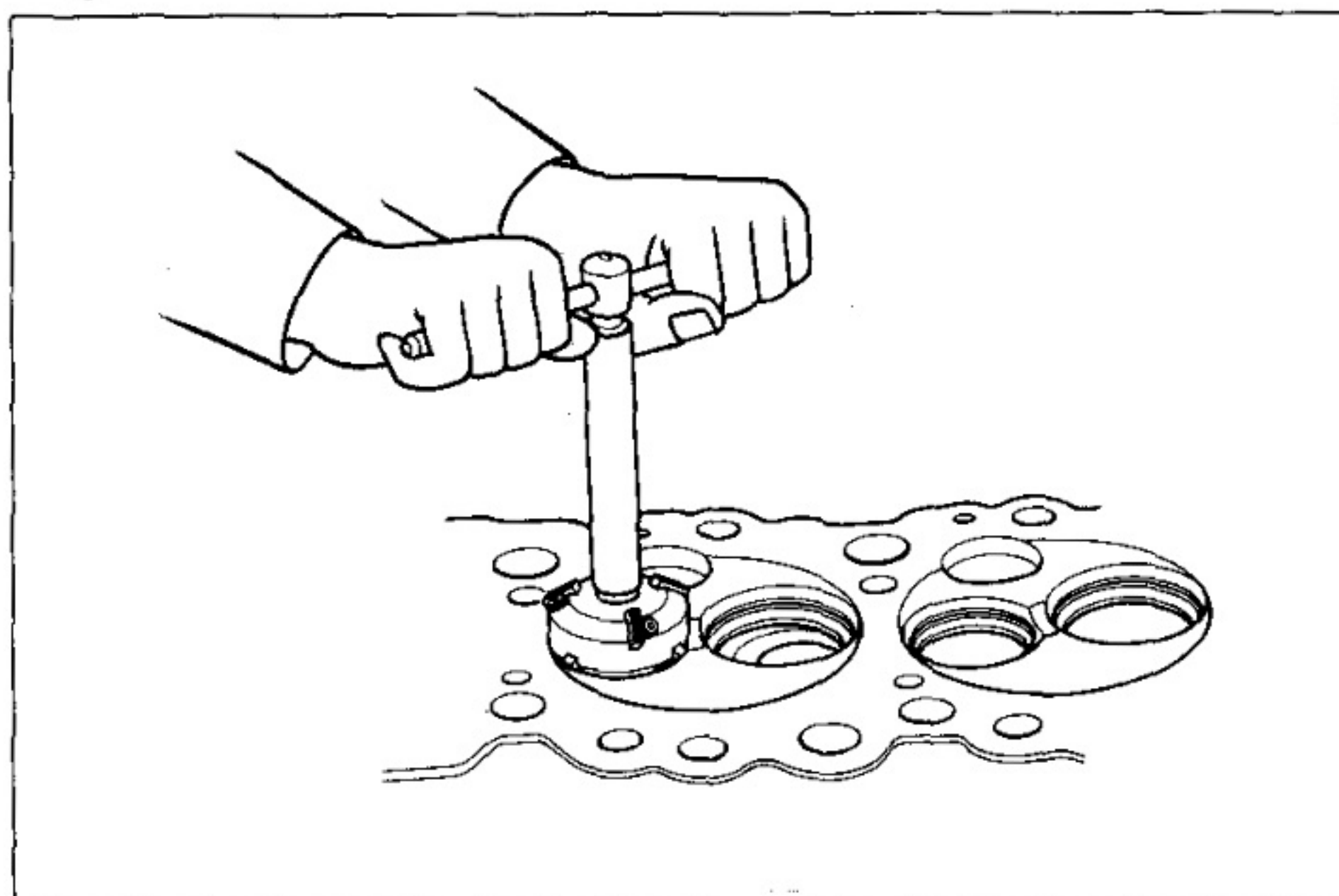
Contact width:

1.4 – 2.0 mm
(0.055 – 0.079 in.)

Contact position:

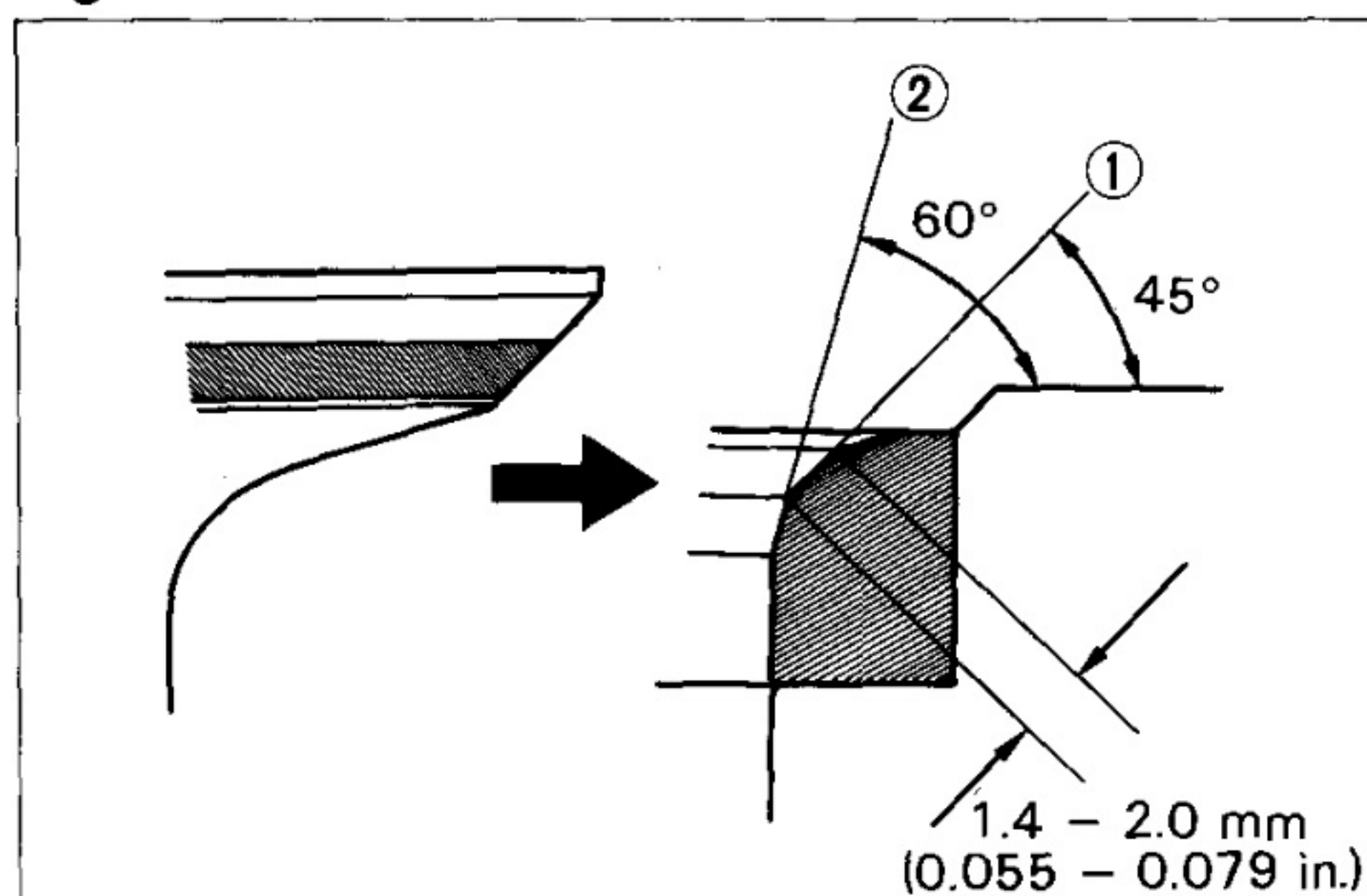
Middle of valve face

Fig. 3-31



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

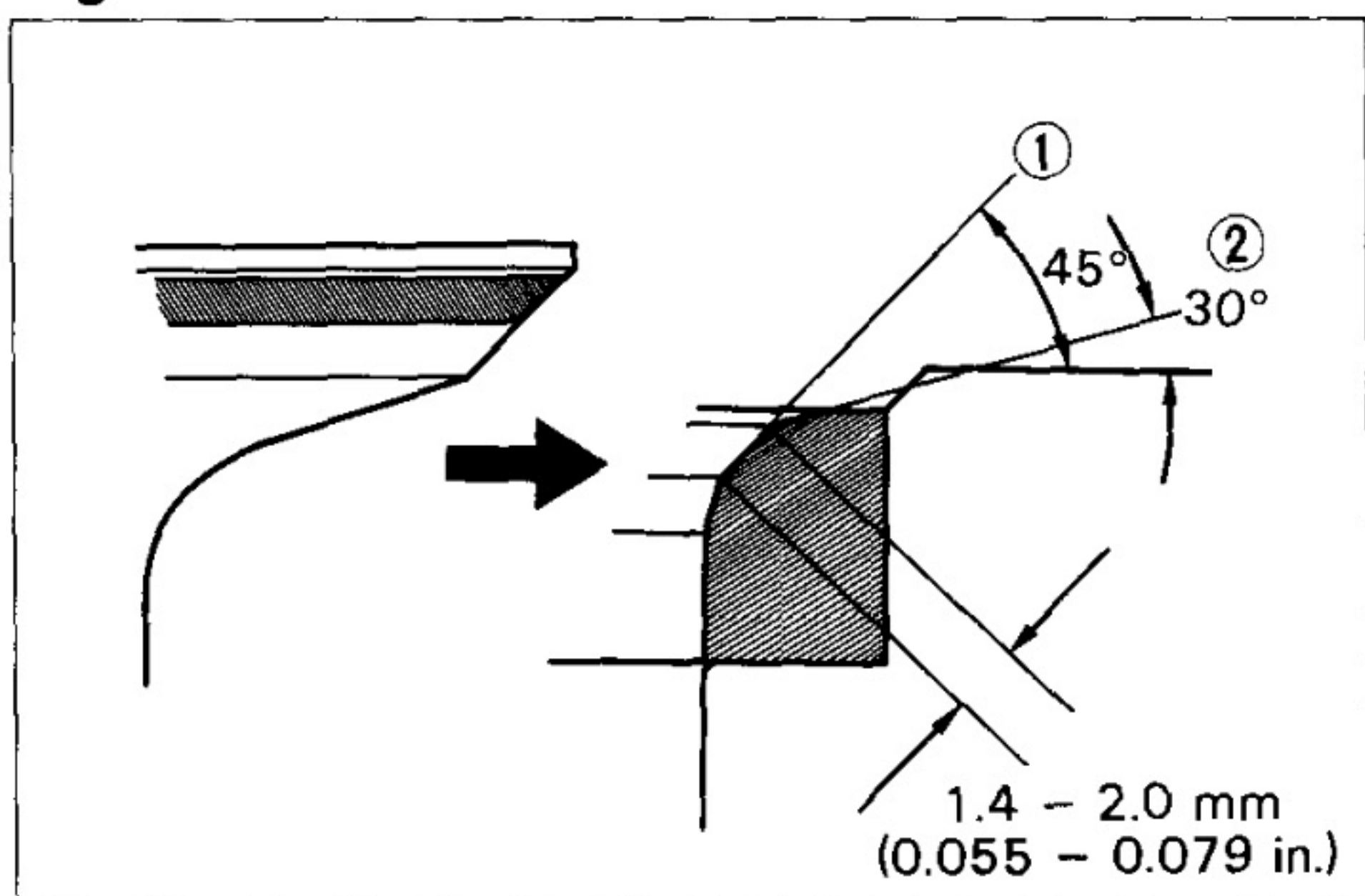
Fig. 3-32



3. Correct the seat position.

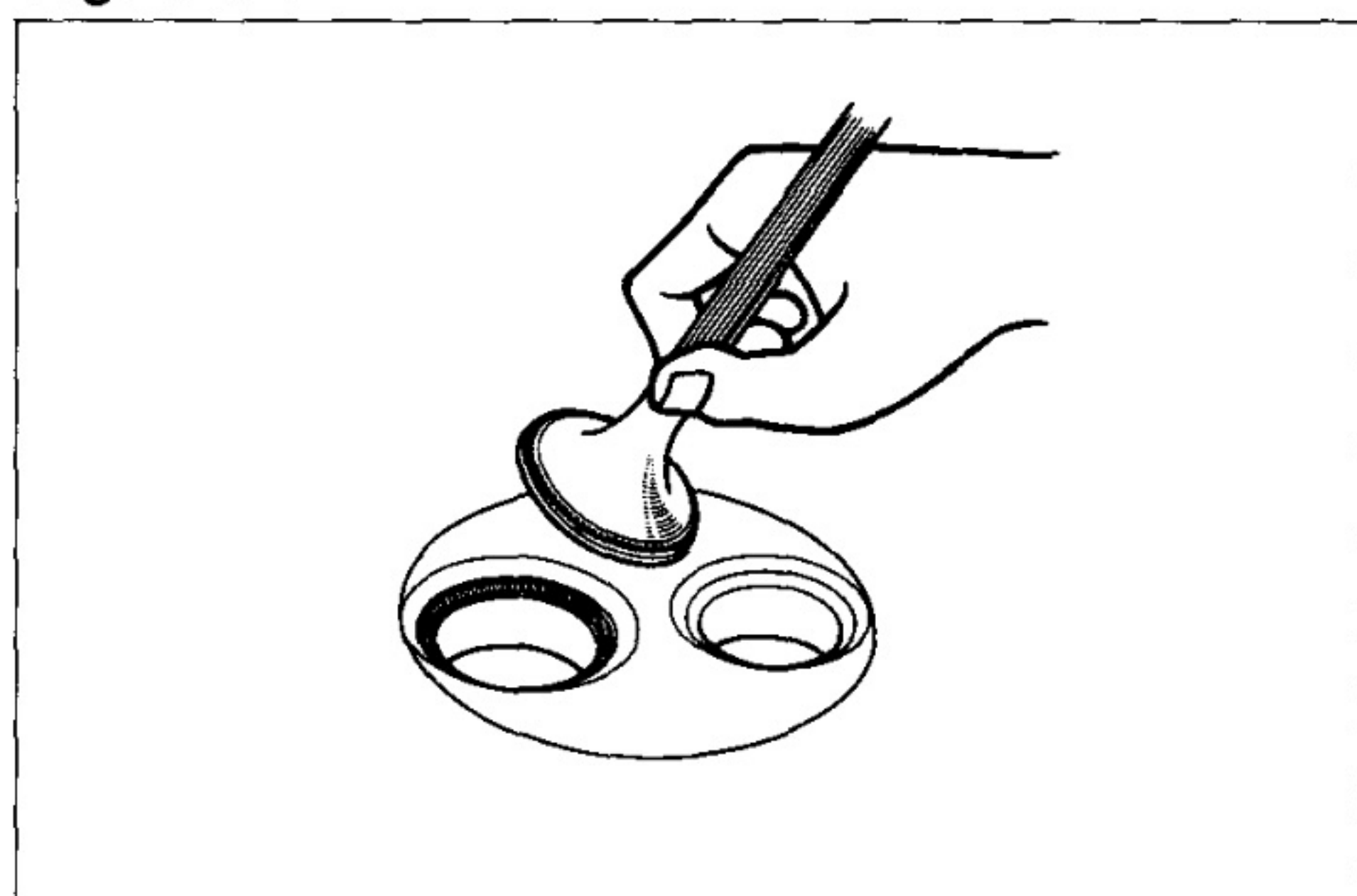
- (1) If the seat position is too high, use a 45° and 60° cutters in the order indicated.

Fig. 3-33



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

Fig. 3-34



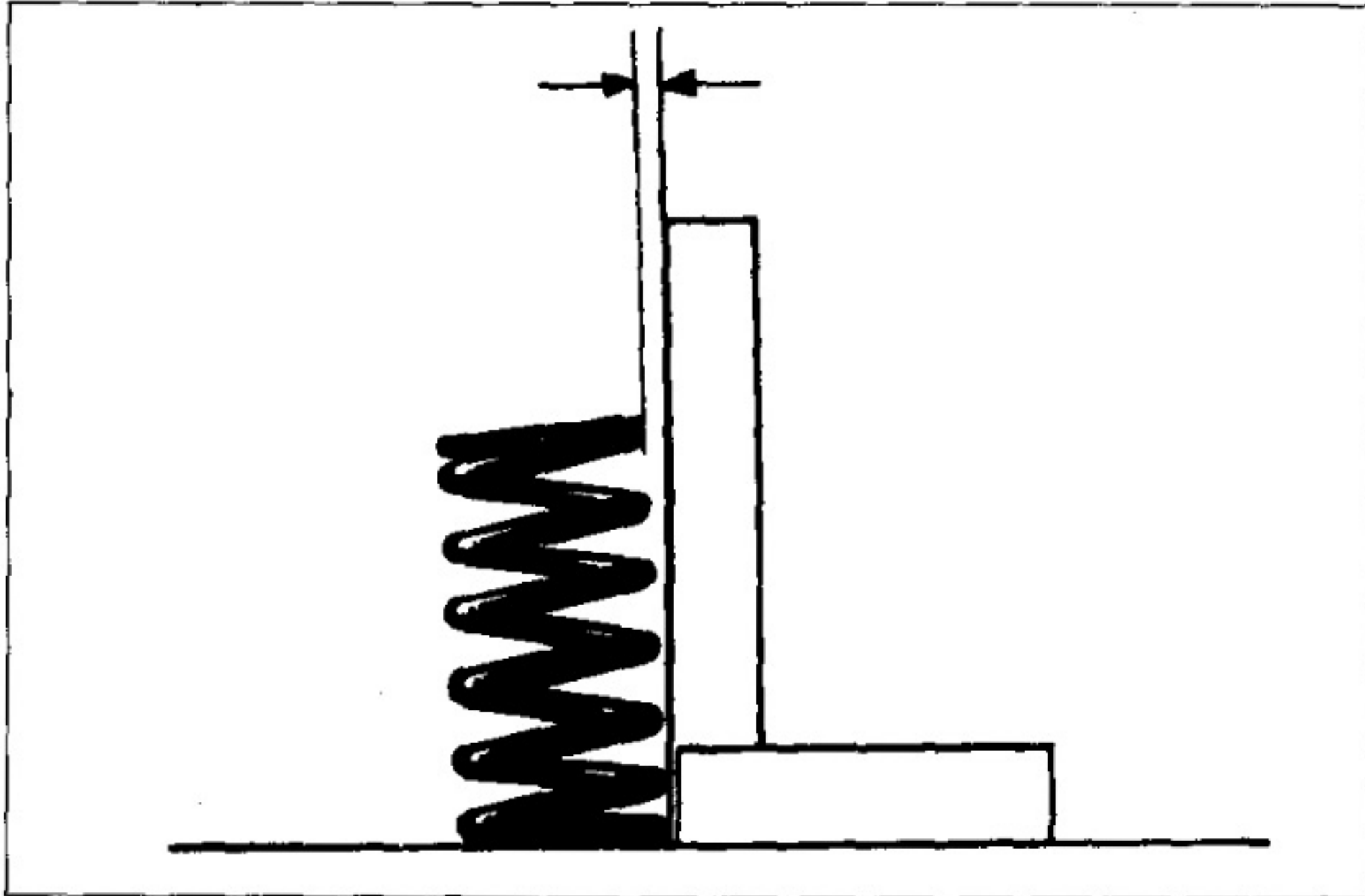
- (3) Check the valve concentricity. Lightly coat the seat with prussian blue. Install the valve and rotate. If blue appears 360° around face, valve stem and face are concentric. If not, replace the valve.

Fig. 3-35



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

Fig. 3-36

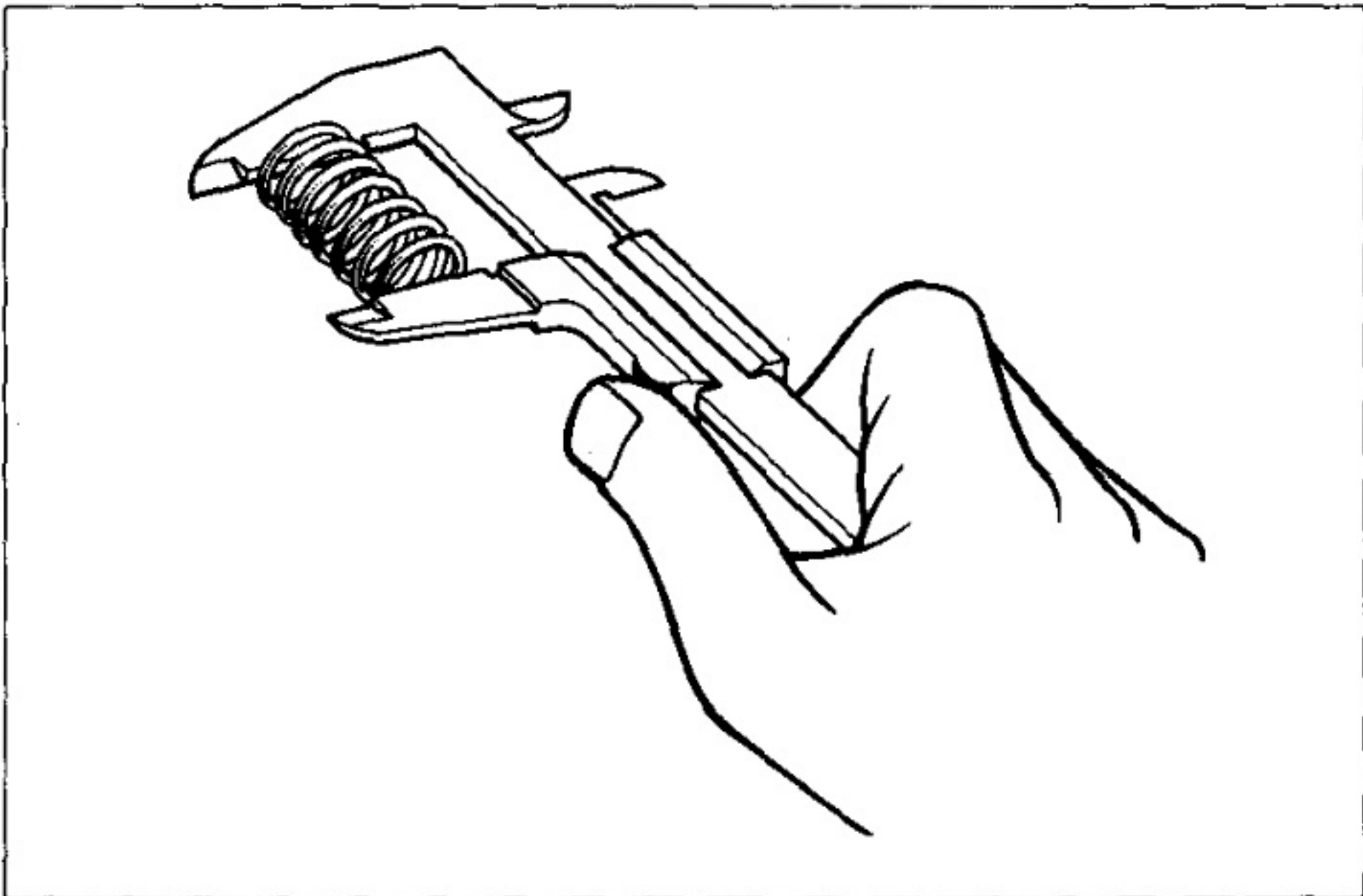
**Valve Spring**

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

Tilt:

Limit **2.0 mm**
 (0.079 in.)

Fig. 3-37



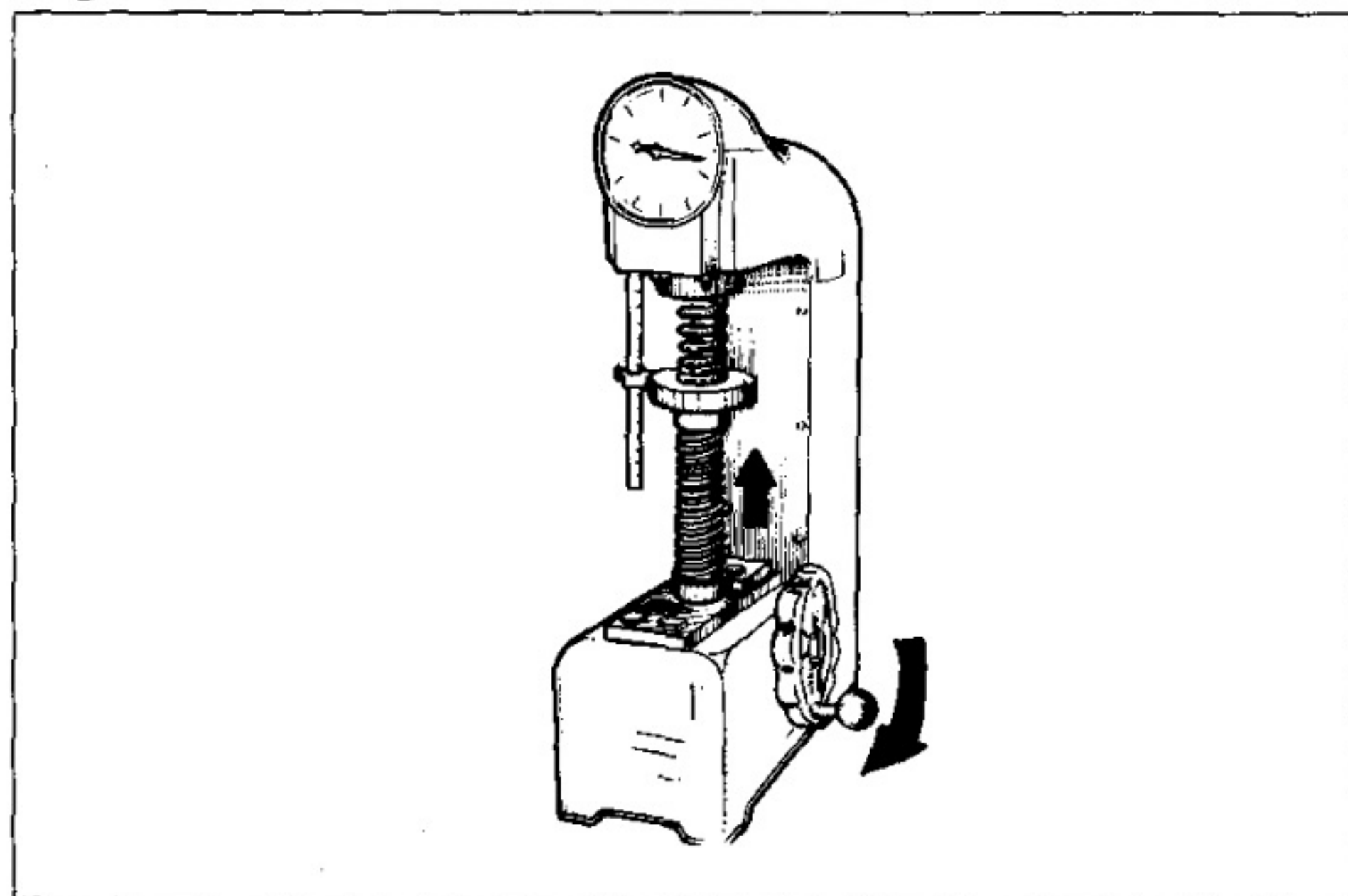
2. Measure the spring free length. Replace the springs that do not meet specification.

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.)

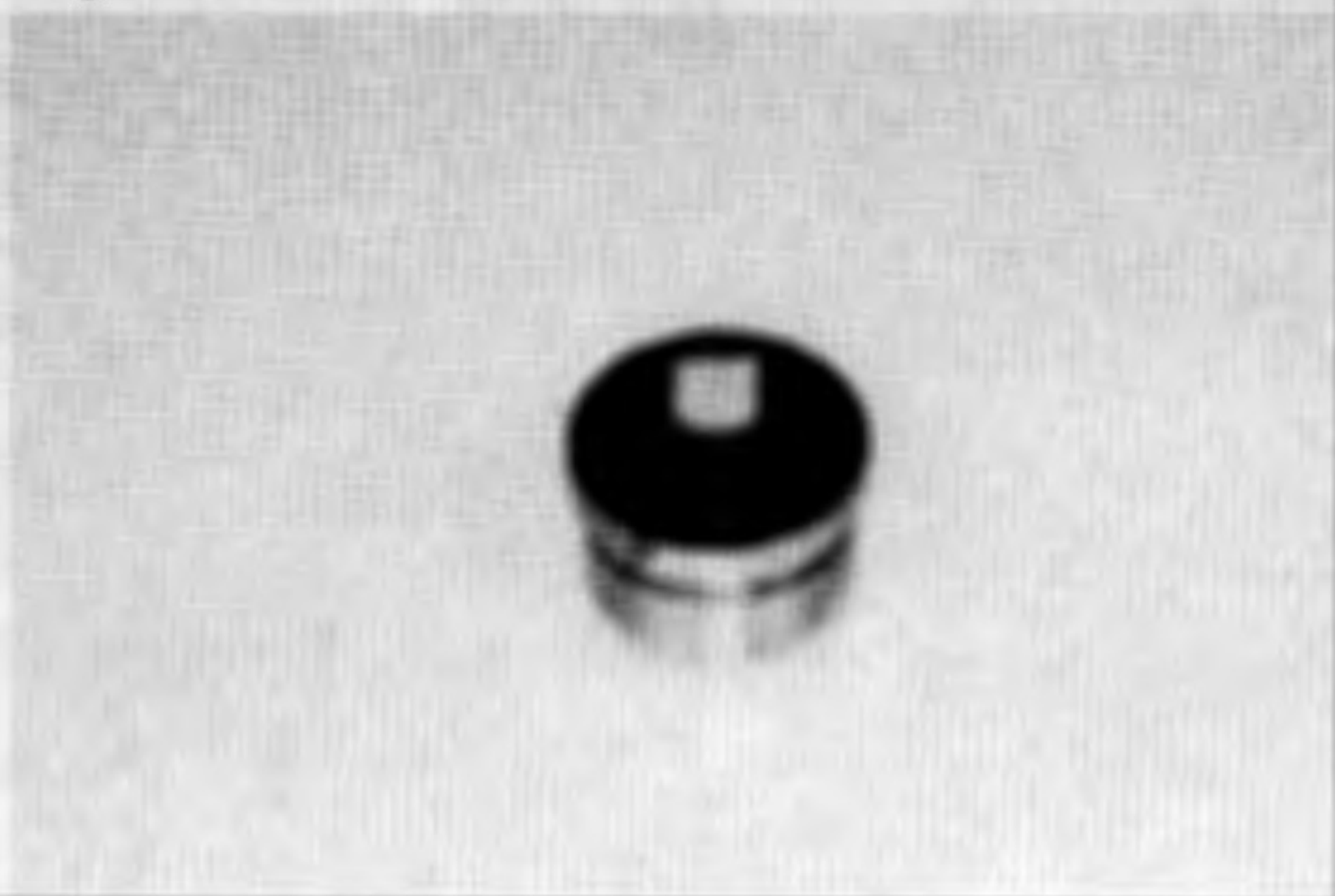
Outer **40.0 mm**
 (1.57 in.)

Installed load:

Inner **7.6 kg**
 (16.8 lb)

Outer **22.5 kg**
 (49.6 lb)

Fig. 3-39

**Combustion Chamber**

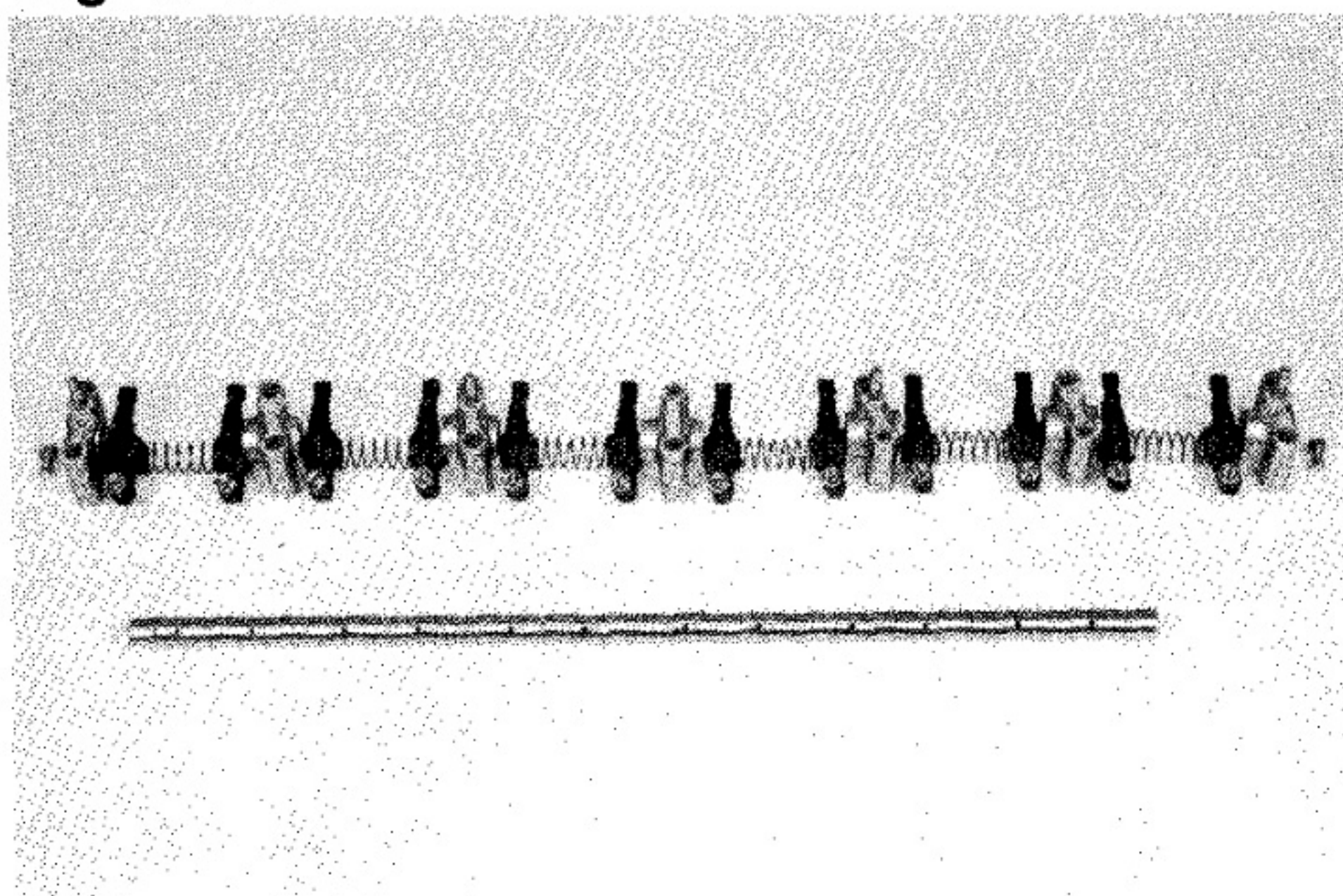
Clean the combustion chamber and check for cracks and extreme damage.

Fig. 3-40

**Rocker Arm & Shaft**

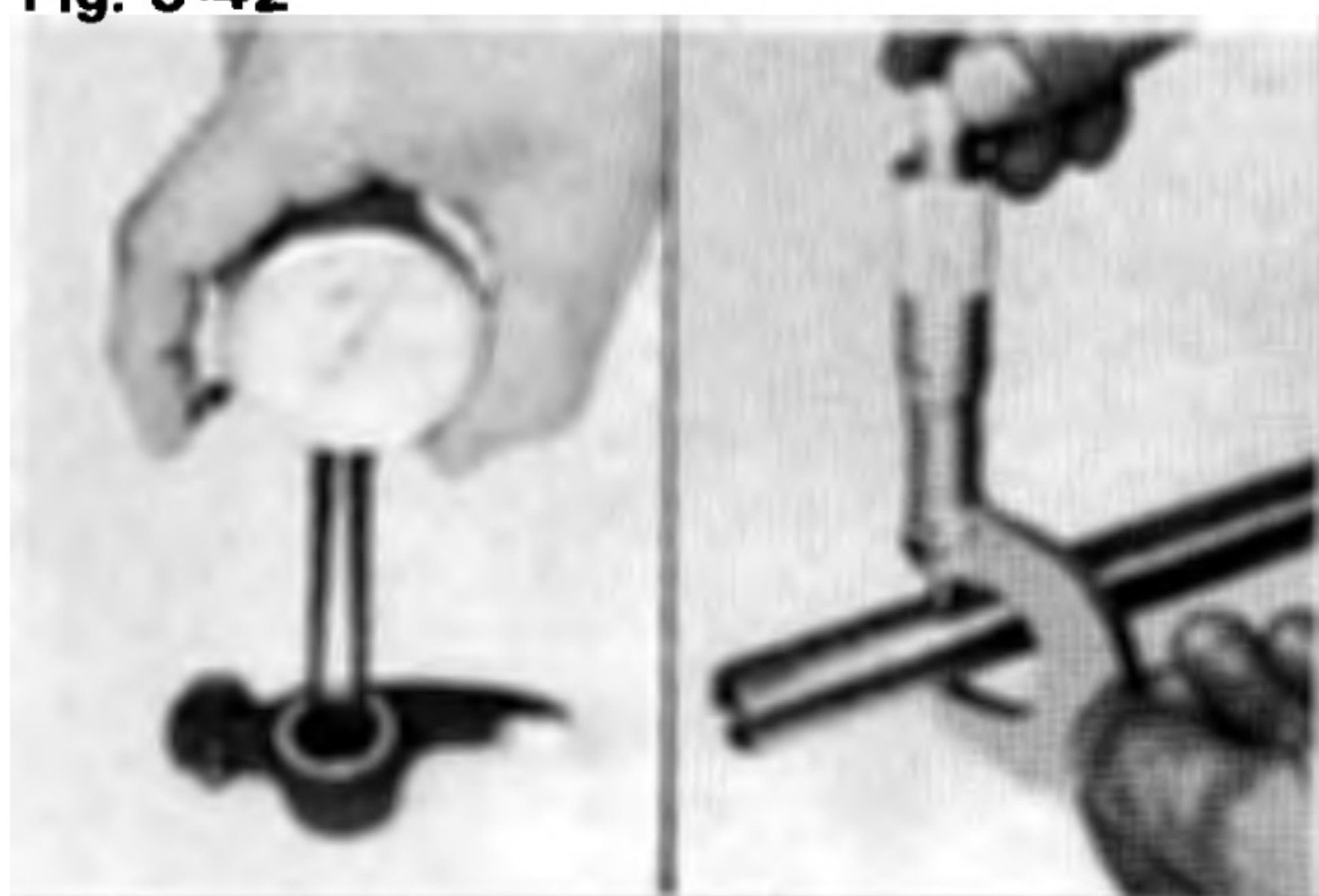
1. Check the rocker arm-to-shaft clearance. If worn excessively, disassemble and check.

Fig. 3-41



2. Arrange the rocker shaft and rocker support.

Fig. 3-42

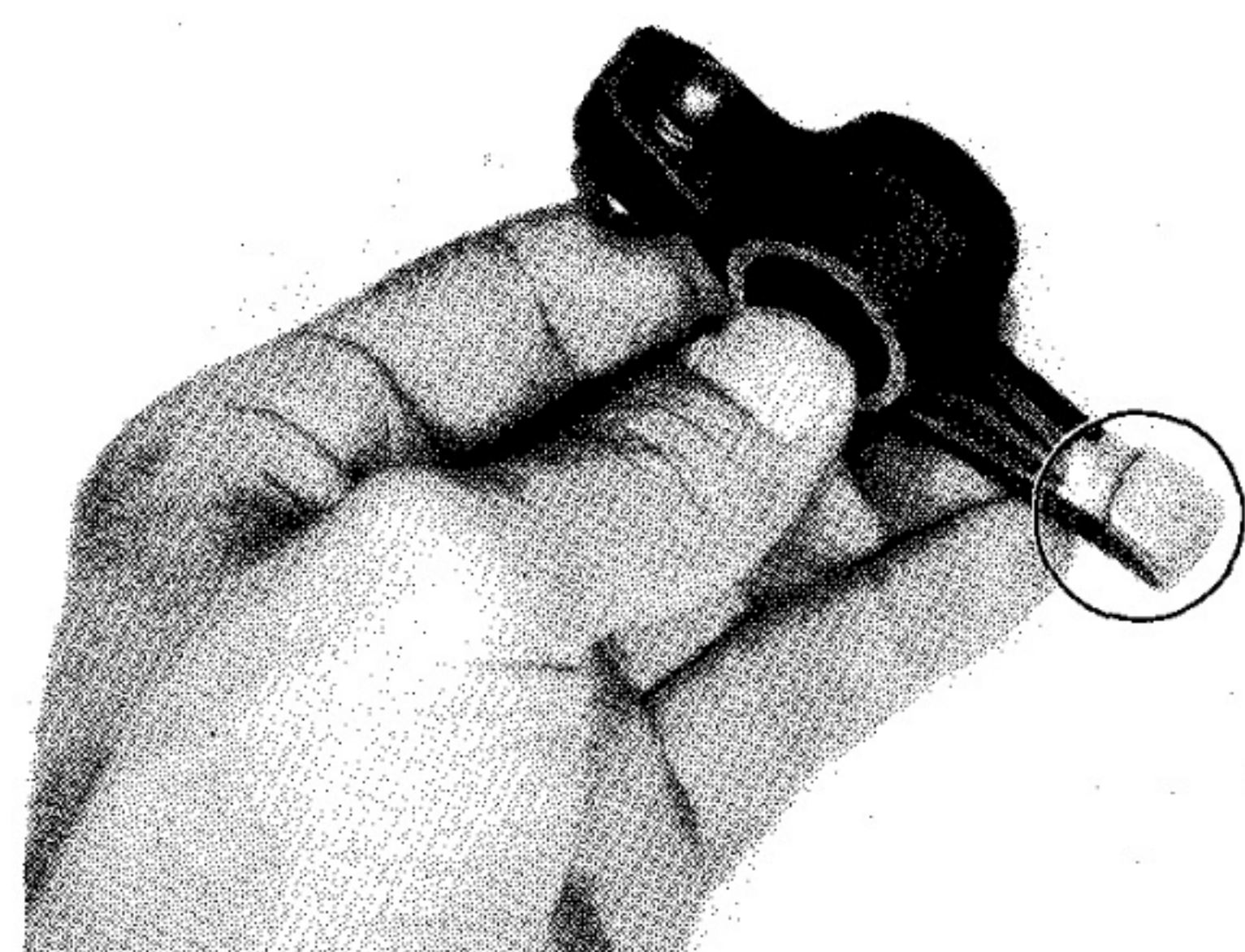


3. Measure the clearance with a dial indicator and outside micrometer. If the clearance exceeds the limit, replace the rocker arm and/or shaft.

Oil clearance:

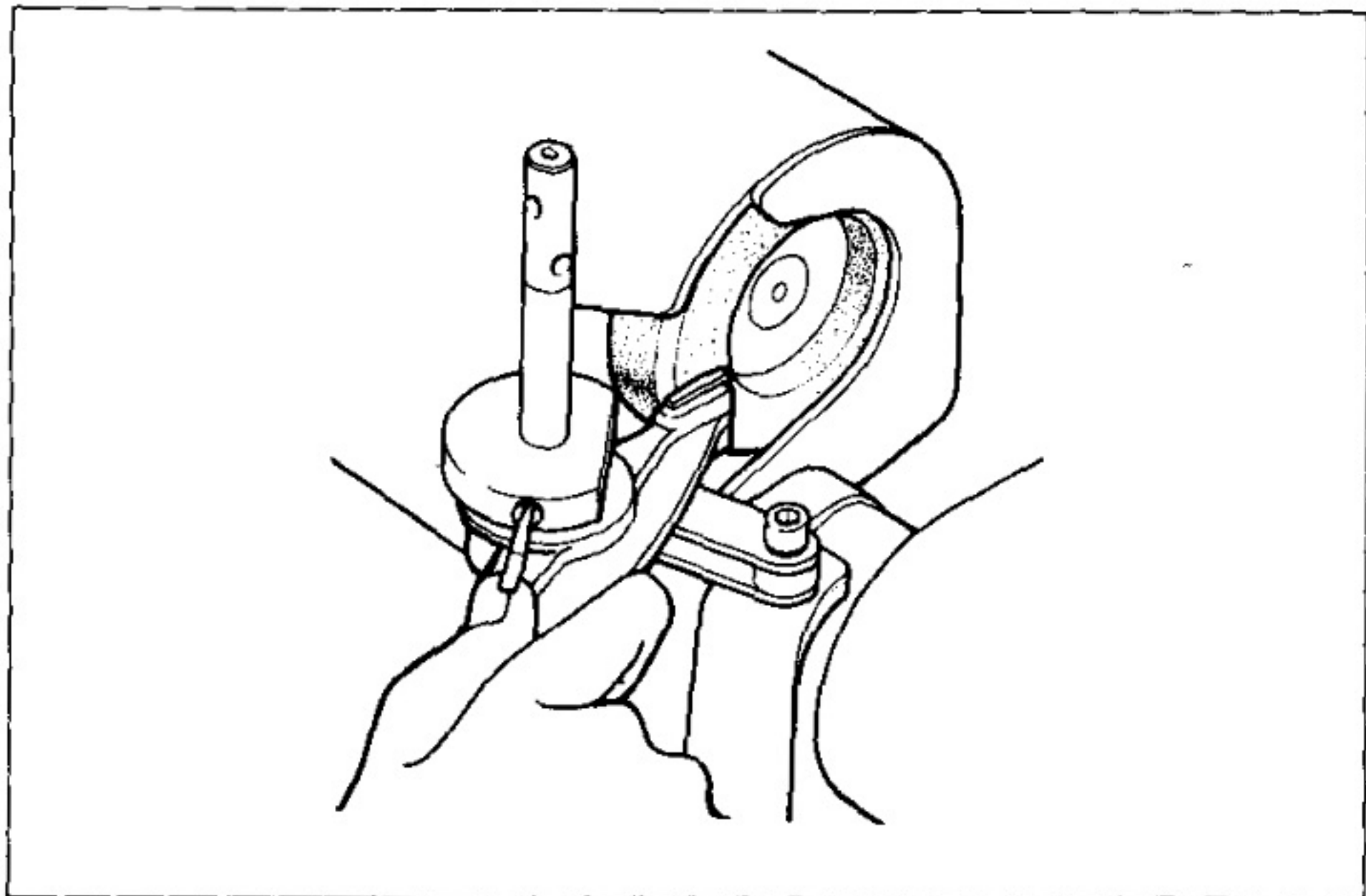
STD	0.007 – 0.049 mm (0.0003 – 0.0019 in.)
Limit	0.1 mm (0.004 in.)

Fig. 3-43



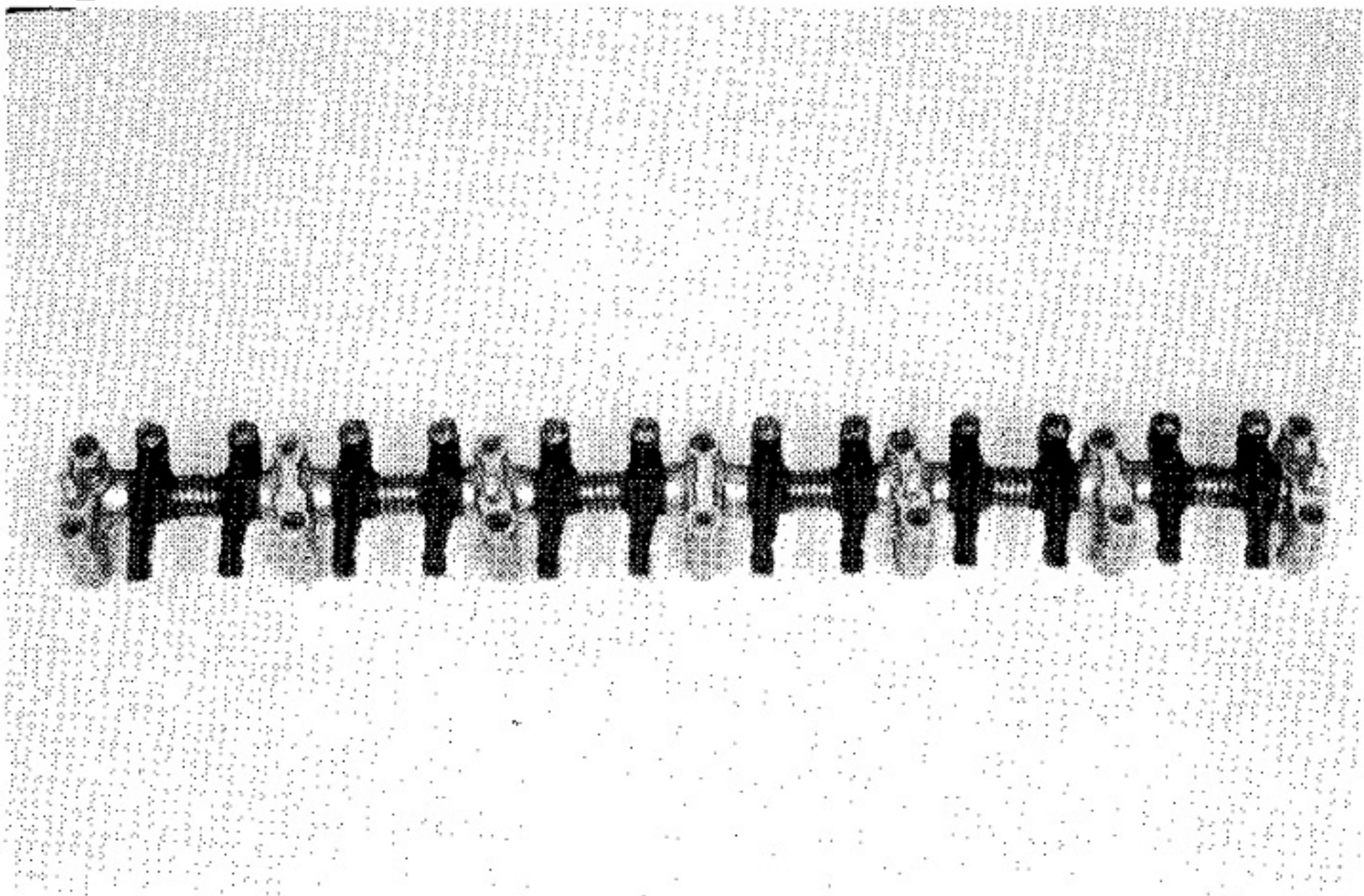
4. Check the contact surface.

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

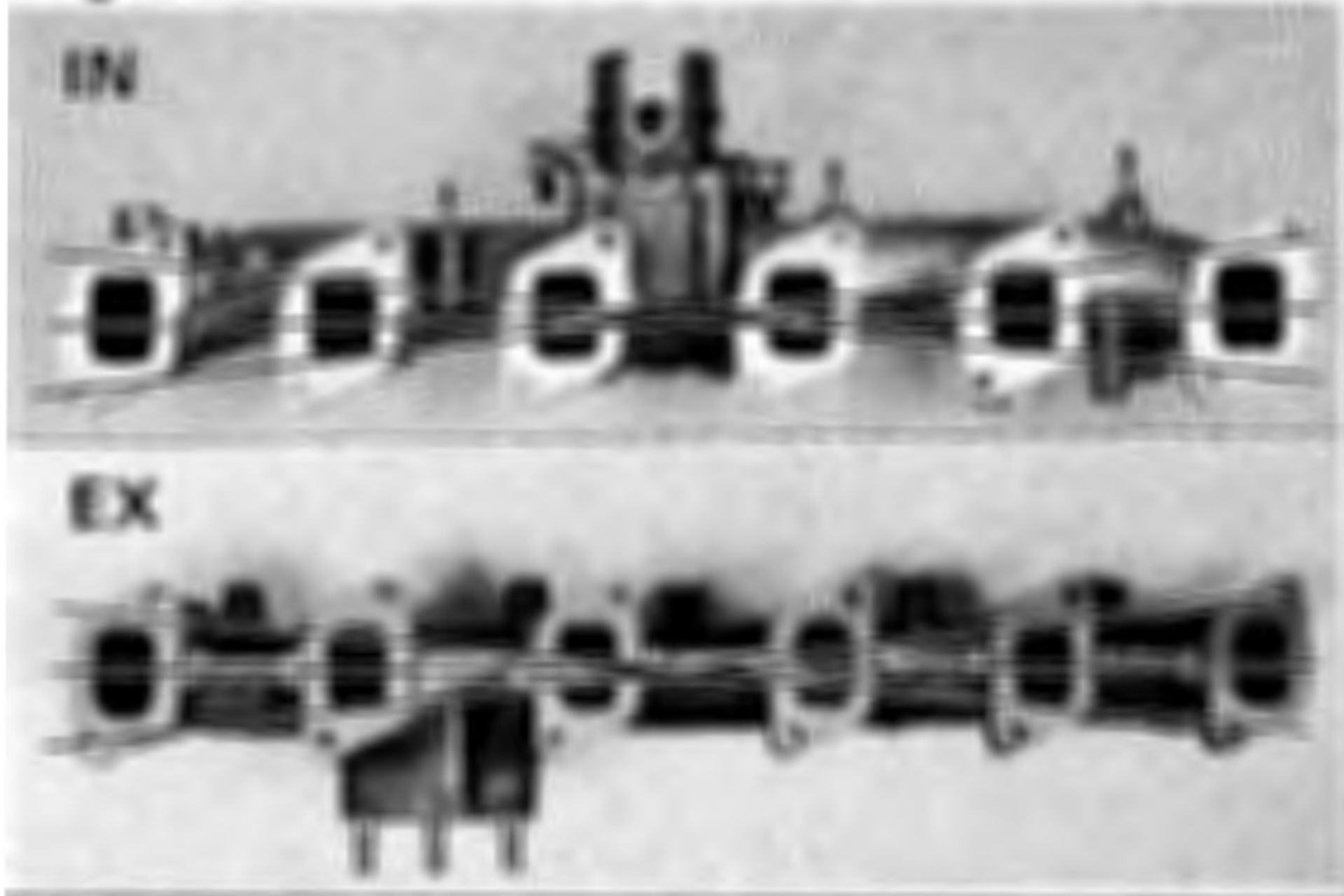
Using a straight edge and thickness gauge, check the cylinder head contacting surfaces for warpage.

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—

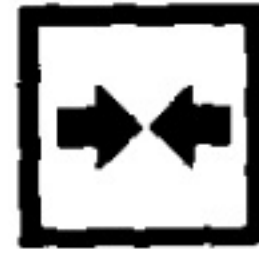
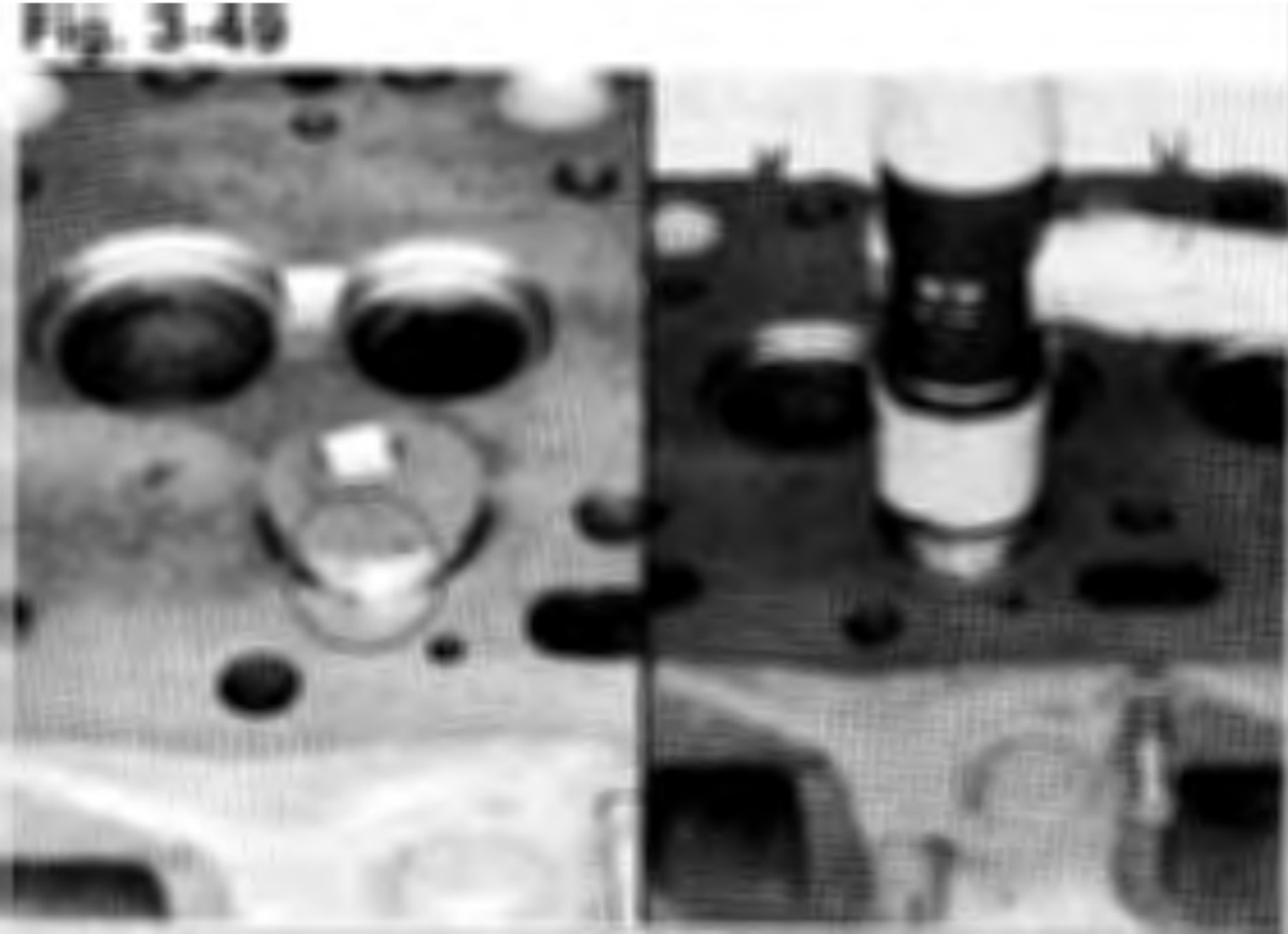
1. Thoroughly clean all parts to be assembled.
2. Apply clean engine oil to all sliding and rotating surfaces of the parts before assembly.

The diagram is an exploded view of an engine cylinder head assembly. It shows the following components and their references:

- 1. Combustion Chamber (Fig. 3-49, 3-50)
- 2. Valve & Compression Spring (Fig. 3-51, 3-53)
- 3. Cylinder Head (Fig. 3-54, 3-57)
- 4. Valve Push Rod
- 5. Valve Rocker Shaft Assembly (Fig. 3-58, 3-63)
- 6. Cylinder Head Cover
- 7. Exhaust Manifold (Fig. 3-64)
- 8. Heat Insulator
- 9. Intake Manifold (Fig. 3-51, 3-53)
- 10. Overinjection Magnet (General countries only) (Fig. 3-66)
- 11. Fuel Control Motor (Fig. 3-67, 3-68)
- 12. Fuel Filter
- 13. Water Outlet Housing
- 14. Injection Nozzle Holder (Fig. 3-69, 3-70)
- 15. Leakage Pipe
- 16. Injection Pipe
- 17. Glow Plug & Glow Plug Connector

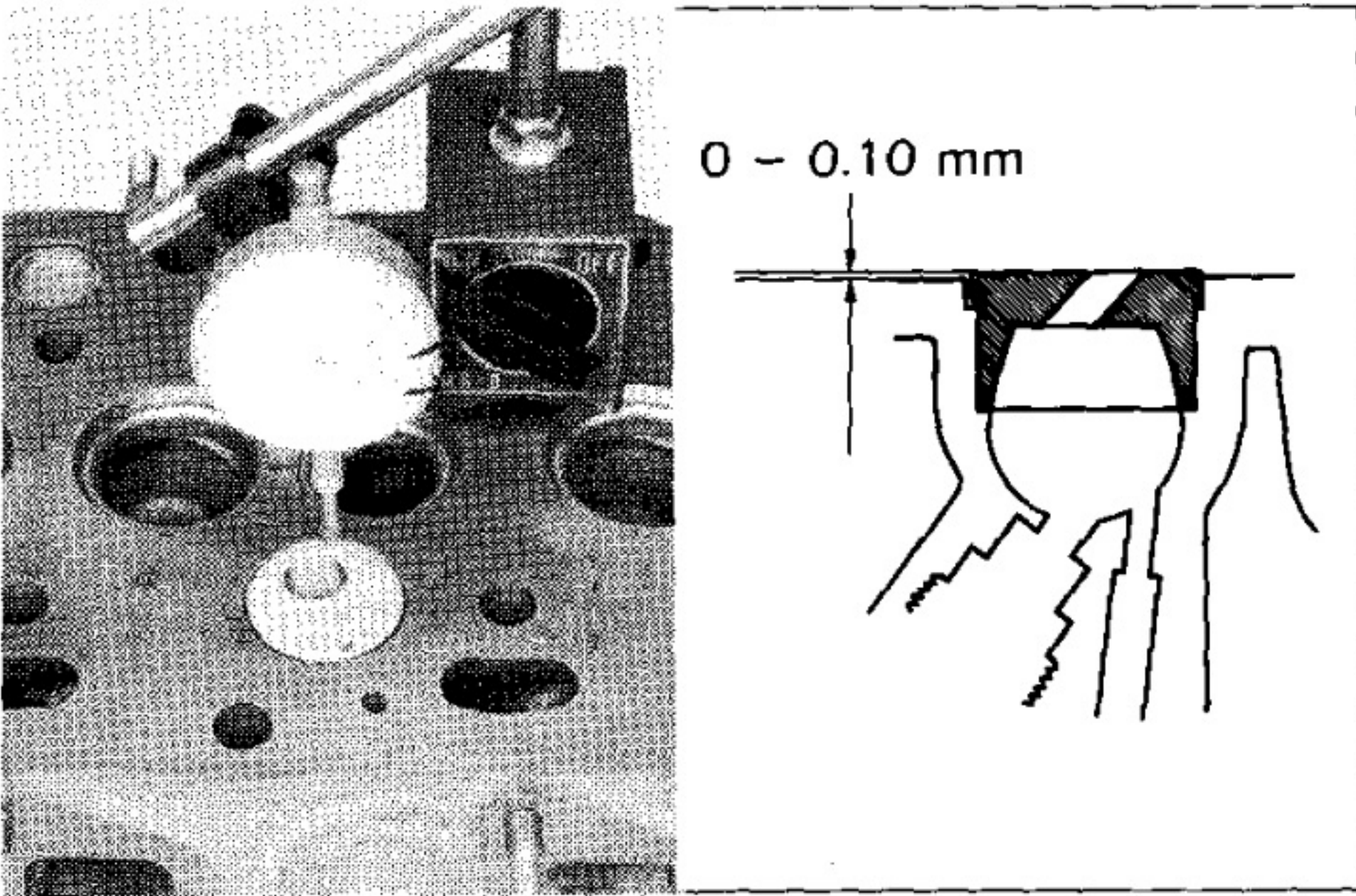
1. Combustion Chamber	10. Overinjection Magnet (General countries only)
2. Valve & Compression Spring	11. Fuel Control Motor
3. Cylinder Head	12. Fuel Filter
4. Valve Push Rod	13. Water Outlet Housing
5. Valve Rocker Shaft Assembly	14. Injection Nozzle Holder
6. Cylinder Head Cover	15. Leakage Pipe
7.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

Fig. 3-49



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

Fig. 3-50



0 - 0.10 mm



Check the combustion chamber protrusion.

Combustion chamber protrusion:

0 - 0.10 mm

(0 - 0.0039 in.)

Fig. 3-51

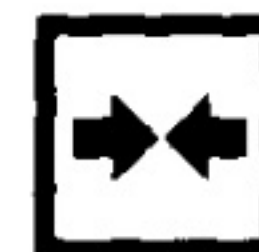


Press in the oil seal by hand.

—Note—

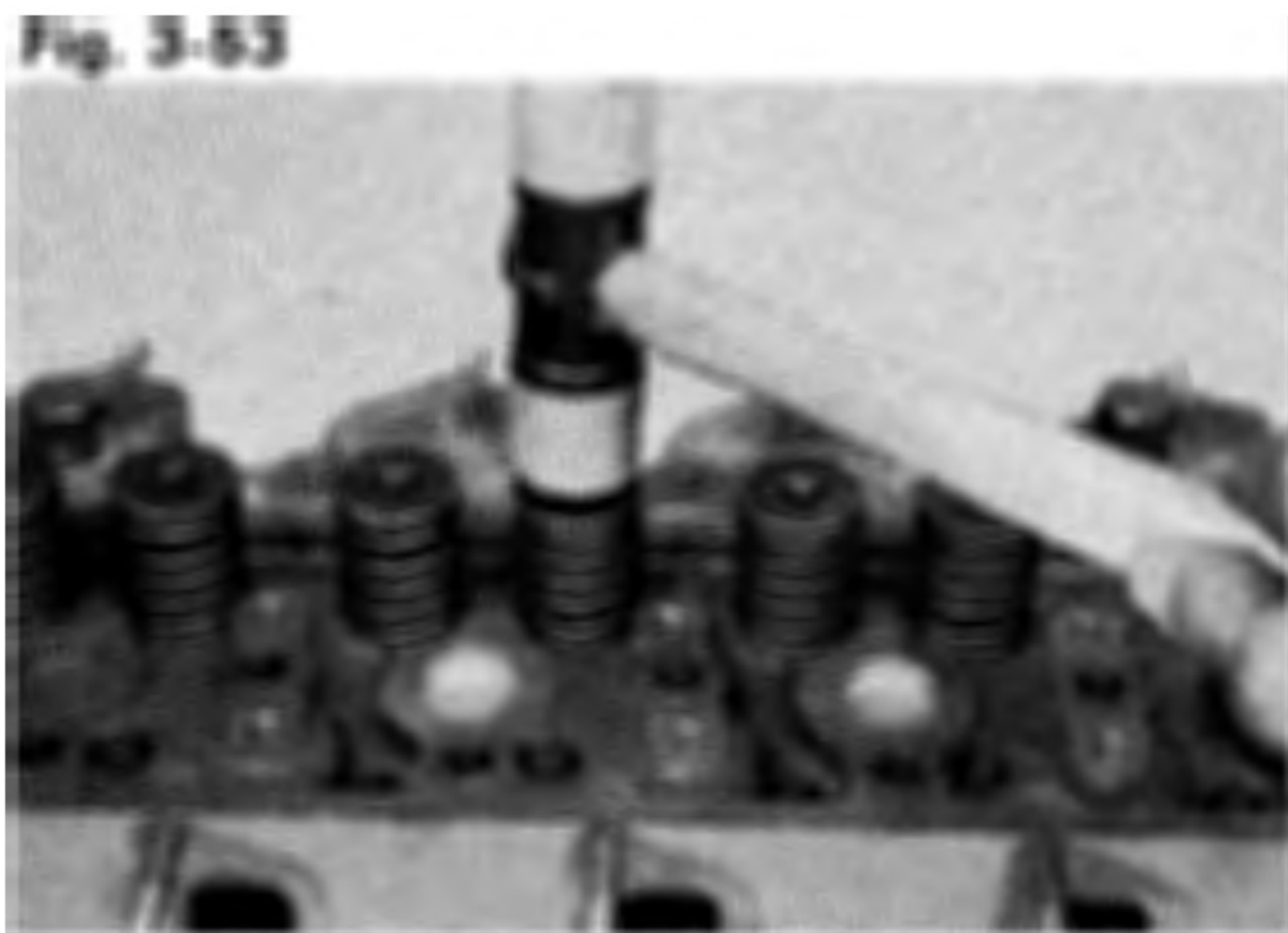
1. A new oil seal should be used whenever the valve is disassembled.
2. Be careful not to press it in slantwise.

Fig. 3-52



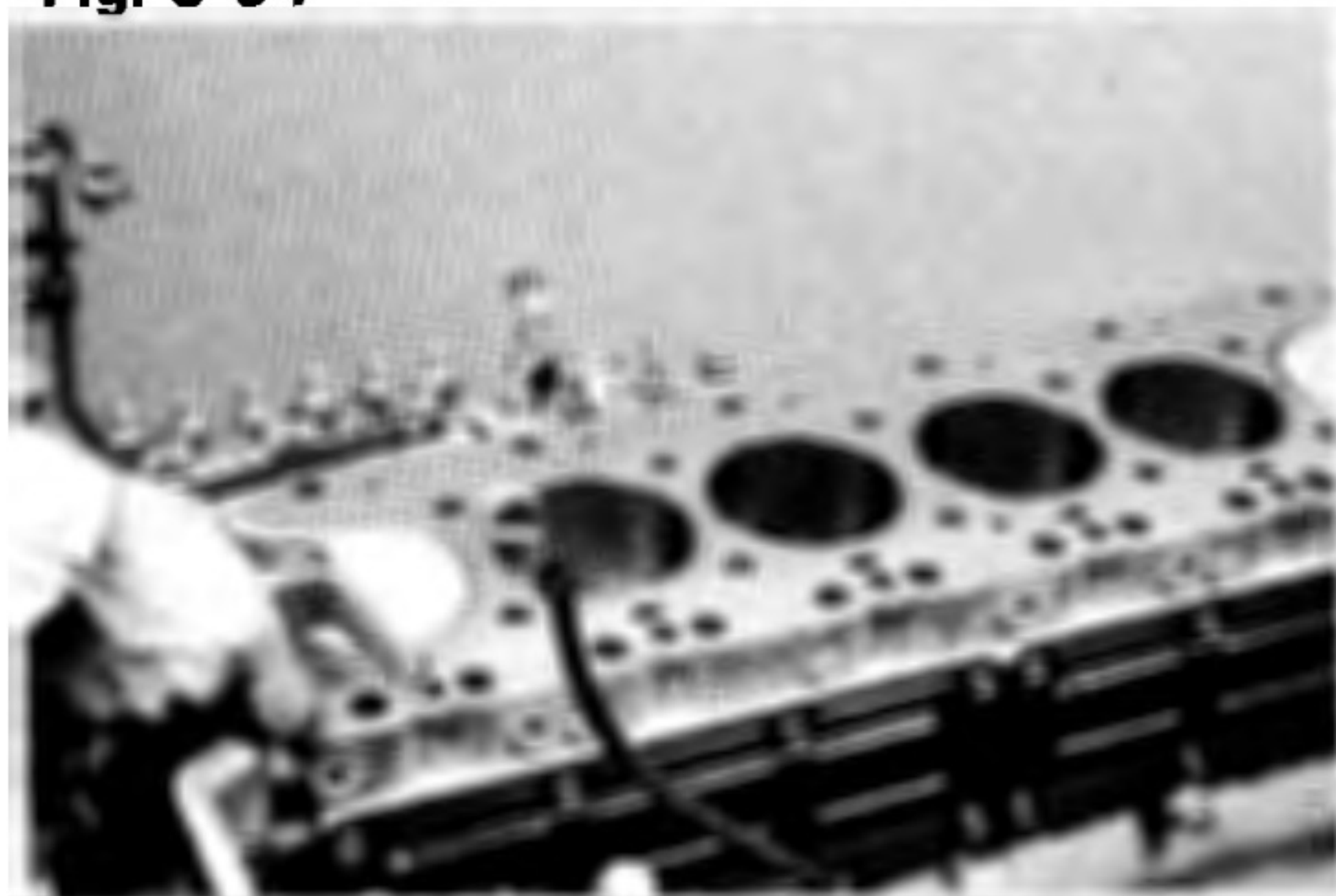
Compress the valve spring with SST and insert the spring retainer locks.
SST [09202-43012]

Fig. 3-53



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

Fig. 3-54

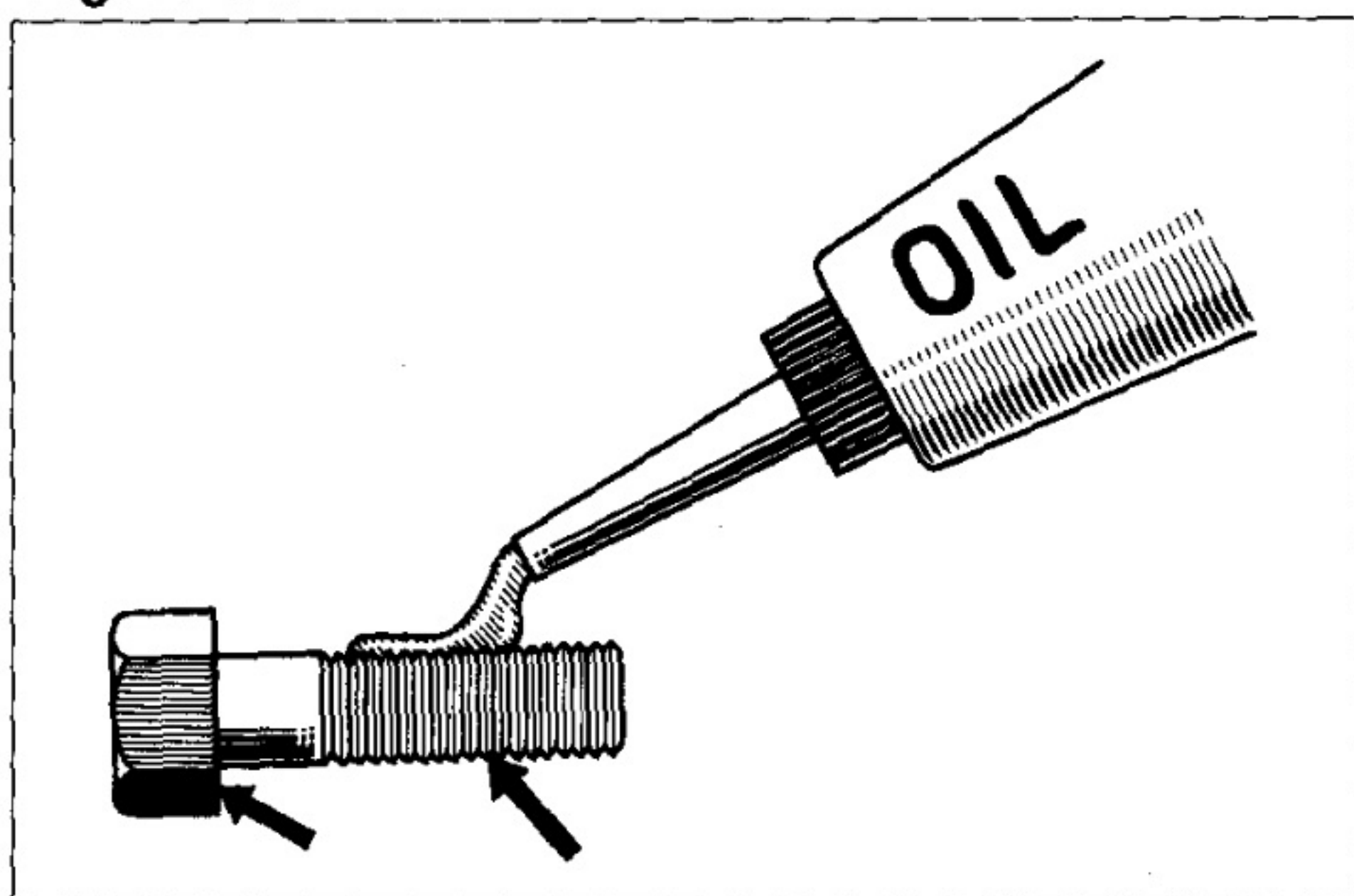


Put the cylinder head gasket on the cylinder block, aligning the bolt holes.

—Note—

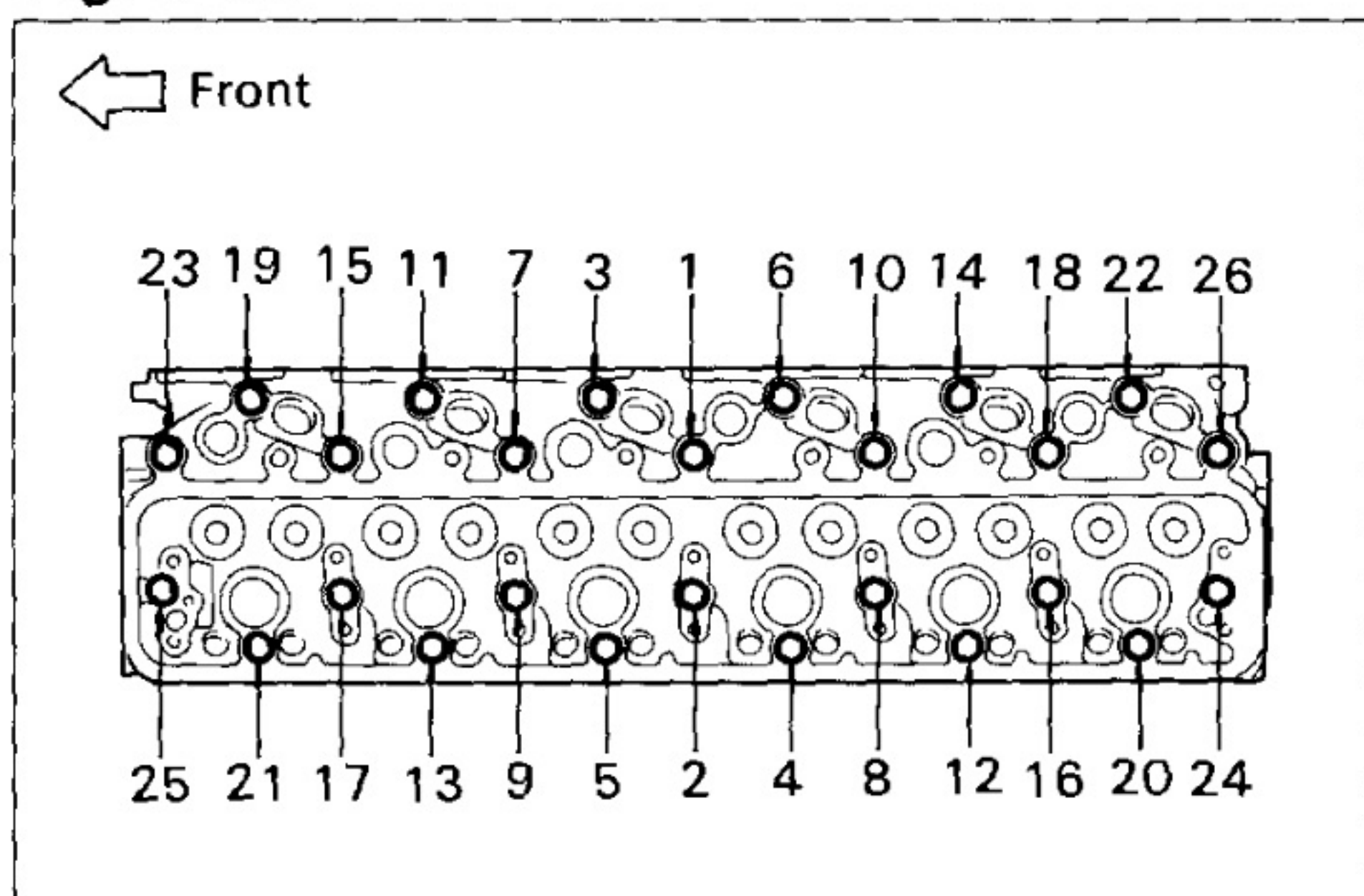
1. Clean the cylinder block bolt holes with compressed air.
2. Clean the cylinder block upper surface with a scraper before installing the head gasket.

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

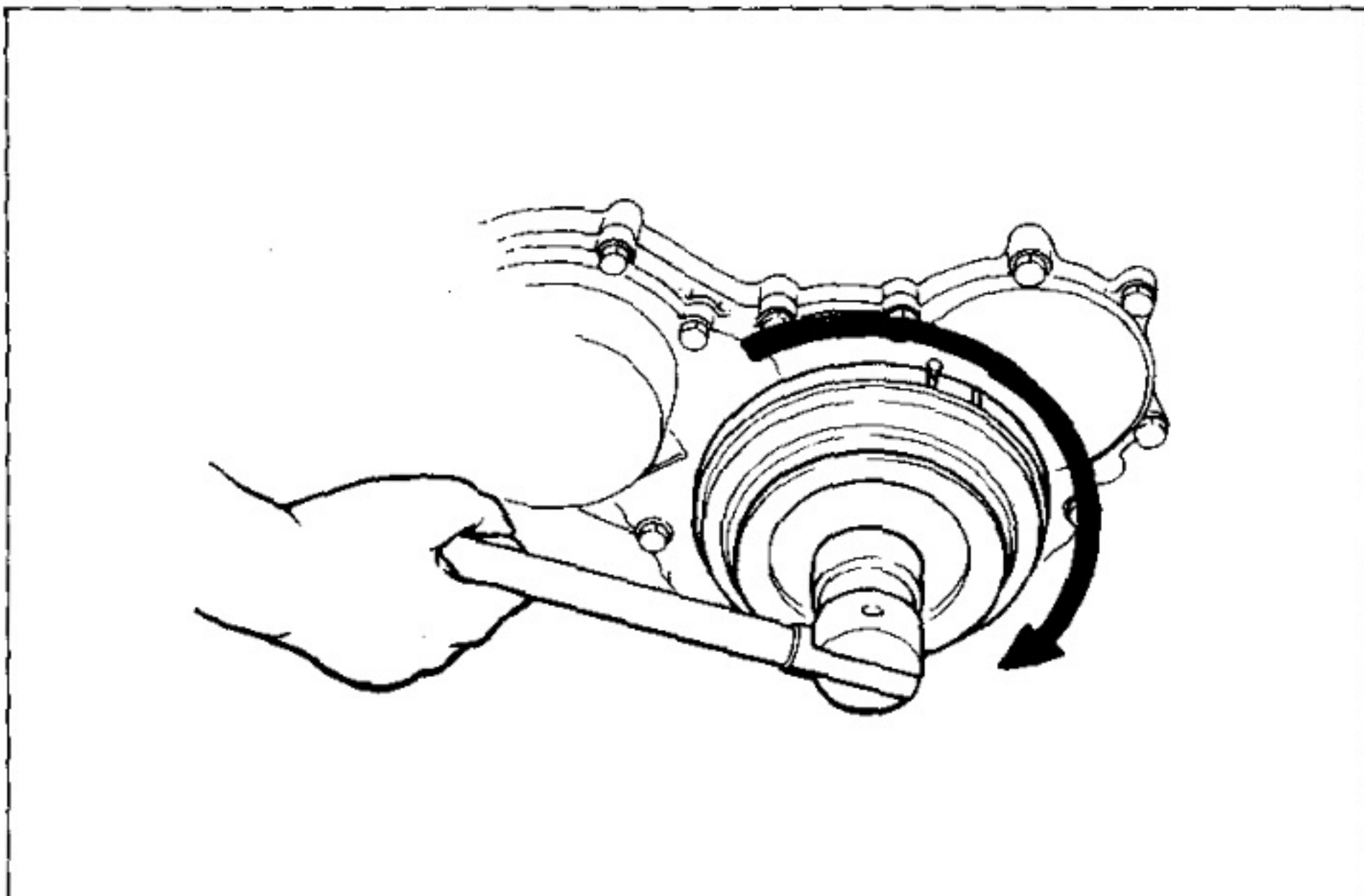


Tighten the valve rocker support bolts to specified torque.

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



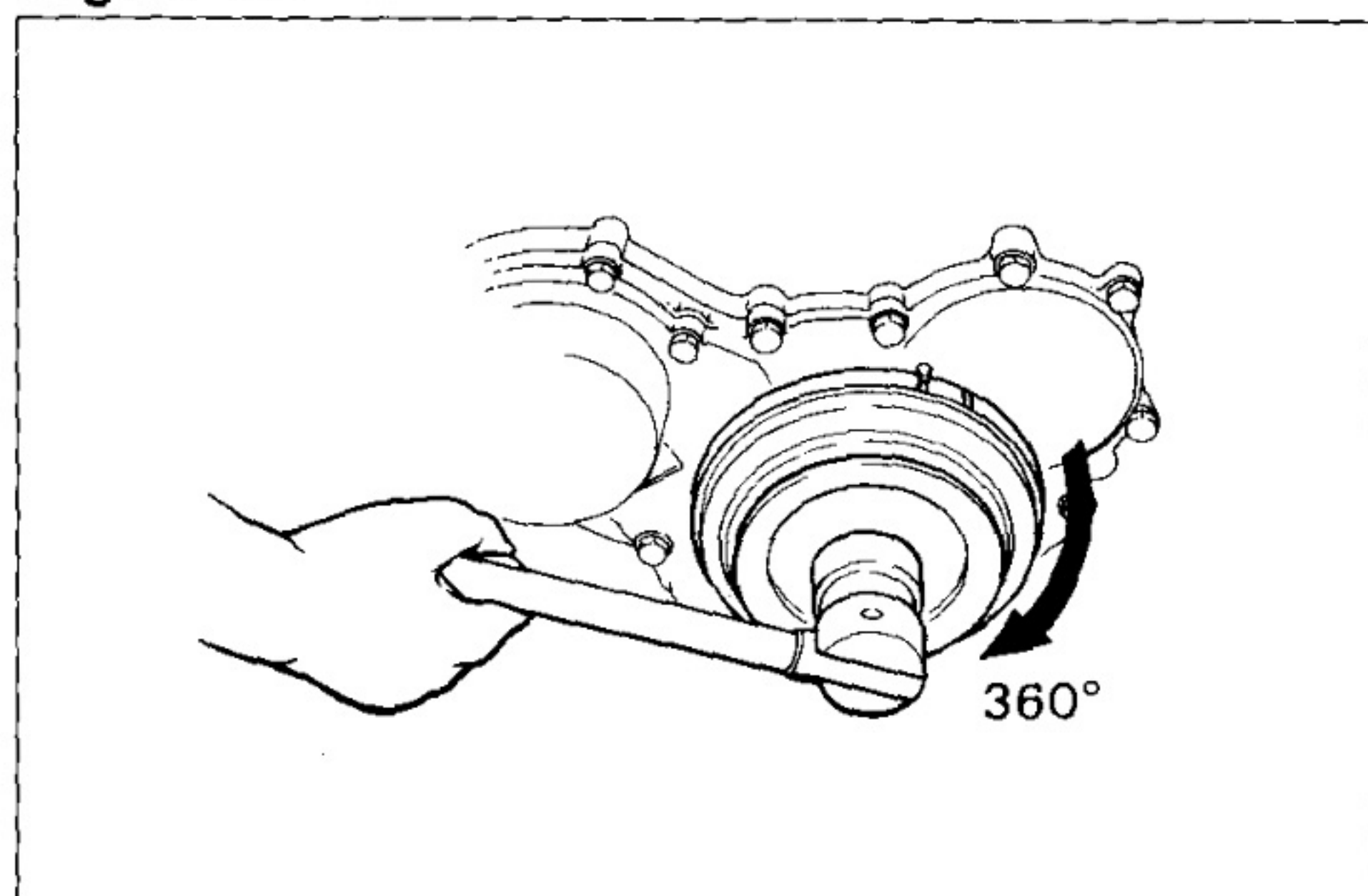
2. Adjust the valve clearance.
The valve clearance is measured between the valve stem and rocker arm adjusting screw.
Adjust only the valves indicated by arrows.

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)

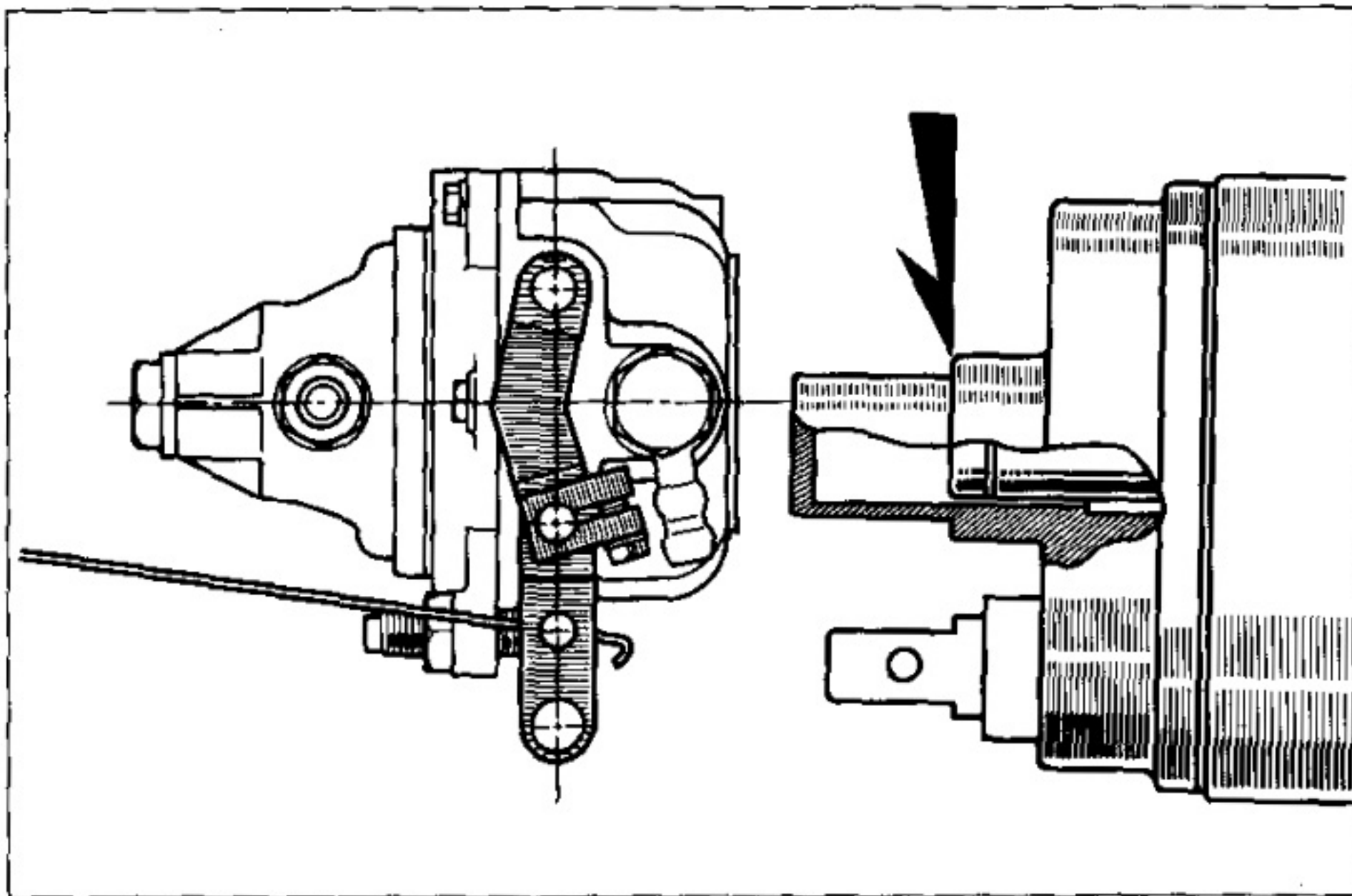
Fig. 3-65



Install the intake manifold.

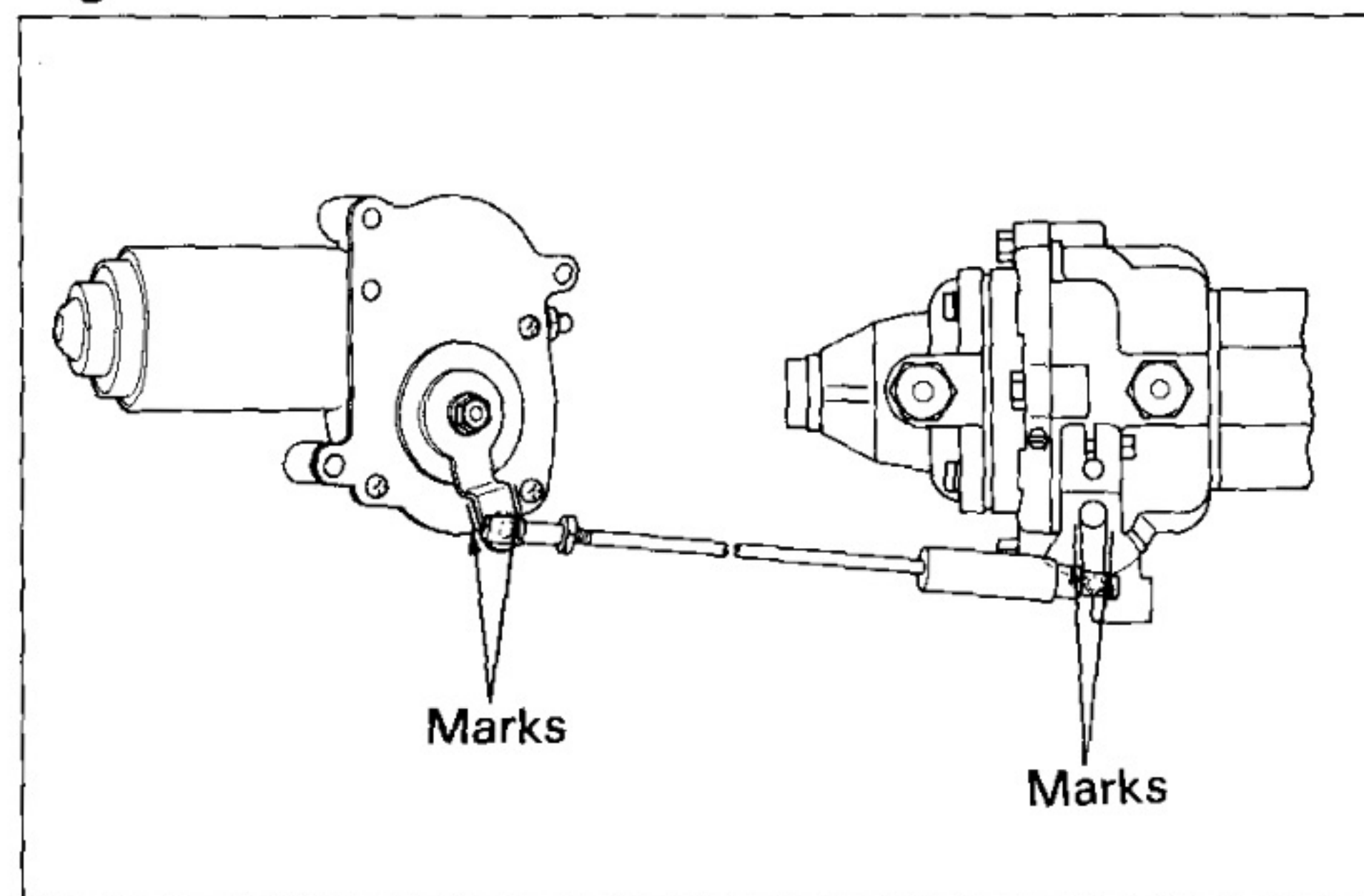
Tightening torque: 1.5 – 2.2 kg-m
(1.1 – 15 ft-lb)

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—

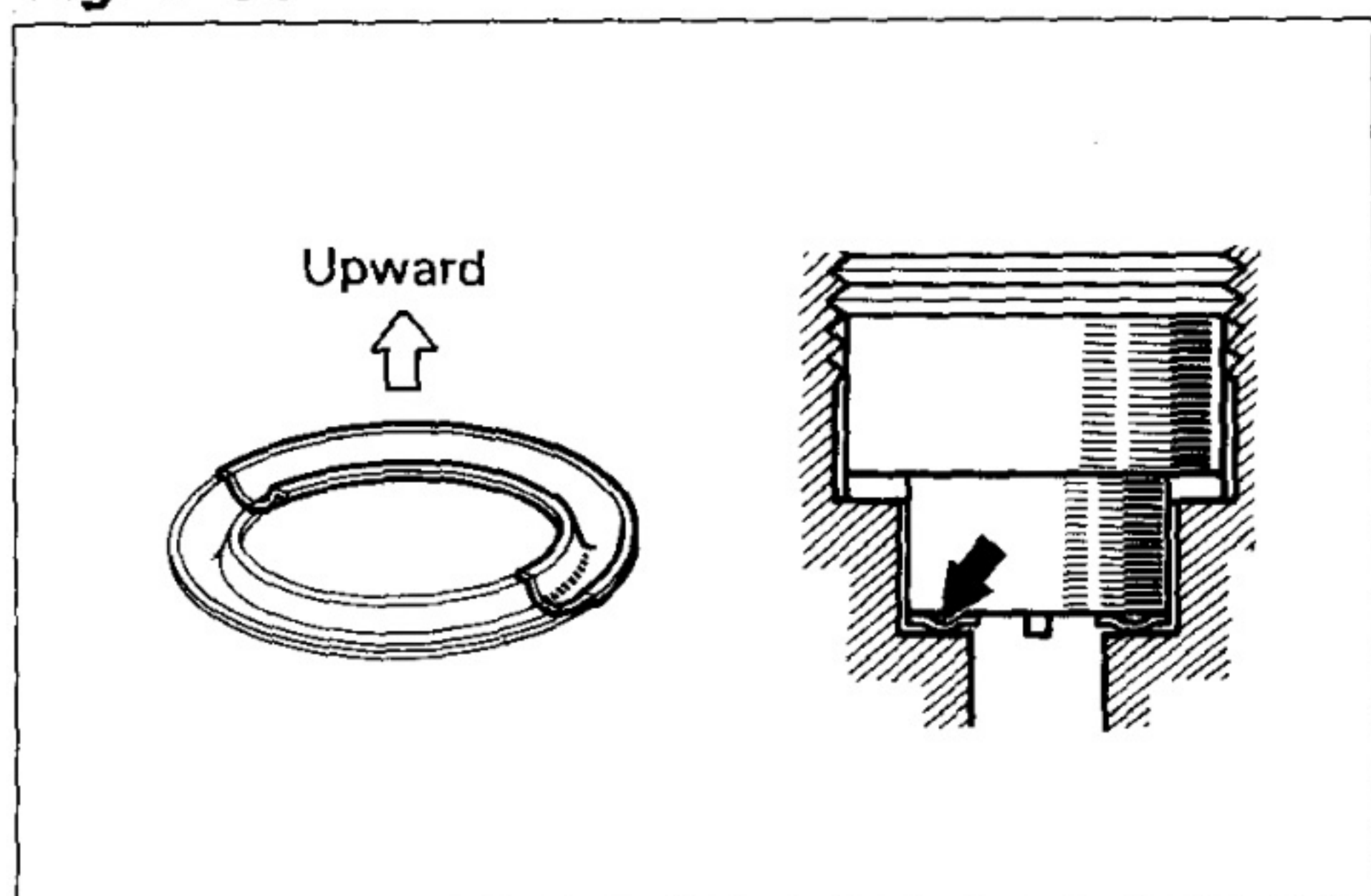
The fuel control motor lever should be positioned between the two marks while the engine is running.

Fig. 3-68



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

Fig. 3-69

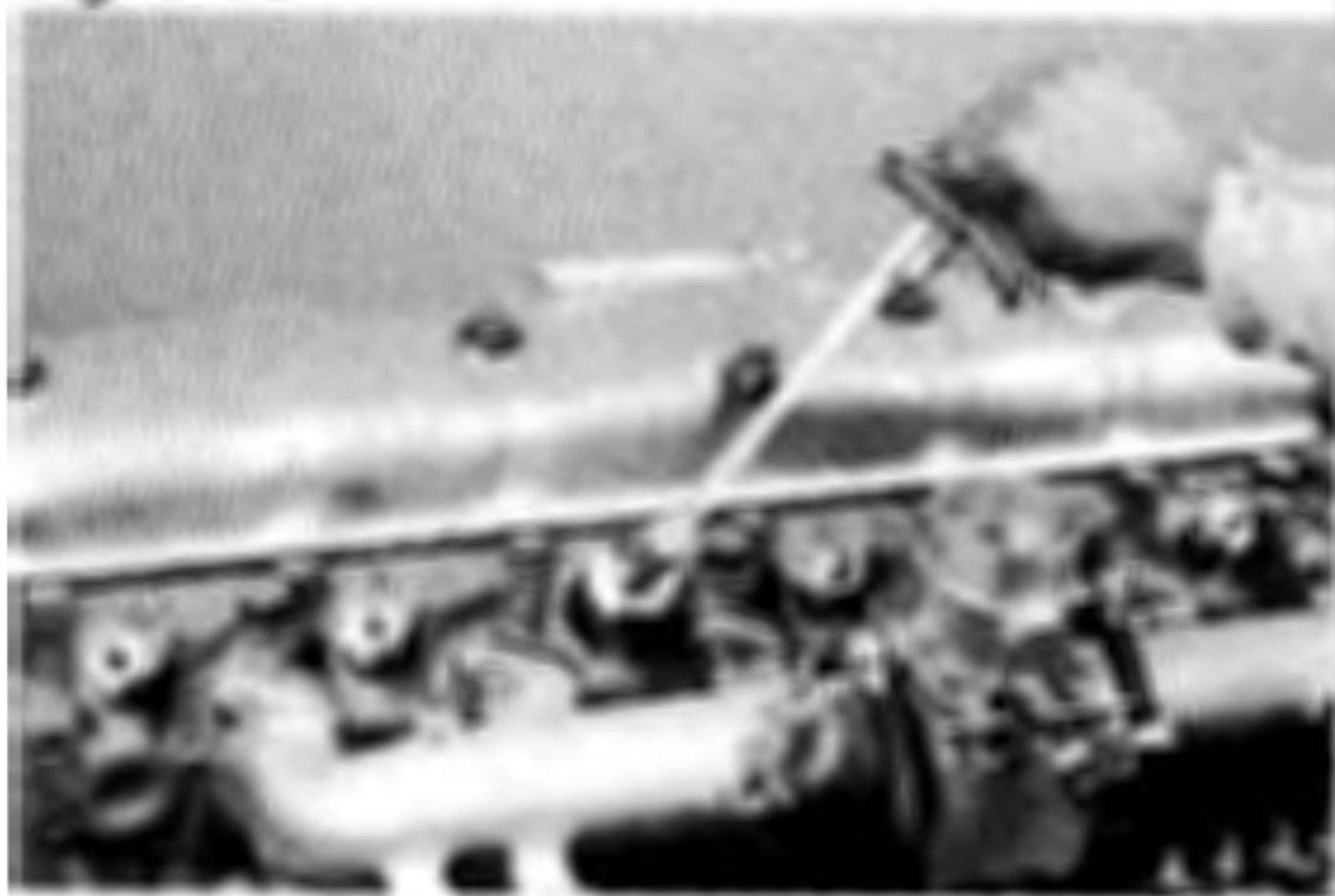


Note the orientation of the nozzle seat gasket as shown in the figure.

—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

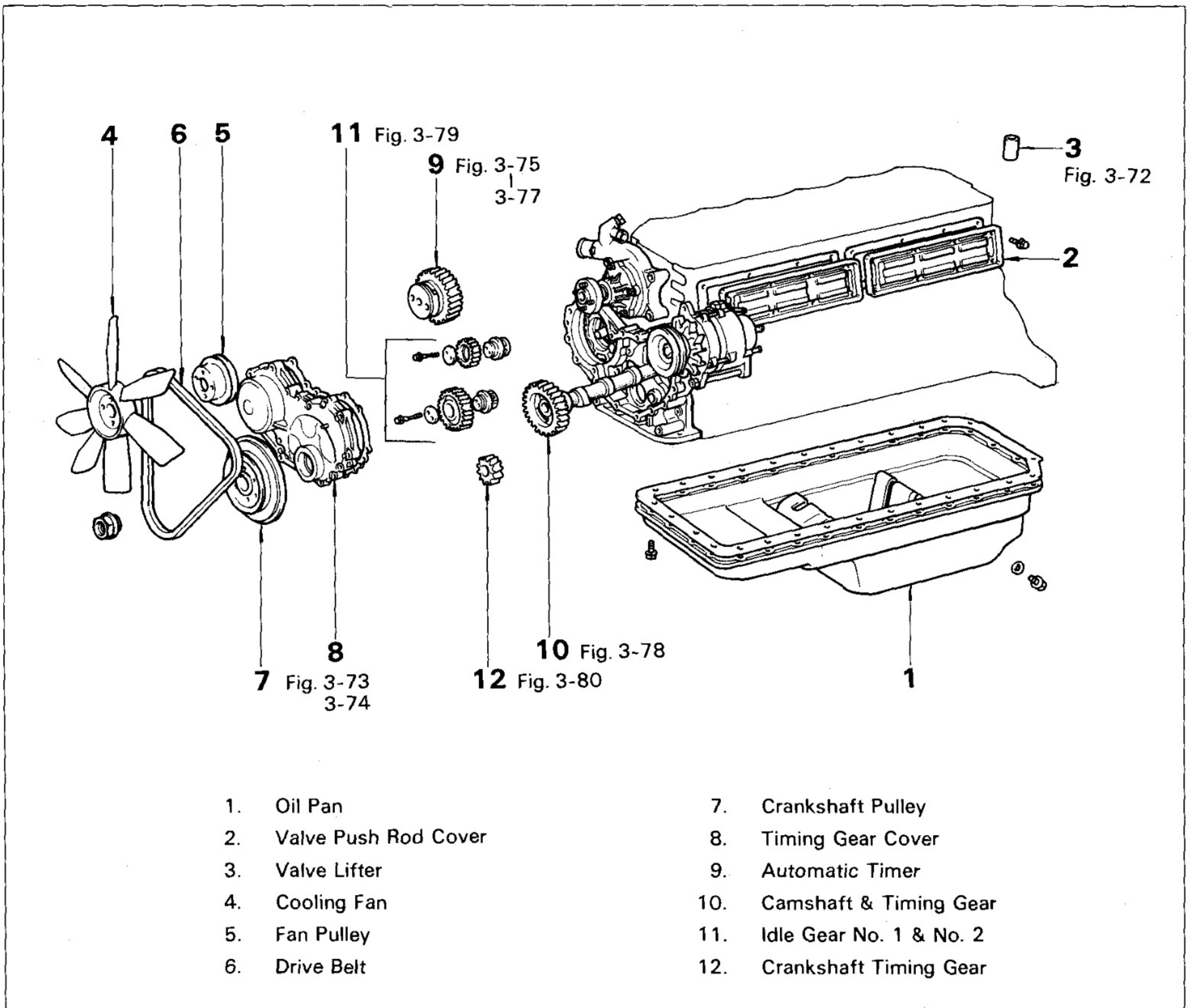
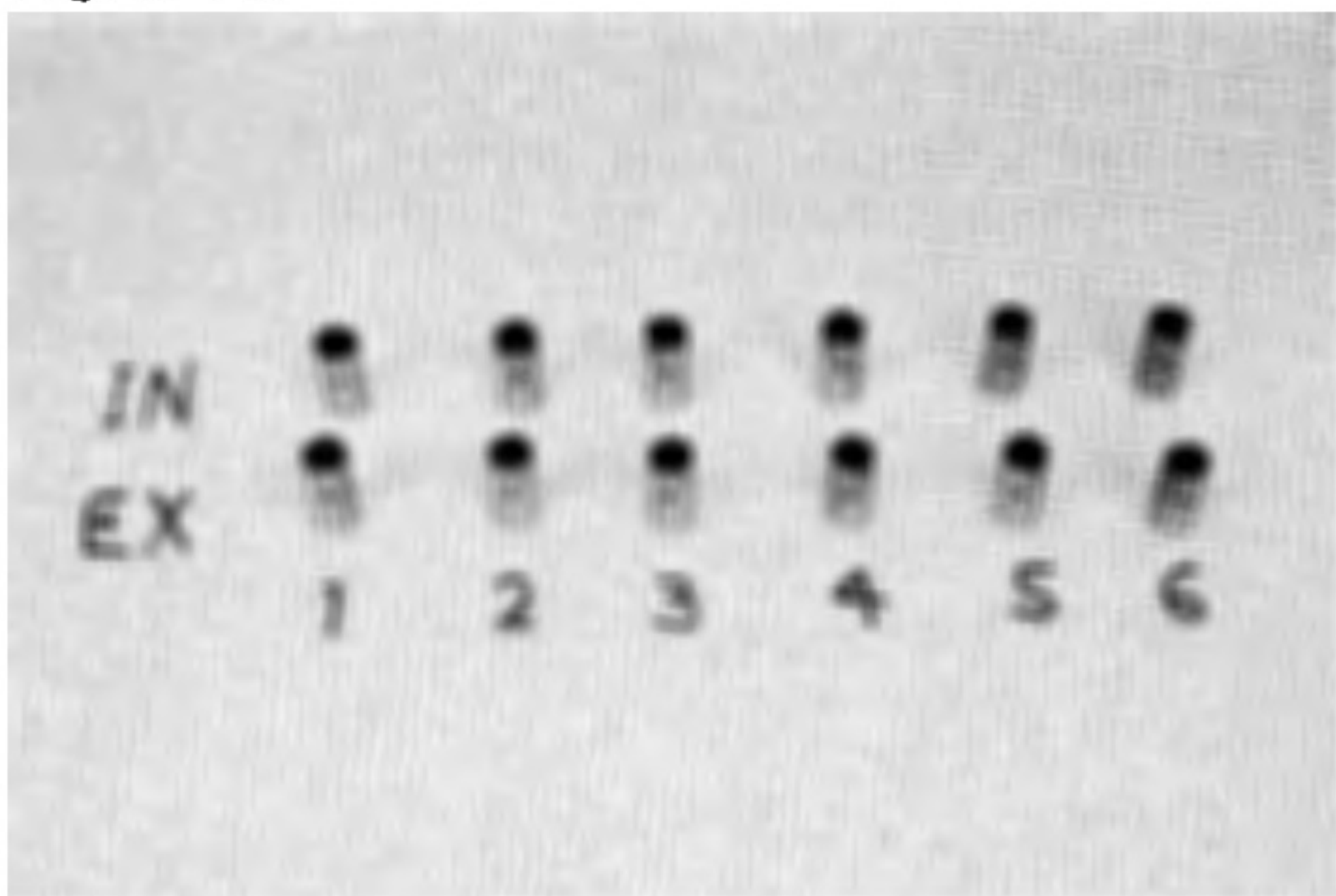
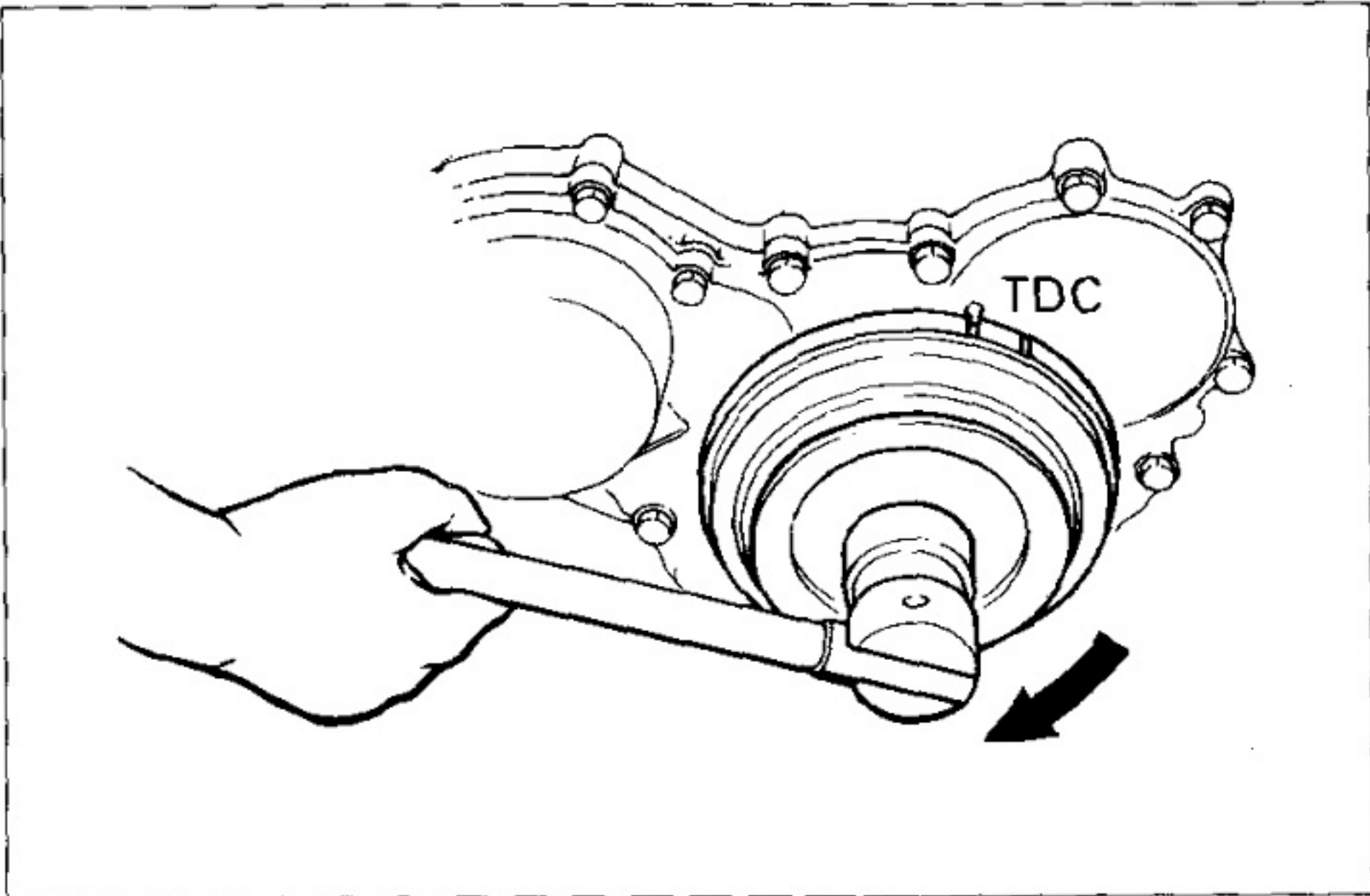


Fig. 3-72



Keep the valve lifters in correct order.

Fig. 3-73



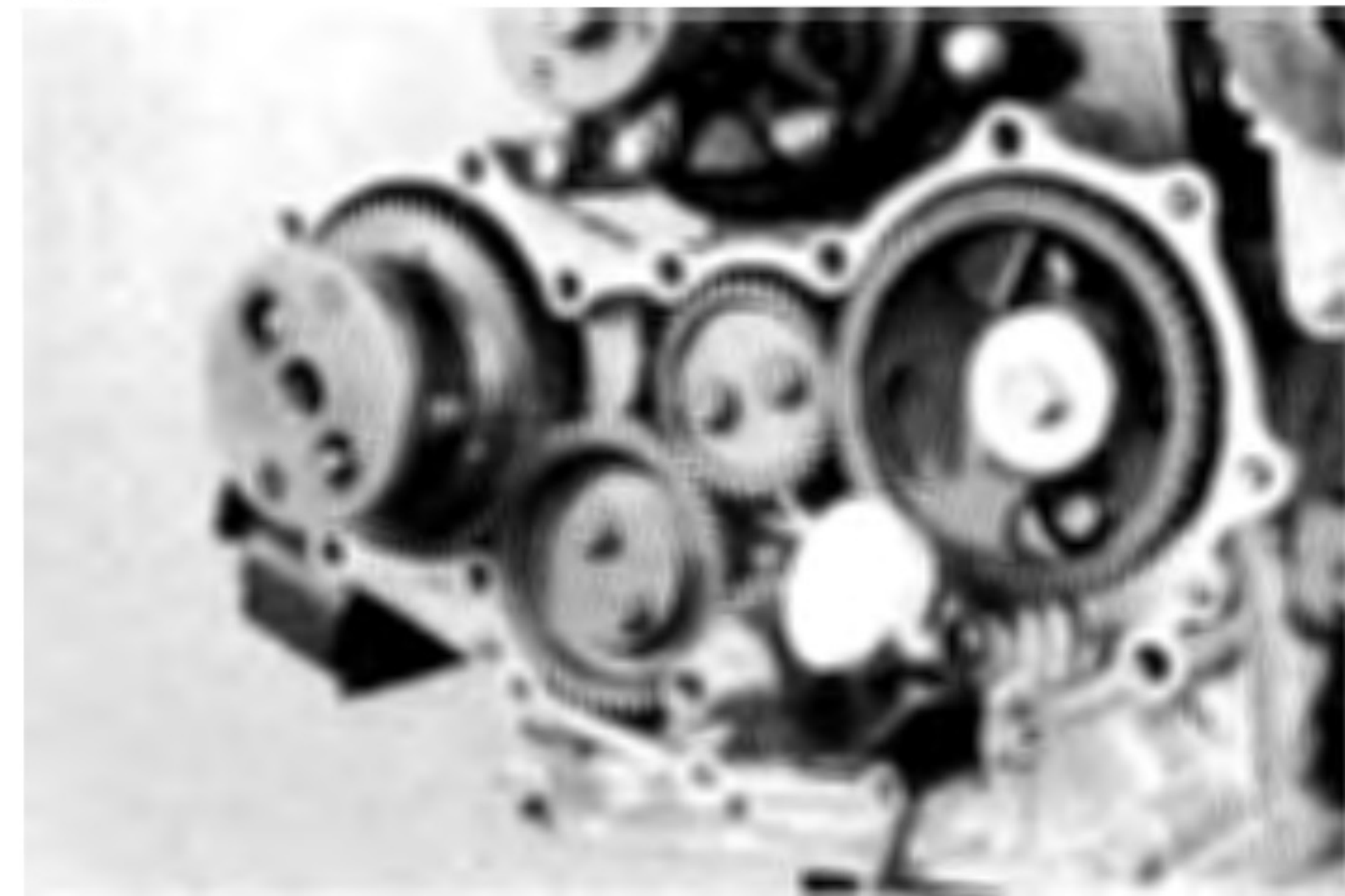
Before starting work, set No.1 cylinder piston to TDC/compression.

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.

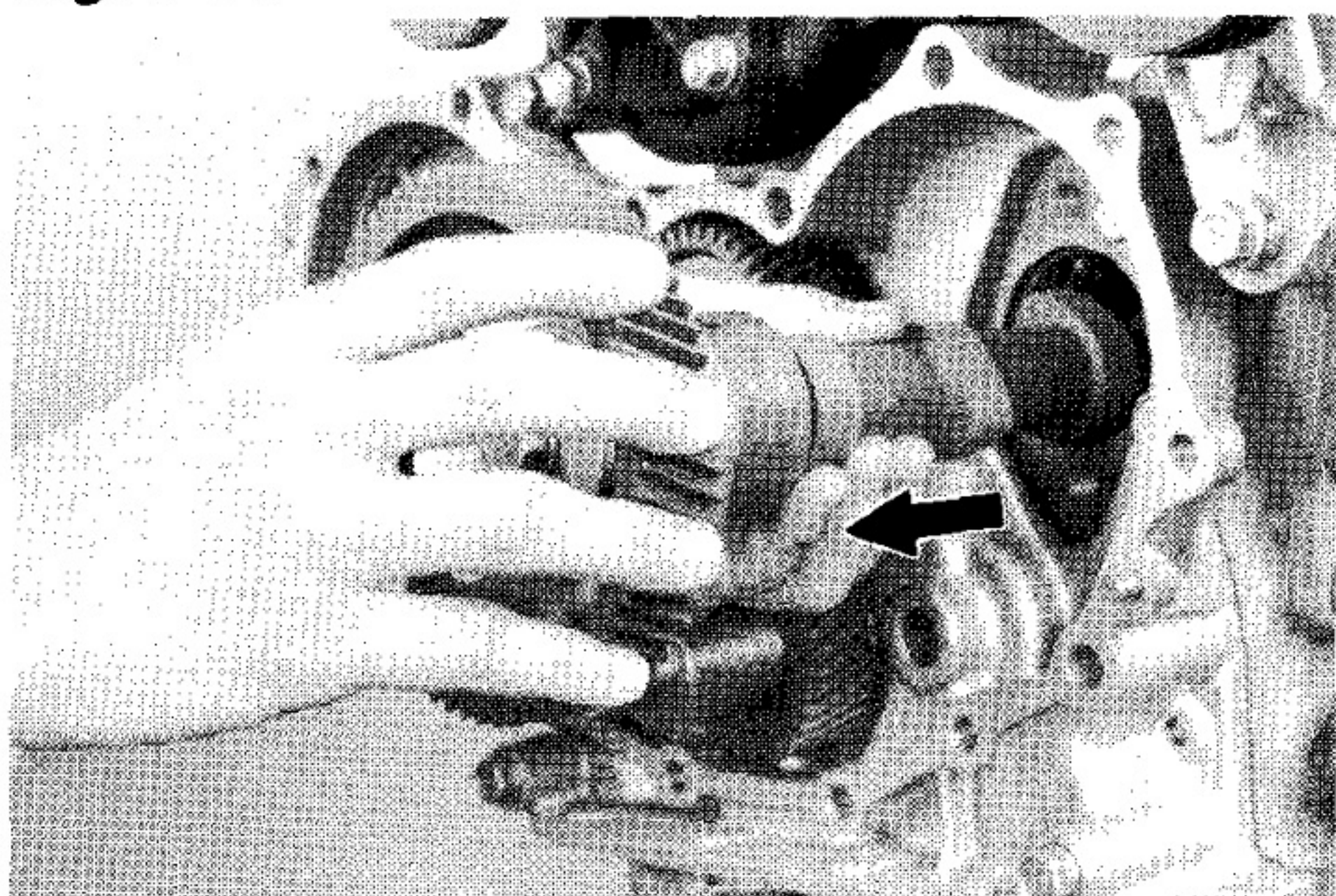
—Note—
Be careful not to scratch the timer weight sliding surface.

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



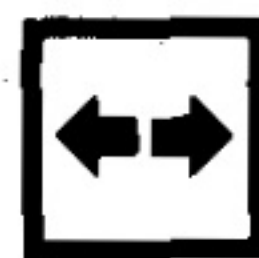
- Measure the idle gear thrust clearance.

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

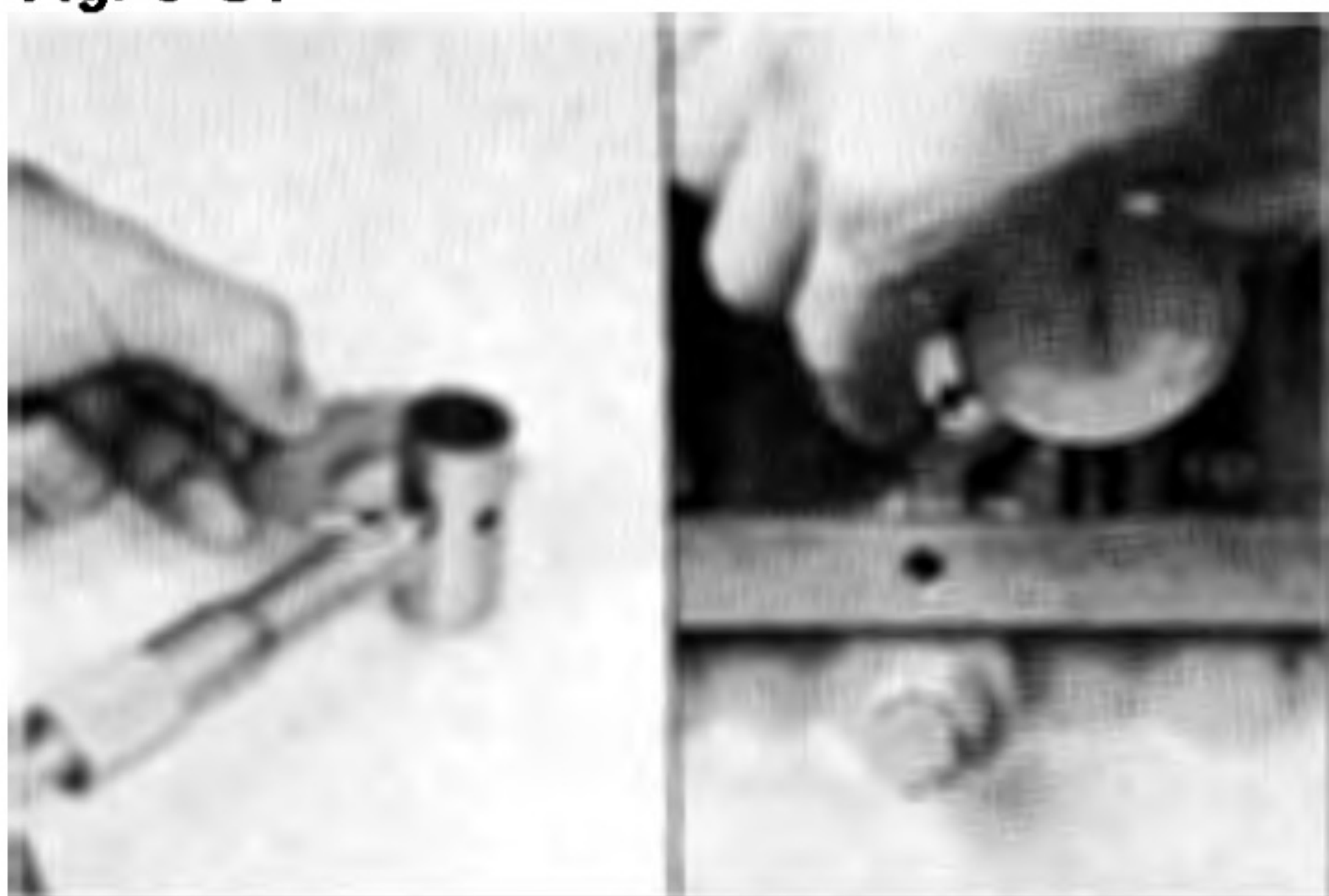


Fig. 3-82

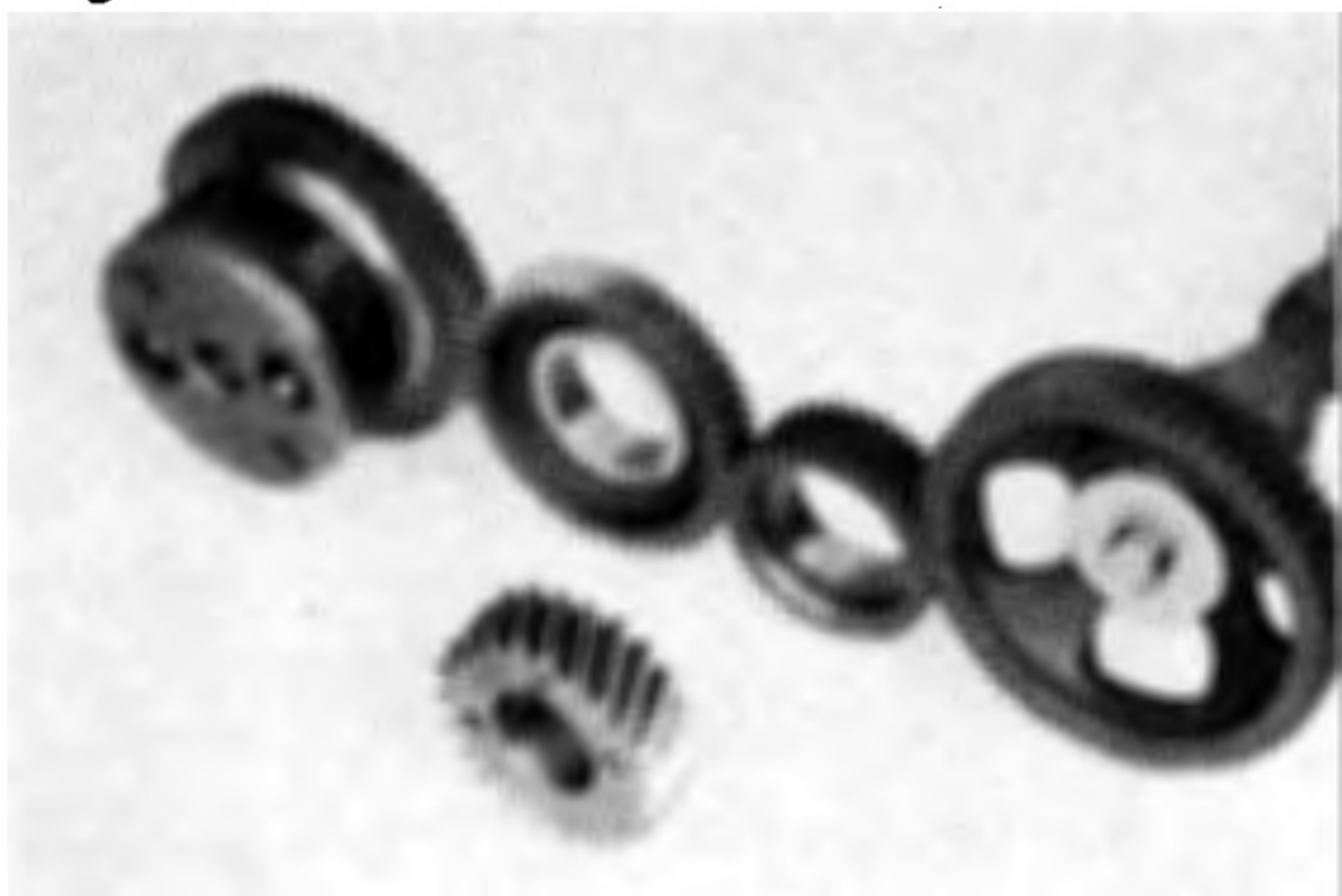


Fig. 3-83

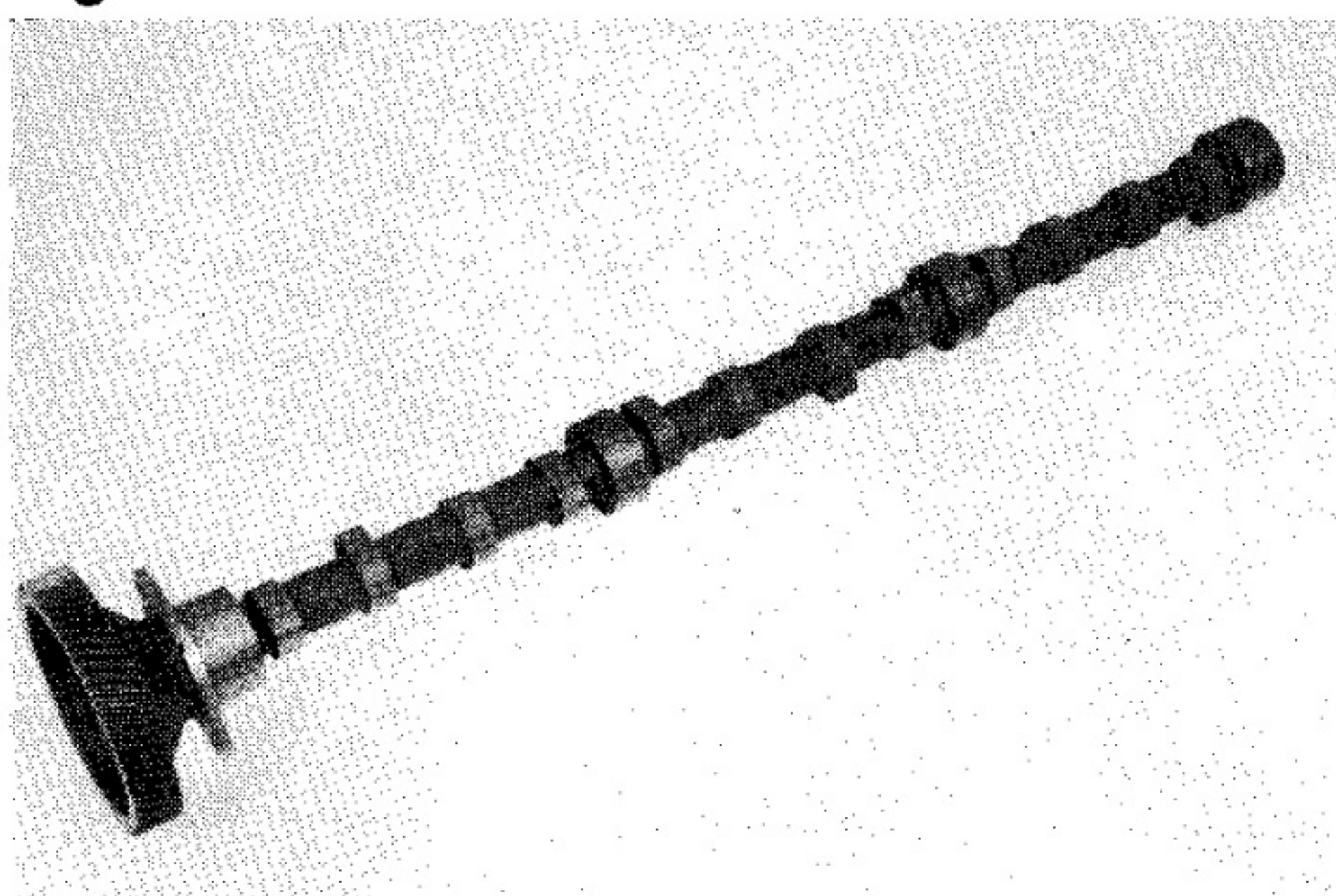
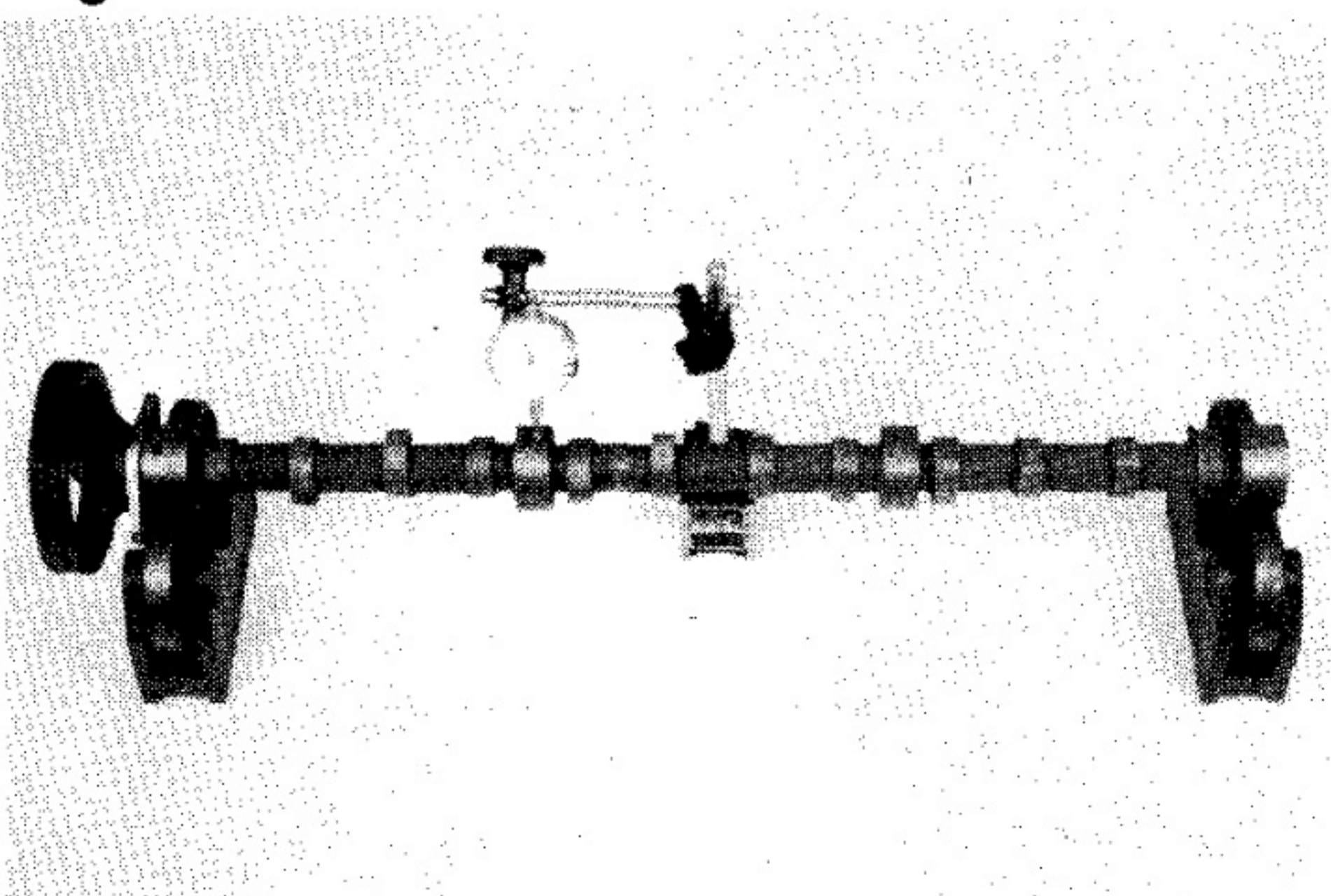


Fig. 3-84

**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.



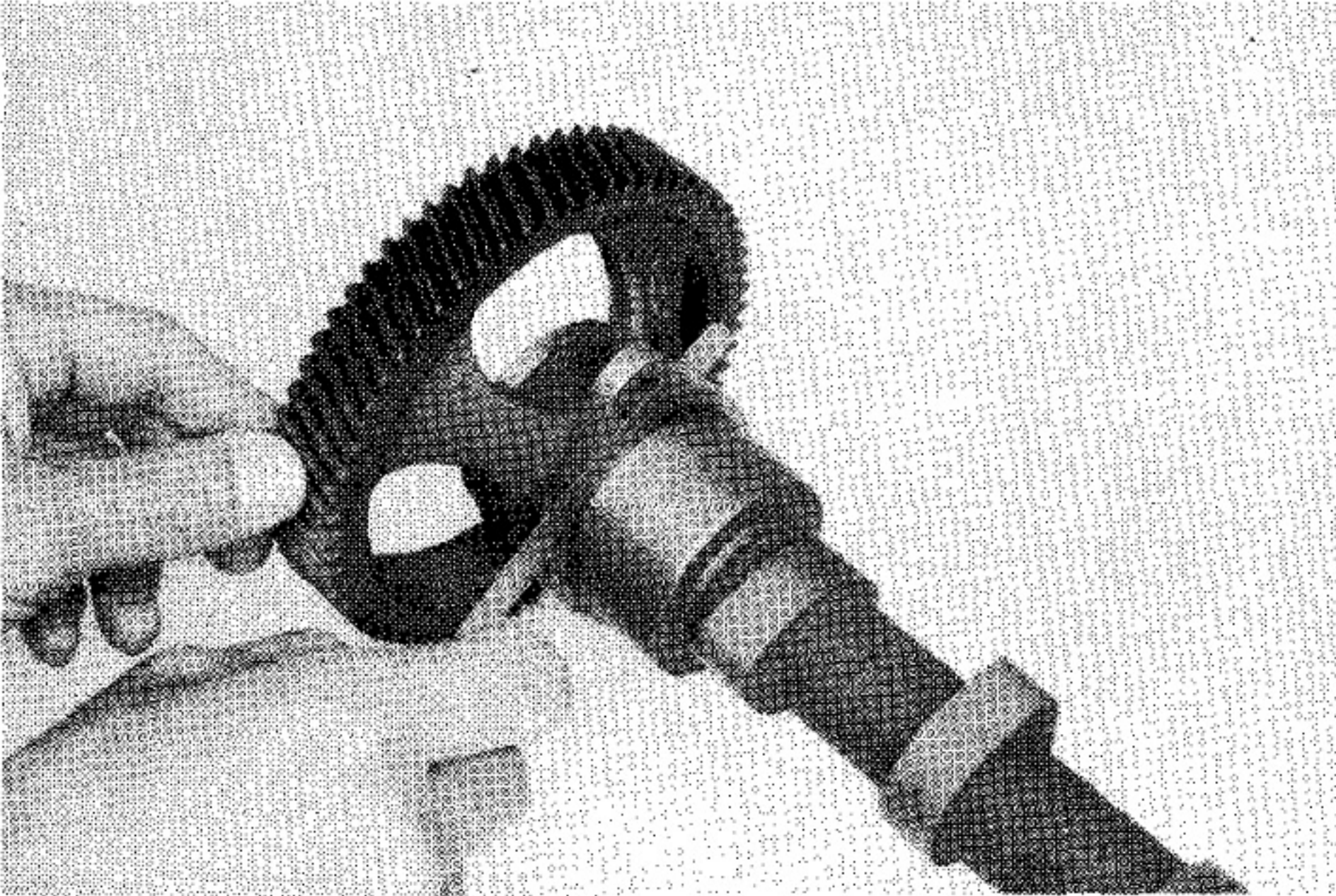
2. Check the camshaft for runout. Replace the camshaft if it exceeds the limit.

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.)

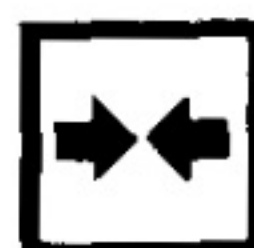
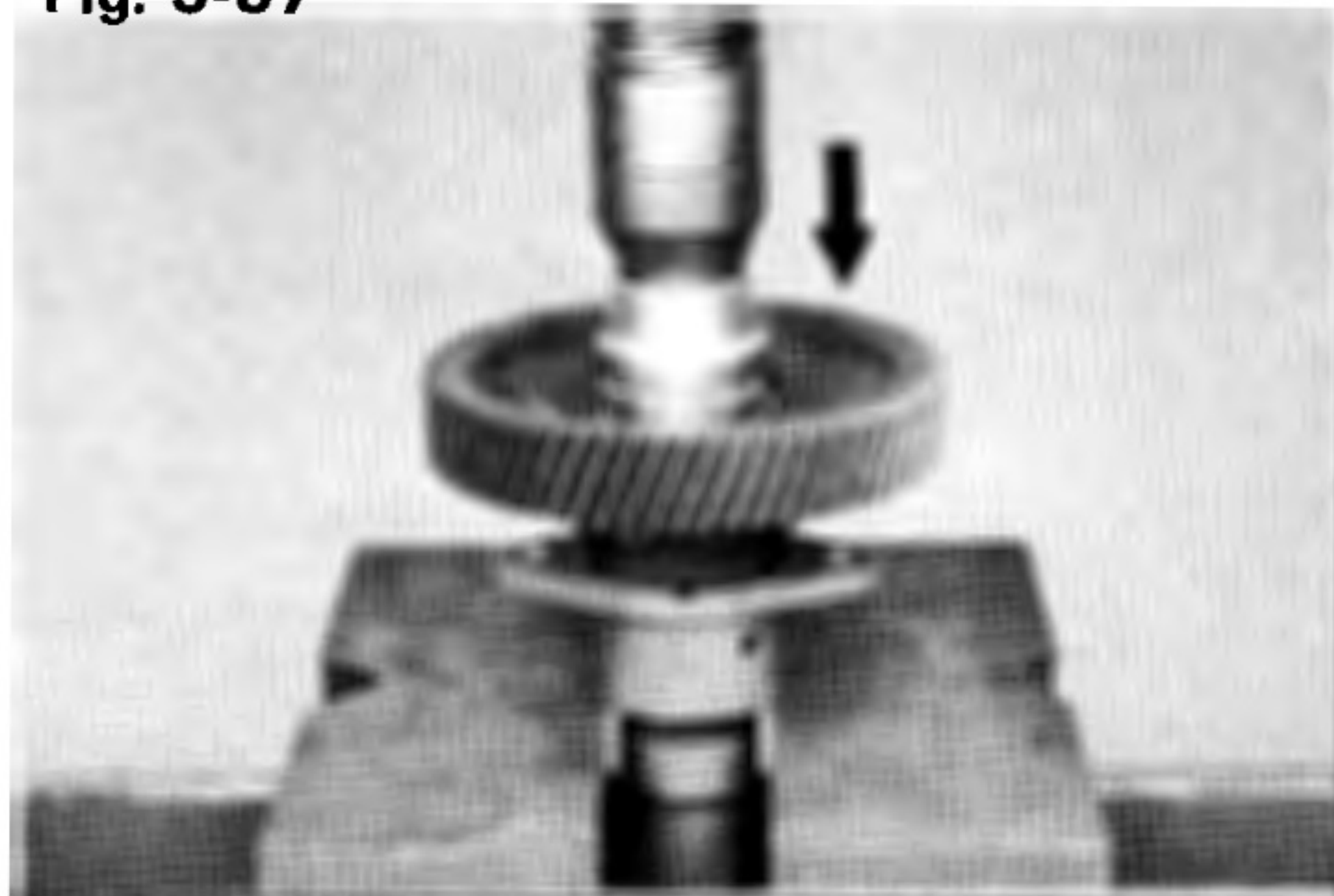
Fig. 3-86



4. Replace the thrust plate if the thrust clearance exceeds the limit.

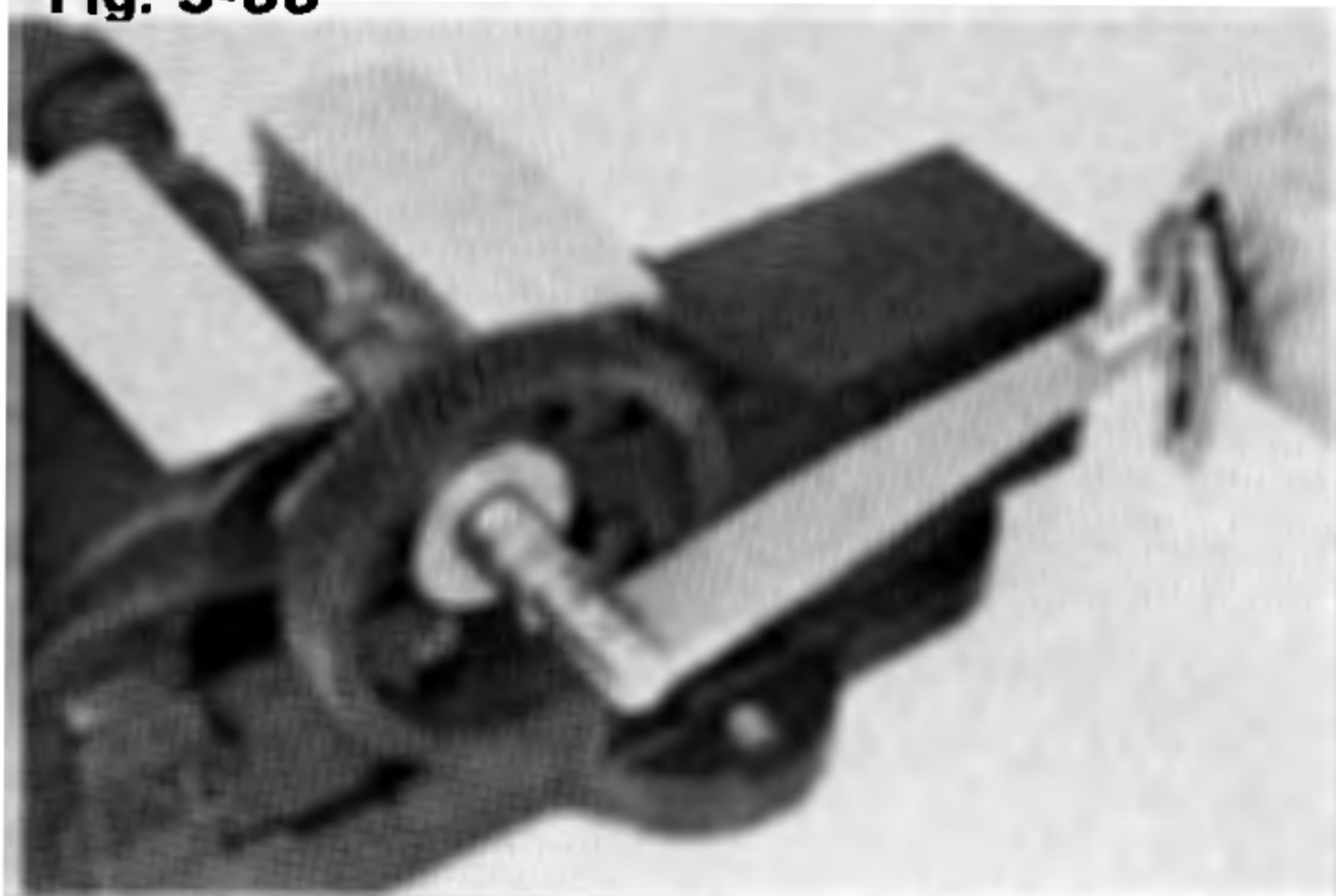
(1) Using a press and 19 mm socket wrench, press out the timing gear from the camshaft.

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.

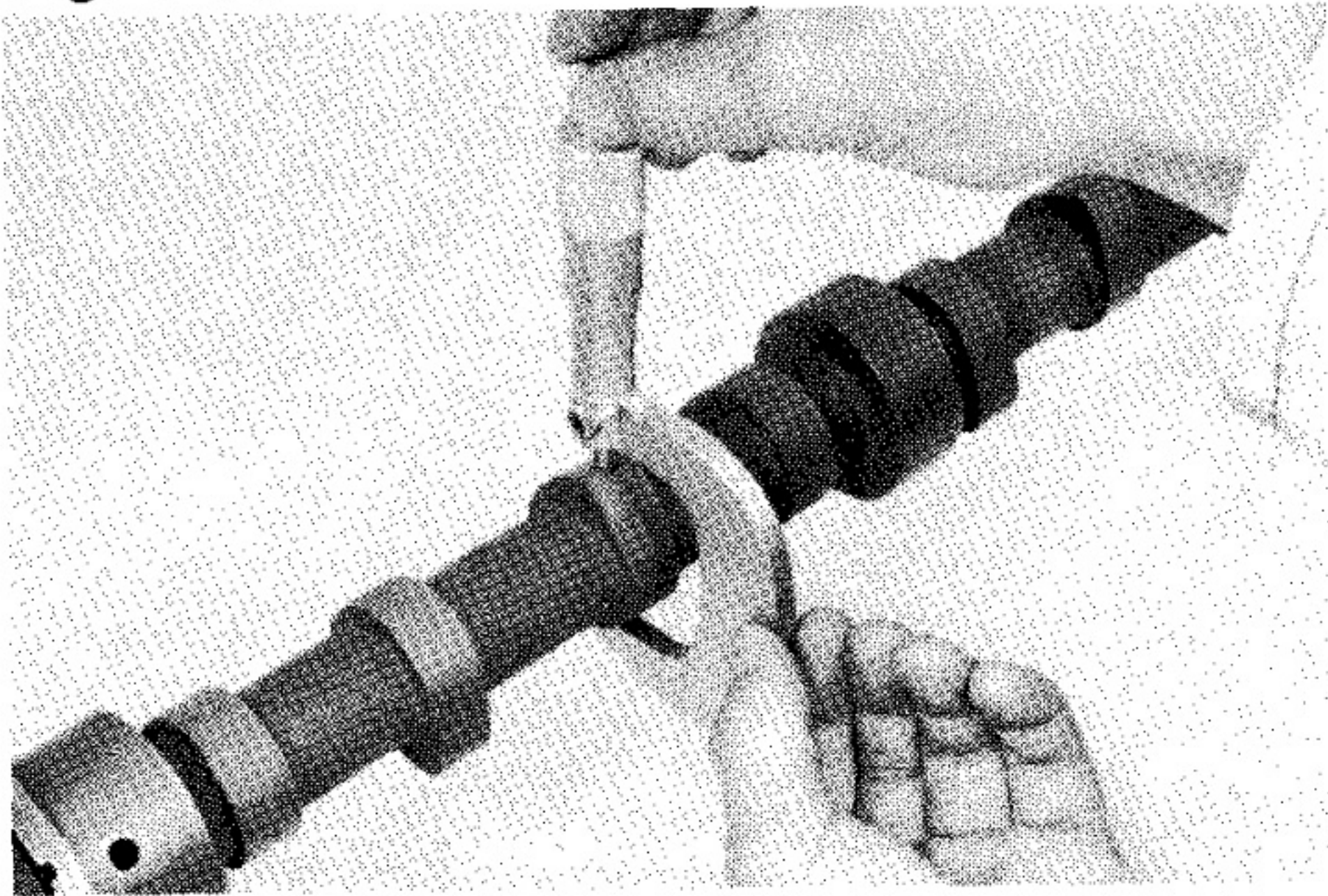
Tightening torque:

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

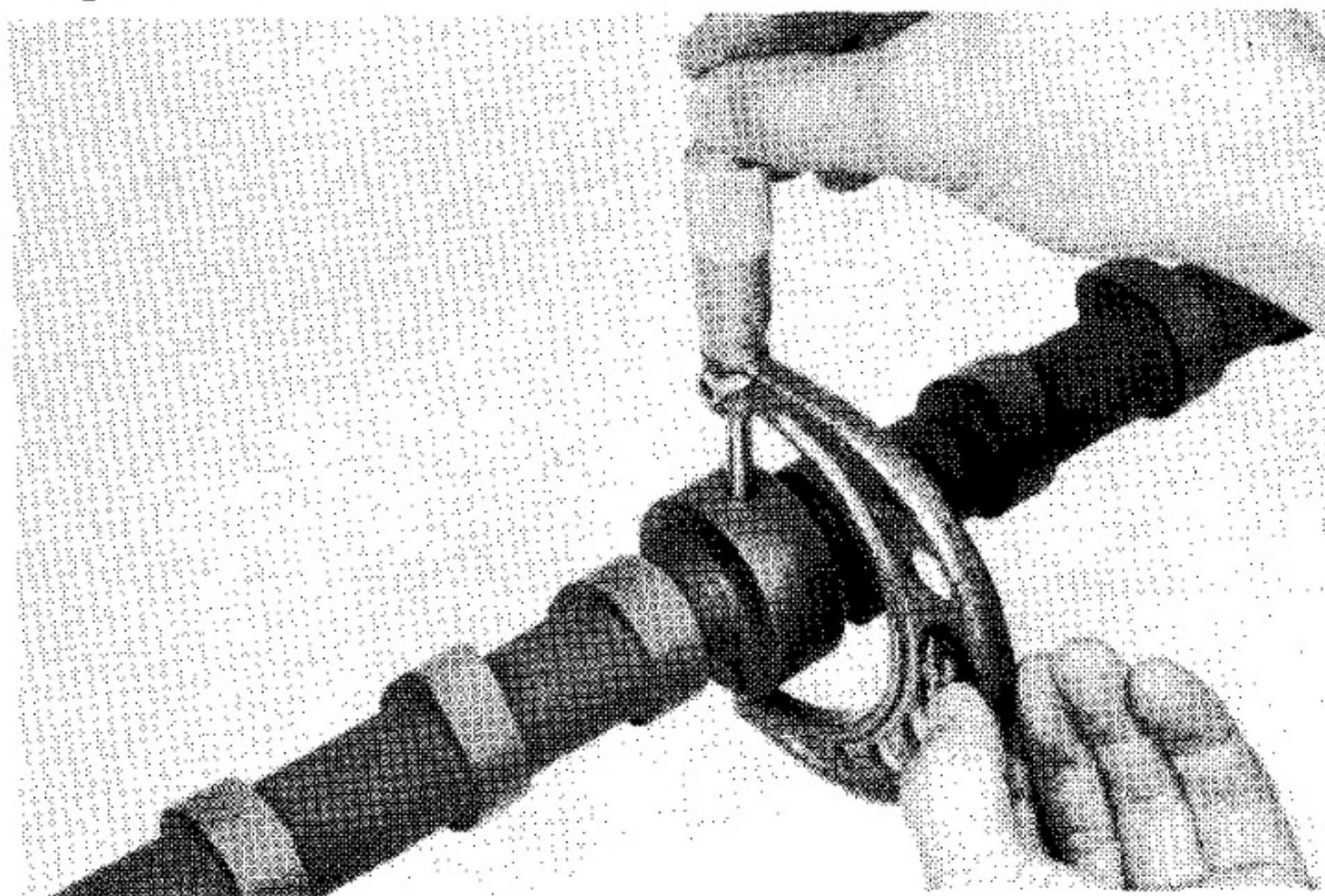


5. Measure the cam lobe height.

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

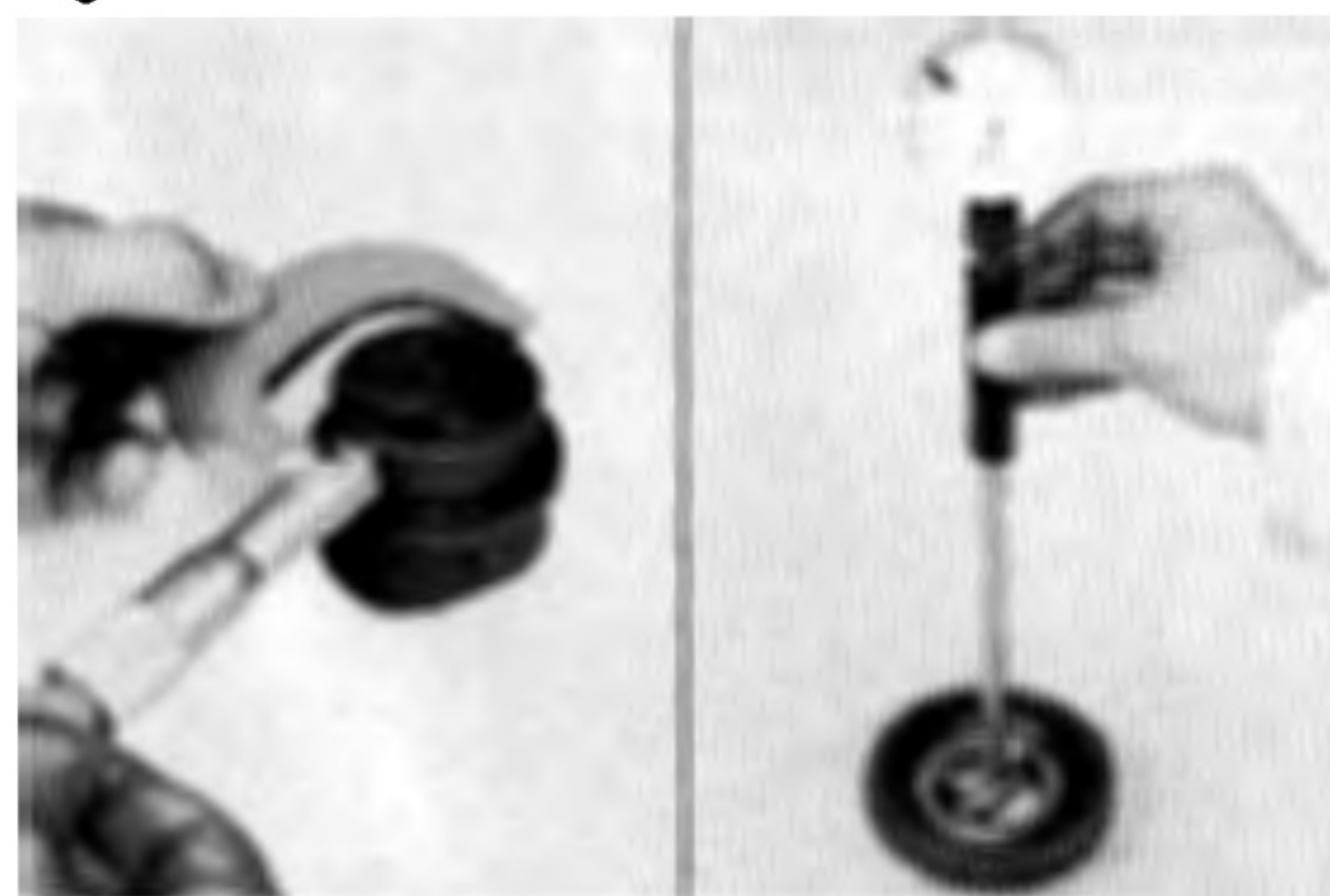


- (2) Measure the bearing inner diameter, referring to CYLINDER BLOCK section.

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:

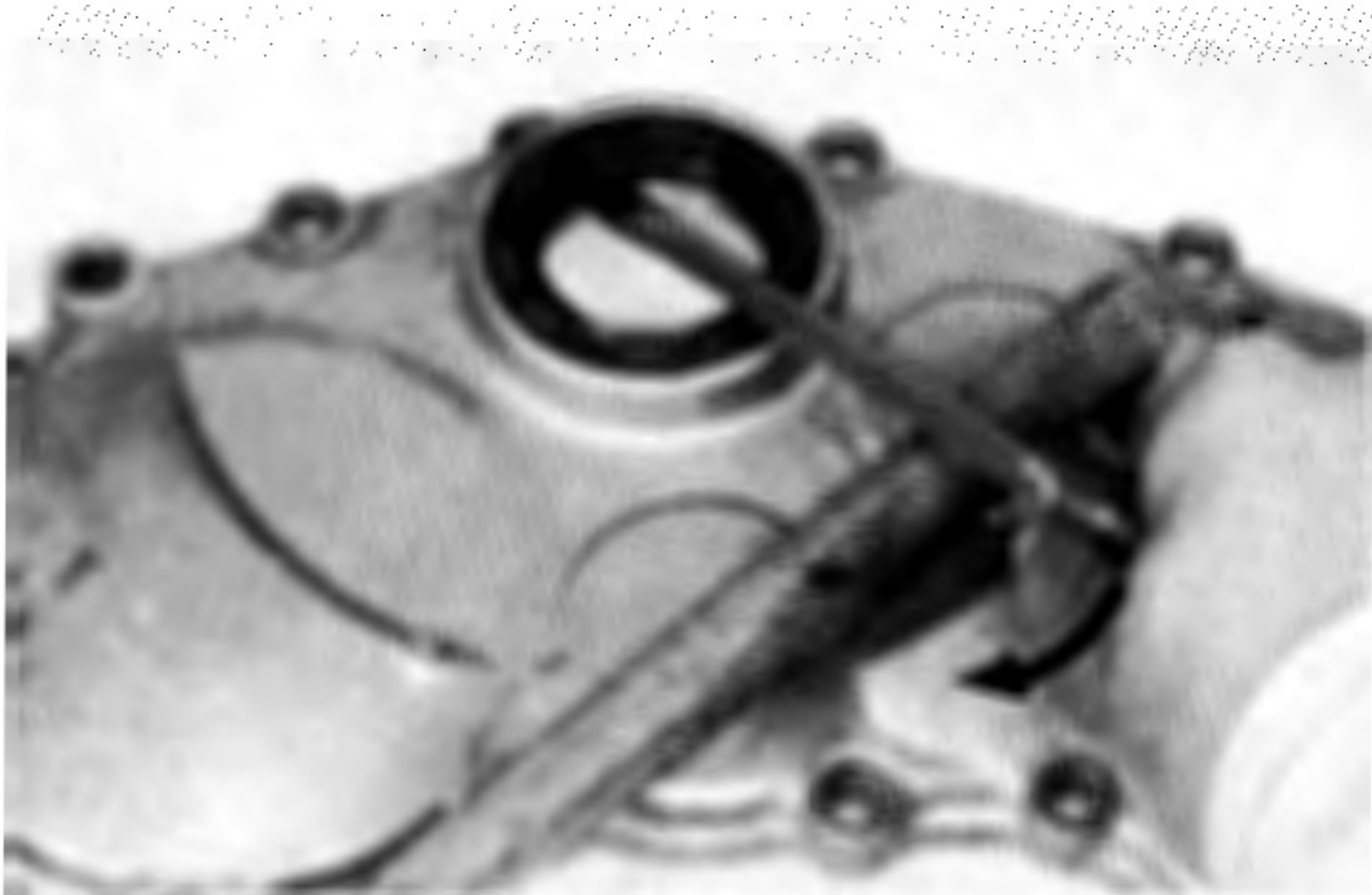
No.1 & No.2	45.00 – 45.25 mm (1.7717 – 1.7815 in.)
------------------------	---

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

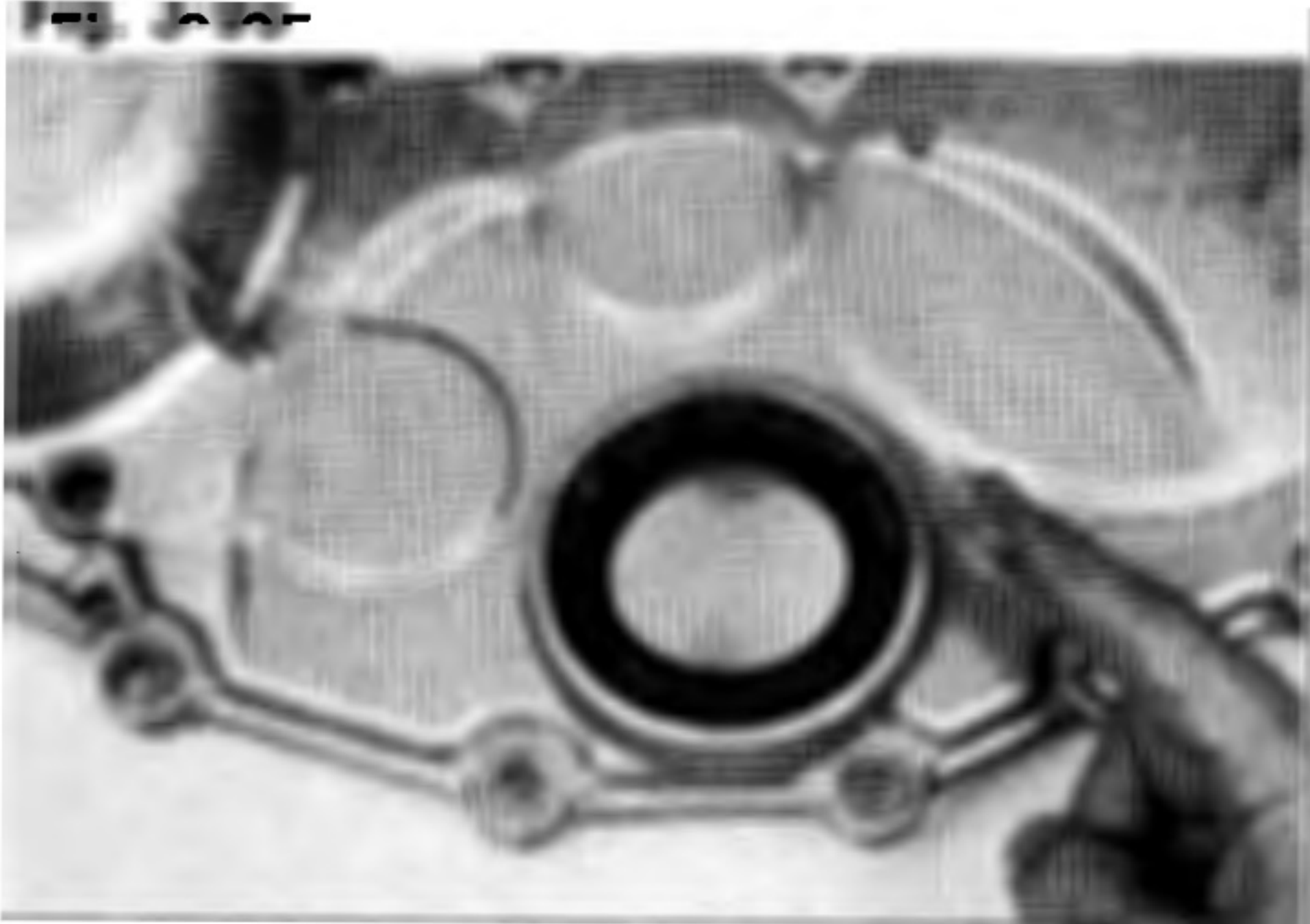


- (2) Install a new oil seal with SST.
SST [09223-46011]

—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.

Fig. 3-95



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

ASSEMBLY

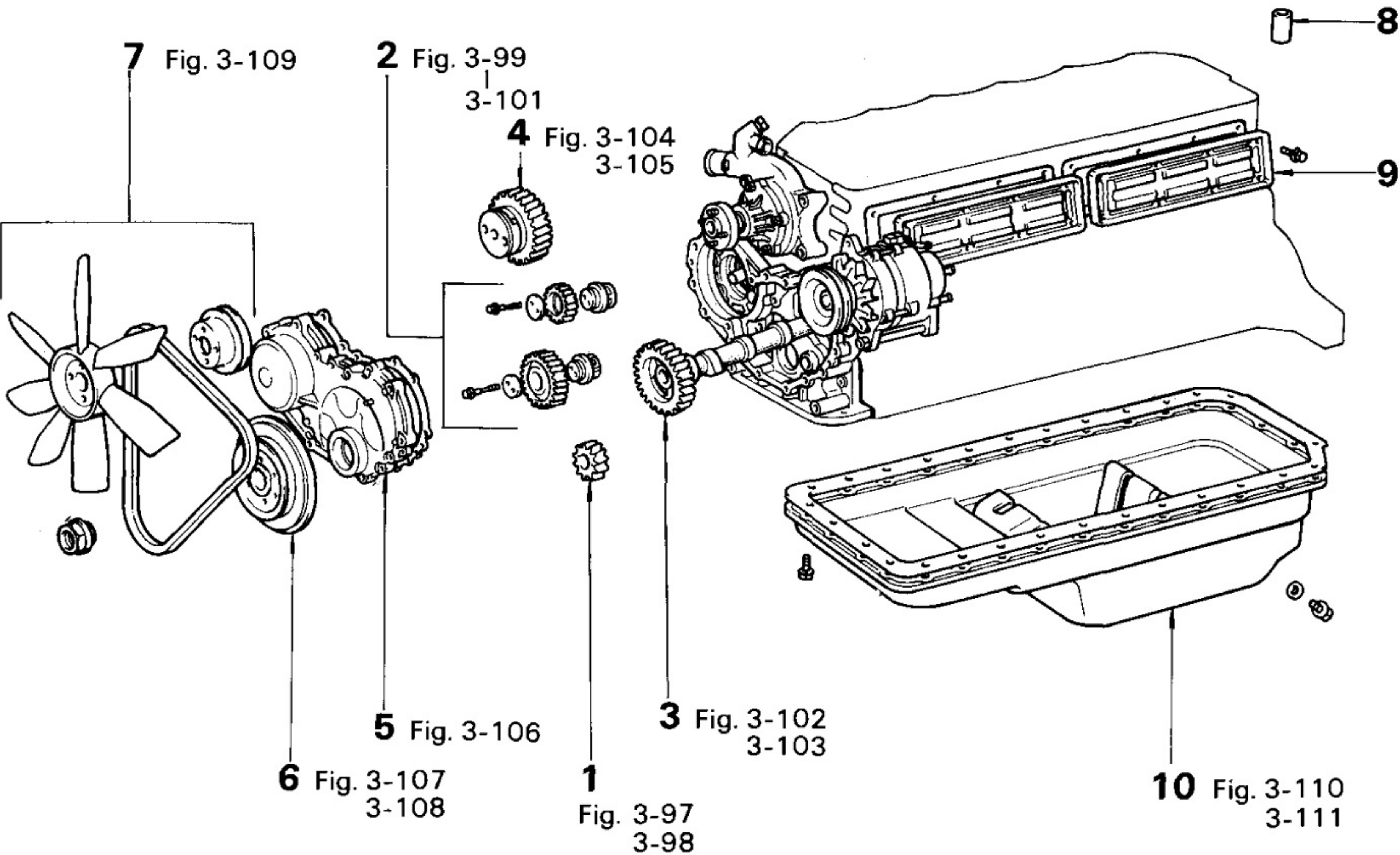
Assemble the parts in the numerical order shown in the figure.

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



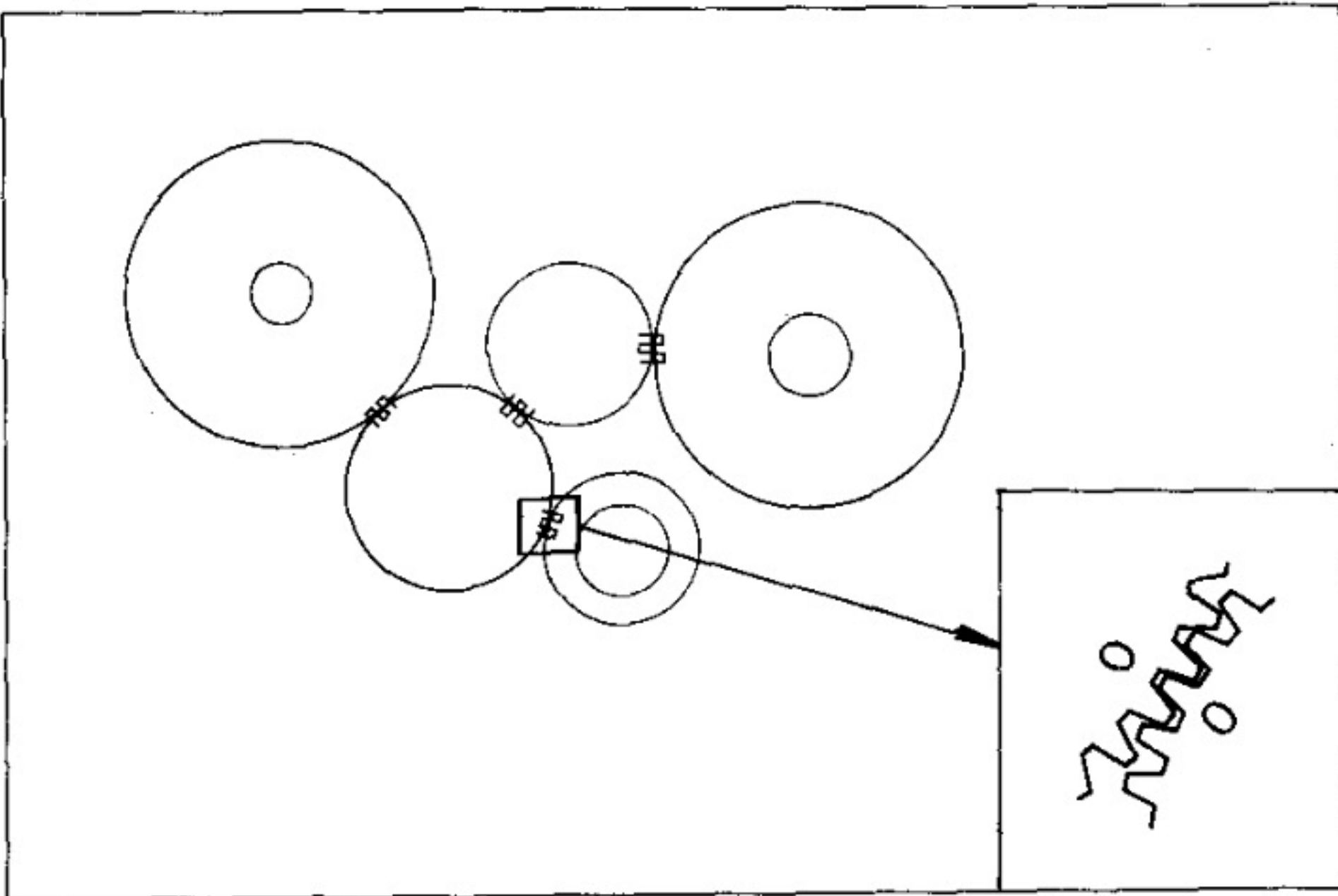
Drive in the crankshaft timing gear with SST.
SST [09608-35013]

Fig. 3-98



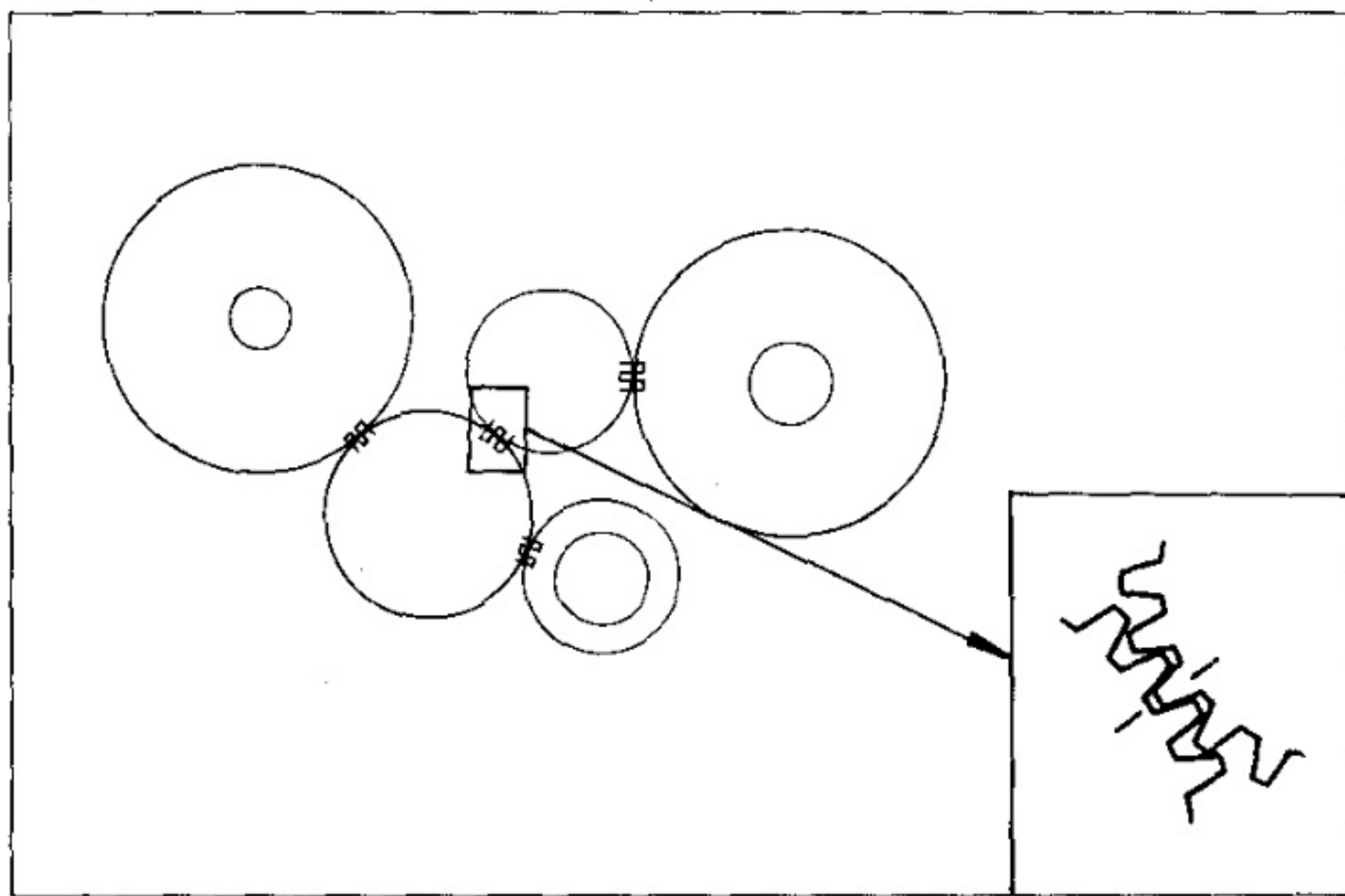
Set No.1 cylinder piston to TDC/compression.

Fig. 3-99



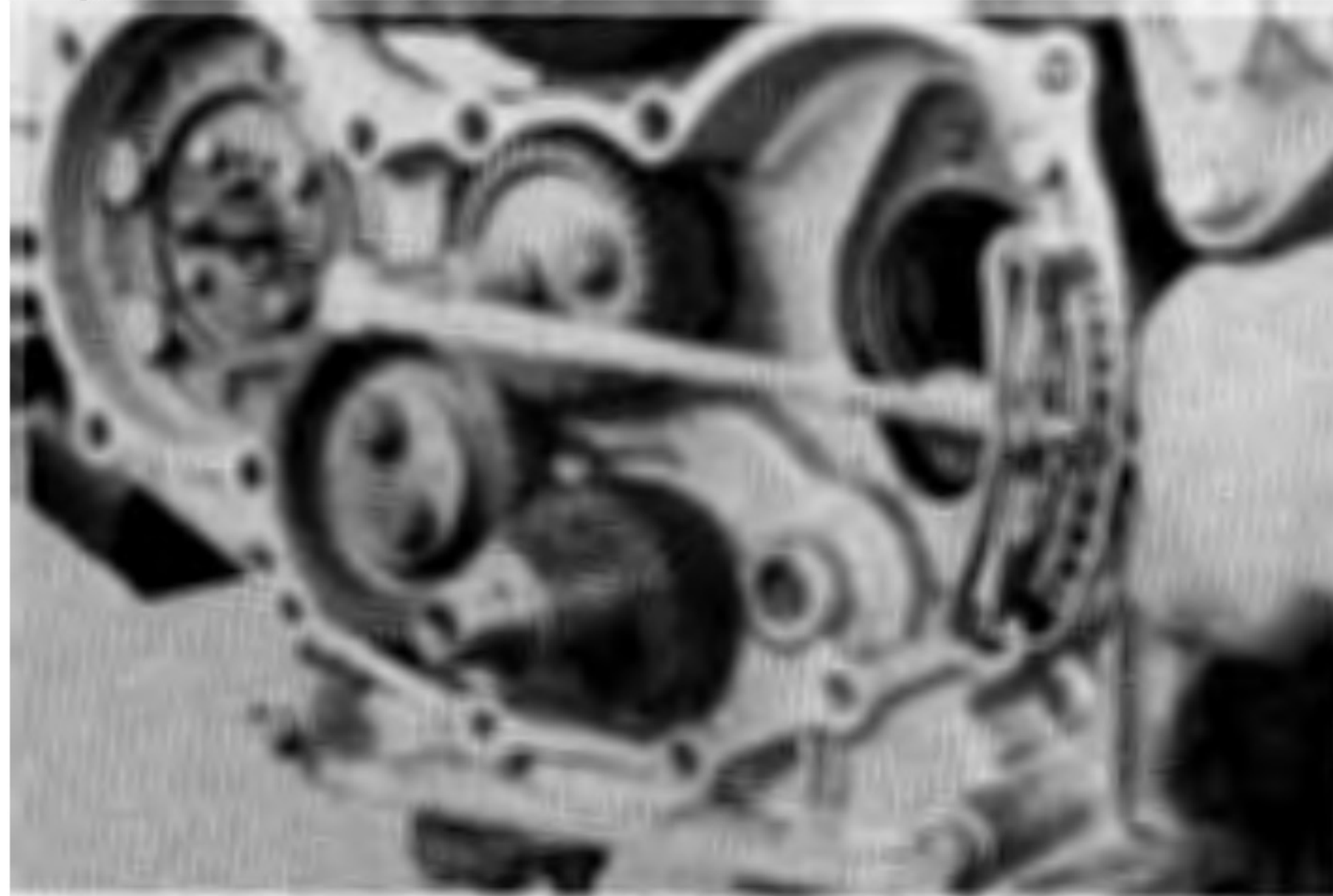
Align the matchmark of idle gear No.1 with that of the crankshaft timing gear.

Fig. 3-100



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

Fig. 3-101

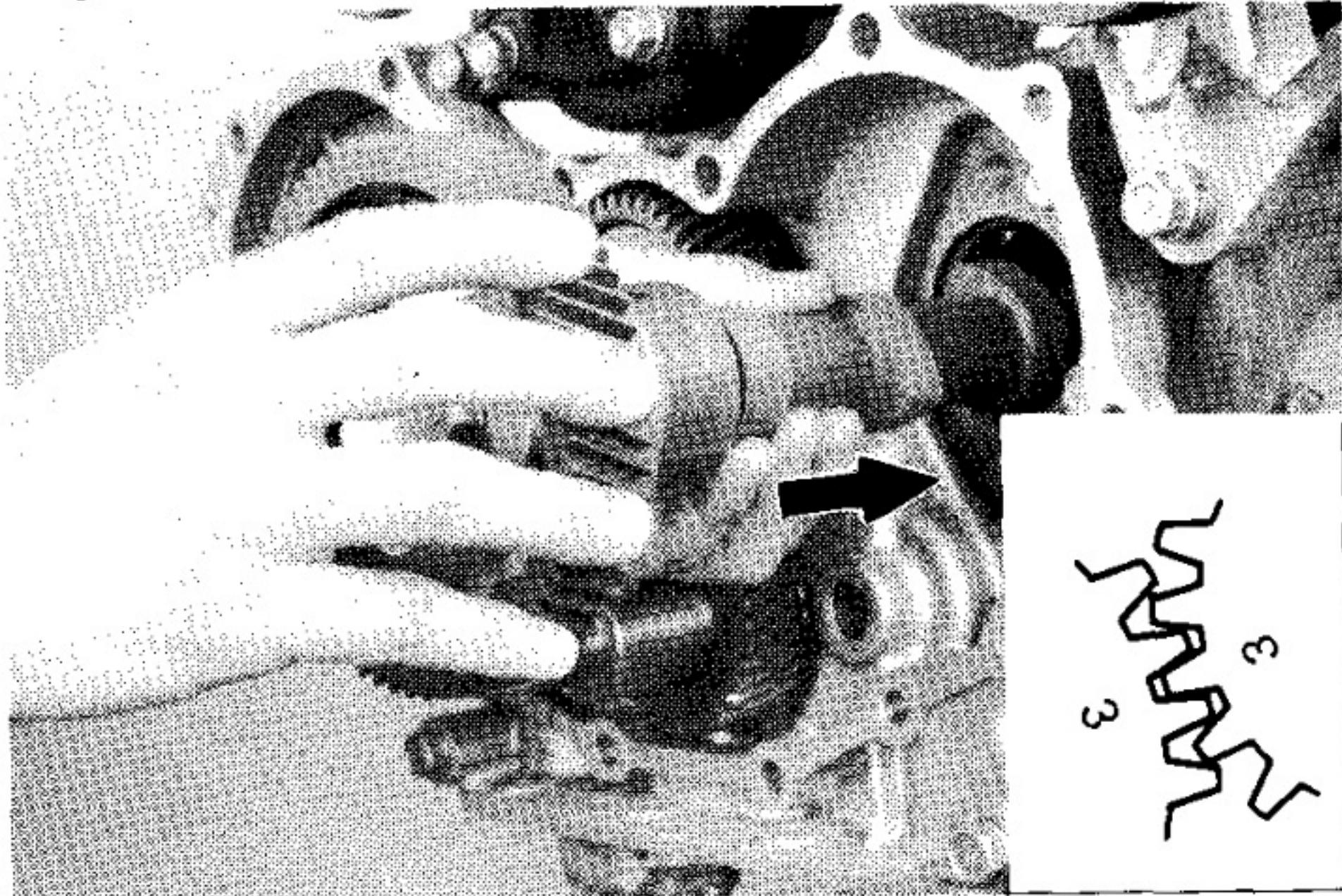


Tighten the idle gear and shaft.

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.

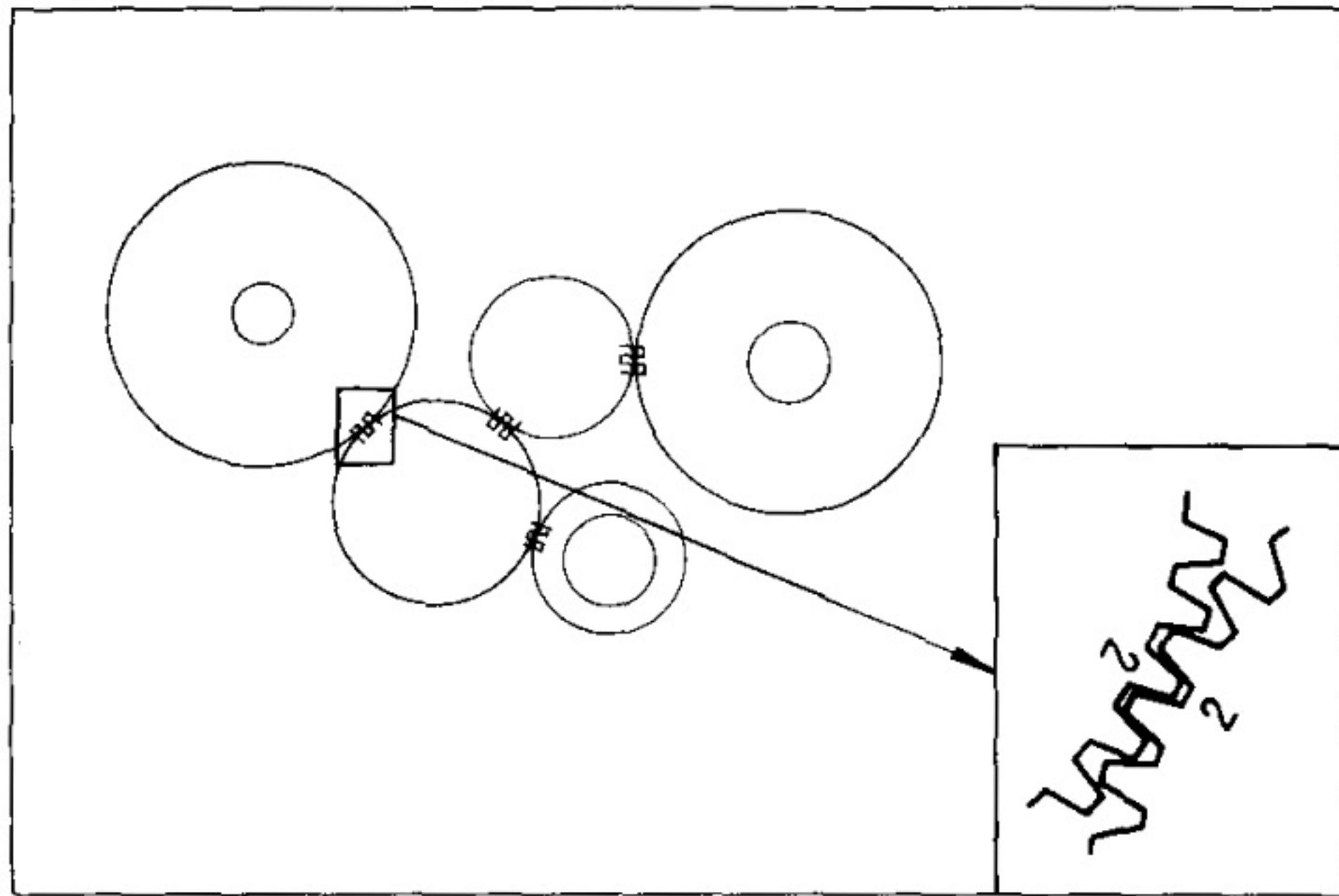
Fig. 3-103



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]

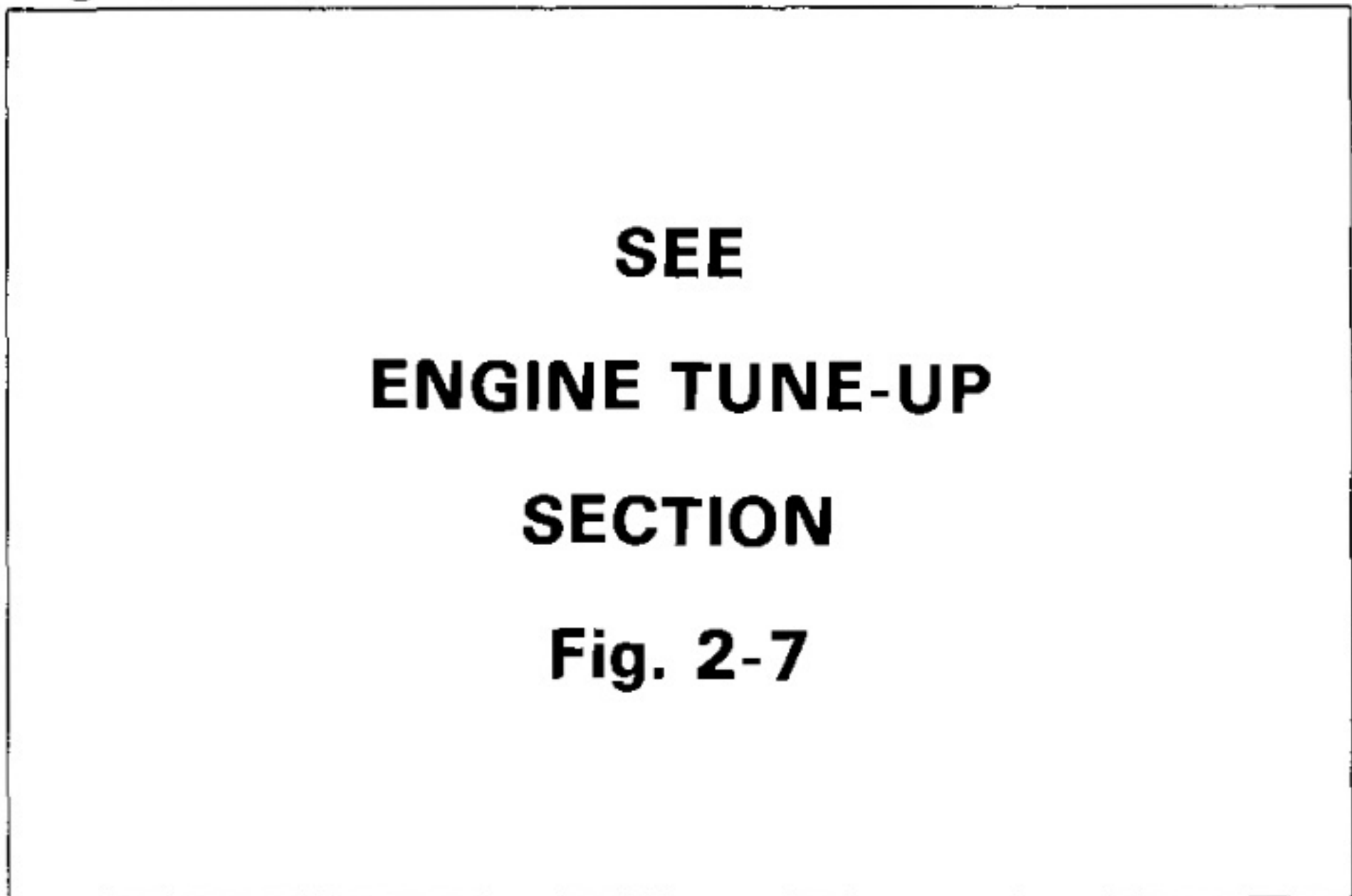
Fig. 3-108



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

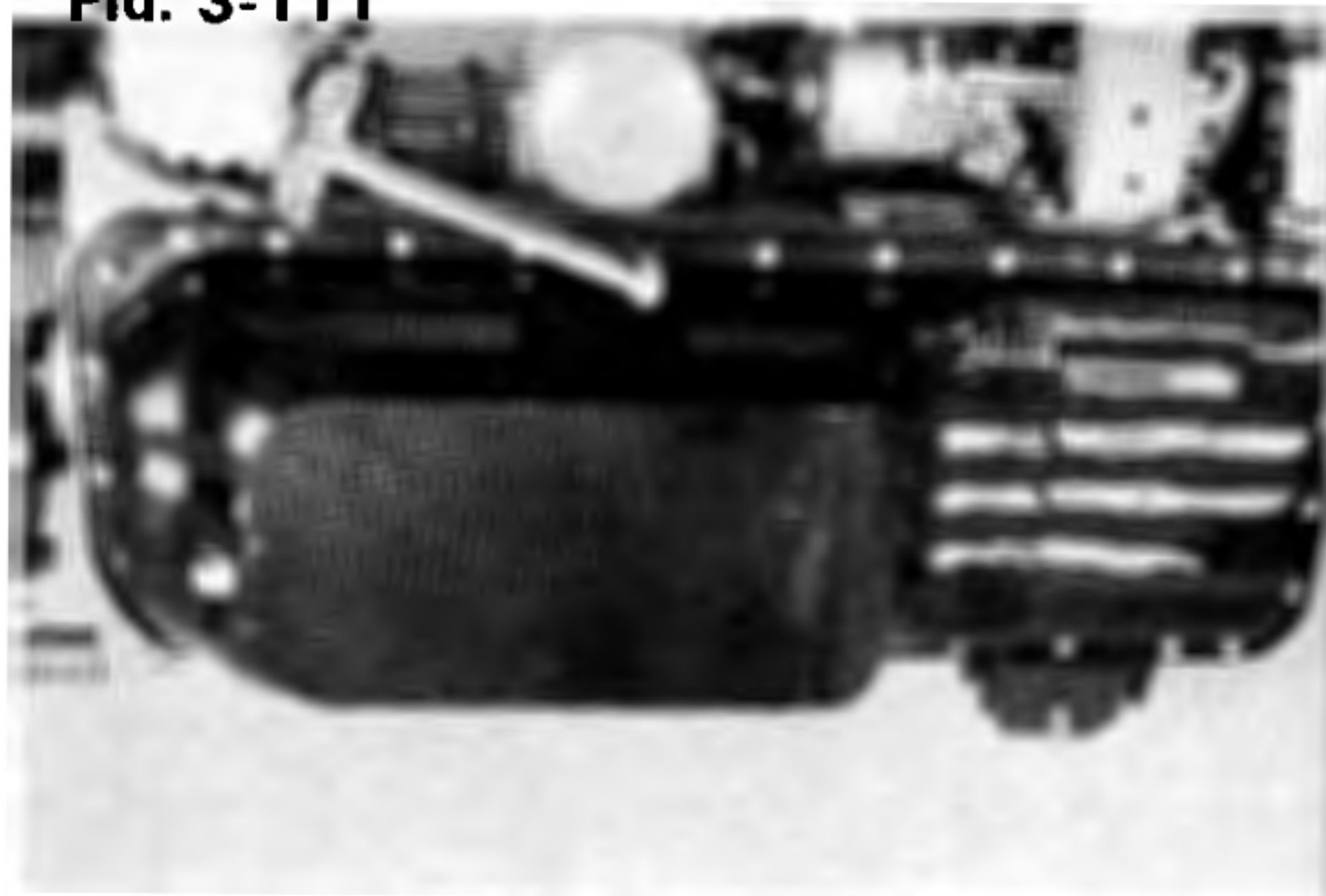
Adjust drive belt tension.

Fig. 3-110



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

Fig. 3-111



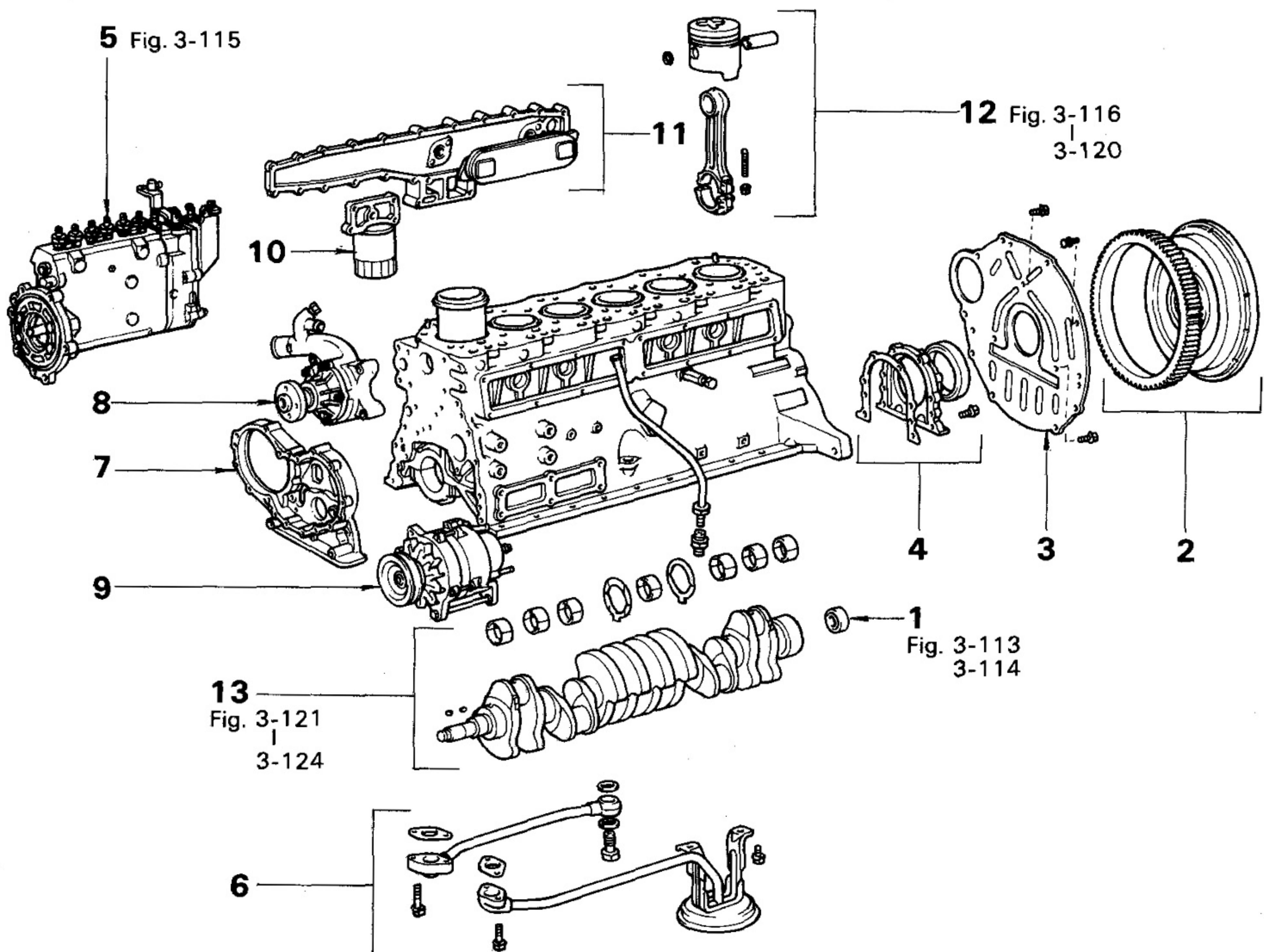
Install the oil pan.
Tightening torque: 1.0 – 1.6 kg-m
(7 – 12 ft-lb)

CYLINDER BLOCK

DISASSEMBLY

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

Fig. 3-112



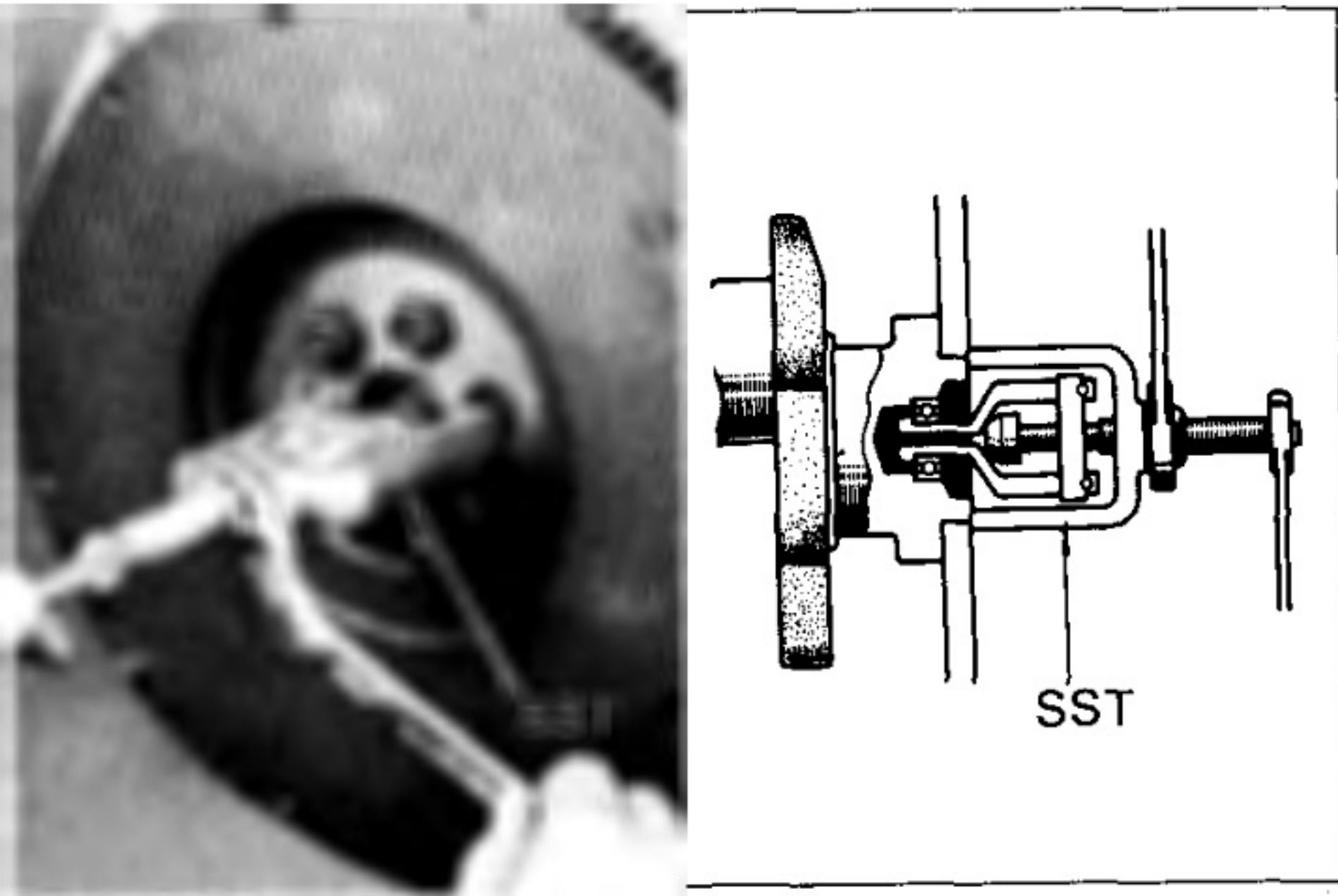
- | | |
|--------------------------------------|--------------------------------------|
| 1. Input Shaft Bearing | 8. Water Pump |
| 2. Flywheel | 9. Alternator |
| 3. Rear End Plate | 10. Oil Filter & Cap |
| 4. Rear Oil Seal & Retainer | 11. Water Inlet Housing & Oil Cooler |
| 5. Injection Pump with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

Fig. 3-113



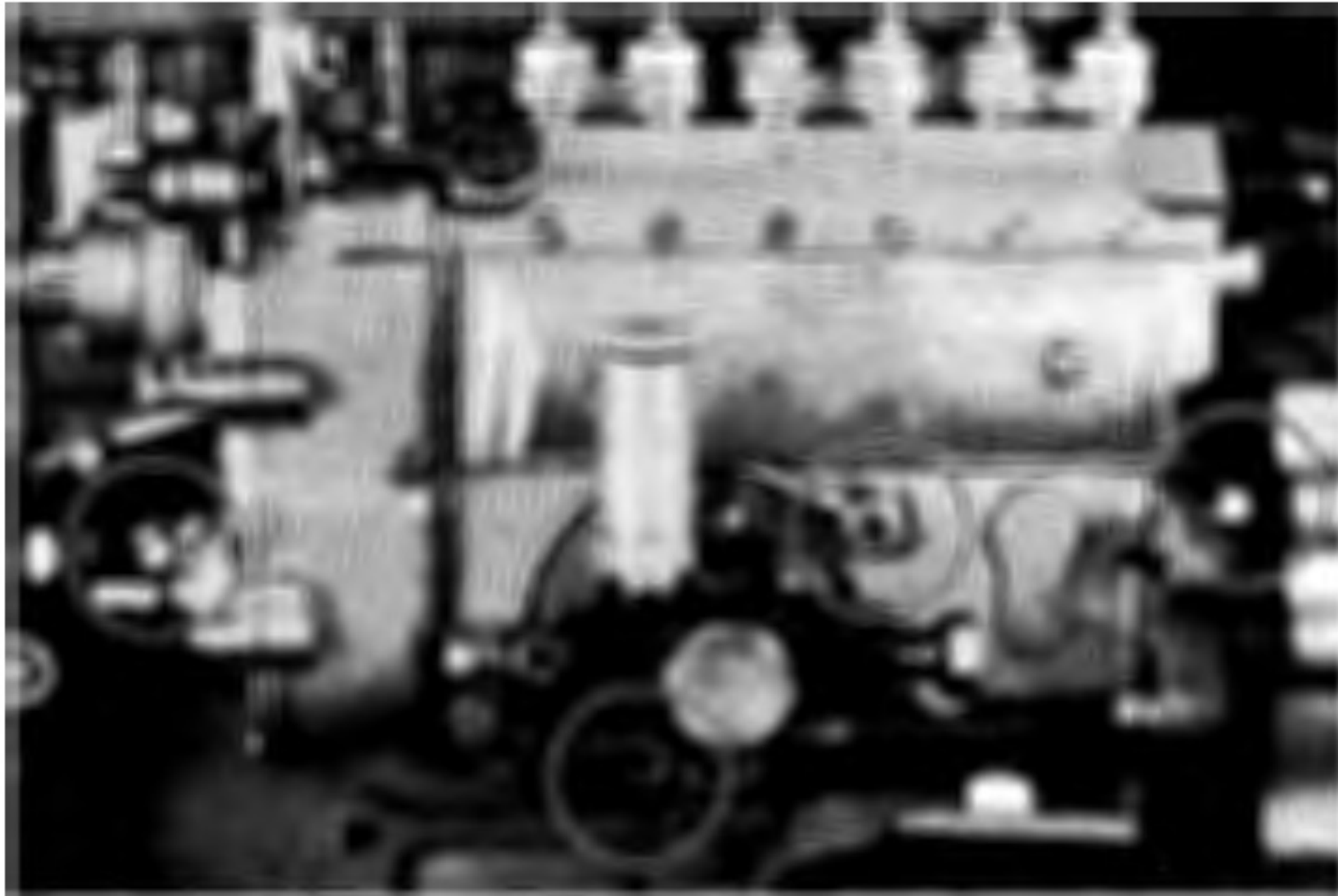
Check the input shaft bearing for wear.
Check to see that there is no drag on the bearing when it is turned.

Fig. 3-114



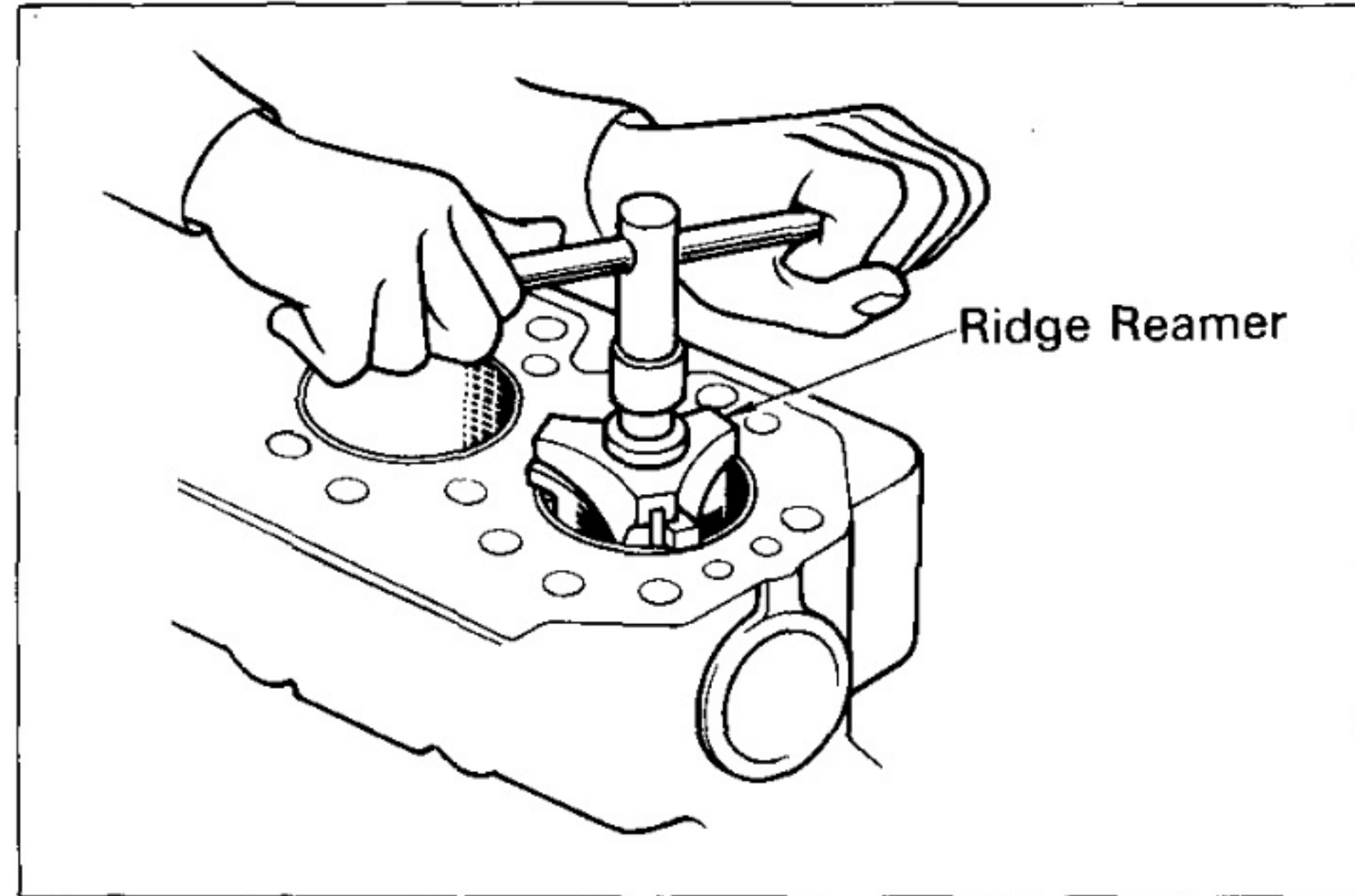
If necessary, remove the input shaft bearing with SST.
SST [09303-55010]

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



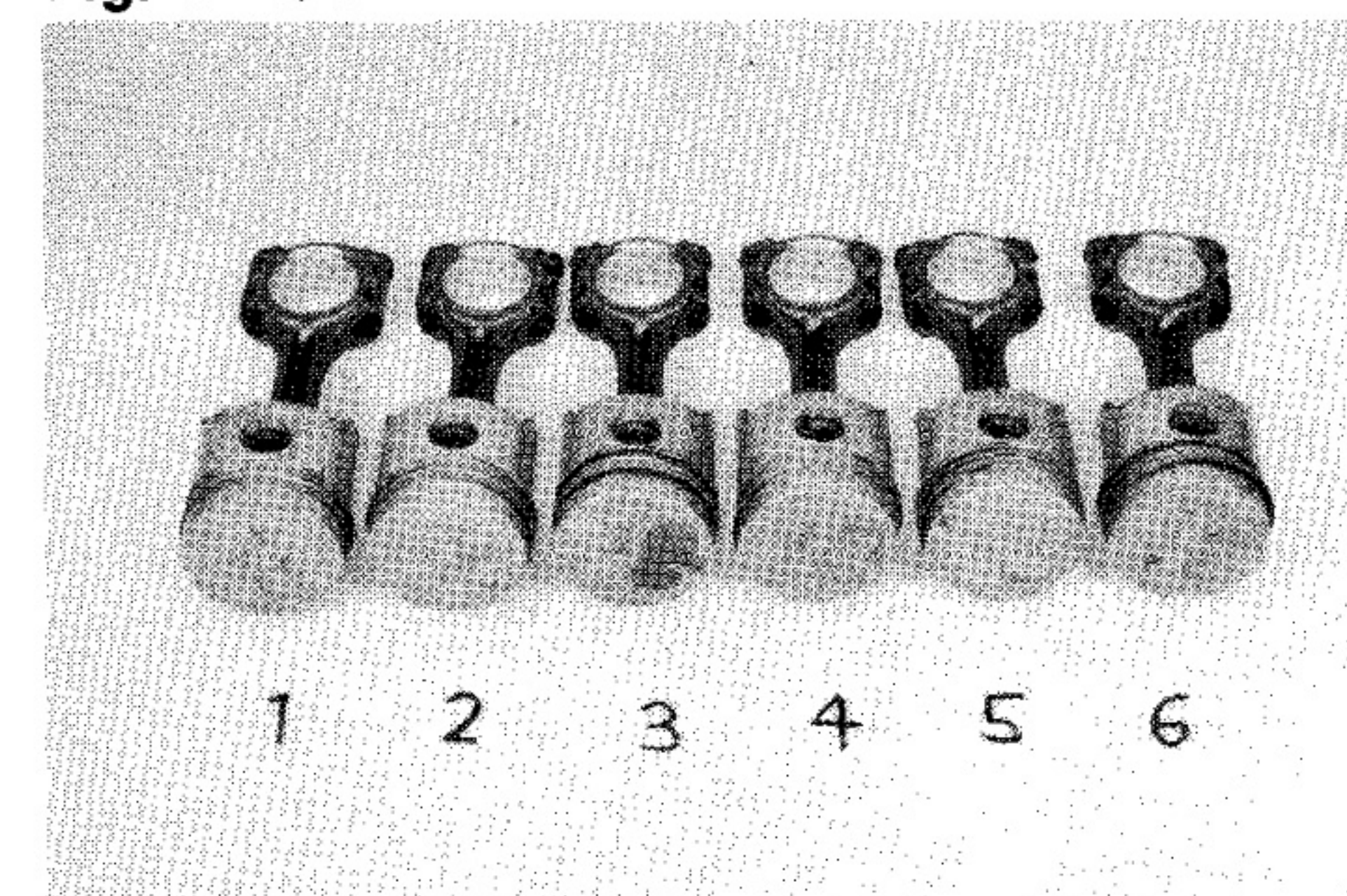
If the connecting rod cap is tight, lightly tap the stud bolt.

Fig. 3-119



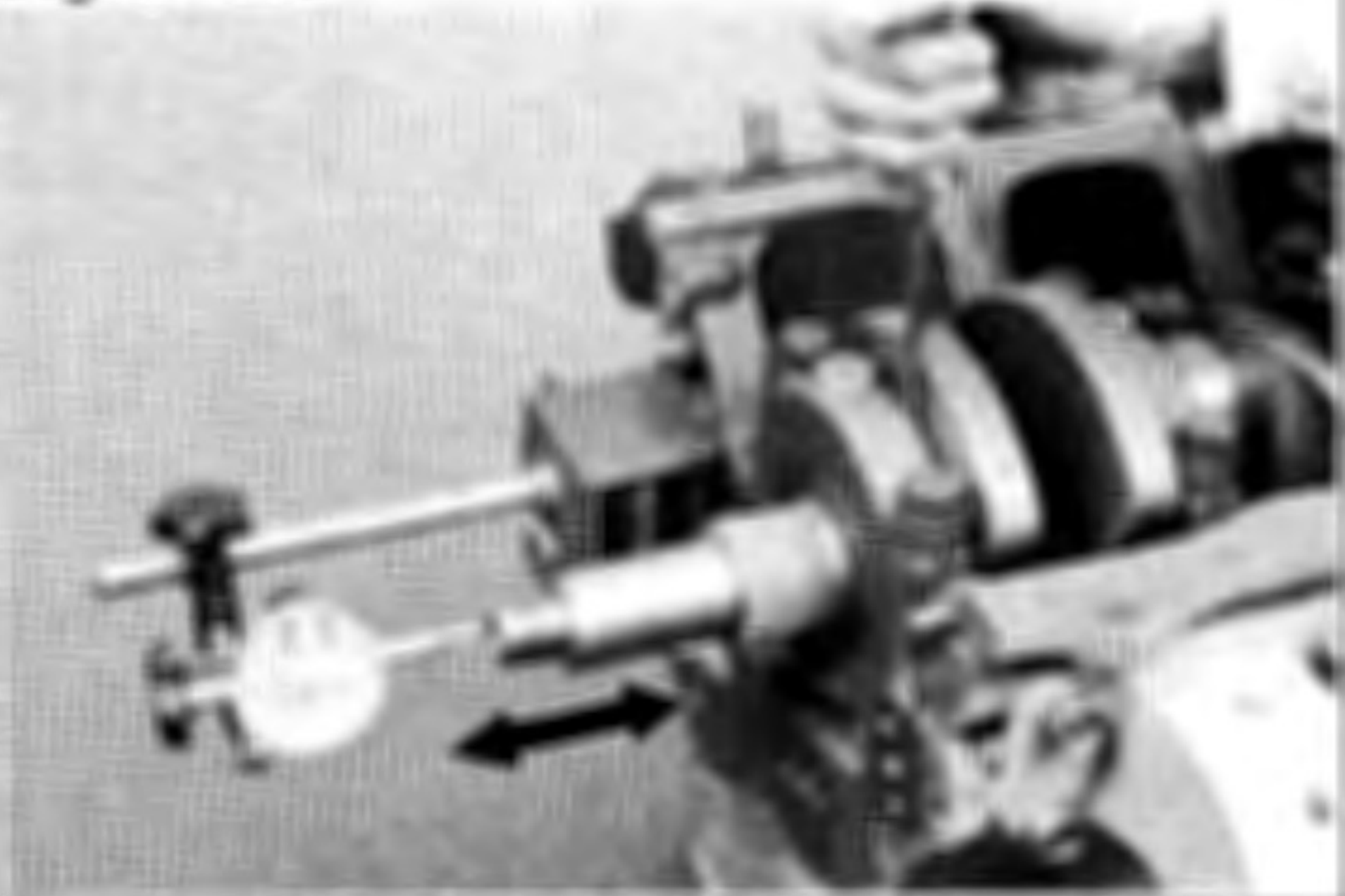
Cover the rod bolts with short pieces of hose to protect the crankshaft from damage.

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



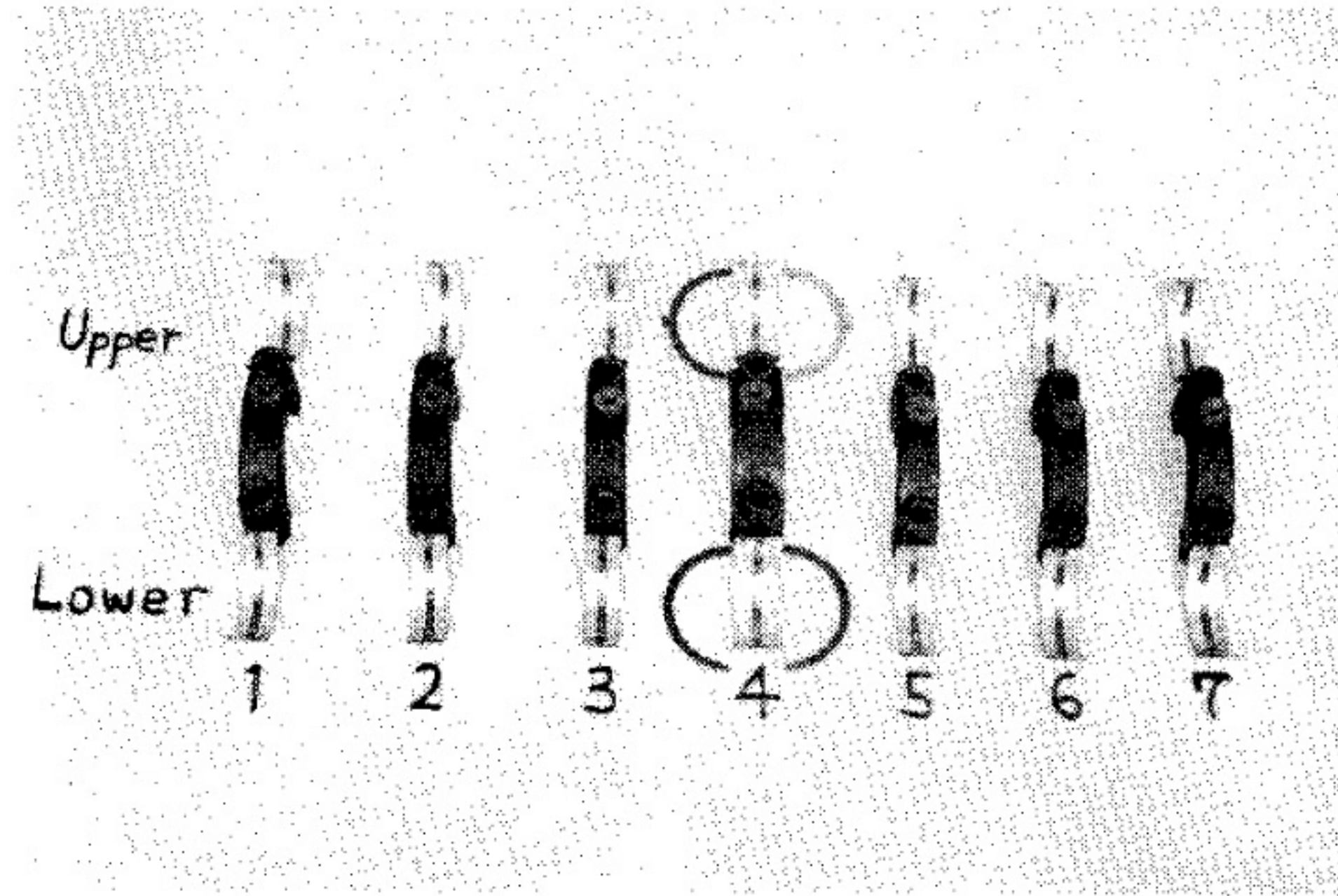
Loosen each crankshaft bearing bolts a little at a time in the sequence shown in the figure.

Fig. 3-123



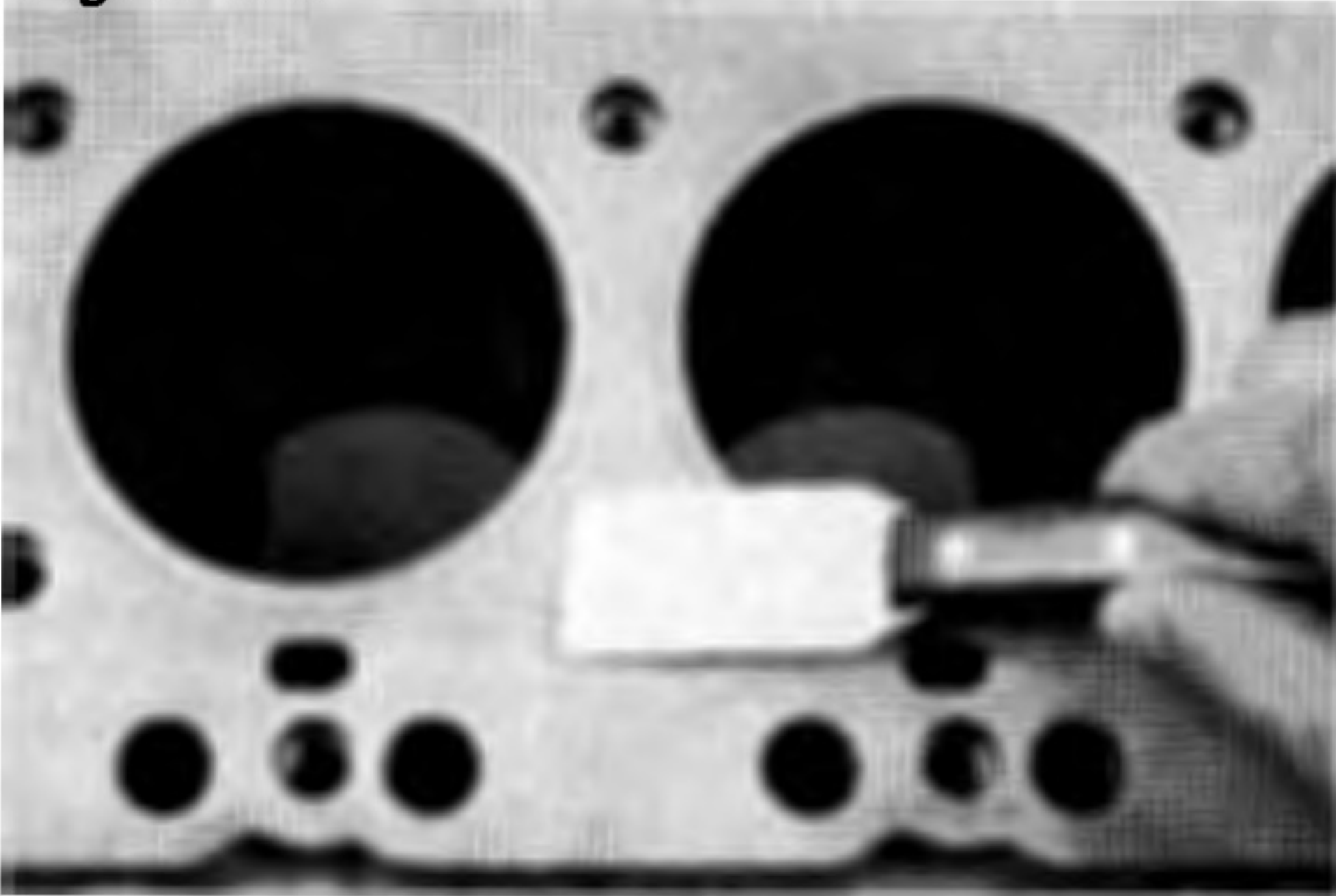
If the crankshaft bearing cap will not come off, remove by raising the bolts and prying fore and aft.

Fig. 3-124



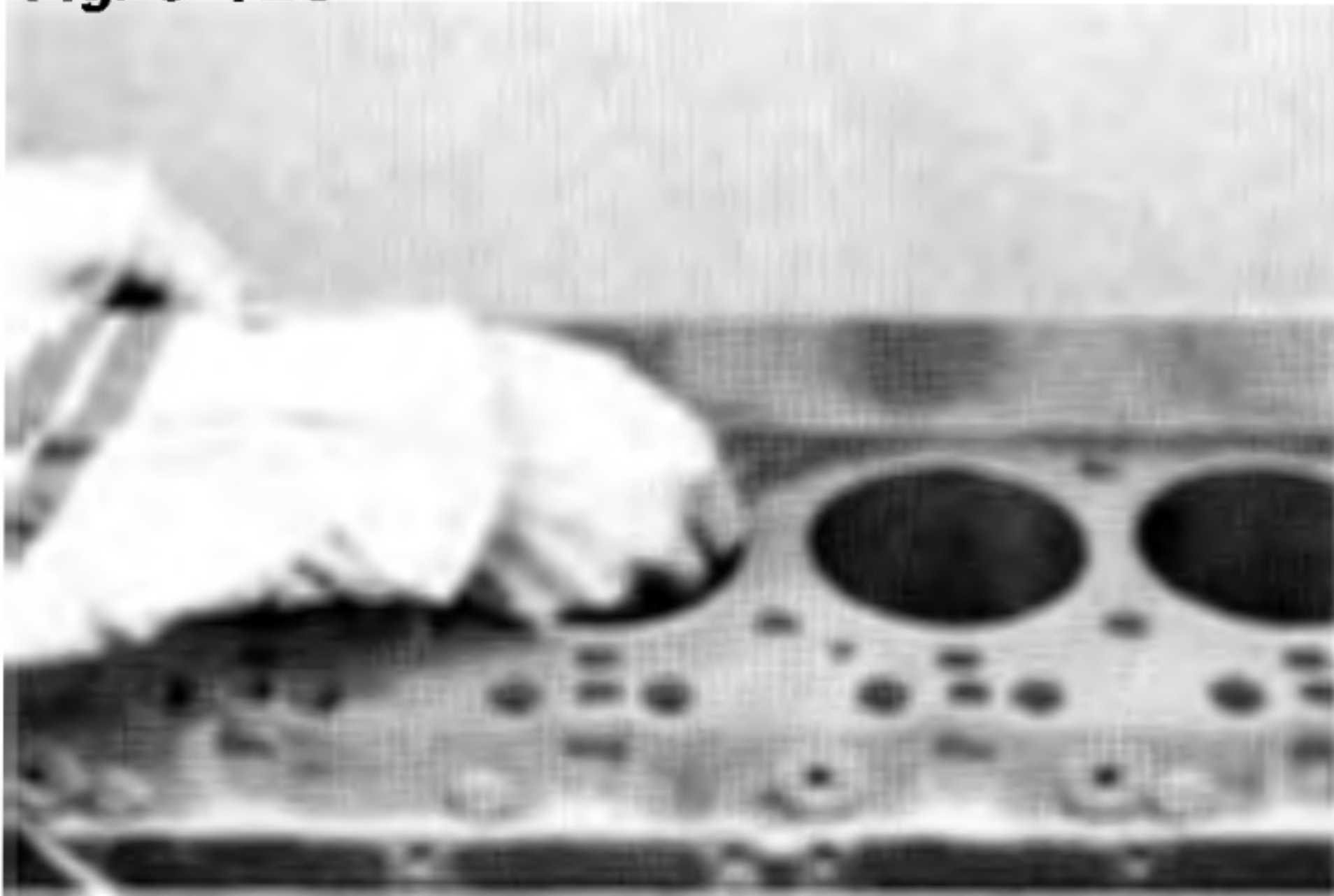
Keep the crankshaft bearings and caps in correct order.

Fig. 3-125

**INSPECTION & REPAIR****Cylinder Block & Liner**

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

Fig. 3-126

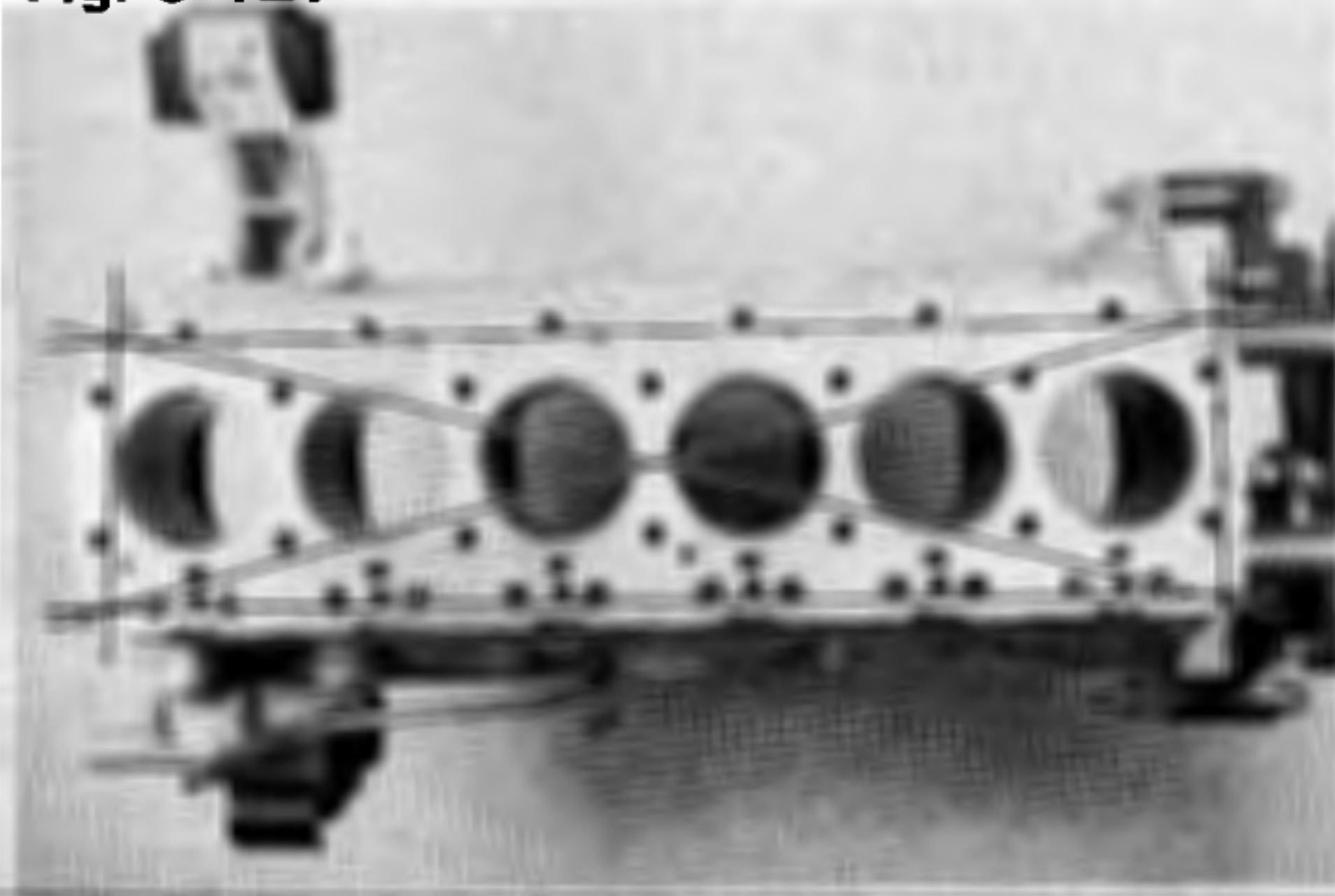


2. Check the cylinder block topside surface for warpage with a precision straight edge and thickness gauge.

Topside surface warpage:

**Limit 0.2 mm
 (0.008 in.)**

Fig. 3-127



3. Check for warpage along the indicated lines.

Fig. 3-128

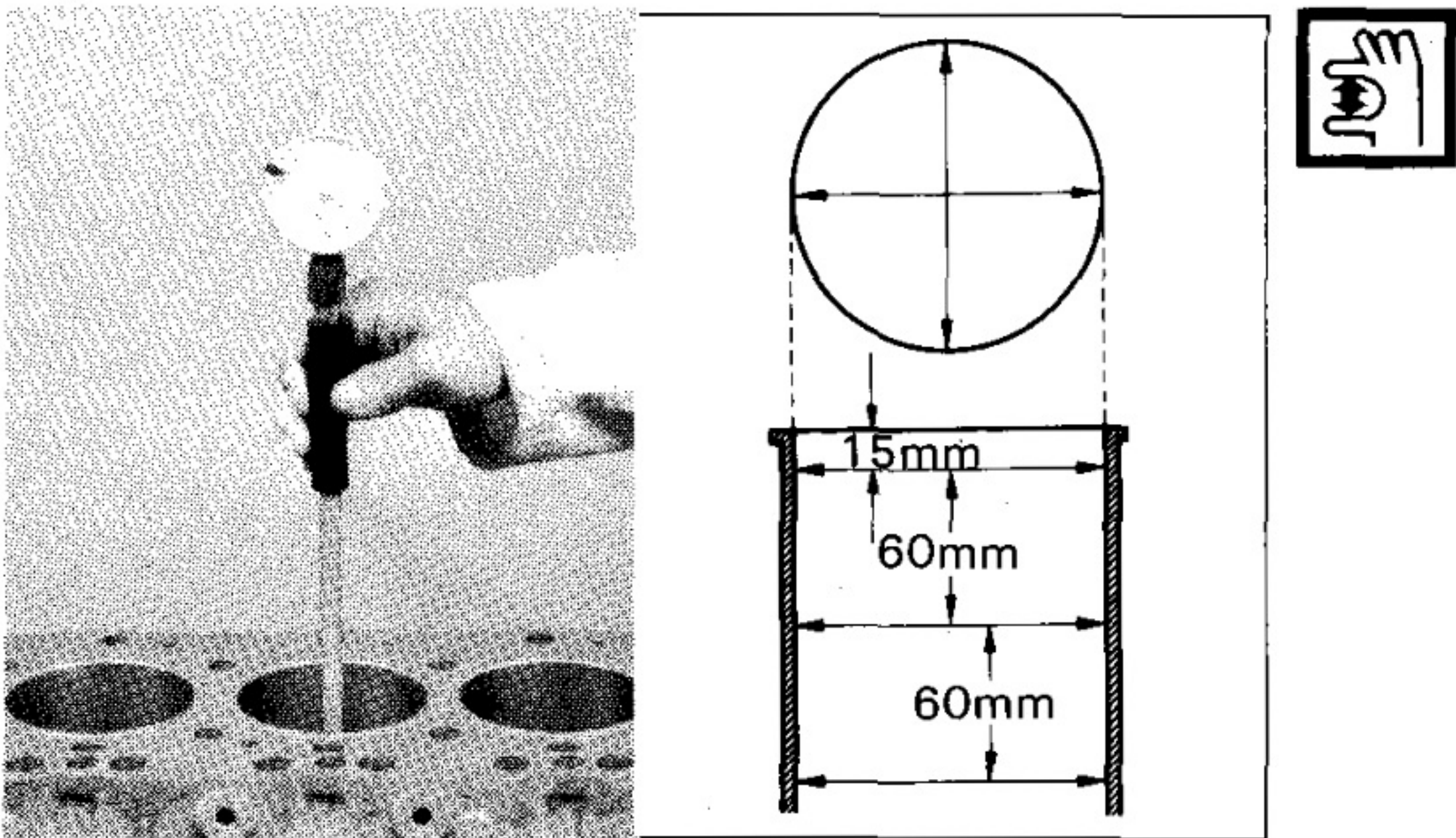


4. Visually check the cylinder for vertical scratches. If there are deep scratches, the cylinder liner must be rebored or replaced referring to Fig. 3-131 to 3-137.

— Note —

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

Fig. 3-129



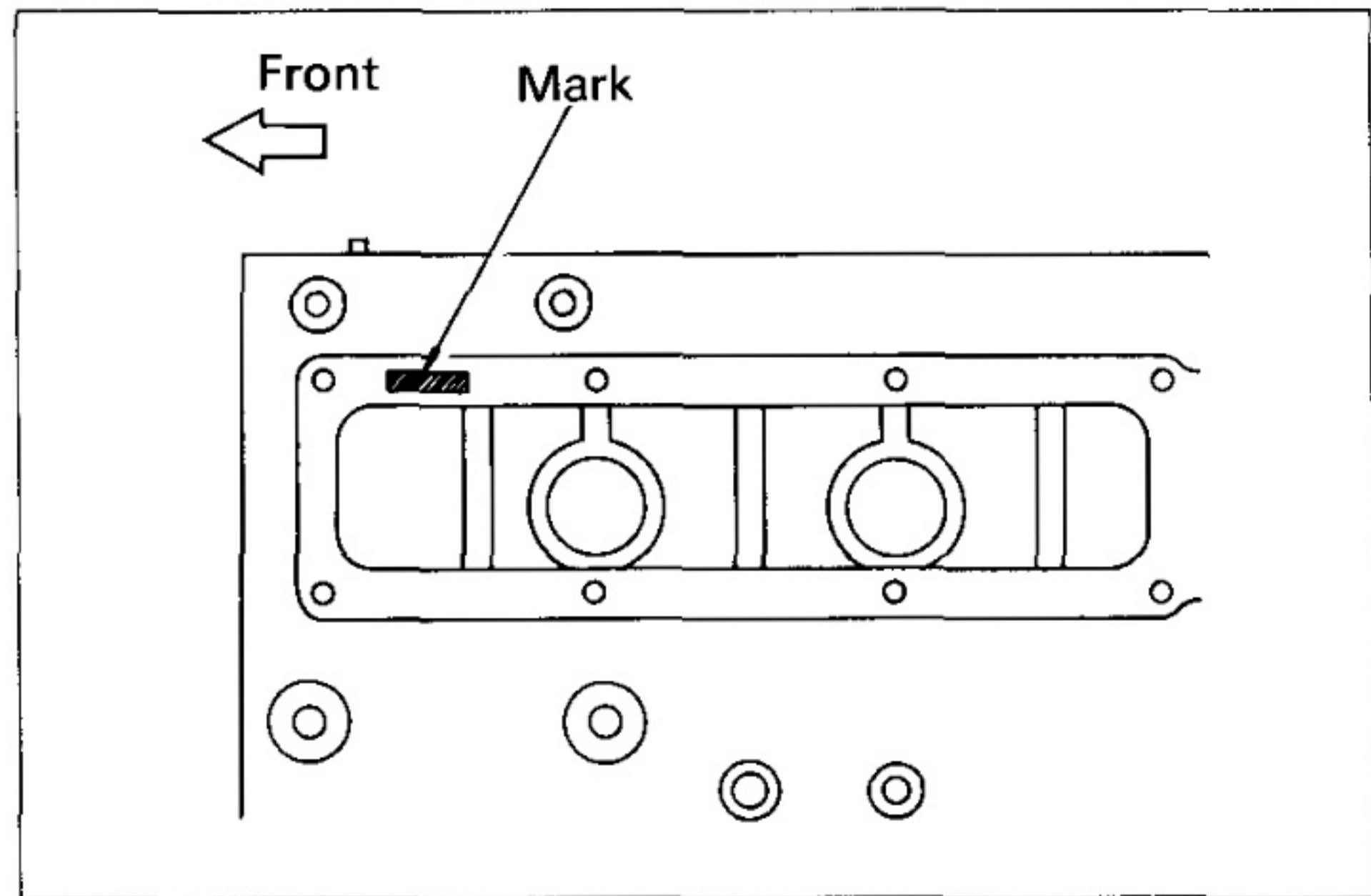
5. Measure the cylinder bore at top, middle and bottom as shown in the figure. If wear exceeds the limit, the liner must be rebored or replaced referring to Fig. 3-131 to 3-137.

**Wear limit: 0.2 mm
(0.008 in.)**

Cylinder bore size

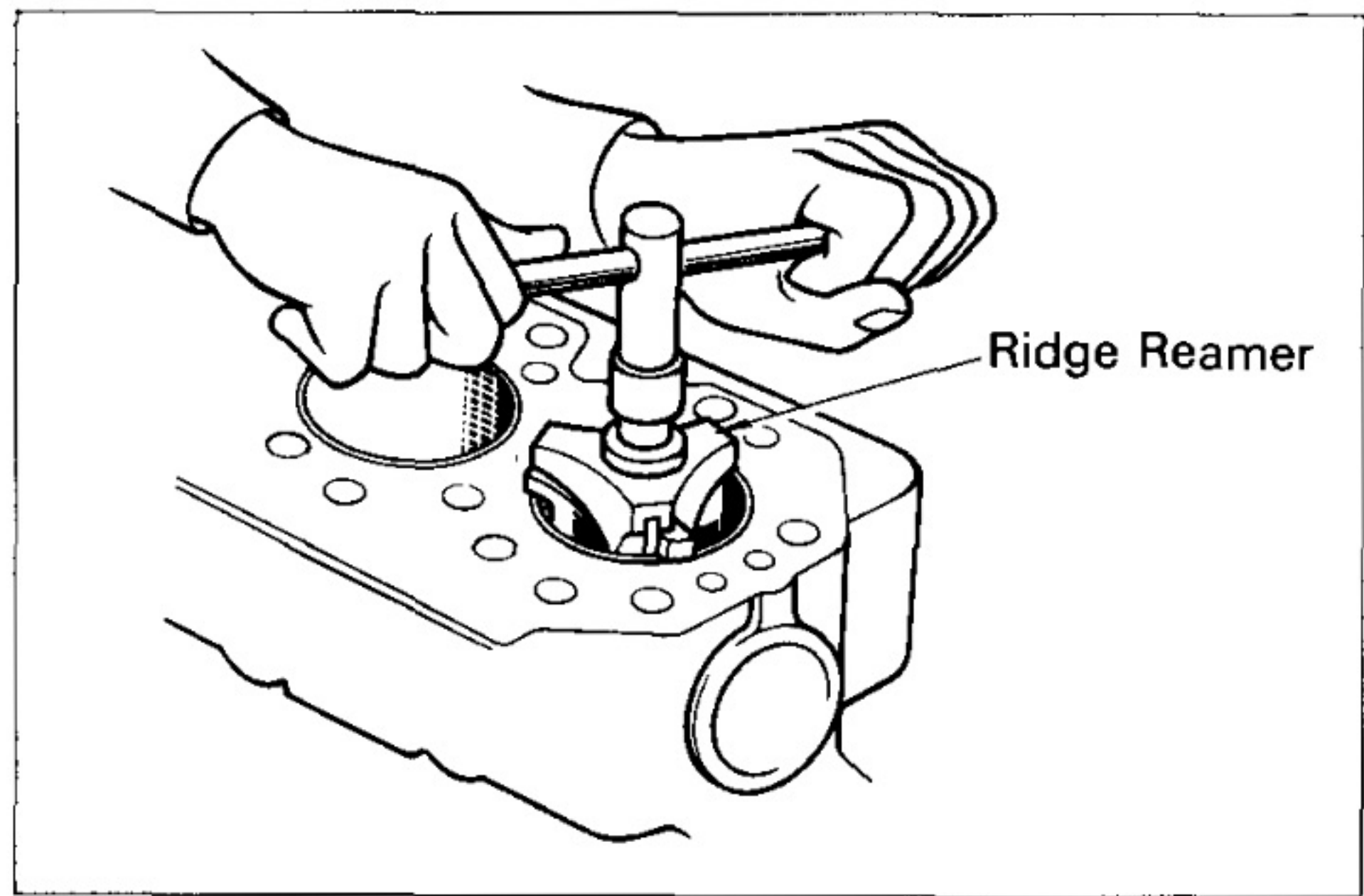
Mark	1	2	3
Size mm (in.)	91.000–91.010 (3.5827–3.5831)	91.010–91.020 (3.5831–3.5835)	91.020–91.030 (3.5835–3.5839)

Fig. 3-130



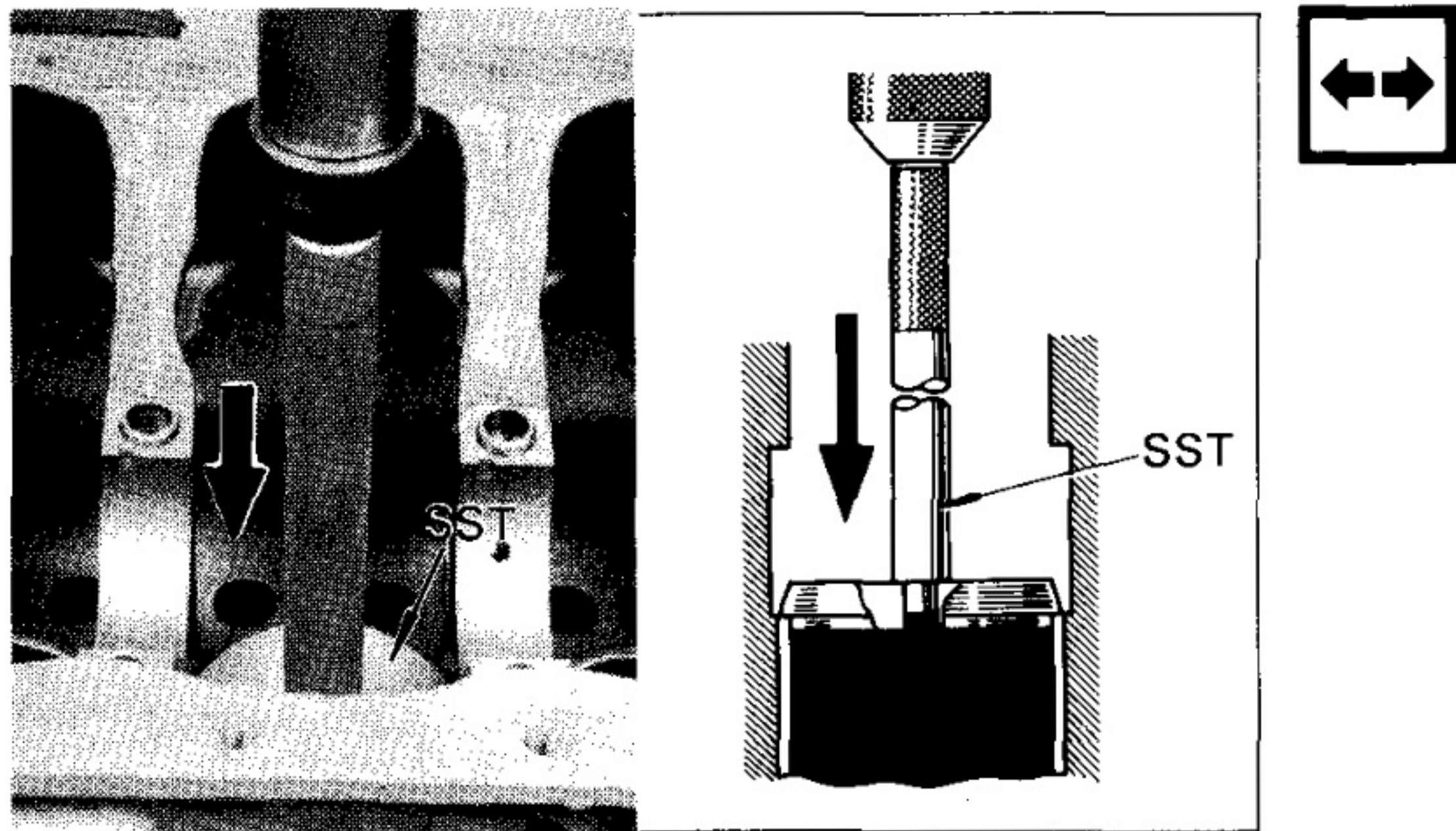
- Note –
The bore marks are stamped on the cylinder block valve lifter side as shown in the figure.

Fig. 3-131



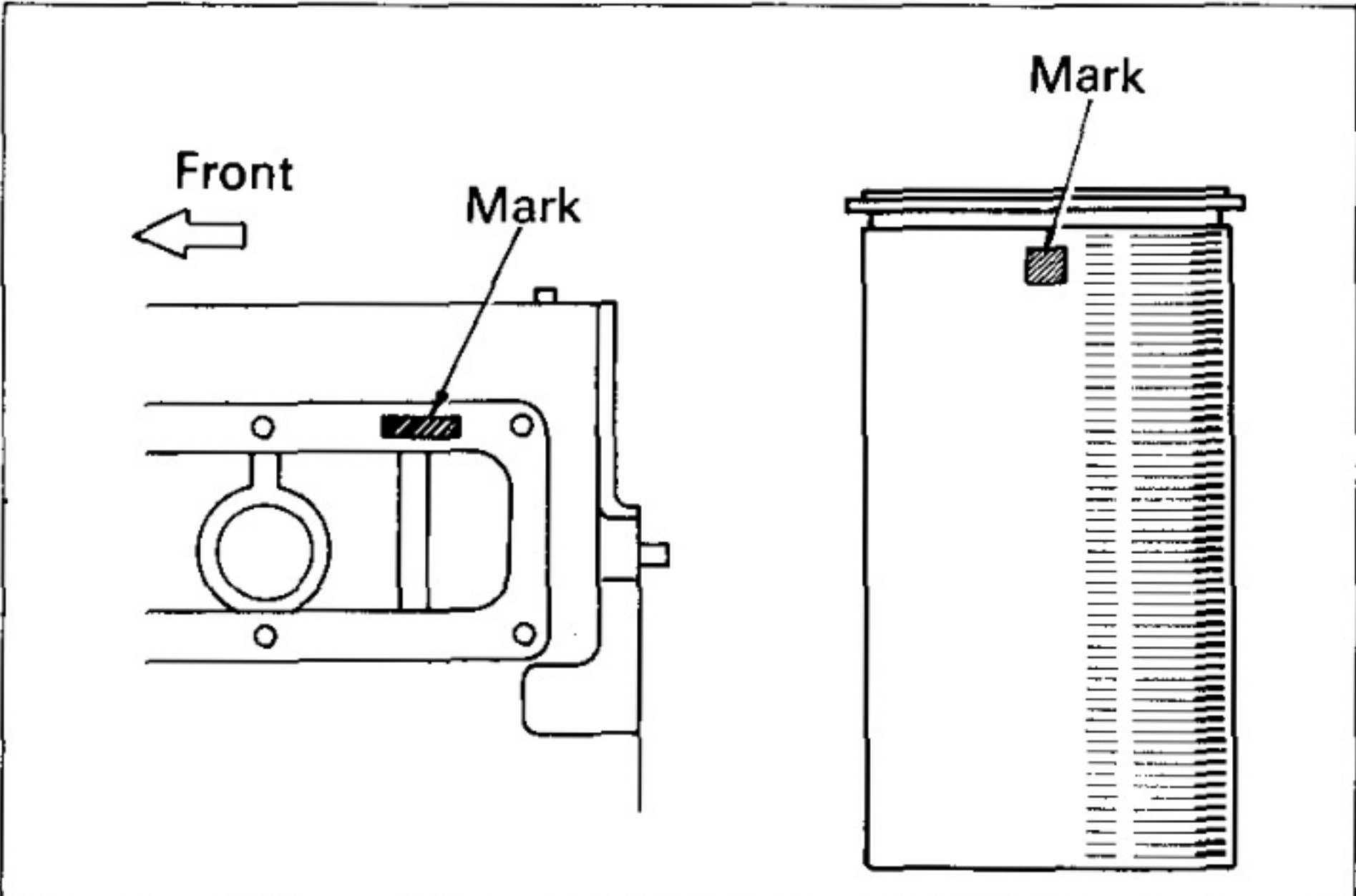
6. If wear is less than 0.2 mm (0.008 in.), machine the piston ring ridge at the top of the bore with a ridge reamer.

Fig. 3-132



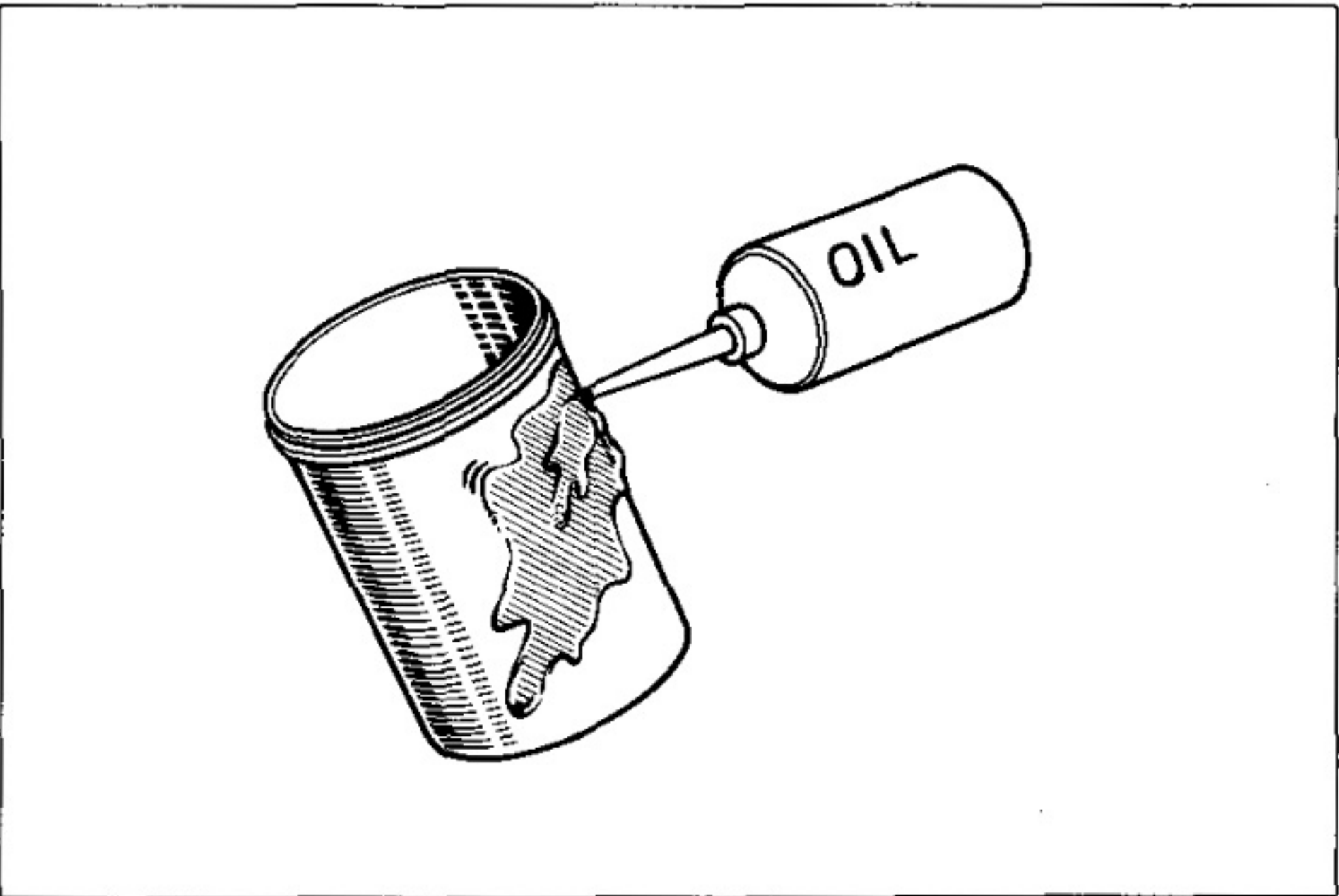
7. If wear exceeds the limit, replace the cylinder liner with SST.
(1) Press out the cylinder liner with SST.
SST [09218-54011]

Fig. 3-133



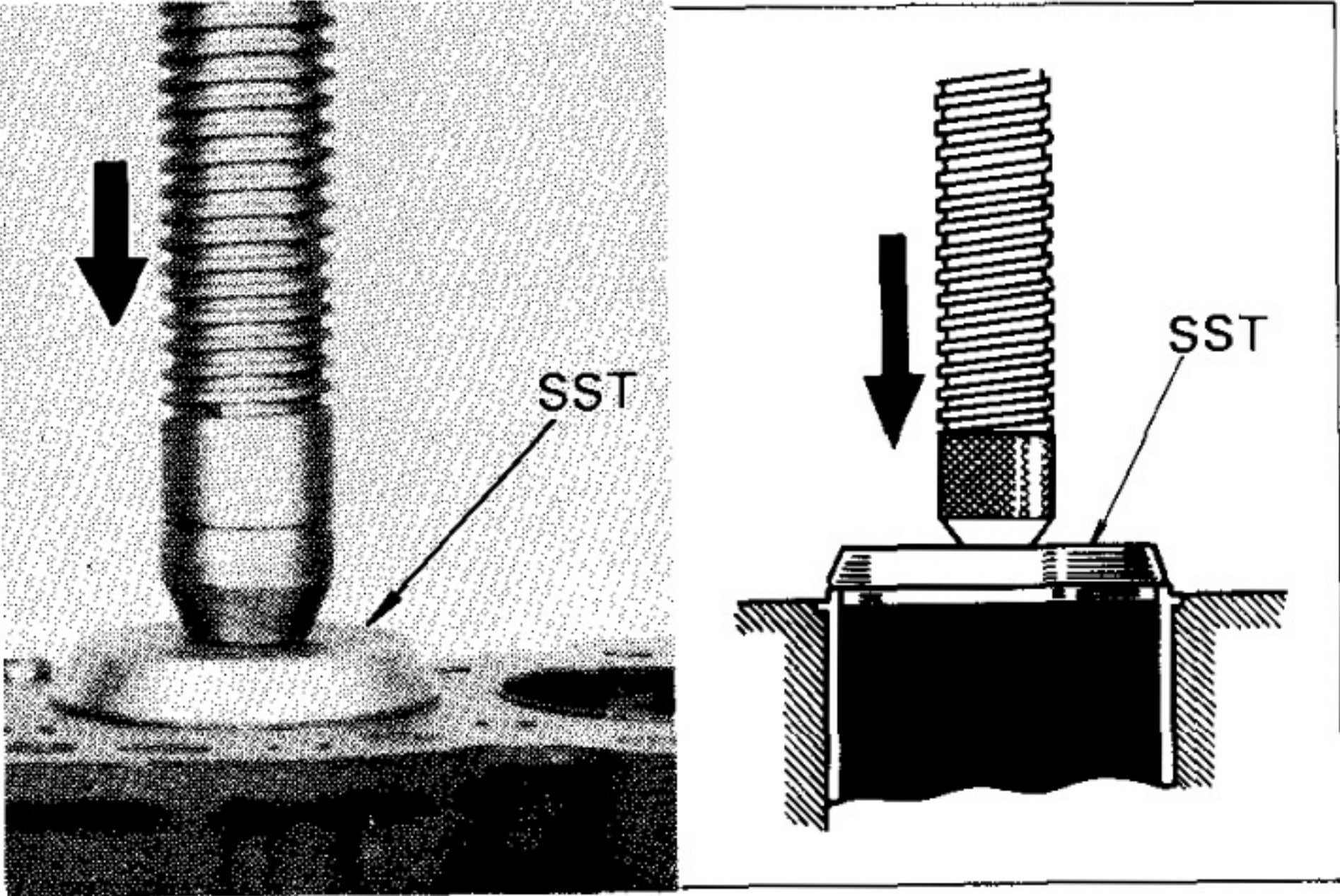
- (2) Select a liner having the same mark as the cylinder block, A or B.

Fig. 3-134



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

Fig. 3-135

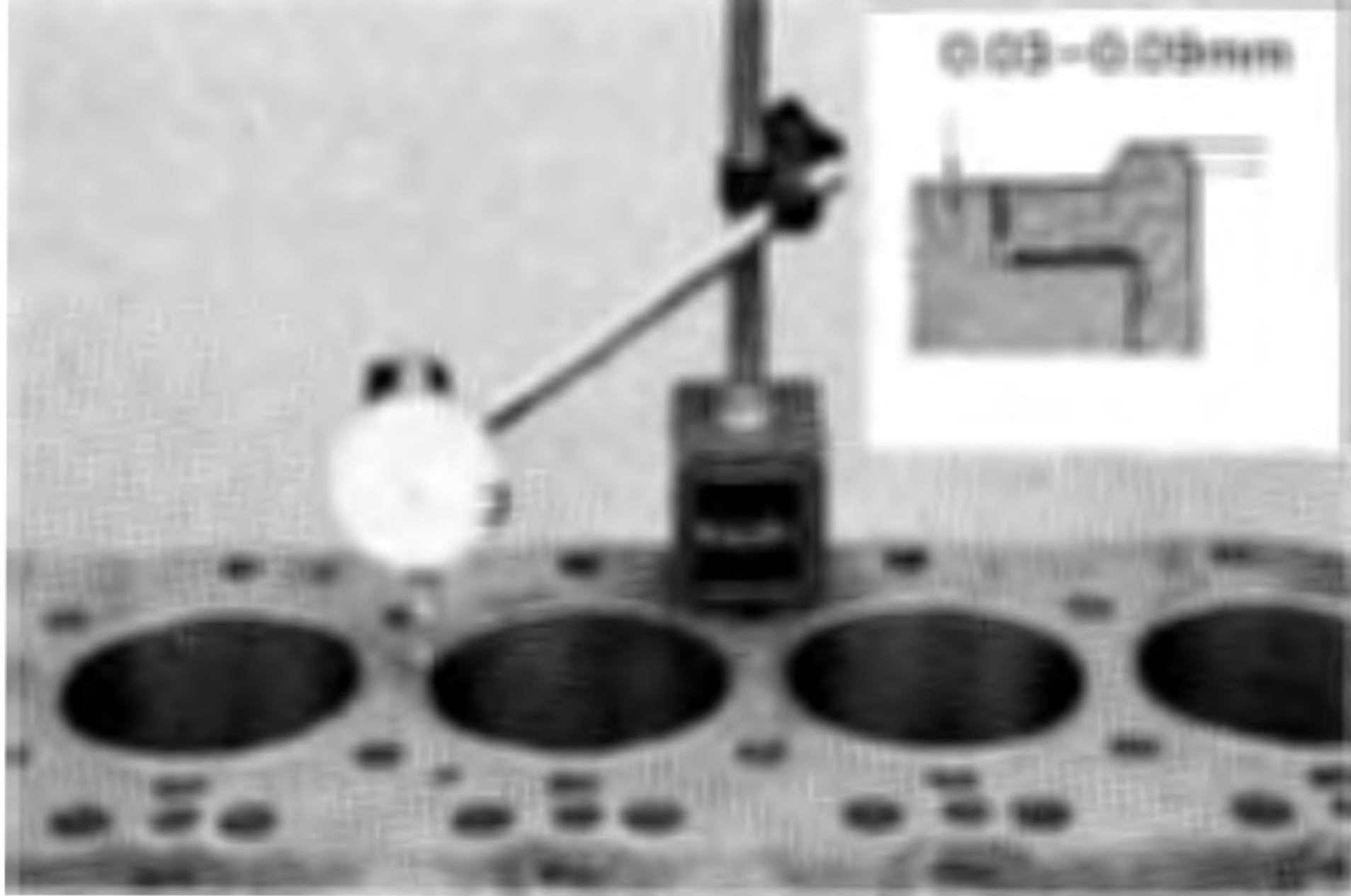


- (4) Press in the cylinder liner with SST. SST [09218-54011]

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.

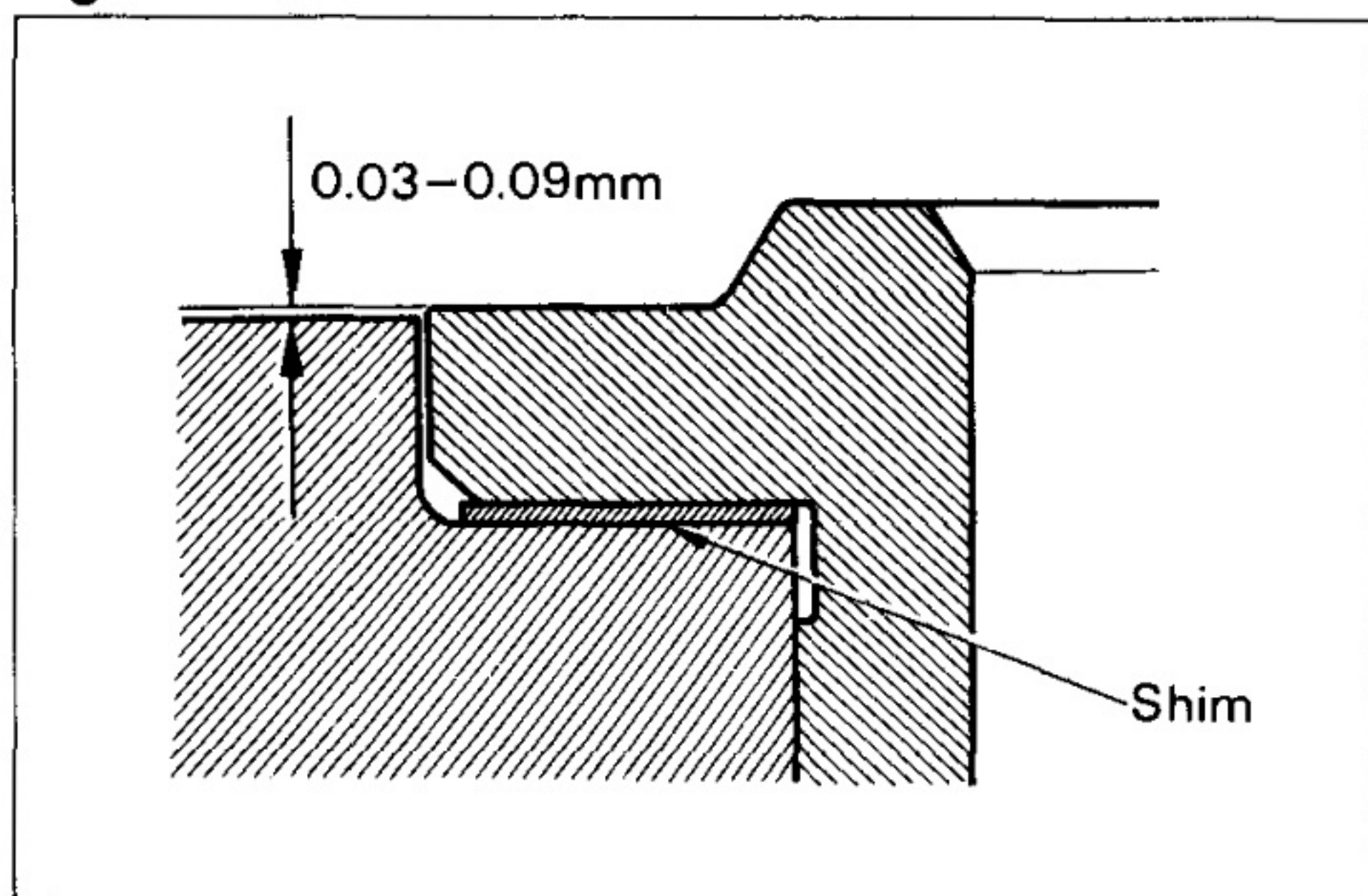
Fig. 3-136



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



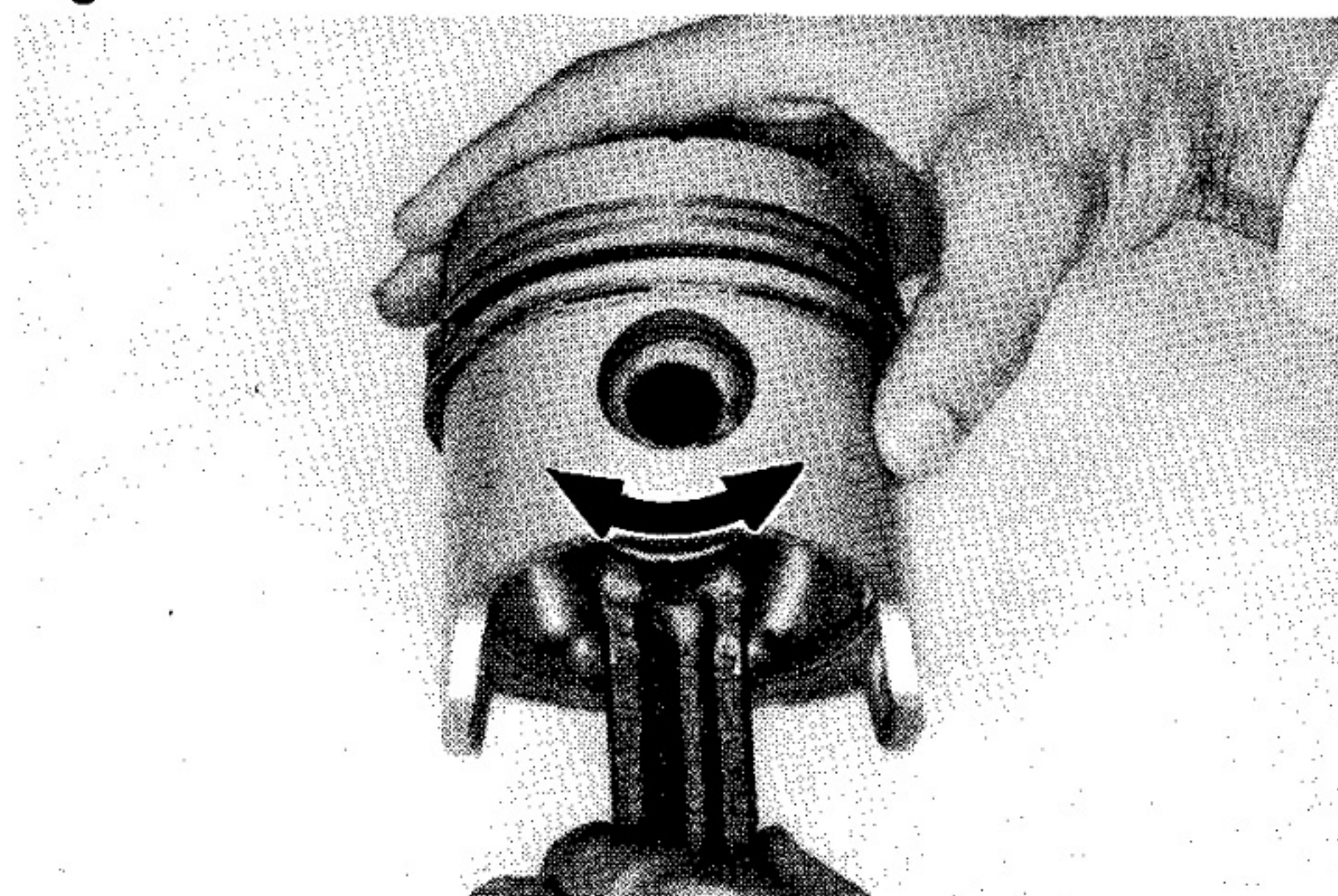
9. Adjust protrusion of the cylinder liner with cylinder liner shims.

Cylinder liner shim thickness:

0.05 mm, 0.10 mm

(0.0020 in., 0.0039 in.)

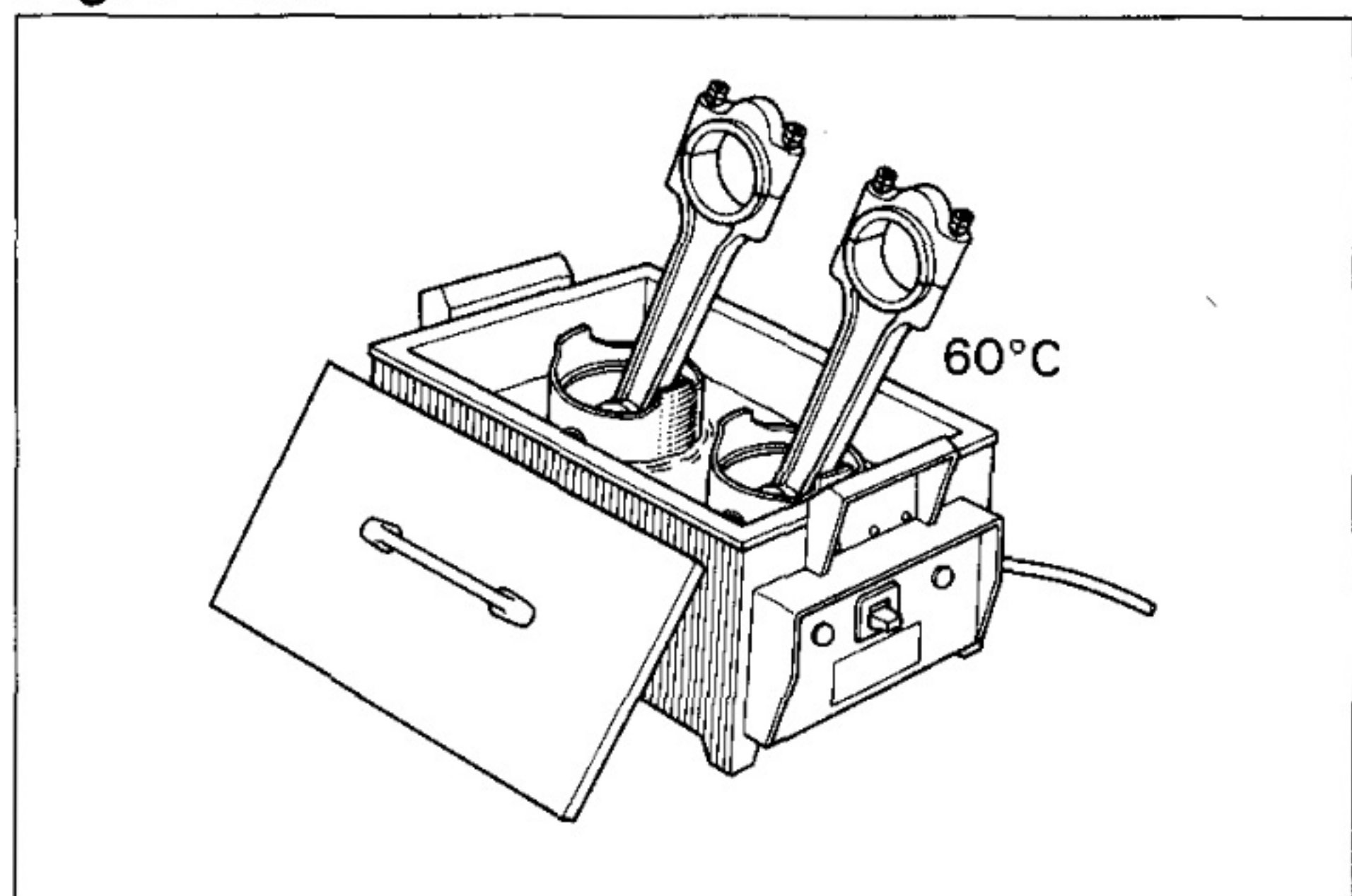
Fig. 3-138



Piston Pin & Connecting Rod

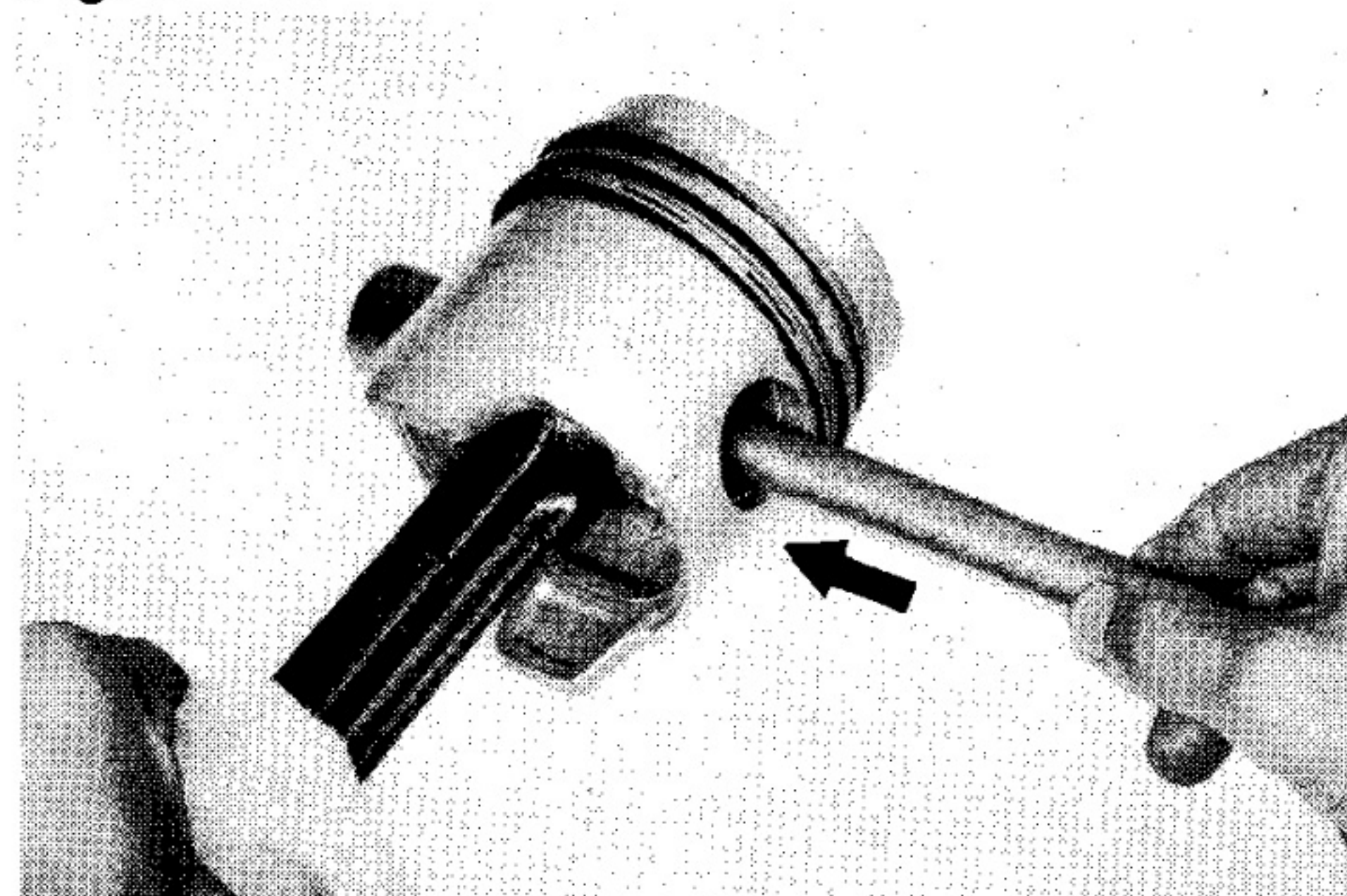
1. Check pin fit by rocking the piston at right angle to the pin.
If any movement is felt, replace the piston and pin.

Fig. 3-139



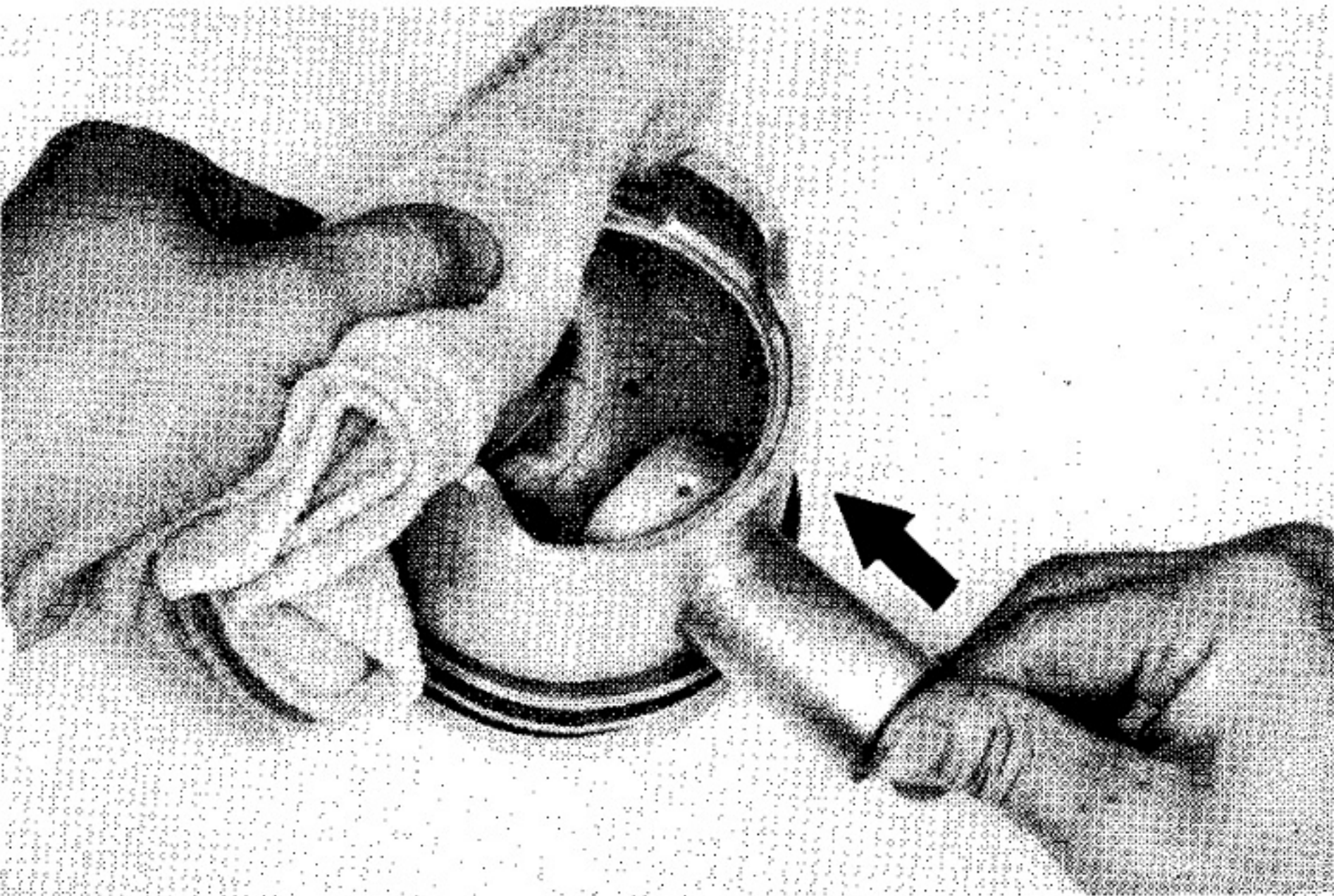
2. Heat the piston in a piston heater to about 60°C (140°F) before removing the piston pin.

Fig. 3-140



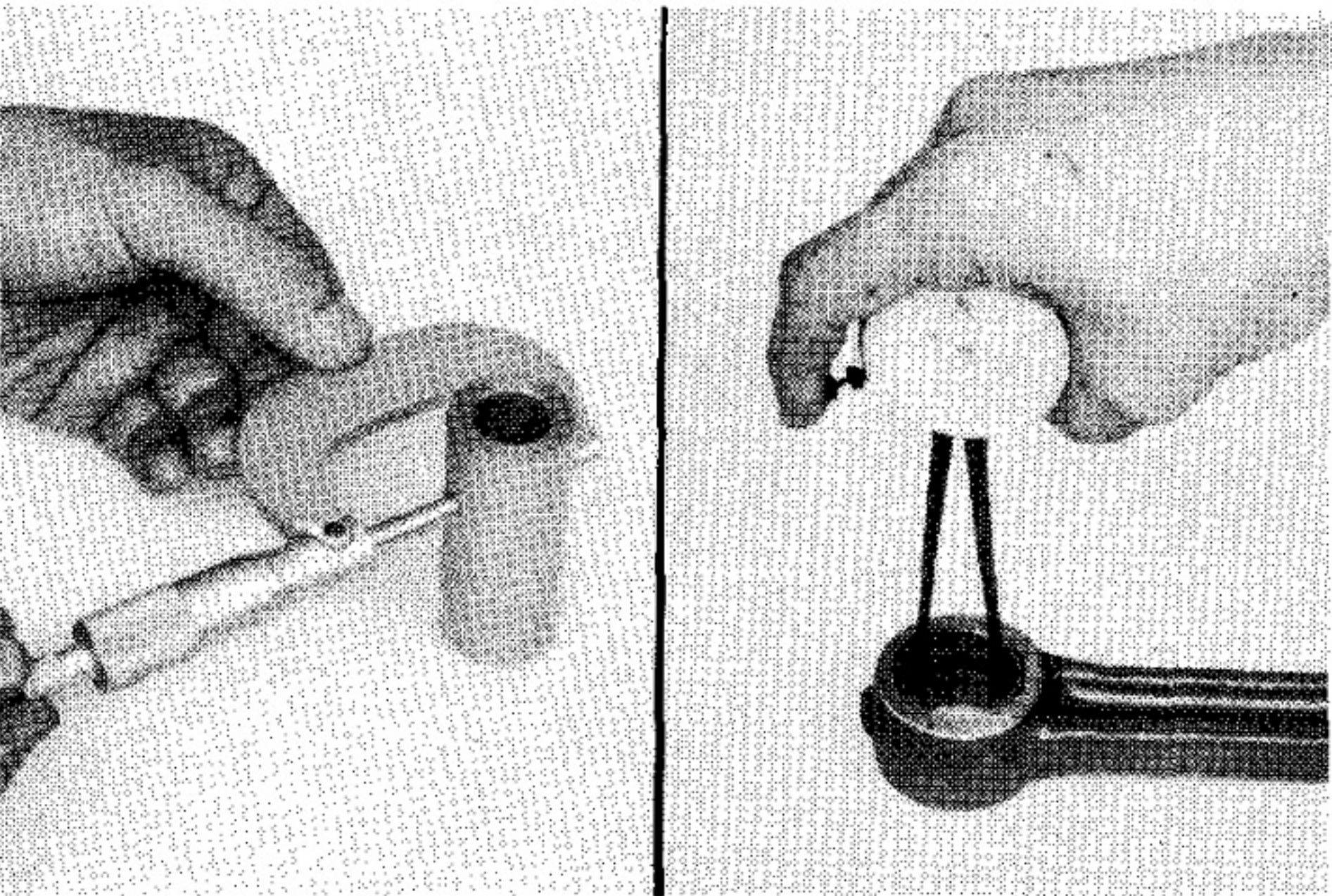
3. Push out the piston pin by hand.
If it does not come out easily, drive it out with a brass bar or such.

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

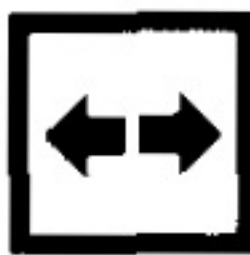
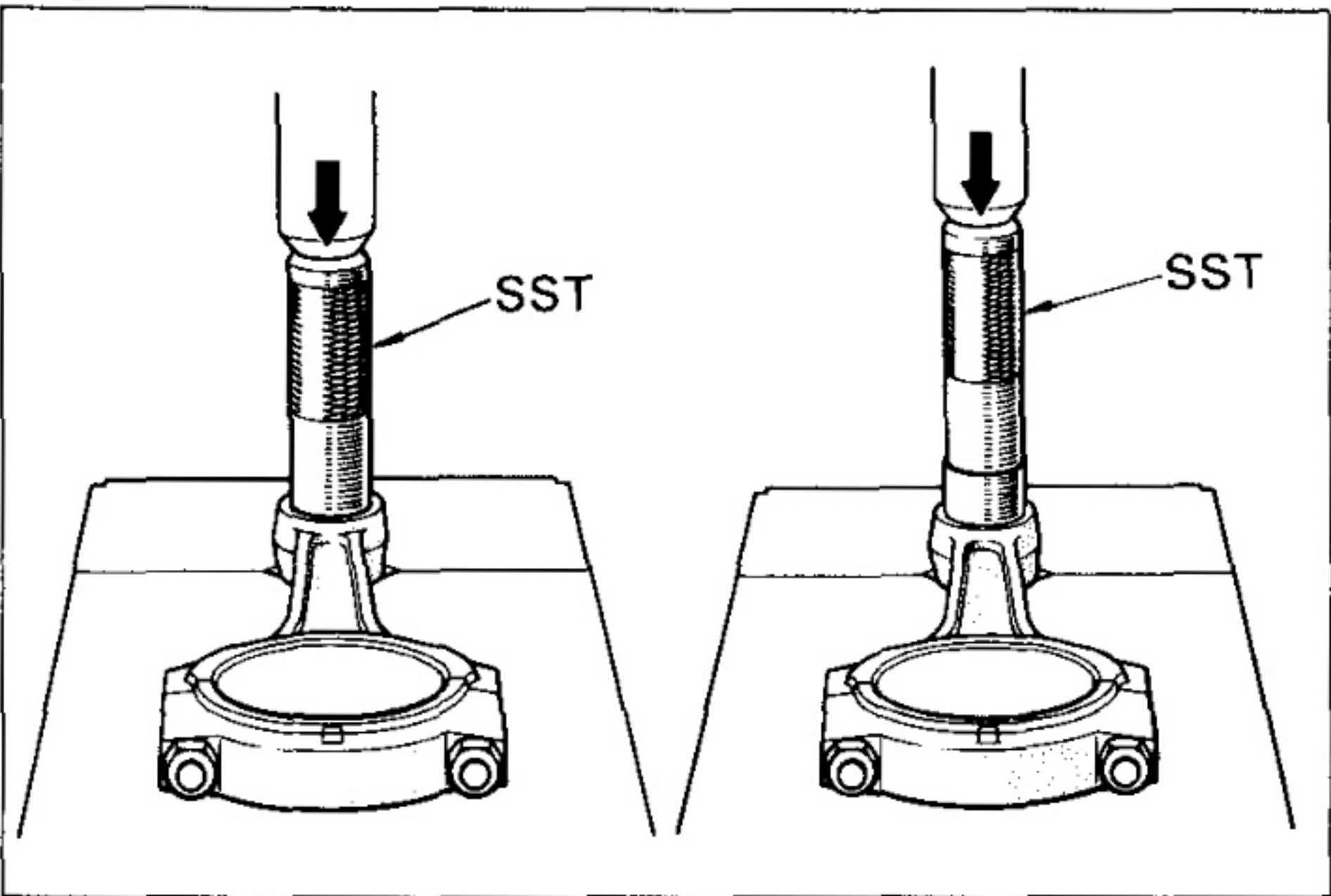


5. Measure the oil clearance between the bushing and piston pin.

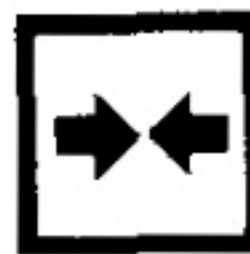
Oil clearance:

STD 0.004 – 0.012 mm
(0.0002 – 0.0005 in.)
Limit 0.05 mm
(0.0020 in.)

Fig. 3-143

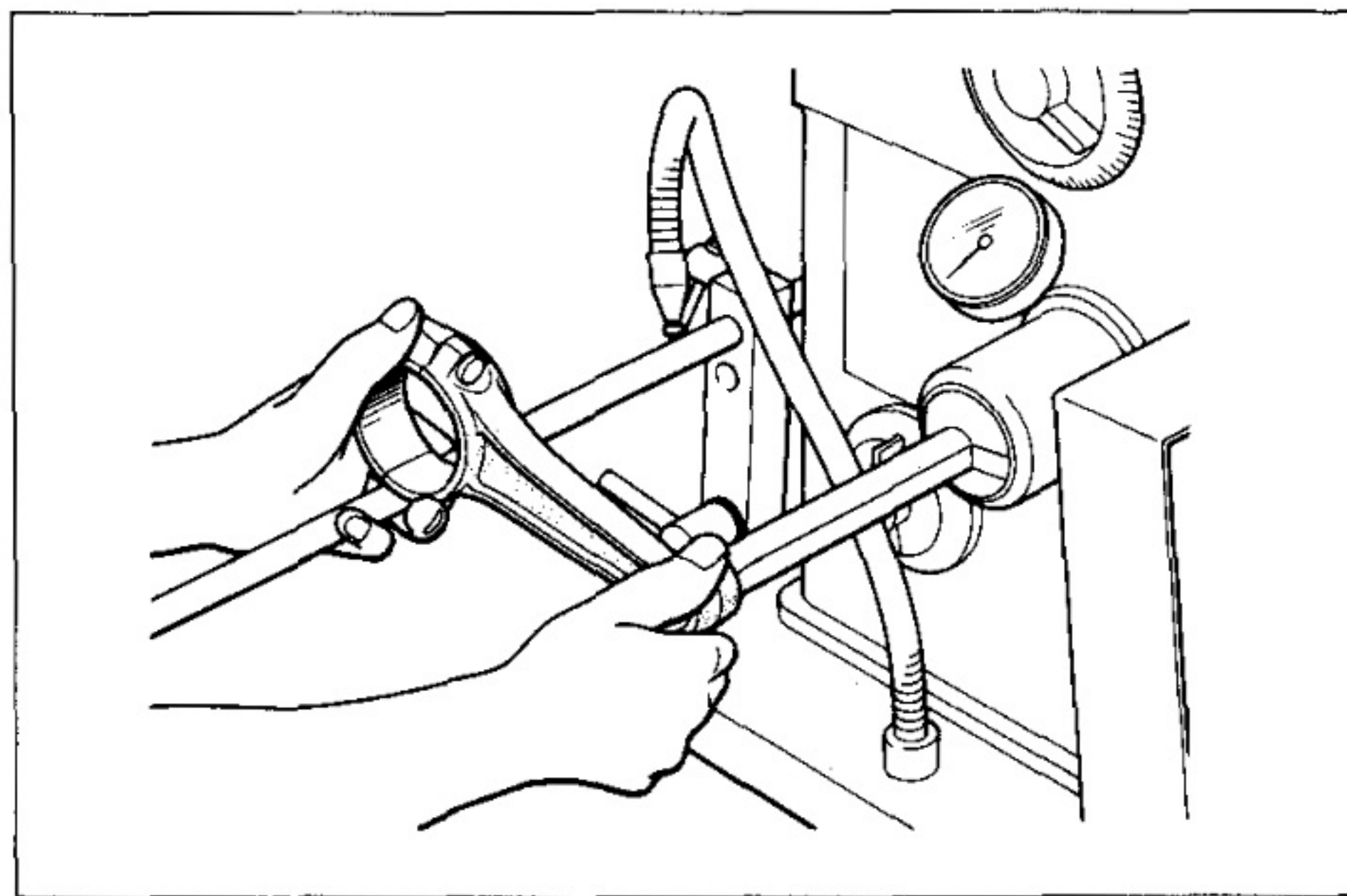


6. Replace the bushing with SST.
SST [09222-66010]



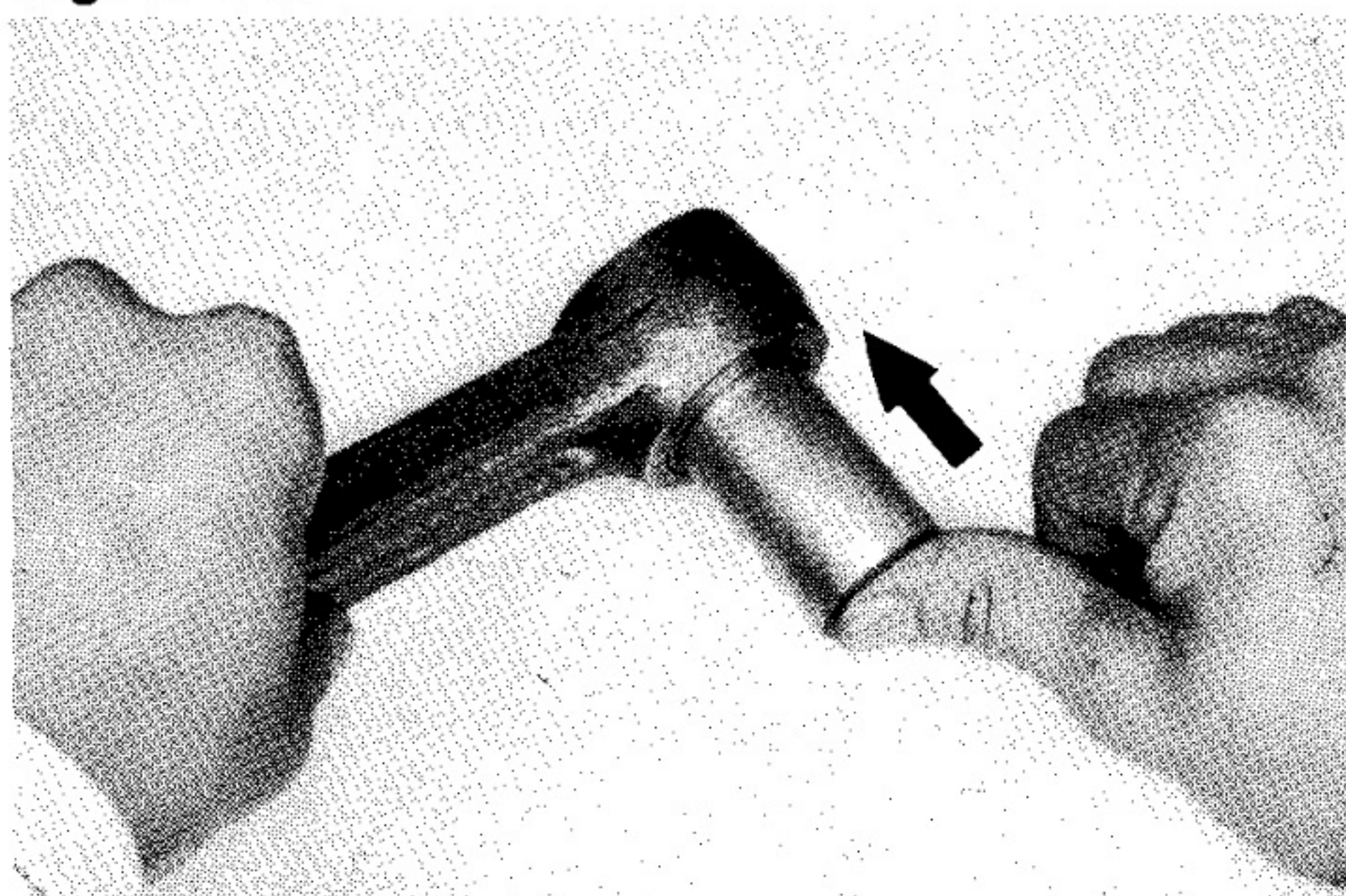
- Note –
Align the bushing oil hole with the connecting rod oil hole.

Fig. 3-144



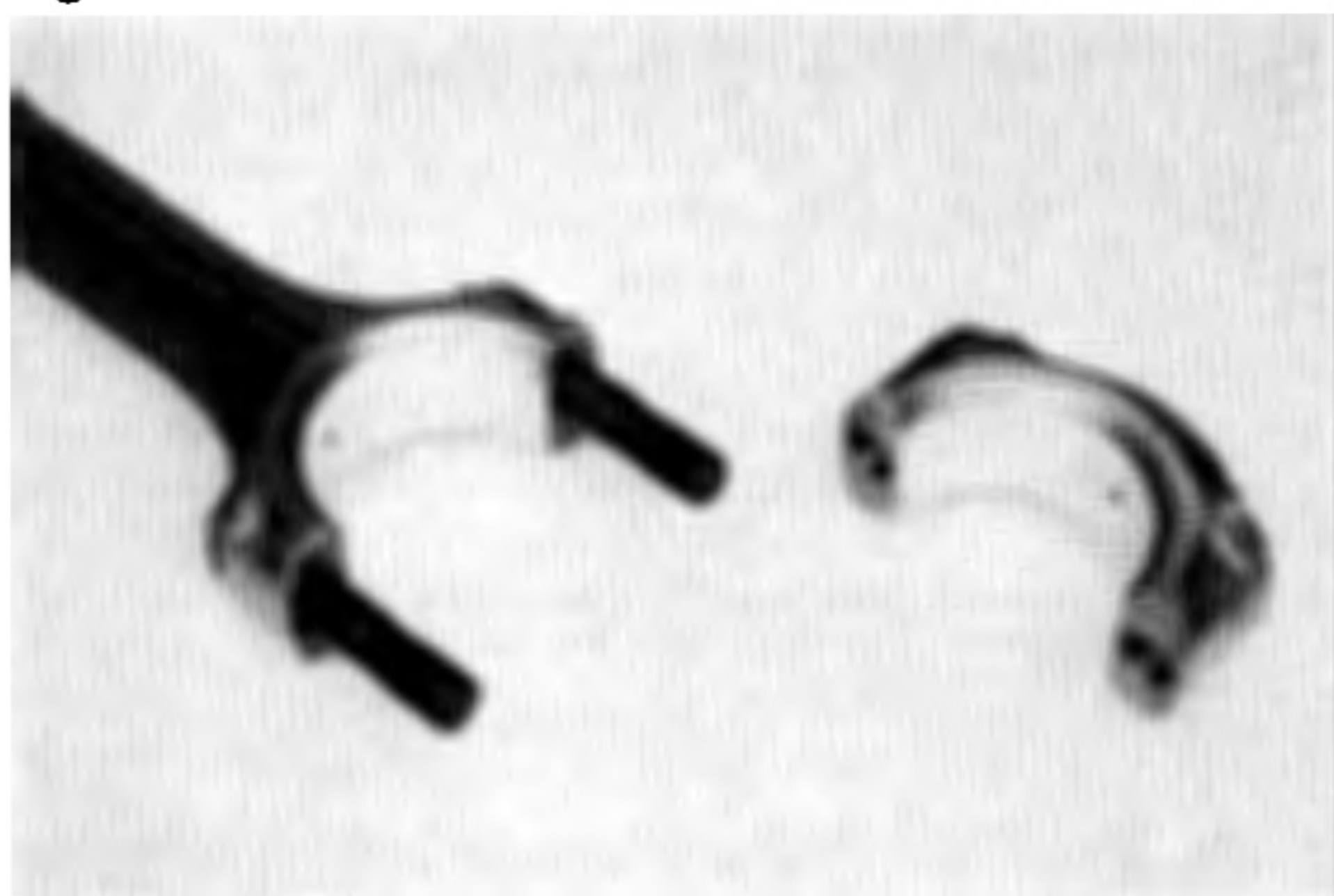
7. After installing the bushing, grind the bushing bore with a pin hole grinder.

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.

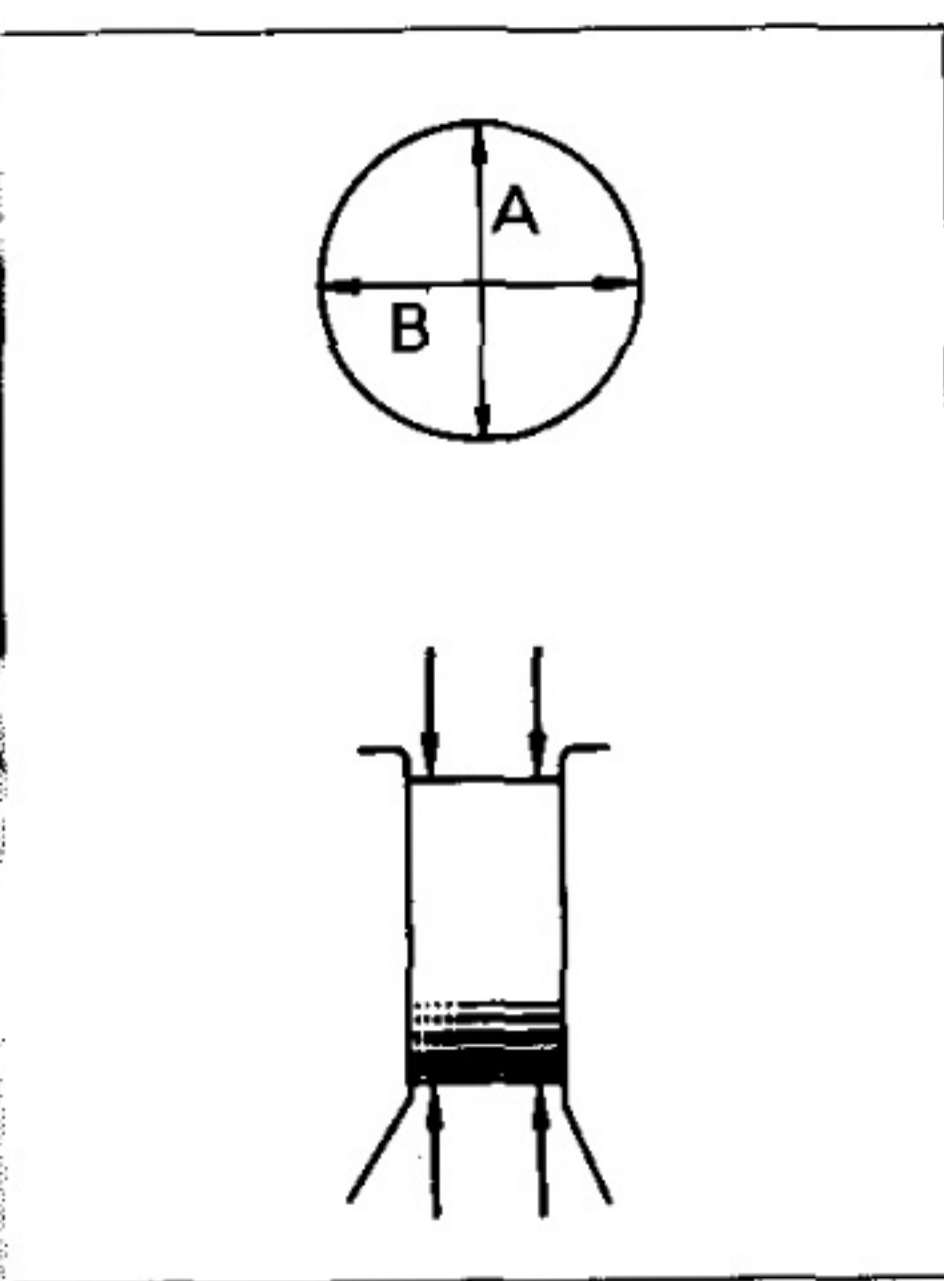
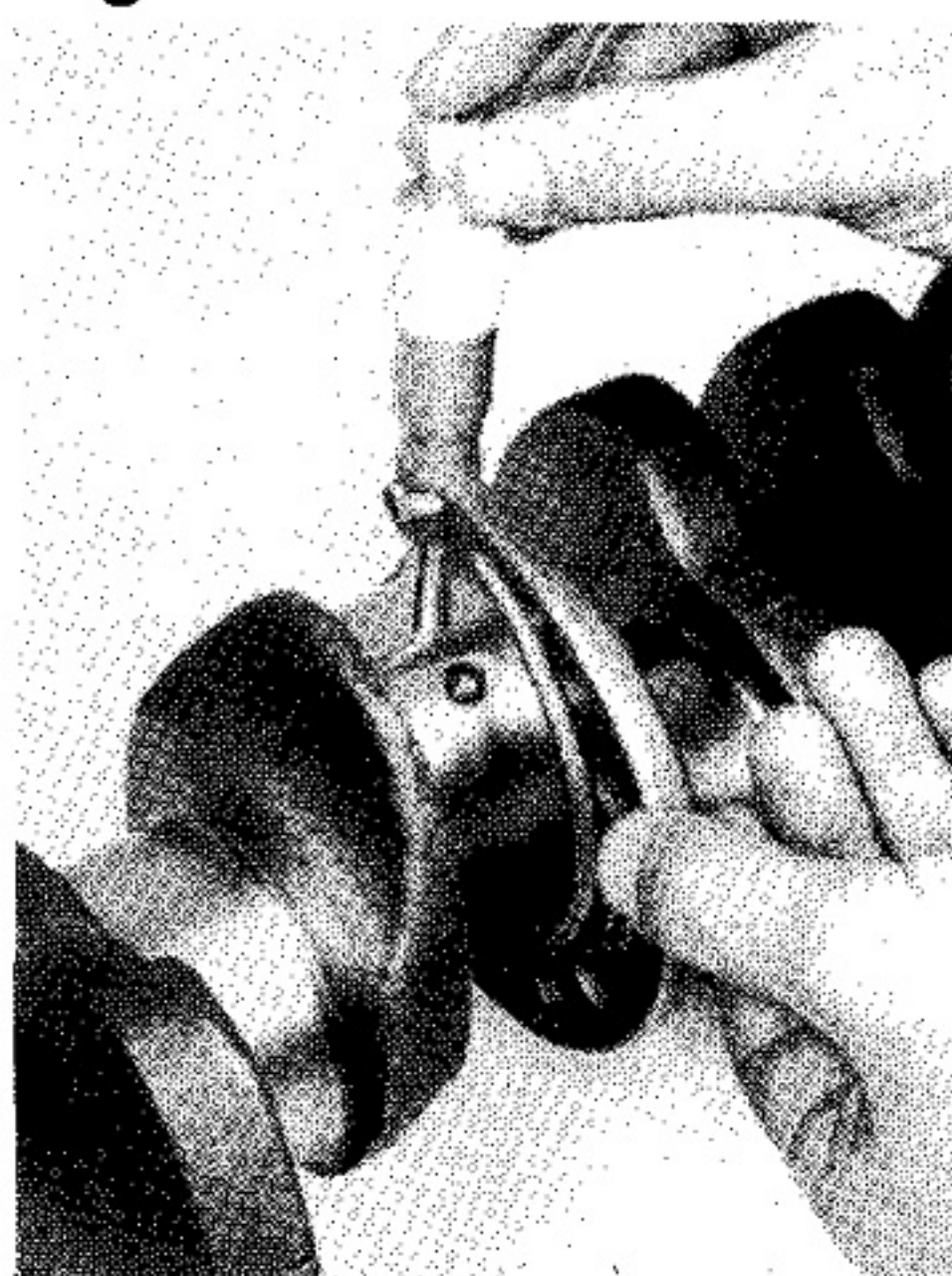
Fig. 3-146



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.)

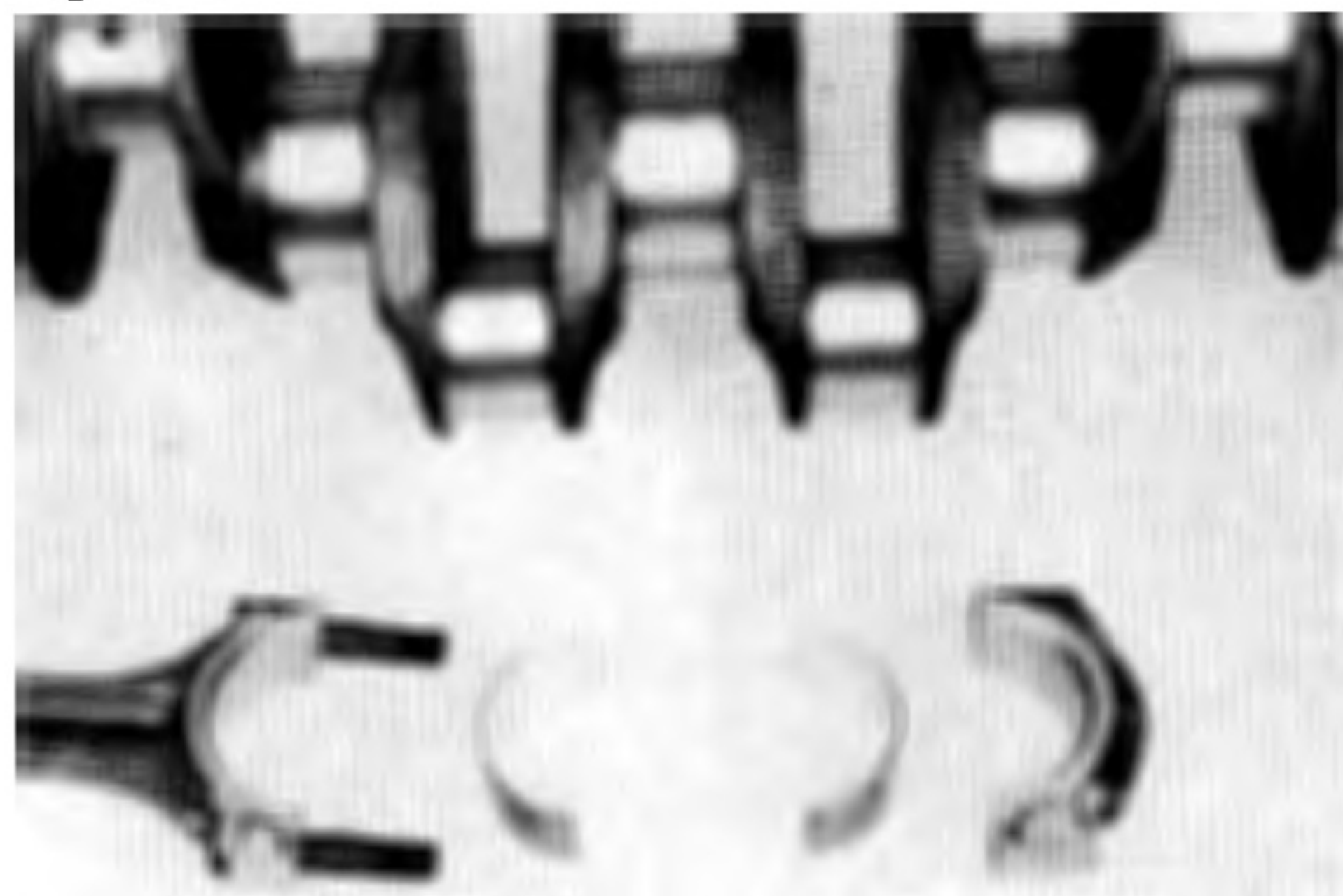
Taper and out-of-round:

Limit 0.02 mm
(0.0008 in.)

— Note —

Measure A and B diameters in two places.

Fig. 3-148



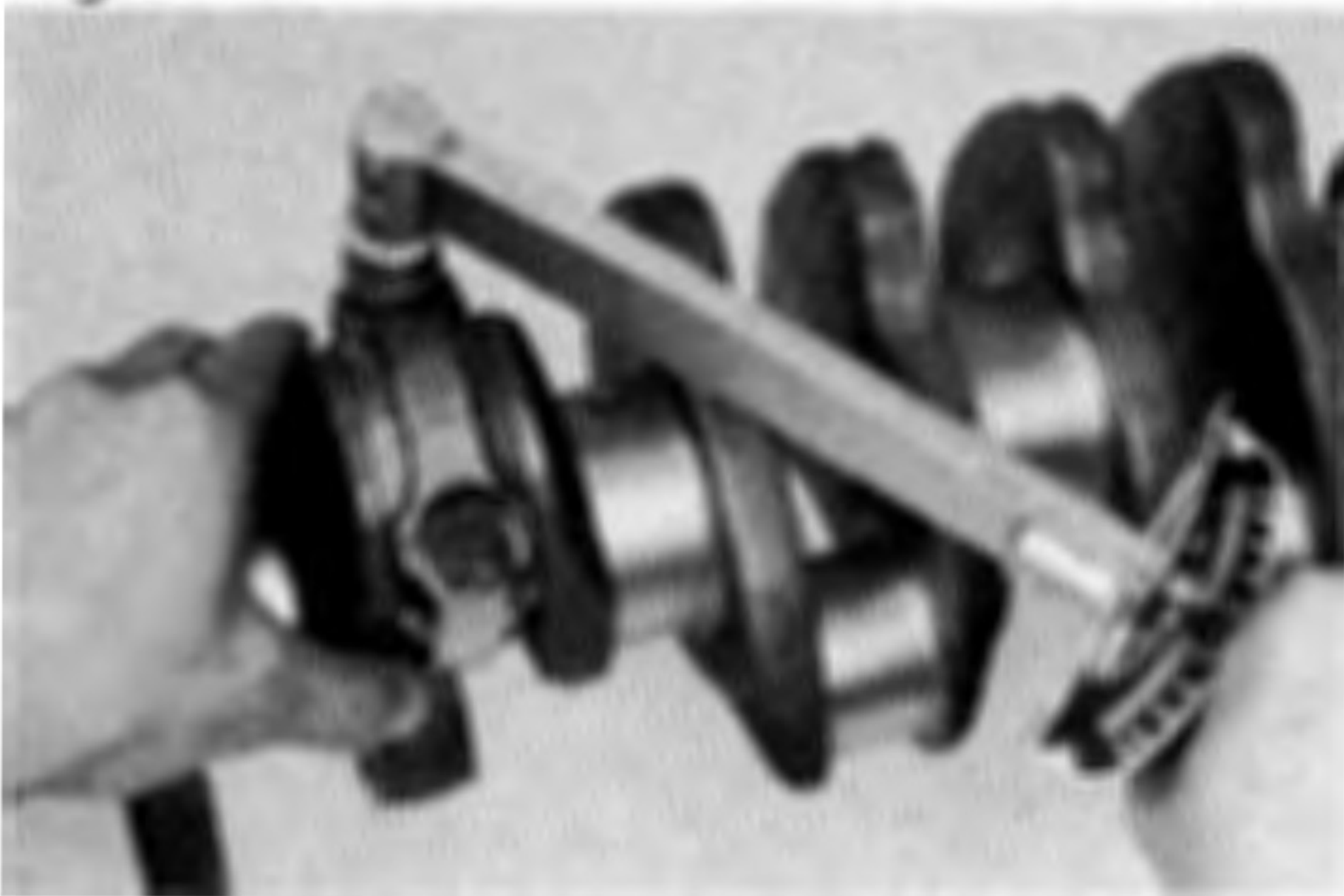
3. Measure the crank pin oil clearance.
 - (1) Clean the crankshaft pin, connecting rod, cap and bearings.

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:

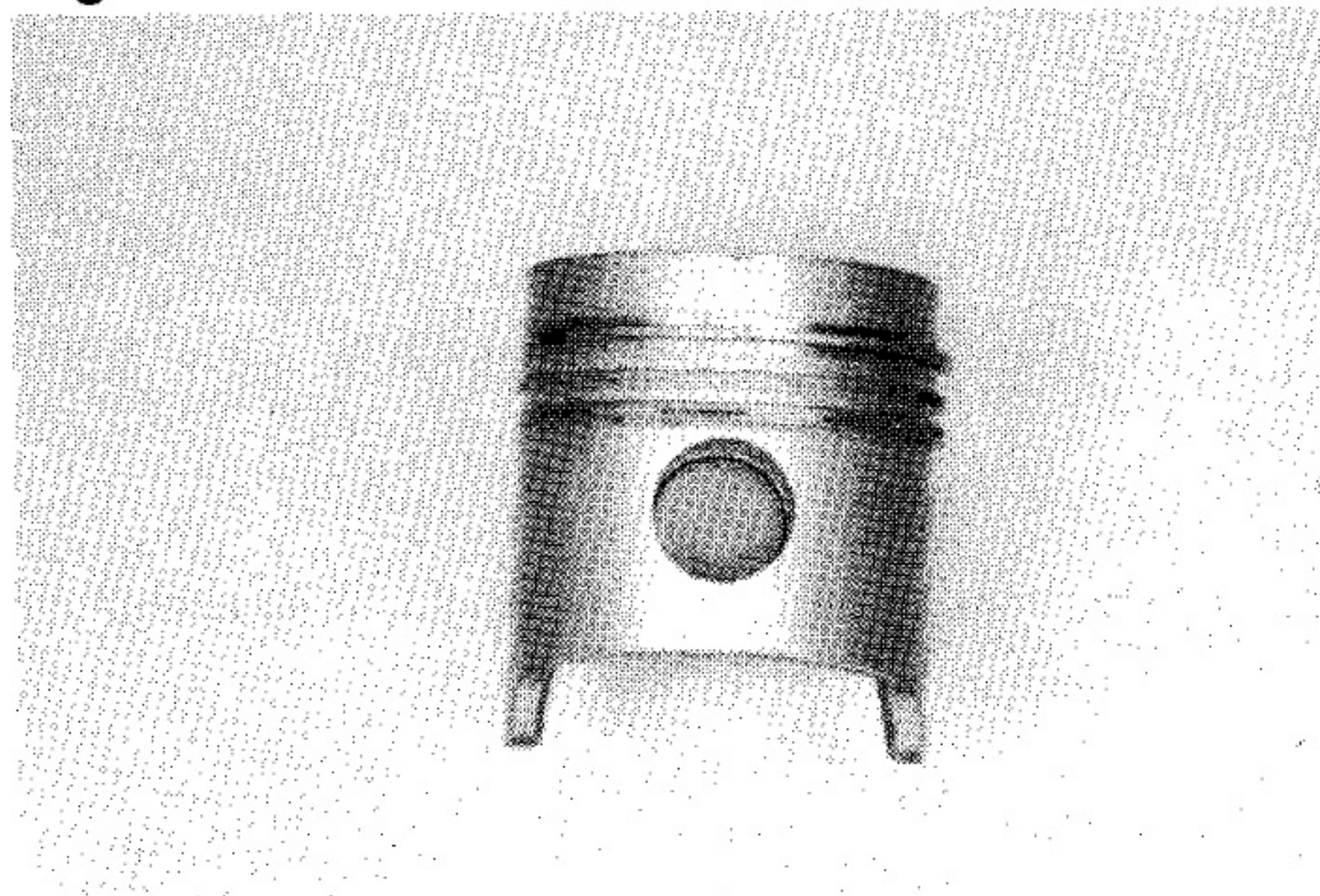
**STD 0.03 – 0.07 mm
(0.0012 – 0.0028 in.)**

**Limit 0.1 mm
(0.004 in.)**

U/S bearing:

**0.05, 0.25, 0.50, 0.75,
1.00**

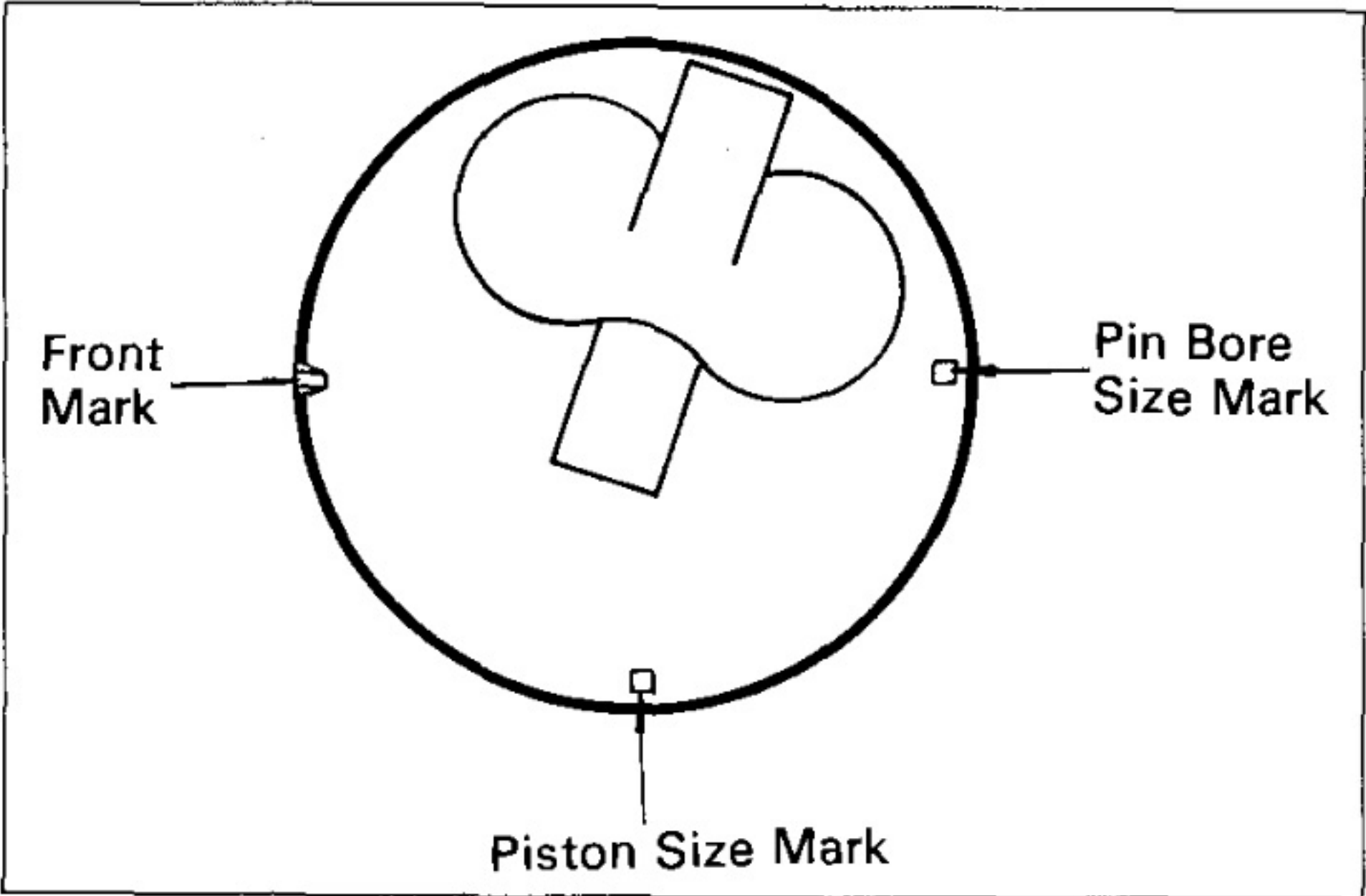
Fig. 3-152



Piston

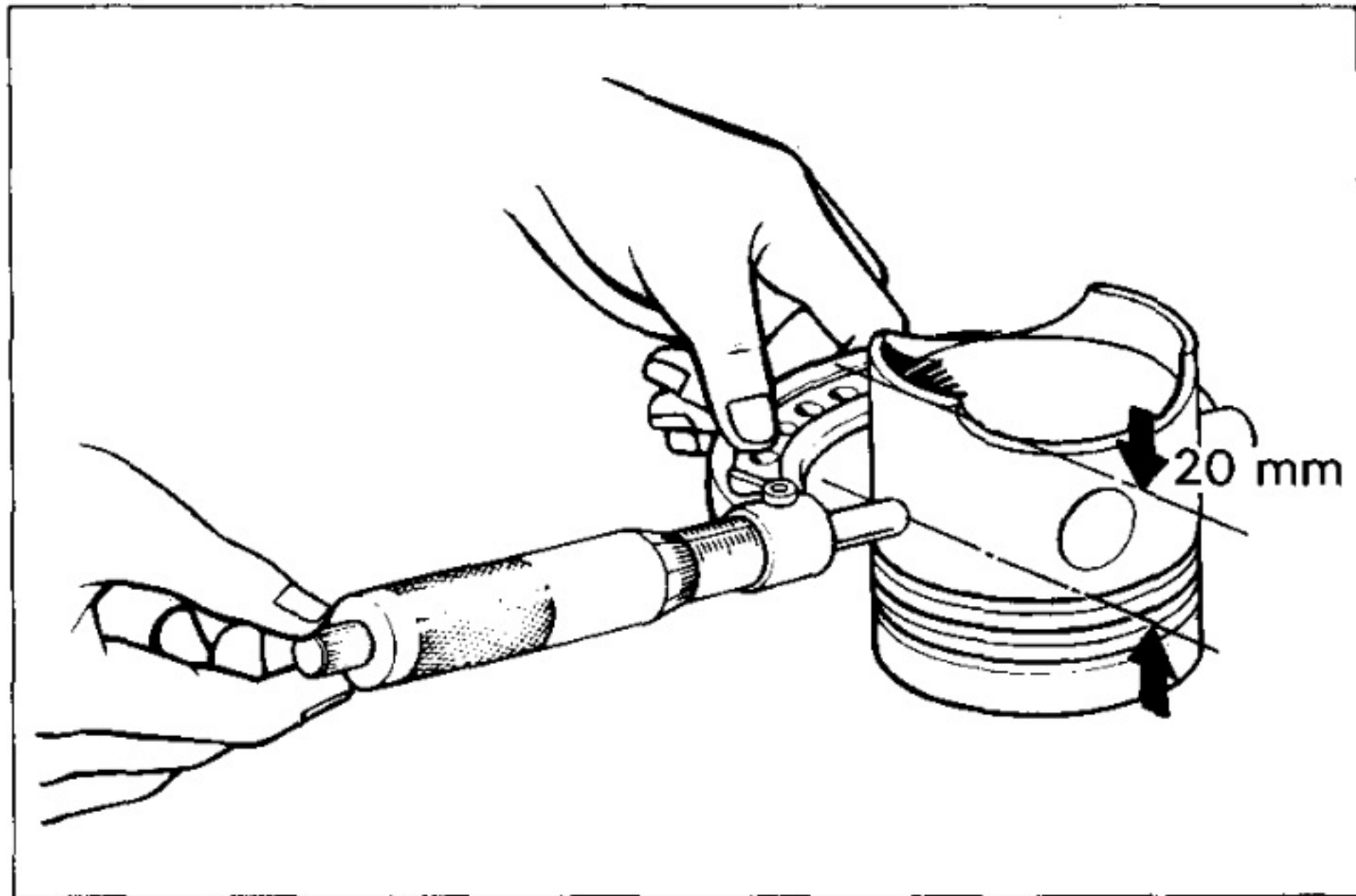
1. Check for wear or damage, especially in the piston ring grooves and ring lands.

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

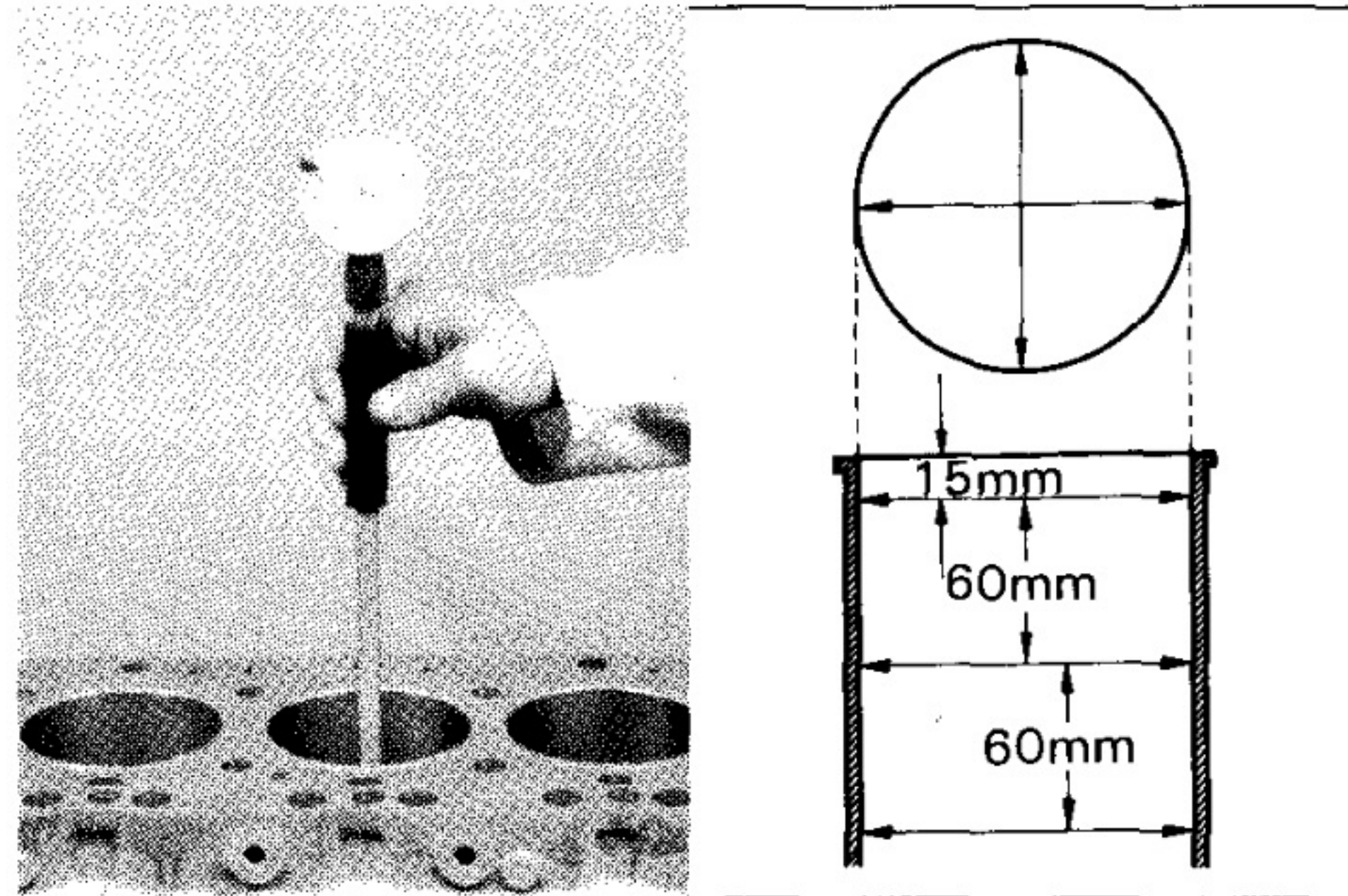


2. Check piston clearance.
- (1) Measure piston diameter in the thrust direction about 20 mm (0.79 in.) down from the skirt bottom edge.
Measurement must be made at normal temperature 20°C (68°F).

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



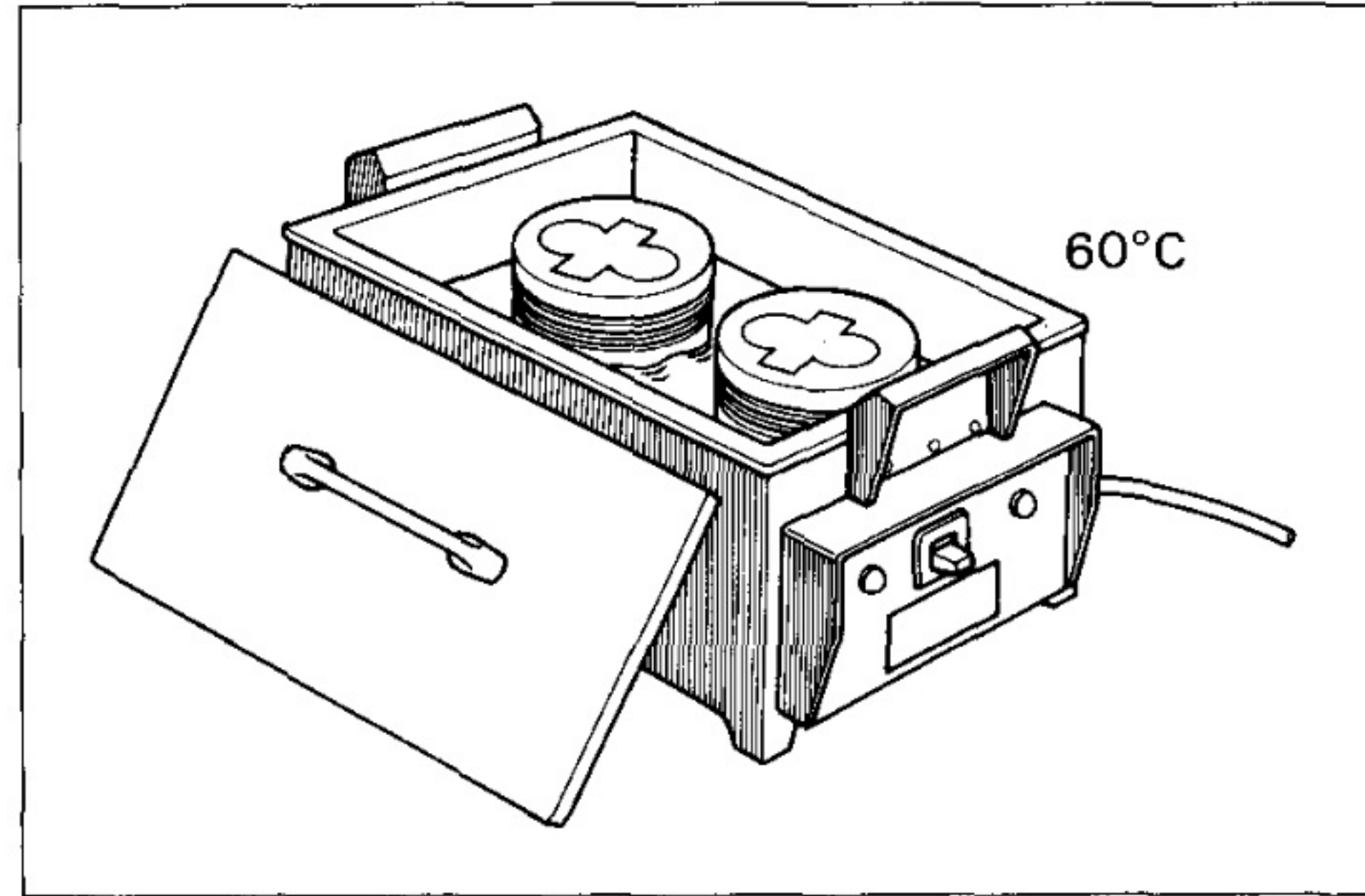
- (2) Measure the cylinder bore and subtract the piston size.

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)

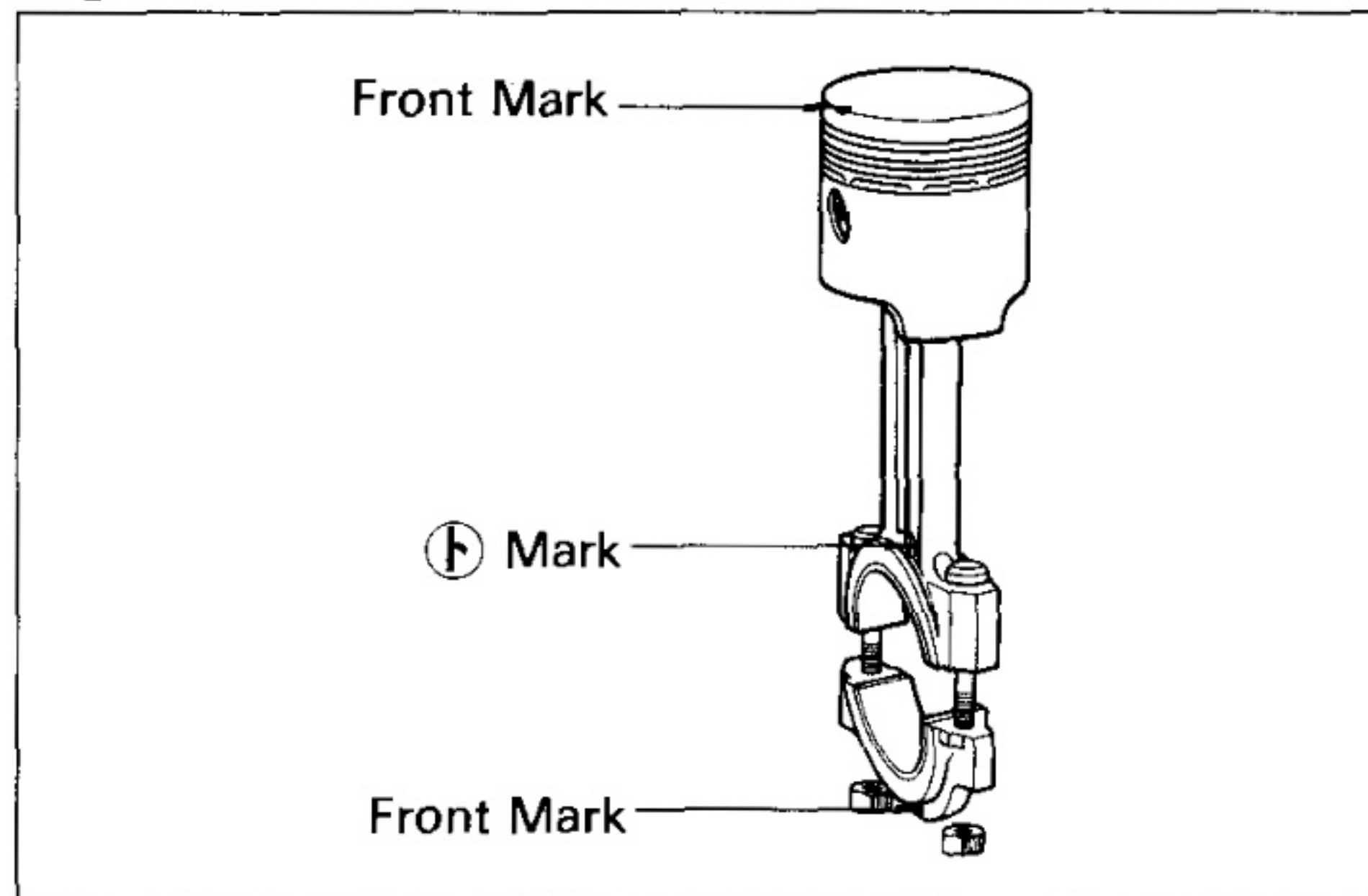
Piston clearance:
0.07 – 0.09 mm
(0.0028 – 0.0035 in.)

Fig. 3-156



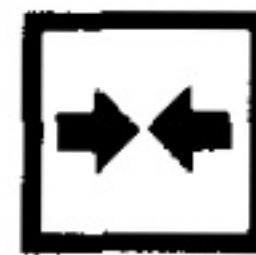
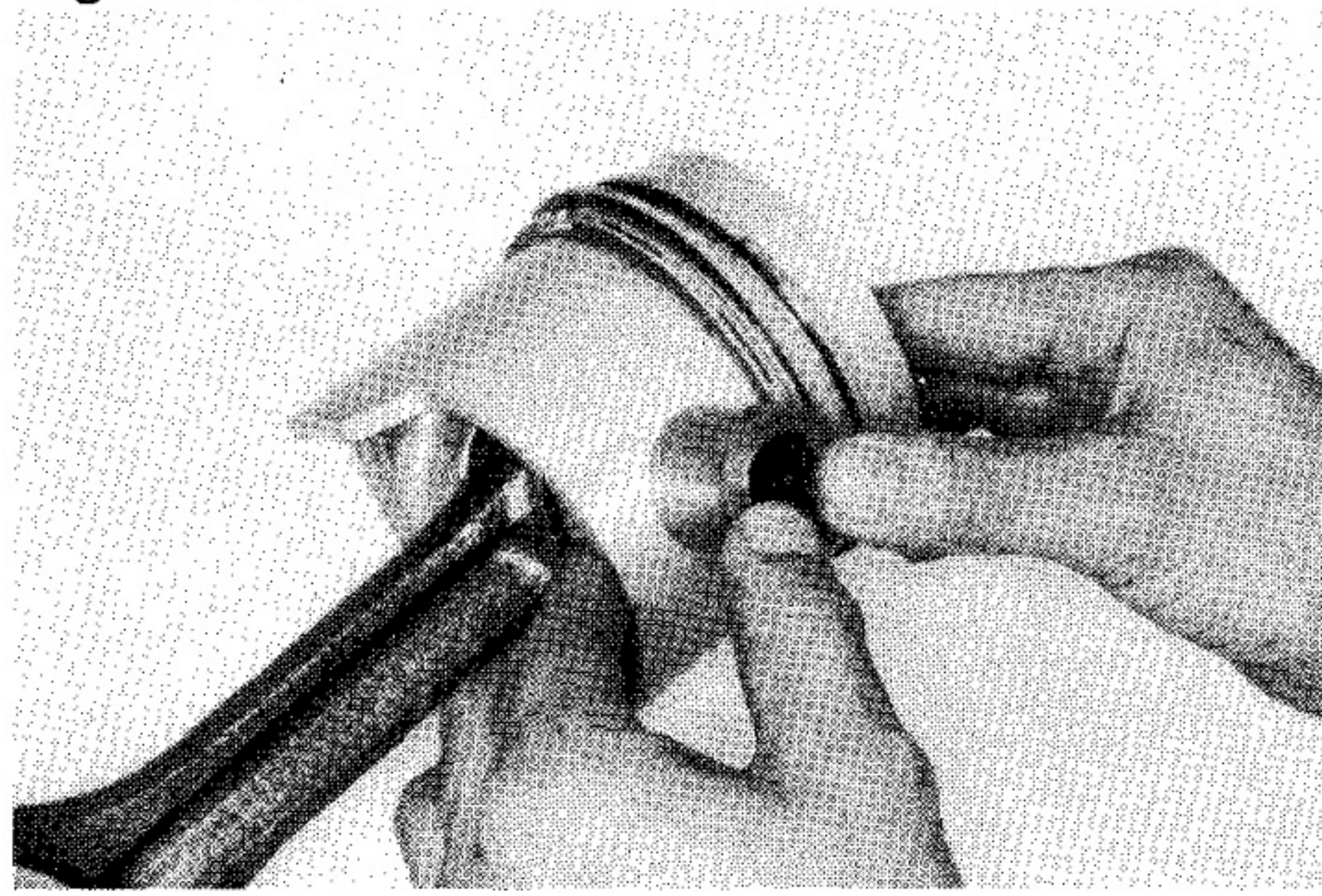
3. Assemble the piston and connecting rod as follows.
- (1) Heat the piston to about 60°C (140°F) before installing the piston pin.

Fig. 3-157



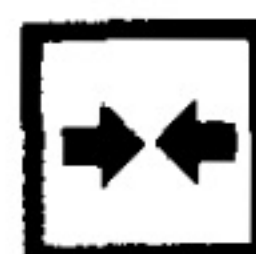
- (2) Align the front mark of the piston and ⌚ mark of the connecting rod as shown in the figure.

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.

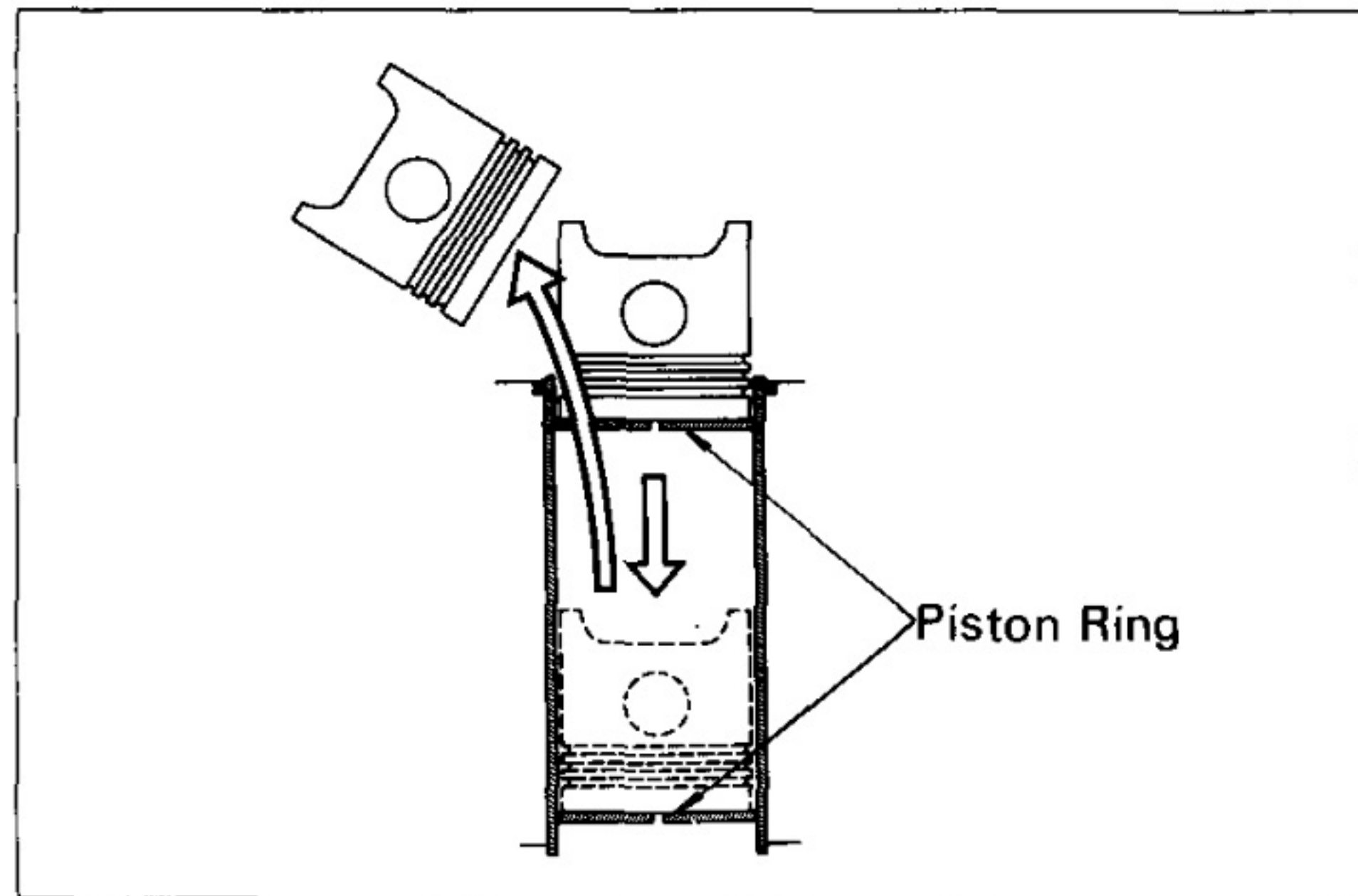
Fig. 3-160



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

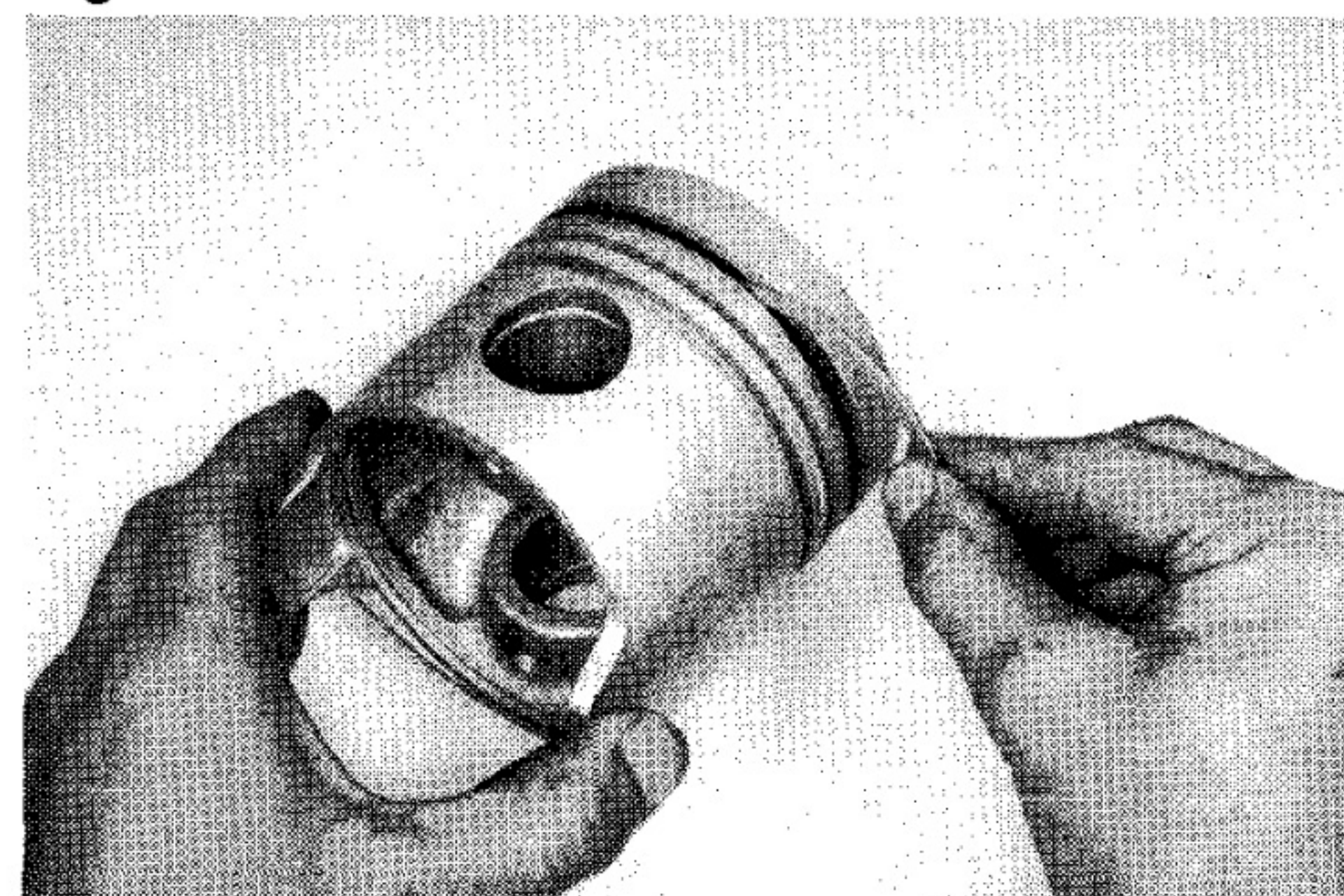
(0.0079 – 0.0185 in.)

Oil

0.20 – 0.52 mm

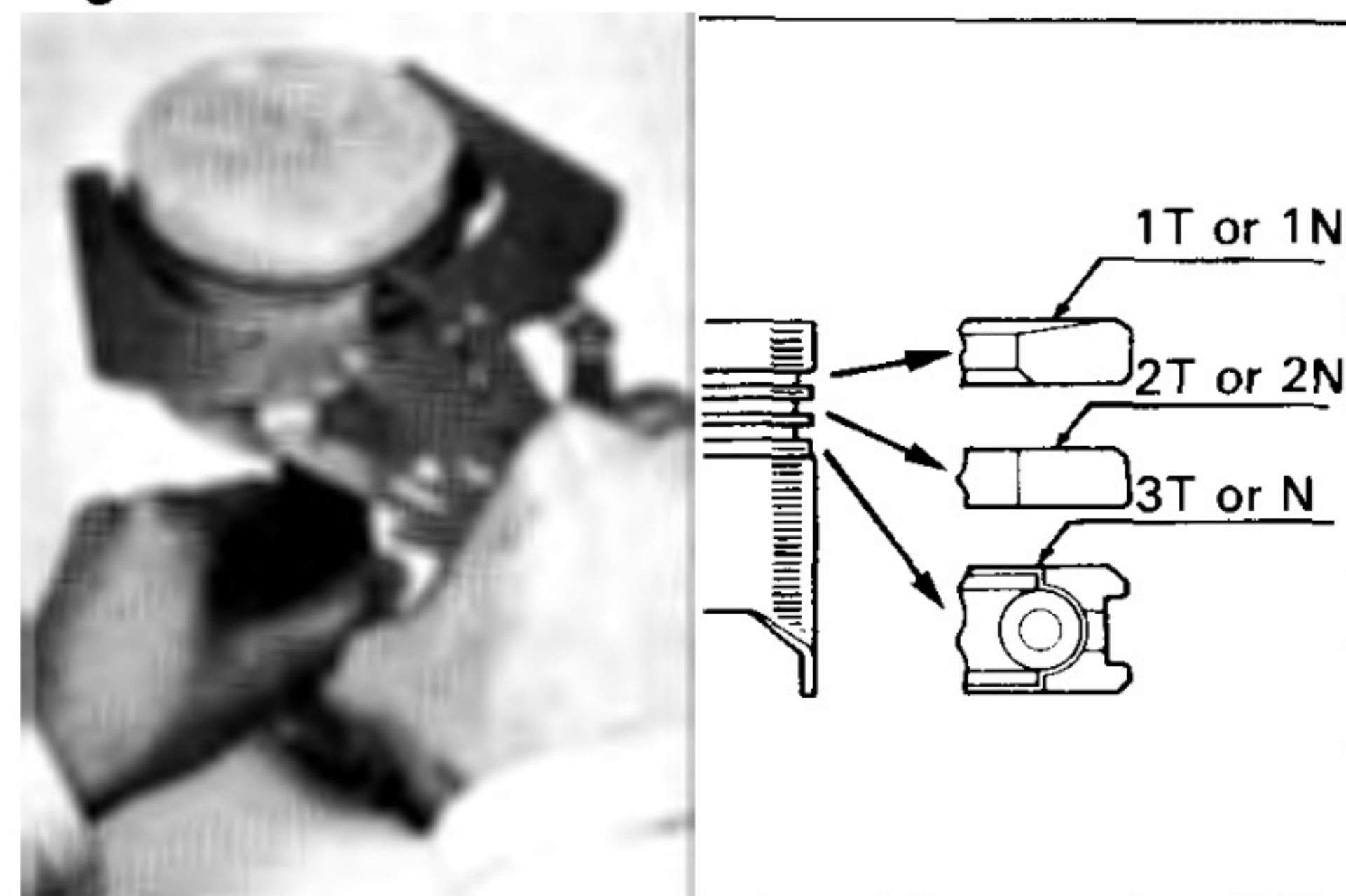
(0.0079 – 0.0204 in.)

Fig. 3-163



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

Fig. 3-164

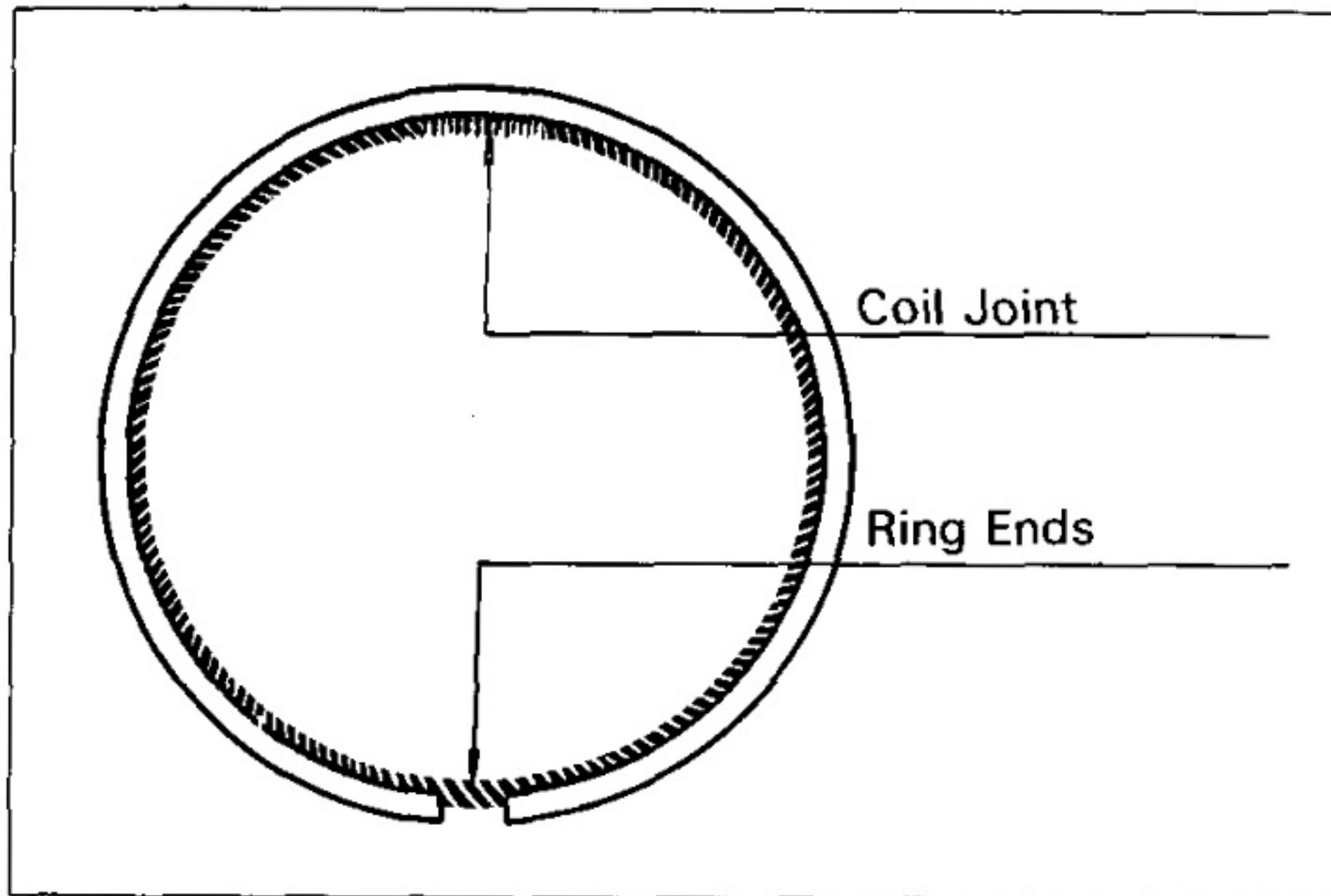


5. Install the piston ring with the piston ring expander.

— Note —

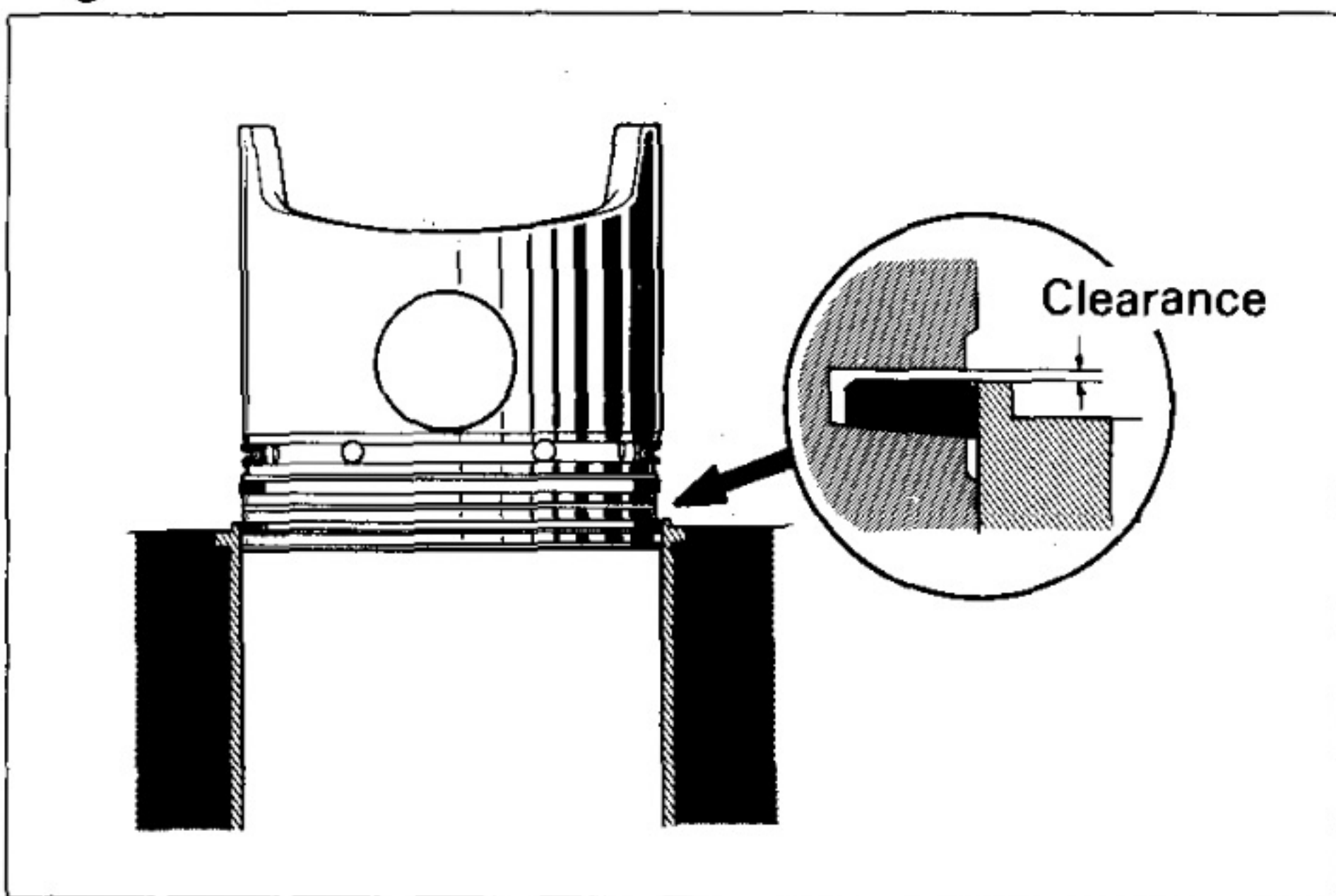
1. **Always install the rings with the code marks facing upward.**

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.

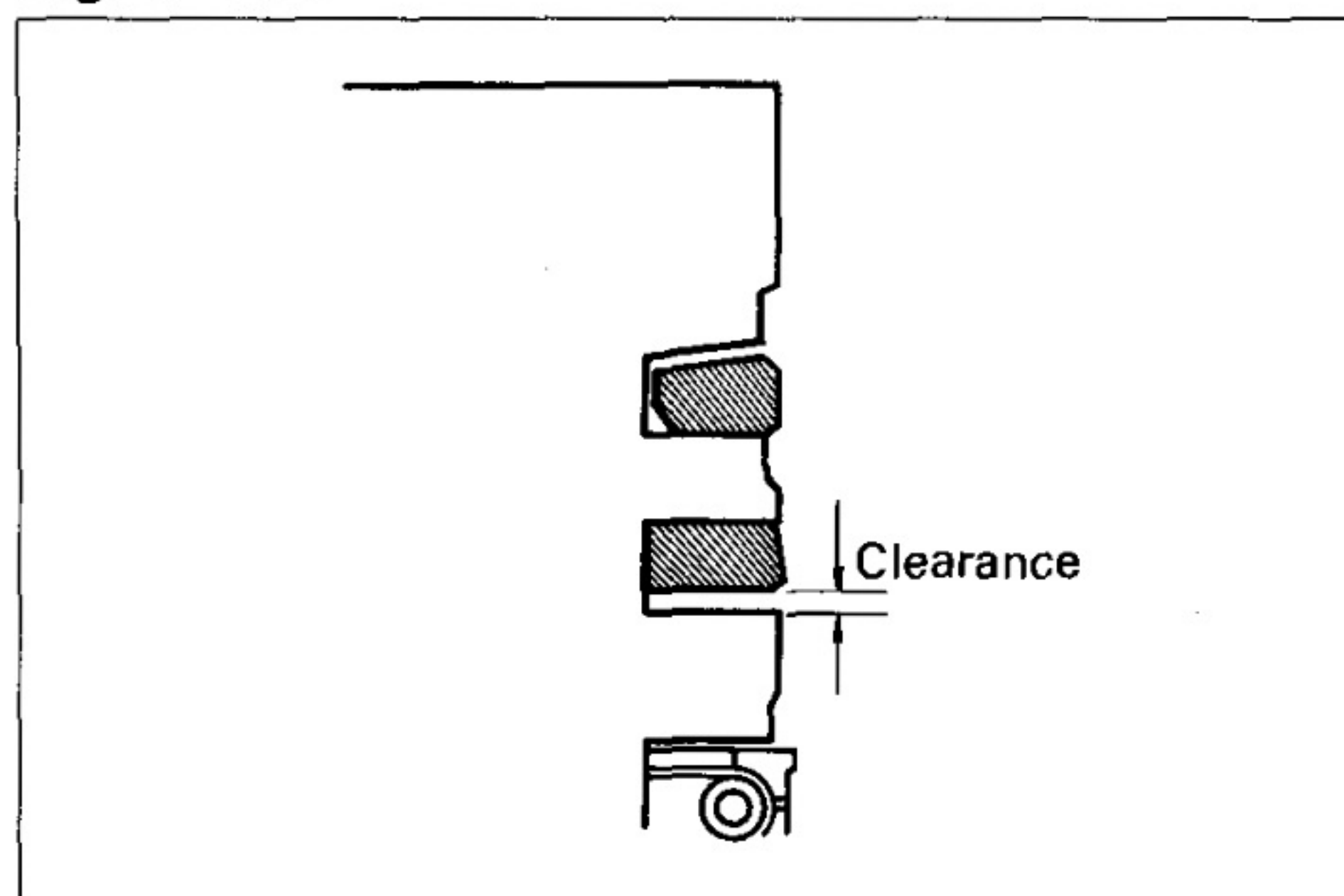
Fig. 3-166



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.)

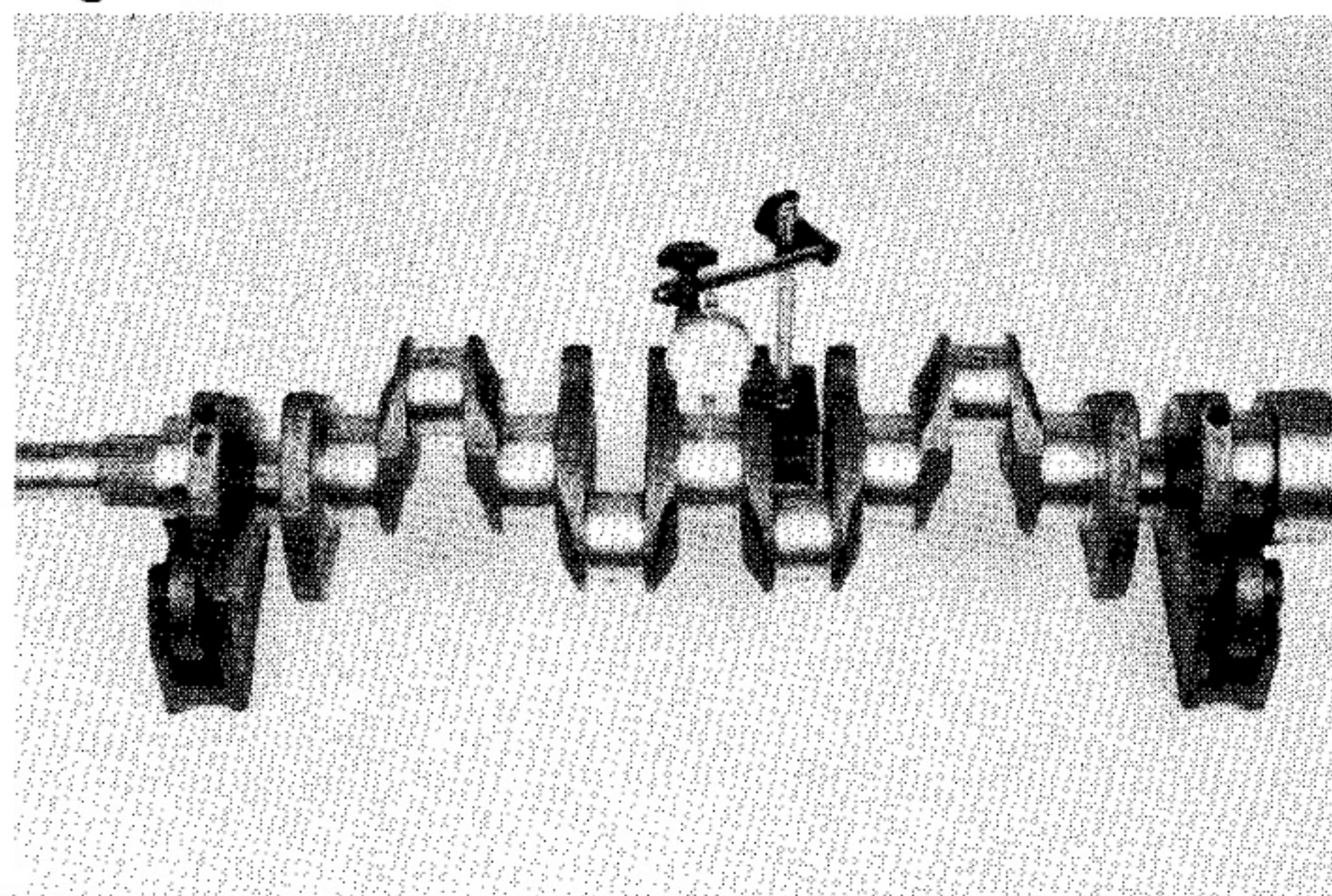
Fig. 3-167



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

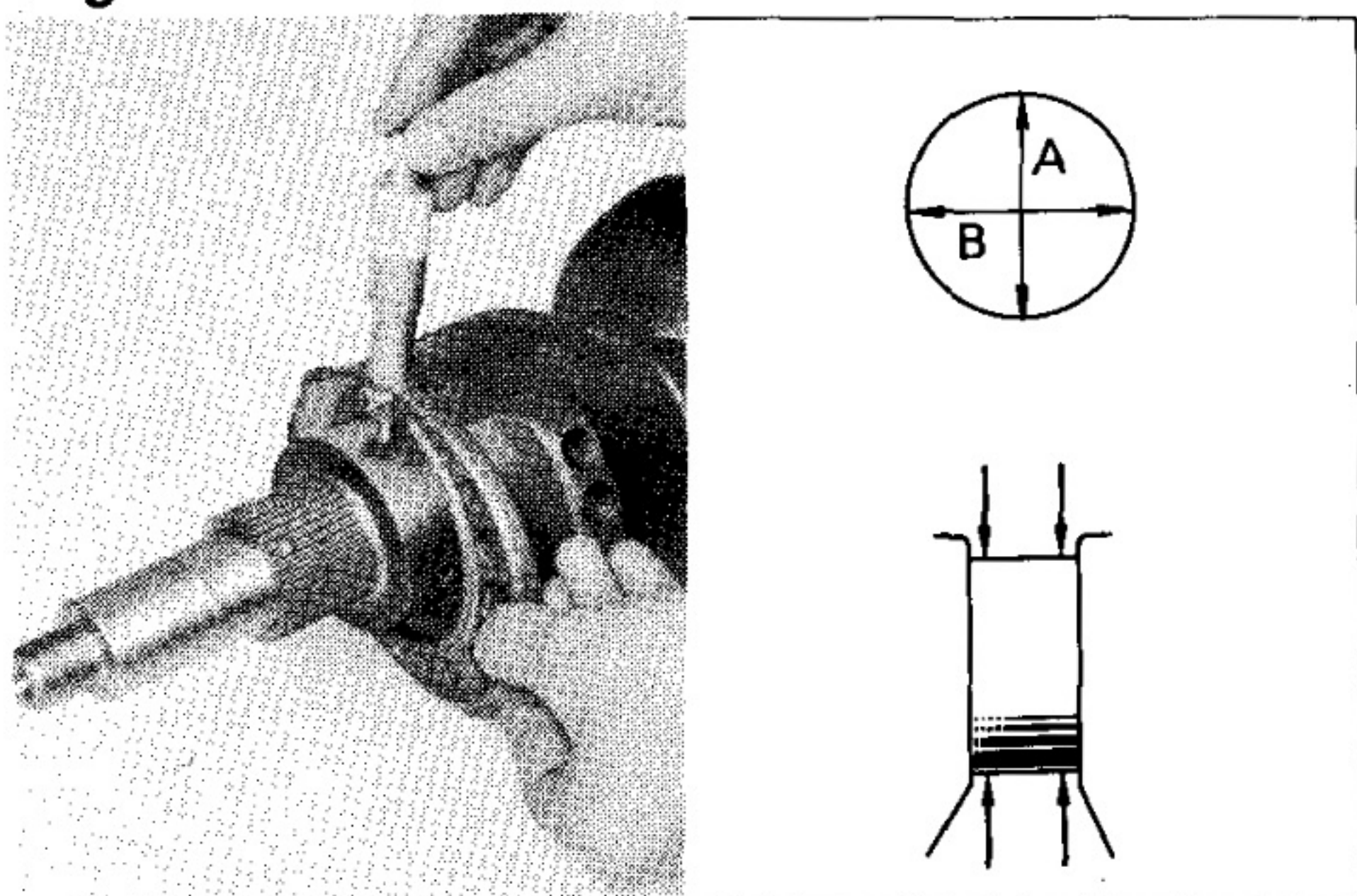


Crankshaft & Bearing

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.)

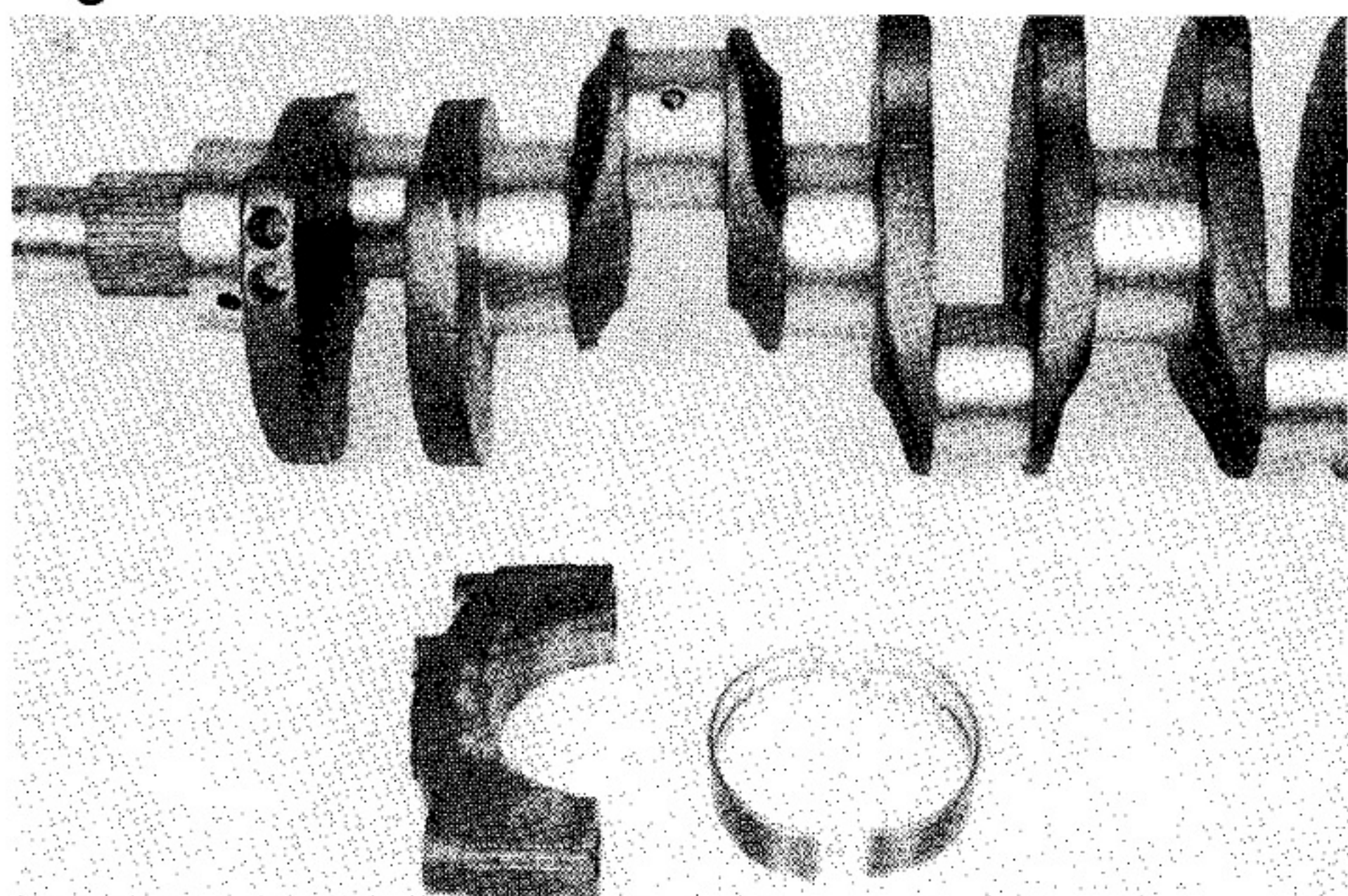
Taper and out-of-round:

Limit 0.02 mm
(0.0008 in.)

– Note –

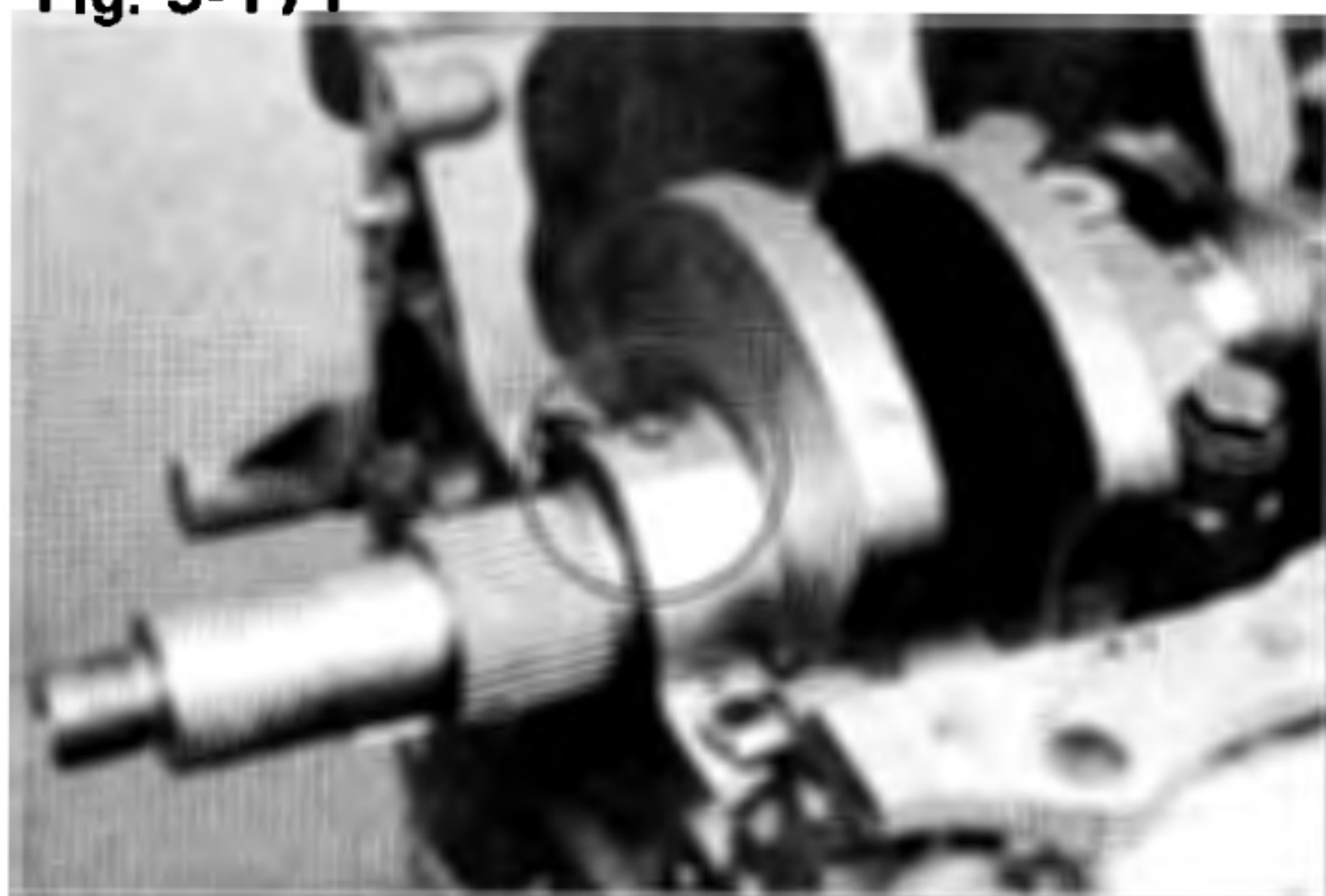
Measure A and B diameters in two places.

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.

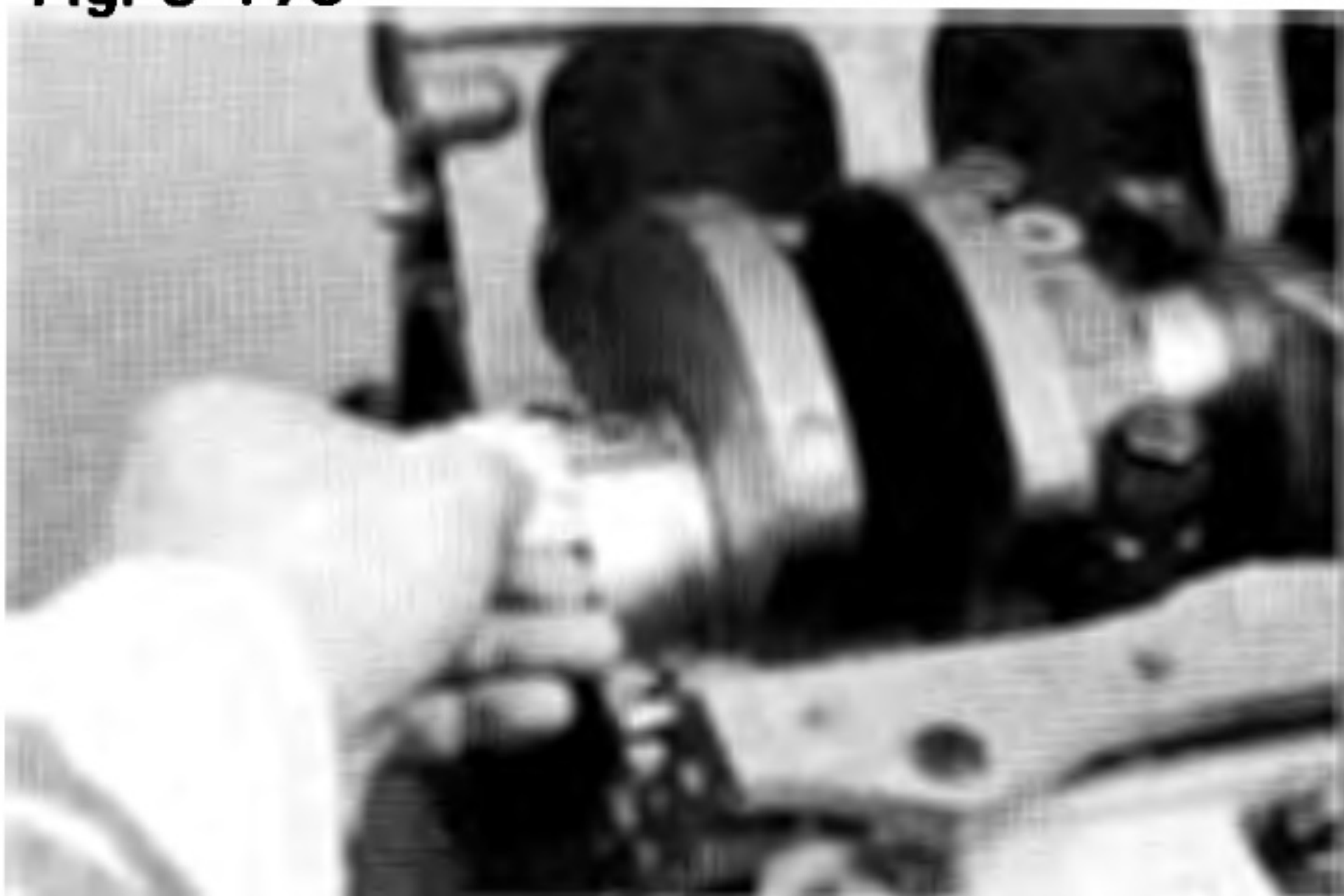
Tightening torque:

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:

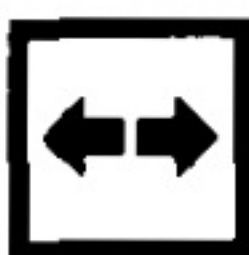
STD 0.03–0.07 mm
(0.0012–0.0028 in.)

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

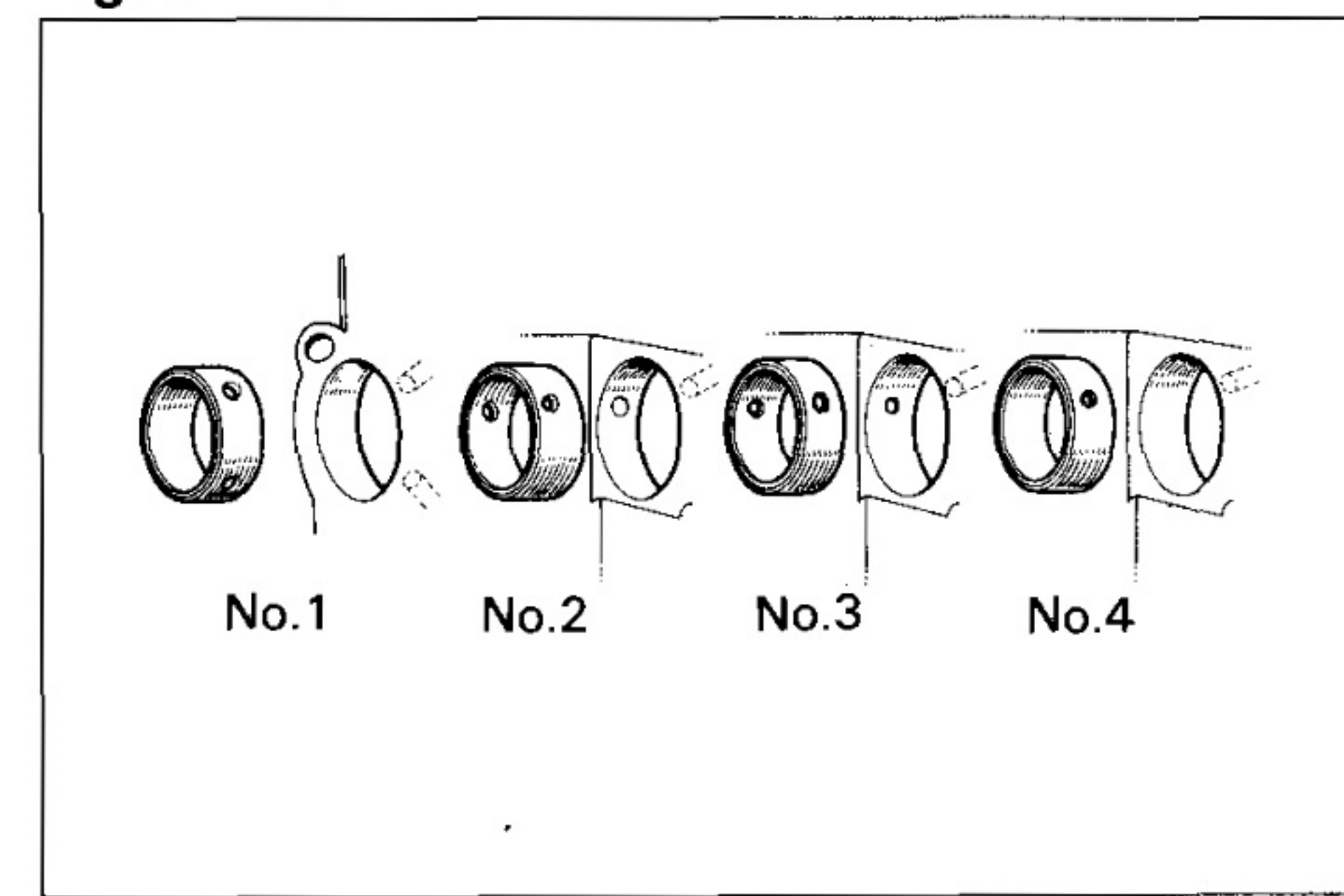


2. Remove the camshaft bearings with SST. SST [09215-00100]

— 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.

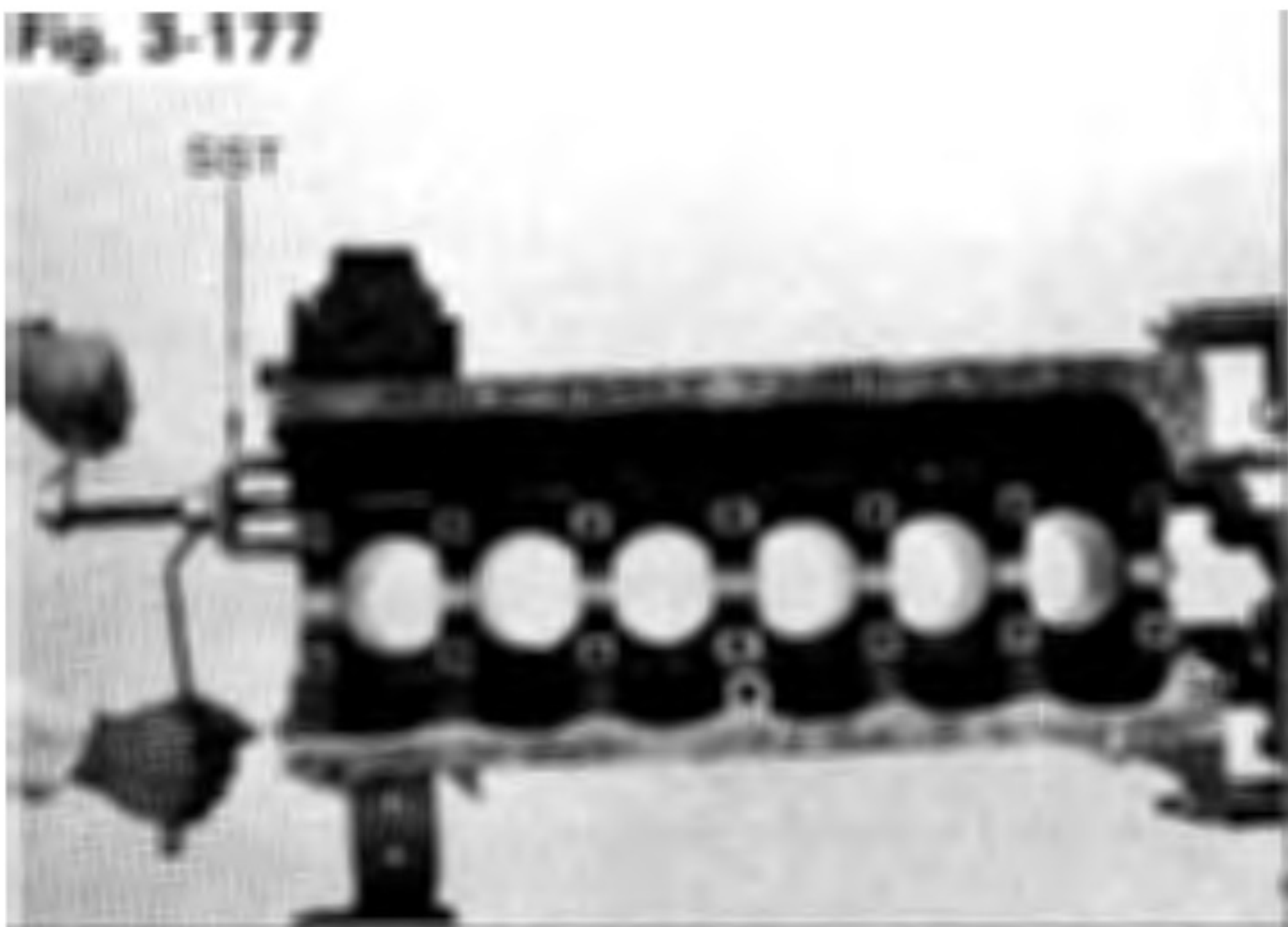


Fig. 3-178



Fig. 3-179

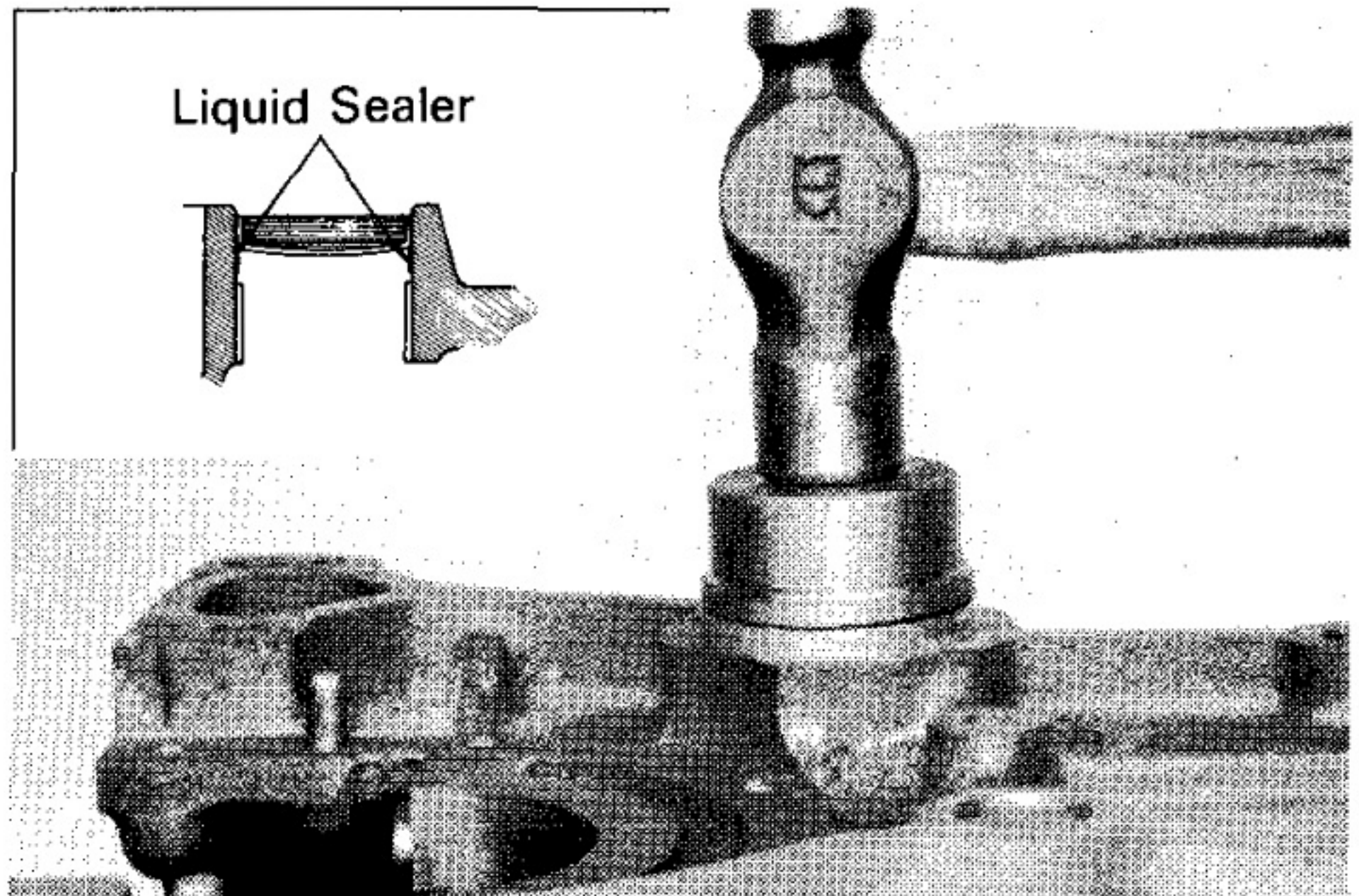
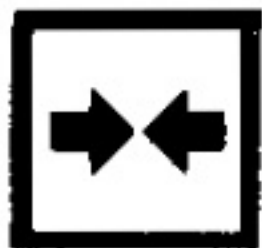
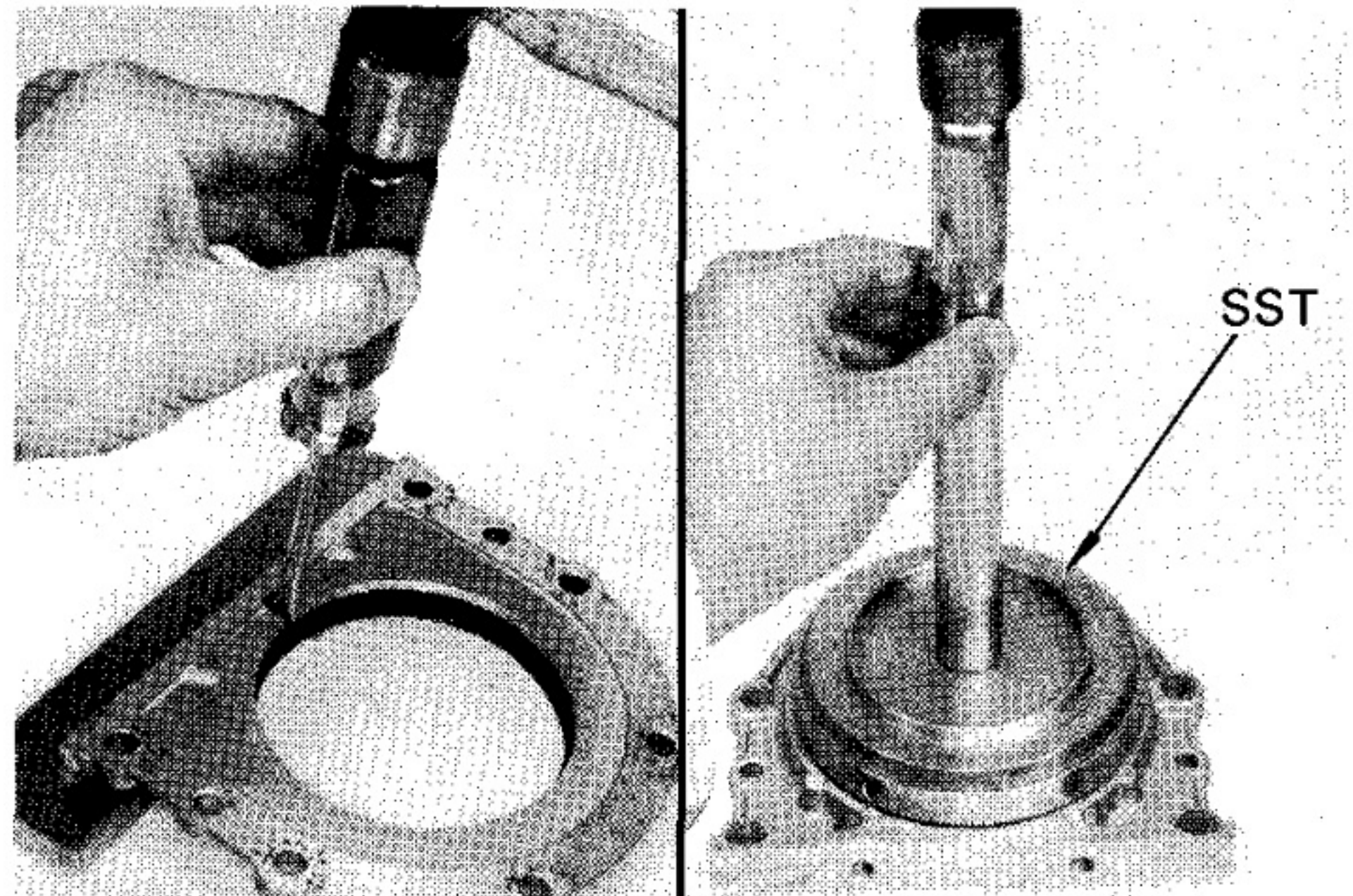


Fig. 3-180



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

— Note —
Install each bearing one at a time.



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.) |

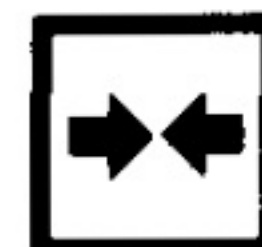


6. Install a new expansion plug with liquid sealer.



Crankshaft Rear Oil Seal

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



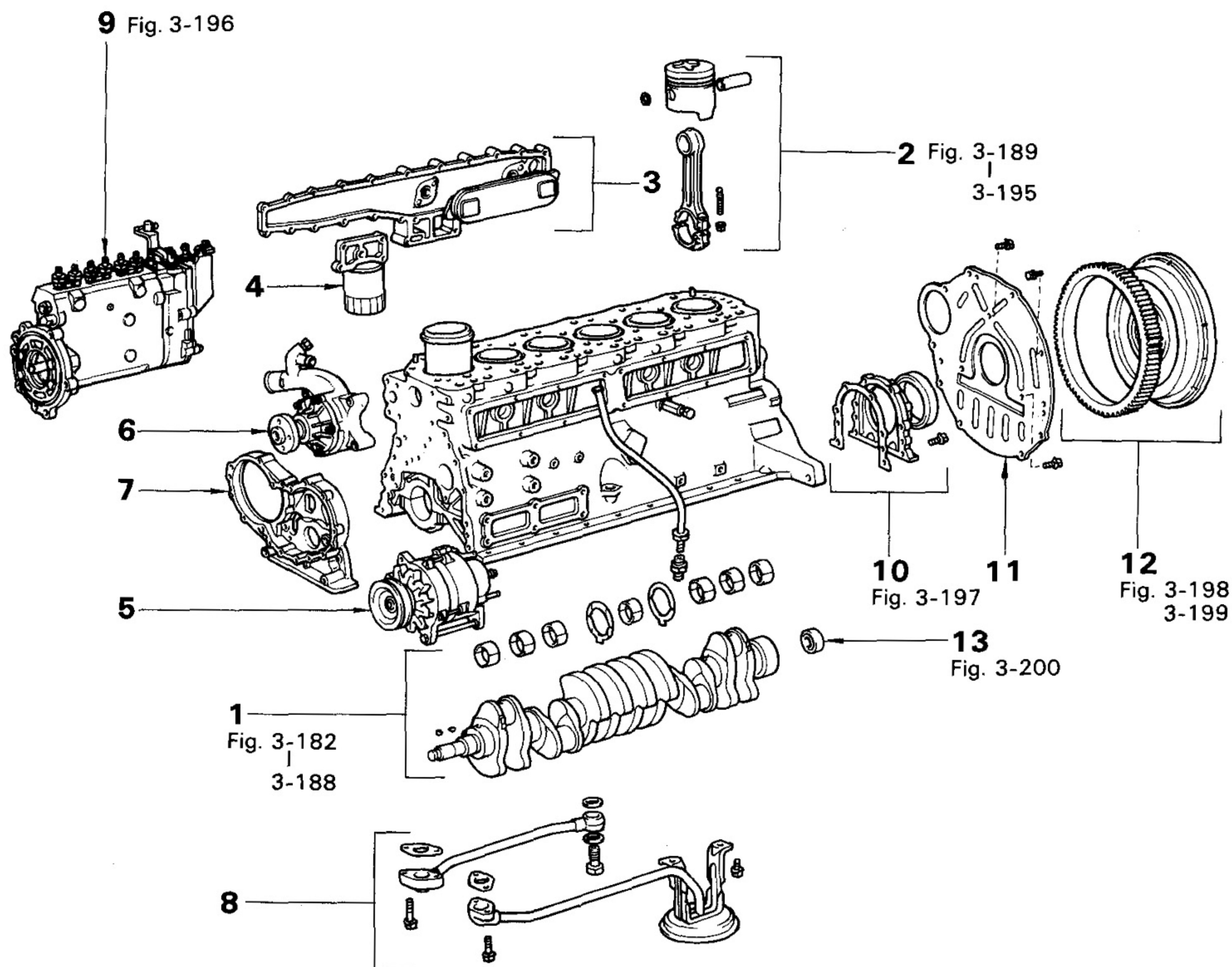
ASSEMBLY

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

Fig. 3-181

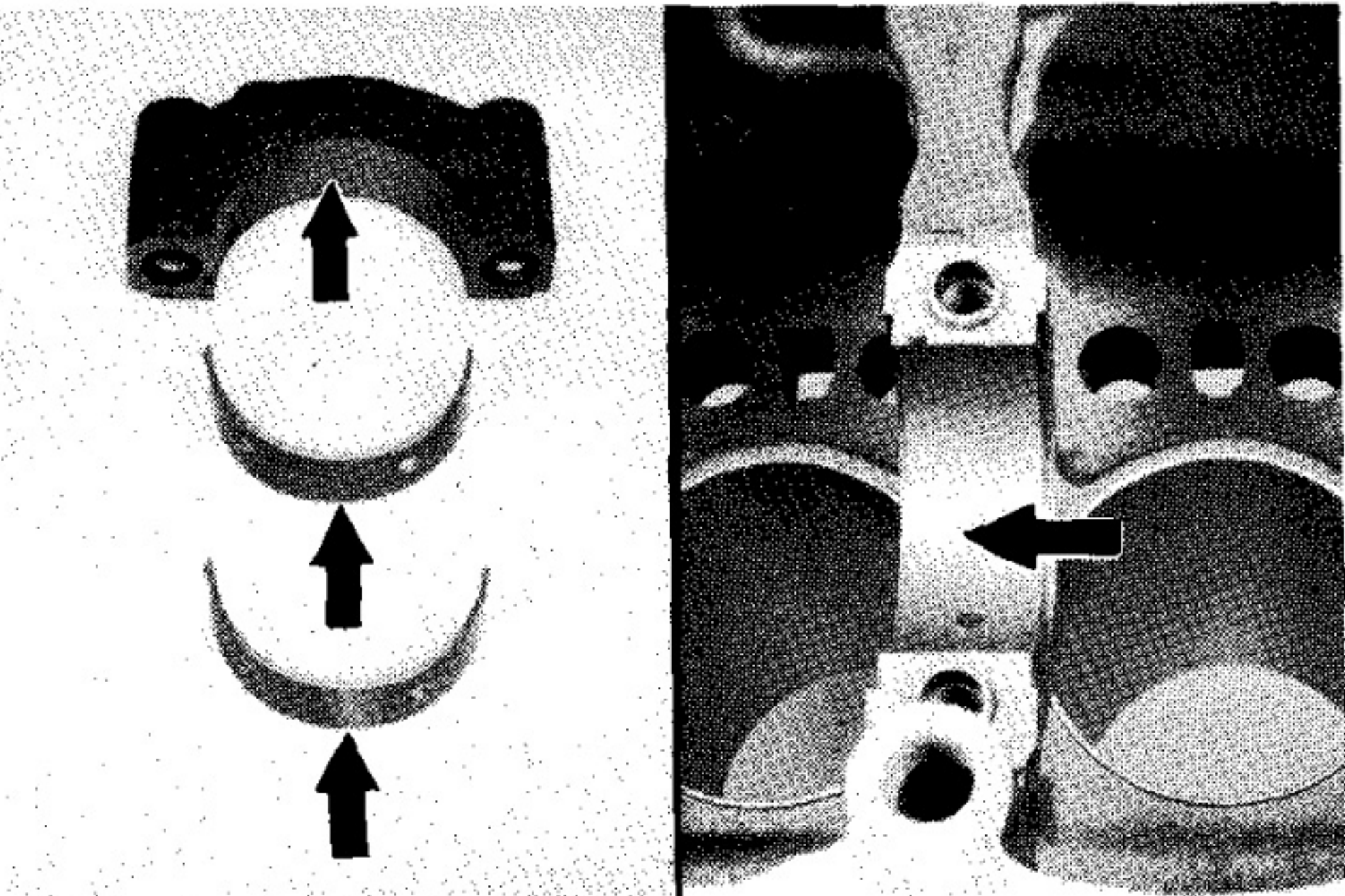
— Note —

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

Fig. 3-182



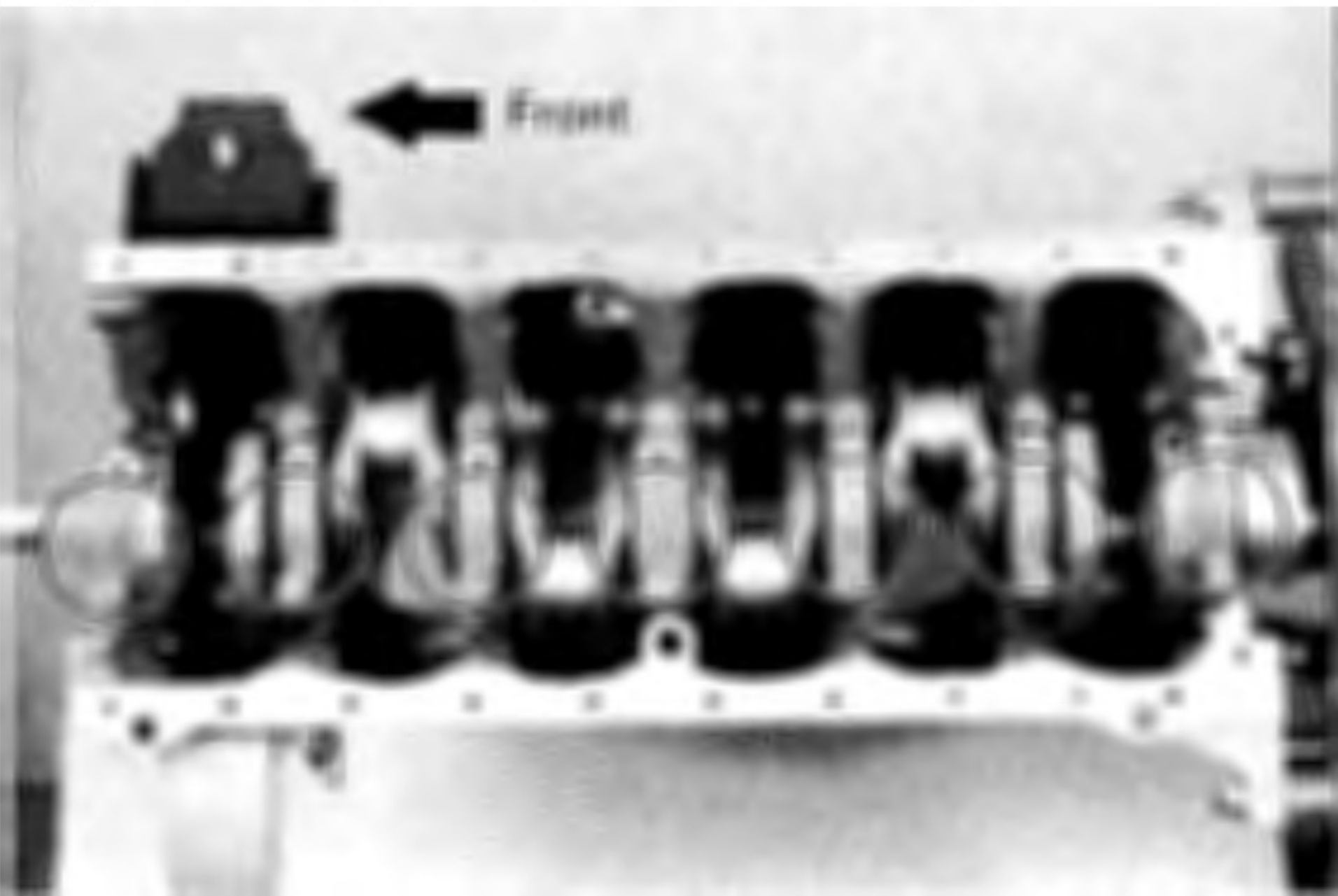
Do not allow oil to get on the back side of the bearing.

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



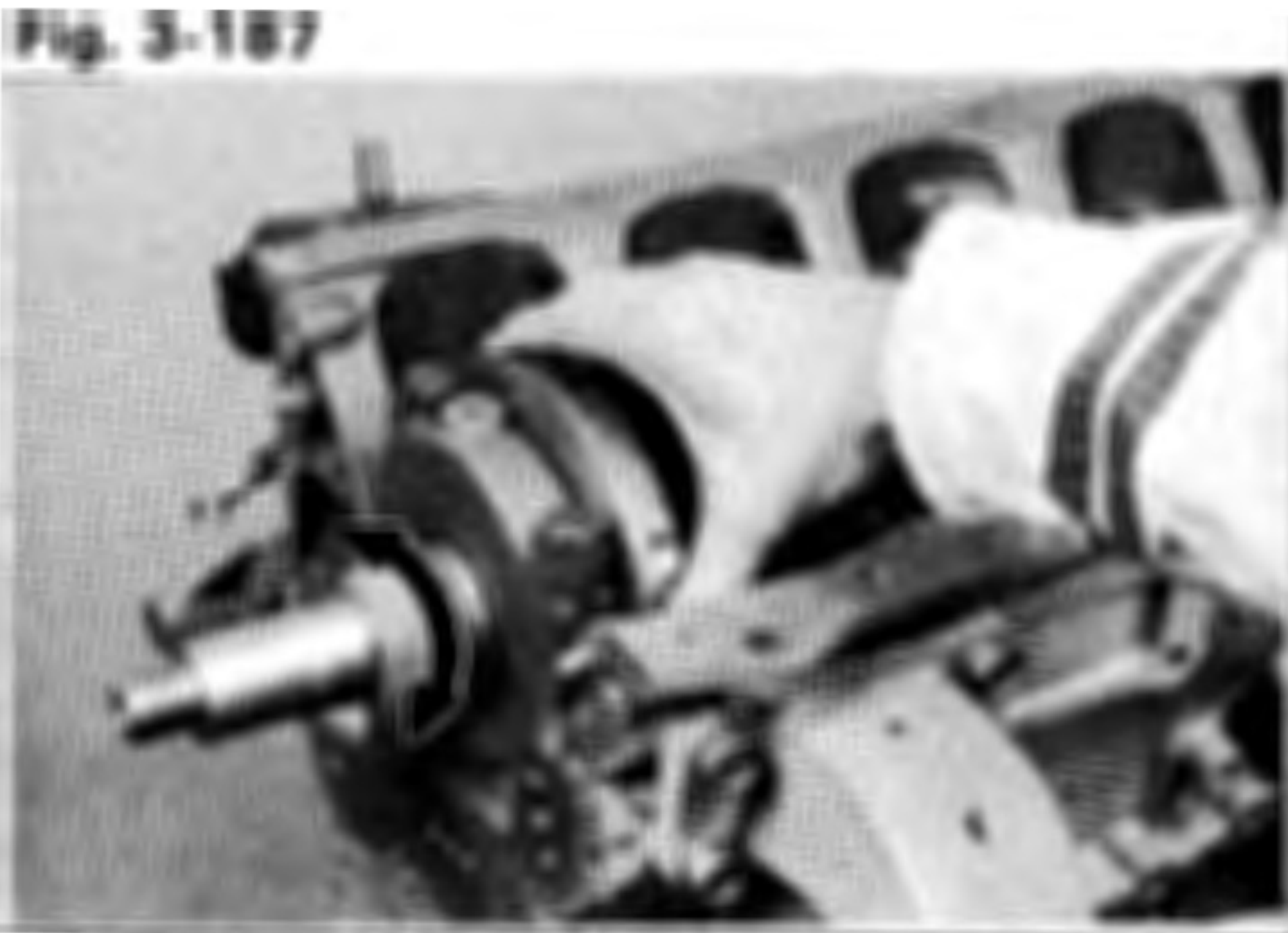
Tighten each bearing cap bolt a little at a time in the sequence shown in the figure.

Fig. 3-186



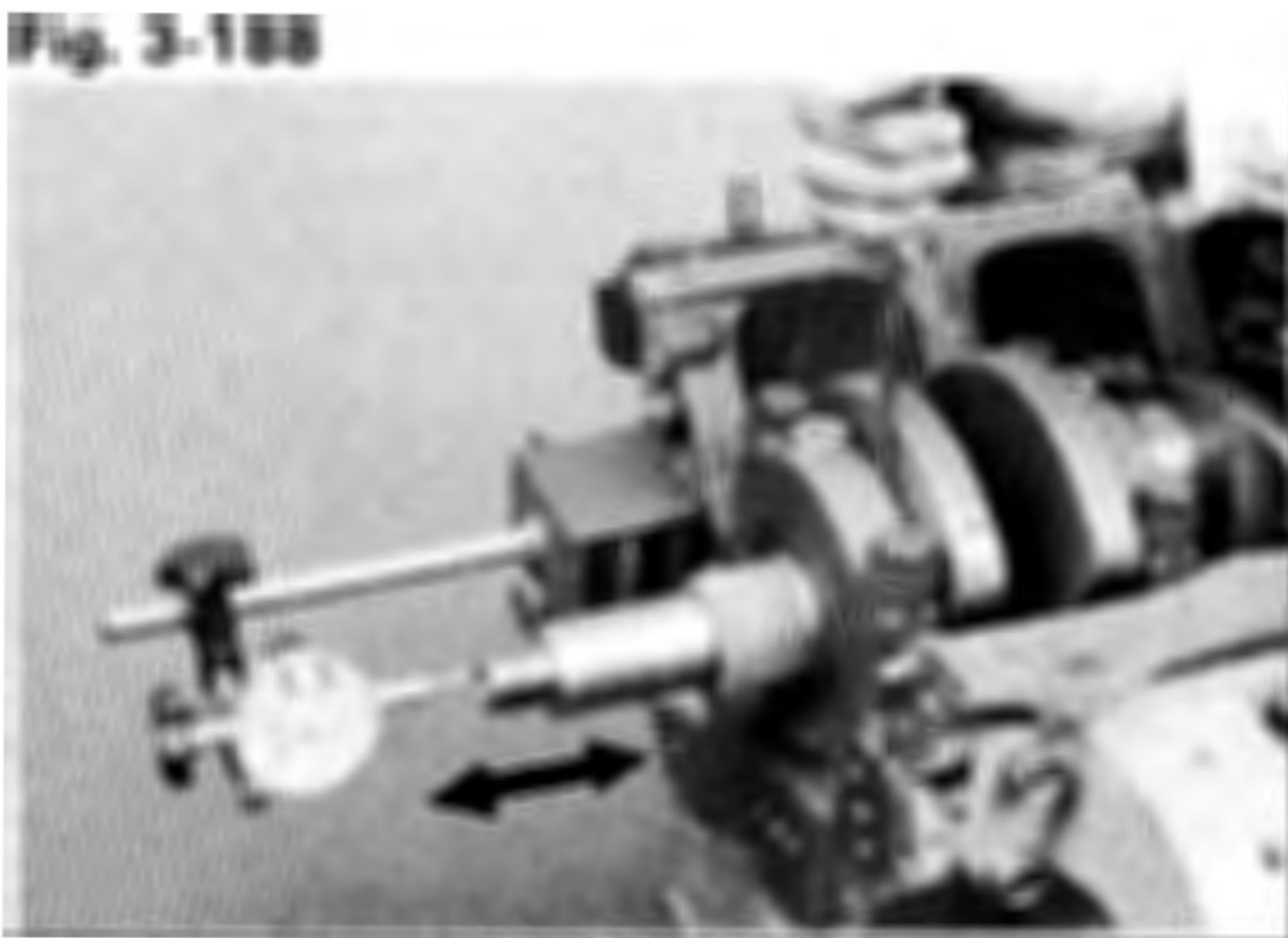
Tighten the bearing caps to specified torque.
Tightening torque: 12.8 – 14.2 kg-m
(93 – 102 ft-lb)

Fig. 3-187



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

Fig. 3-188

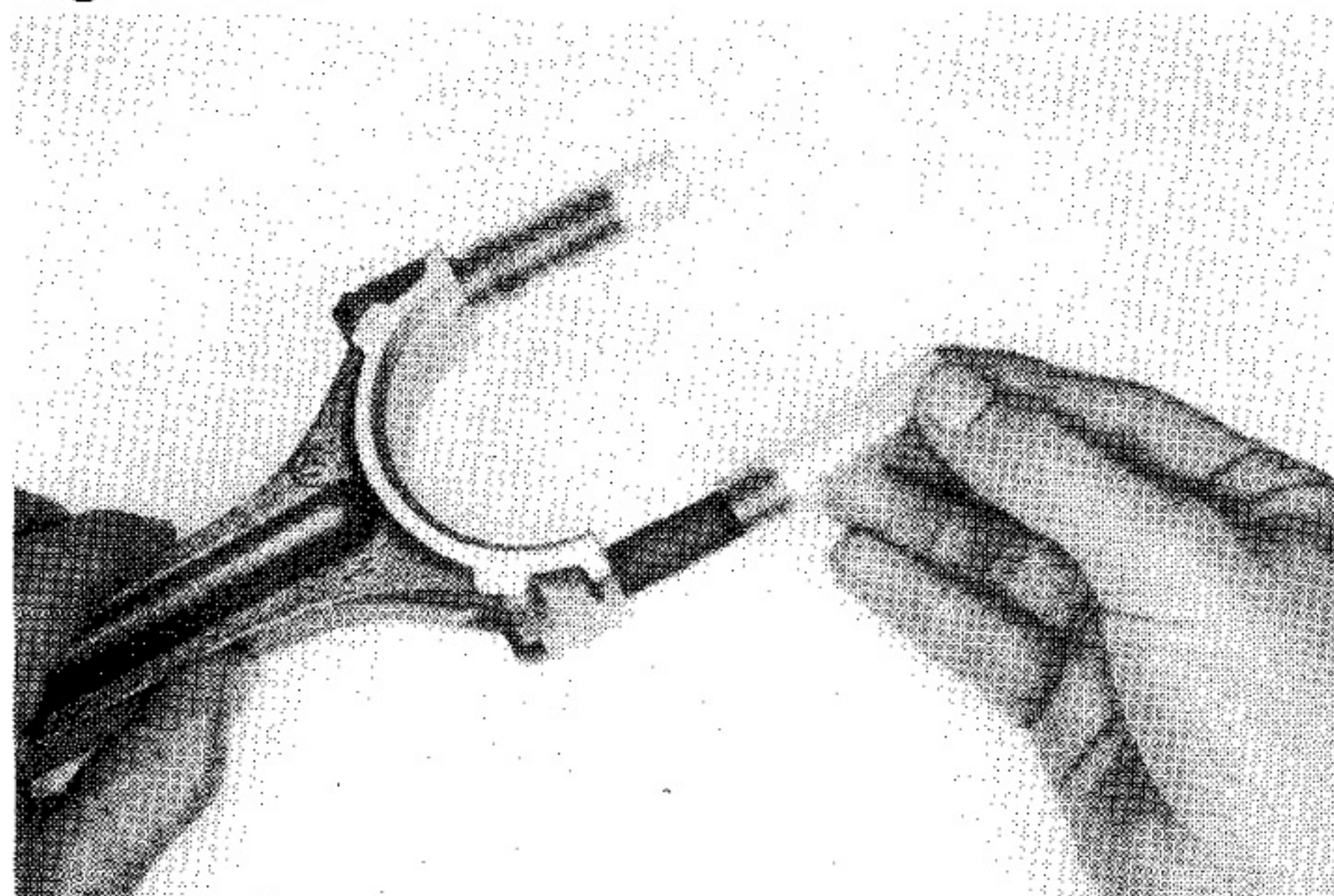


Measure the crankshaft thrust clearance.

Thrust clearance:

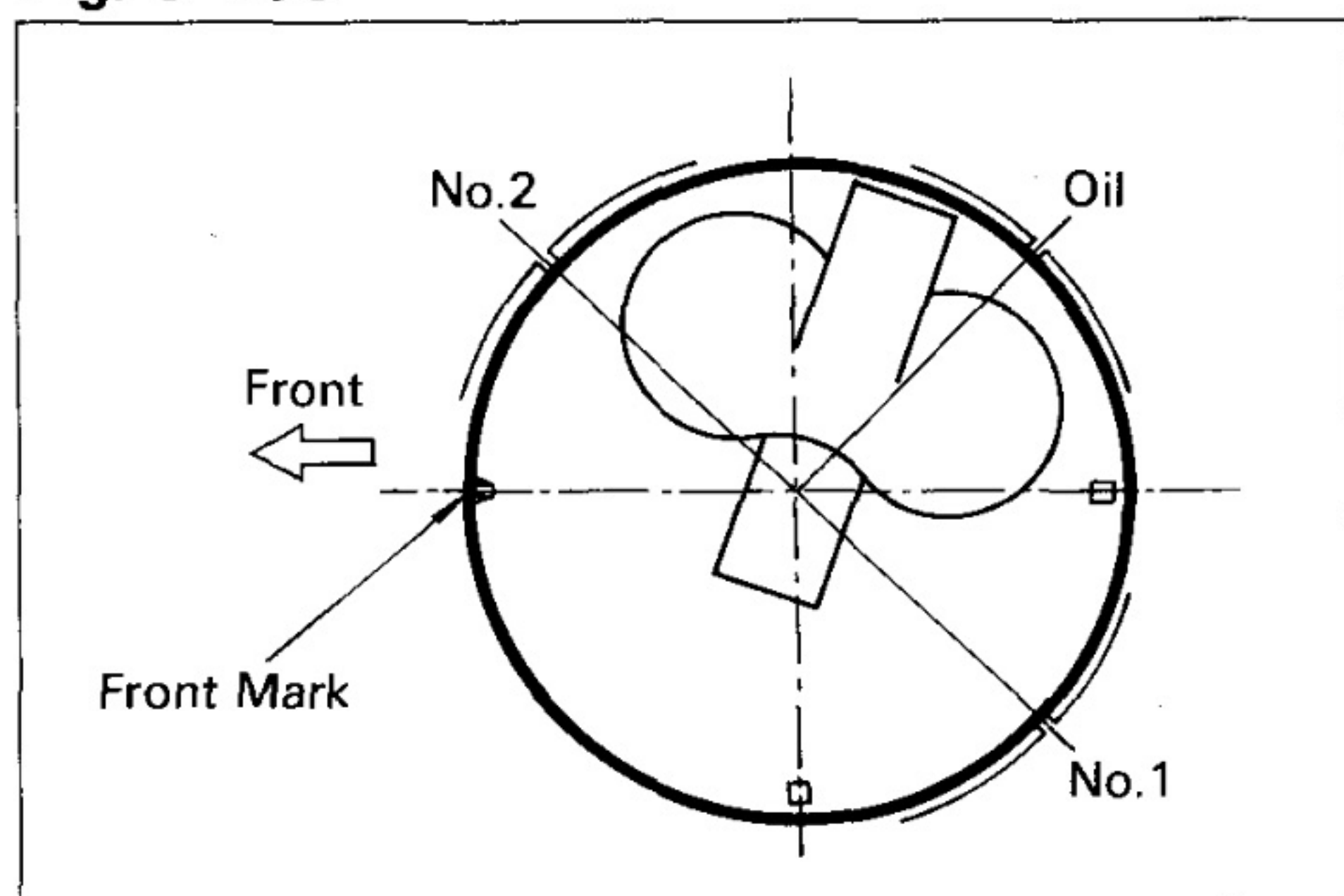
STD	0.04 – 0.24 mm (0.0016 – 0.0094 in.)
Limit	0.3 mm (0.012 in.)

Fig. 3-189



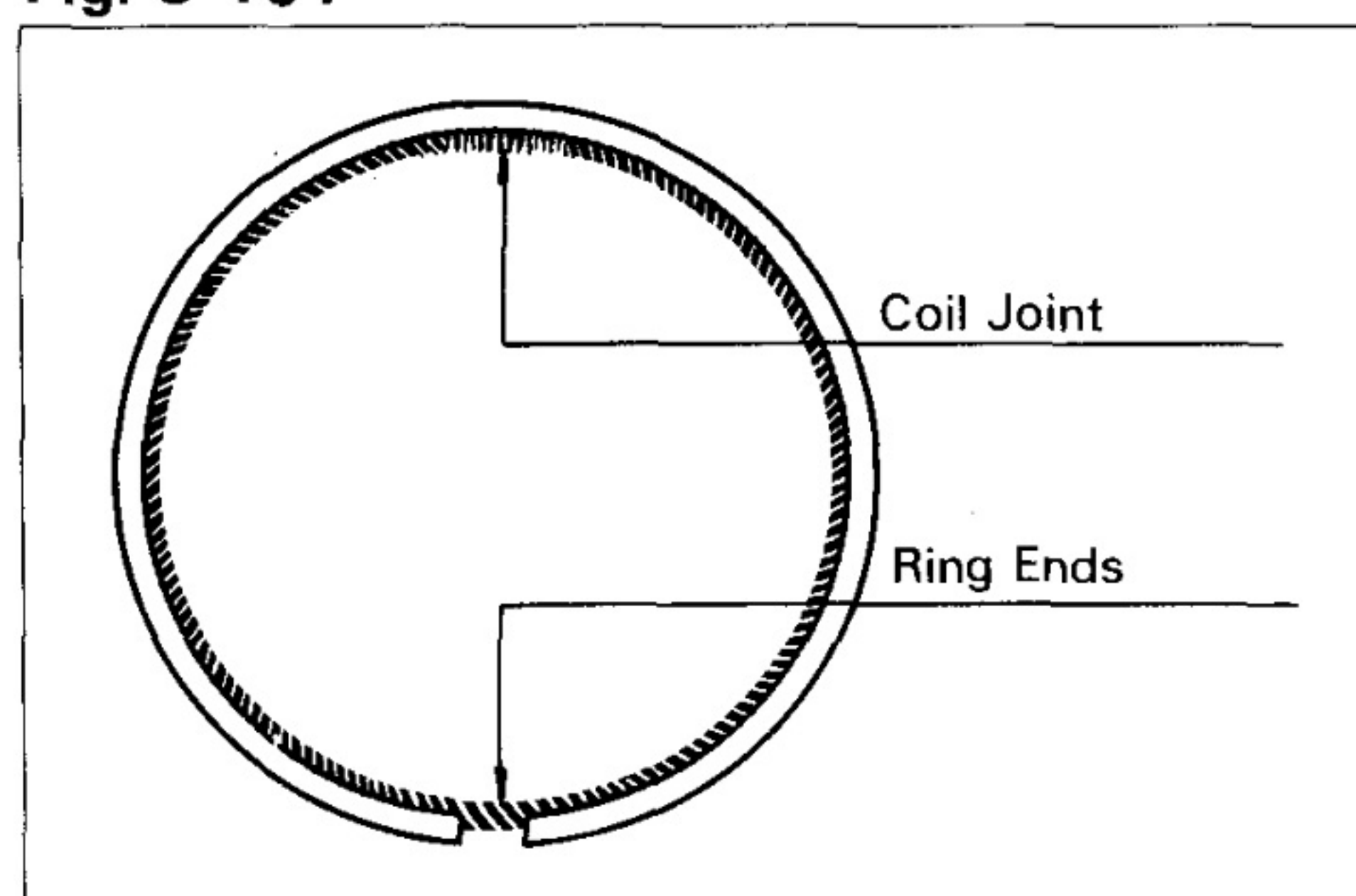
Cover the rod bolts with a piece of hose to protect the crank pins from damage.

Fig. 3-190



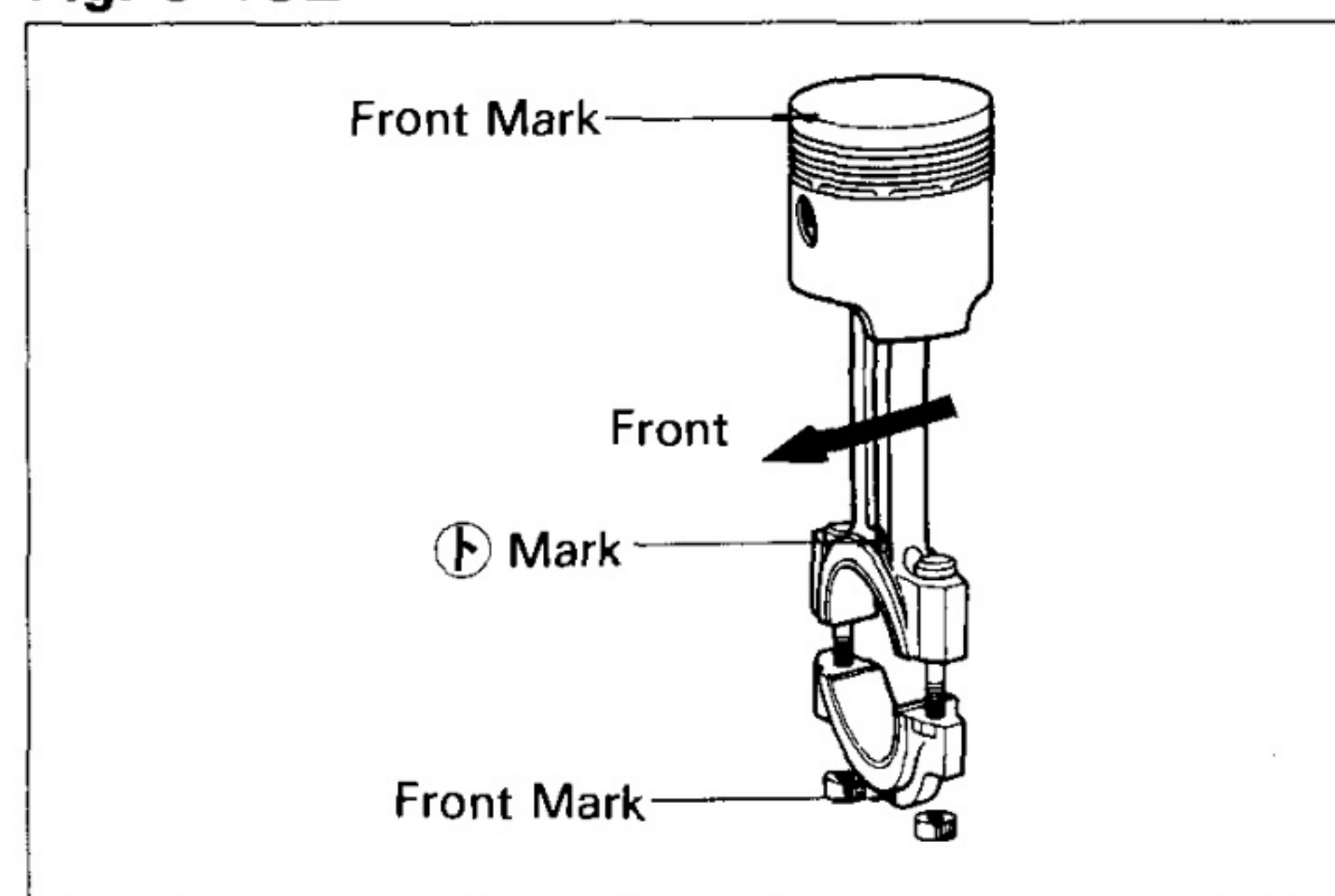
Position the ring gap in the direction shown in the figure.

Fig. 3-191



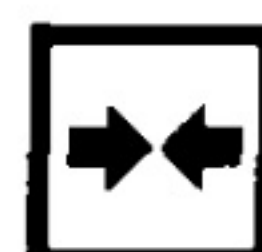
The oil ring ends should be at the opposite side of the expander coil joint.

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



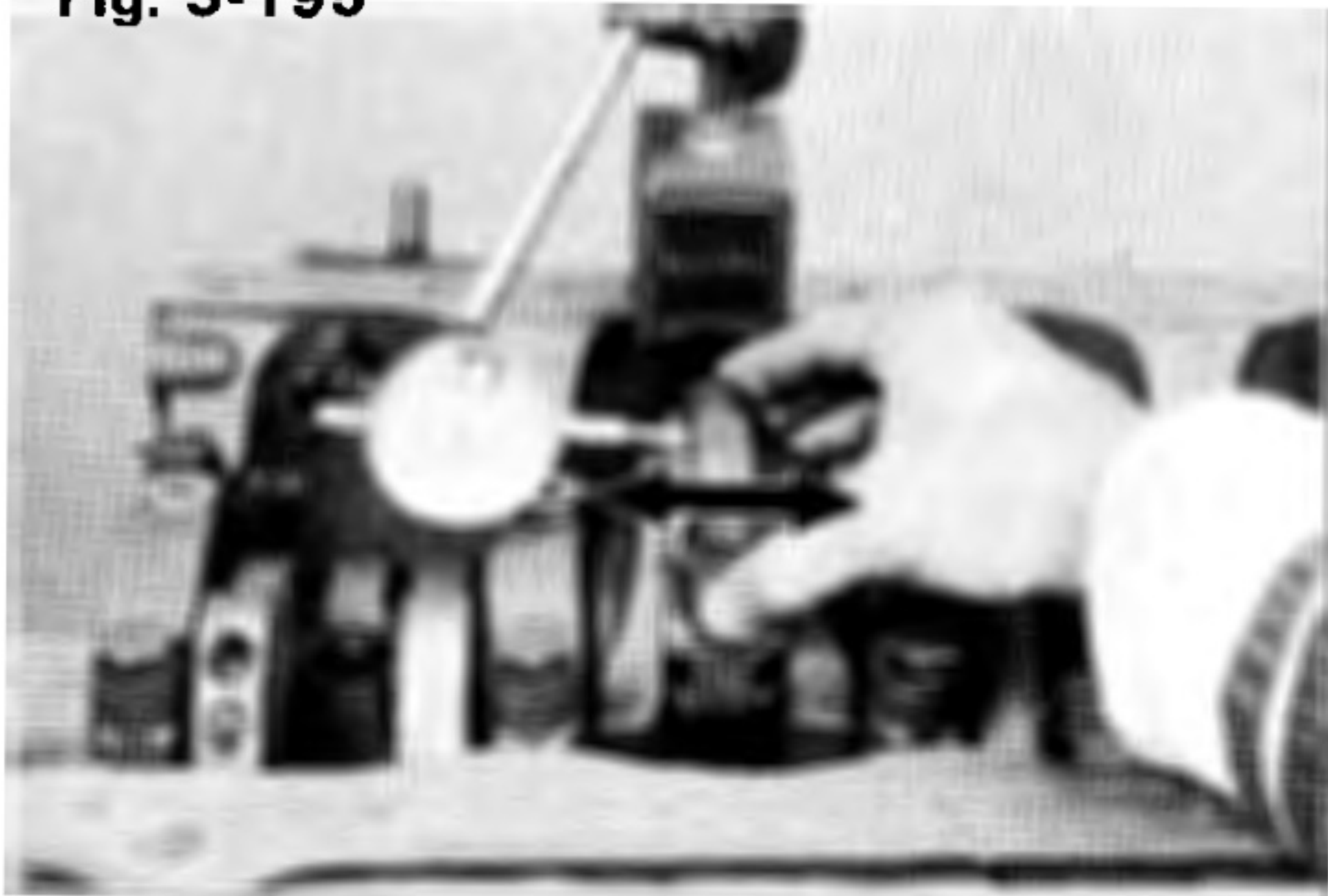
Tighten the connecting rod cap to specified torque.

**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



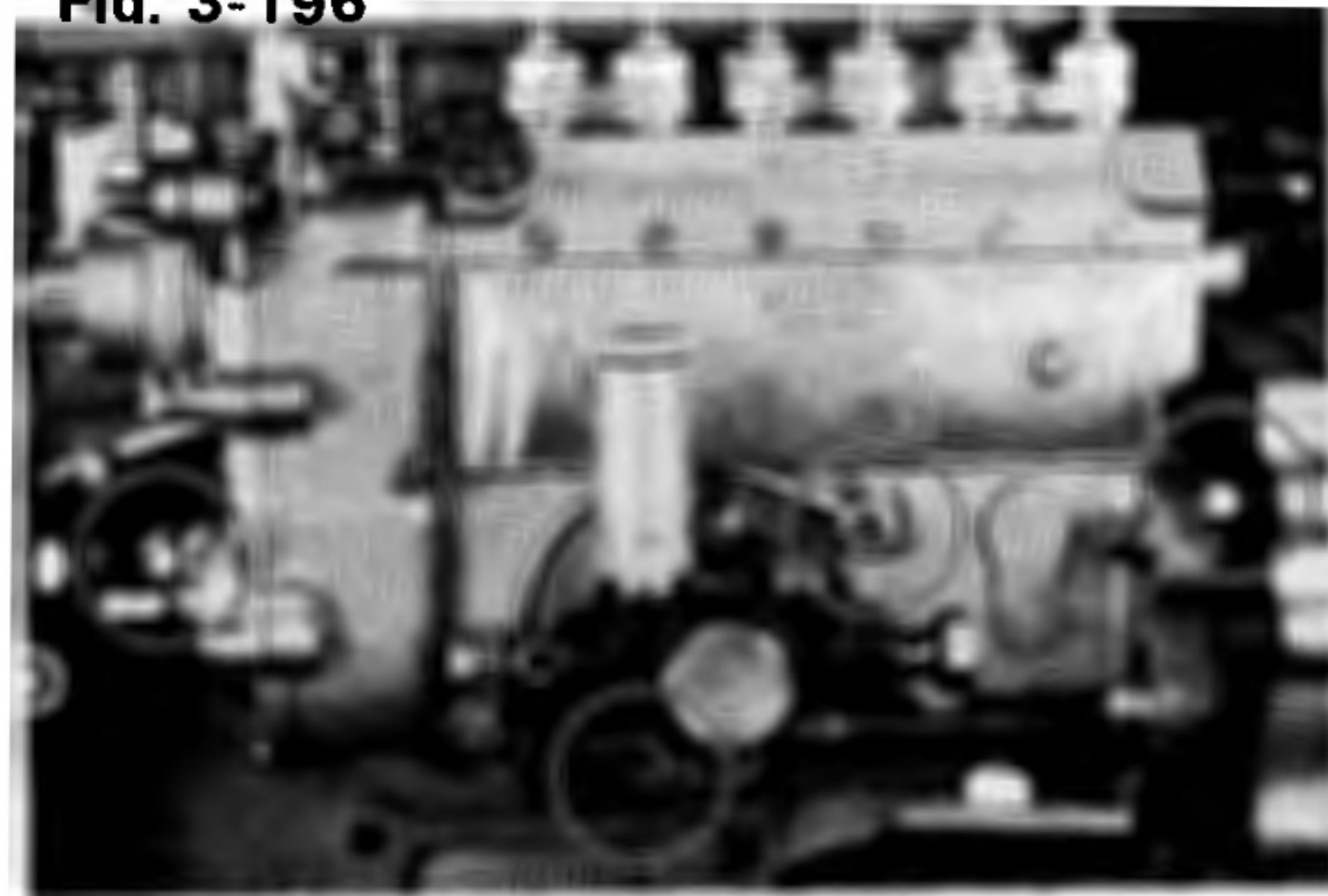
Check the connecting rod thrust clearance.

Thrust clearance:

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

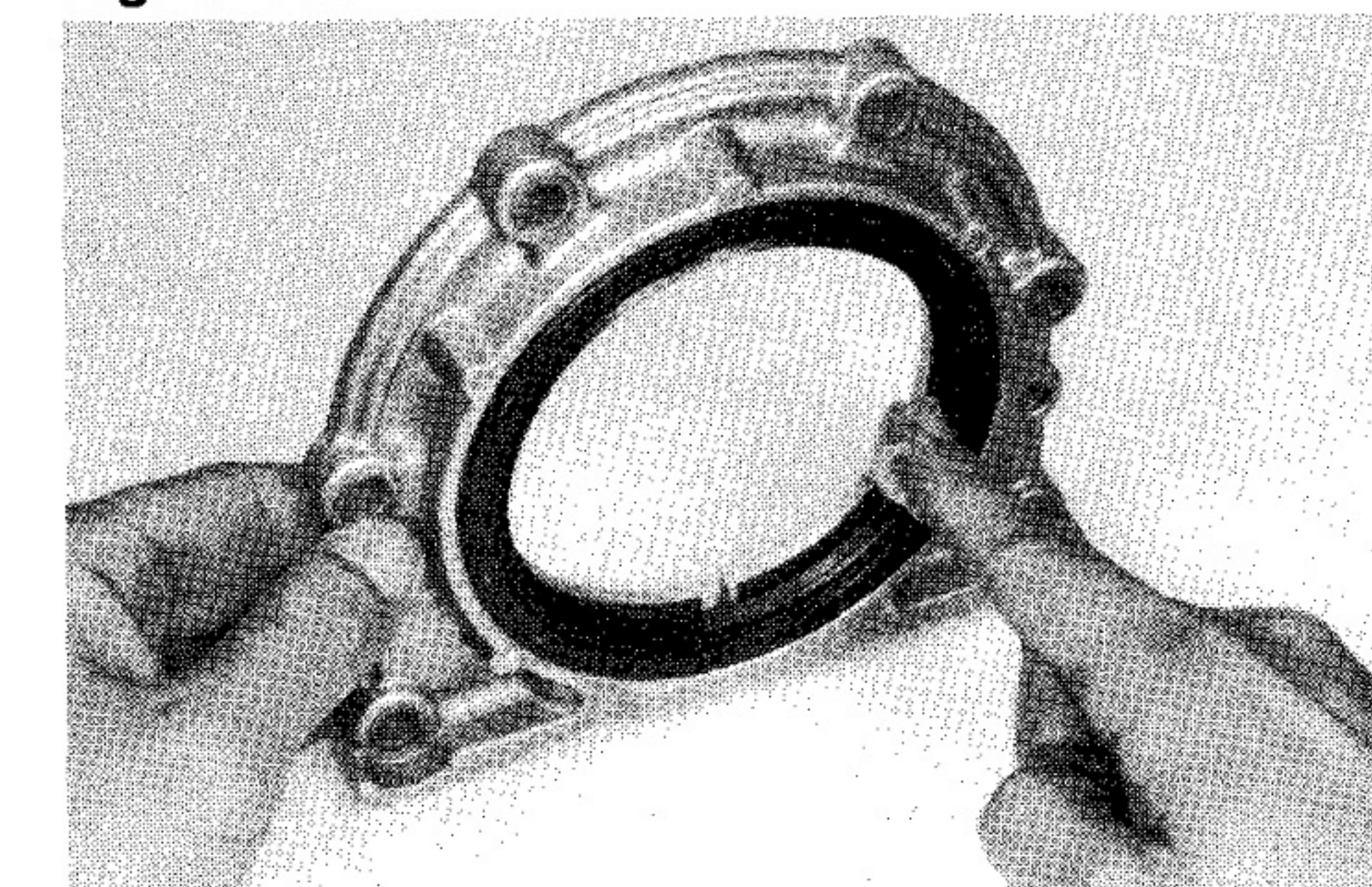
**Limit 0.3 mm
(0.012 in.)**

Fig. 3-196



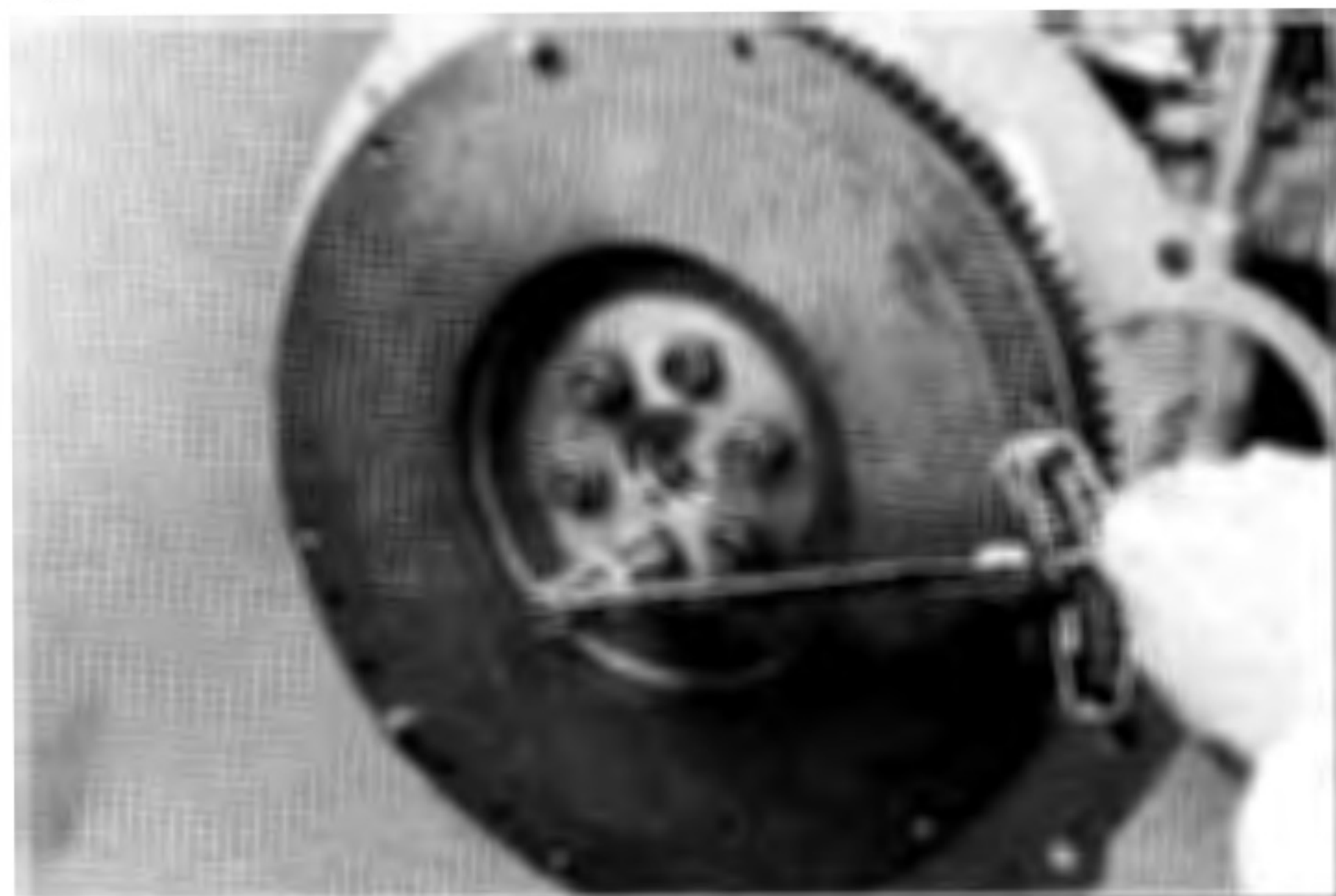
Install the injection pump with the pump retainer by tightening the pump mounting bolts and oil pipe union bolt.

Fig. 3-197



Coat the oil seal lip with MP grease before assembling.

Fig. 3-198



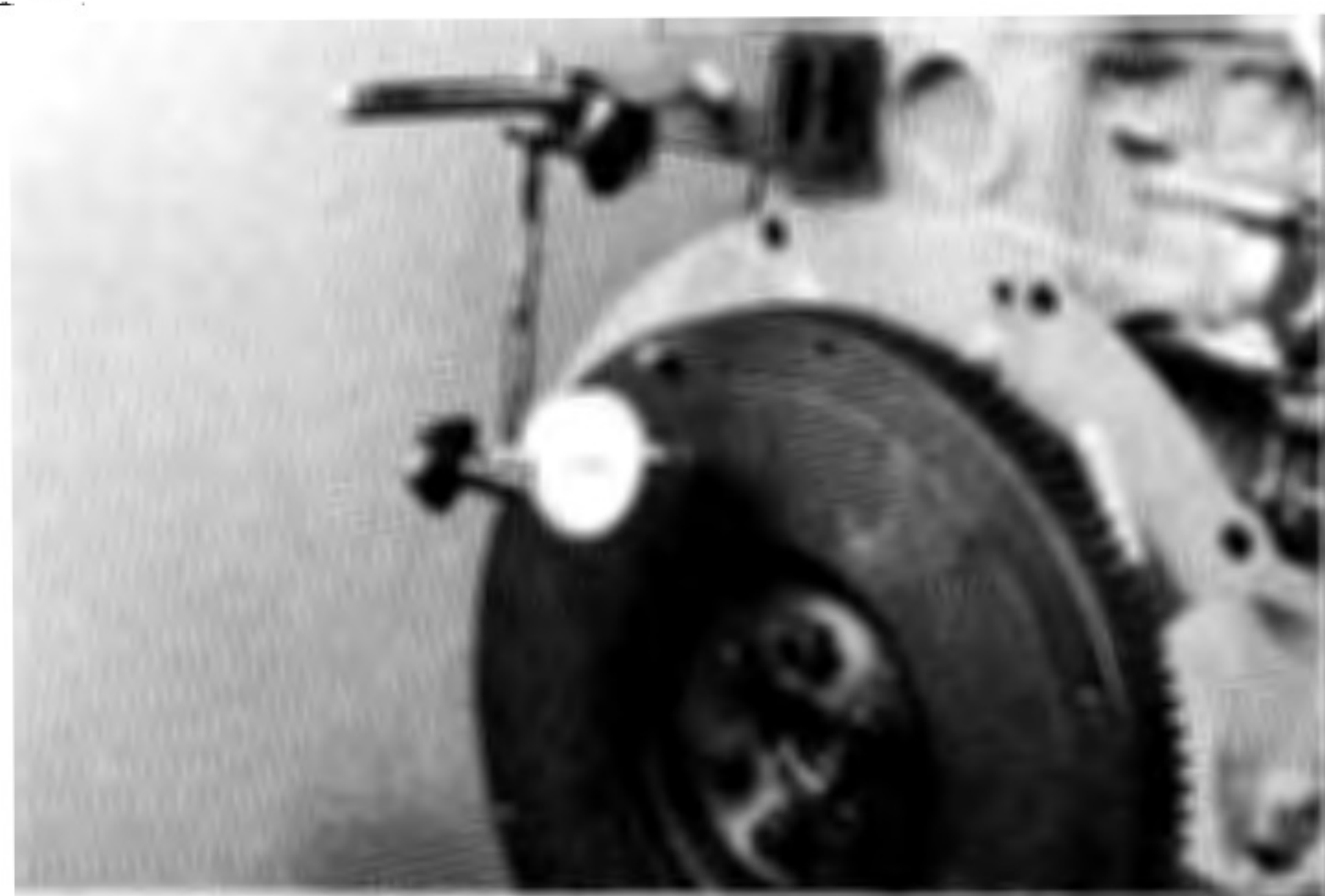
Tighten the bolts to specified torque.

**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

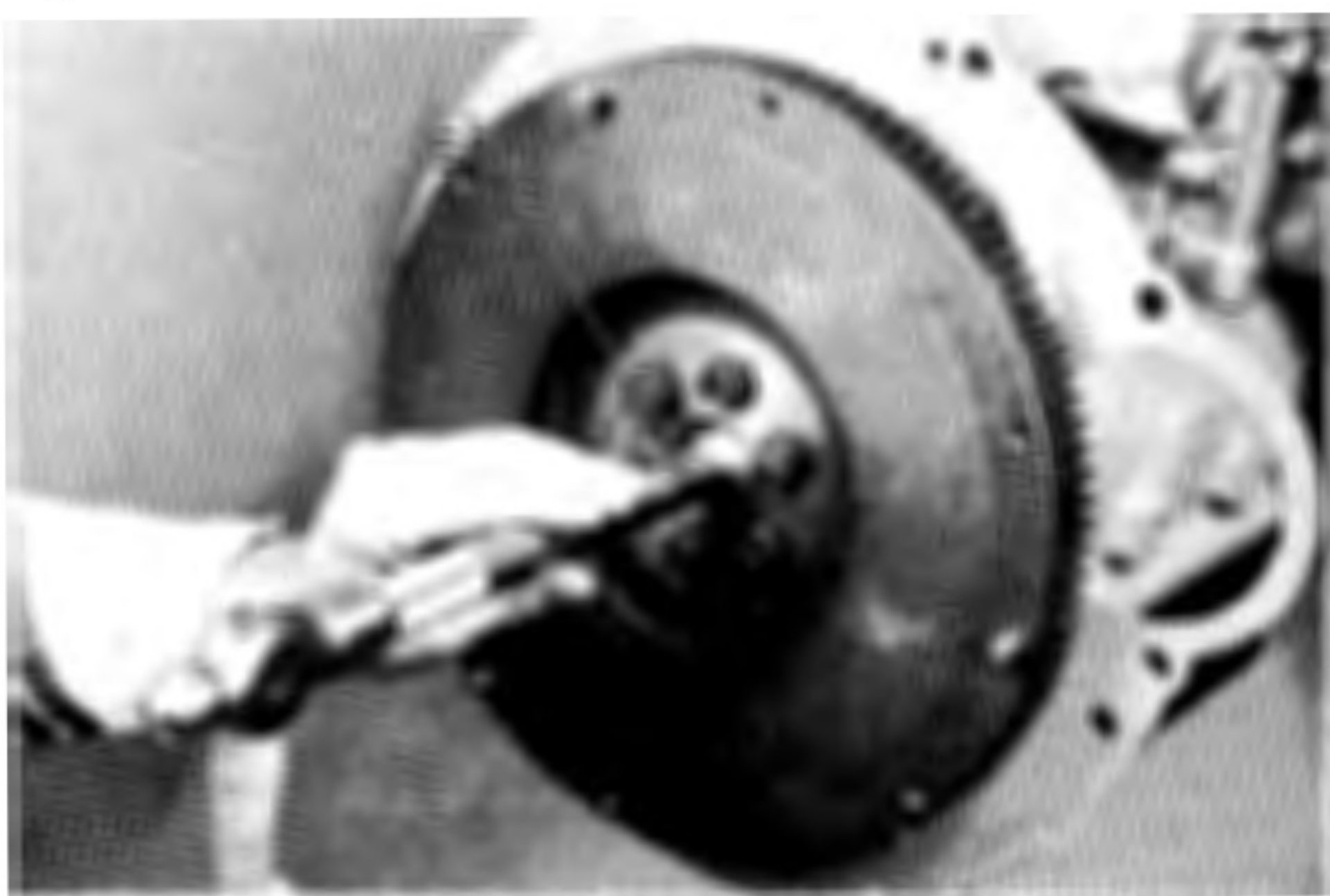


Check the flywheel for runout.

Runout:

**Limit 0.2 mm
(0.008 in.)**

Fig. 3-200



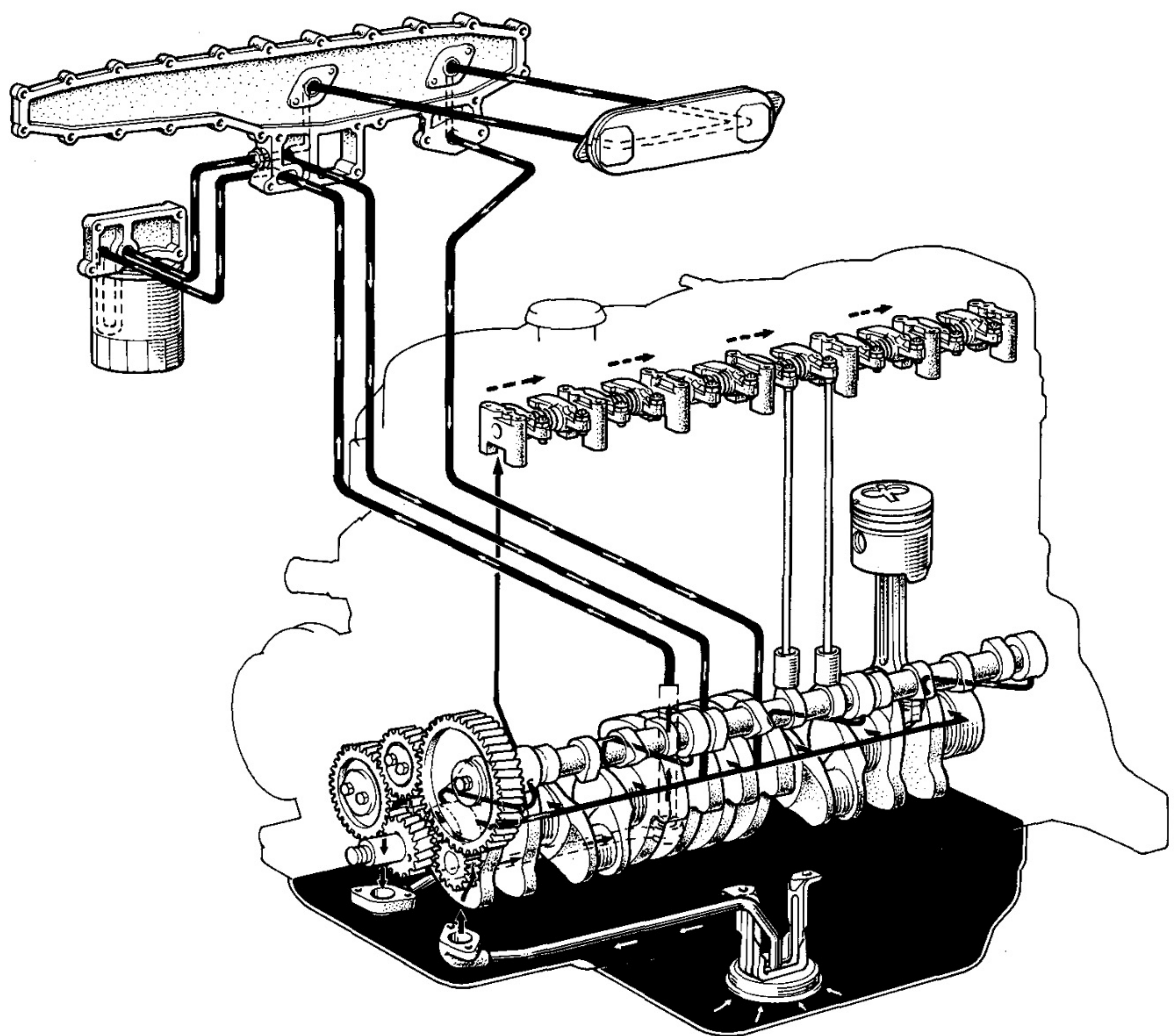
Drive in the input shaft bearing with SST.
SST [09620-30010]

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

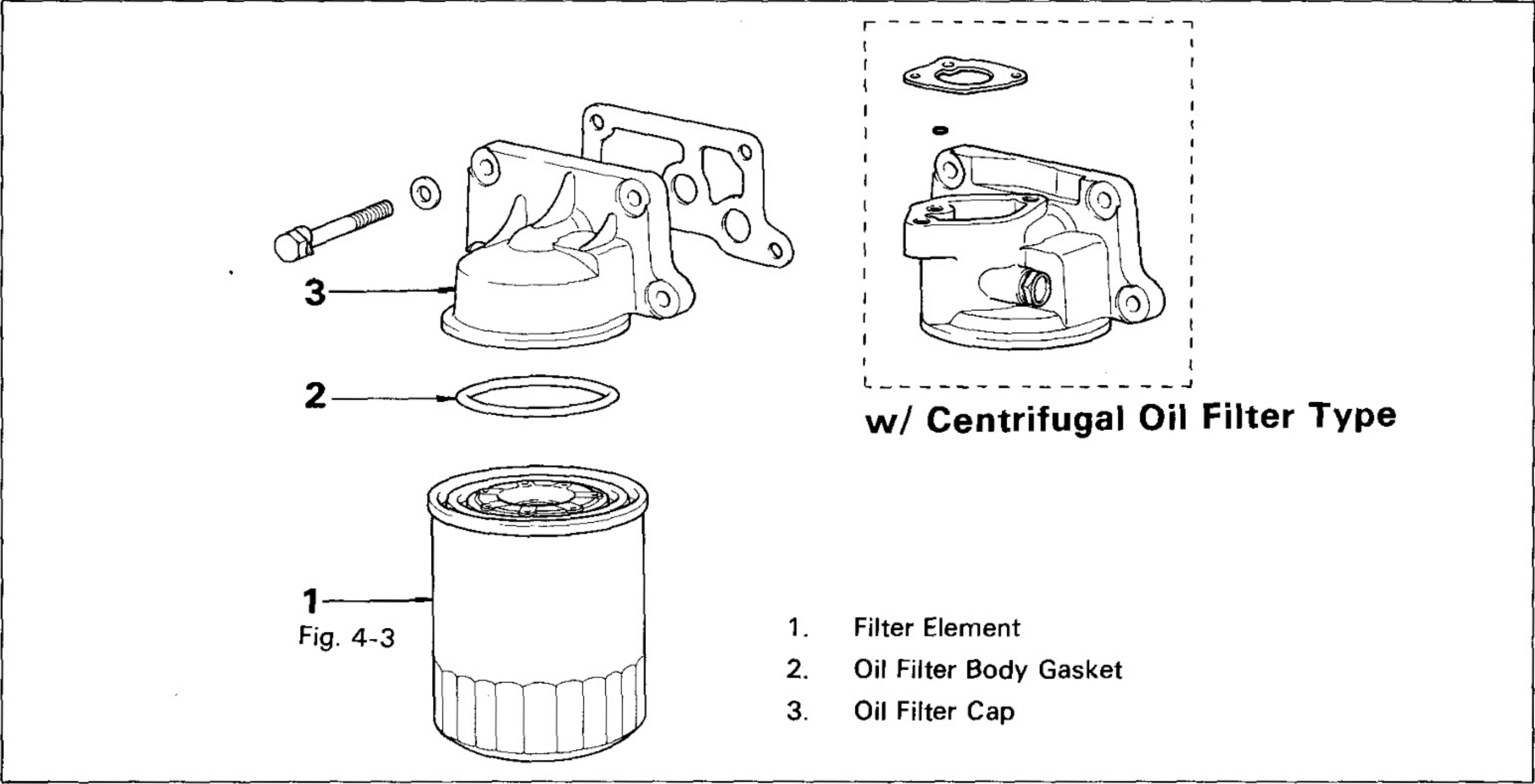
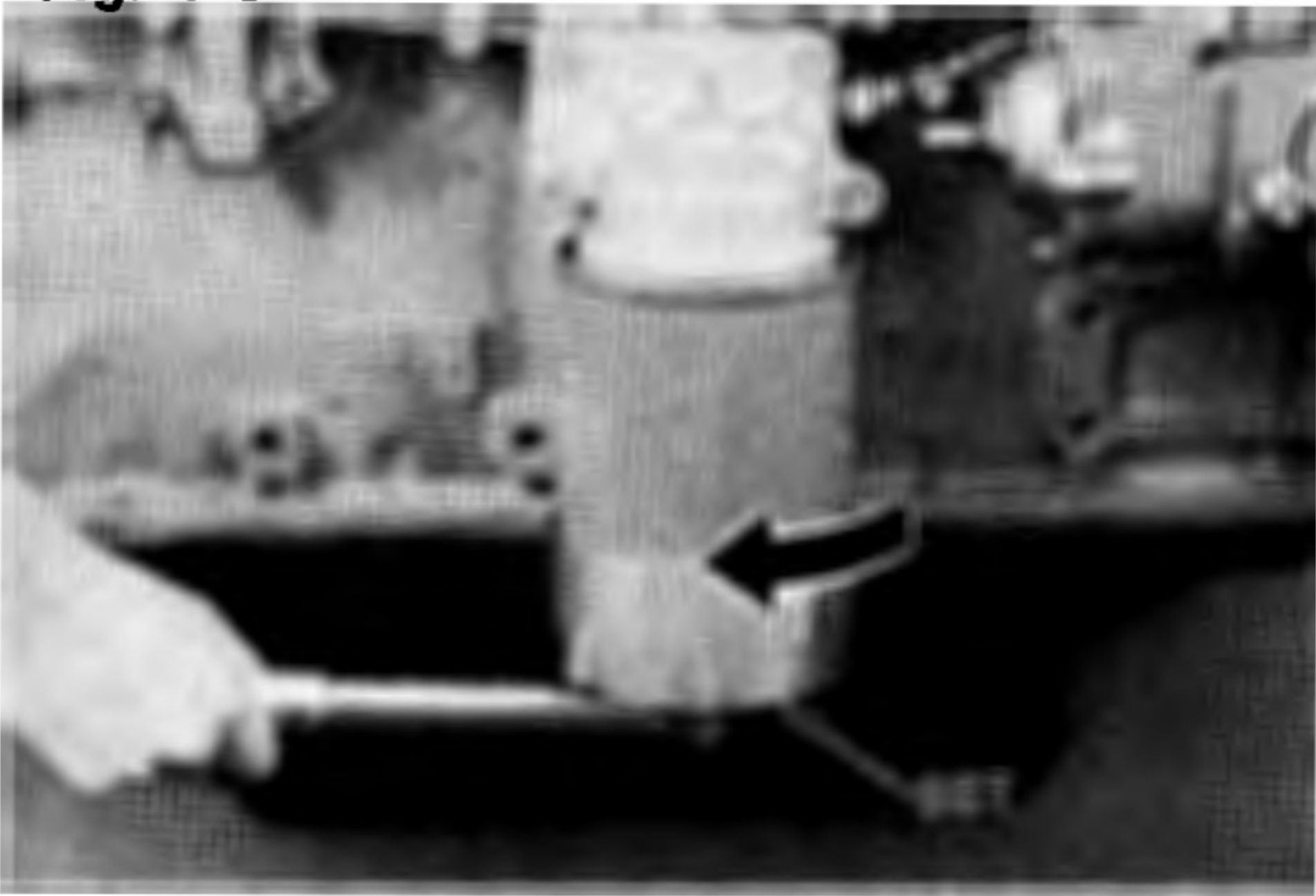
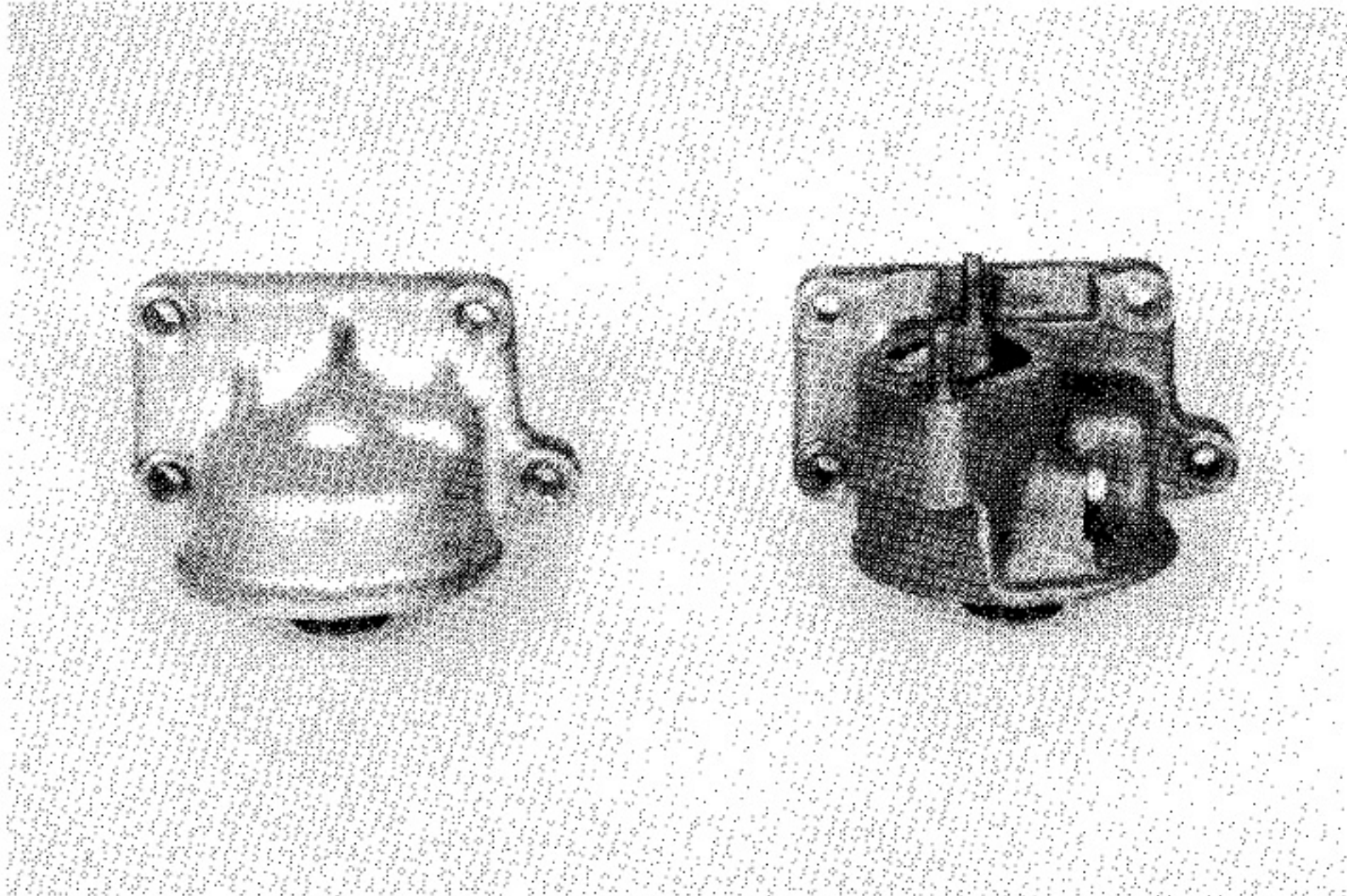


Fig. 4-3



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

Fig. 4-4



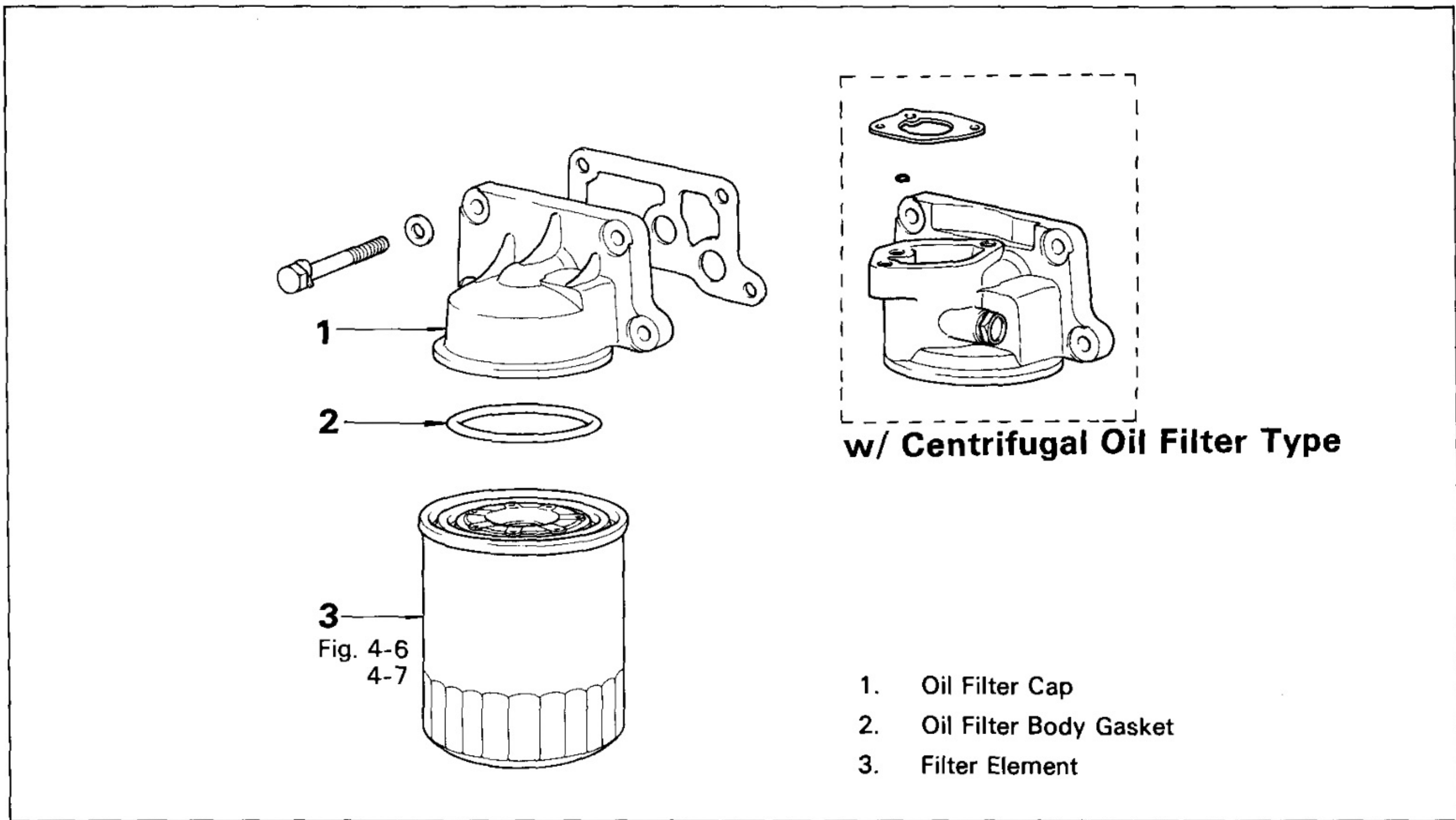
INSPECTION

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



Install the oil filter and tighten it firmly by hand.

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



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

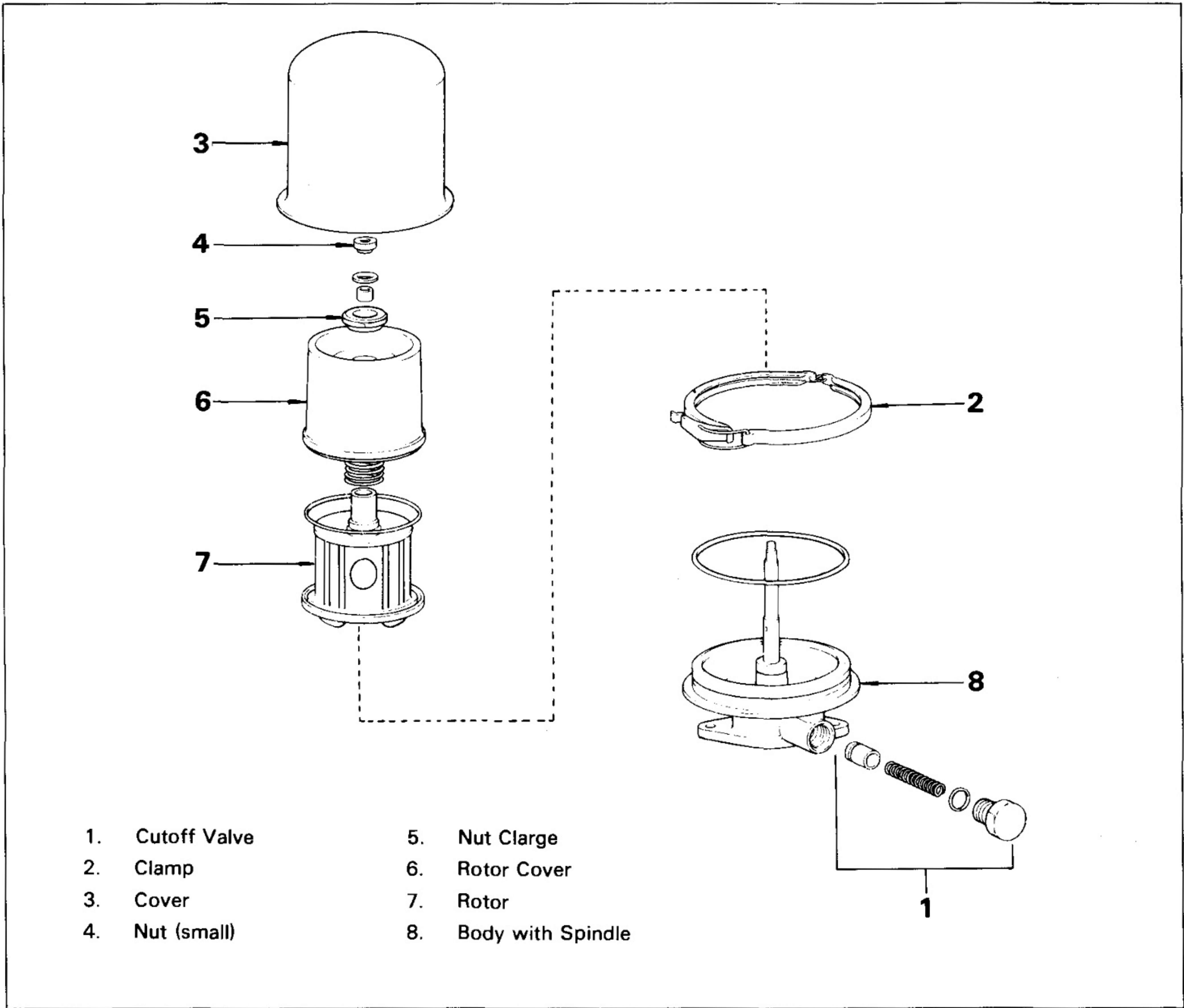
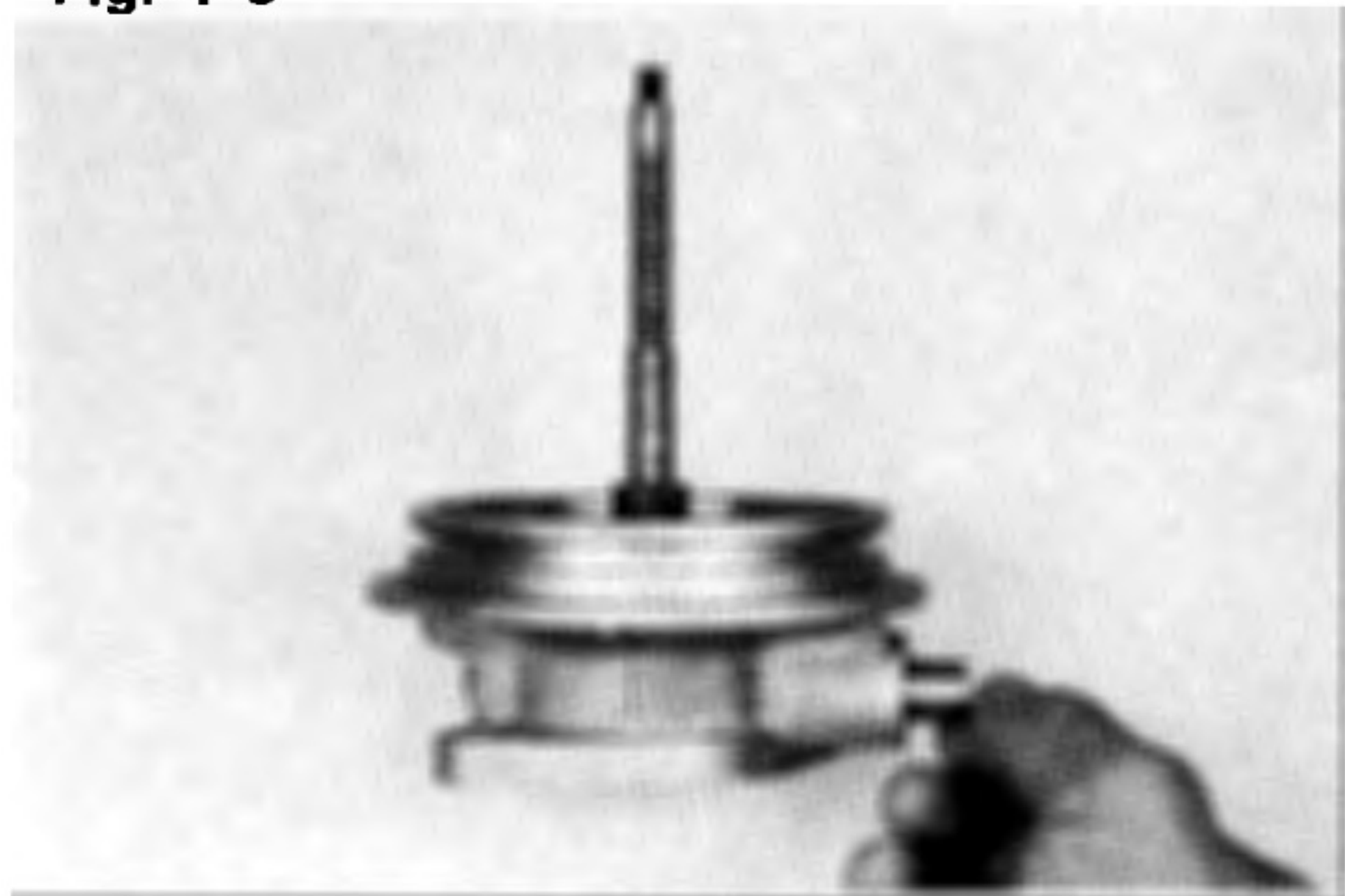


Fig. 4-9

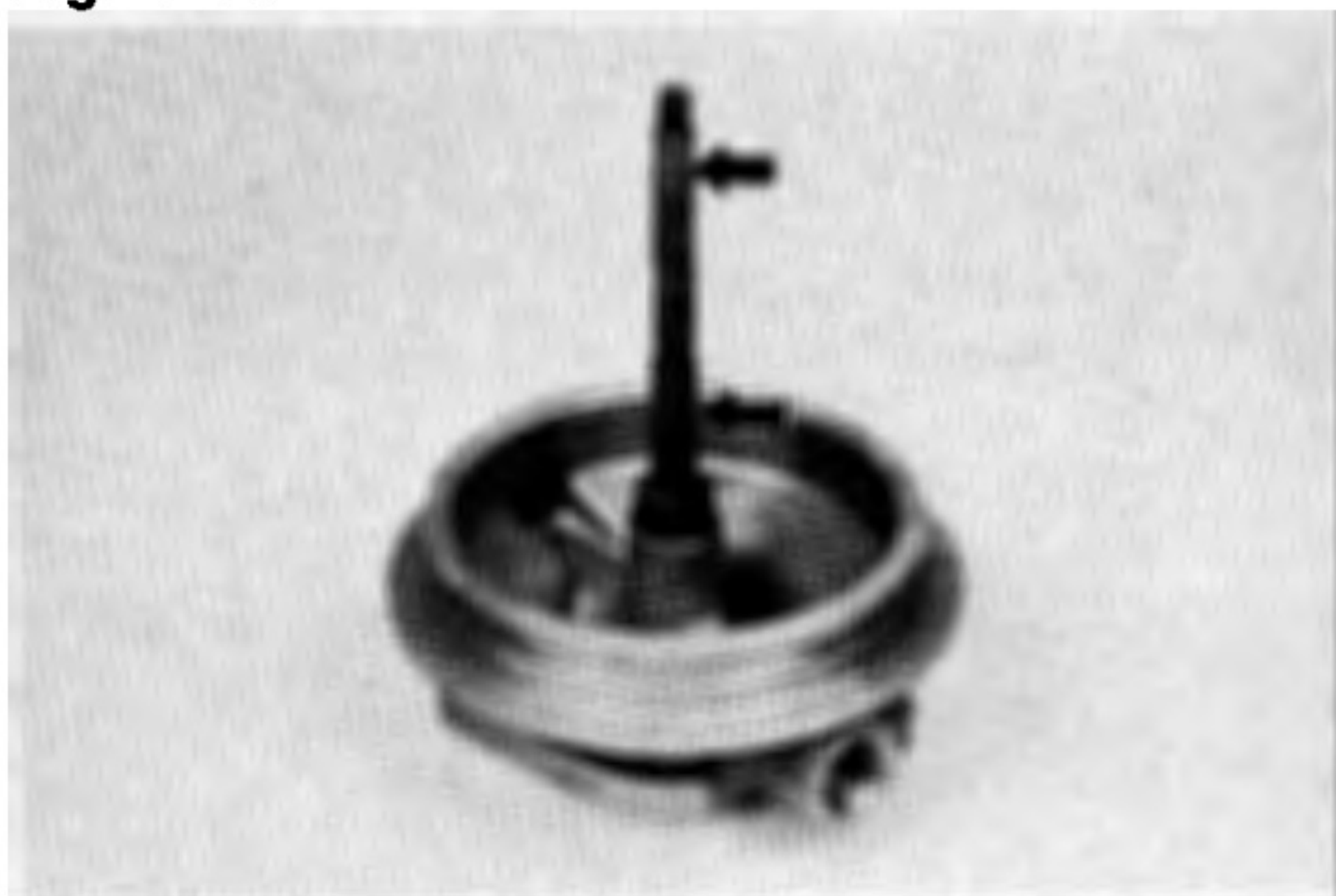


INSPECTION

Cutoff Valve

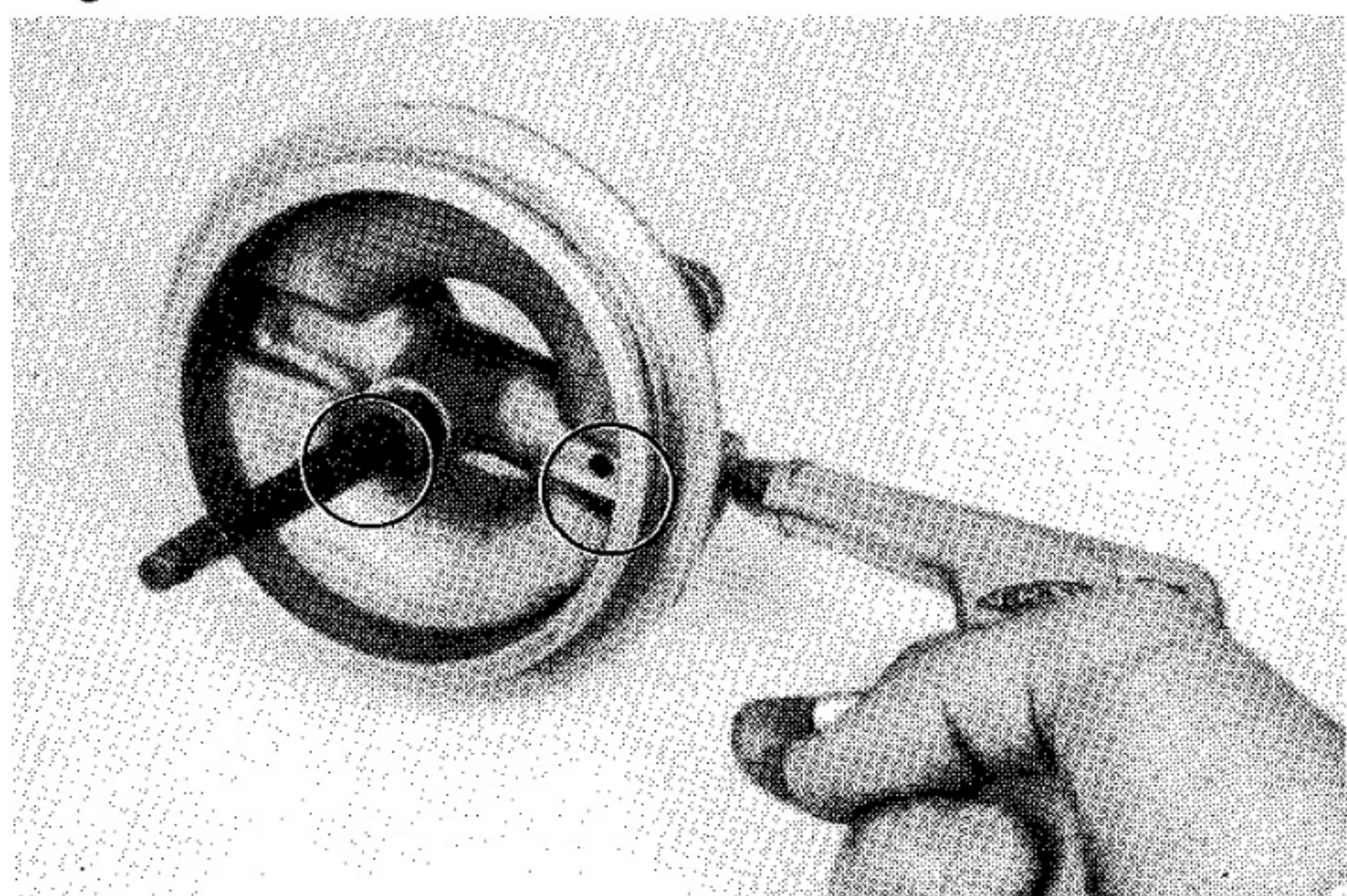
Check for wear and confirm the sliding condition.

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

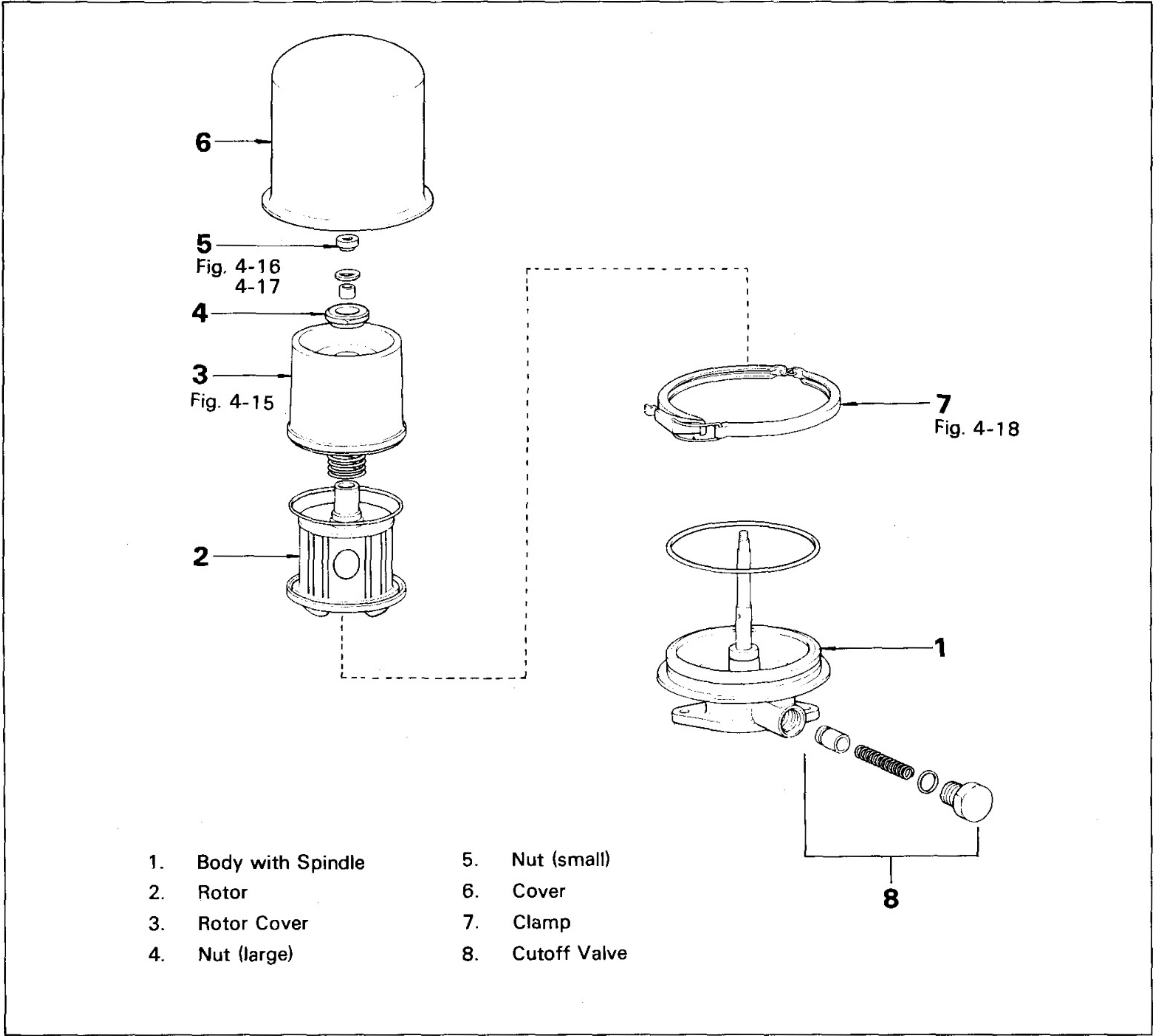
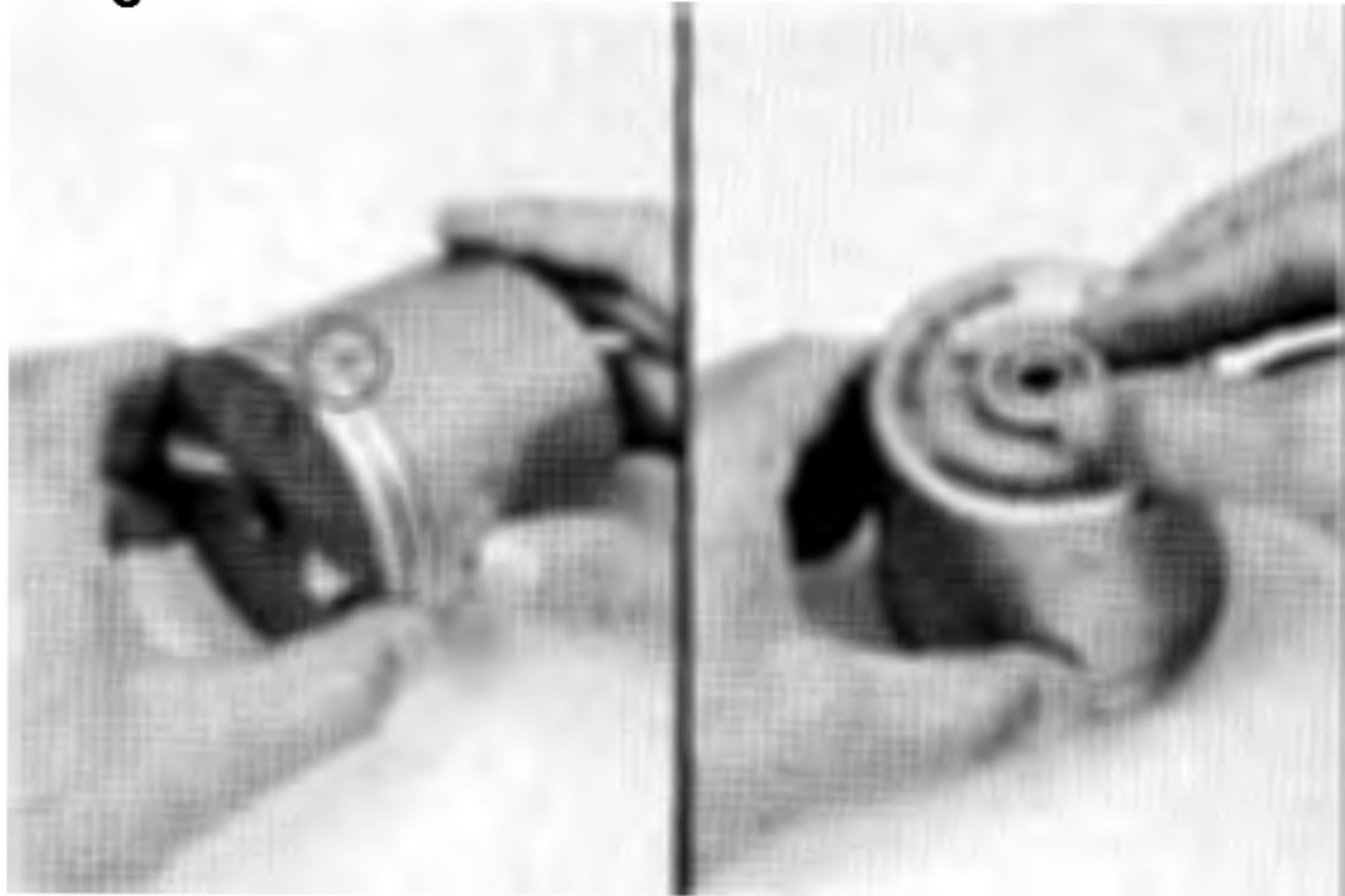
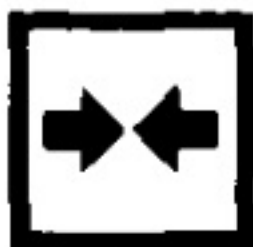
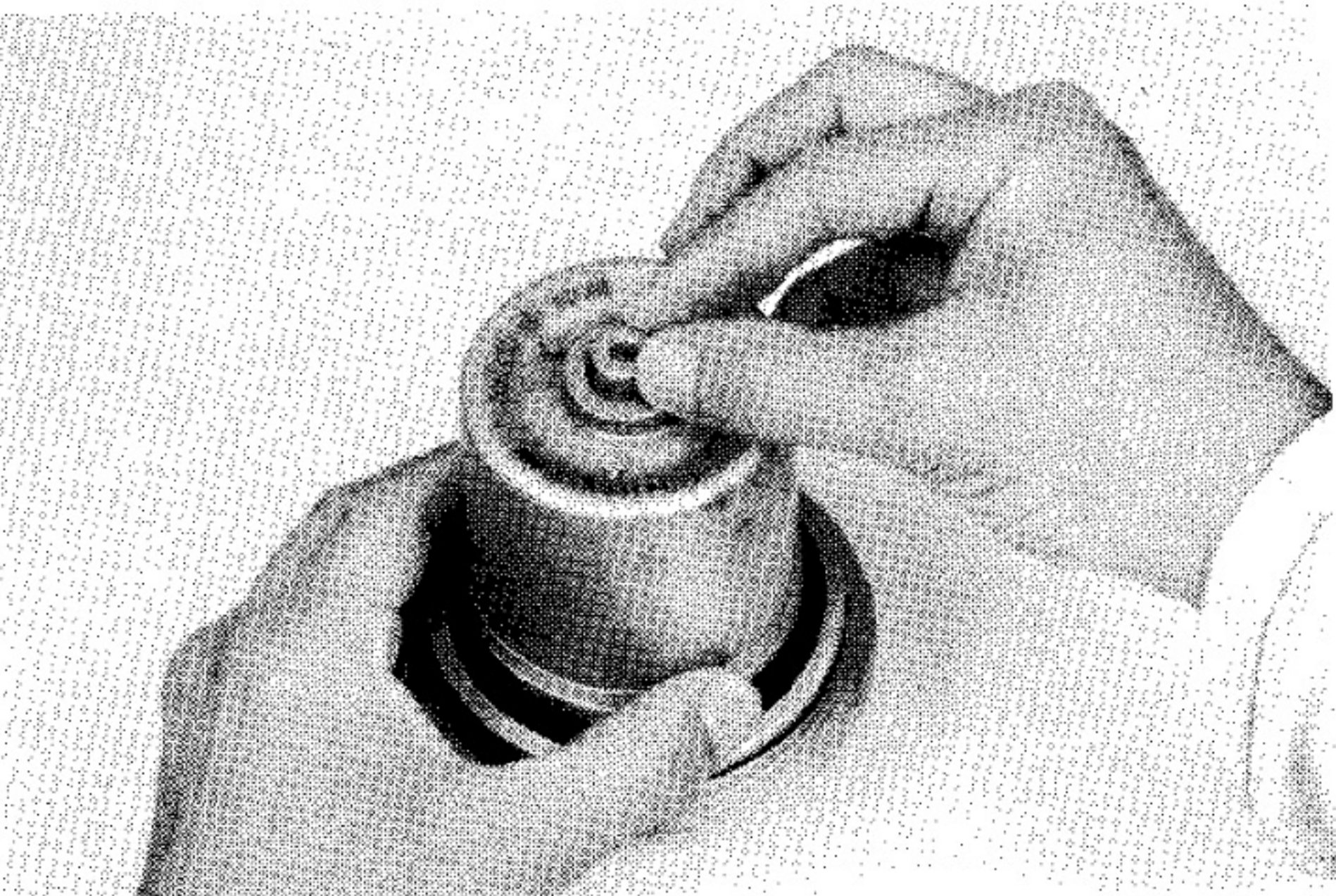


Fig. 4-15



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

Fig. 4-16



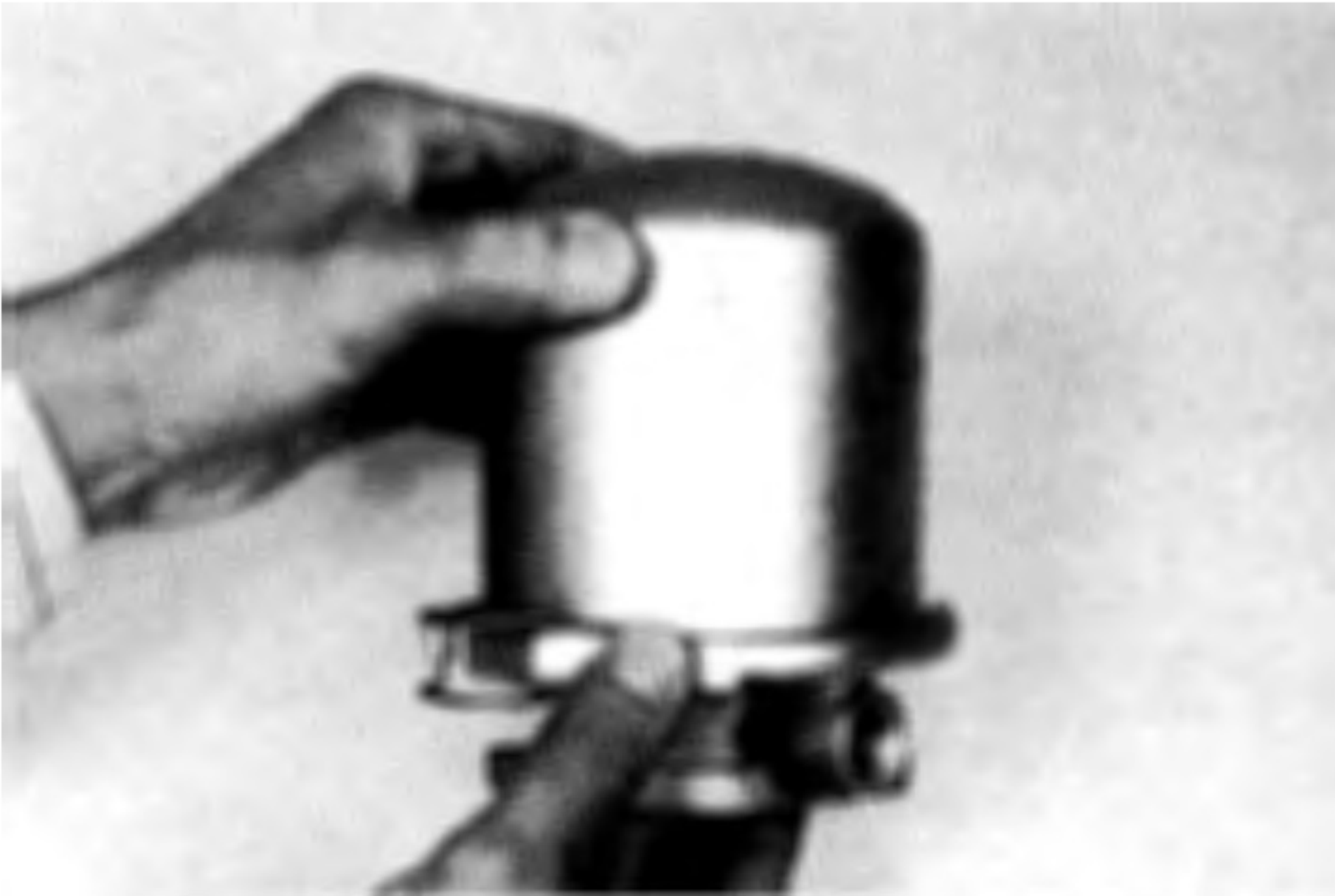
Set the rotor on the body and tighten the nut by hand.

Fig. 4-17



Make sure that the rotor rotates smoothly and lightly.

Fig. 4-18



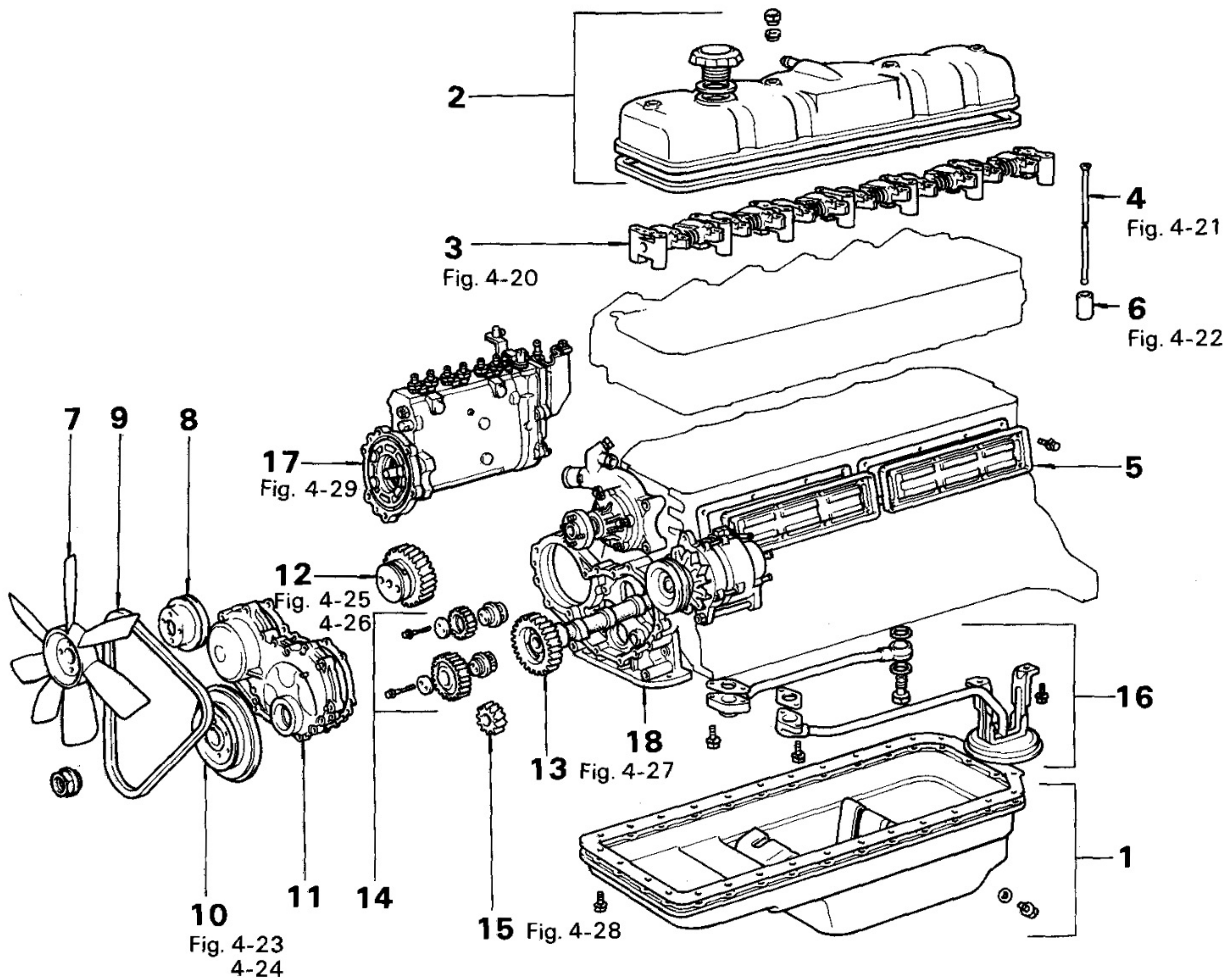
Clamp the filter cover, being careful not to clamp over the hole for the cutoff valve.

OIL PUMP

REMOVAL

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

Fig. 4-19



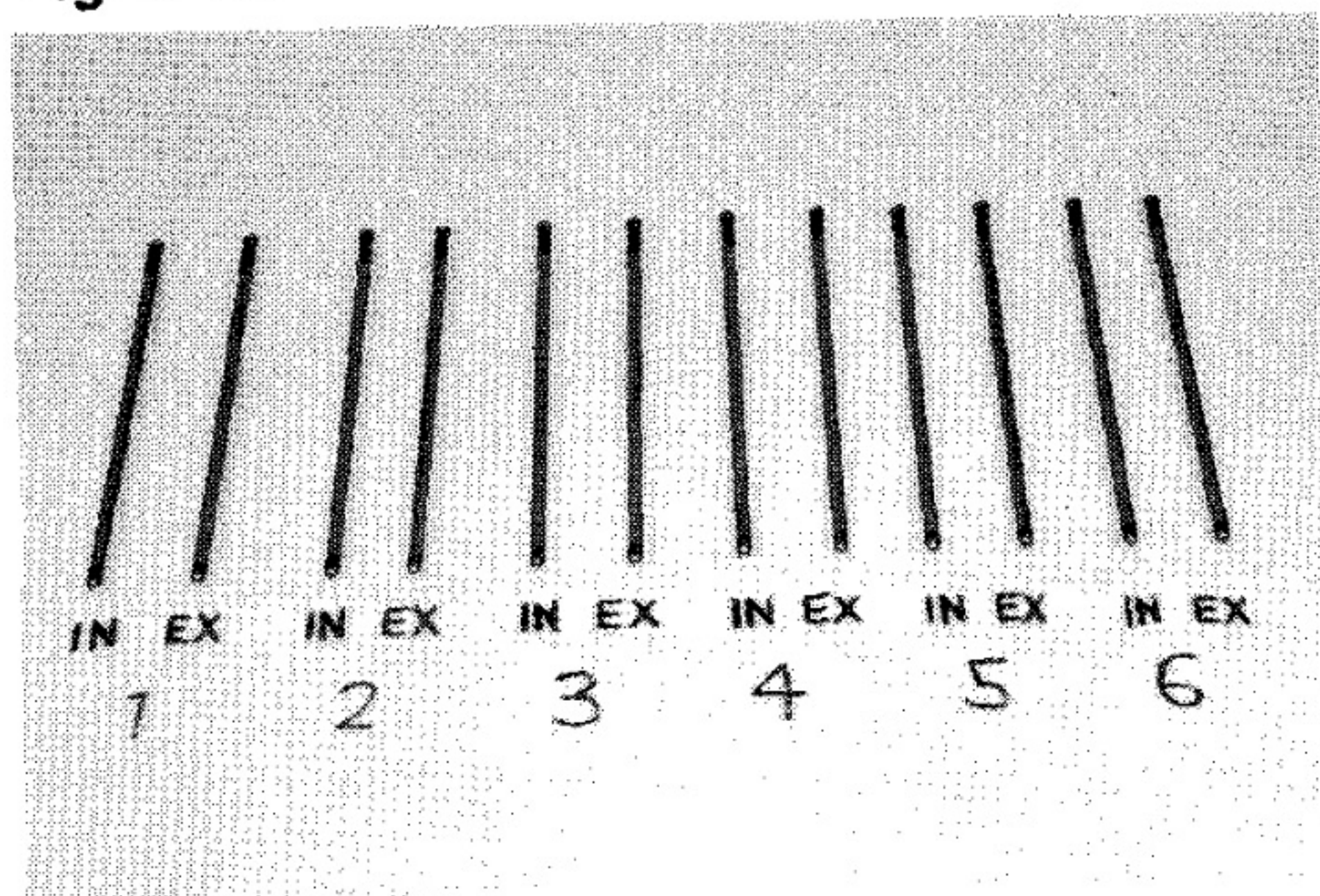
- | | |
|--------------------------------|---------------------------------|
| 1. Oil Pan | 10. Crankshaft Pulley |
| 2. Cylinder Head Cover | 11. Timing Gear Cover |
| 3. Valve Rocker Shaft Assembly | 12. Automatic Timer |
| 4. Valve Push Rod | 13. Camshaft & Timing Gear |
| 5. Valve Push Rod Cover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

Fig. 4-20



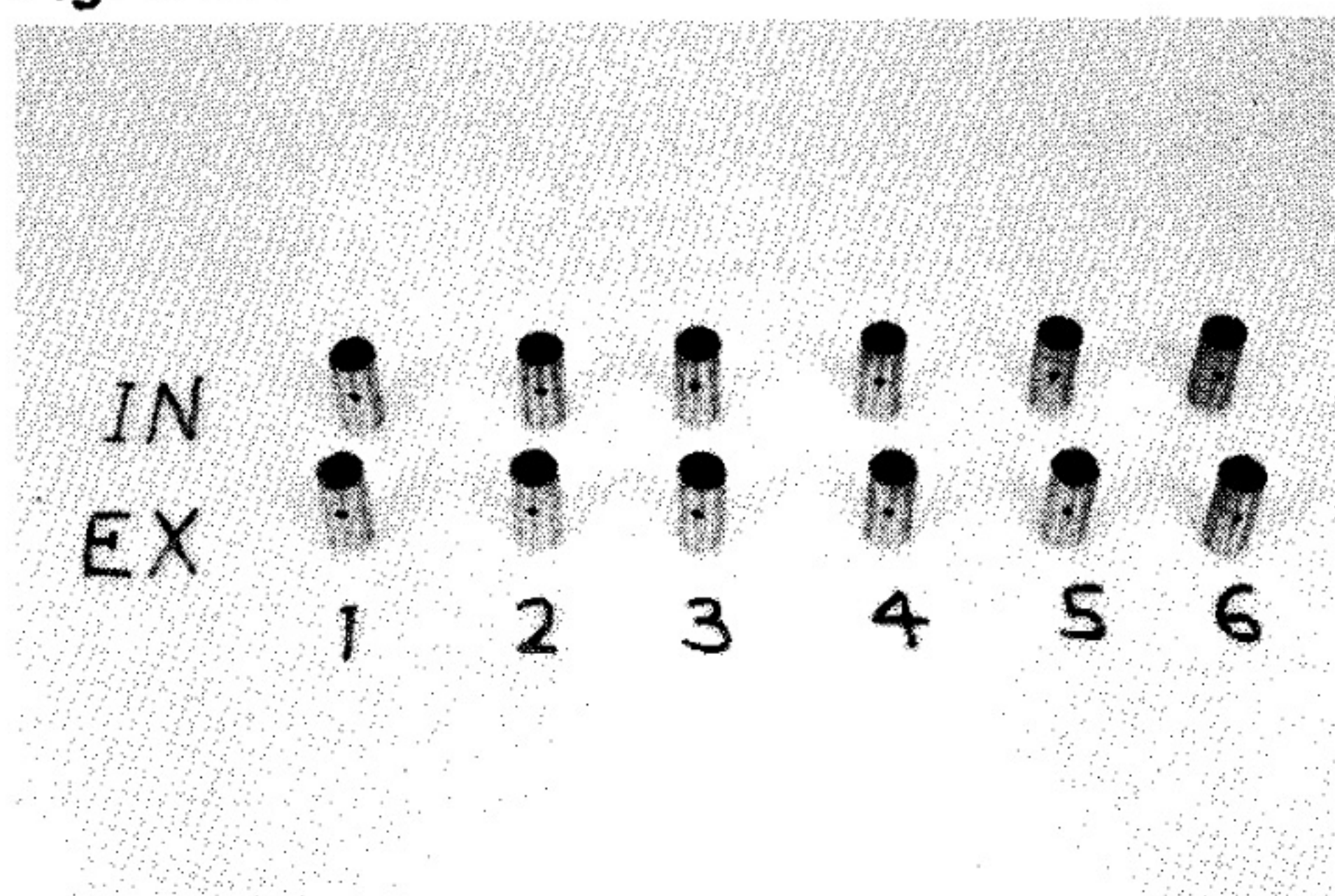
Loosen each rocker support bolt a little at a time in the sequence shown in the figure.

Fig. 4-21



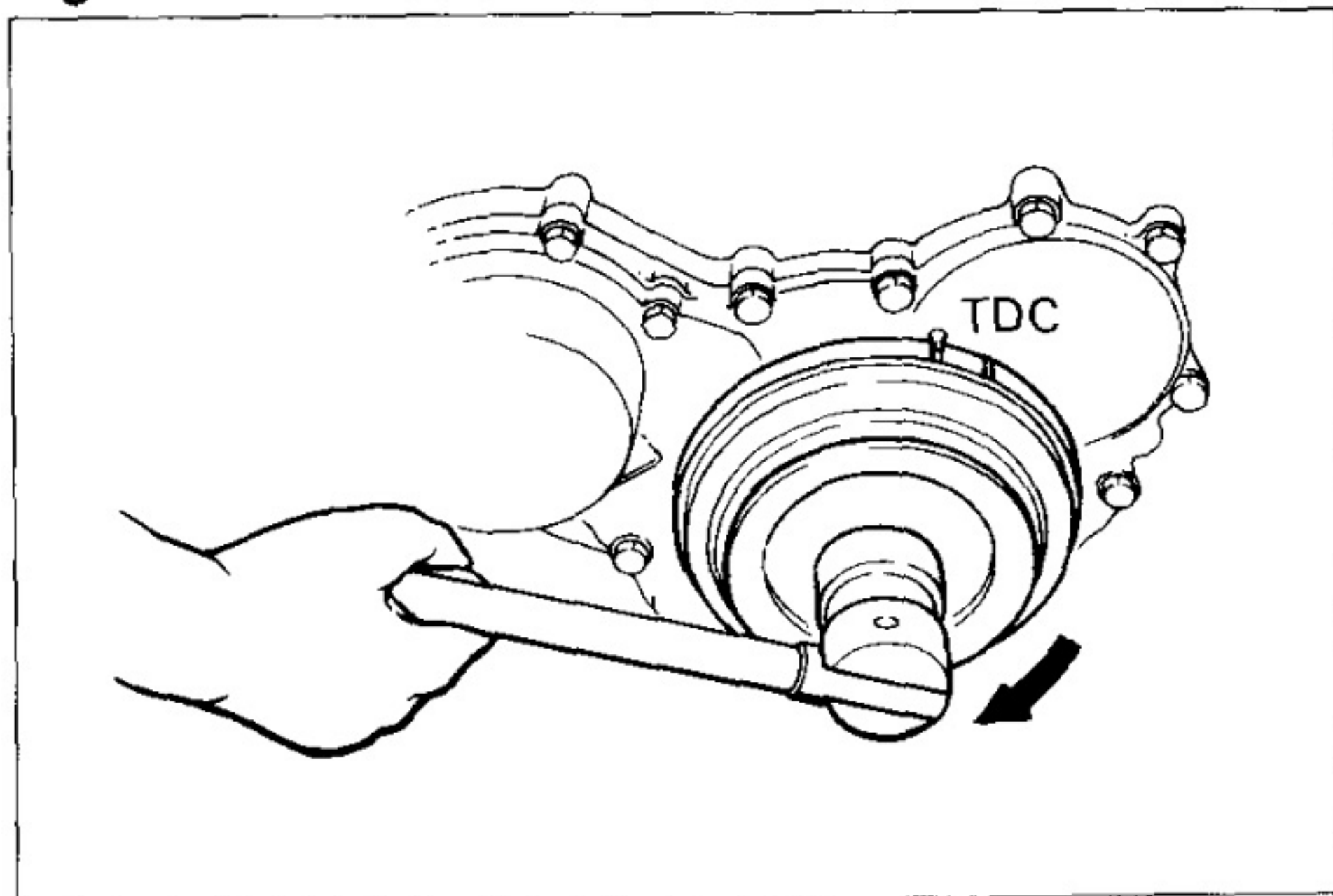
Keep the push rods in correct order.

Fig. 4-22



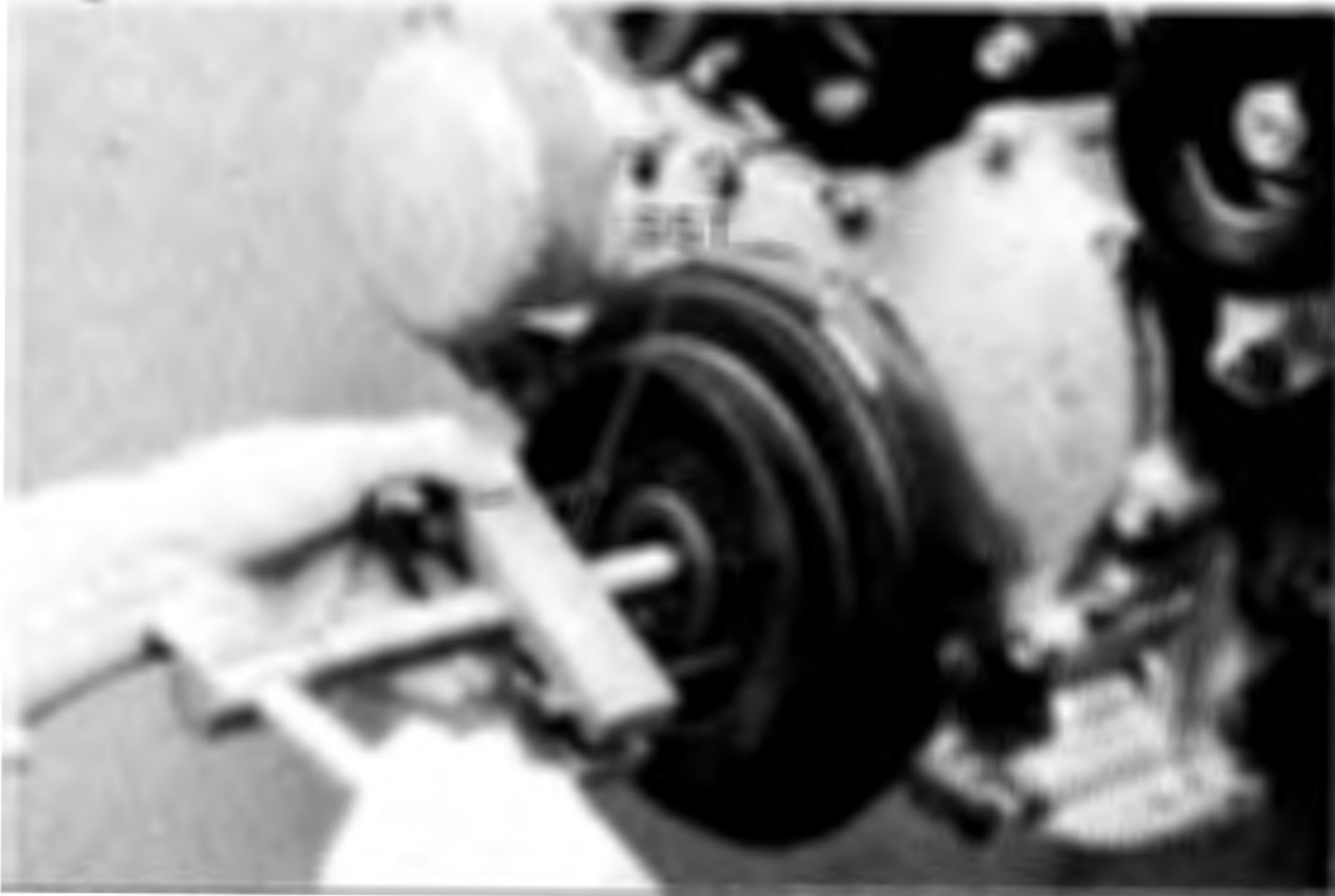
Keep the valve lifters in correct order.

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—

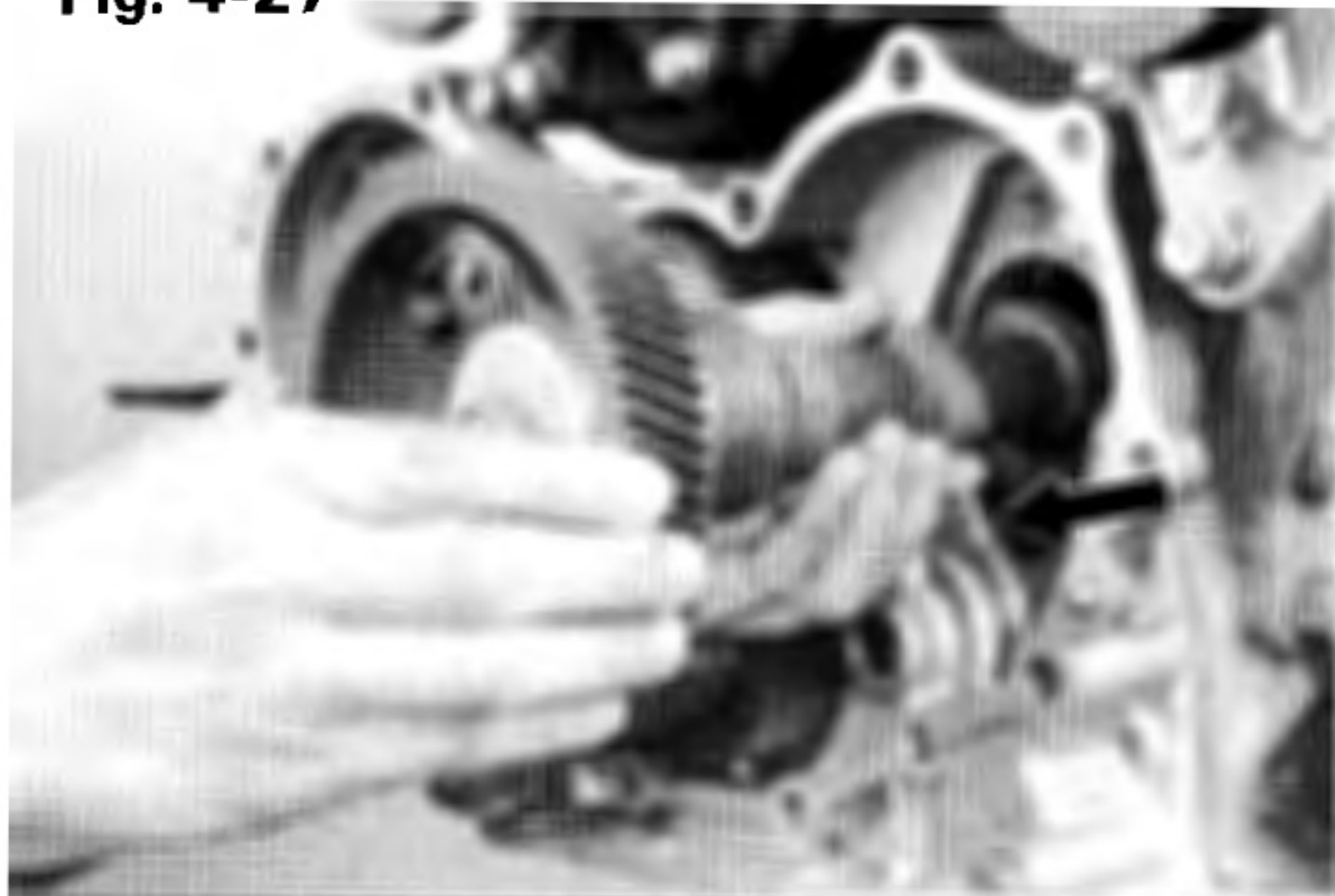
Be careful not to scratch the timer weight sliding surface.

Fig. 4-26



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

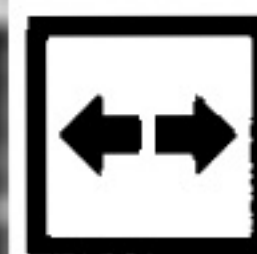
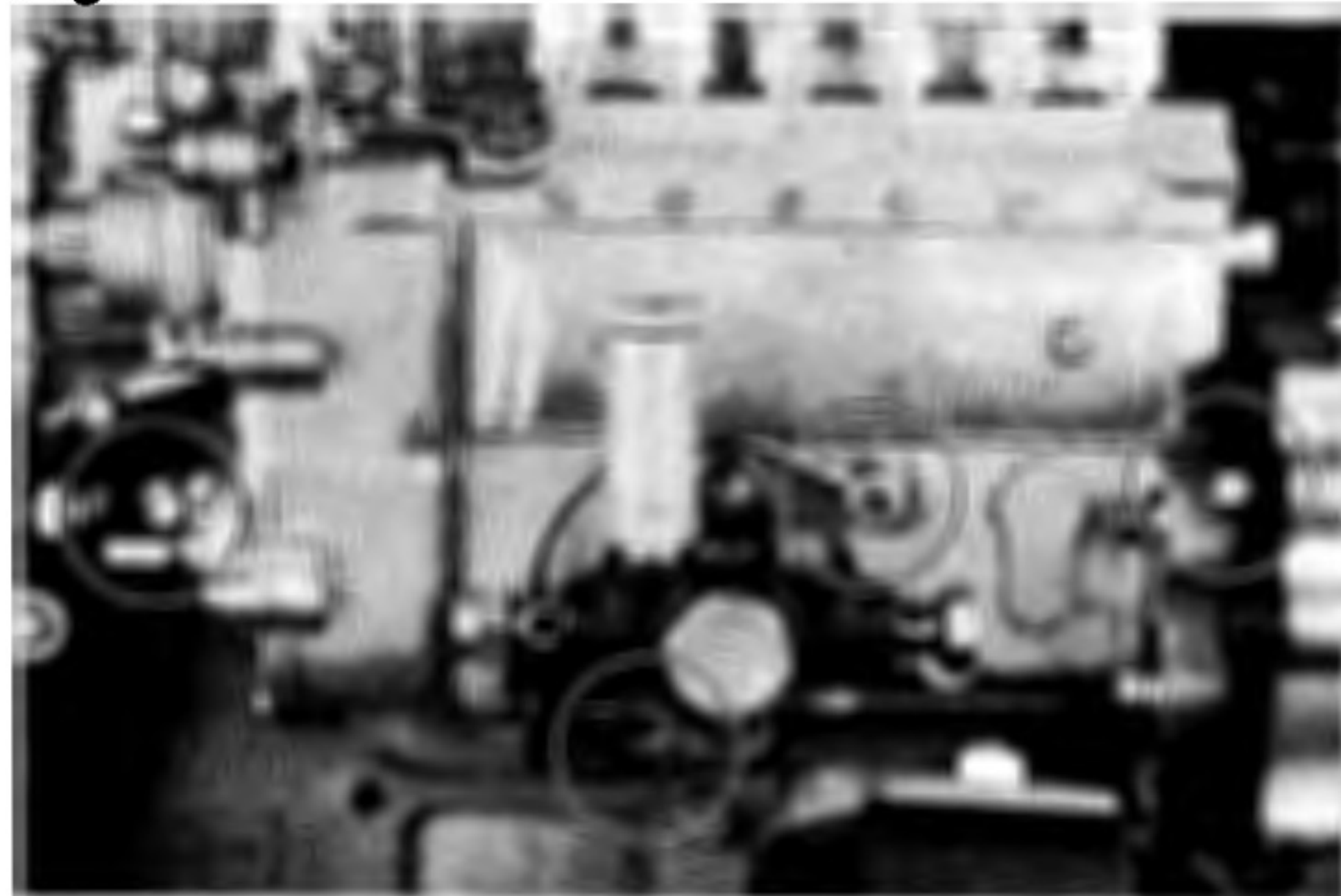
Fig. 4-27



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

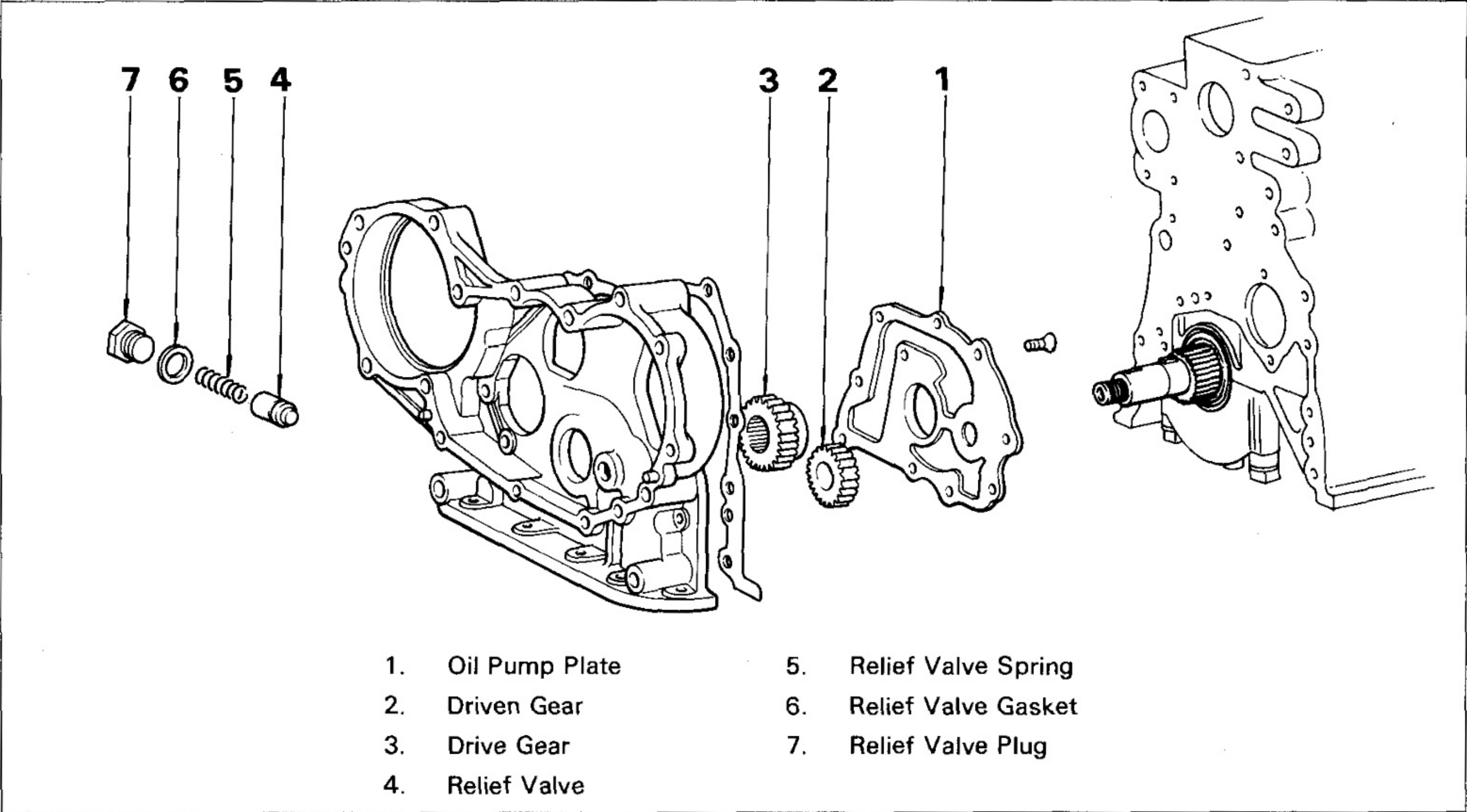


Fig. 4-31



INSPECTION



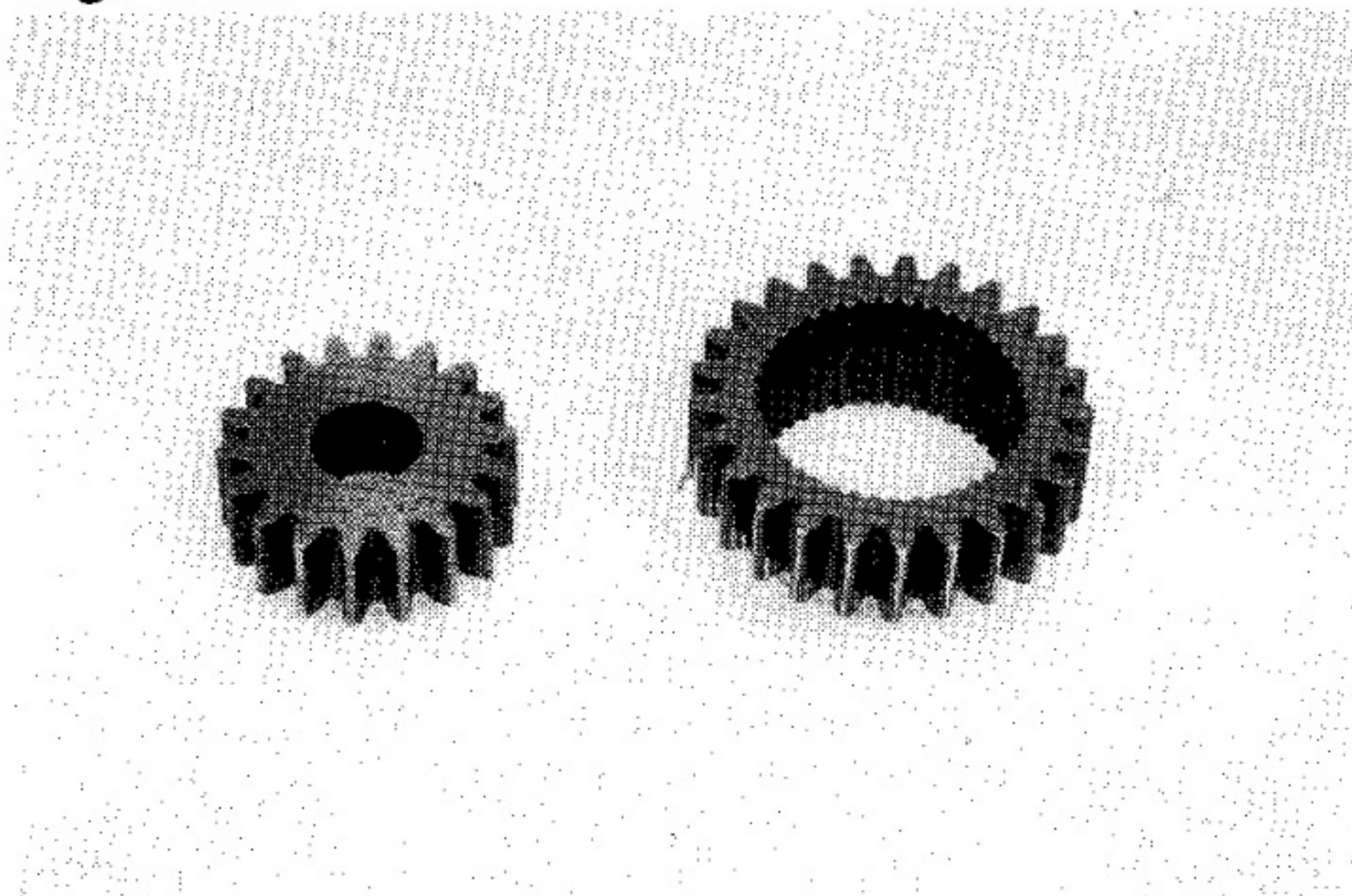
1. Check the timing gear case and oil pump plate for wear or damage.

Fig. 4-32



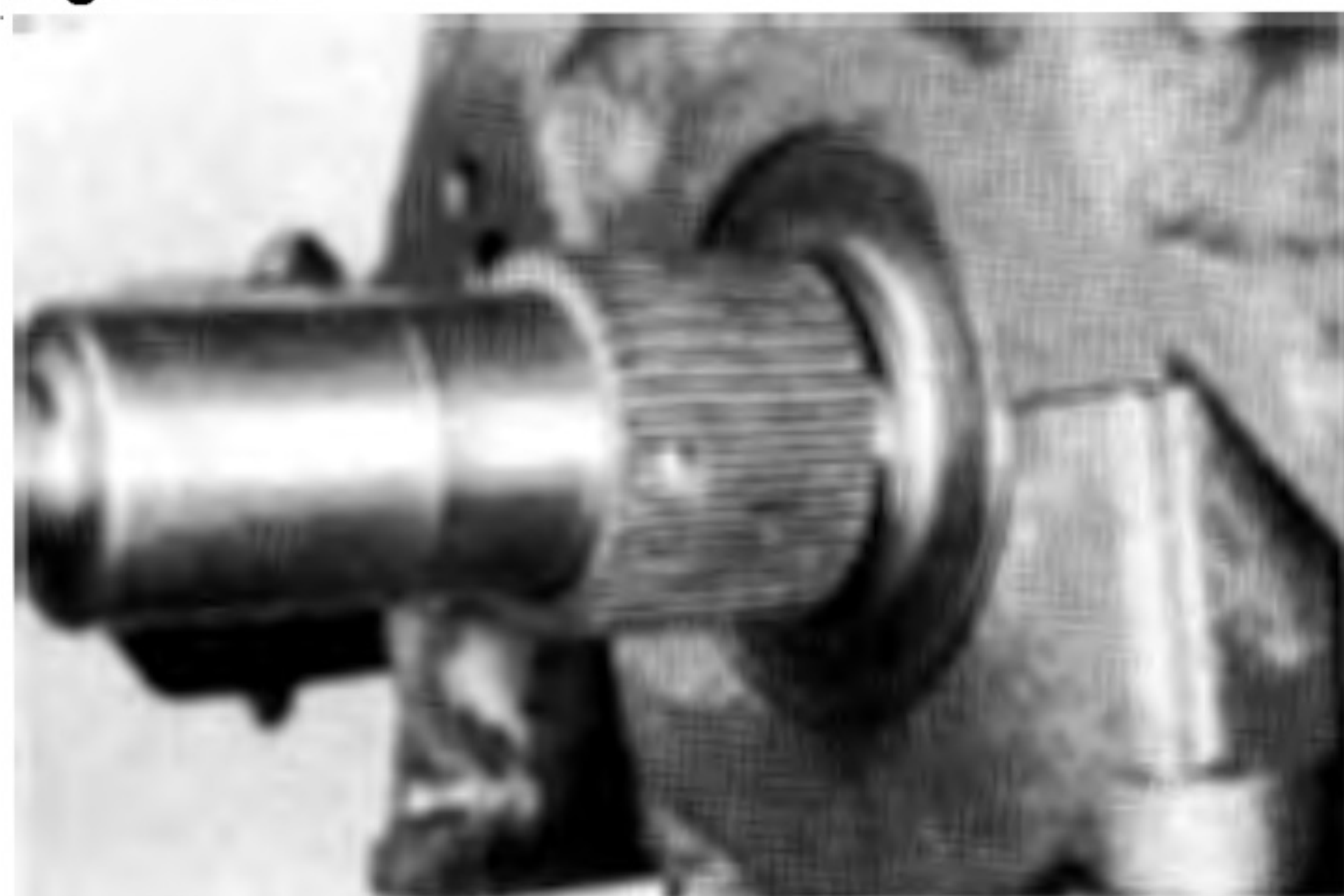
2. Check the driven gear shaft and driven gear for wear or damage.

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

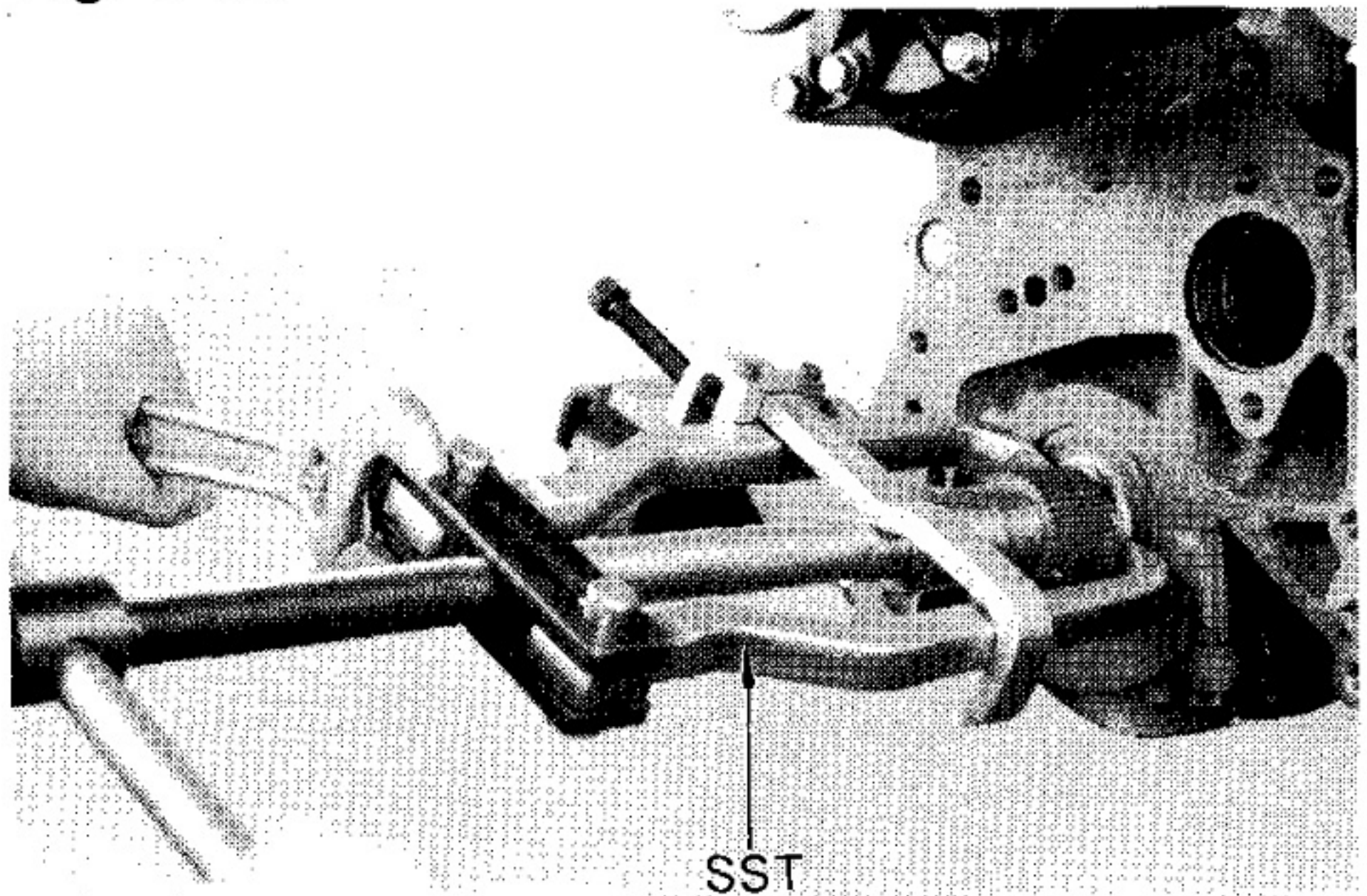


5. Replace the oil pump drive spline.
 - (1) Drive out the spline with a chisel until SST can be hooked on the spline end.
SST [09950-20014]

— Note —

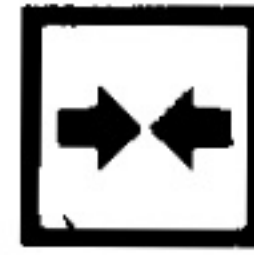
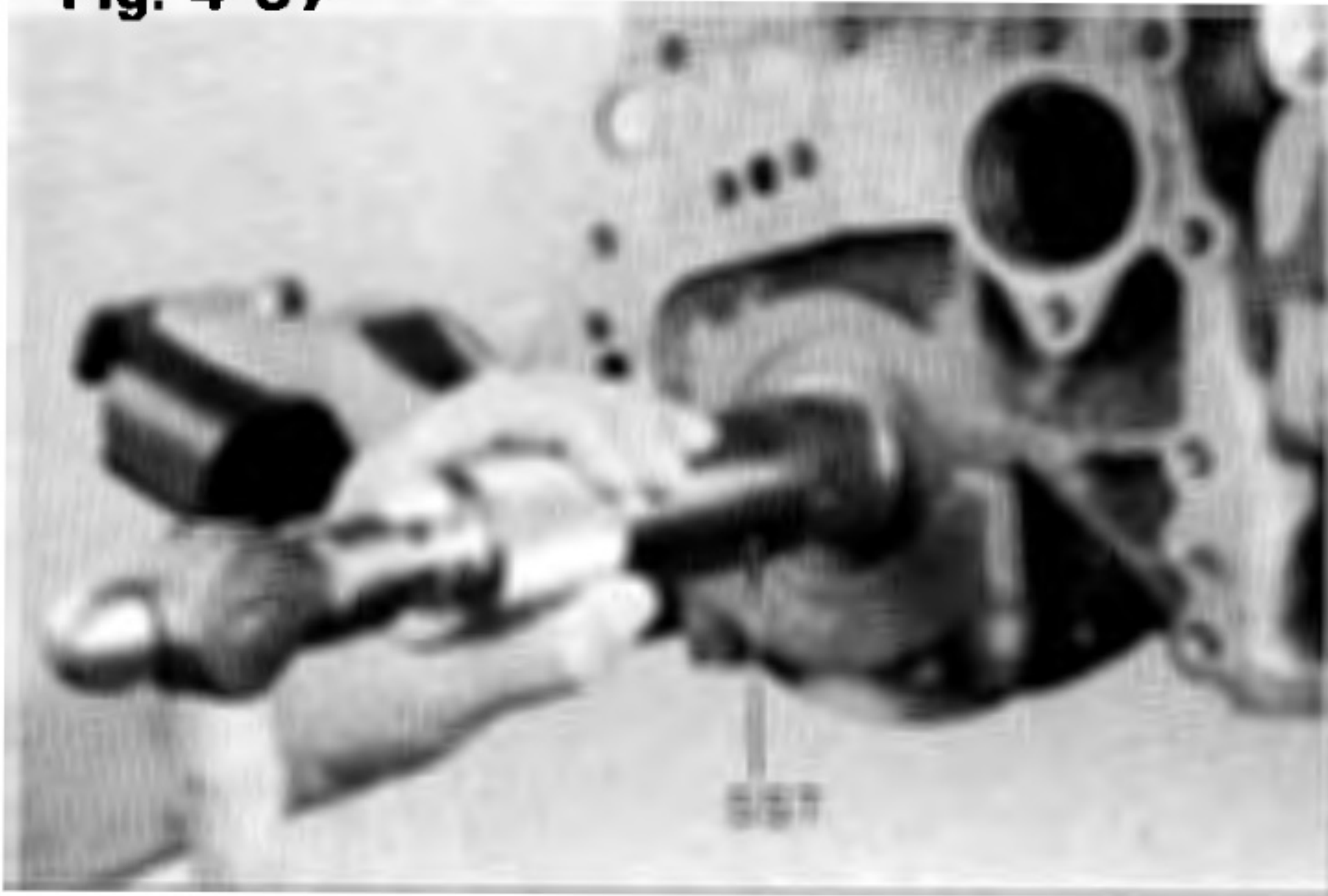
Place the chisel point in the oil pump drive spline hole indicated in the figure.

Fig. 4-36



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

Fig. 4-37



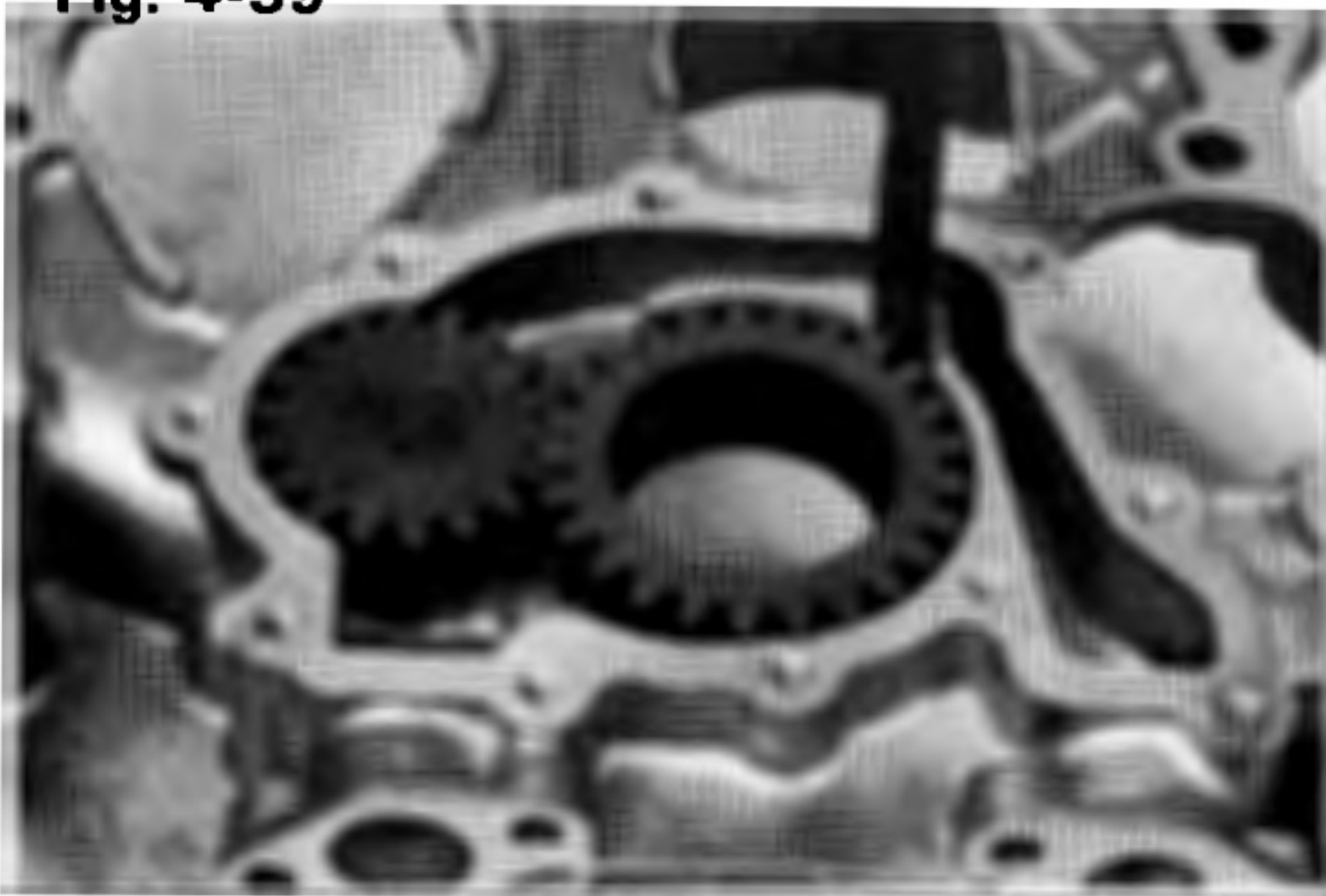
- (3) Drive in a new spline with SST.
SST [09316-60010]

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

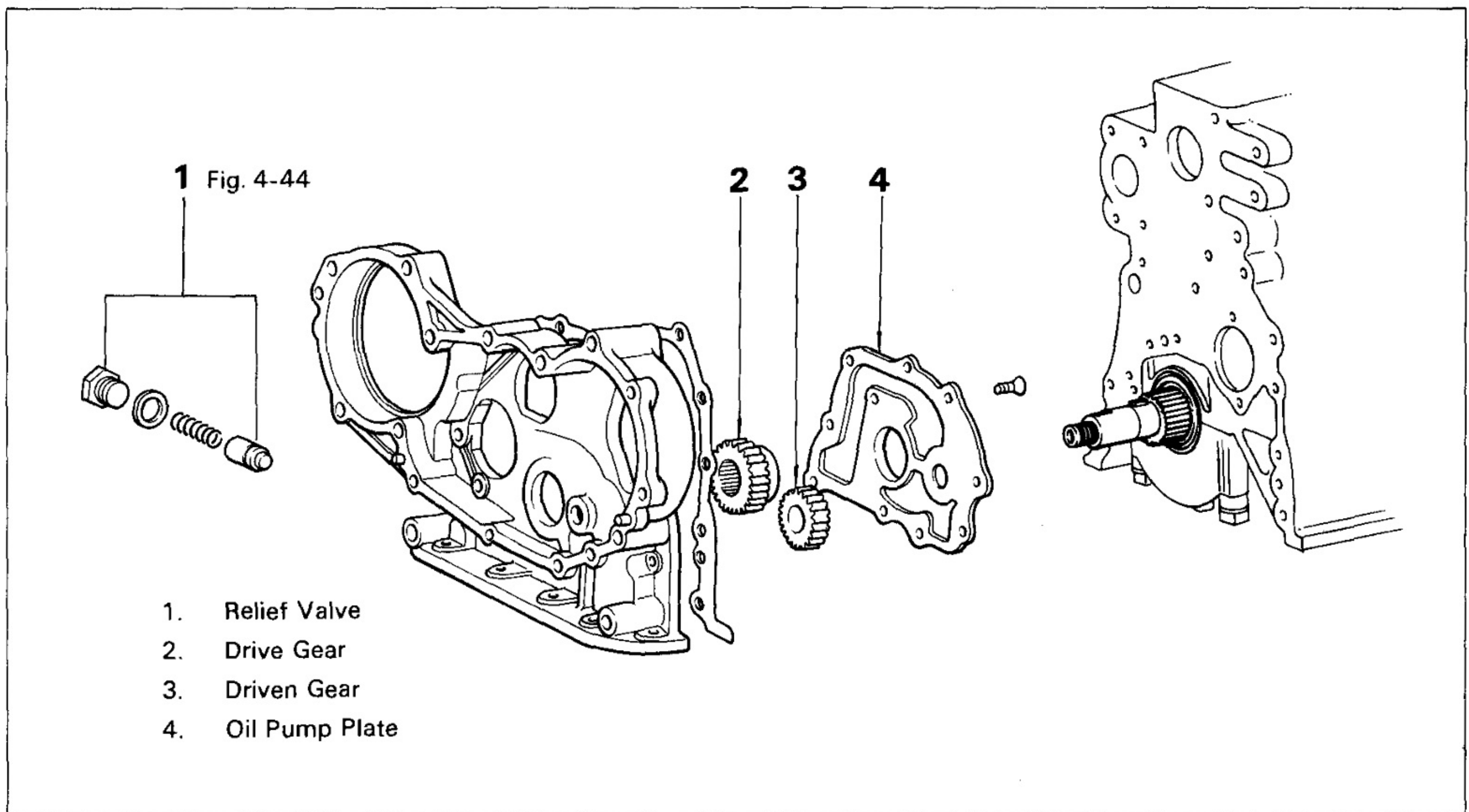


10. Measure the side clearance.

Side clearance:	
STD	0.03 – 0.10 mm (0.0012 – 0.0039 in.)
Limit	0.15 mm (0.0059 in.)

ASSEMBLY

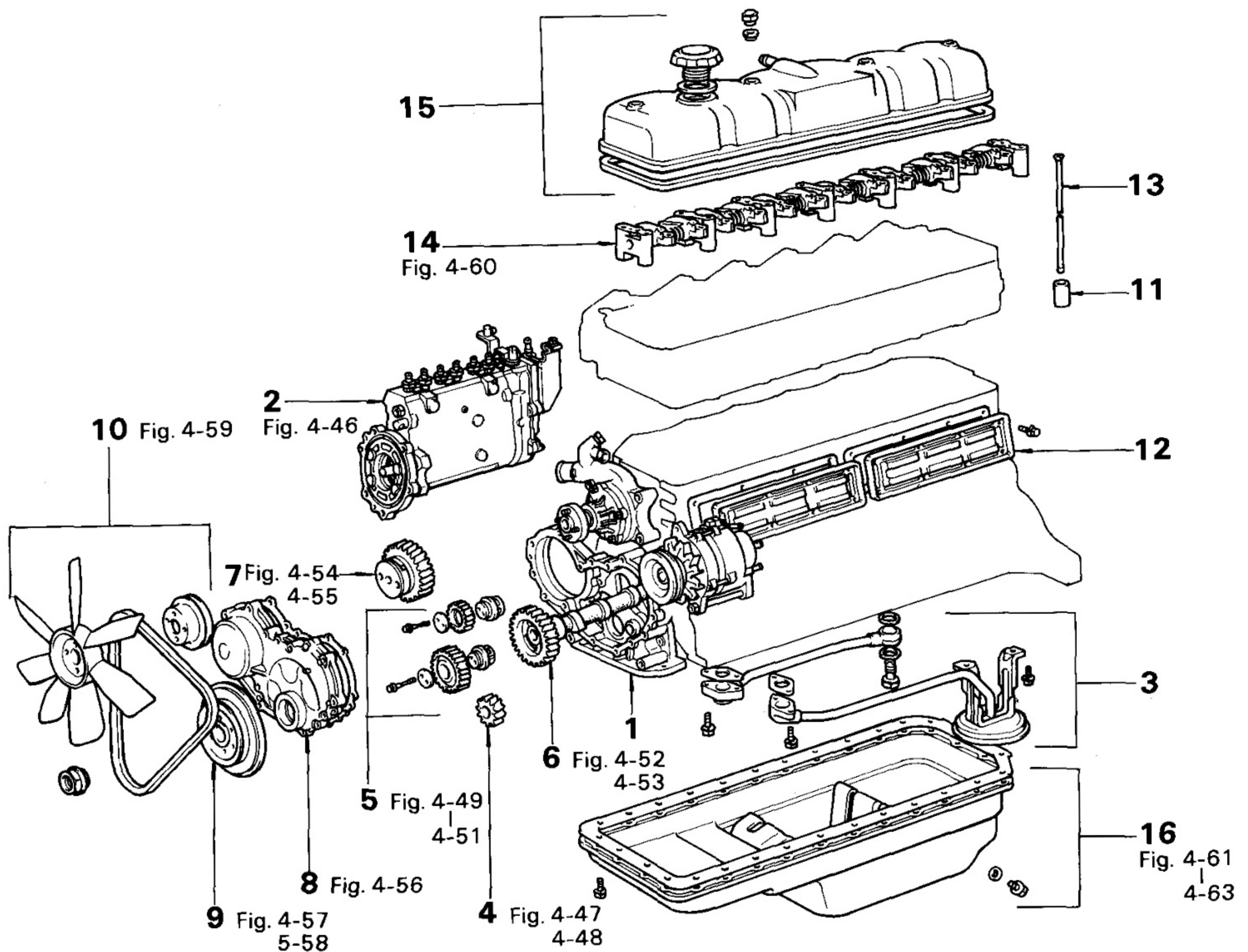
Assemble the parts in the numerical order shown in the figure.

Fig. 4-43**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

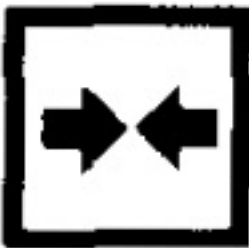
- | | |
|--------------------------------|---------------------------------|
| 1. Timing Gear Case & Oil Pump | 9. Crankshaft Pulley |
| 2. Injection Pump & Oil Pipe | 10. Fan Pulley & Drive Belt |
| 3. Oil Strainer & Pipe | 11. Valve Lifter |
| 4. Crankshaft Timing Gear | 12. Valve Push Rod Cover |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



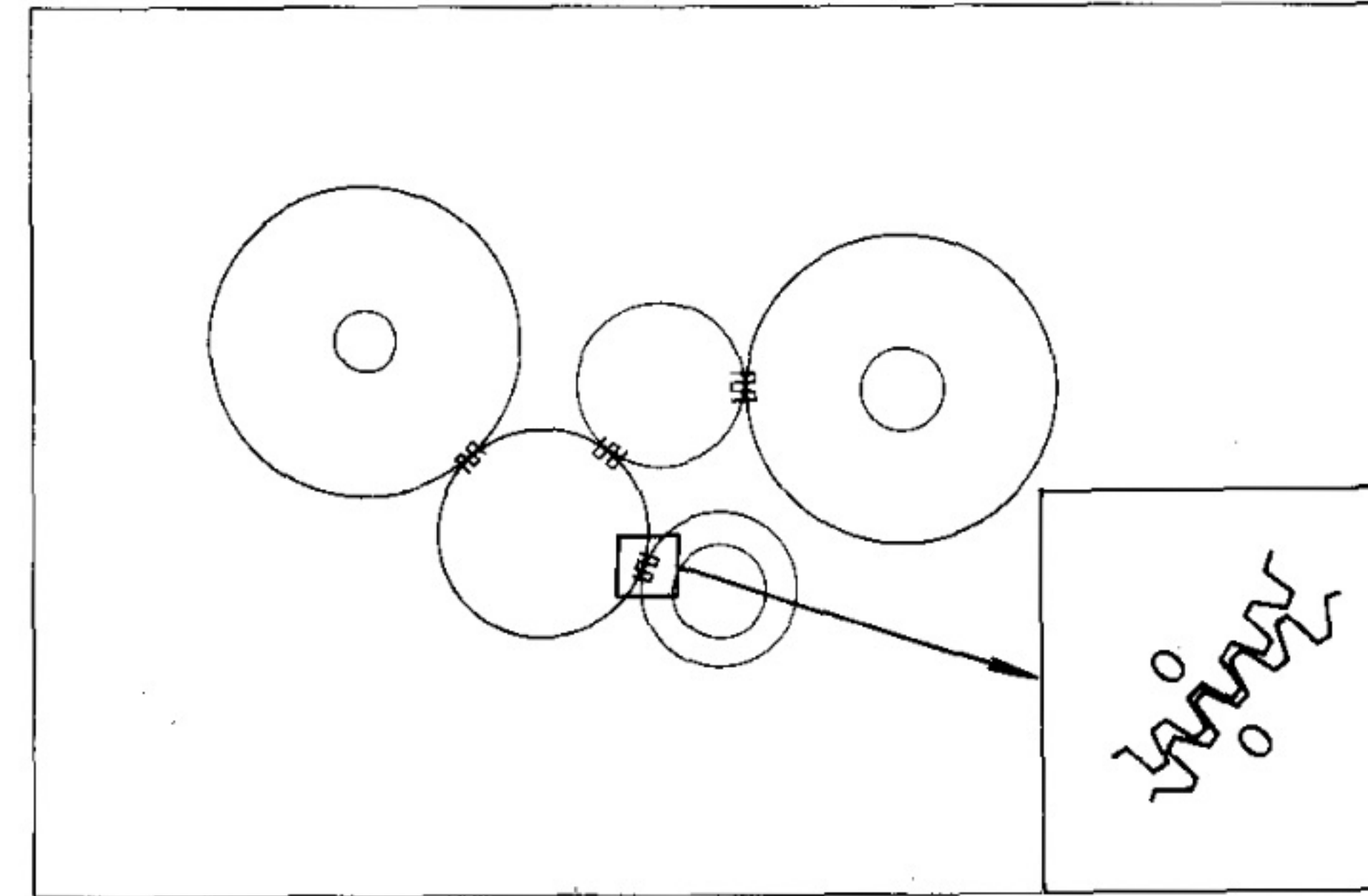
Drive in the crankshaft timing gear with SST. SST [09608-35013]

Fig. 4-48



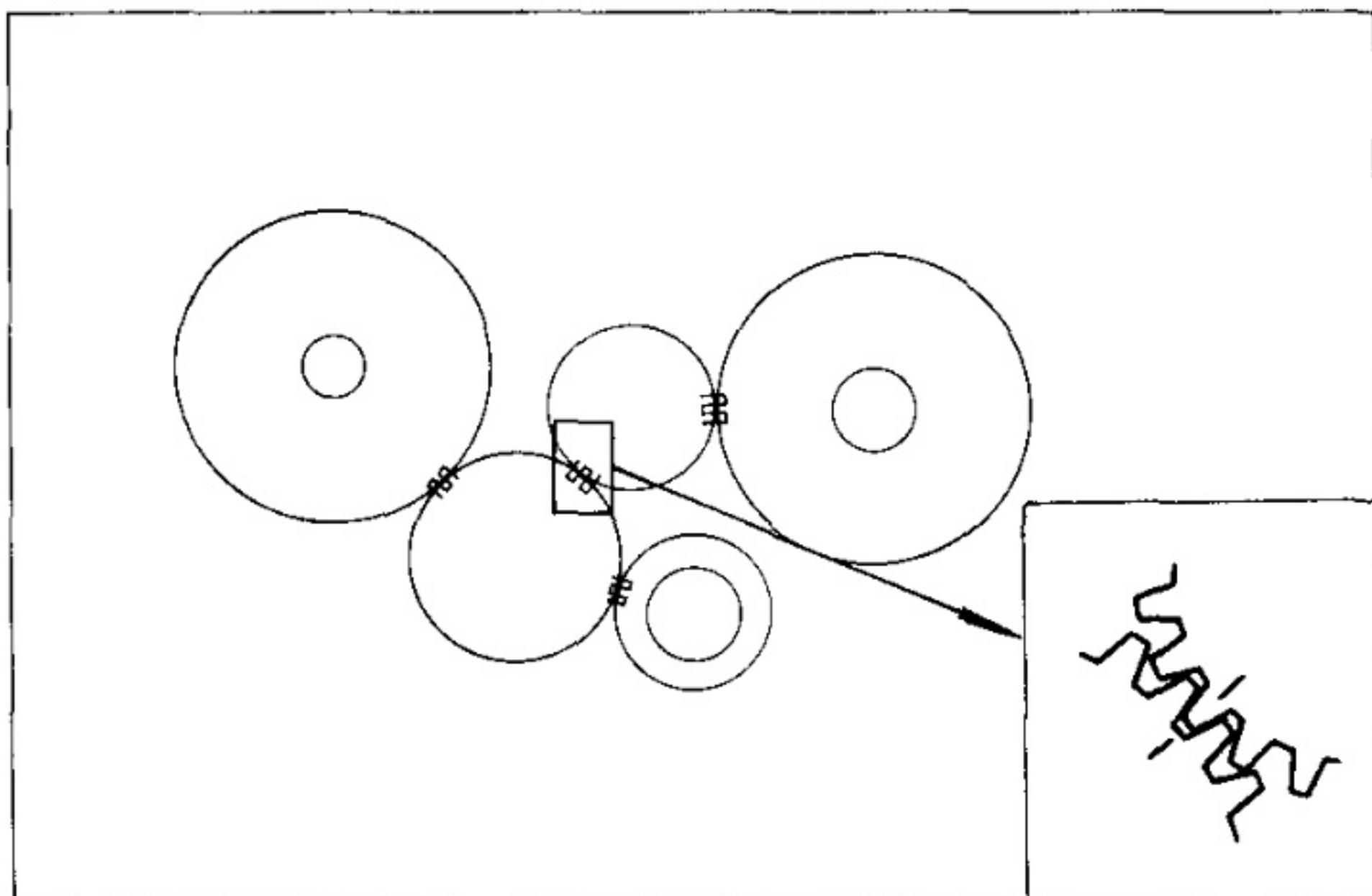
Set No.1 cylinder piston to TDC/compression.

Fig. 4-49



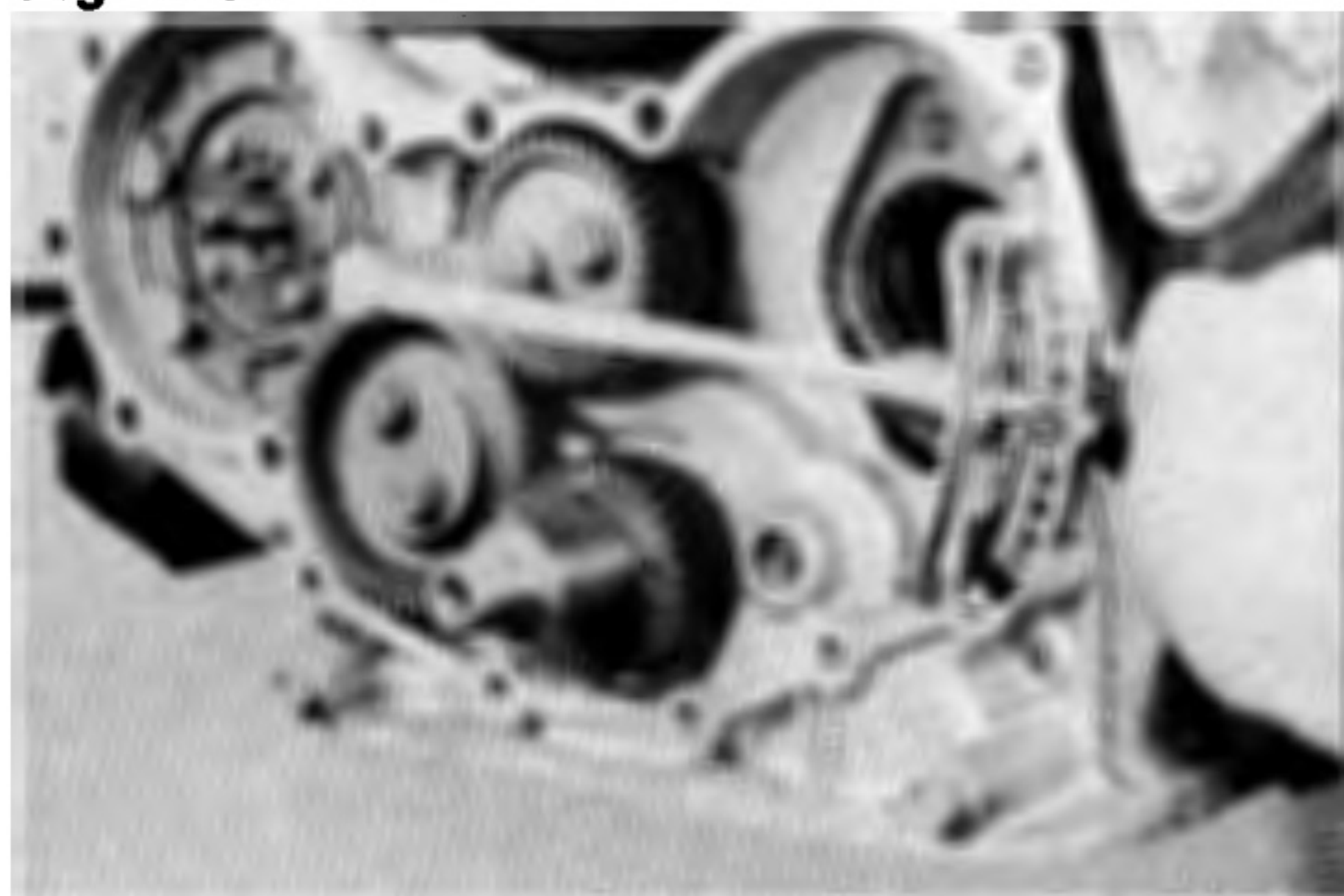
Align the matchmark of idle gear No.1 with that of the crankshaft timing gear.

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

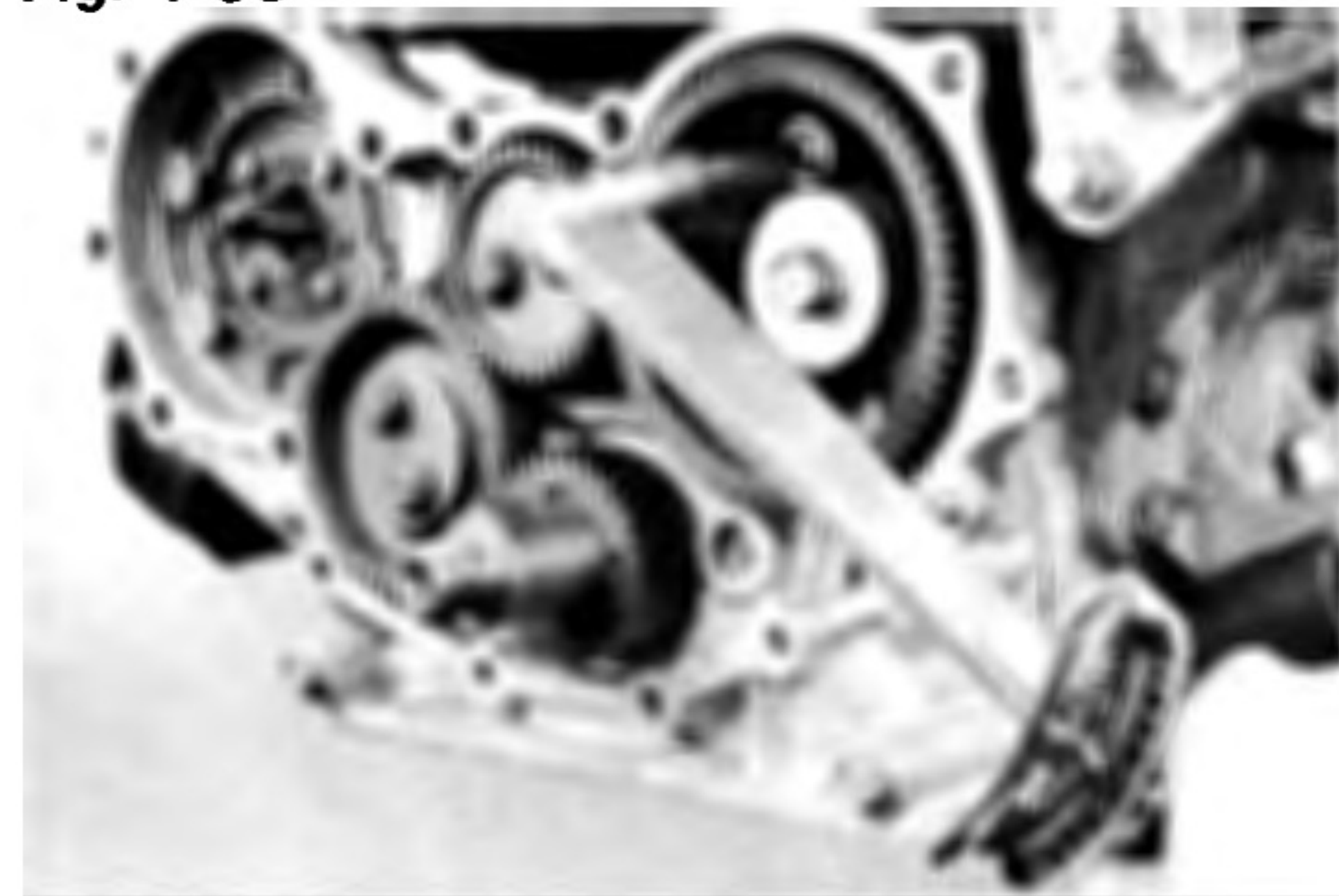


Insert the camshaft, aligning the matchmark with that of idle gear No.2.

—Note—

Be careful not to damage the camshaft bearings.

Fig. 4-53



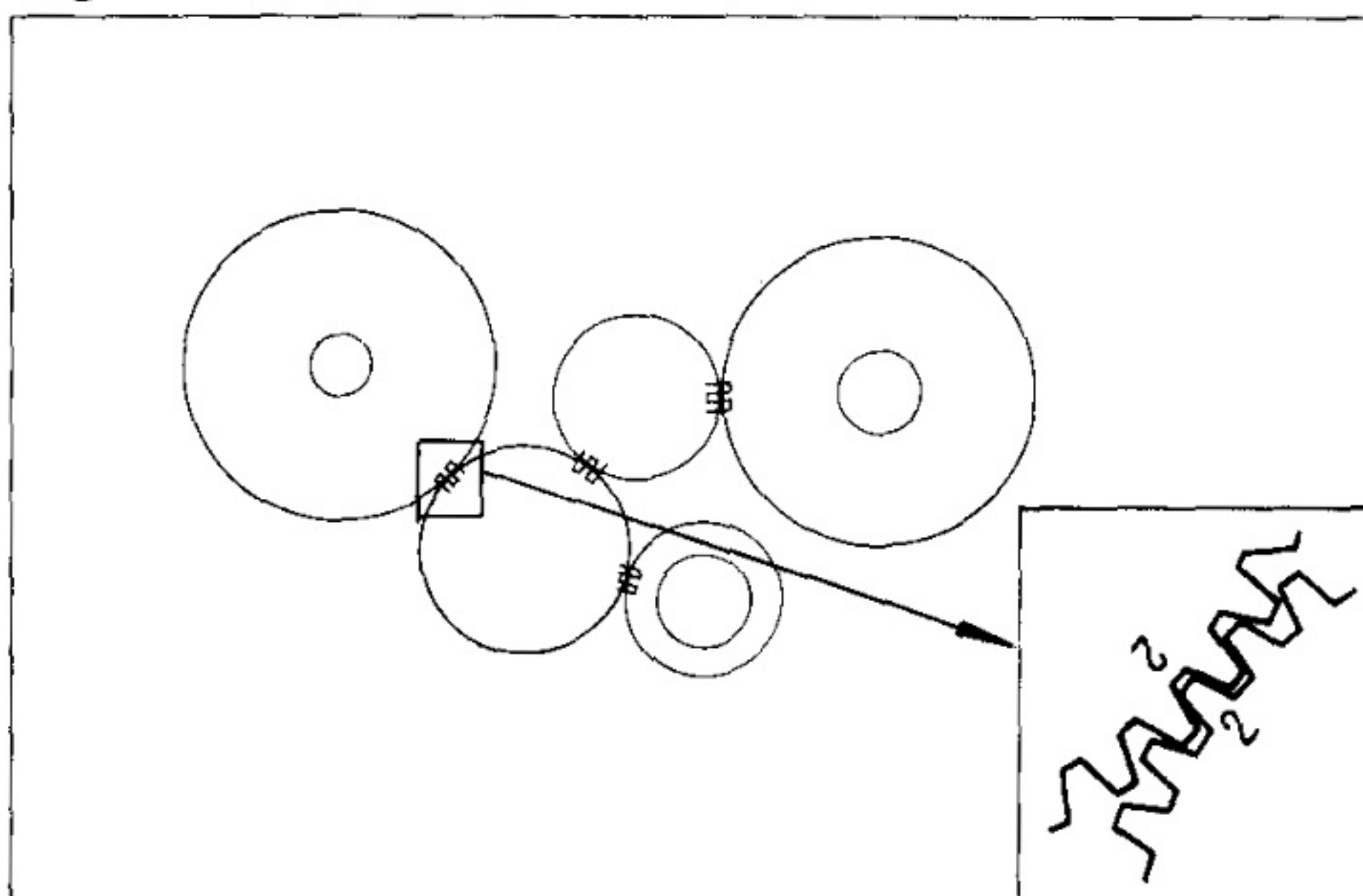
Tighten the camshaft thrust plate.

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

—Note—

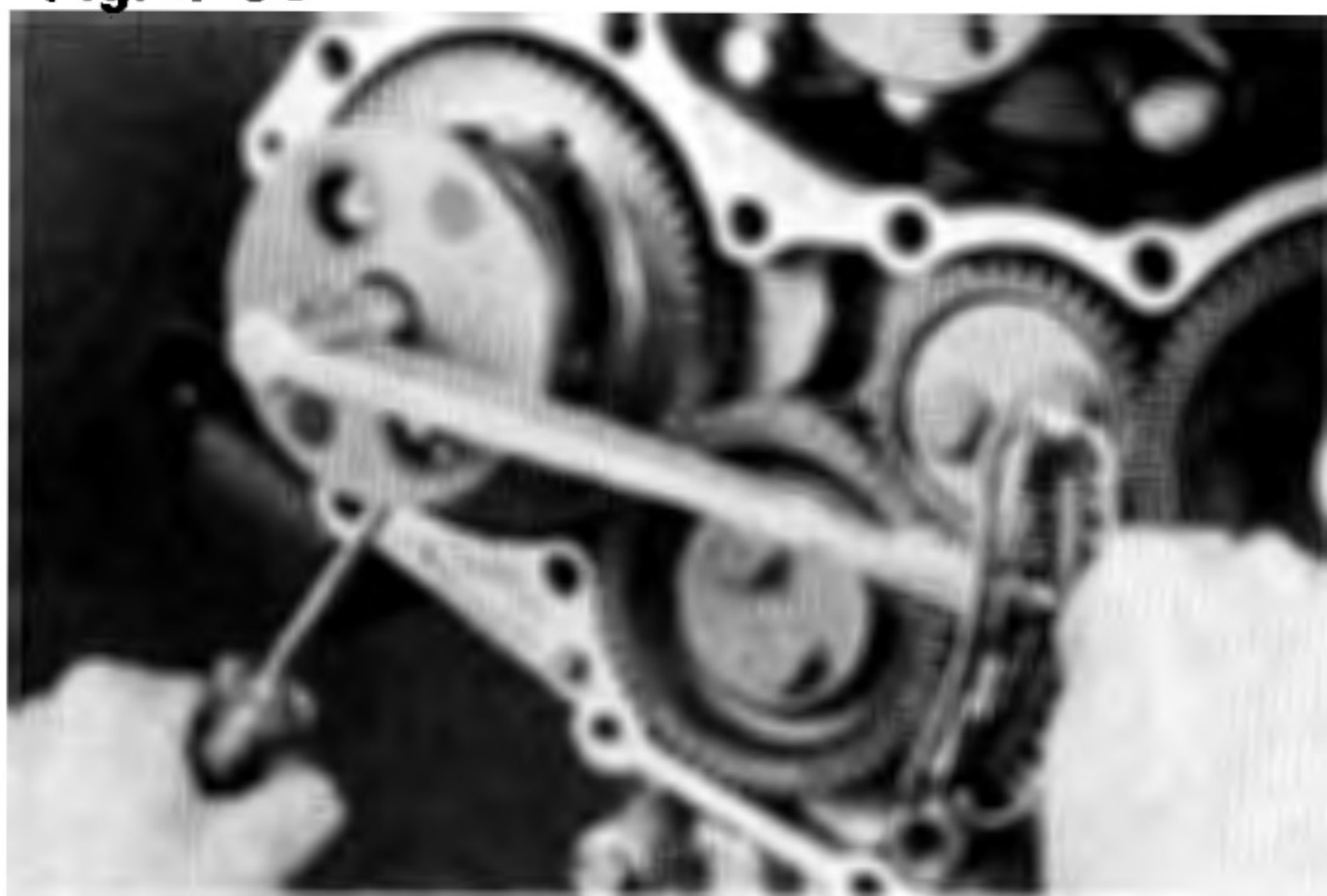
Apply a light coat of engine oil on the bolt threads and under the bolt head before installing.

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.

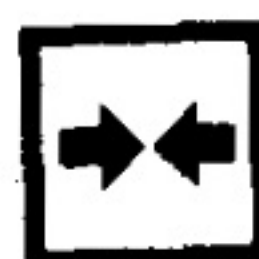
Fig. 4-56



Tighten the timing gear cover.

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

Fig. 4-57



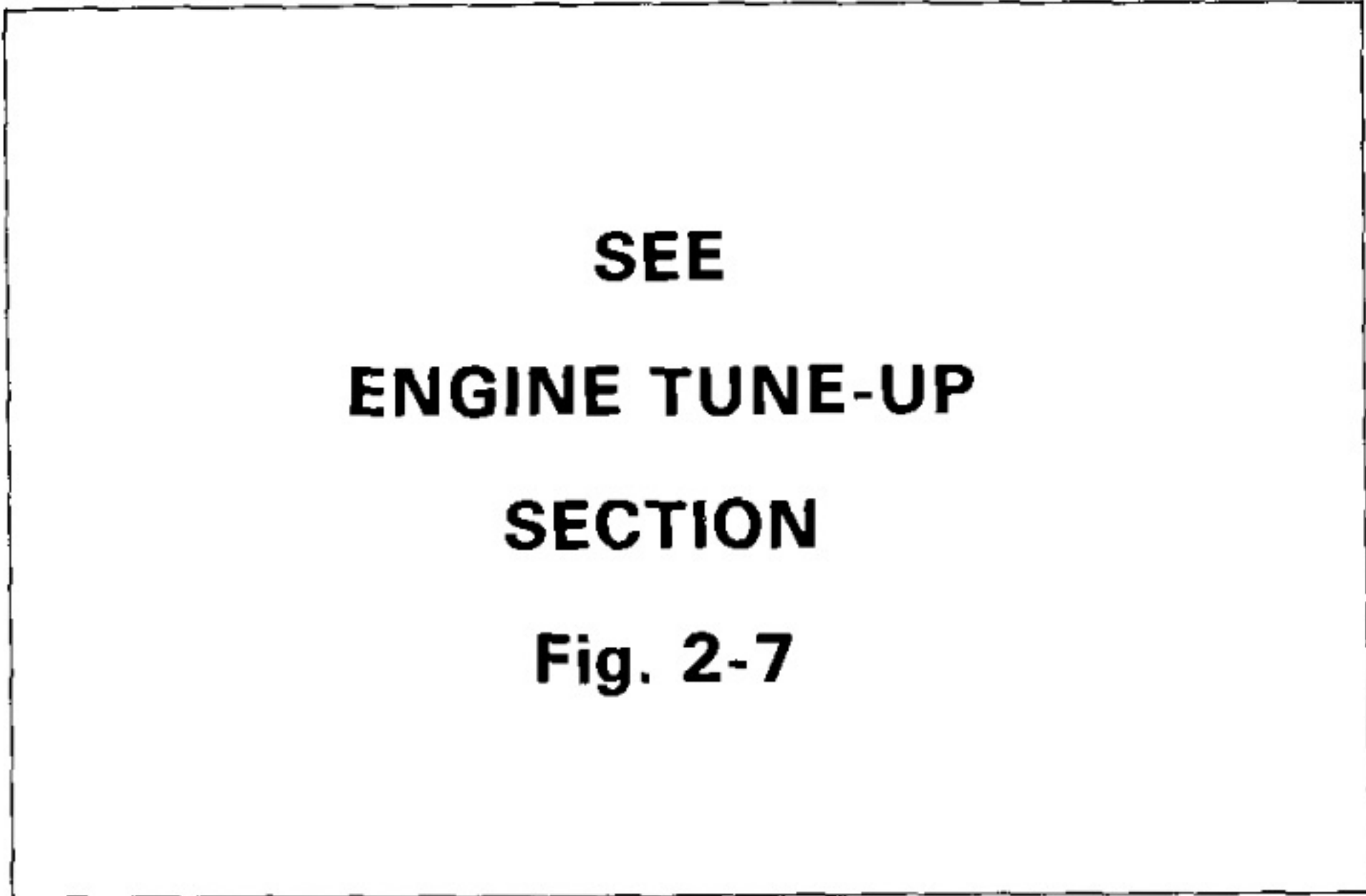
Drive in the crankshaft pulley with SST.
SST [09608-35013]



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

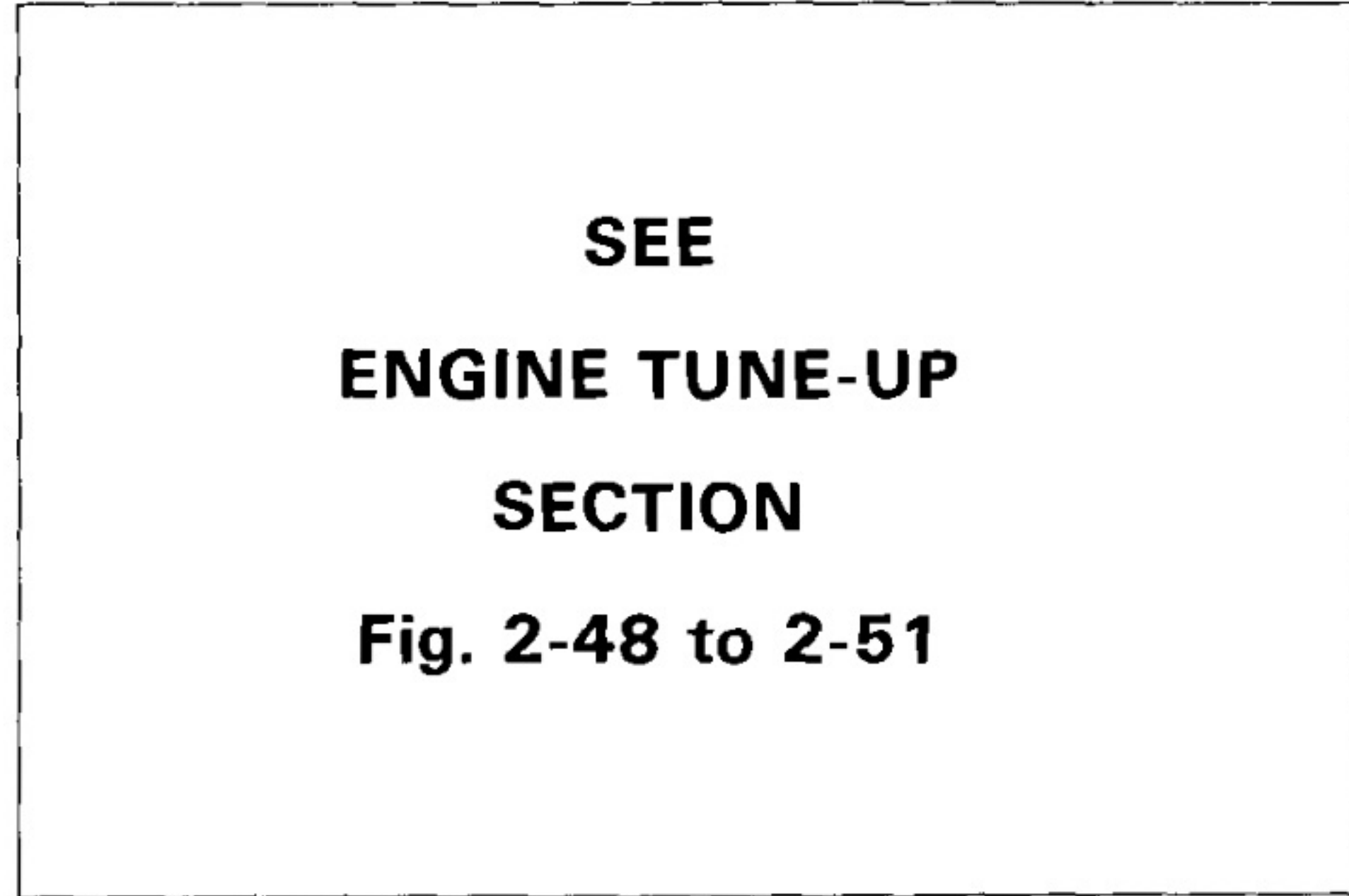
—Note—
Apply a light coat of engine oil on the bolt threads and under the bolt head before installing.

Fig. 4-59



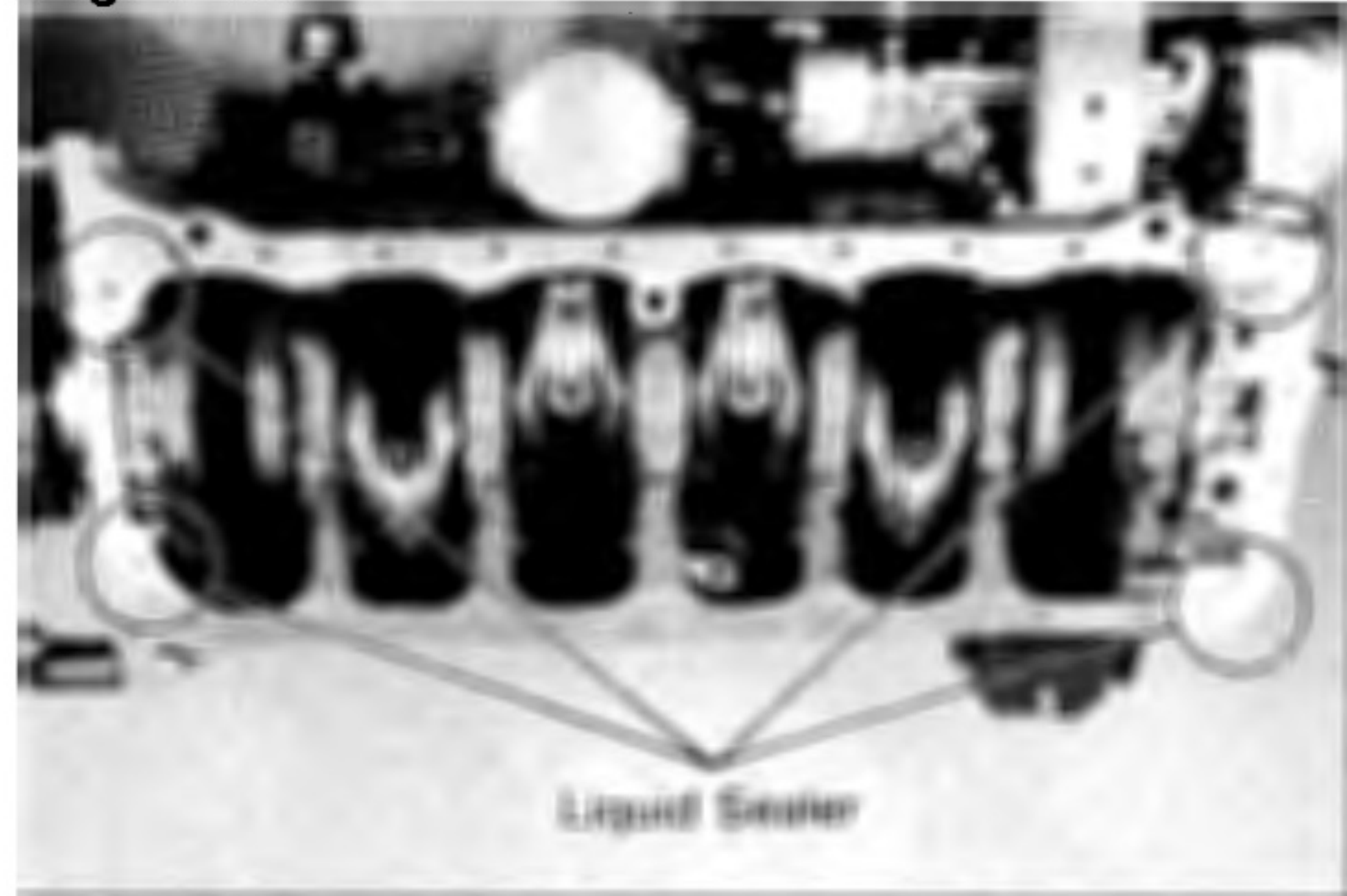
Adjust drive belt tension.

Fig. 4-60



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)

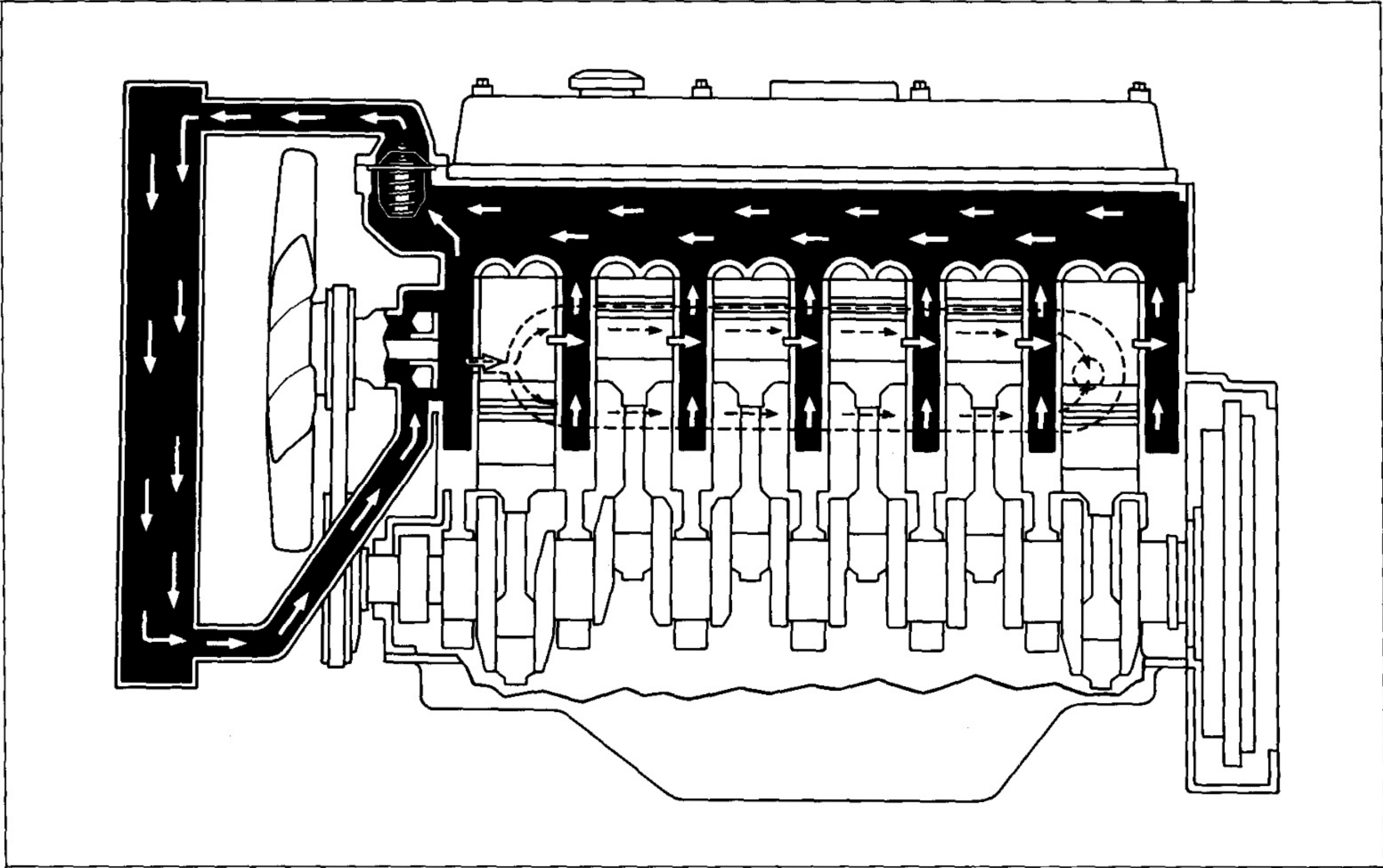
10.3 liters (10.9 US qt, 9.1 Imp.qt)

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

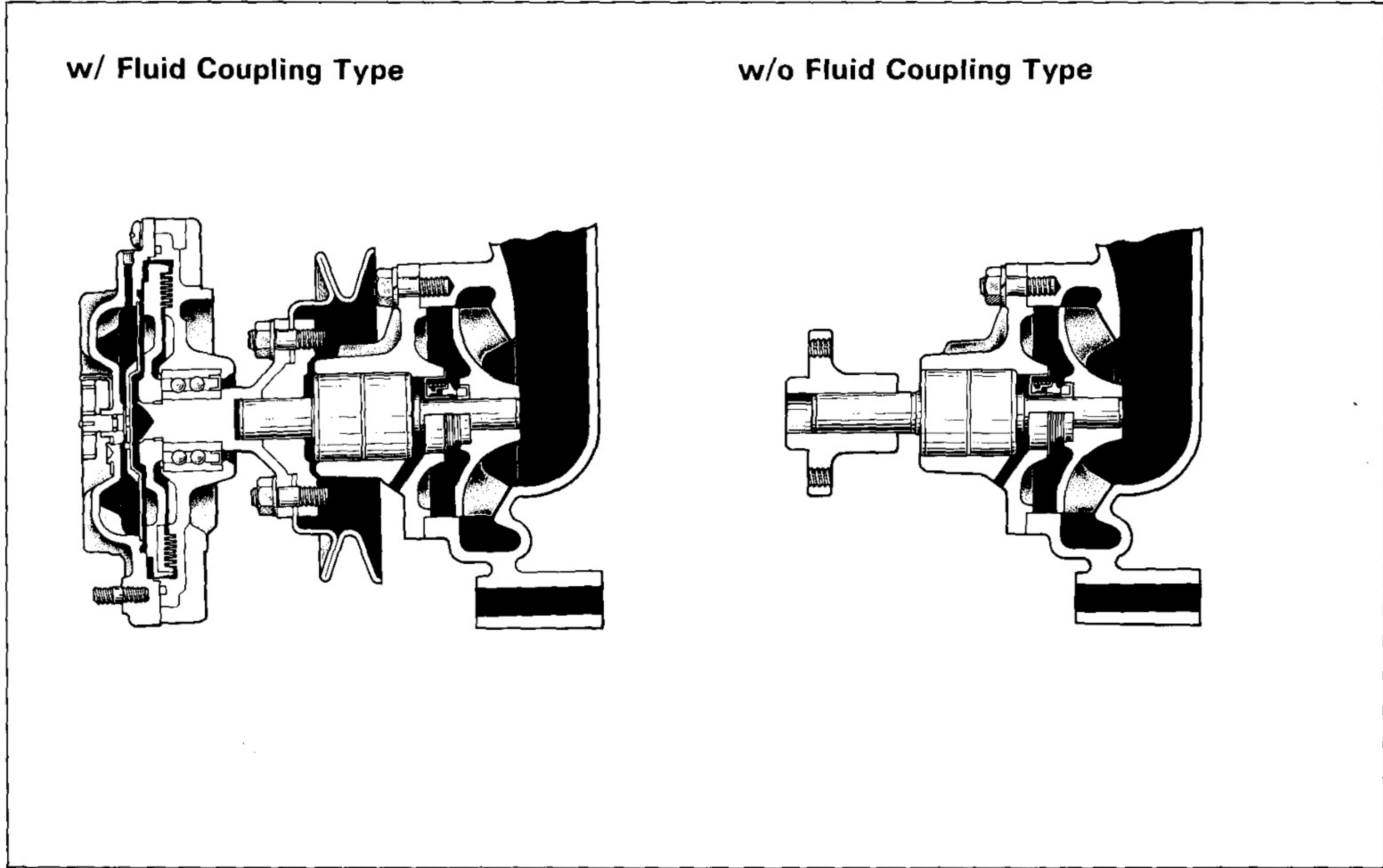
COOLING SYSTEM CIRCUIT

Fig. 5-1



WATER PUMP CUTAWAY VIEW

Fig. 5-2



WATER PUMP

DISASSEMBLY

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

Fig. 5-3

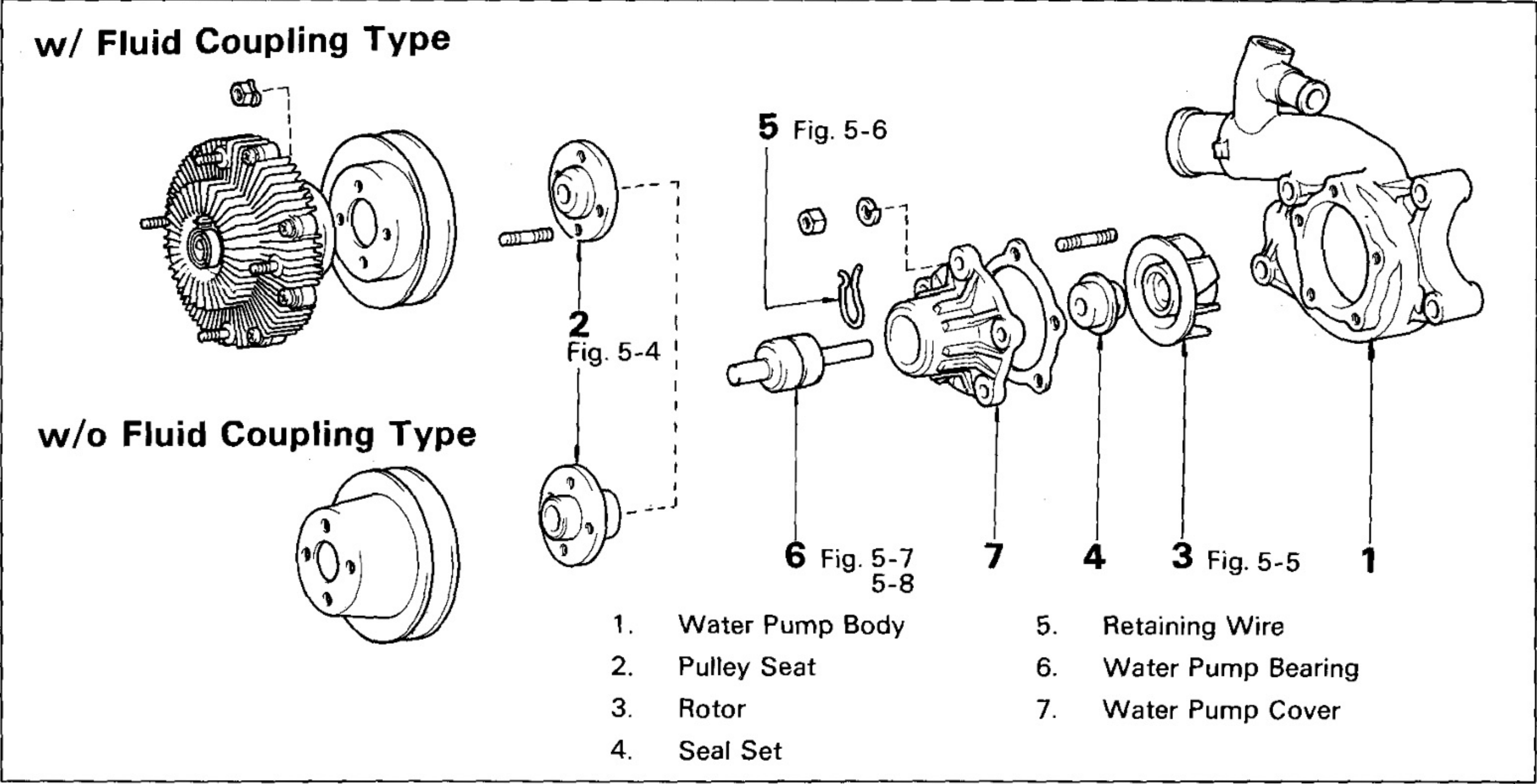
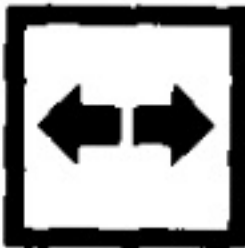
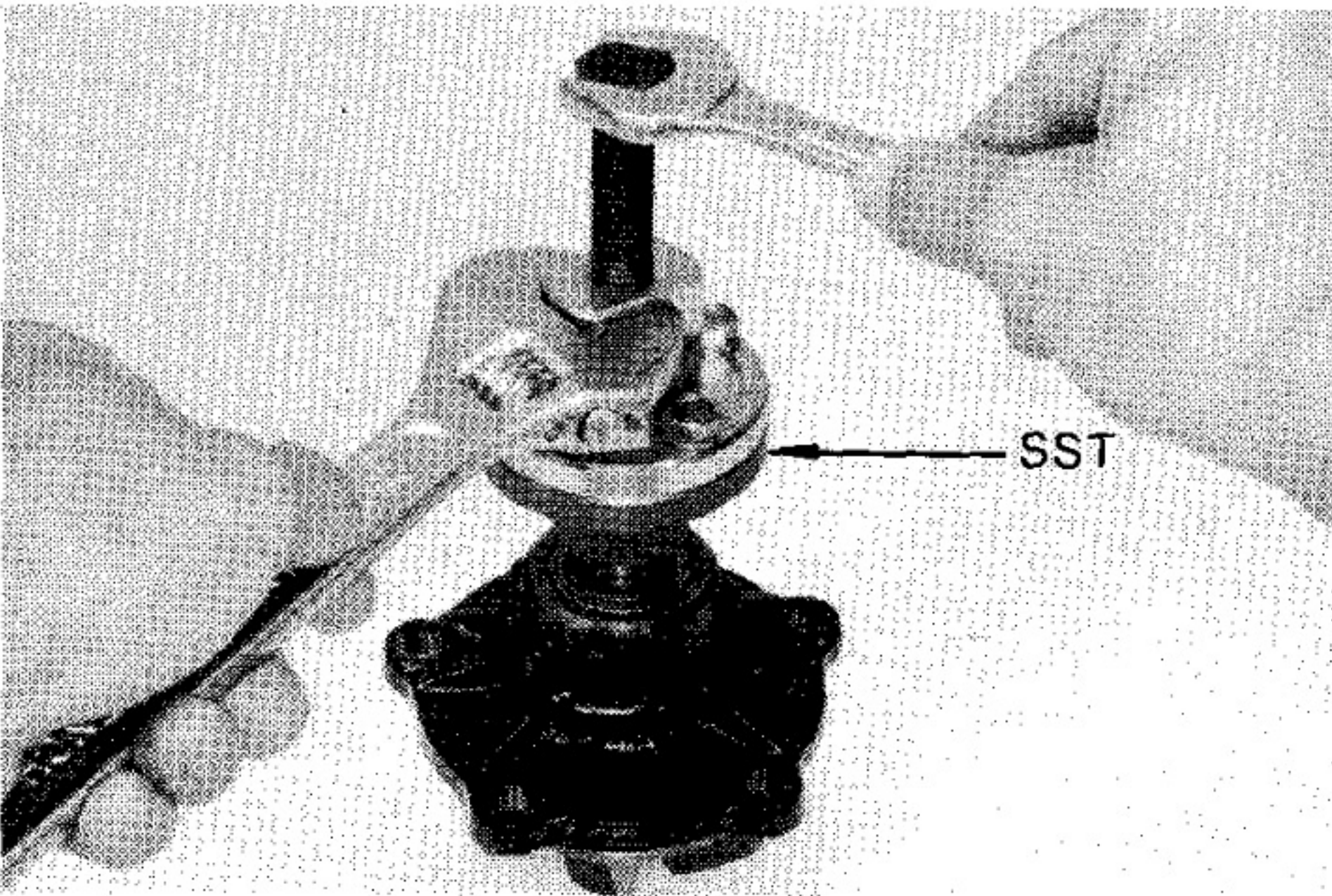
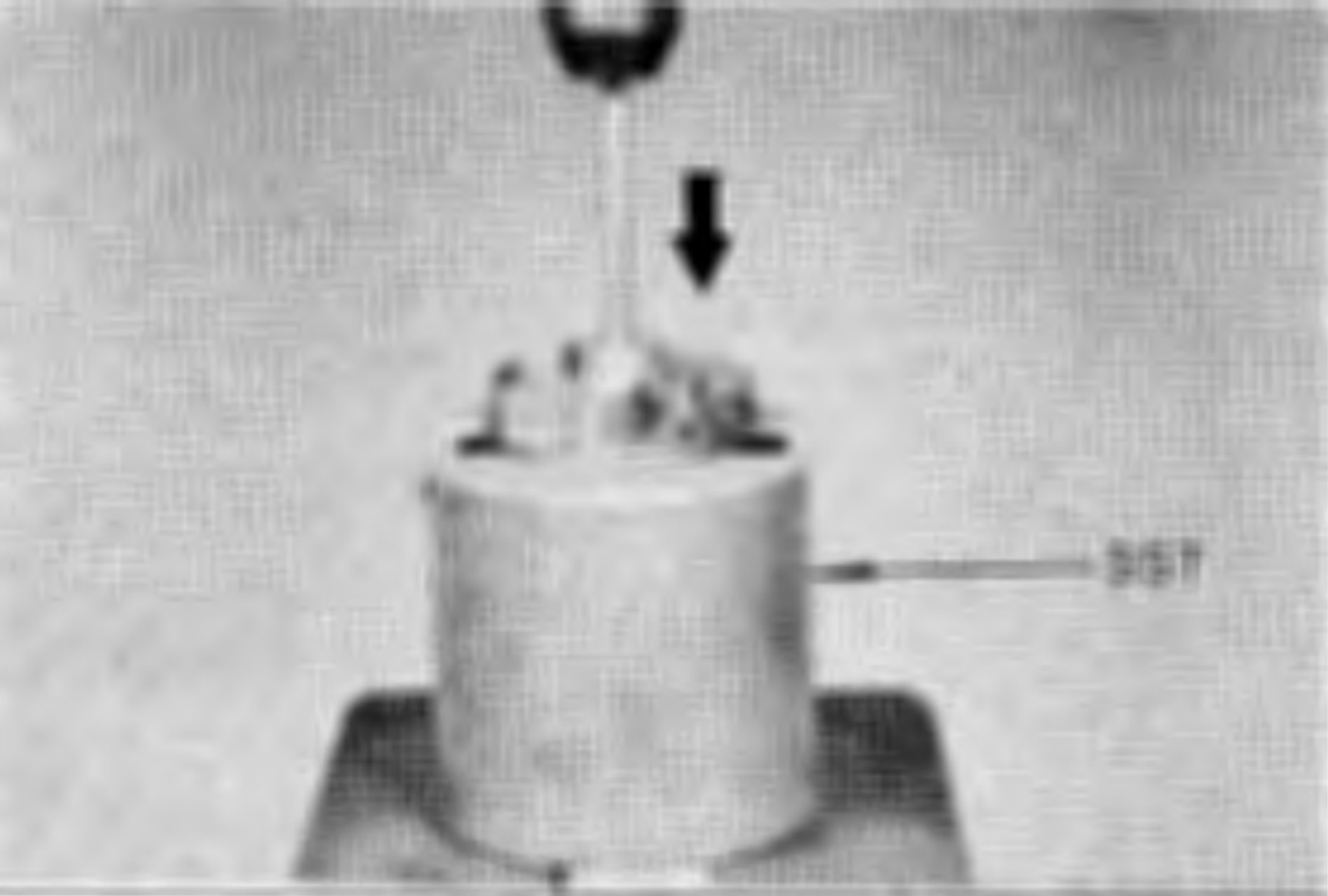


Fig. 5-4



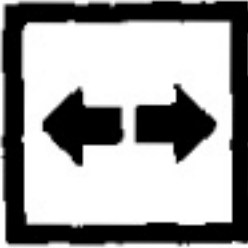
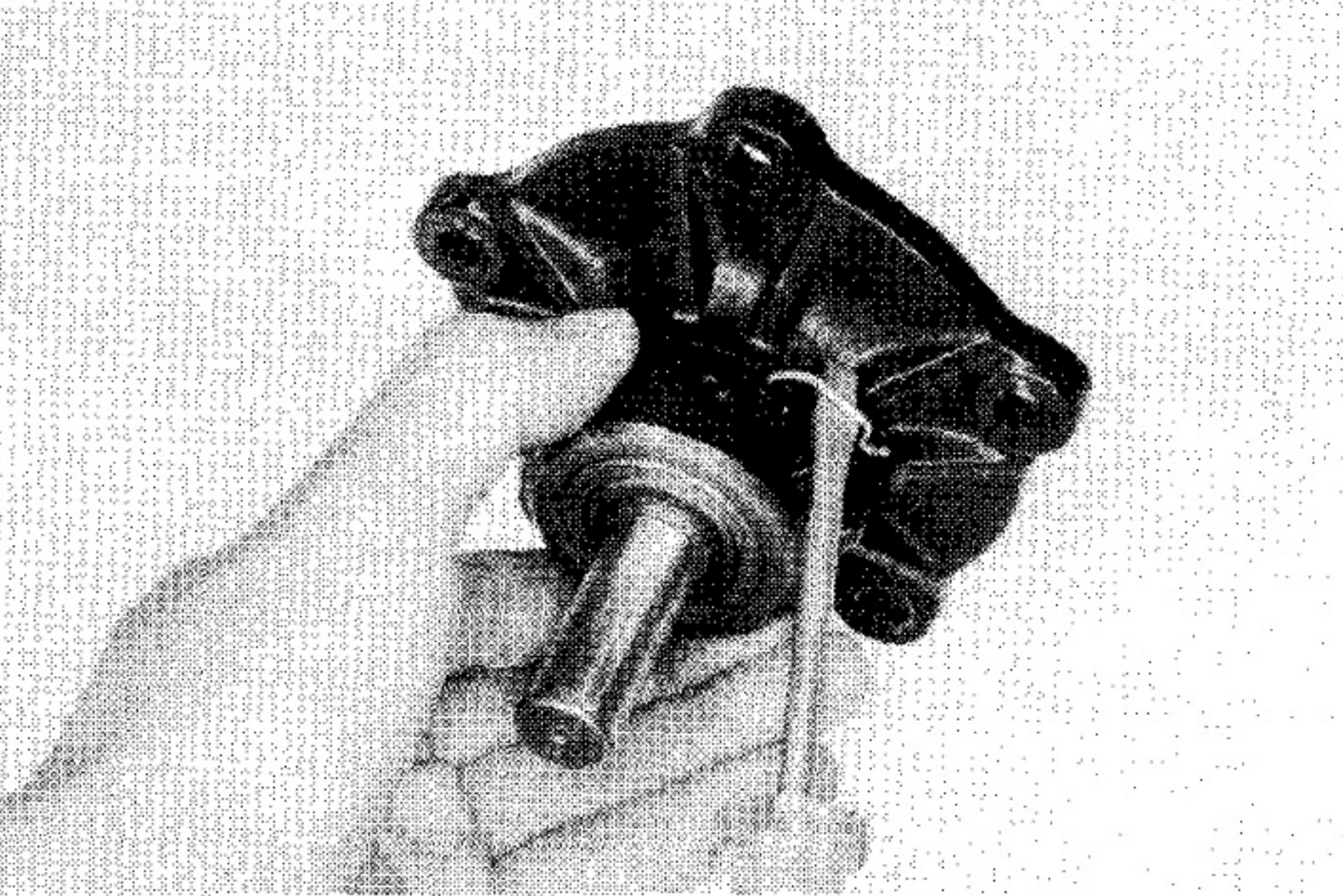
Remove the pulley seat with SST.
SST [09235-60010]

Fig. 5-5



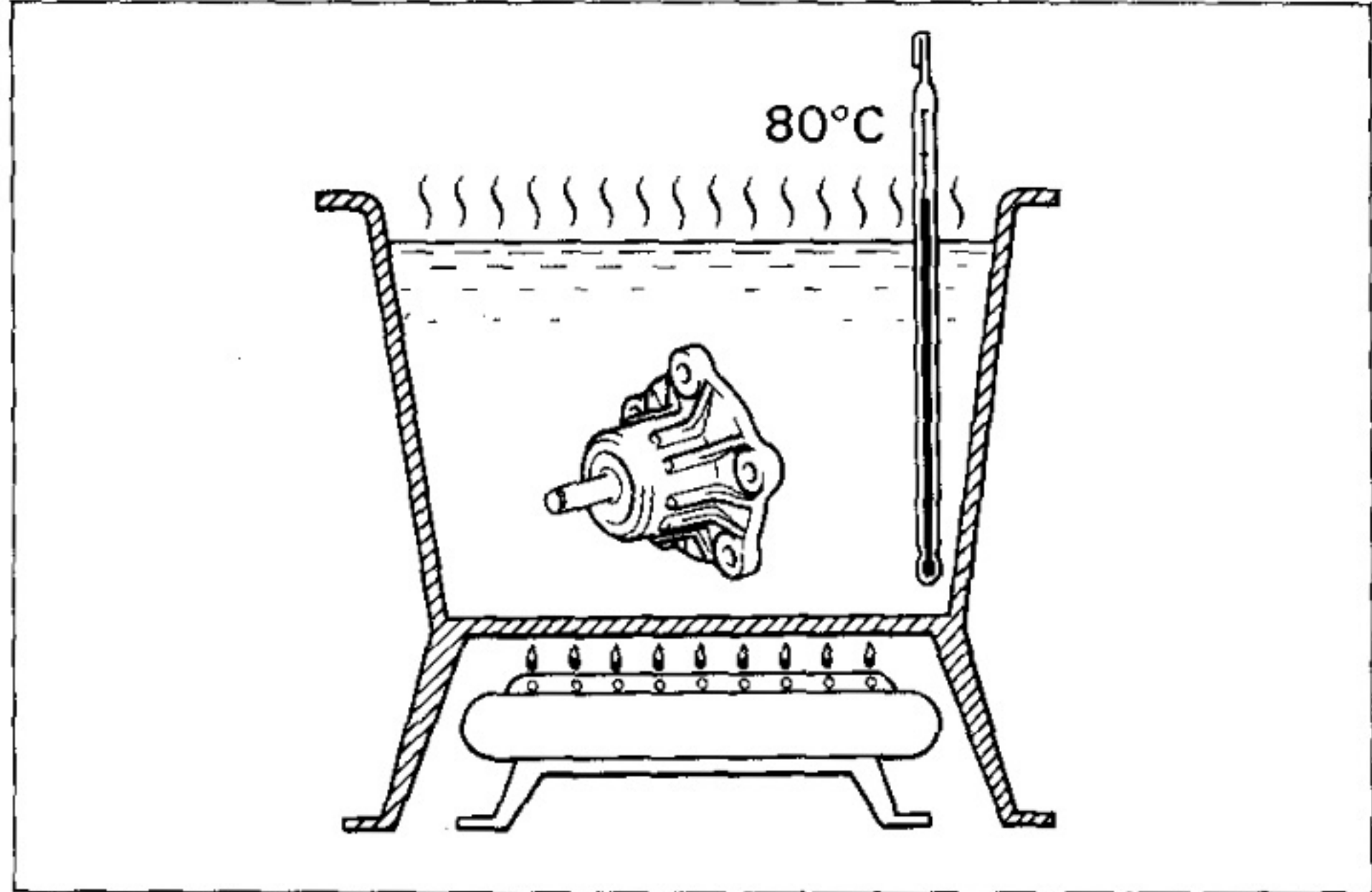
Remove the rotor with SST and a press.
SST [09239-40010]

Fig. 5-6



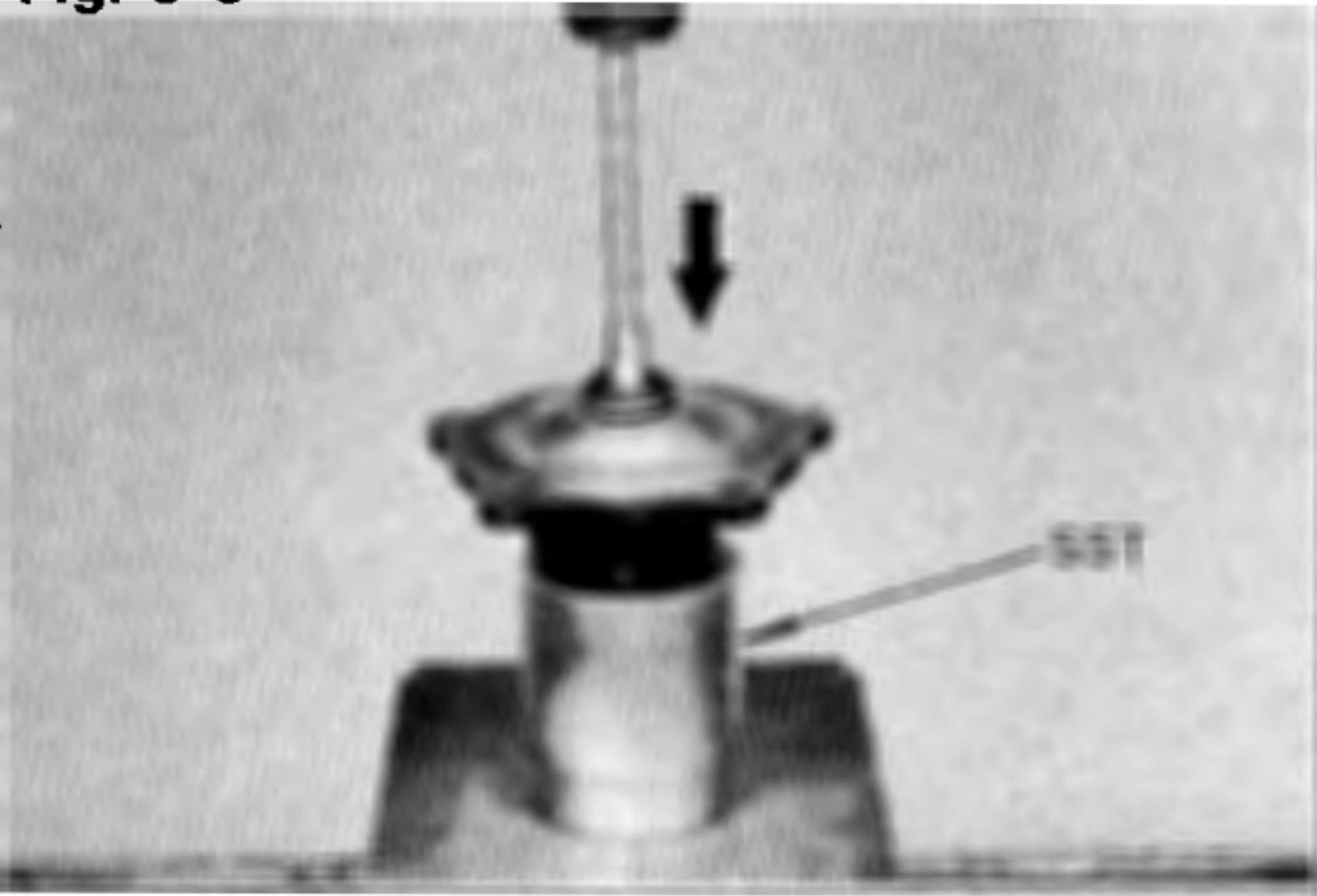
Remove the retaining wire from the water pump cover.

Fig. 5-7



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

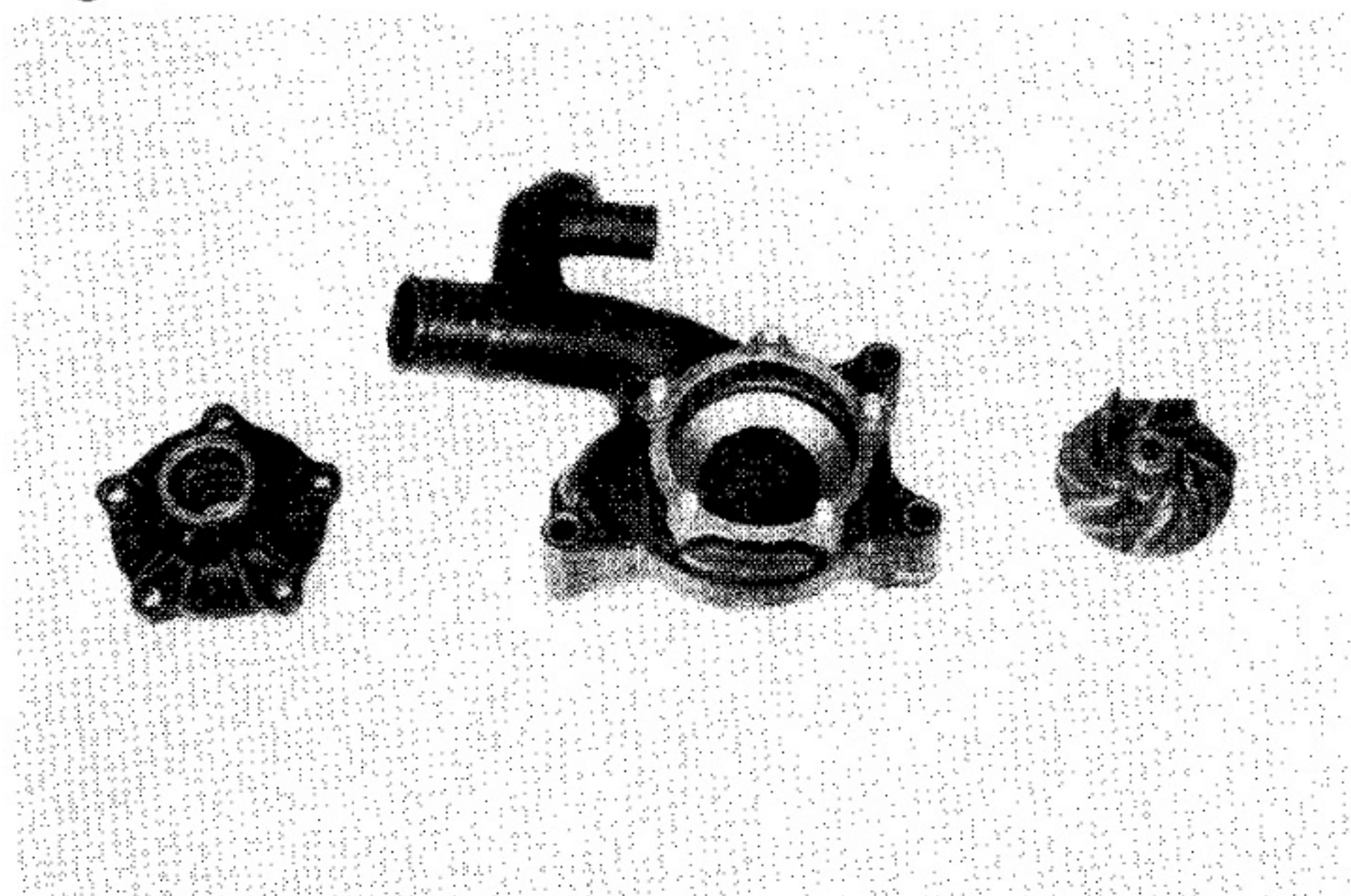
Fig. 5-8



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

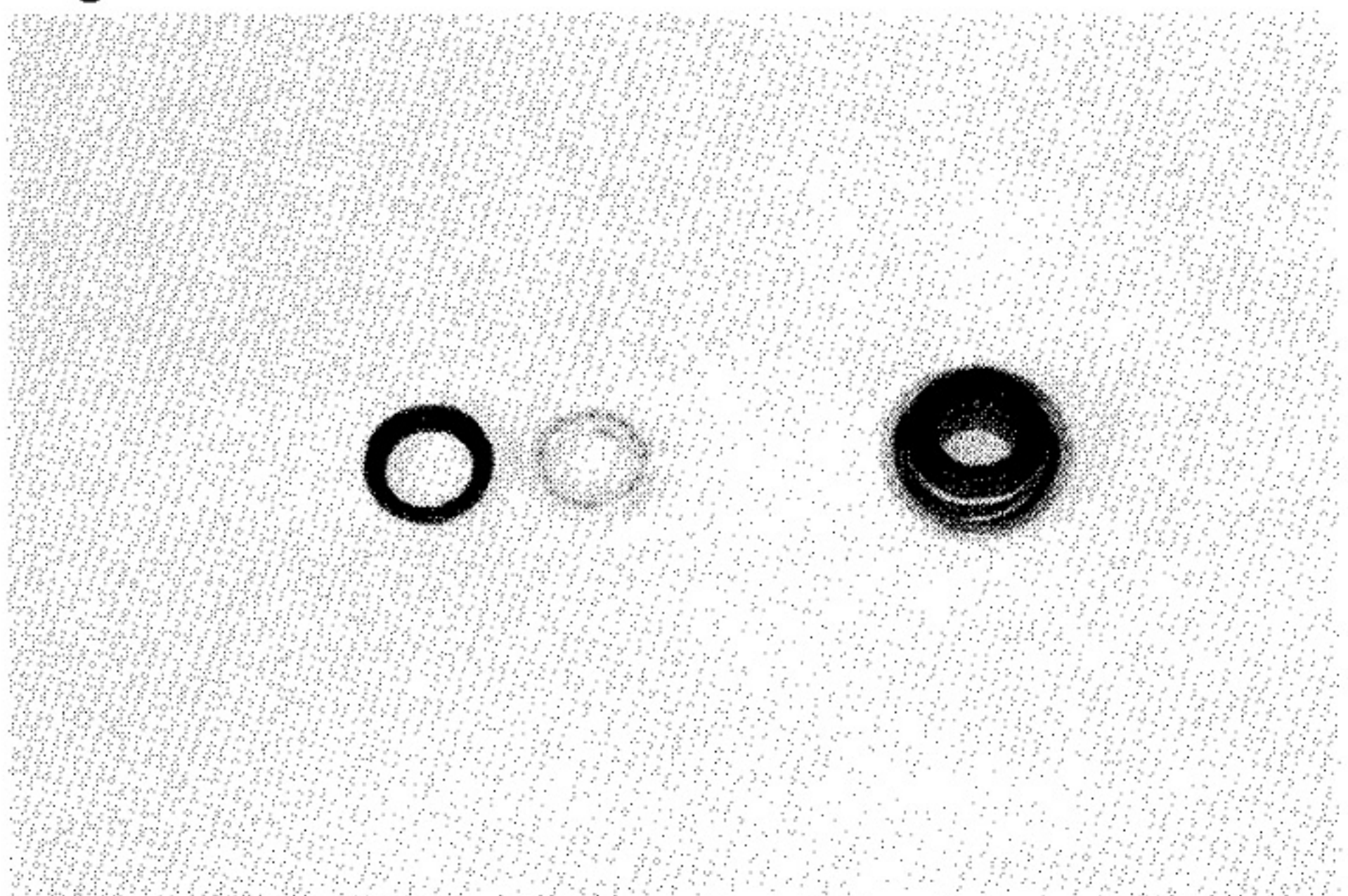
—Note—
Press the bearing toward the pulley seat side.

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

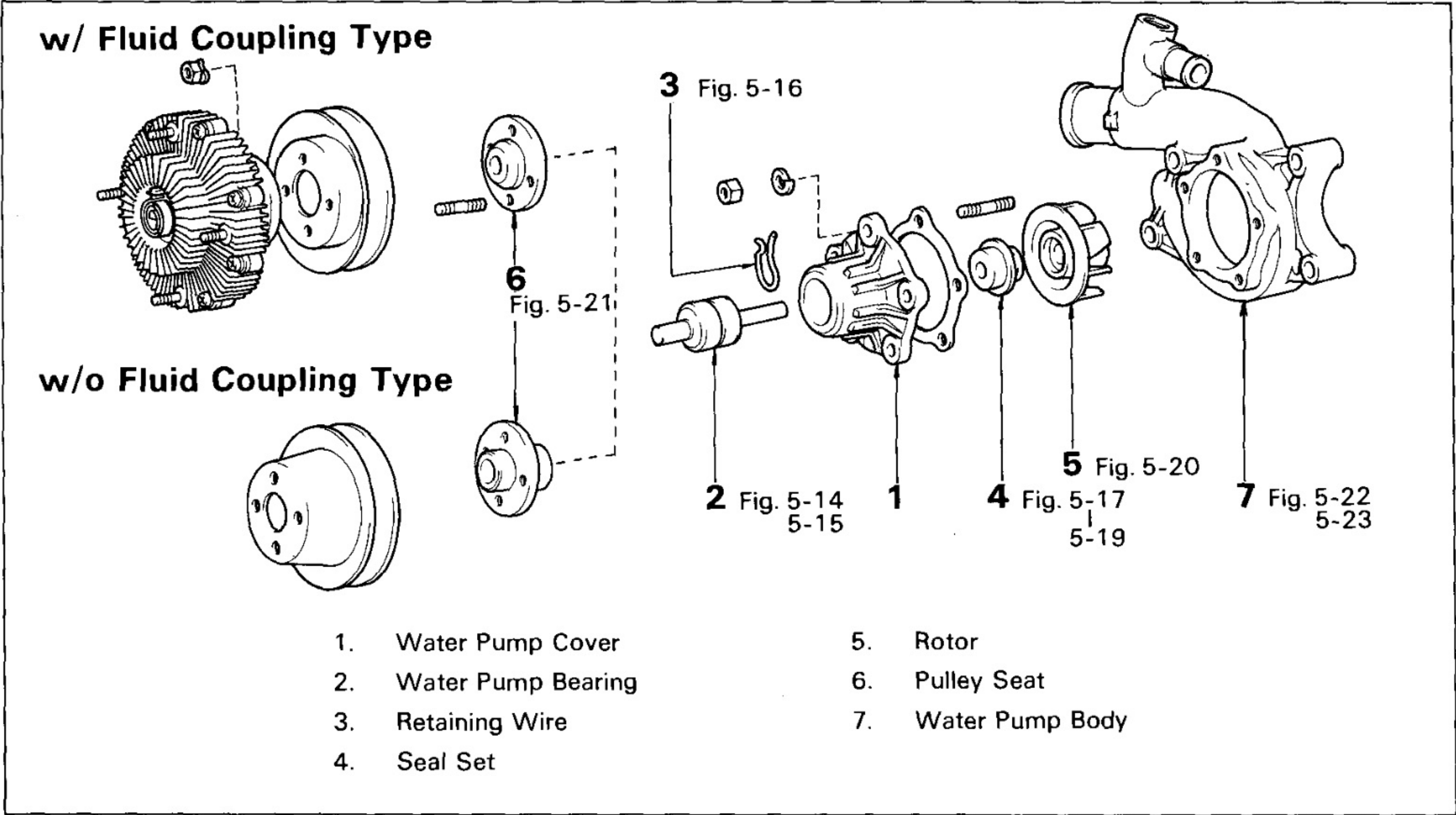
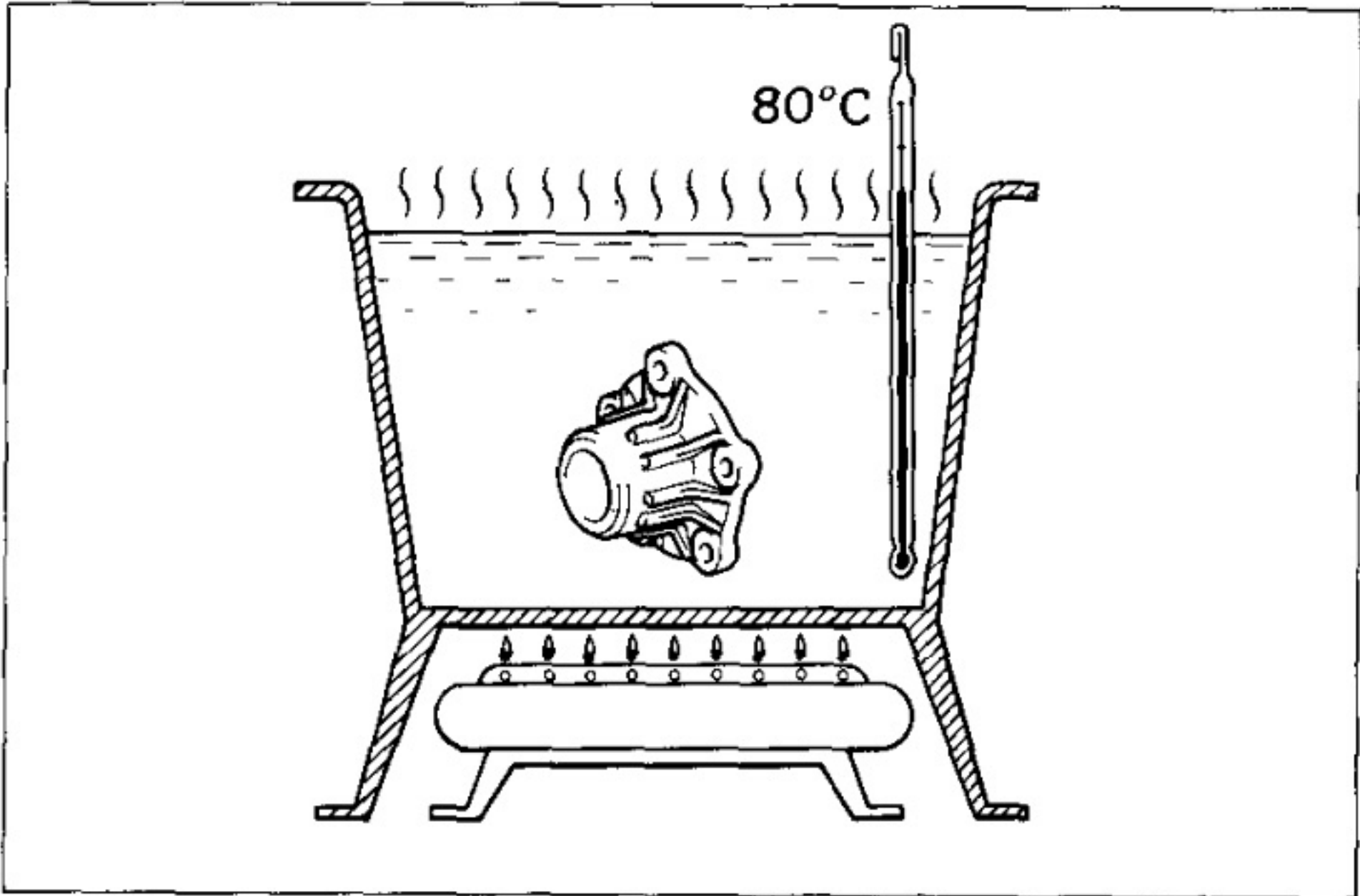
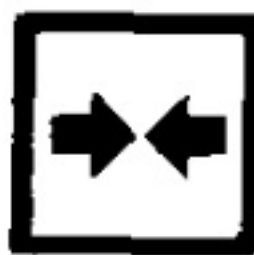
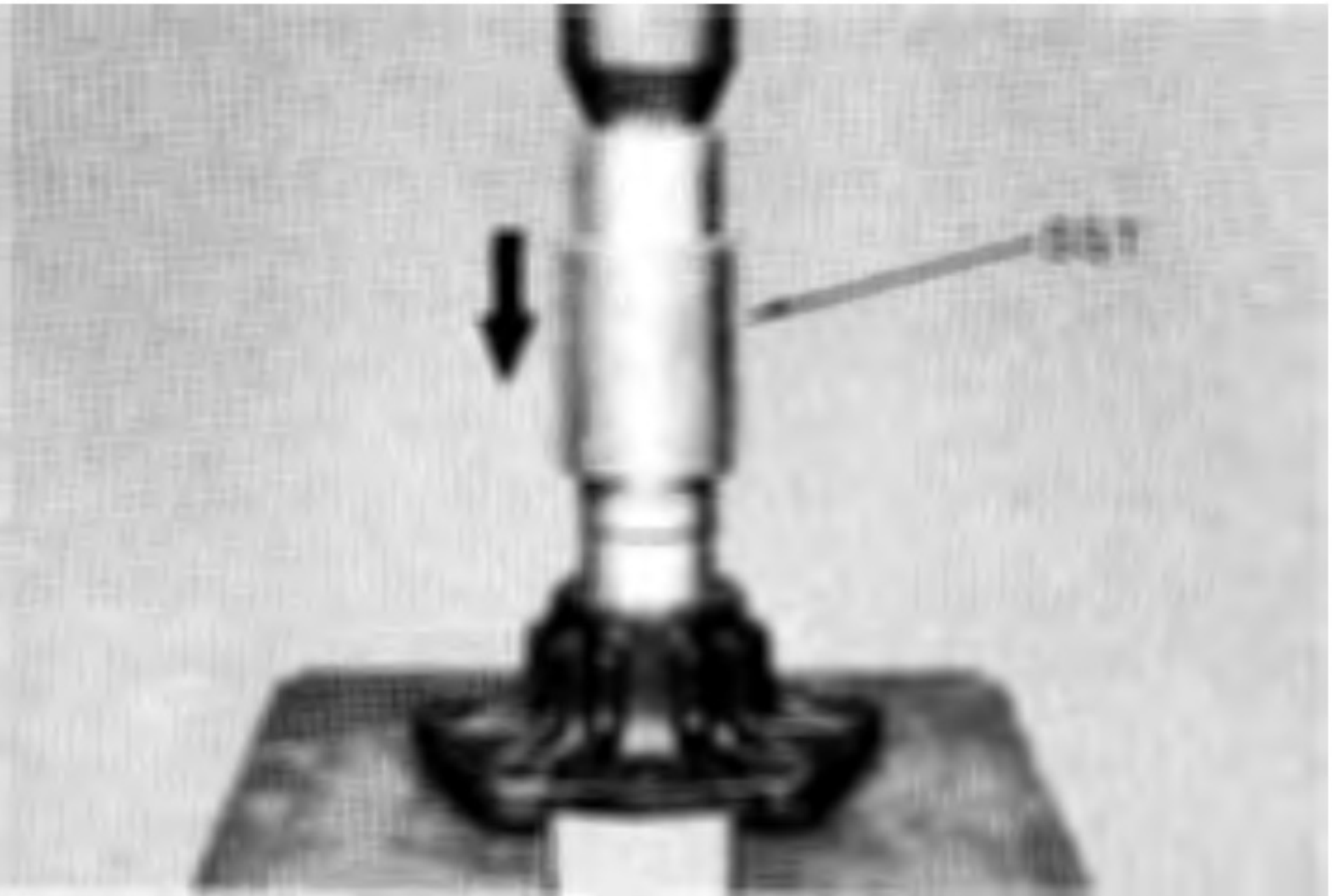


Fig. 5-14



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

Fig. 5-15

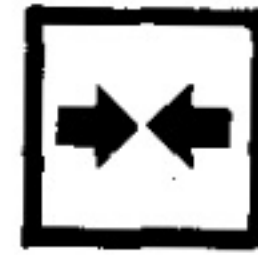
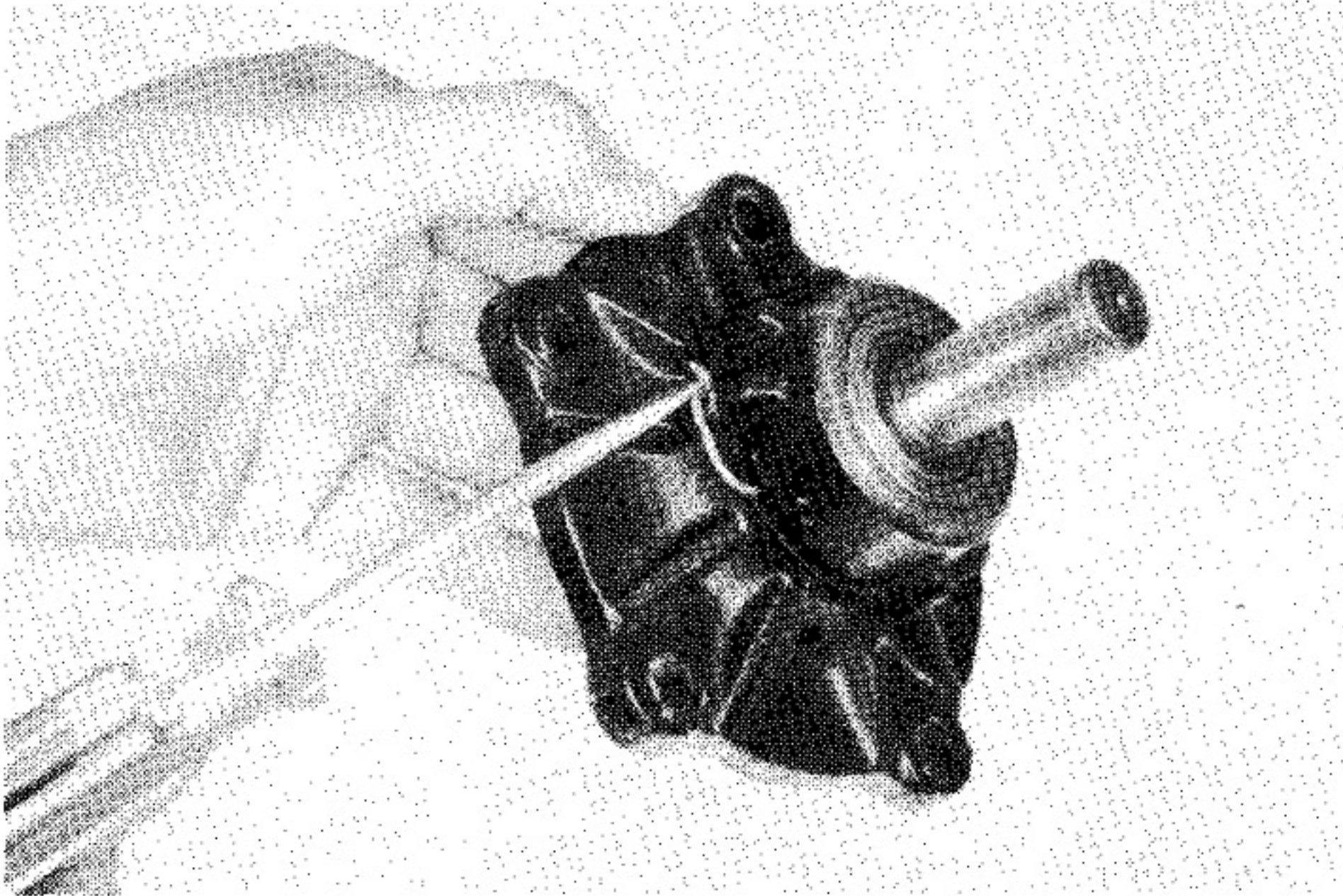


Using SST and a press, press in the water pump bearing until its end surface is flush with the water pump cover.
SST [09238-47010]

—Note—

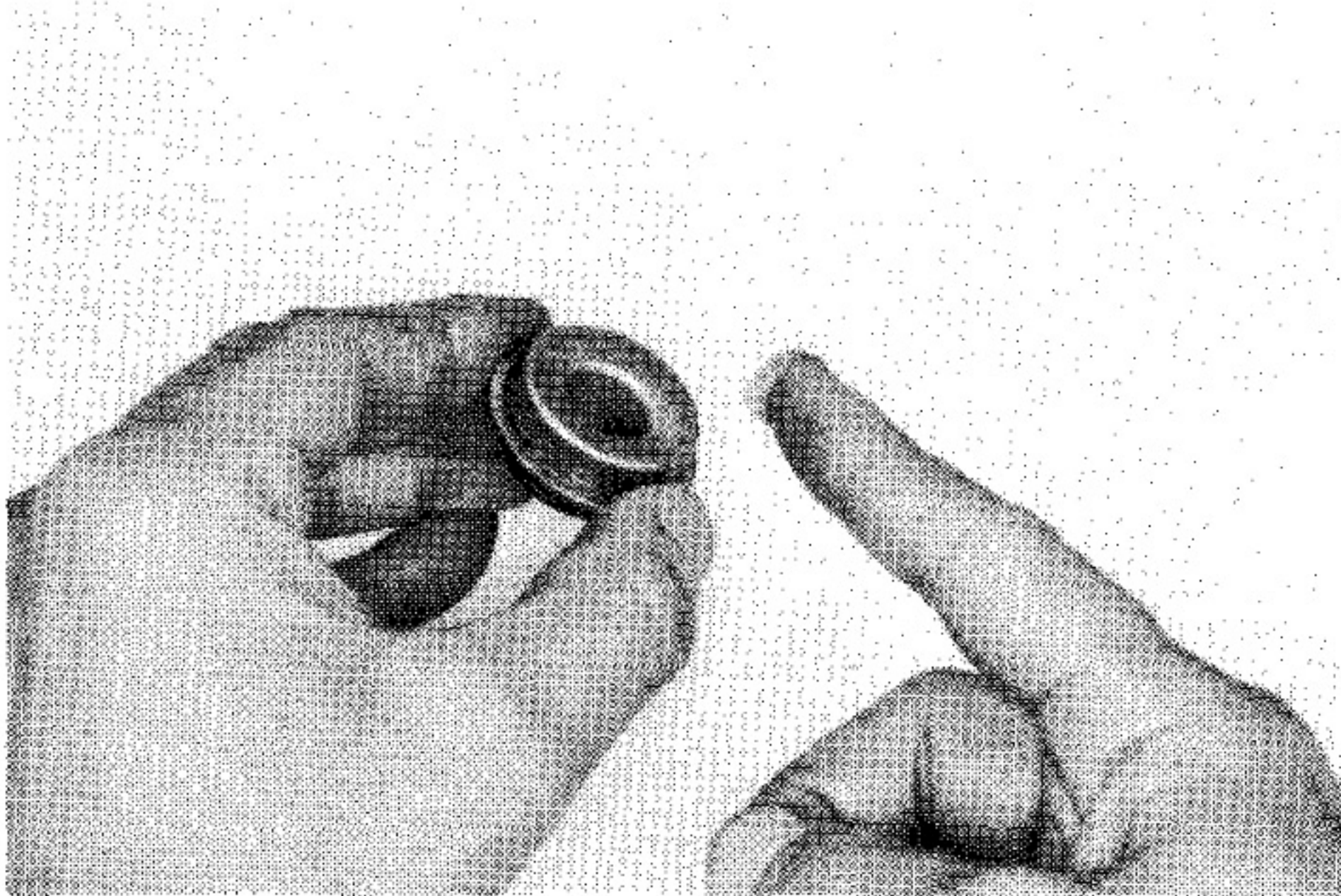
Press in the bearing from the pulley seat side.

Fig. 5-16



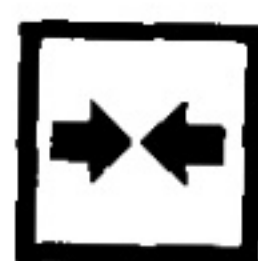
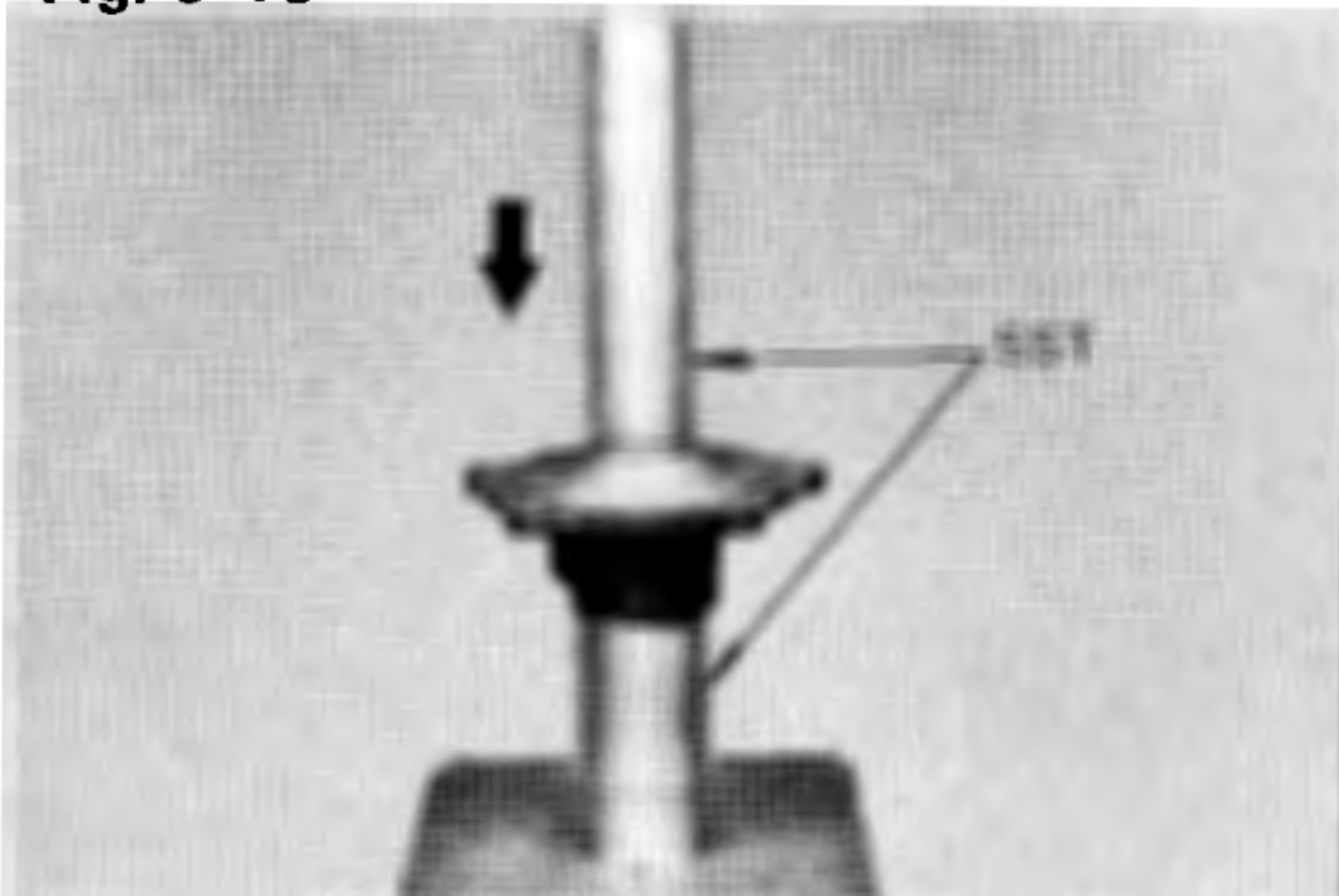
Install the retaining wire to the water pump cover.

Fig. 5-17



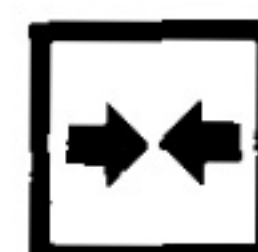
Apply liquid sealer to the seal set surface contacting the water pump cover.

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

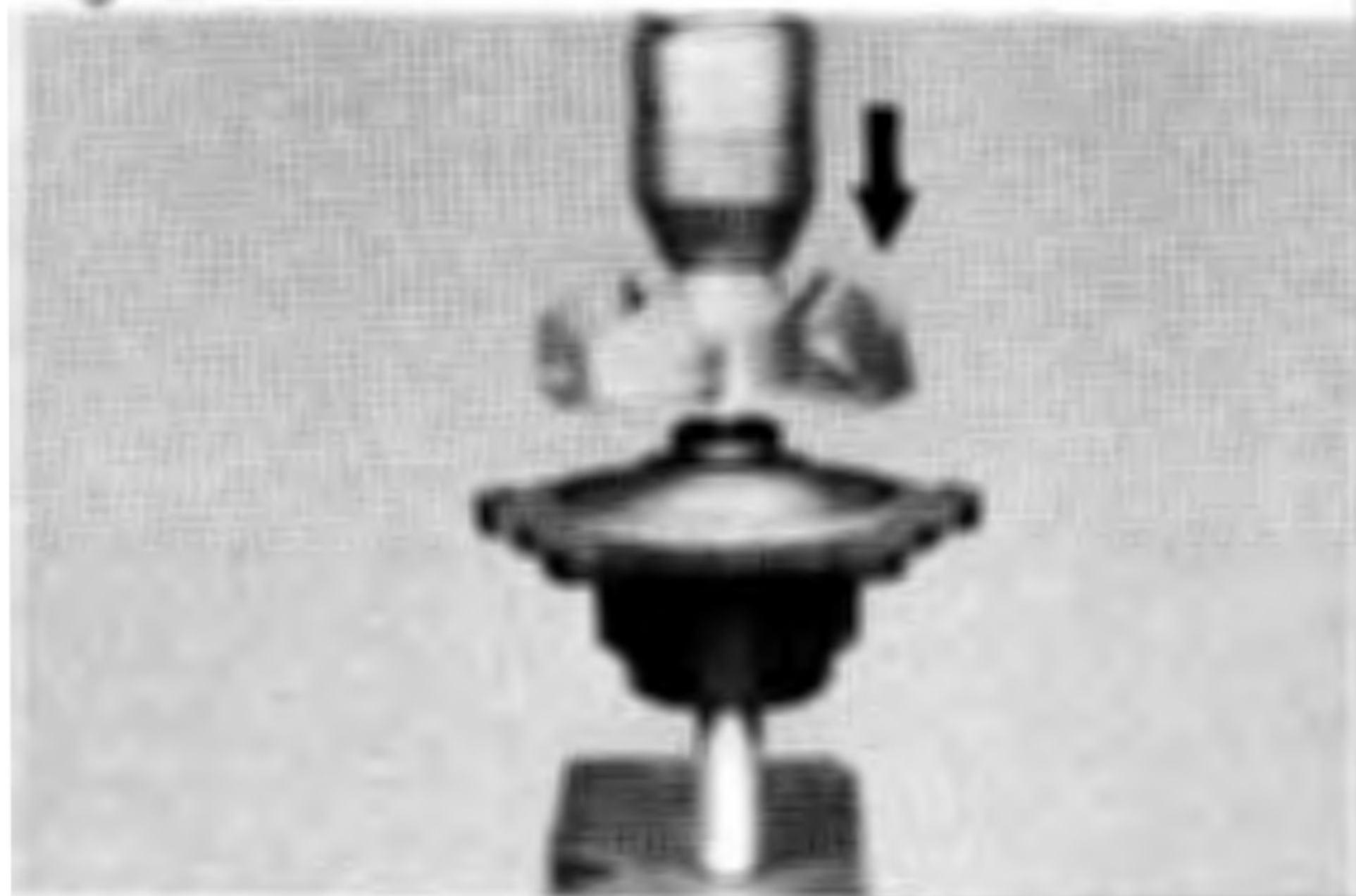


Install the seat and packing into the rotor.

—Note—

Lightly coat the seat with engine oil.

Fig. 5-20



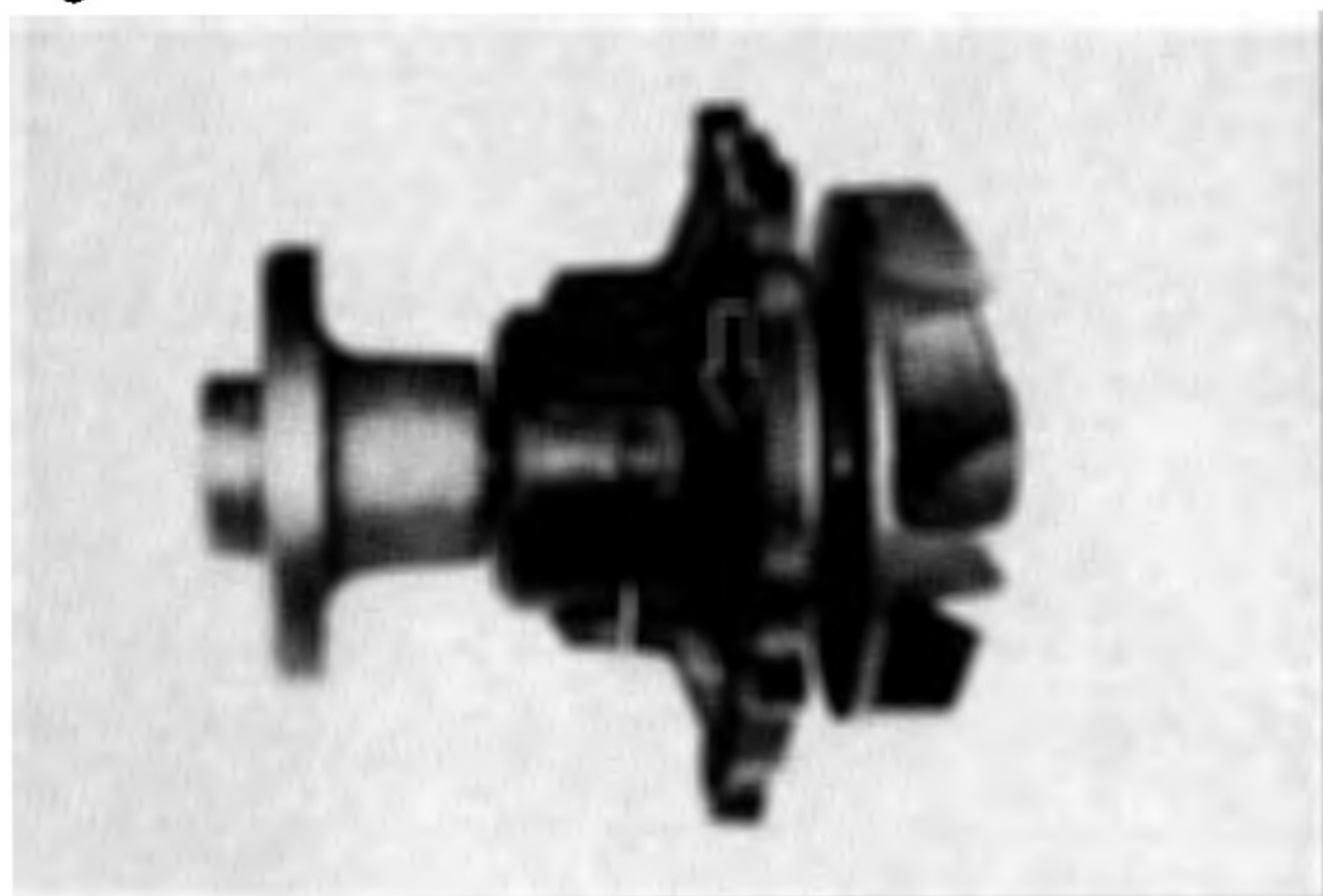
Press in the rotor from the rear side of pump cover until its end surface is flush with the water pump shaft.

Fig. 5-21



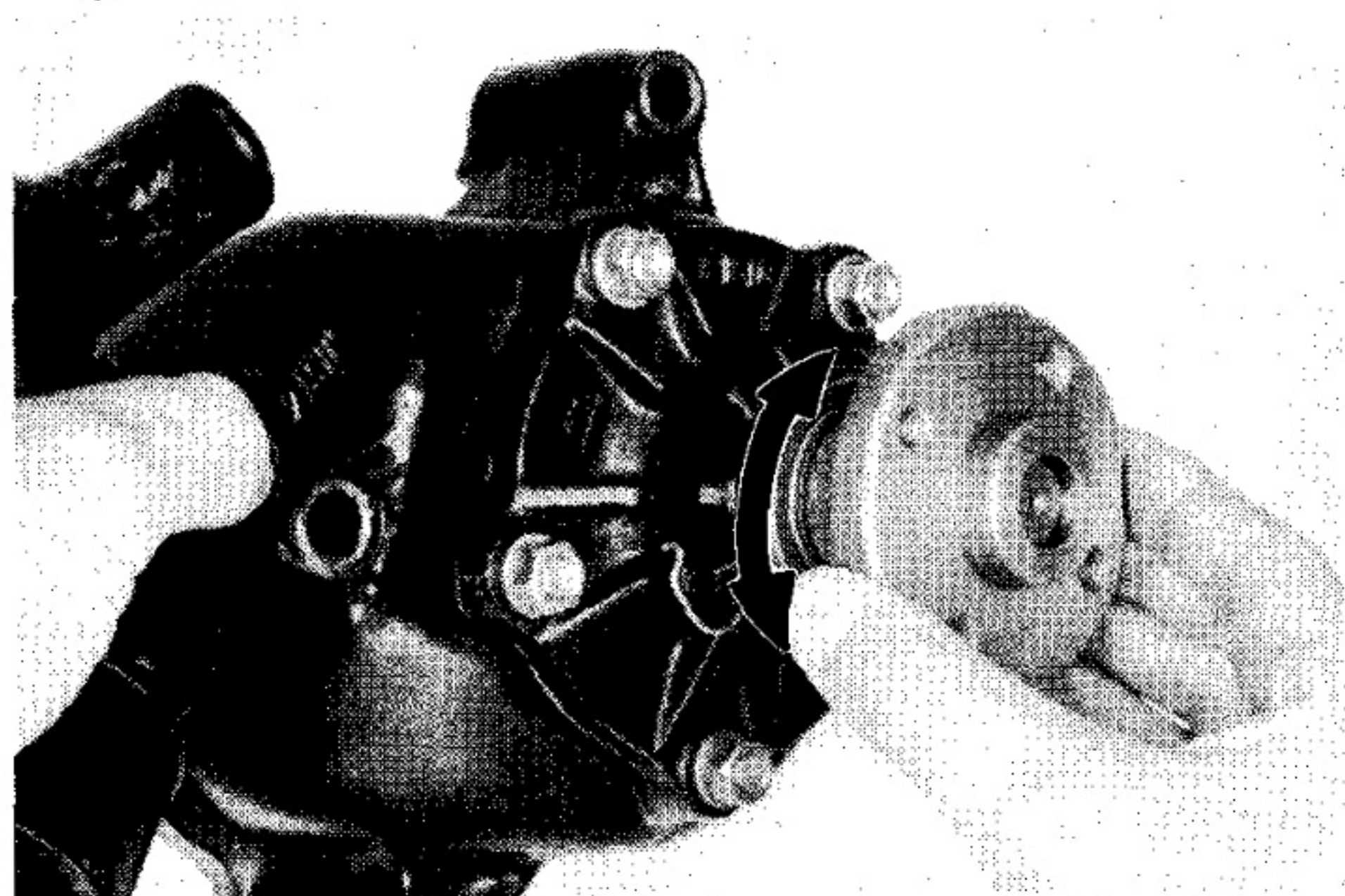
Press in the pulley seat until it touches the bearing inner race.

Fig. 5-22



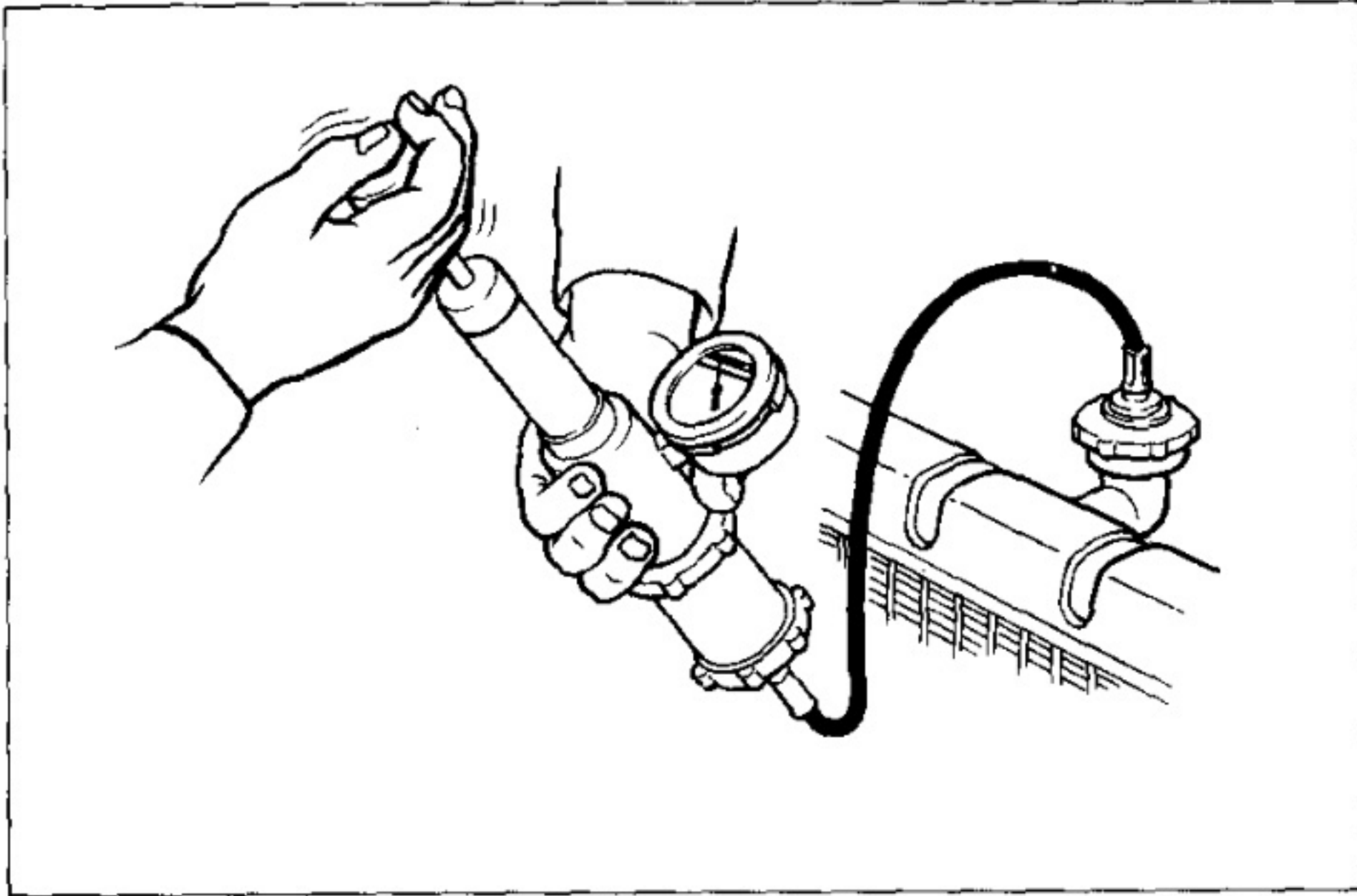
Assemble the water pump cover and body facing the cover drain hole downward.

Fig. 5-23



After assembling, make sure that the rotor rotates smoothly.

Fig. 5-24

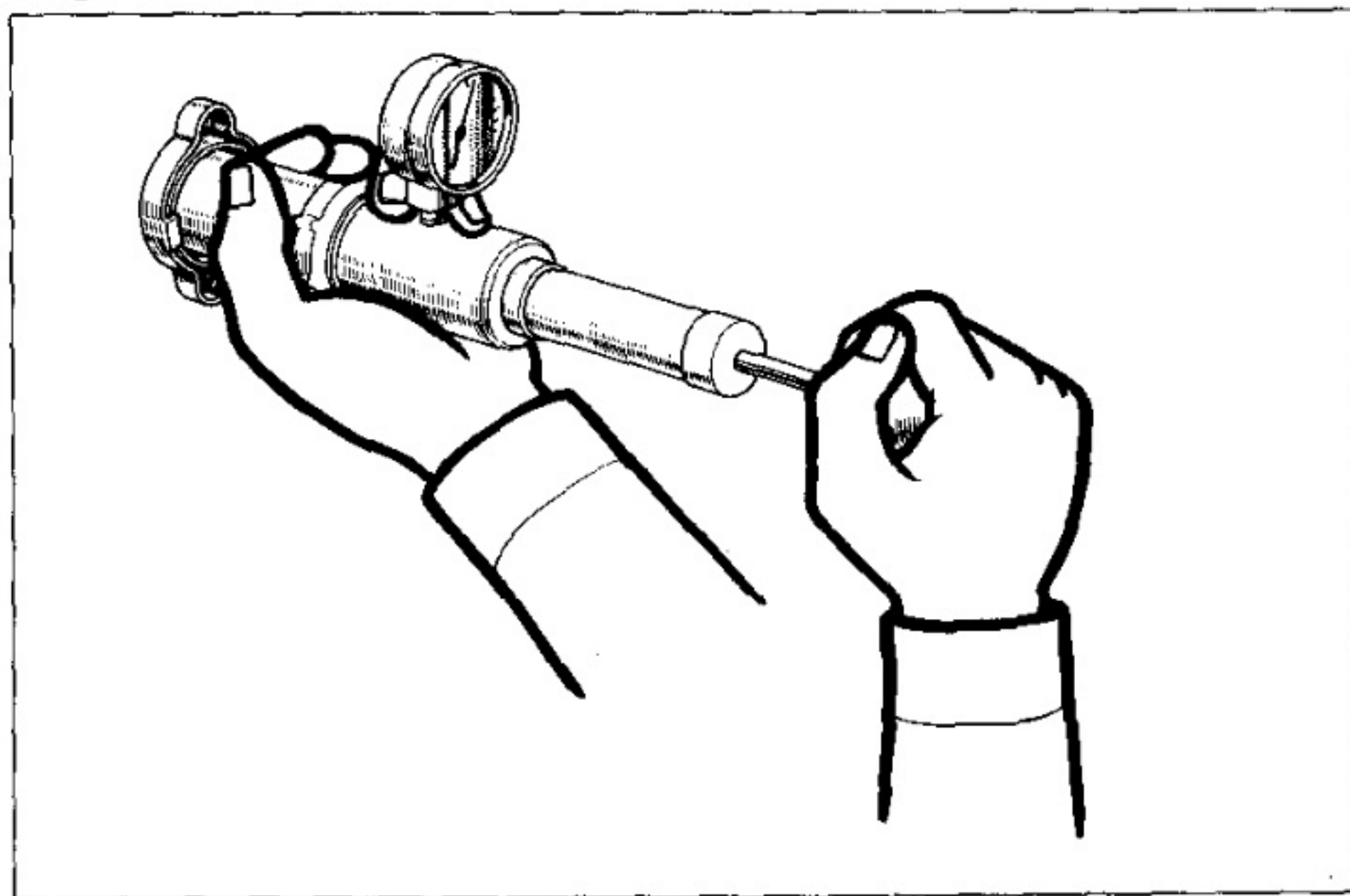


RADIATOR INSPECTION

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.

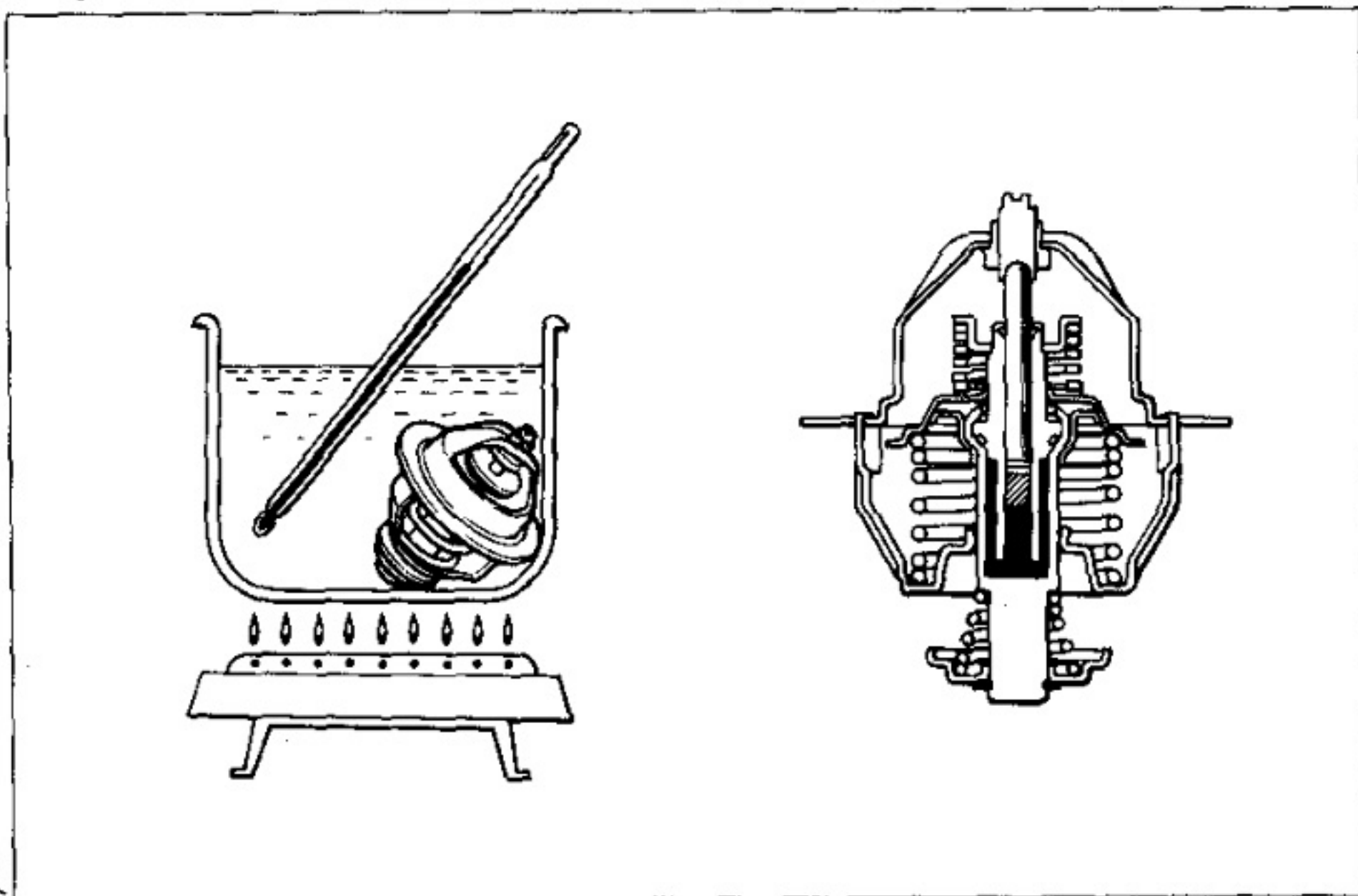
Valve opening pressure:

**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.

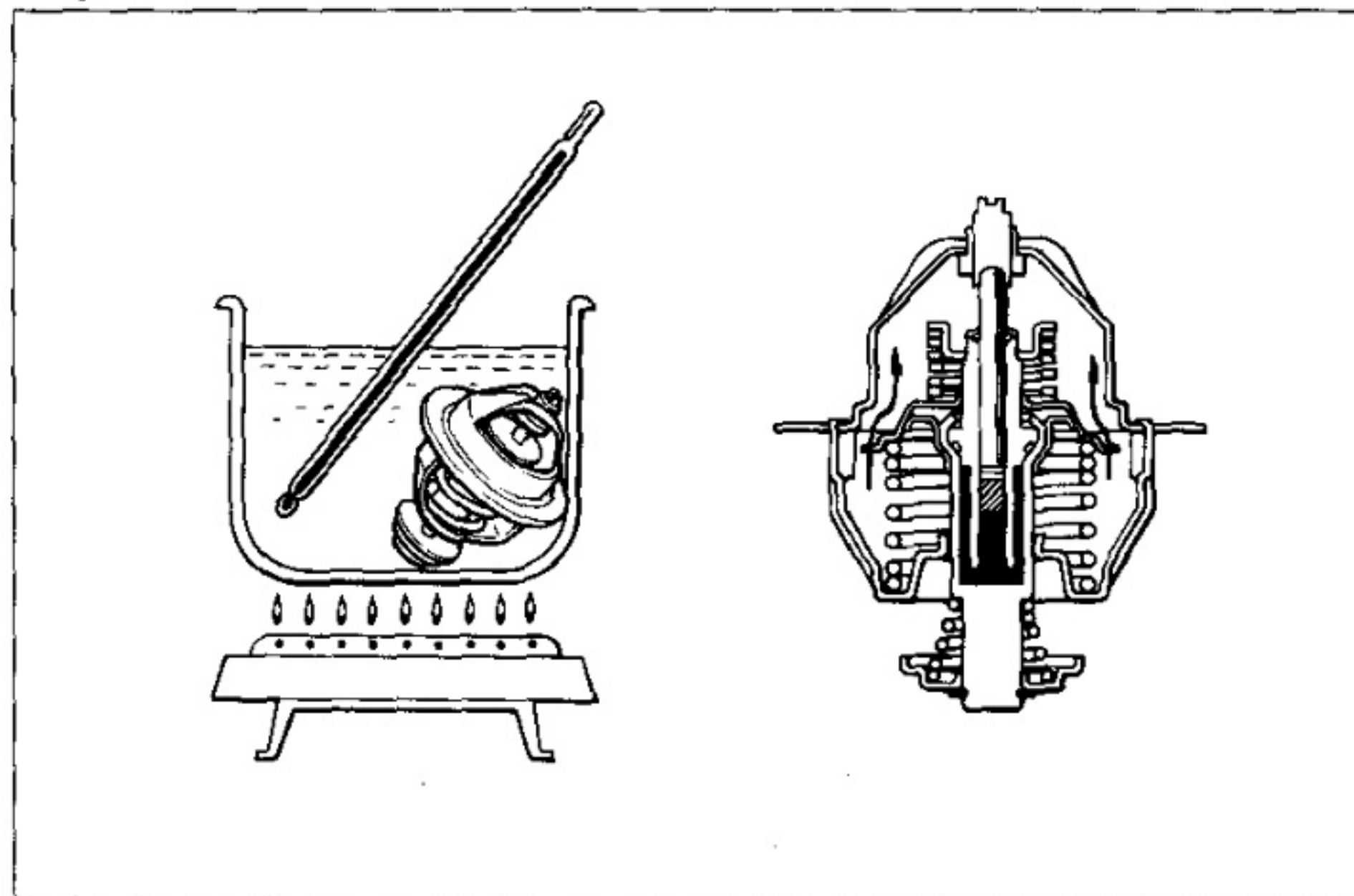
Fig. 5-26



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)

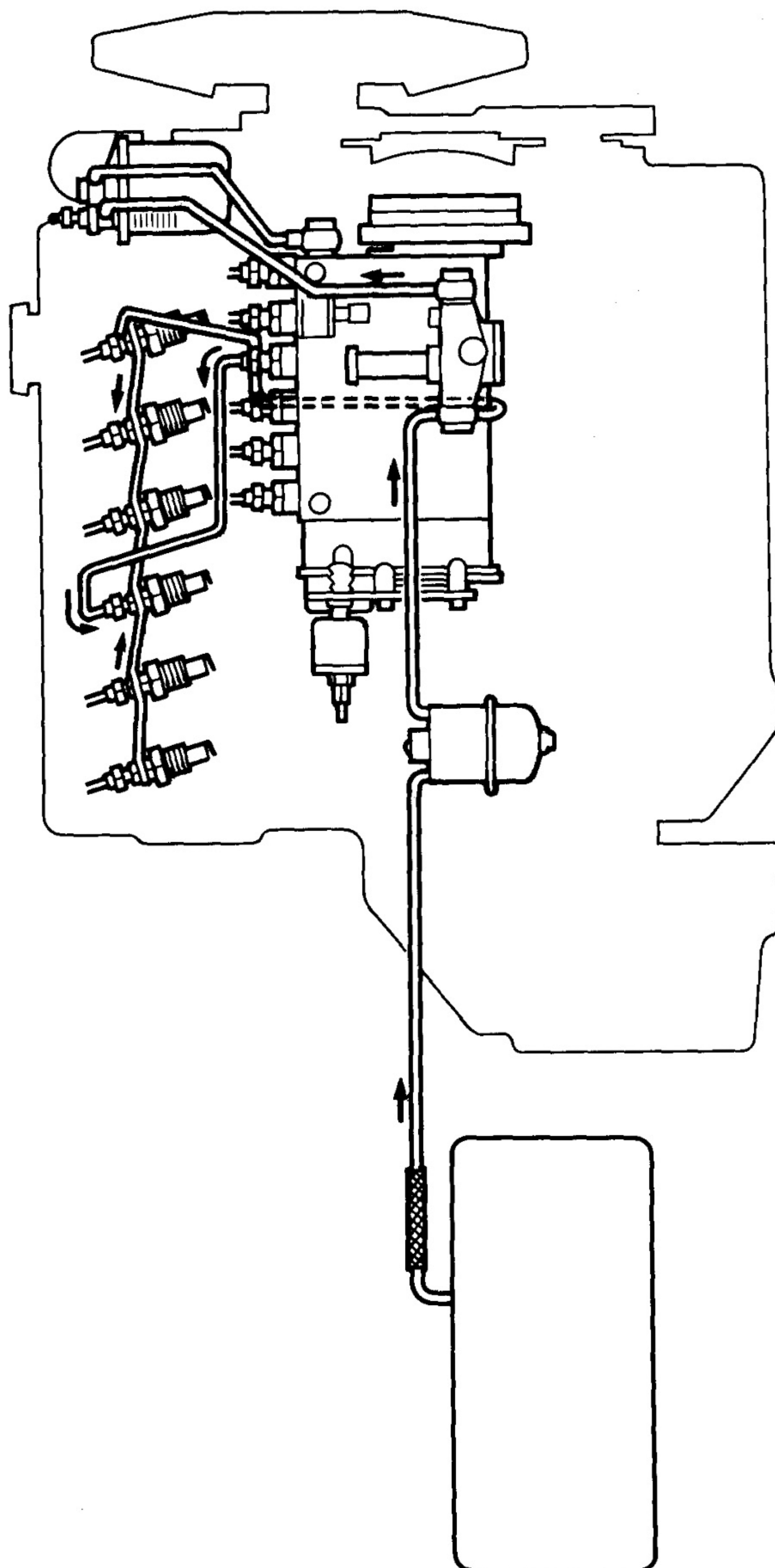
Valve opens by more than 10 mm (0.39 in.) at 100°C (212°F)

FUEL SYSTEM

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FUEL 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

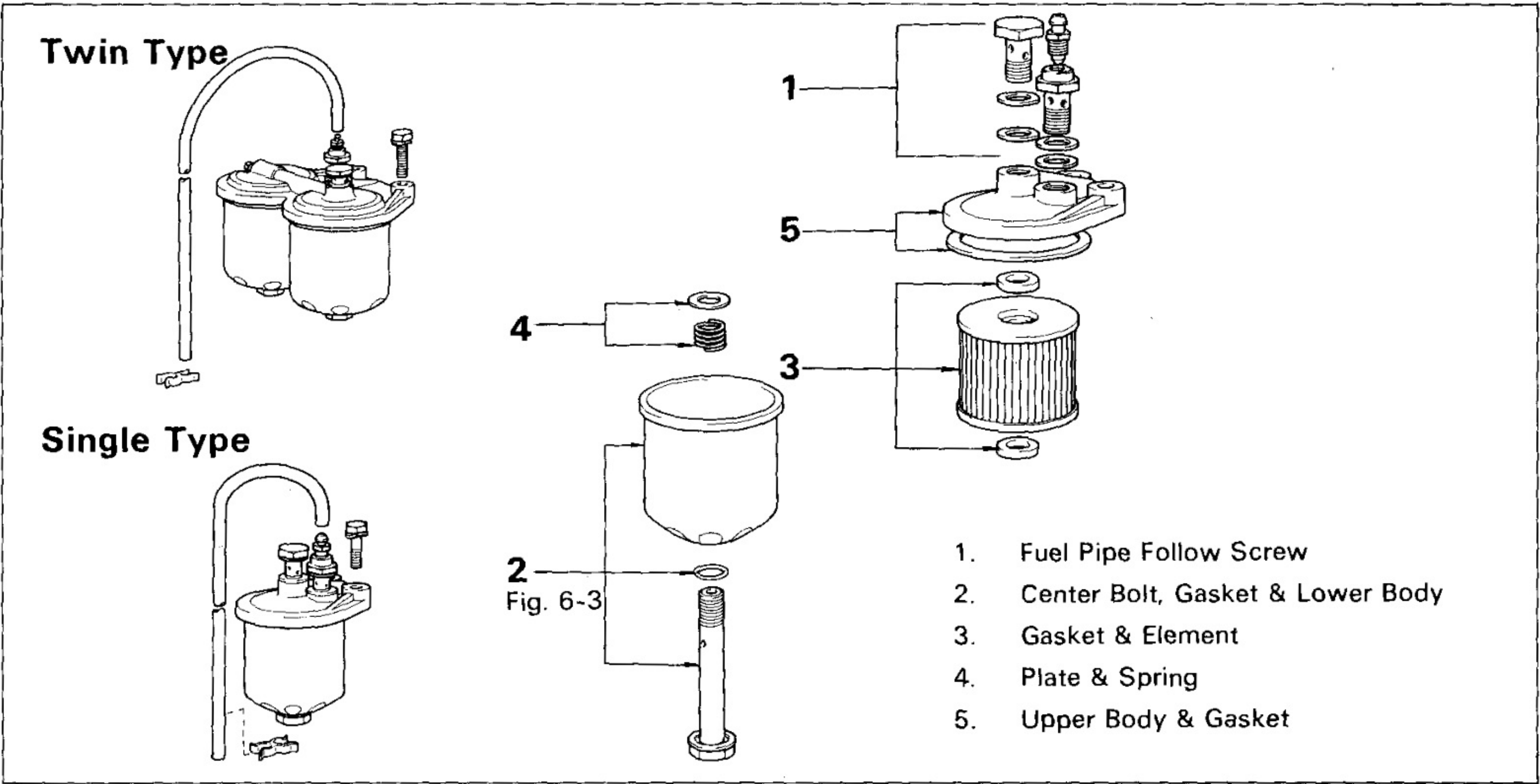
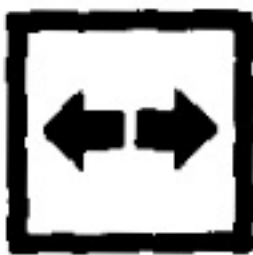
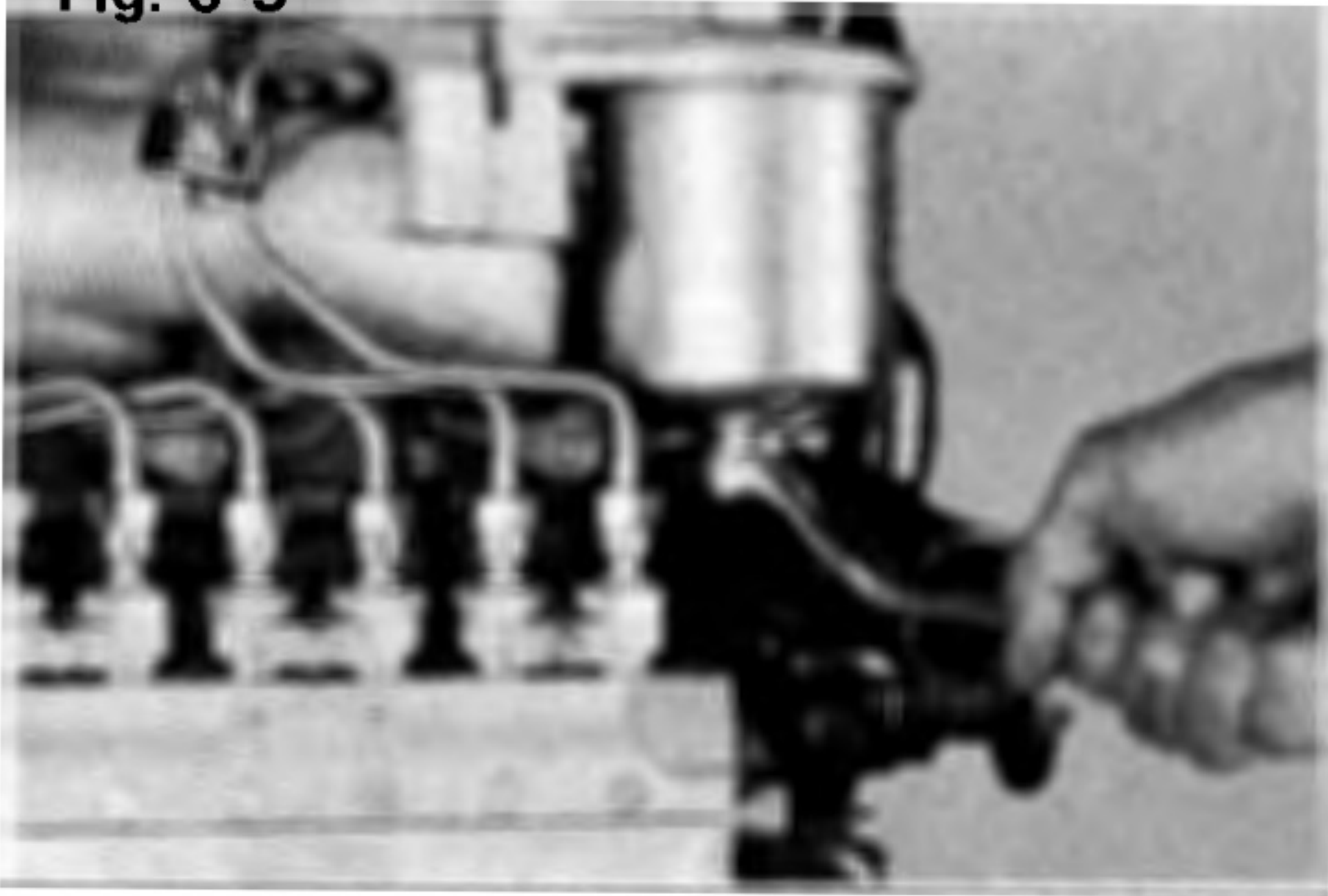
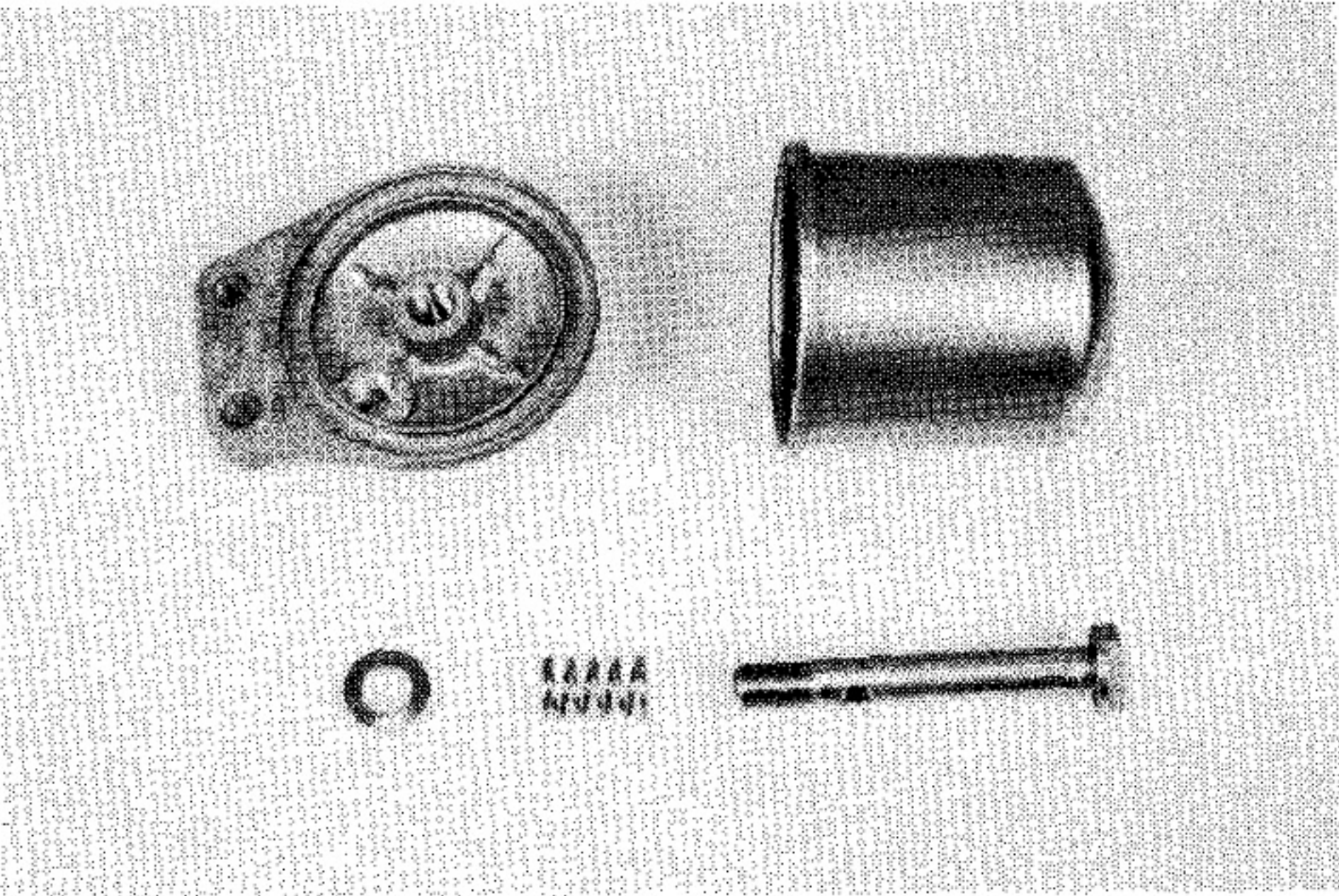


Fig. 6-3



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

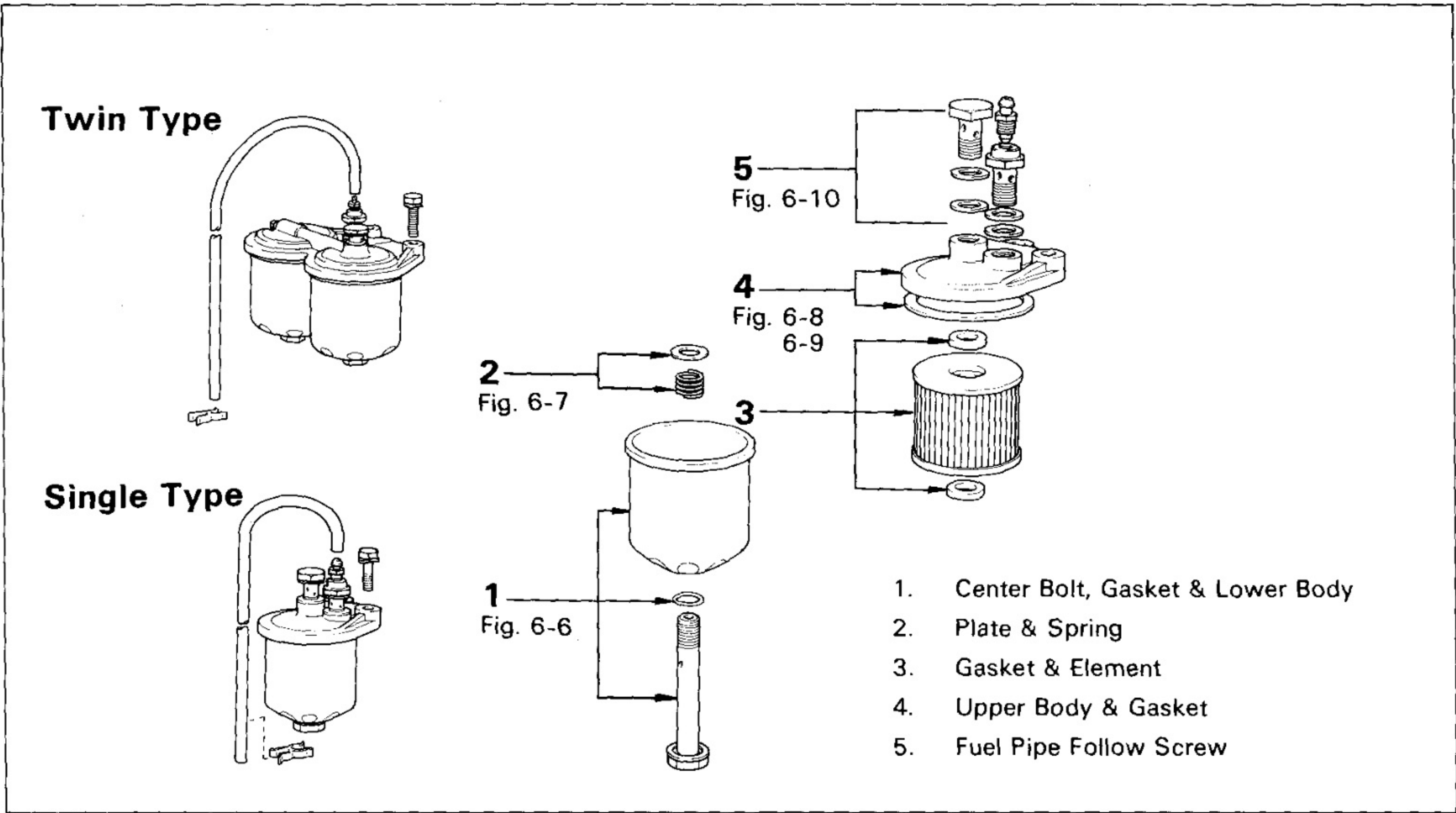
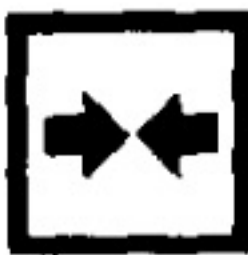
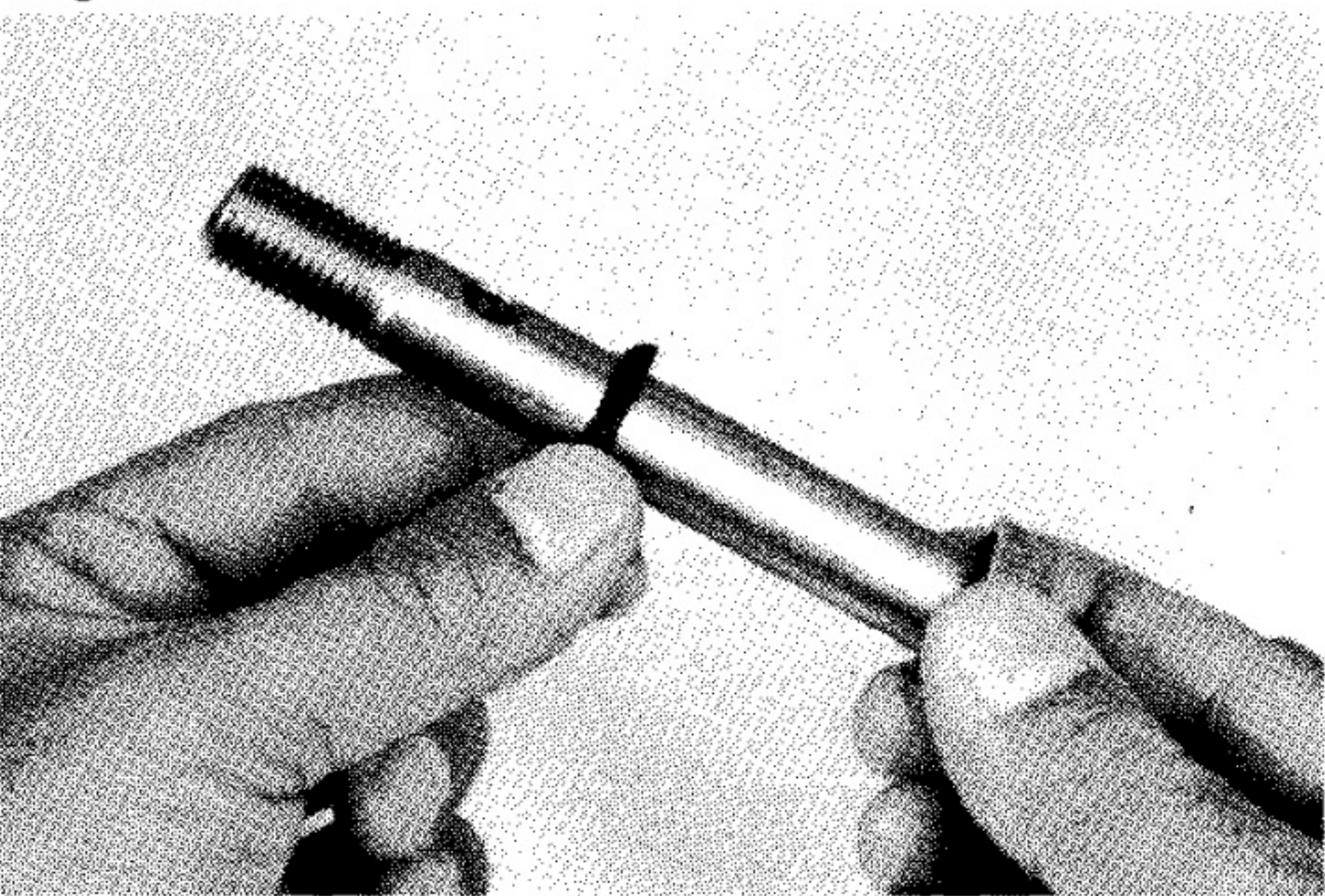


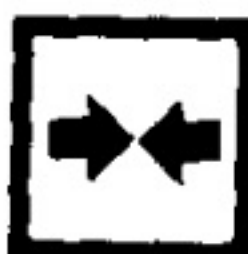
Fig. 6-6



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

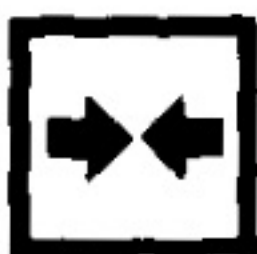
— Note —
Use a new gasket.

Fig. 6-7



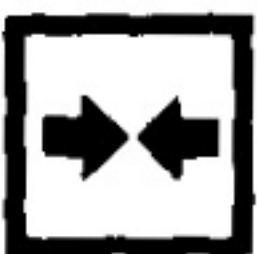
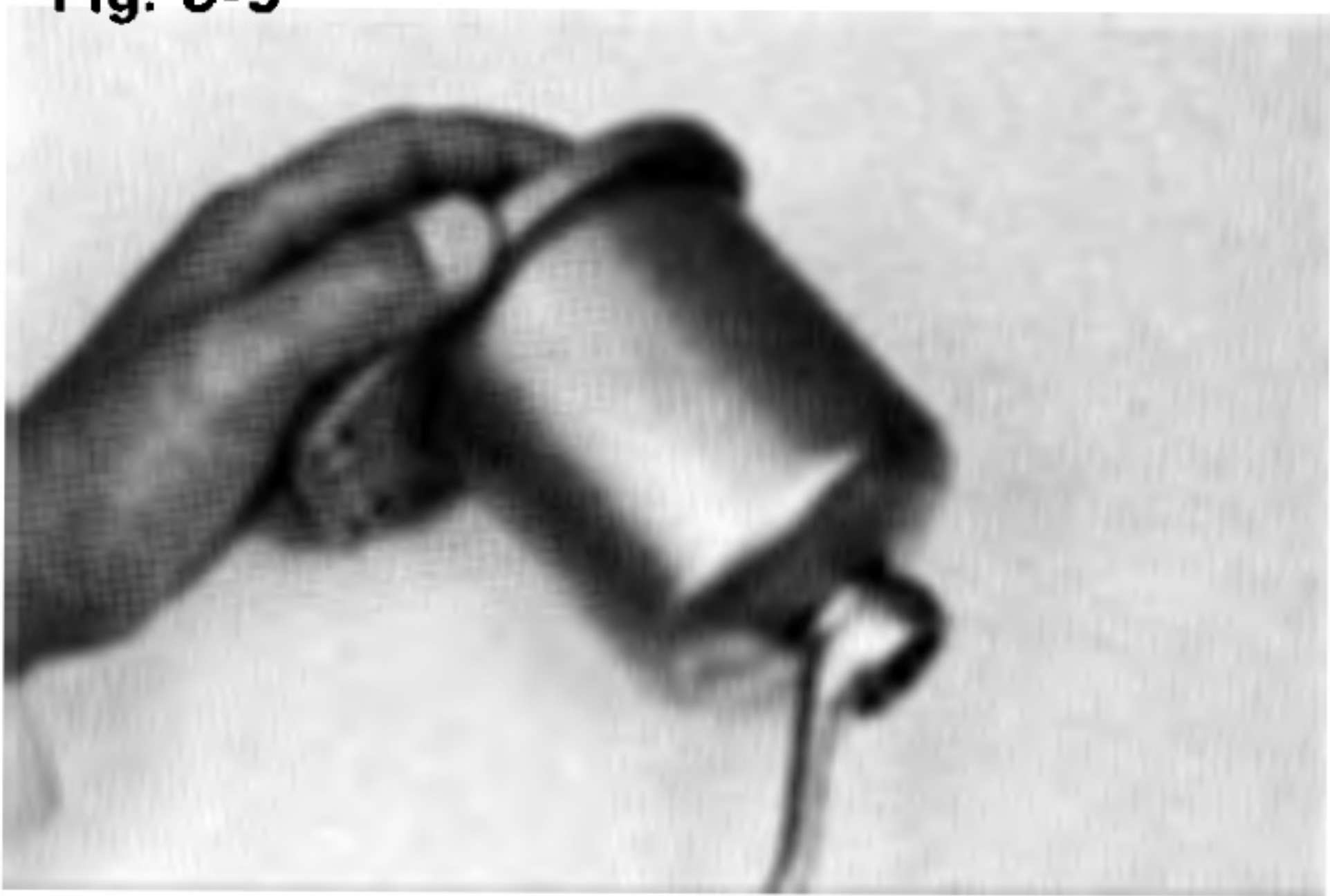
Install the spring and plate to the lower body.

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

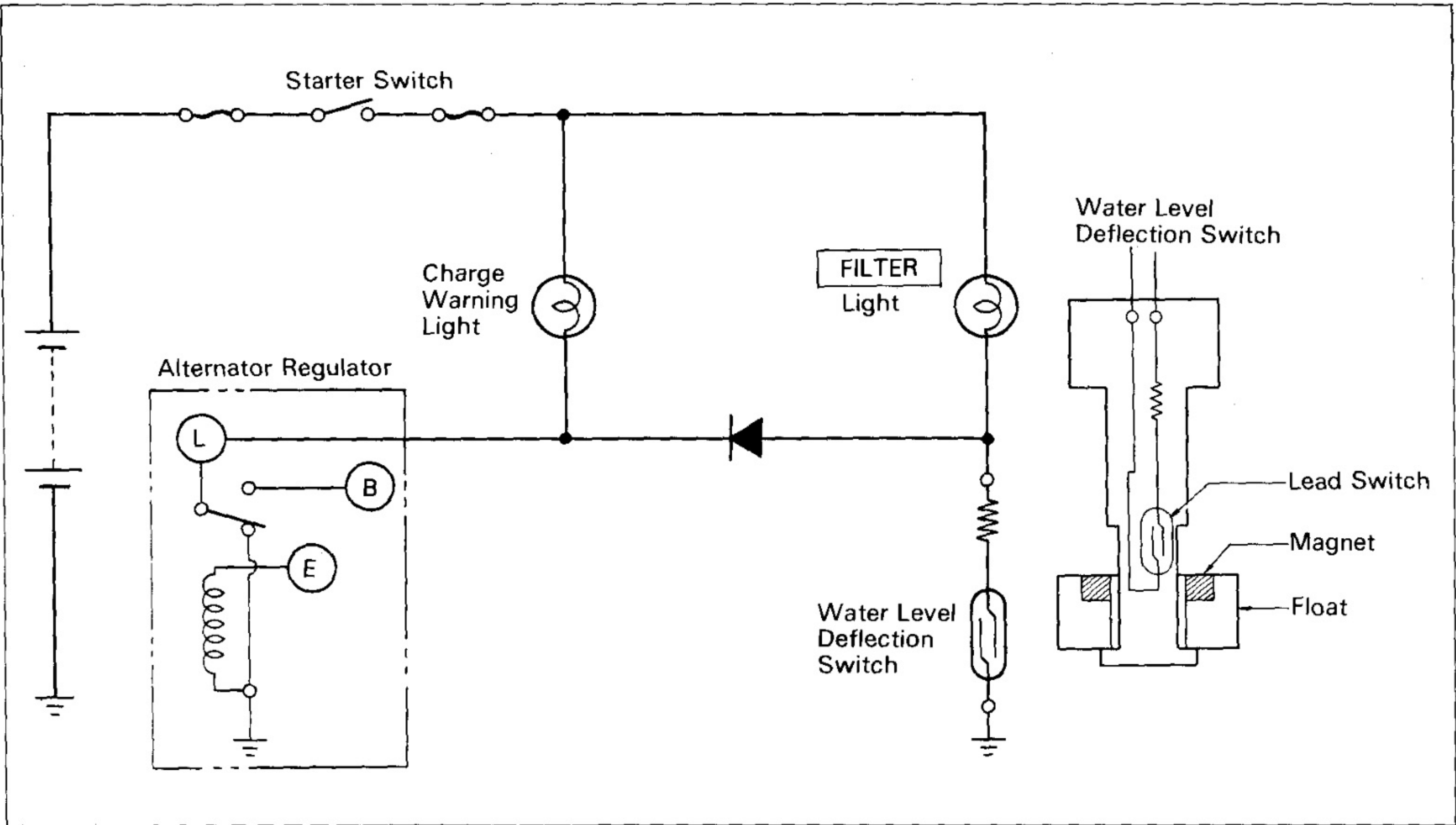
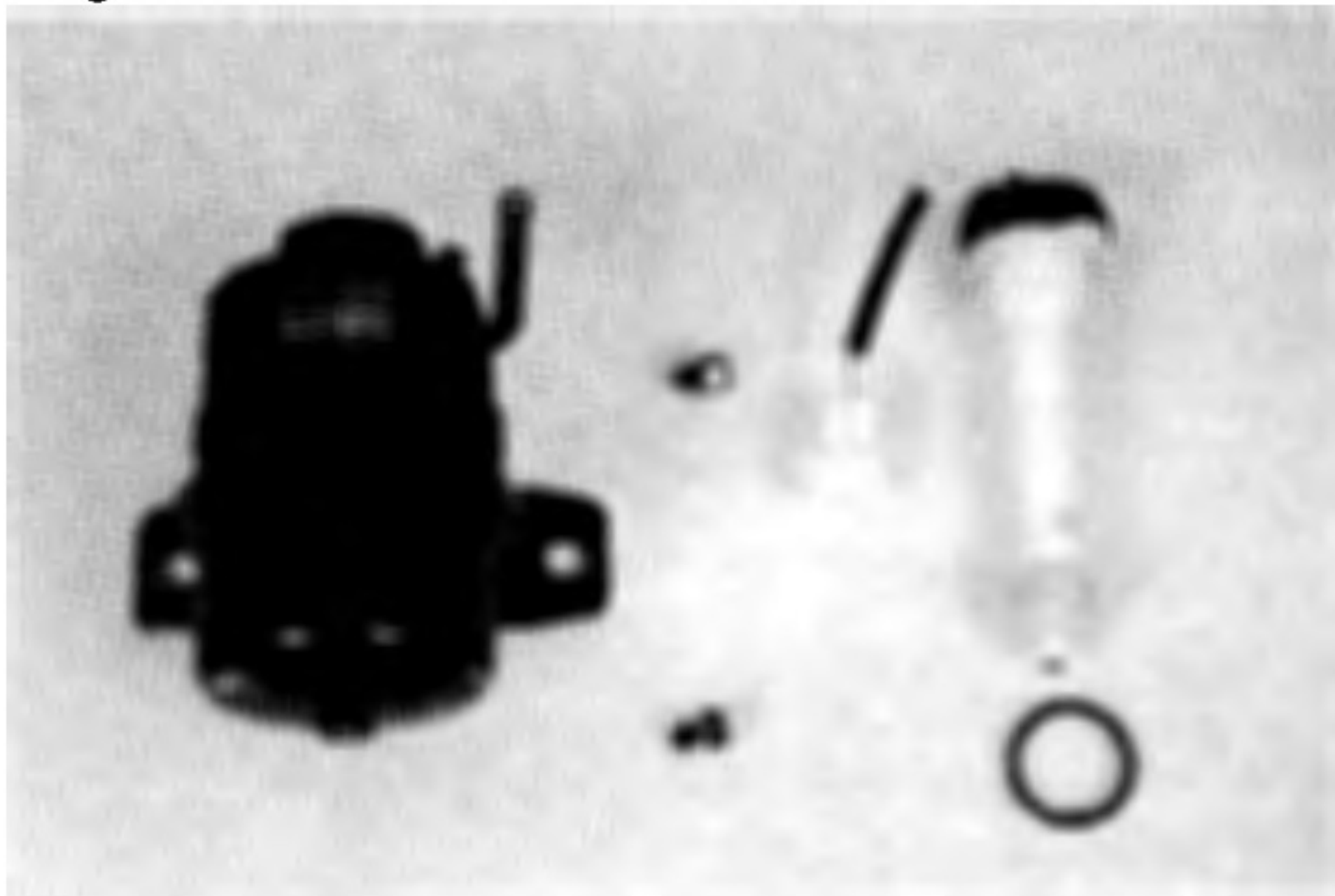


Fig. 6-12



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 conductivity when the float is raised.

INJECTION NOZZLE

REMOVAL

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

Fig. 6-14

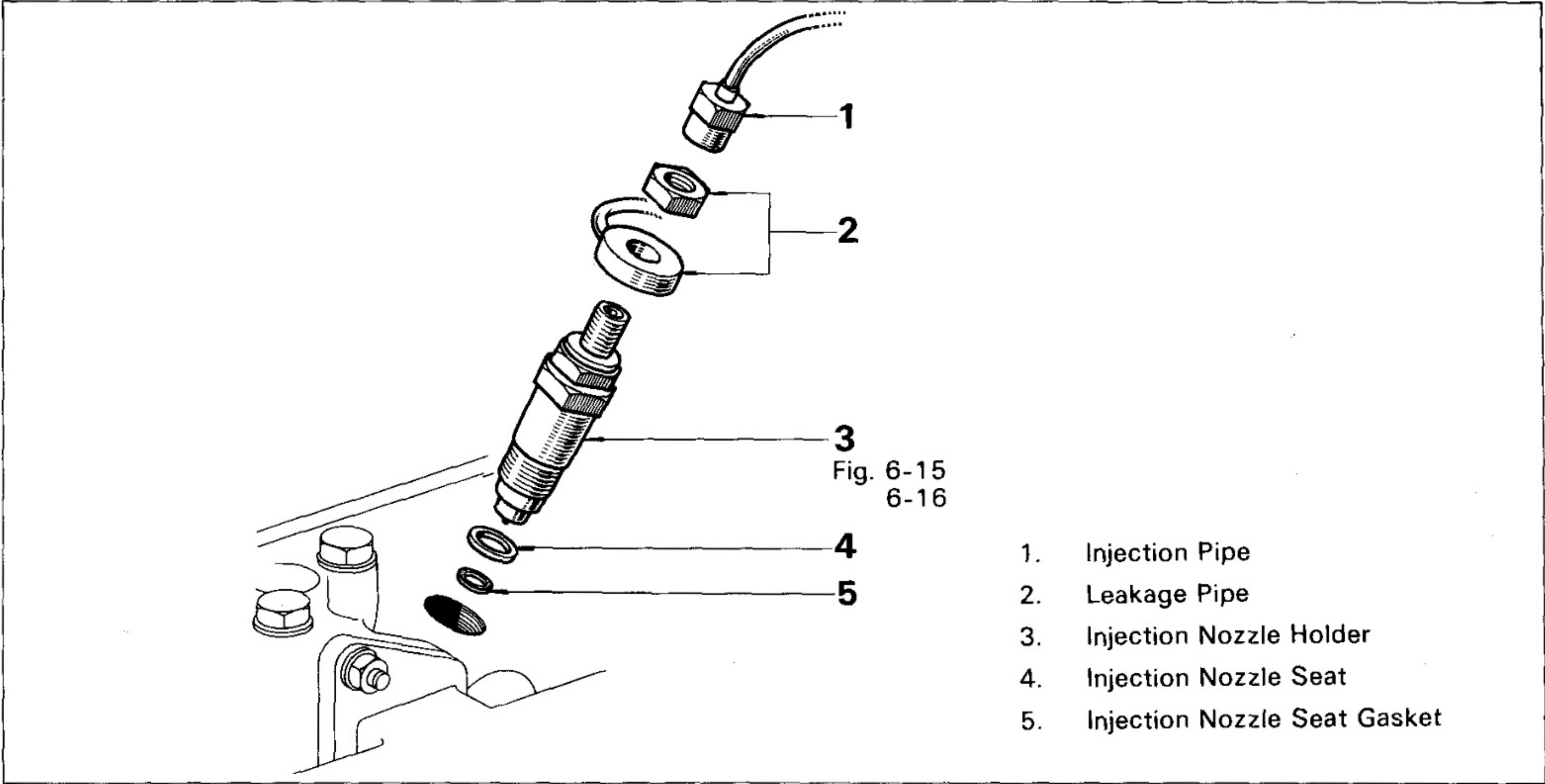
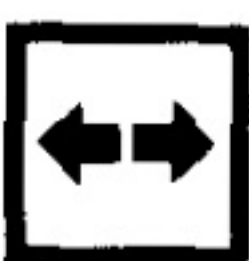
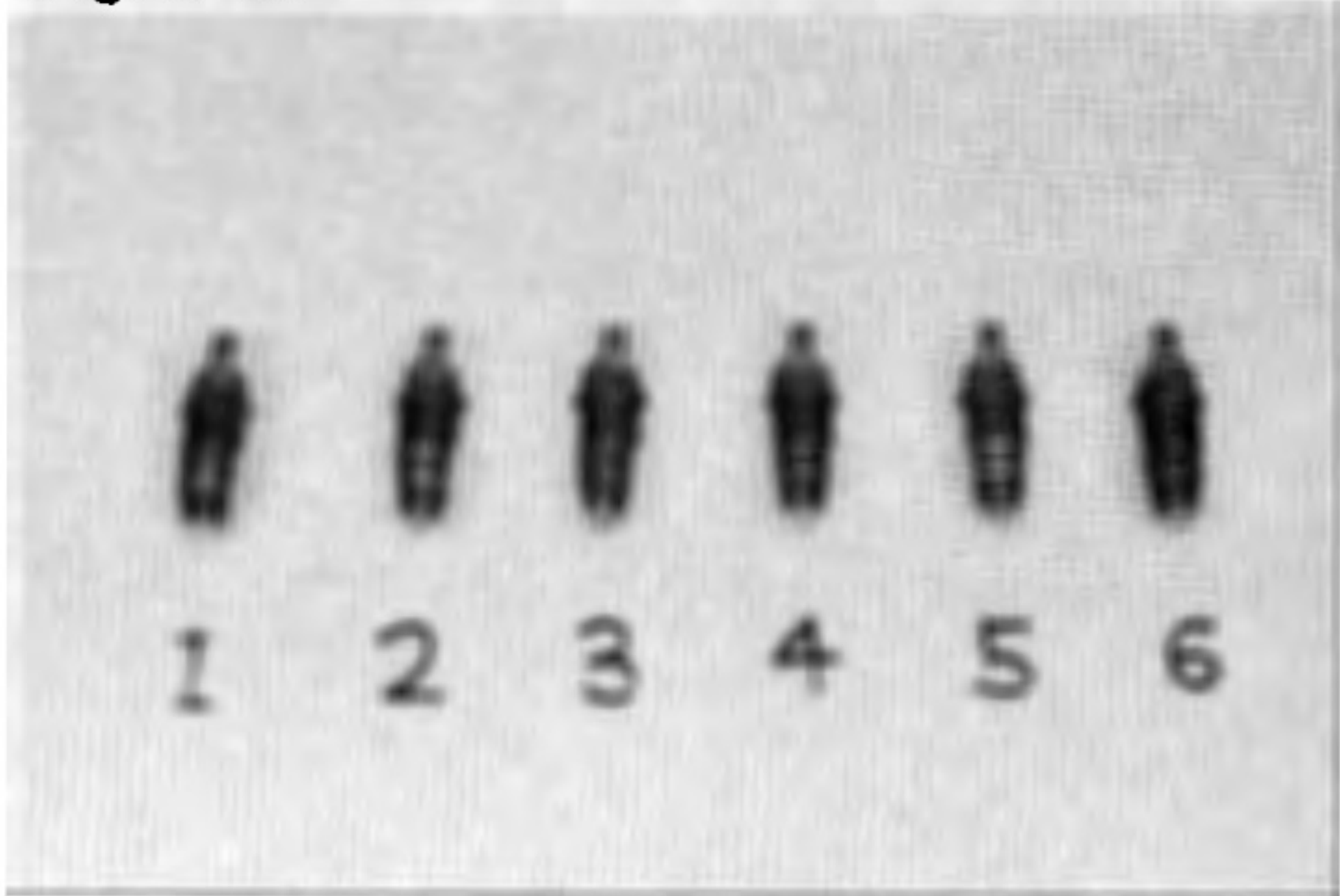


Fig. 6-15



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

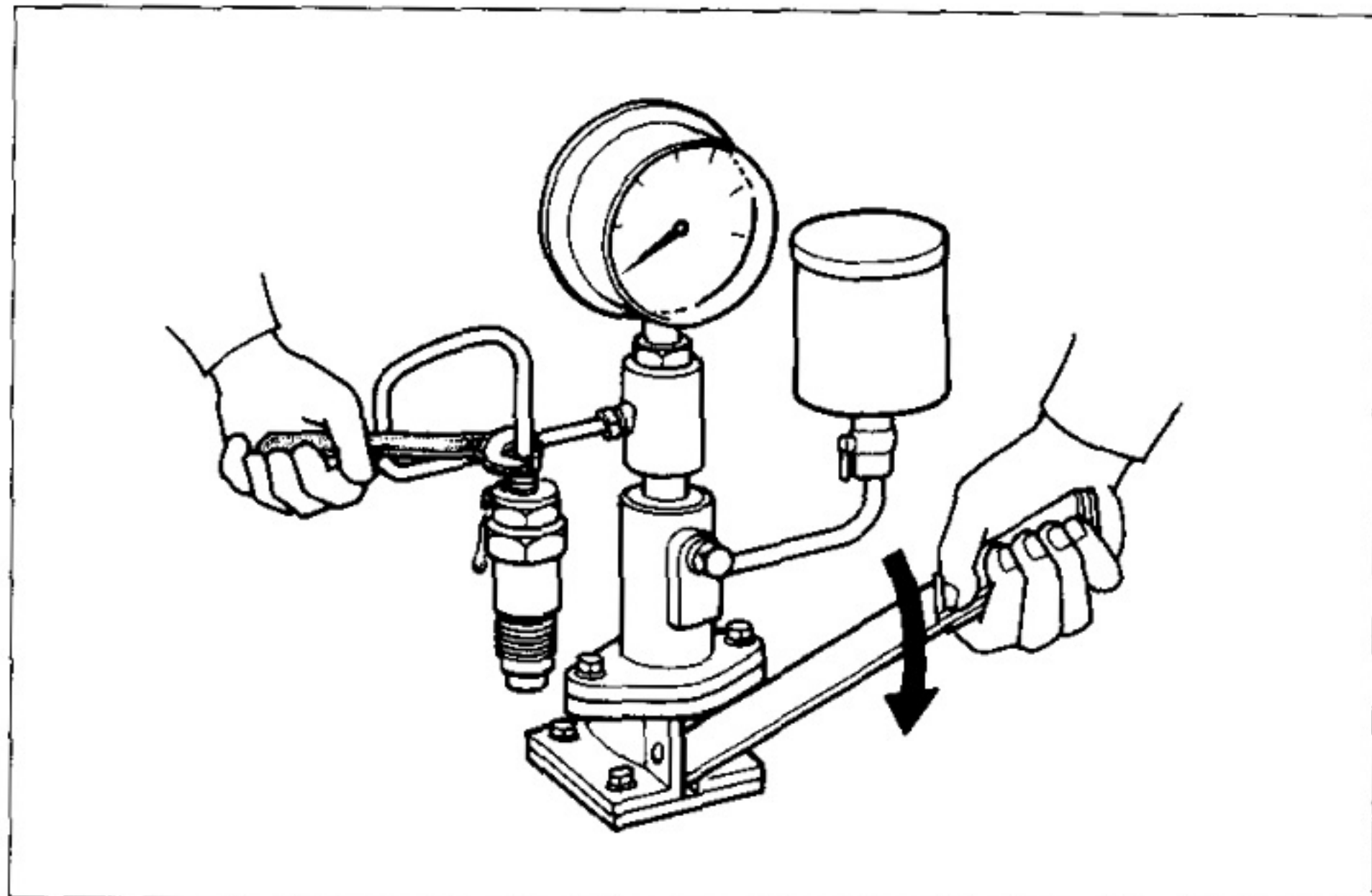


Fig. 6-18

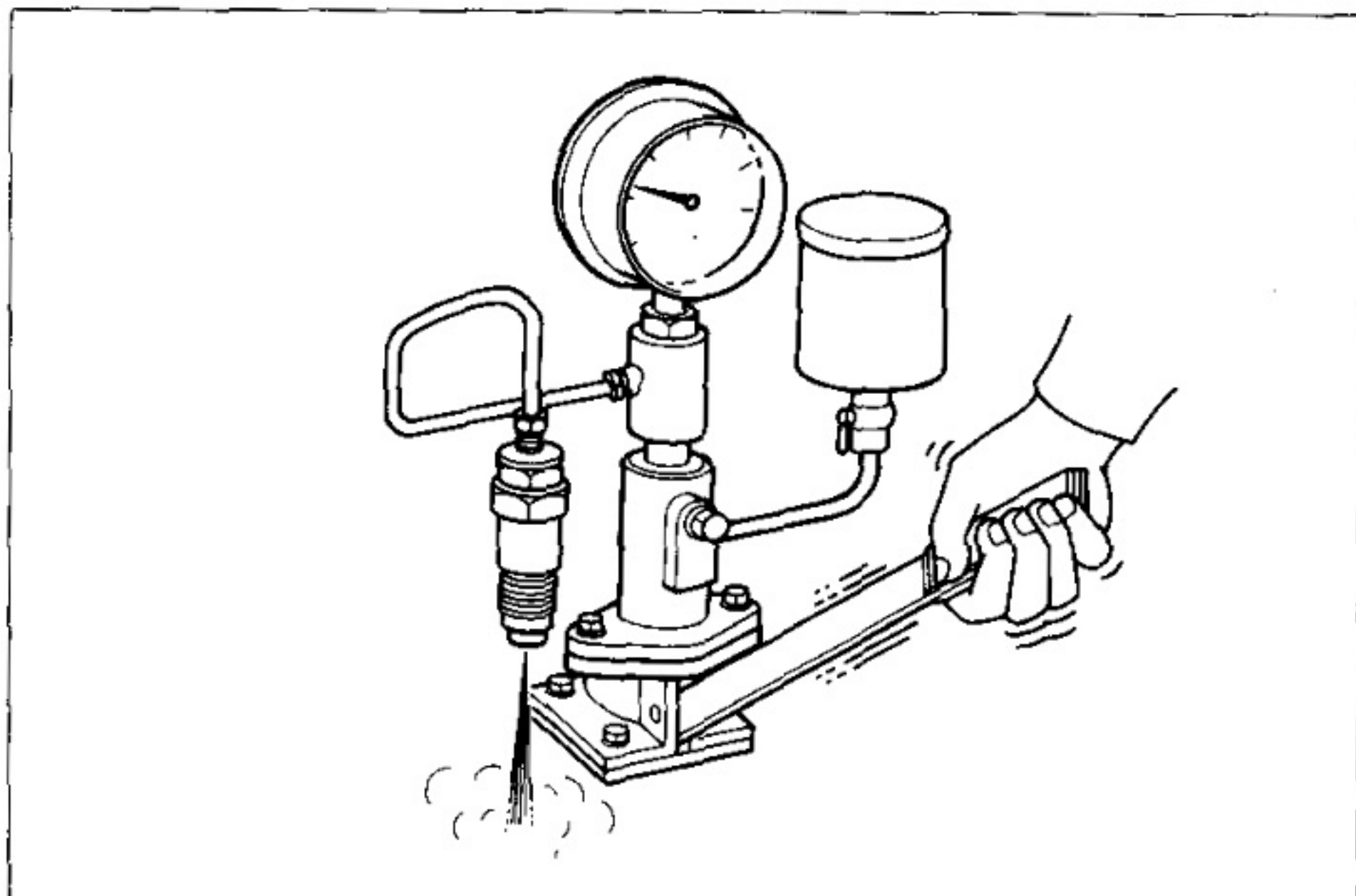


Fig. 6-19

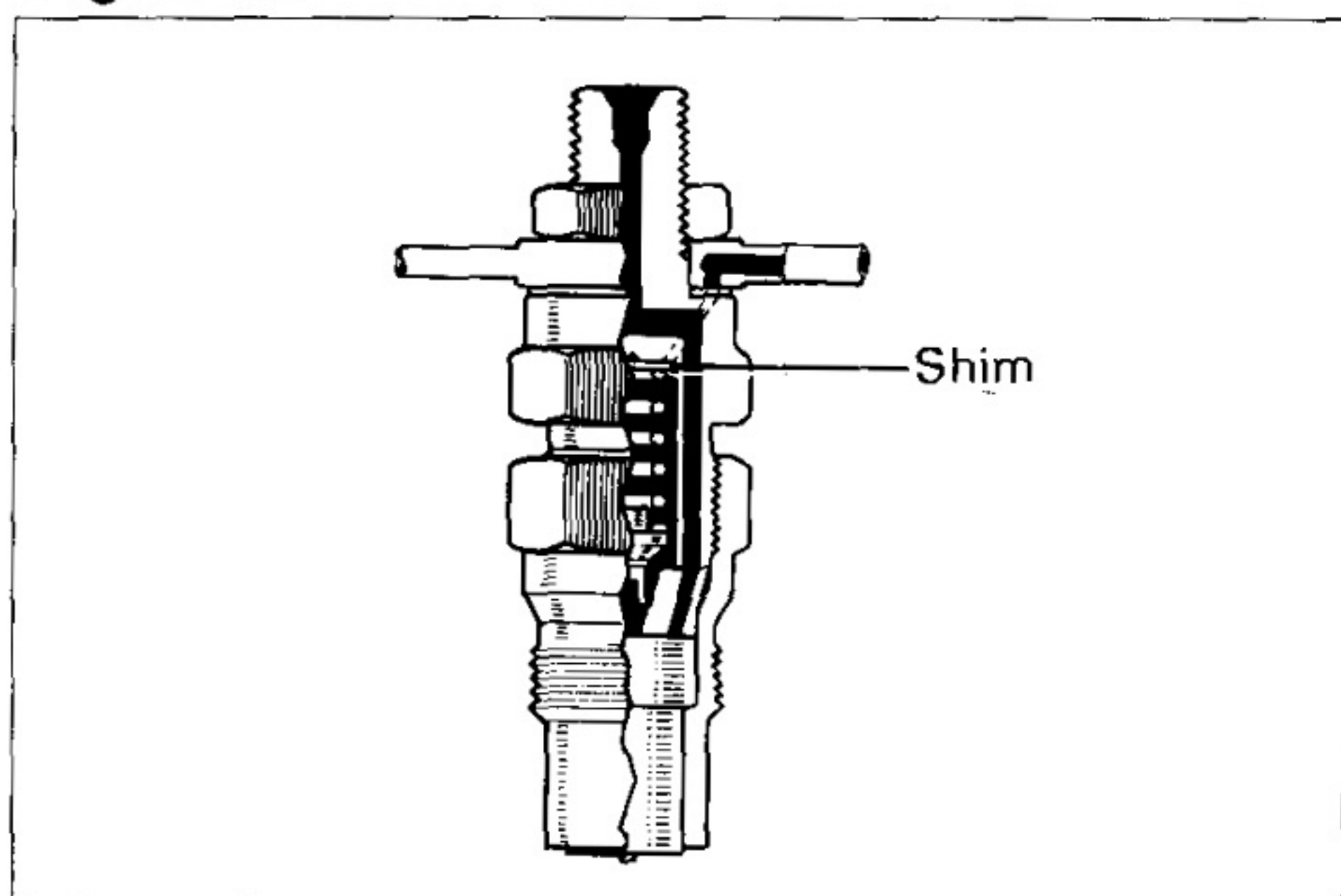
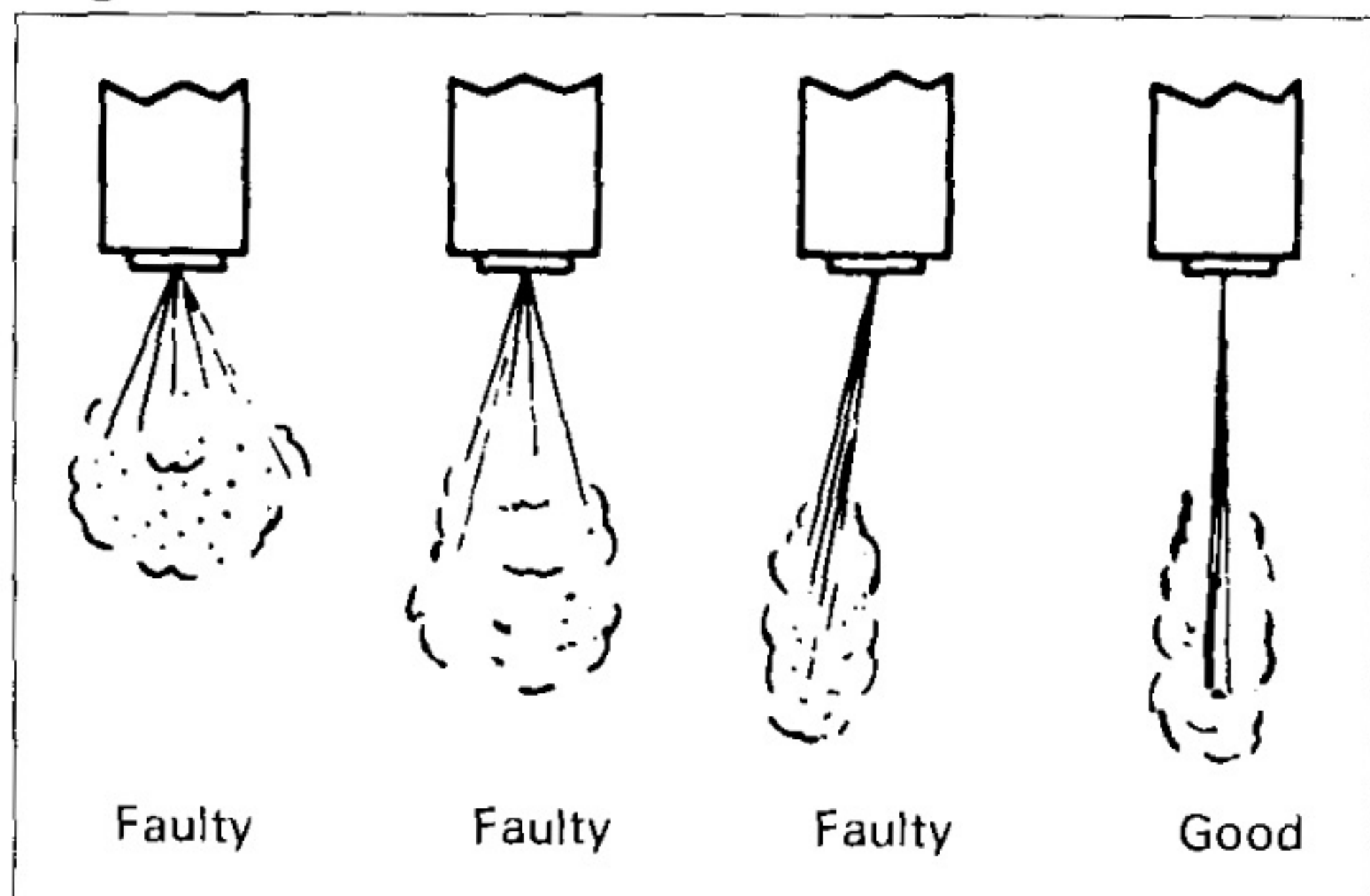


Fig. 6-20



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.

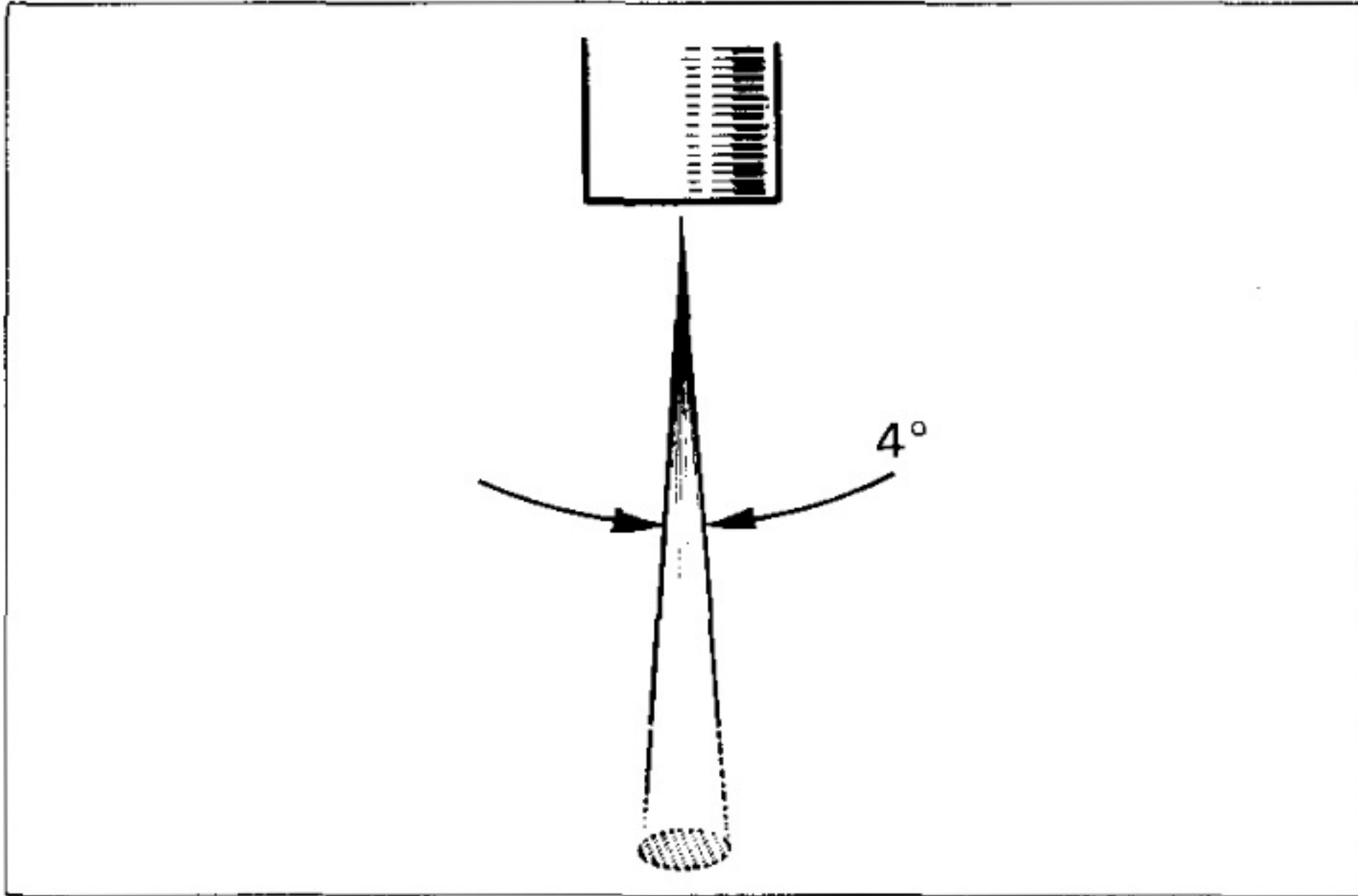
– Note –

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.

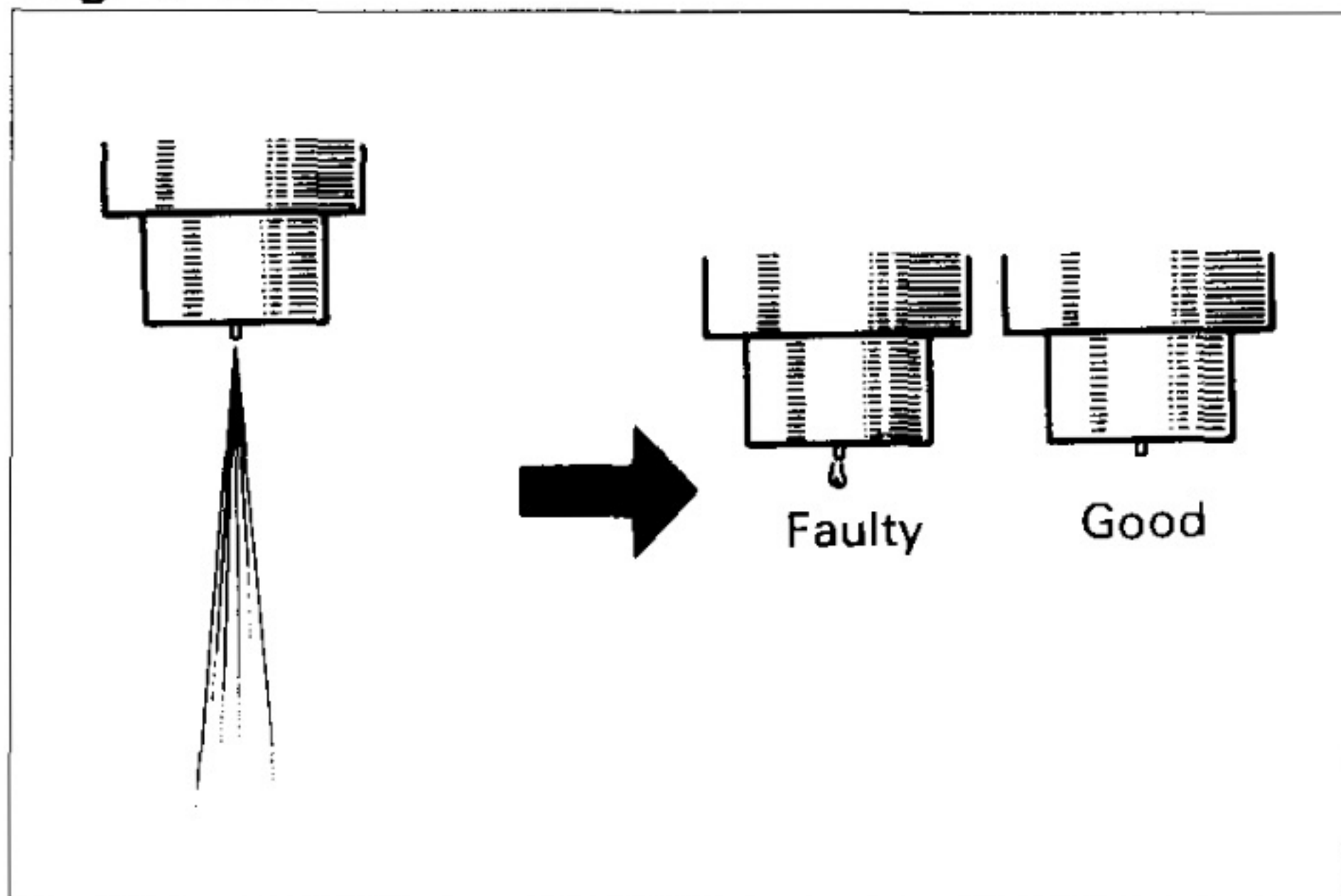


Fig. 6-21



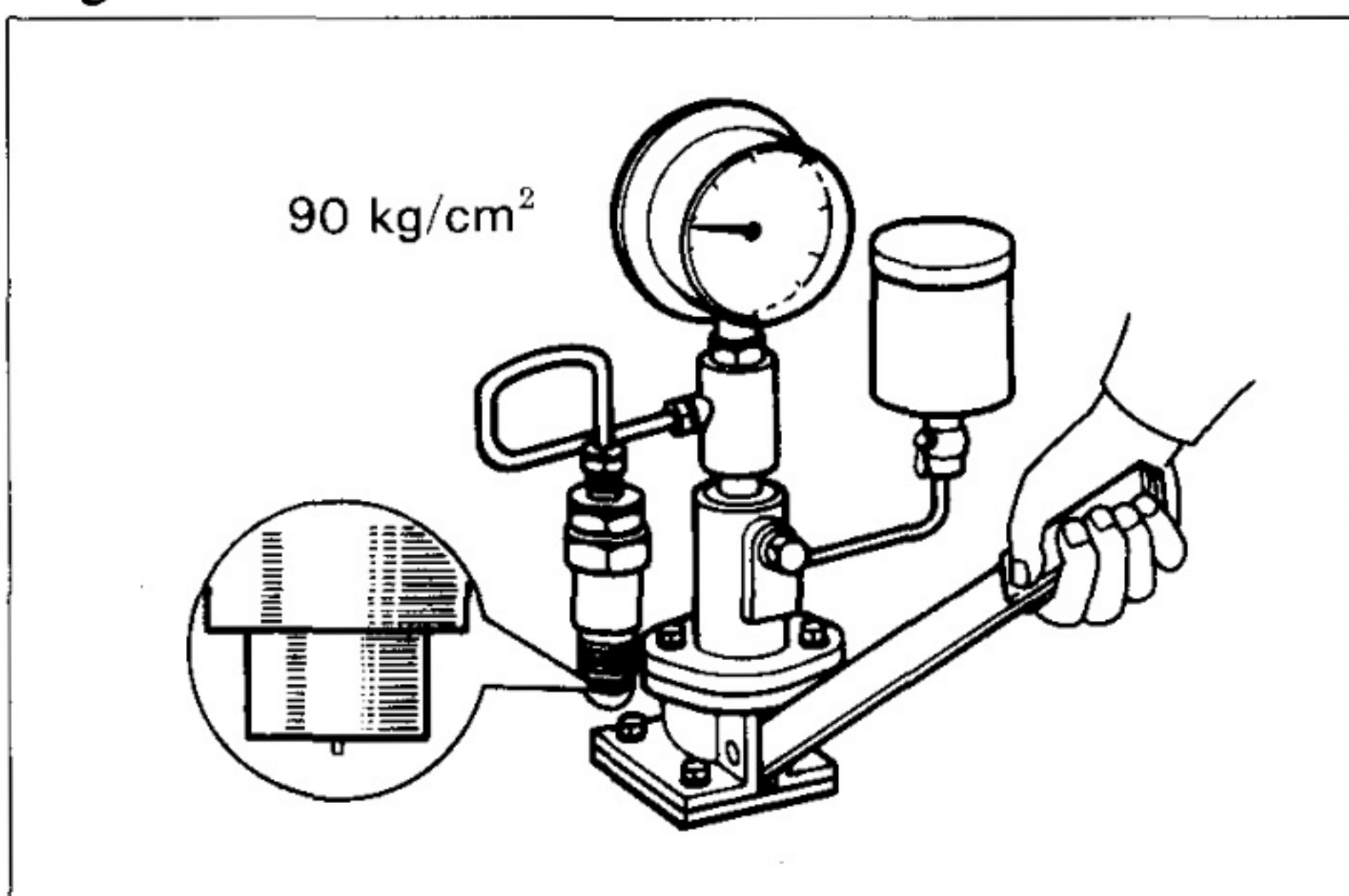
- (2) Spray should spread evenly down the nozzle center line in a 4° conical form.
- (3) Place a white sheet of paper about 30 cm (11.8 in.) away from the nozzle to check if spray pattern is in circular form.

Fig. 6-22



5. There should be no dripping after injection.

Fig. 6-23



6. Leakage test
Apply 90 kg/cm² (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

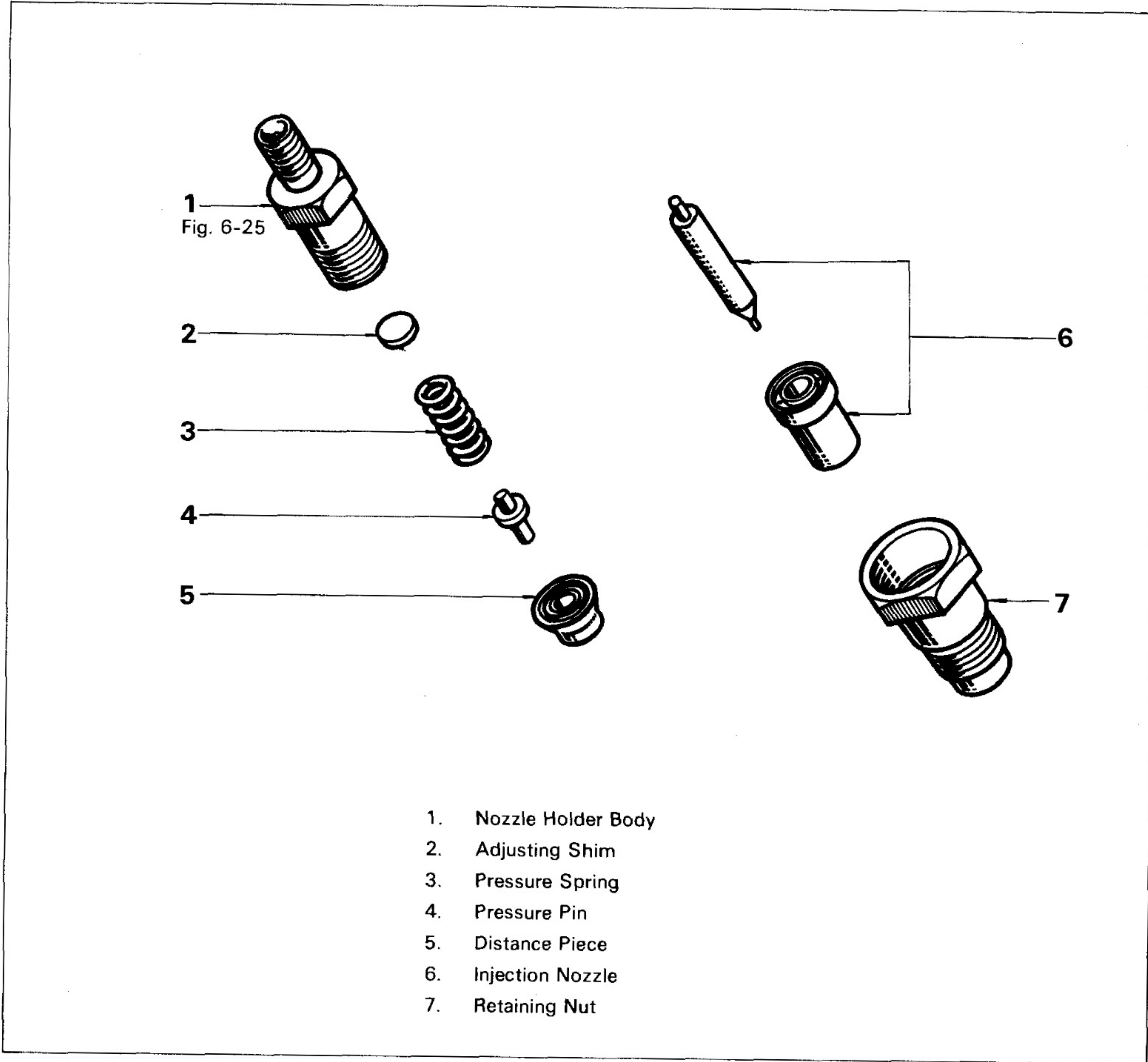
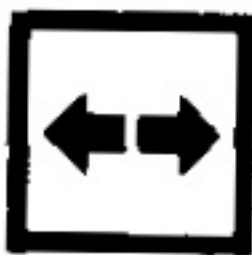
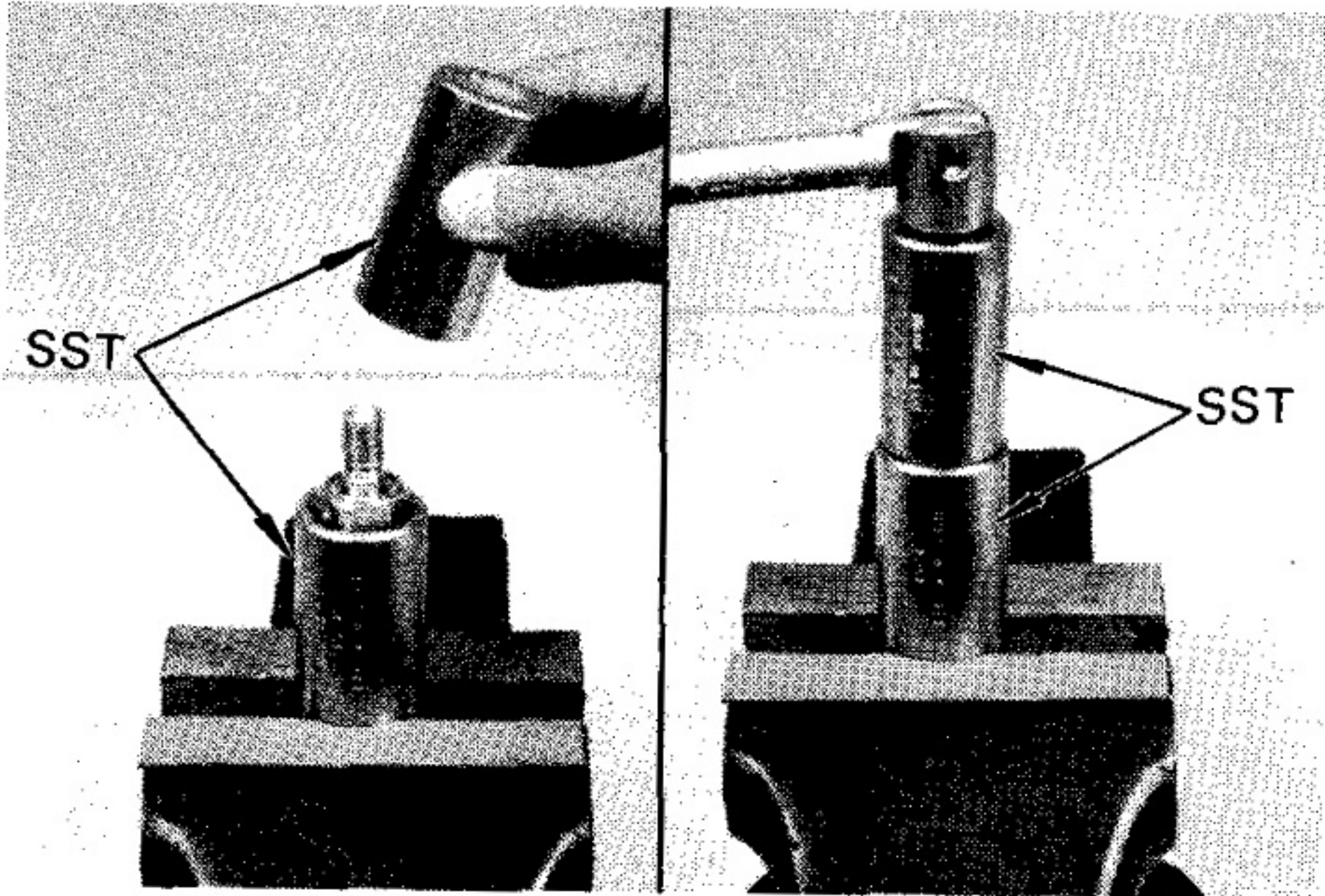


Fig. 6-25



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

Fig. 6-26



Fig. 6-27

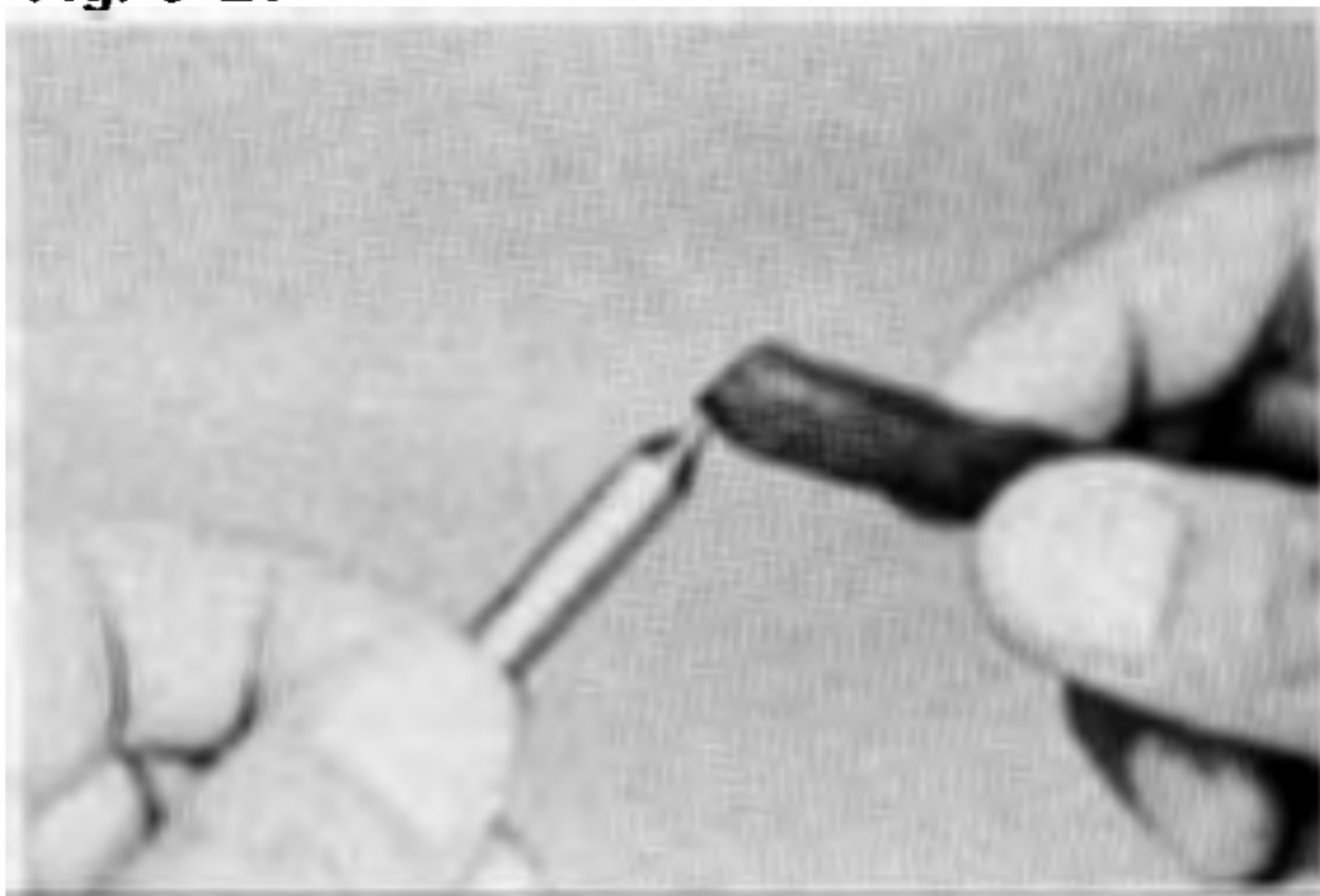


Fig. 6-28

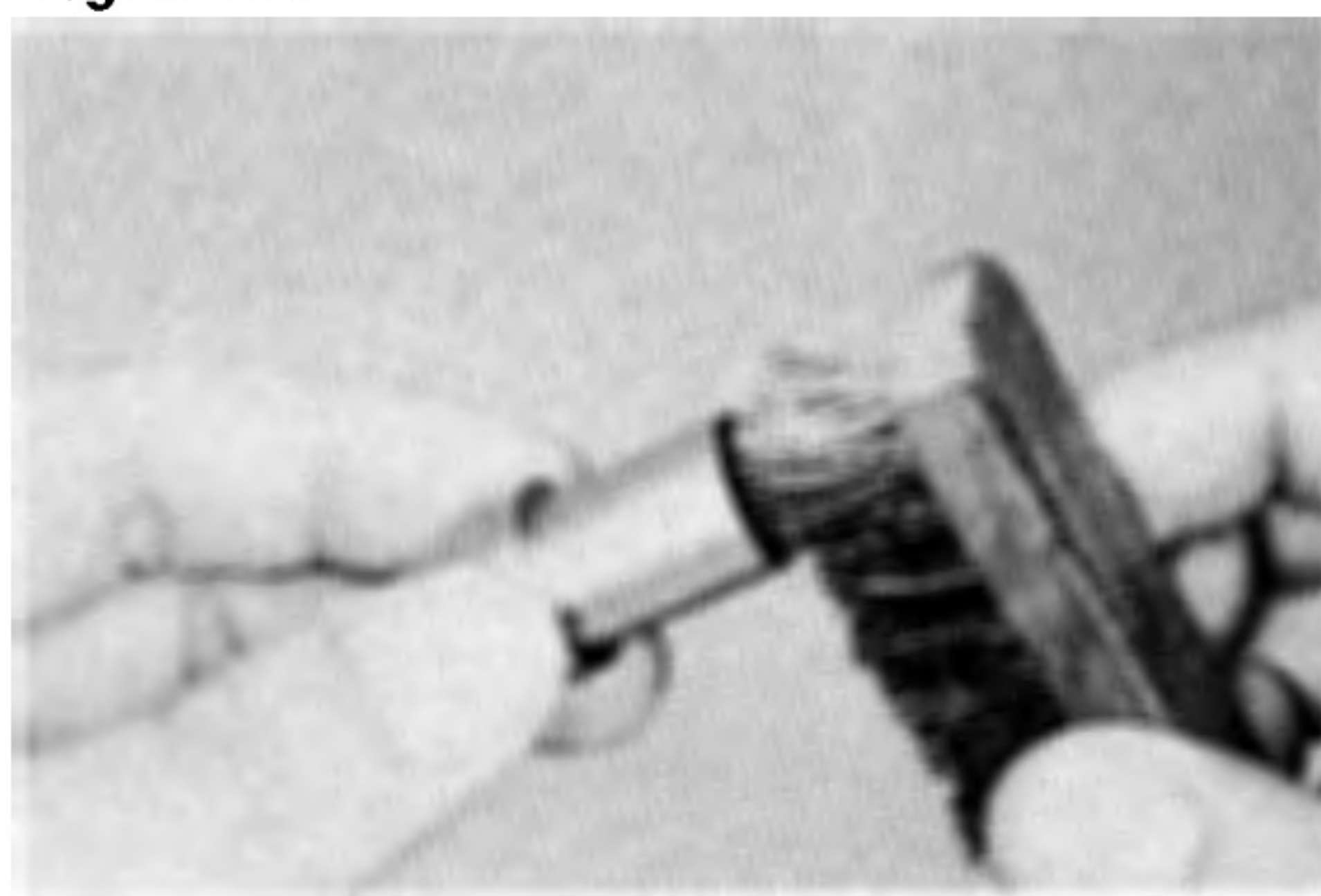
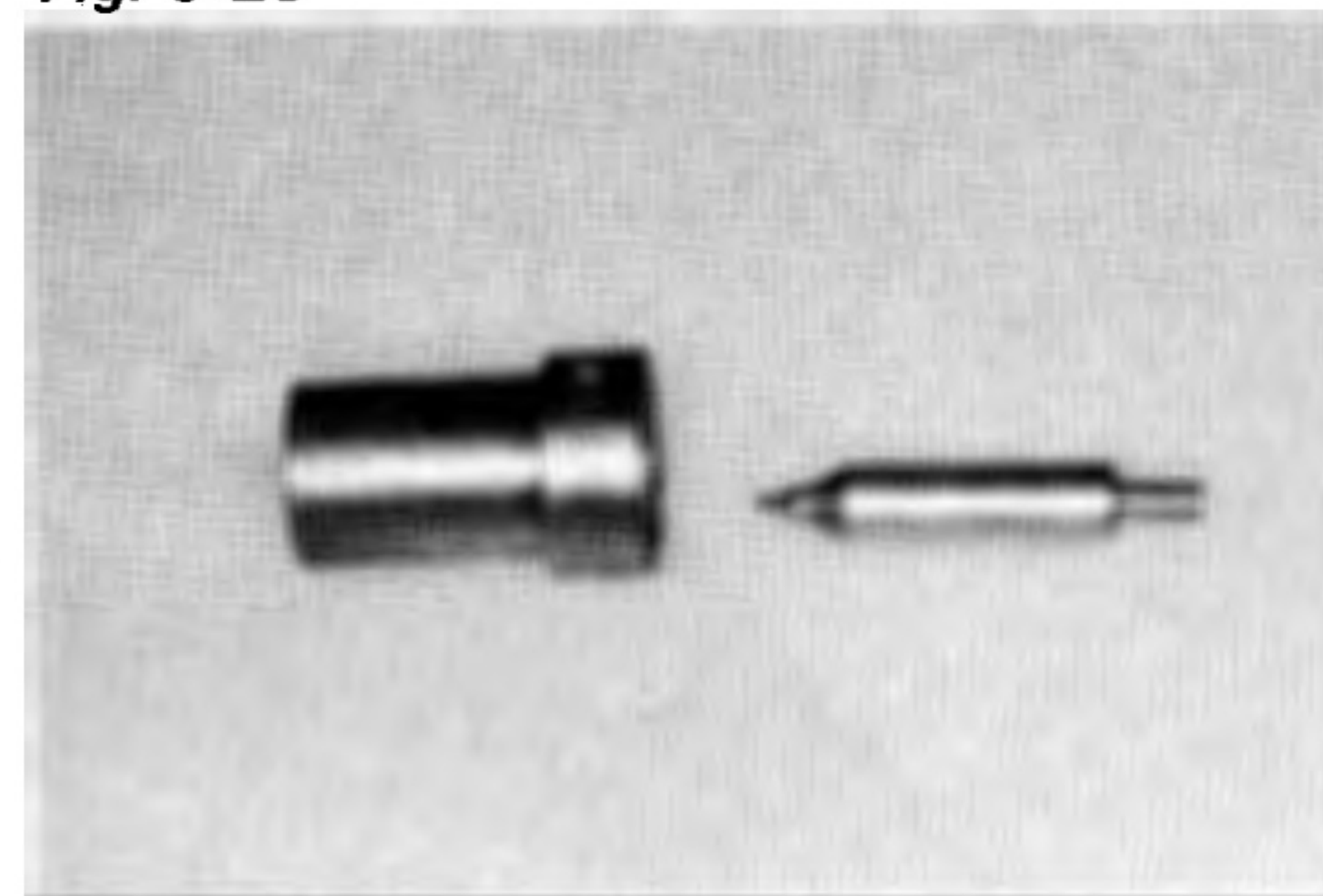


Fig. 6-29

**NOZZLE CLEANING**

1. To wash the nozzles, use a wooden stick and brass brush. Wash in clean diesel fuel or light oil.
2. Remove the carbon adhering to the nozzle needle tip with a wooden stick.
3. Remove the carbon from the exterior of the nozzle body (except wrapping angle) with a brass brush.
4. Wash the nozzle in clean diesel fuel or light oil.

Fig. 6-30



Fig. 6-31

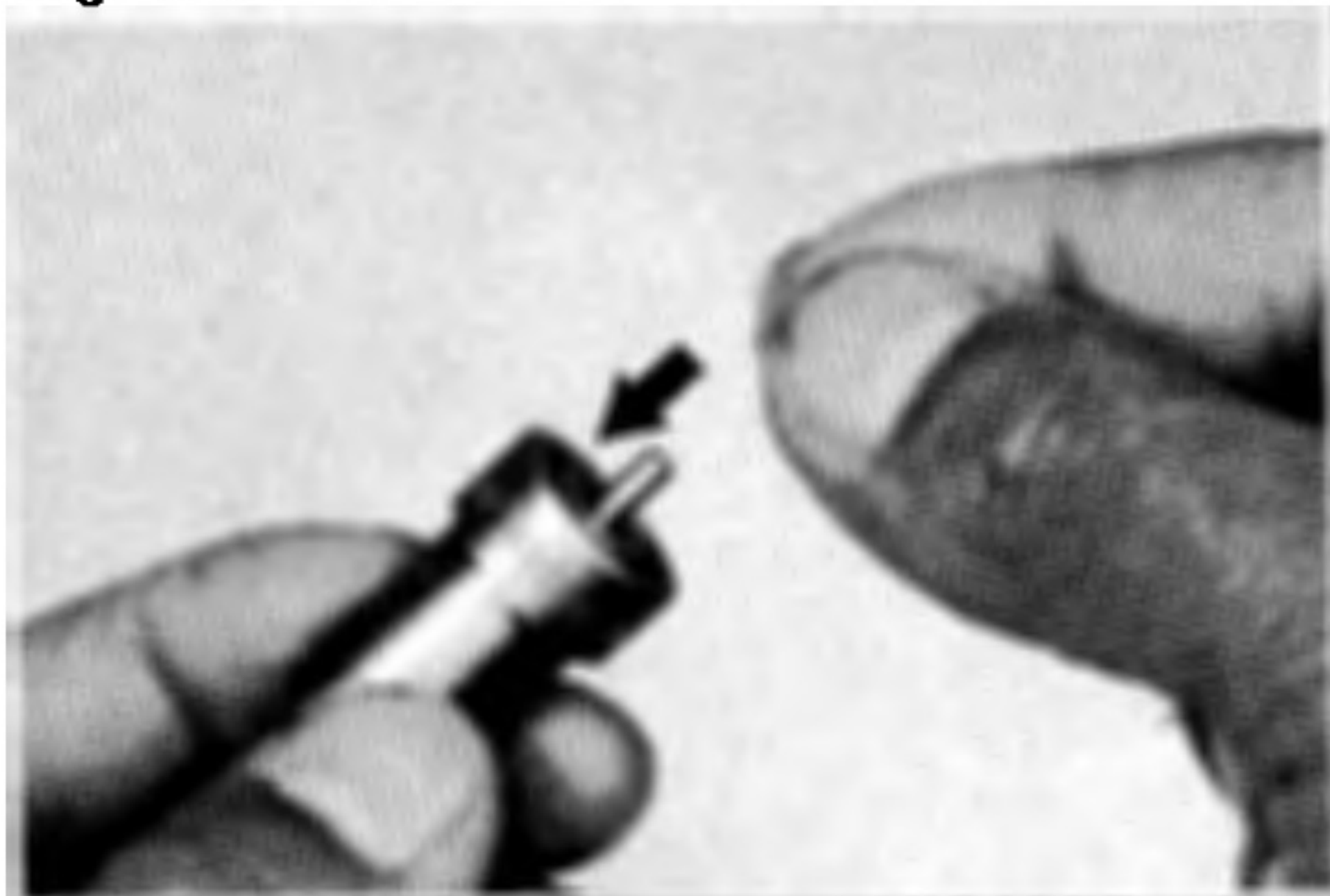
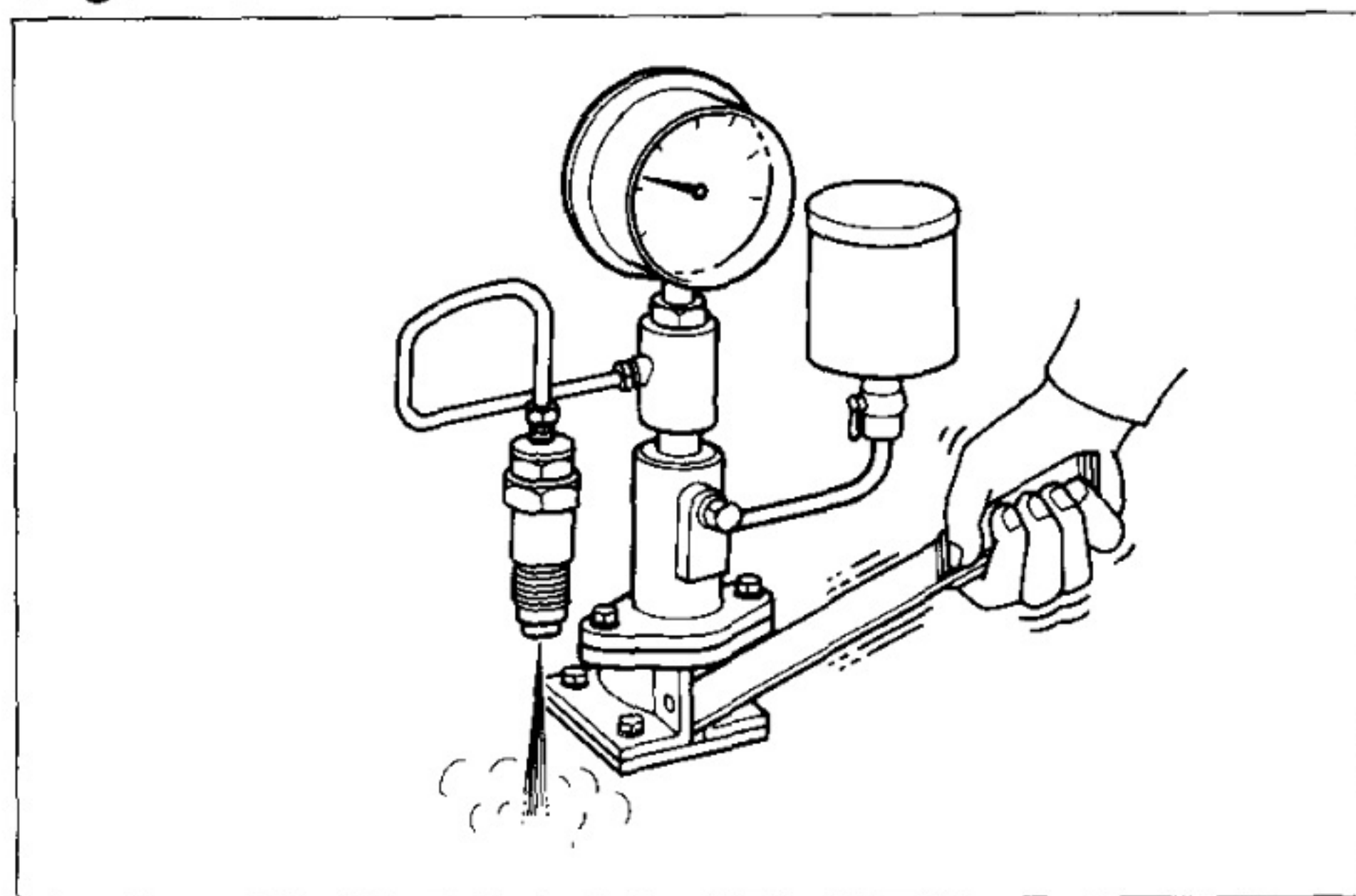


Fig. 6-32



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

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

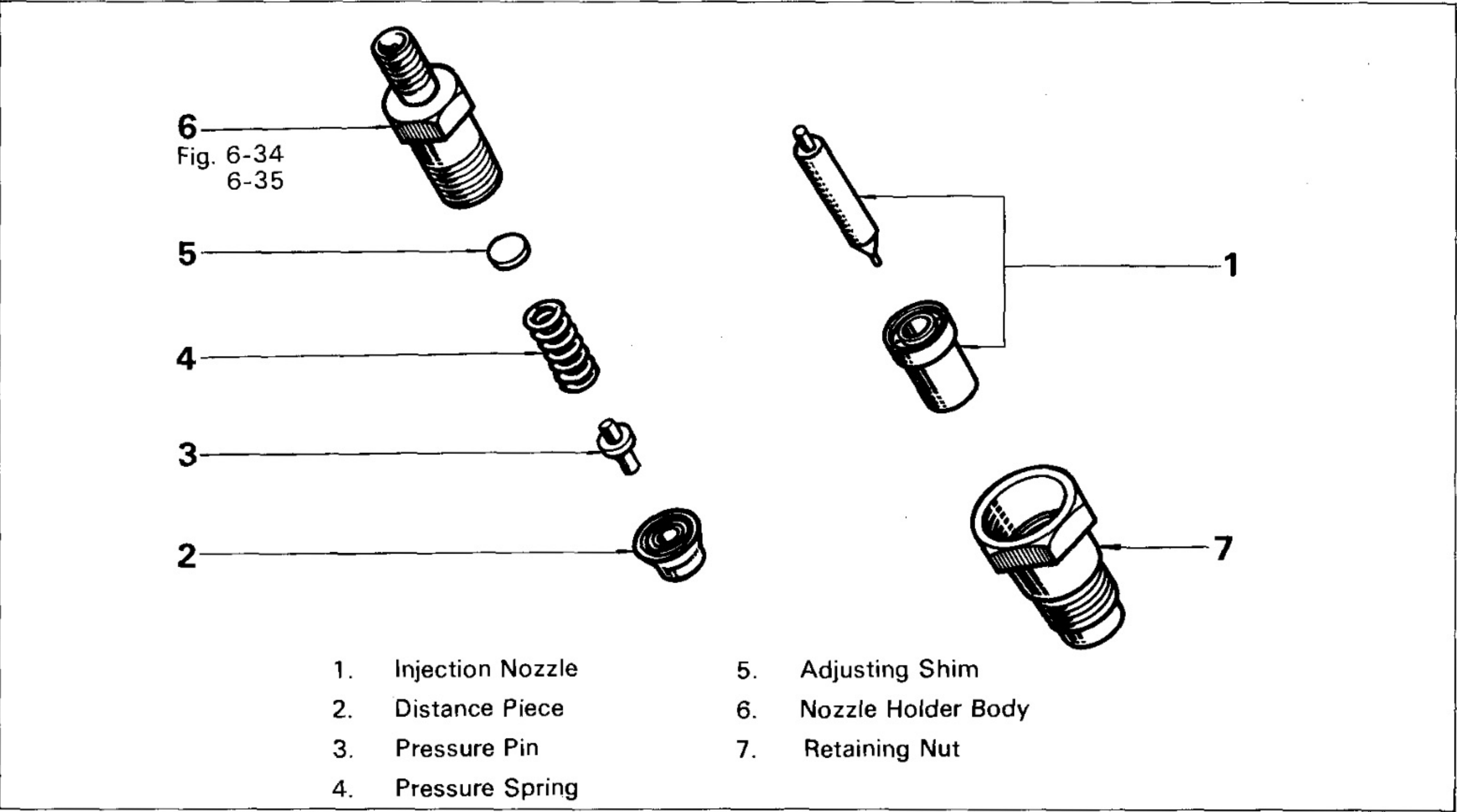
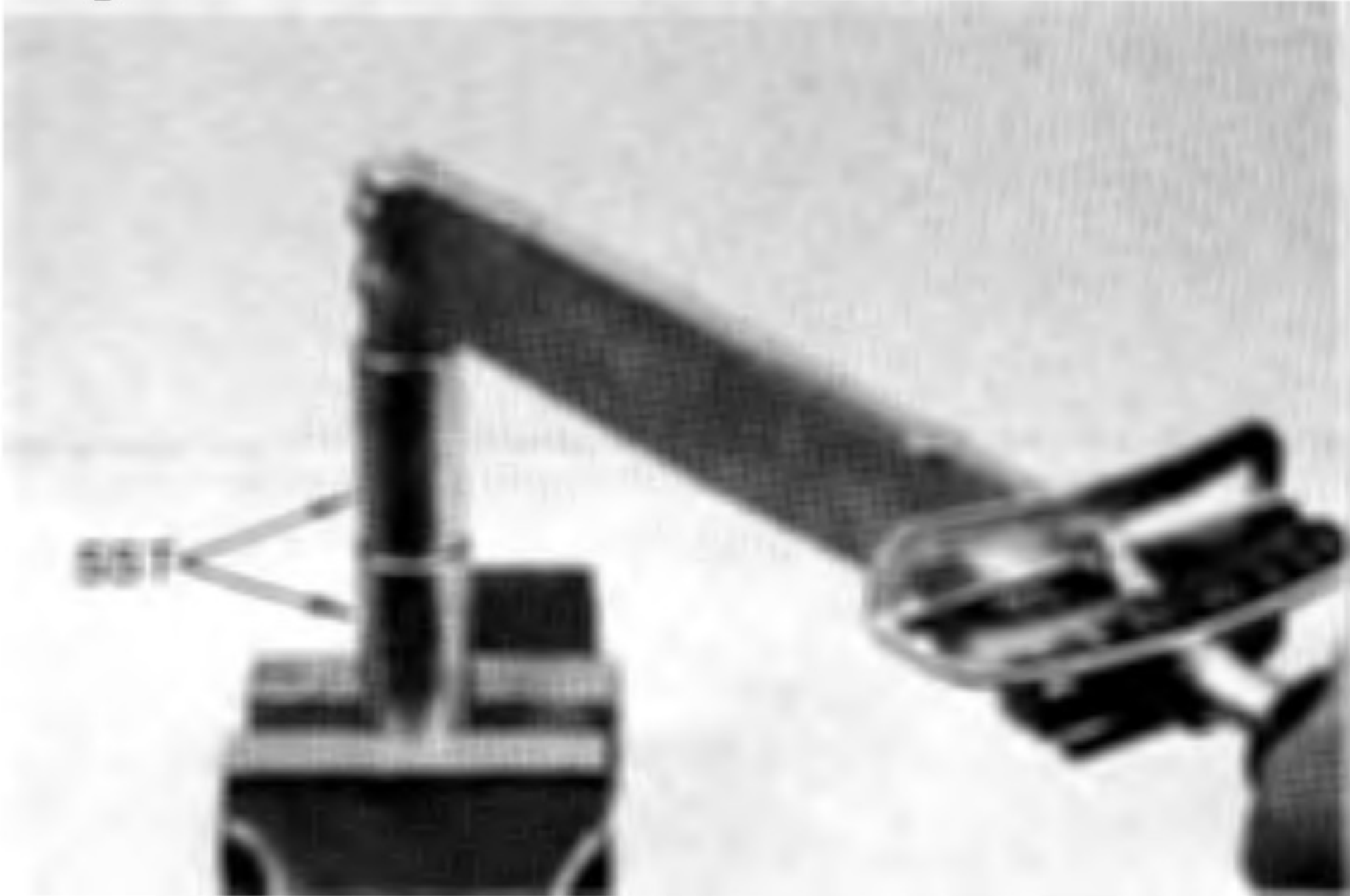


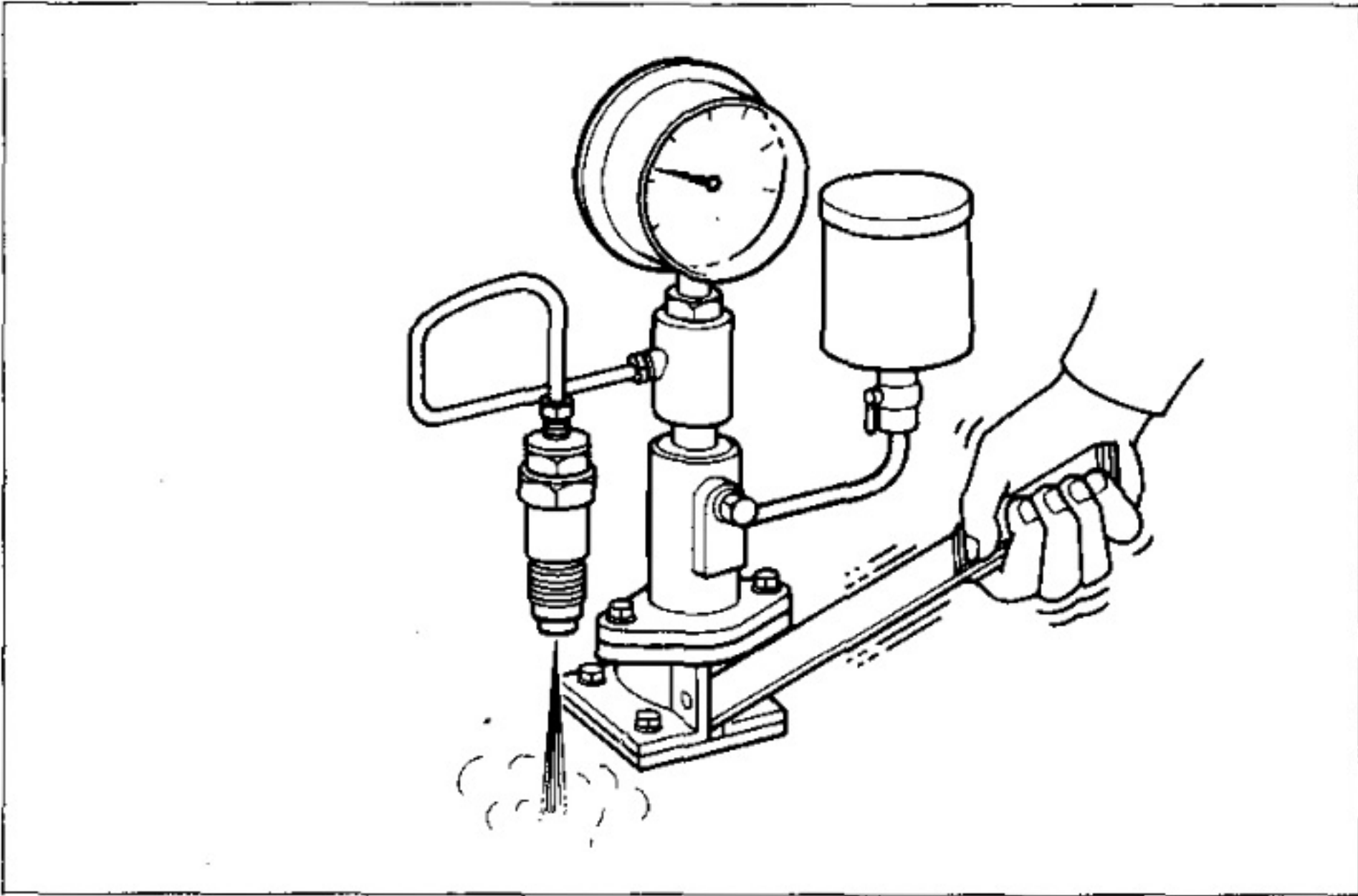
Fig. 6-34





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

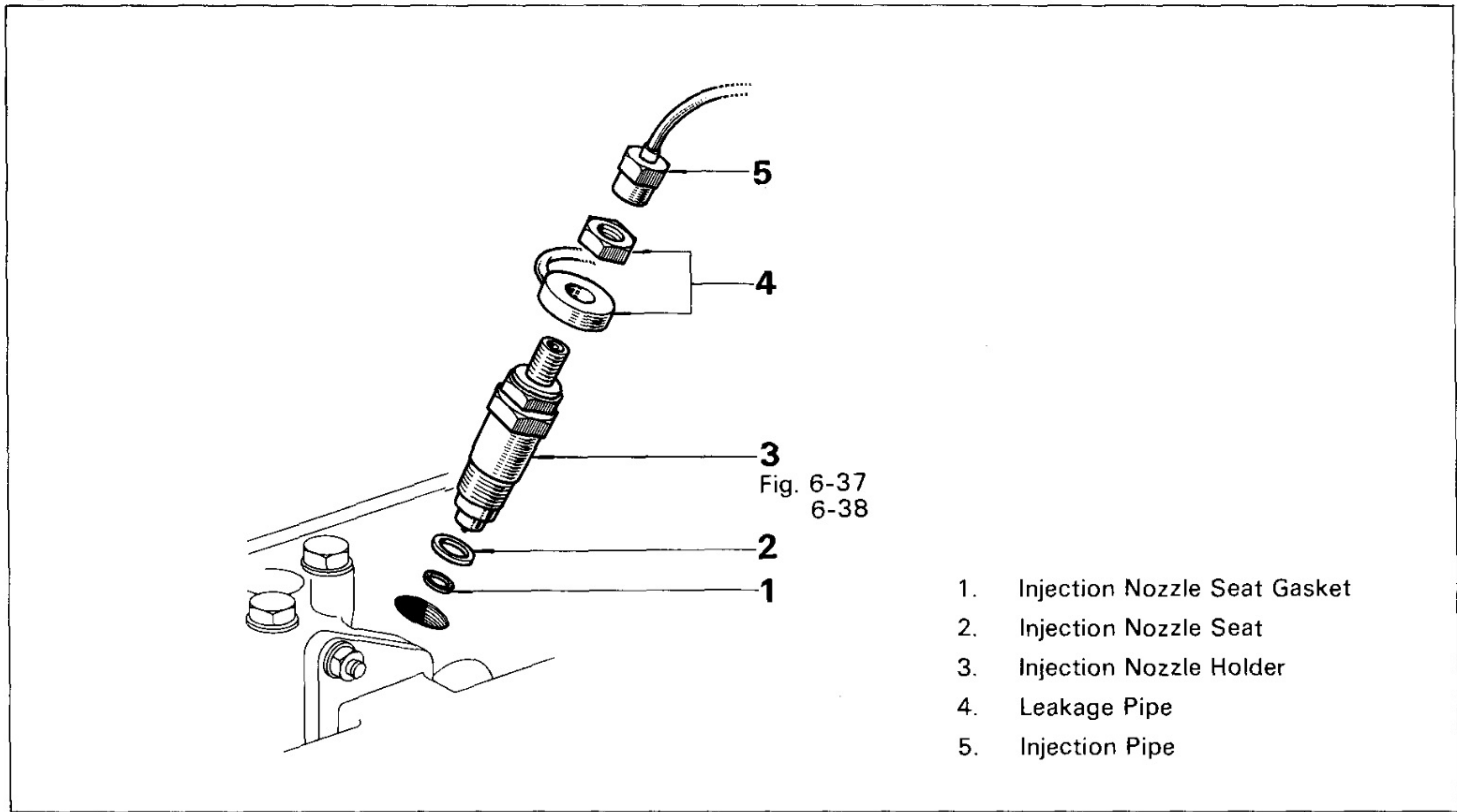
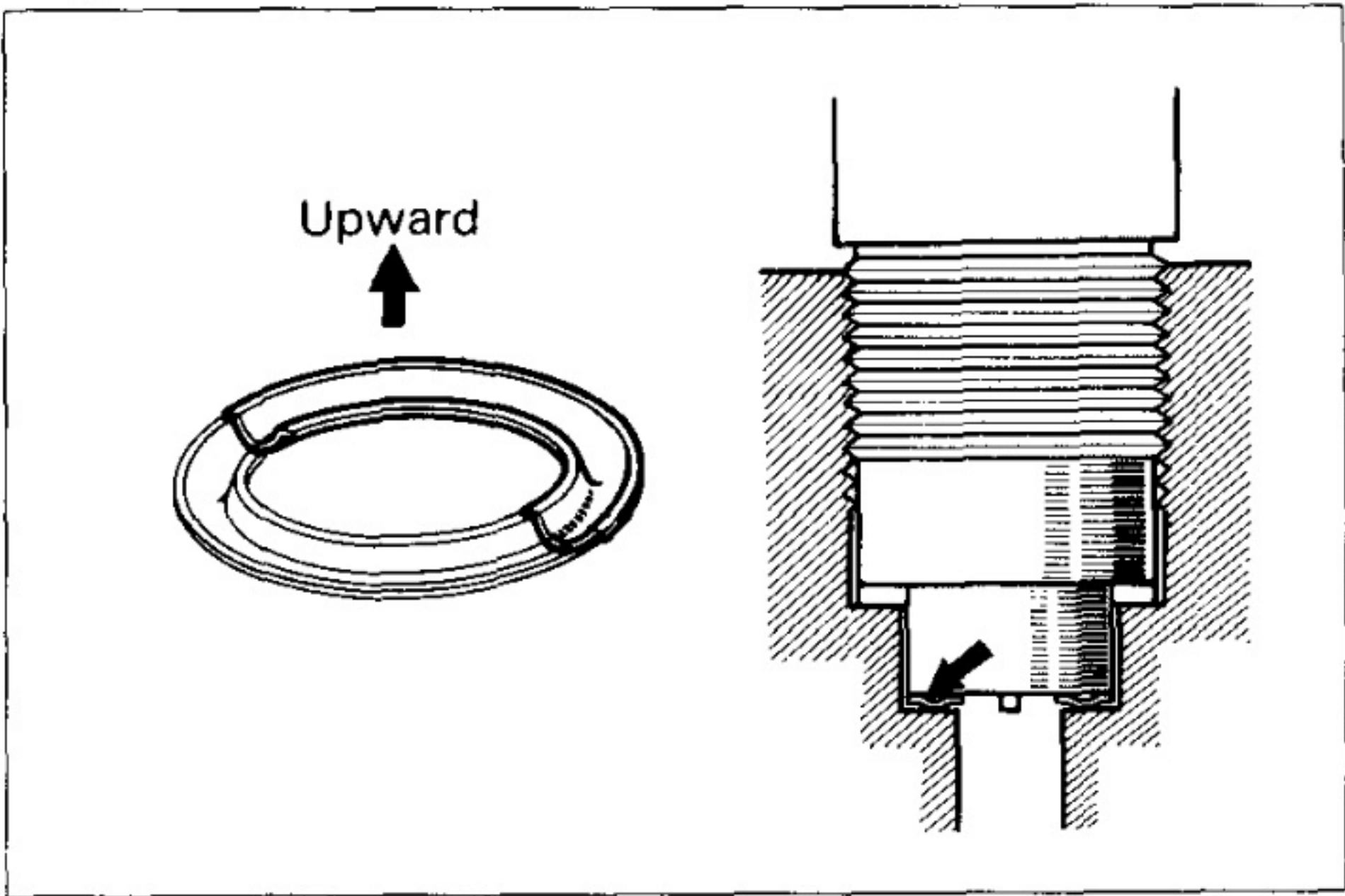
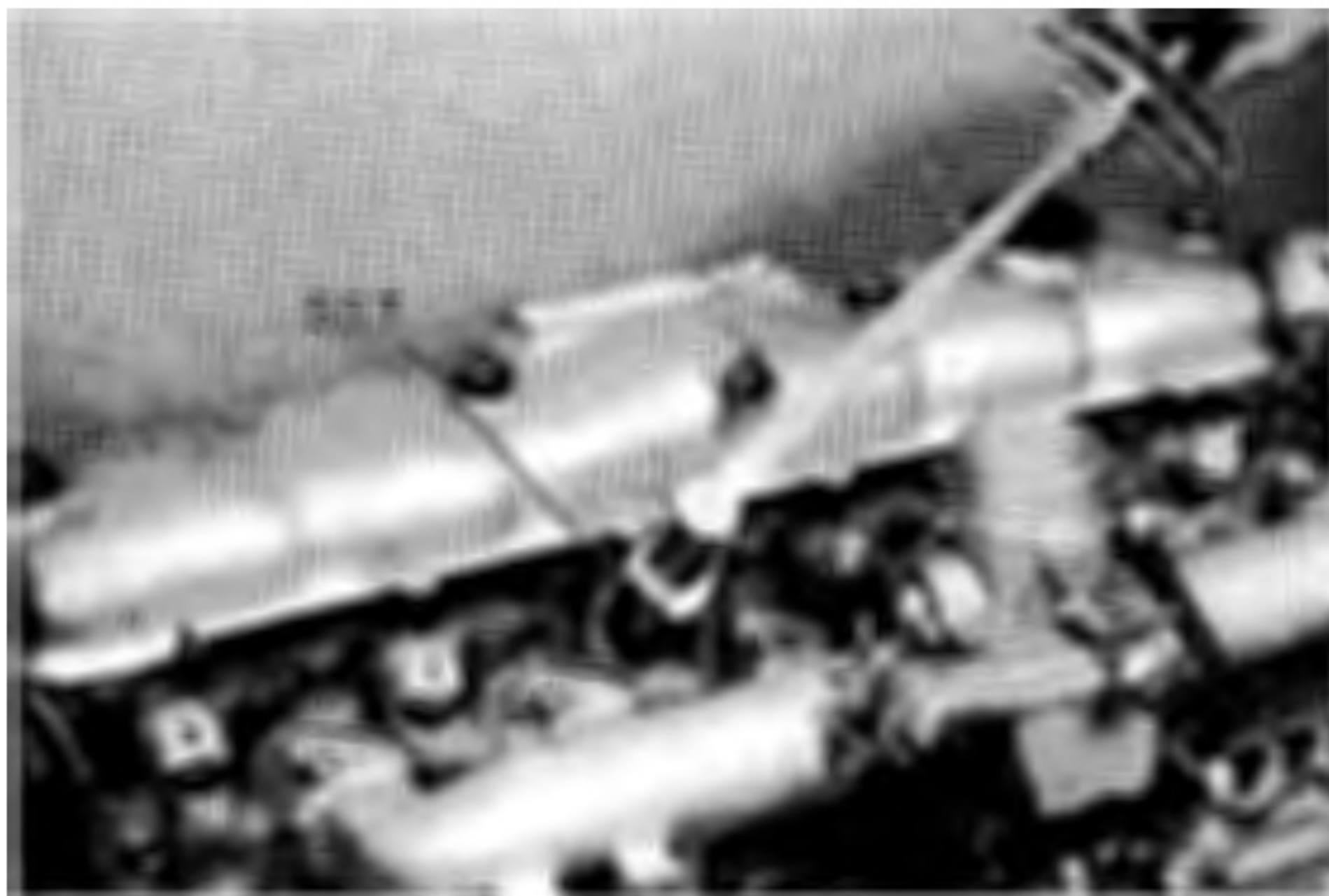


Fig. 6-37



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

Fig. 6-38



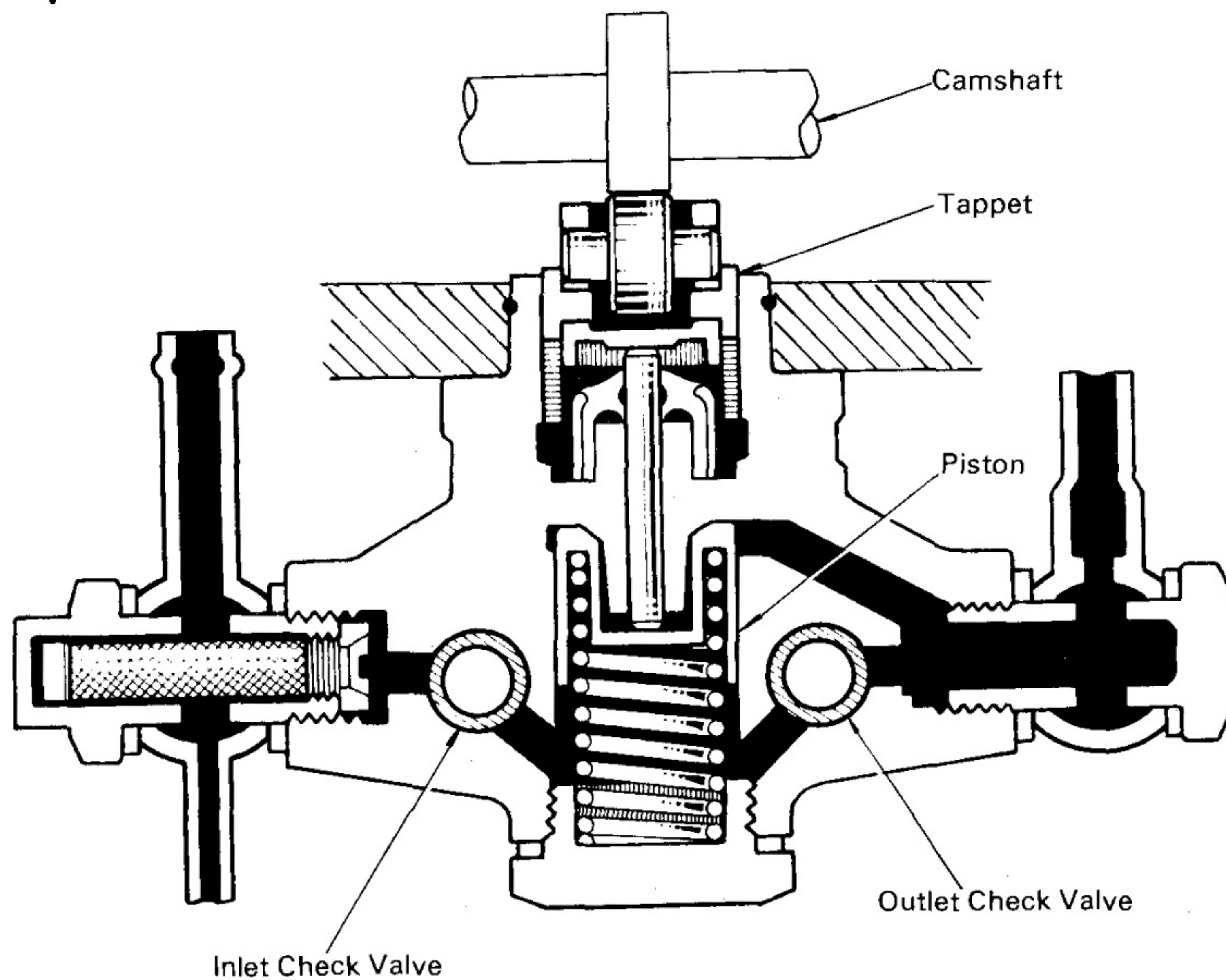
Tighten the nozzle holder with SST.
SST (09268-46011) of set [09260-46011]
**Tightening torque: 6.0 – 8.0 kg-m
(44 – 57 ft-lb)**

— Note —
After installing, bleed the air.

FUEL FEED PUMP CUTAWAY VIEW

Fig. 6-39

Feed Pump



Priming Pump

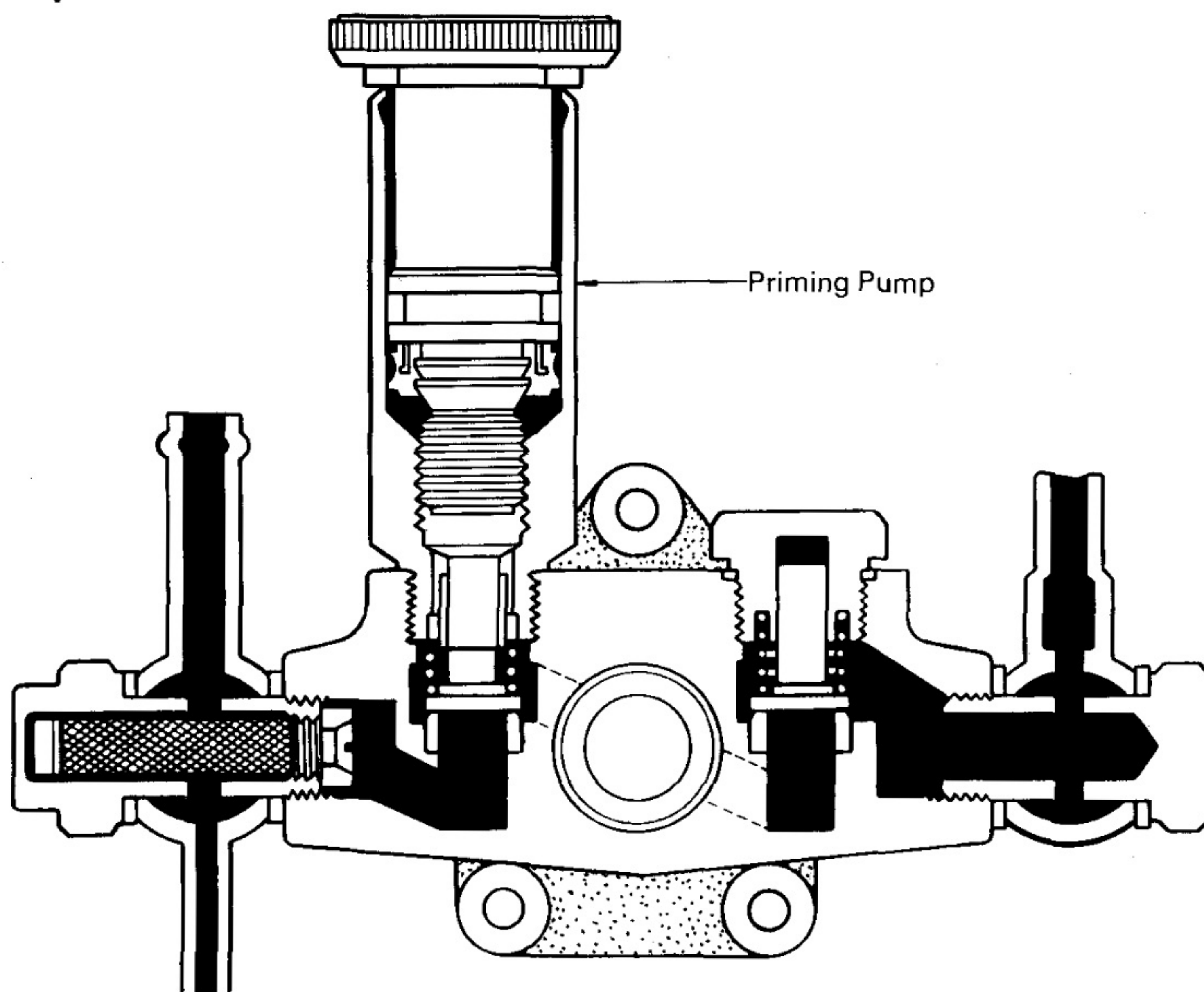


Fig. 6-40

**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

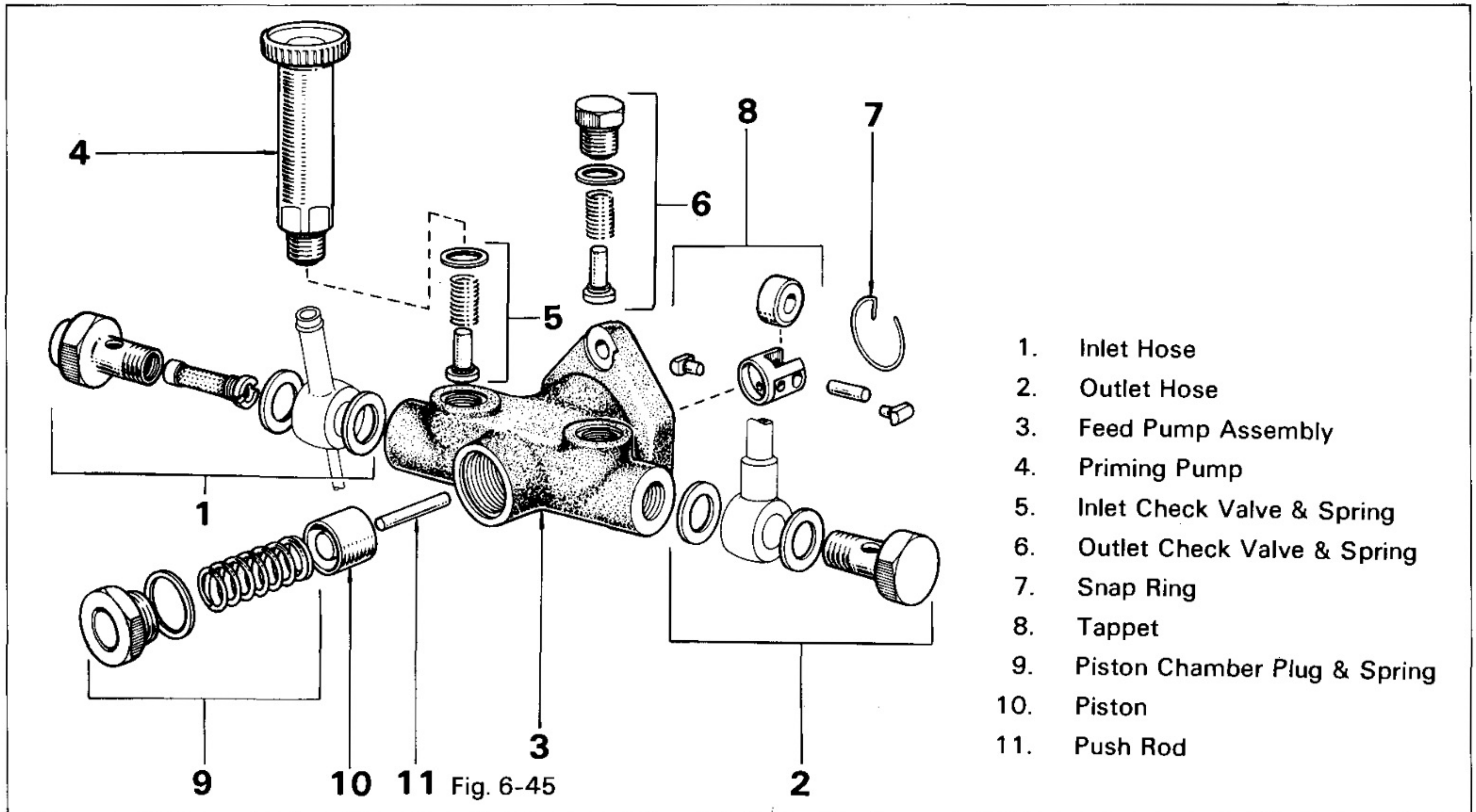
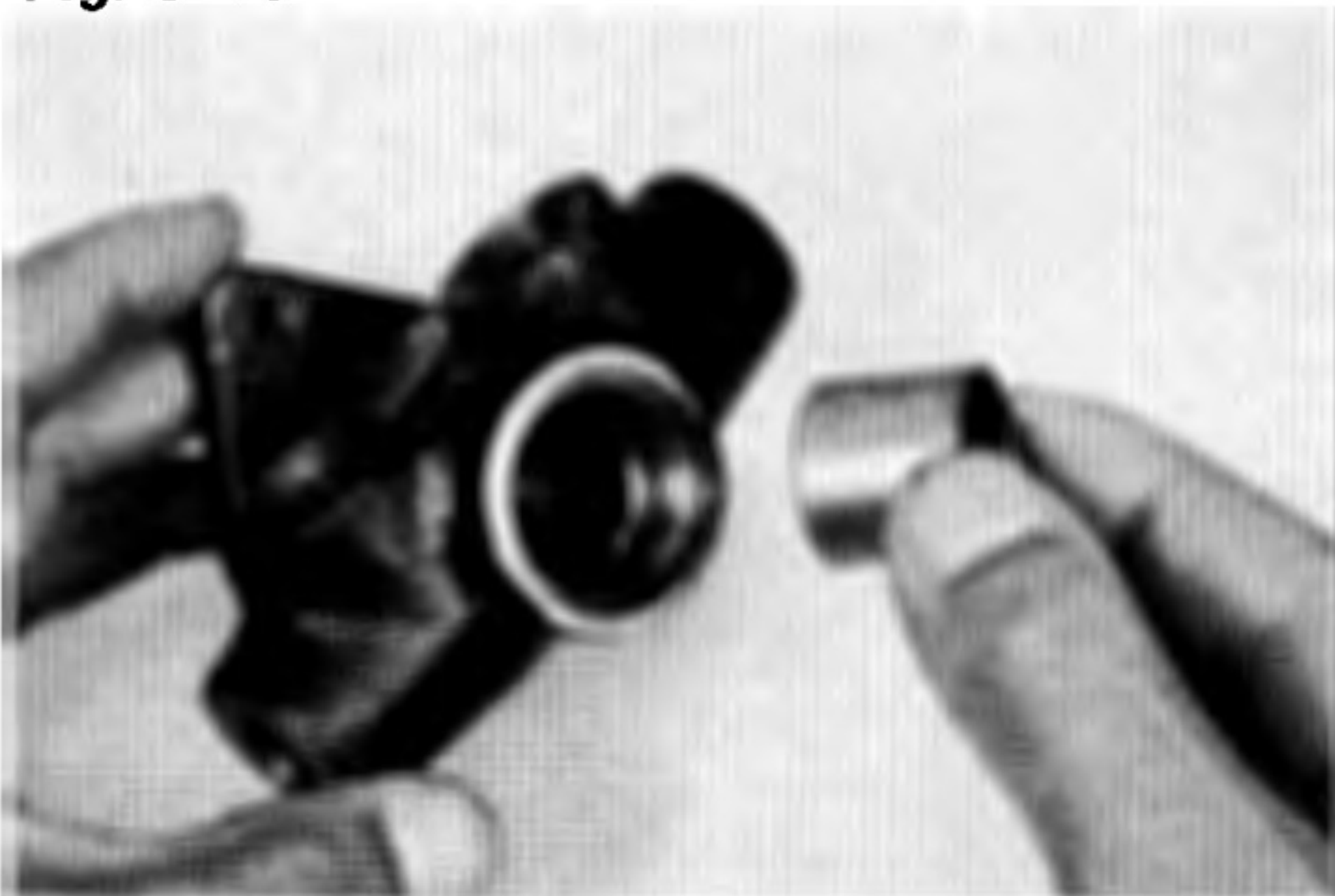


Fig. 6-45



Since the push rod is precisely 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

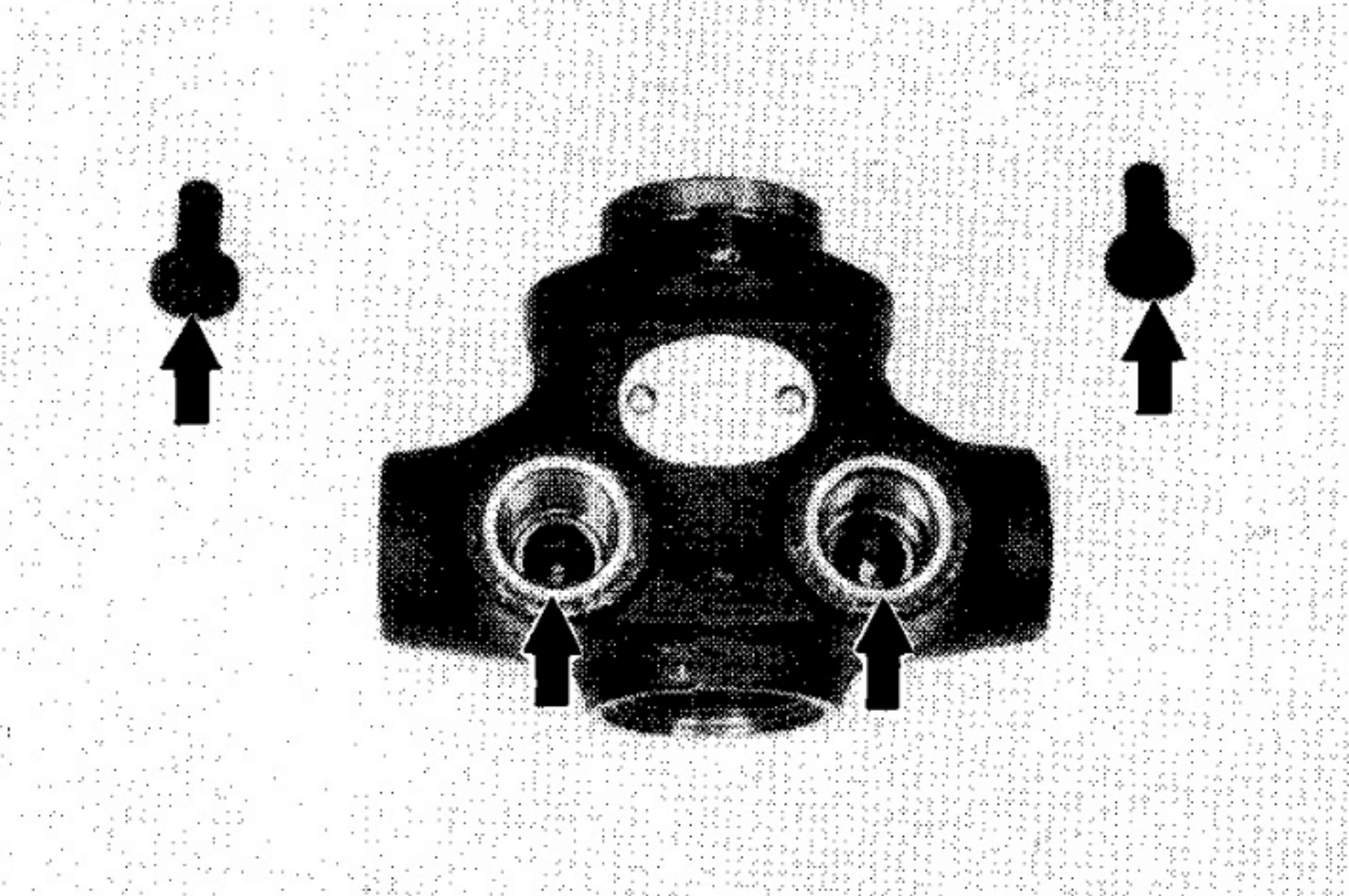
Inspect the piston, push rod and feed pump housing for wear or damage.

Clearance (Reference):

STD

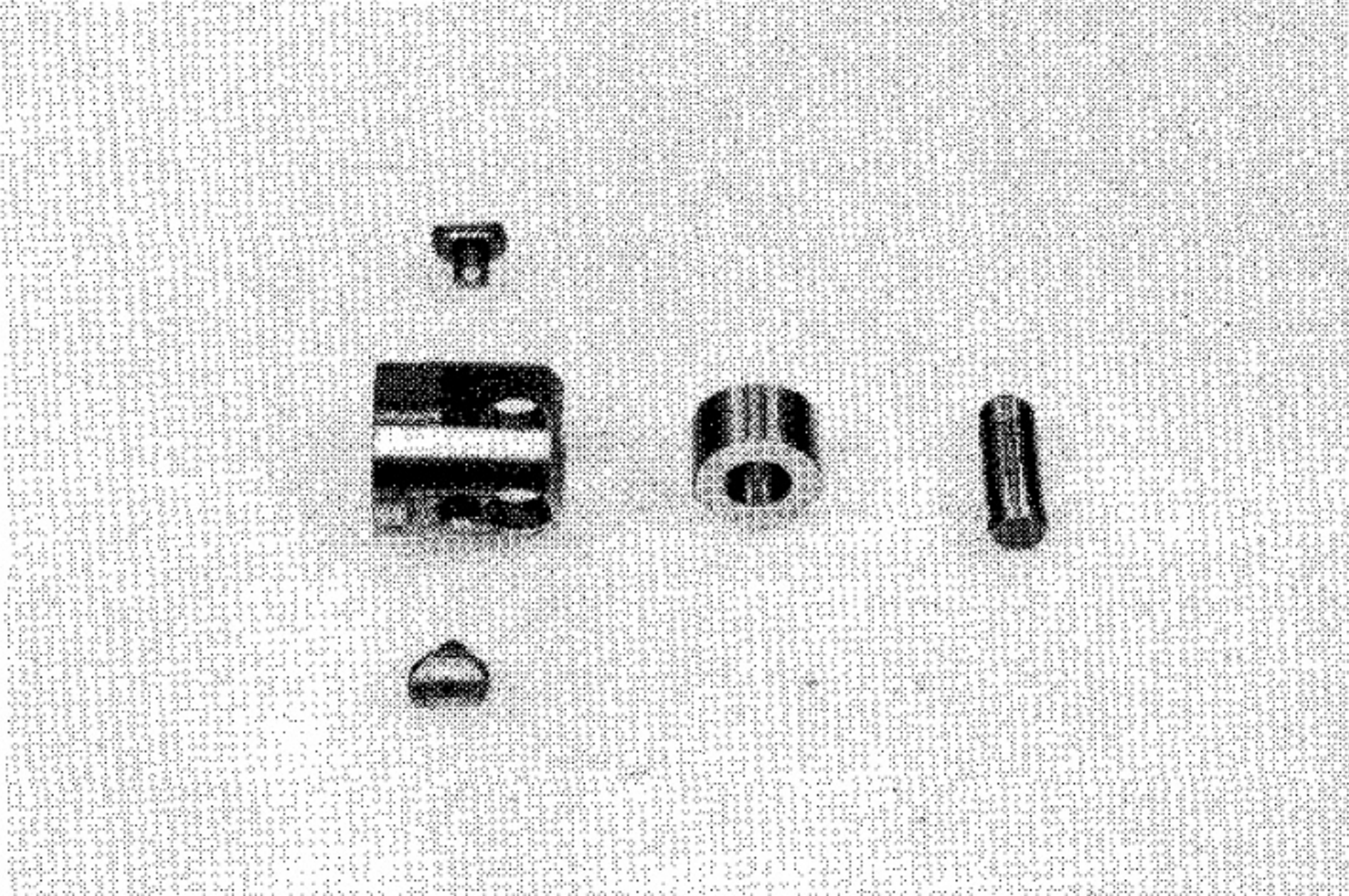
Piston	0.009 – 0.013 mm (0.0004 – 0.0005 in.)
Push Rod	0.003 – 0.006 mm (0.0001 – 0.0002 in.)

Fig. 6-47



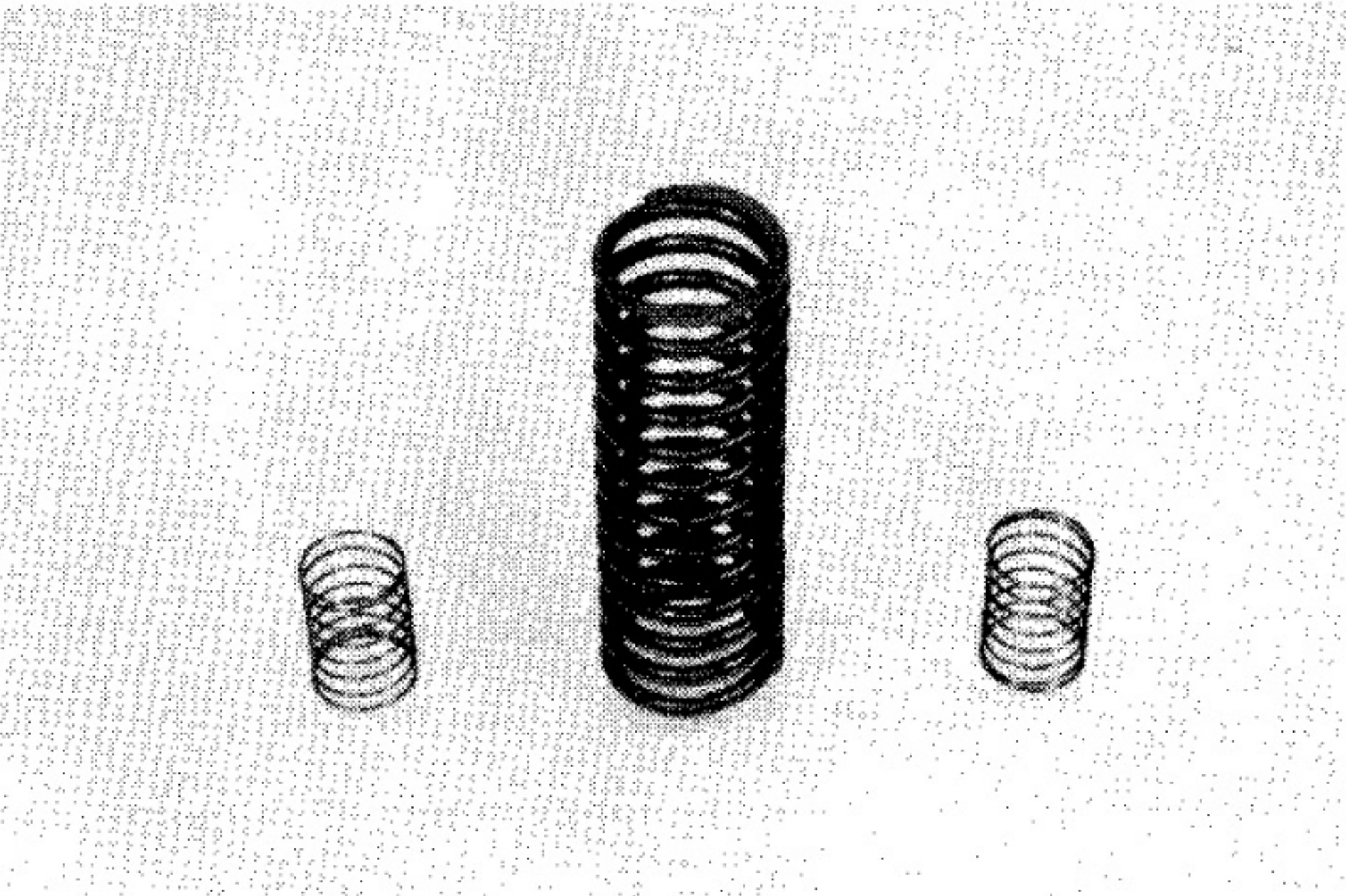
Inspect the check valve and valve seat for wear or damage.

Fig. 6-48



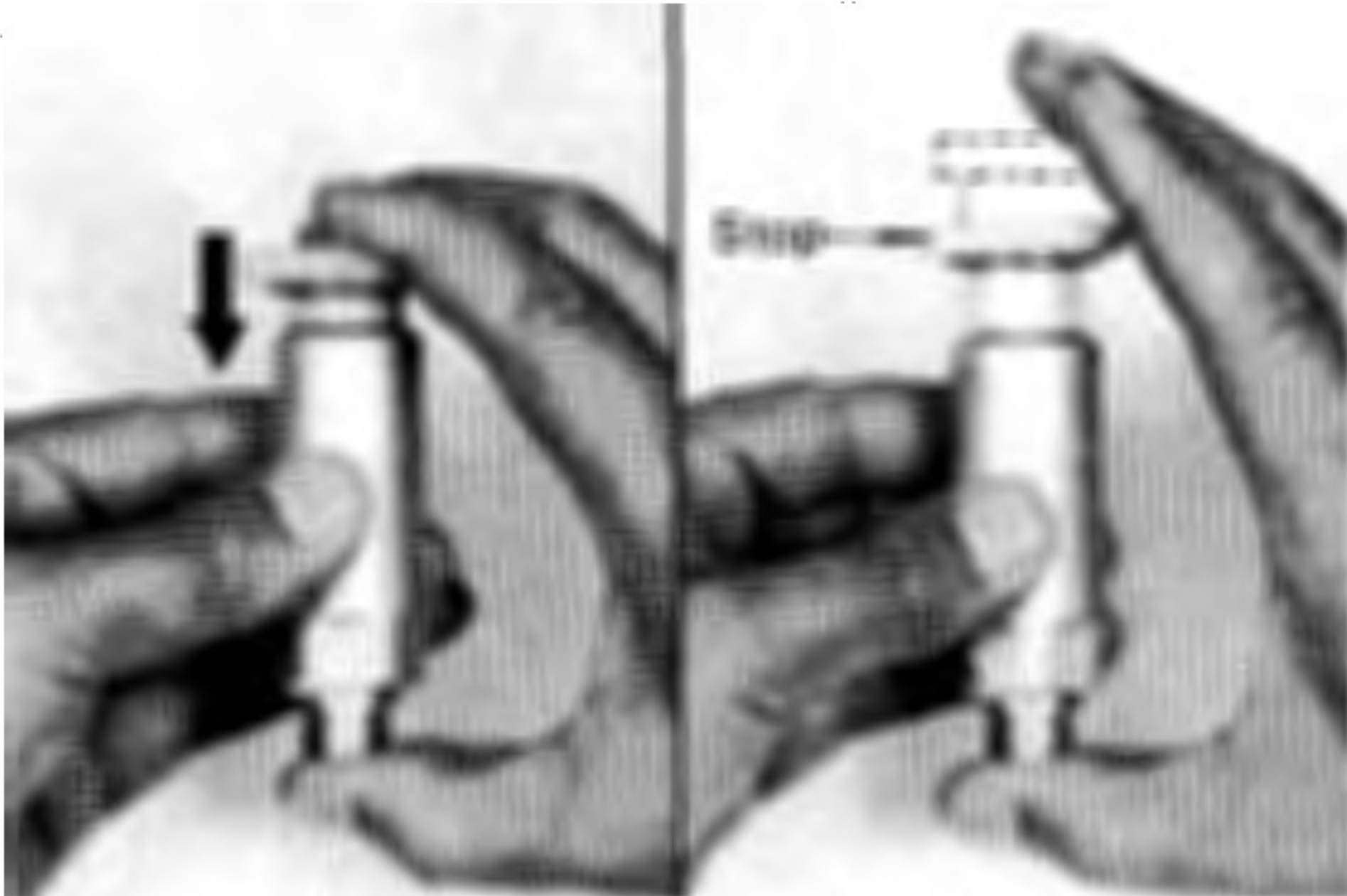
Inspect the tappet and roller for wear or damage.

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

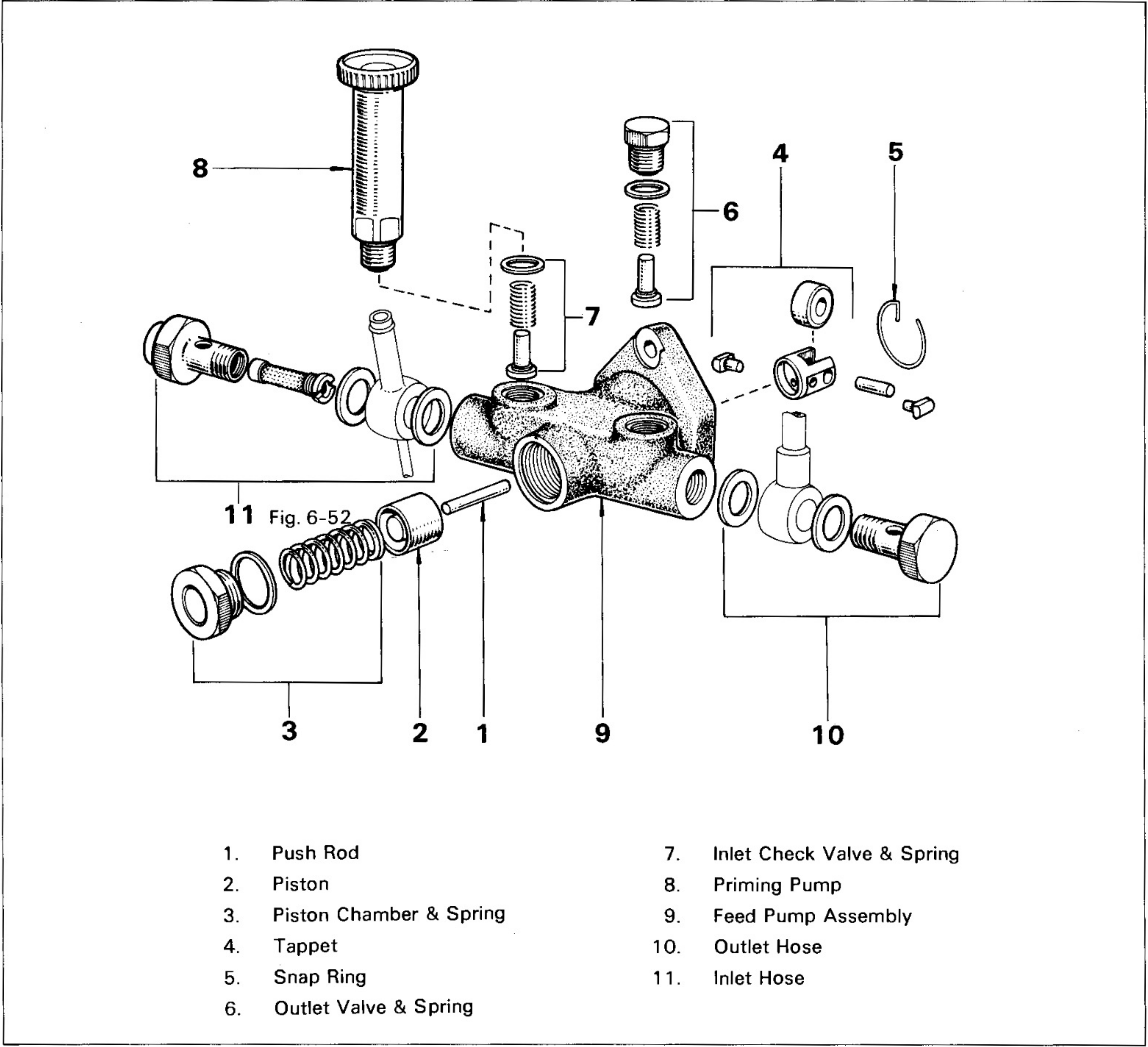
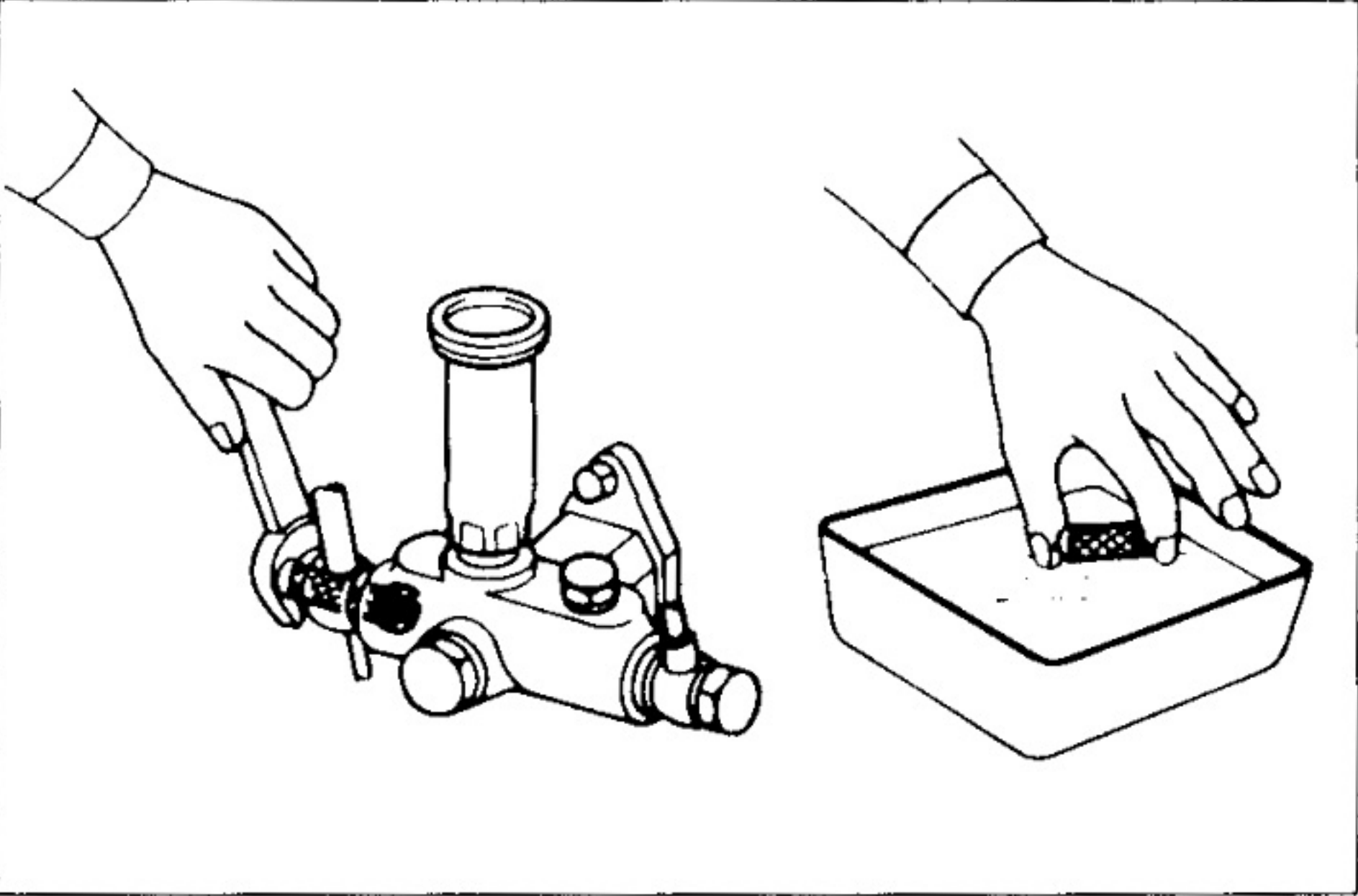


Fig. 6-52



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

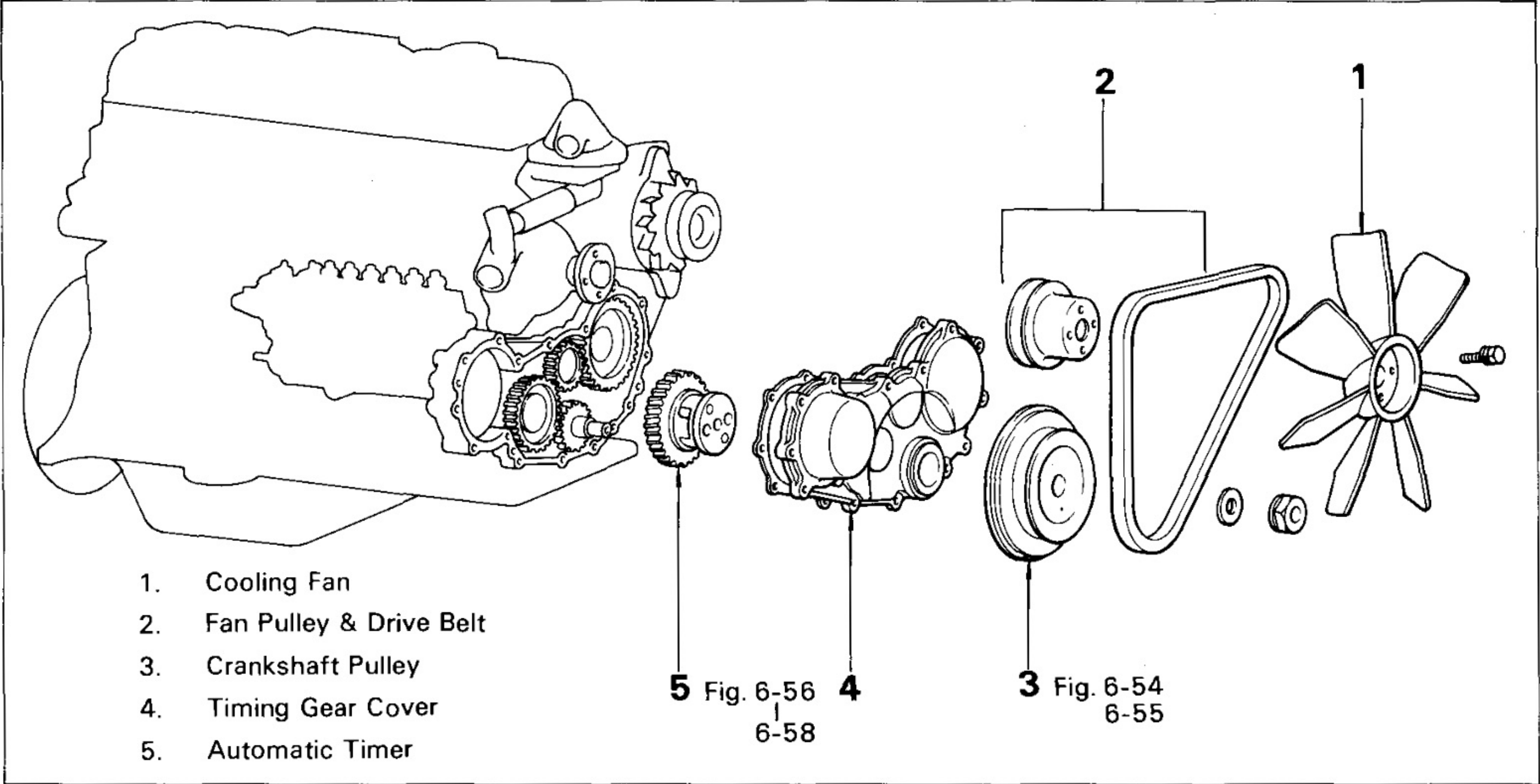
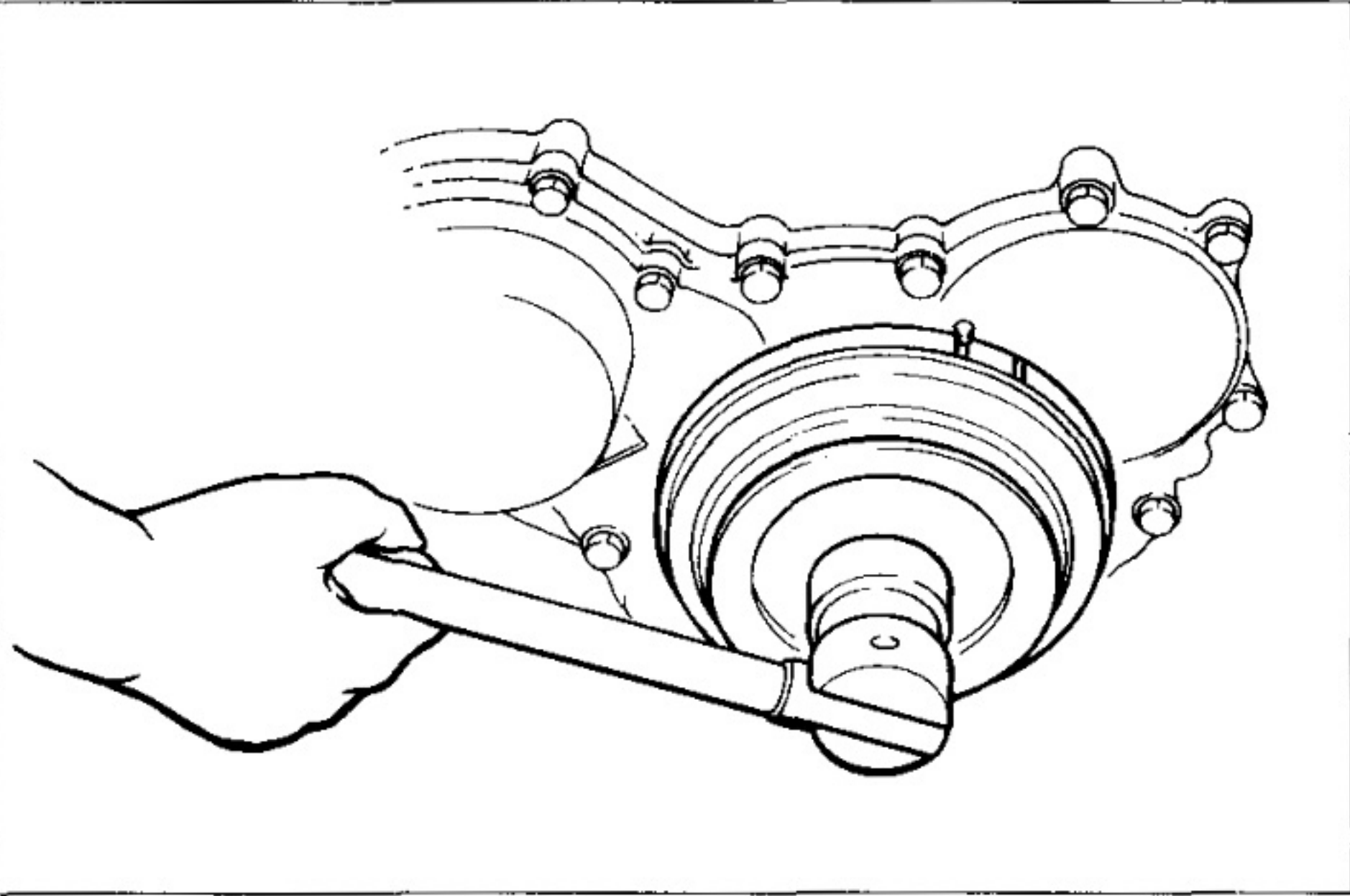


Fig. 6-54



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

Fig. 6-55



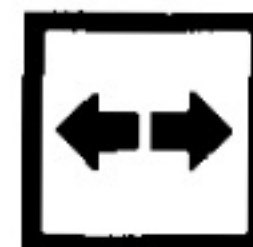
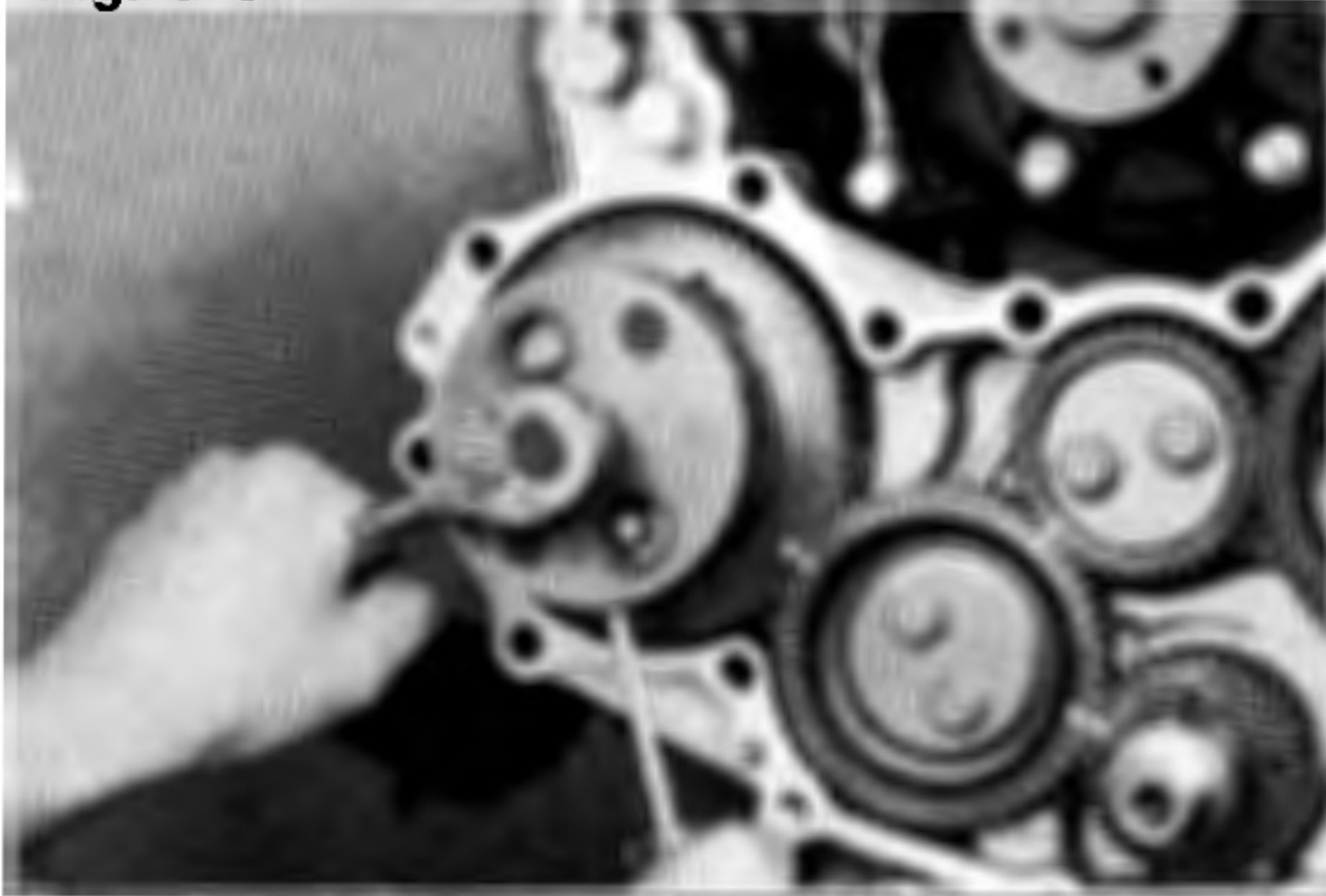
Pull out the crankshaft pulley with SST.
SST [09213-60016]

Fig. 6-56



Put matchmarks on each gear to facilitate reassembly.

Fig. 6-57



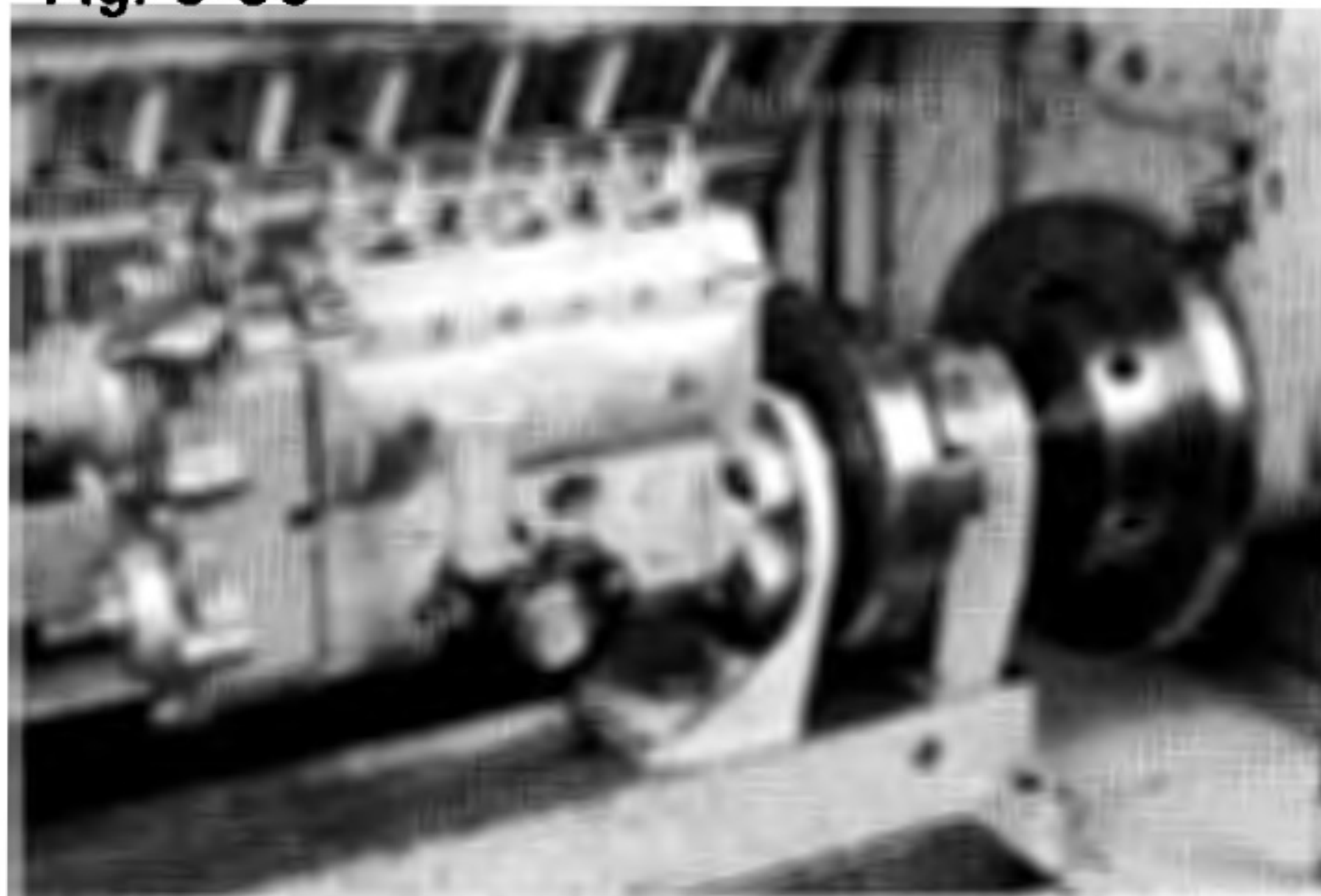
Hold the automatic timer with a screwdriver and remove the round nut.

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

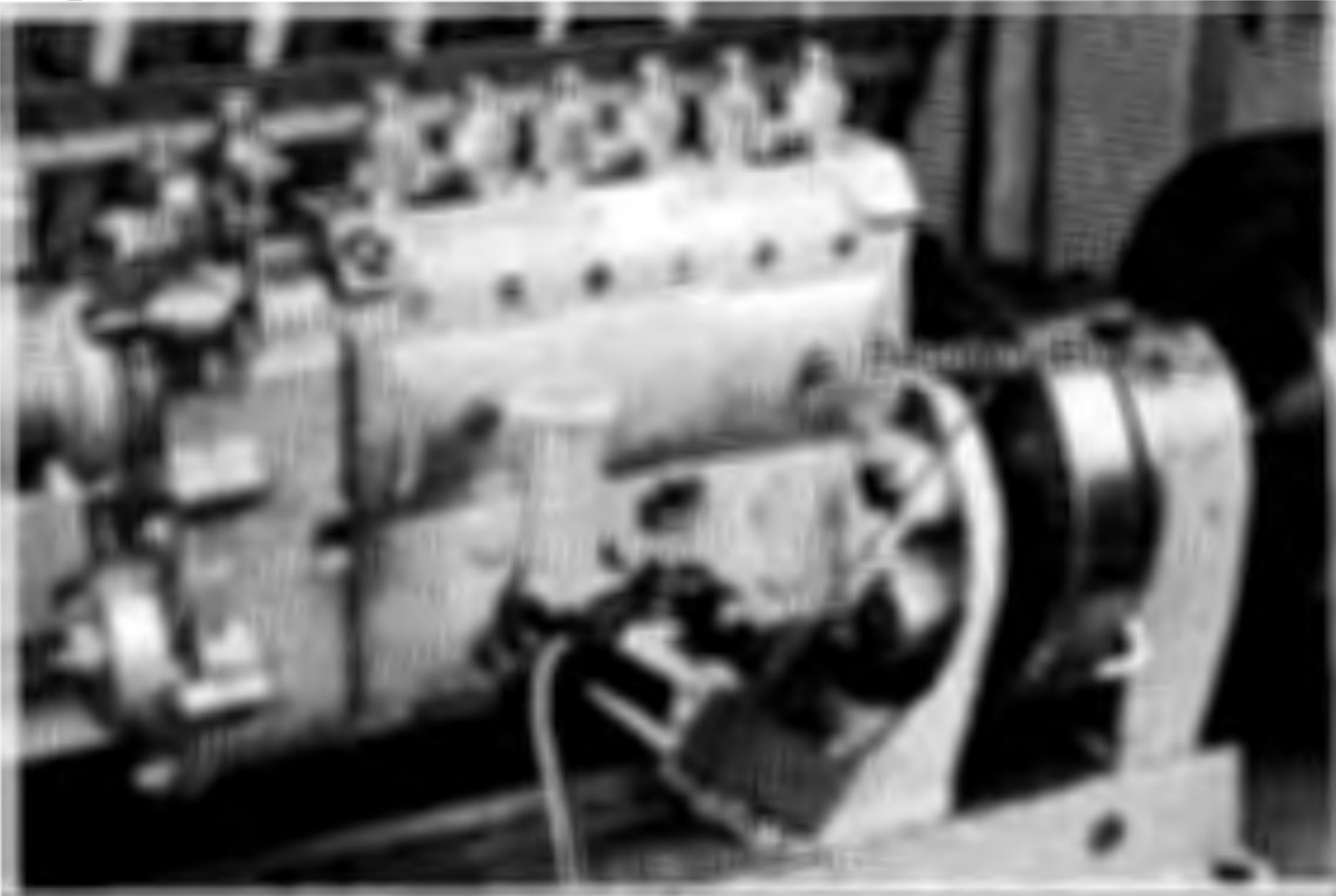


Fig. 6-61



Fig. 6-62

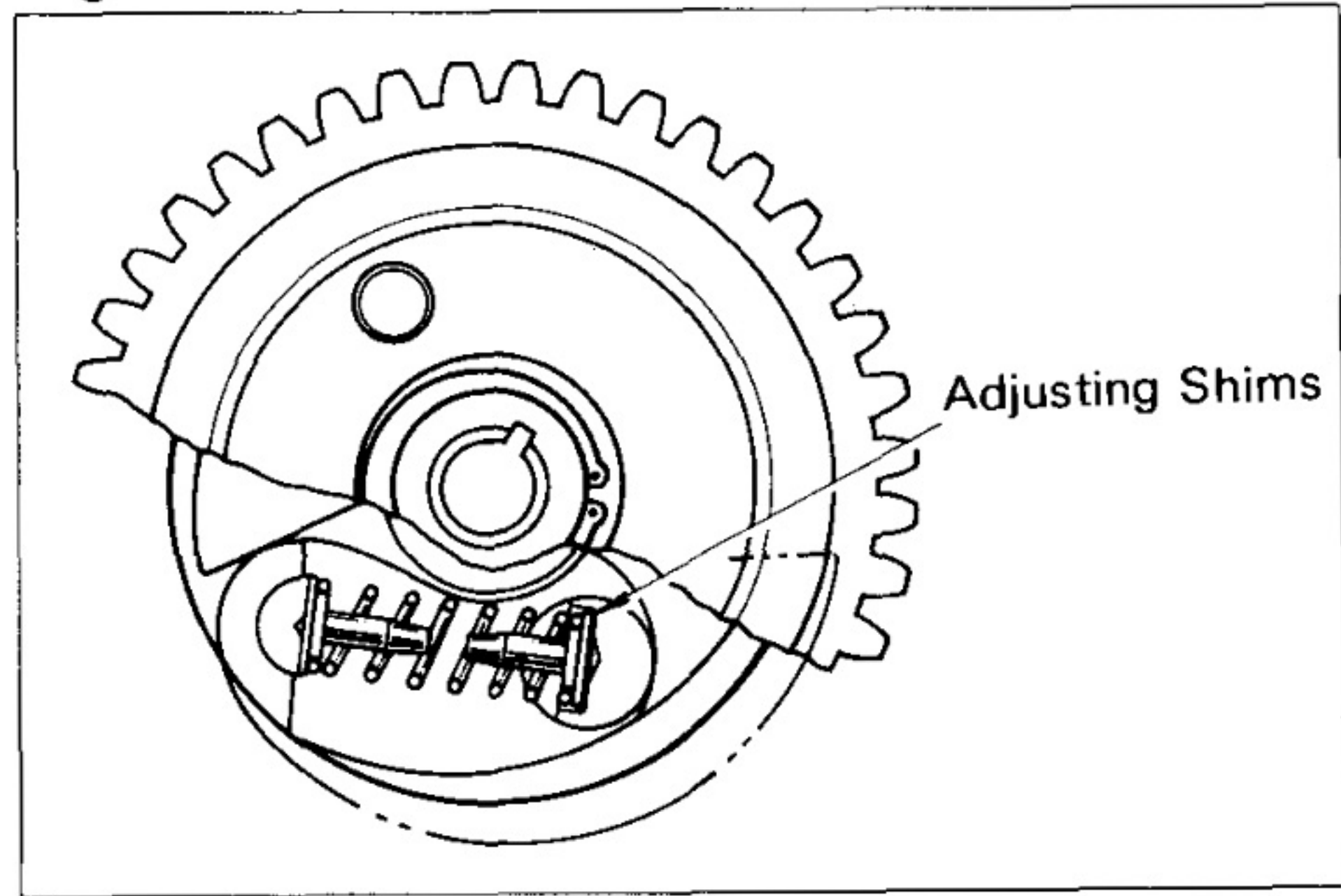
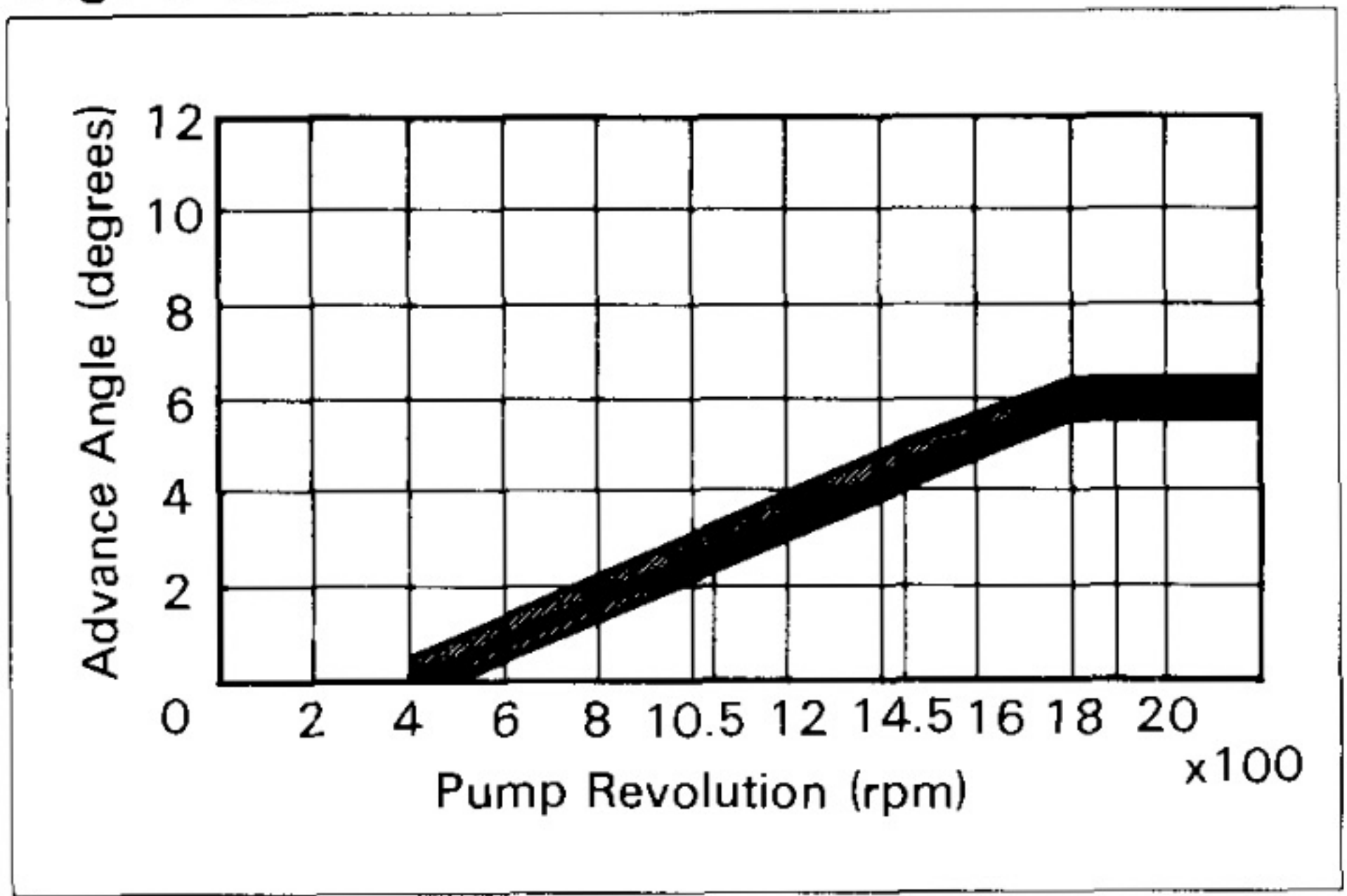


Fig. 6-63



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



4. Use a timing light to check advance angle.

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

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 careful that the springs and shims do not fly out.
When injection timing is advanced, increase shim thickness.

DISASSEMBLY

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

Fig. 6-64

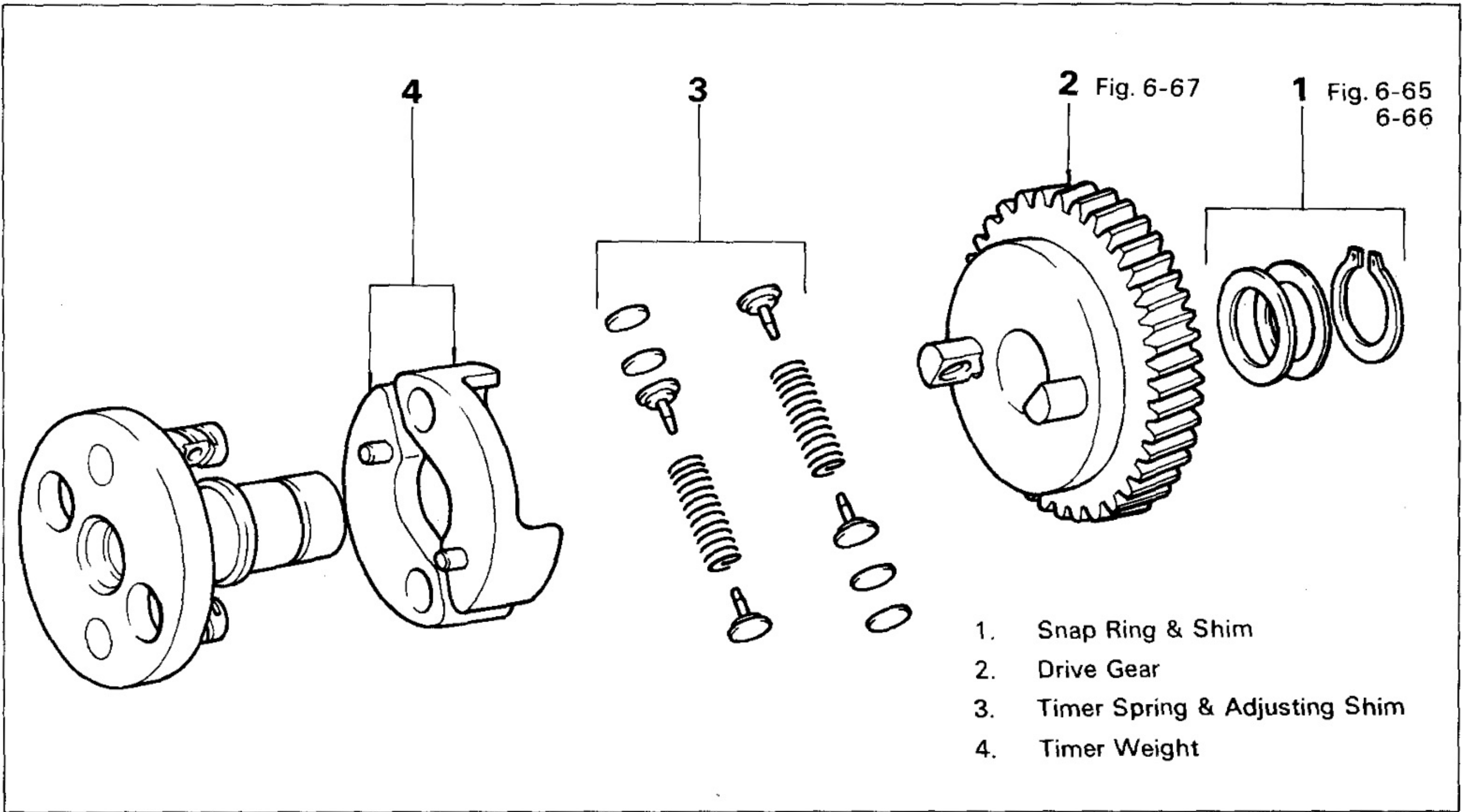


Fig. 6-65



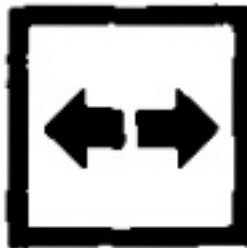
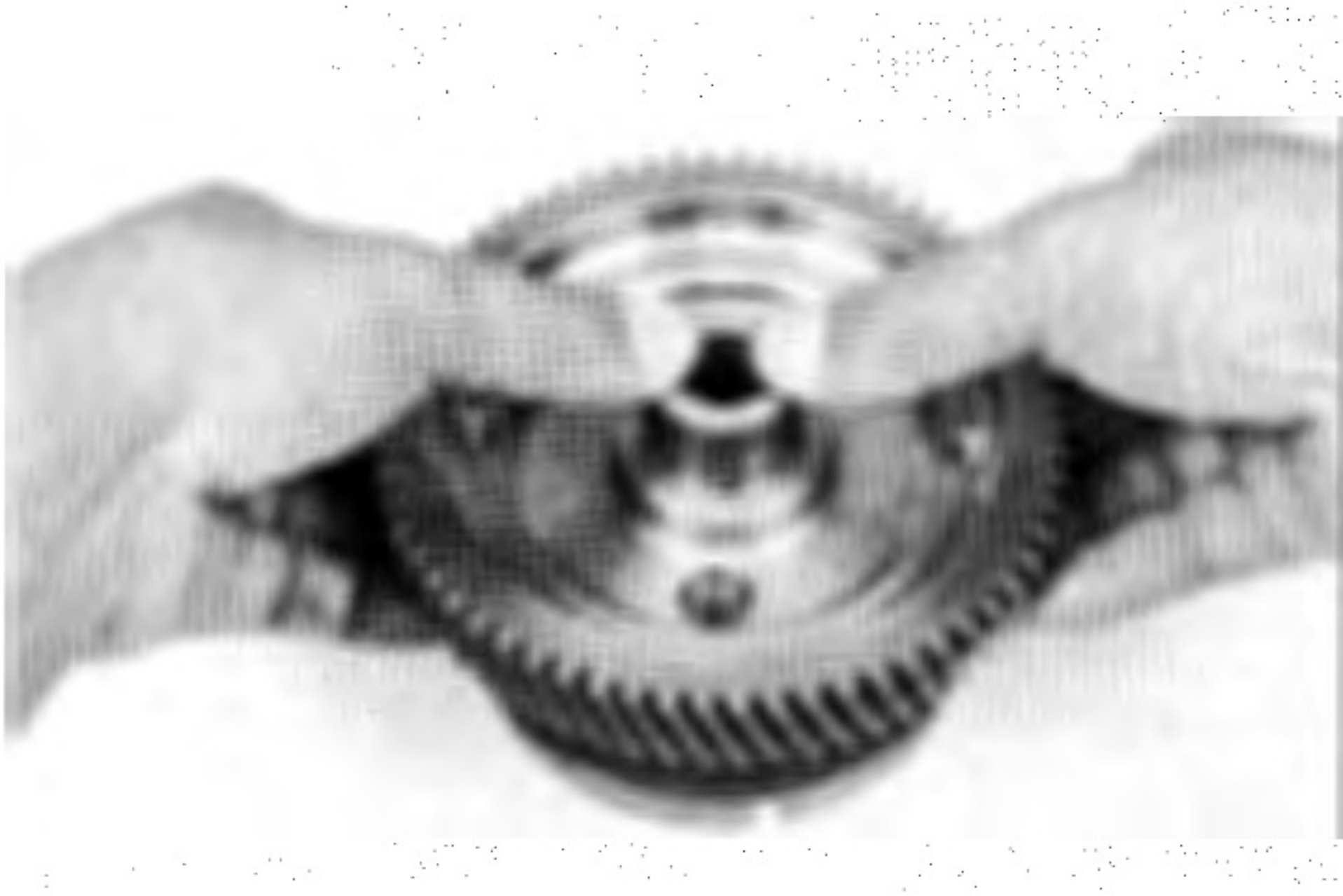
Place matchmarks on the timer hub and drive gear.

Fig. 6-66



Remove the snap ring with a snap ring expander.

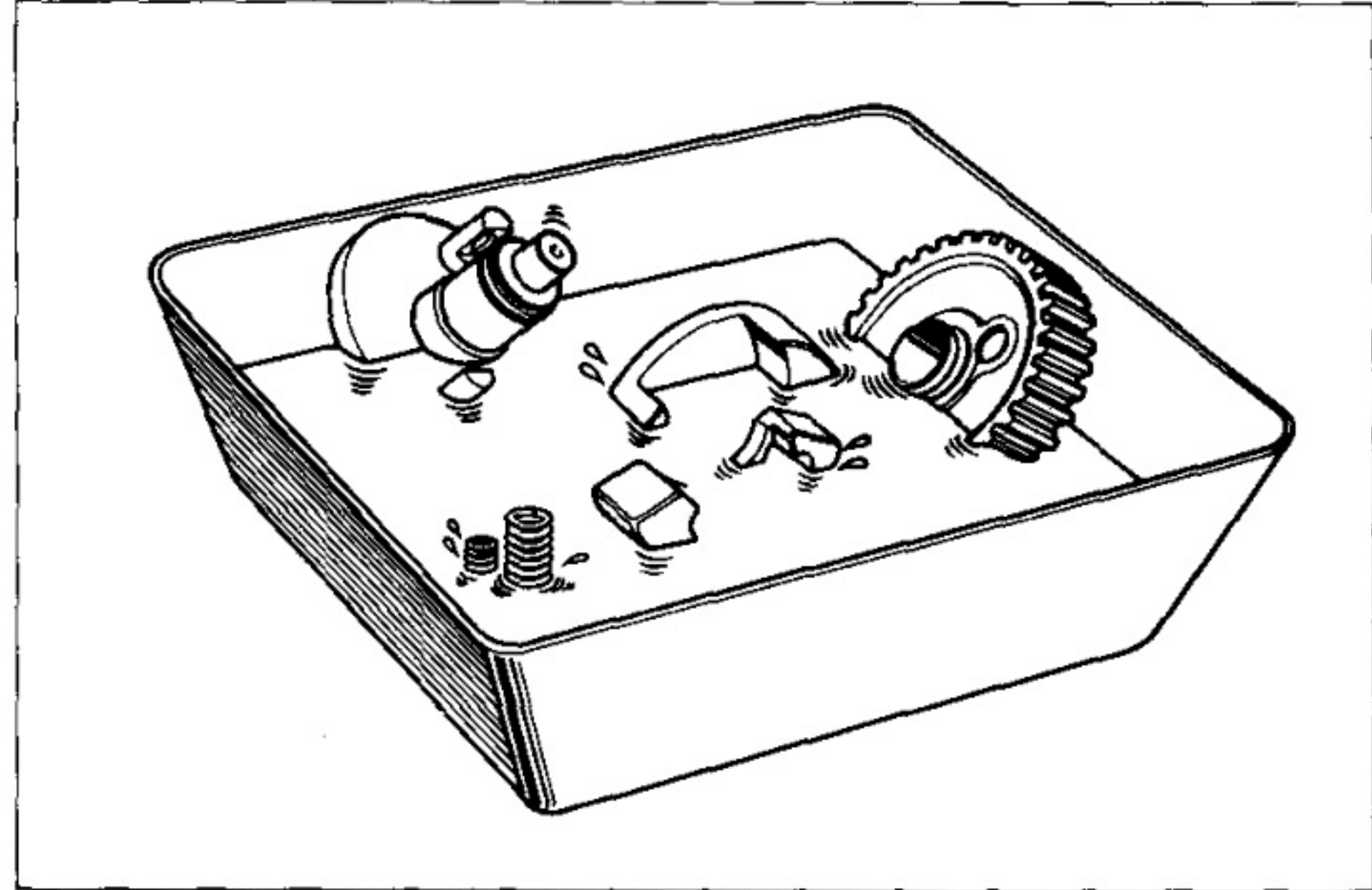
Fig. 6-67



Pull up the drive gear.

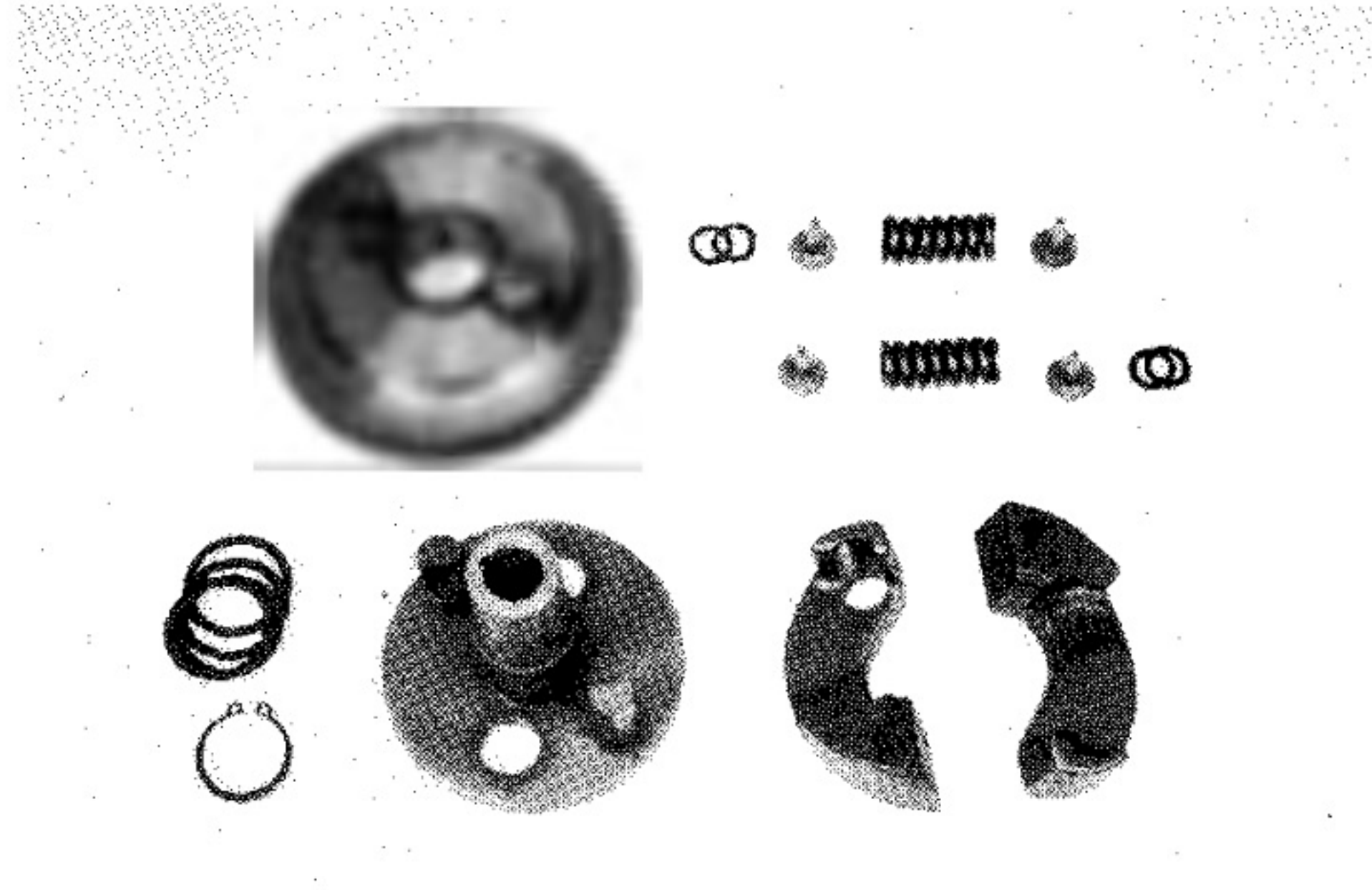
— Note —
Be careful that the springs and shims do not fly out.

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

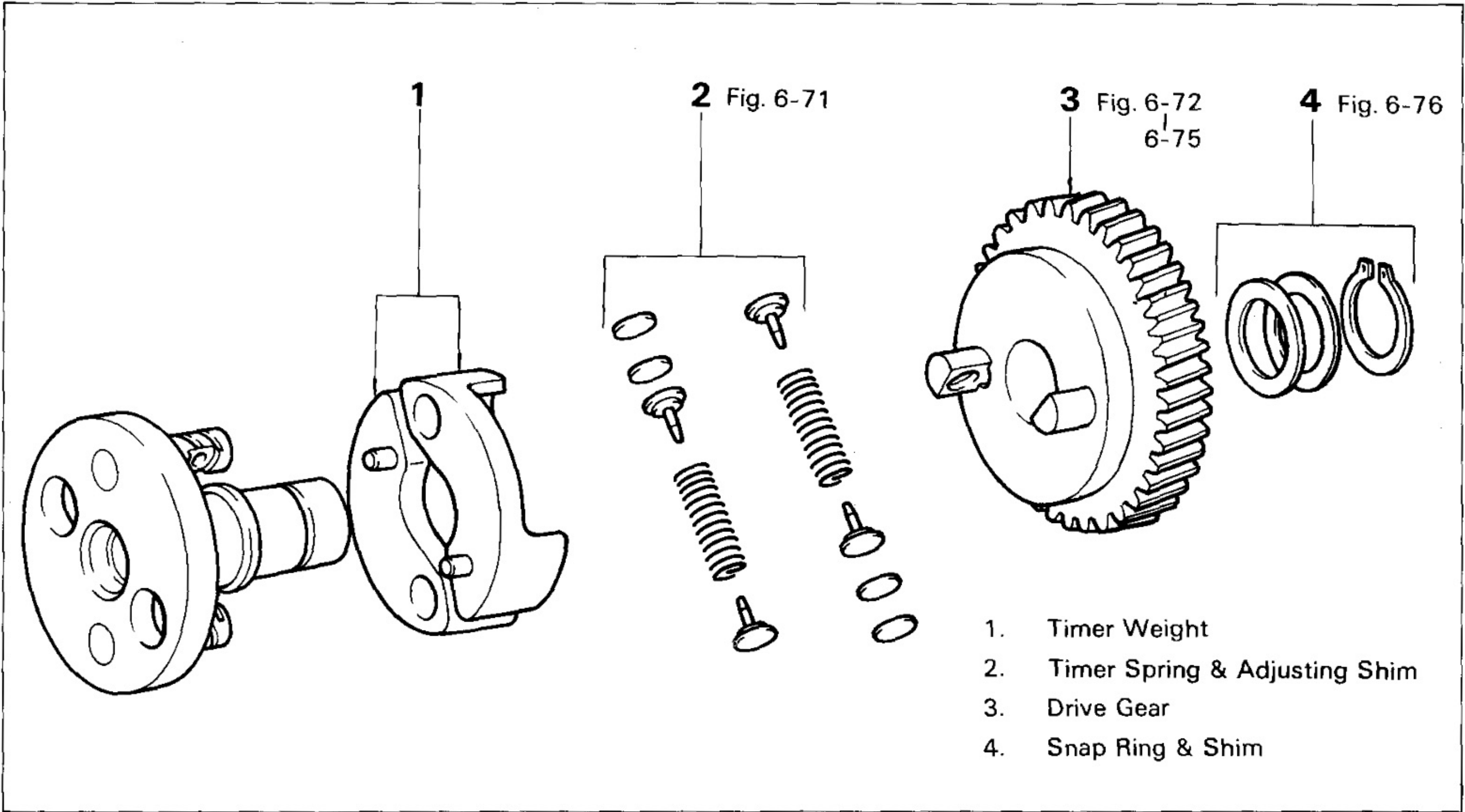
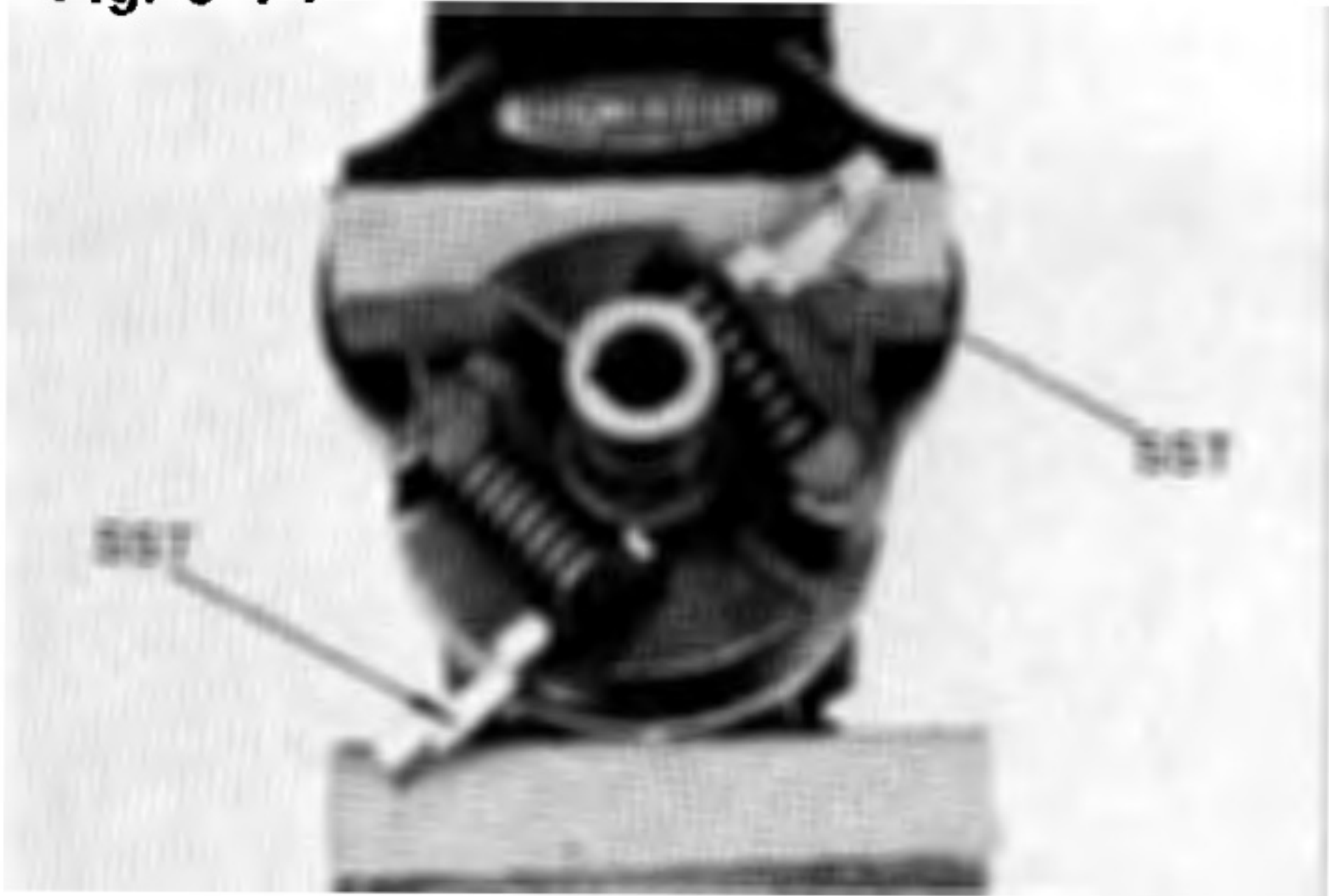
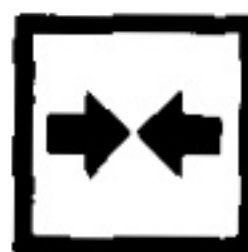
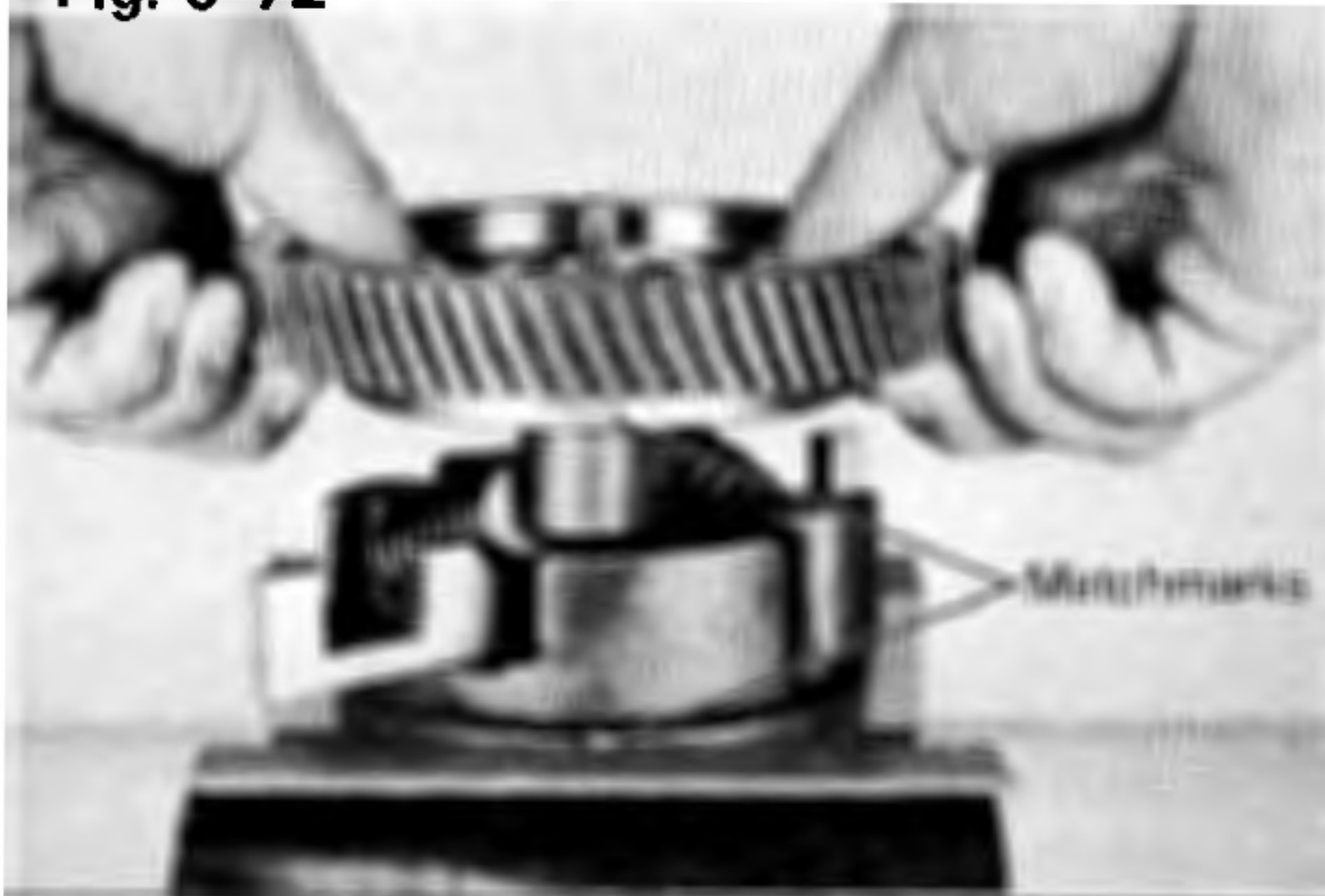


Fig. 6-71



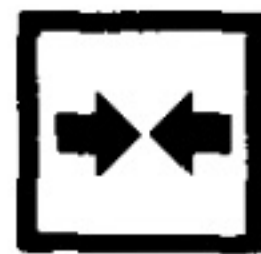
Set the timer springs, adjusting shims and spring seats with SST.
SST (09280-76010) of set [09260-76016]

Fig. 6-72



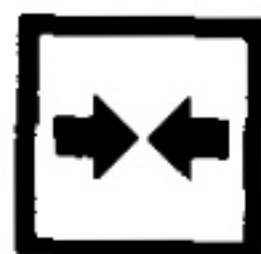
Align the matchmarks of the drive gear with that of the timer hub.

Fig. 6-73



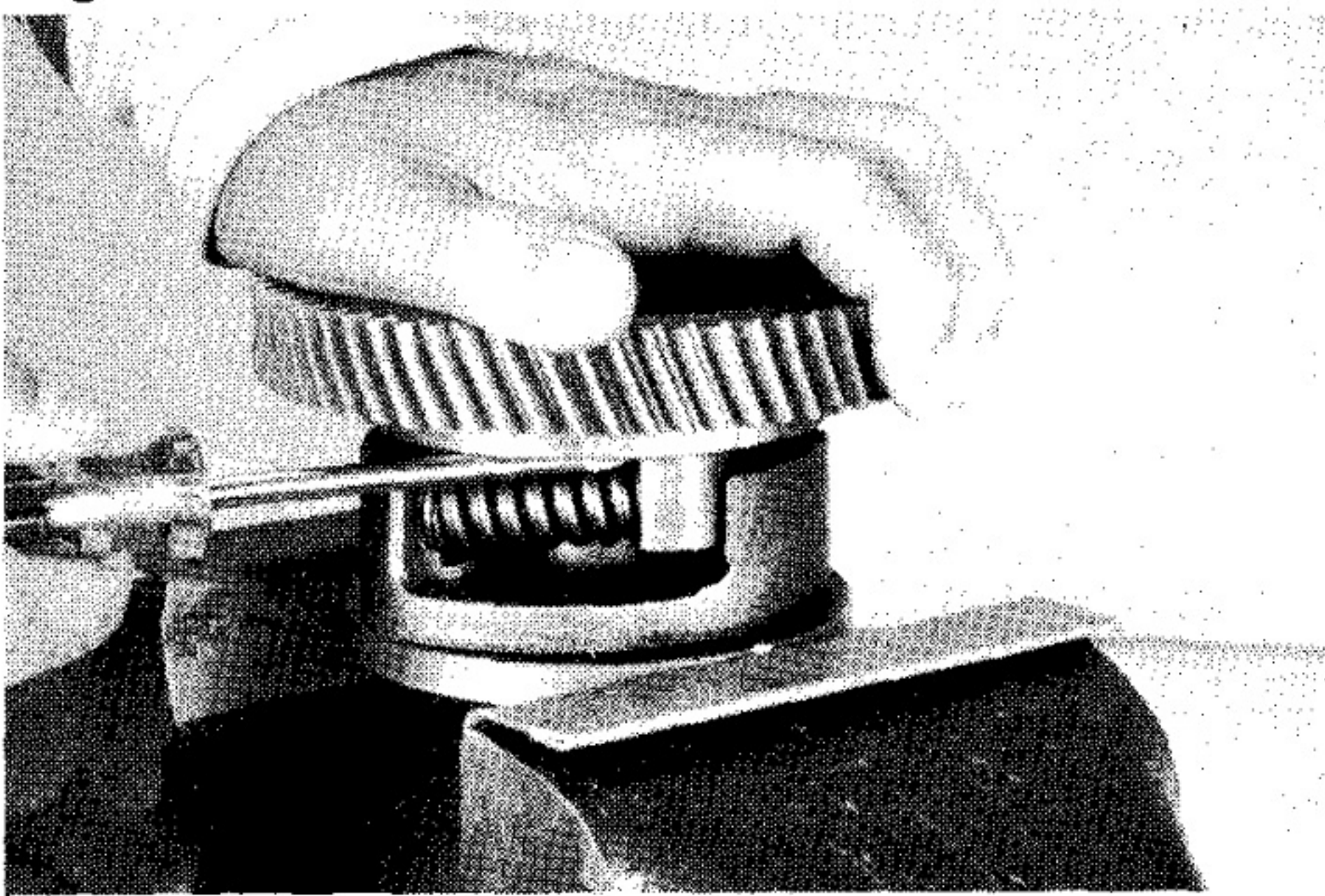
Hold the drive gear so that the springs will not fall out and remove SST.

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

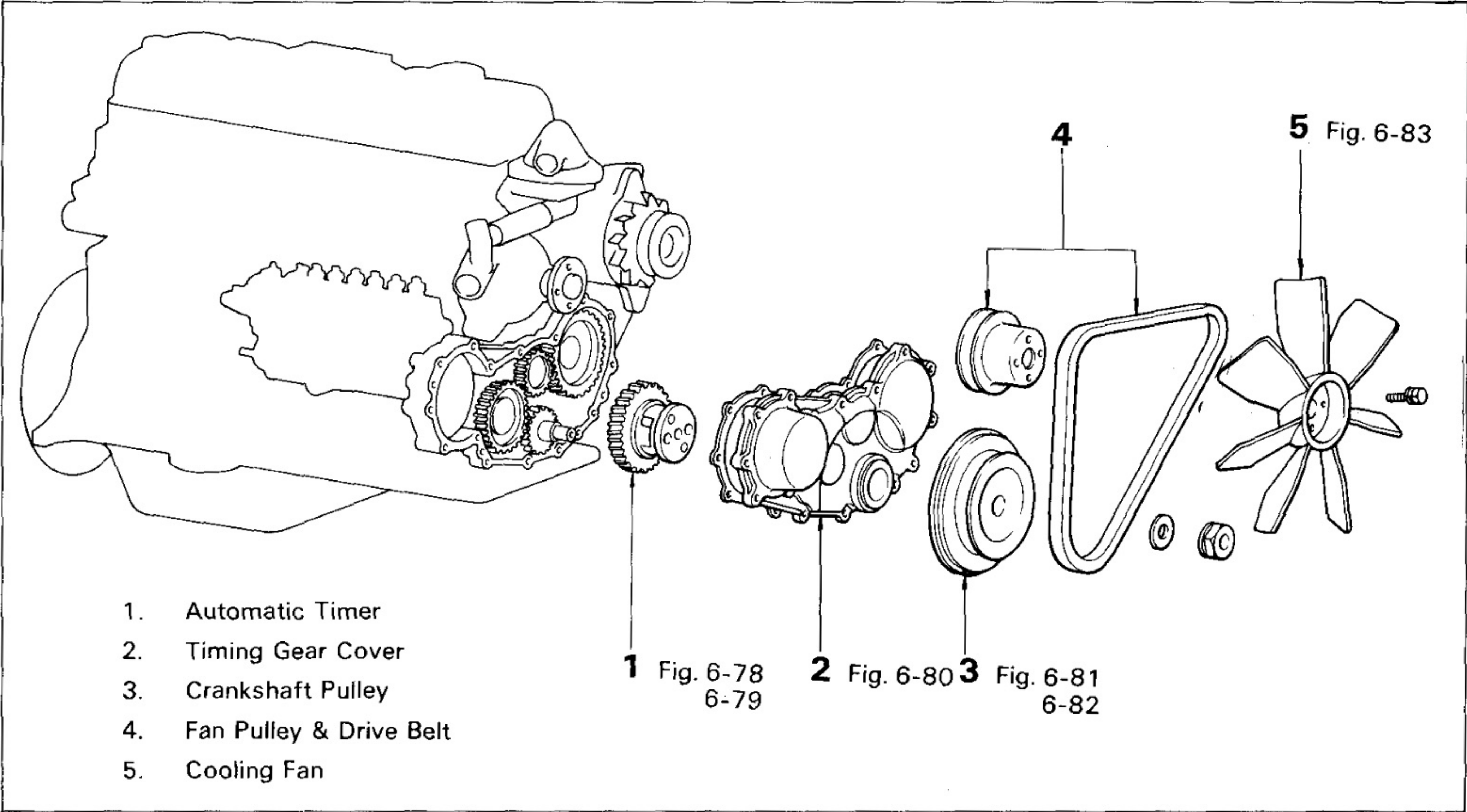


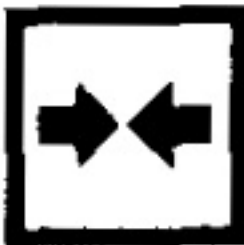
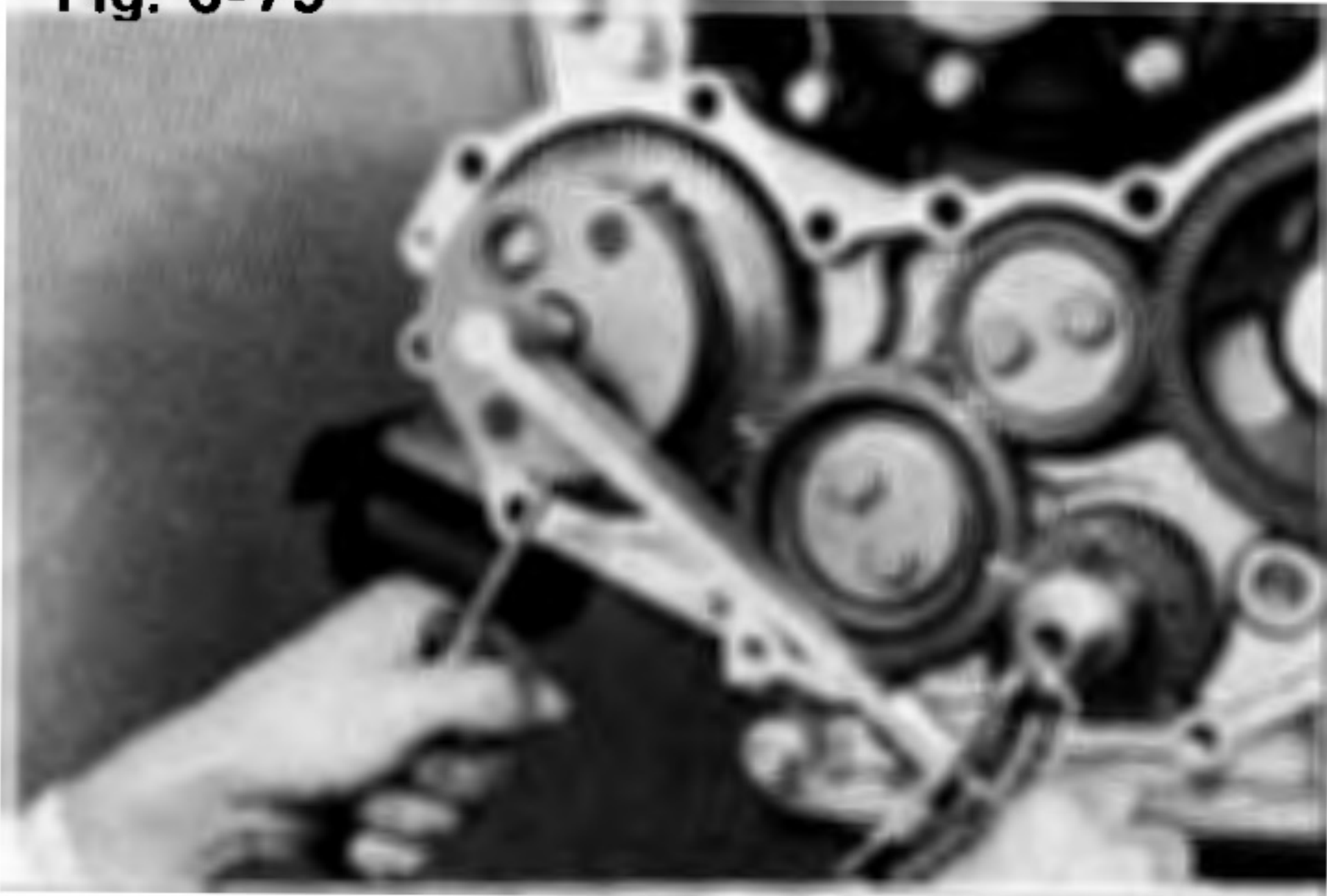
Fig. 6-78



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)

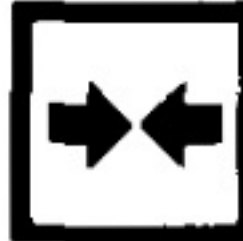
— Note —
Apply a light coating of engine oil on the contacting surface of the round nut before tightening.

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.

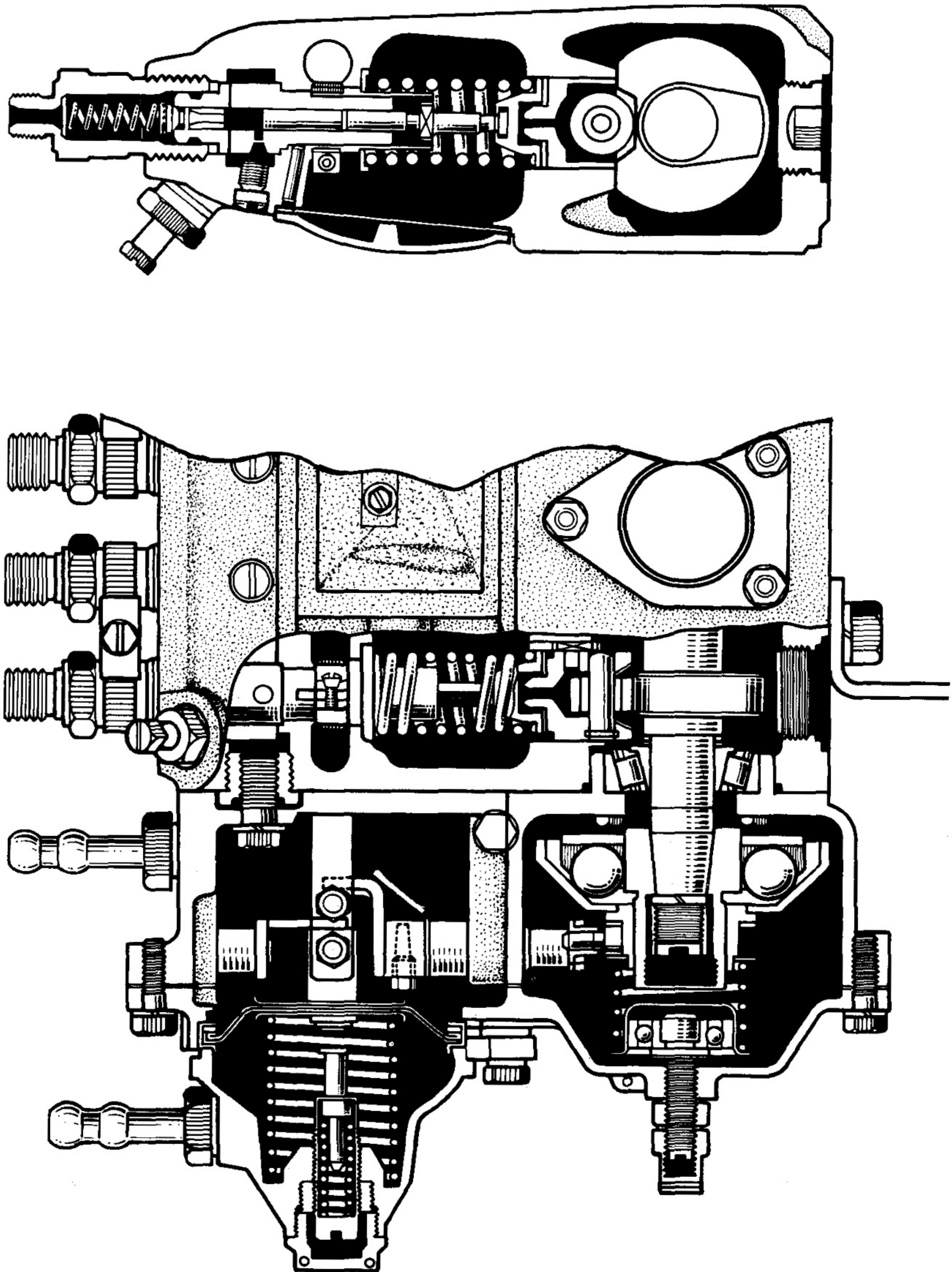
Fig. 6-83

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

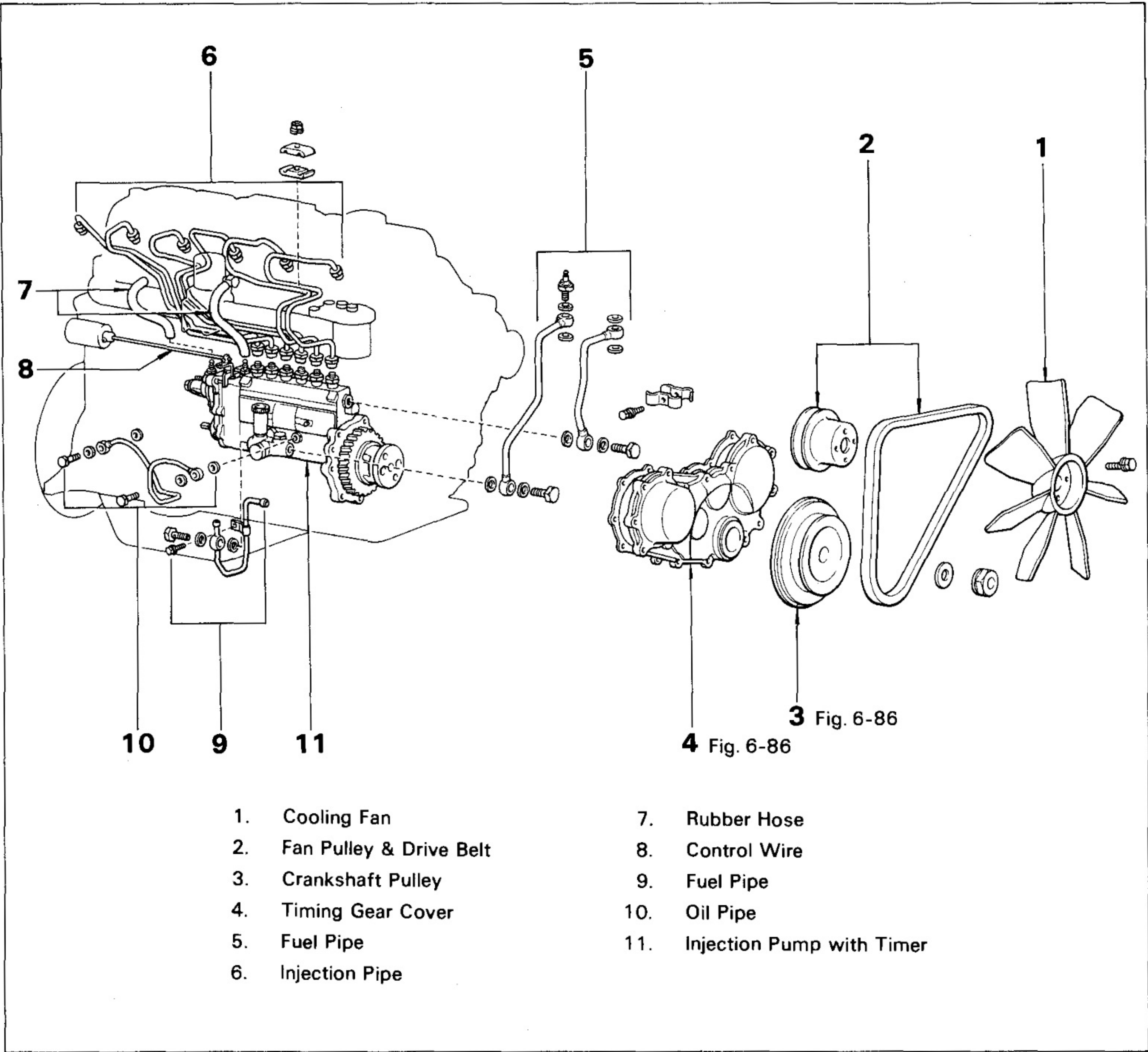


Fig. 6-86

Remove the timing gear cover.

AUTOMATIC TIMER

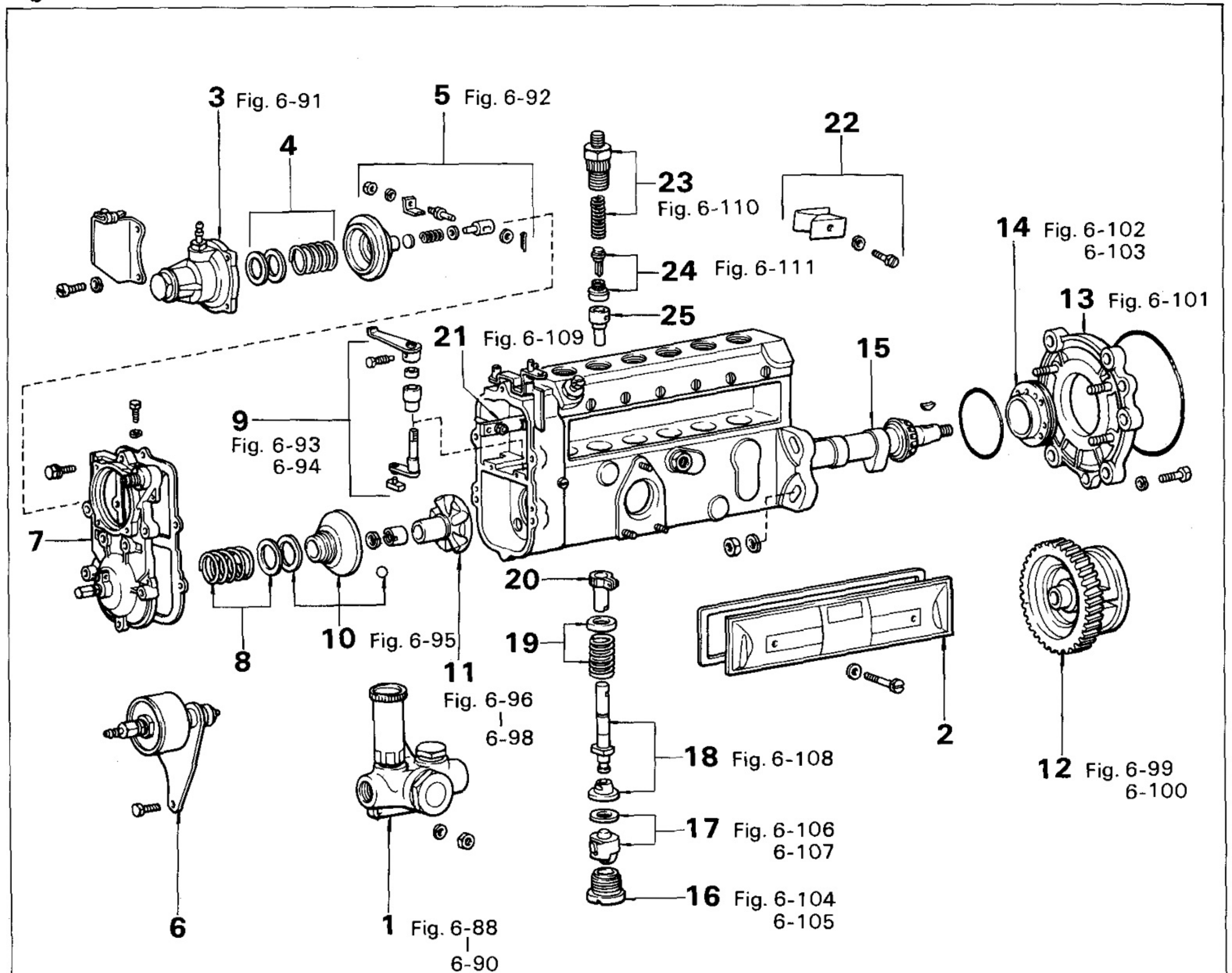
REMOVAL

SECTION

Fig. 6-53 to 6-56

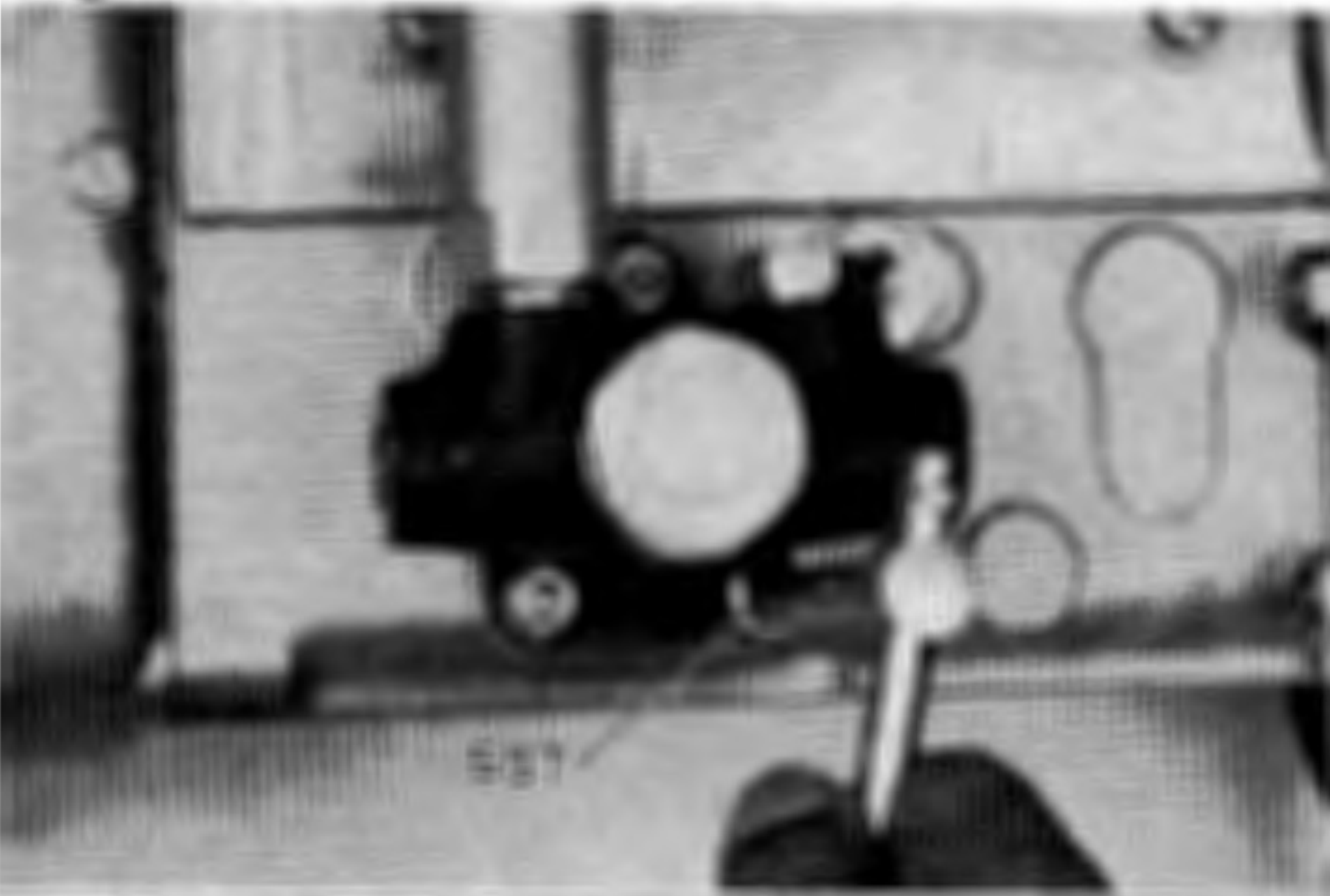
DISASSEMBLY

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

Fig. 6-87

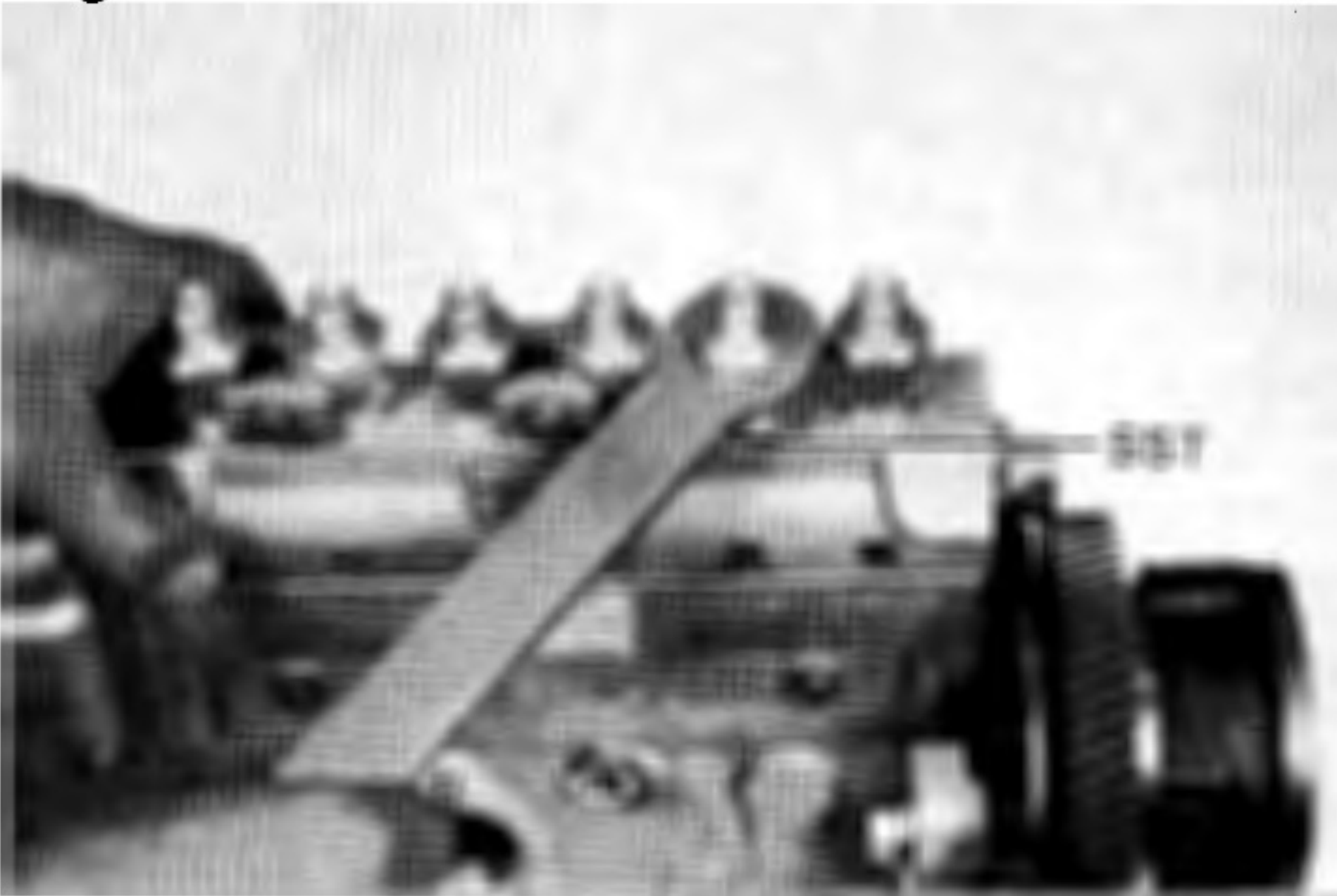
- | | |
|---------------------------------|------------------------------------|
| 1. Fuel Feed Pump | 14. Bearing Cover |
| 2. Injection Pump Cover | 15. Camshaft |
| 3. Diaphragm Housing | 16. Plug |
| 4. Main Spring & Adjusting Shim | 17. Tappet |
| 5. Diaphragm & Connecting Rod | 18. Plunger & Lower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

Fig. 6-88



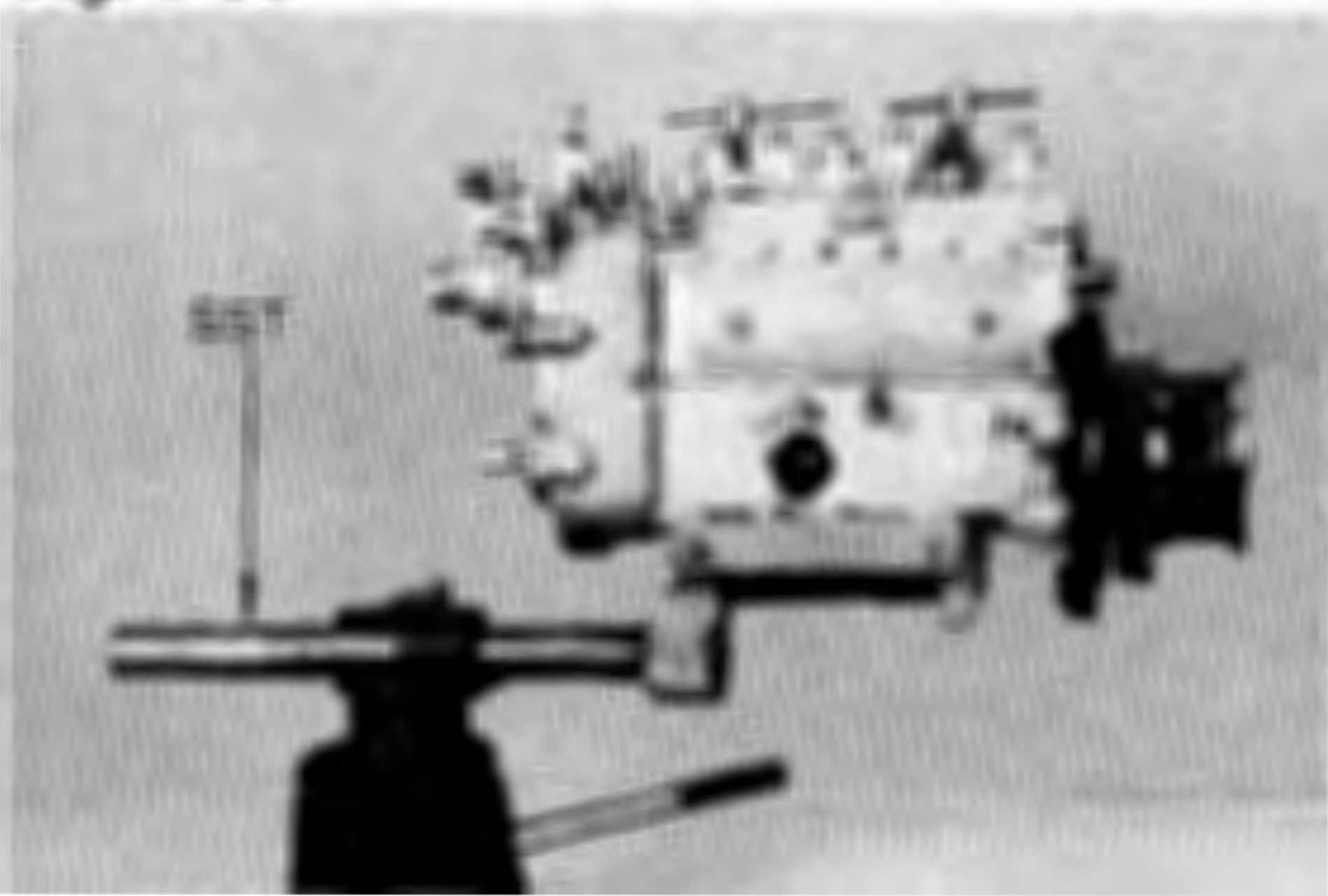
Remove the fuel feed pump with SST.
SST (09276-76010) of set [09260-76016]

Fig. 6-89



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

Fig. 6-90



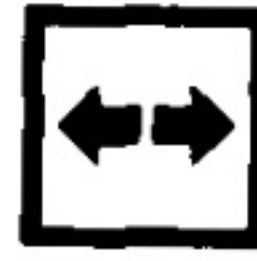
Install the injection pump to the SST.
SST [09241-76021]

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

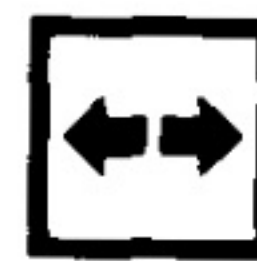


Disconnect the diaphragm from the control rack.

— Note —

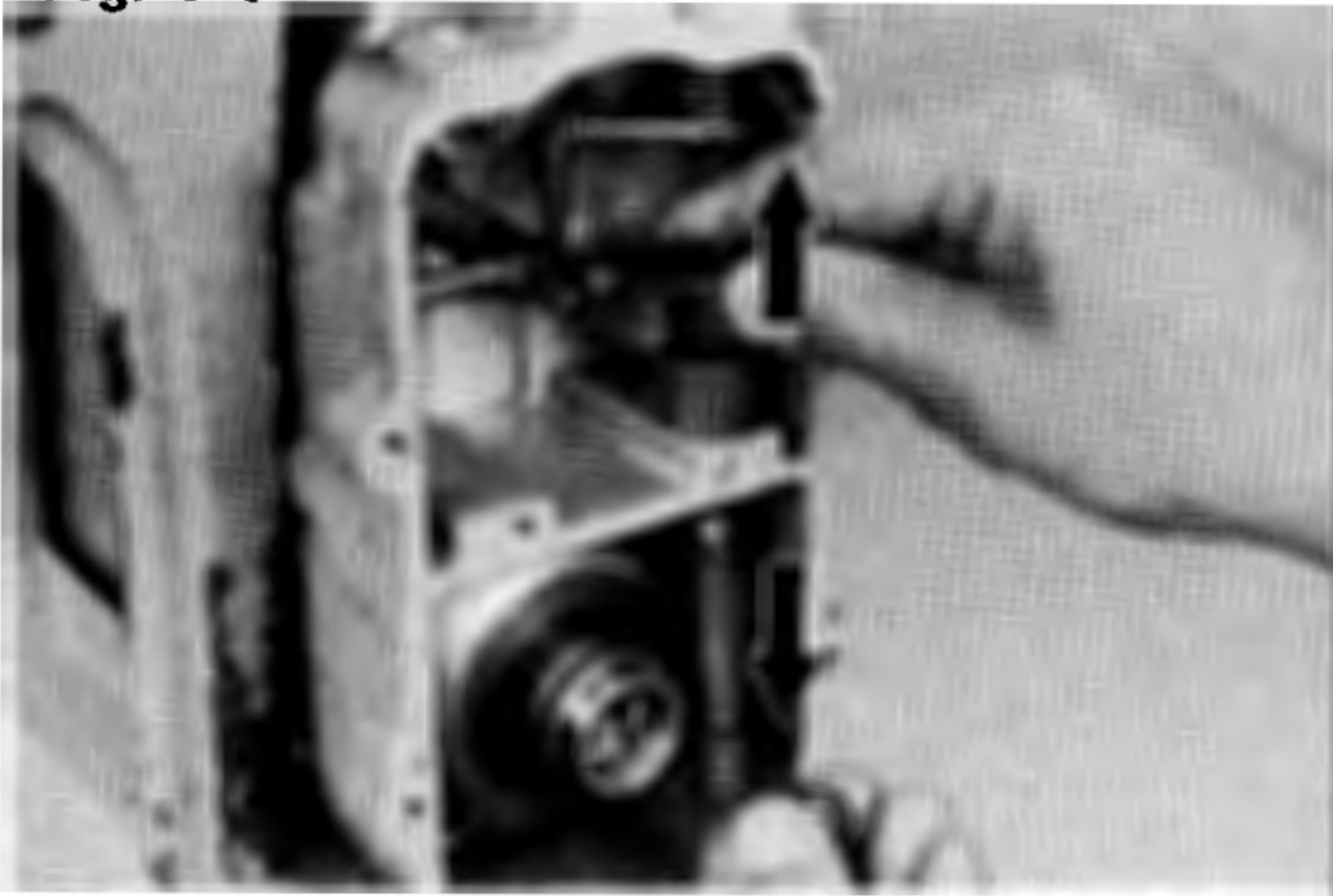
Do not allow any engine oil, fuel or grease to get on the diaphragm.

Fig. 6-93



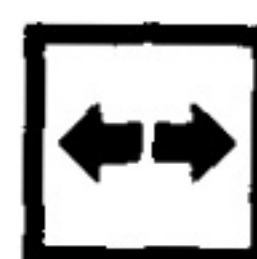
Remove the stop lever bolt with a 6 mm socket wrench.

Fig. 6-94



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

Fig. 6-95

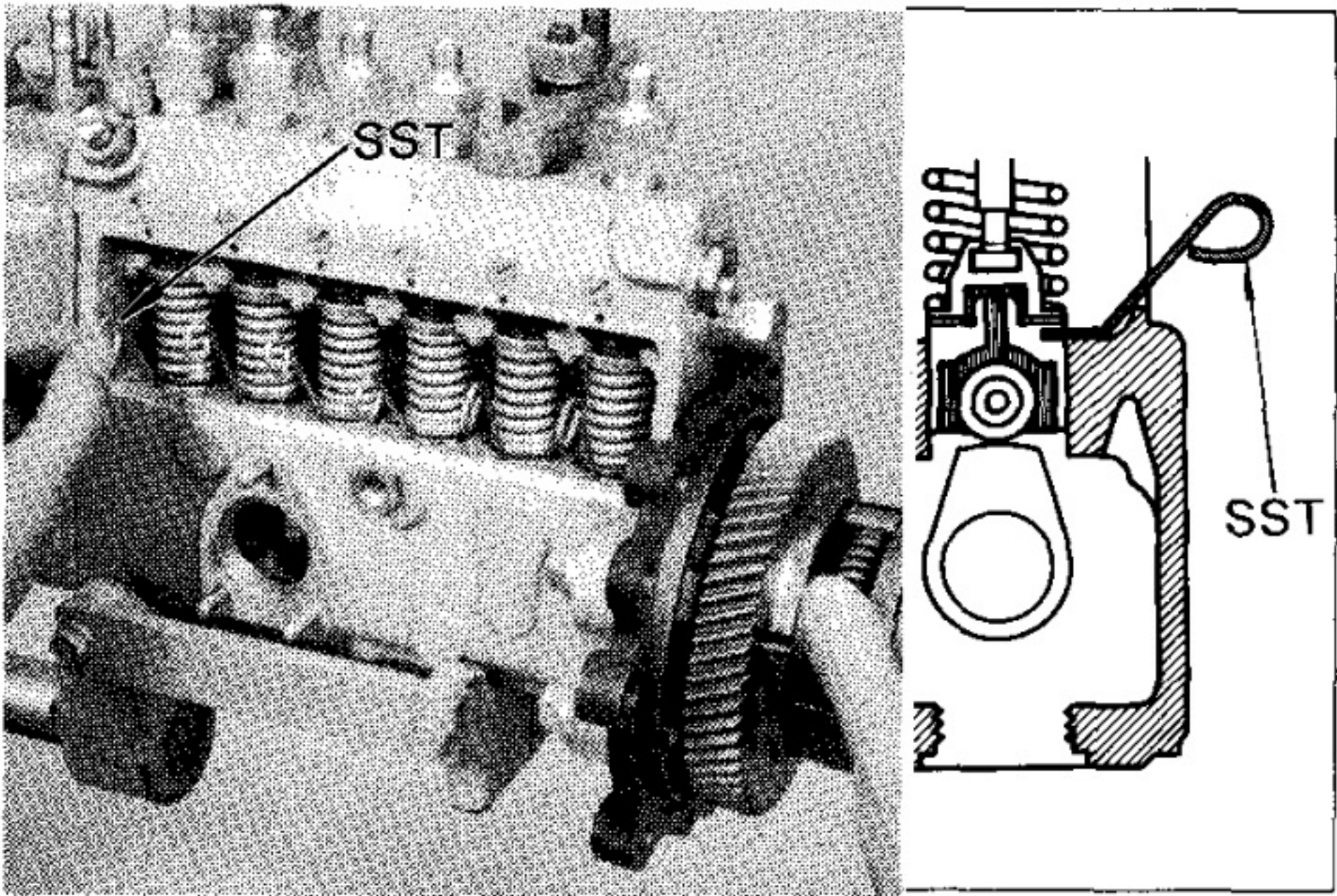


Remove the spring seat and slider, and then take out the six steel balls.

— Note —

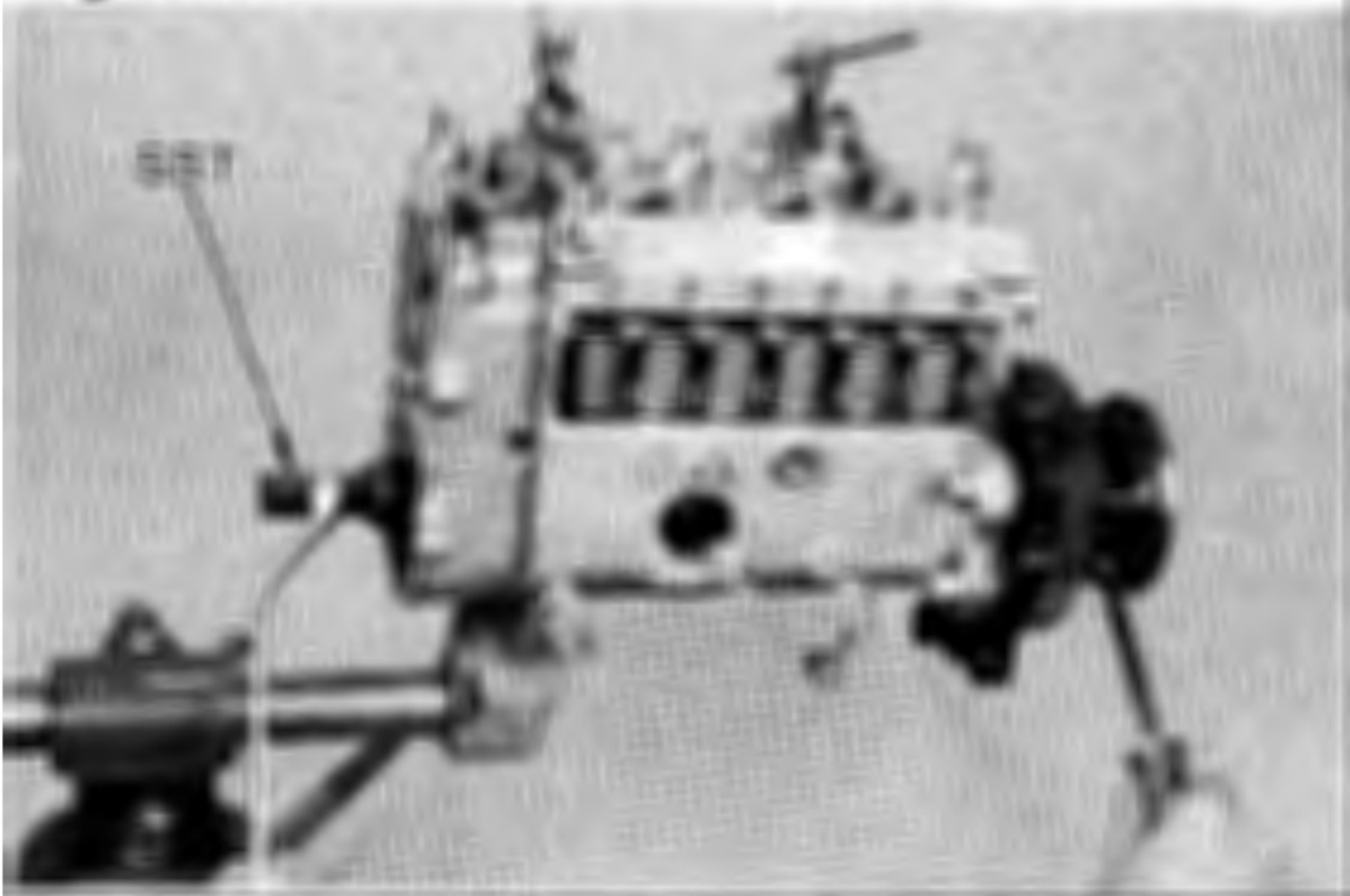
Do not drop the steel balls.

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]

Fig. 6-97



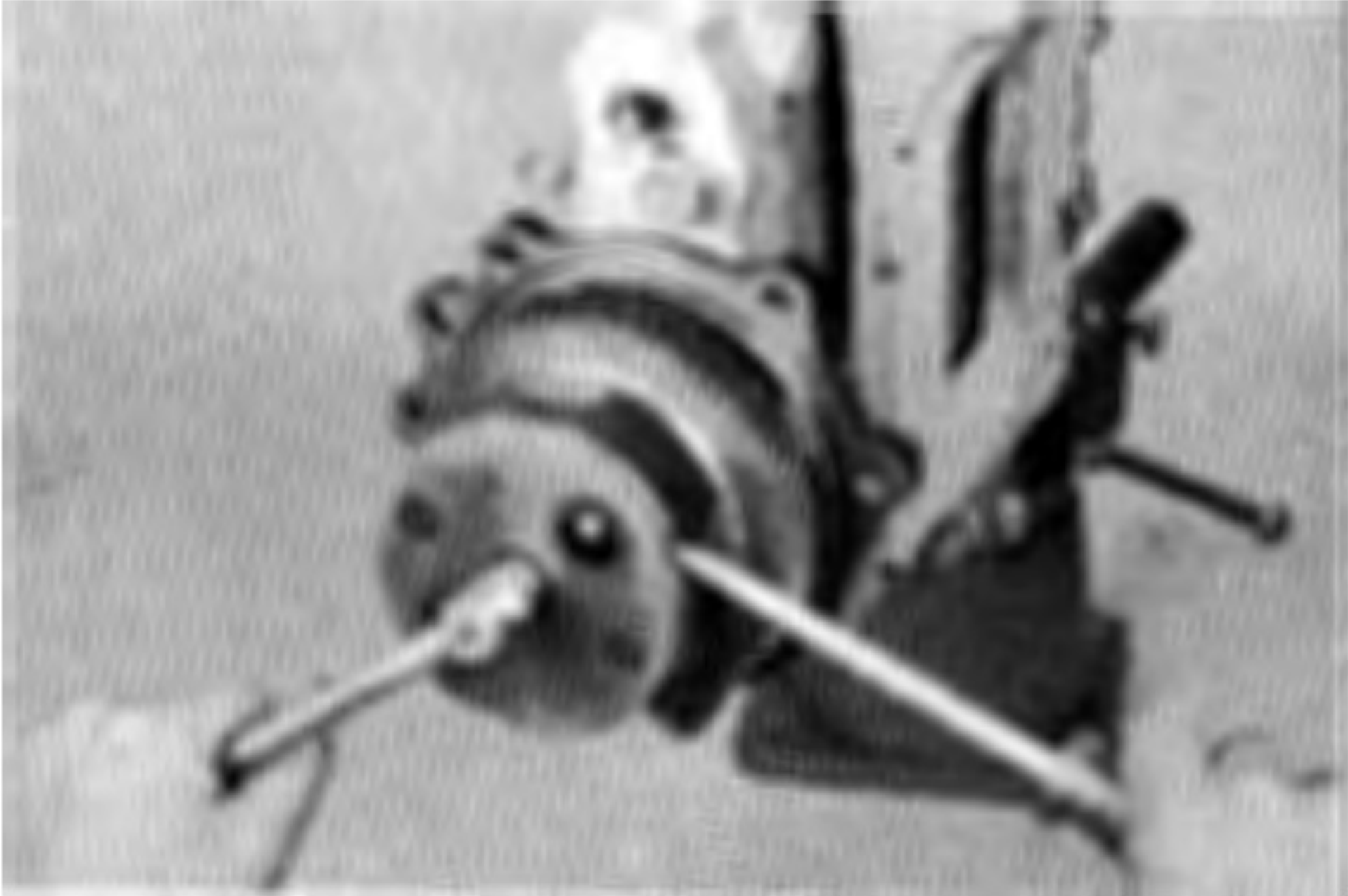
Hold the automatic timer with a screwdriver and remove the round nut with SST.
SST (09266-67011) of set [09260-76016]

Fig. 6-98



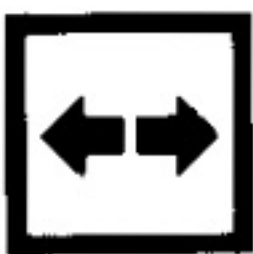
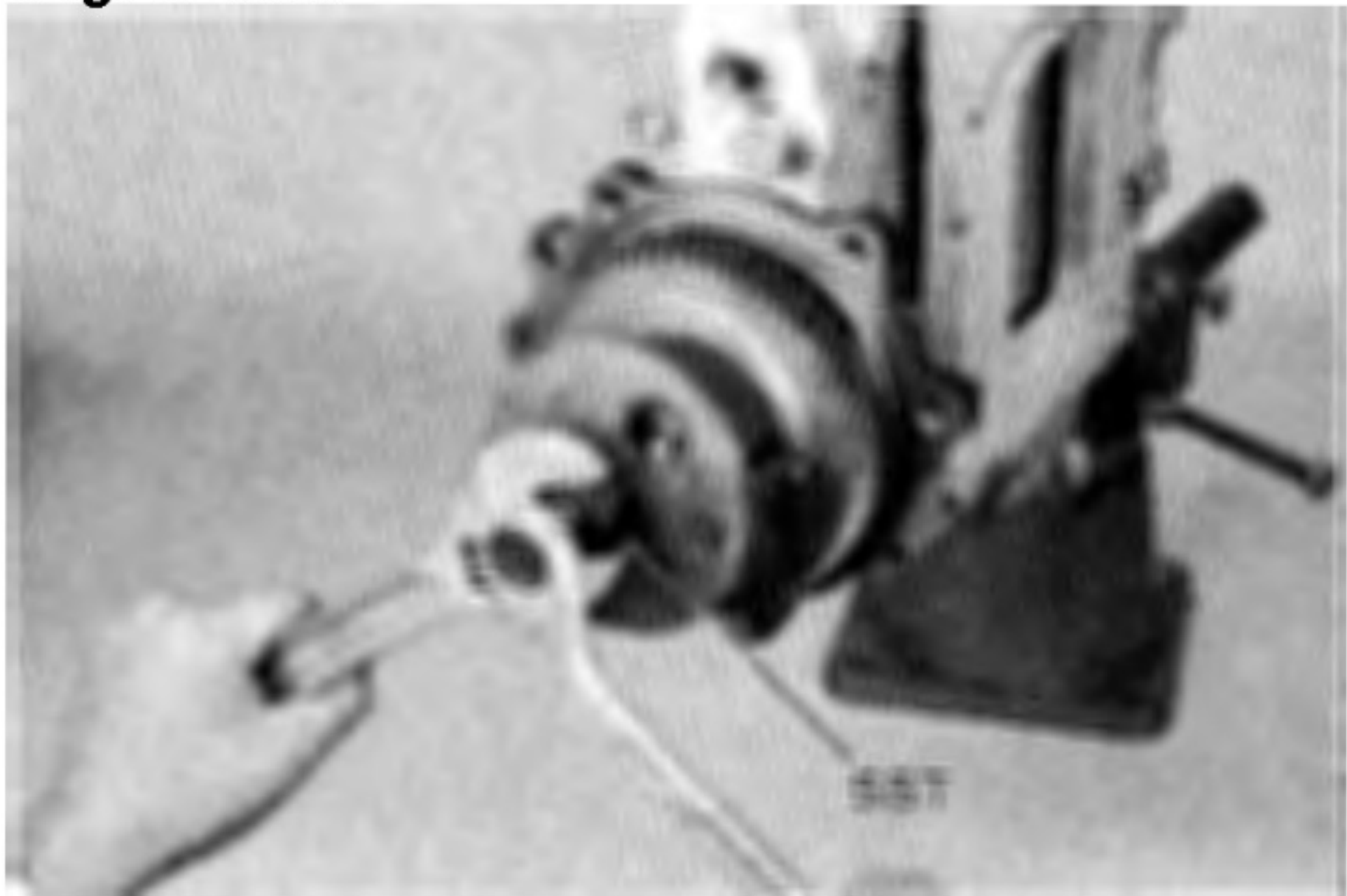
Pull out the ball guide with SST.
SST (09267-76011) of set [09260-76016]

Fig. 6-99



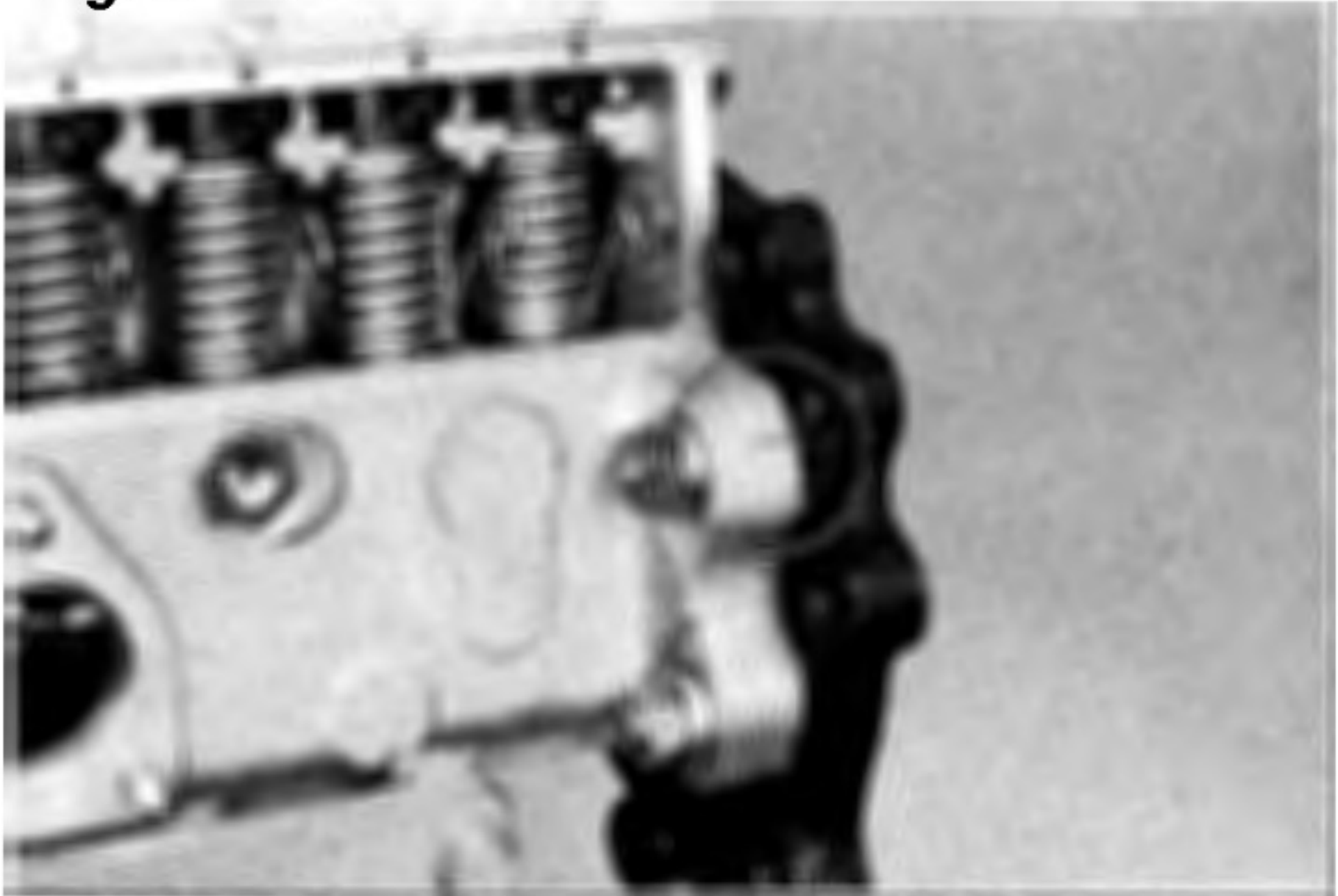
Hold the automatic timer with a screwdriver and remove the round nut.

Fig. 6-100



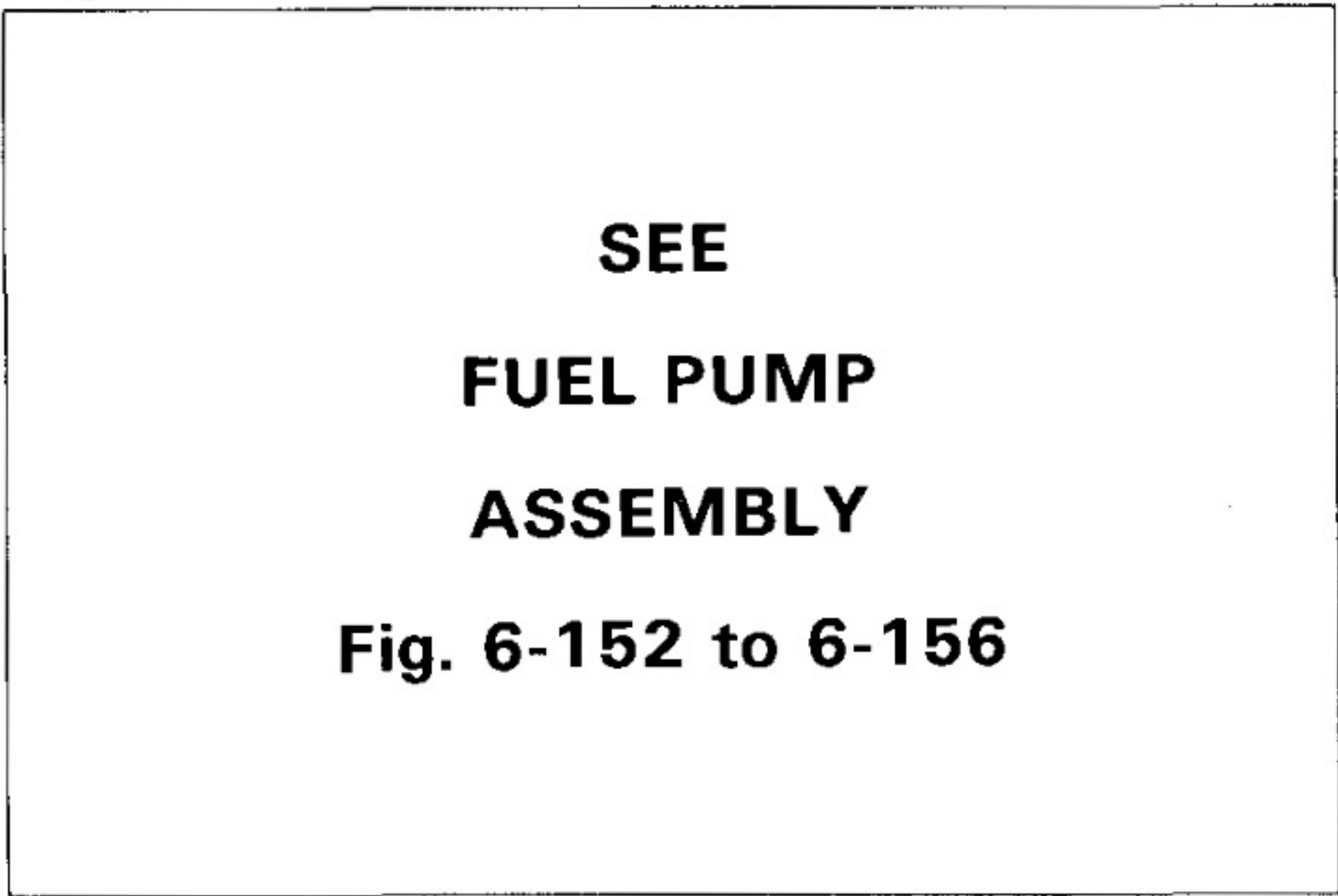
Pull out the automatic timer with SST.
SST[09267-76020]

Fig. 6-101



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

Fig. 6-102



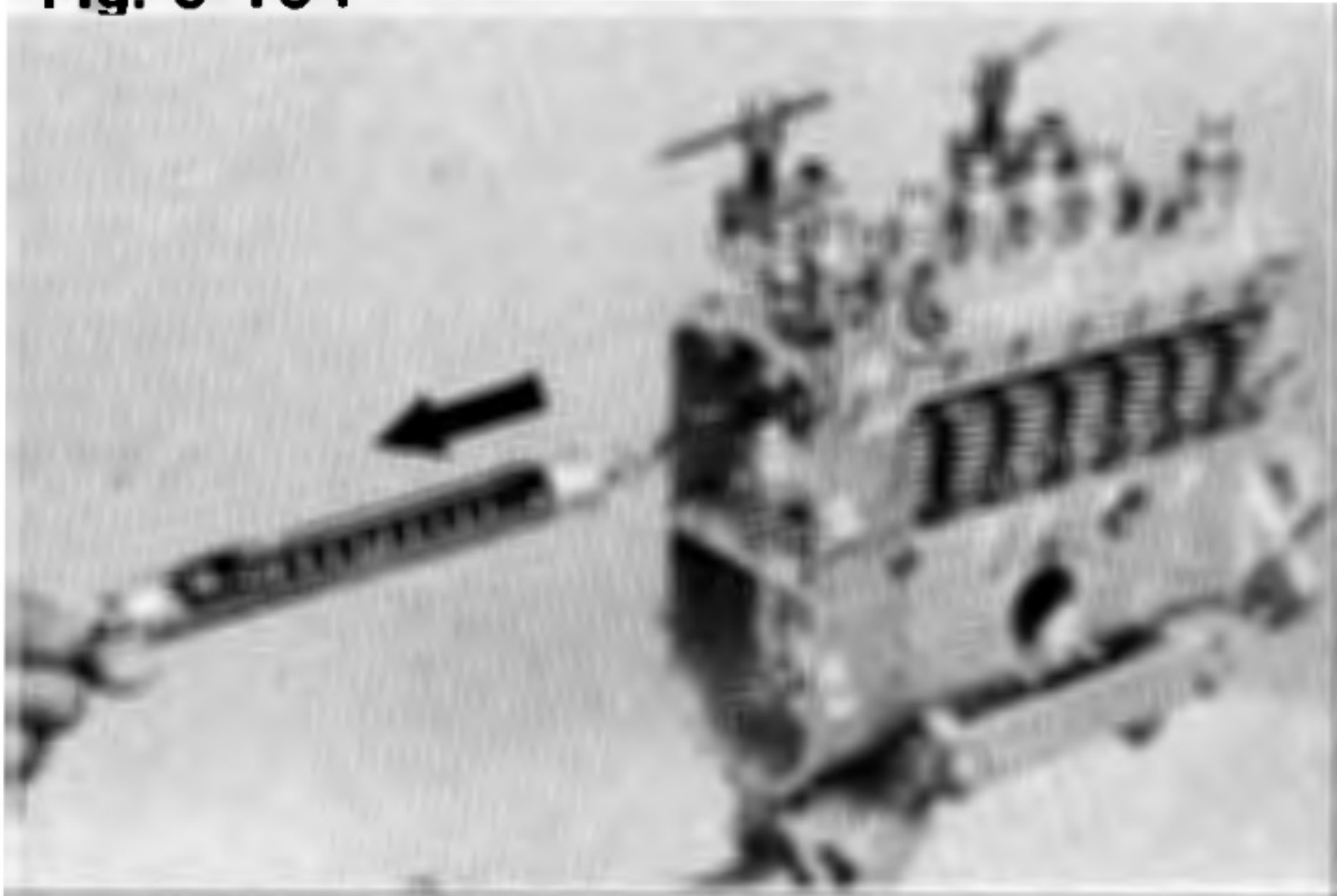
Before removing the bearing cover, measure
the thrust clearance and refer to this value
when inspecting or reassembling.

Fig. 6-103



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

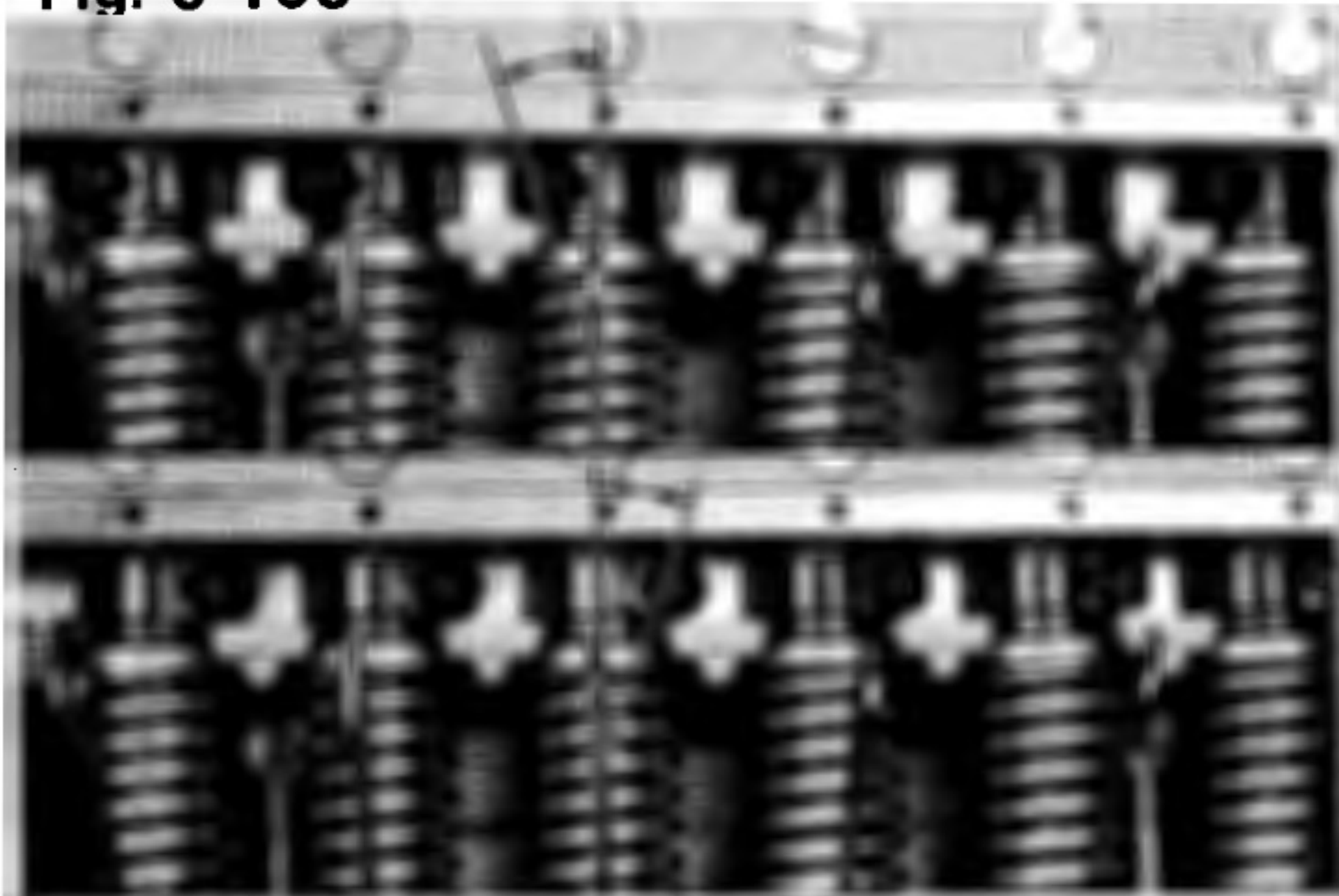
Fig. 6-104



Check the sliding resistance of the control rack.

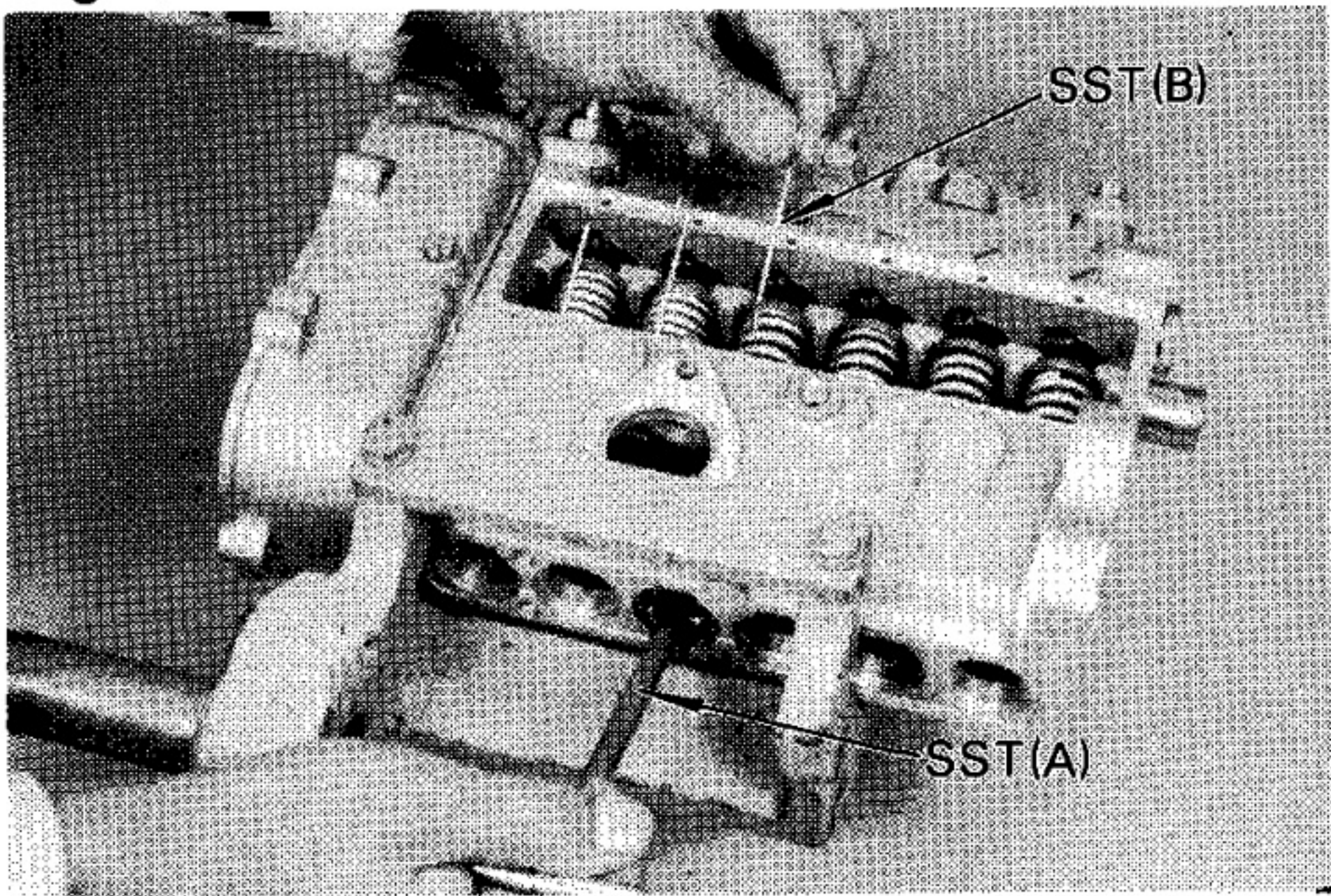
**Sliding resistance: Less than 120 g
(4.2 oz)**

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.

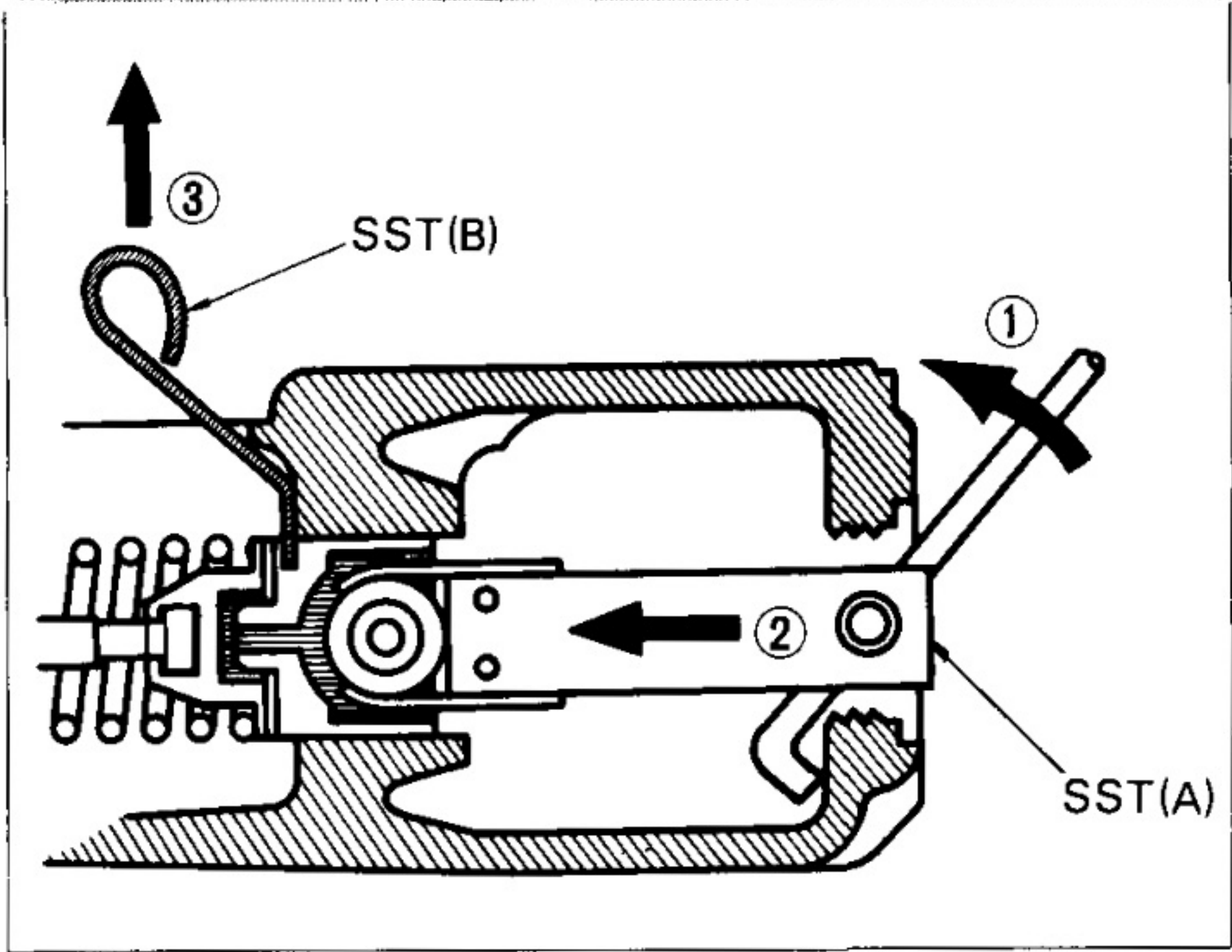
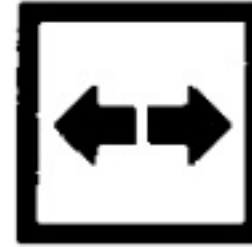
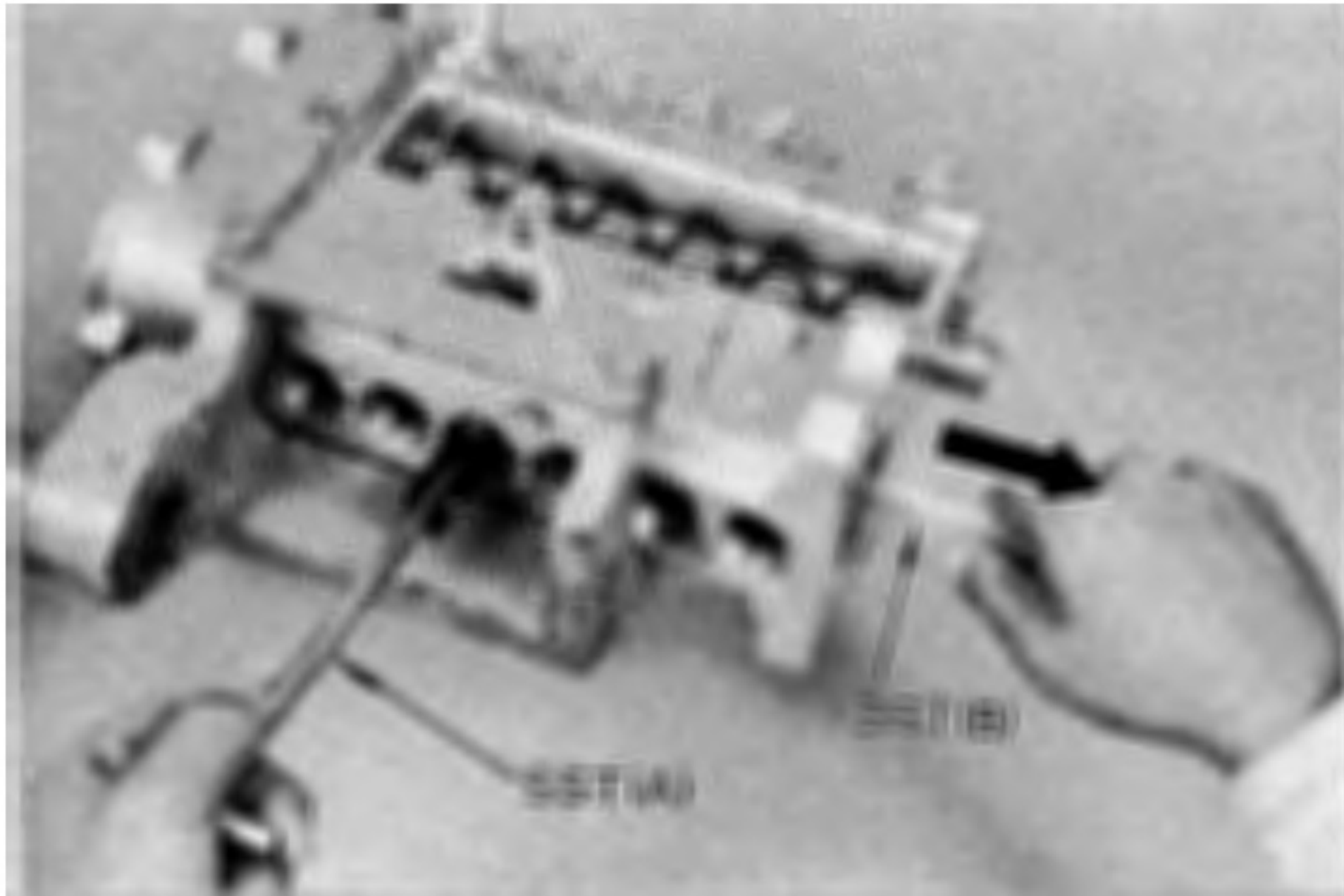
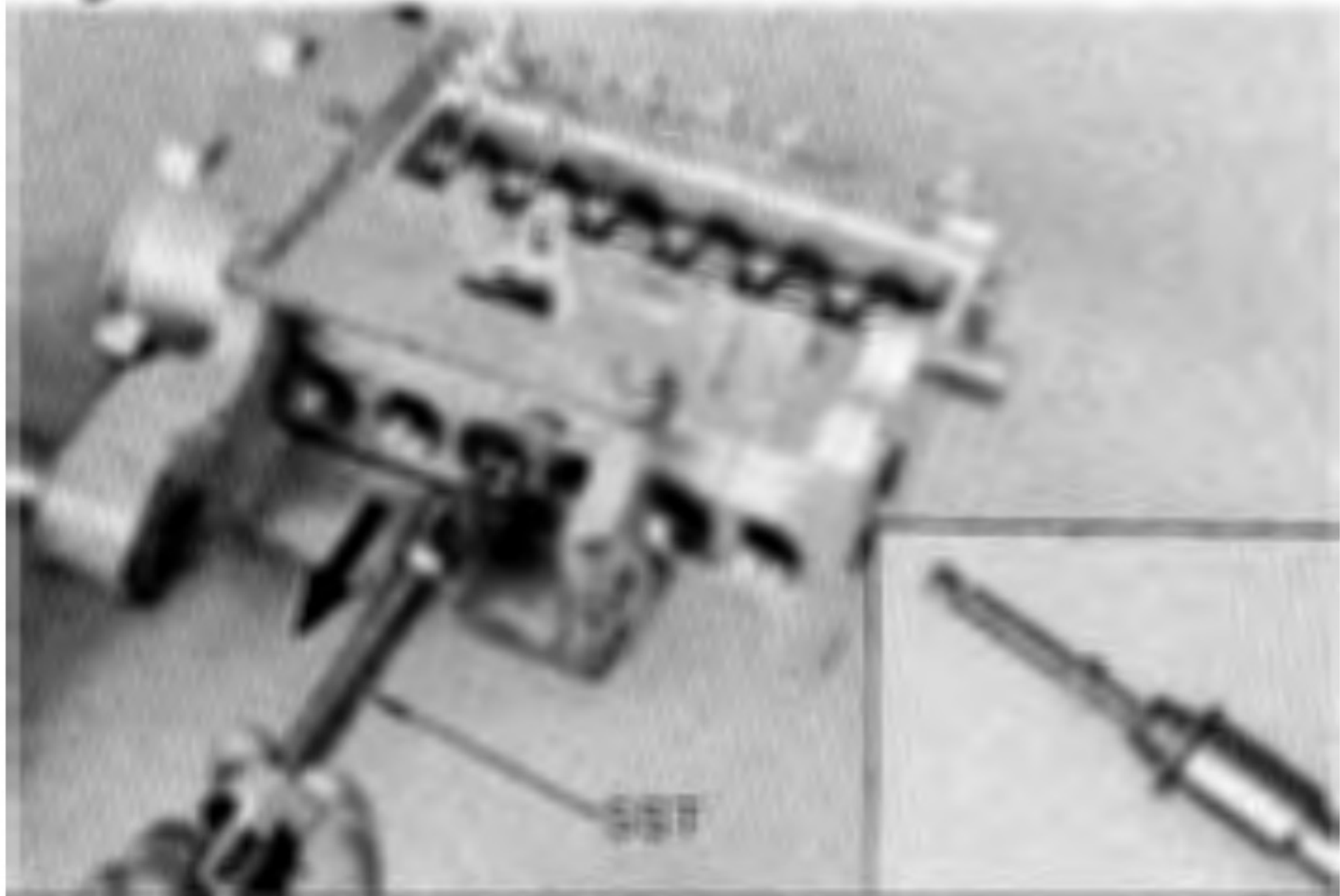


Fig. 6-107



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 —

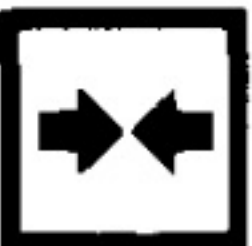
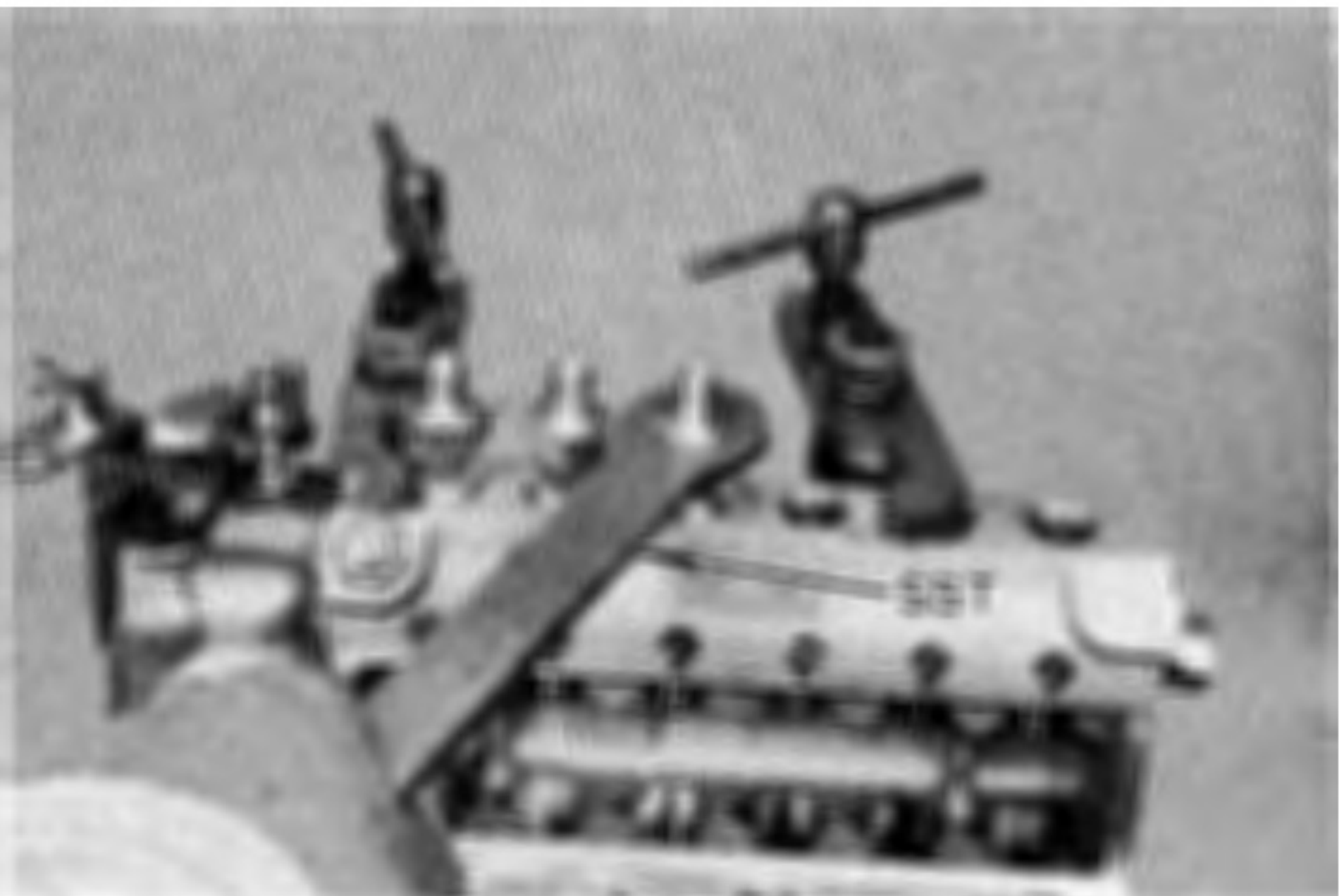
Do not touch the sliding surfaces of the delivery valve.

Fig. 6-109



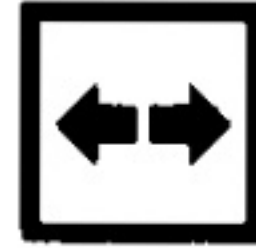
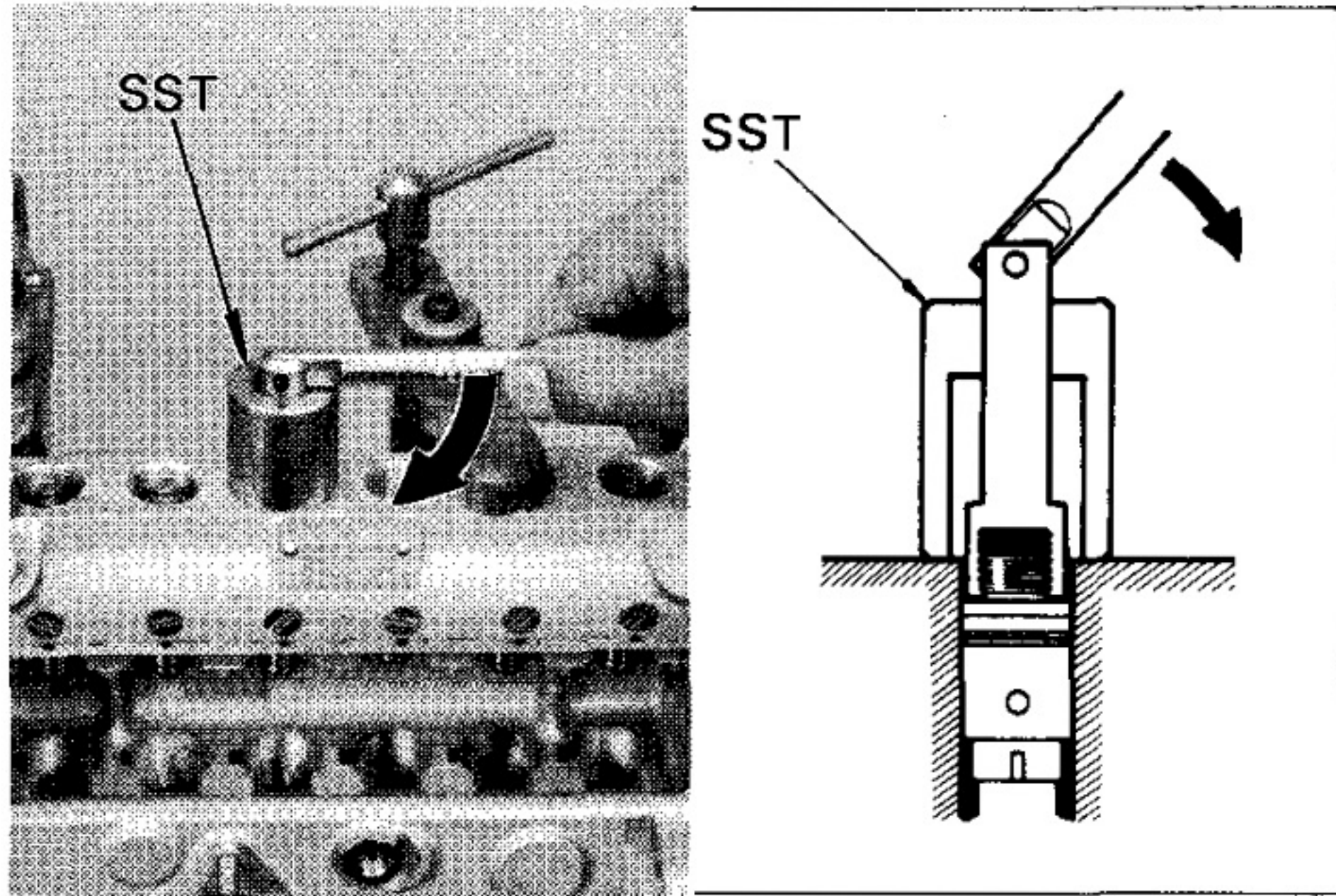
Loosen the rack guide screw and pull out the control rack.

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.

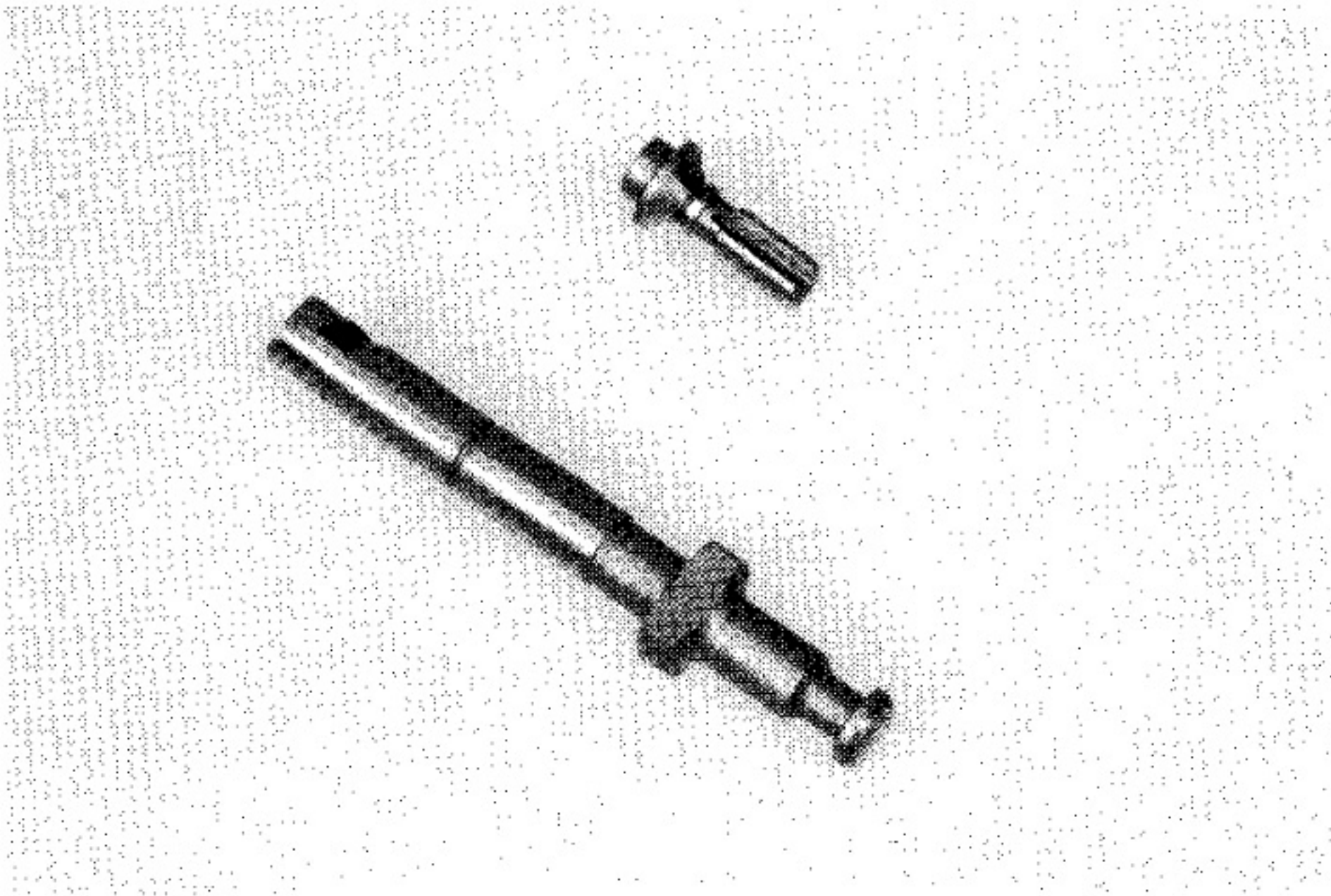
Using the handle as lever, pull out the delivery valve seat and gasket together.

SST (09271-76011) of set [09260-76016]

— Note —

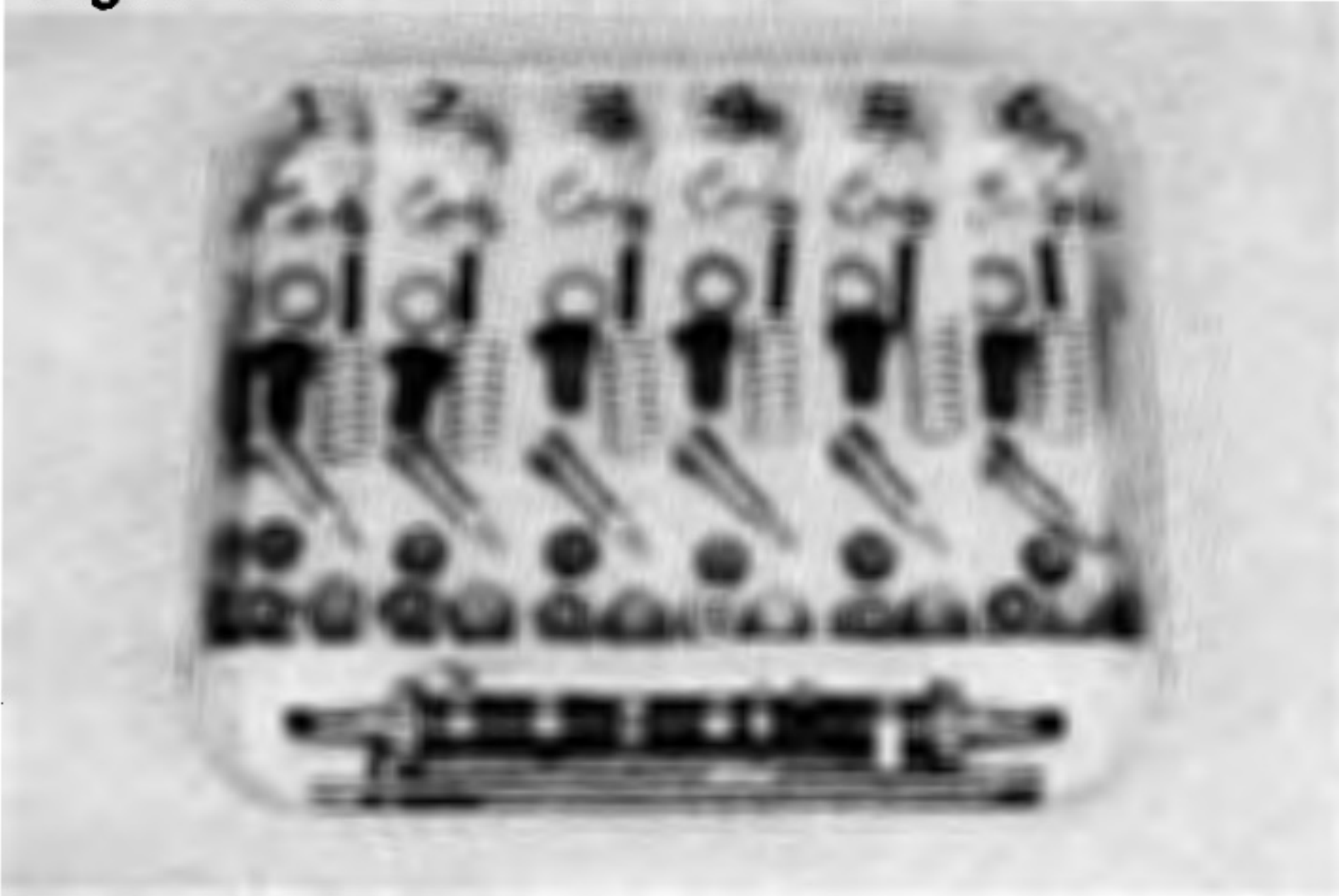
Do not touch the sliding surfaces of the delivery valve.

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.

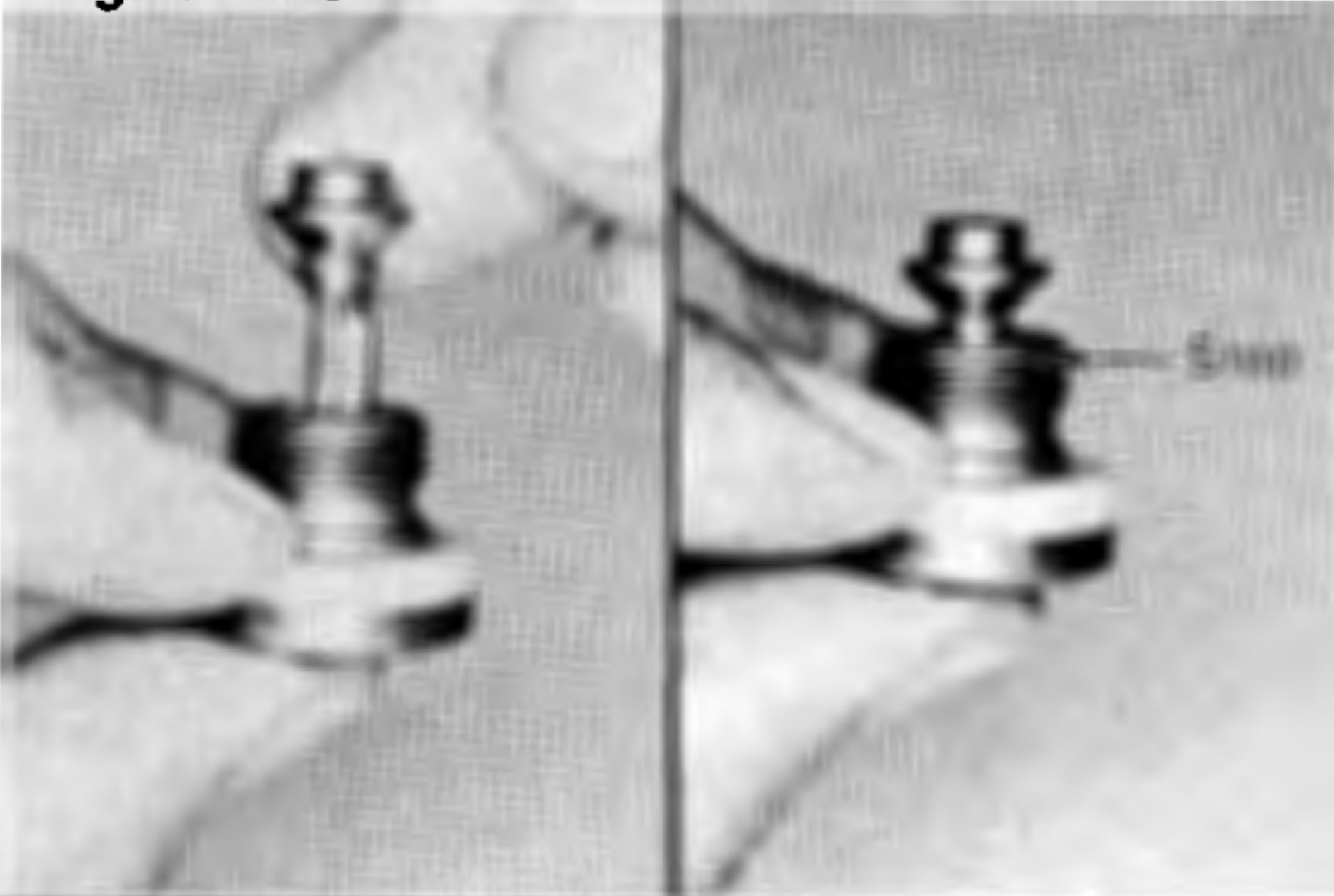
Wash and clean the outer surfaces of the housings with a soft brush, and blow out the tapped holes with compressed air.

Fig. 6-114

**Diaphragm**

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

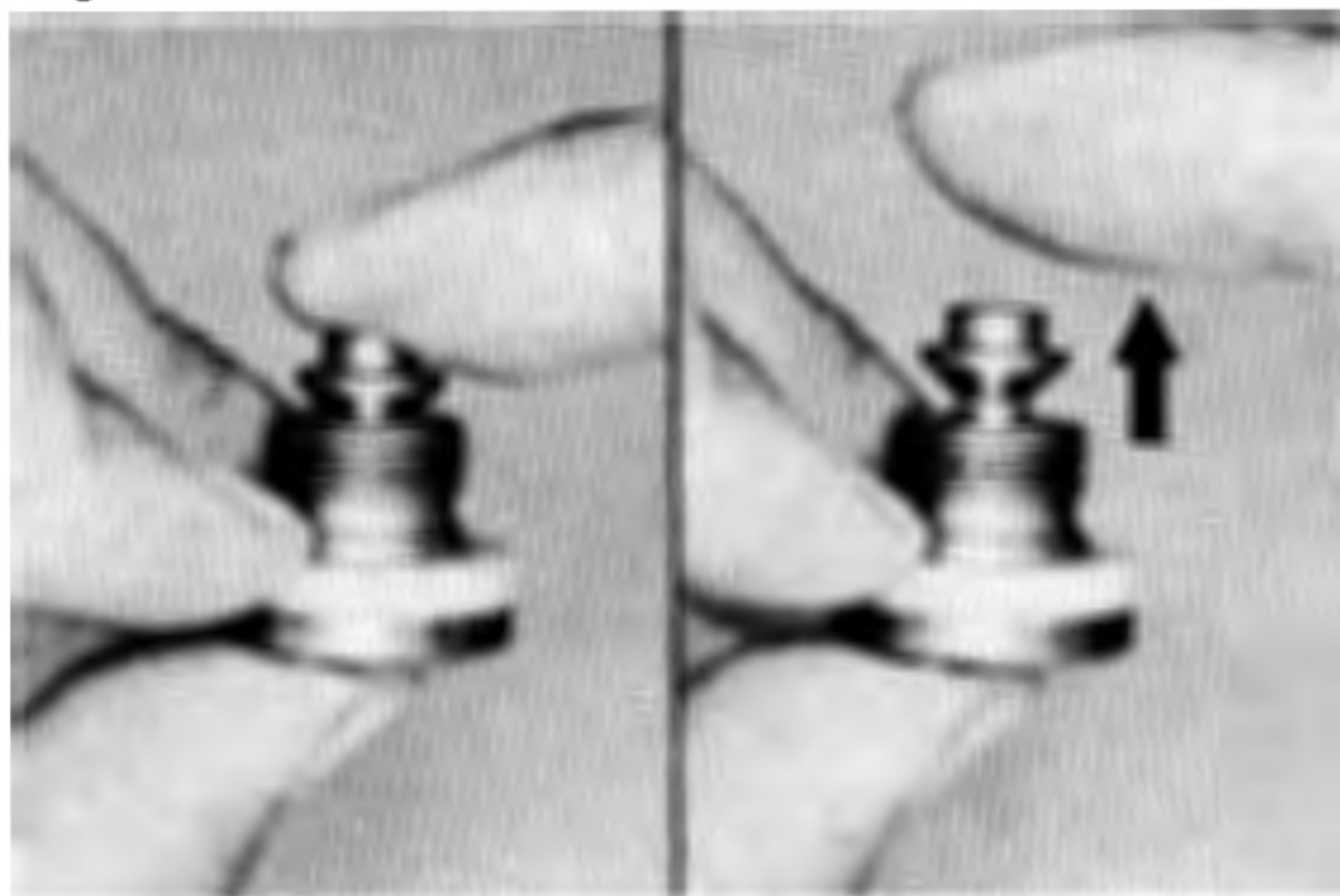
Fig. 6-115

**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.

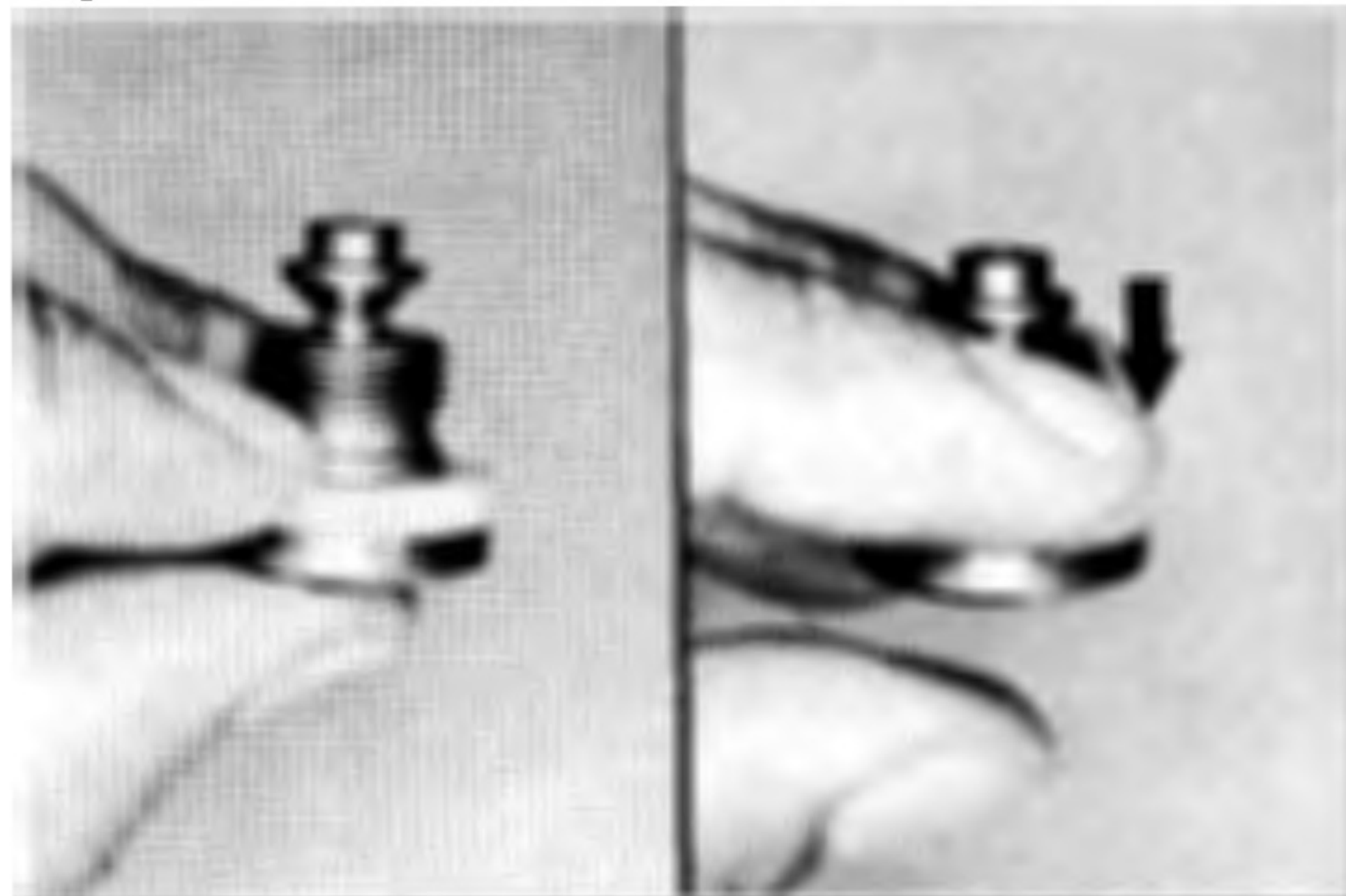
If defective, replace the valve as a set.

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

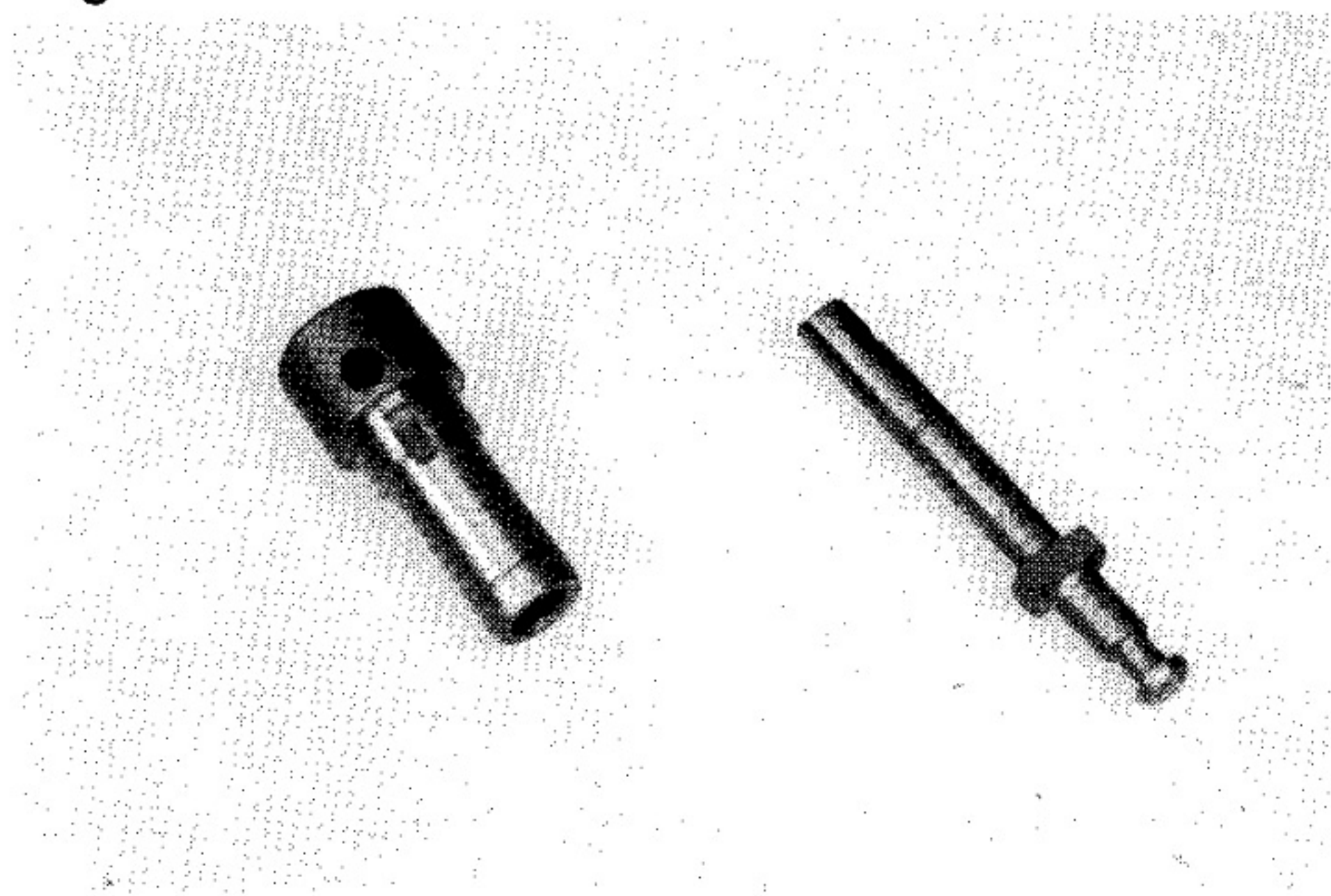


3. Remove your thumb from the valve seat hole. The valve should close completely by its own weight. Replace if defective.

— Note —

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

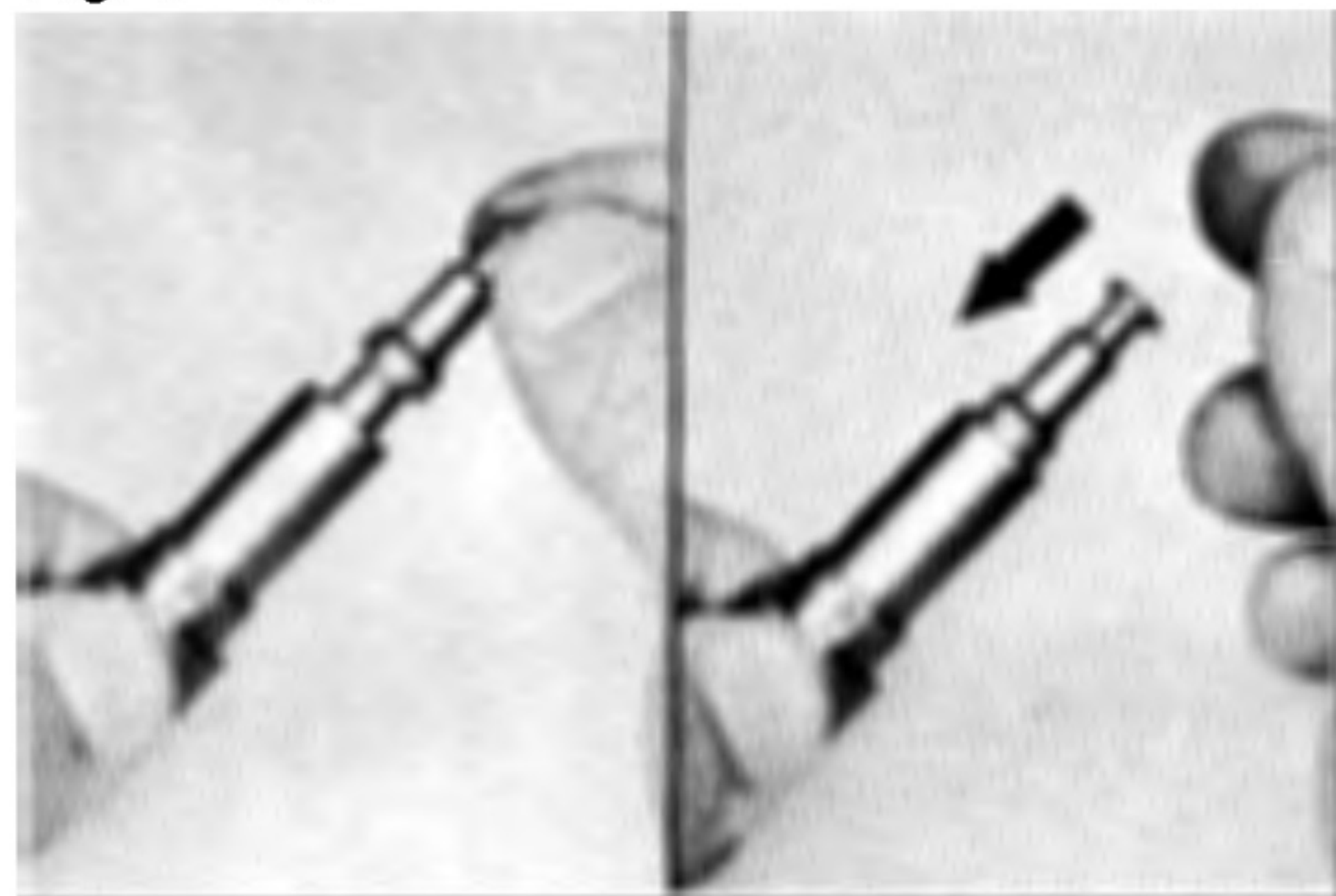
Fig. 6-118



Plunger & Cylinder

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

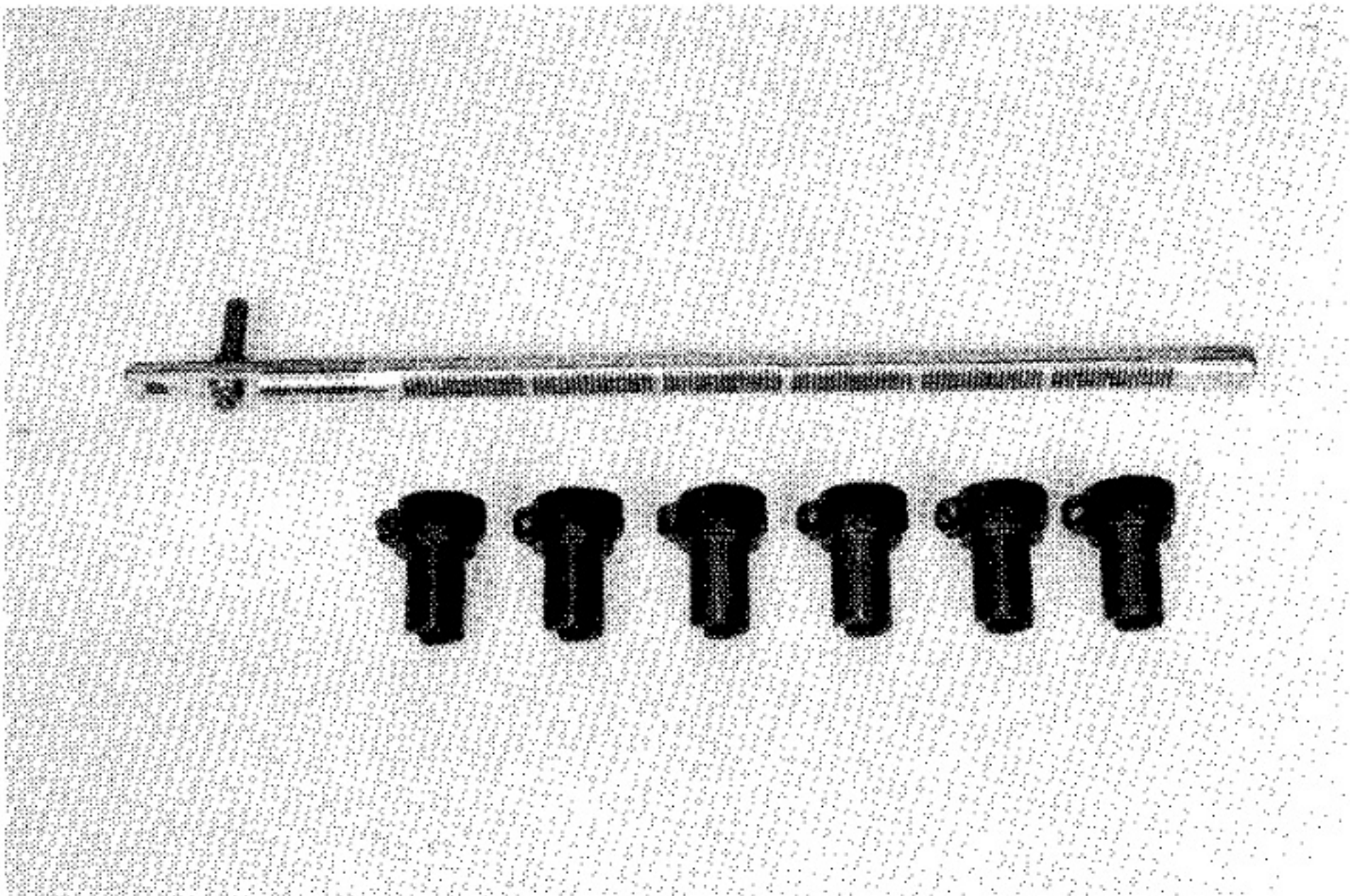
Fig. 6-119



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.

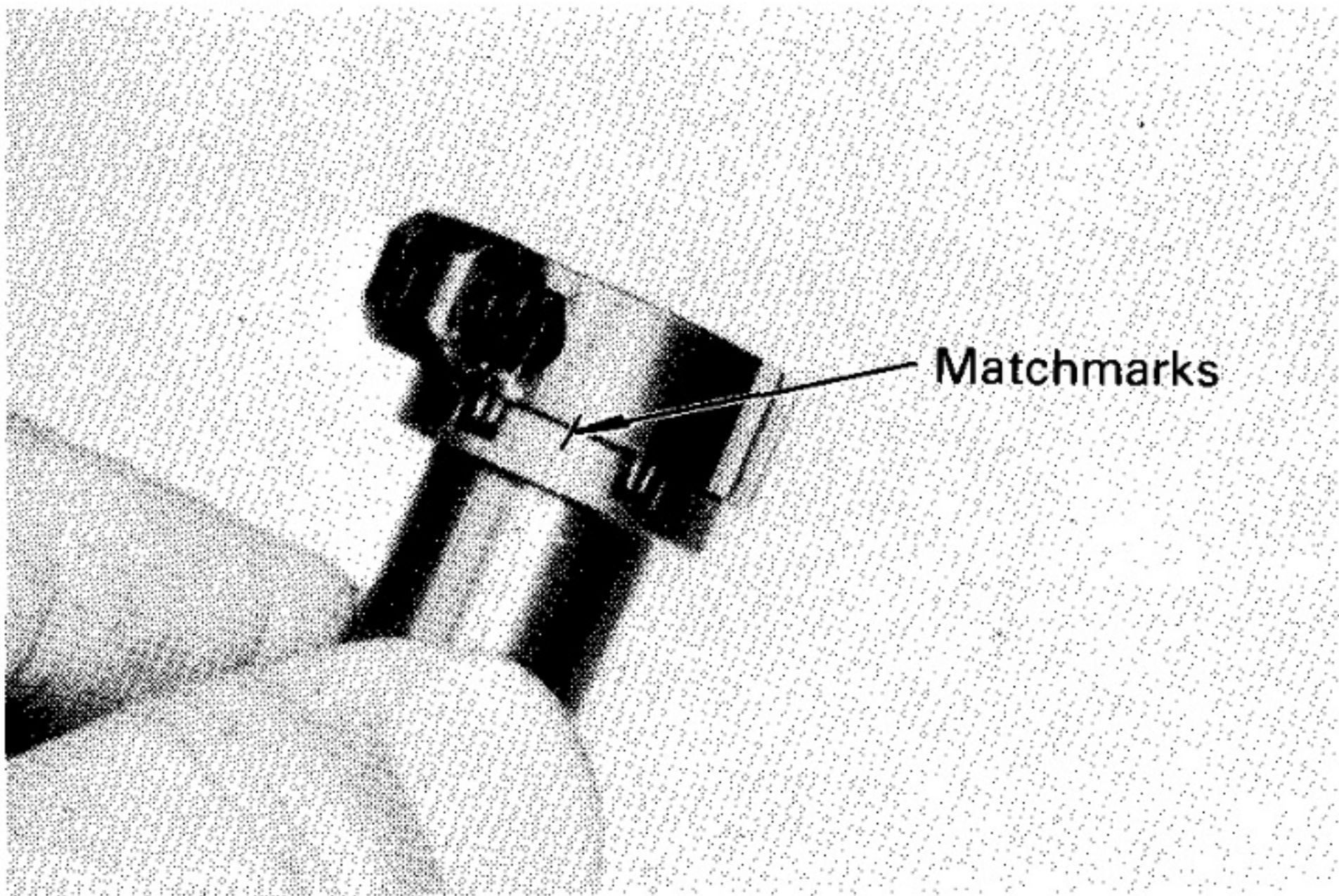
Fig. 6-120



Control Rack & Pinion

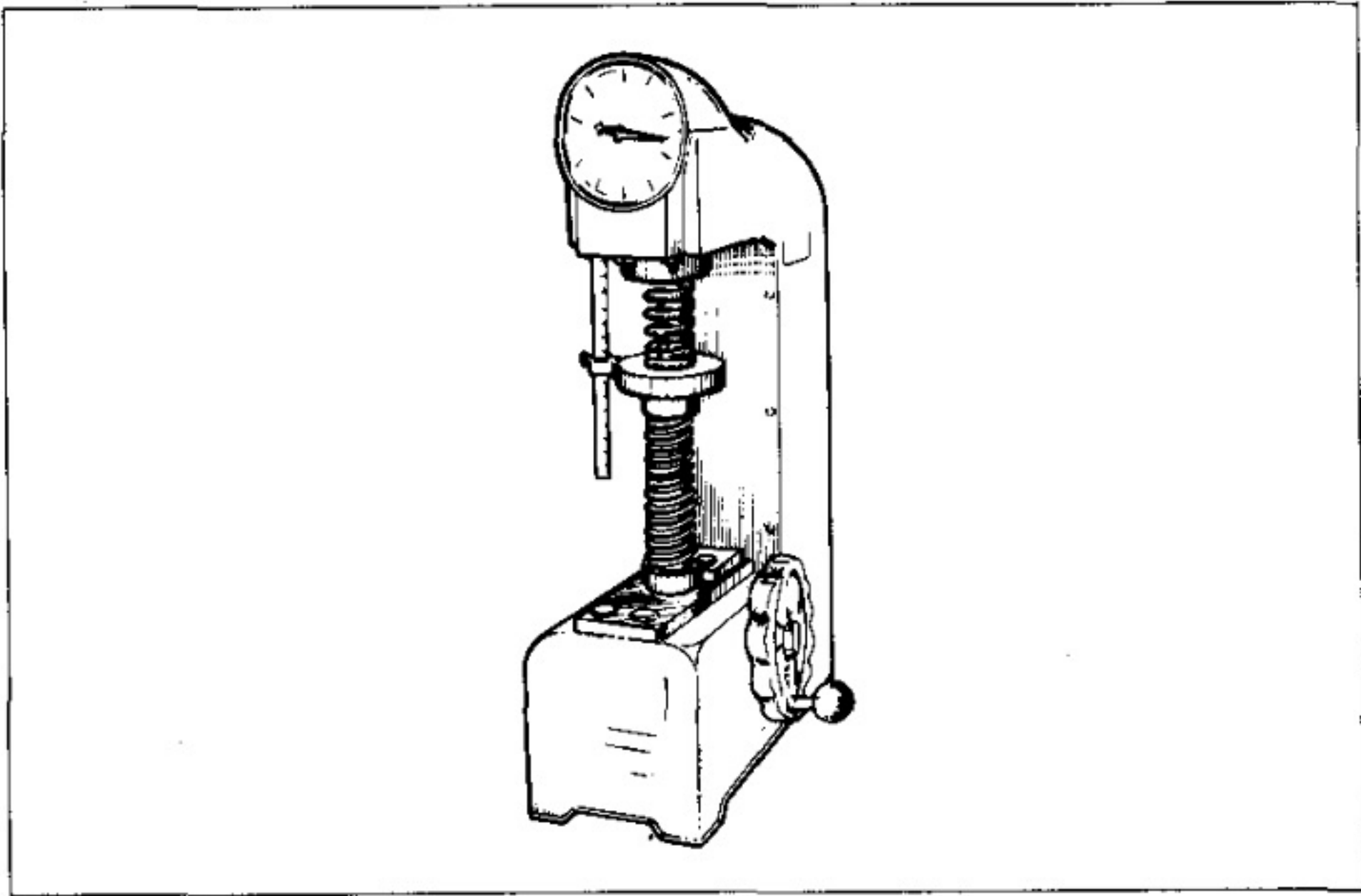
Inspect the tooth surfaces of the control rack and pinion for wear or damage and replace if defective.

Fig. 6-121



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

Fig. 6-122



Spring

Spring Item	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)

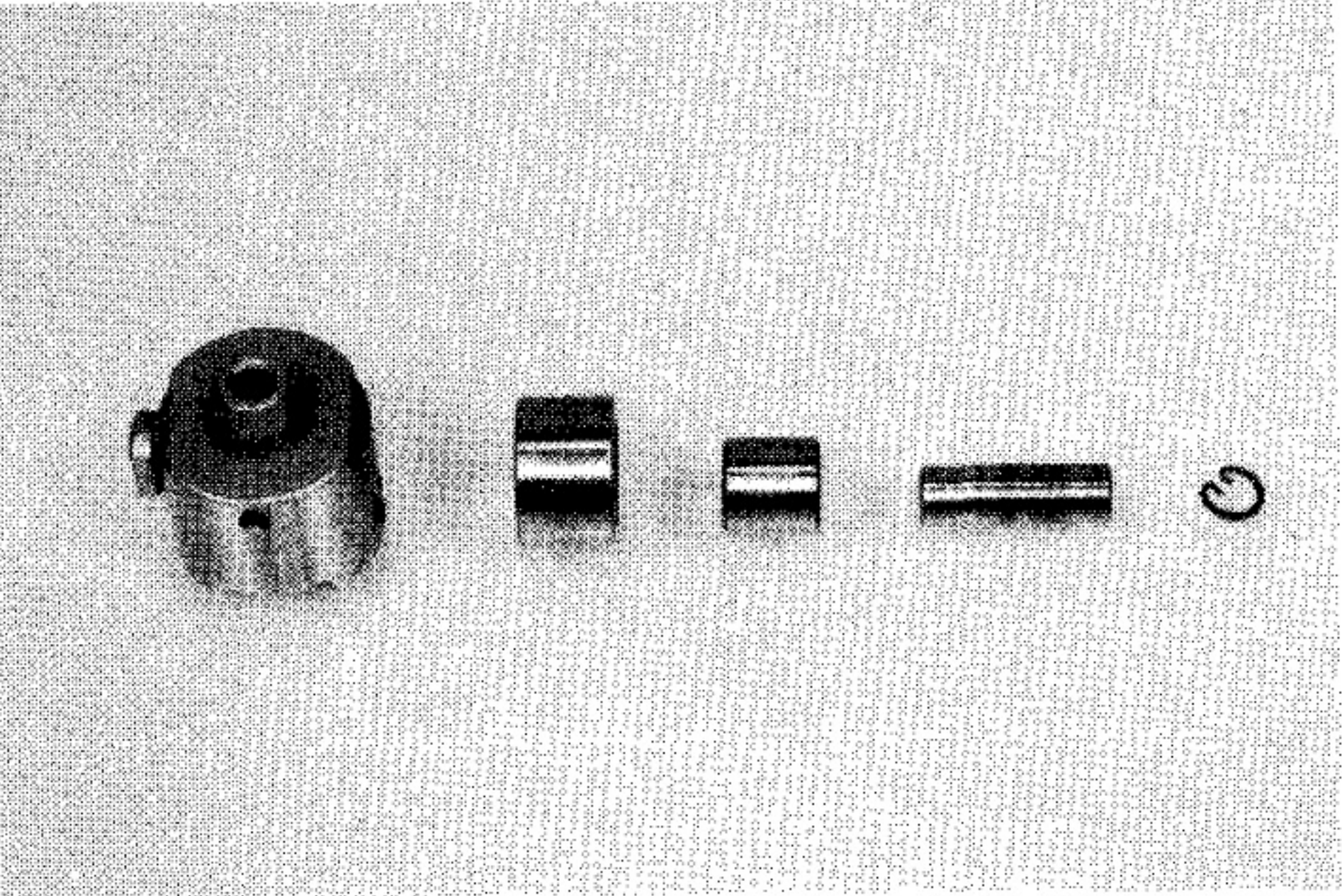
Fig. 6-123



Tappet

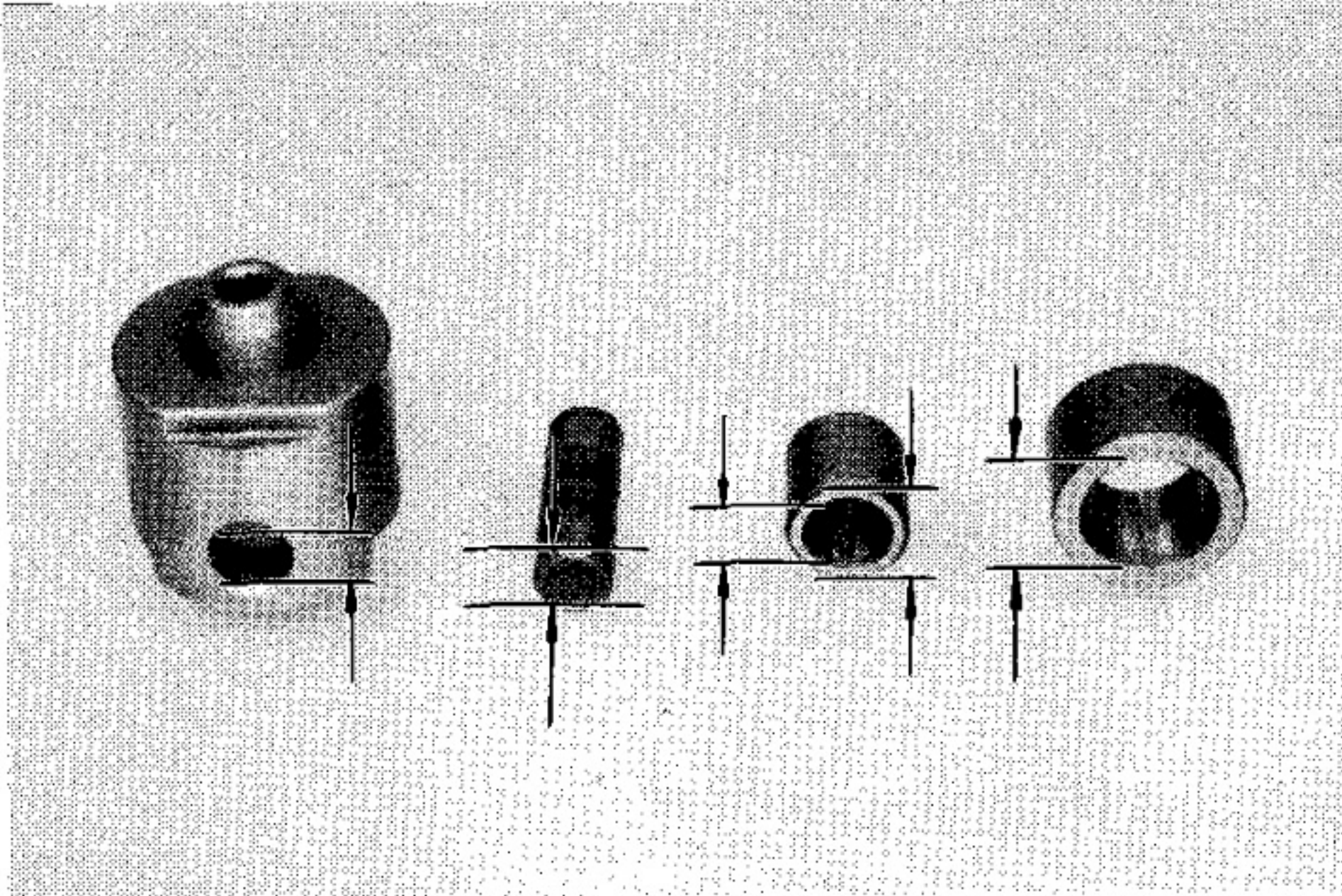
Check the tappet holes of the pump housing for wear or damage.

Fig. 6-124



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

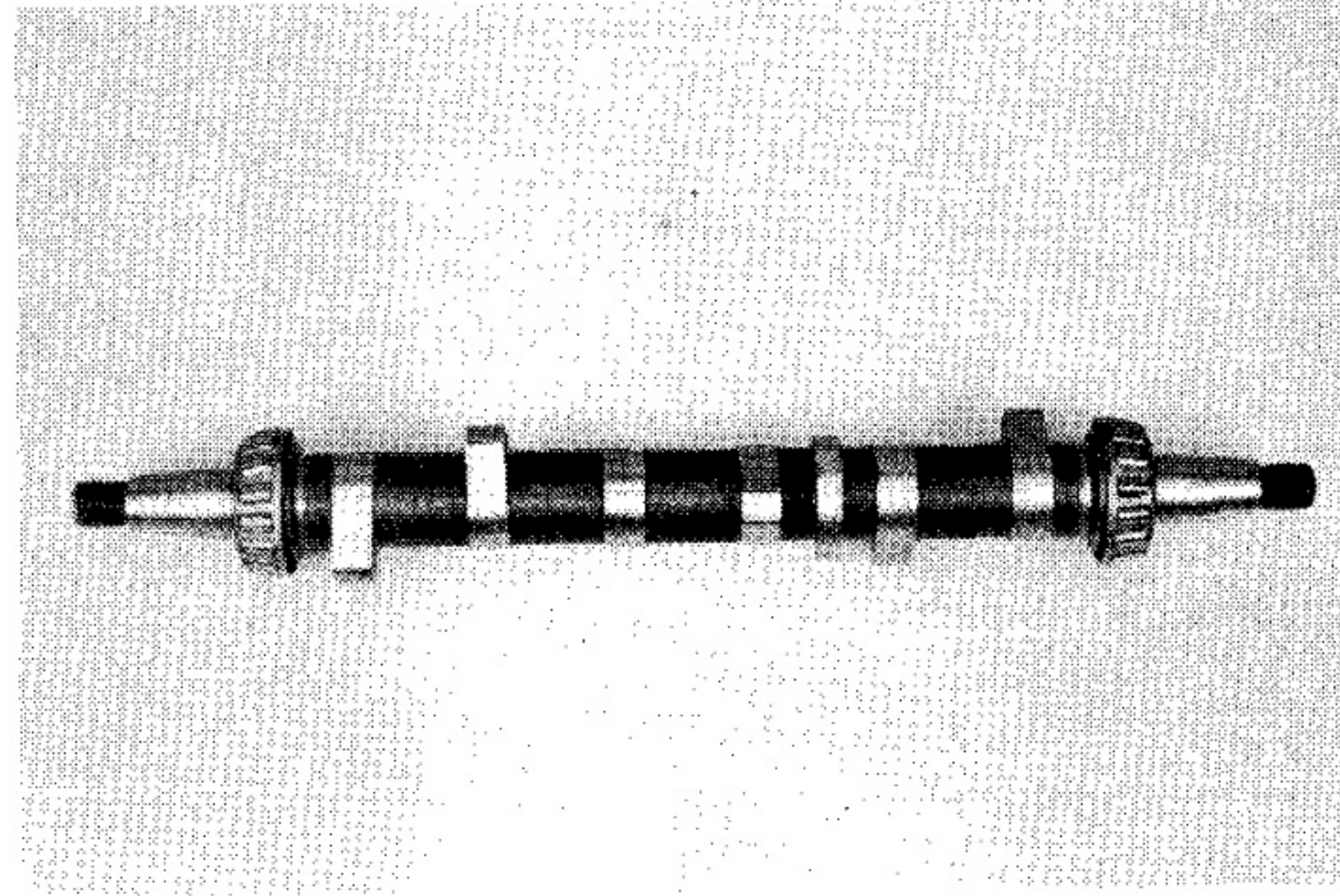
Fig. 6-125



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.)

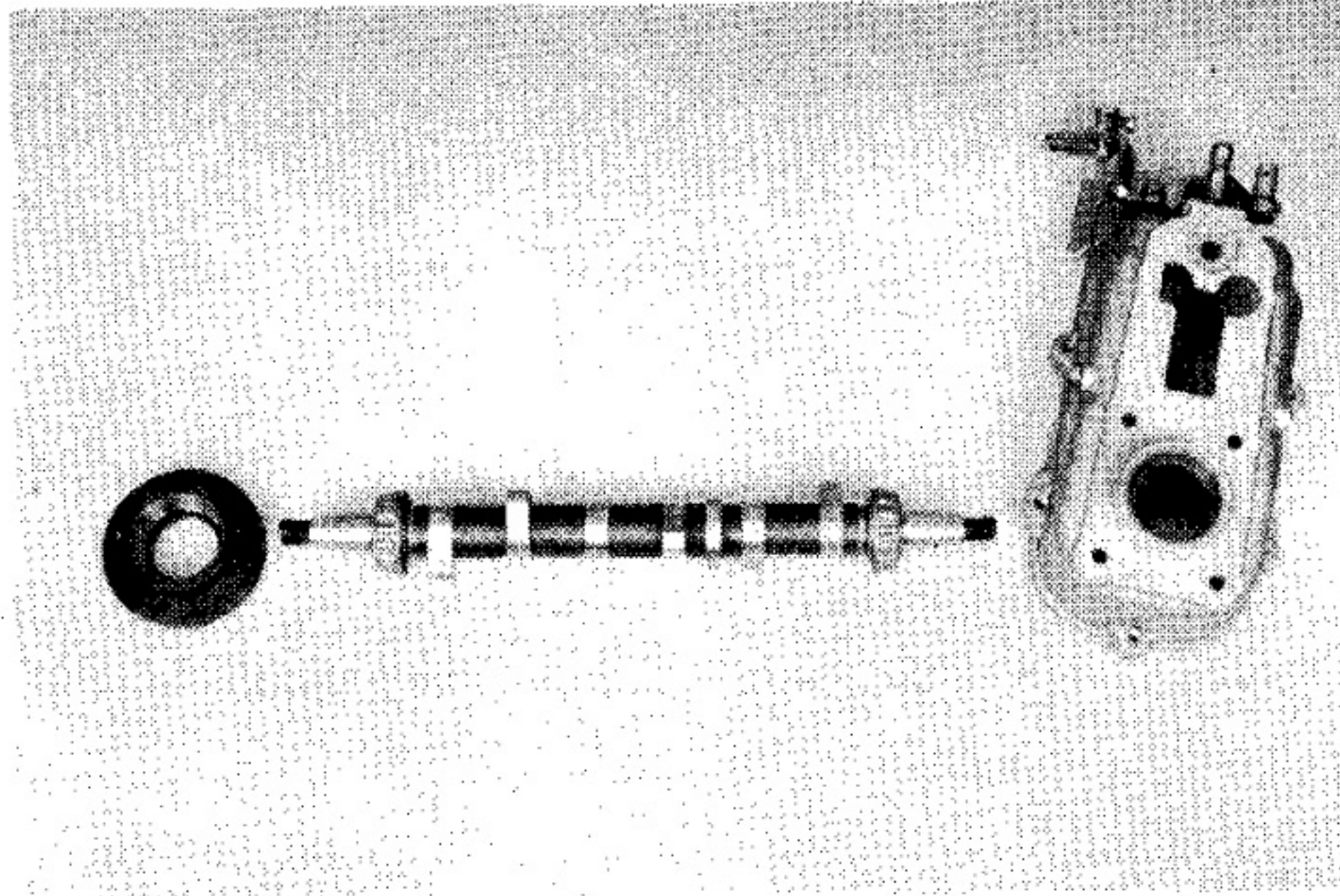
Fig. 6-126



Camshaft

Check the cam surfaces for wear or damage.

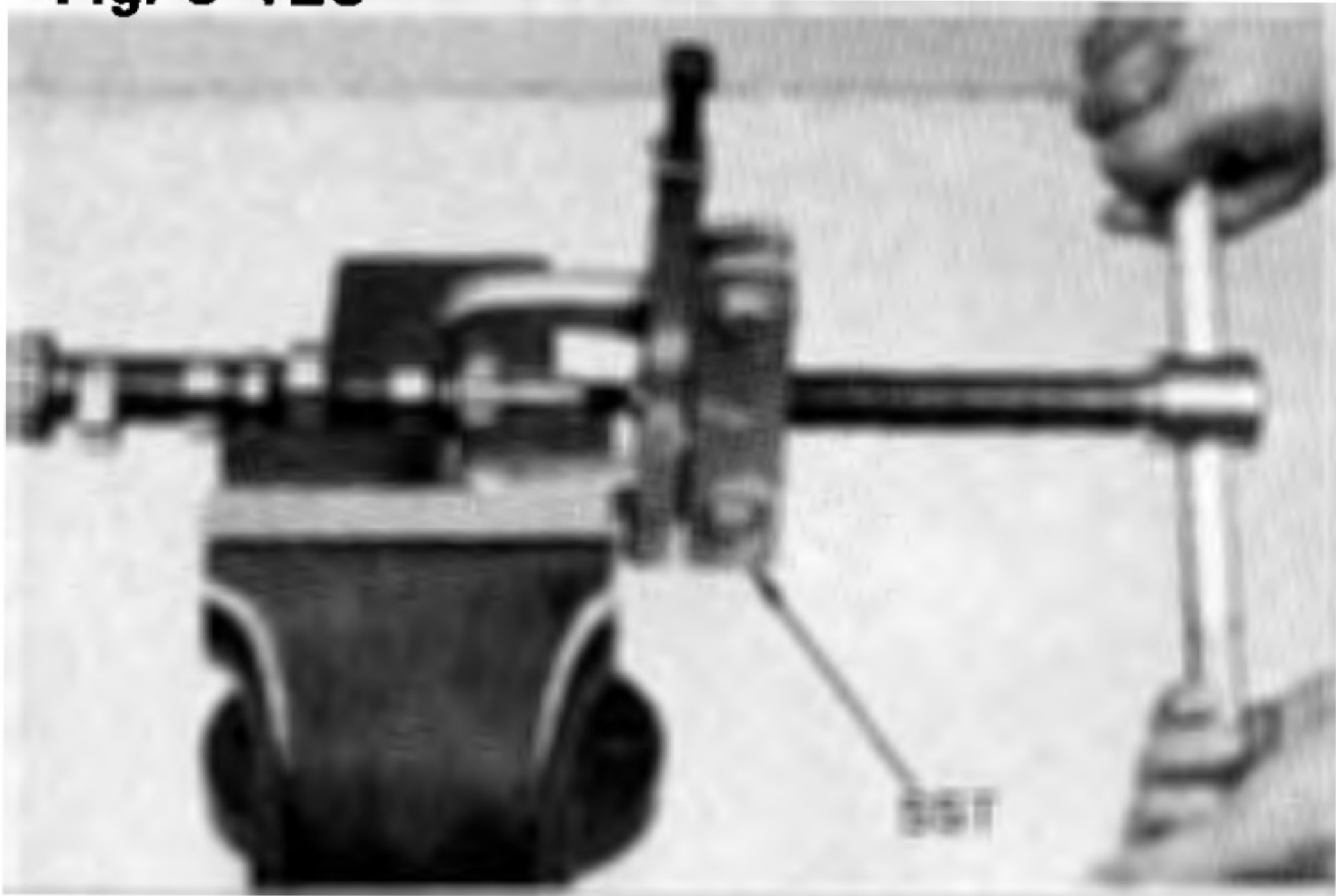
Fig. 6-127



Camshaft Bearing

Check the roller and race for wear or damage.

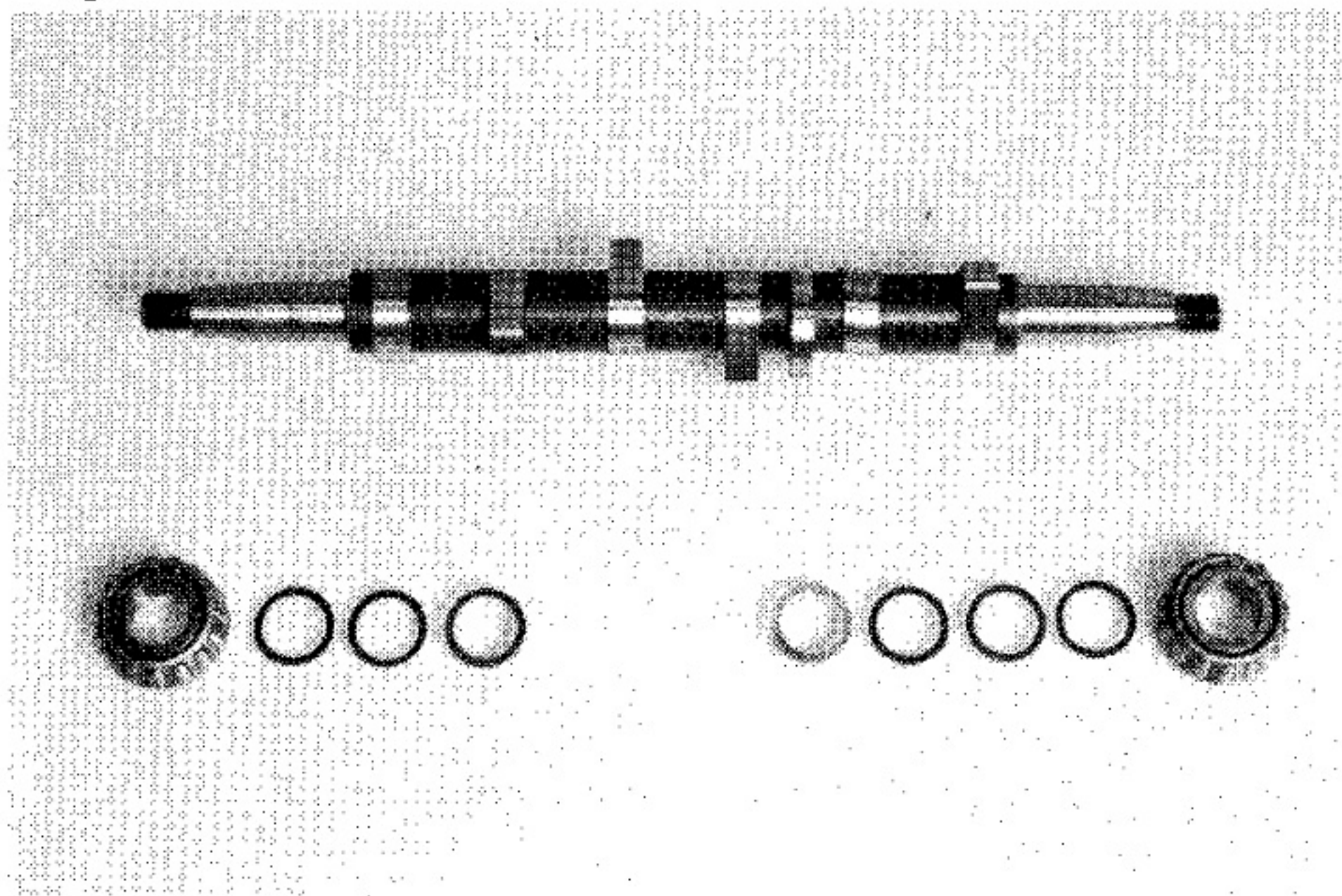
Fig. 6-128



Replace Camshaft Bearing

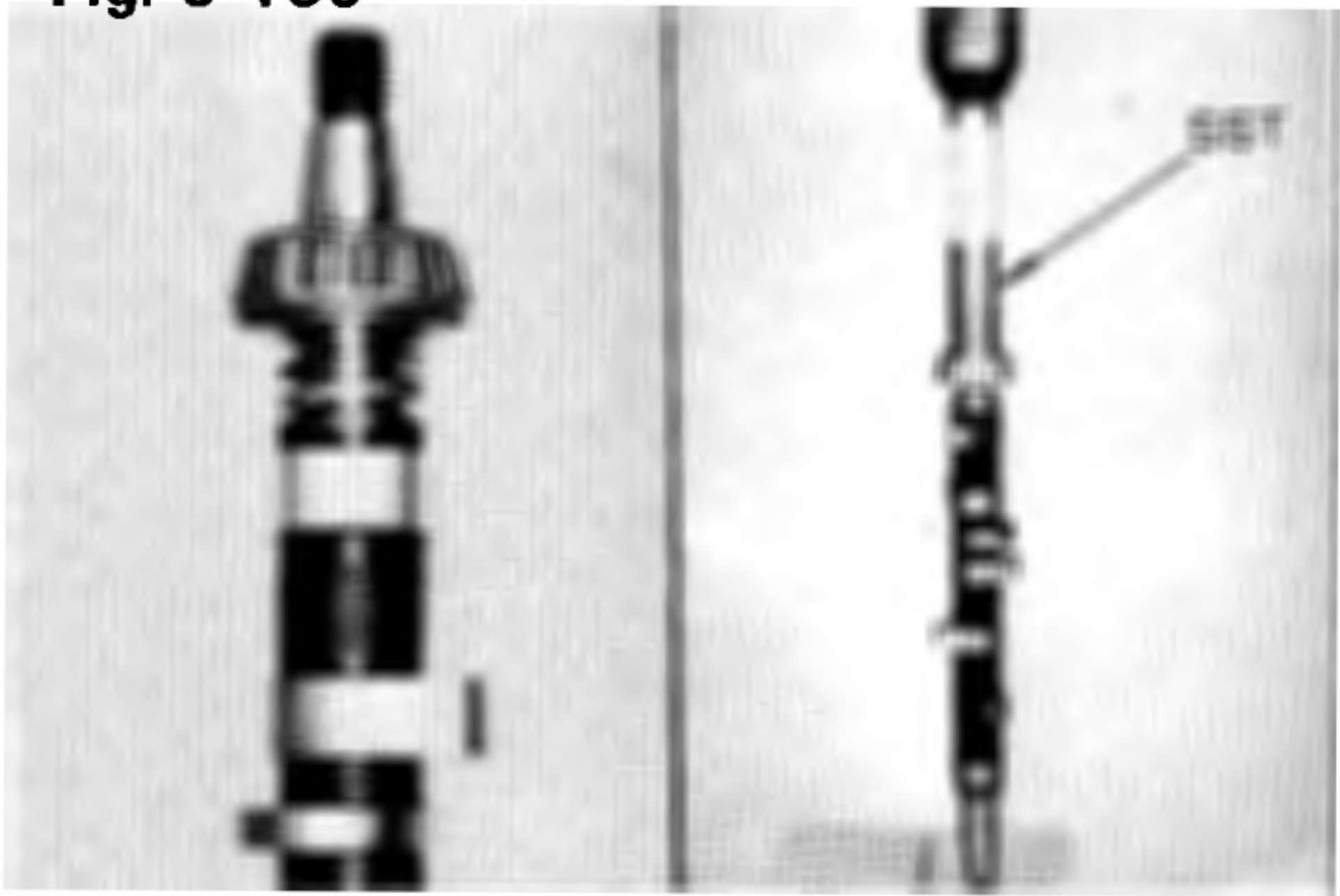
1. Pull out the front bearing with SST.
SST [09950-20014]

Fig. 6-129



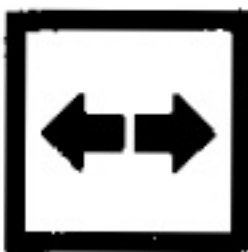
2. Keep the removed shims separately to prevent loss or getting them mixed up with other shims.

Fig. 6-130



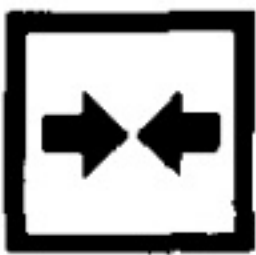
3. Using a press and SST, press in the camshaft adjusting ring, shims and bearing onto the camshaft.
SST [09285-76010]

Fig. 6-131



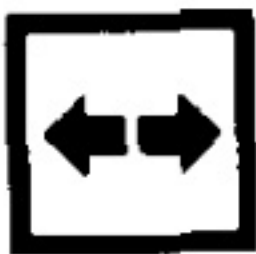
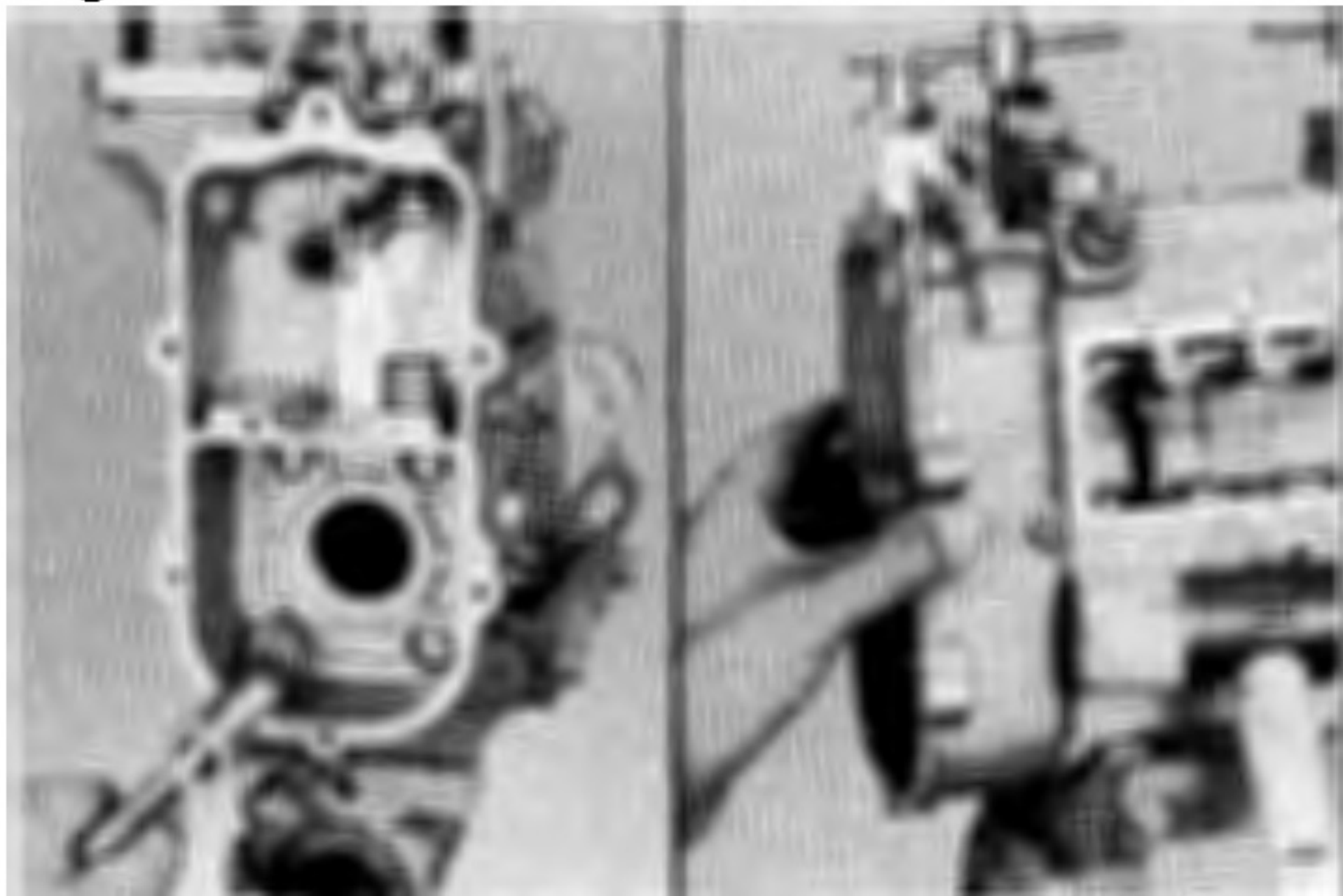
4. Install SST to the bearing cover and drive out the outer race.
SST [09286-76011]

Fig. 6-132



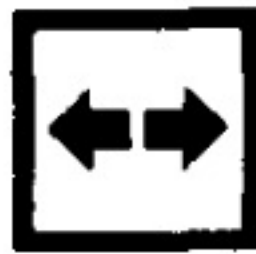
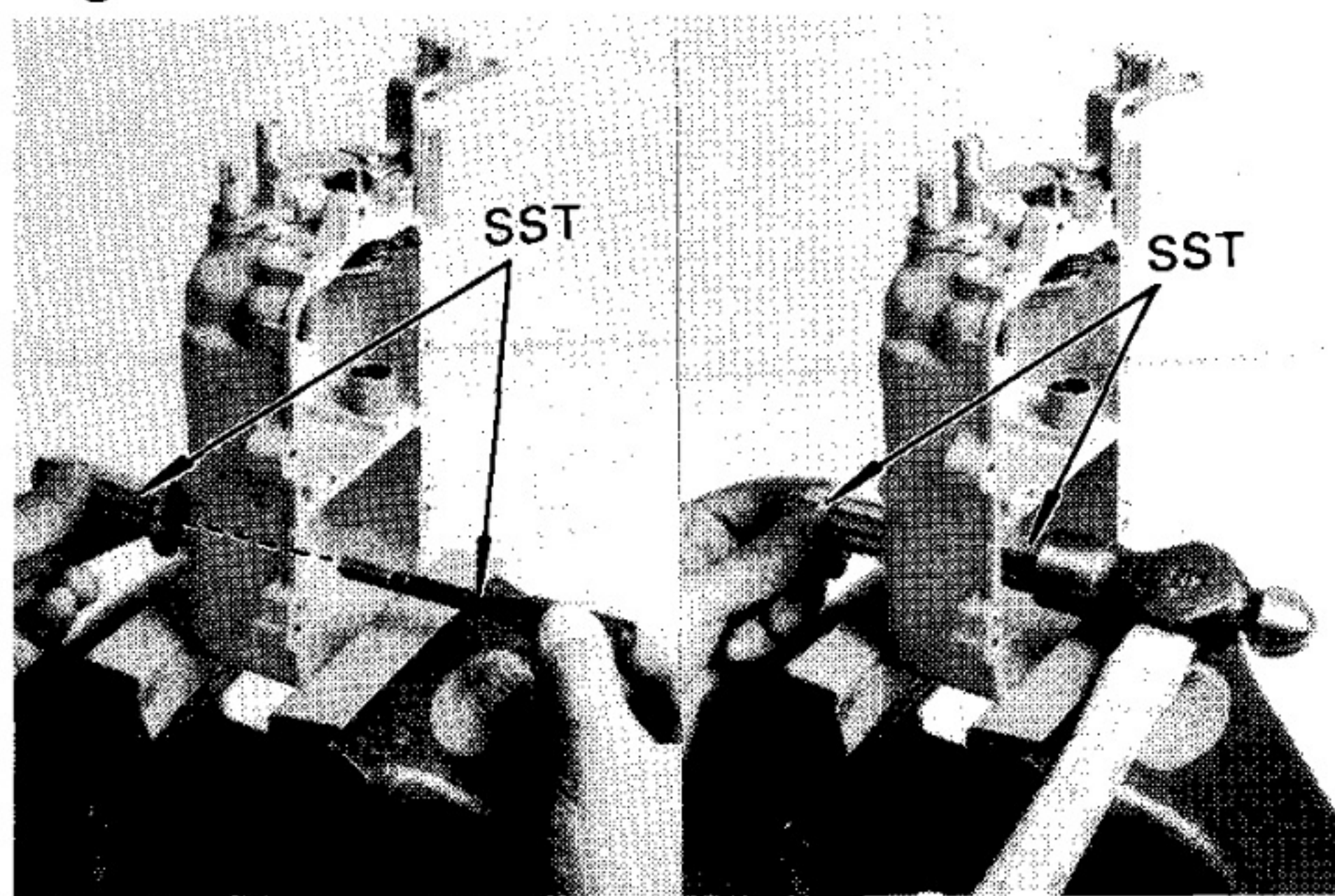
5. Drive a new bearing outer race into the cover with SST.
SST [09608-12010]

Fig. 6-133



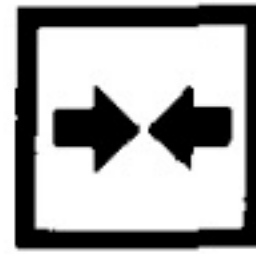
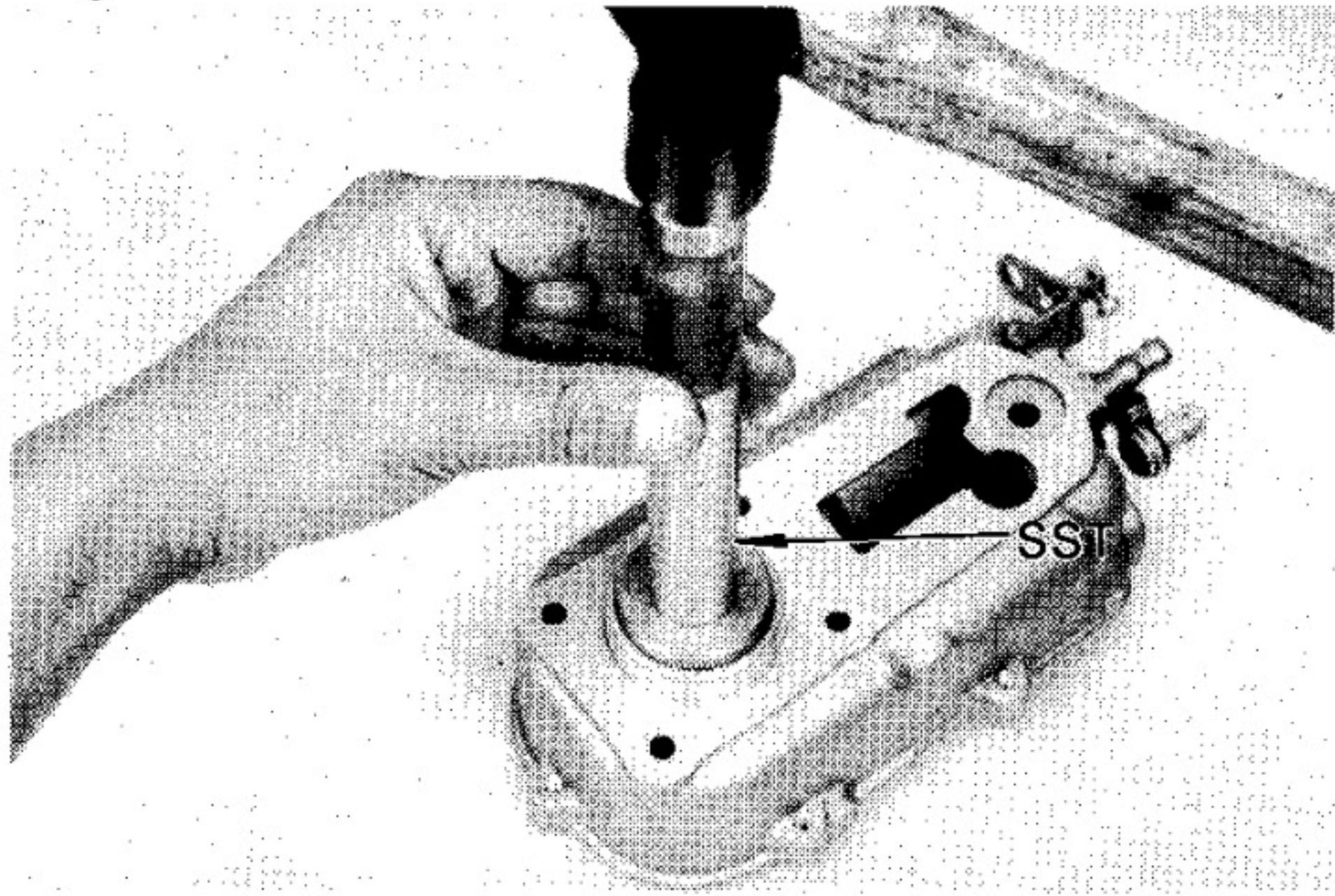
6. Remove the governor housing from the pump body.

Fig. 6-134



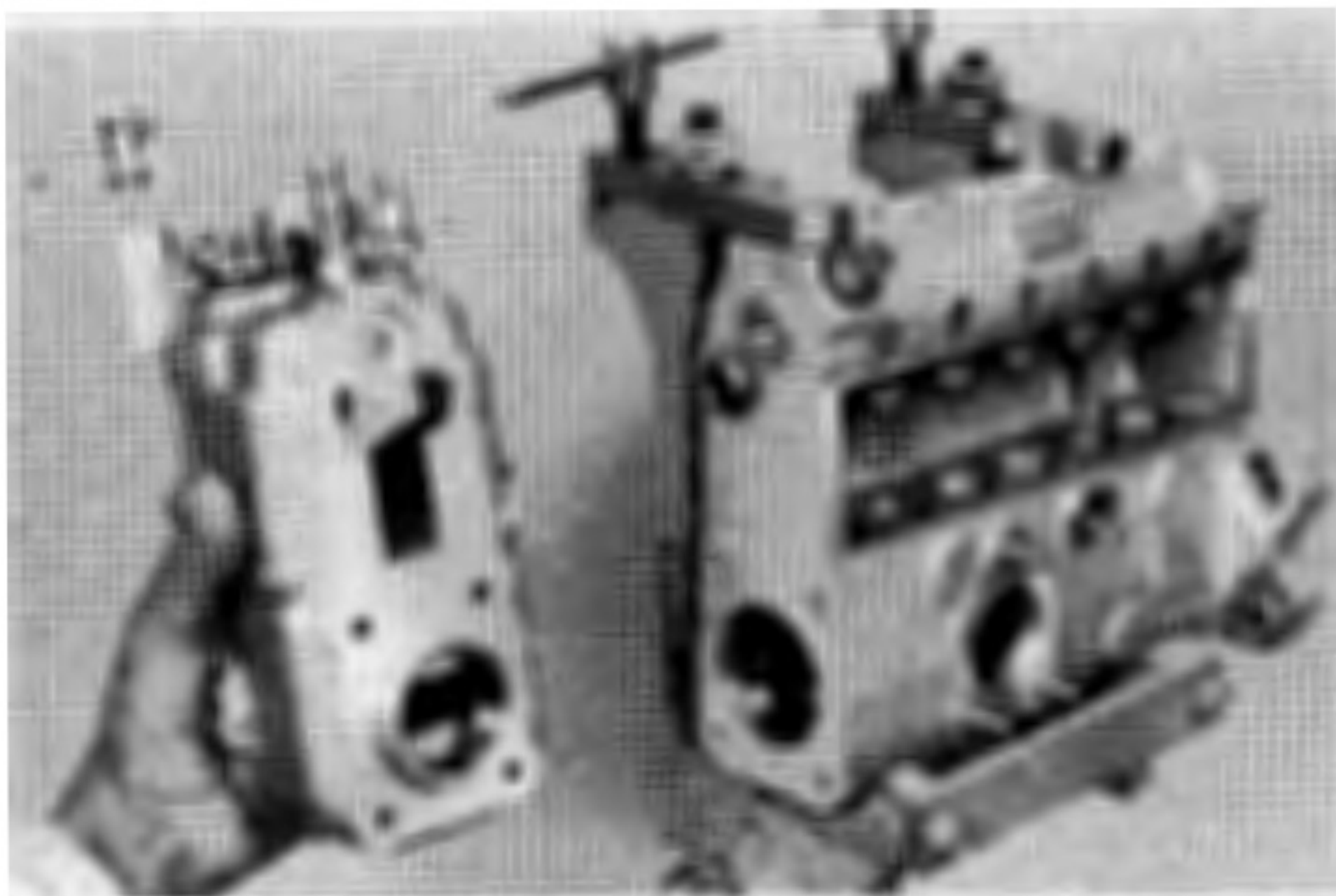
7. Install SST to the governor housing and drive out the outer race.
SST [09286-76011]

Fig. 6-135



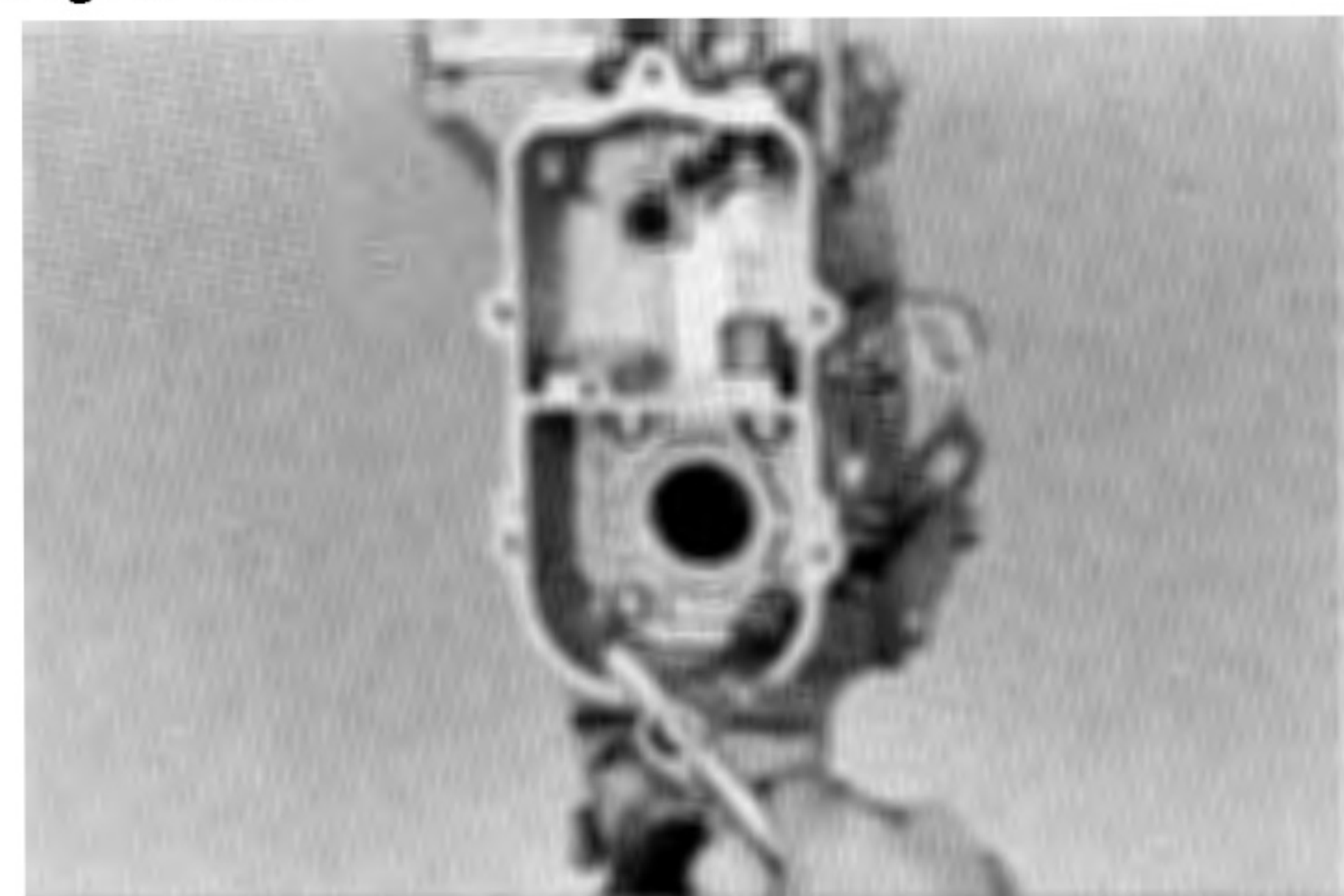
8. Drive a new bearing outer race into the governor housing with SST.
SST [09608-12010]

Fig. 6-136



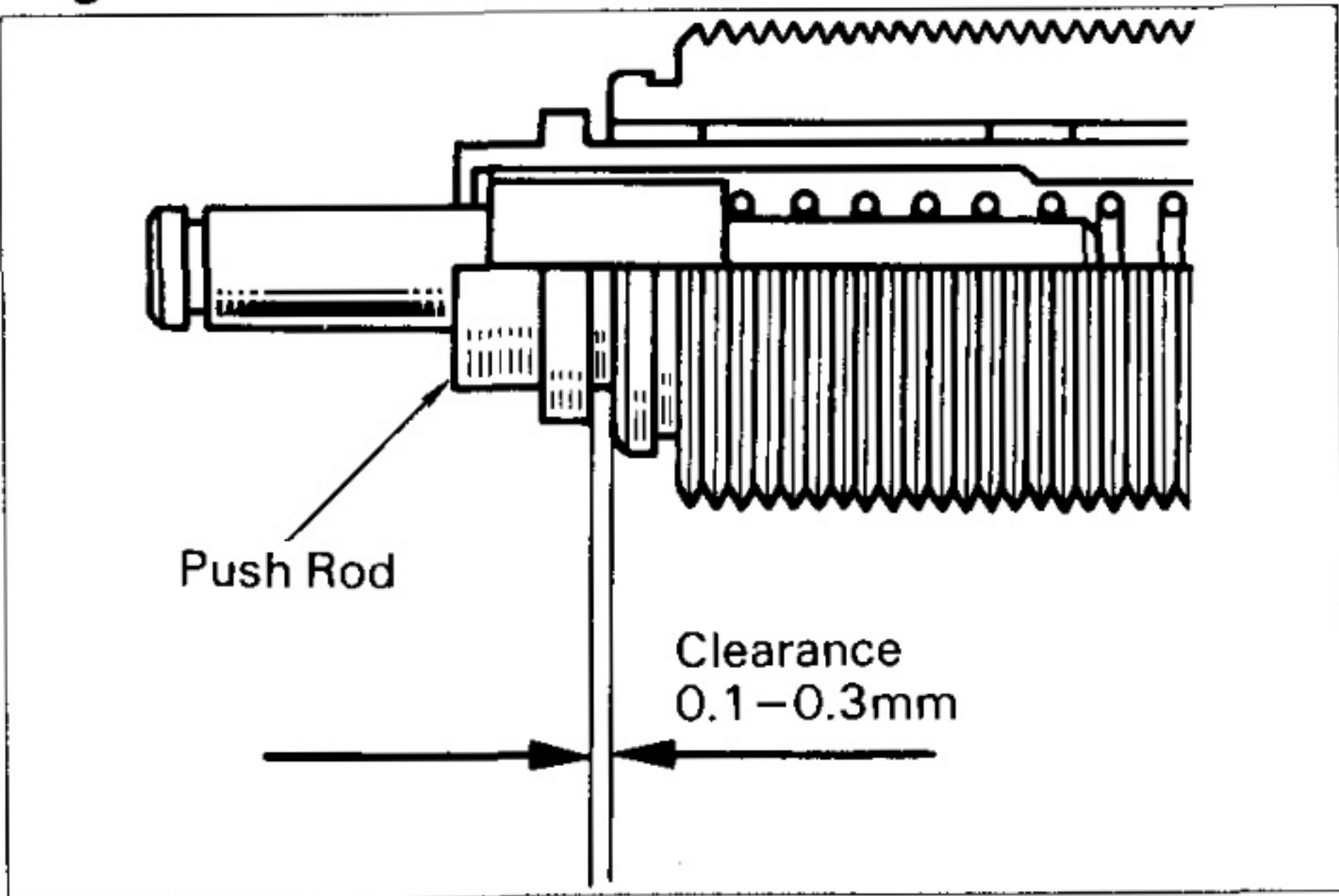
9. Clean the installing surfaces.

Fig. 6-137



10. Install a new gasket and the governor housing.

Fig. 6-138



Diesel High Altitude Compensator (DHAC)

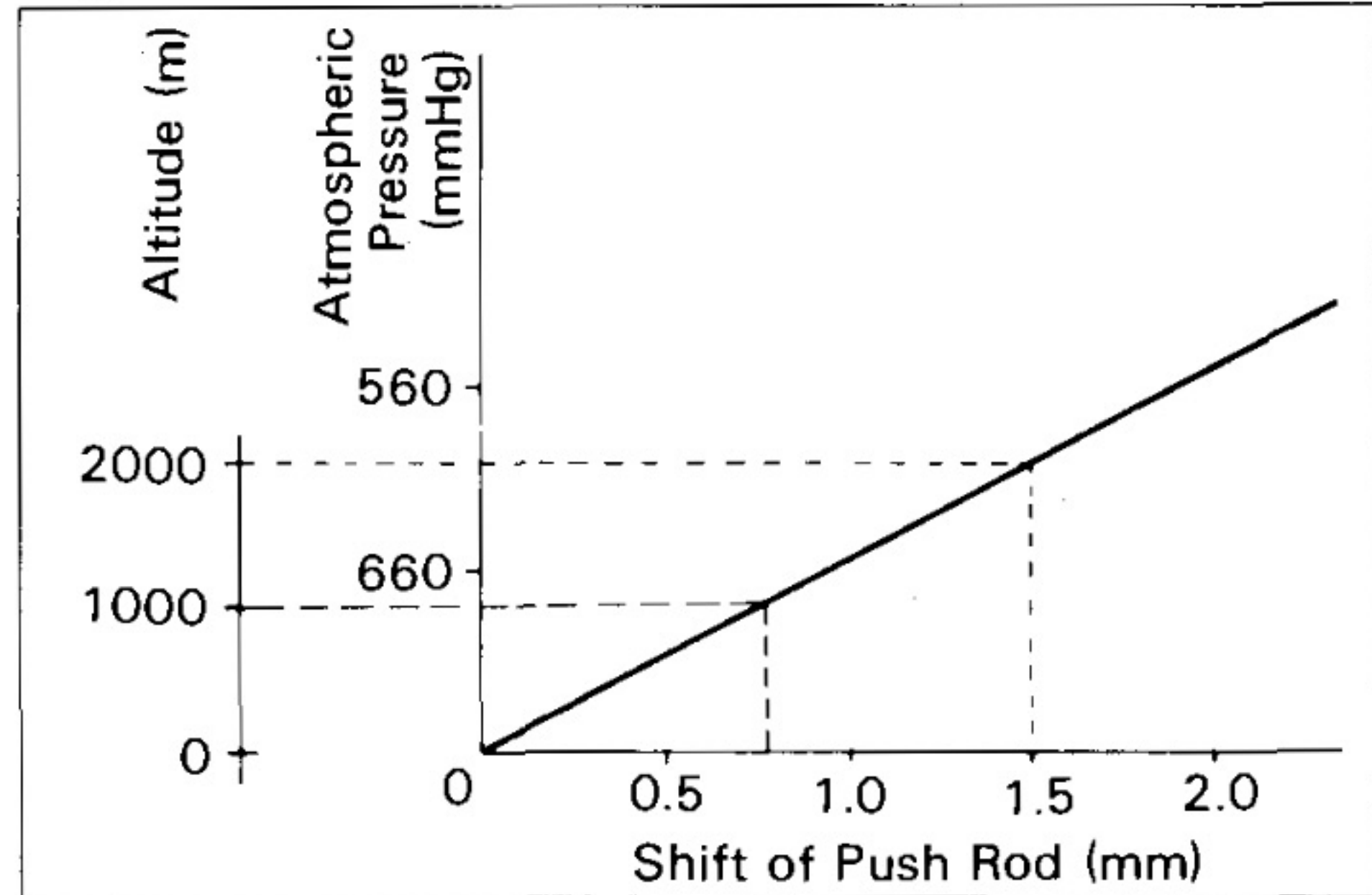
1. Check the DHAC for correct clearance between full stop capsule flange and DHAC body.

Clearance at sea level:

0.1 – 0.3 mm

(0.004 – 0.012 in.)

Fig. 6-139

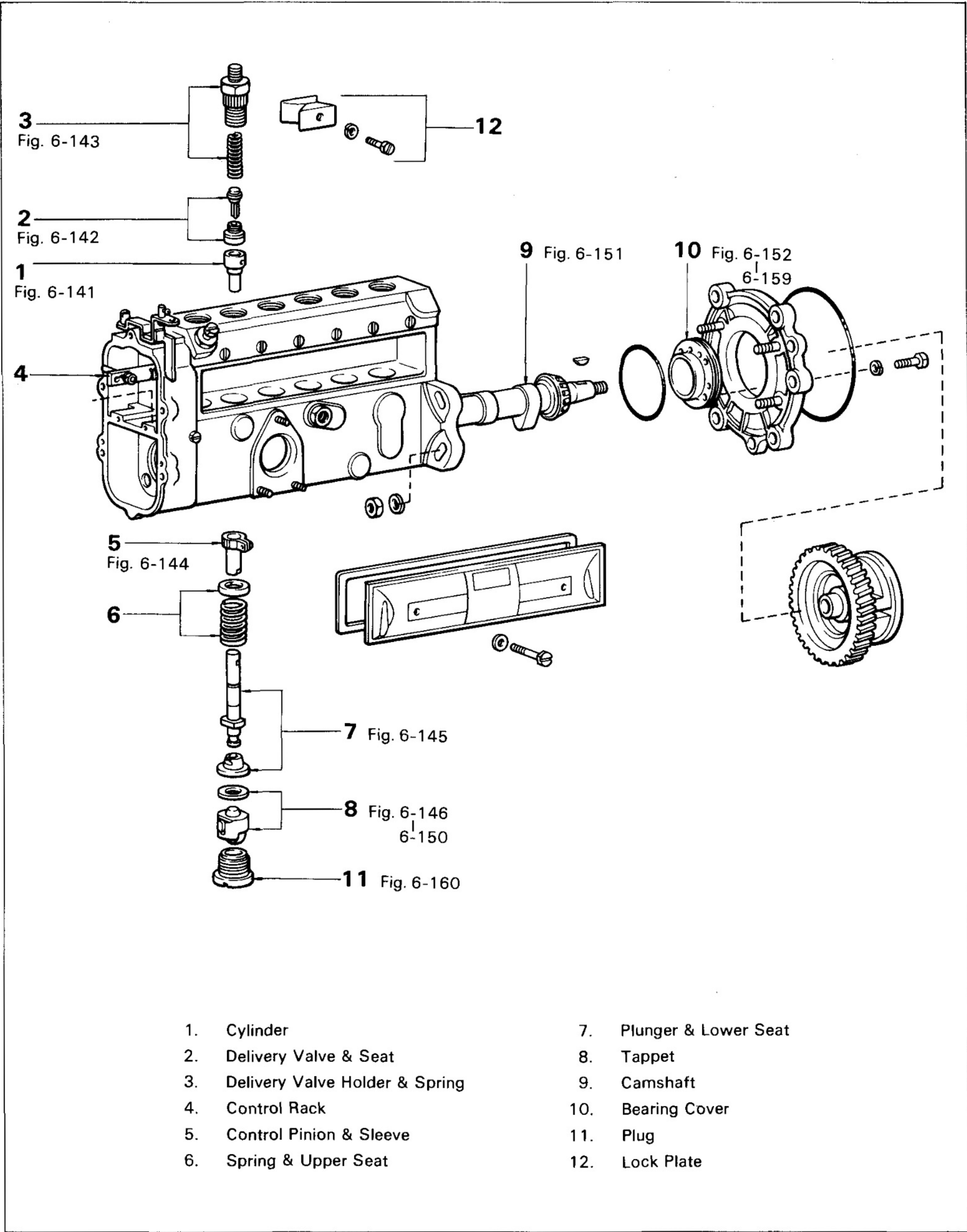


2. Since the position of the push rod depends on altitude, the clearance mentioned above must be 0.1–0.3 mm (0.004–0.012 in.) plus the amount of push rod shift as shown in the figure.

ASSEMBLY (PUMP BODY)

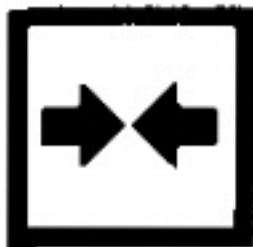
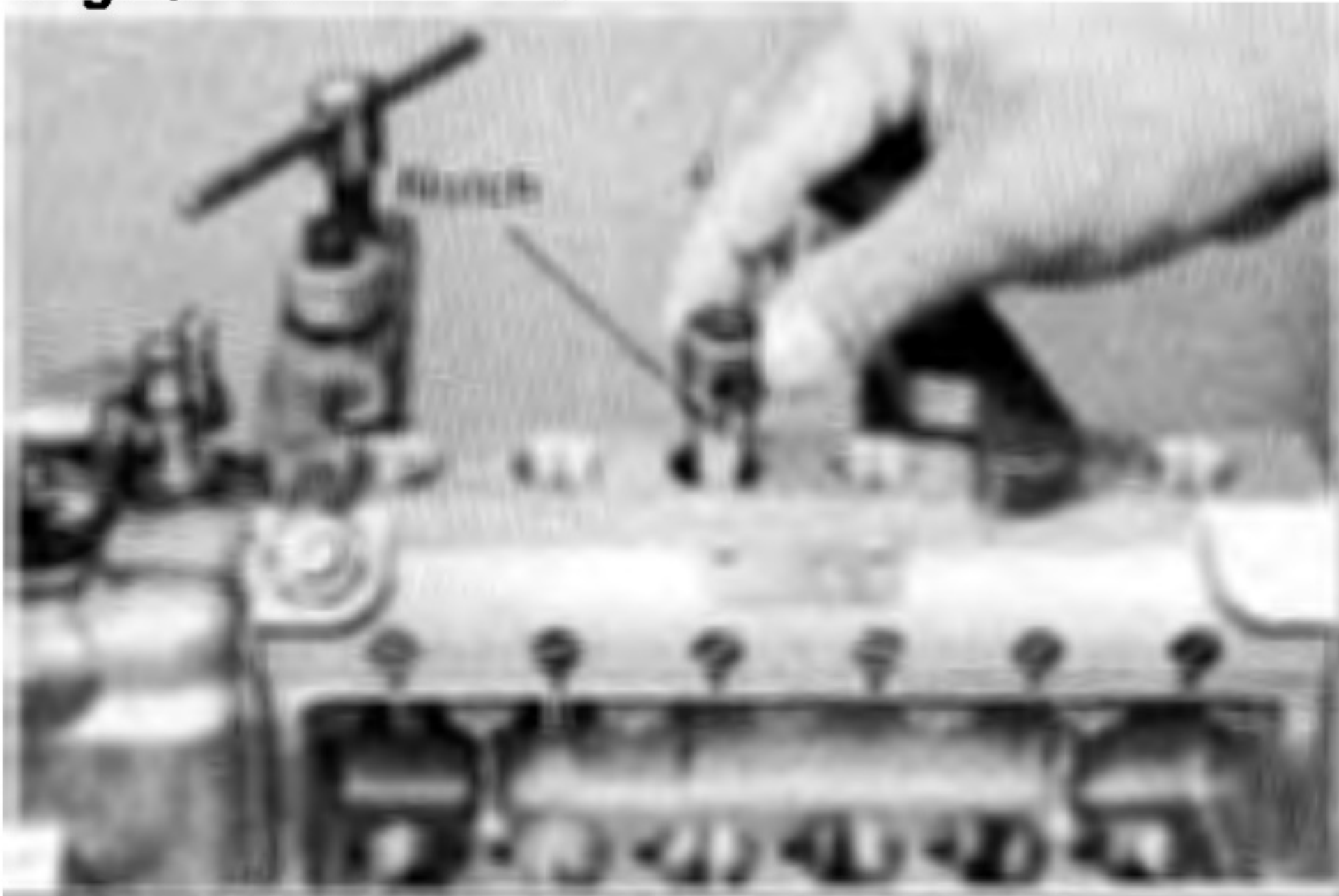
Assemble the parts in the numerical order shown in the figure.

Fig. 6-140



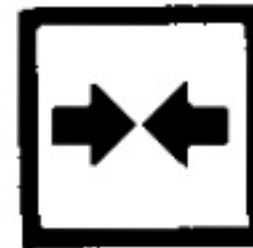
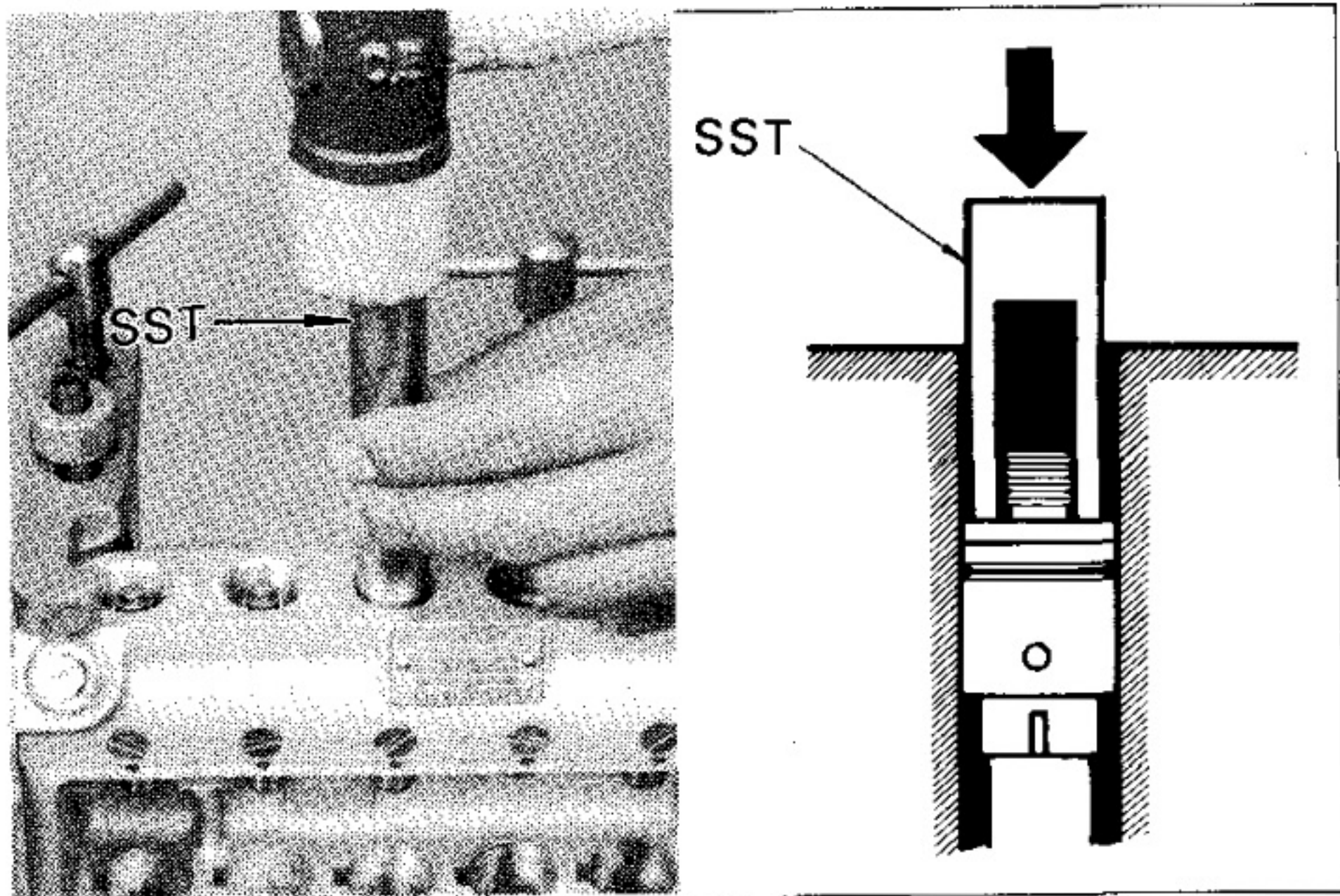
- | | |
|-----------------------------------|-------------------------|
| 1. Cylinder | 7. Plunger & Lower Seat |
| 2. Delivery Valve & Seat | 8. Tappet |
| 3. Delivery Valve Holder & Spring | 9. Camshaft |
| 4. Control Rack | 10. Bearing Cover |
| 5. Control Pinion & Sleeve | 11. Plug |
| 6. Spring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

Fig. 6-141



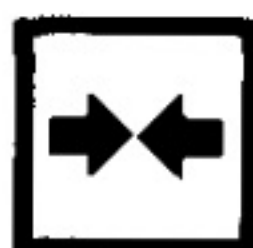
To assemble the cylinder, match the pump cylinder notch with the pump housing knock pin.

Fig. 6-142



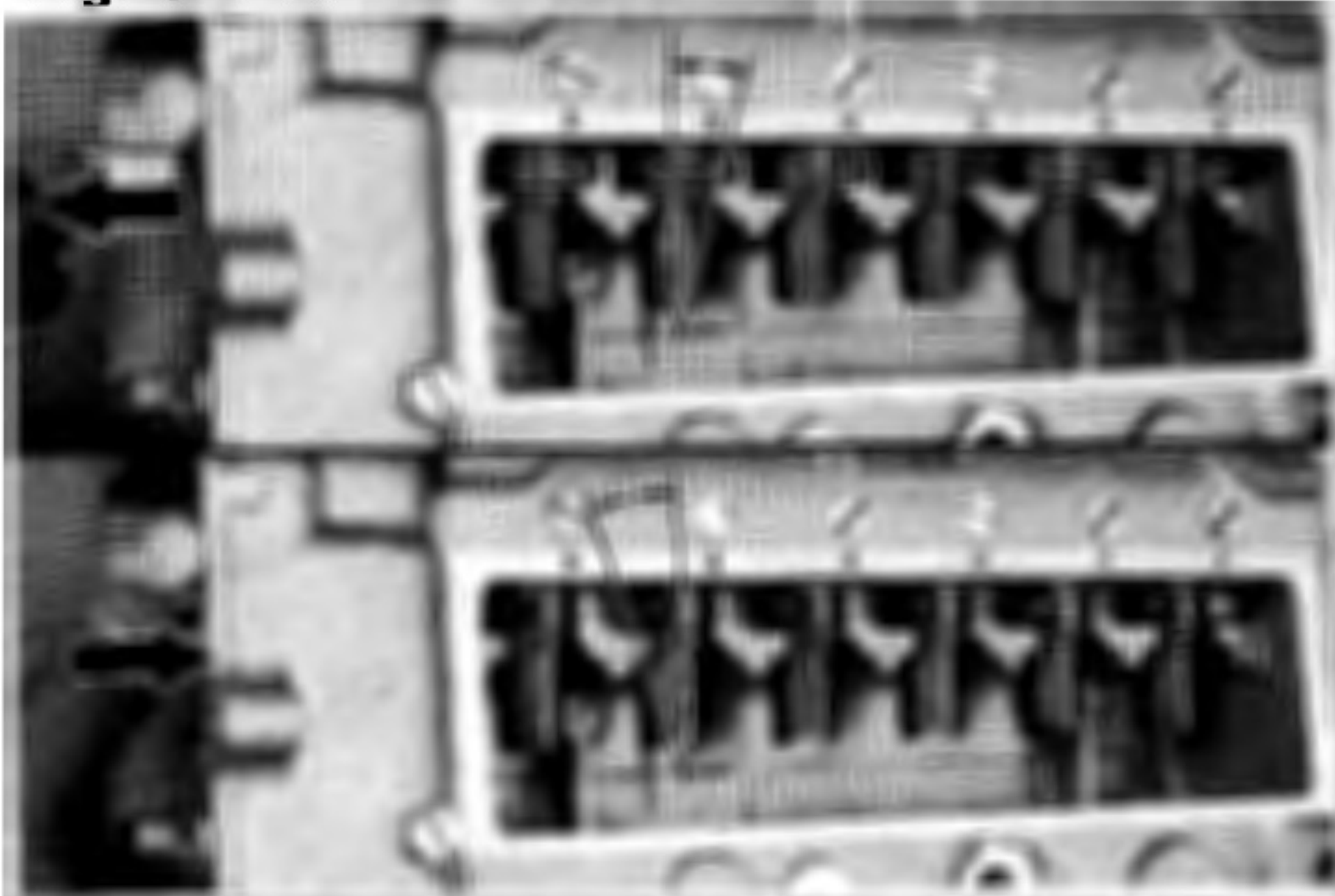
Drive in the pump cylinder lightly with SST. SST (09262-76010) of set [09260-76016]

Fig. 6-143



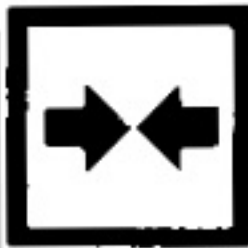
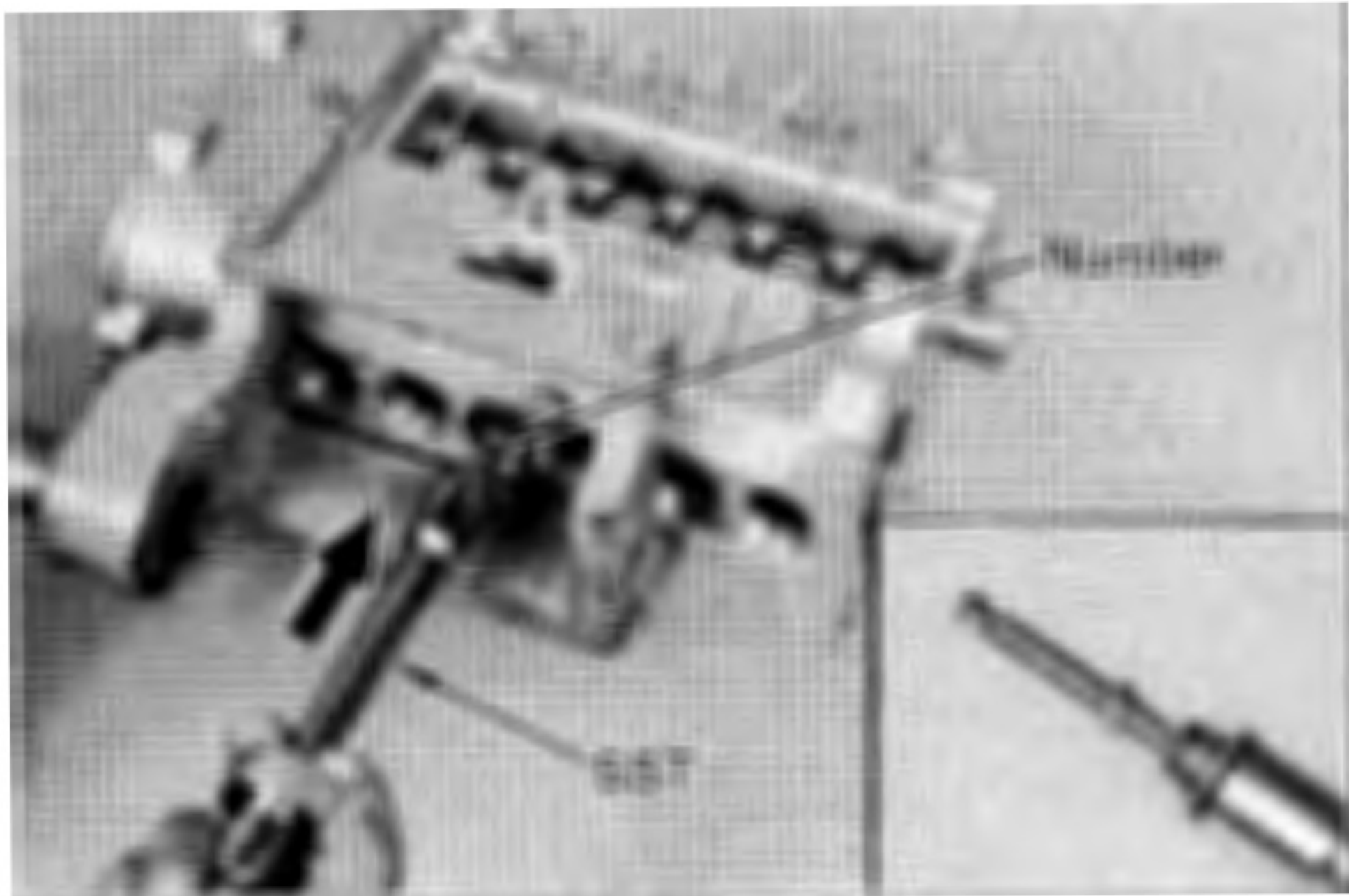
Lightly tighten the delivery valve holder by hand.

Fig. 6-144



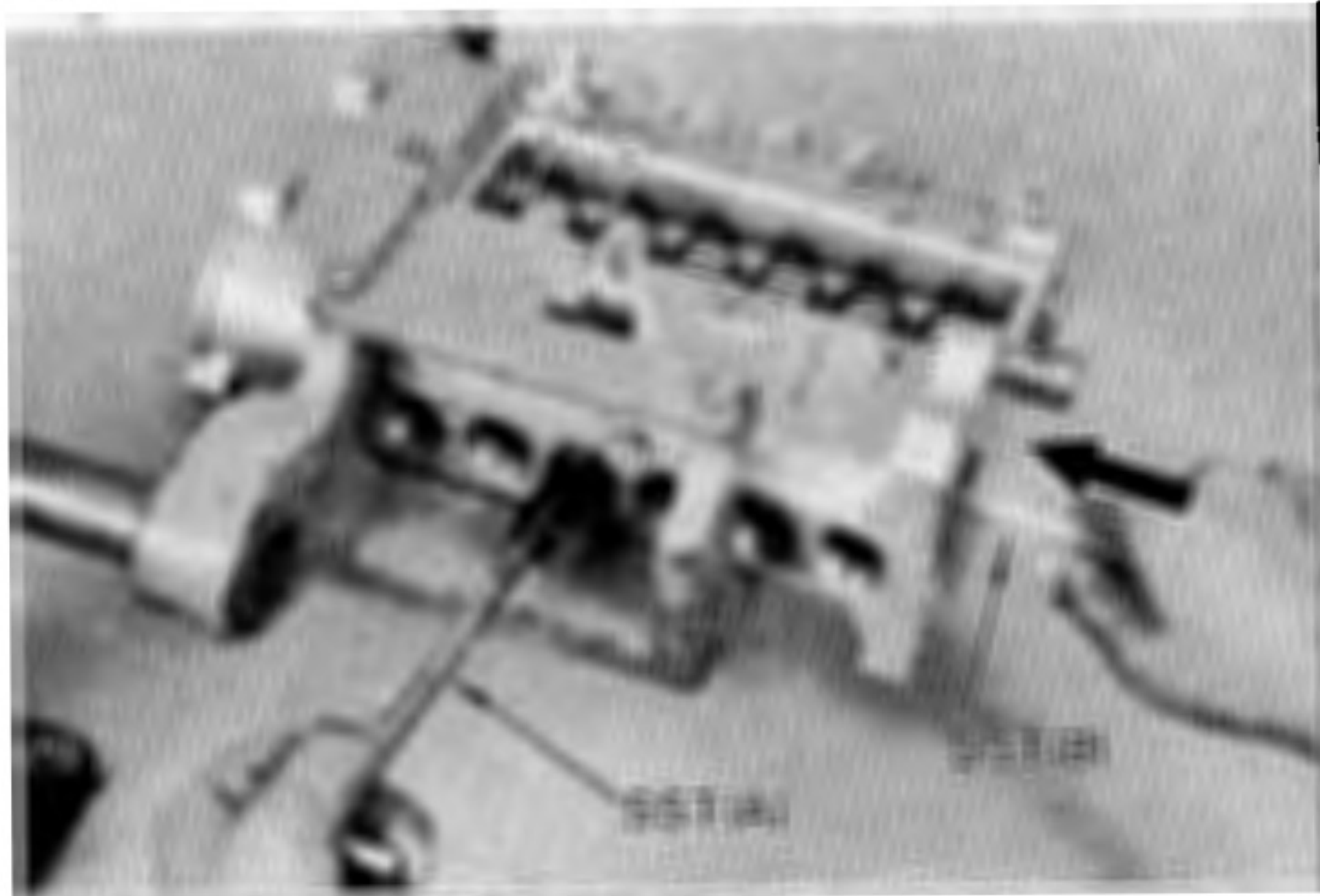
Assemble so that the pinion swings evenly left and right when the rack is moved to the right and left.
When assembling the sleeves, inspect the fitting by moving the rack.

Fig. 6-145



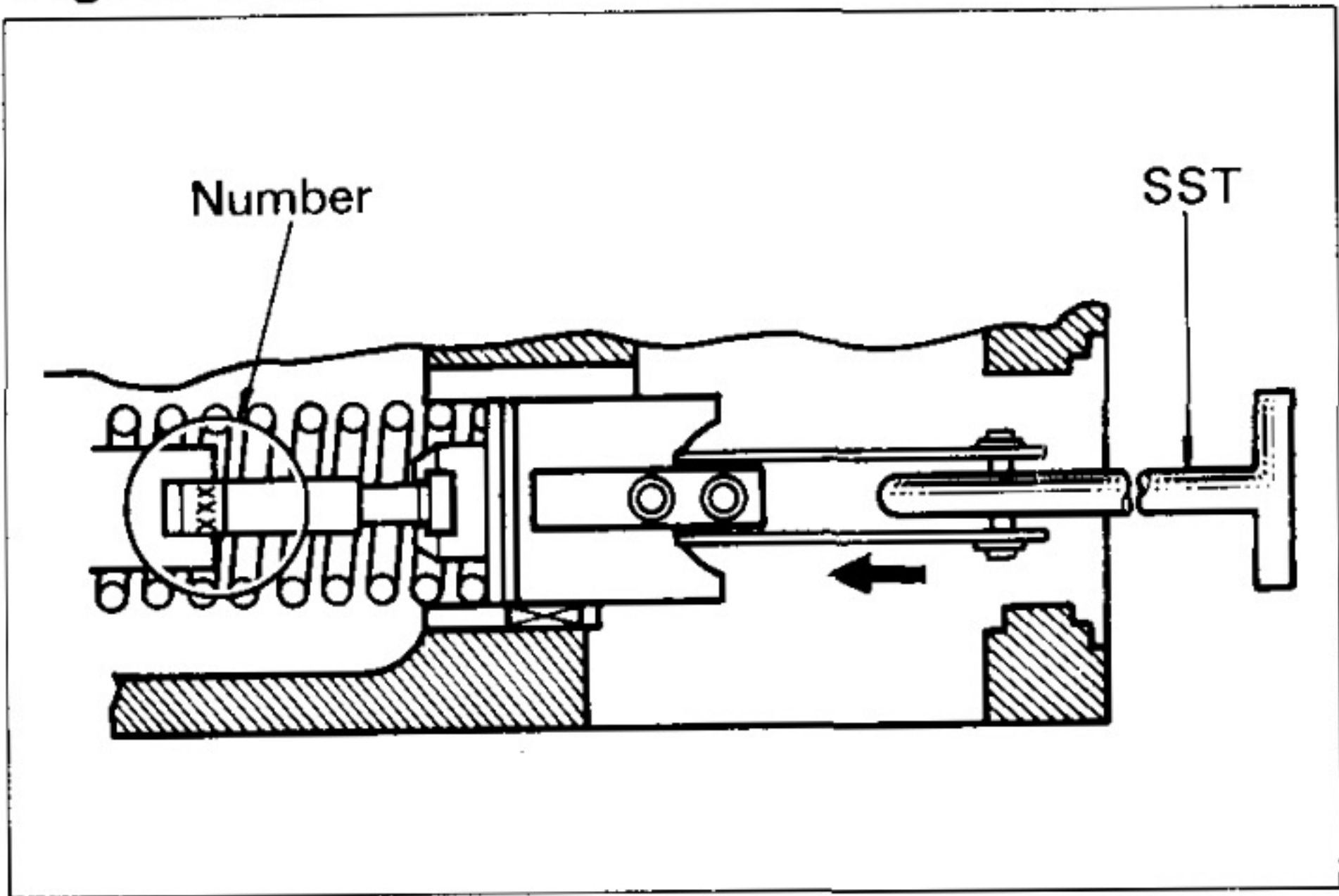
Using SST, assemble the plunger and spring lower seat, inserting the driving face marked with a number and the lower seat notch part upward (cover plate side).
SST (09275-46010) of set [09260-46011]

Fig. 6-146



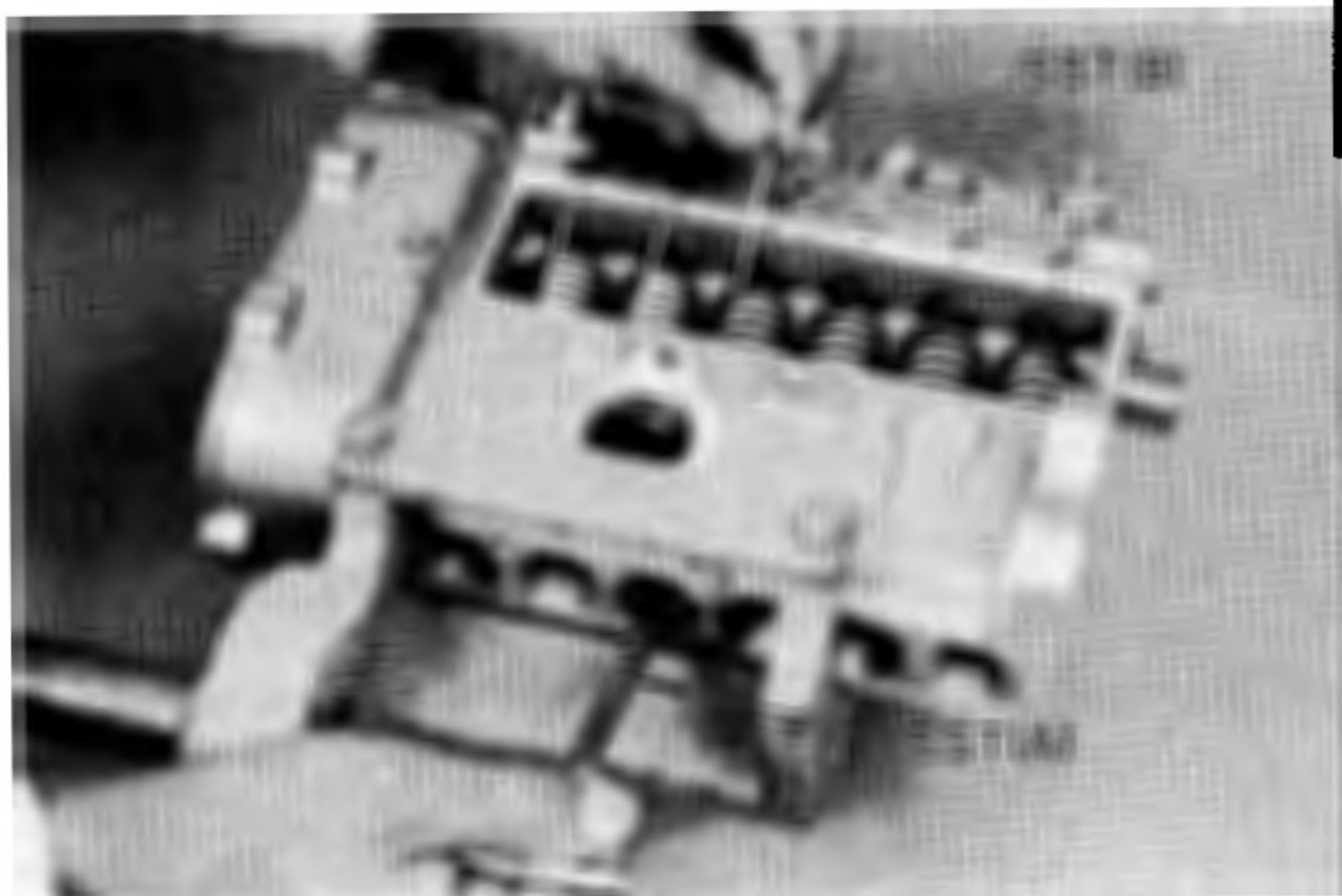
Insert the tappet into the housing with SST (A) and (B).
SST (A) (09273-76011) &
(B) (09272-76011) of set [09260-76016]

Fig. 6-147



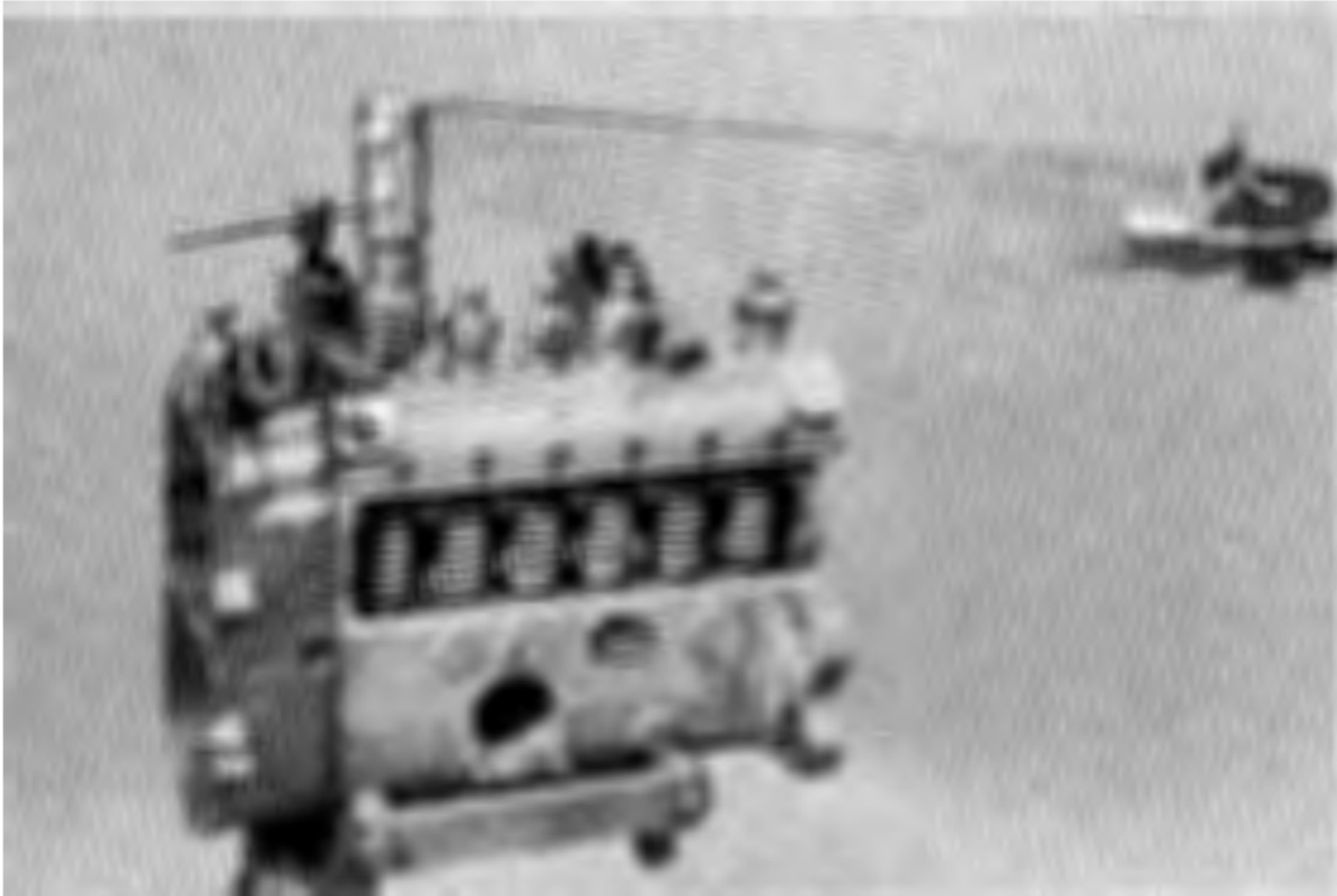
Fit the driving face into the cylinder groove, facing its number toward pump cover side.

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]

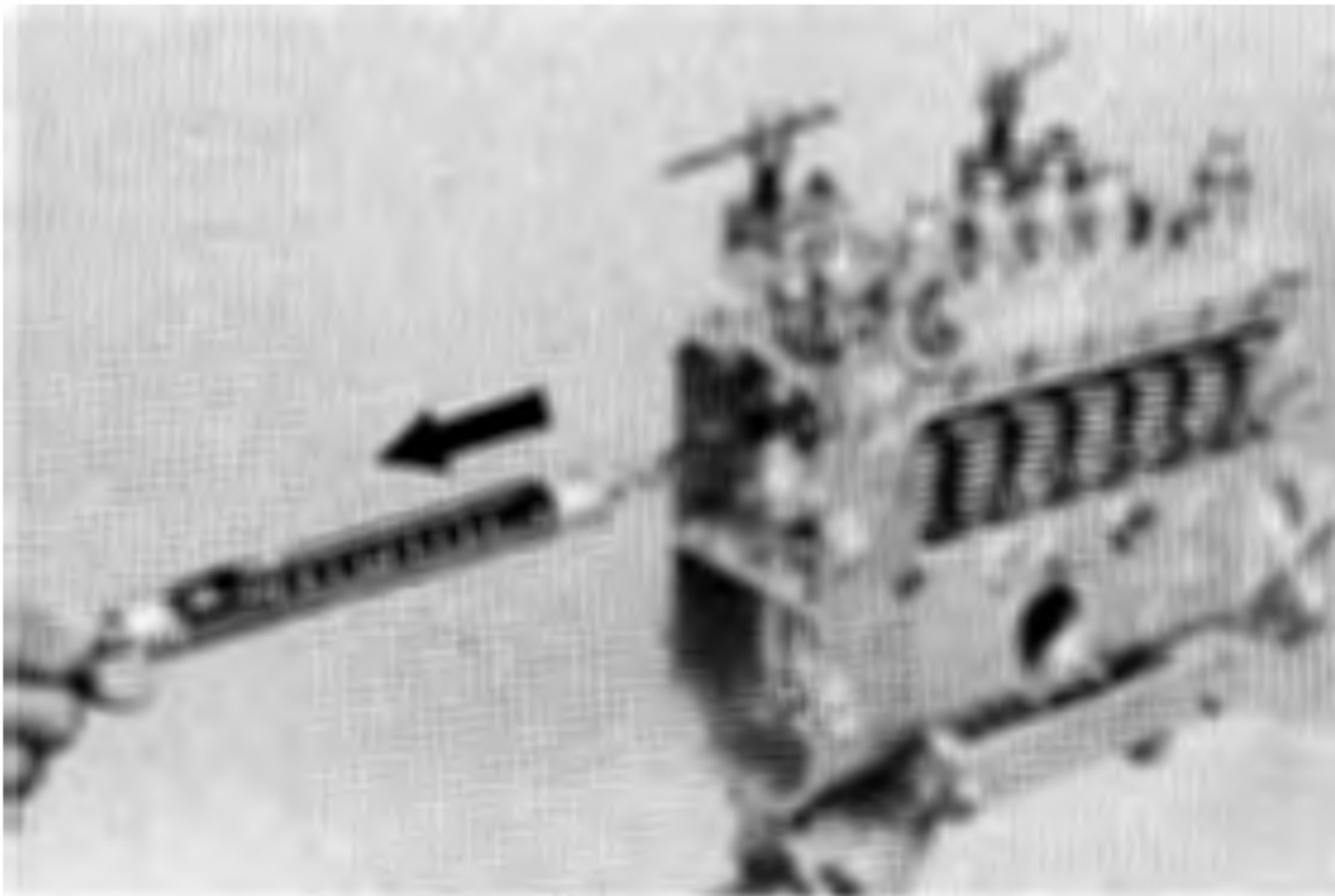
Fig. 6-149



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)**

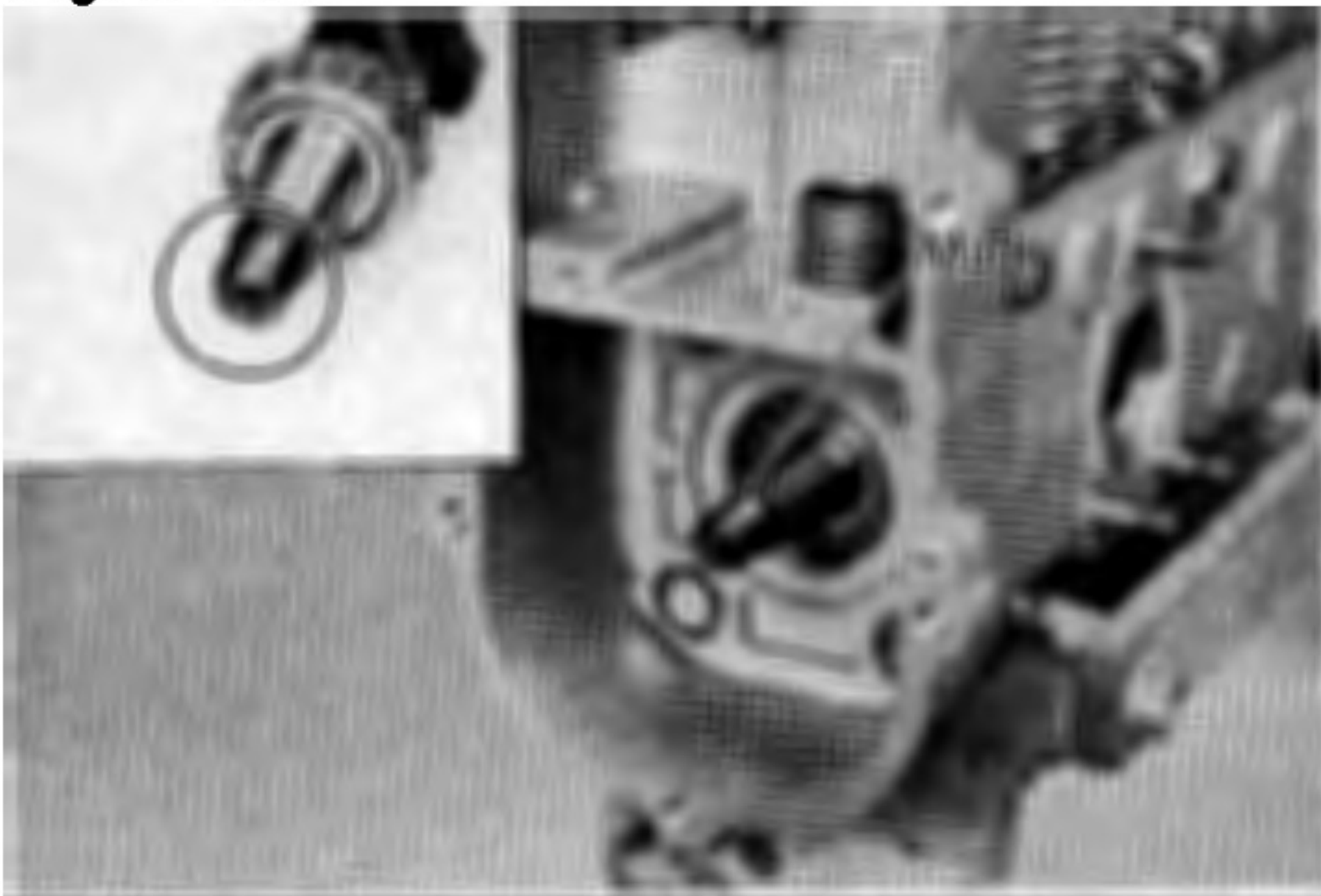
Fig. 6-150



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.)

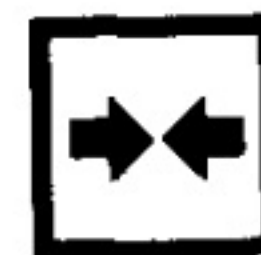
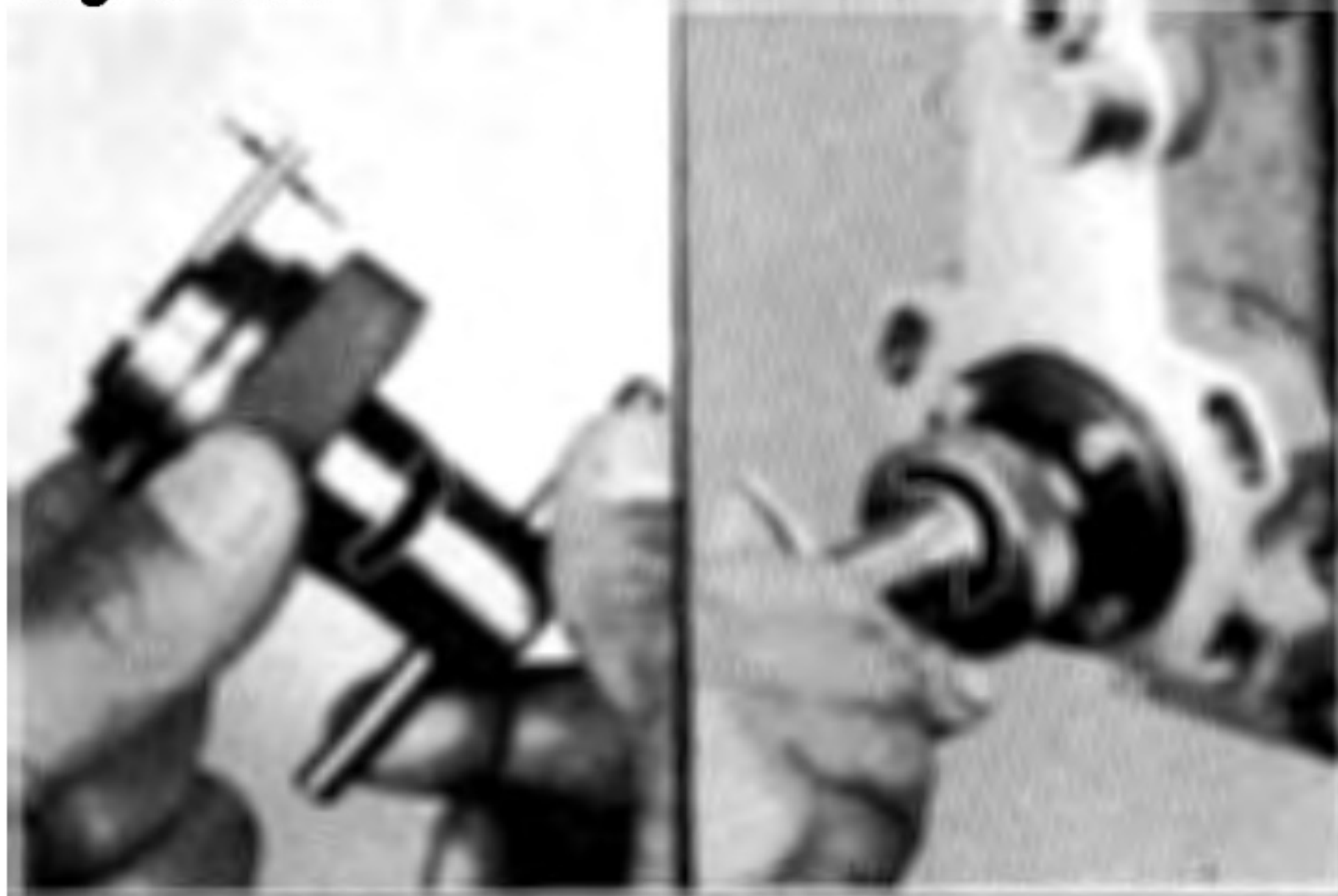
Fig. 6-154



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

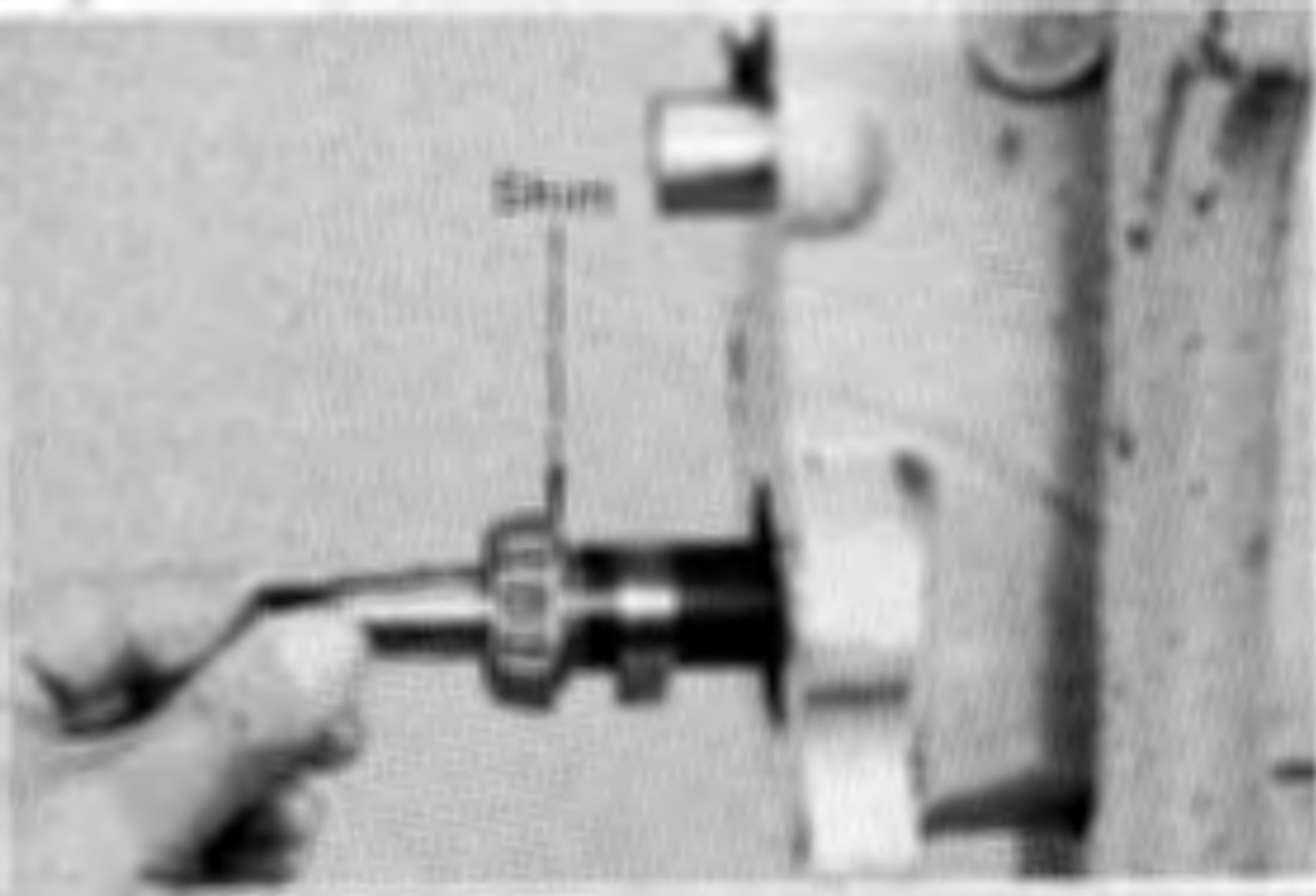


- 5. Pull SST toward the front, and contact the outer dial with the bearing cover by screwing in the outer dial.
- 6. The screwing distance is the camshaft thrust clearance.

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.



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

Fig. 6-159

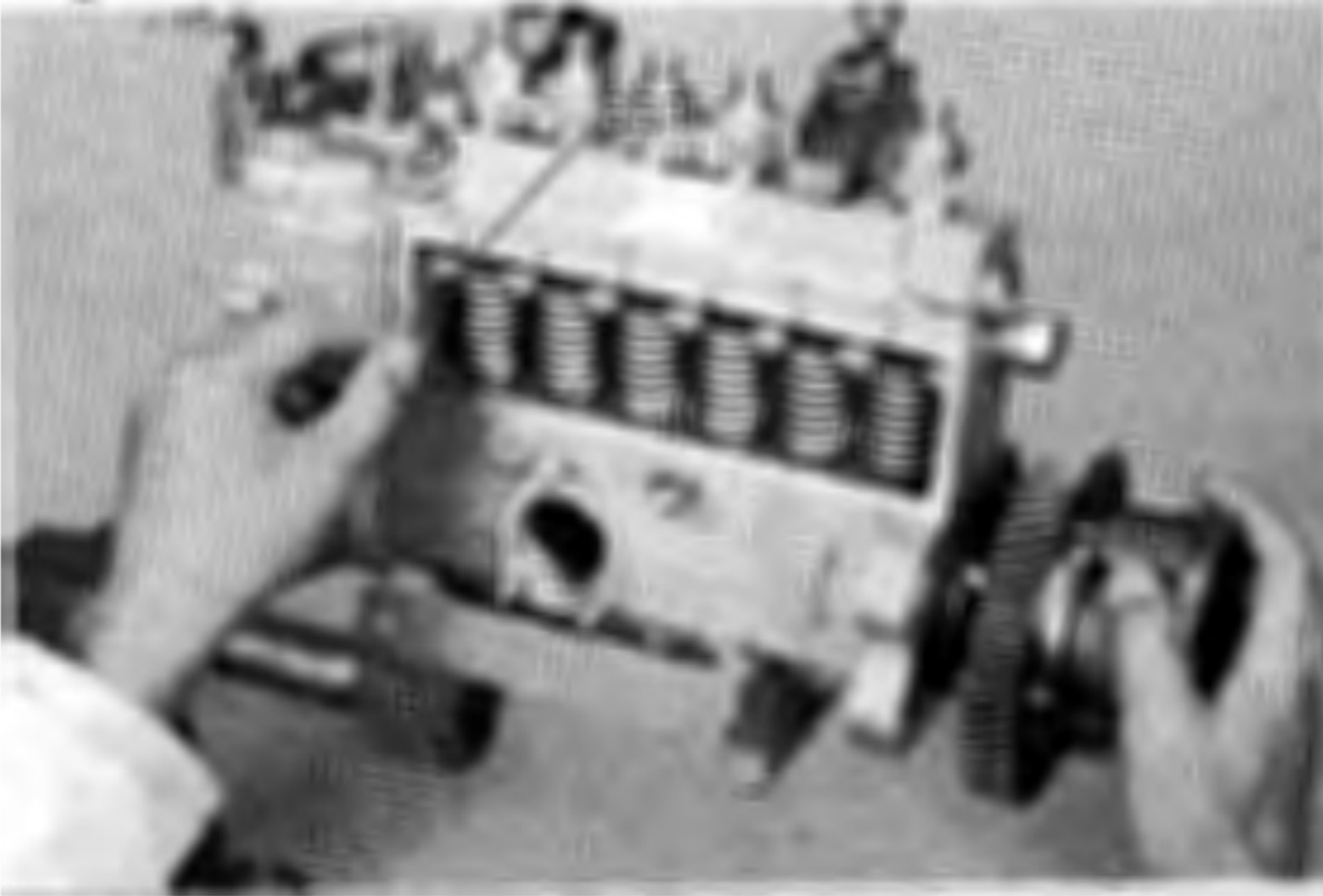
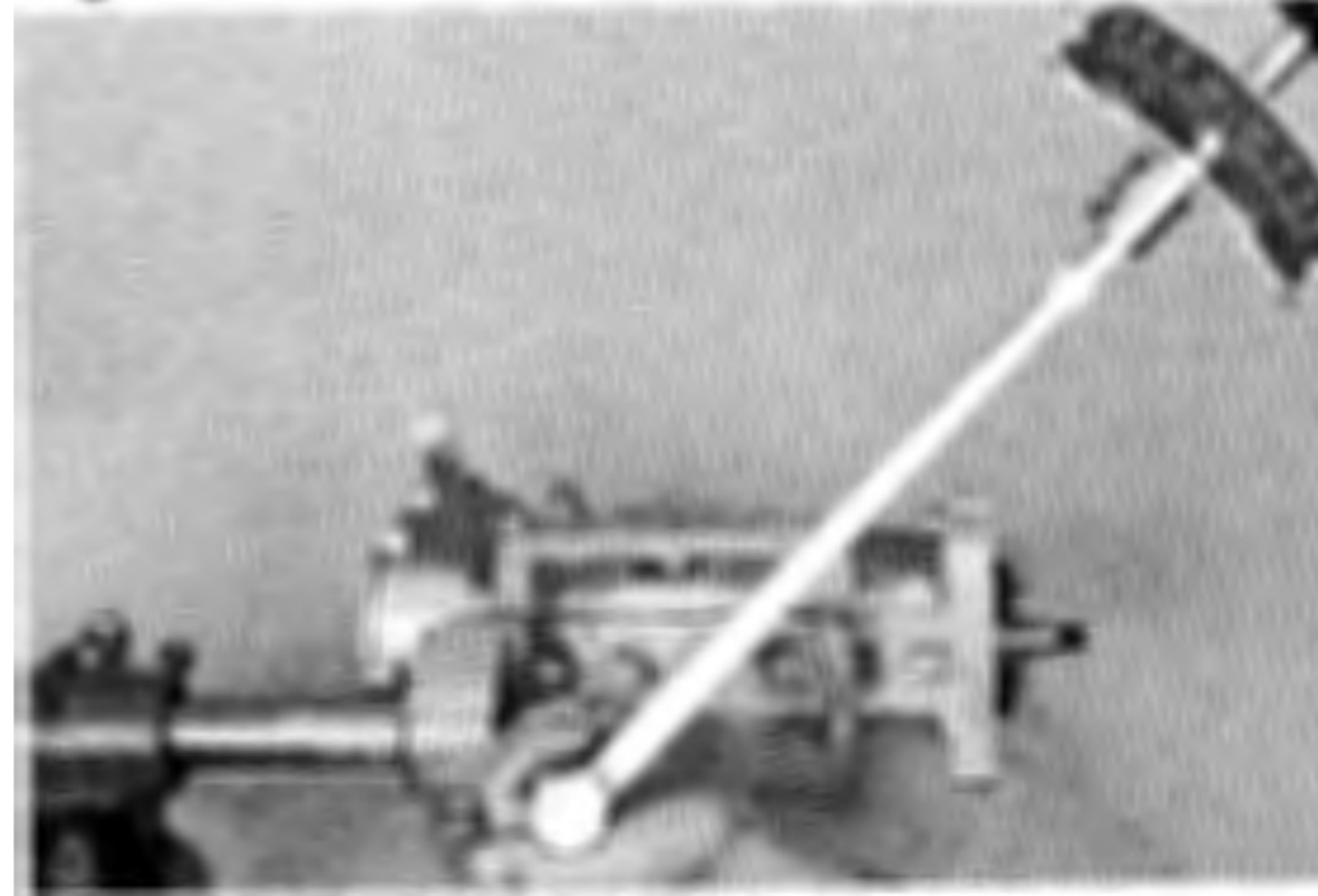


Fig. 6-160



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

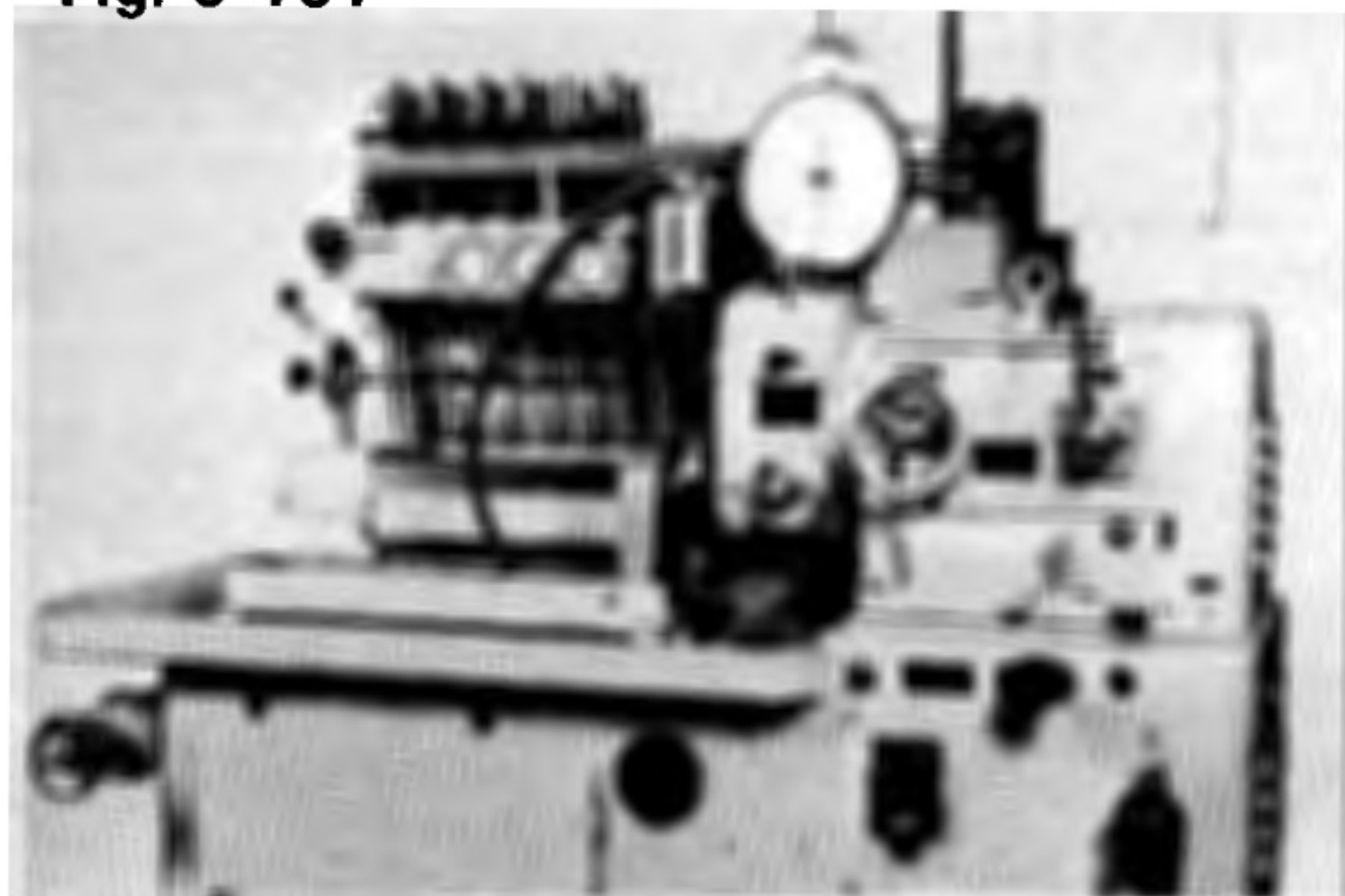


Fig. 6-162

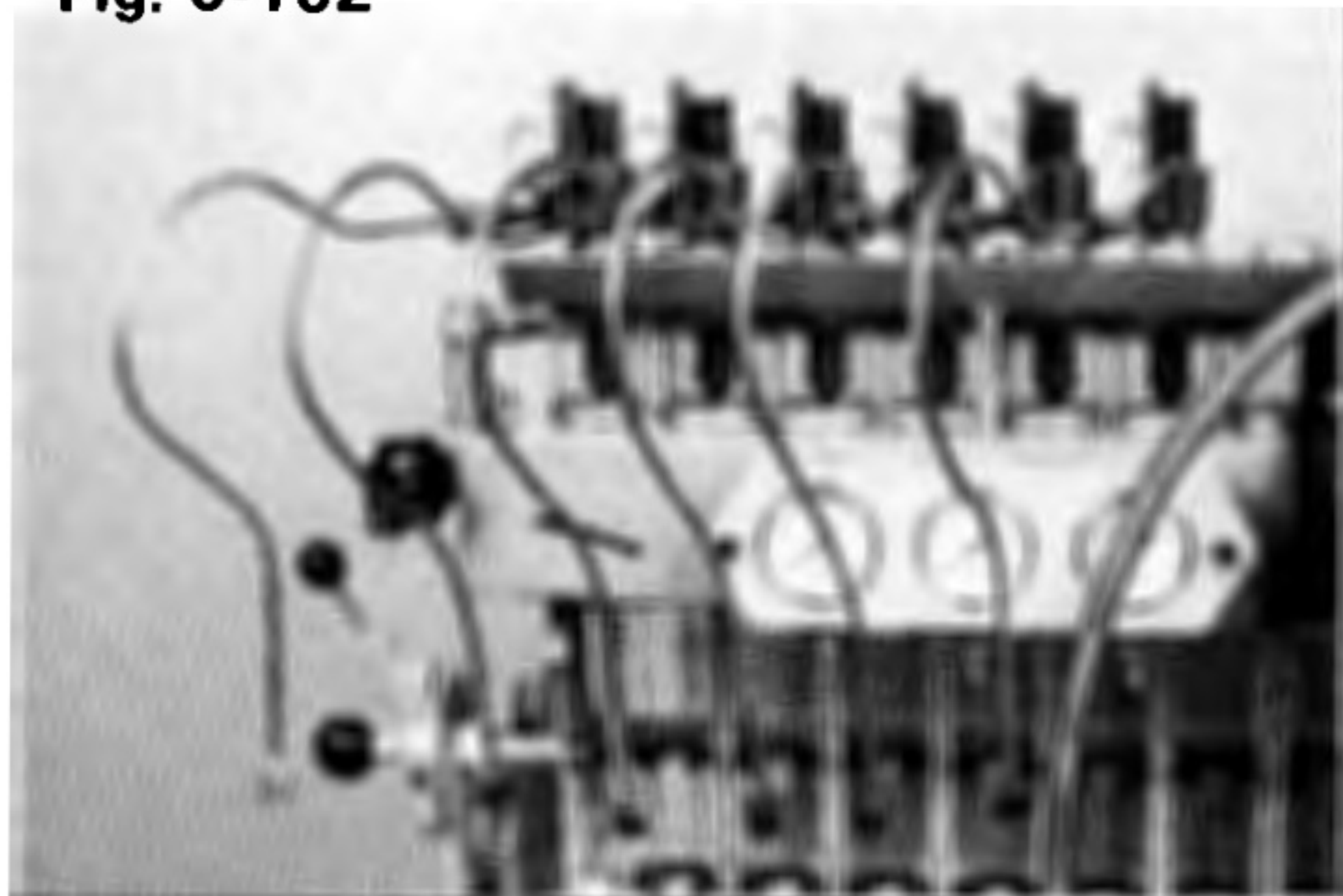


Fig. 6-163

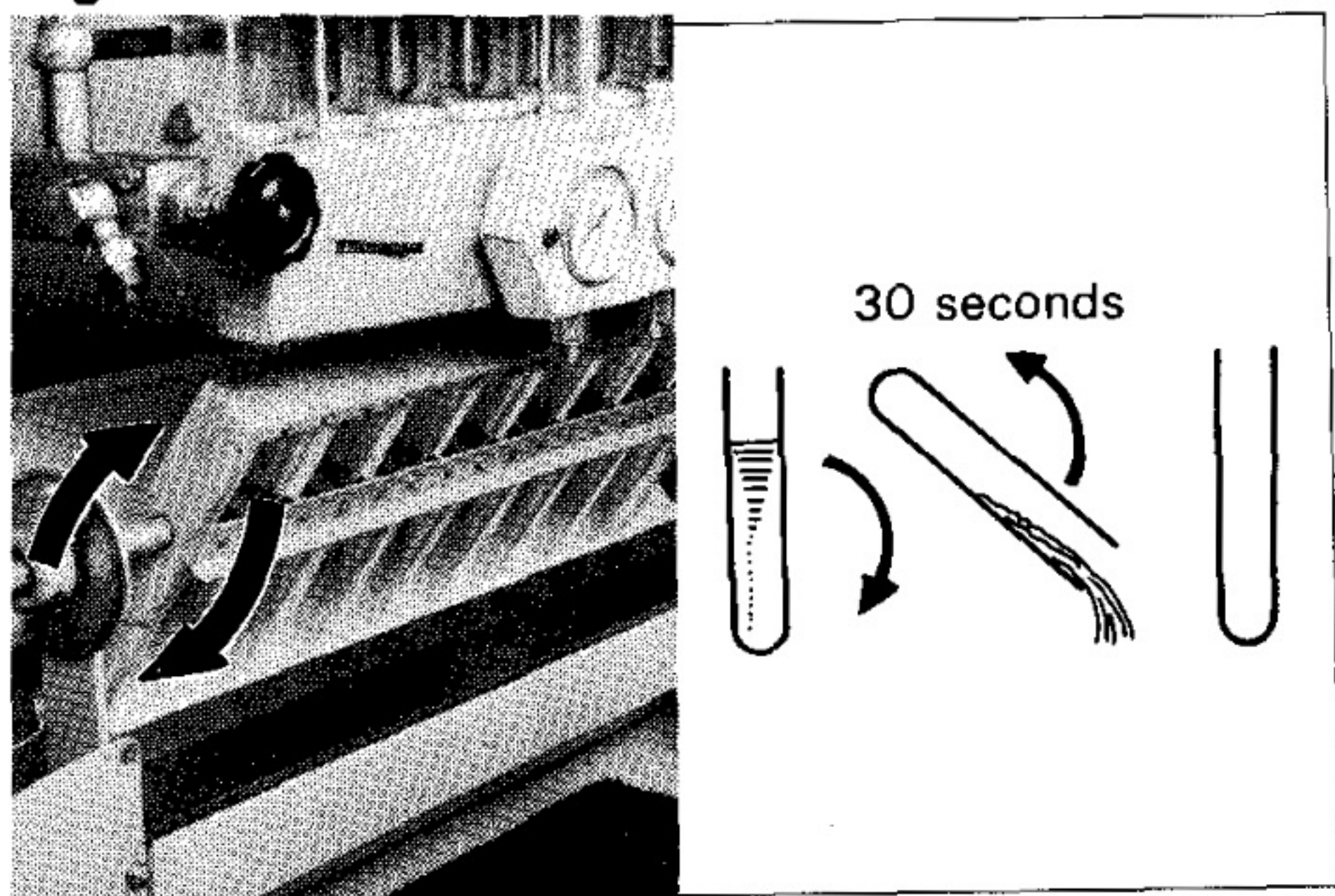
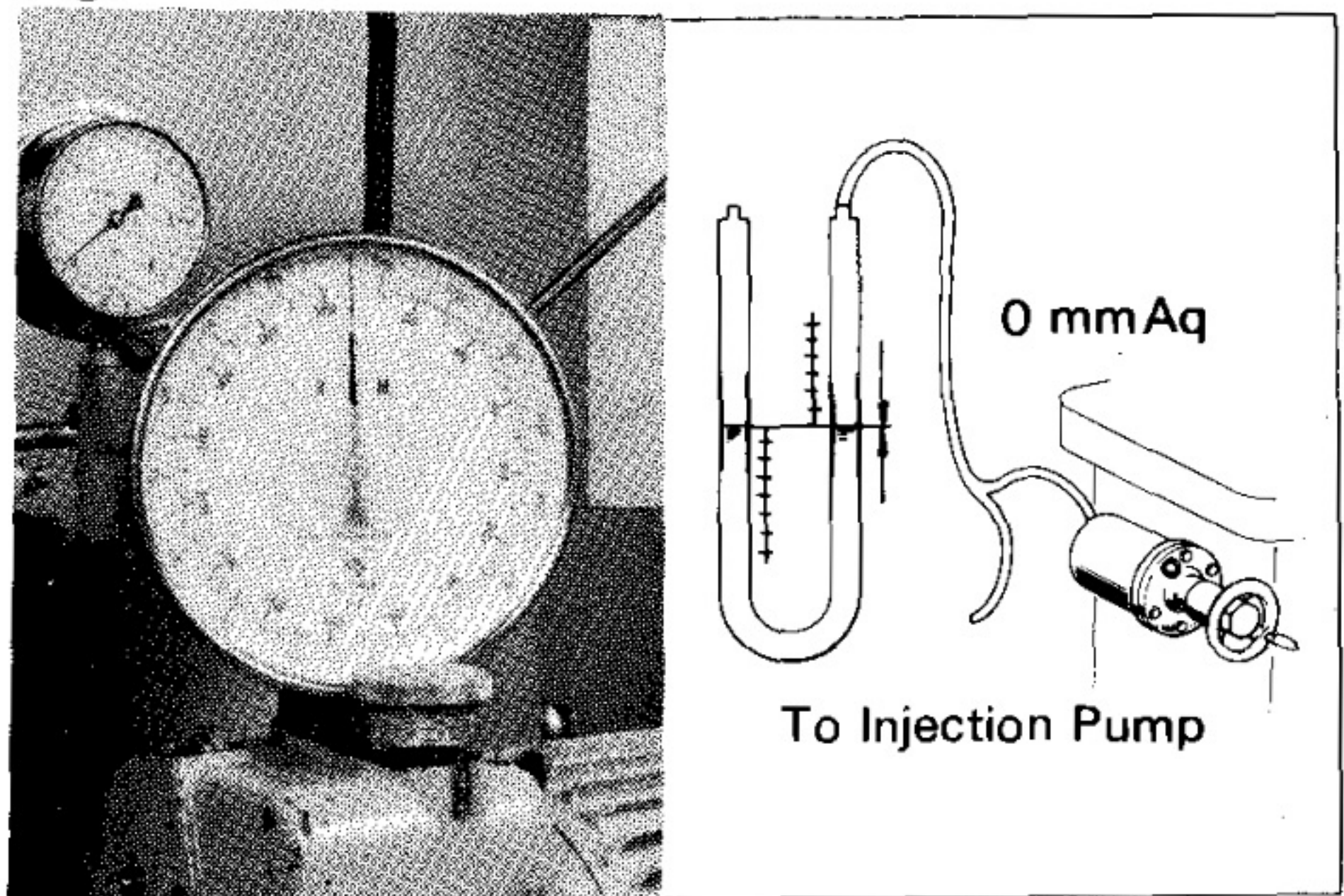


Fig. 6-164

**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)

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.)

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.

5. Check tachometer accuracy.

Allowable error: ± 40 rpm

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

Fig. 6-165



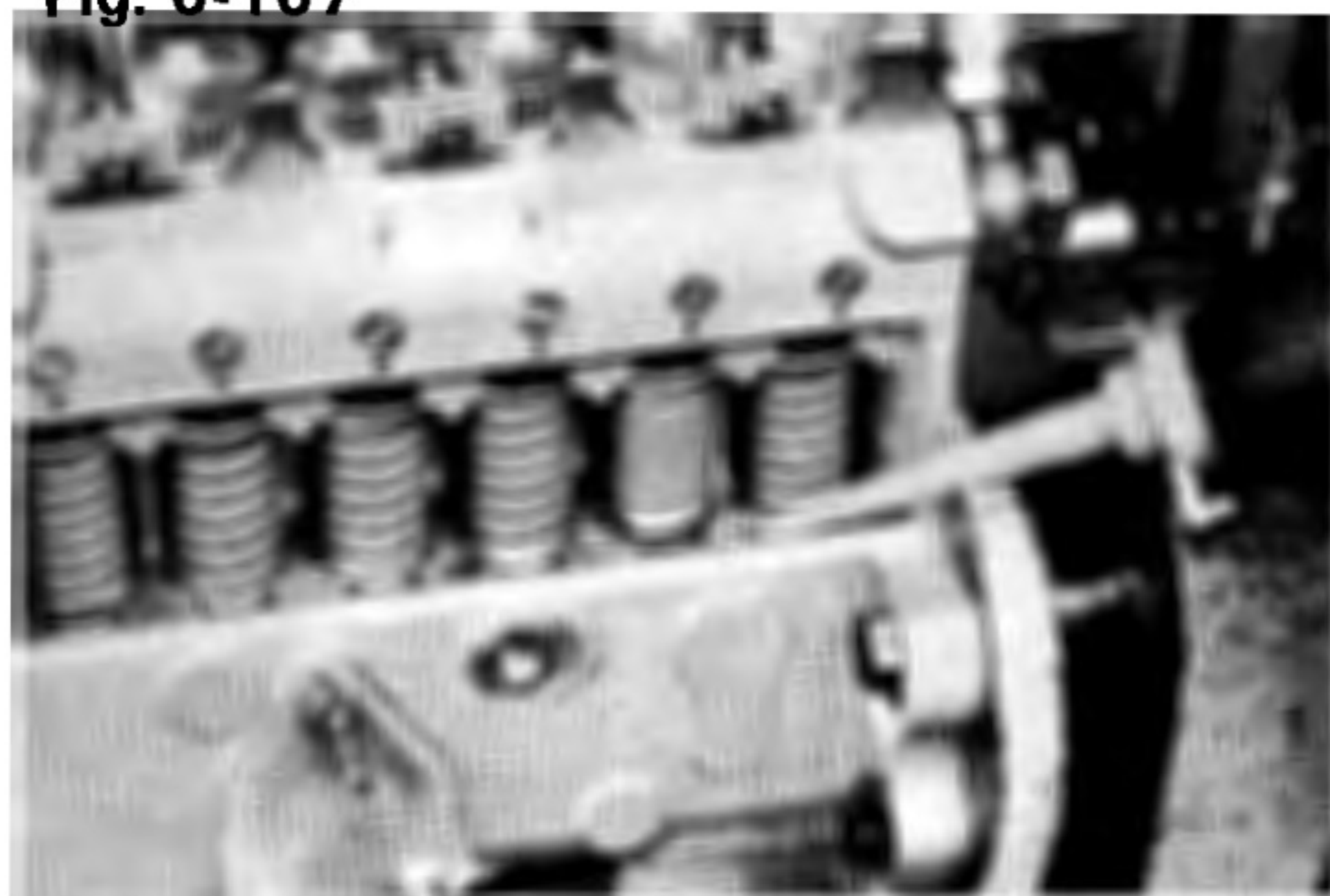
7. Mount the injection pump body on the pump tester.

Fig. 6-166



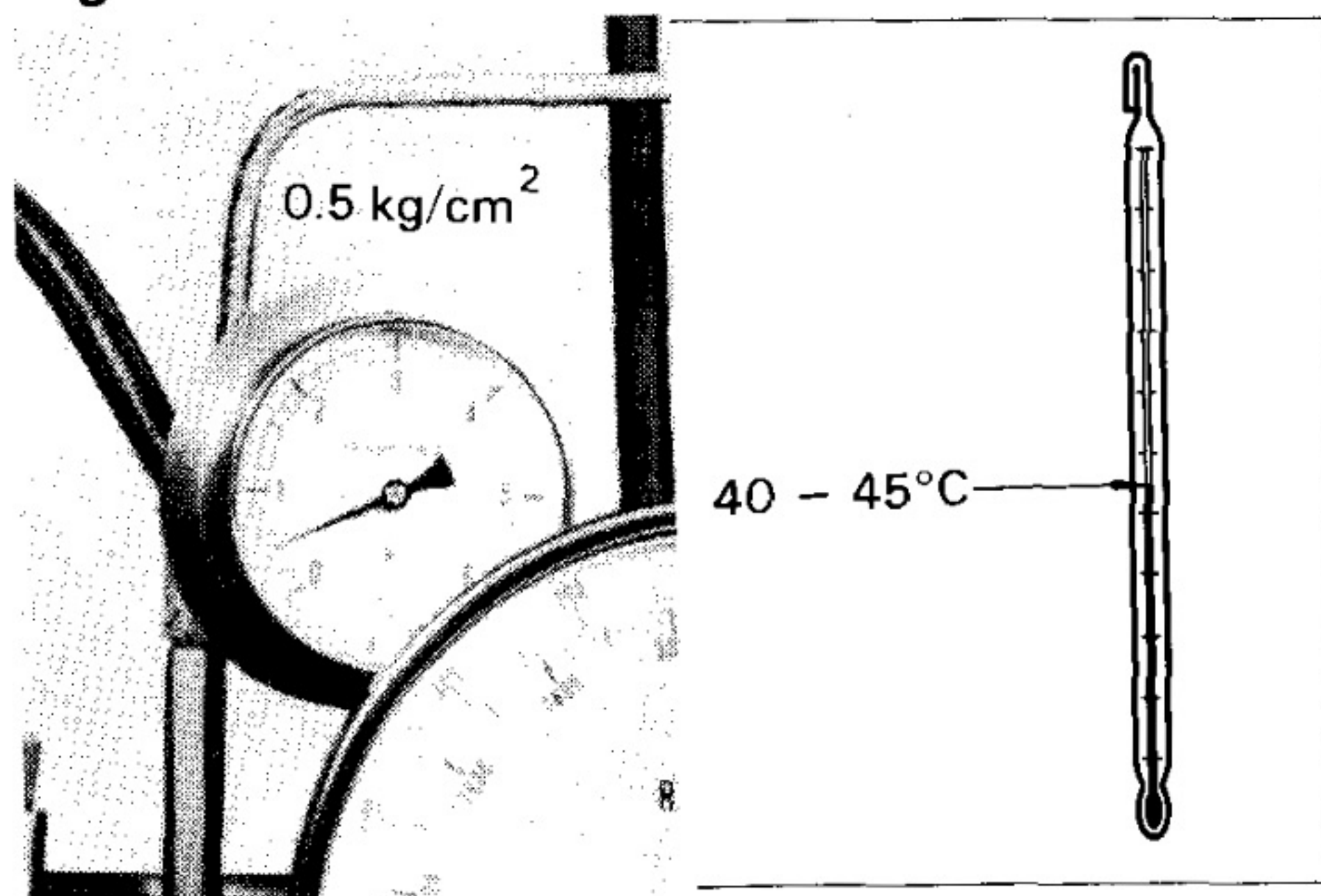
8. Install the rack scale so that its zero point will be at the position where the control rack is pushed fully toward the governor side, and set to allow easy reading of the scale graduations.

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 $40-45^\circ\text{C}$ ($104-113^\circ\text{F}$).

Fig. 6-169



12. Bleed air from pump housing.

Fig. 6-170

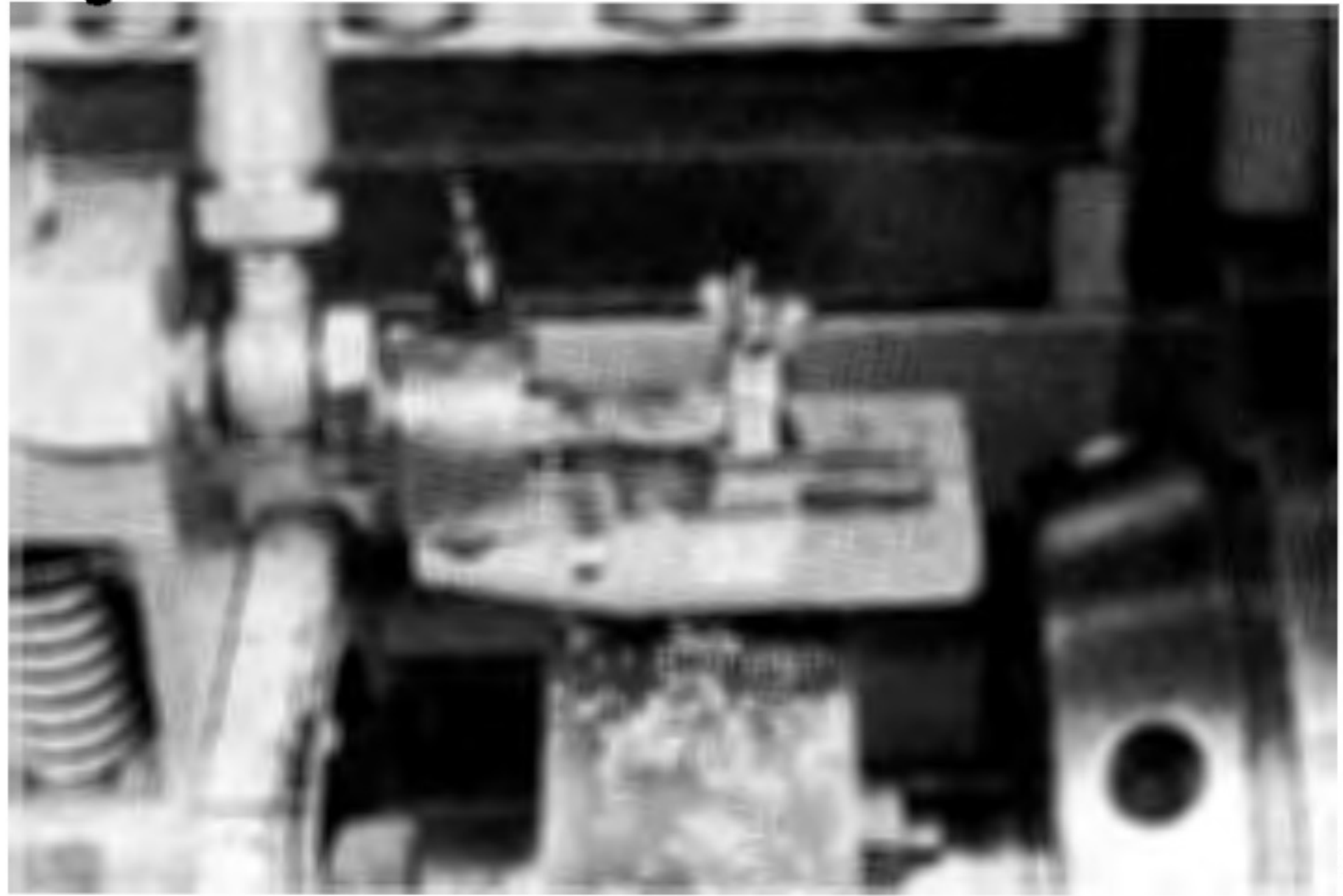


Control Rack Sliding Resistance

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)

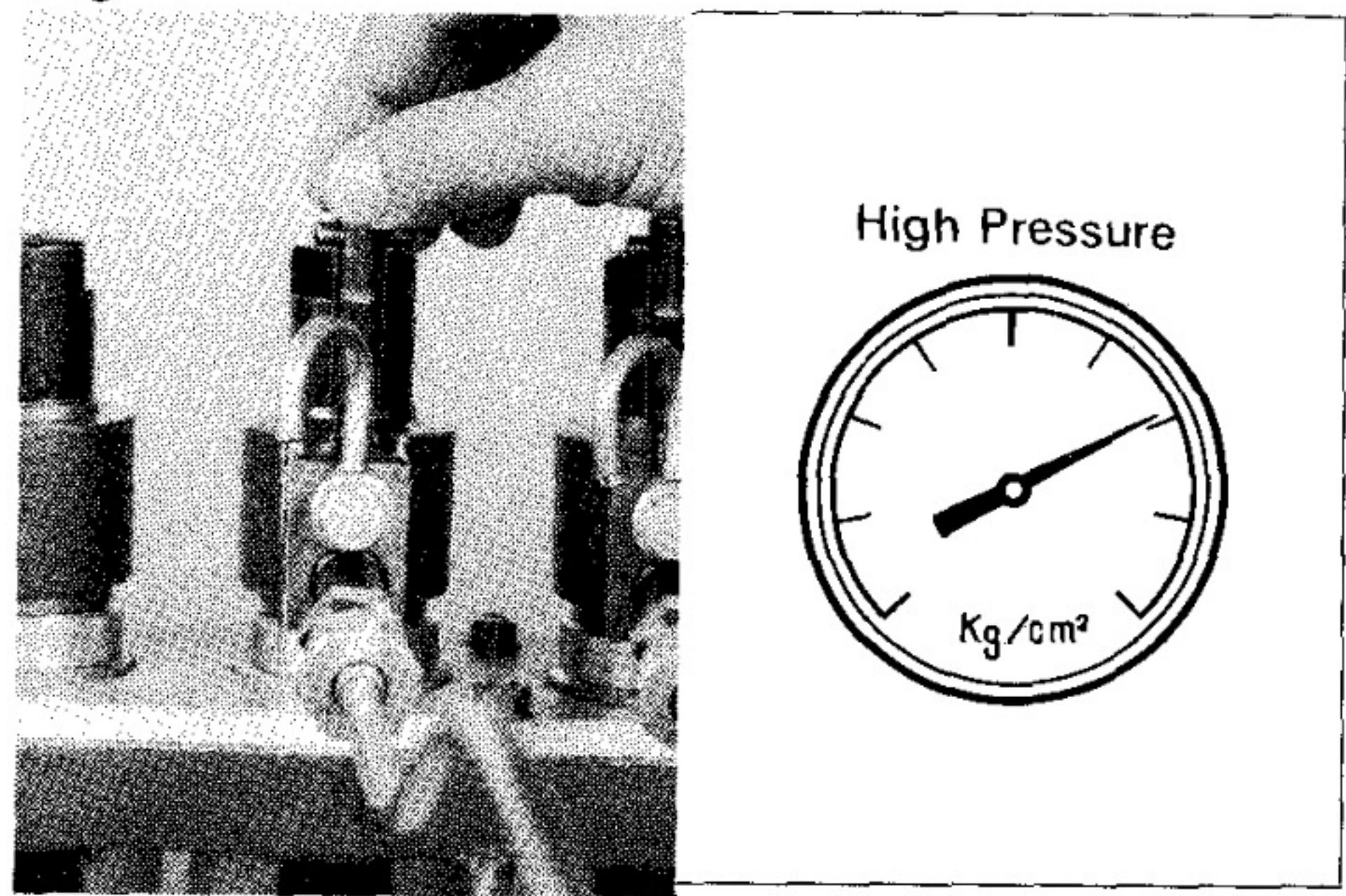
Fig. 6-171



Adjust Injection Timing

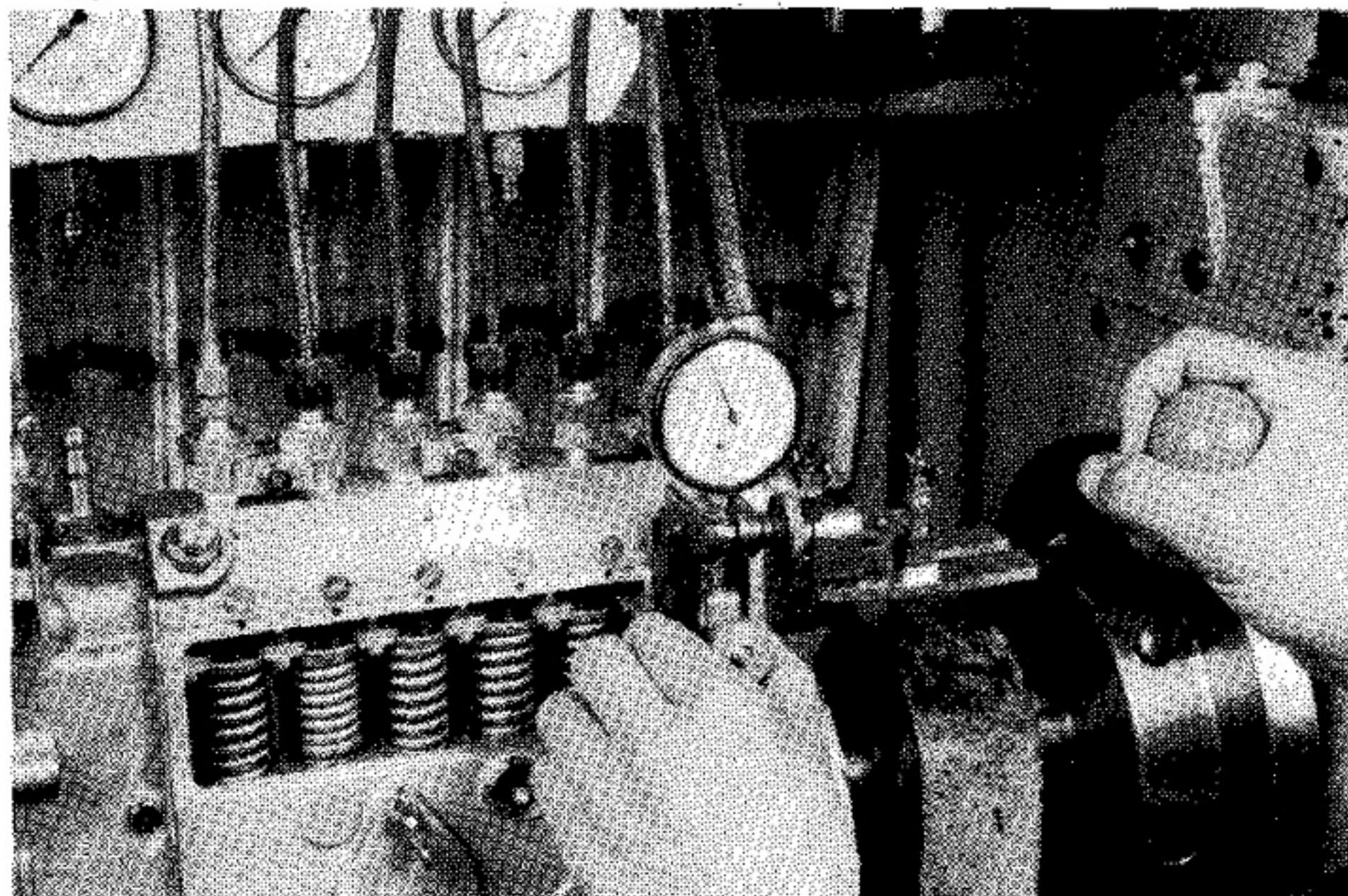
1. Pre-stroke (for No.1 plunger)
 - (1) Set the control rack position at 8.0 mm (0.315 in.).

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]

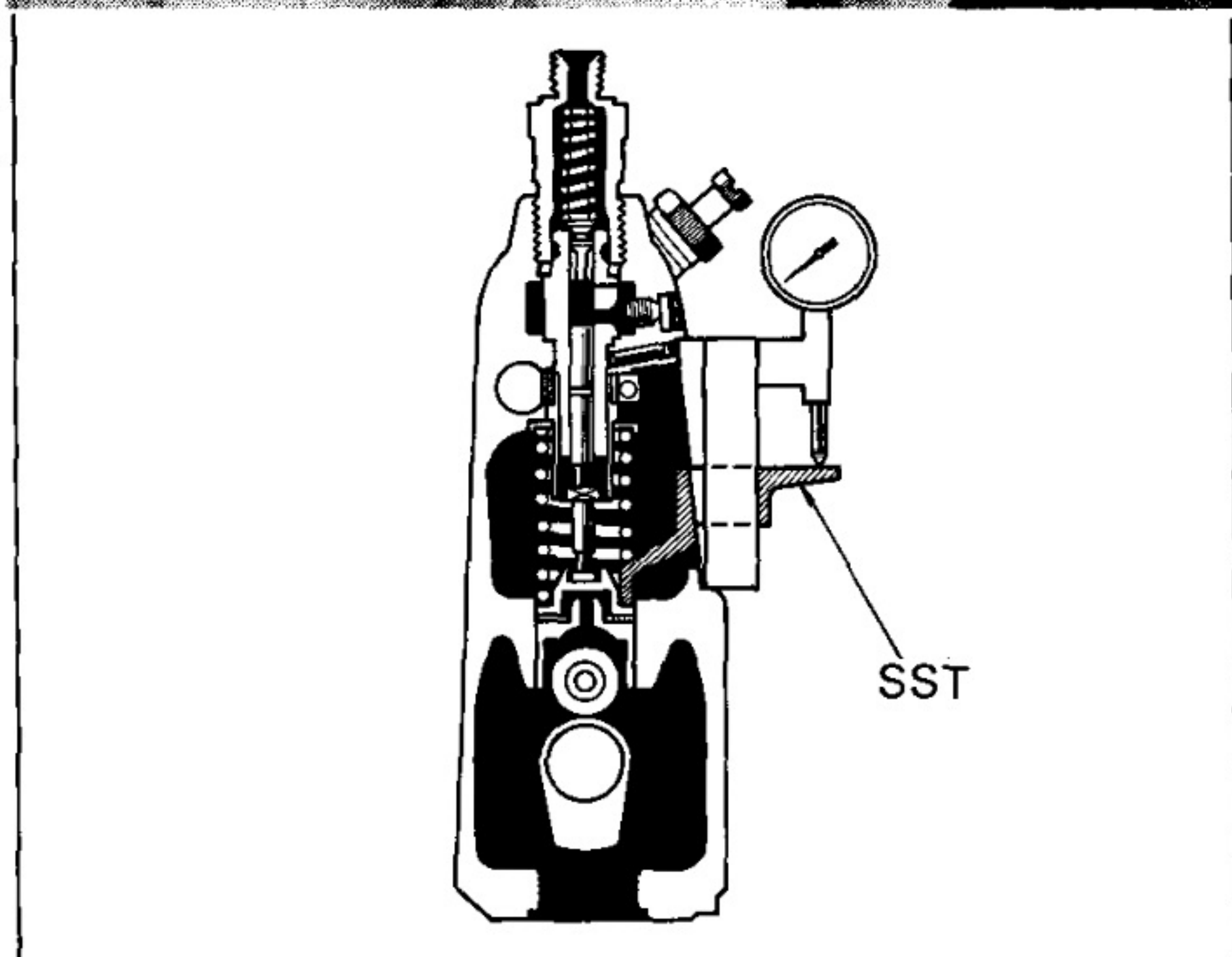
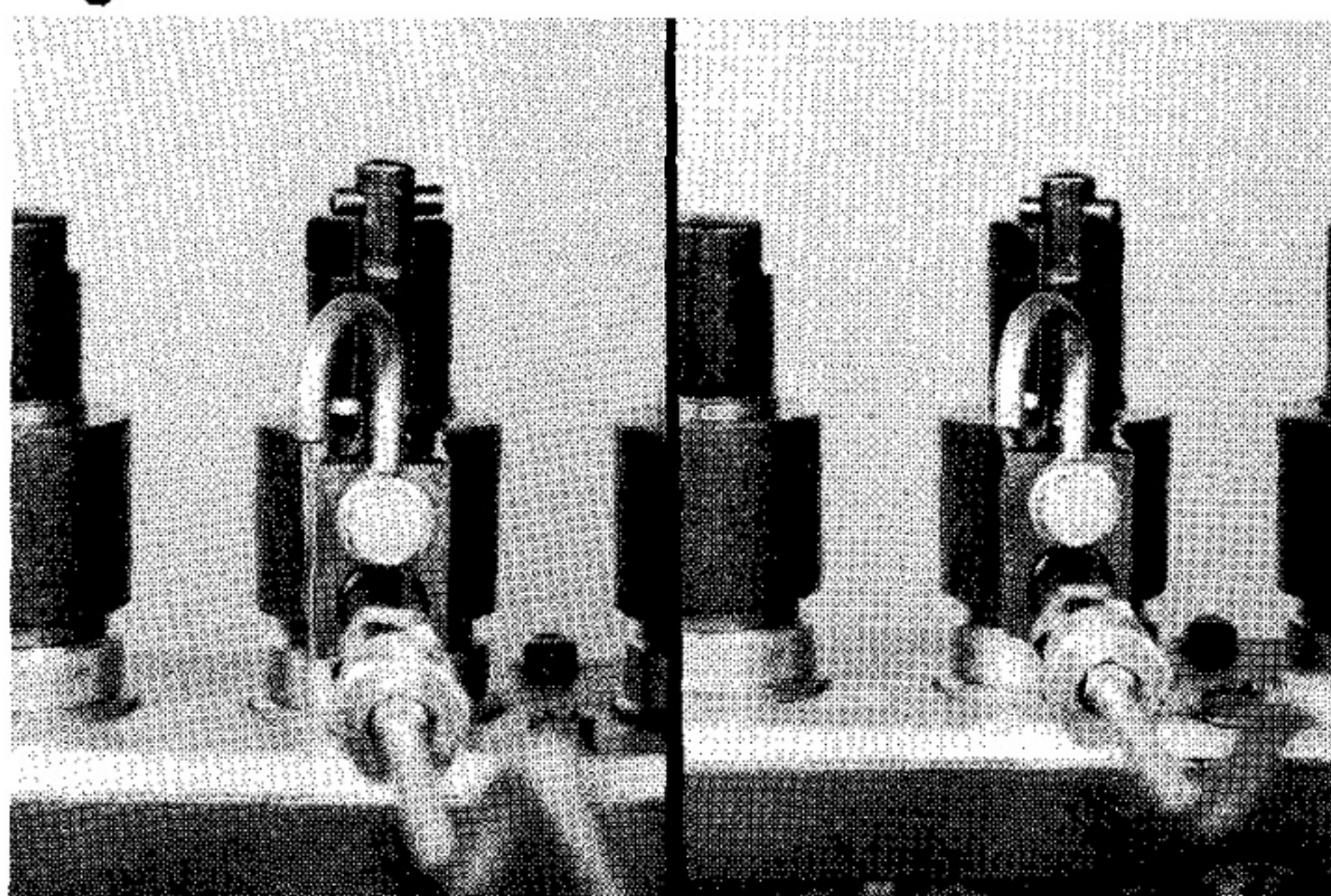


Fig. 6-174



- (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.)**

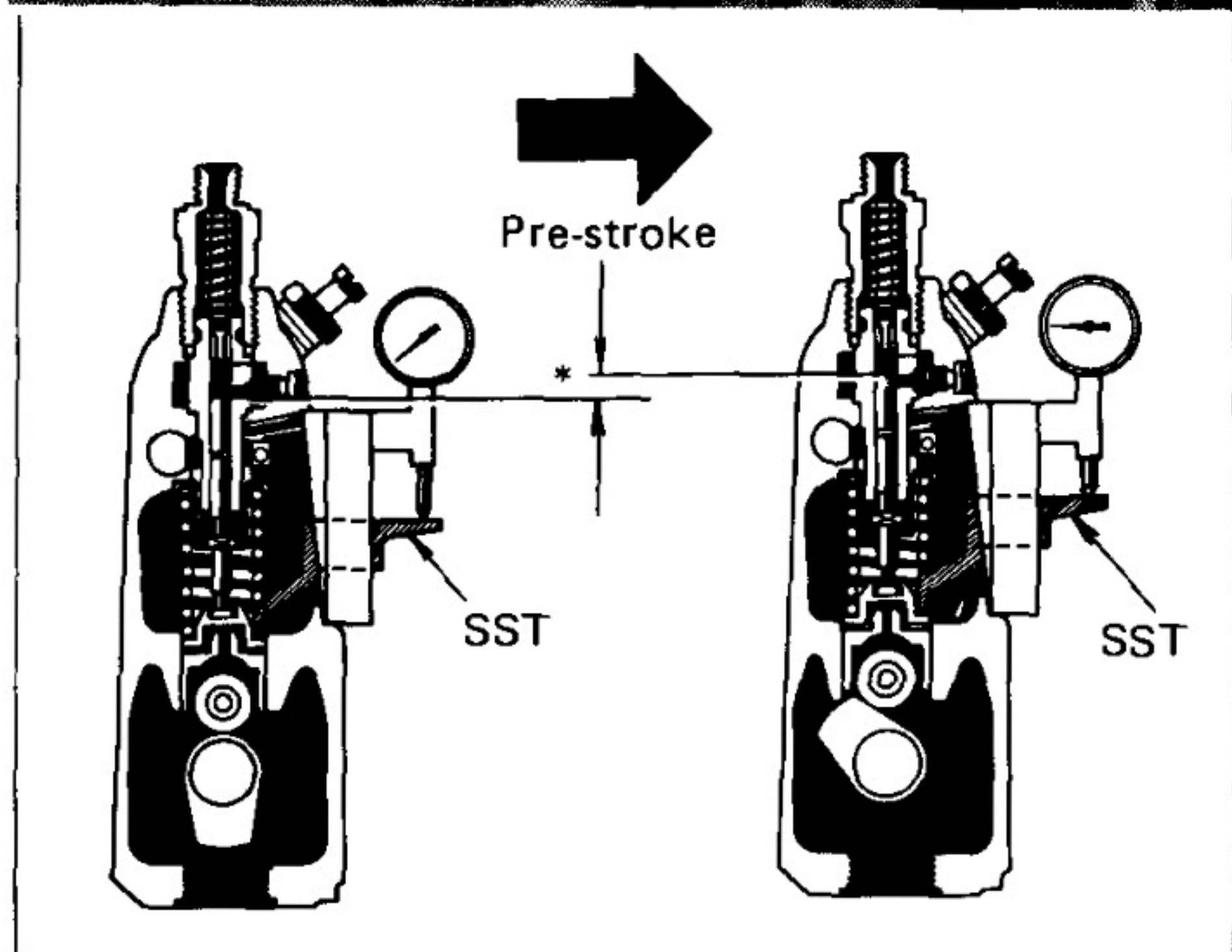


Fig. 6-175



Fig. 6-176

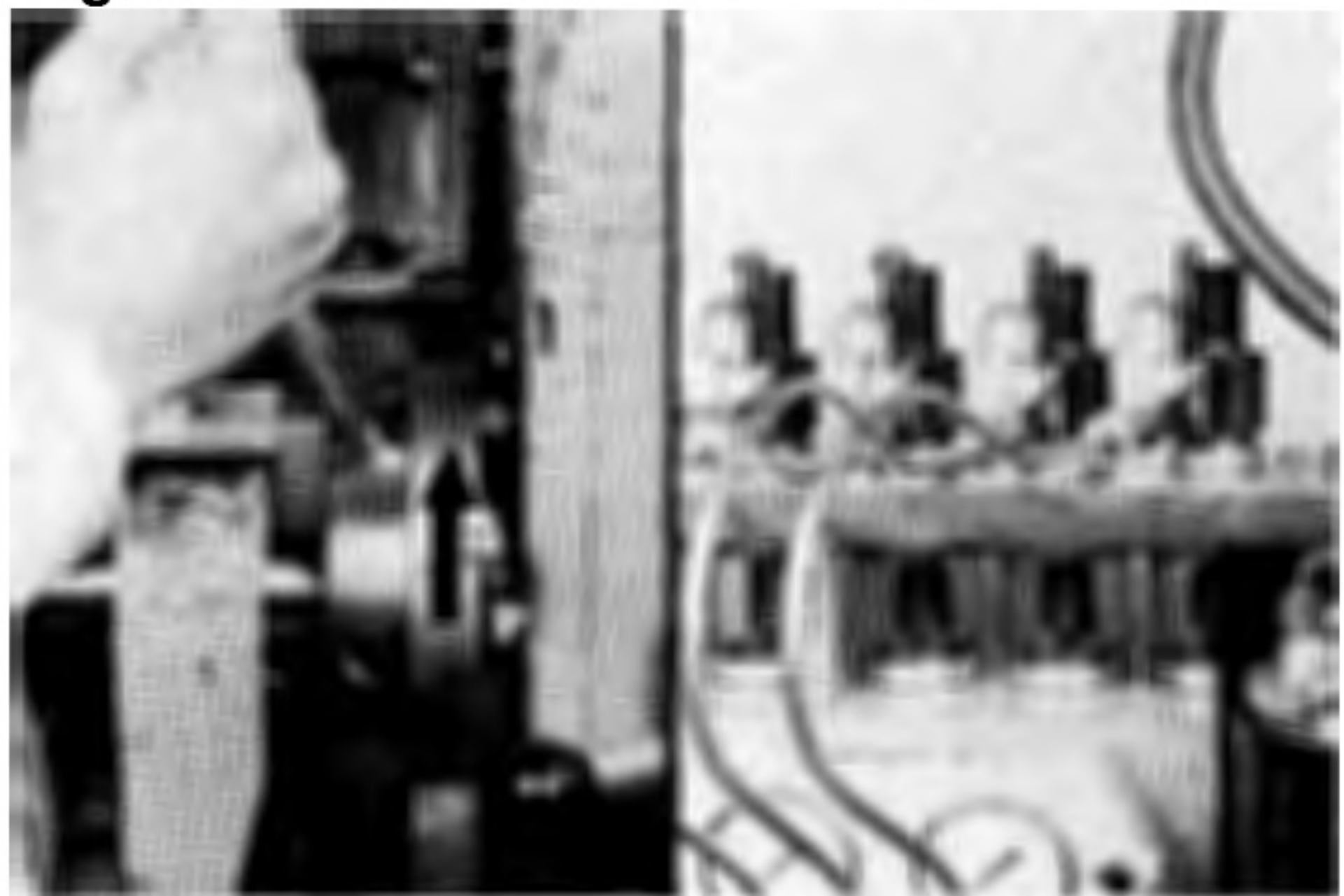


Fig. 6-177



Fig. 6-178



- (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.).



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'

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



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.)

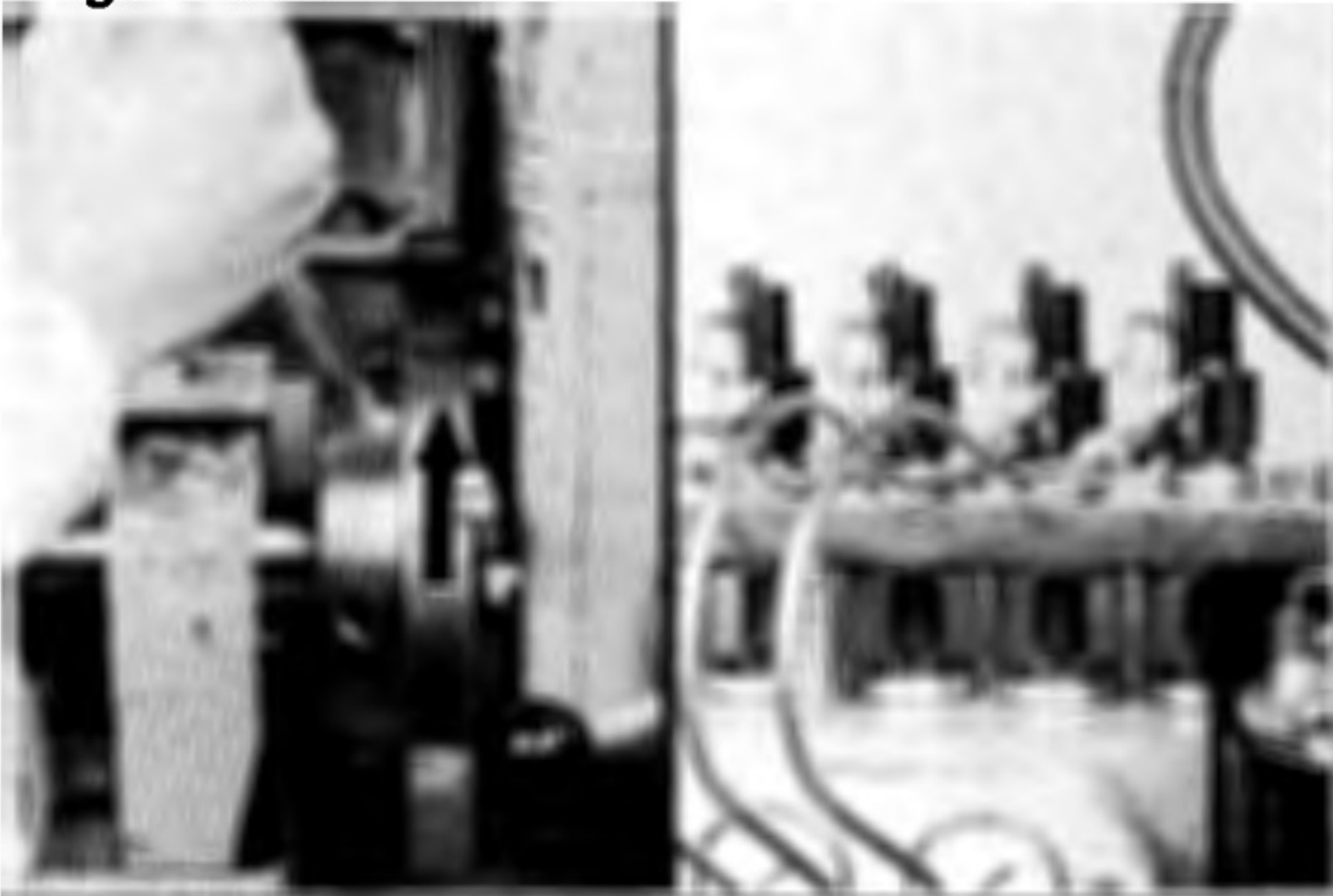
Fig. 6-179



- (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.)**

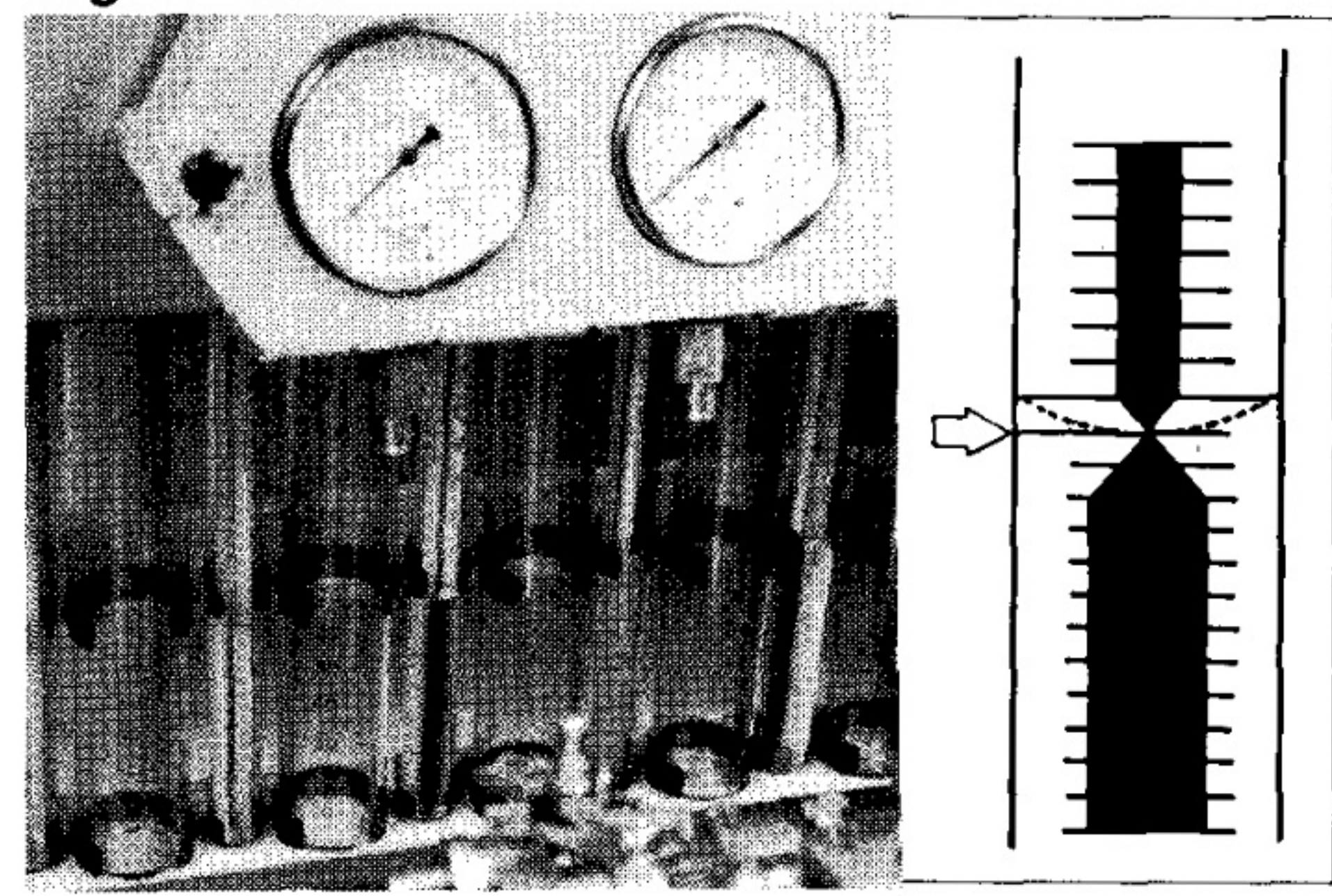
Fig. 6-180



- (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

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

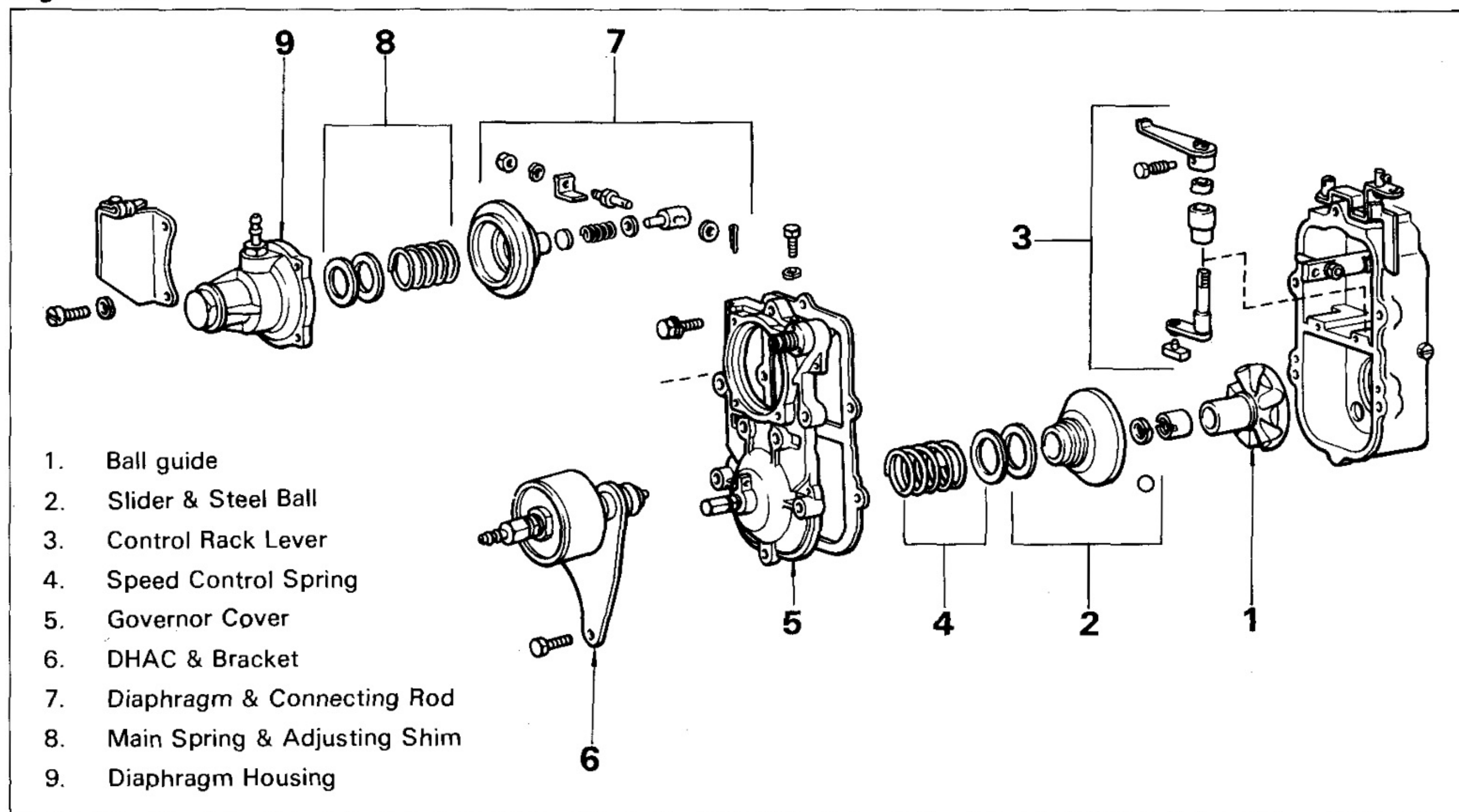
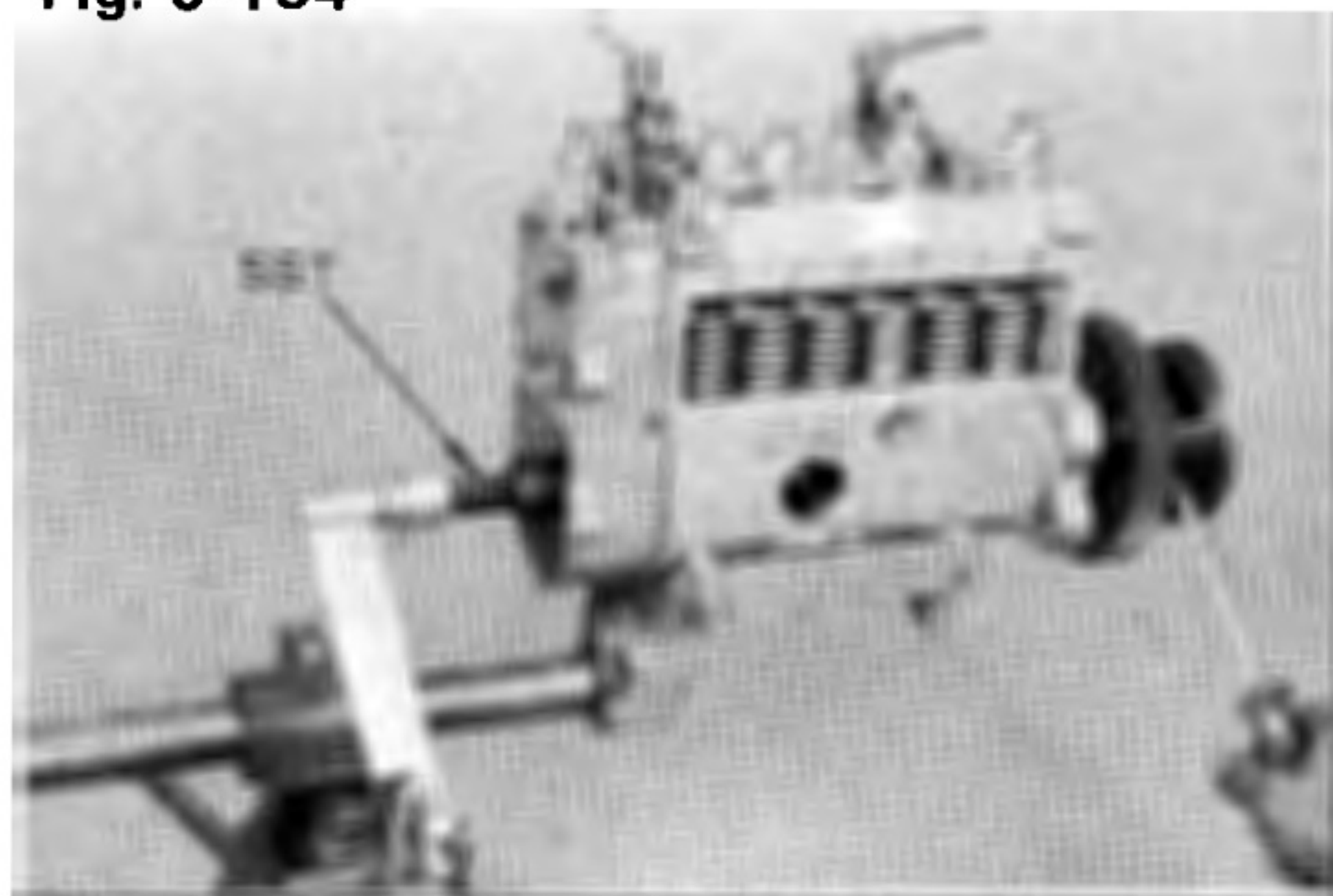
Fig. 6-182



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

ASSEMBLY (COMBINED GOVERNOR)

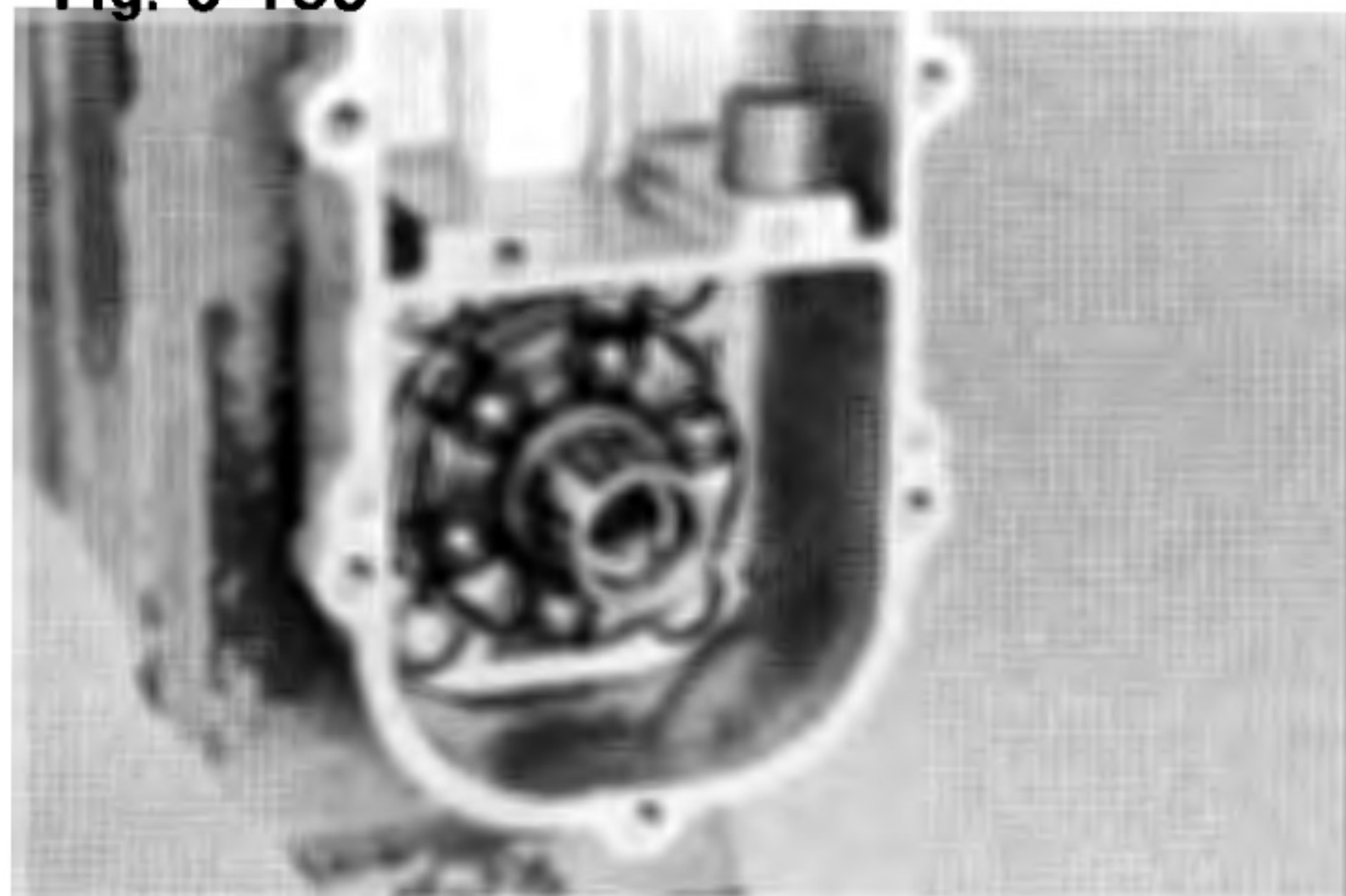
Assemble the parts in the numerical order shown in the figure.

Fig. 6-183**Fig. 6-184**

Temporarily install the automatic timer and hold it with a screwdriver. Then tighten the round nut with SST.

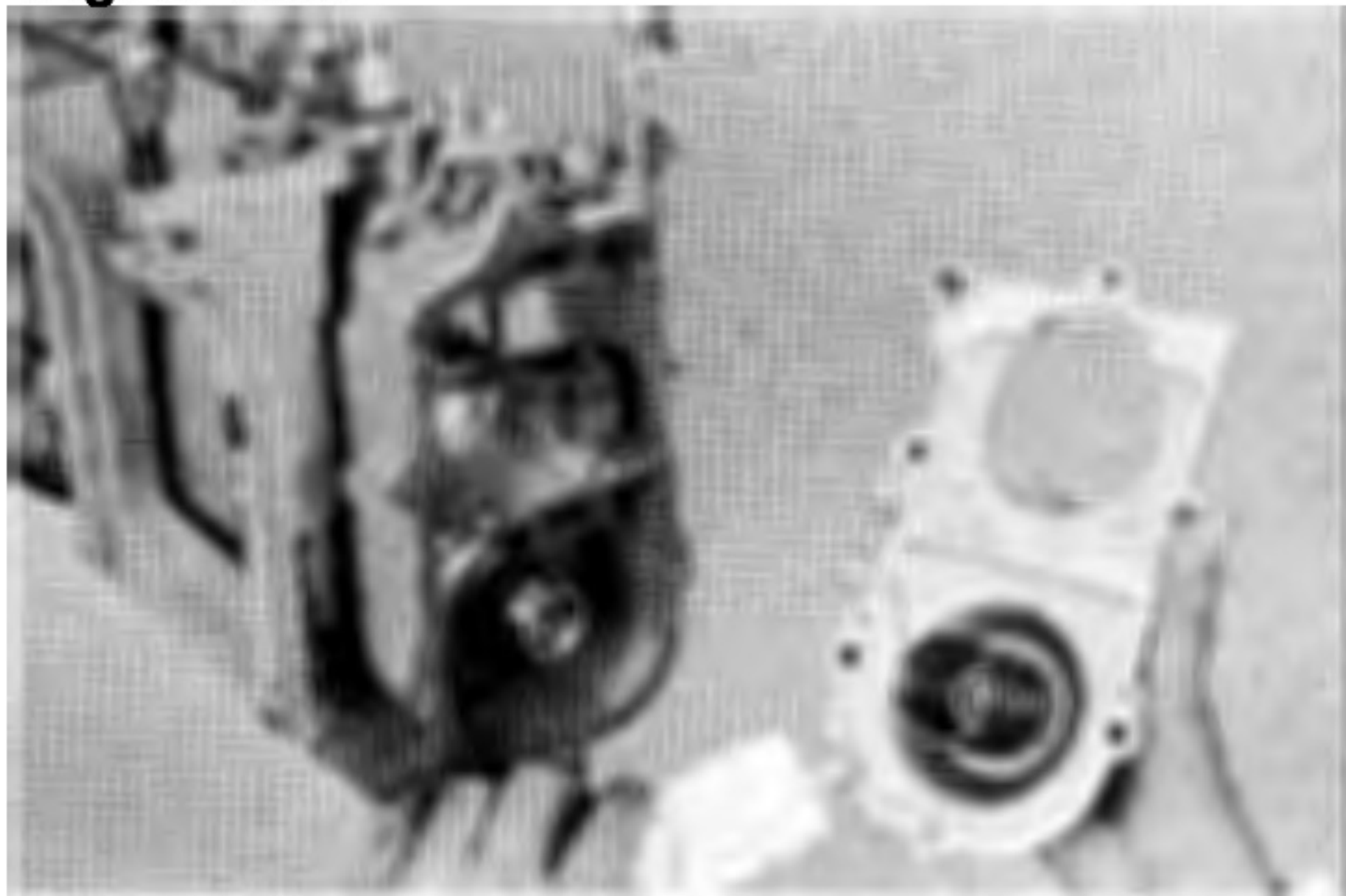
SST (09266-67011) of set [09260-76016]

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

Fig. 6-185

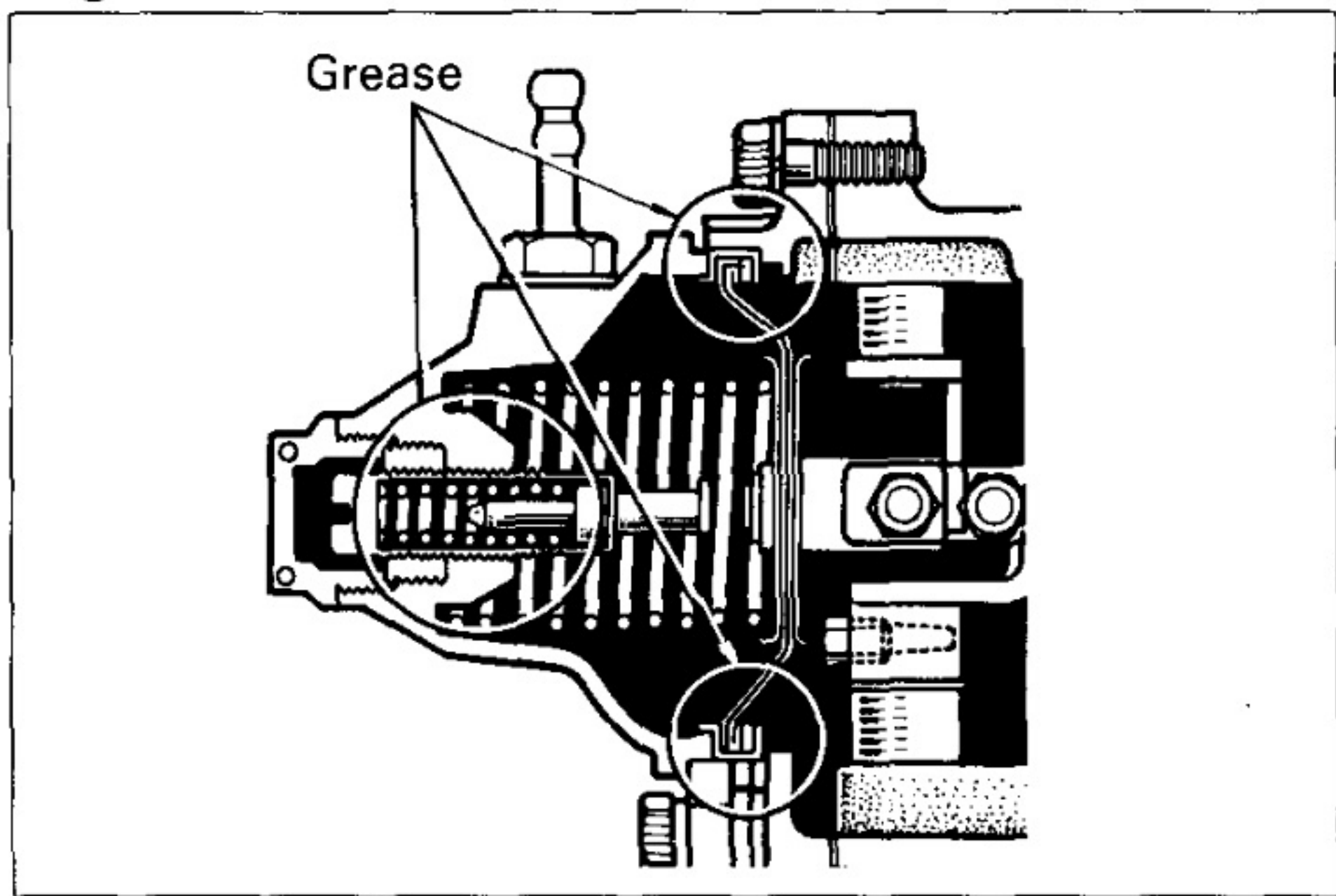
Apply grease to the ball guide groove and put six steel balls in the groove. Place the slider onto the ball guide.

Fig. 6-186



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

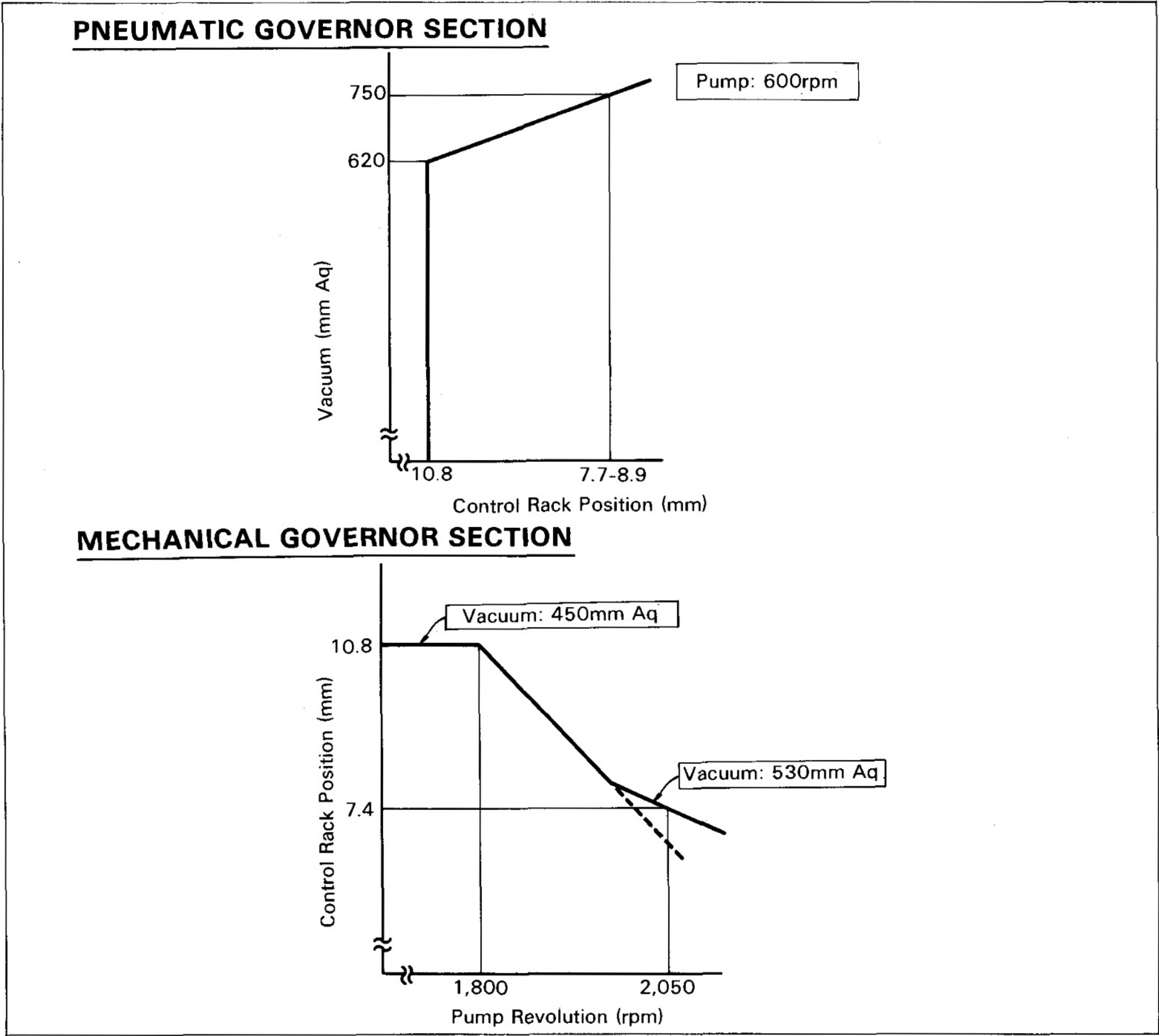
Fig. 6-187



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



Fig. 6-190

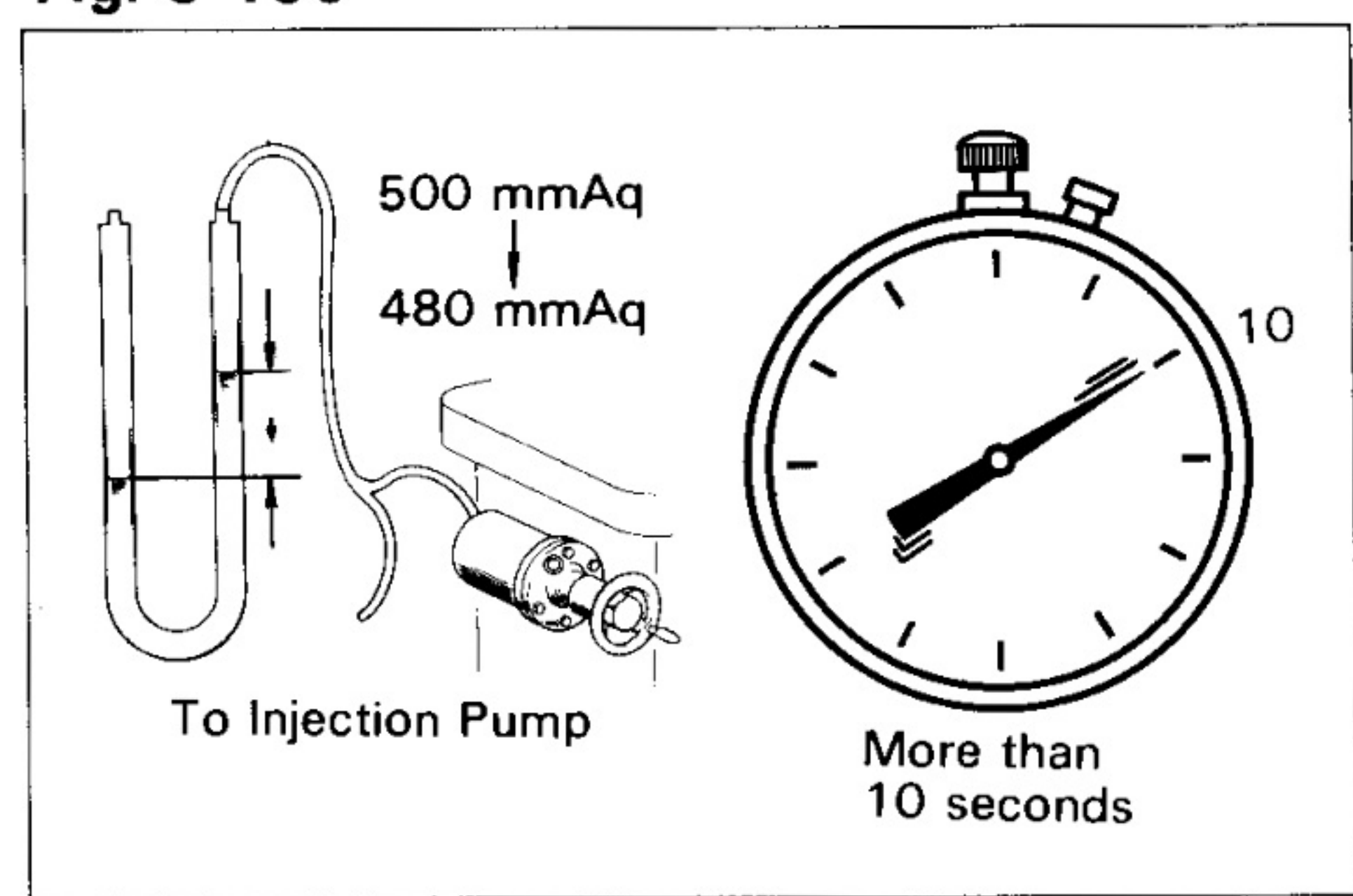


Fig. 6-191

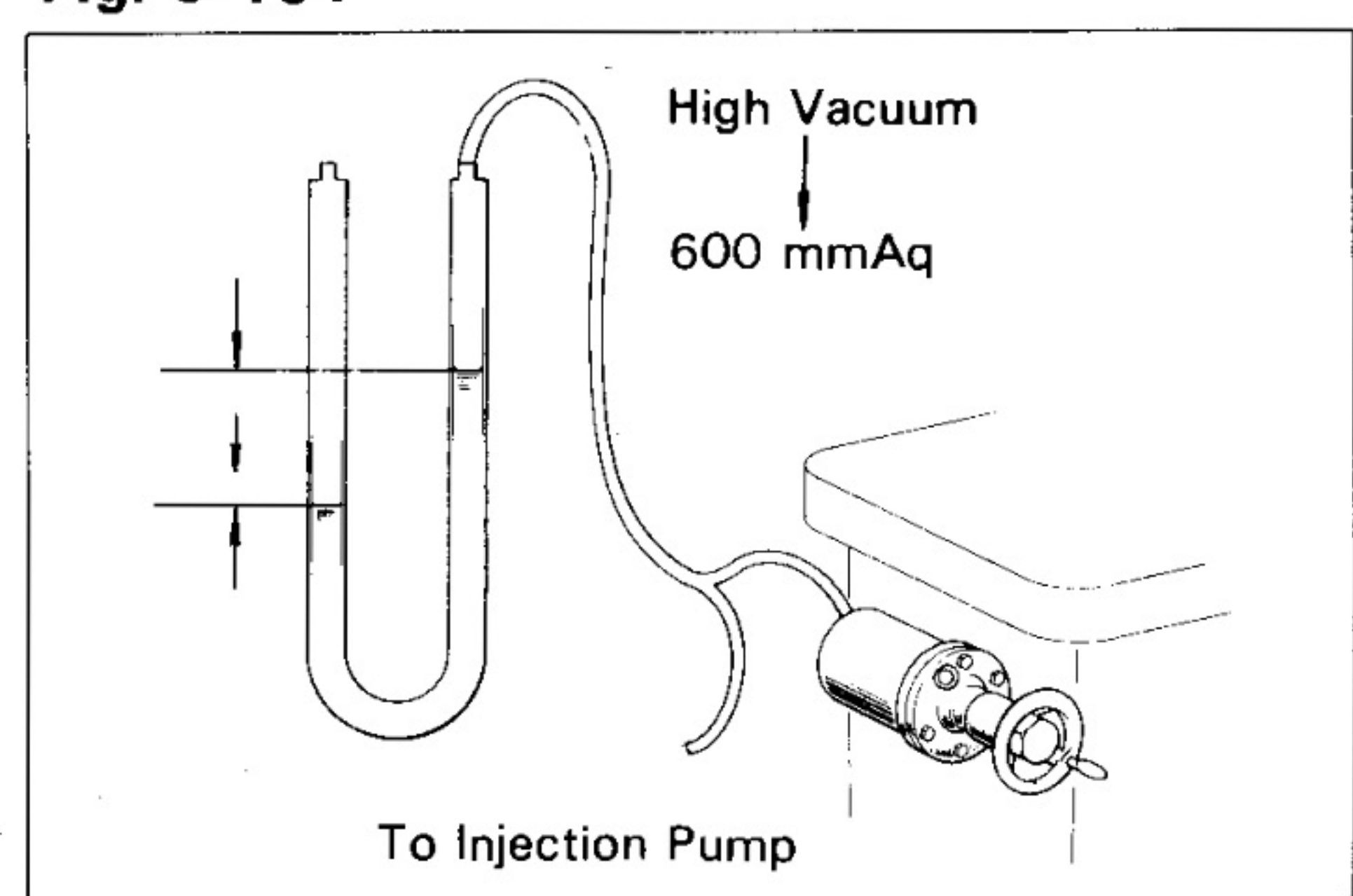


Fig. 6-192



Test Airtightness

1. Set the injection pump revolution at 600 rpm.



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.



Adjust Initial Set of Control Rack

1. Set the vacuum to specified value.

— Note —

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



2. Check the initial set point of control rack.

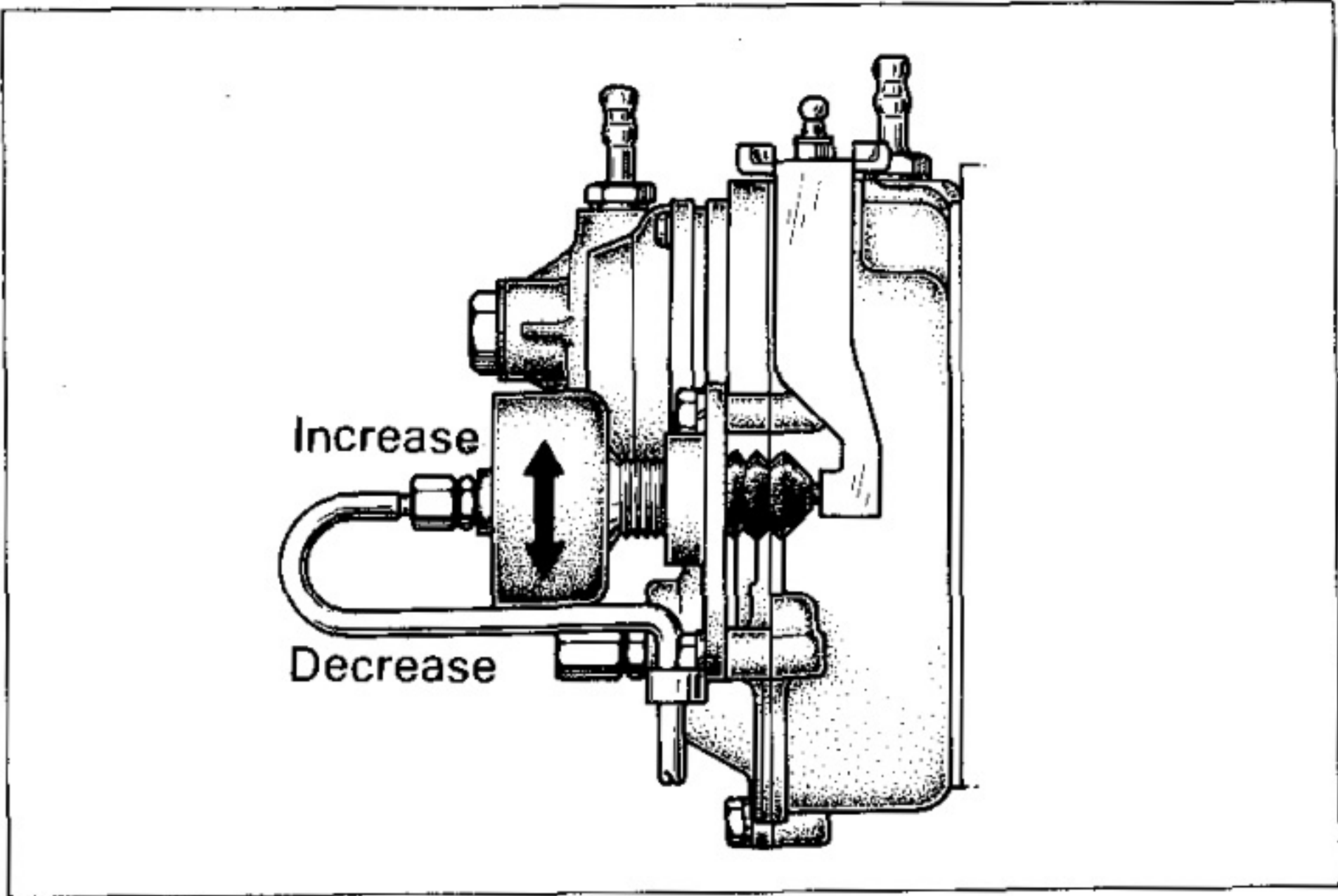
Pump revolution (rpm)	Vacuum mm Aq (in.Aq)	Control rack position mm (in.)
600	600 (23.62)	10.8±0.1 (0.425±0.004)

Fig. 6-193



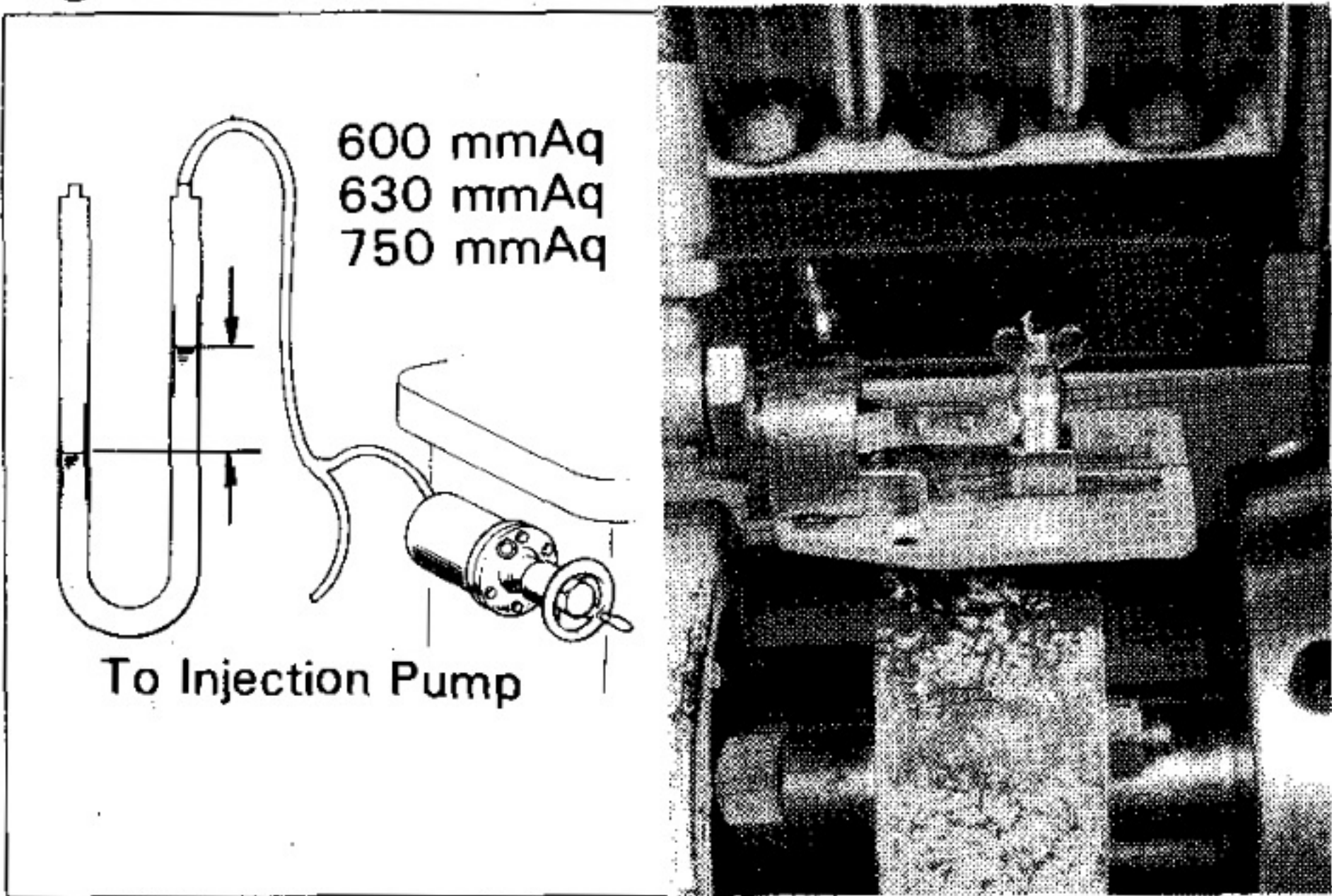
- 3. Adjust the initial set of the control rack by turning the full stop capsule with SST. SST [09283-76010]

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

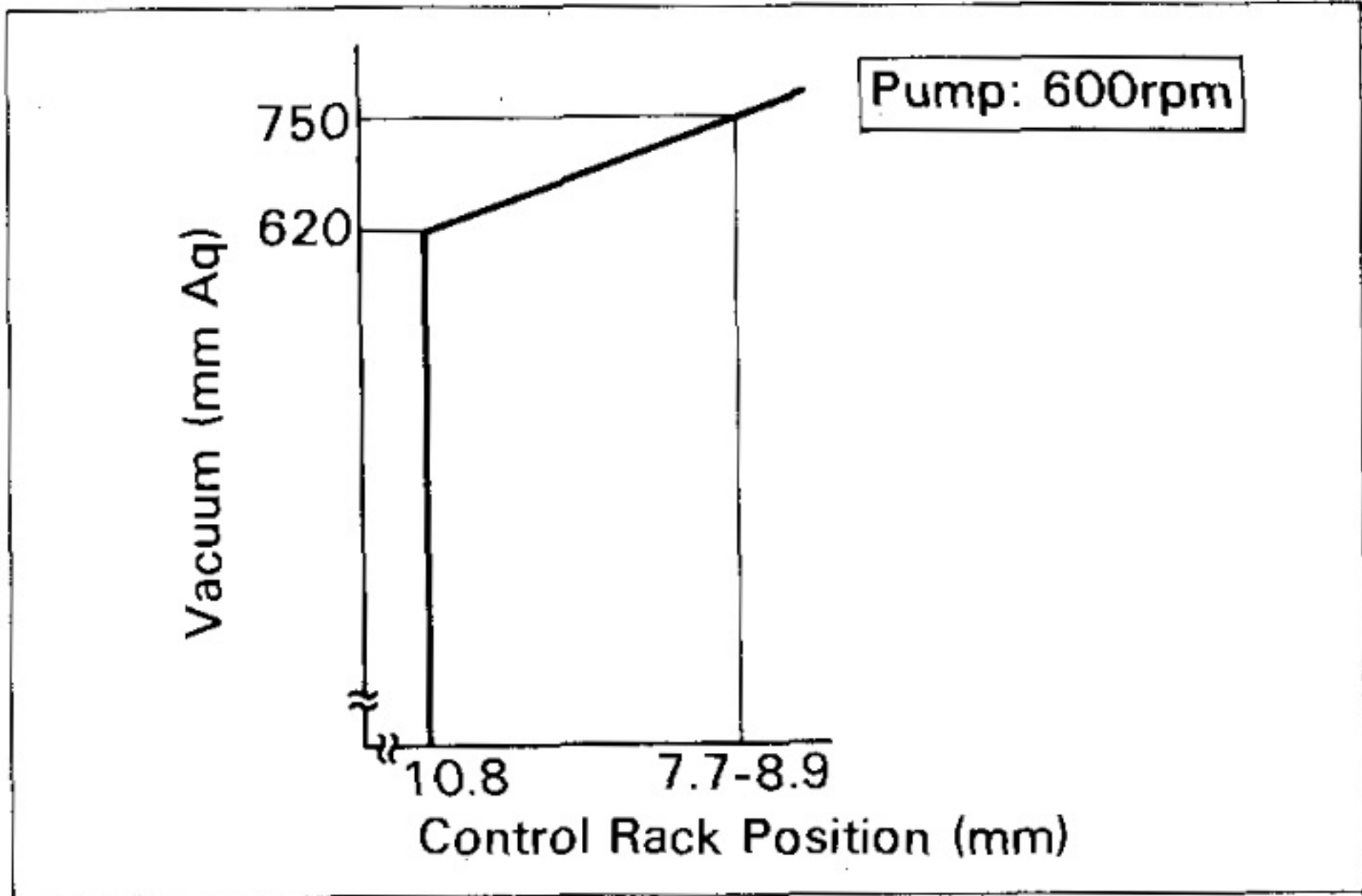


Adjust Main Spring

- 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.

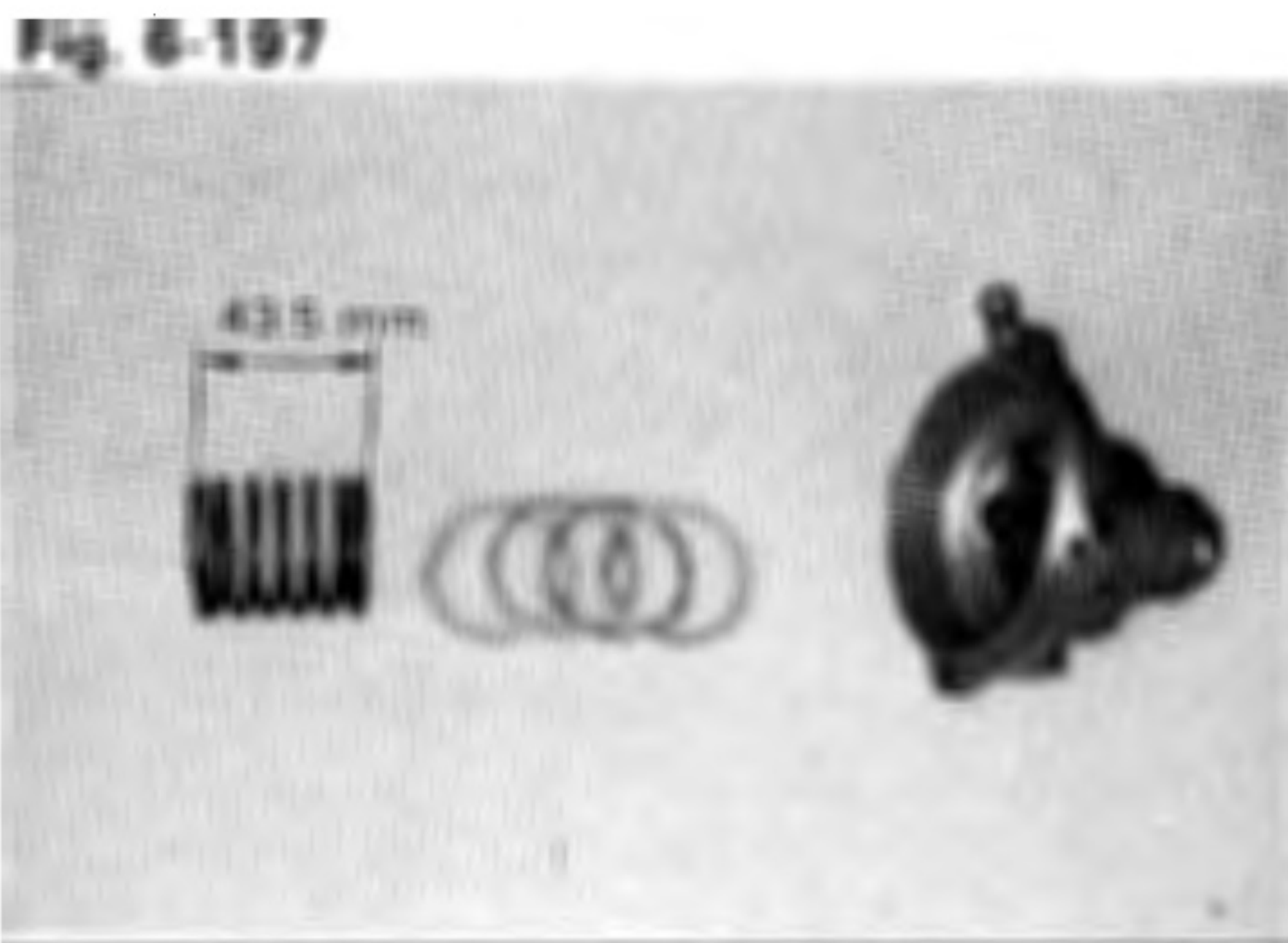


Fig. 6-198



Fig. 6-199



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



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)



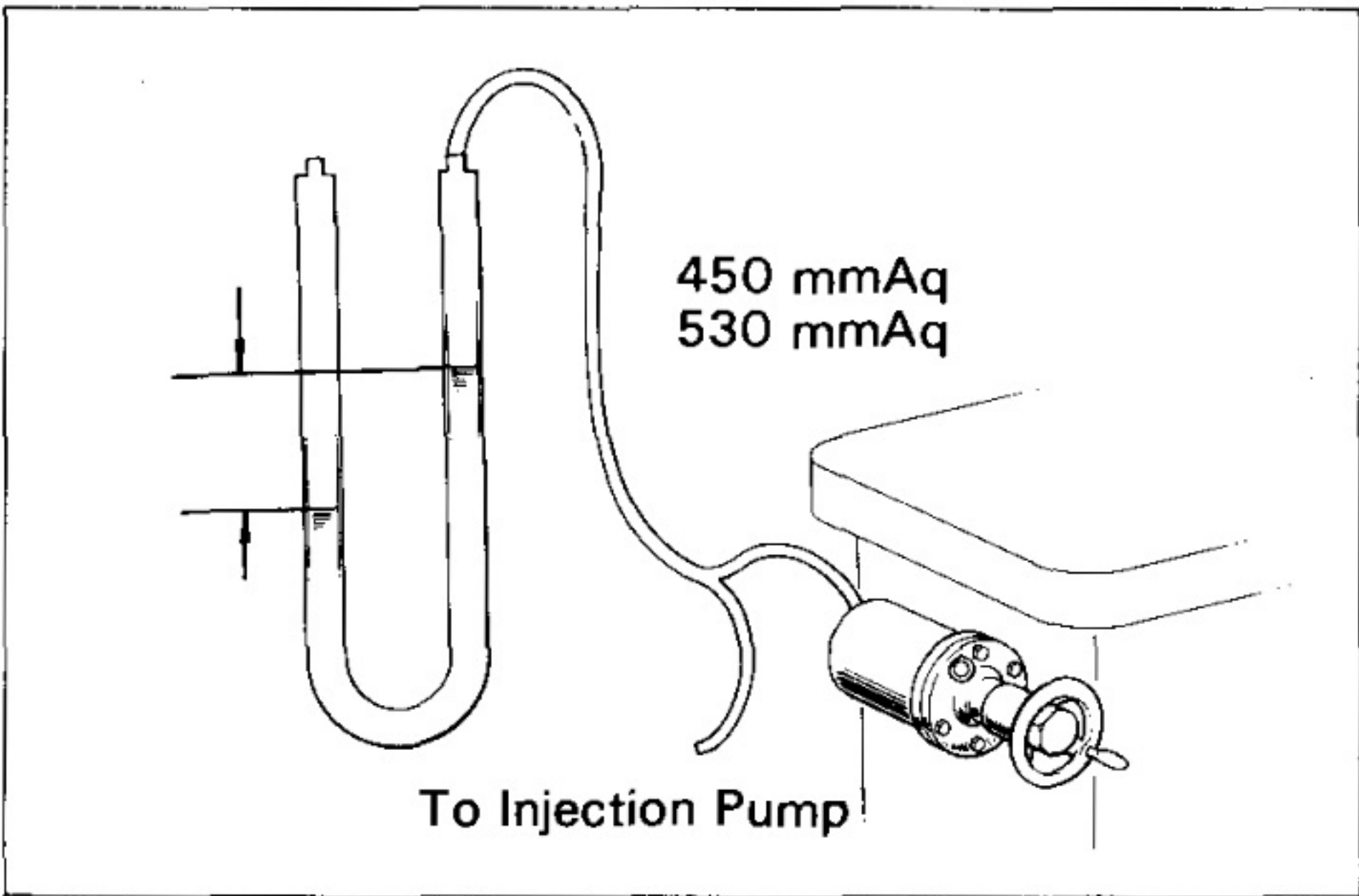
Adjust Idling Spring Capsule

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)

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

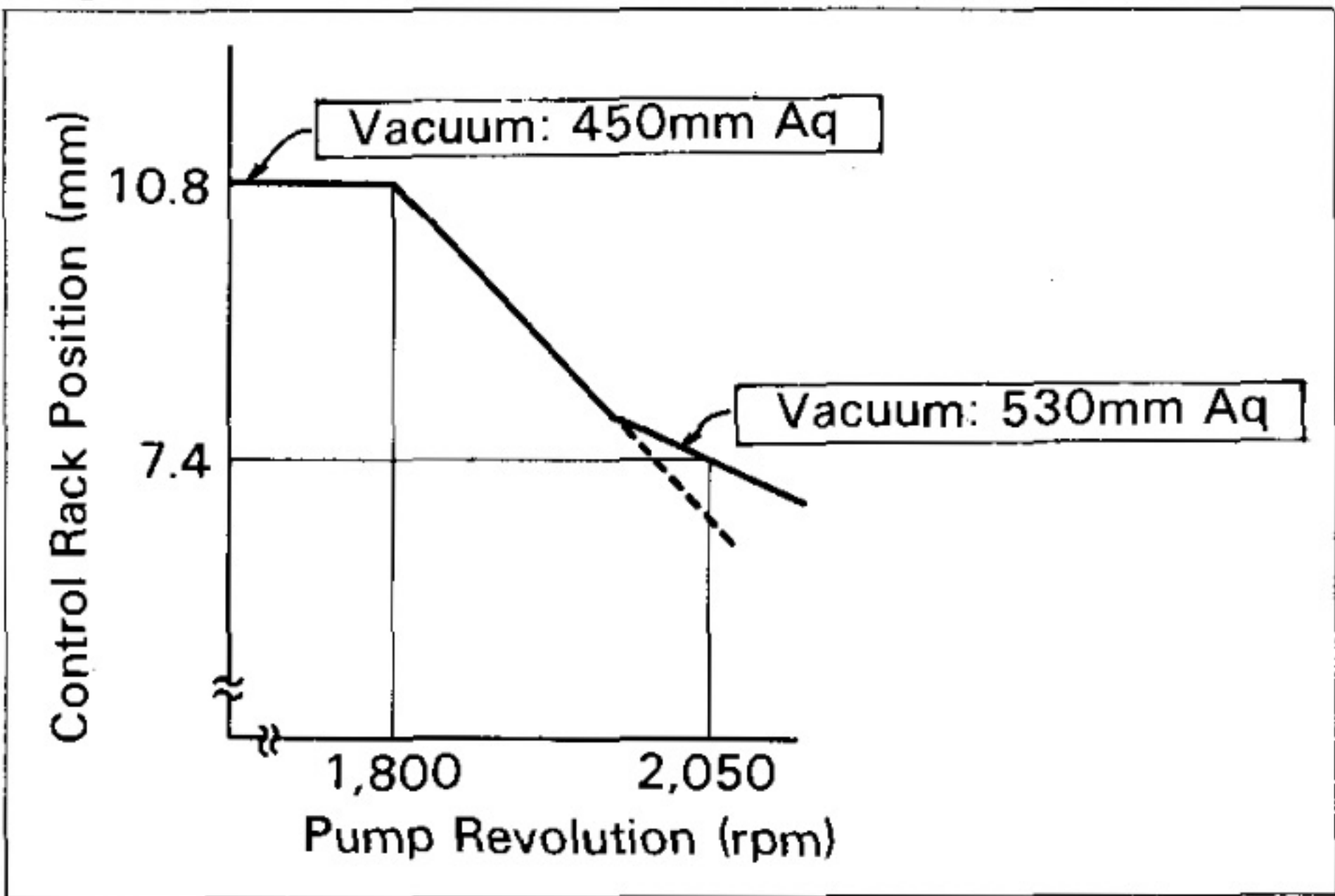
Fig. 6-201



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

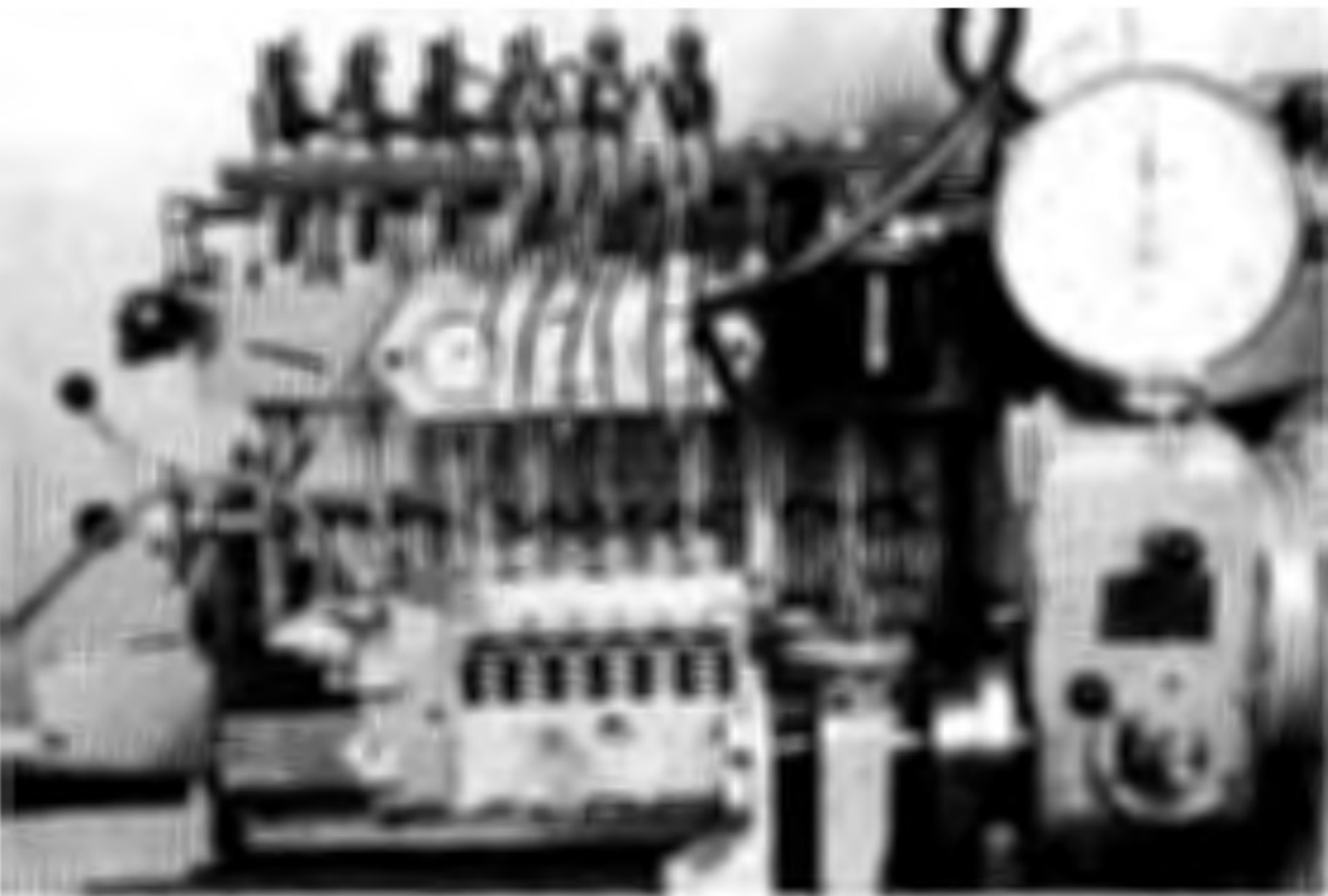
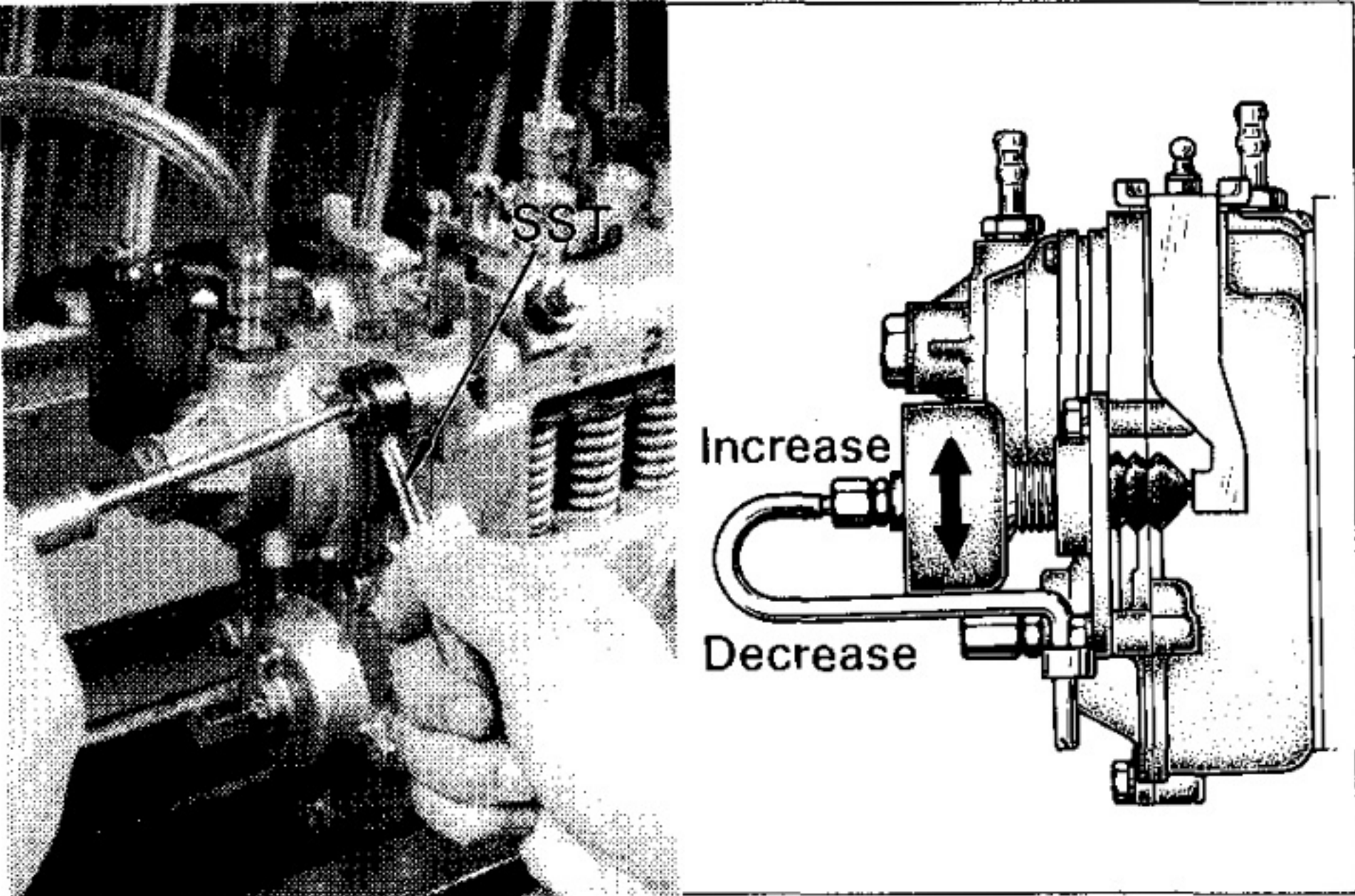


Fig. 6-206



2. Measure the total injection volume at 500 strokes.

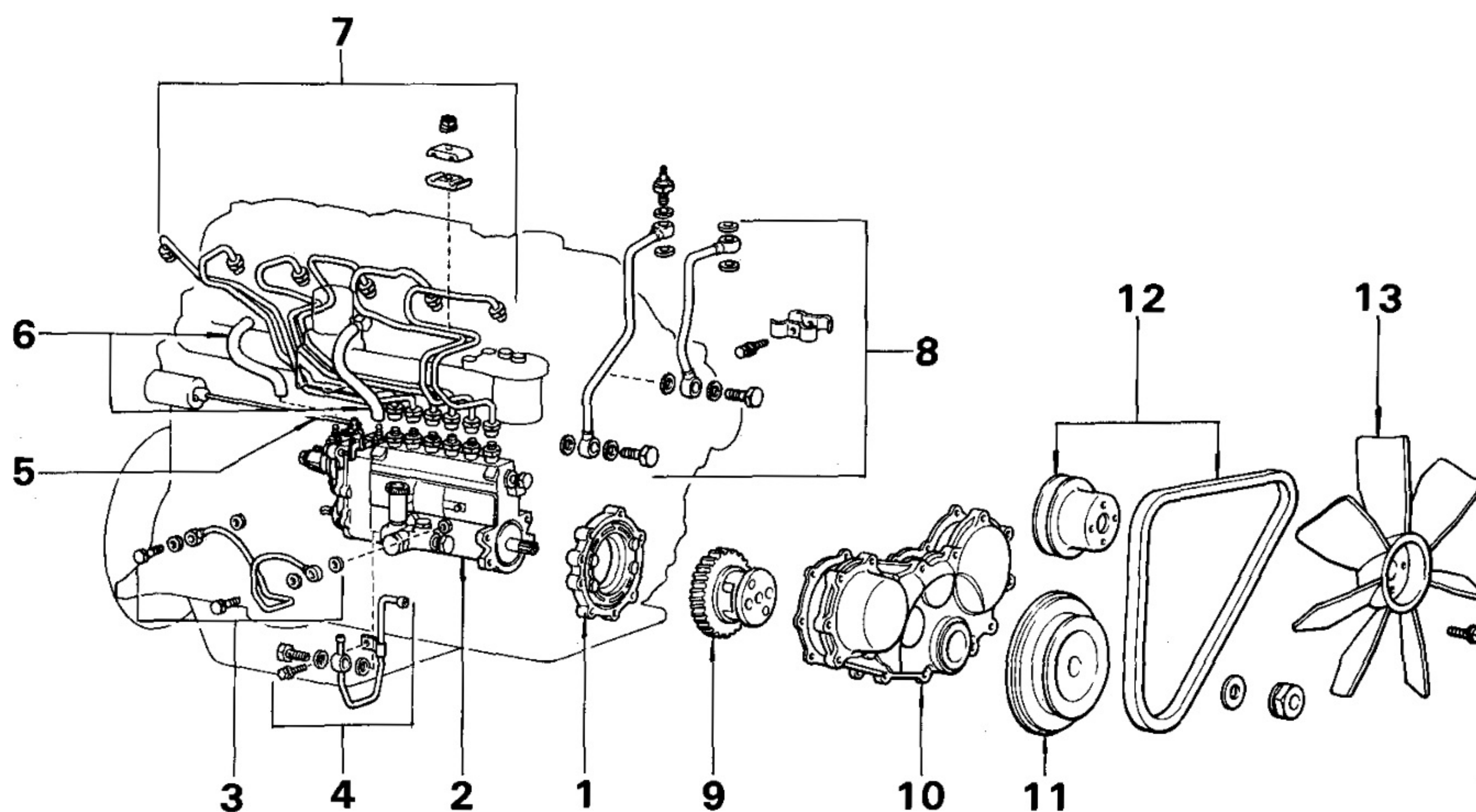
Pump revolution (rpm)	Vacuum mm Aq (in.Aq)	Total injection volume cc (cu in.)
700	60 (2.36)	117.0–129.0 (7.14–7.87)
1,100	150 (5.91)	132.0–138.0 (8.06–8.42)
1,700	400 (15.75)	138–150 (8.42–9.15) *133.5–145.5 (8.15–8.88)

*w/ DHAC

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

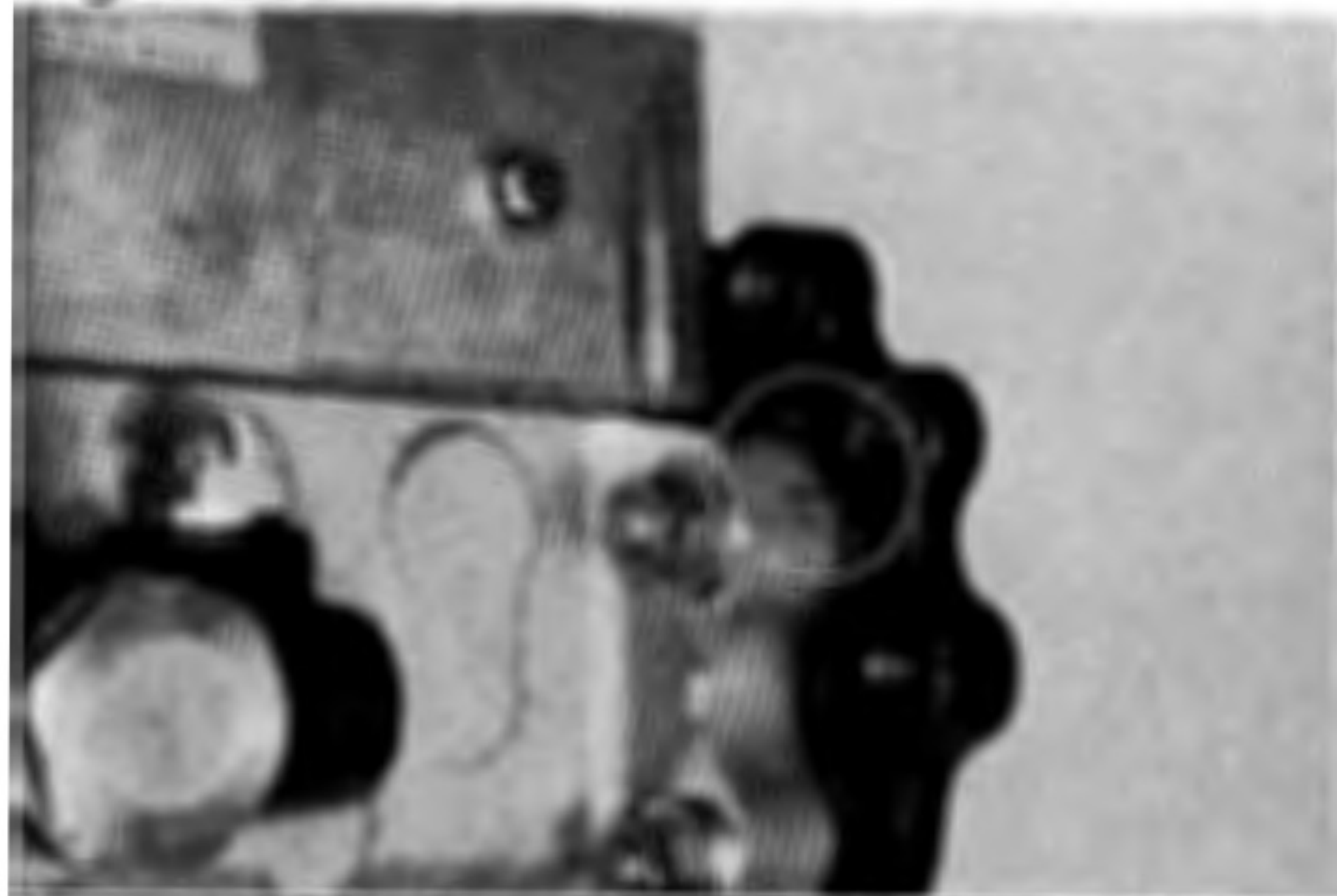
INSTALLATION

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



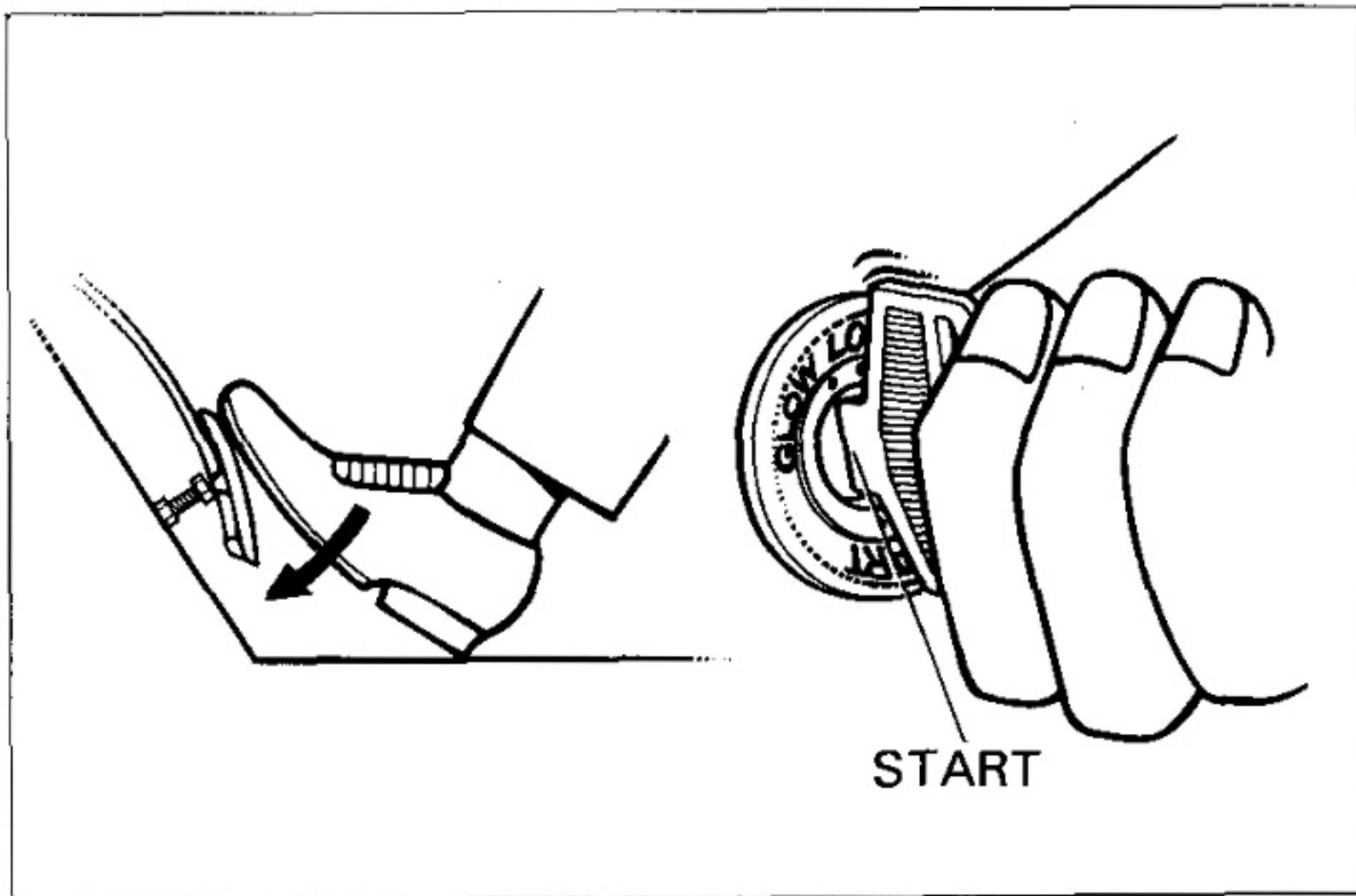
5. Tighten the injection pump bleeder plug.

Fig. 6-213



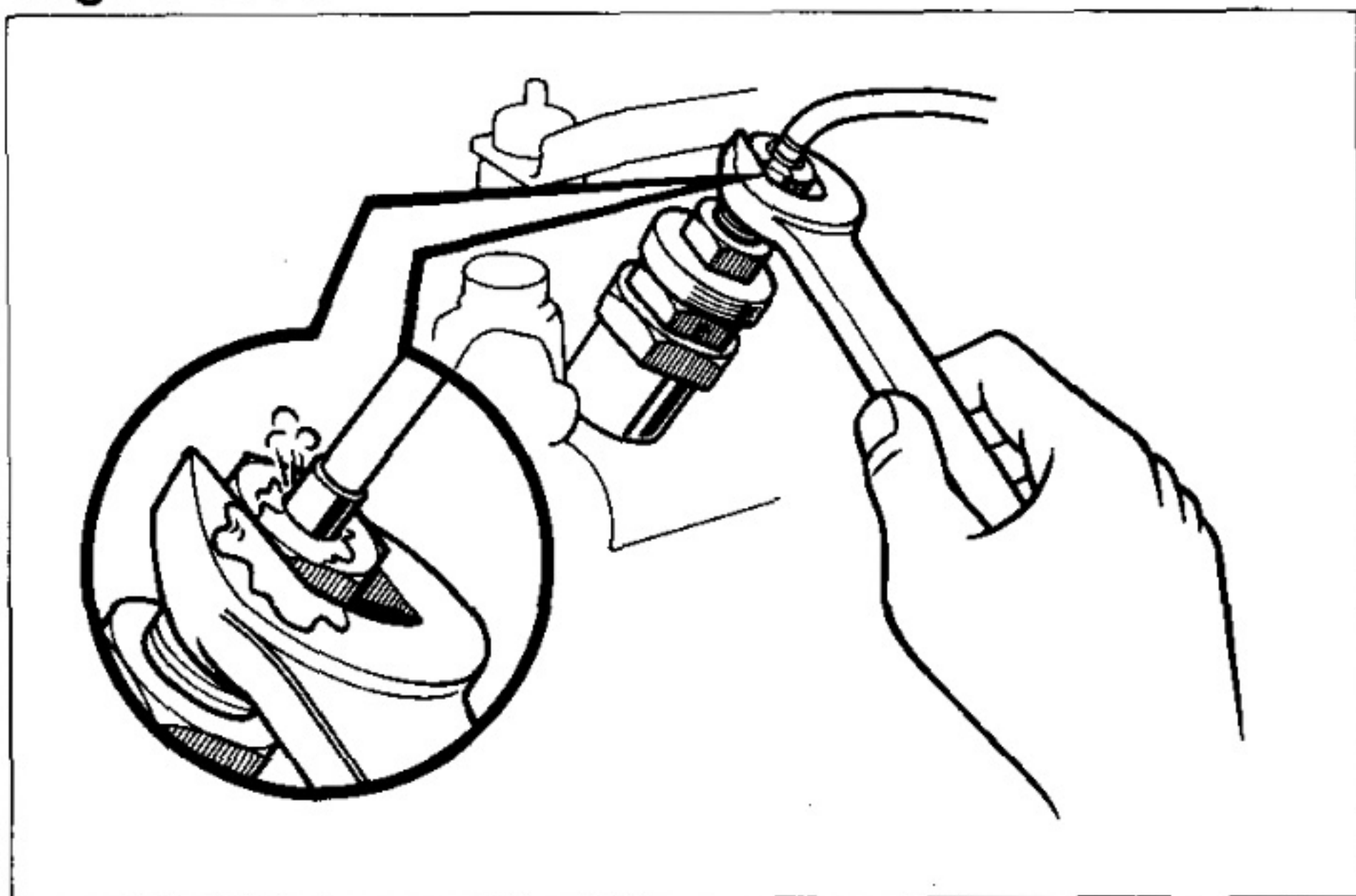
6. Loosen all union nuts of the injection pipe on the nozzle holder side.

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

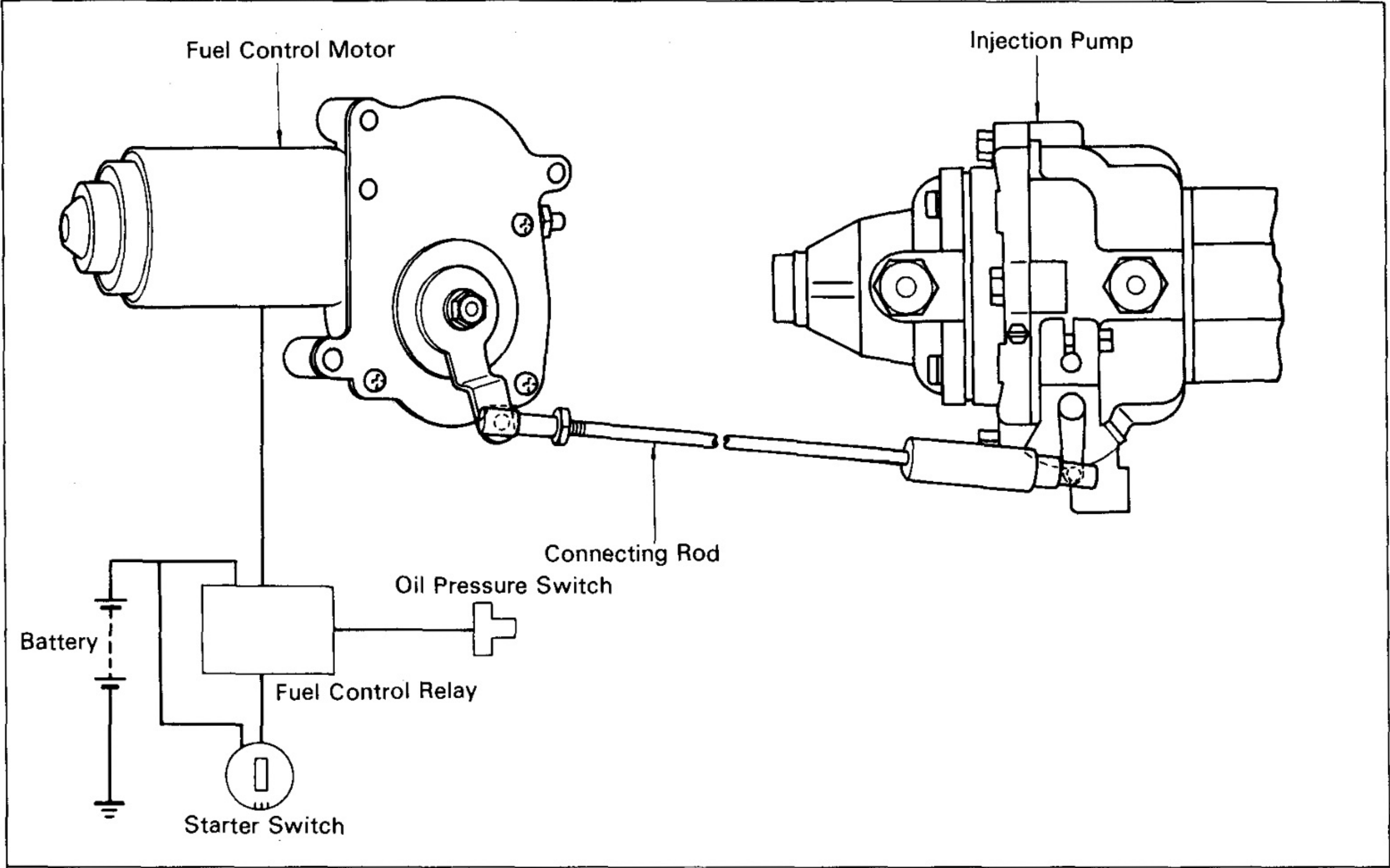
Check the engine idle speed and maximum speed.

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

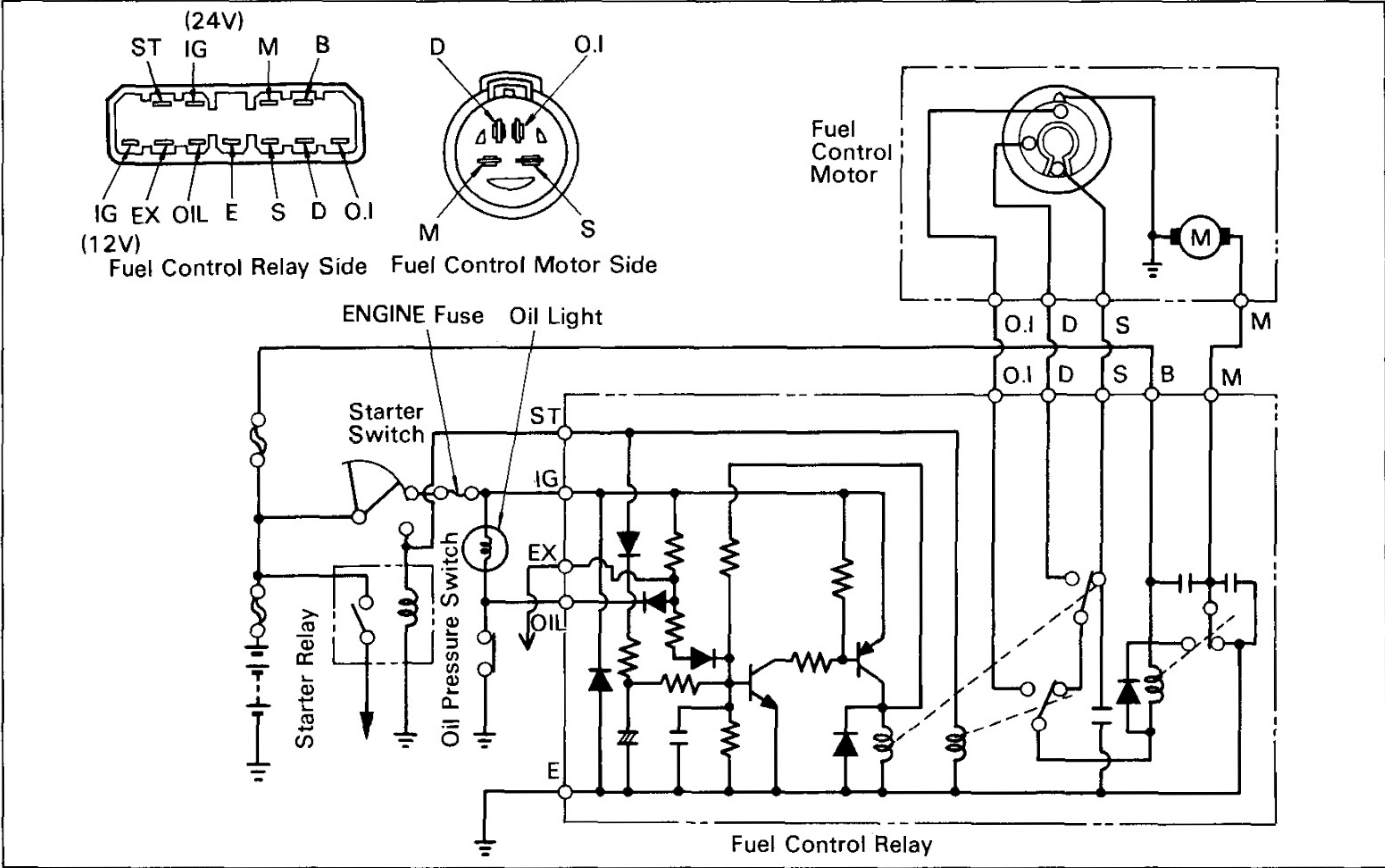
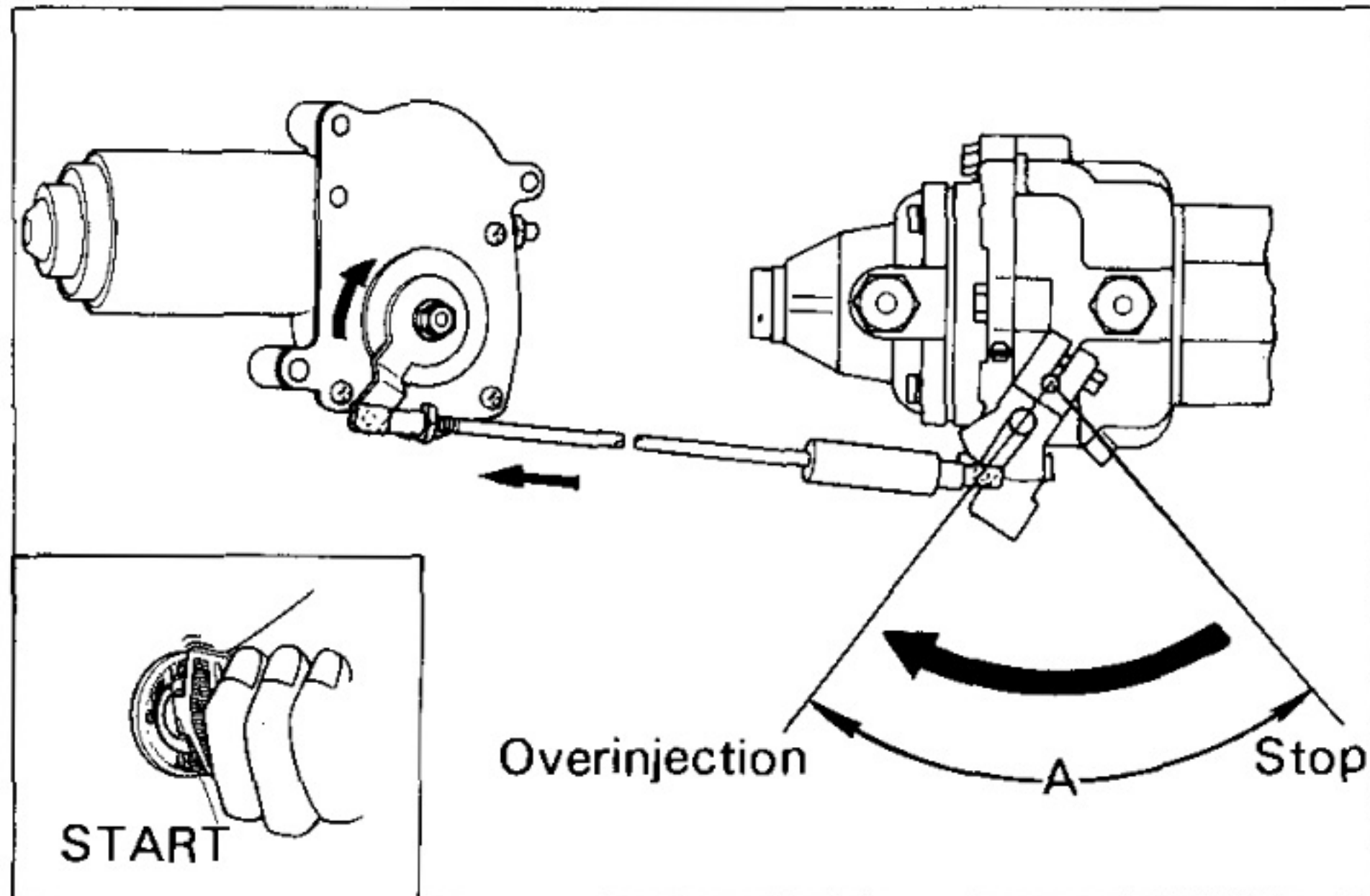


Fig. 7-3



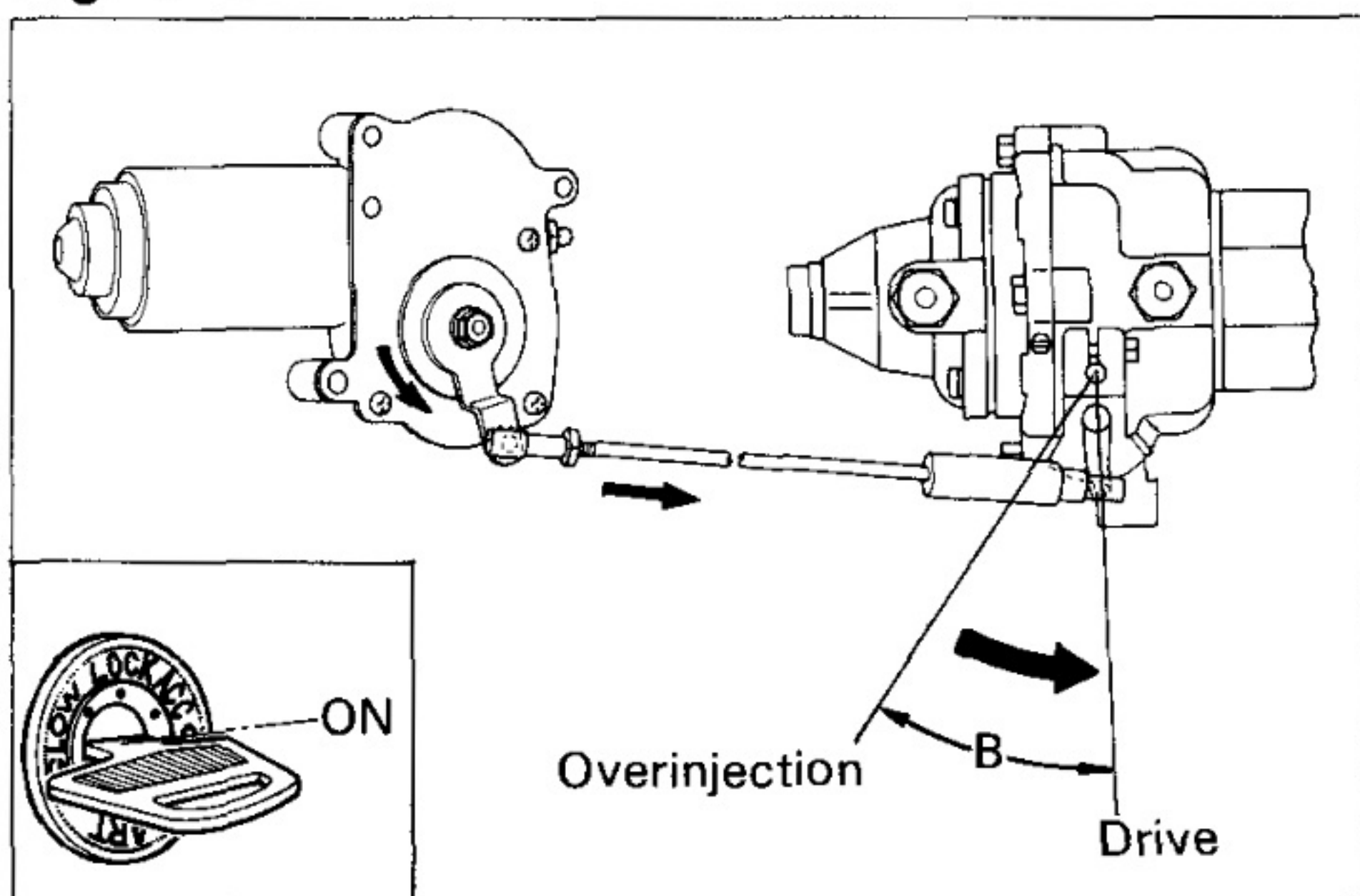
OPERATIONAL CHECK

STARTING OVERINJECTION

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

A: 78.5°

Fig. 7-4

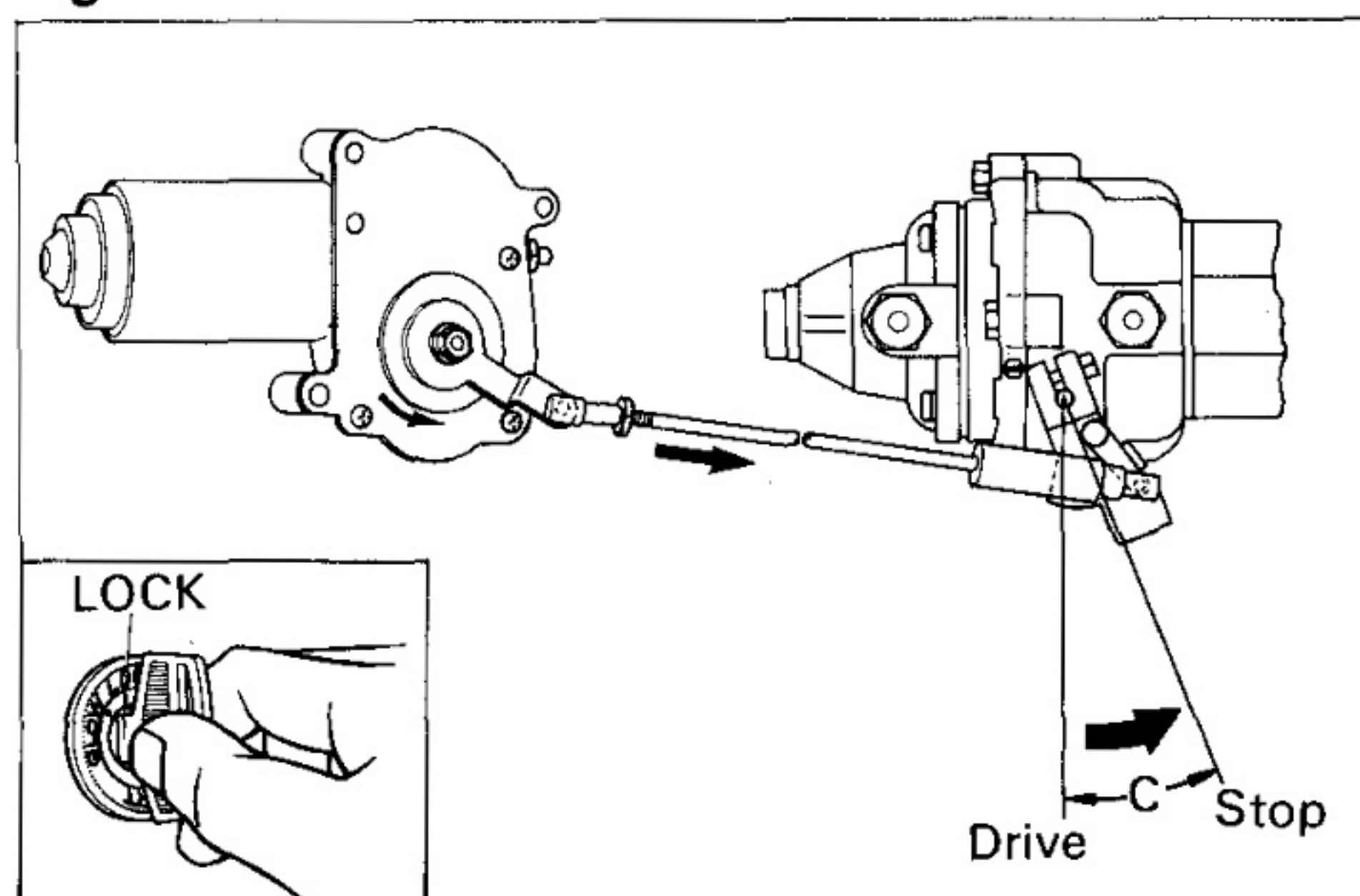


AFTER STARTING (DRIVE POSITION)

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

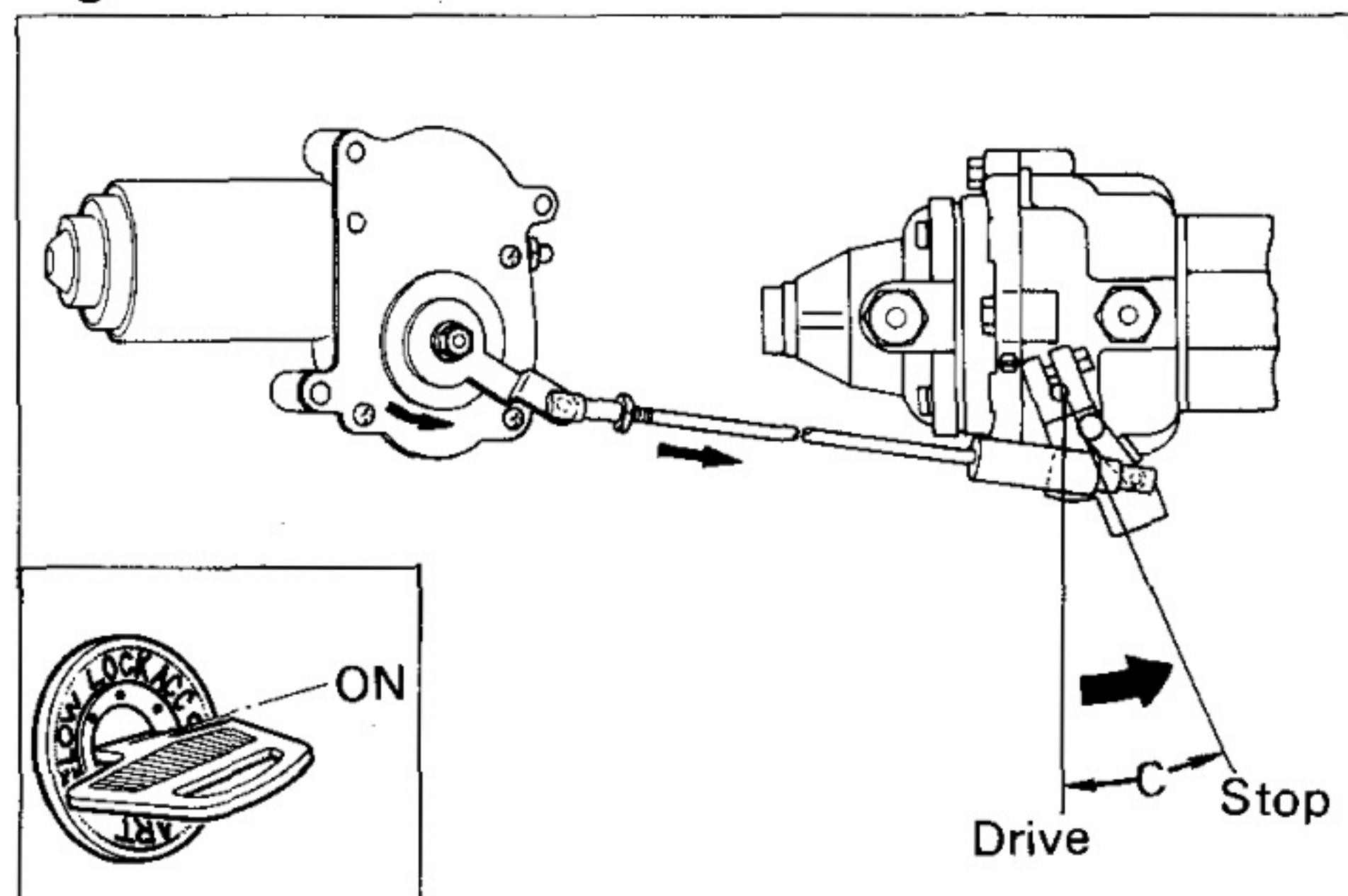


ENGINE STOPPING ACTION

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

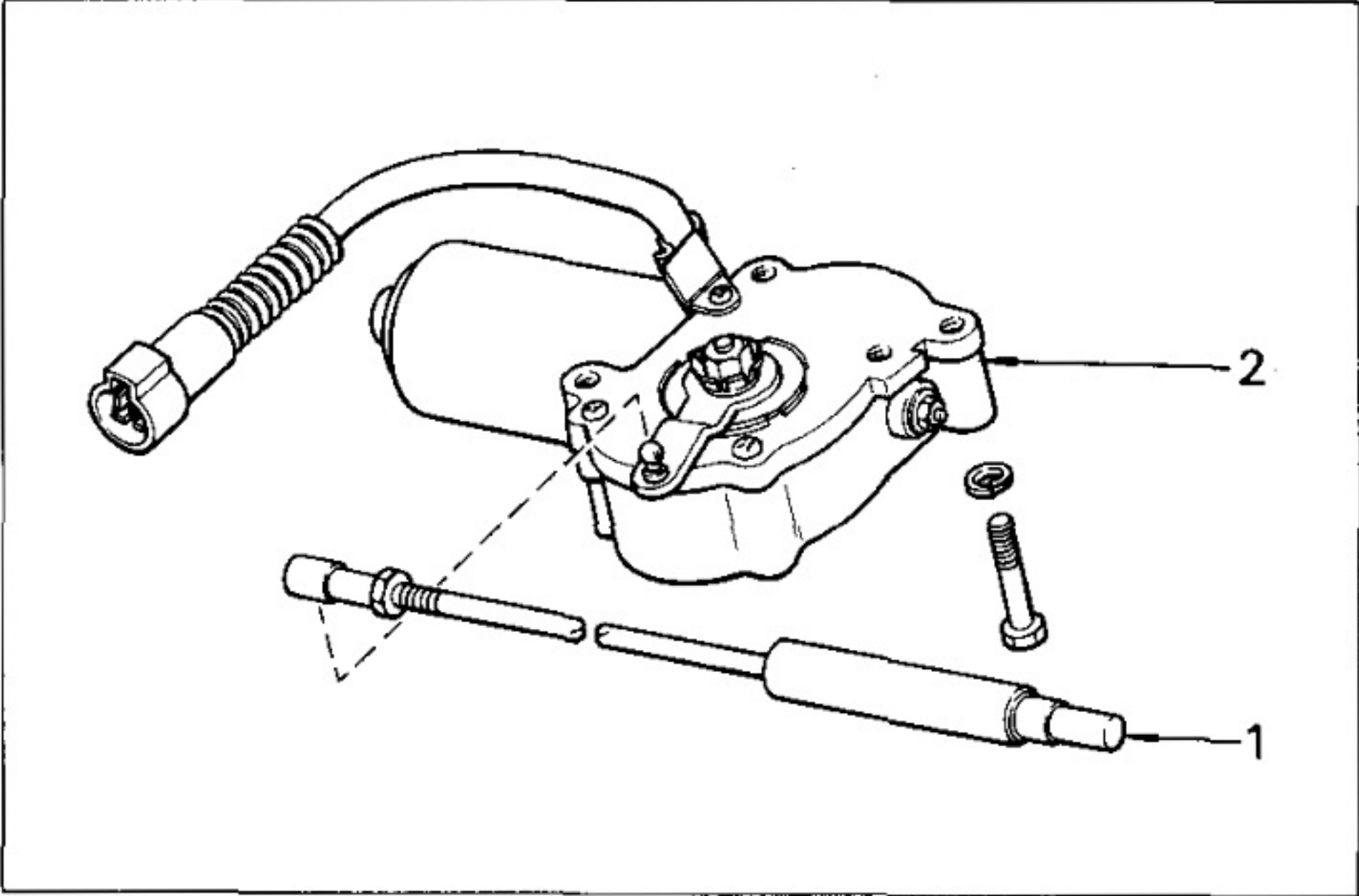


Fig. 7-8

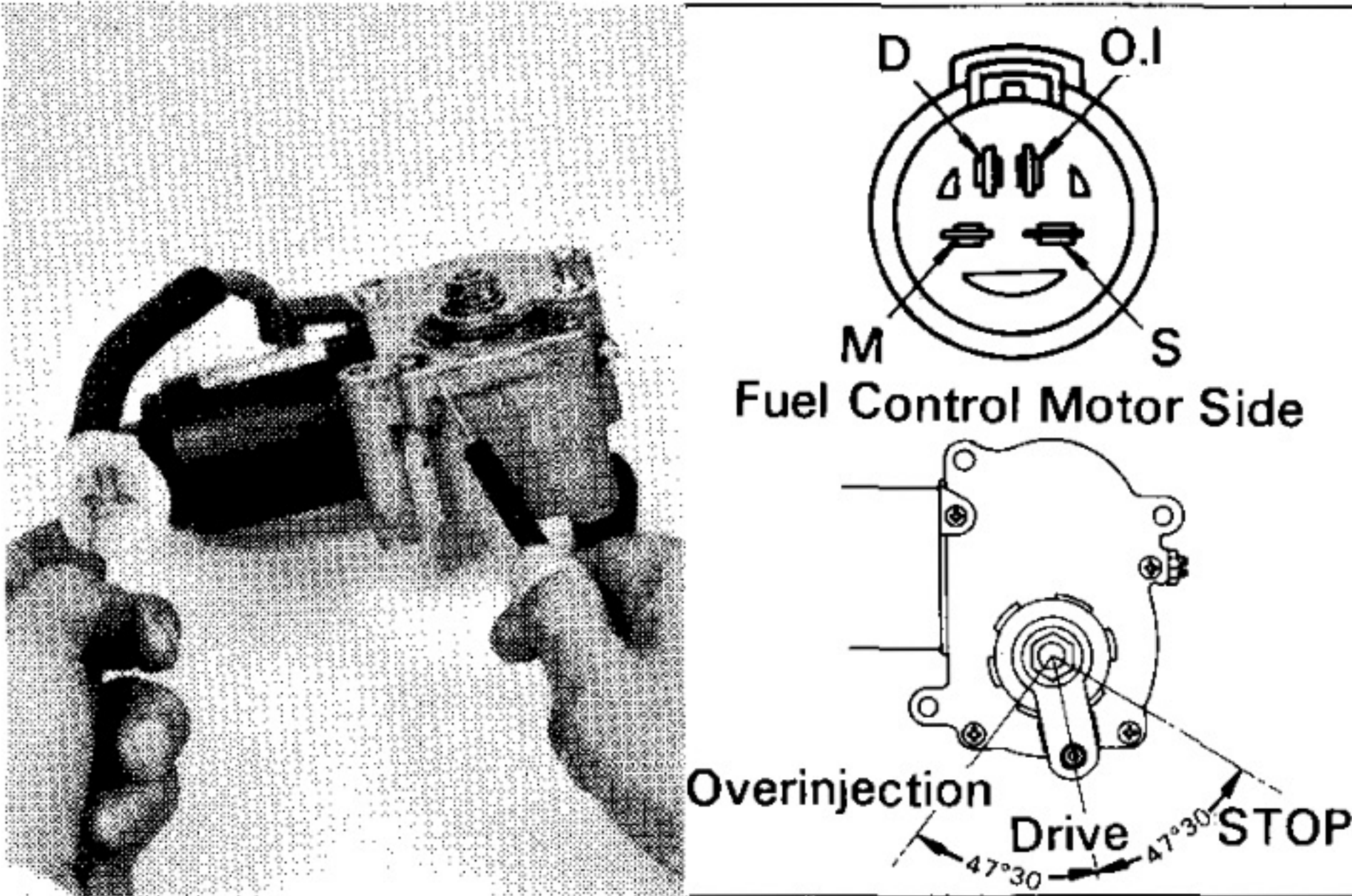


Fig. 7-9

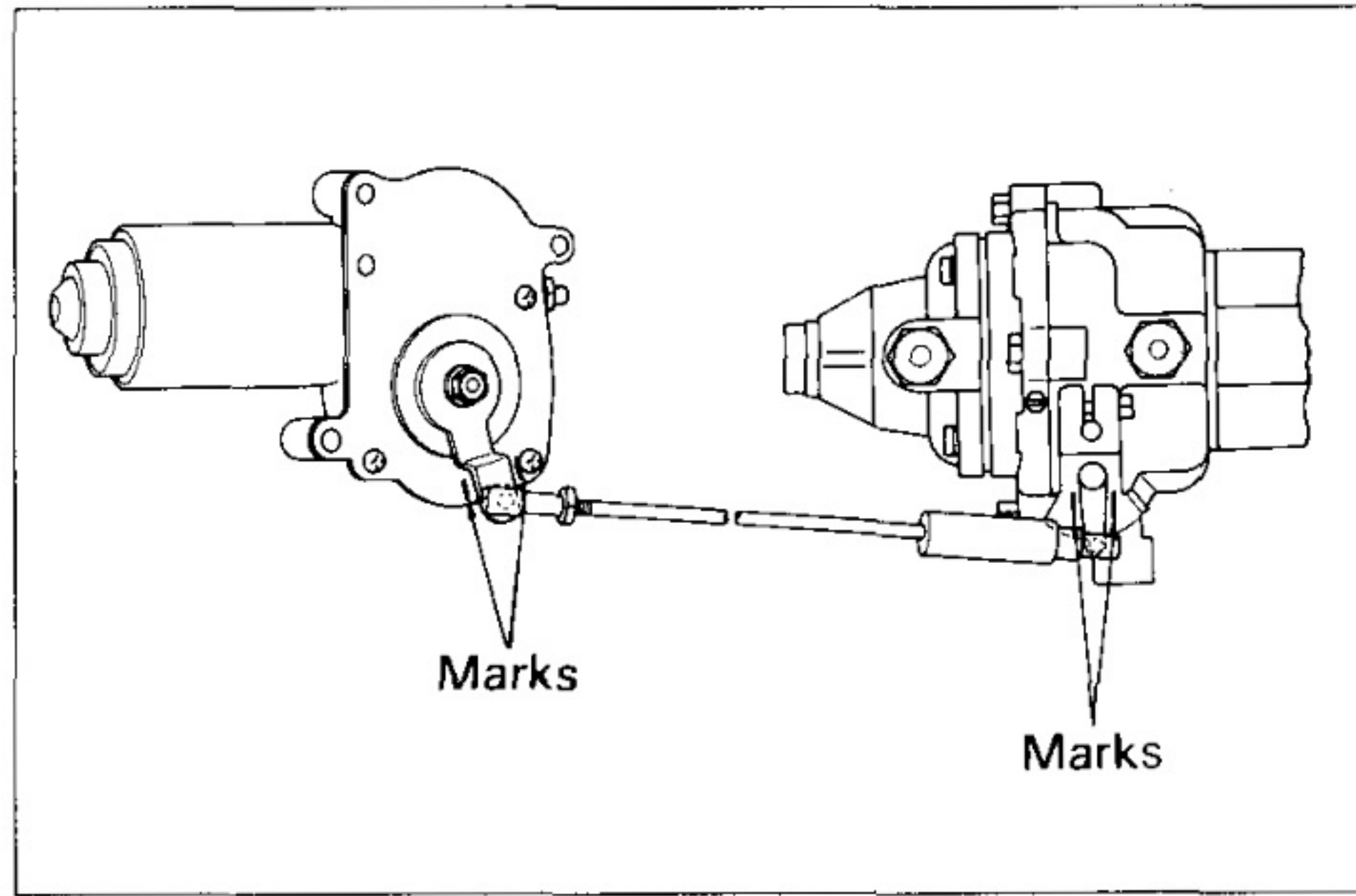


Fig. 7-10



FUEL CONTROL MOTOR



REMOVAL

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



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



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.



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

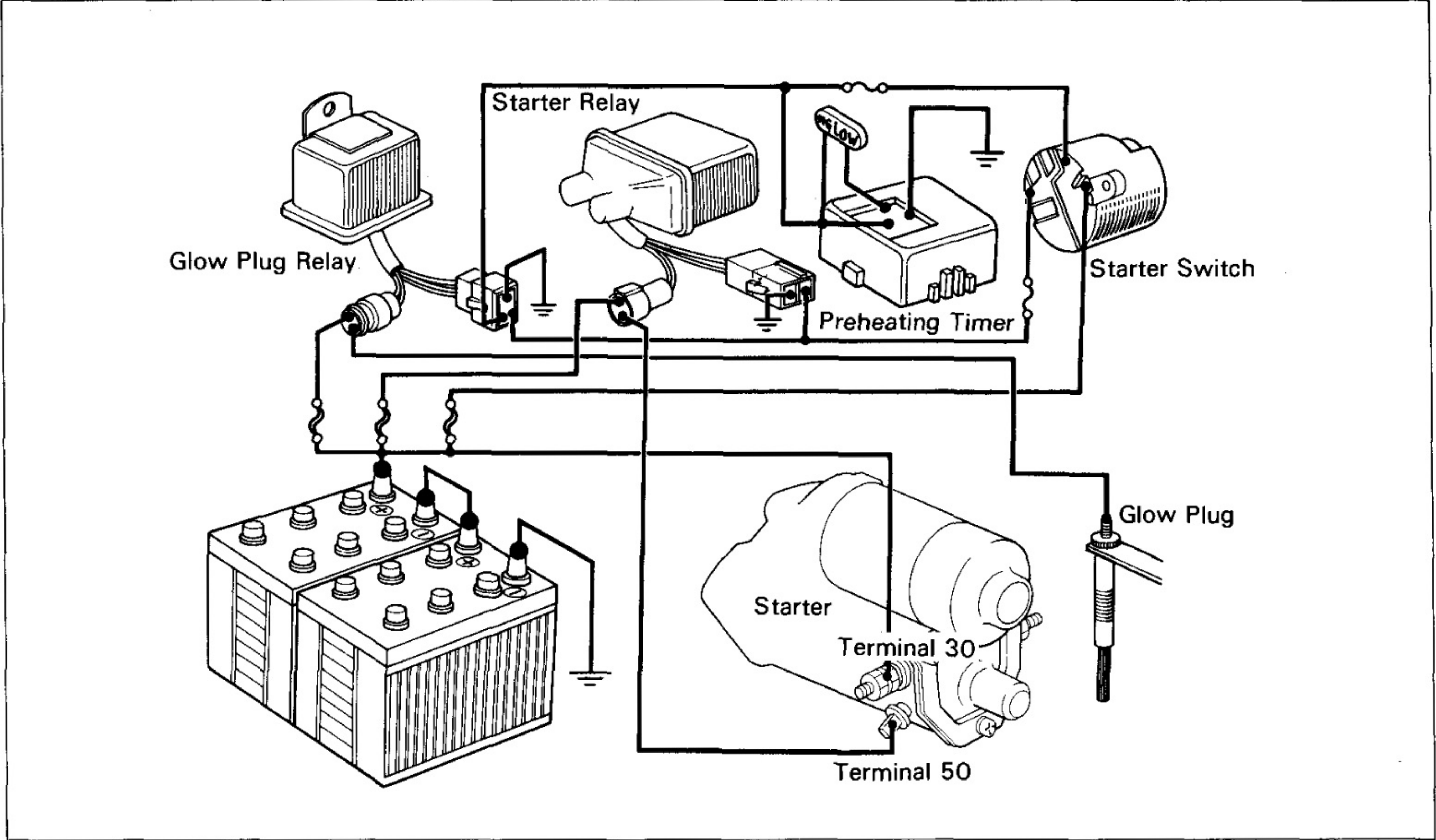
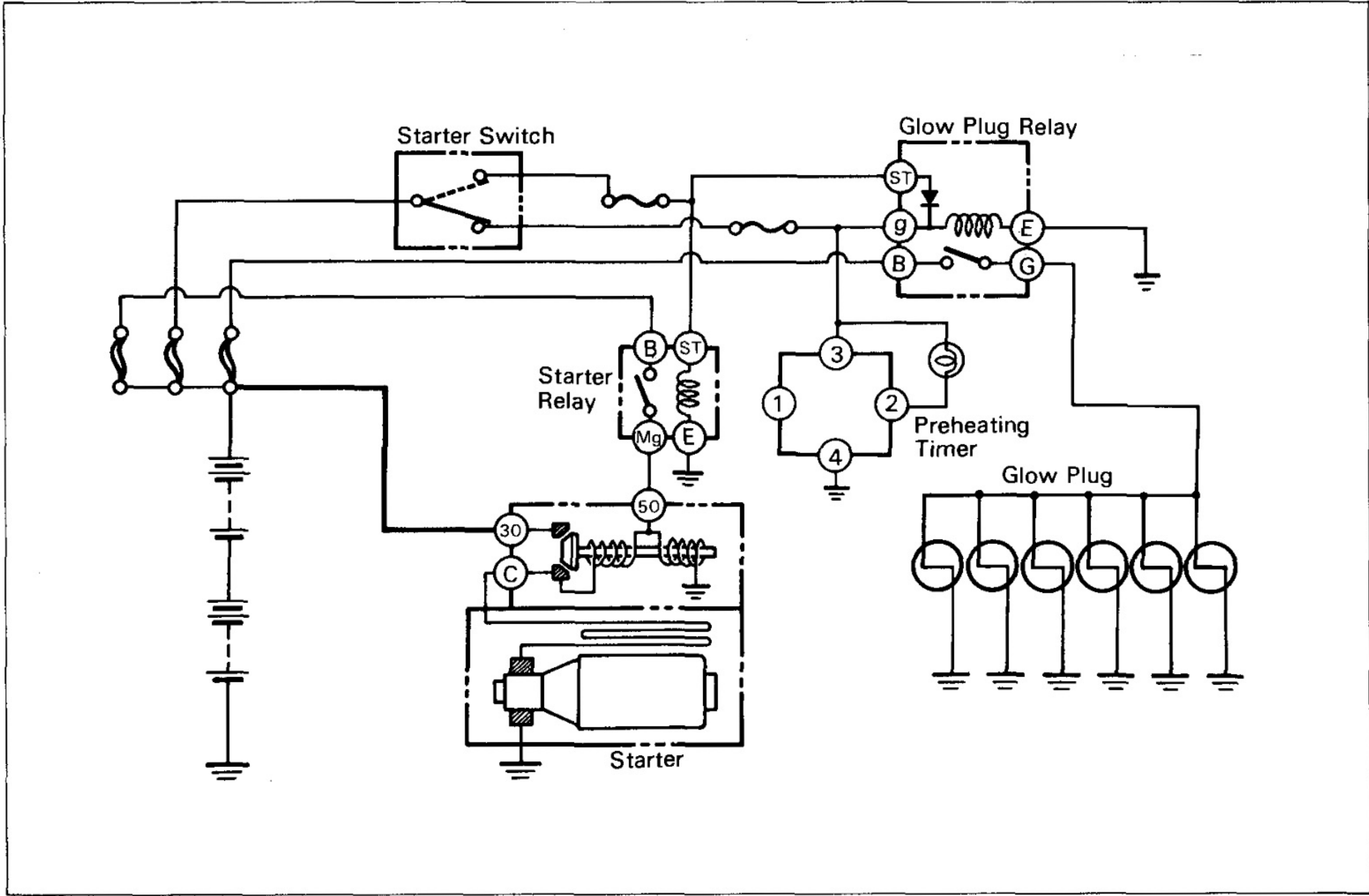


Fig. 8-2



For HJ47

Fig. 8-3

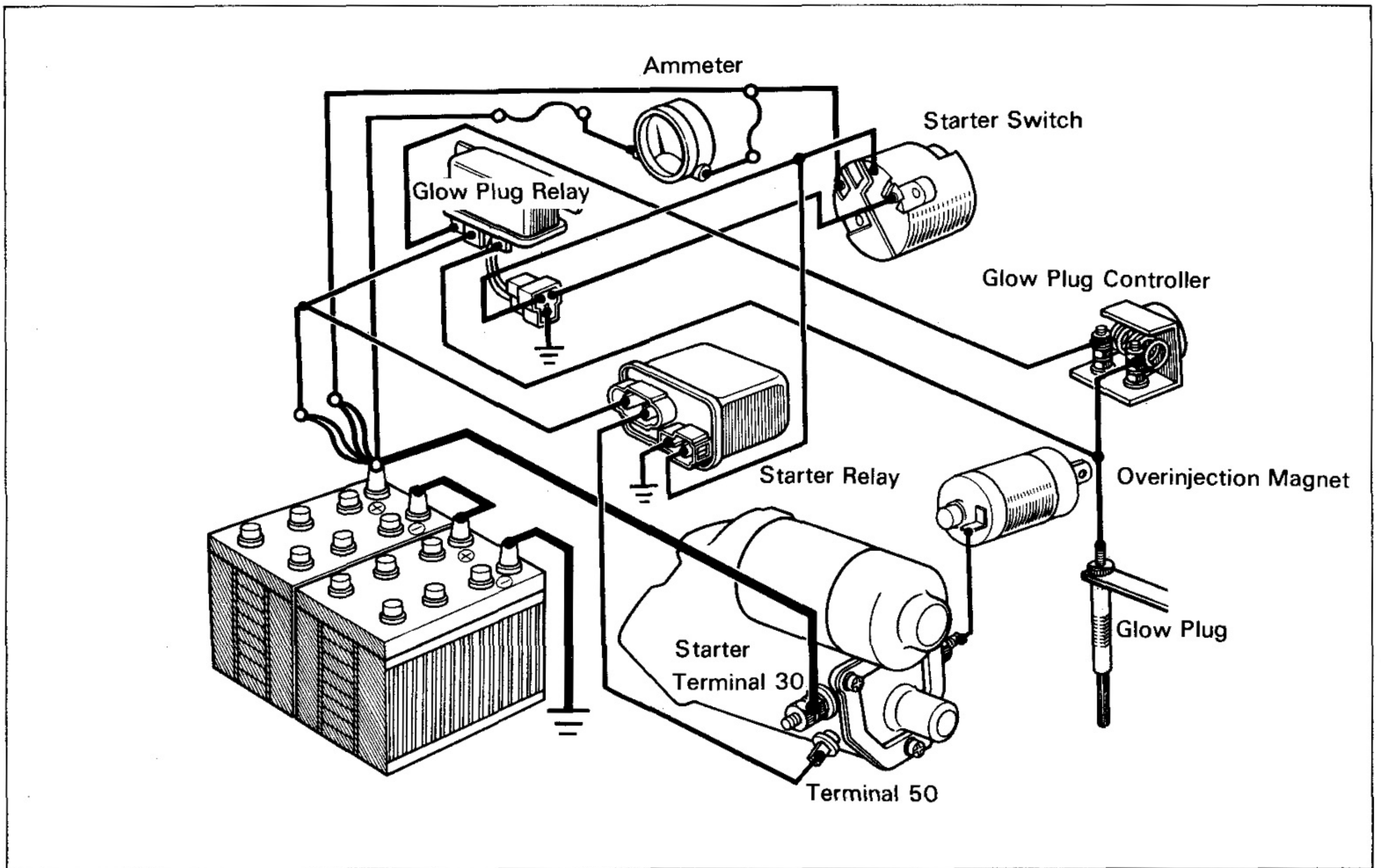


Fig. 8-4

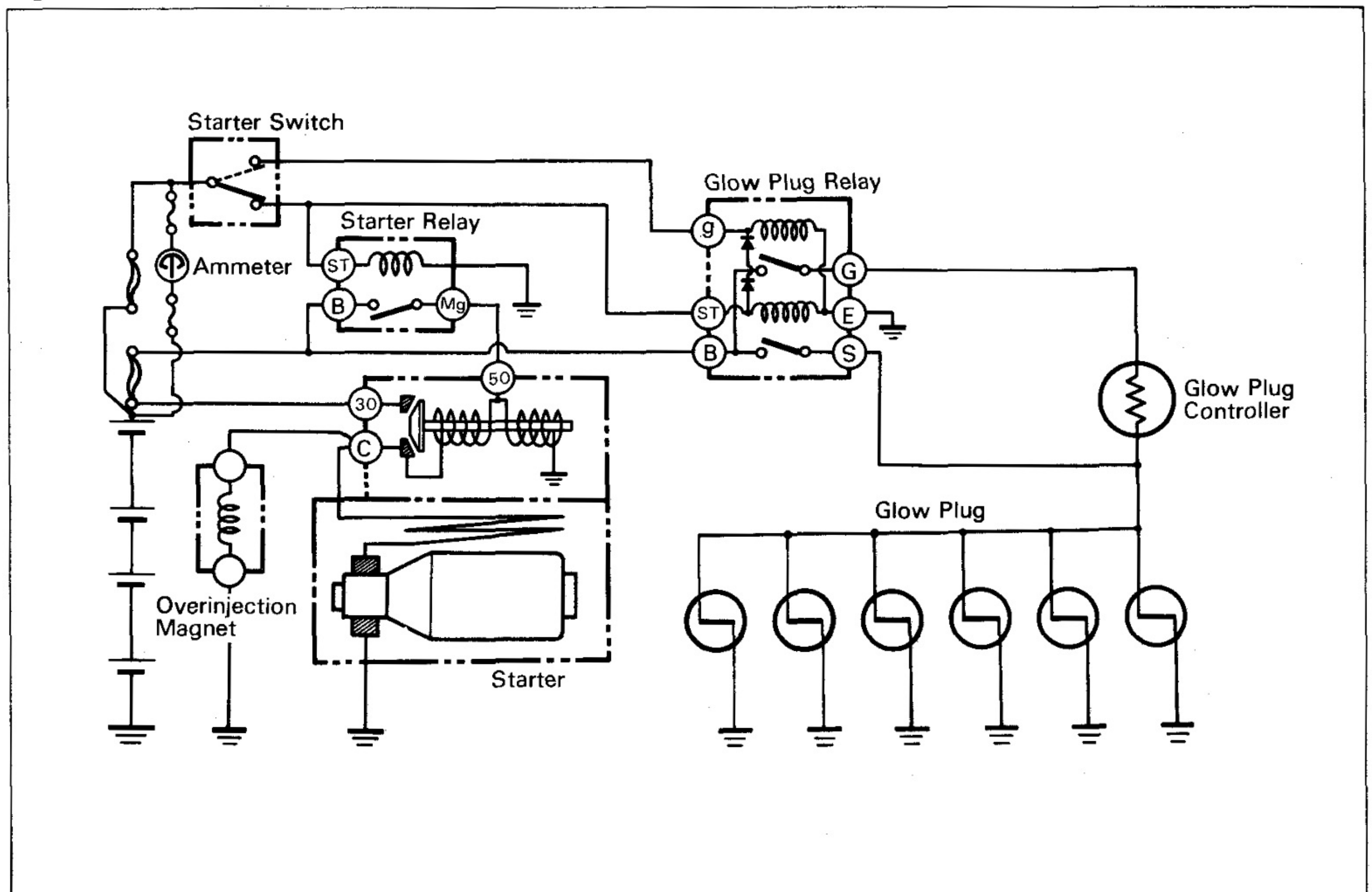


Fig. 8-5

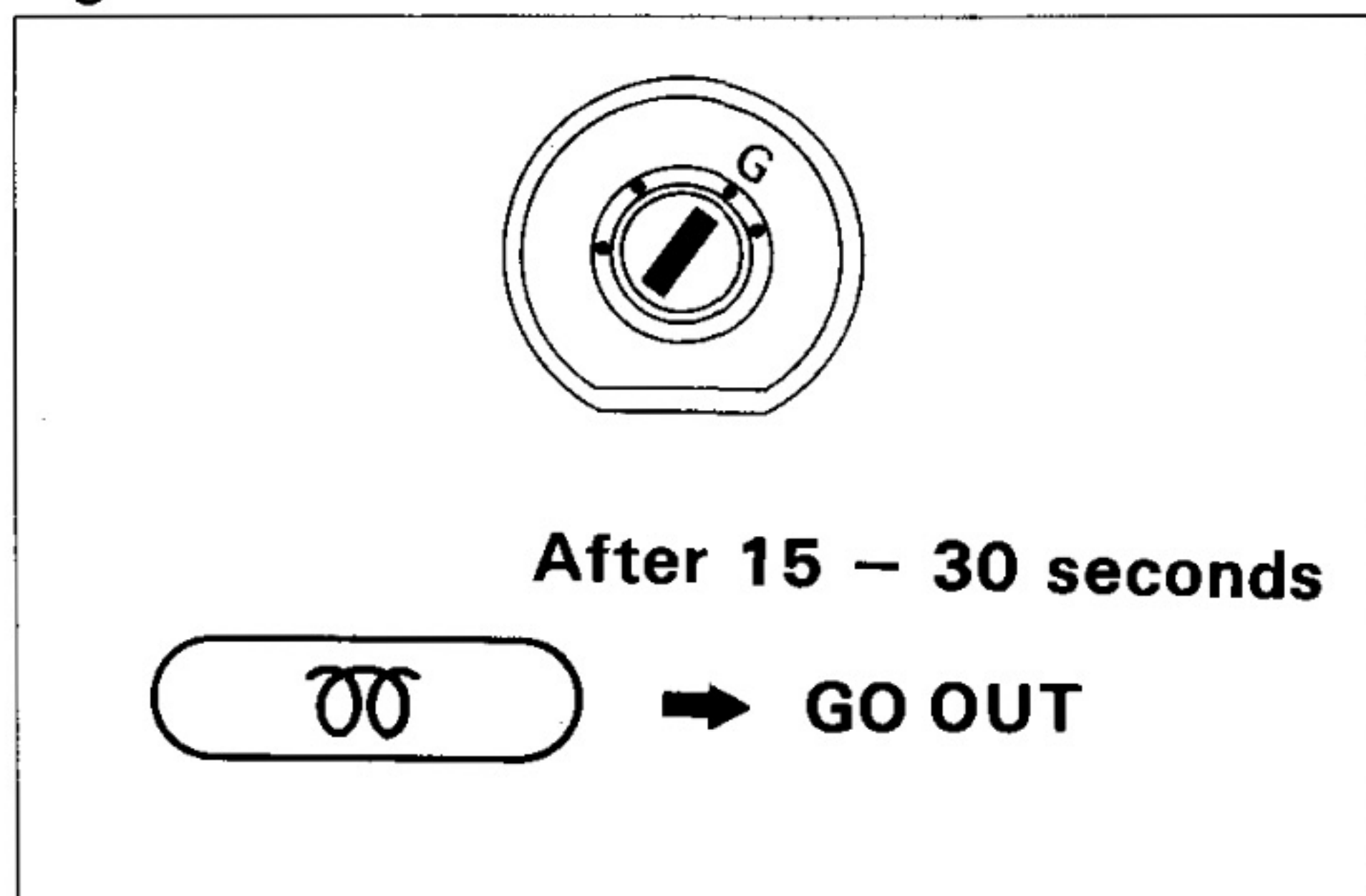


Fig. 8-6

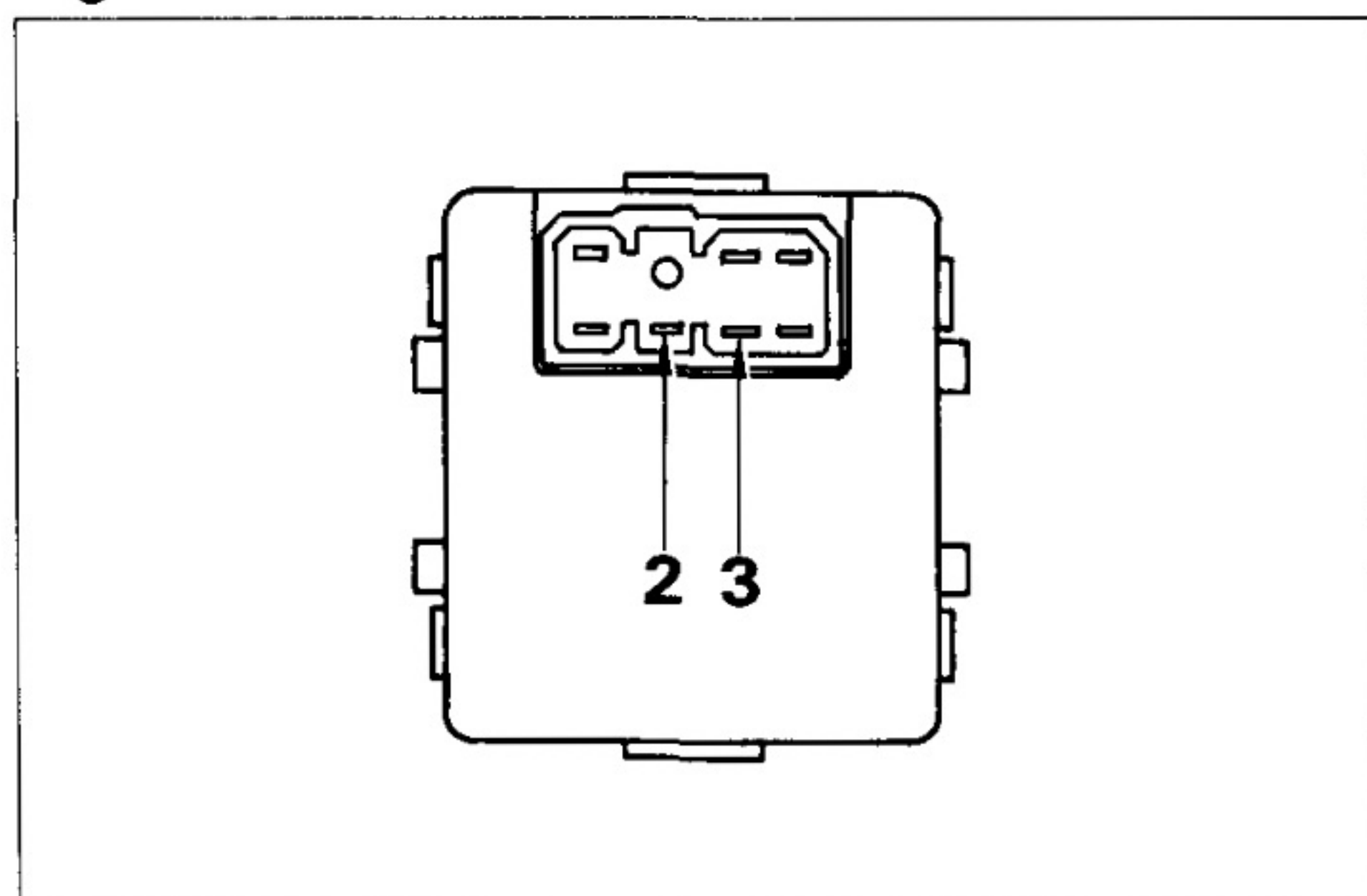


Fig. 8-7

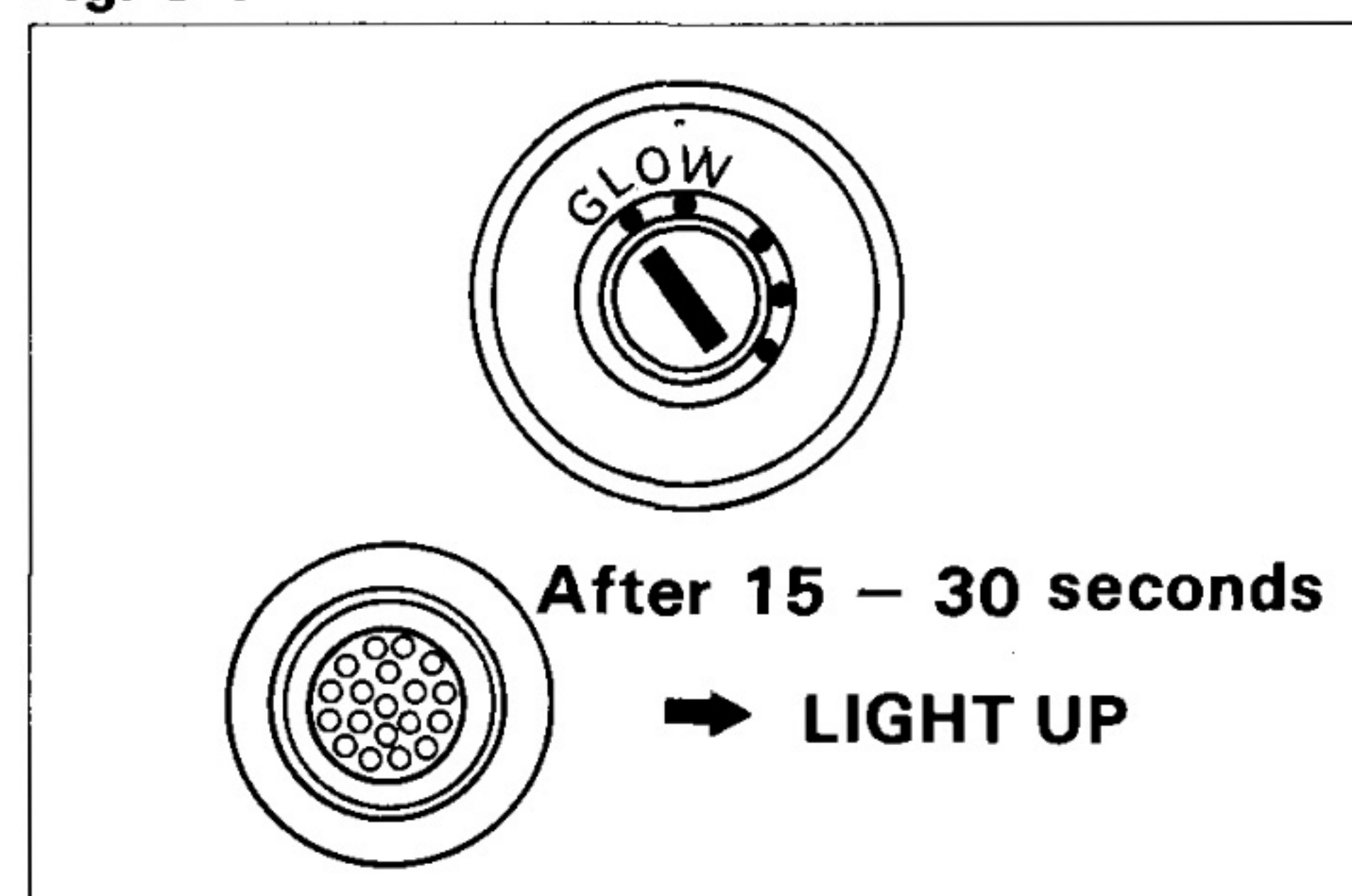
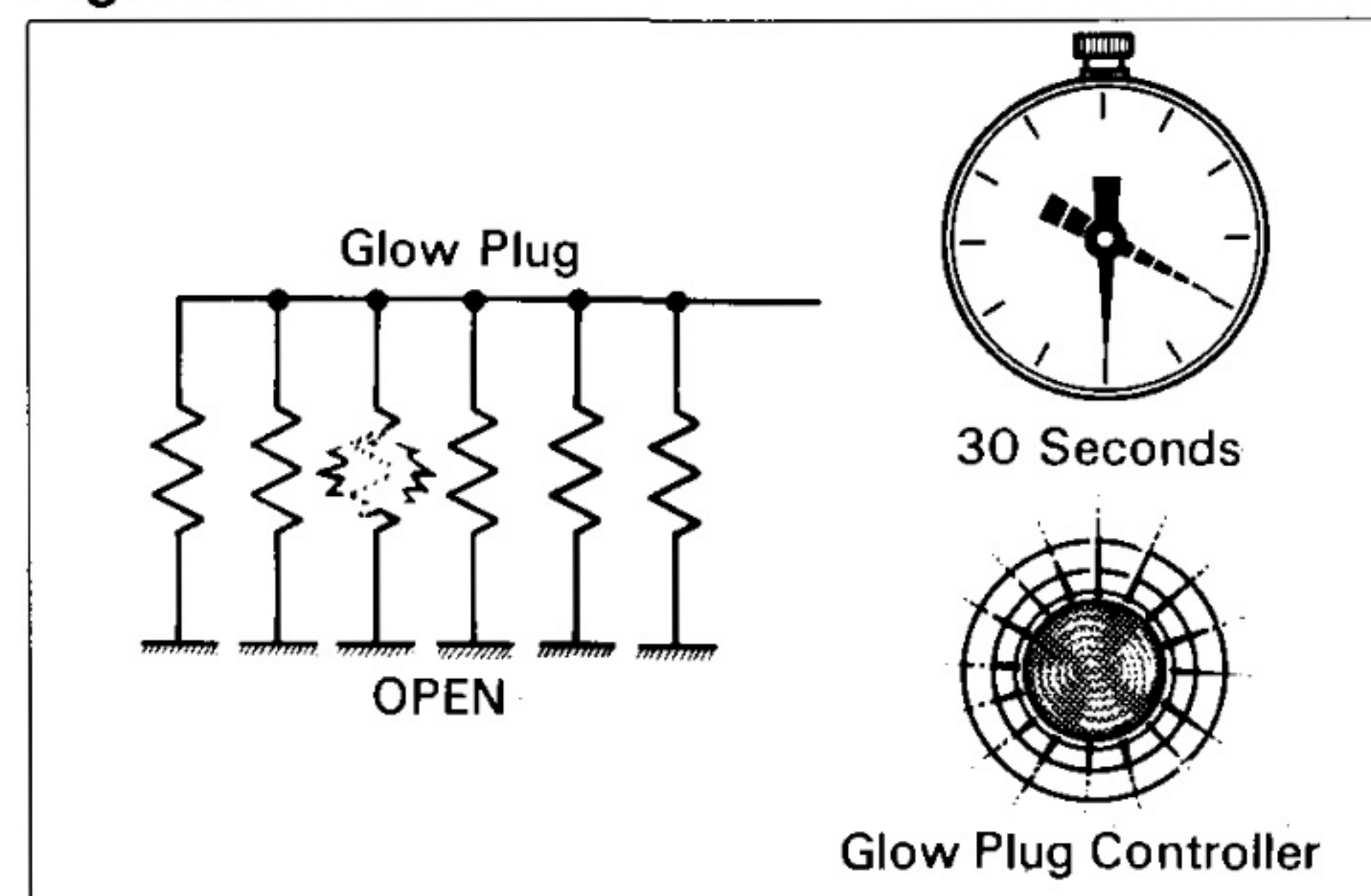


Fig. 8-8



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



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.



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.

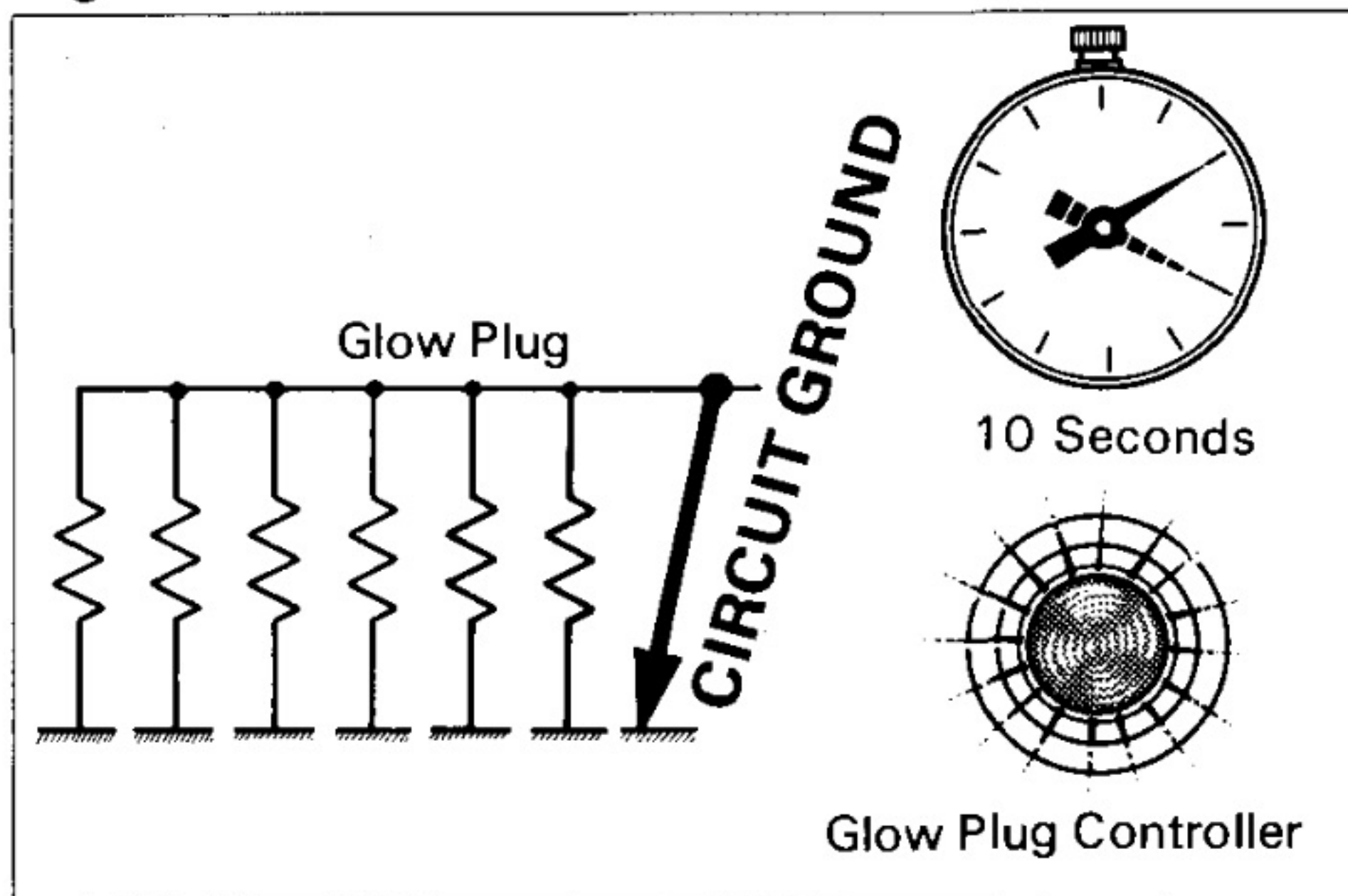
Glow time: 15 – 30 seconds



2. If glow time is more than 30 seconds, check the following conditions.

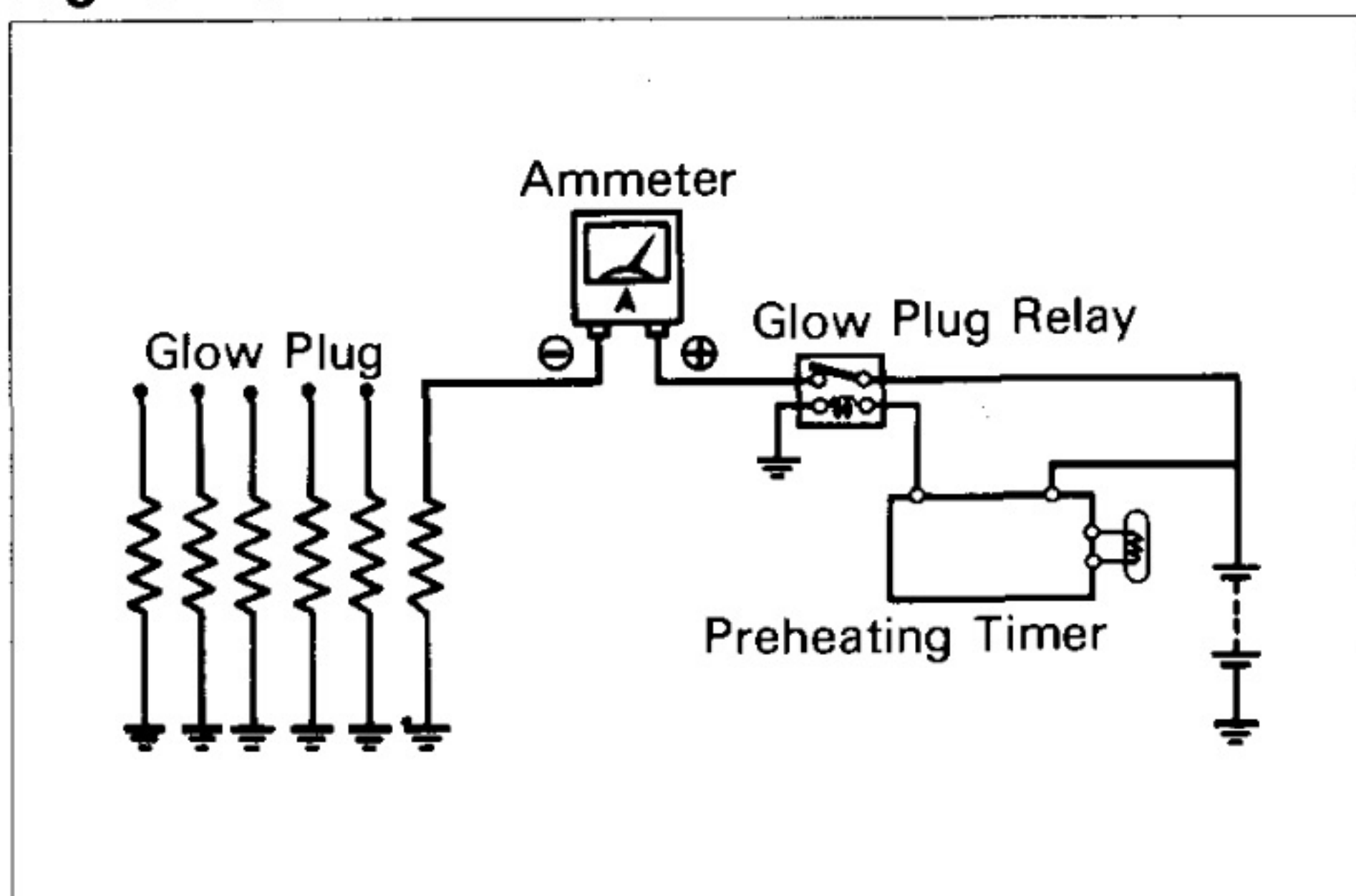
- (1) Open circuit in wiring
- (2) Loose terminal connection
- (3) Burnt switch or relay points
- (4) Open glow plug or controller

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

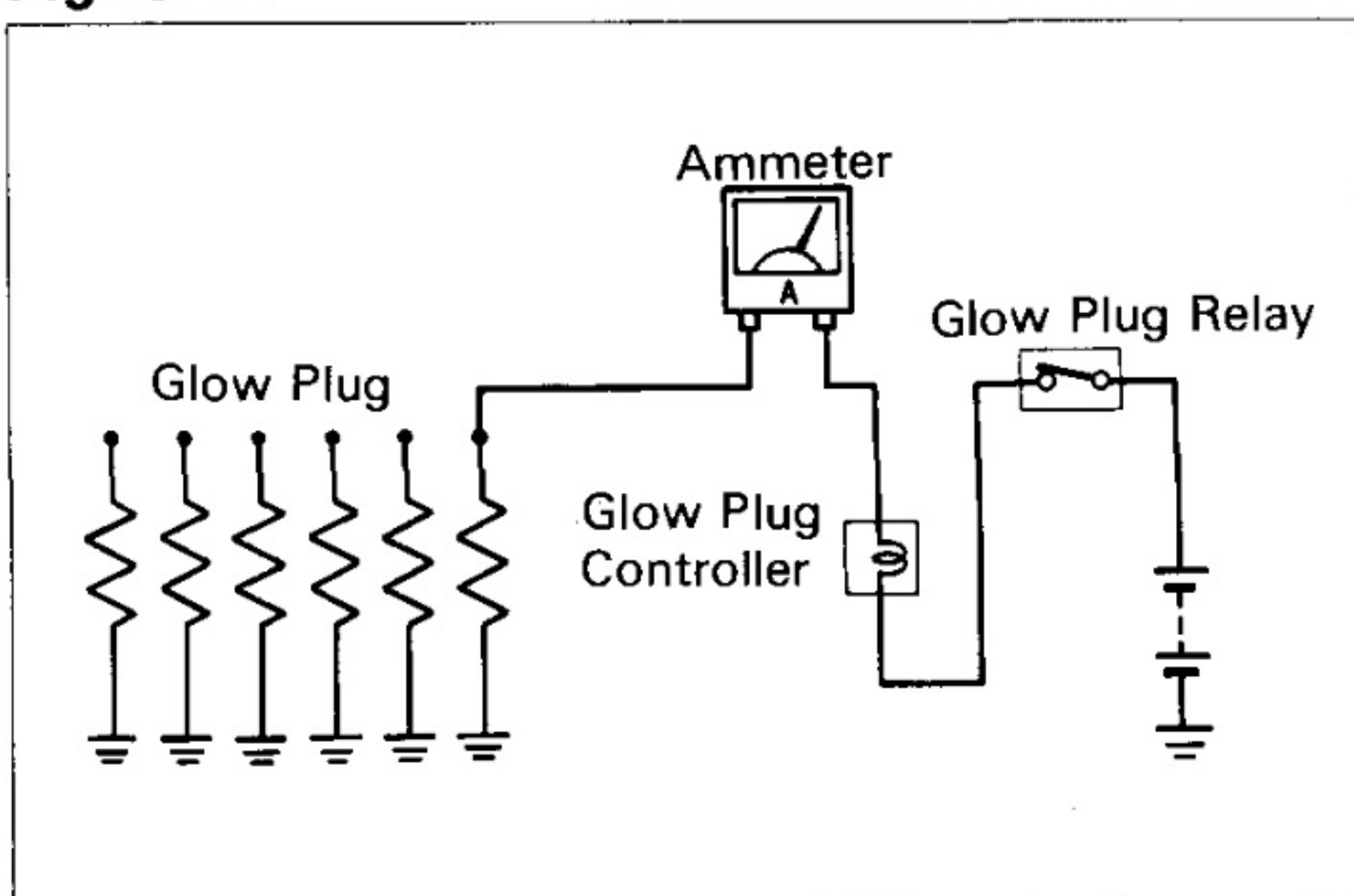
12V type 7.2 – 9.8A

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

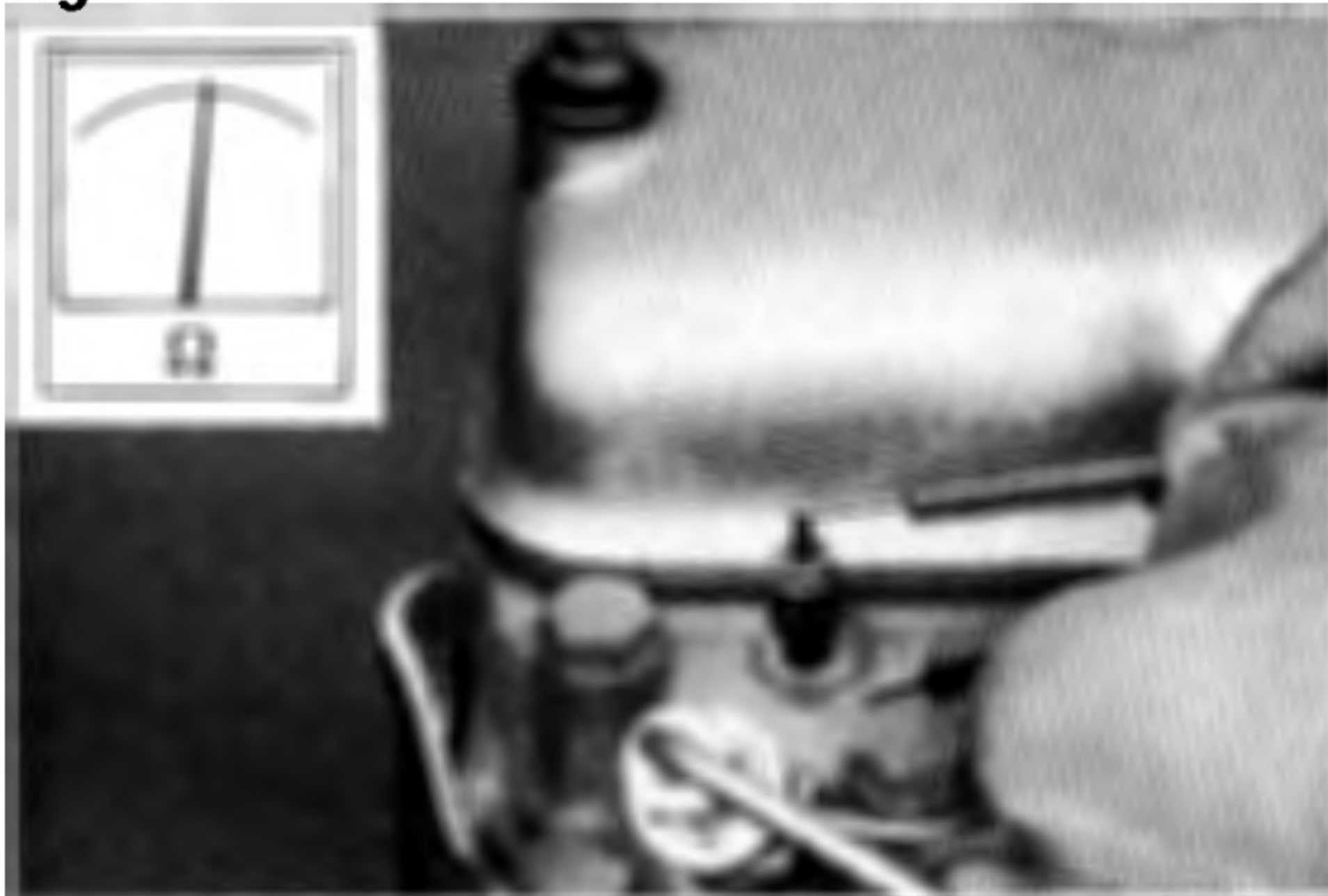
12V type 0.2Ω

24V type 1.0Ω

HJ47

12V type 0.2Ω

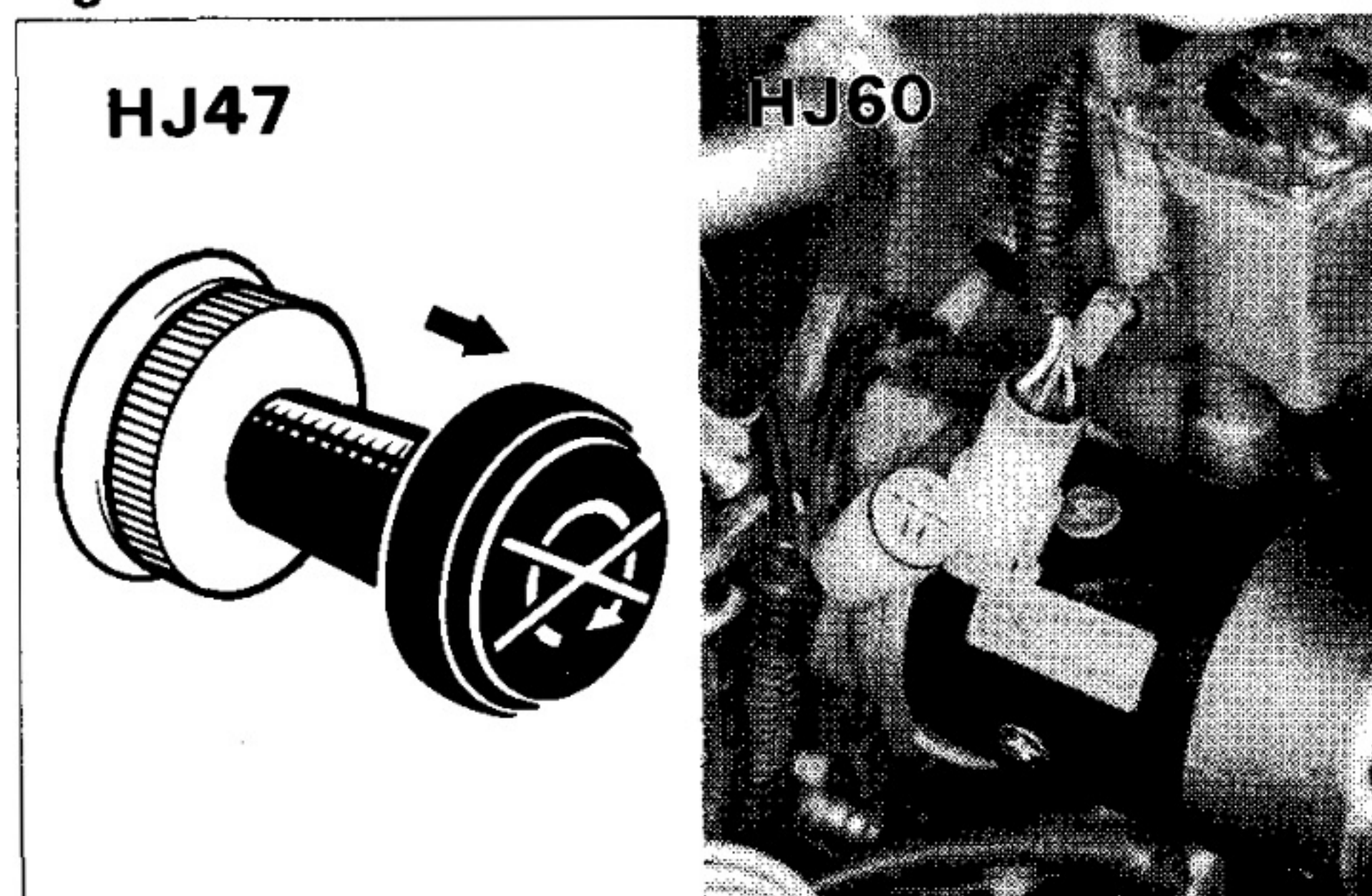
Fig. 8-12



—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.

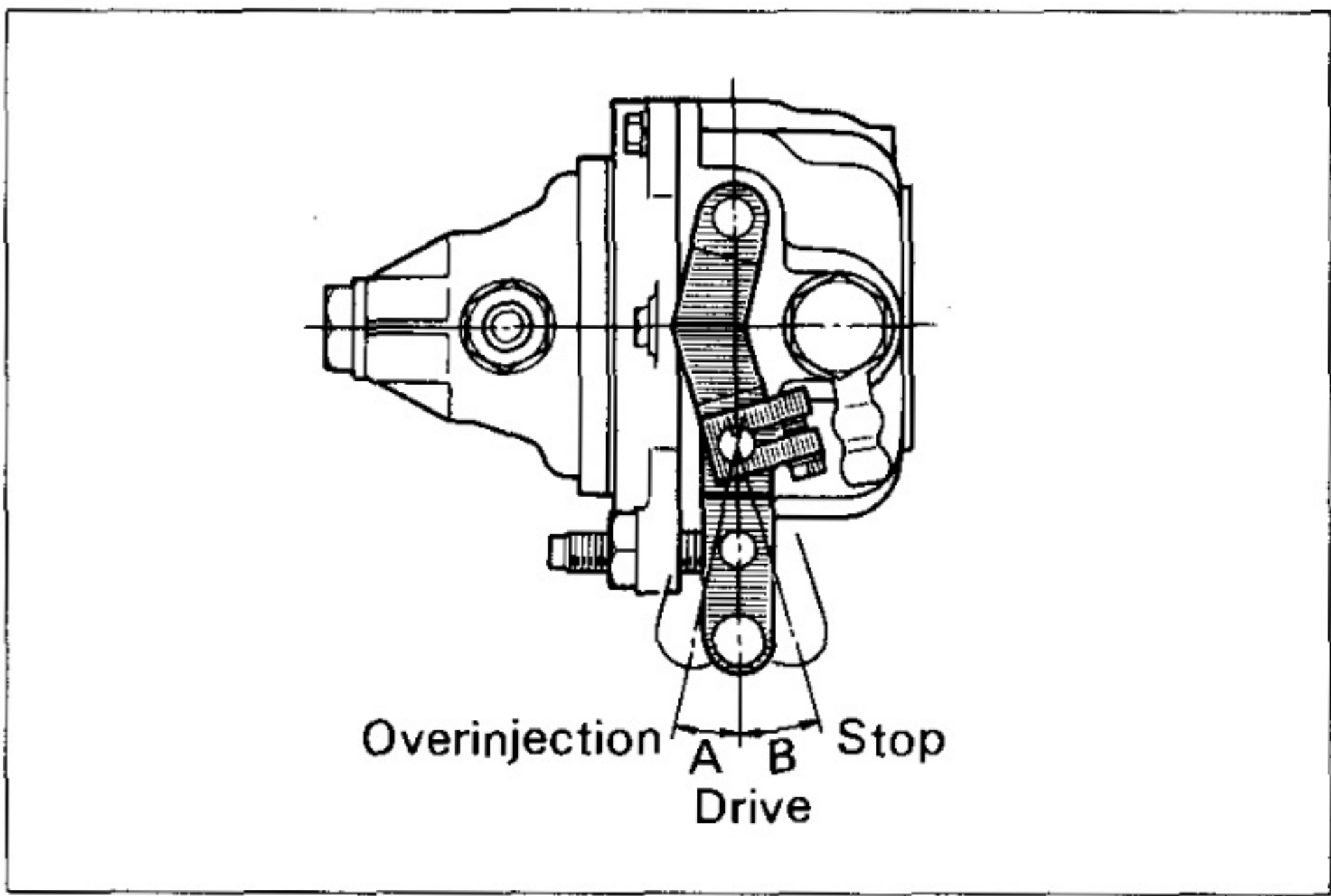
Fig. 8-16



Overinjection Magnet

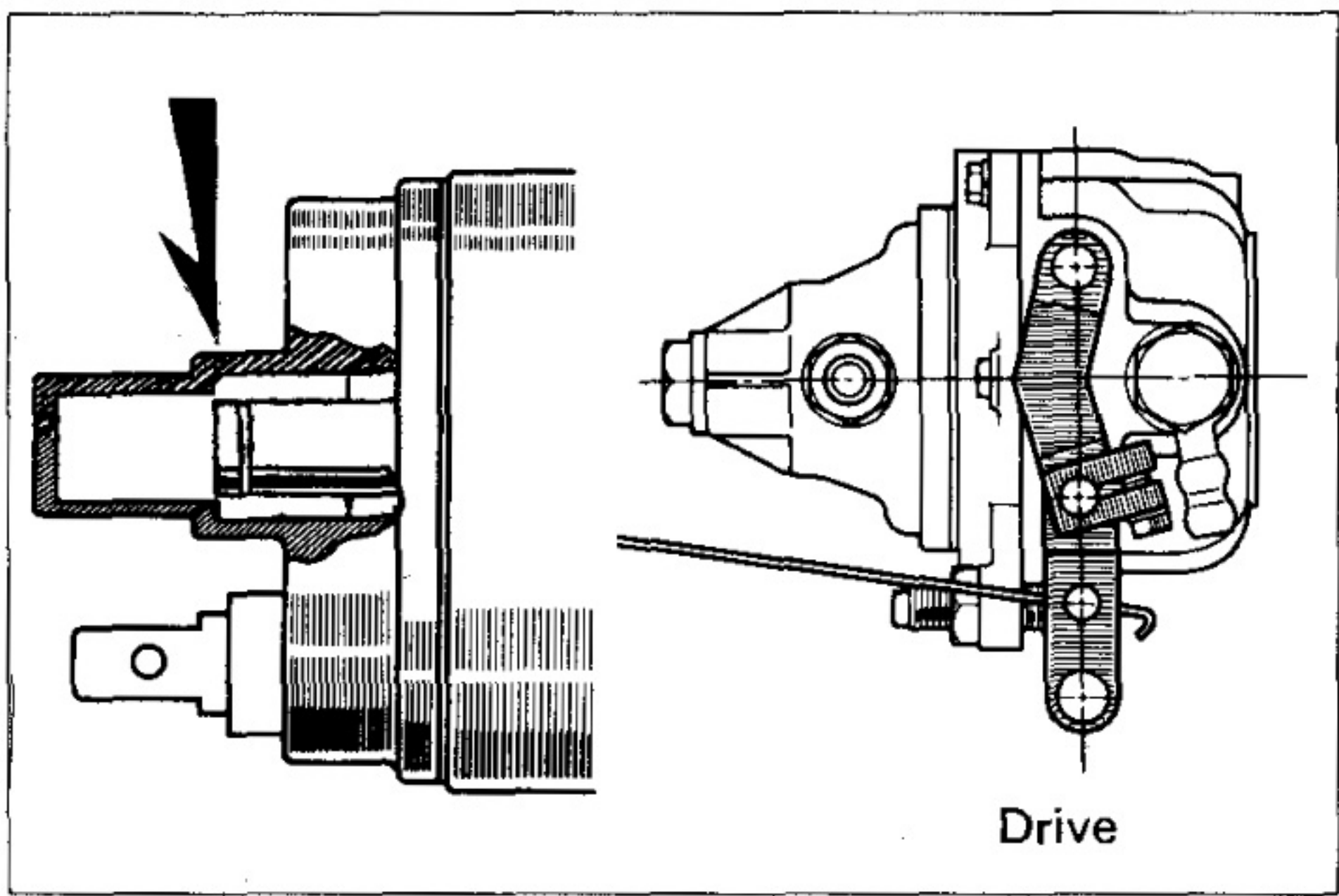
Check to see if the injection pump lever moves to the overinjection position when the starter switch is turned to START position.

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

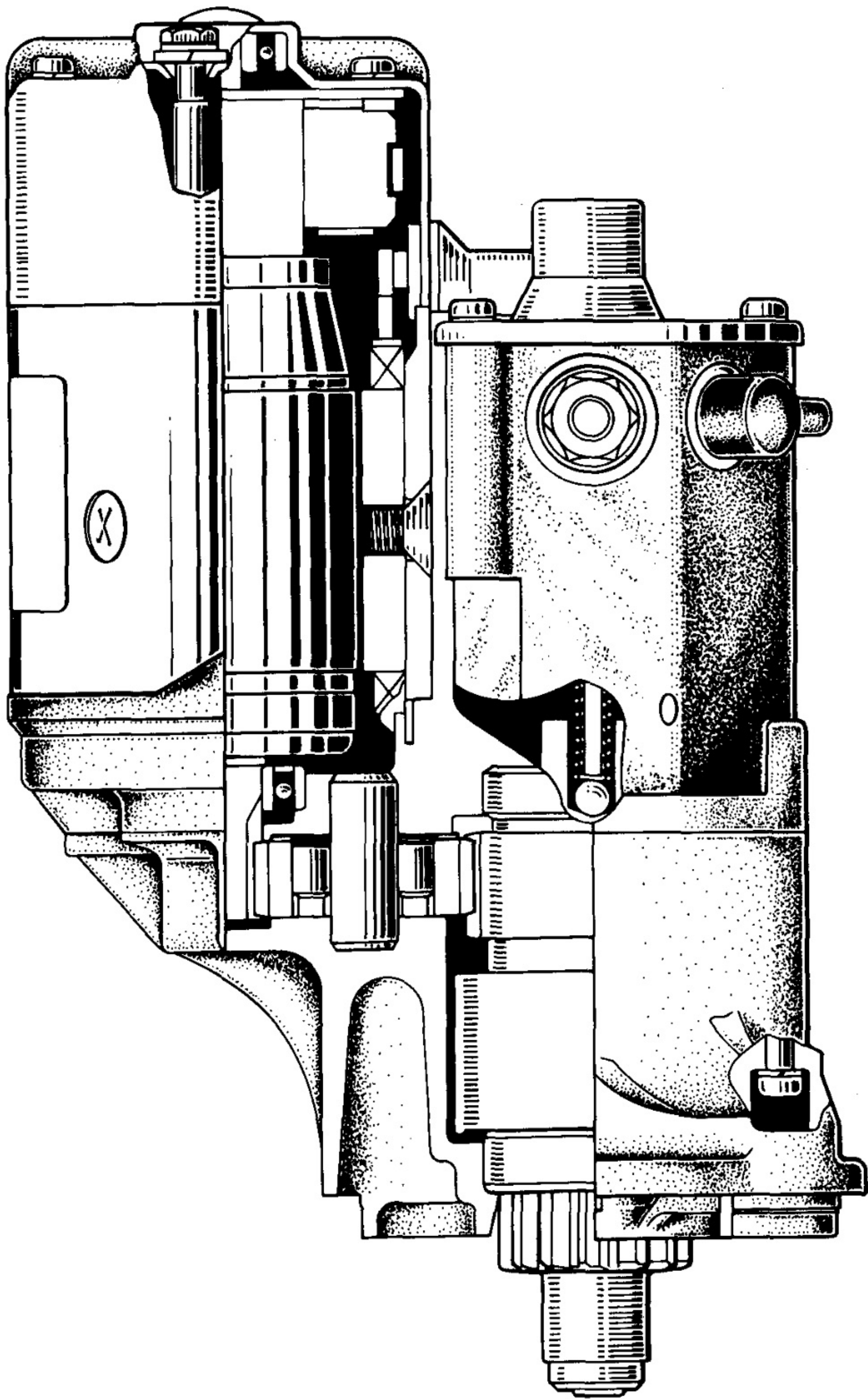


Fig. 8-20



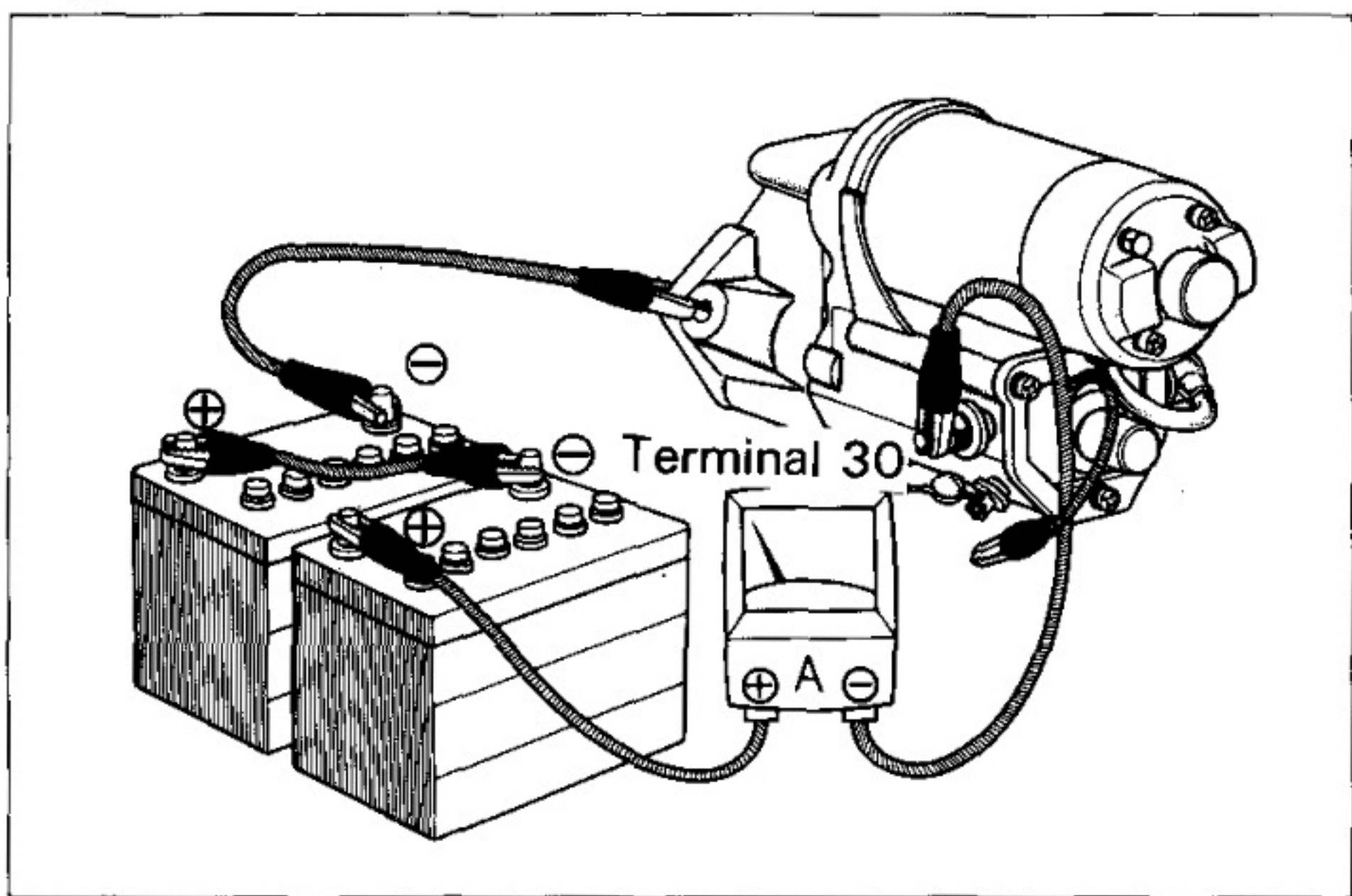
PERFORMANCE TEST

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

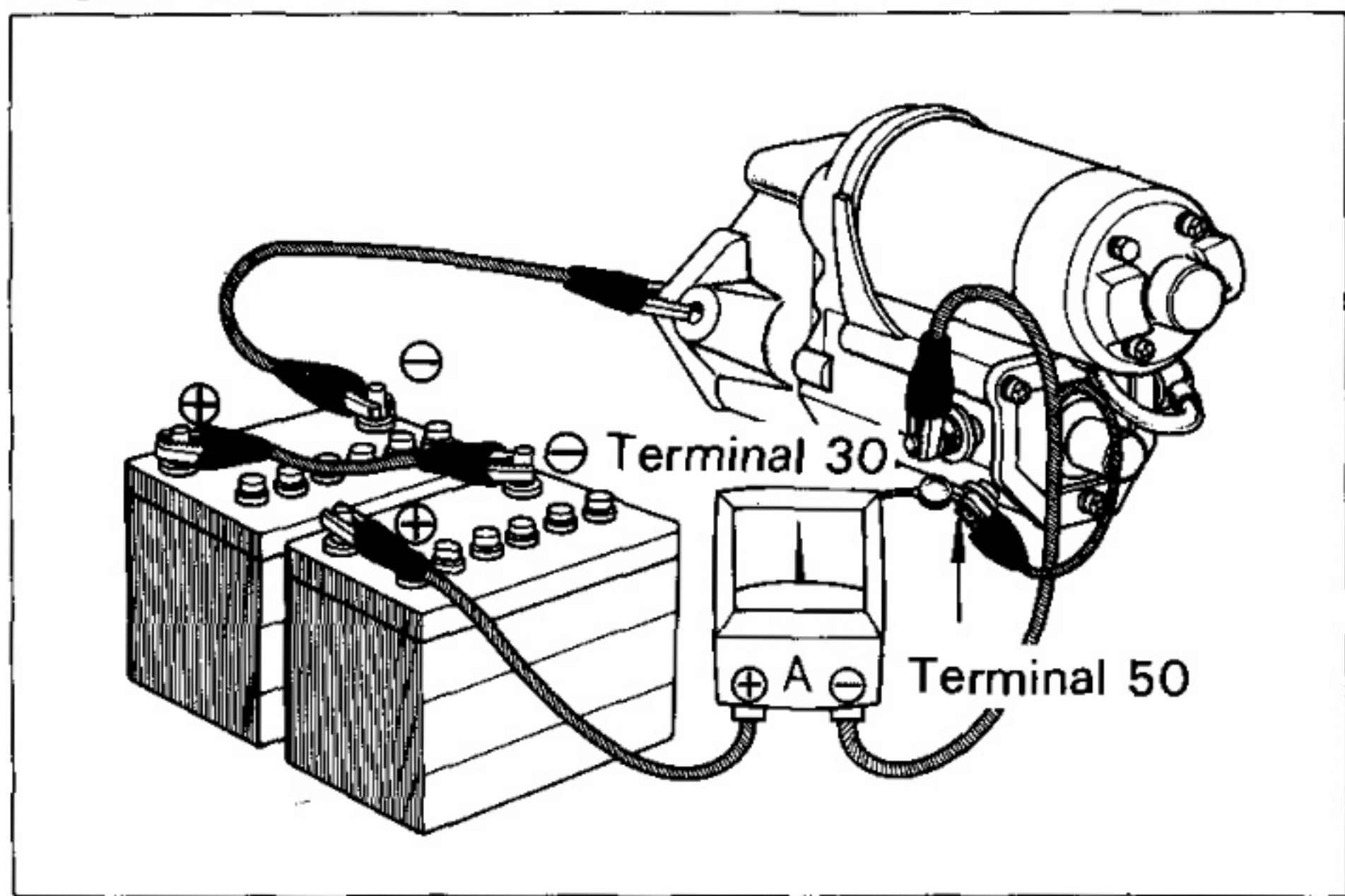
Battery (+) —→ Ammeter (+)

Ammeter (-) —→ Terminal 30

Negative side

Battery (-) —→ Starter housing

Fig. 8-22



3. Connect the positive wire to the terminal 50.

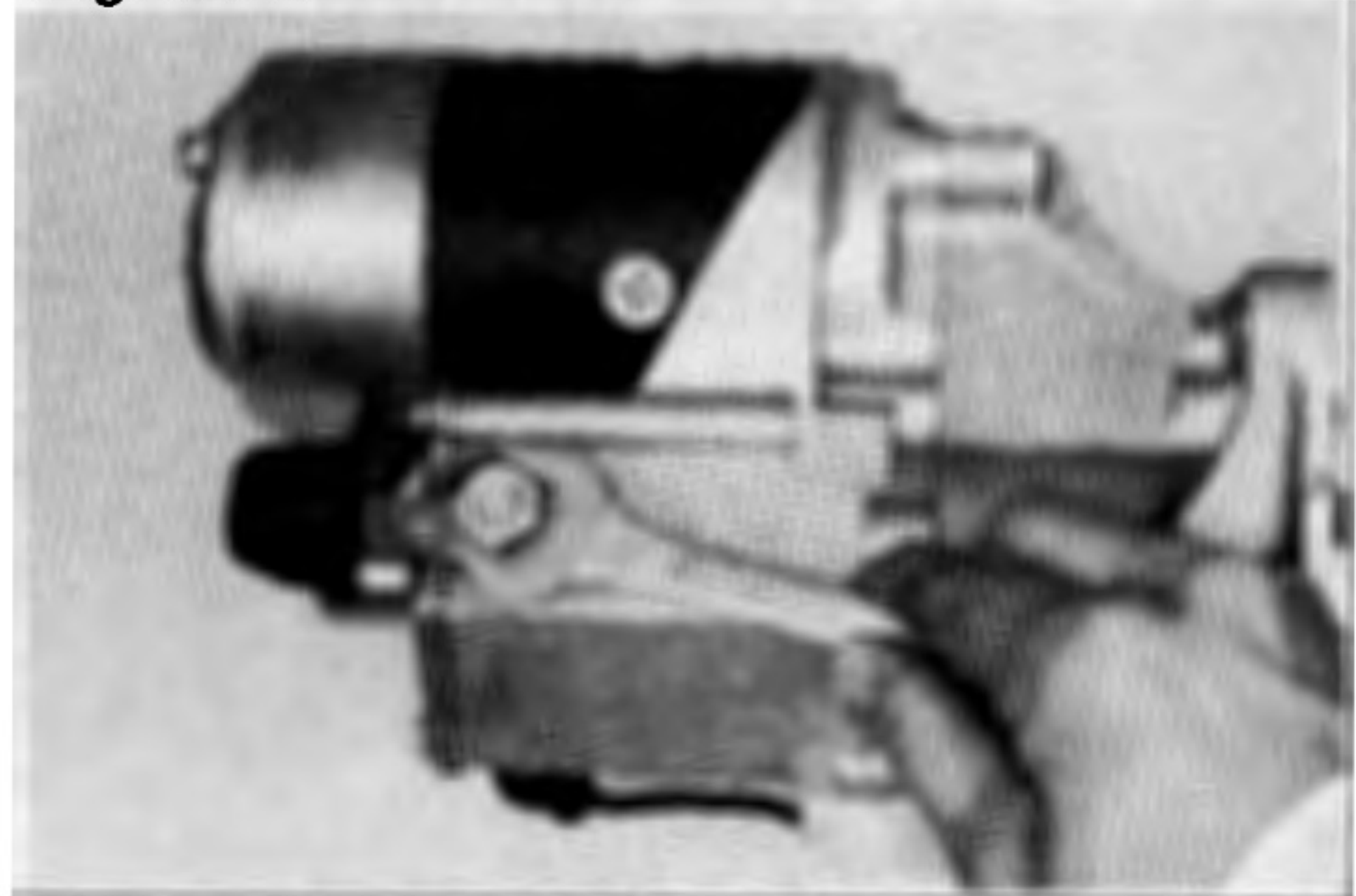
If the starter shows smooth and steady rotation with the pinion jumping out and drawing less than specified current, it is satisfactory.

Specified current:

12V type Less than 180A

24V type Less than 90A

Fig. 8-23



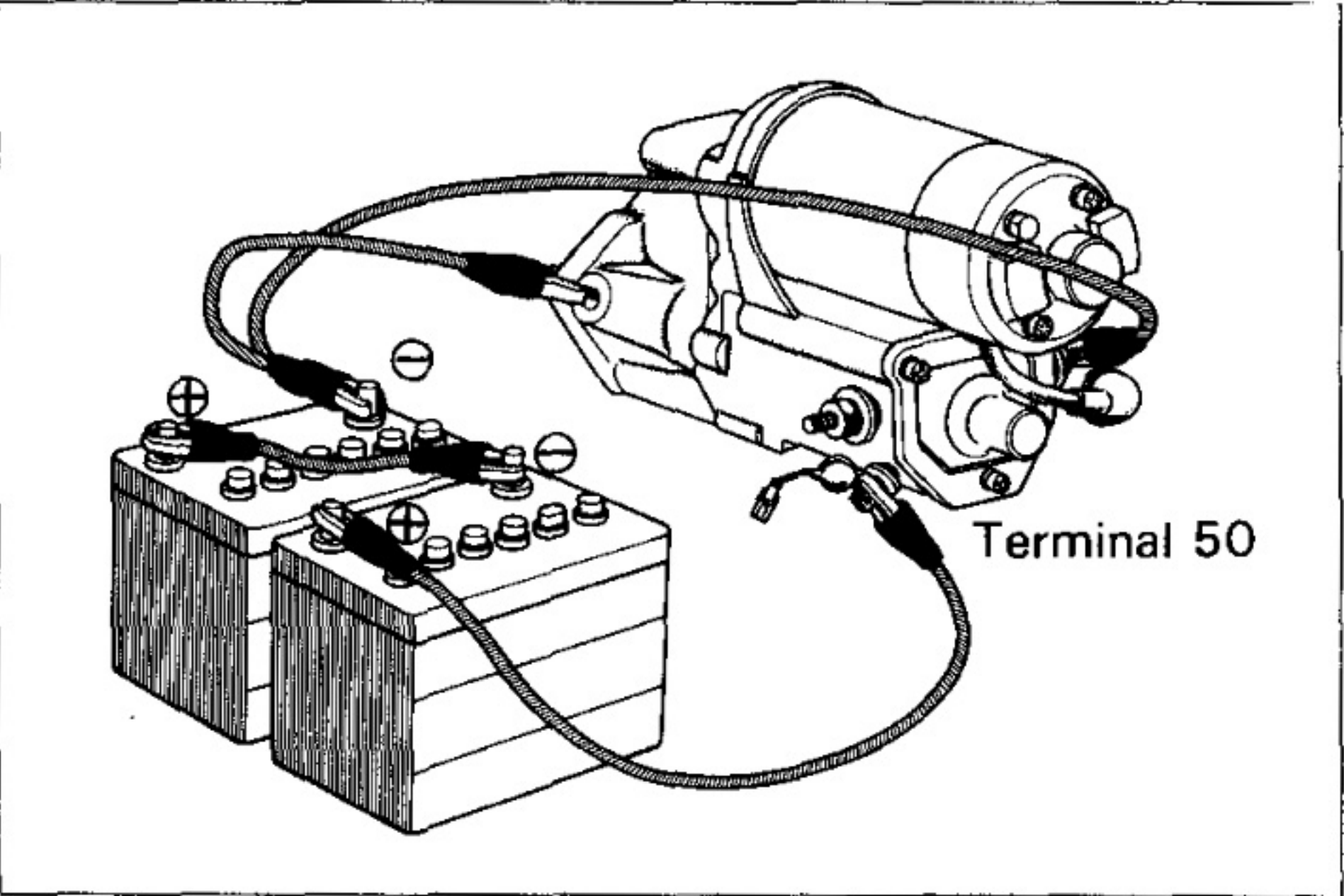
Magnetic Switch Test

—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

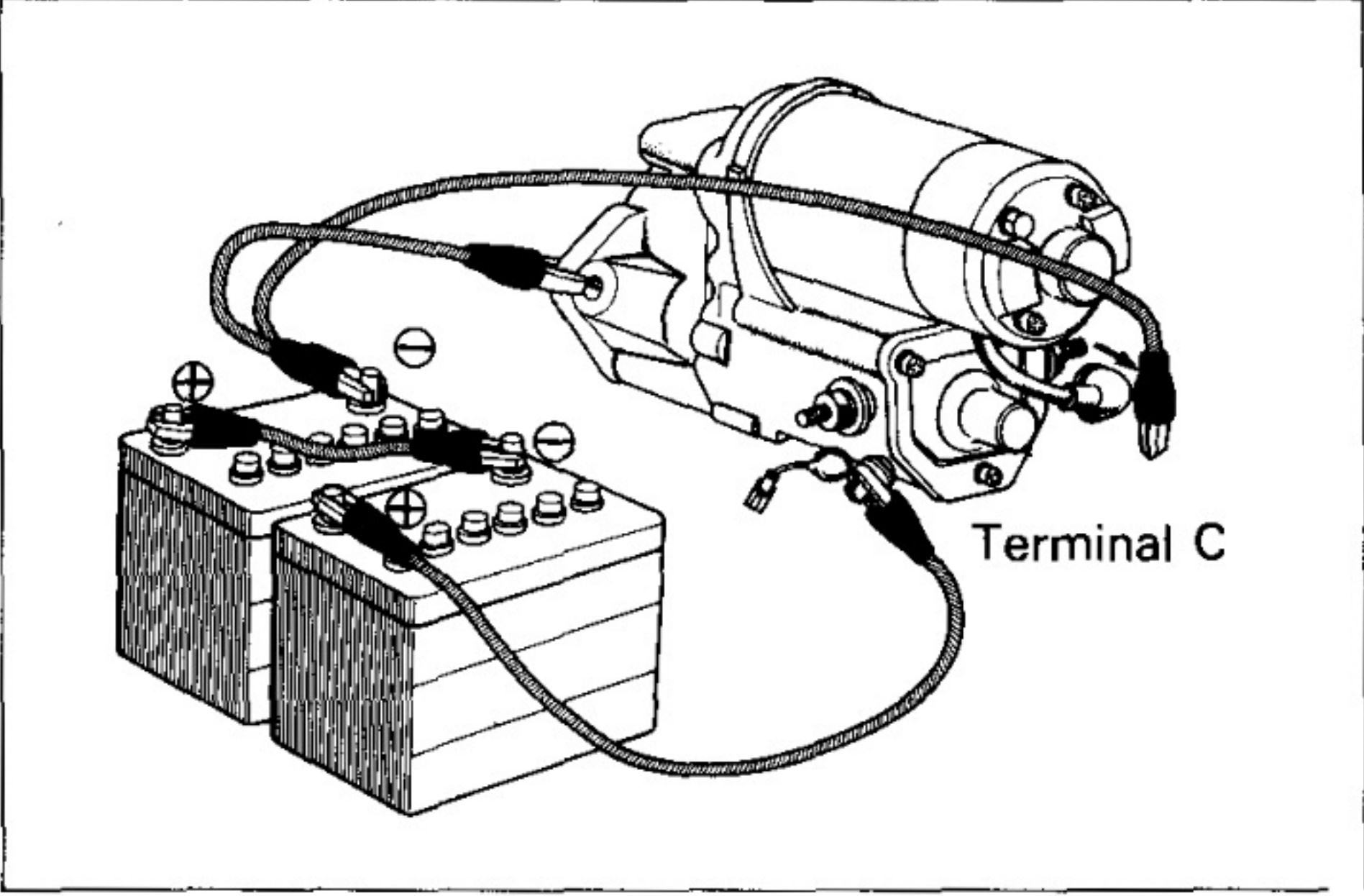


2. Test pull-in coil.
Connect the magnetic switch to the battery as shown in the figure. The pinion should jump out.

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

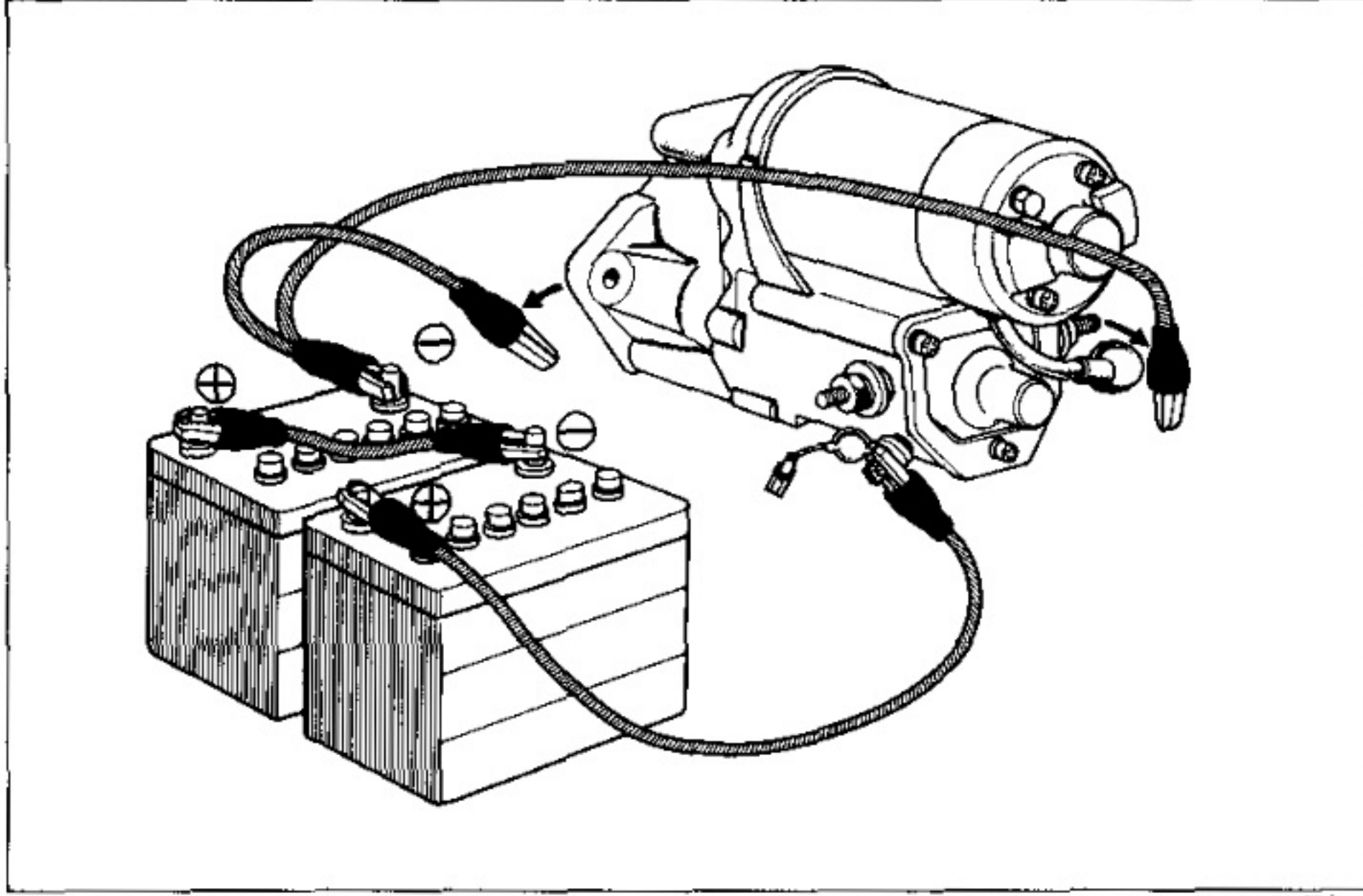
Positive side
Battery (+) —→ Terminal 50

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

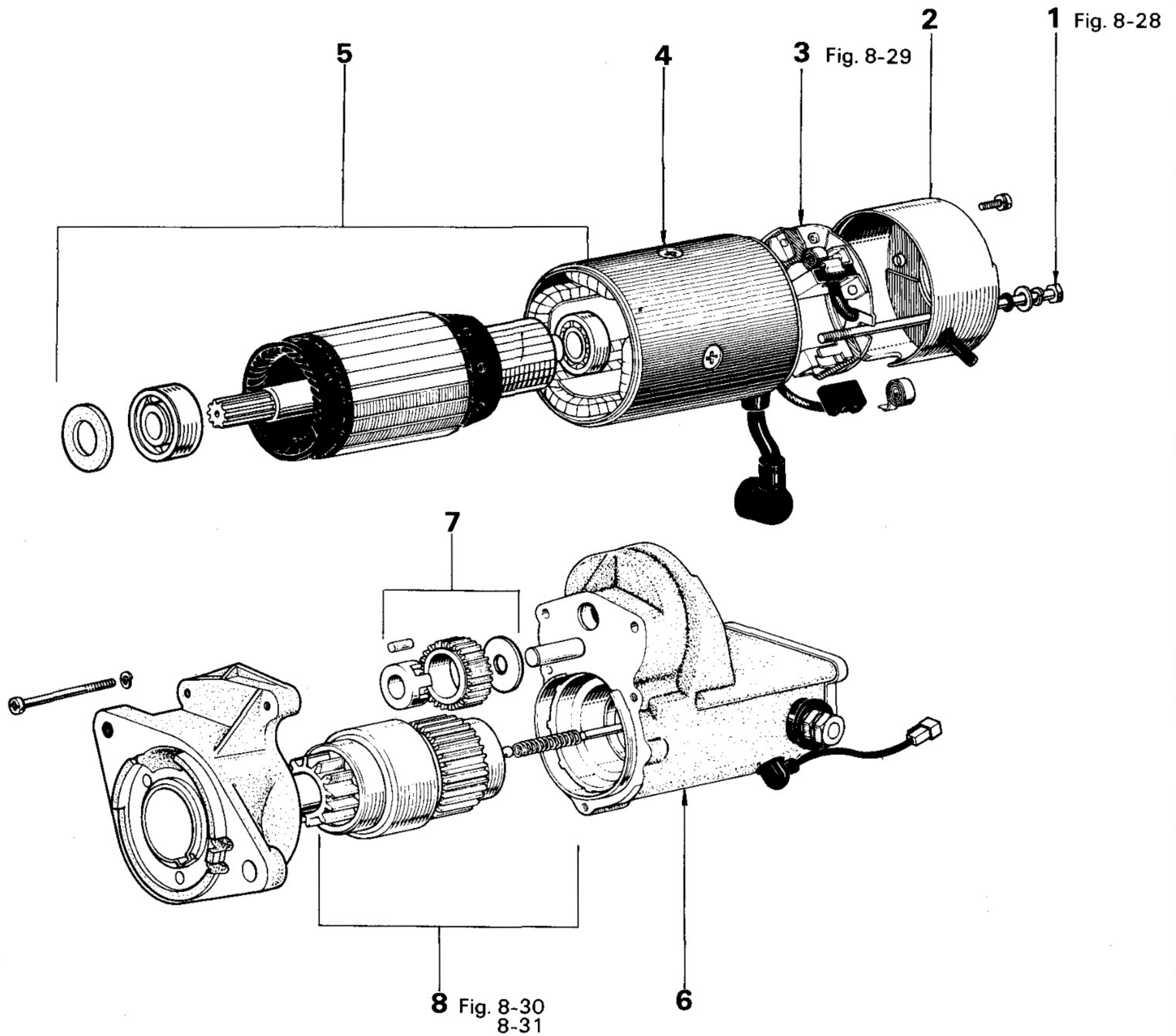


4. Check pinion return.
When disconnecting the cable from the starter housing, the protruded pinion should return quickly.

DISASSEMBLY

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

Fig. 8-27



- | | |
|-----------------|--------------------------------|
| 1. Through Bolt | 5. Armature |
| 2. End Frame | 6. Magnetic Switch |
| 3. Brush Holder | 7. Pinion, Roller & Retainer |
| 4. Yoke | 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—

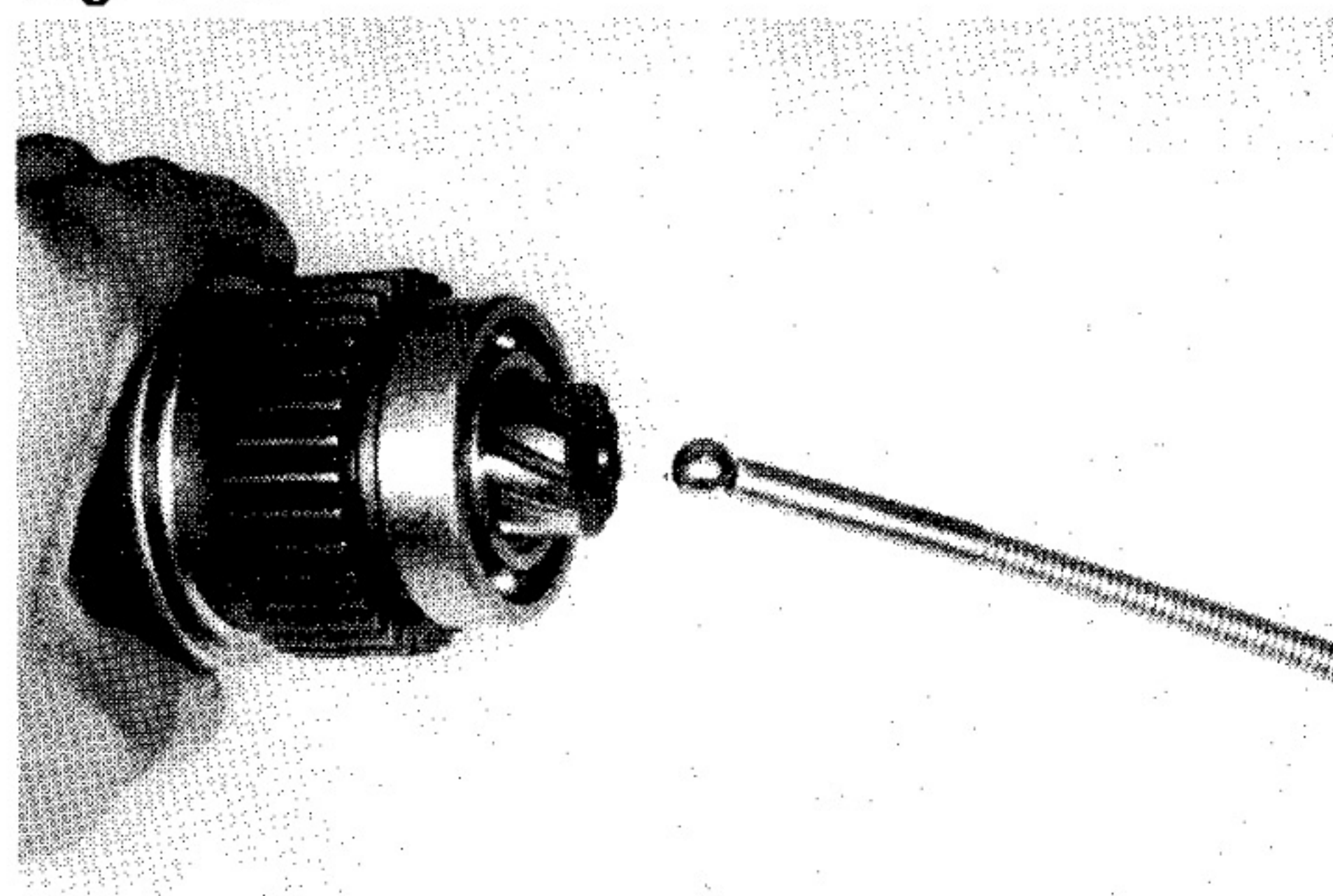
Use care not to damage the brush and commutator and do not allow oil or grease to get on them.

Fig. 8-30



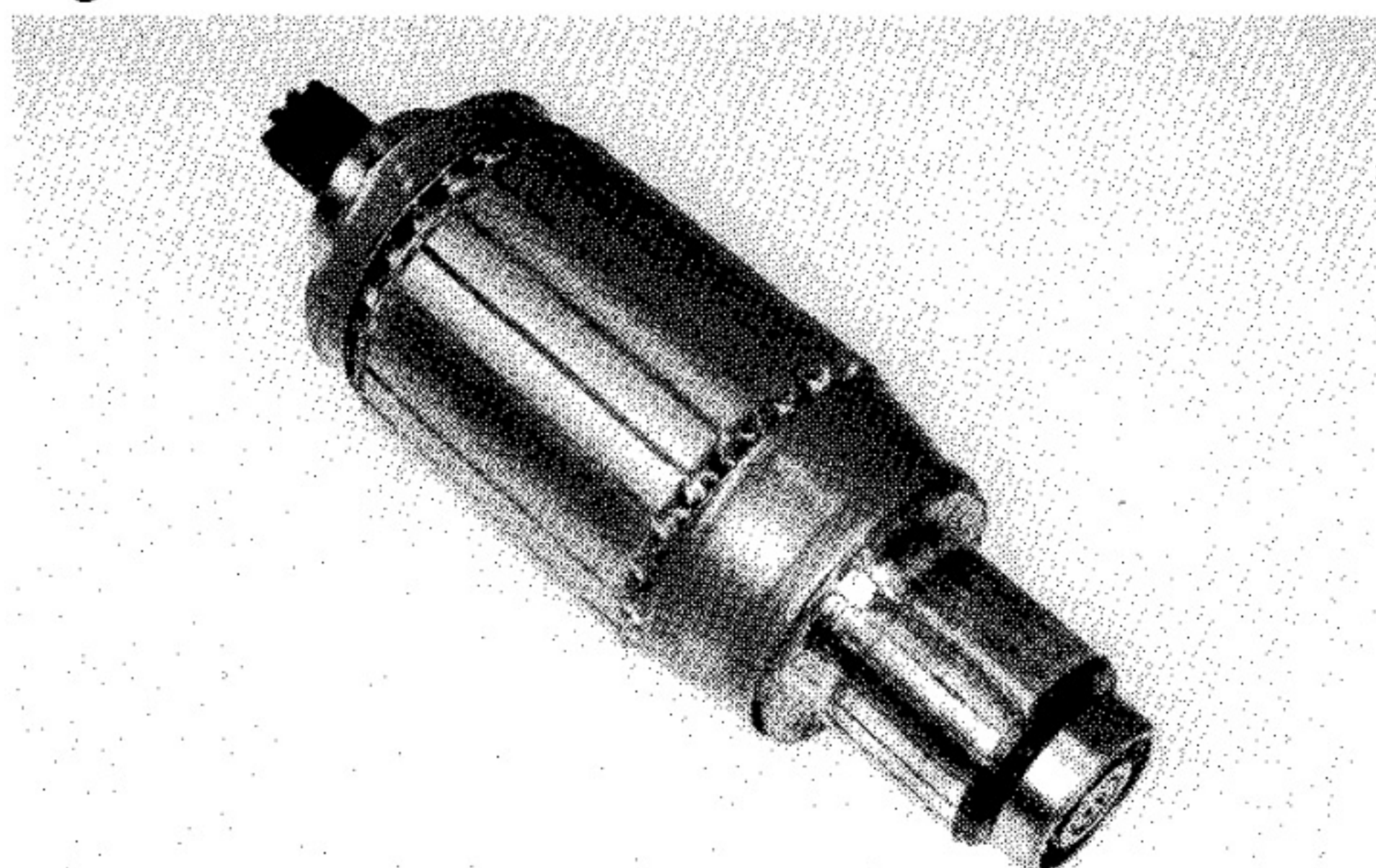
Remove the starter housing together with the idler gear and clutch.

Fig. 8-31



Take the steel ball out from the clutch shaft hole.

Fig. 8-32

**INSPECTION & REPAIR**

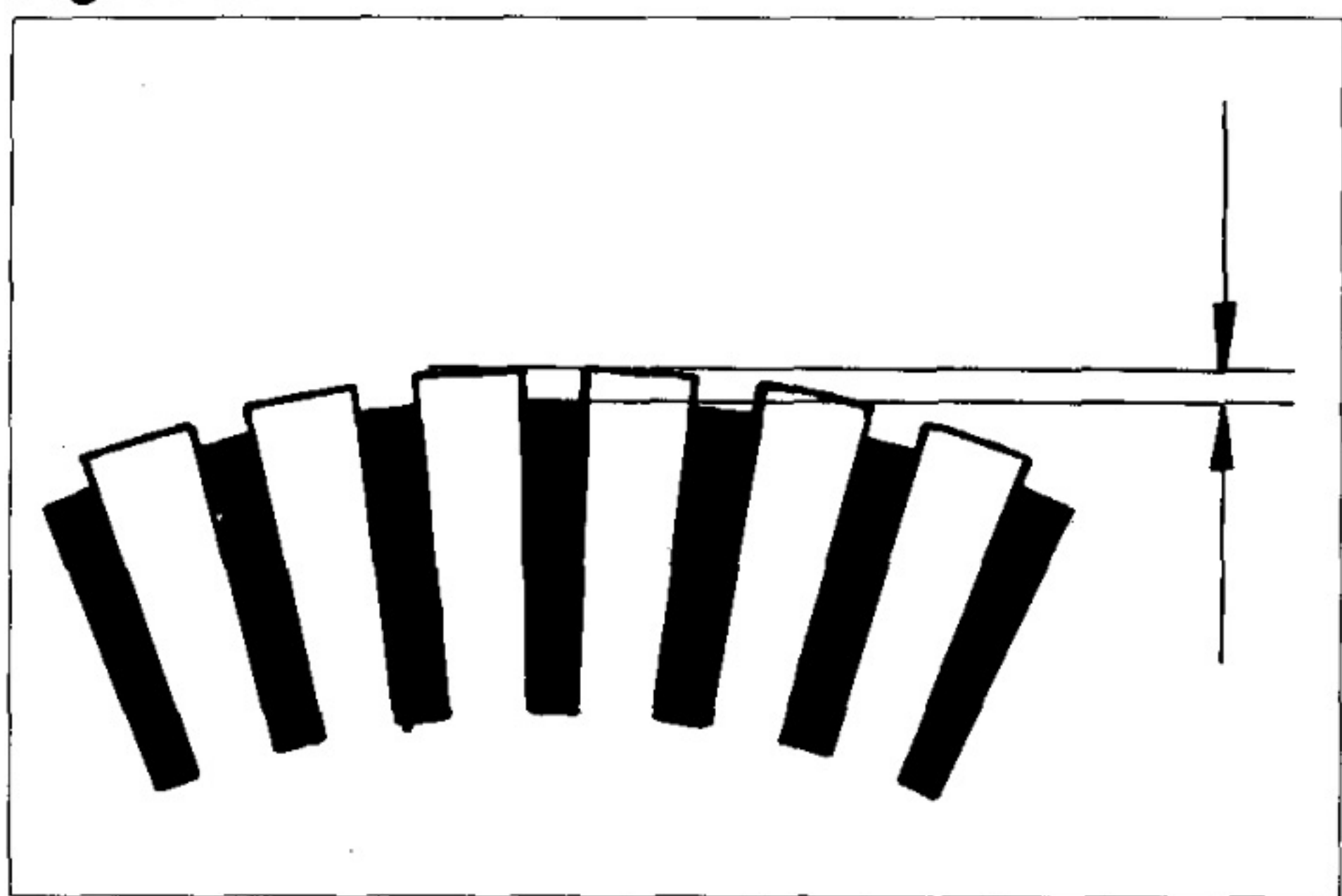
Wipe off dirt and grease from the disassembled parts.

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

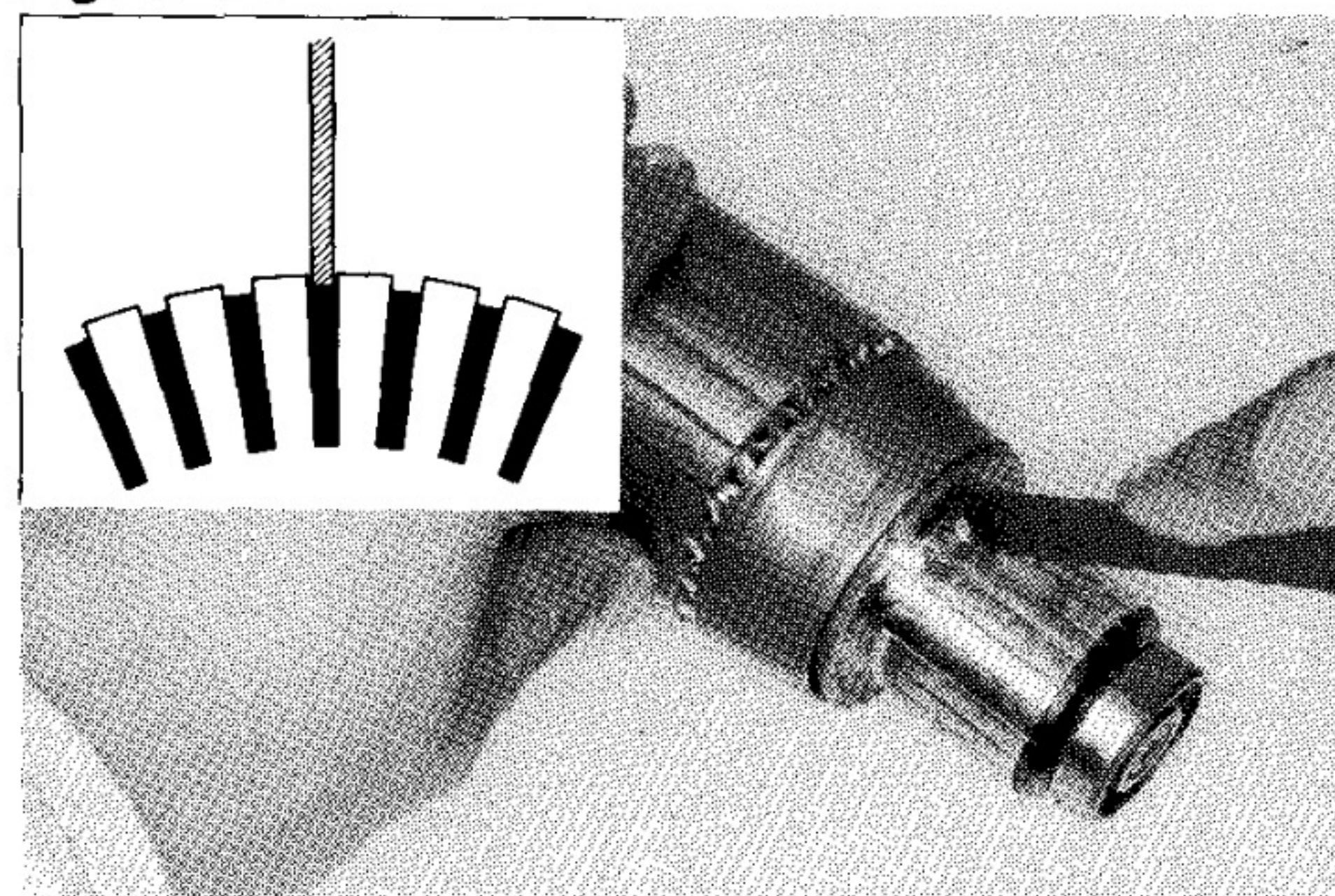


2. Depth of segment mica:

Mica depth:

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

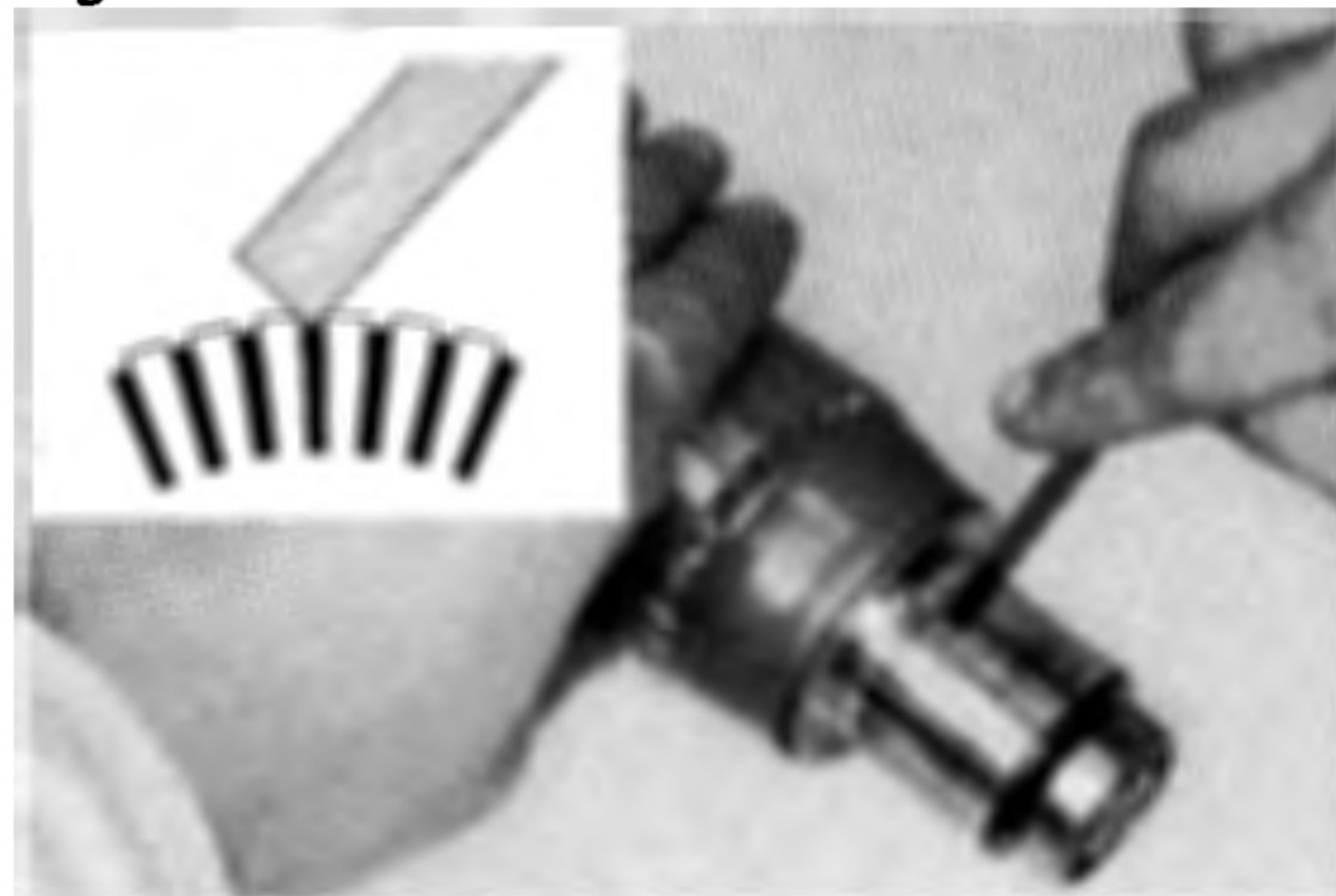
Fig. 8-34



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



Fig. 8-37

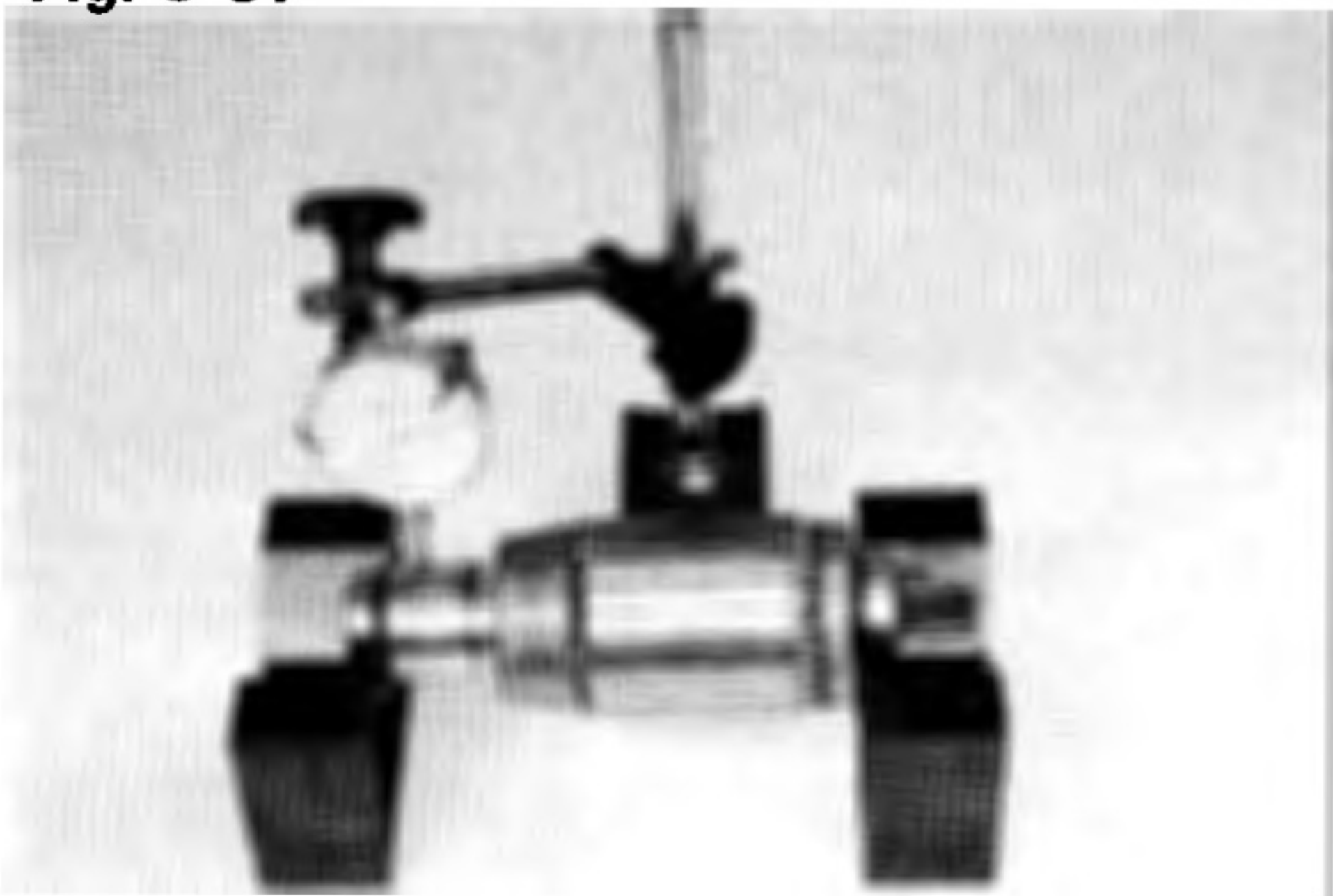
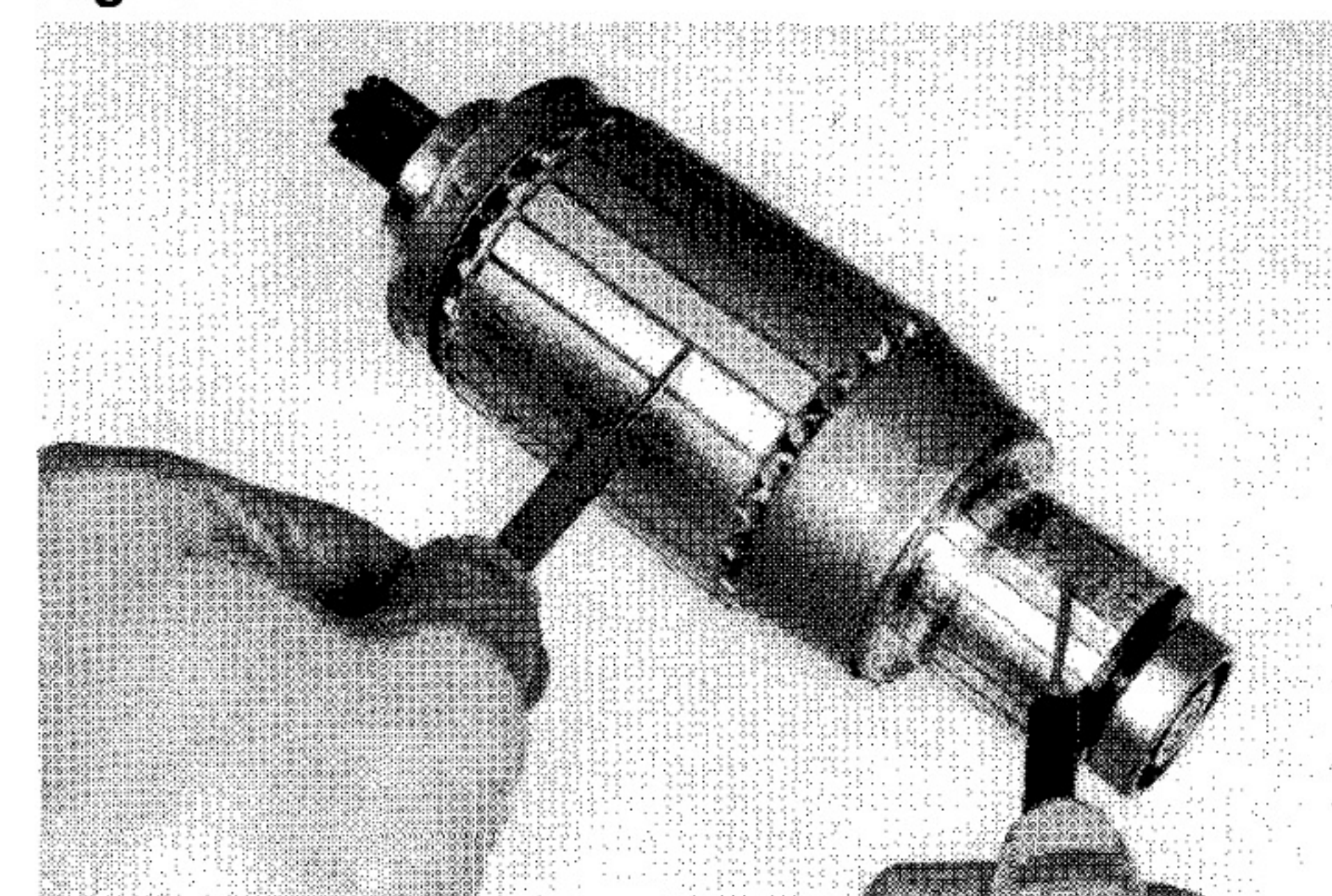


Fig. 8-38



Fig. 8-39



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



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.)**



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.)



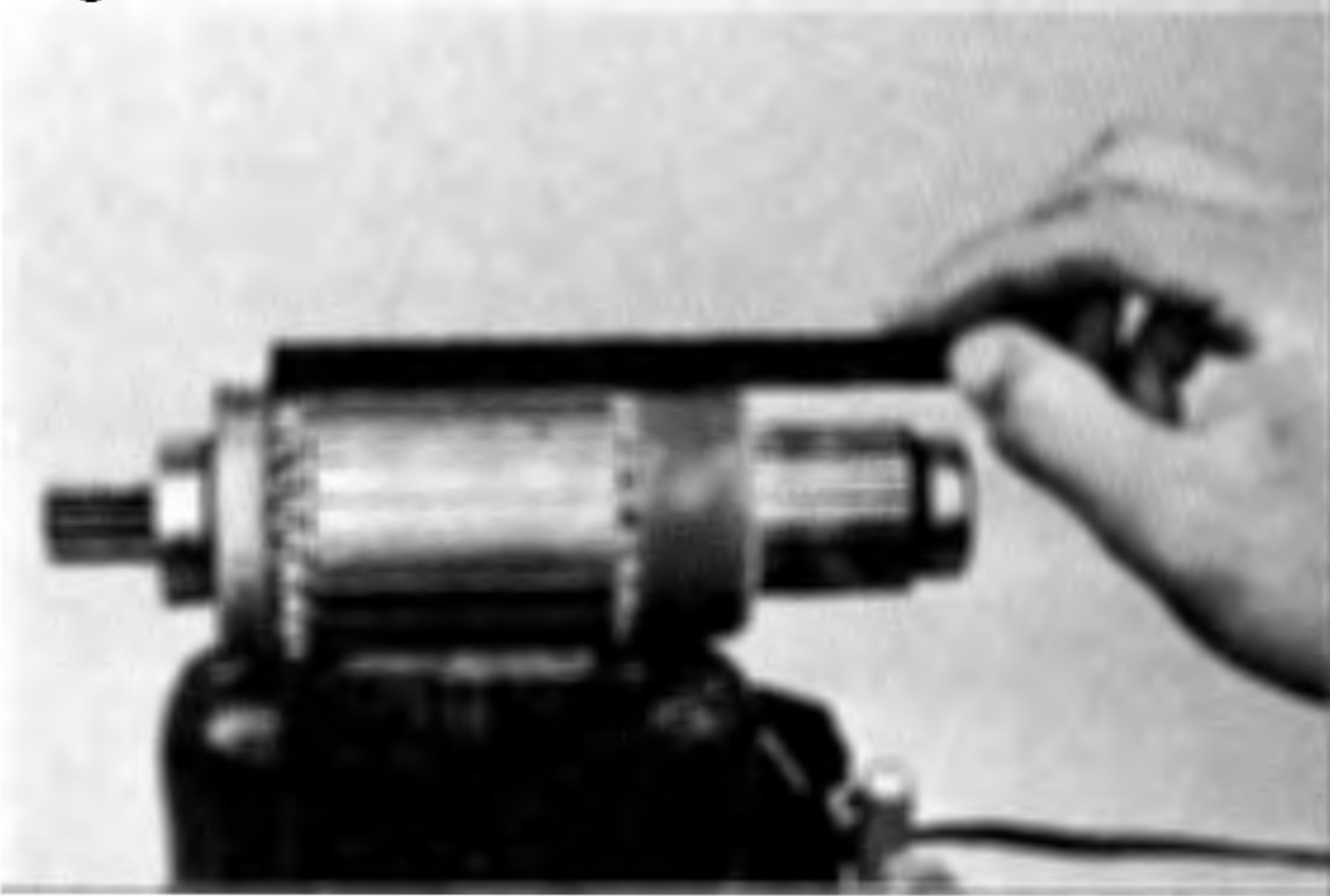
Armature Coil

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



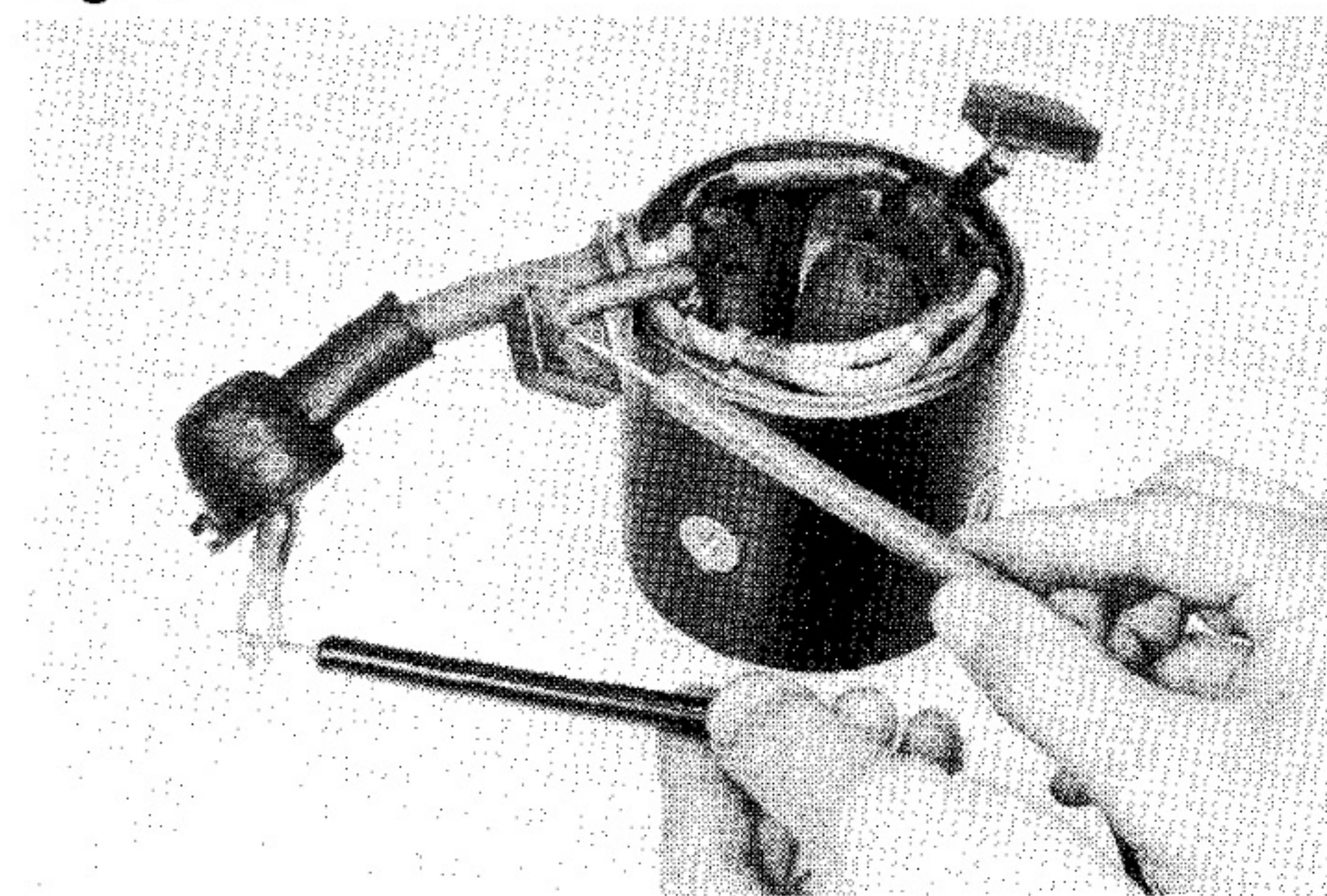
2. Short circuit test:
Place the armature on the armature tester and hold a hacksaw blade against the armature core while turning the armature. If the hacksaw blade is attracted or vibrates, the armature is shorted and must be replaced.

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.

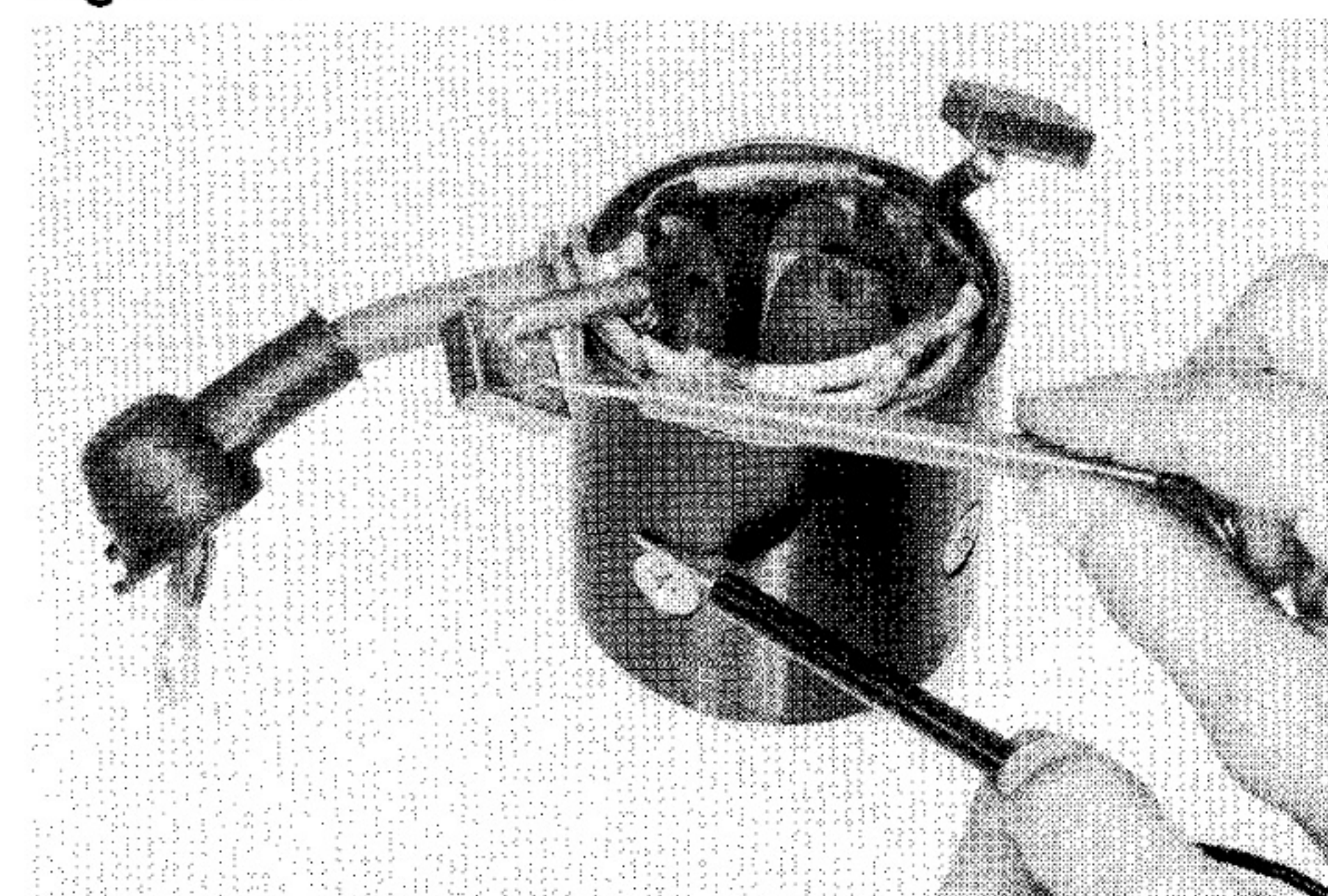
Fig. 8-42



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

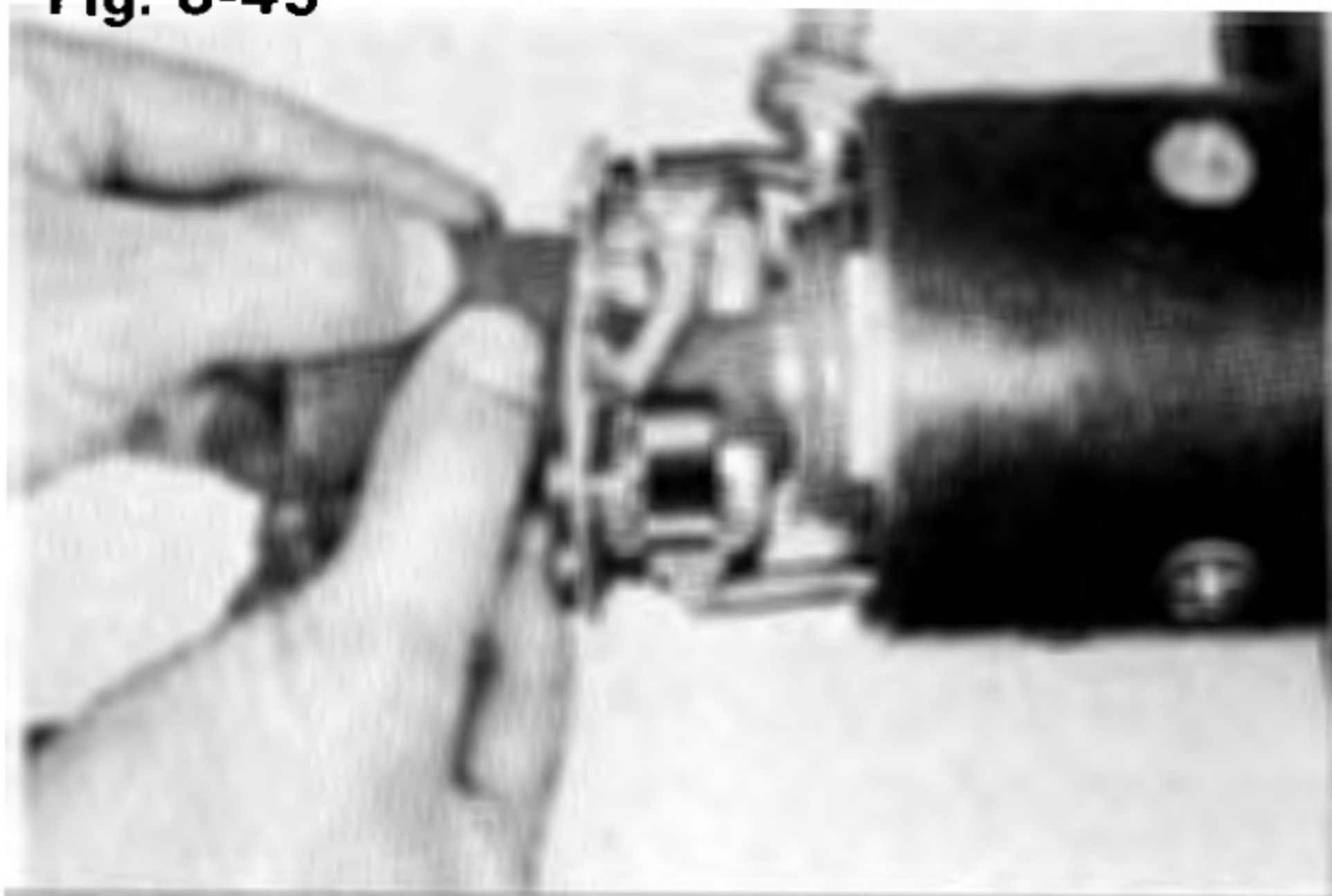
**Brush**

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

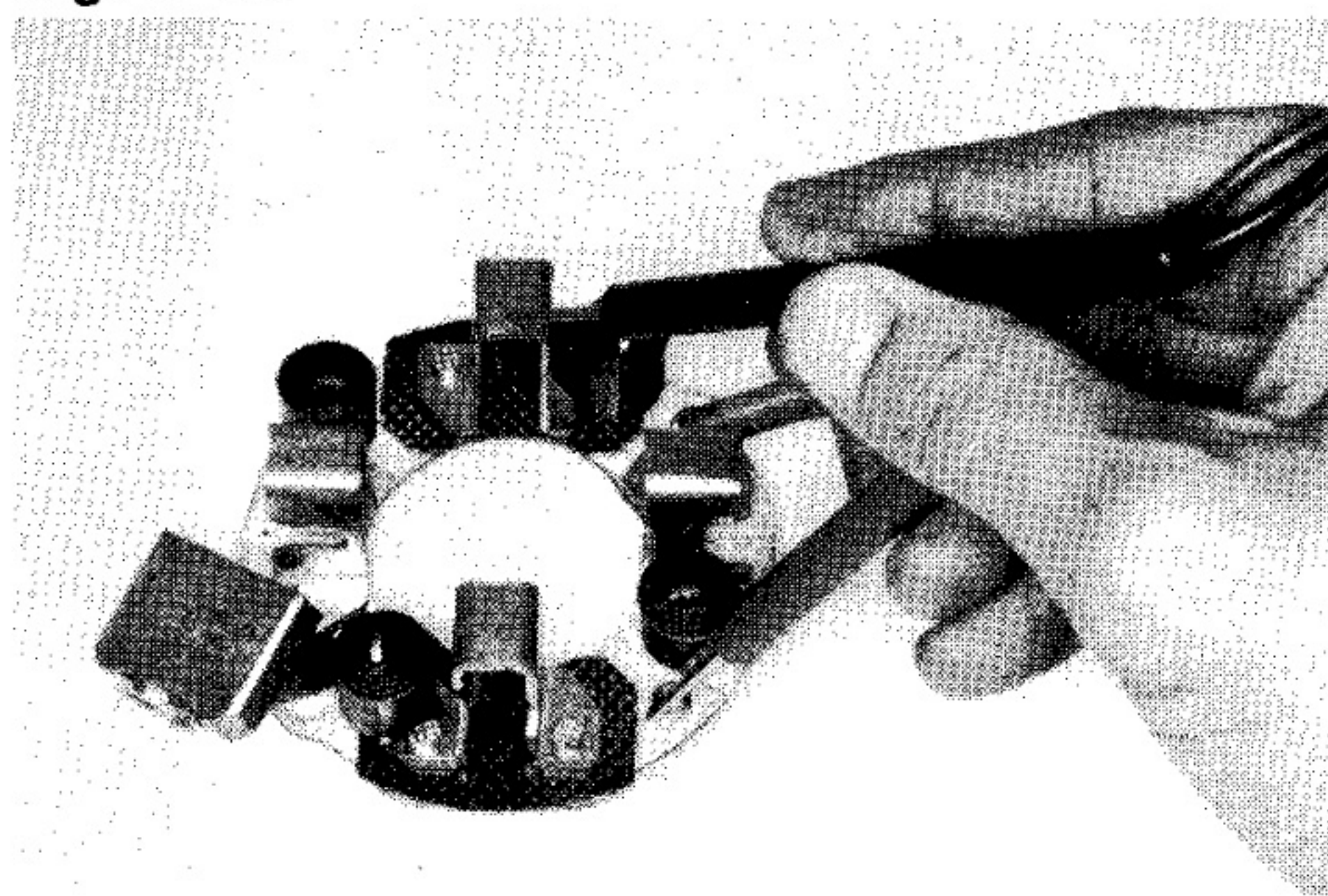


2. Using #400 sandpaper, clean and fit the brushes so they make proper contact with the commutator.

—Note—

Secure the armature gear in a vise or such.

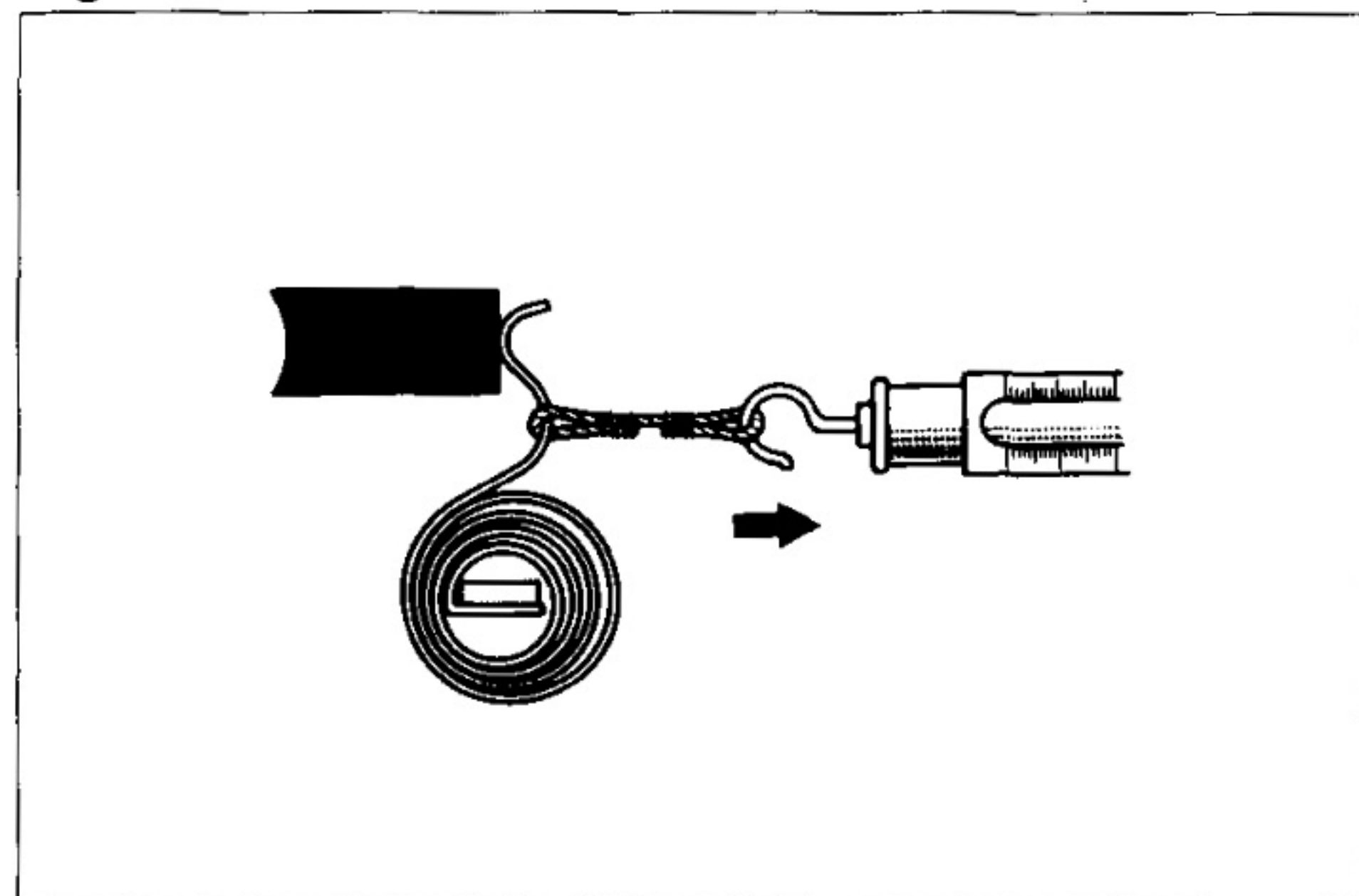
Fig. 8-46

**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

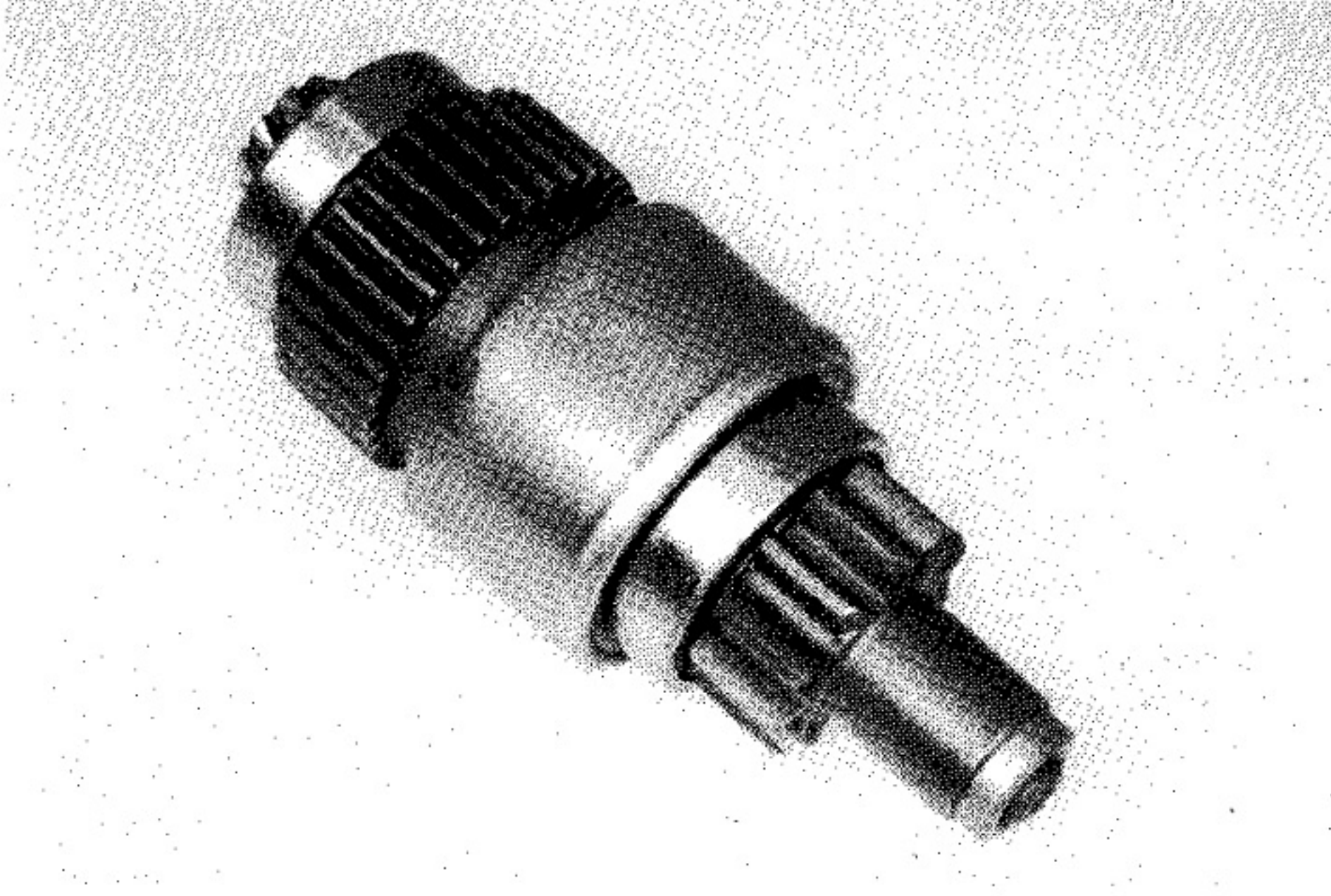


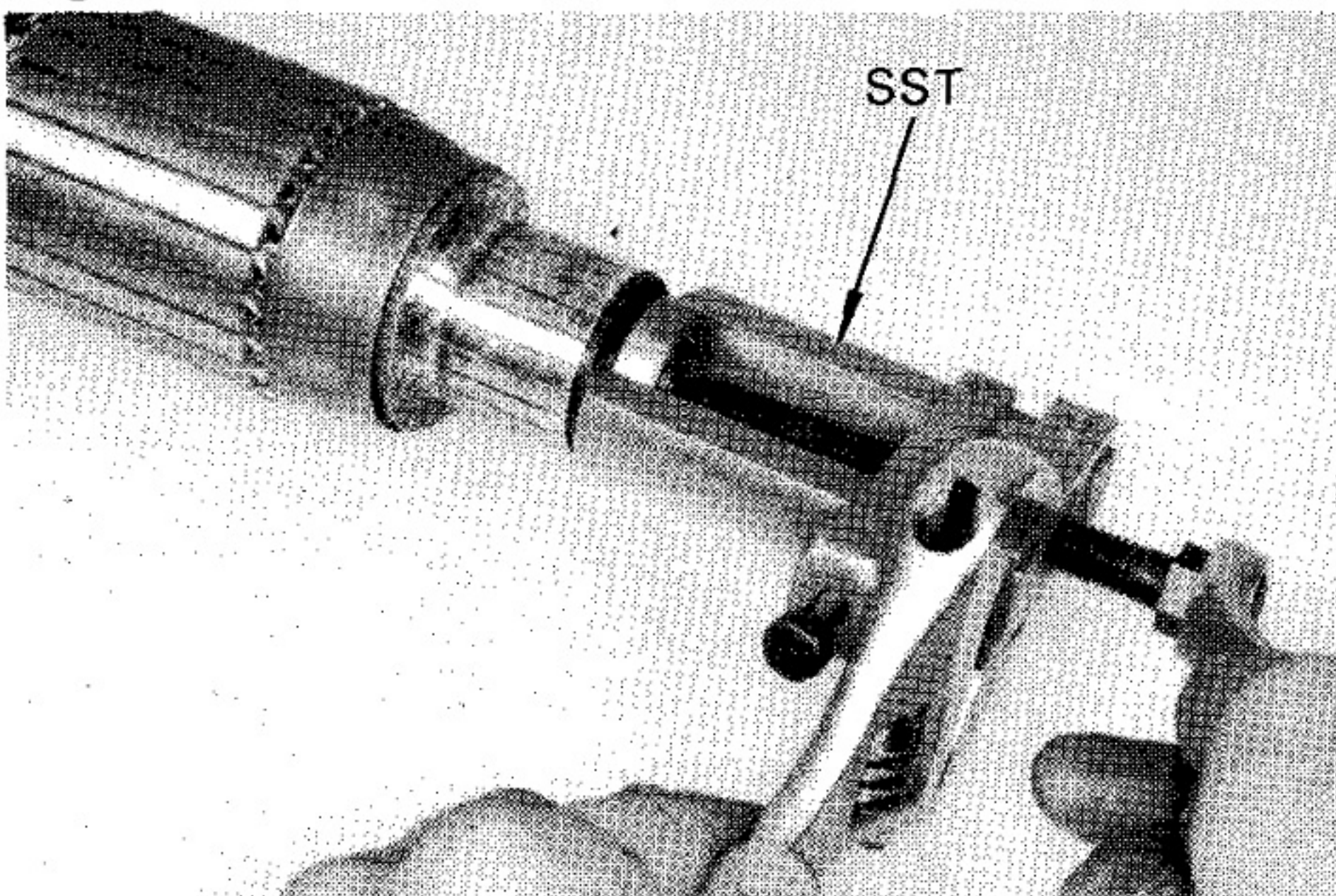
Fig. 8-49



Fig. 8-50



Fig. 8-51

**Clutch & Gear**

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

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

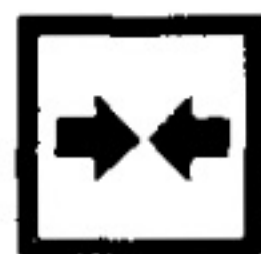
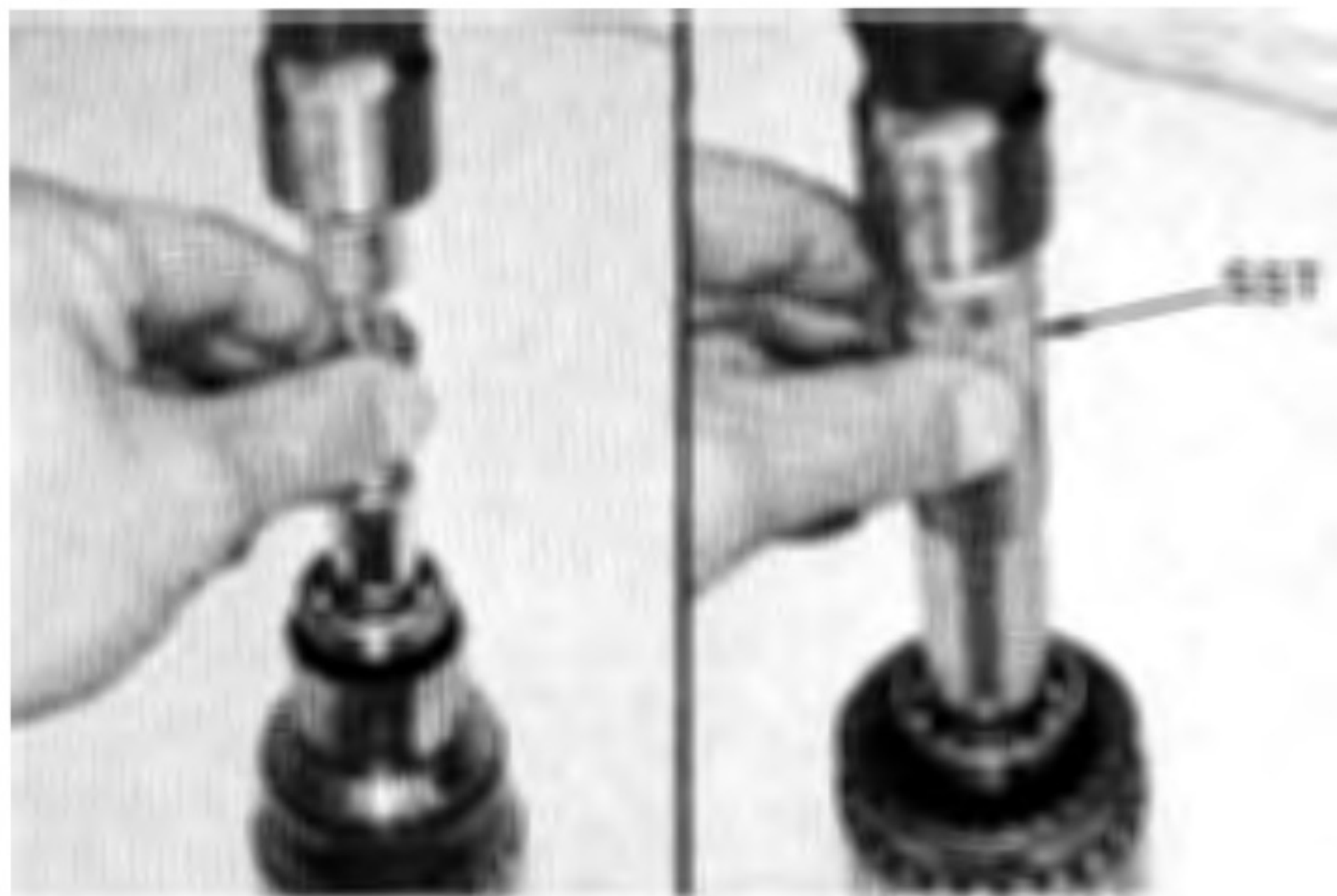
**Bearing**

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



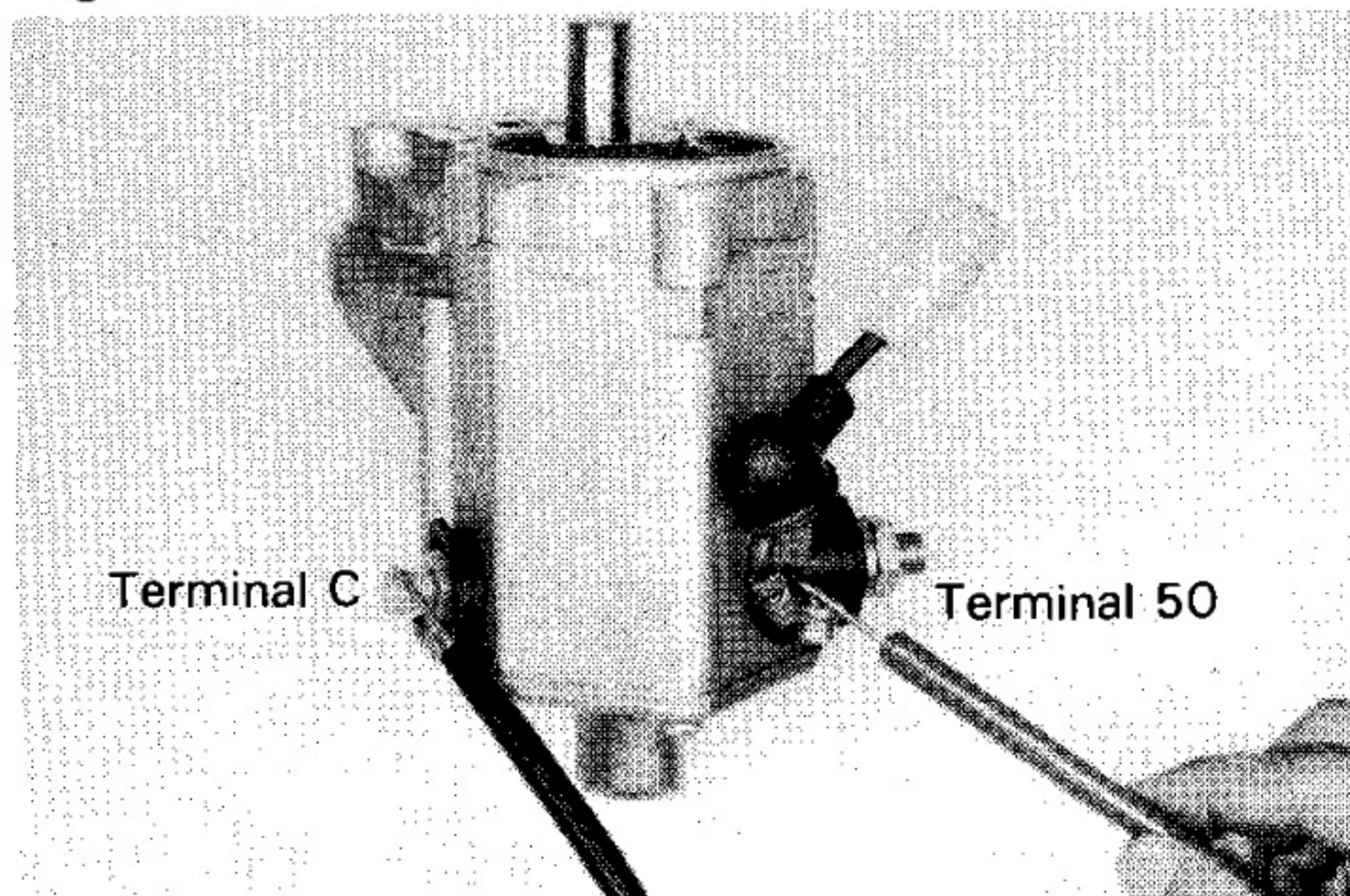
2. Replace the armature bearing if defective.
(1) Remove the bearing with SST.
SST [09286-46011]

Fig. 8-52



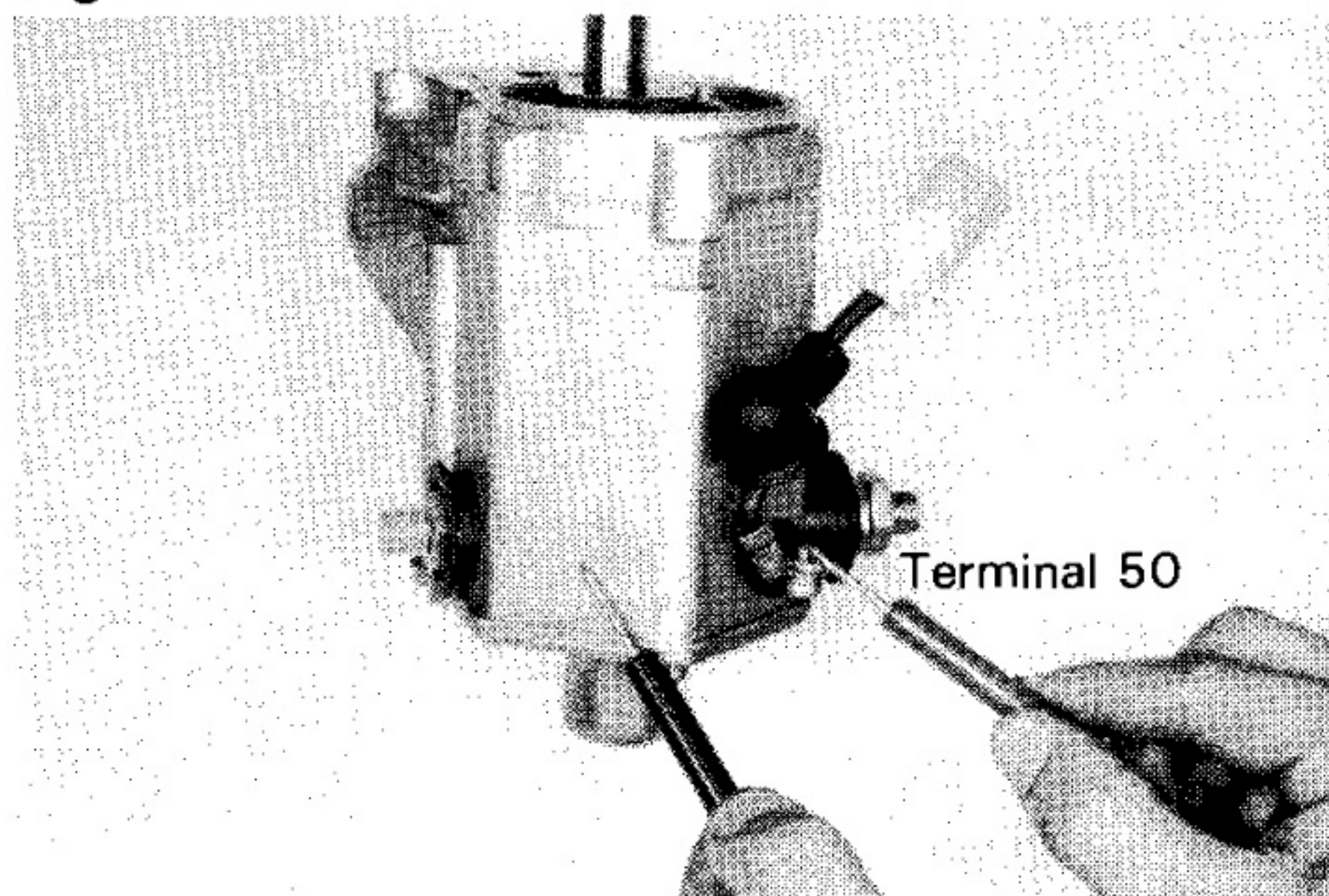
- (2) Replace the front bearing and drive in the rear bearing with SST.
SST [09285-76010]

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



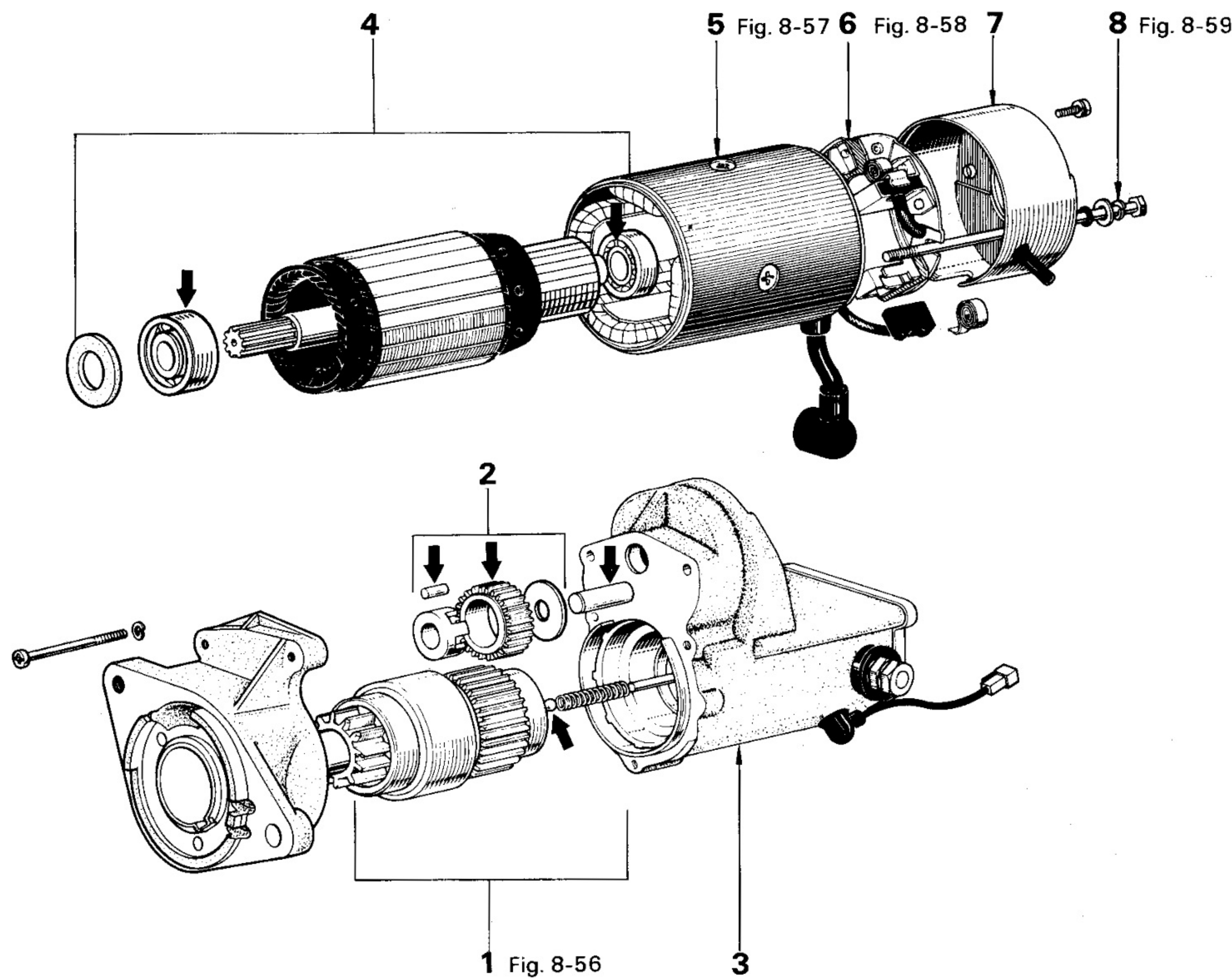
2. Hold-in coil open circuit test:
Check for continuity between the terminal 50 and magnetic switch body.

ASSEMBLY

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

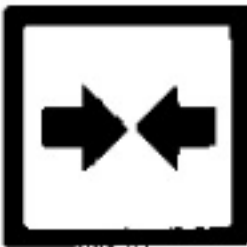
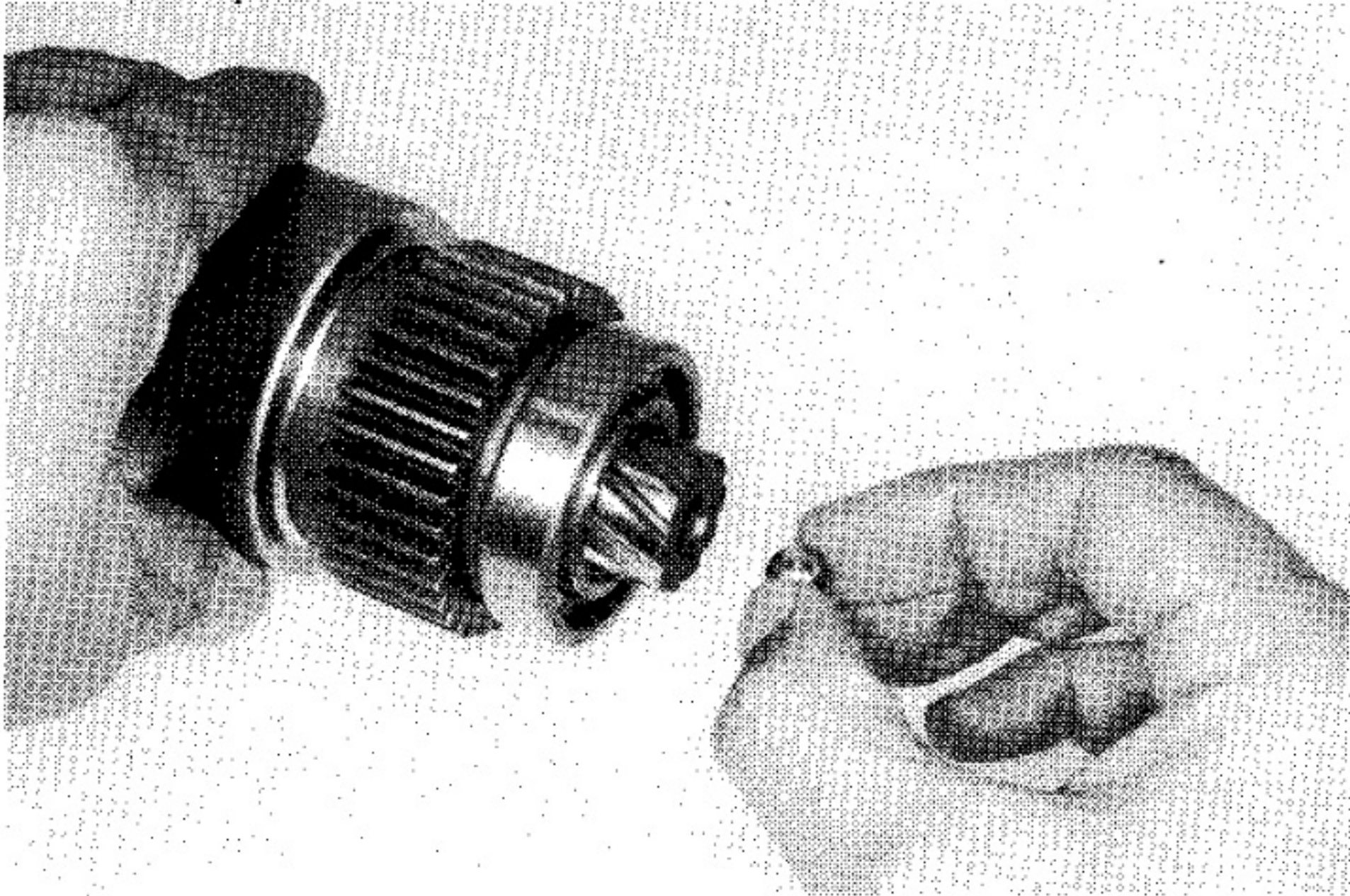
Fig. 8-55

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



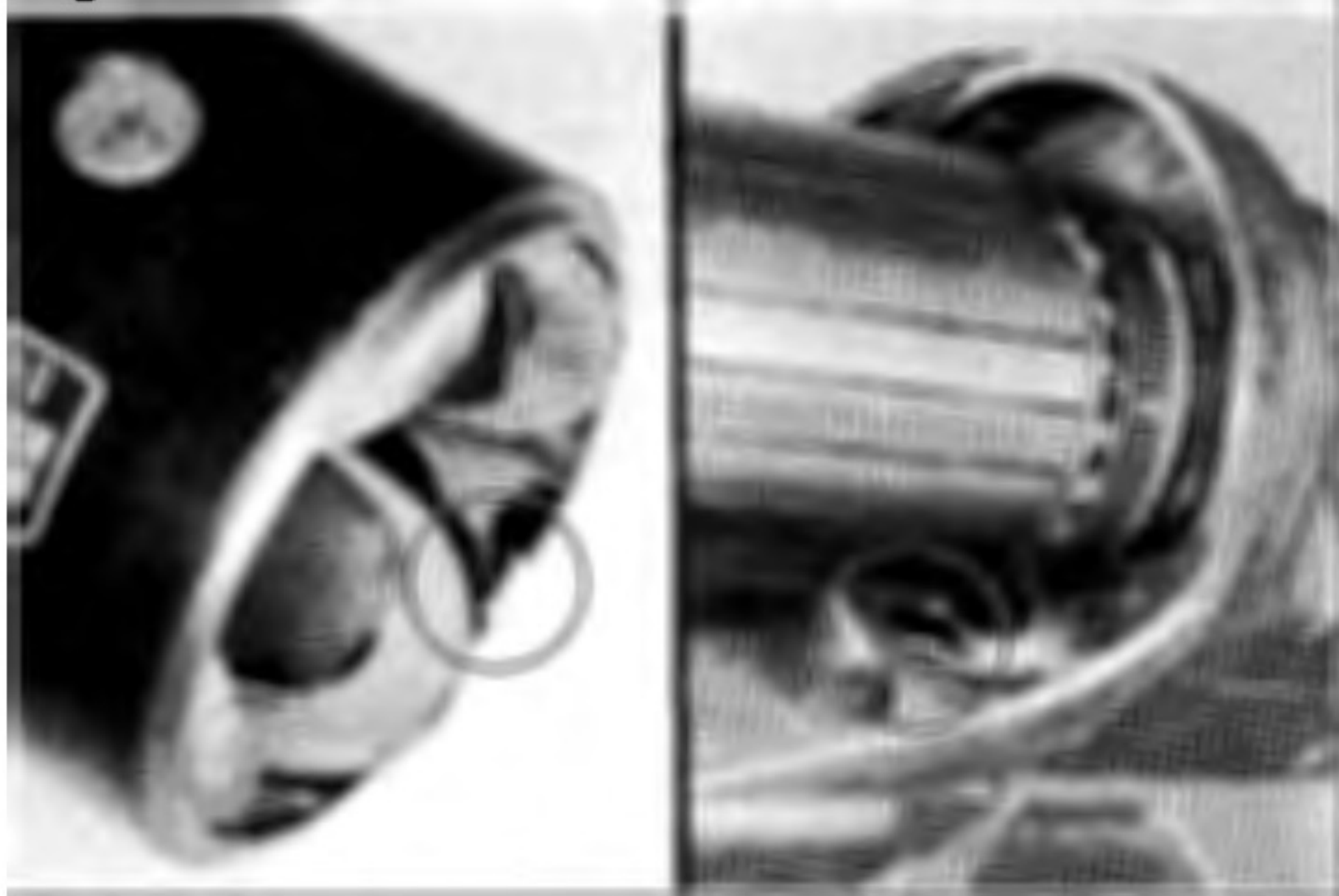
- | | |
|--------------------------------|-----------------|
| 1. Clutch, Spring & Steel Ball | 5. Yoke |
| 2. Pinion, Roller & Retainer | 6. Brush Holder |
| 3. Magnetic Switch | 7. End Frame |
| 4. Armature | 8. Through Bolt |

Fig. 8-56



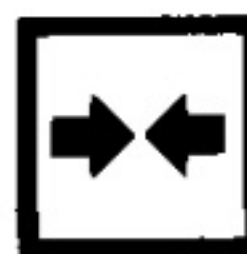
Apply grease and insert the ball into the clutch shaft hole.

Fig. 8-57



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

Fig. 8-58

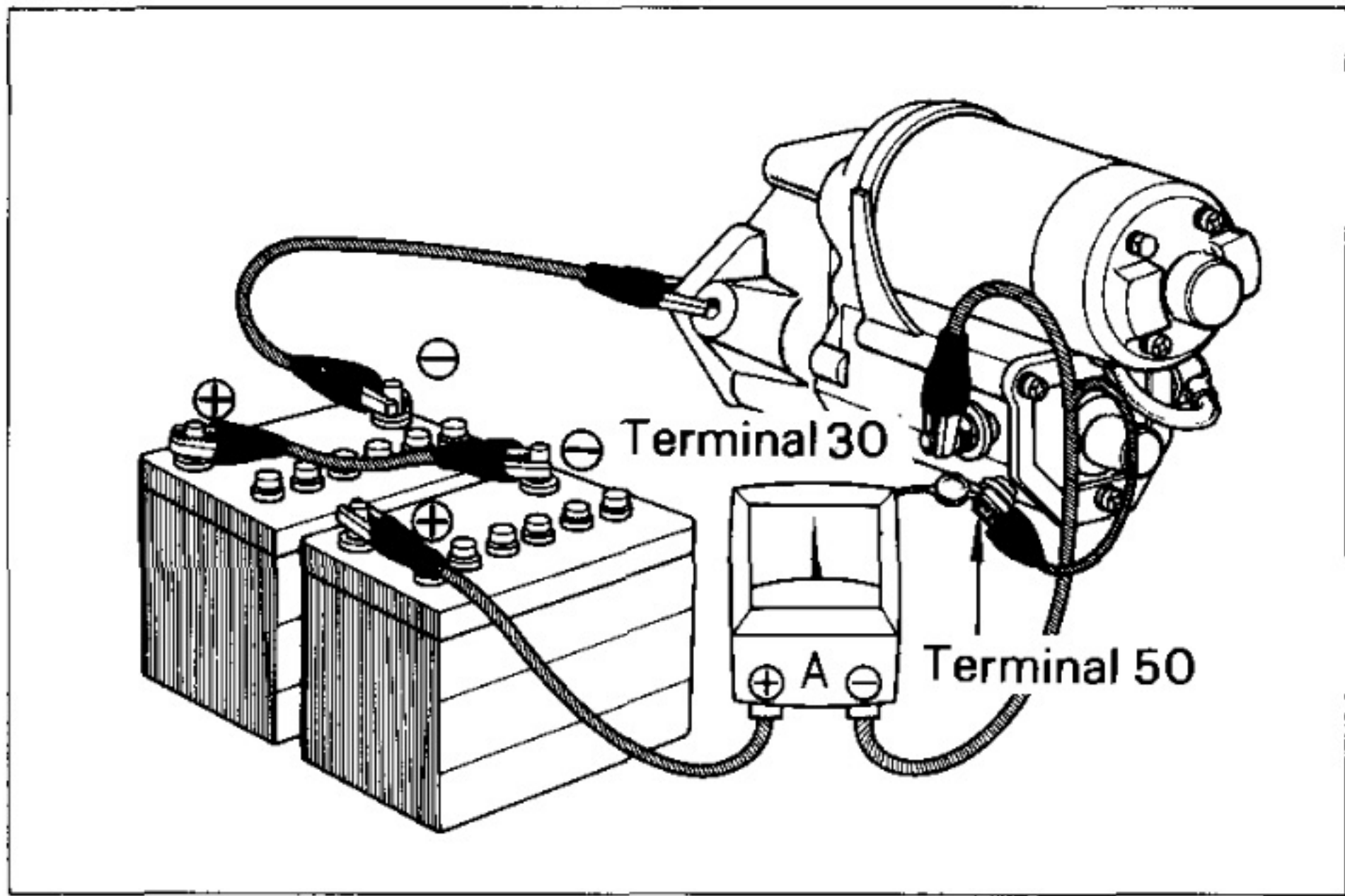


Assemble the brush holder.

—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

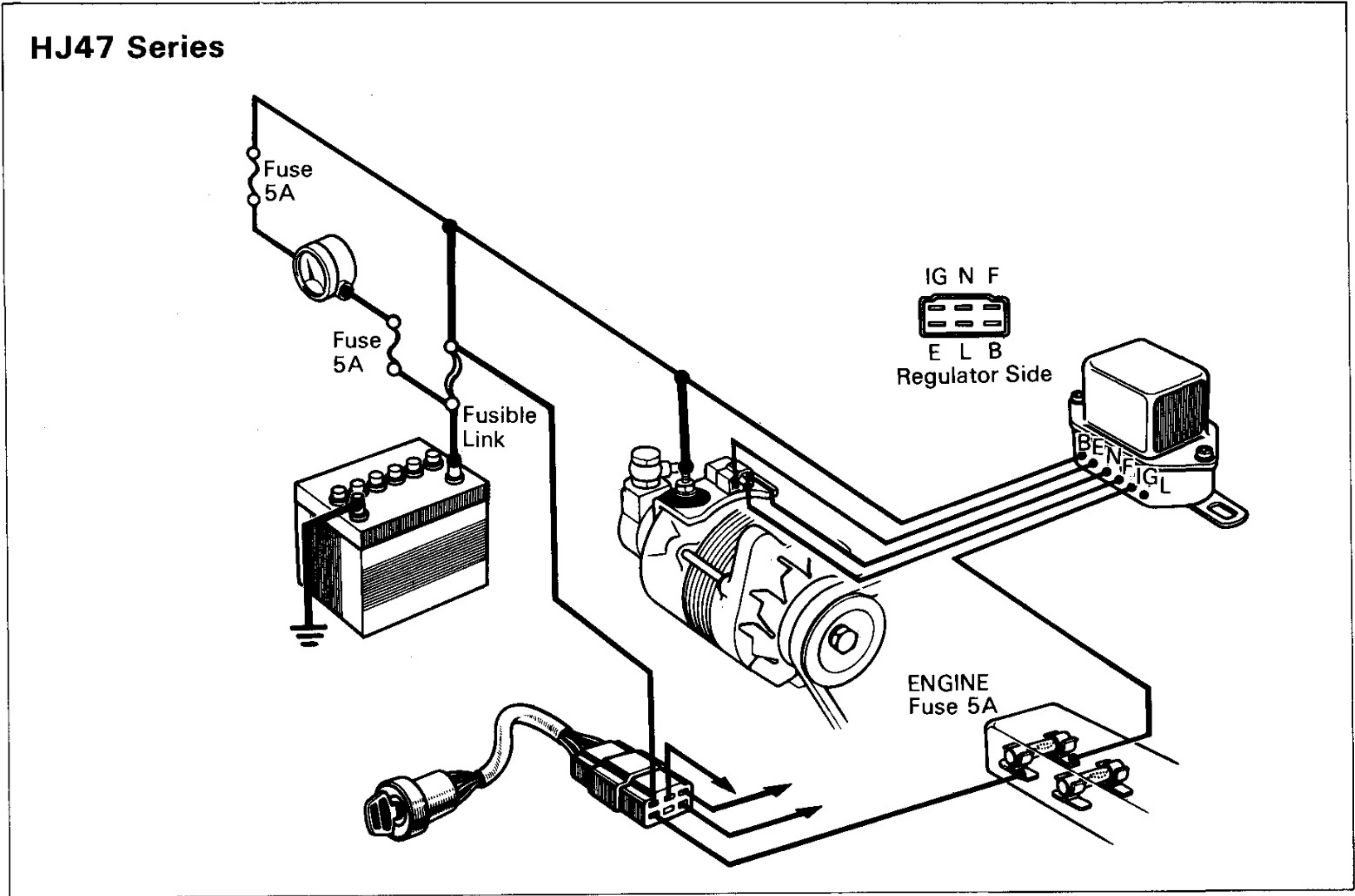


Fig. 9-2

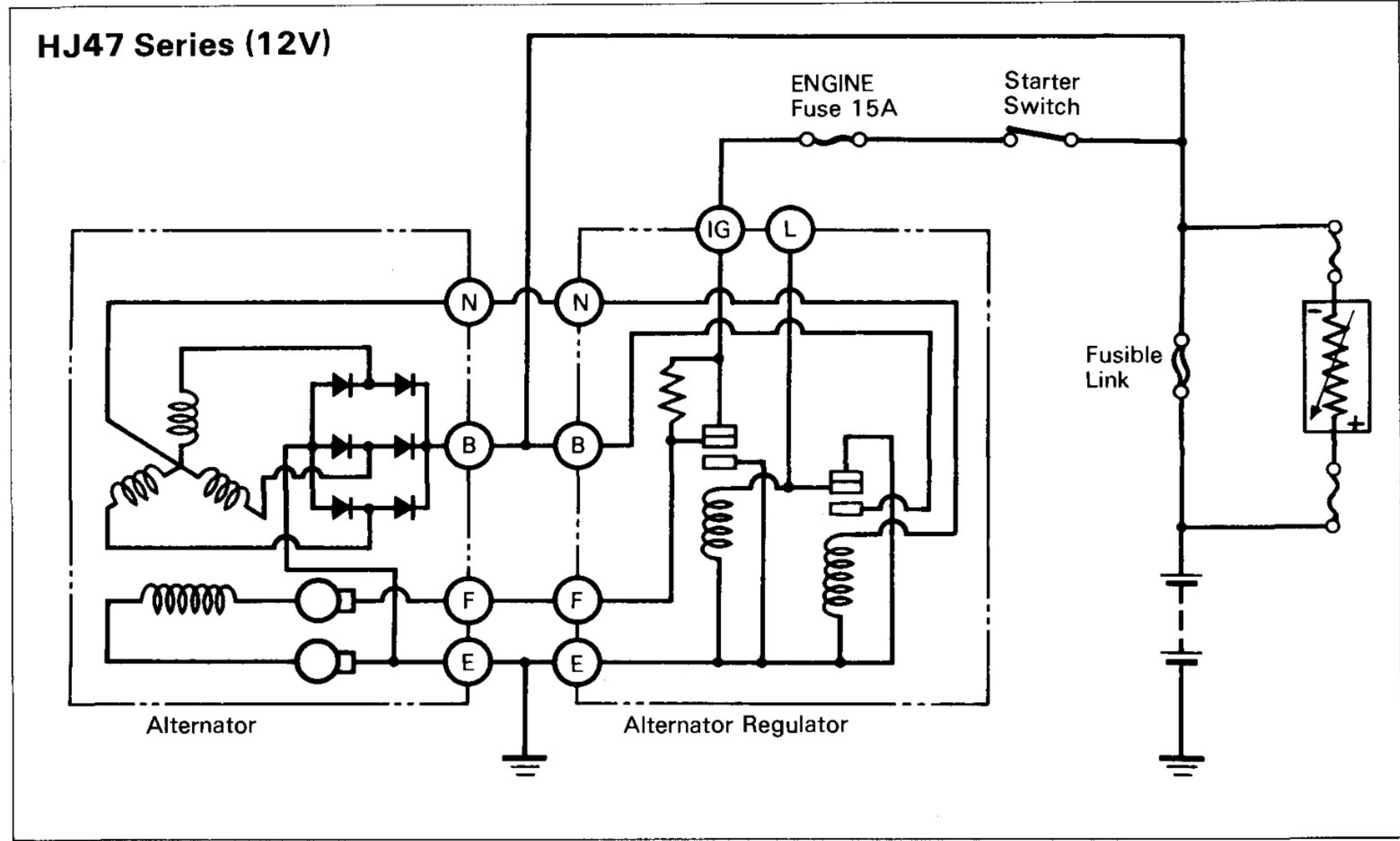


Fig. 9-3

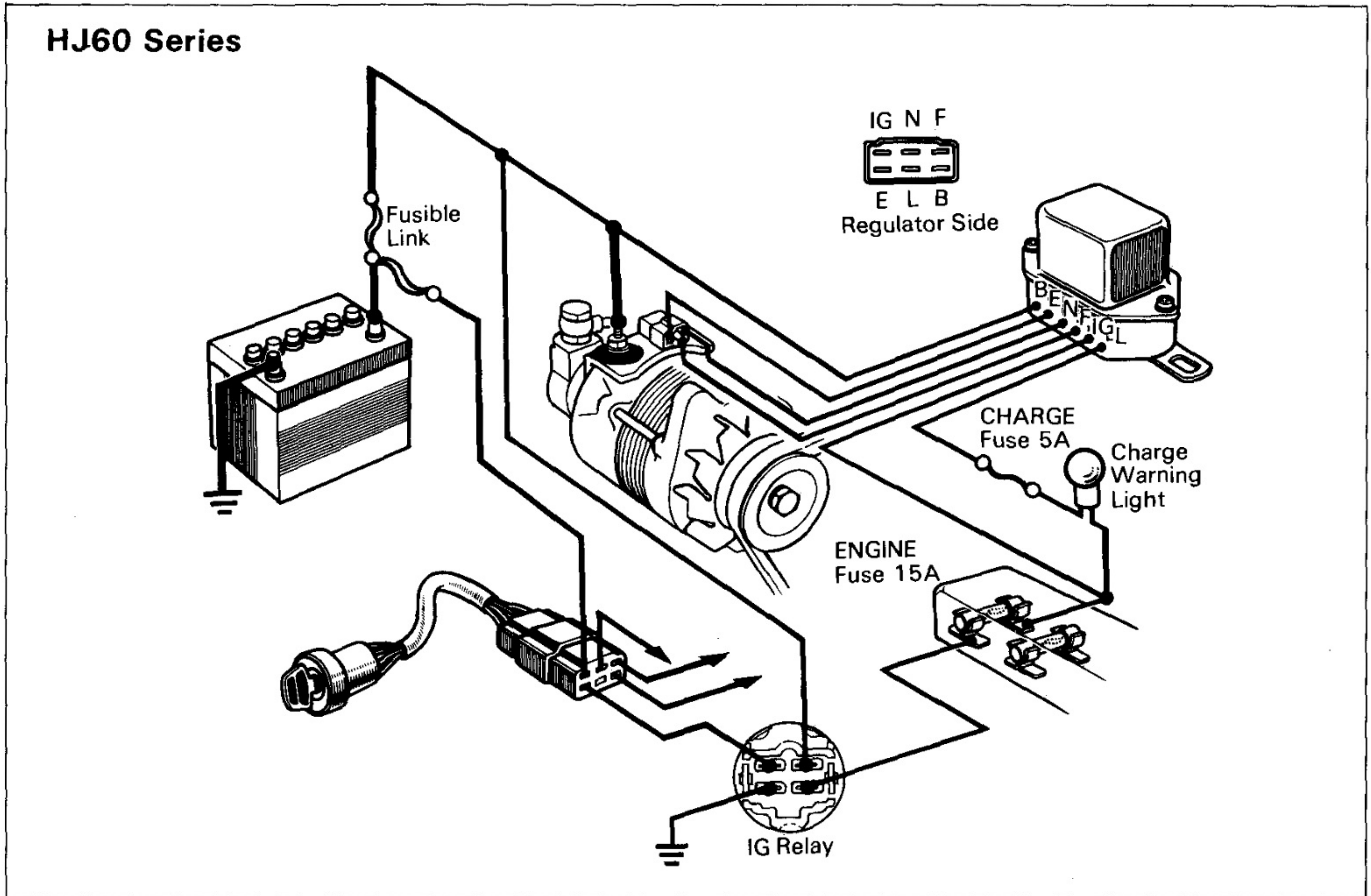


Fig. 9-4

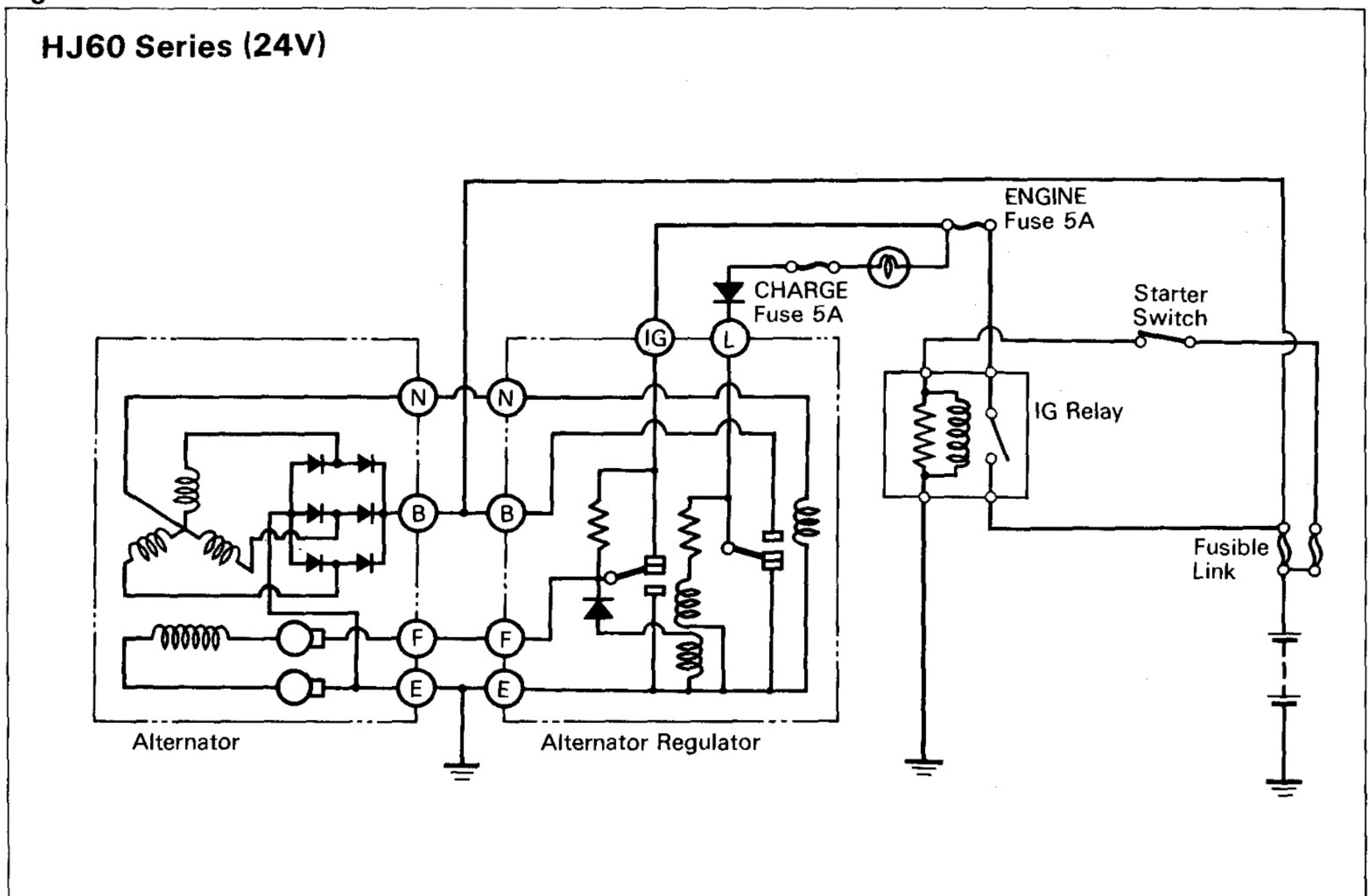
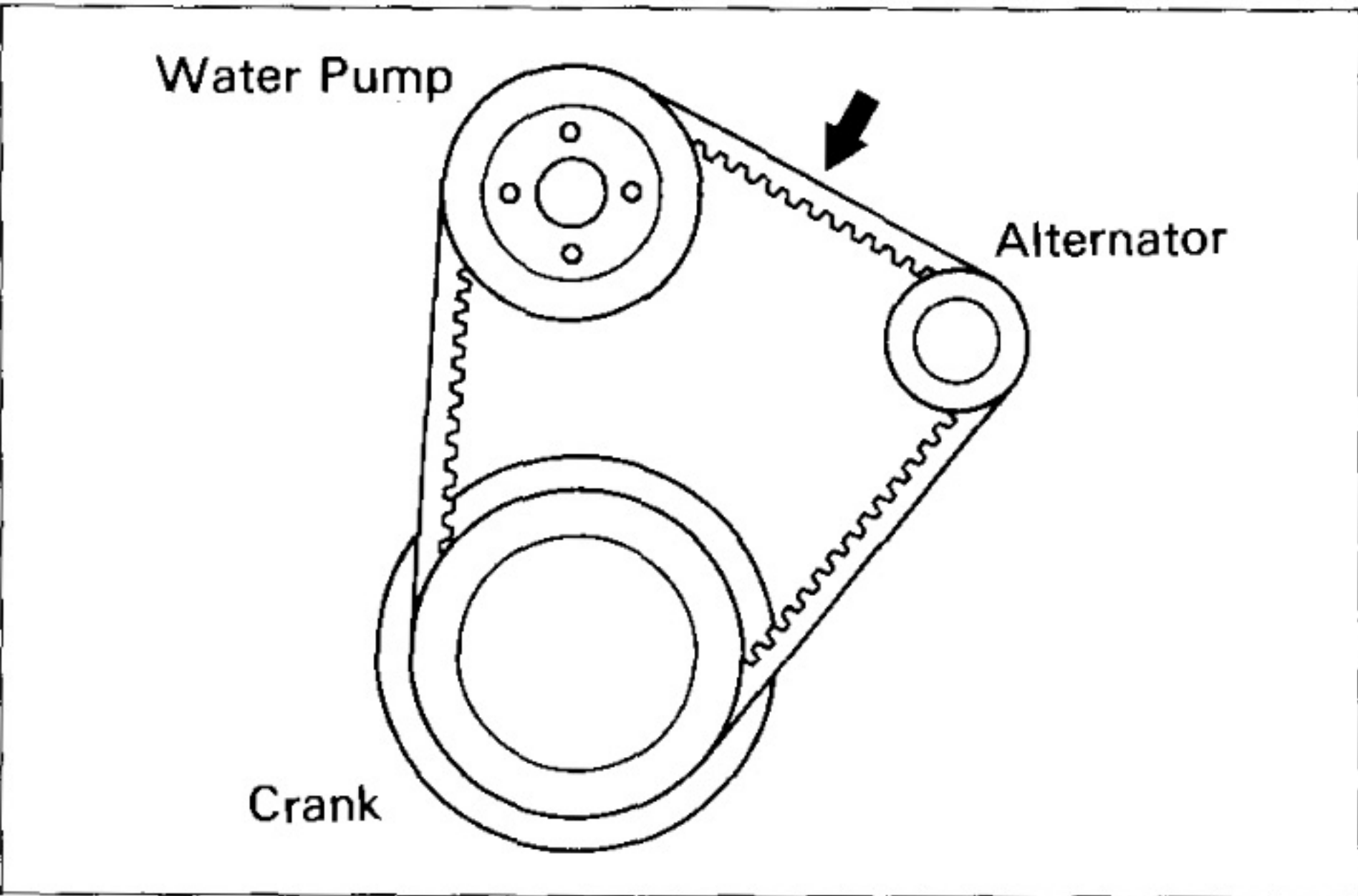


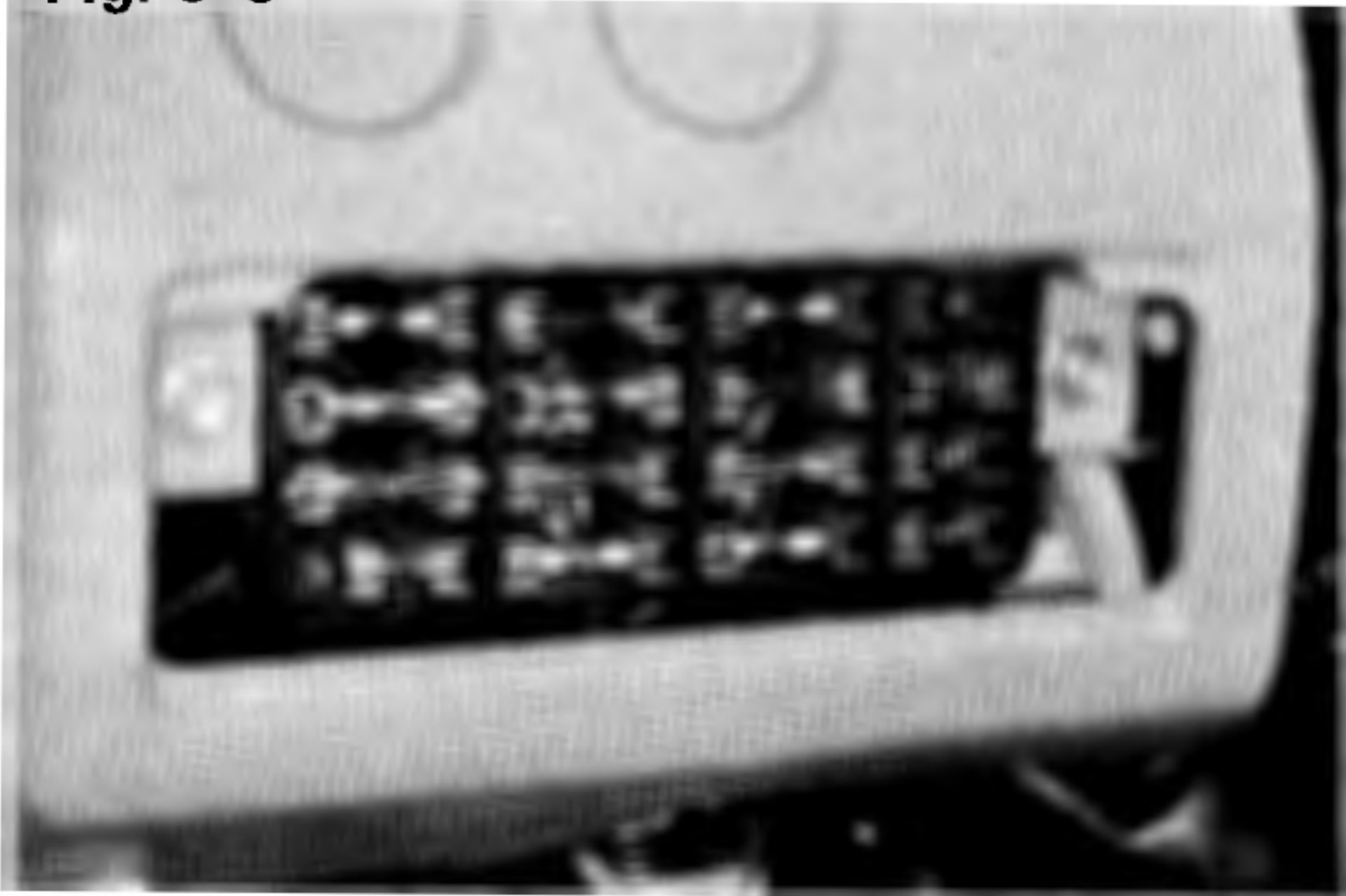
Fig. 9-5



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



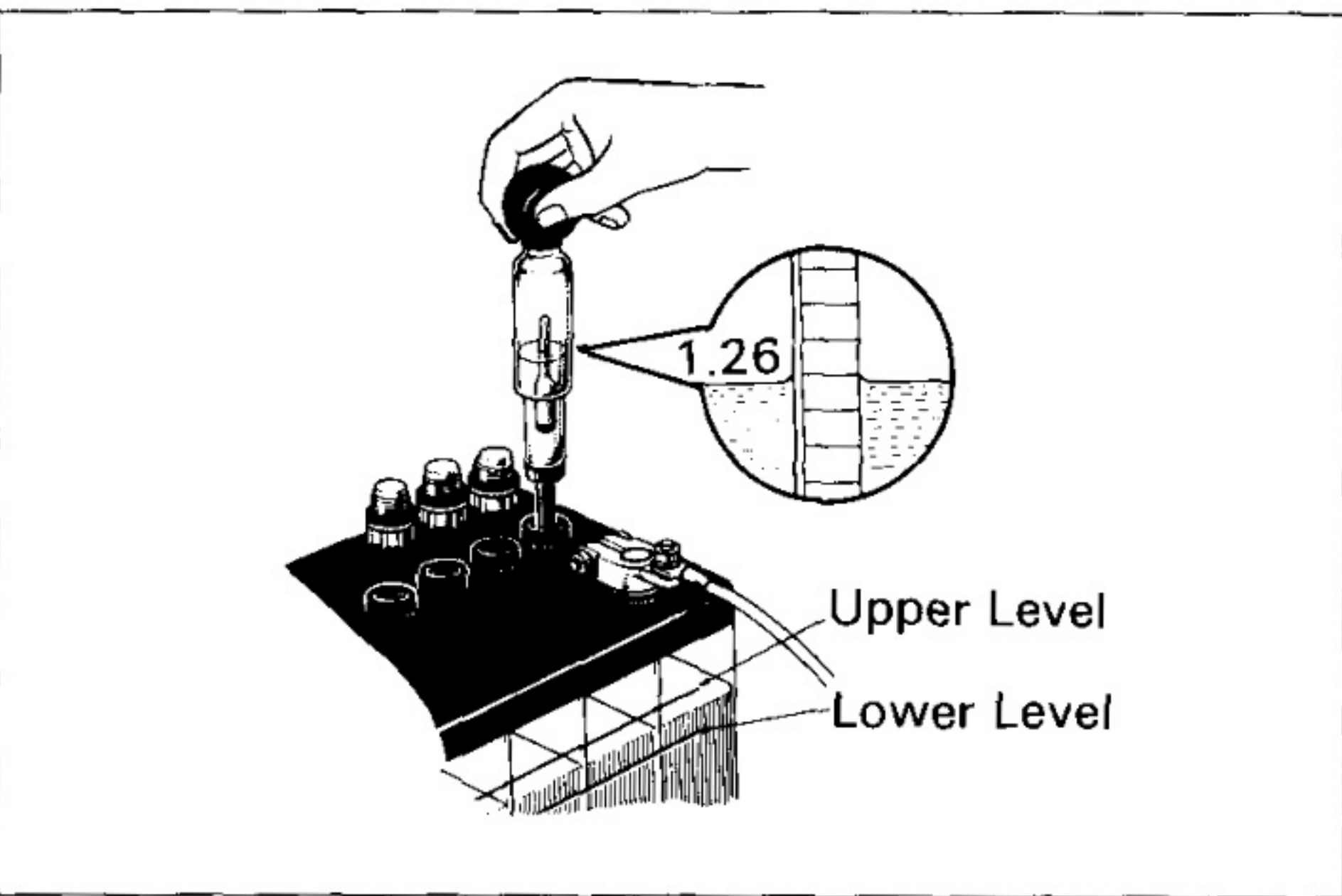
- 2. Fuses

Fig. 9-7



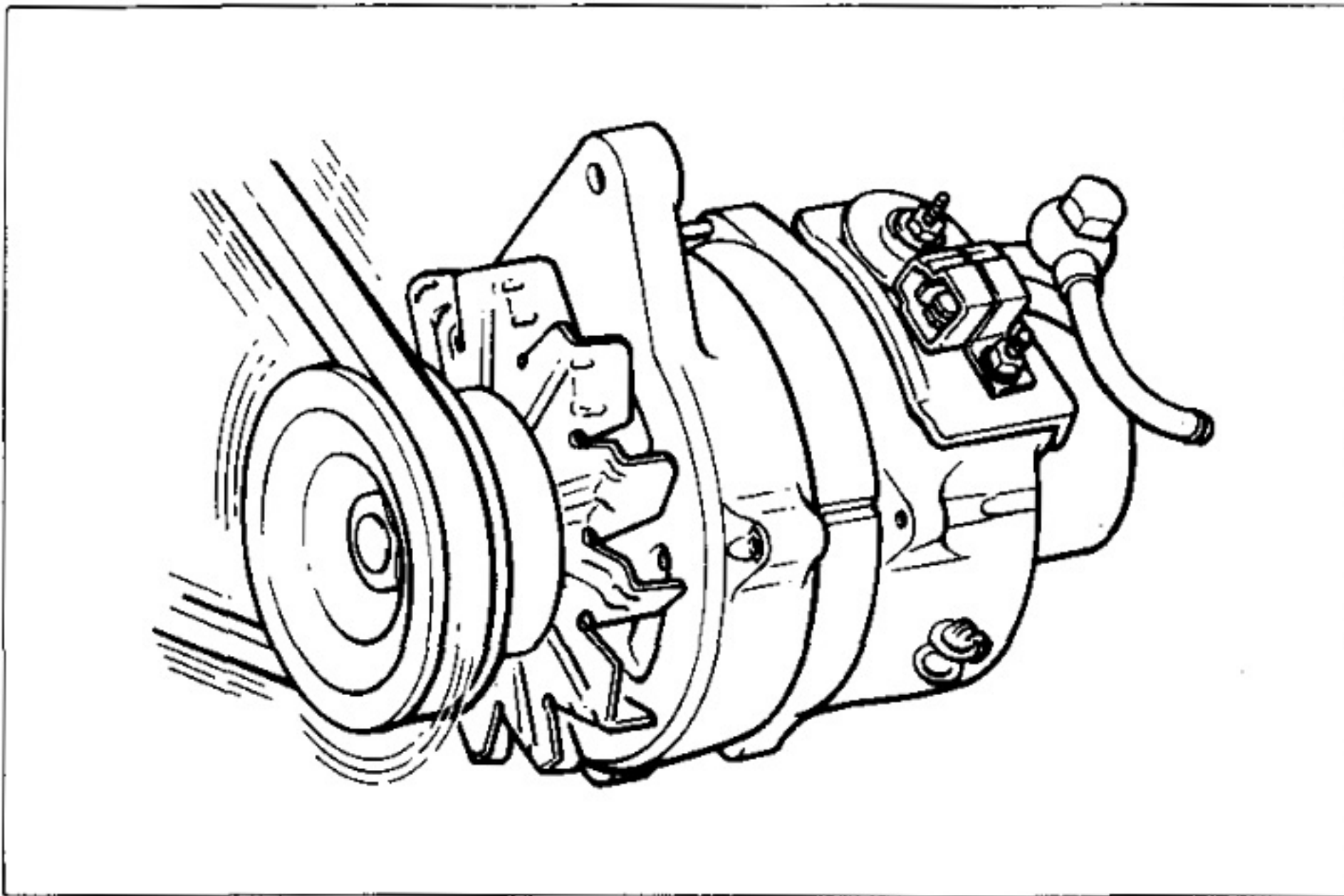
- 3. Installed condition of wiring for alternator and regulator.

Fig. 9-8



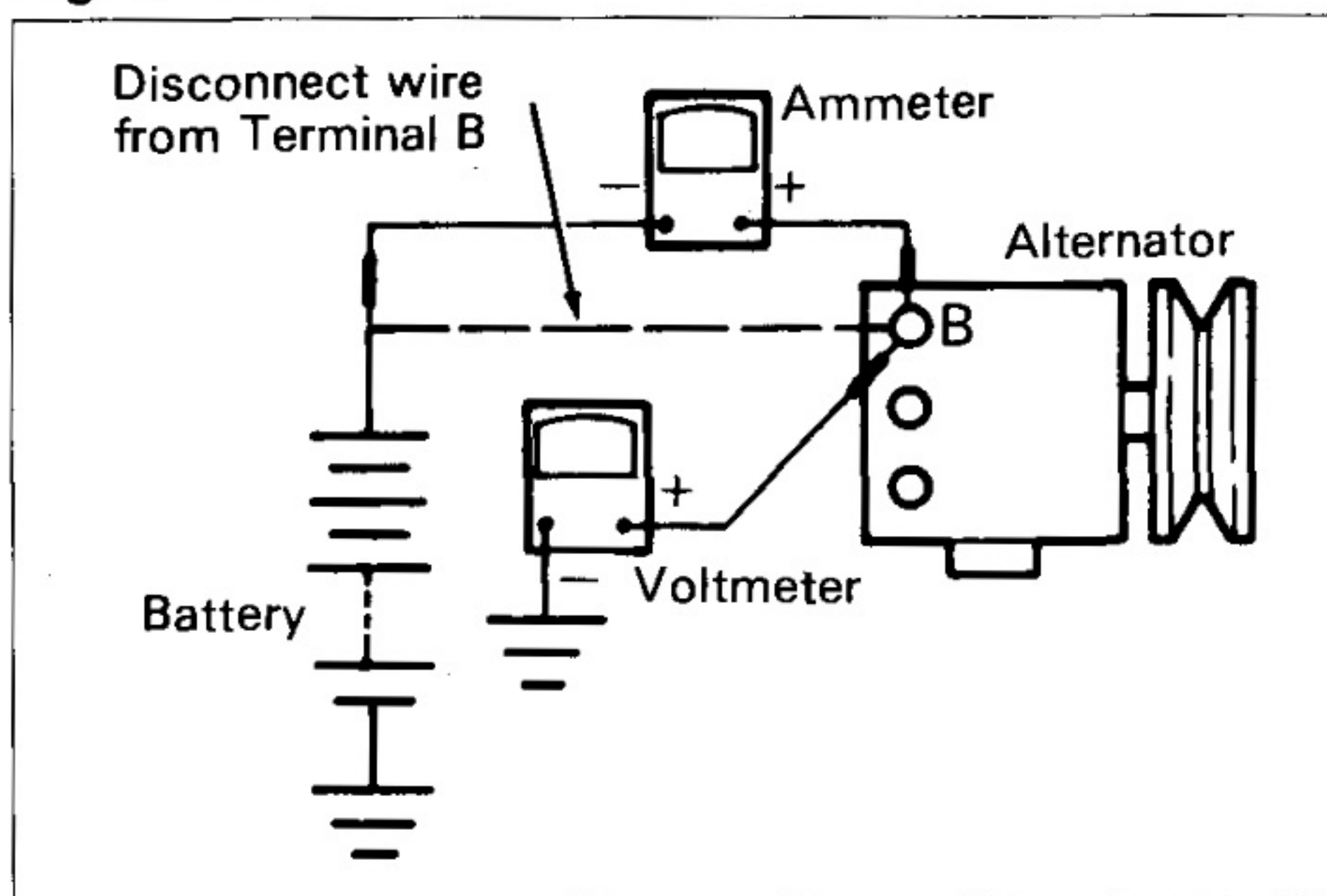
- 4. Battery terminal and fusible link.
 Loose
 Corroded
 Burnt
 Specific gravity: 1.25 – 1.27 at 20°C
 (68°F)

Fig. 9-9



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

Fig. 9-10



PERFORMANCE TEST BY VOLTMETER & AMMETER

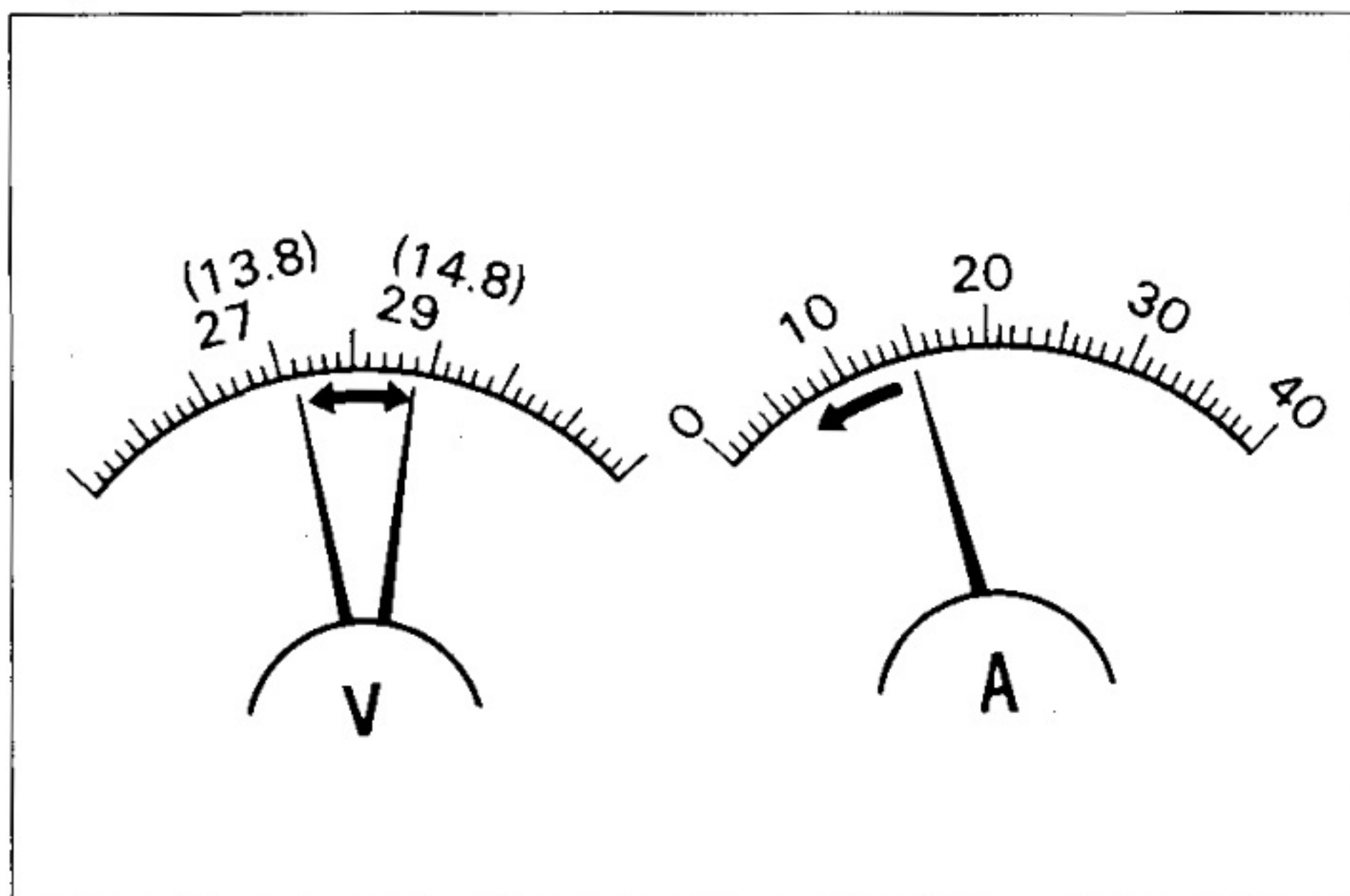
Connect the voltmeter and ammeter as follows.

- 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:

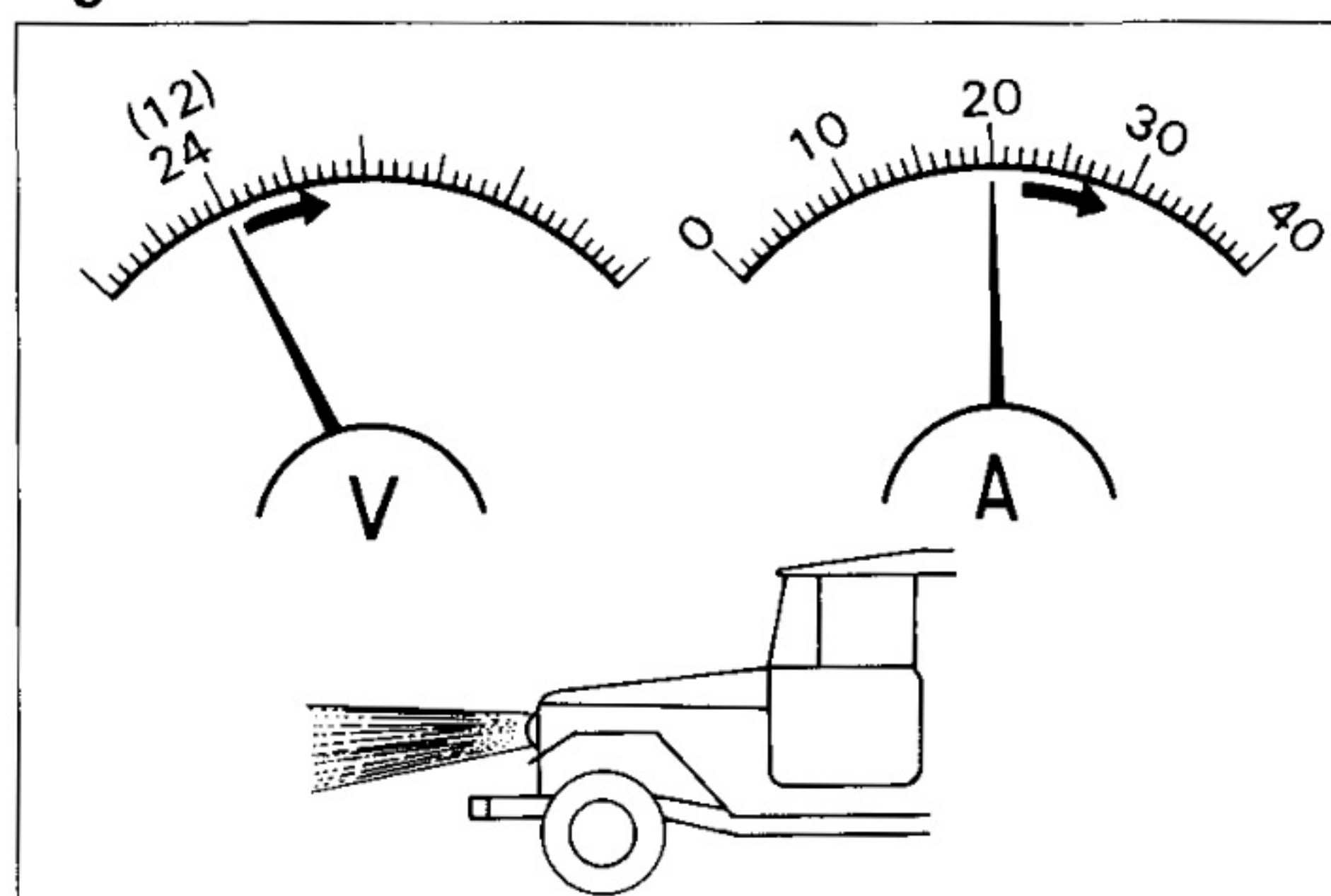
12V type 13.8 – 14.8V

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.

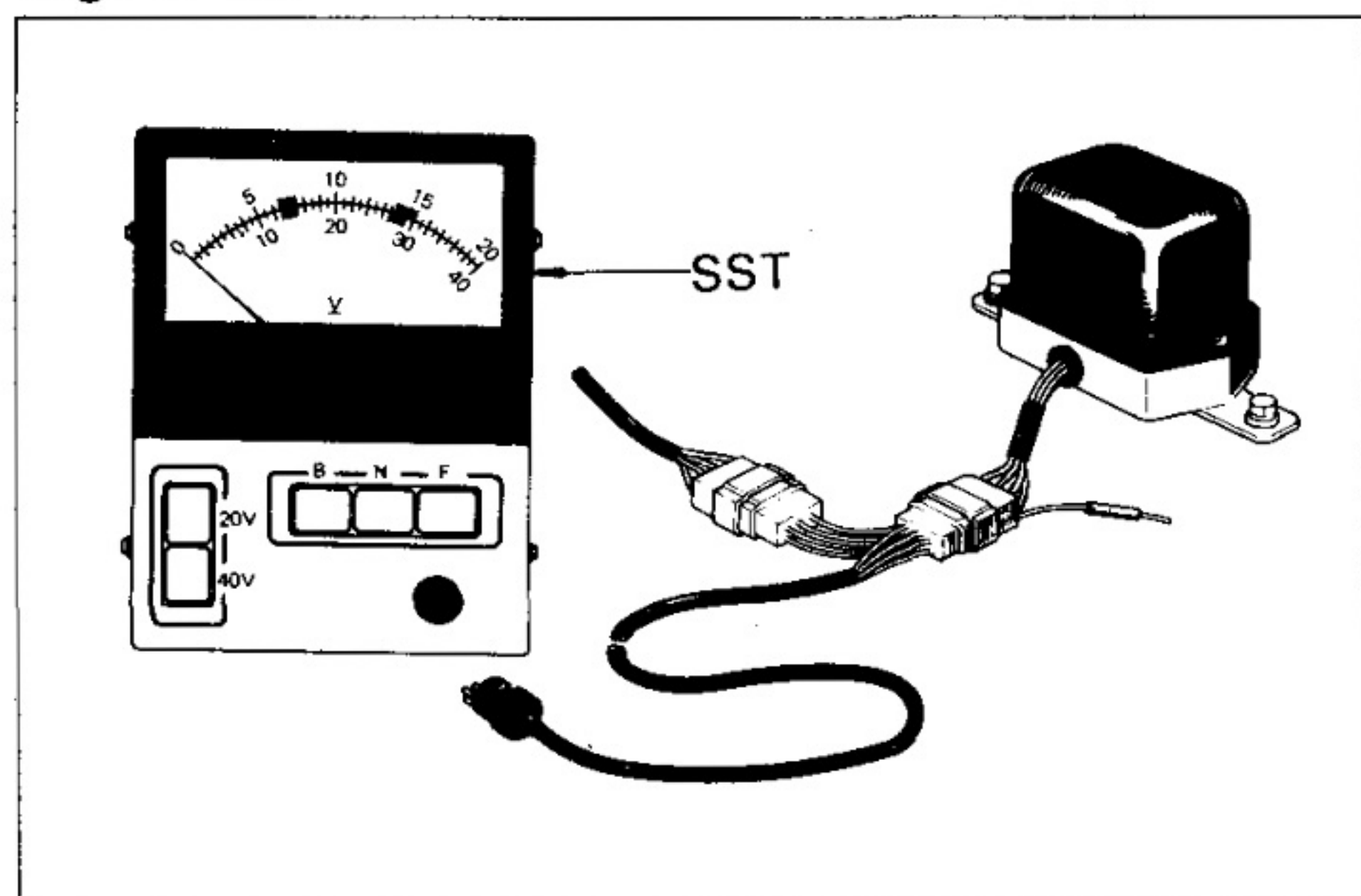
Voltage:

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]

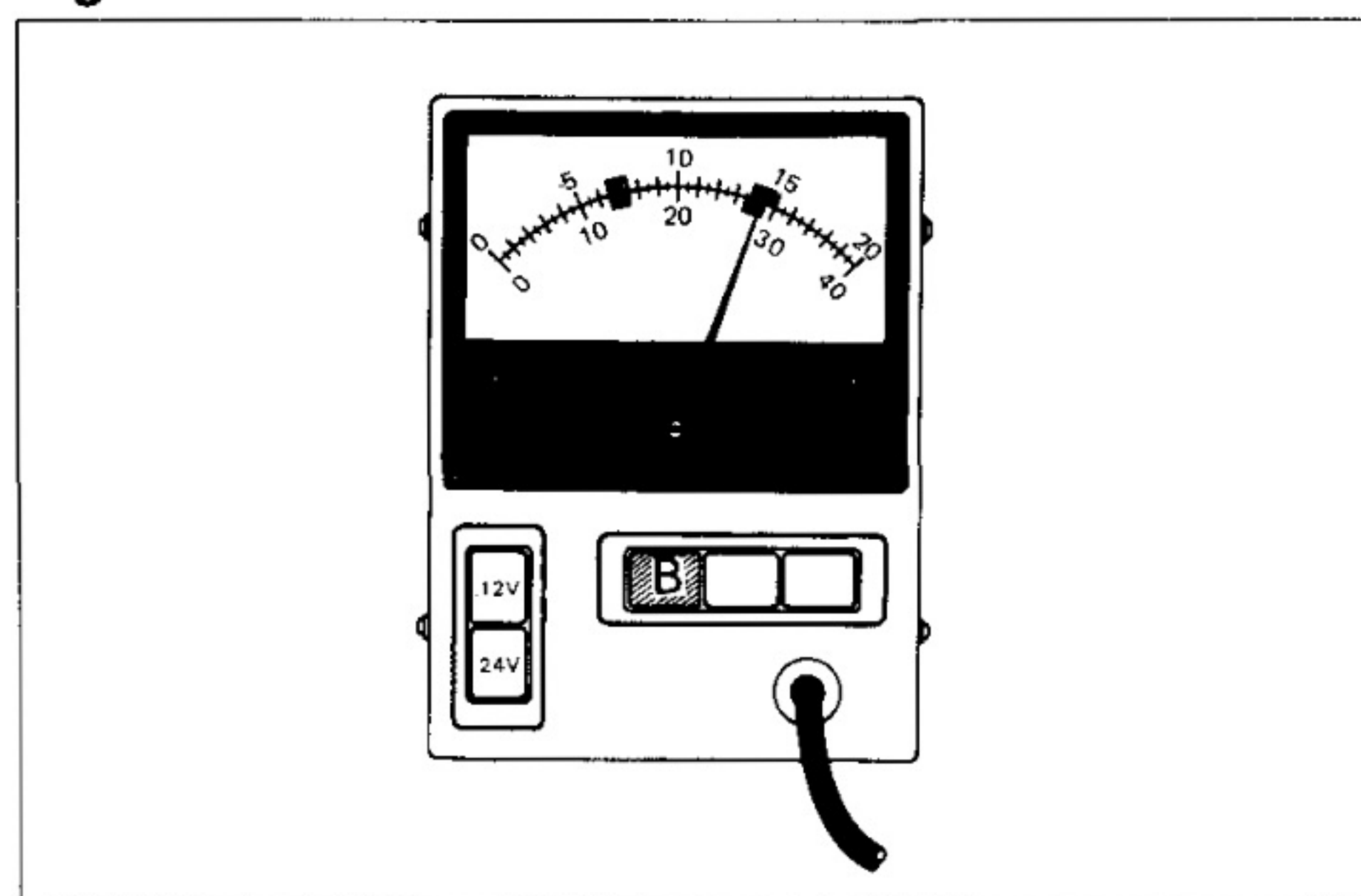
12V type alternator

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.

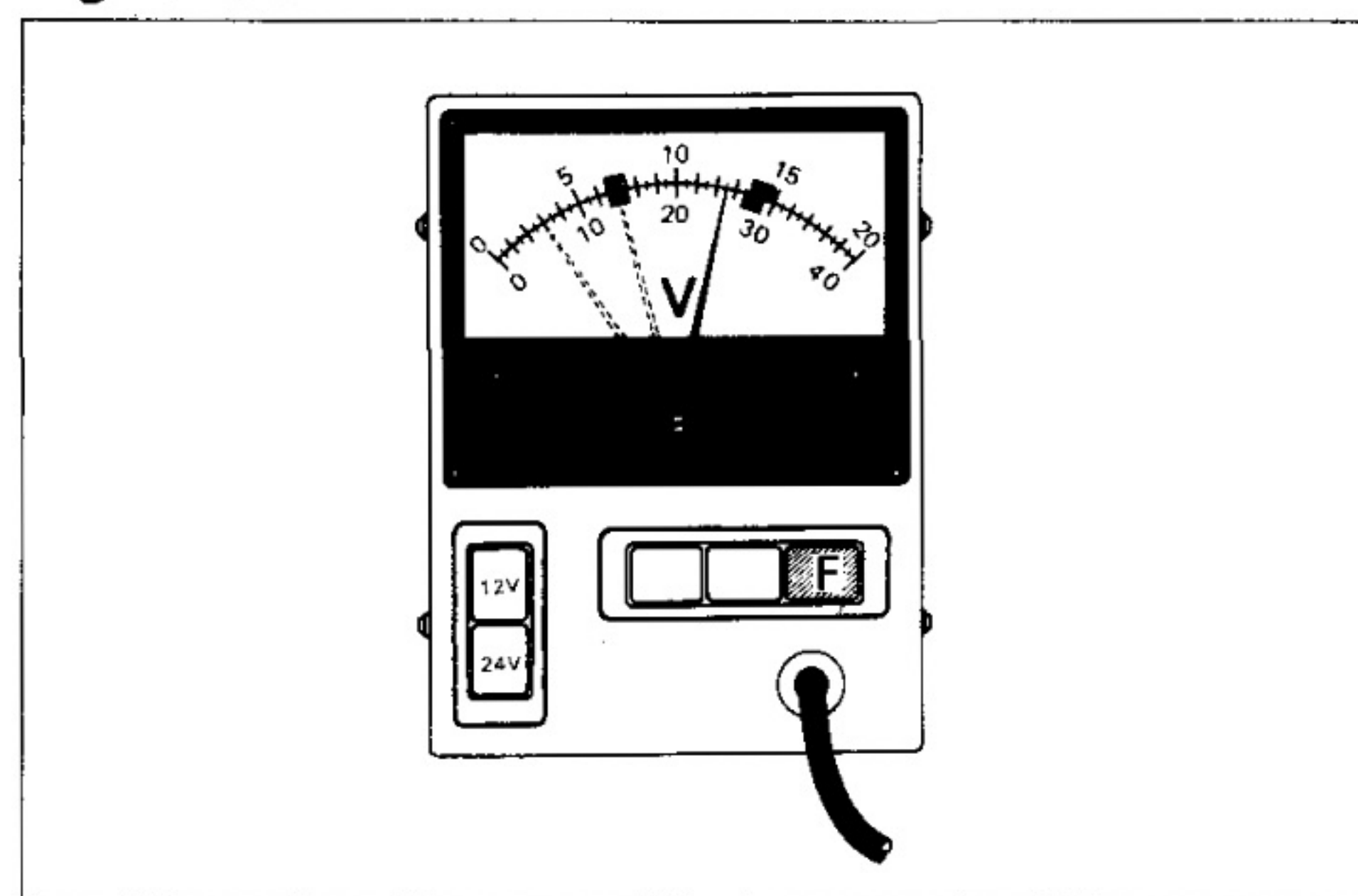
Voltage:

STD 12V type 13.8 – 14.8V

24V type 27 – 29V

If not within standard, probable cause is the alternator regulator.

Fig. 9-15



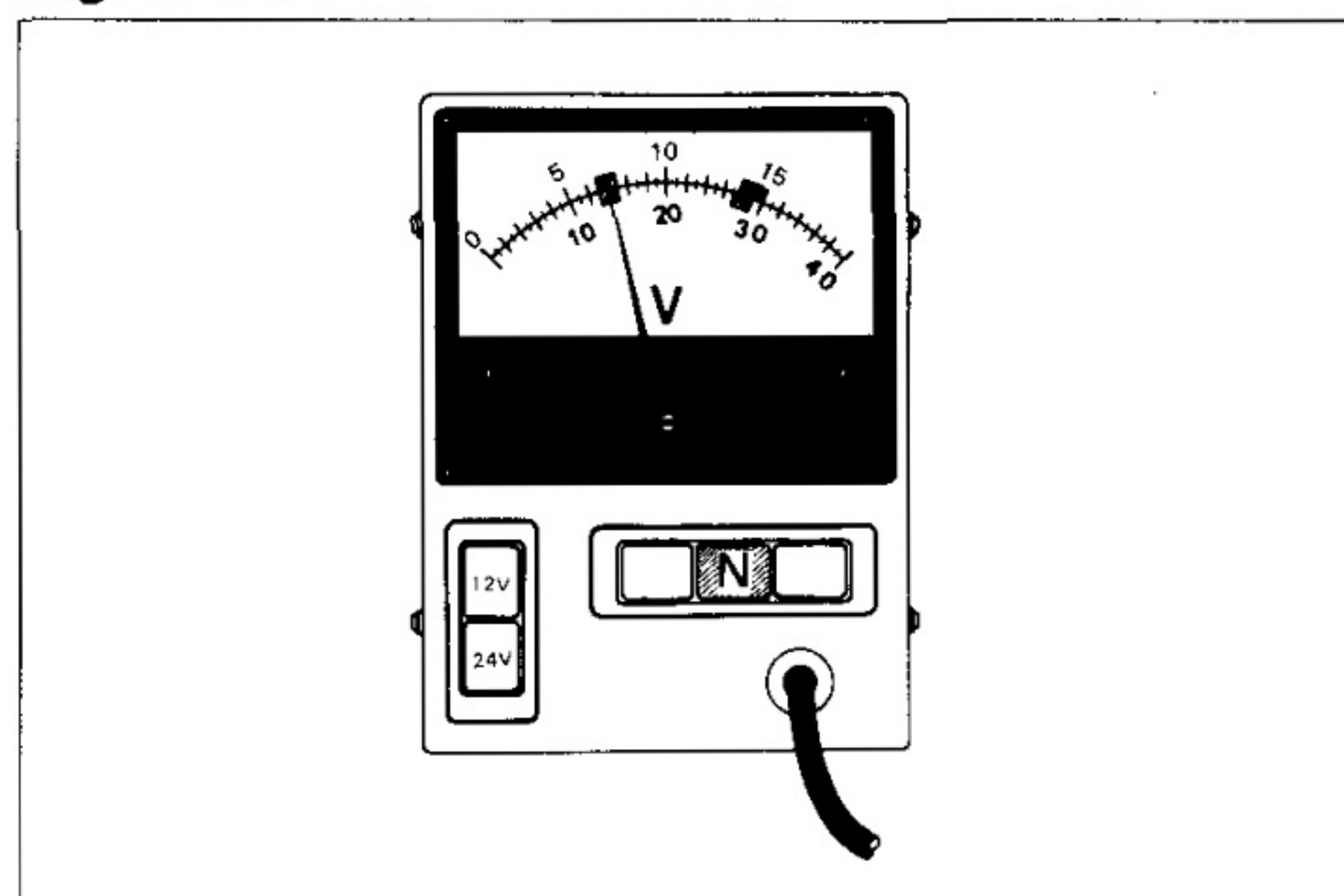
2. Check terminal F voltage.

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.

Fig. 9-17



Fig. 9-18

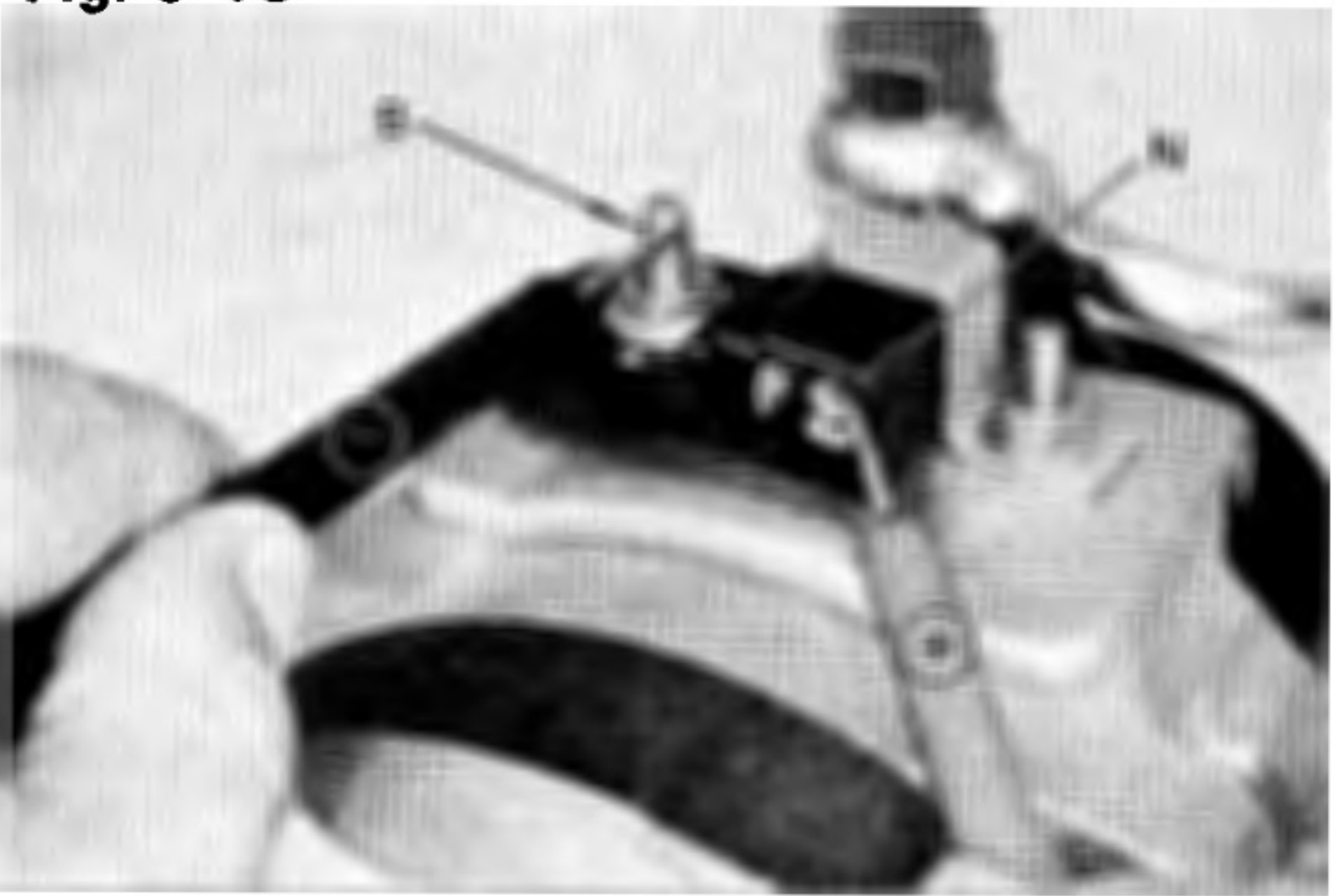


Fig. 9-19



Fig. 9-20

**ALTERNATOR INSPECTION**

1. Negative side rectifier short test
Connect an ohmmeter $\ominus$ lead to terminal N and the $\oplus$ lead to terminal E.
The meter should indicate infinity.



2. Positive side rectifier short test
Connect an ohmmeter $\ominus$ lead to terminal B and the $\oplus$ lead to terminal N.
The meter should indicate infinity.



3. Check the rotor coil resistance.

Resistance:

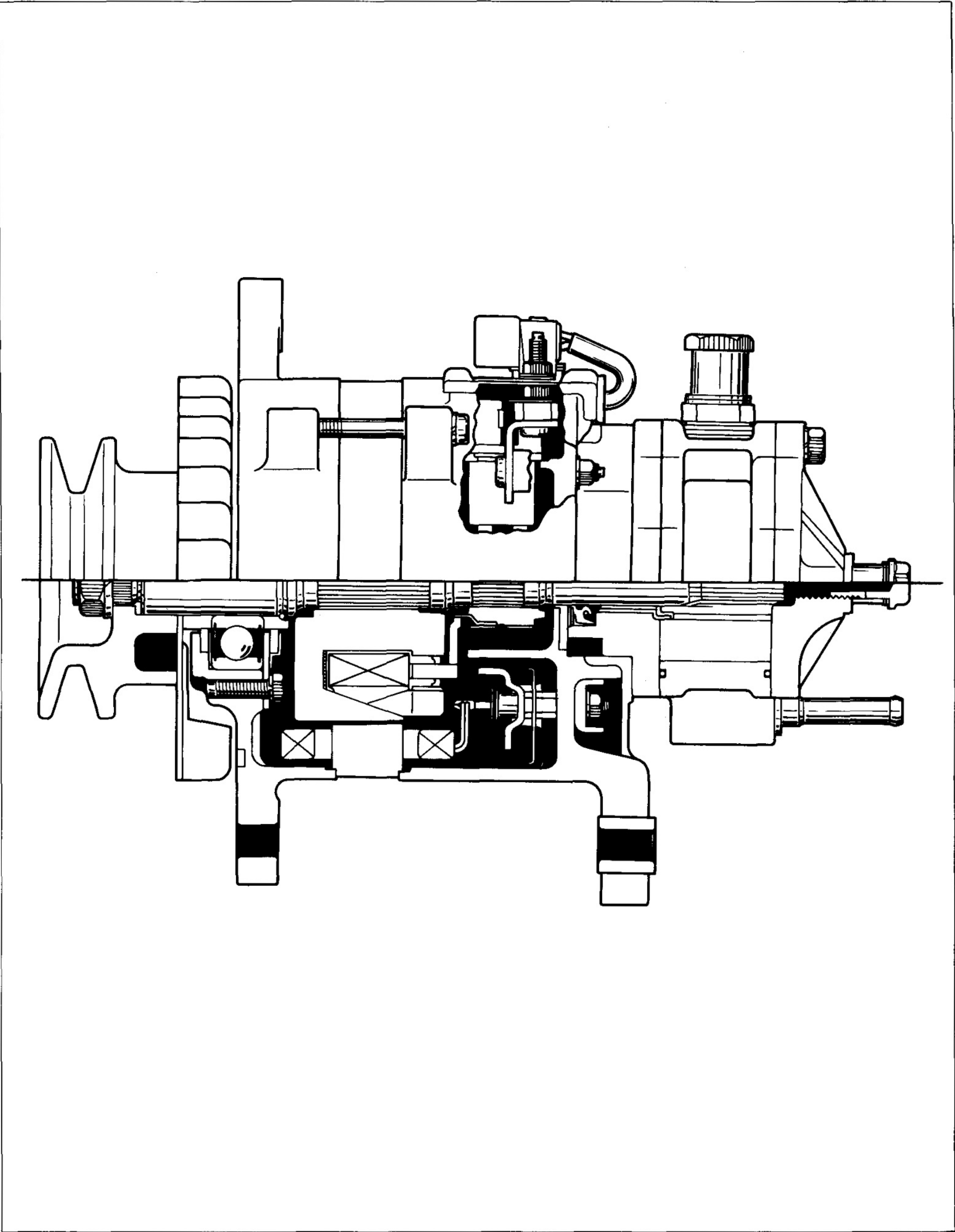
12V type	2.8 – 3.0Ω
24V type	19.0Ω



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

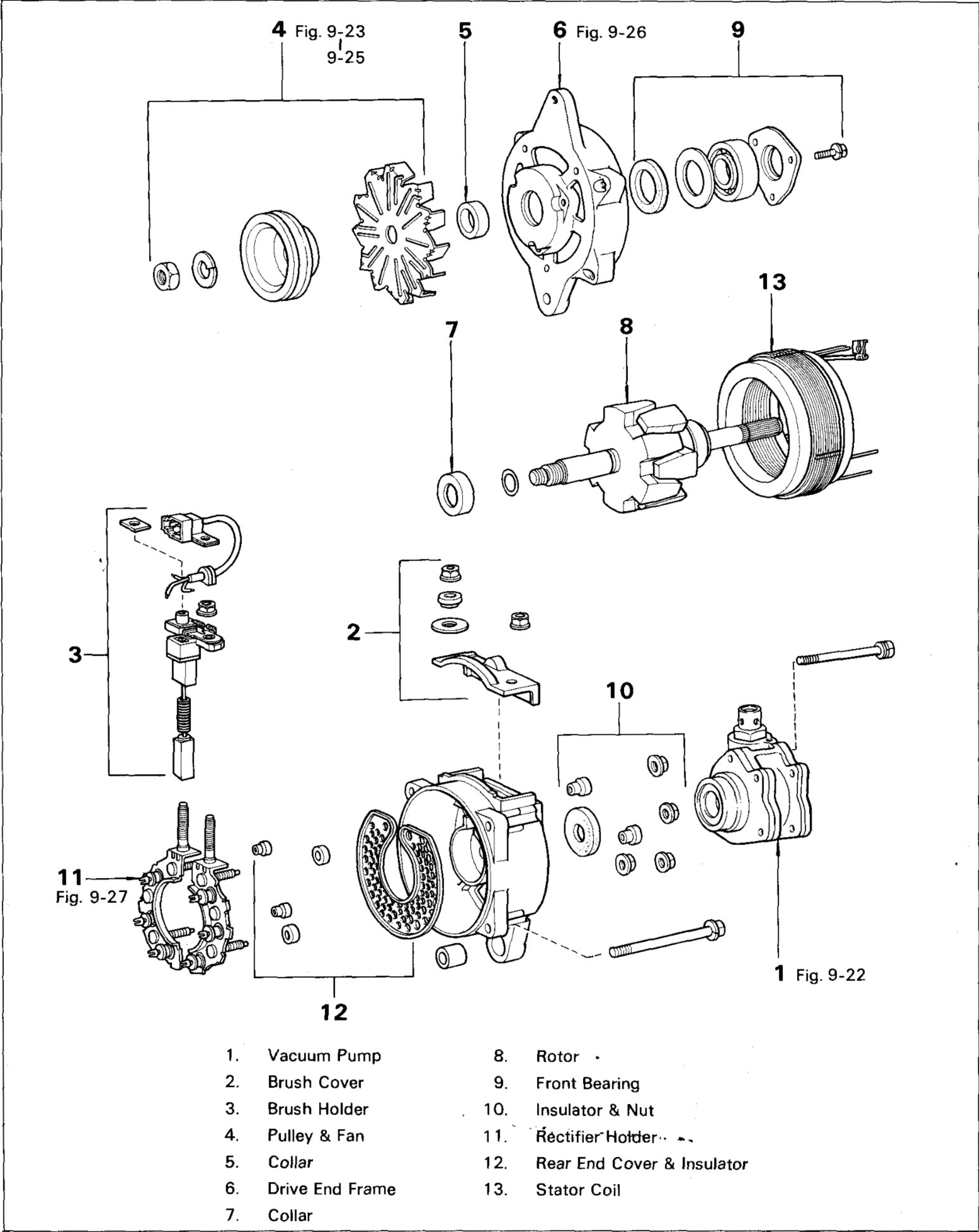
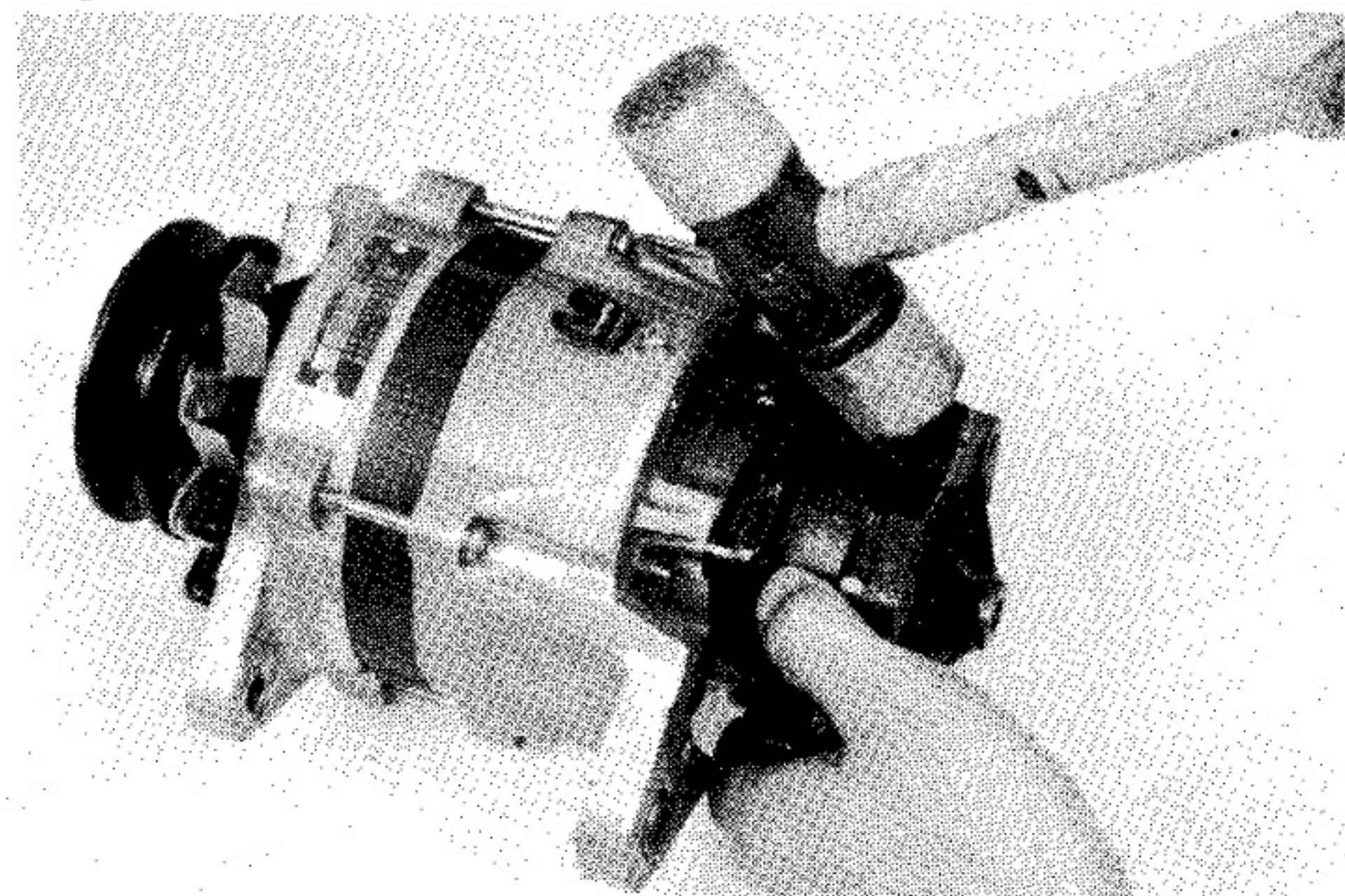


Fig. 9-23



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

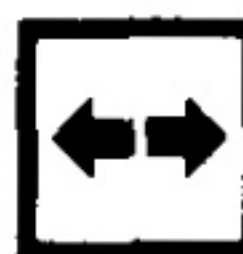
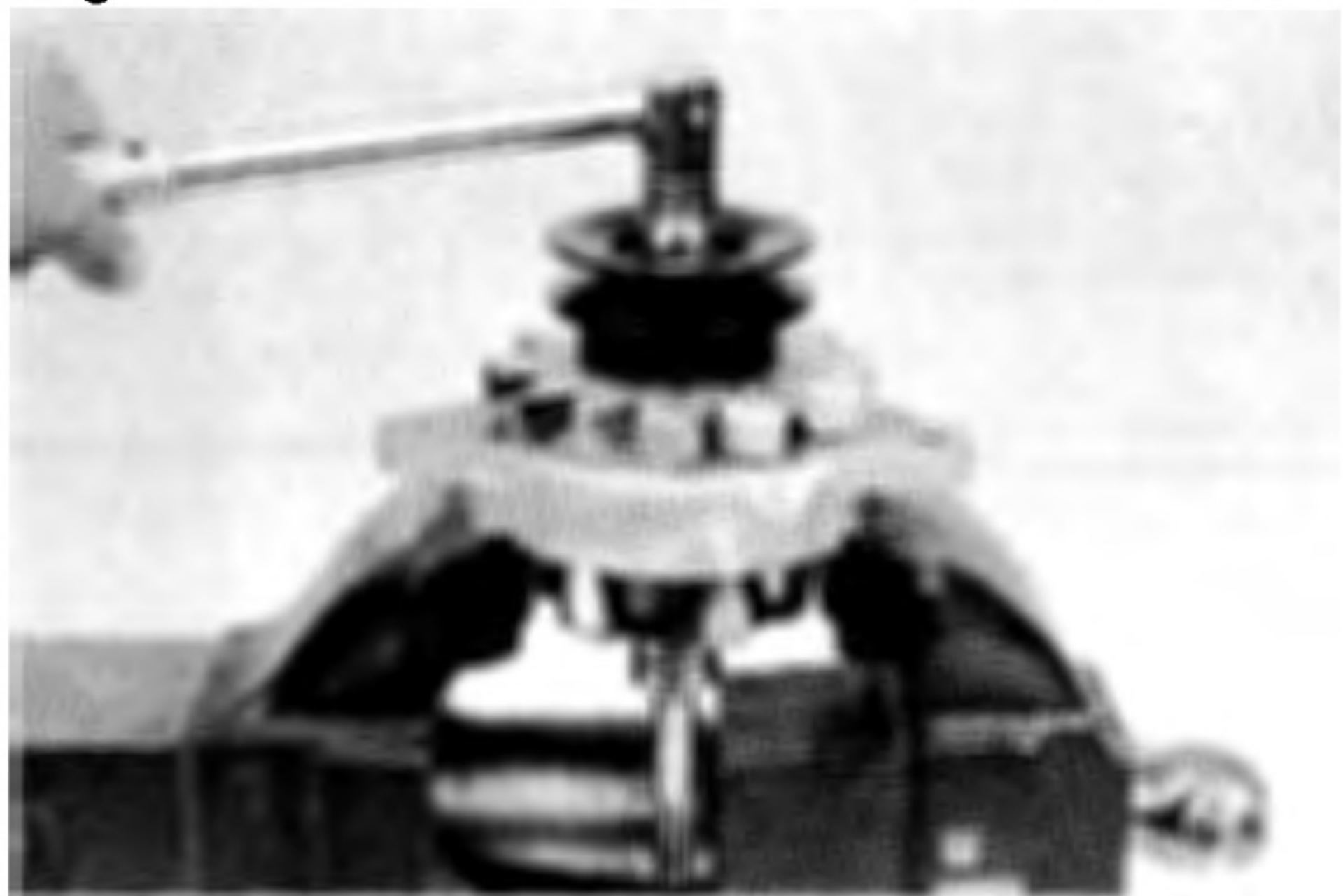
Fig. 9-24



Pry off the drive end frame from the stator.

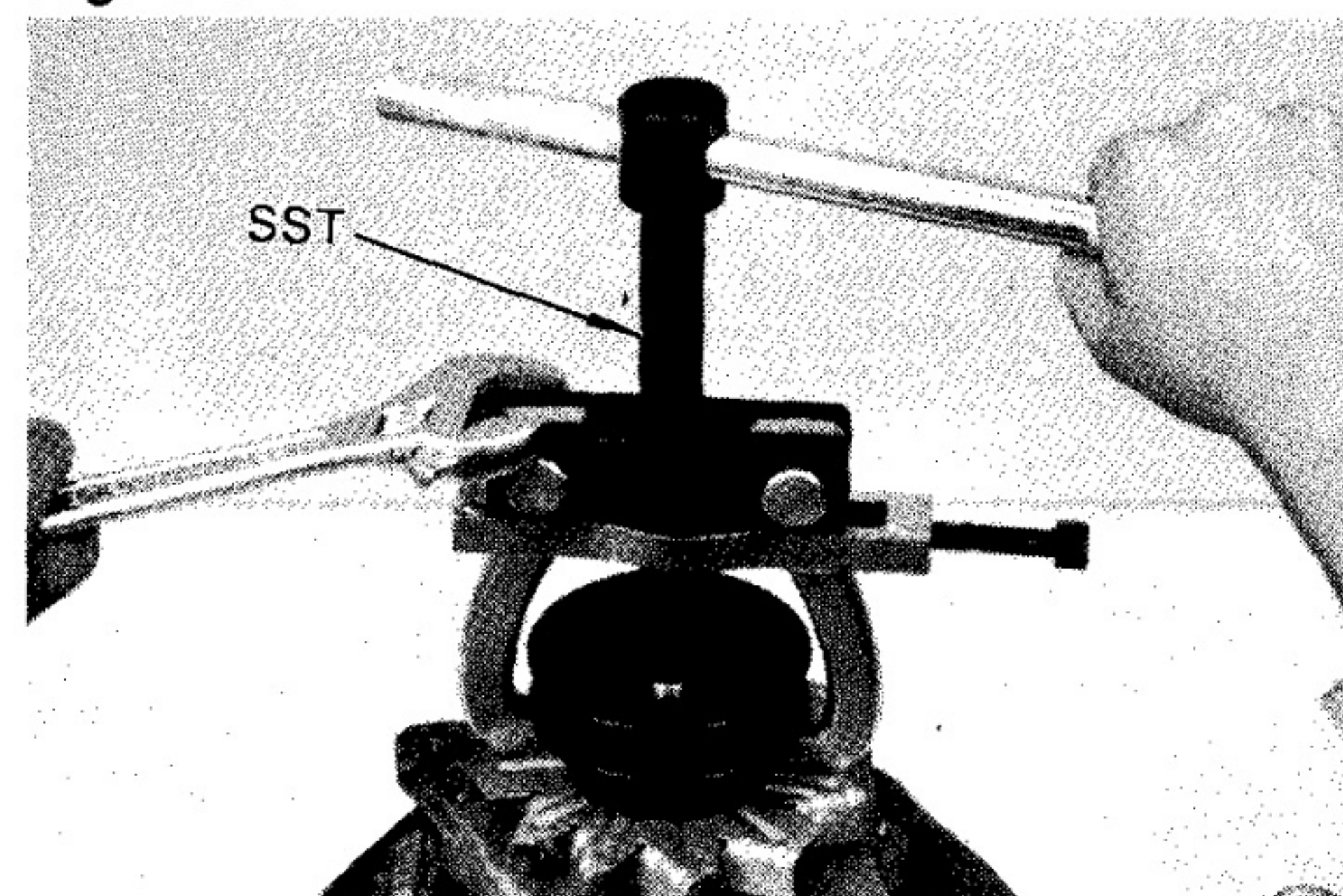
—Note—
Do not damage the coil wires.

Fig. 9-25



Using a soft jaw vise, loosen the pulley nut.

Fig. 9-26

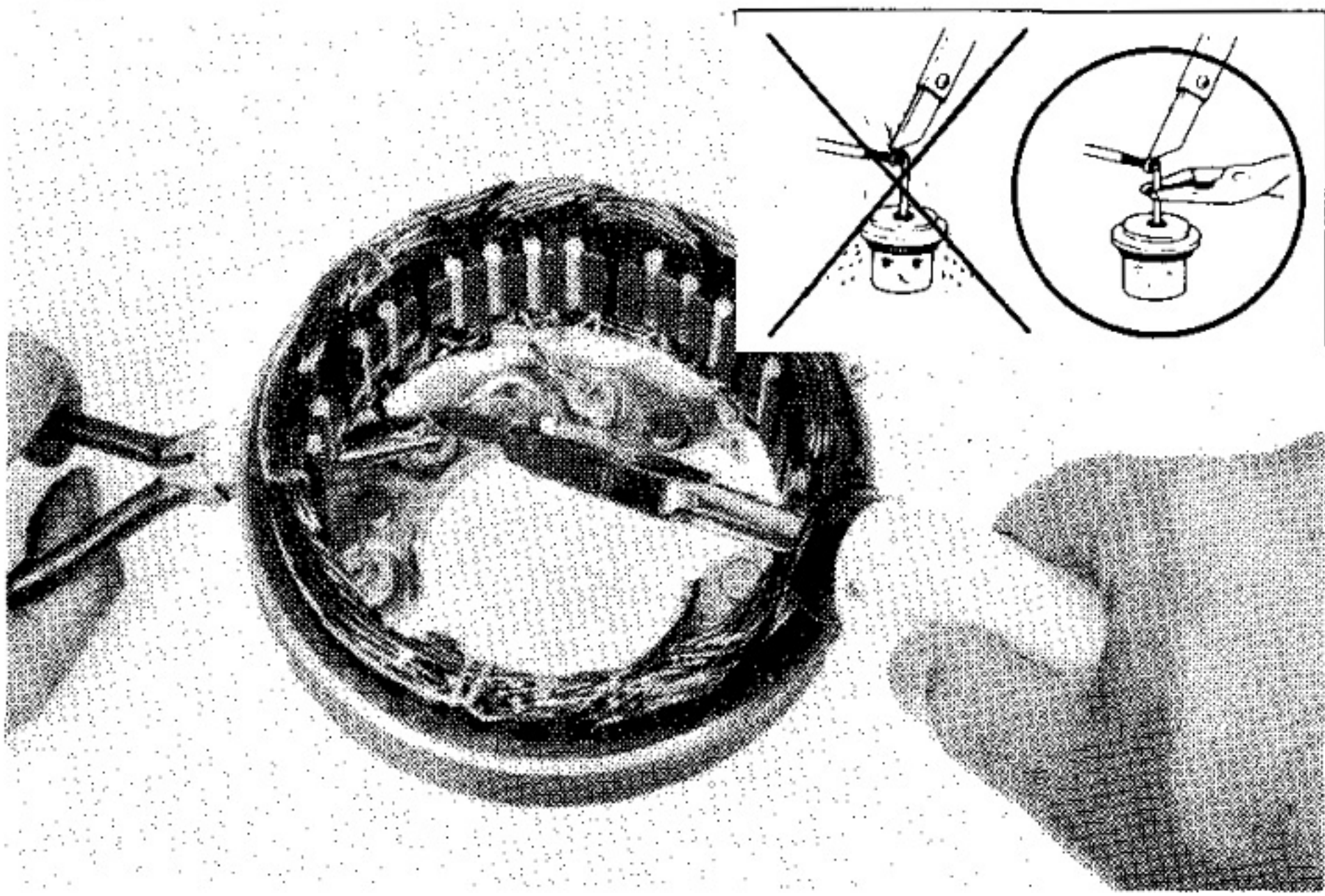


Remove the pulley with SST.
SST [09950-20014]



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

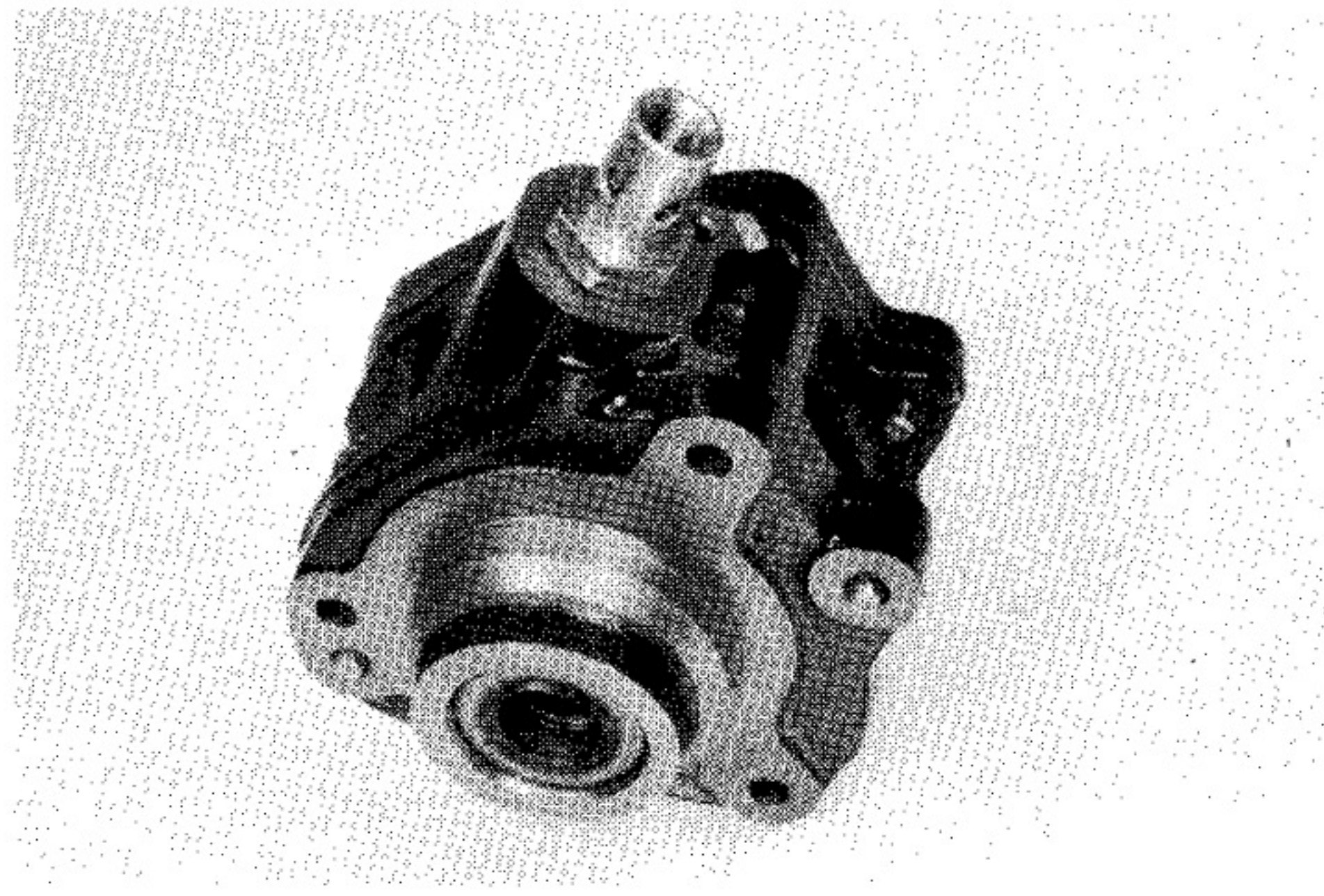
Fig. 9-28



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.

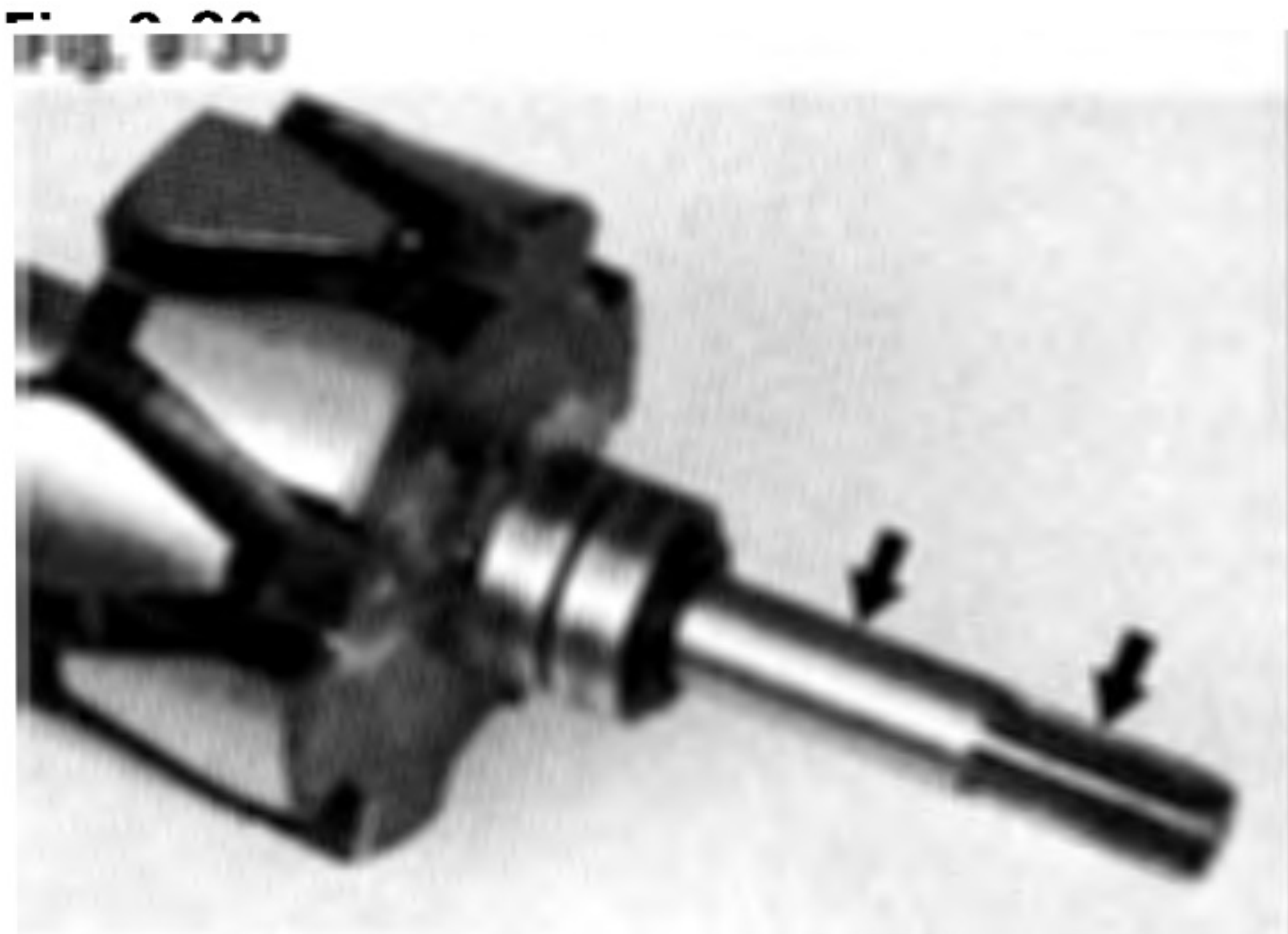
Fig. 9-29



INSPECTION & REPAIR

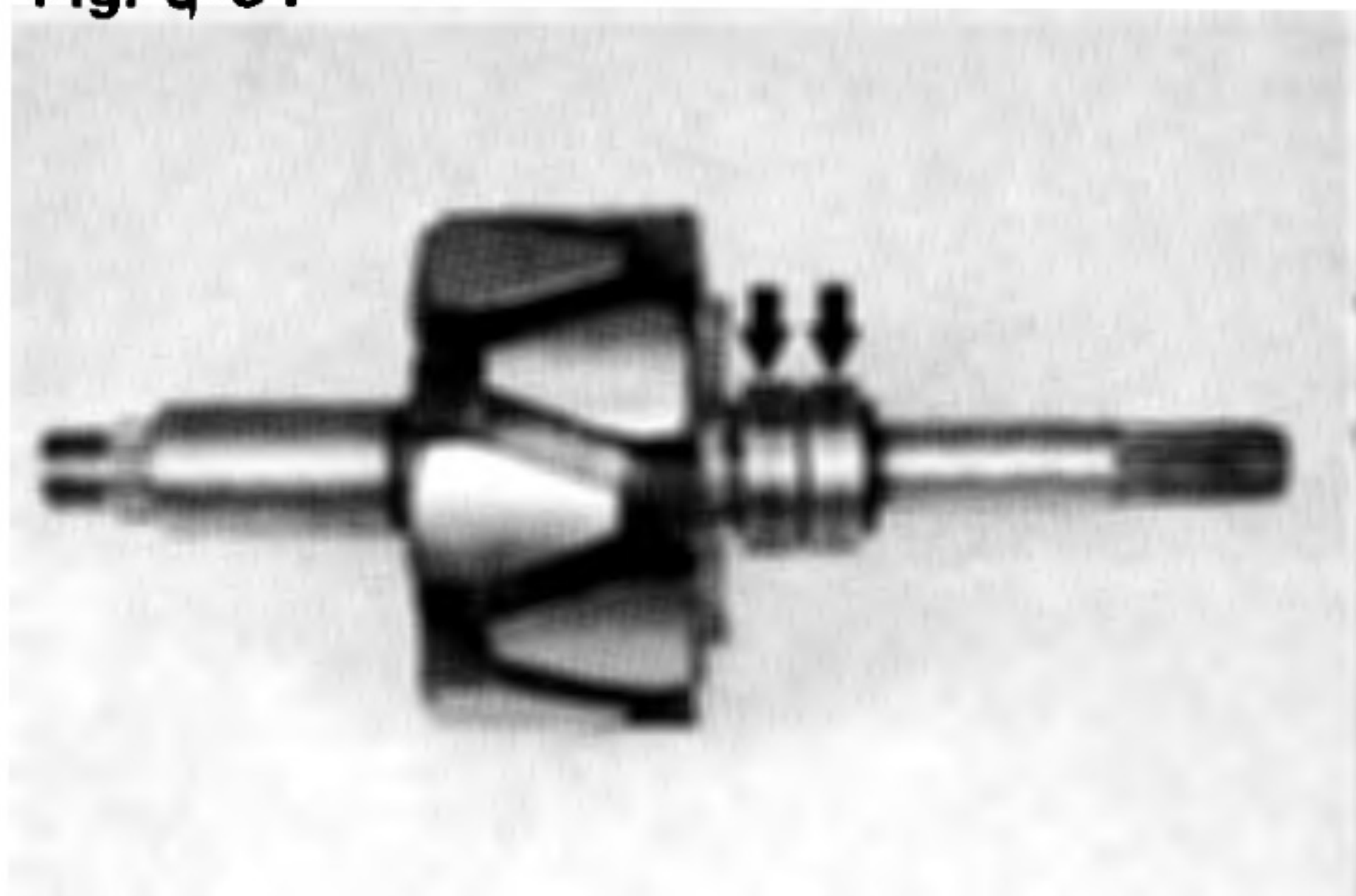
Vacuum Pump

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



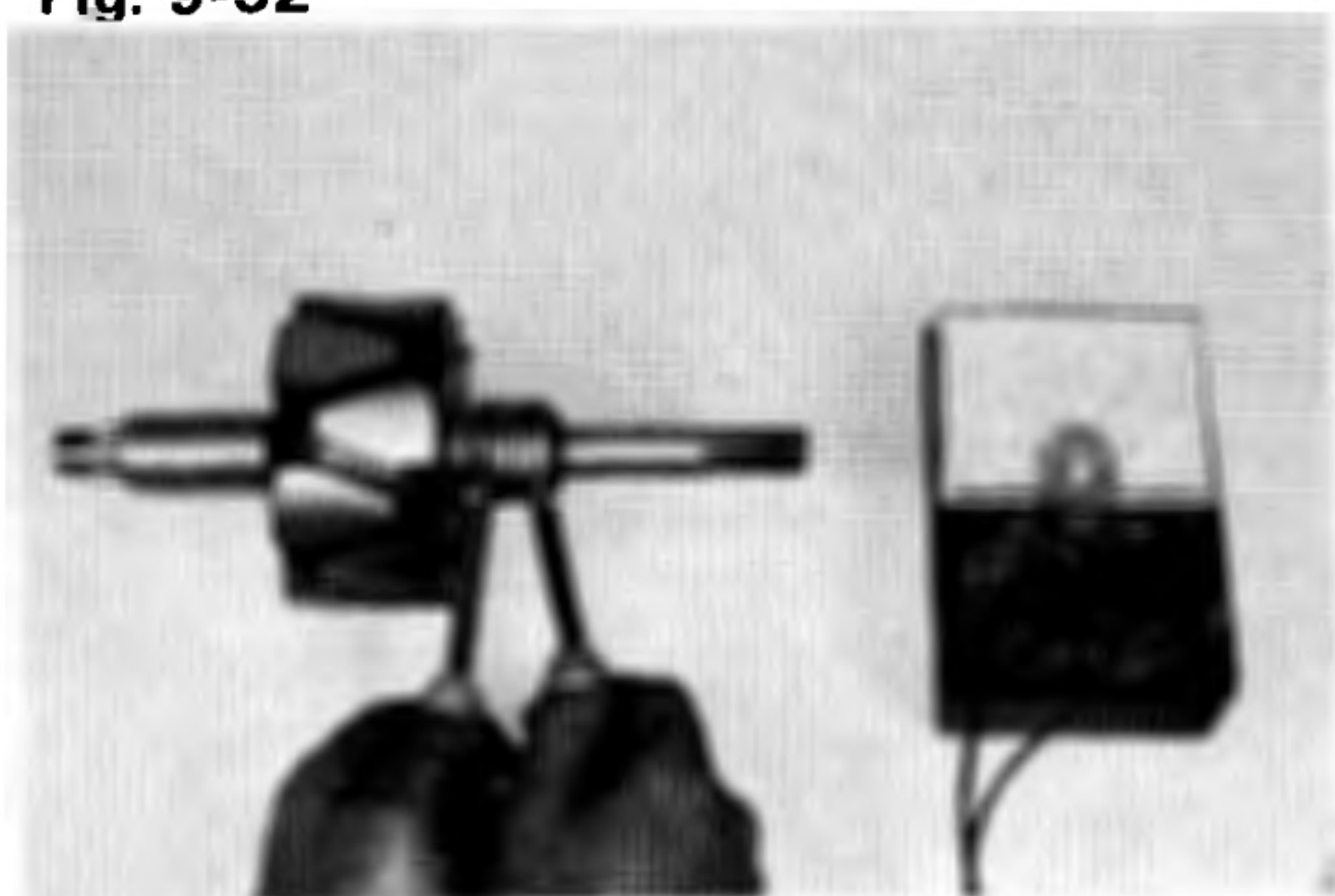
2. Check the journal and spline teeth for wear.

Fig. 9-31

**Rotor**

1. Check the slip ring for dirt or burns.

Fig. 9-32

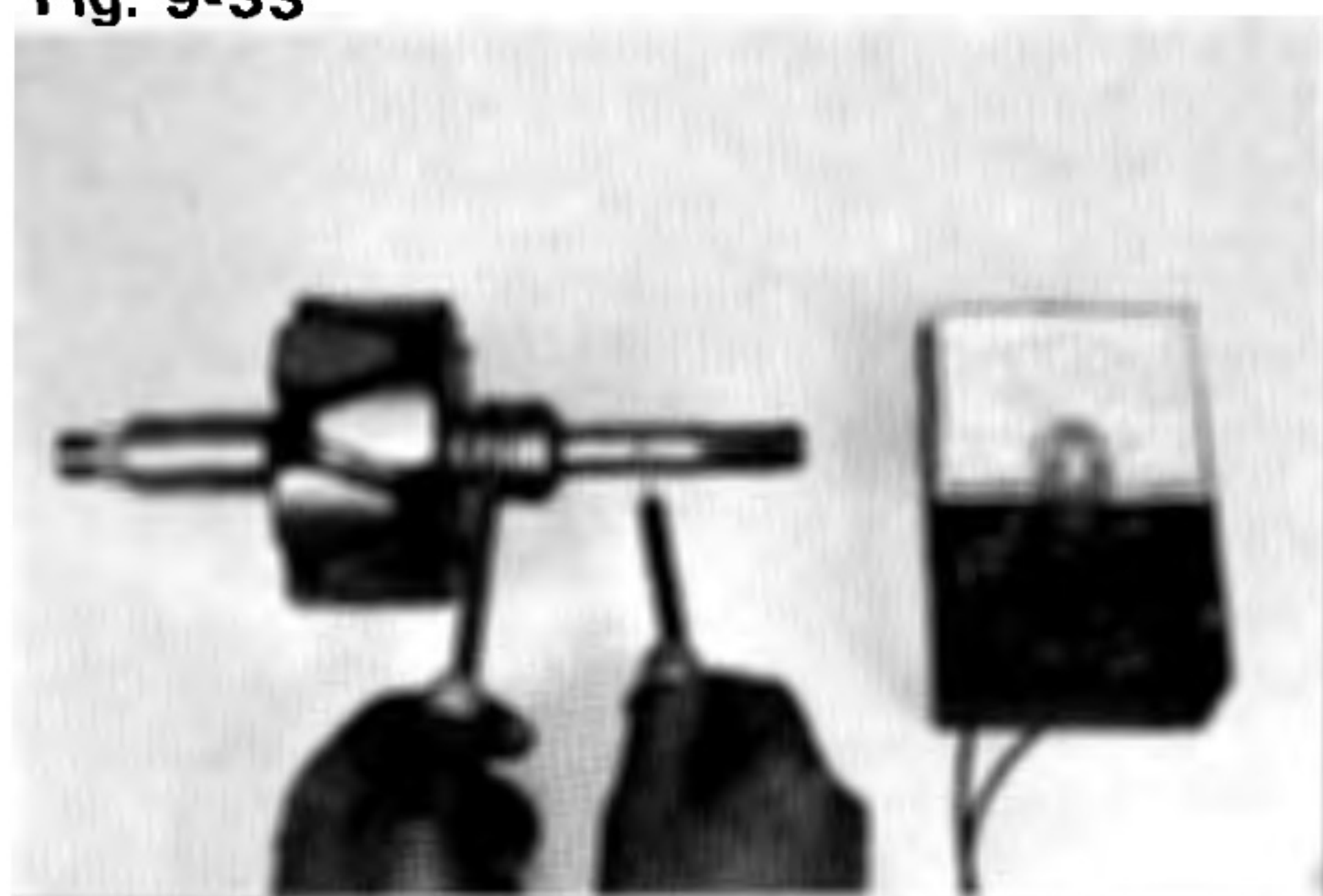


2. Open circuit test
Measure the resistance between both slip rings.

Resistance:

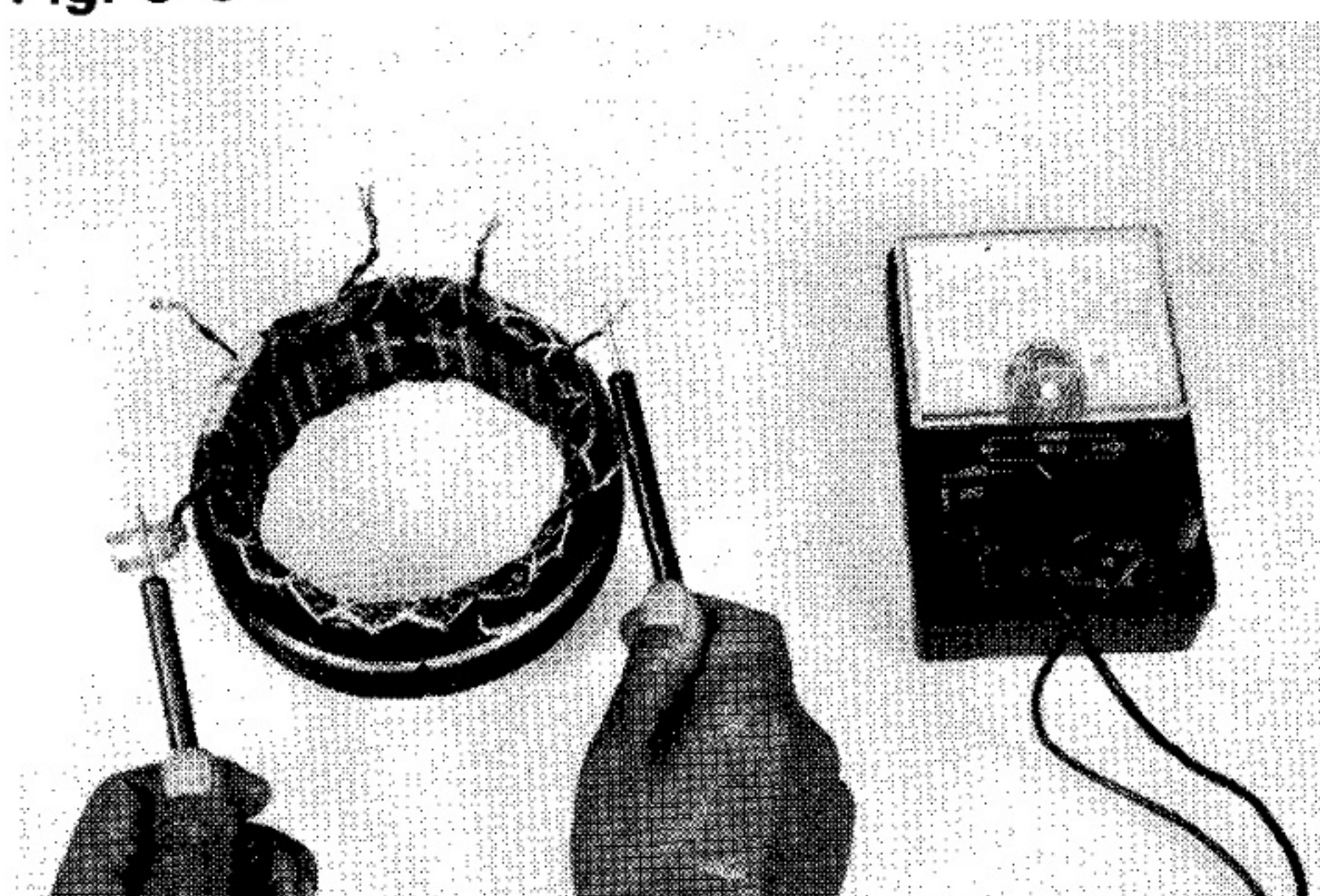
12V type	2.8 – 3.0 Ω
24V type	19.0 Ω

Fig. 9-33



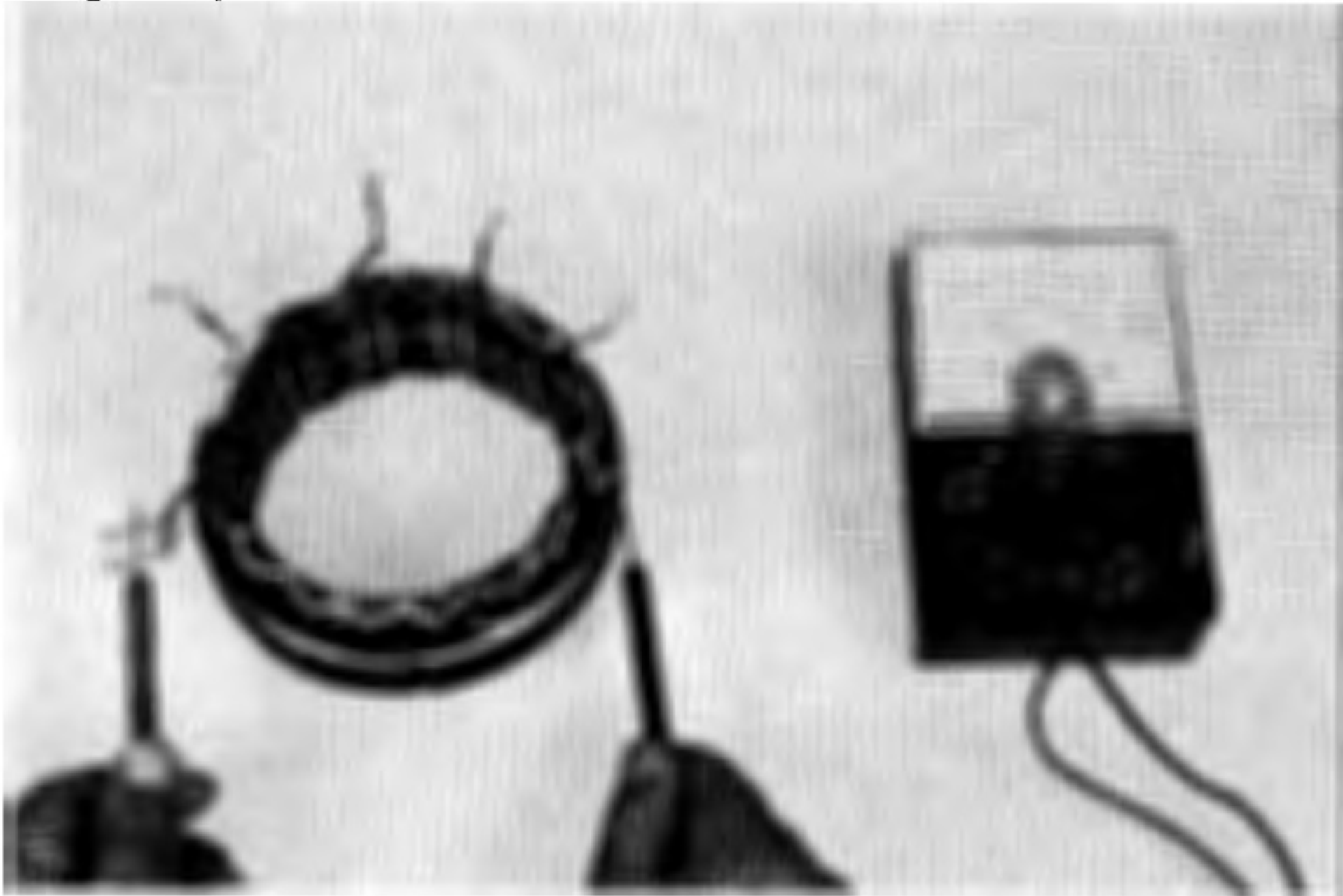
3. Ground test
Check that there is no continuity between the slip ring and rotor.

Fig. 9-34

**Stator**

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

Fig. 9-35



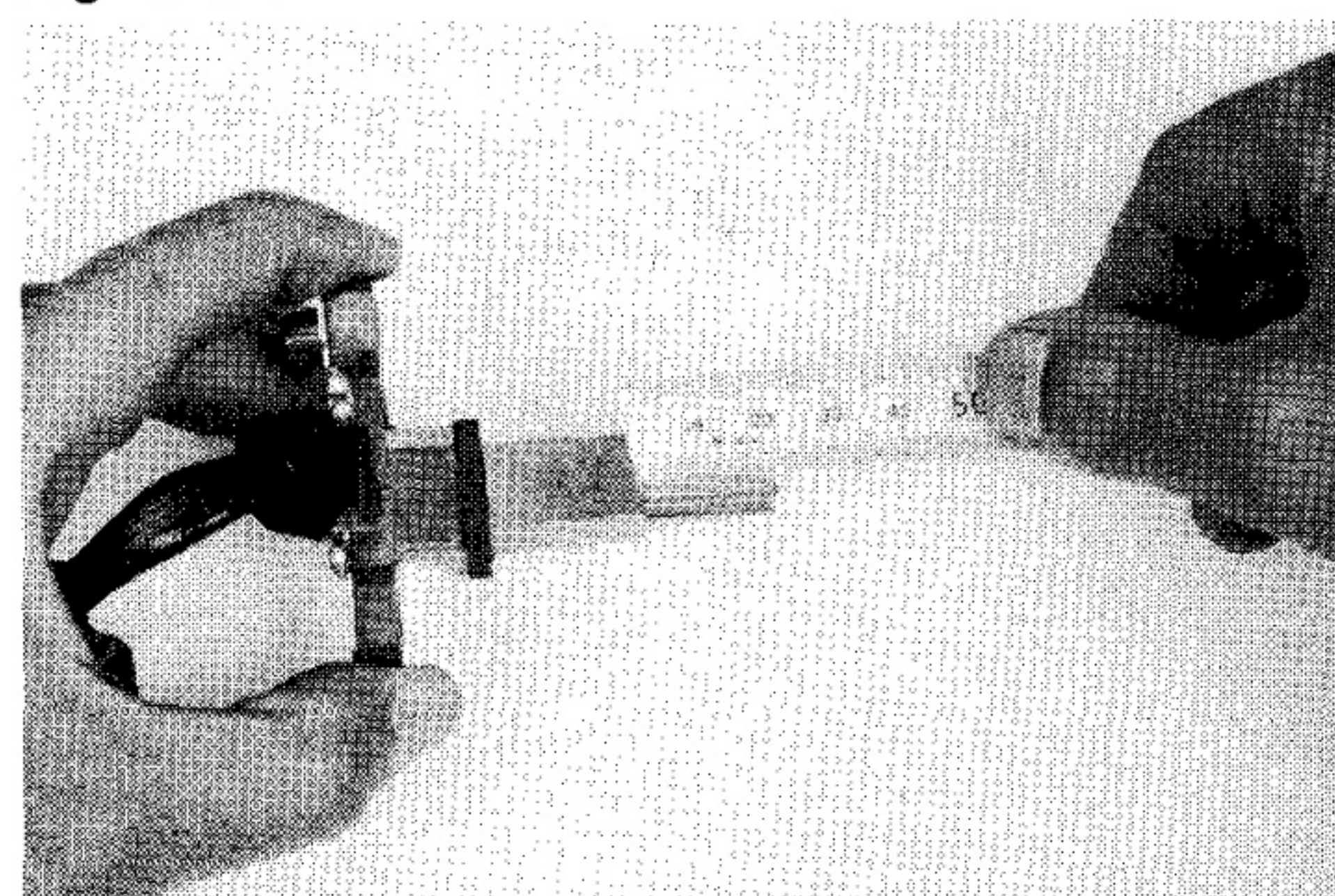
2. Ground test
Check that there is no continuity between each coil lead stator core.

Fig. 9-36



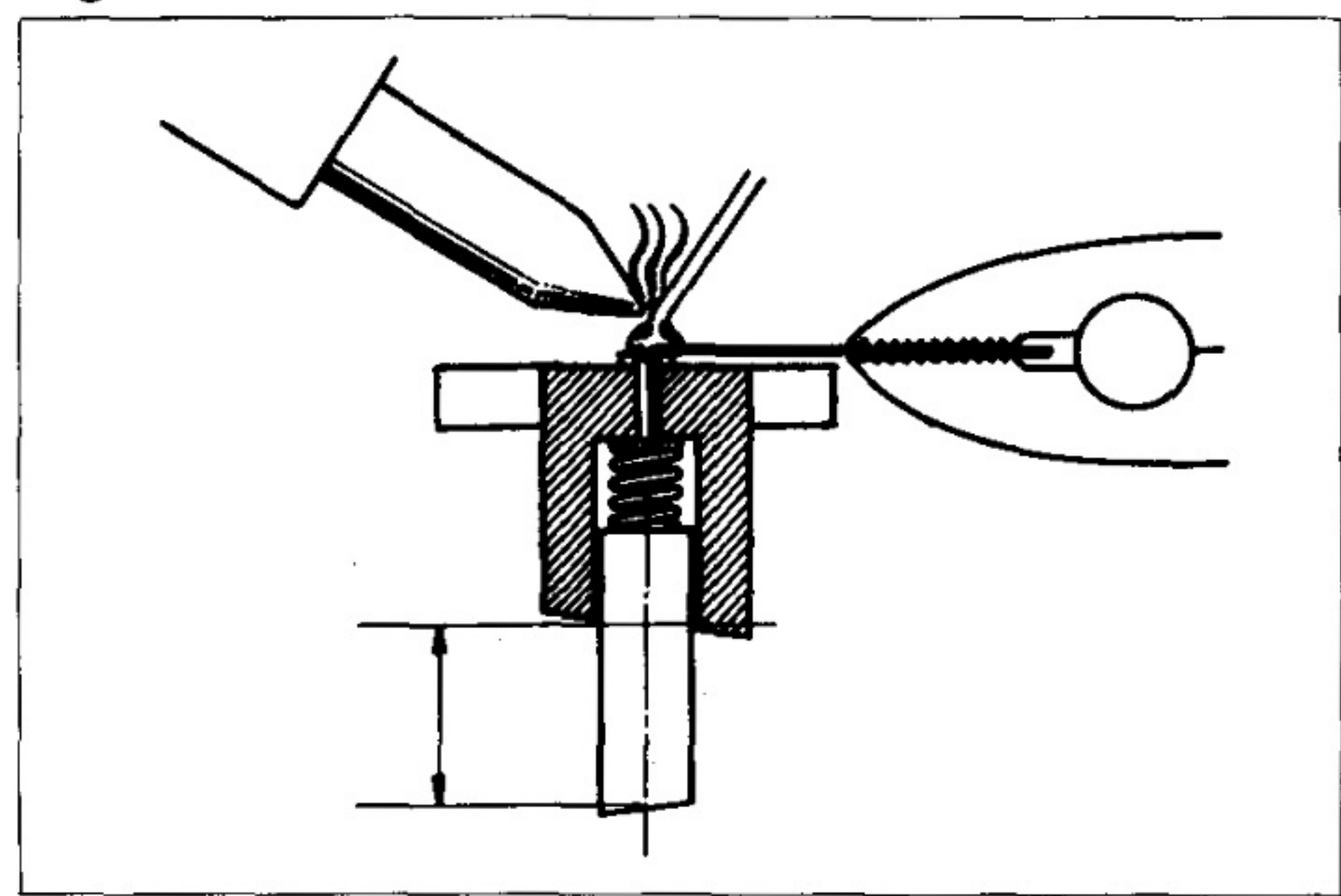
- Bearing**
Check the bearing for wear or roughness.

Fig. 9-37



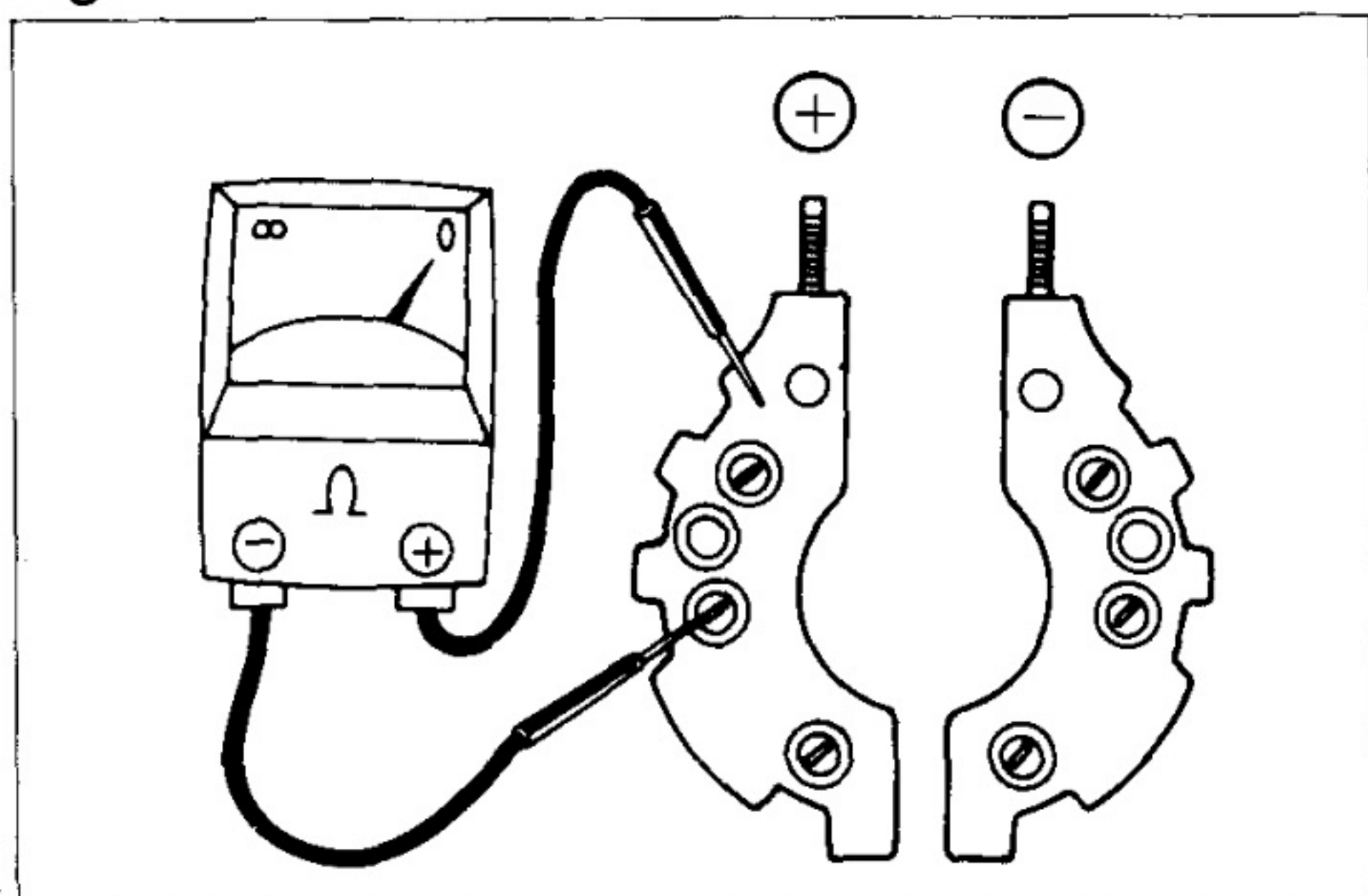
- Brush & Brush Holder**
1. Measure the exposed brush length.
Exposed length:
Minimum 5.5 mm
(0.217 in.)

Fig. 9-38



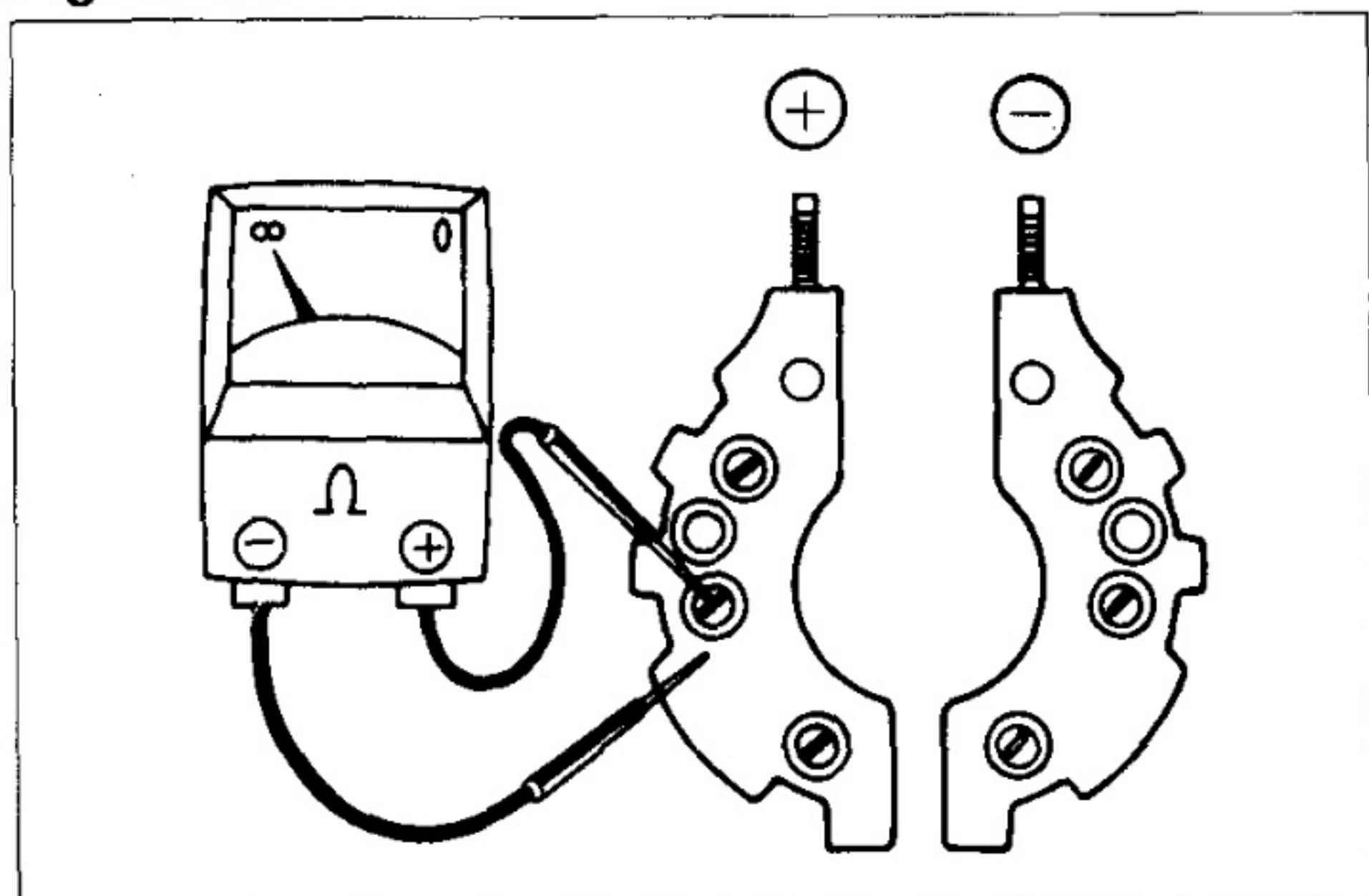
2. When replacing the brushes, assemble them as shown in figure.
Exposed length: 20.0 mm
(0.787 in.)

Fig. 9-39

**Rectifier**

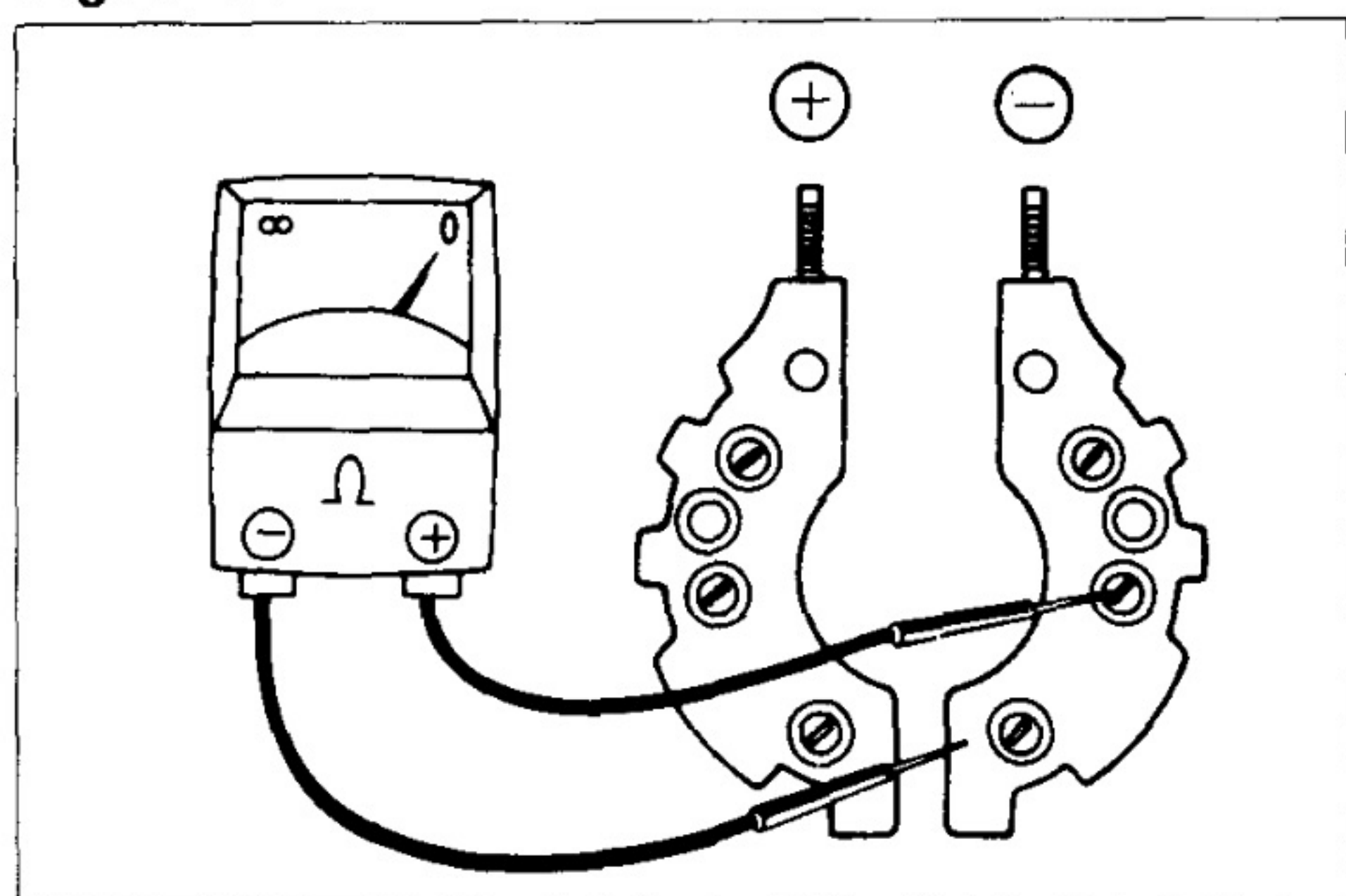
1. Rectifier holder positive side
Connect an ohmmeter $\oplus$ lead to the rectifier holder, and the $\ominus$ lead to the rectifier terminal.
If there is no continuity, the rectifier assembly must be replaced.

Fig. 9-40



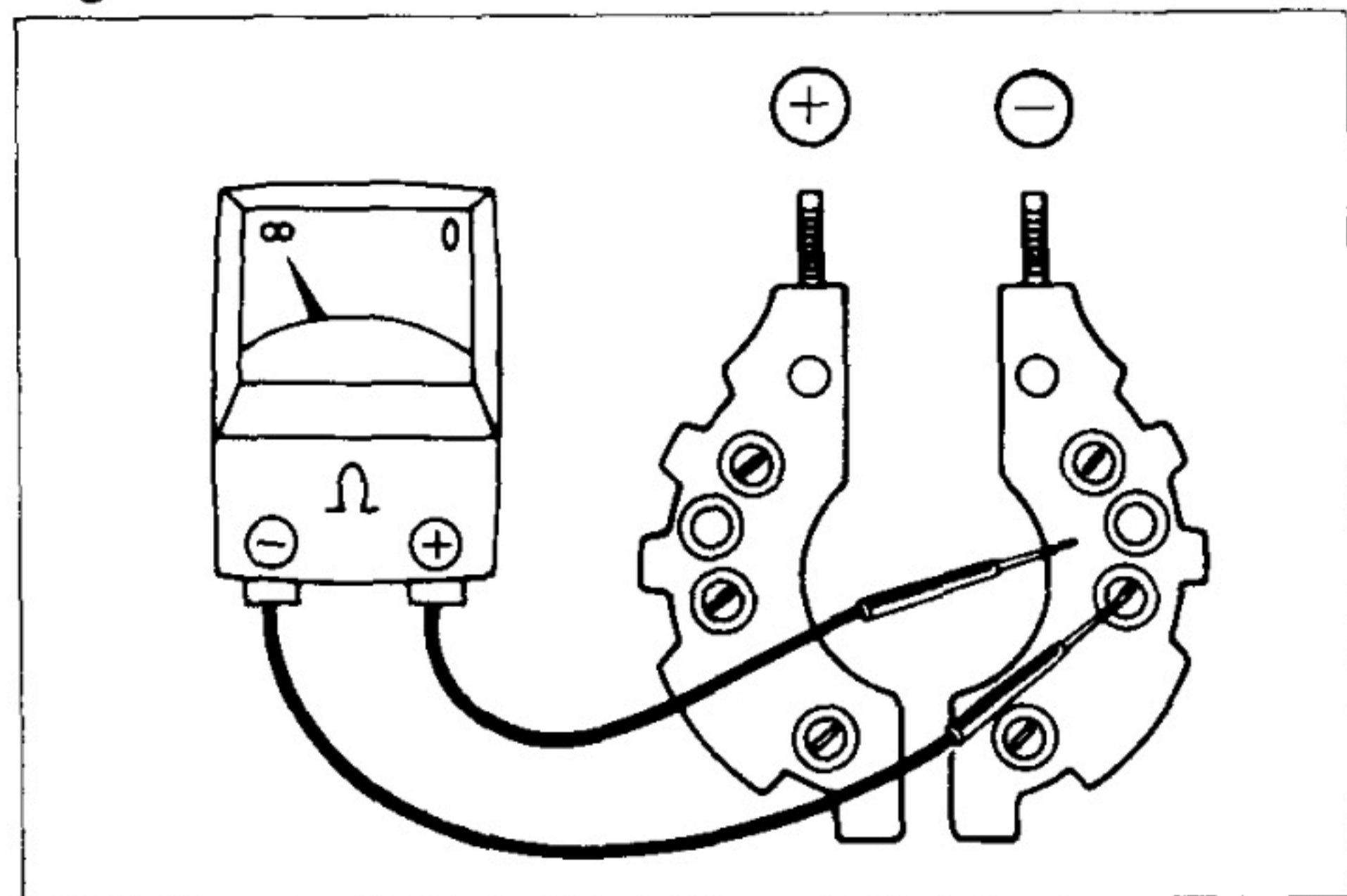
2. Reverse the polarity of the test leads and check again.
If there is continuity, the rectifier assembly must be replaced.

Fig. 9-41



3. Rectifier holder negative side
Connect an ohmmeter $\oplus$ lead to the rectifier terminal, and the $\ominus$ lead to the rectifier holder.
If there is no continuity, the rectifier assembly must be replaced.

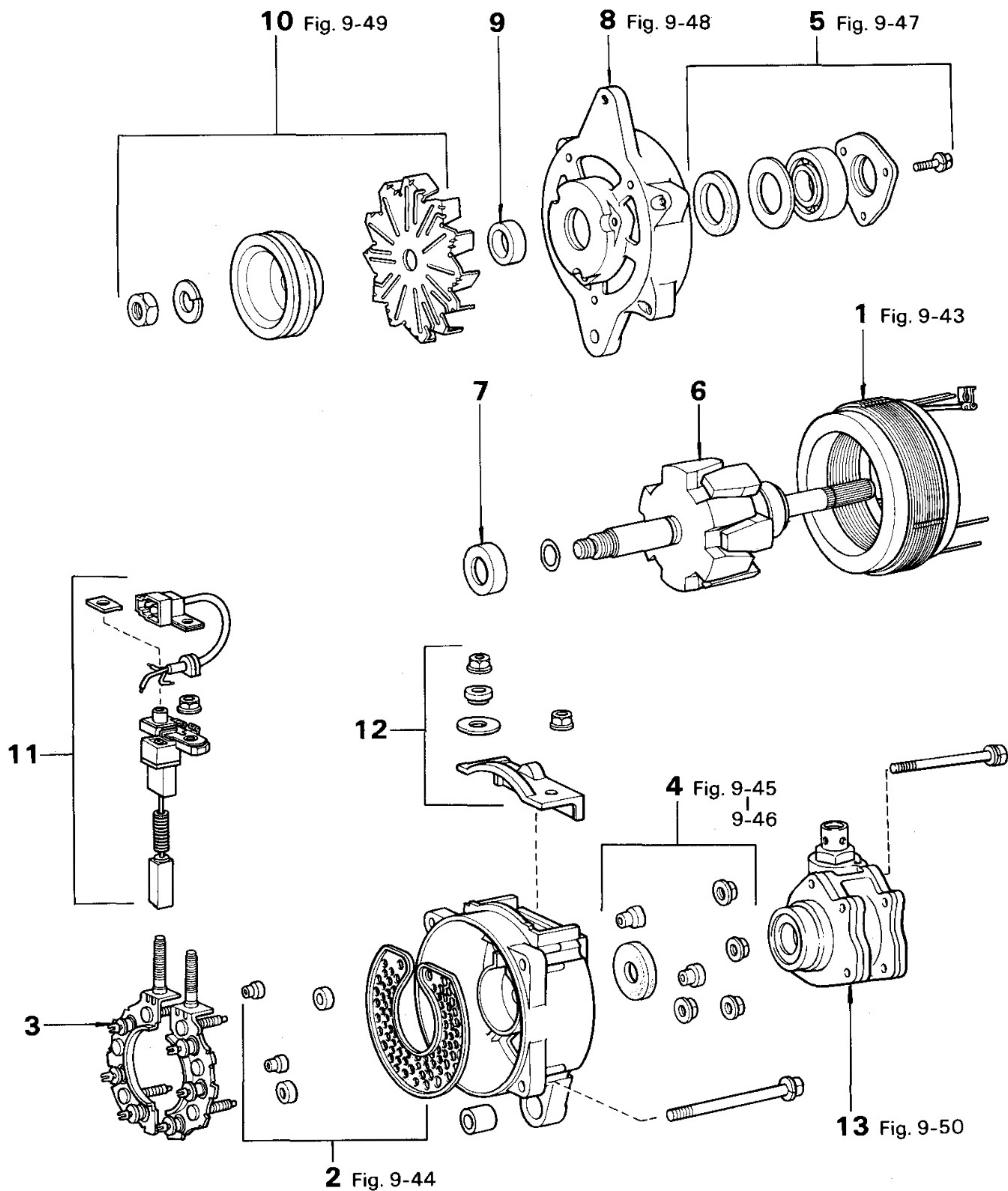
Fig. 9-42



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

ASSEMBLY

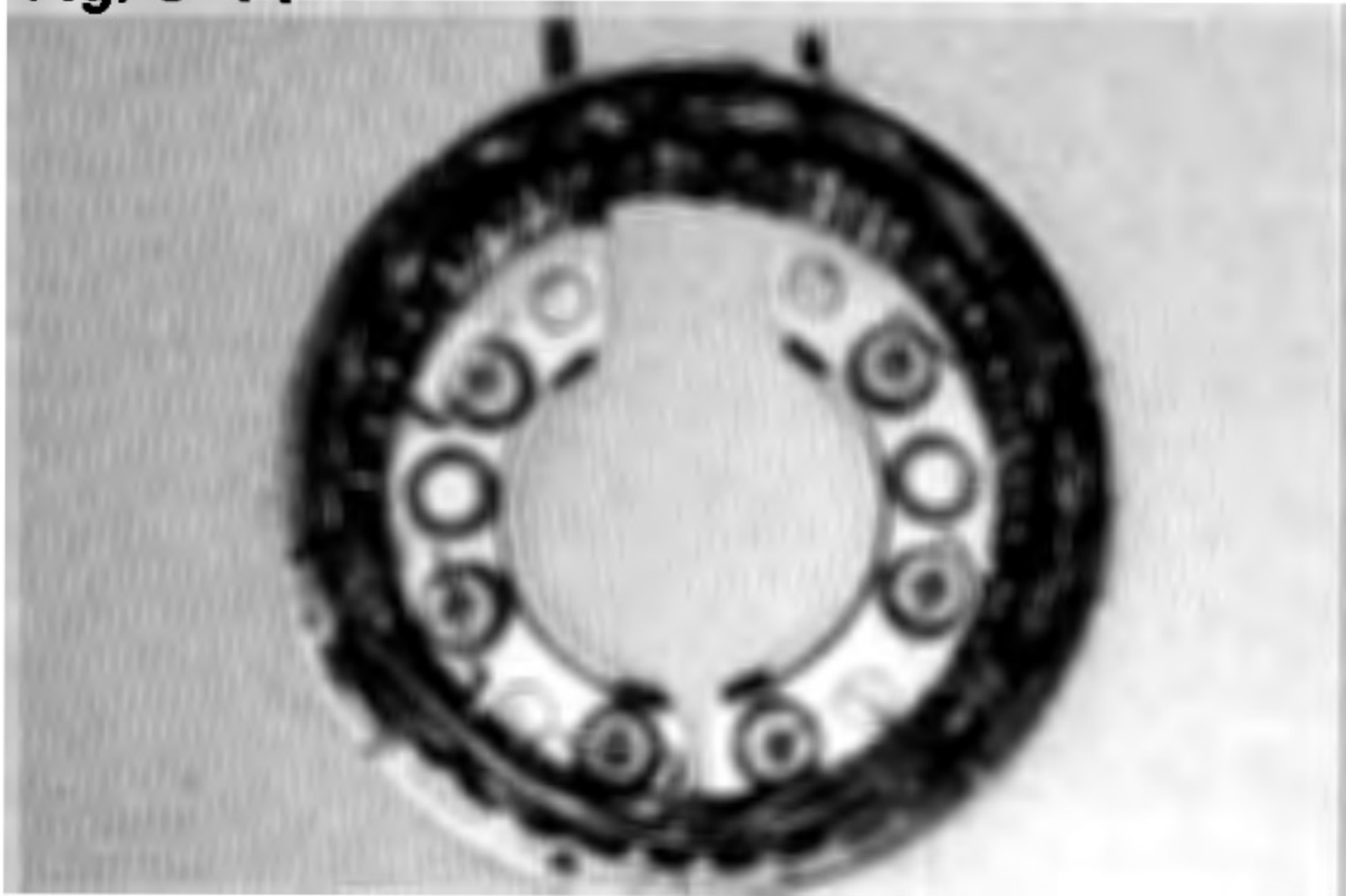
Assemble the parts in the numerical order shown in the figure.

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

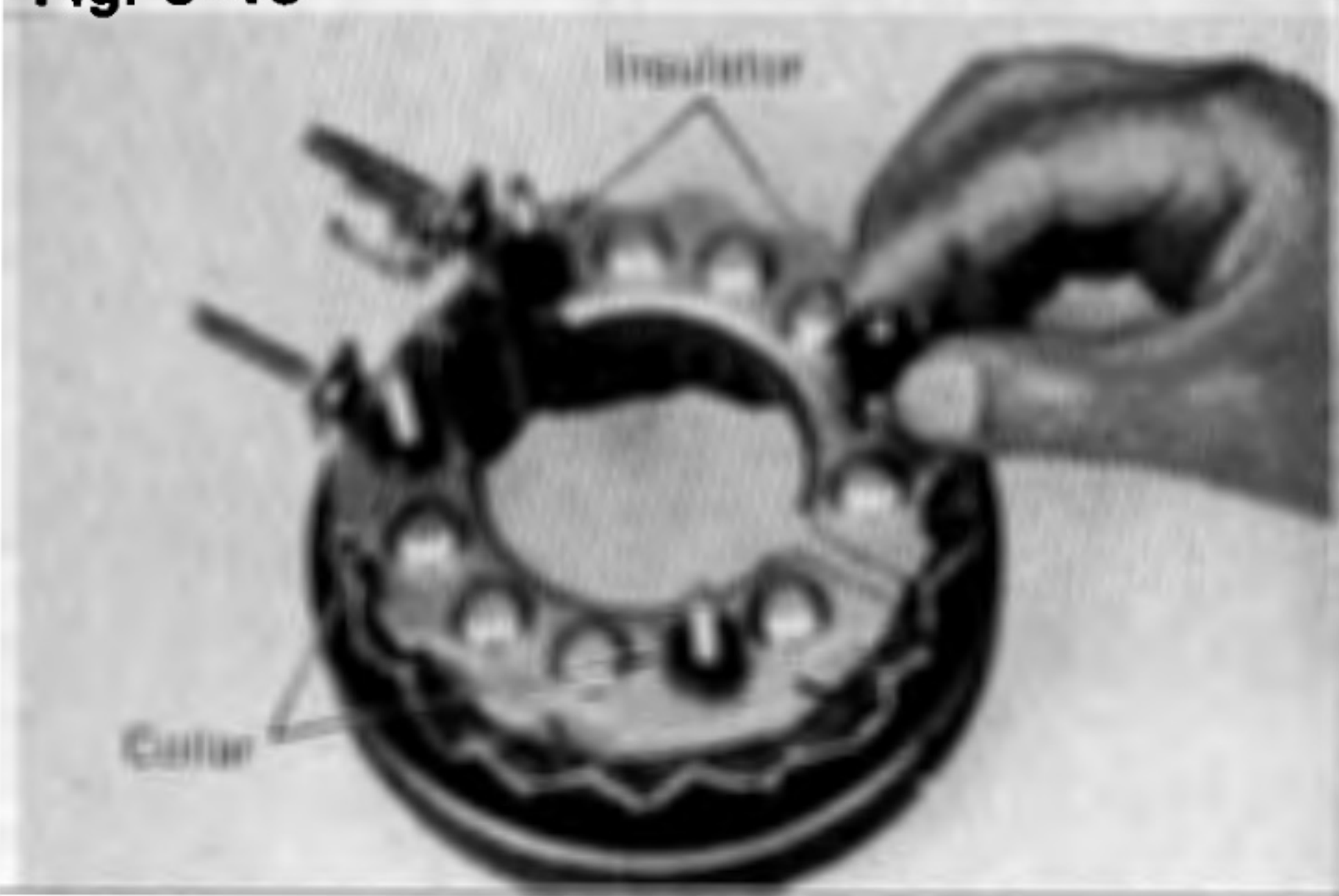
Fig. 9-44



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

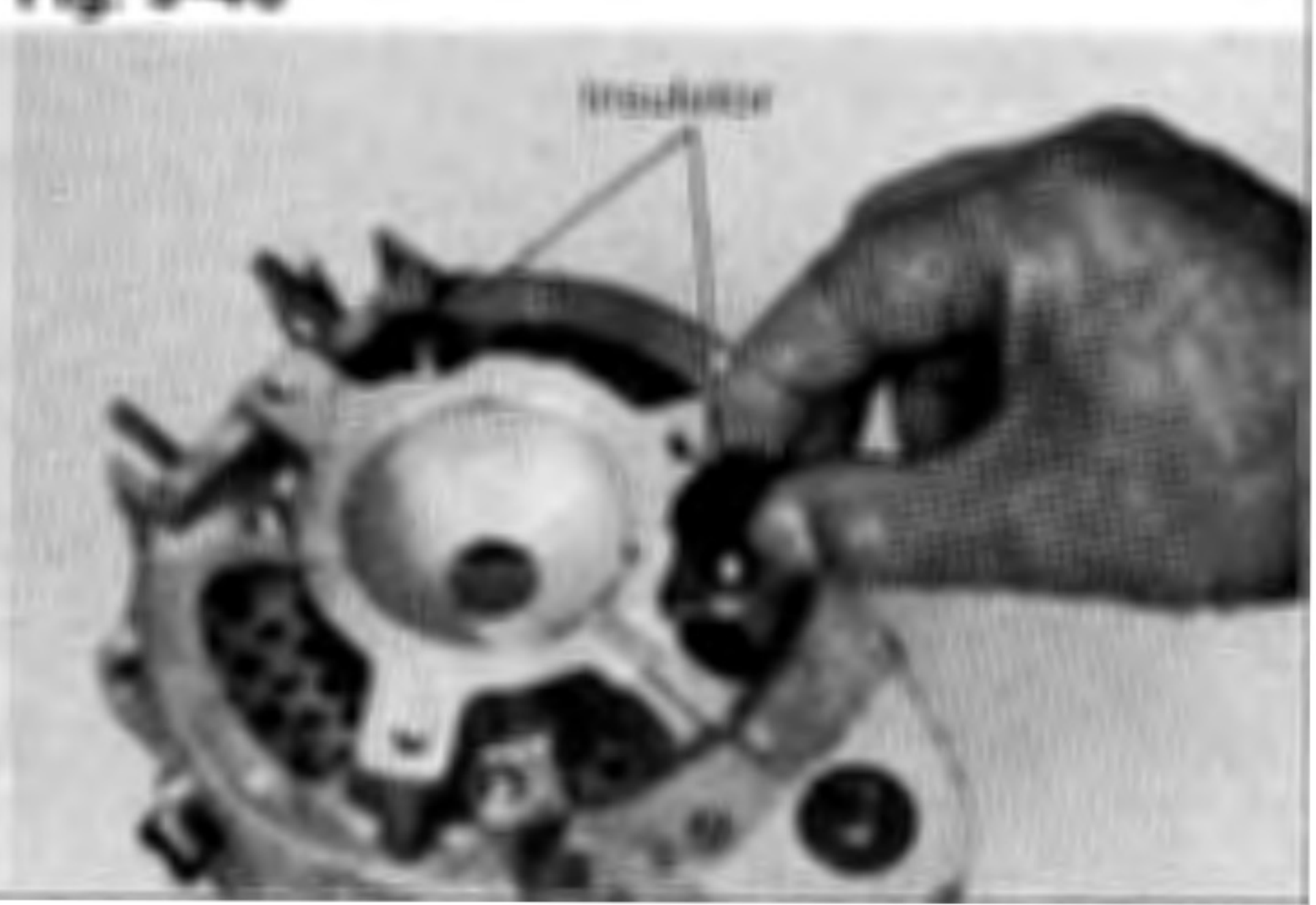
—Note—
When soldering the leads, hold the rectifier terminal with a long nose pliers to protect the rectifier from heat.

Fig. 9-45



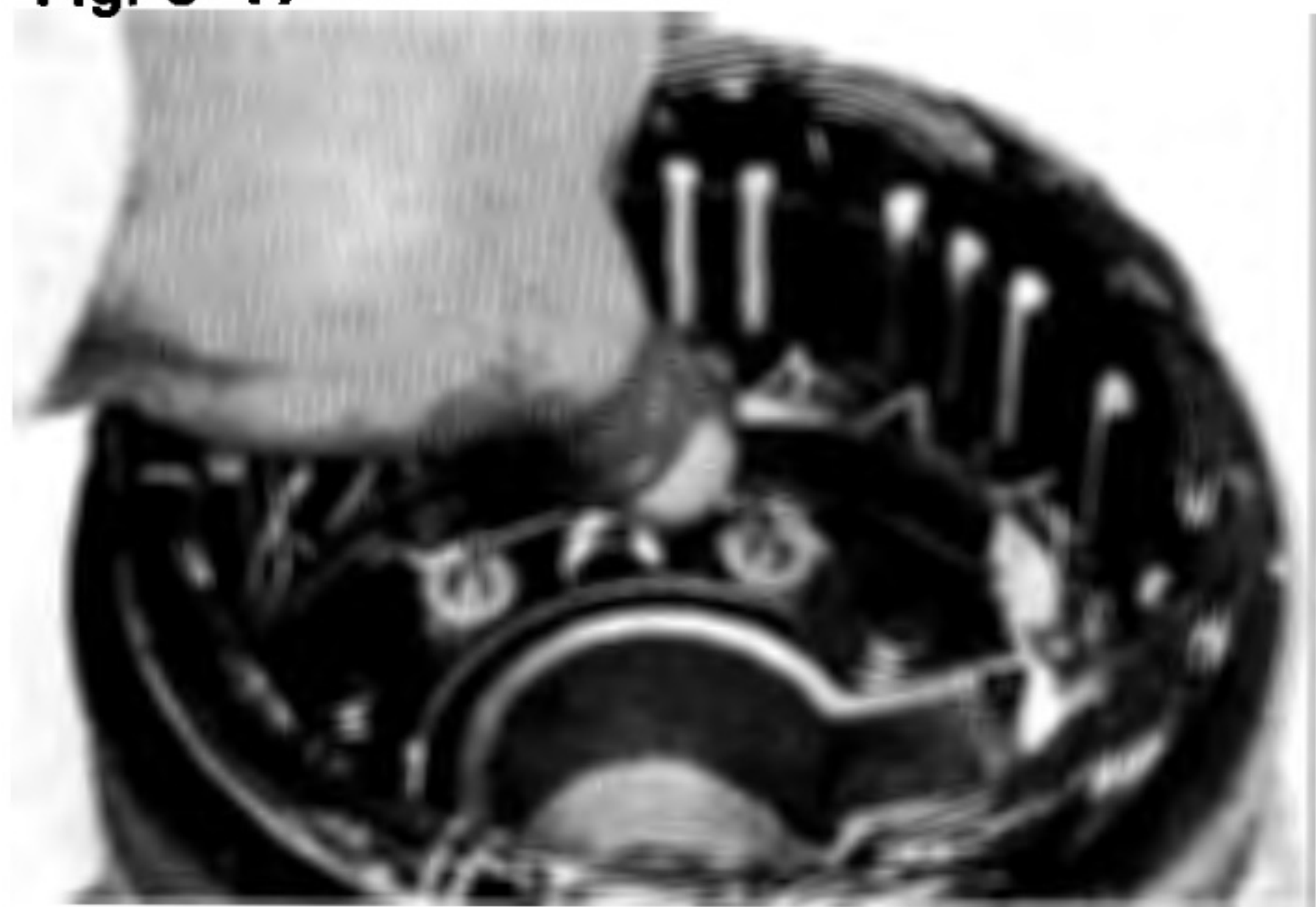
Install the insulator to the rectifier (+) holder and the collar to (-) holder.

Fig. 9-46



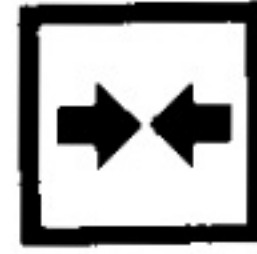
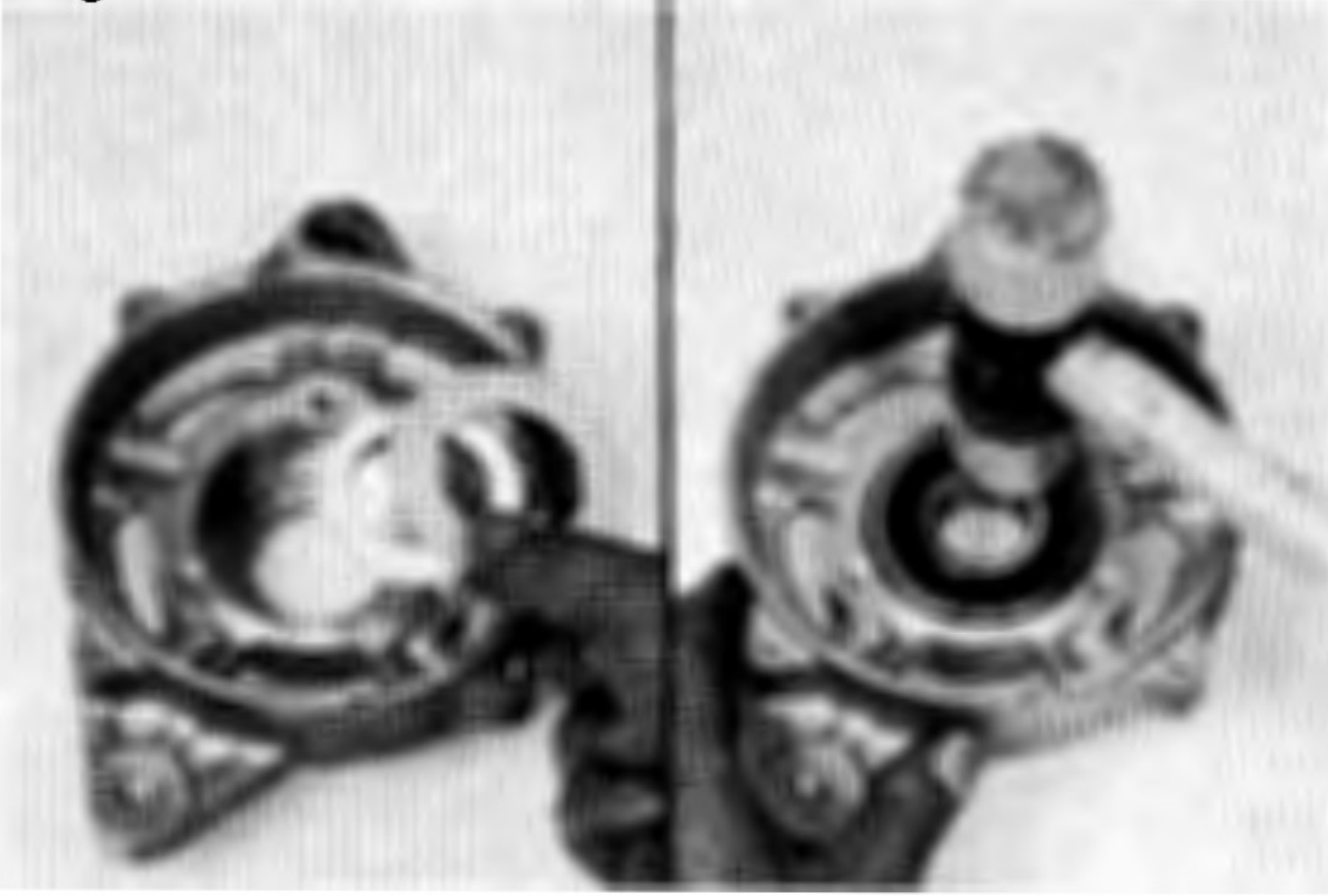
Assemble the rectifier end frame with the insulators.

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

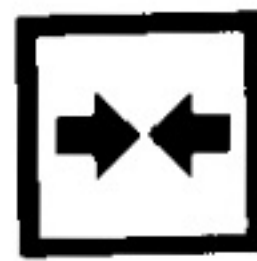
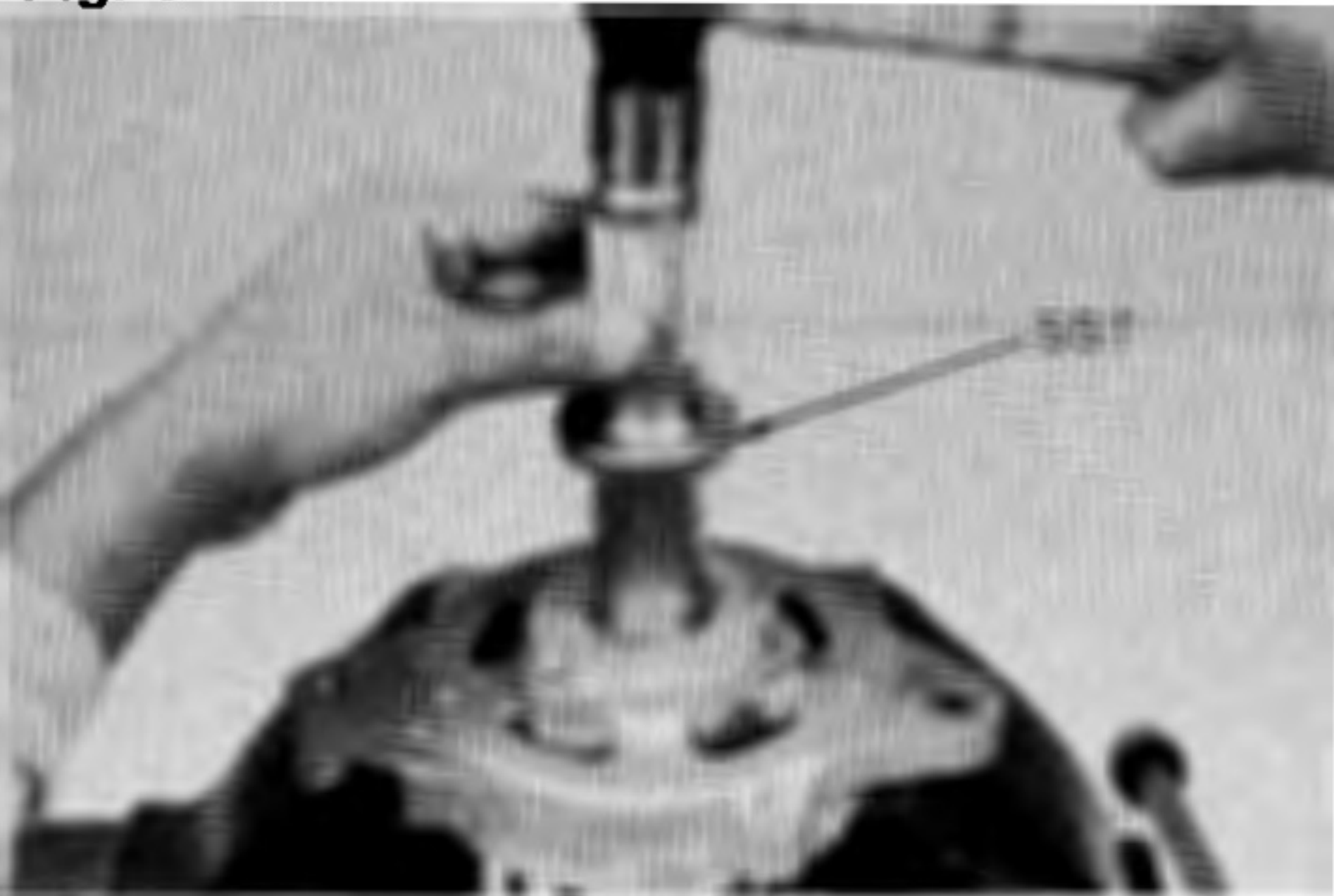


Install the bearing and retainers.

—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]

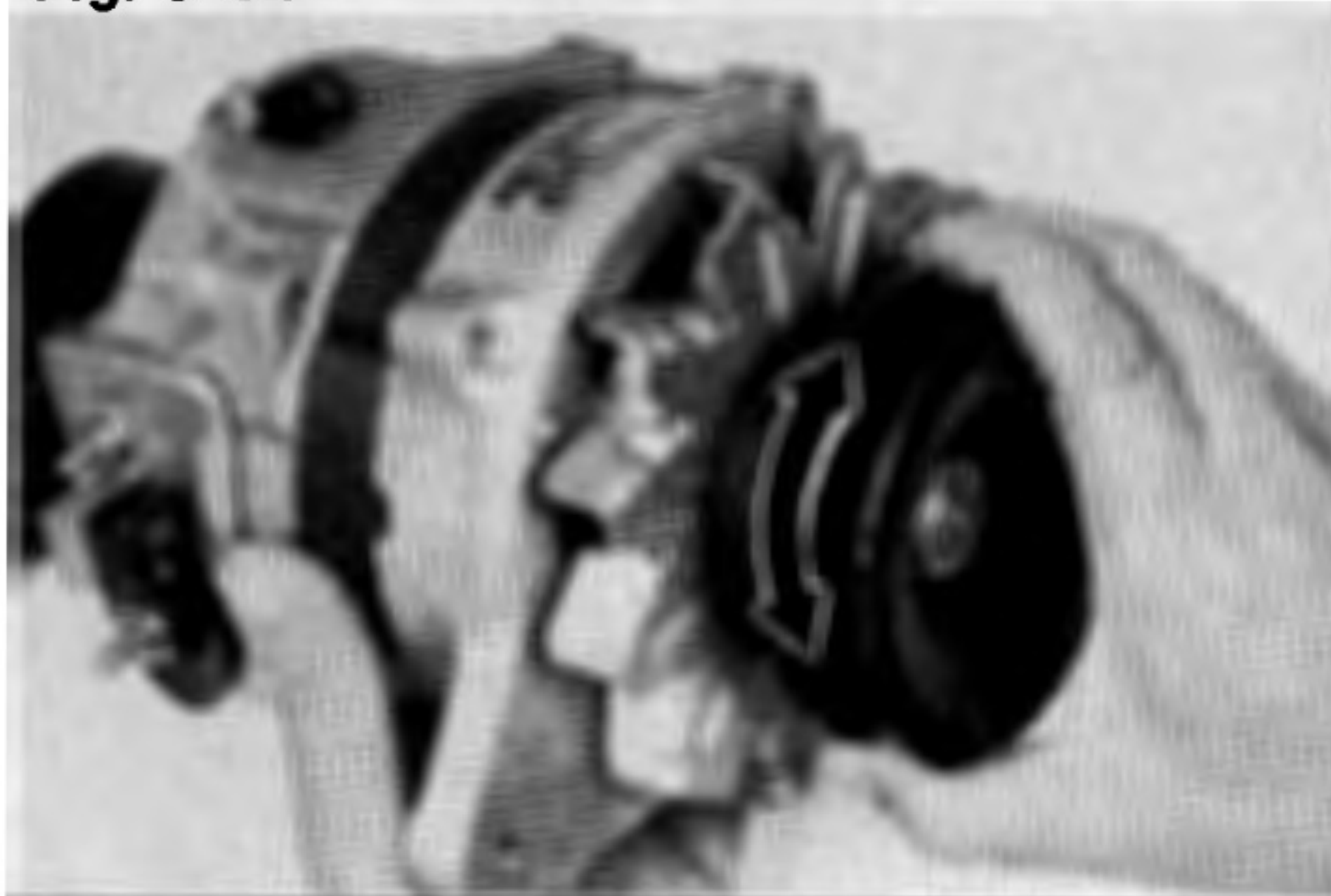
Fig. 9-50



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

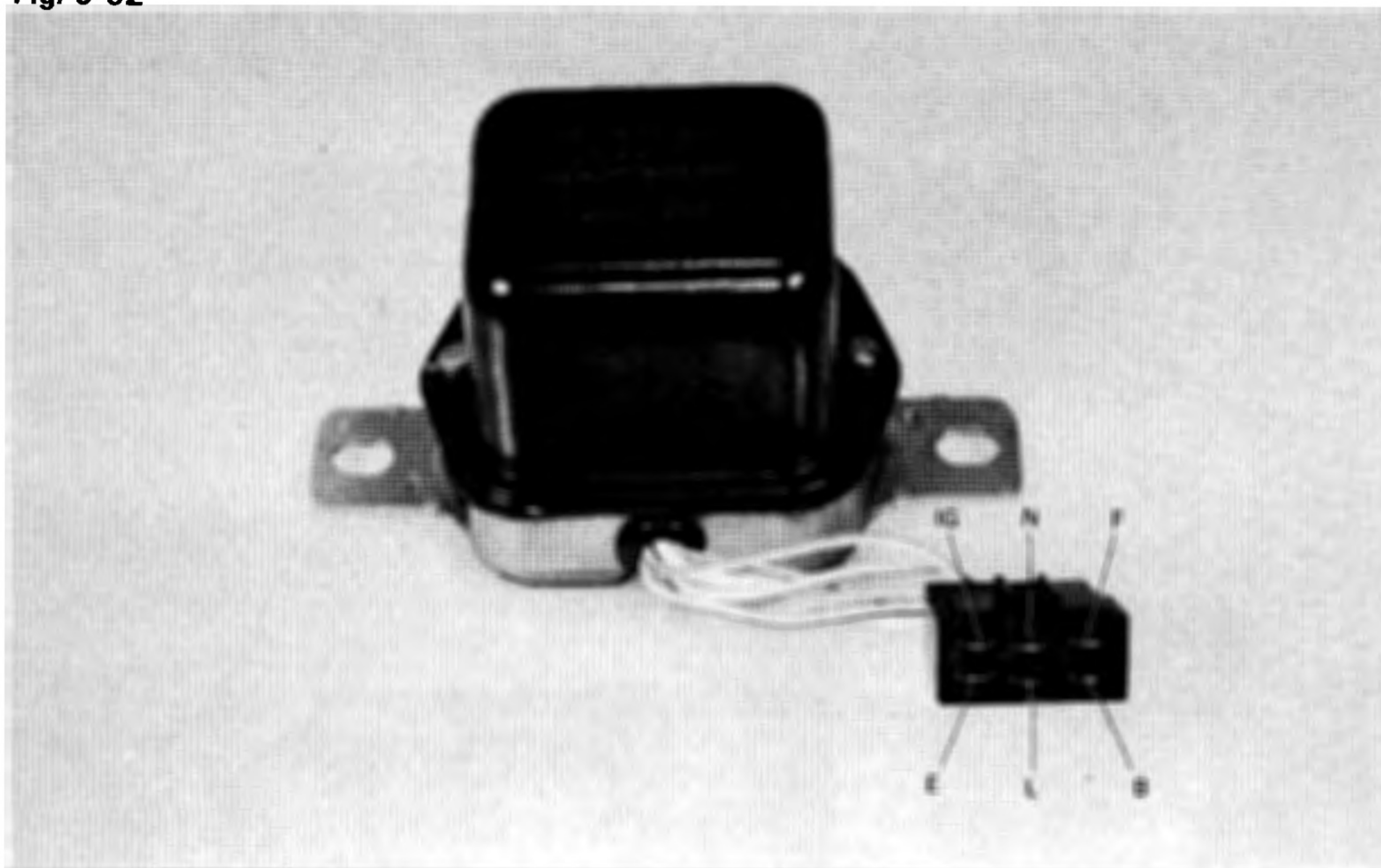


Fig. 9-53



INSPECTION & ADJUSTMENT

Check the connector fitting condition before inspecting the regulator.

—Note—

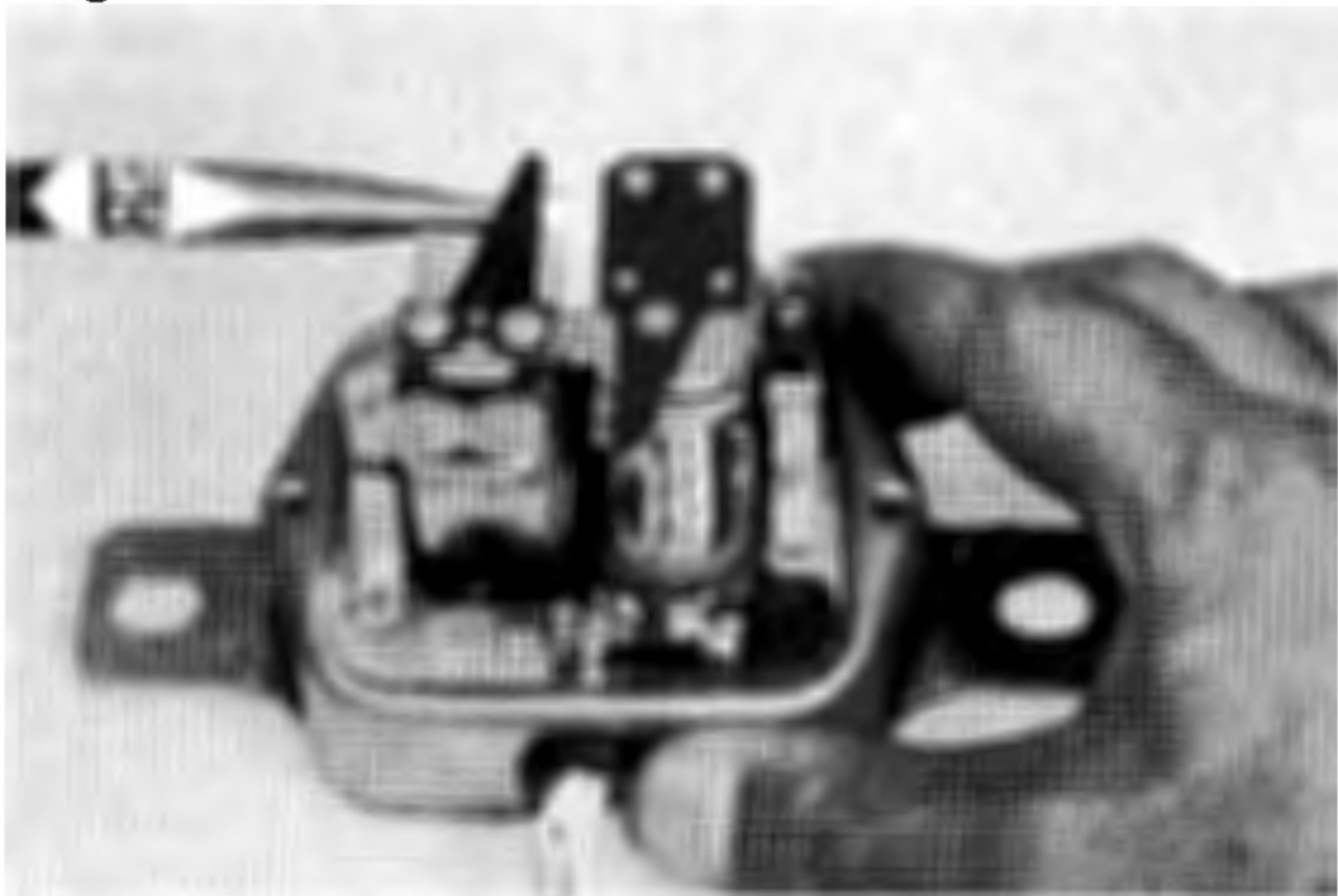
Make sure that the regulator connector is pulled out when inspecting and adjusting.

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

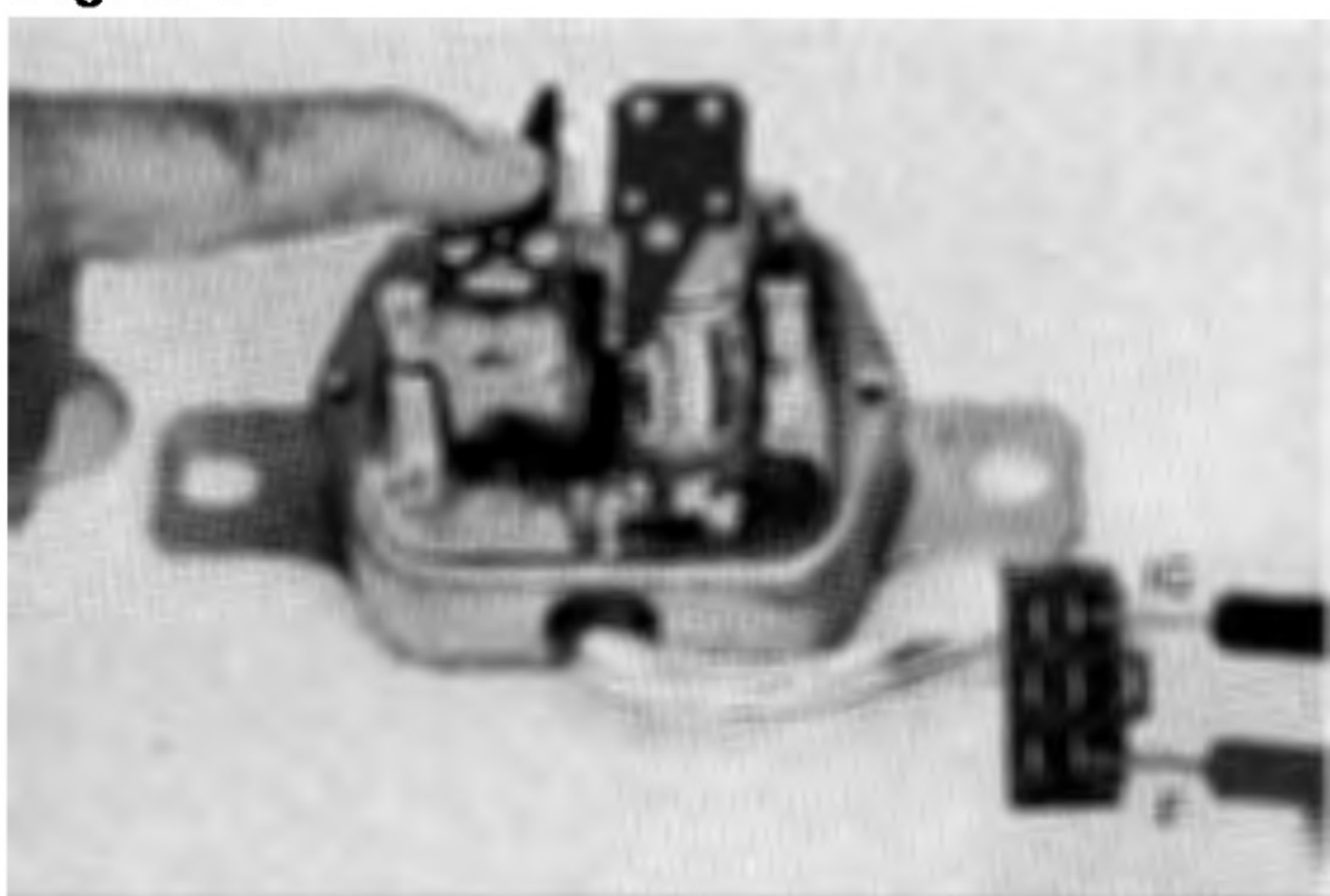
Fig. 9-56



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

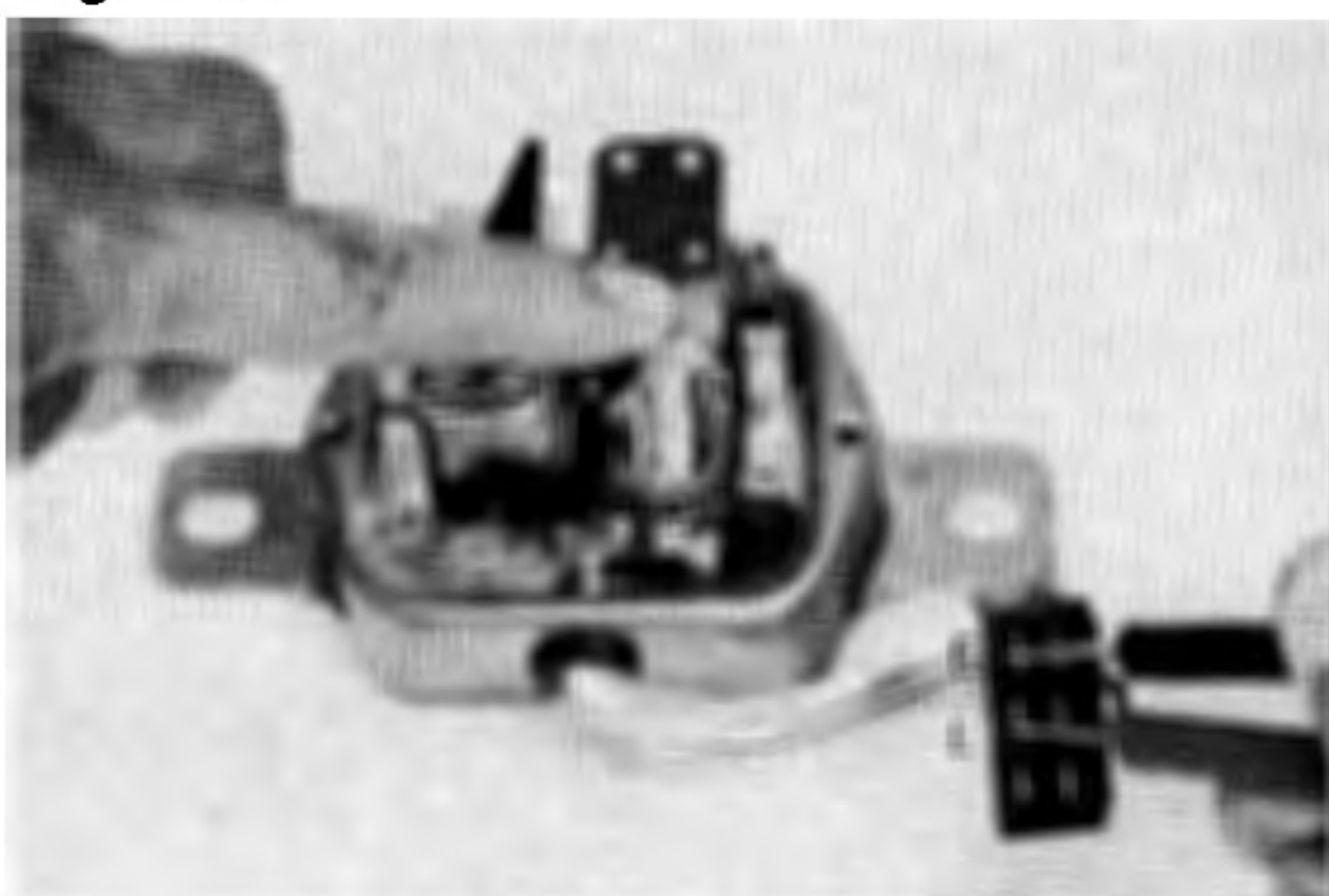


Resistance measurement between the terminals.

IG — F

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

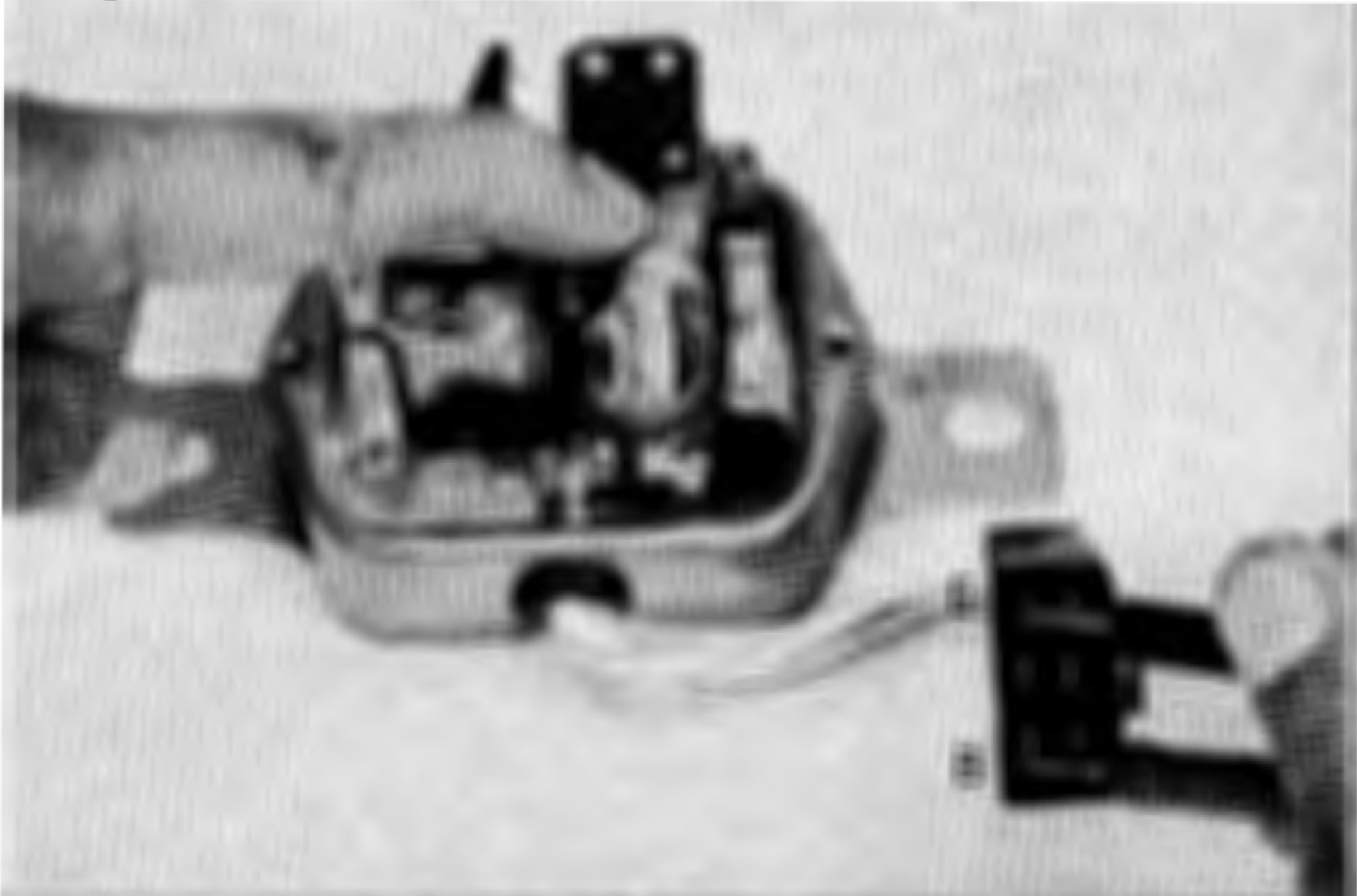
Fig. 9-58



L — E

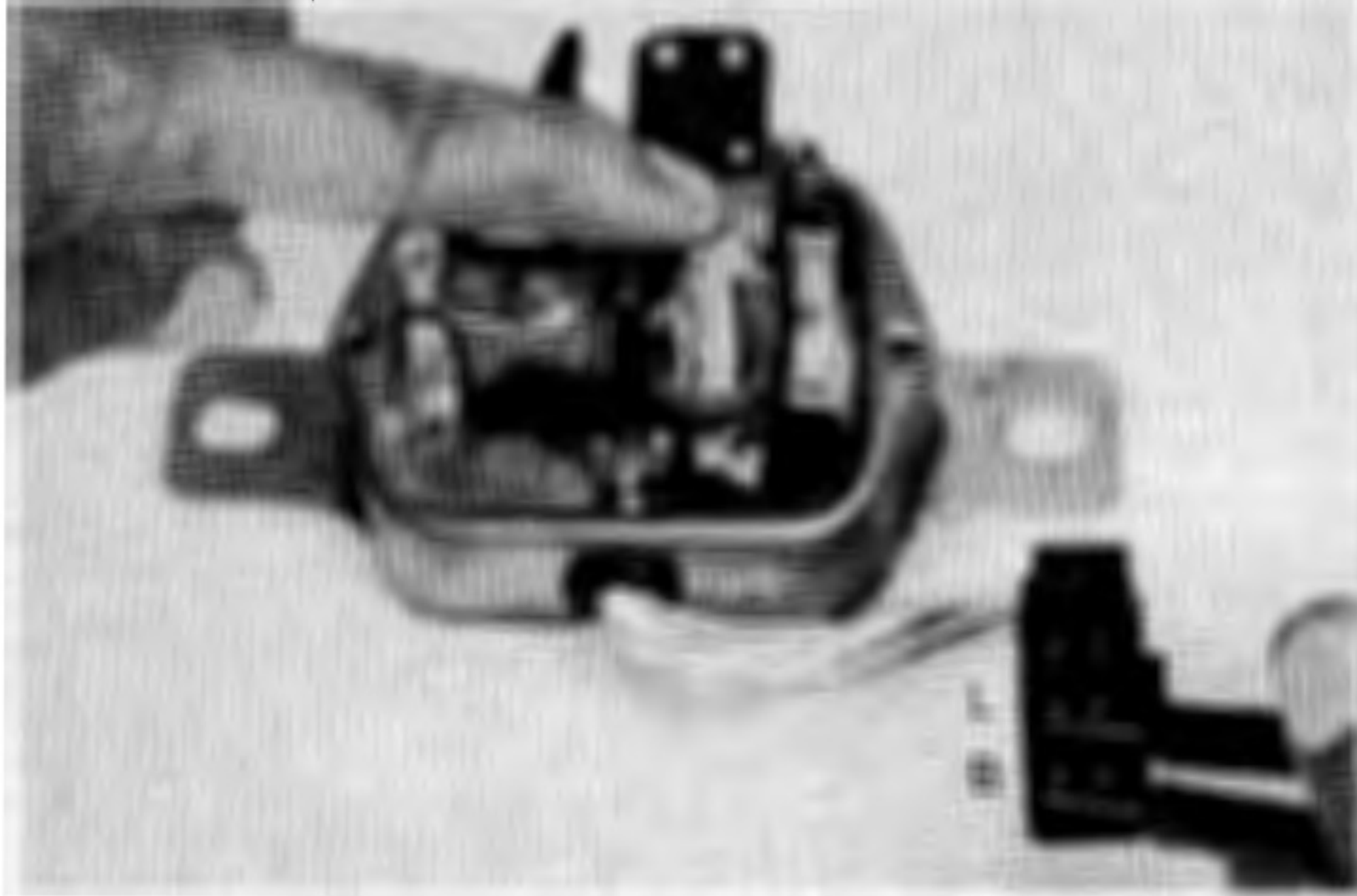
Voltage relay	12V type	24V type
Open	0 Ω	0 Ω
Closed	Approx. 100 Ω	Approx. 200 Ω

Fig. 9-59



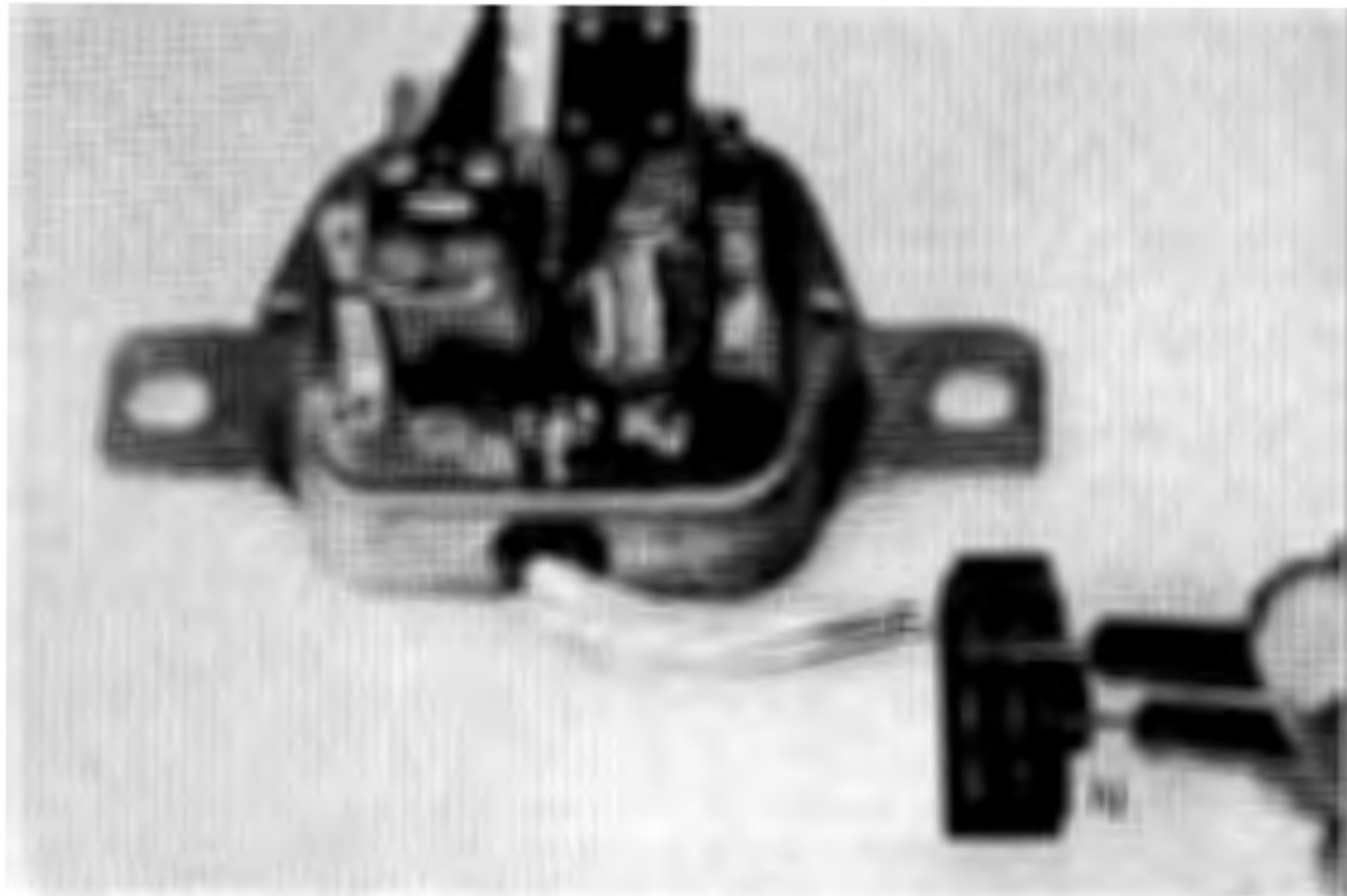
B — E		
Voltage relay	12V type	24V type
Open	Infinity	Infinity
Closed	Approx. 100 Ω	Approx. 200 Ω

Fig. 9-60



B — L		
Voltage relay	12V type	24V type
Open	Infinity	Infinity
Closed	0 Ω	0 Ω

Fig. 9-61

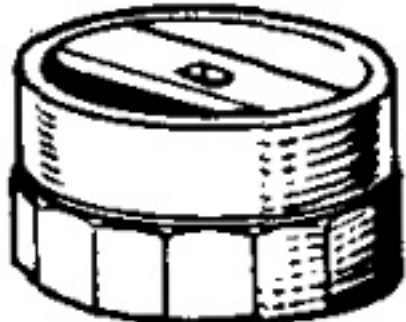


N — E		
12V type	Approx. 24 Ω	
24V type	Approx. 100 Ω	

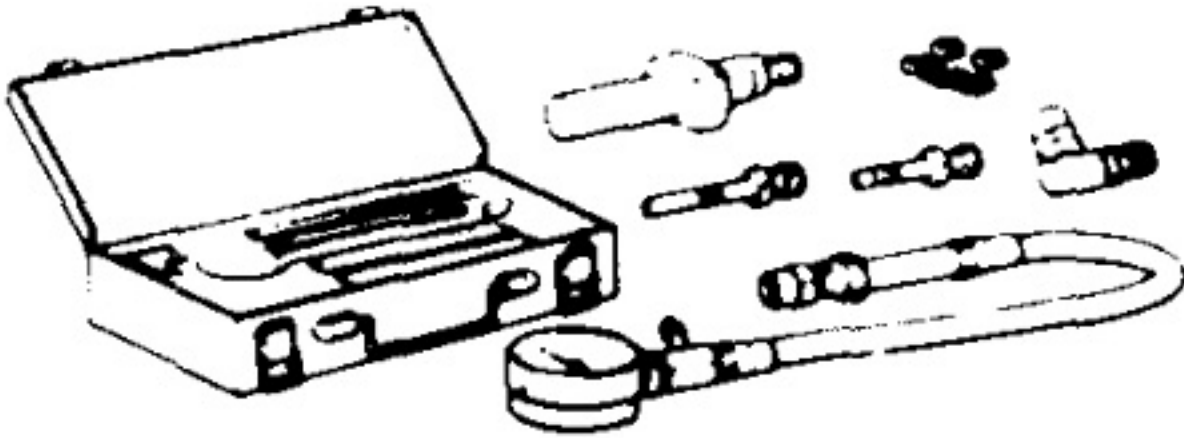
SST & SERVICE SPECIFICATIONS

	Page
SST (SPECIAL SERVICE TOOLS)	10-2
STANDARD BOLT TIGHTENING TORQUE	10-12
TIGHTENING TORQUE FOR MAIN PARTS	10-14
SERVICE SPECIFICATIONS	10-15

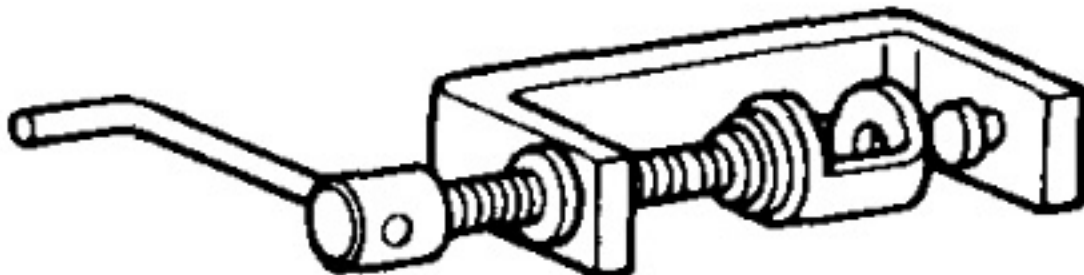
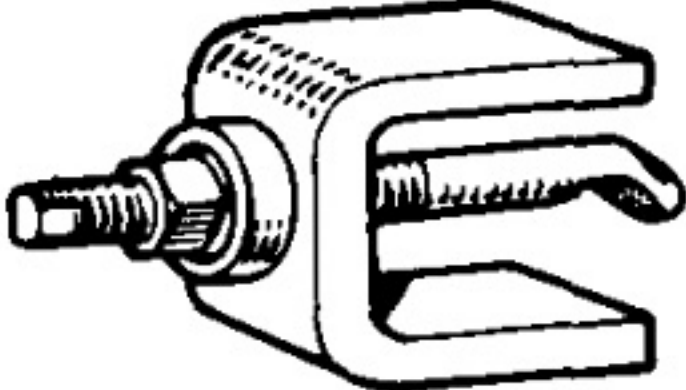
SST (SPECIAL SERVICE TOOLS)**ENGINE TUNE-UP****Oil Filter**

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

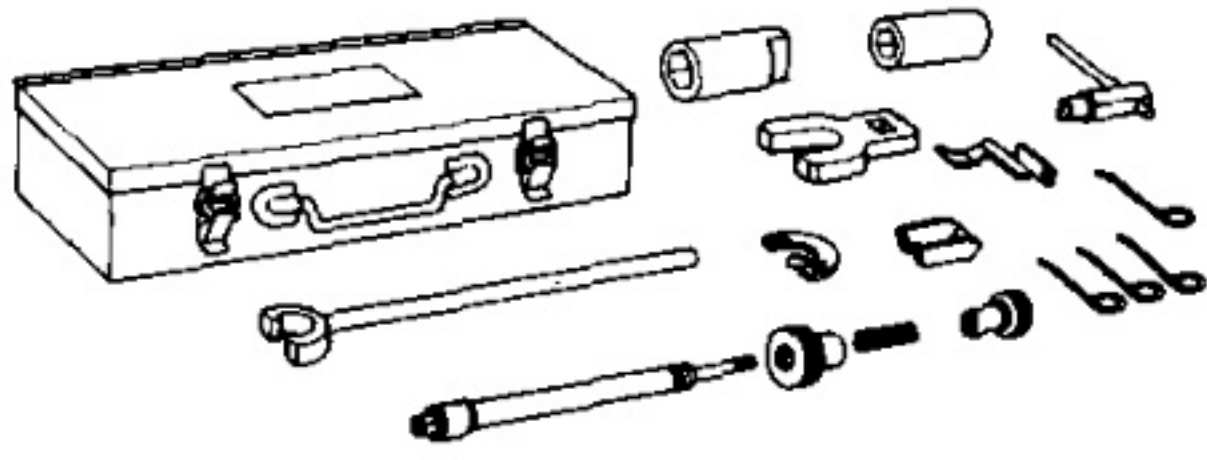
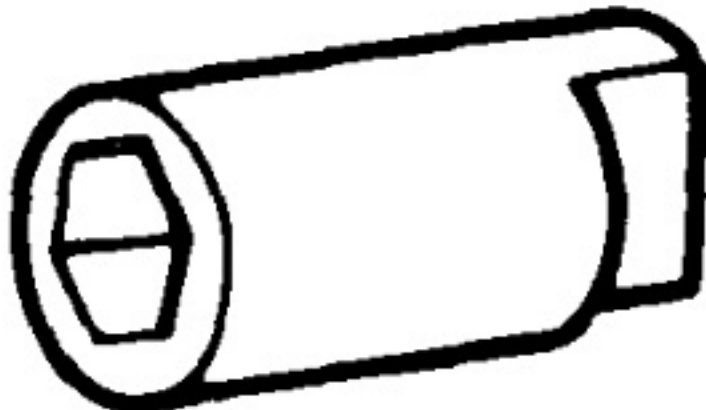
Compression Pressure

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

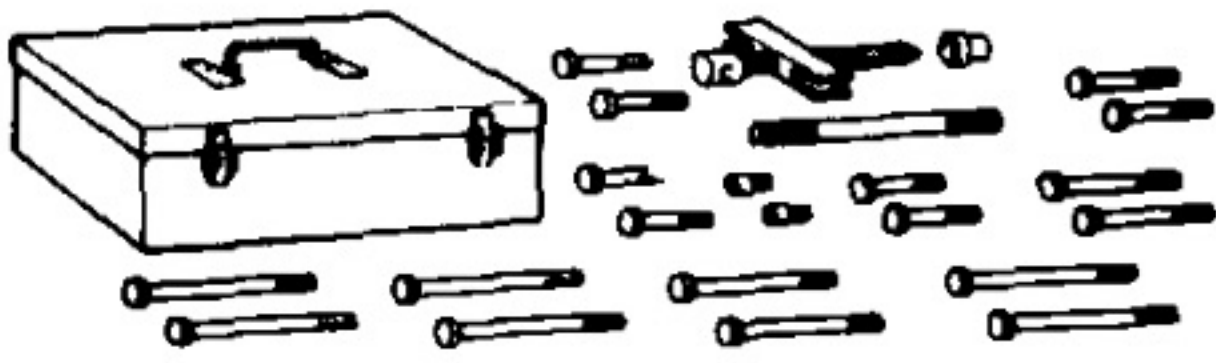
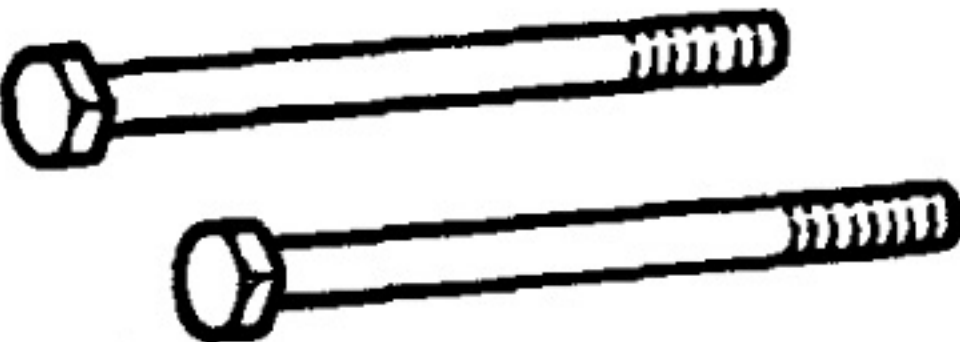
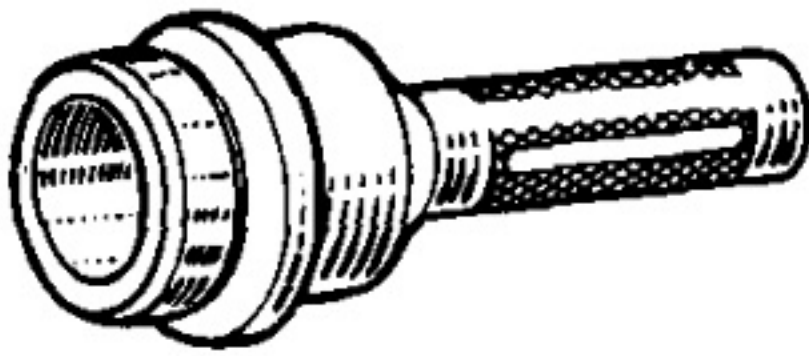
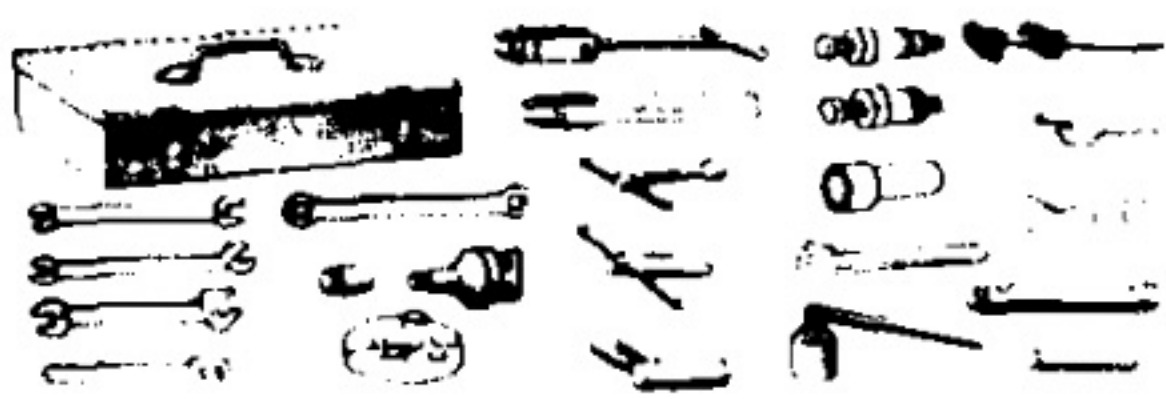
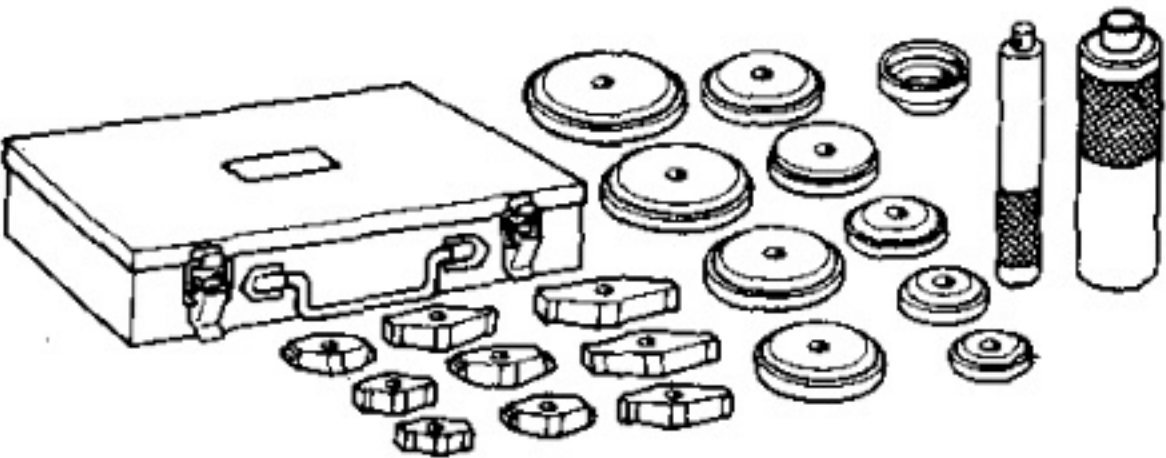
ENGINE SERVICE**Cylinder Head**

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

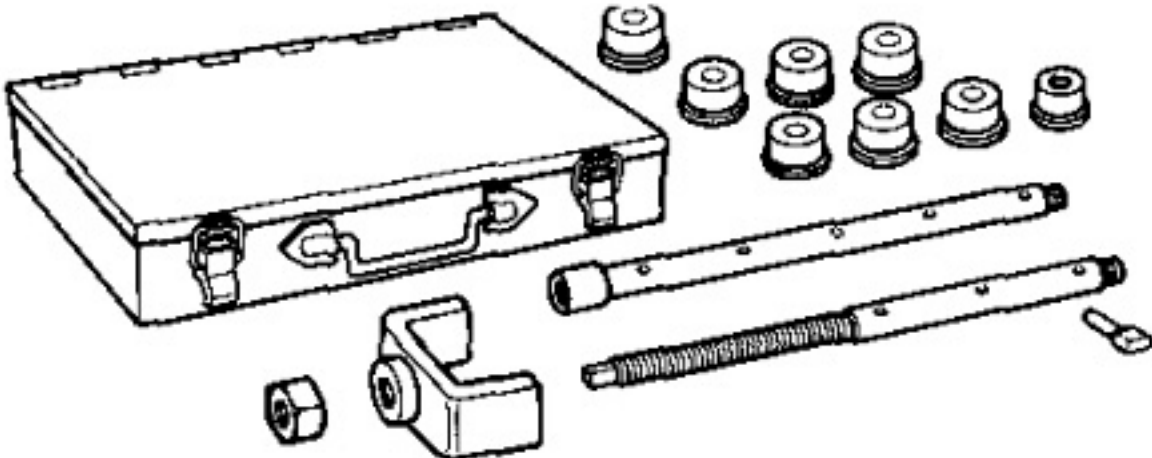
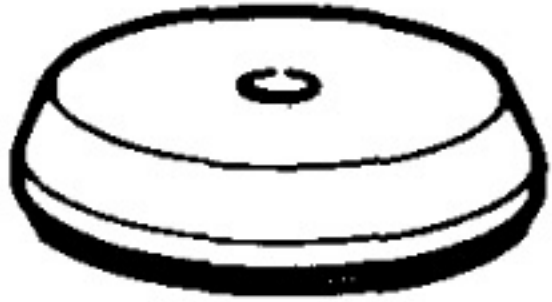
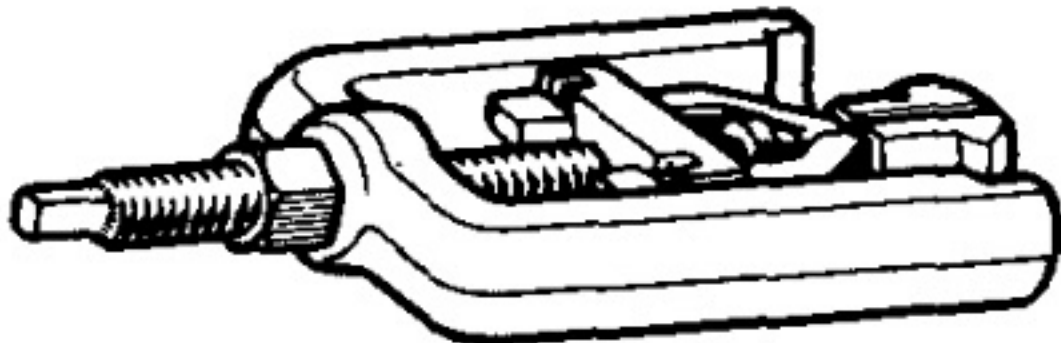
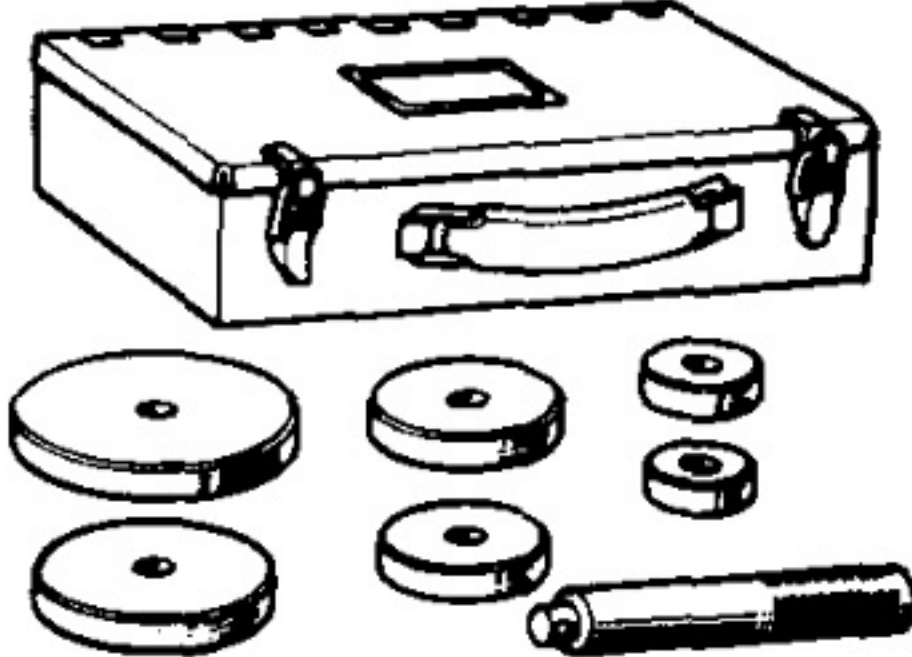
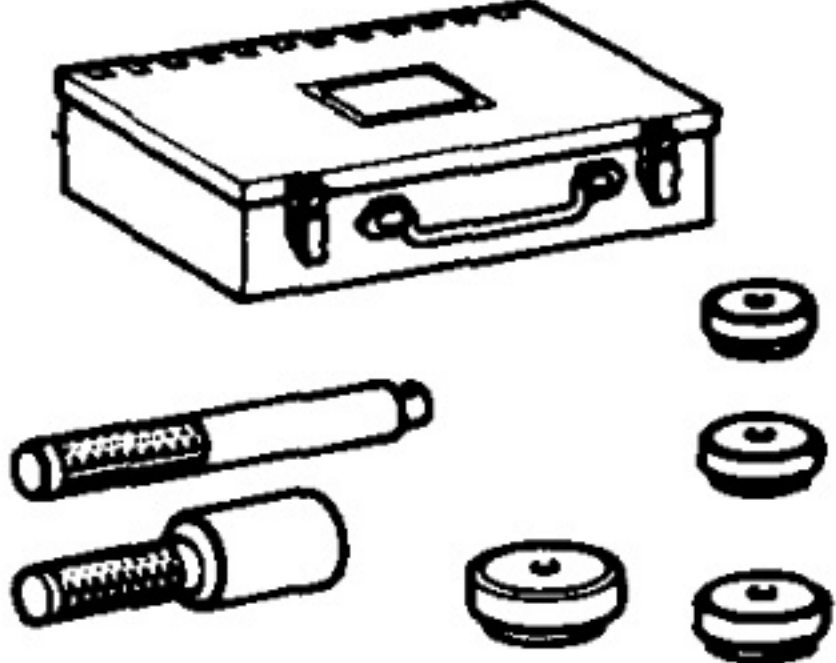
Cylinder Head (Cont'd)

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

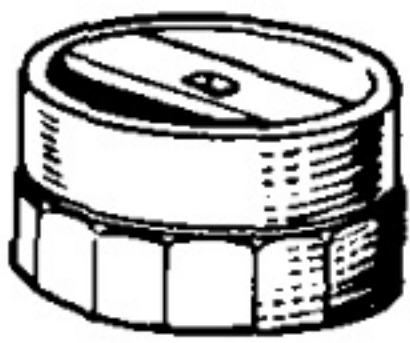
Timing Gear

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

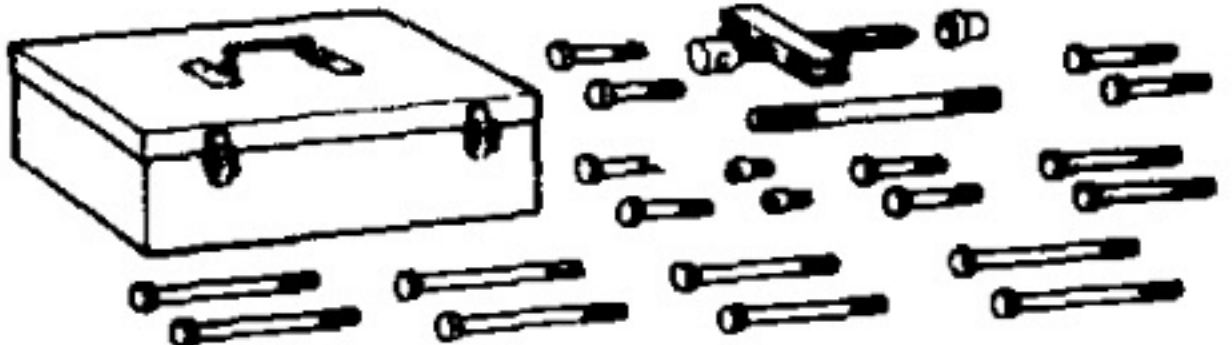
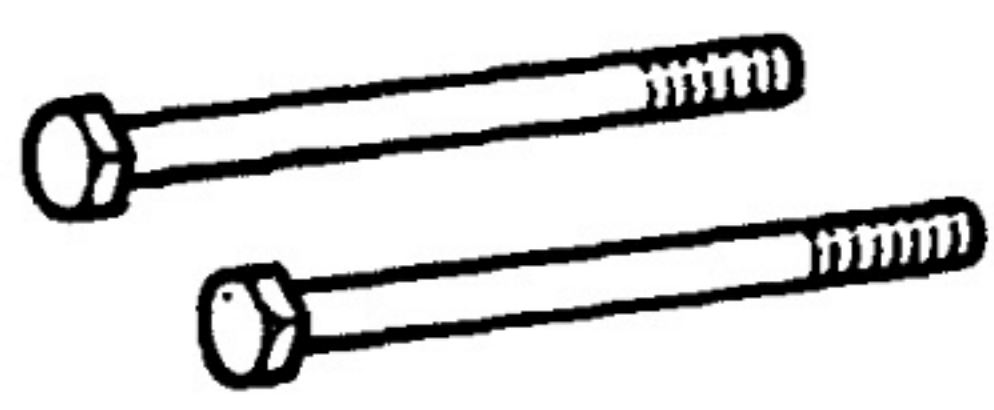
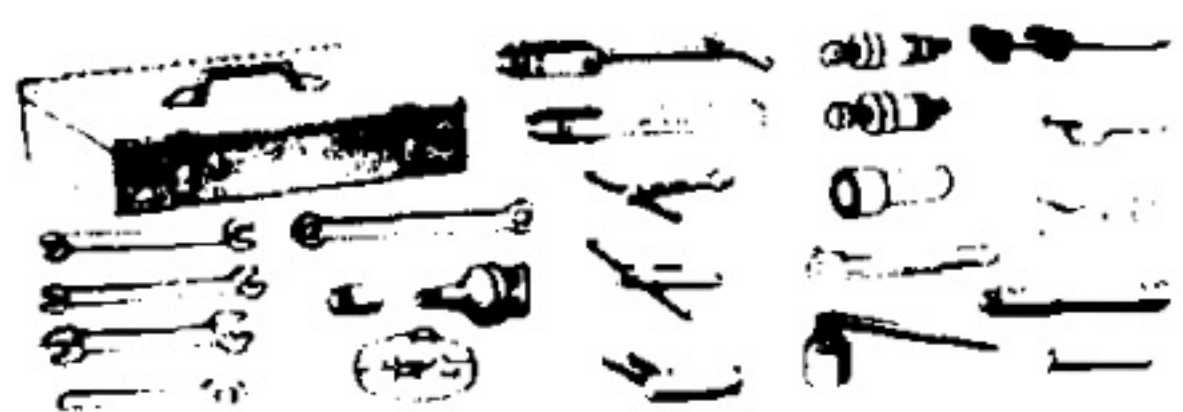
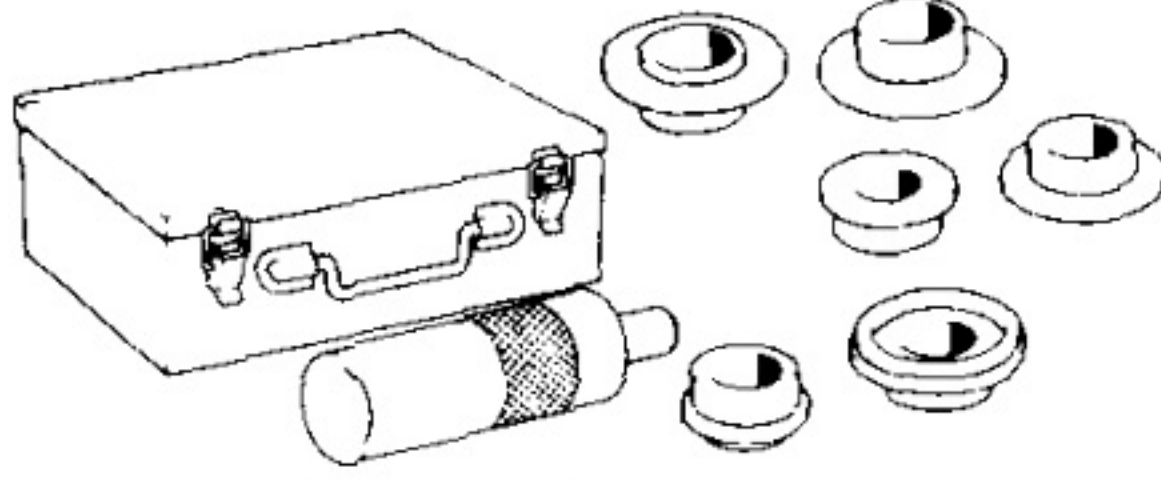
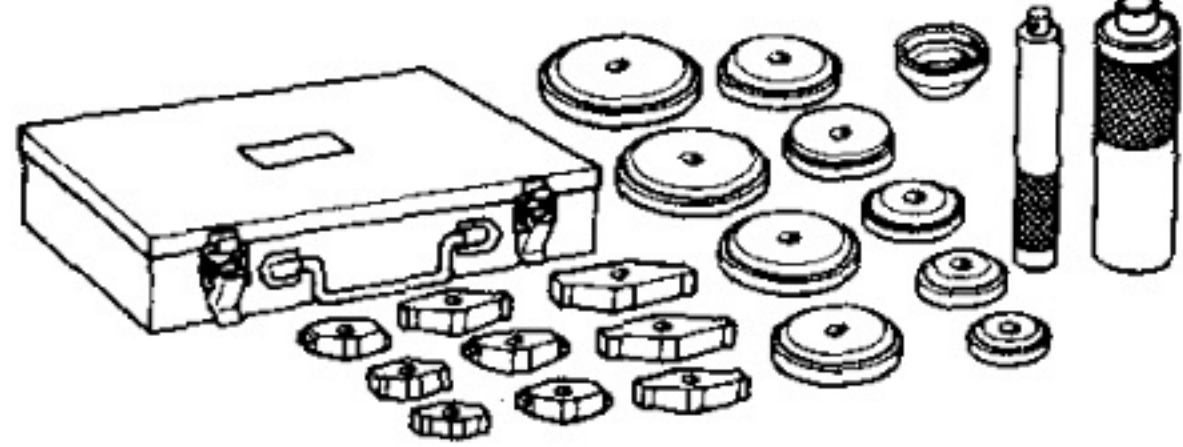
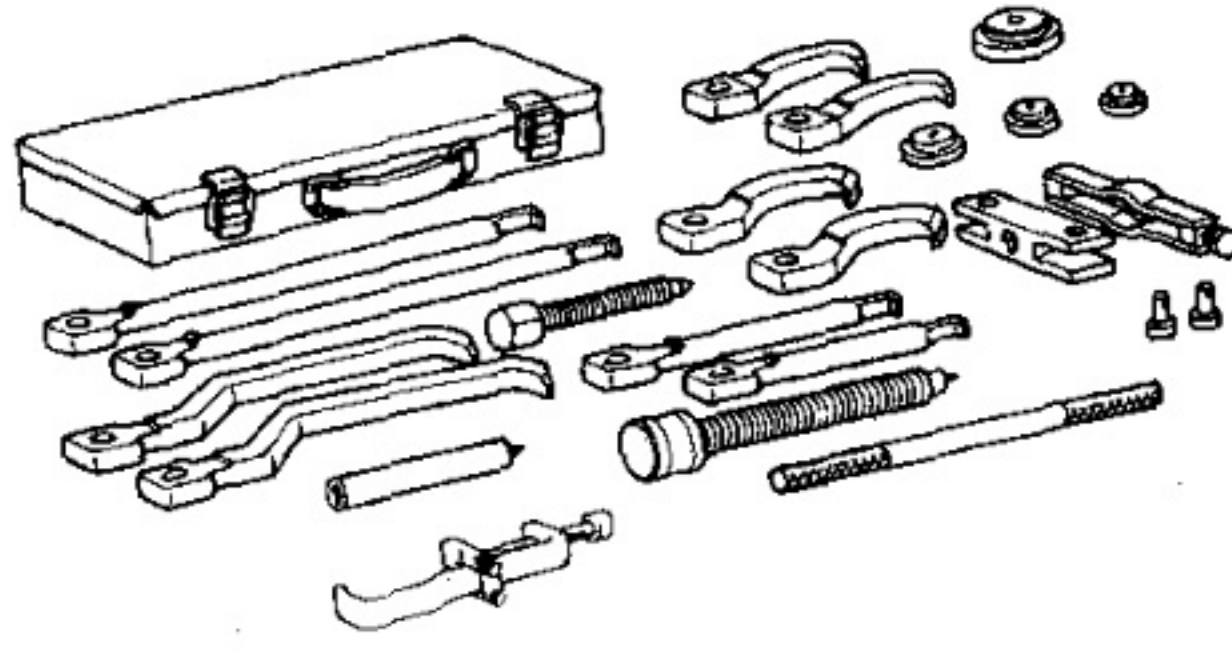
Cylinder Block

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

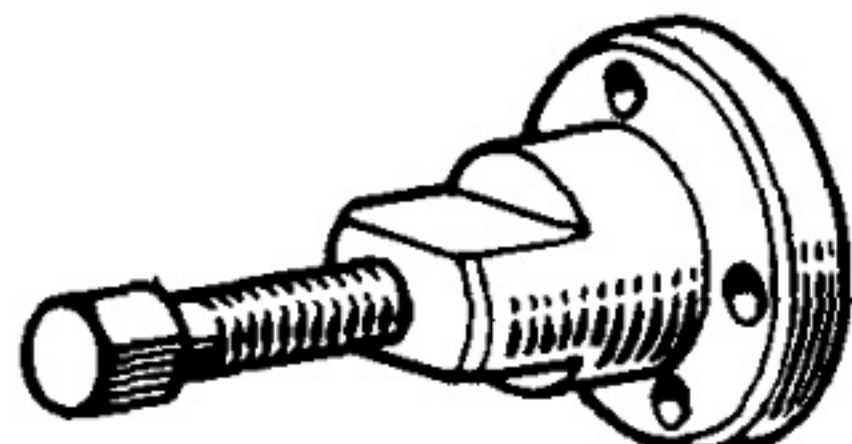
LUBRICATION SYSTEM**Oil Filter**

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

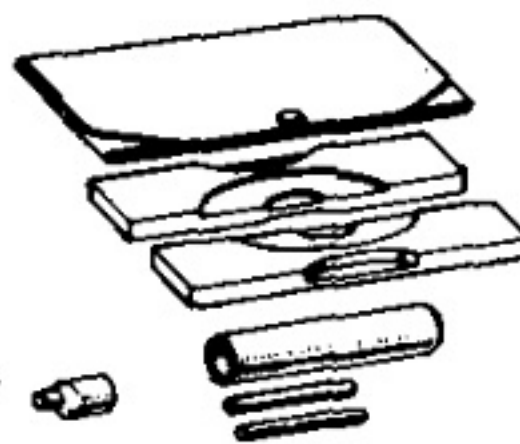
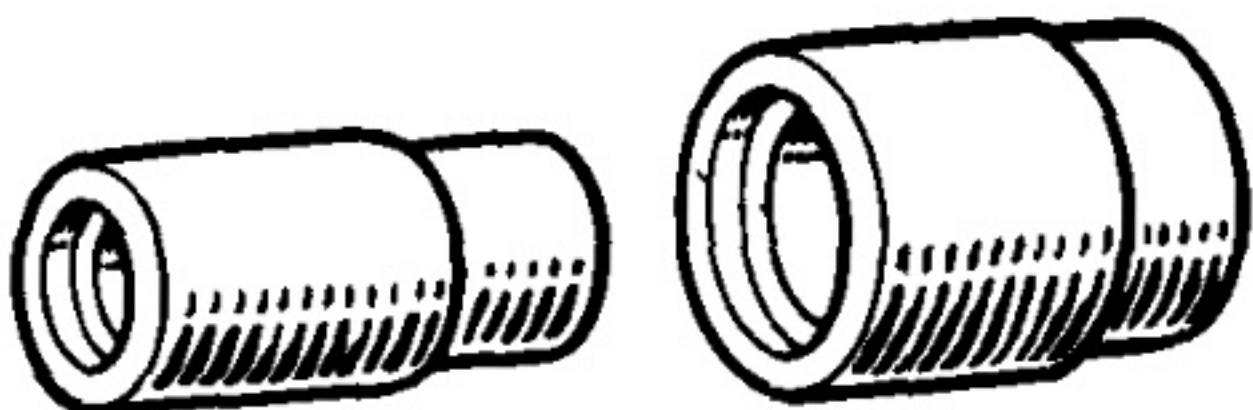
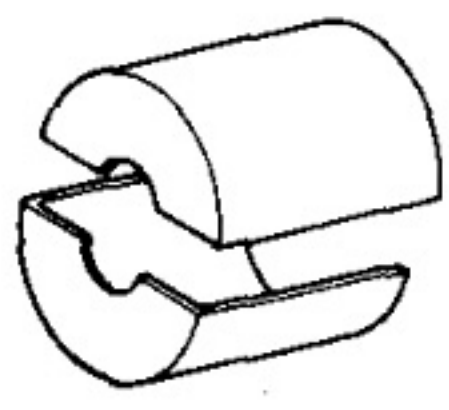
Oil Pump

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

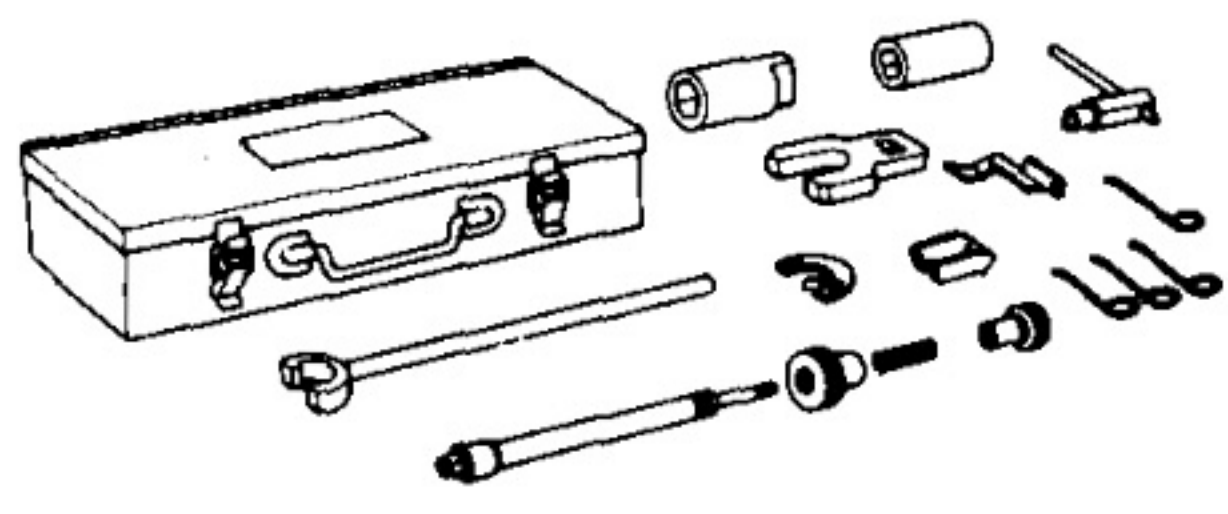
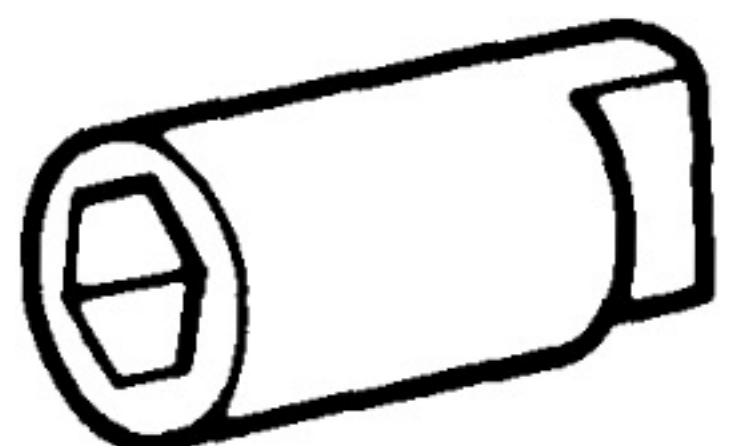
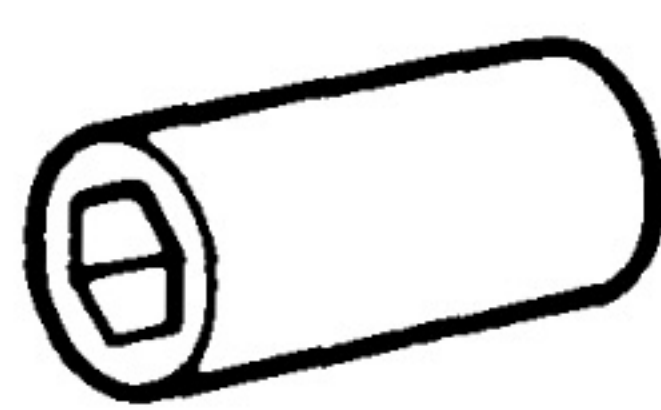
COOLING SYSTEM**Water Pump**

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

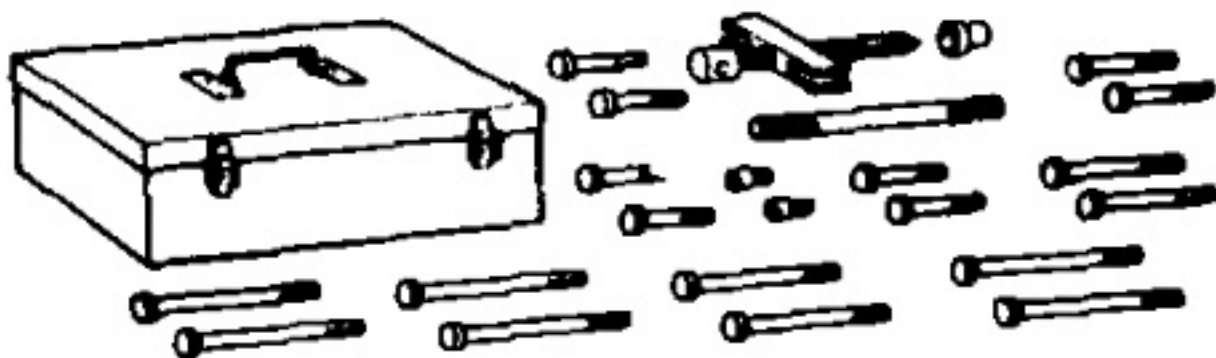
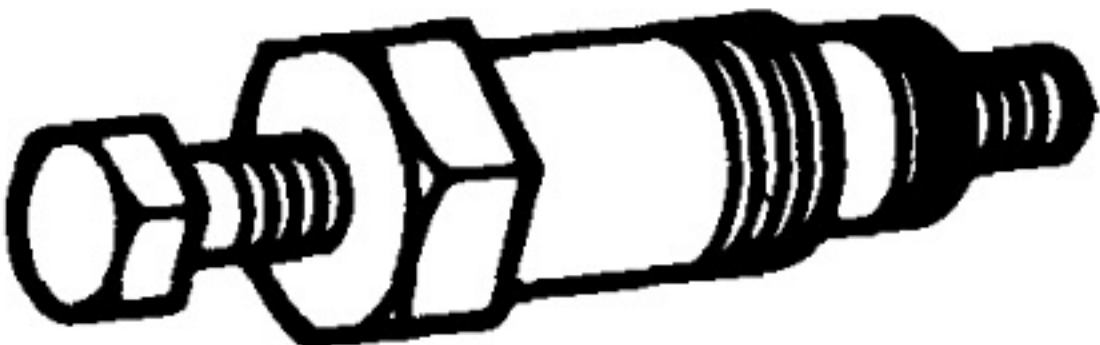
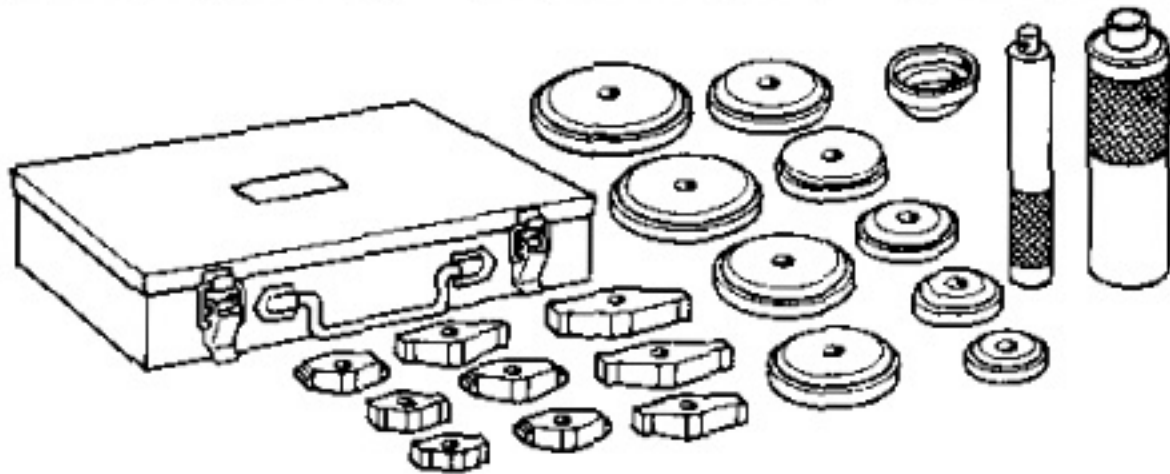
Water Pump (Cont'd)

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

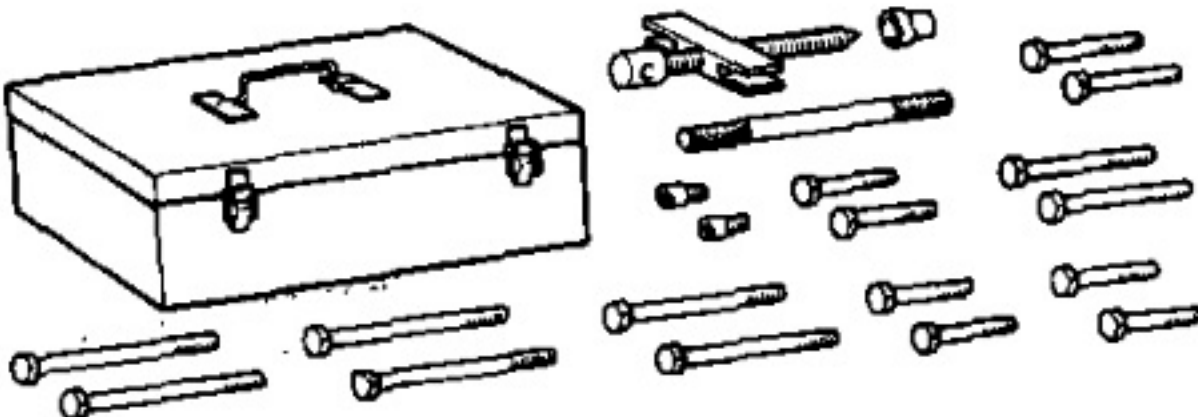
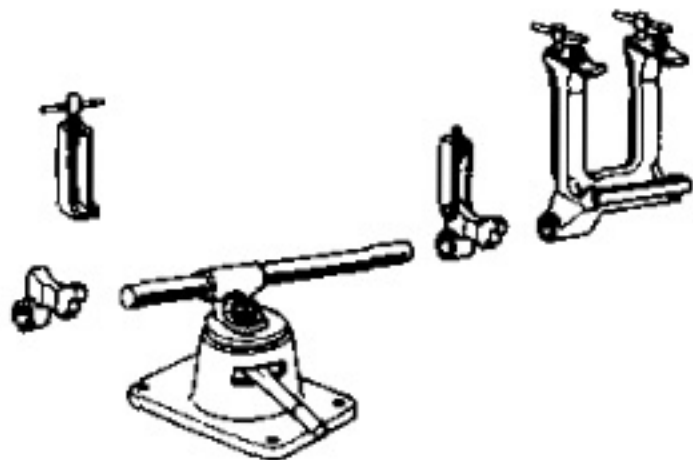
FUEL SYSTEM
Injection Nozzle

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

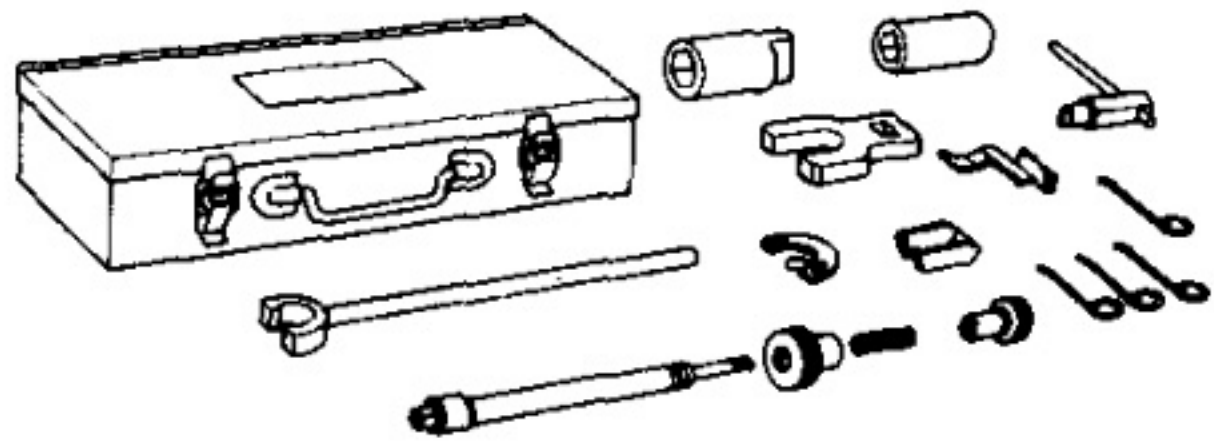
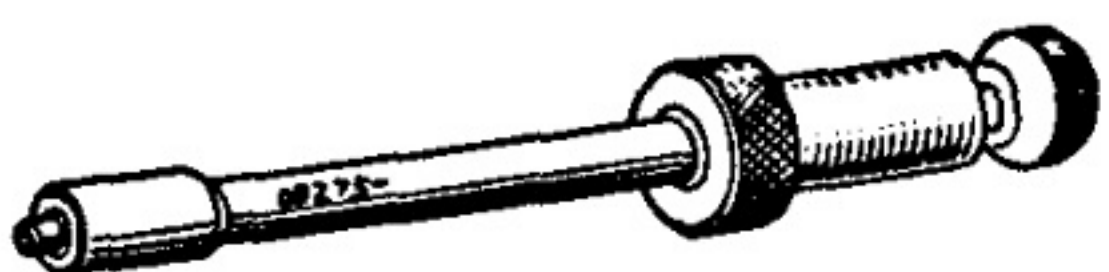
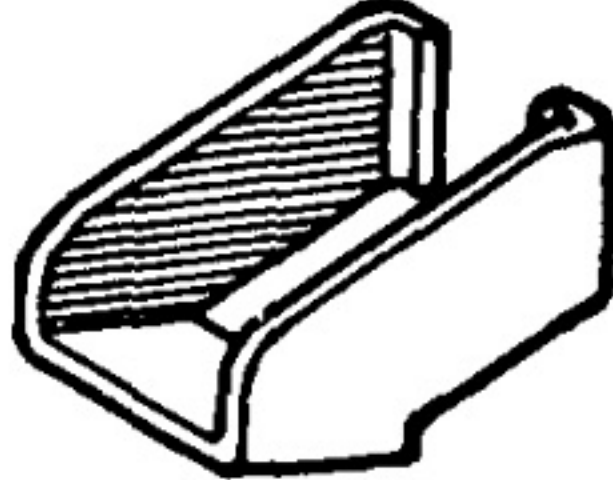
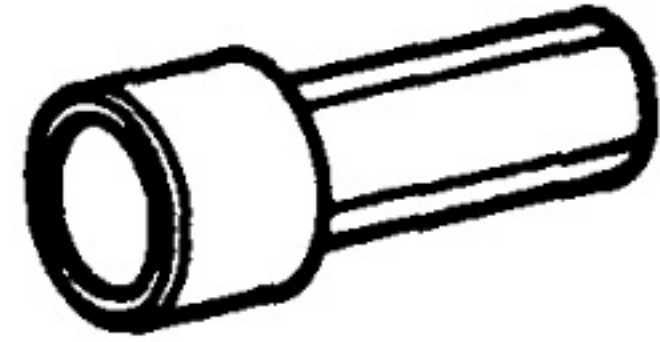
Automatic Timer

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

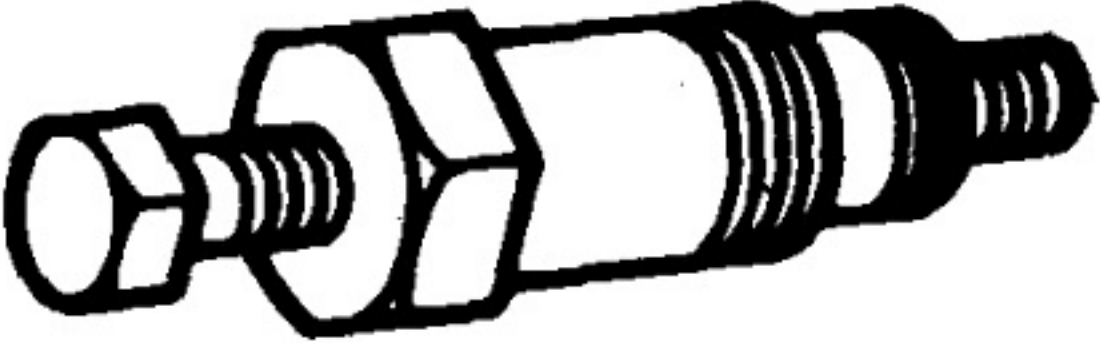
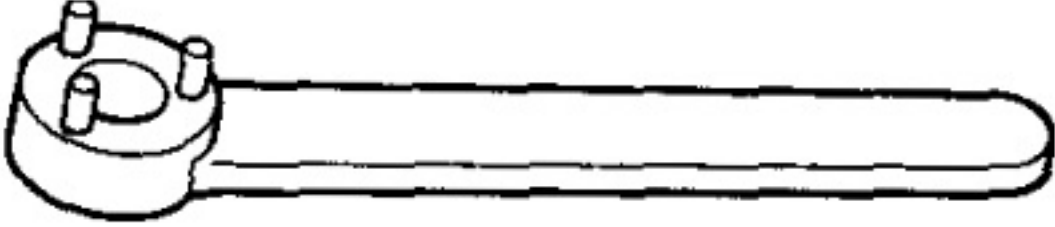
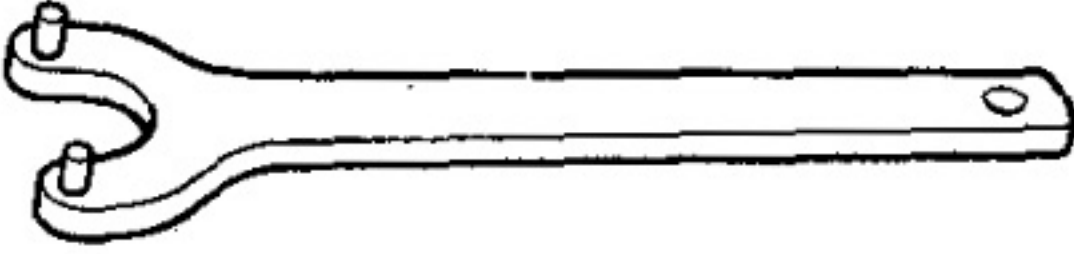
Injection Pump

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

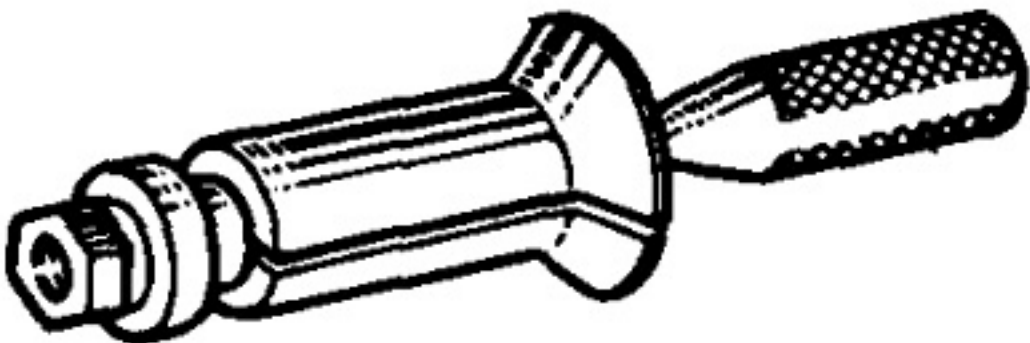
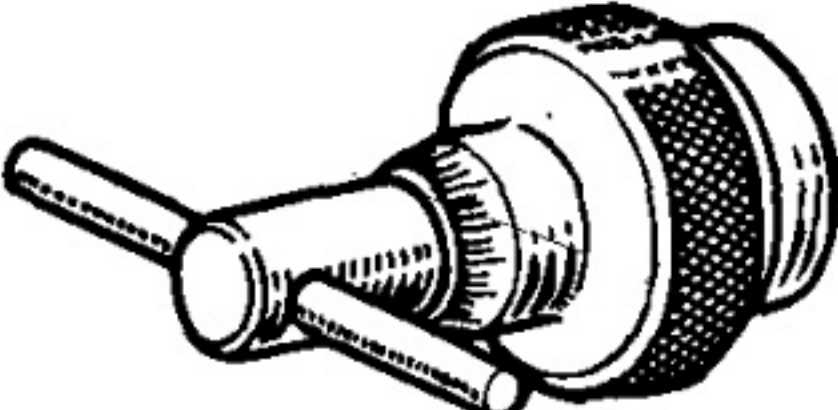
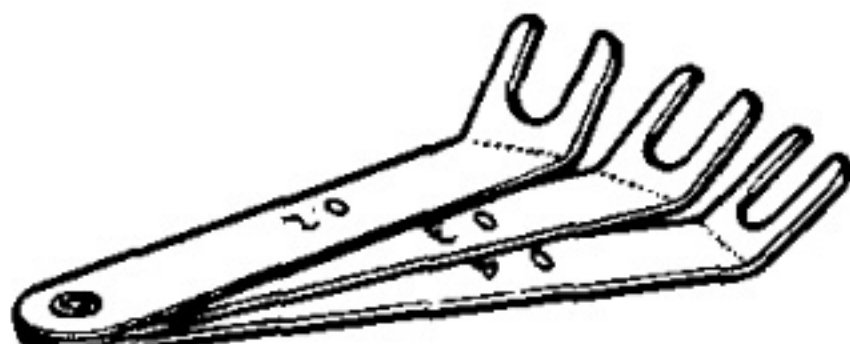
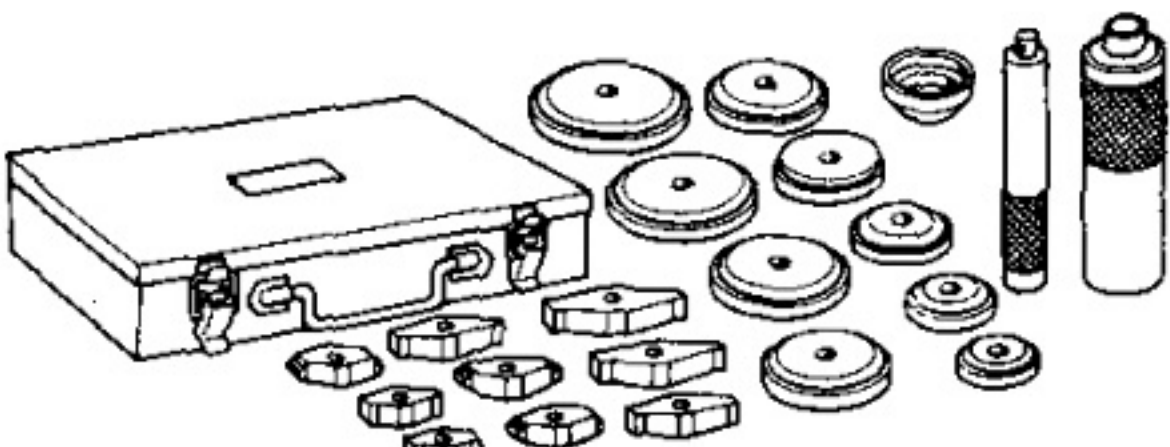
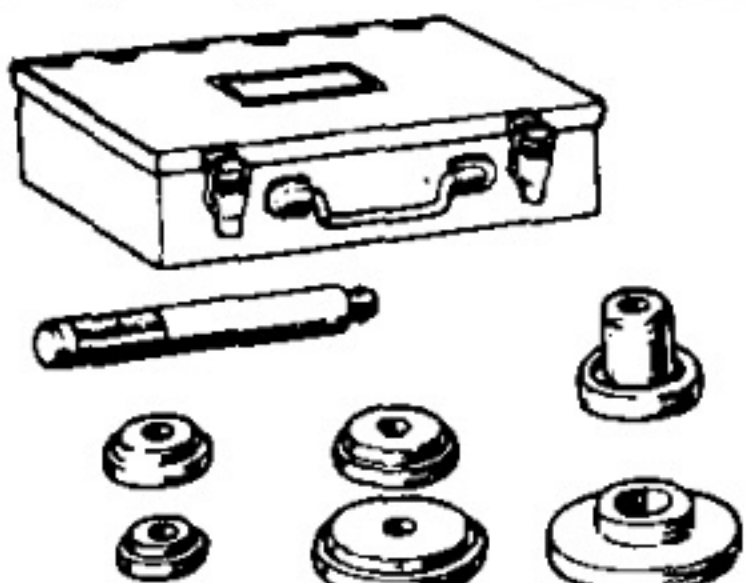
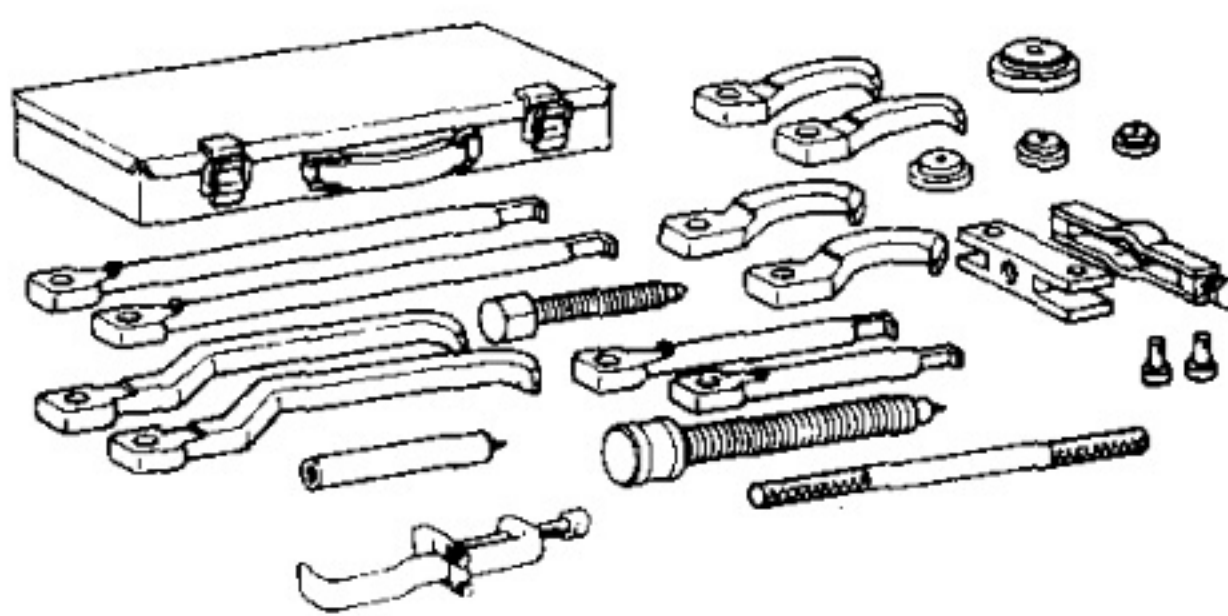
Injection Pump (Cont'd)

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)

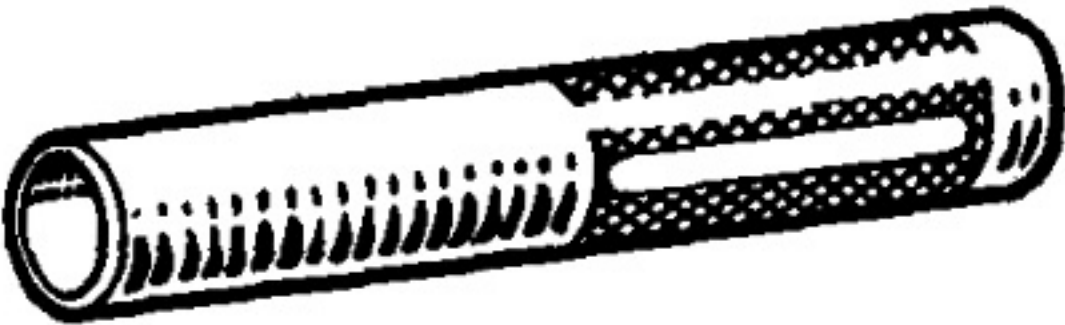
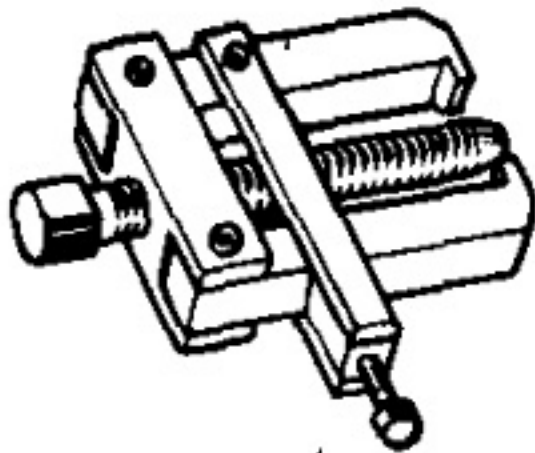
Injection Pump (Cont'd)

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

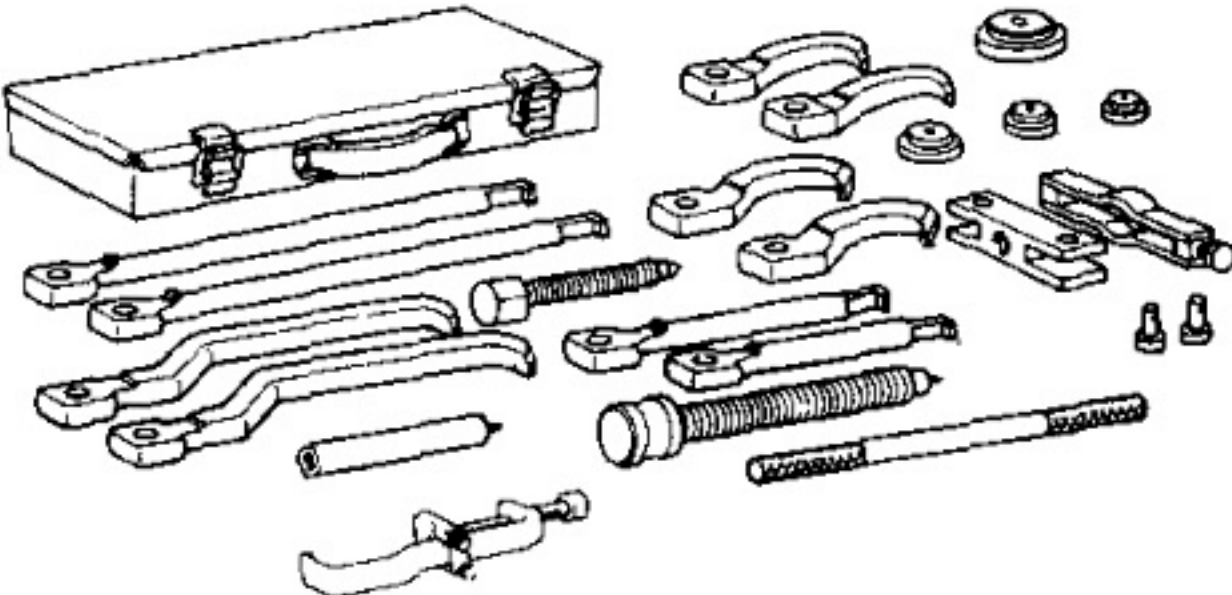
STARTING SYSTEM
Starter

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

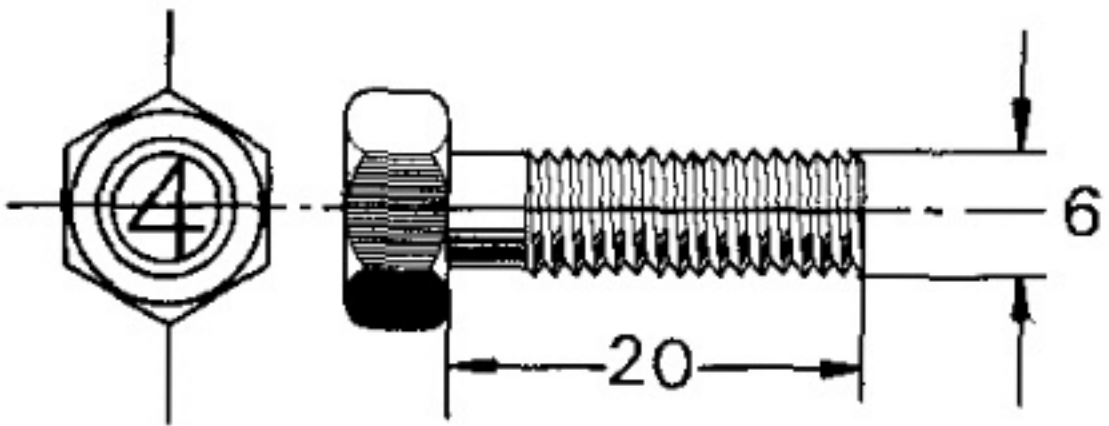
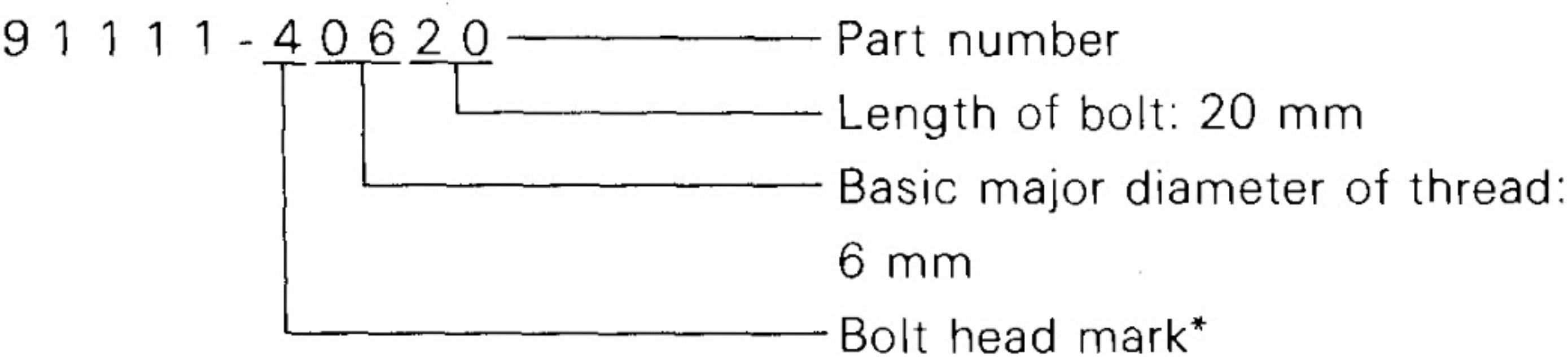
CHARGING SYSTEM
On-Vehicle Inspection

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
		HJ47	14.1 liters	14.9 US 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/cm ²	398 psi
		Limit	20.0 kg/cm ²	284 psi
Difference between each cylinder			Less than 2.0 kg/cm ² (28 psi)	
Injection nozzle opening pressure				
		New nozzle	115 — 125 kg/cm ²	1,636 — 1,778 psi
		Reused nozzle	105 — 125 kg/cm ²	1,493 — 1,778 psi

ENGINE**Cylinder head**

Surface warpage	Limit	0.2 mm	0.008 in.
Manifold mounting surface warpage	Limit	0.2 mm	0.008 in.
Valve seat			
Contacting surface angle		45°	
Contacting width		1.4 — 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.
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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 Oil		0.20 — 0.47 mm	0.0079 — 0.0185 in.
			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.
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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/cm ²	10.7 – 14.9 psi
	Limit	0.6 kg/cm ²	8.5 psi

Water Pump

Bearing installing temperature	80°C	176°F
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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/cm ² 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/cm ²	1,636 – 1,778 psi
	Reused Nozzle	105 – 125 kg/cm ²	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 ($\leq 0.5^\circ$)
	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

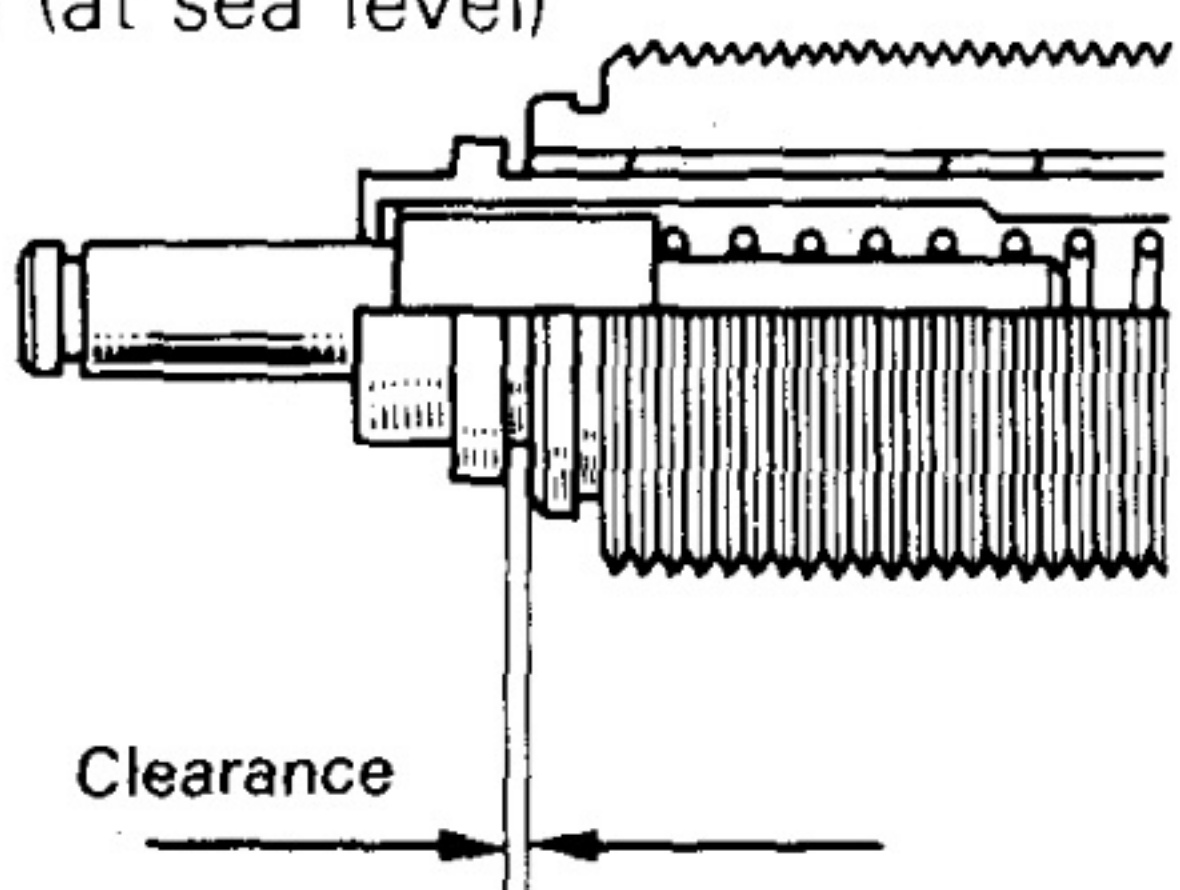
Injection Pump (Cont'd)

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.
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INJECTION PUMP ADJUSTMENT & TEST**Preparations of Pump Tester**

Nozzle type	ND-DN4 SD24	
Nozzle opening pressure	115 – 125 kg/cm ²	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/cm ²	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	1.9 – 2.0 mm		0.075 – 0.079 in.
Control rack position at 11.0 mm (0.433 in.)	60° ± 30'		
Injection interval	More than 0.2 mm (0.008 in.)		
Tappet clearance			

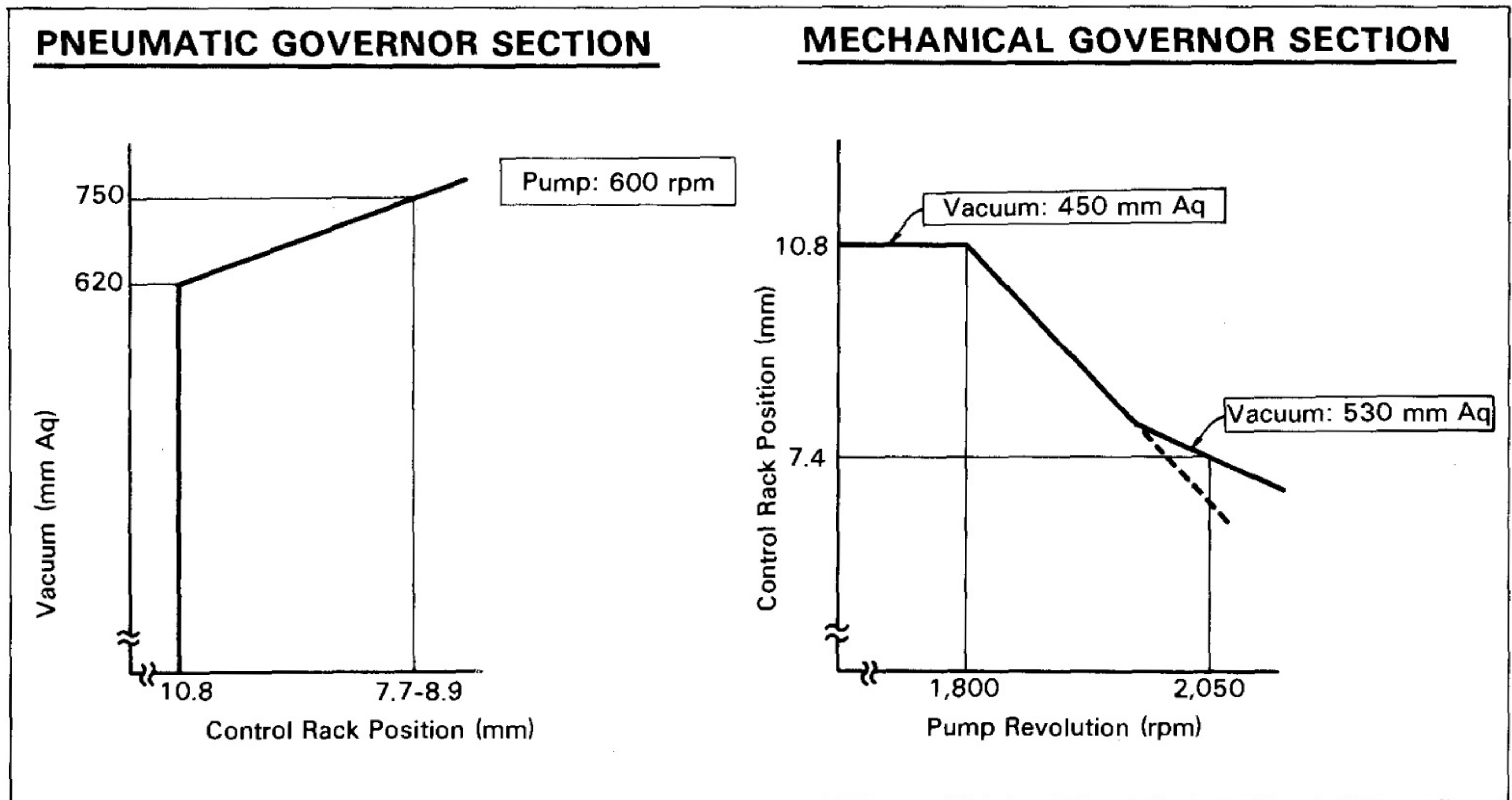
Injection Volume Adjustment

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



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°	
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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°	
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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 – 3.0 Ω	19.0 Ω
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